Building a bridge between the May and the September Reference Cases for the South African resource and related matters

Rebecca Rademeyer and Doug Butterworth
October 2016

Summary

An investigation of the reasons for the changes in particularly *M. paradoxus* assessment results from the May to the September Reference Case (RC) assessments shows these to be almost entirely a consequence of the changed formulations for selectivities, with updating of and further years' data having little impact. The probability of a TAC drop of greater than 5% under the current OMP is not high, and in terms of the September RC is not forecast to occur with more than 5% probability before the end of the decade.

Building a bridge

Rademeyer and Butterworth (2016a) presented results for an updated RC of the South African hake resource (from here onwards referred to as the "September RC"). The September RC included taking account of new/updated data as well as making some modifications to the survey selectivities compared to the May RC (Rademeyer and Butterworth, 2016b). Spawning biomass trends for *M. paradoxus* have changed appreciably between the May and September RC, and this paper attempts to build a bridge between the two, to understand the reason for these changes.

Initially four runs are compared:

1) Run 1: the May RC;
2) Run 2: New/updated catches, CPUE, survey indices and survey sex-aggregated CAL data with the new density weighting are included but the sex-disaggregated survey CAL data are kept as for the May RC;
3) Run 3: As Run 2 but now including updated sex-disaggregated survey CAL data (2015 and 2016 update; and density weighted method to compute the CAL); and
4) Run 4: Run 3 with different survey selectivities (the September RC).

Results and Discussion

Results for runs 1 to 4 are given in Table 1, with the spawning biomass trajectories plotted in Figure 1. The survey and commercial selectivities-at-length are compared in Figures 2 and 3 for Run 3 and the September RC (Run 4).

Comparisons of the results from these four runs make clear that the new/updated data, except to some extent the updated sex-disaggregated CAL data, have little impact on the differences between the May and September RC's. Clearly it is the change in the formulation of the selectivities that is the primary cause of the differences for *M. paradoxus* (in particular)..

From Figures 2 and 3, it is clear that the major changes in selectivities for *M. paradoxus* are:

a. West coast summer survey selectivities;
b. South coast spring and autumn survey selectivities; and
c. West coast offshore trawl selectivities.

Further runs have therefore been carried out to investigate the effect of these selectivity changes on the *M. paradoxus* results:

5) Run 5: September RC (Run 4) with West coast summer survey selectivities fixed to those estimated in Run 3;
6) Run 6: September RC (Run 4) with South coast spring and autumn survey selectivities fixed to those estimated in Run 3; and
7) Run 7: September RC (Run 4) with West coast offshore trawl selectivities fixed to those estimated in Run 3.

Results for runs 3 to 7 are given in Table 2, with the spawning biomass trajectories plotted in Figures 4 and 5. These suggest that the change for *M. paradoxus* results primarily from the changes to West coast summer survey and offshore trawl selectivities. The change to South coast survey selectivities has little impact on *M. paradoxus* but does have the largest impact on *M. capensis.*

Related matters

1. Run leaving out juvenile information from survey sex-disaggregated CAL data

In Run 8, the juvenile information from the sex-disaggregated CAL data are omitted in the model fitting procedure. Results are compared to the September RC in Table 3. This is to check a (legitimate) concern raised by Mike Bergh about the separate normalisation of these data – specifically whether it has any major impact on results.

Results are relatively insensitive to this change, which suggests that there need be no concern that this has comprised results presented previously to any major extent. This aspect will however be corrected for subsequent computations.

2. TAC projections under OMP-2014

In response to a question asked at an earlier DWG meeting, Figure 6 plots the projected annual TAC change under OMP-2014 and the corresponding proportion of these annual TAC decreases which are greater than 5%. These projections are computed for the September RC.

The probability of a TAC drop of greater than 5% is not high, and in terms of this RC is not forecast to occur with more than 5% probability before the end of the decade.

3. Data tables correction

Data in Table App.A.6 of Rademeyer and Butterworth (2016a) are incorrect; the correct version is included at the end of the paper for reference.

REFERENCES

Rademeyer RA and Butterworth DS. 2016a. A further update of the Reference Case assessment and related projections for the South African hake resource. FISHERIES/2016/SEPT/SWG-DEM/.

Rademeyer RA and Butterworth DS. 2016b. An update of the Reference Case assessment and related projections for the South African hake resource. FISHERIES/2016/MAY/SWG-DEM/11.

Table 1: Estimates of management quantities for runs 1 to 4.

		Run 1	Run 2	Run 3	Run 4
New/updated data included:		May RC	a.-d. data updated, survey sex-dis. CAL as May RC	All new/updated data	September RC (changed selectivities)
a. Catches			✓	✓	✓
b. CPUE			✓	✓	✓
c. Survey indices			✓	✓	✓
d. Surv. sex-aggr. CAL, with density weighting			✓	✓	✓
e. Surv. sex-dis. CAL, with density weighting				✓	✓
	-lnL total	-223.0	-206.3	-215.1	-220.5
M. paradoxus	K^{sp}	964	963	1011	604
	B^{sp}_{MSY}	169	167	176	166
	B^{sp}_{2016}	158	152	176	129
	B^{sp}_{2016}/K^{sp}	0.16	0.16	0.17	0.21
	$B^{sp}_{2016}/B^{sp}_{MSY}$	0.93	0.91	1.00	0.78
	MSY	116	116	121	117
M. capensis	K^{sp}	221	222	228	234
	B^{sp}_{MSY}	67	66	72	95
	B^{sp}_{2016}	163	158	152	164
	B^{sp}_{2016}/K^{sp}	0.74	0.71	0.67	0.70
	$B^{sp}_{2016}/B^{sp}_{MSY}$	2.43	2.40	2.11	1.73
	MSY	62	64	63	65

Table 2: Estimates of management quantities for runs 3 to 7. Runs 5-7 replicate Run 4, but fix the selectivity for either survey or the commercial fishery for *M. paradoxus* to that estimated earlier for Run 3.

		Run 3 All new/updated data	Run 4 September RC	Run5 Fix paradoxus WC summer survey sel.	Run 6 Fix paradoxus SC spring and autumn survey sel.	Run 7 Fix paradoxus WC offshore trawl sel.
	-lnL total	-215.1	-221.5	-220.2	-210.2	-220.0
M. paradoxus	K^{sp}	1011	604	674	615	803
	B^{sp}_{MSY}	176	166	193	168	176
	B^{sp}_{2016}	176	129	168	129	146
	B^{sp}_{2016}/K^{sp}	0.17	0.21	0.25	0.21	0.18
	$B^{sp}_{2016}/B^{sp}_{MSY}$	1.00	0.78	0.87	0.77	0.83
	MSY	121	117	119	118	117
M. capensis	K^{sp}	228	234	234	284	232
	B^{sp}_{MSY}	72	95	94	119	94
	B^{sp}_{2016}	152	164	163	196	162
	B^{sp}_{2016}/K^{sp}	0.67	0.70	0.70	0.69	0.70
	$B^{sp}_{2016}/B^{sp}_{MSY}$	2.11	1.73	1.73	1.65	1.73
	MSY	63	65	65	64	65

Table 3: Estimates of management quantities for the September RC and Run 8 which replicates Run 8 except that it omits the juvenile survey CAL data from the model fitting.

		Run 4 September RC	Run 8 Omit the juveniles in the sex-dis. survey CAL data
	-lnL total	-221.5	-238.4
M. paradoxus	K^{sp}	604	601
	B^{sp}_{MSY}	166	166
	B^{sp}_{2016}	129	128
	B^{sp}_{2016}/K^{sp}	0.21	0.21
	$B^{sp}_{2016}/B^{sp}_{MSY}$	0.78	0.77
	MSY	117	117
M. capensis	K^{sp}	234	239
	B^{sp}_{MSY}	95	97
	B^{sp}_{2016}	164	168
	B^{sp}_{2016}/K^{sp}	0.70	0.70
	$B^{sp}_{2016}/B^{sp}_{MSY}$	1.73	1.73
	MSY	65	65

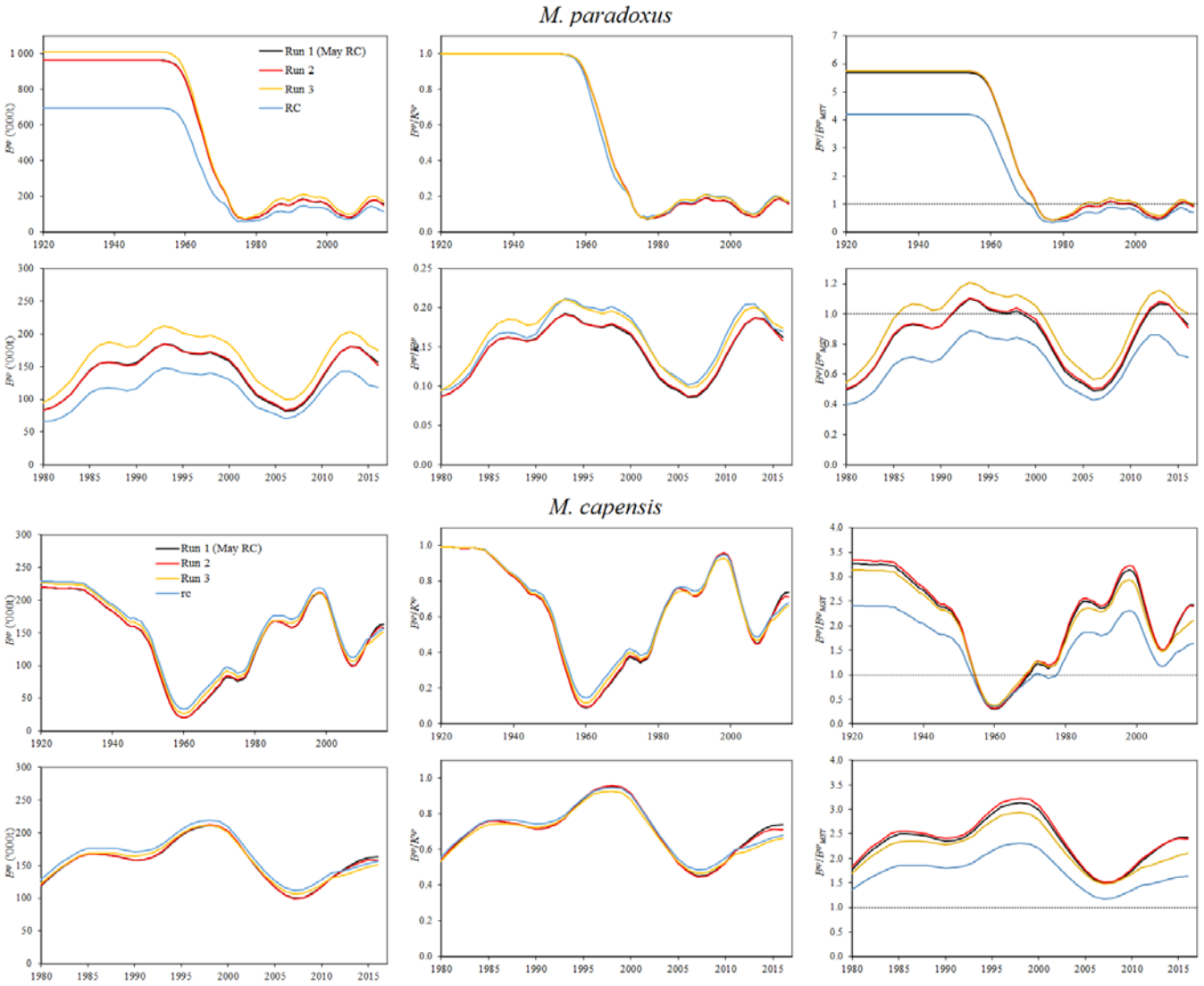

Figure 1: Spawning biomass trajectories (in absolute terms, and relative to pre-exploitation level and to B_{MSY}) for the Runs 1-4 (Run 4 being the September RC). For each species, the second row repeats the first row but with a different range of years.

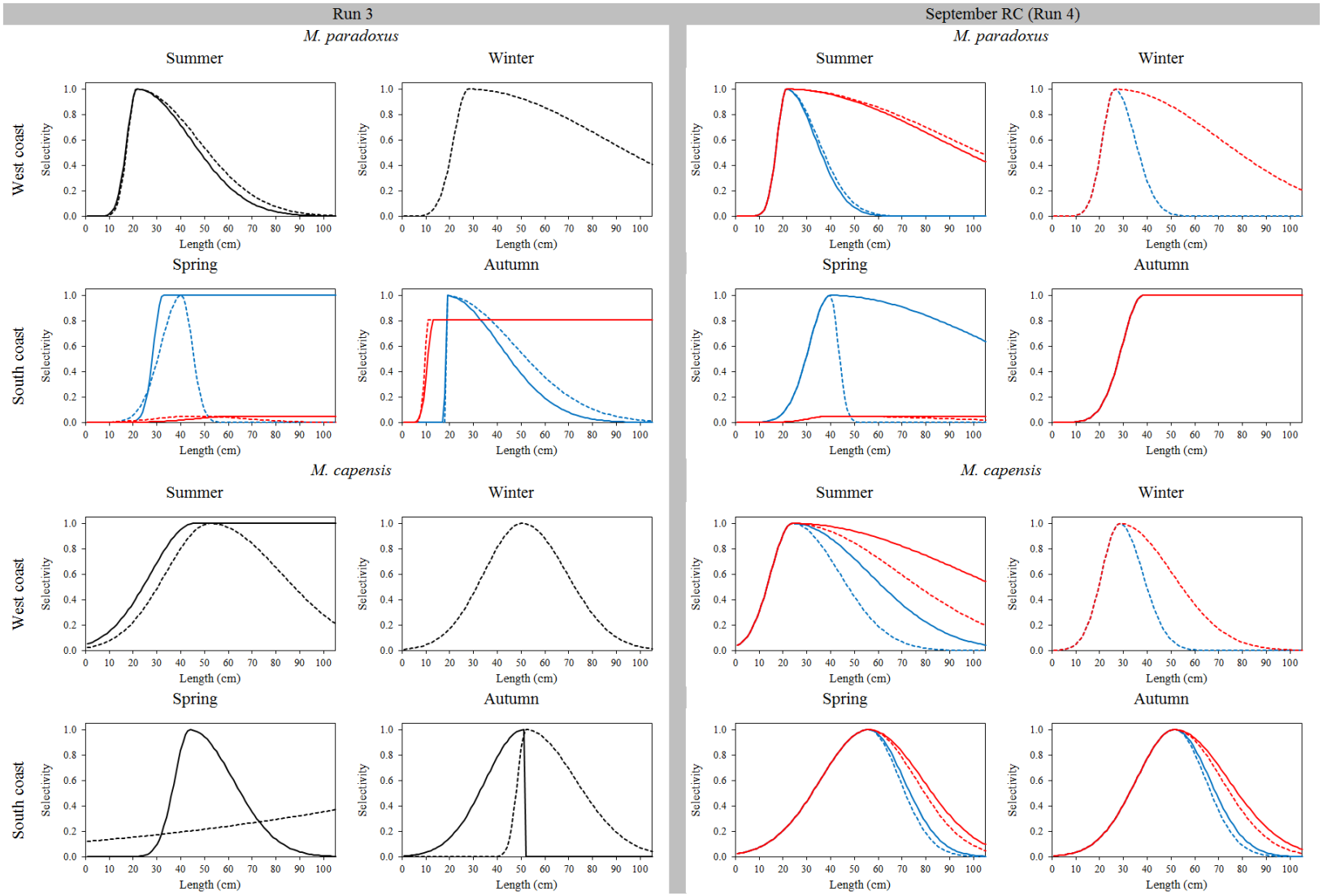

Figure 3: Survey selectivities-at-length for Run 3 and Run 4 (September RC). Black curves for sex-combined, blue curves for males, red curves for females, dashed curves for old gear and full curves for new gear.

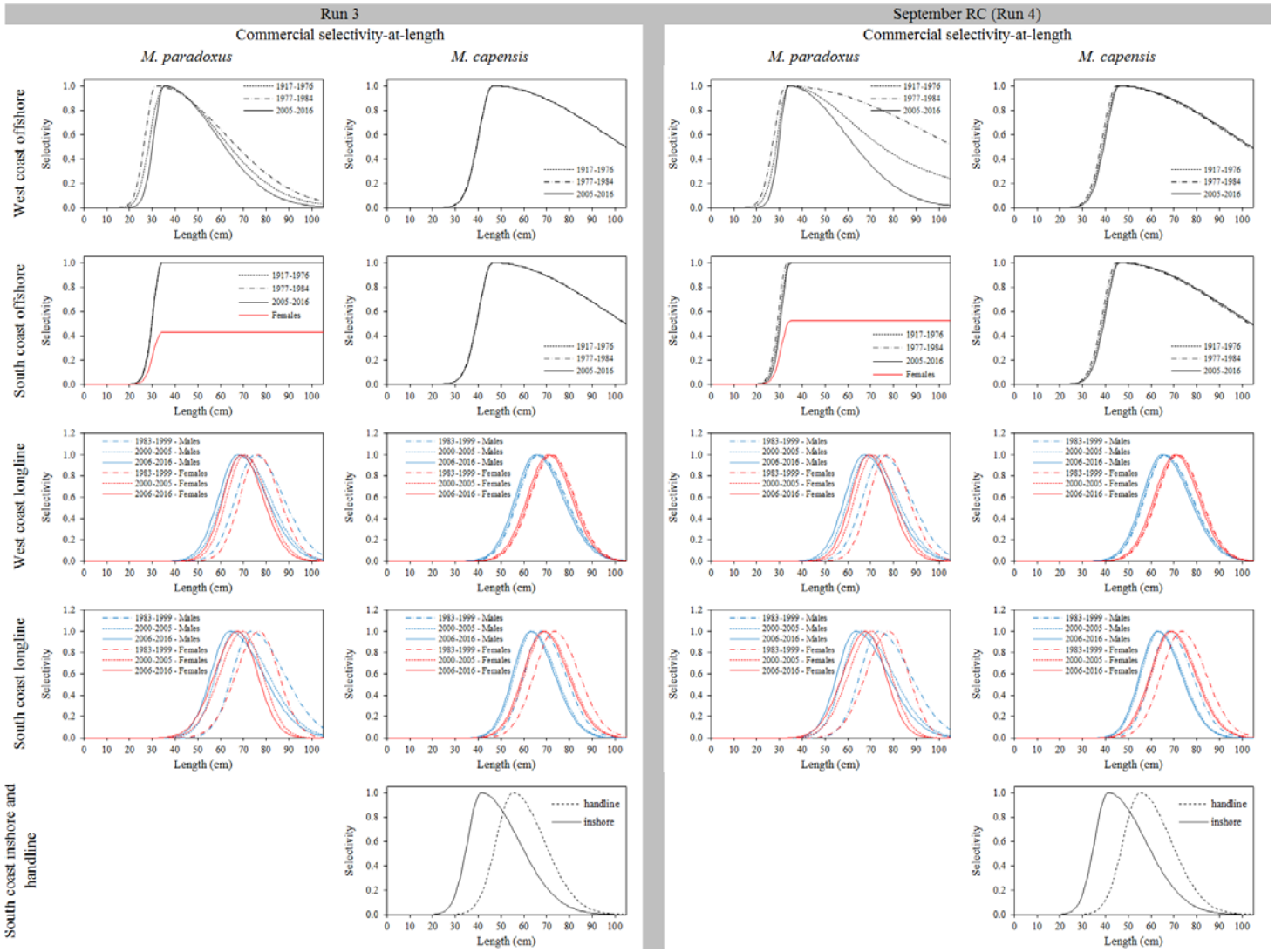

Figure 4: Commercial selectivities-at-length for the September RC (black curves for sex-aggregated, blue curves for males and red curves for females) for the May and September RCs.

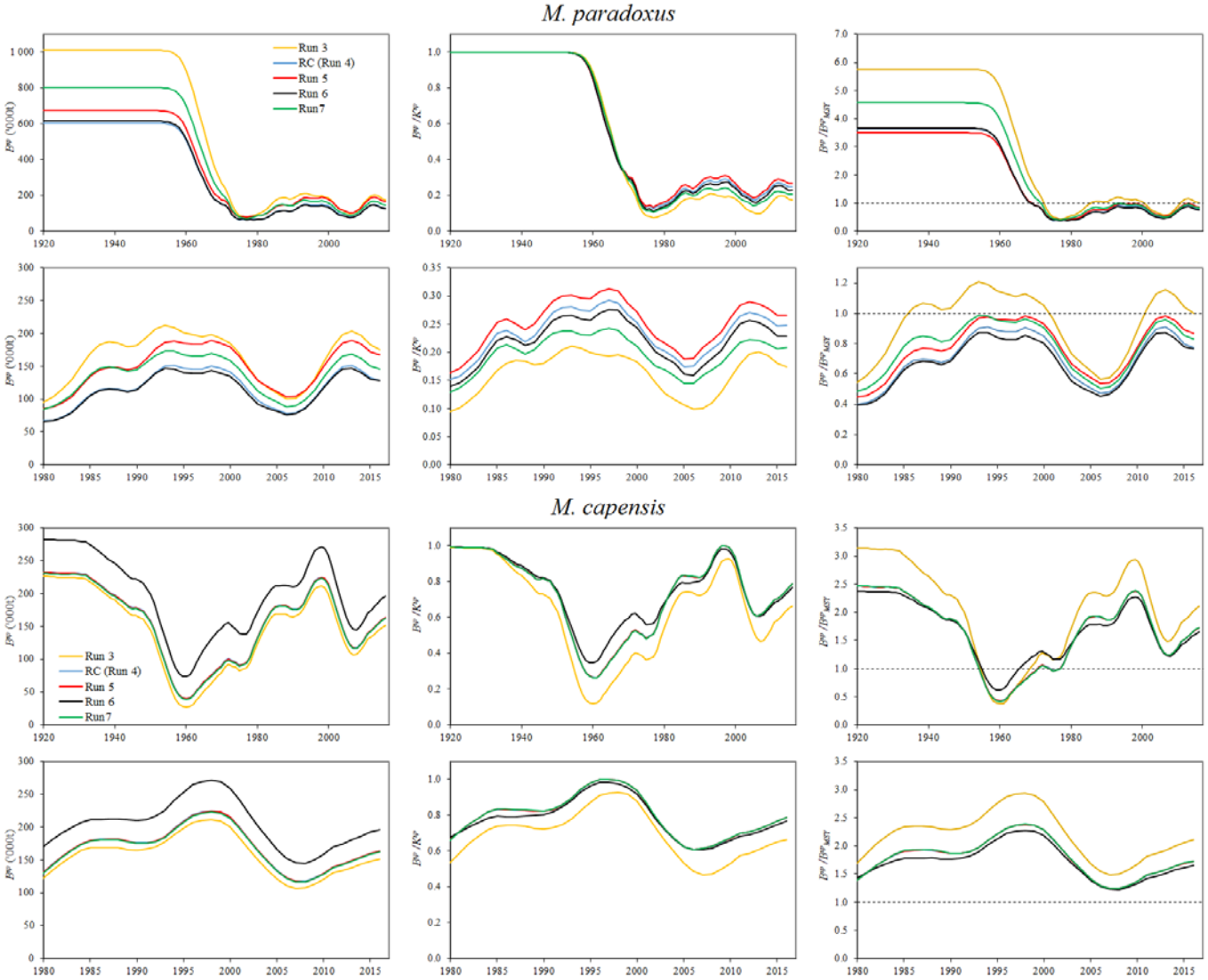

Figure 5: Spawning biomass trajectories (in absolute terms, and relative to pre-exploitation level and B_{MSY}) for run 3 (all new data and selectivity as for May RC), the September RC (run 4) and the three runs fixing different *M. paradoxus* selectivities for the September RC to those estimated in run 3: Run 5 – WC summer survey, Run 6 – SC spring and autumn surveys, and Run 7 - WC offshore trawl. For each species, the second row repeats the first row but with a different range of years.

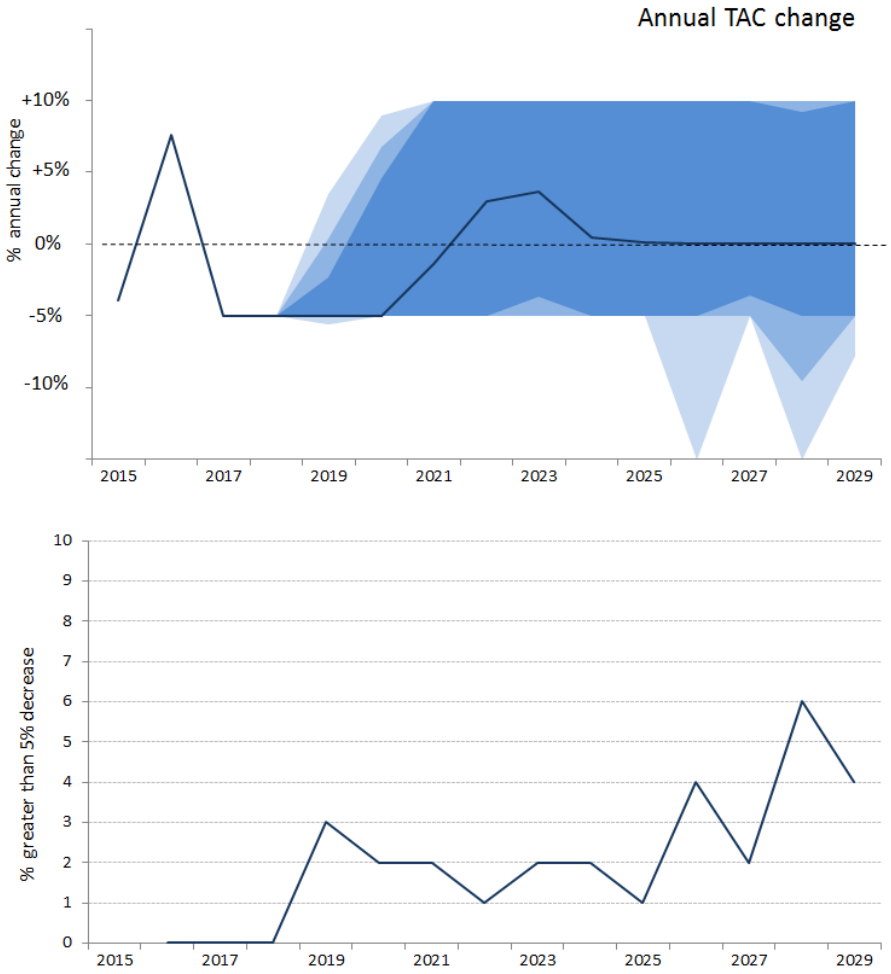

Figure 6: Projected percentage annual change in TAC under OMP-2014 (top plot) and proportion of annual decrease in TAC greater than 5%.

Table App.A.6a – corrected from Rademeyer and Butterworth (2006a): *M. paradoxus*, sex-aggregated, survey catch-at-length data (Fairweather, pers. commn).

West coast summer survey, *M. paradoxus*

Year	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	81+
1985	0.000	0.000	0.000	0.000	0.000	0.004	0.024	0.068	0.105	0.125	0.145	0.130	0.105	0.075	0.083	0.051	0.023	0.013	0.010	0.008	0.005	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000
1986	0.000	0.000	0.000	0.001	0.004	0.009	0.013	0.025	0.045	0.058	0.091	0.097	0.152	0.170	0.126	0.068	0.045	0.024	0.029	0.017	0.008	0.005	0.004	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
1987	0.000	0.000	0.002	0.006	0.011	0.037	0.097	0.135	0.081	0.081	0.087	0.074	0.081	0.081	0.060	0.032	0.024	0.017	0.015	0.013	0.009	0.007	0.005	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.000
1988	0.000	0.000	0.000	0.007	0.022	0.049	0.096	0.127	0.099	0.077	0.103	0.107	0.122	0.075	0.032	0.022	0.010	0.012	0.010	0.006	0.006	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1990	0.000	0.000	0.000	0.004	0.034	0.081	0.053	0.038	0.034	0.047	0.097	0.115	0.134	0.131	0.081	0.060	0.028	0.019	0.015	0.006	0.006	0.003	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.001	0.000	0.000	0.003	0.035	0.153	0.183	0.103	0.083	0.084	0.069	0.067	0.052	0.028	0.019	0.017	0.013	0.012	0.009	0.007	0.008	0.004	0.004	0.004	0.003	0.005	0.004	0.004	0.005	0.006	0.004	0.005	0.002	0.003	0.001	0.001	0.001	0.000	0.001
1992	0.000	0.000	0.001	0.003	0.014	0.029	0.050	0.110	0.200	0.158	0.111	0.077	0.079	0.061	0.037	0.017	0.011	0.008	0.006	0.005	0.004	0.004	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.000	0.000	0.001	0.005	0.025	0.039	0.053	0.079	0.113	0.121	0.162	0.142	0.094	0.049	0.028	0.017	0.013	0.013	0.011	0.008	0.007	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.000	0.000	0.001	0.003	0.020	0.066	0.107	0.094	0.094	0.118	0.129	0.114	0.075	0.043	0.030	0.023	0.016	0.011	0.008	0.006	0.006	0.006	0.006	0.005	0.004	0.004	0.003	0.003	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.000	0.000	0.001	0.003	0.013	0.039	0.064	0.098	0.111	0.106	0.090	0.118	0.133	0.094	0.057	0.026	0.014	0.009	0.005	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.000	0.002	0.022	0.055	0.074	0.090	0.059	0.060	0.090	0.107	0.096	0.081	0.061	0.042	0.033	0.021	0.019	0.015	0.012	0.010	0.010	0.008	0.006	0.005	0.004	0.003	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000

West coast winter survey, *M. paradoxus*

1985	0.000	0.000	0.000	0.005	0.008	0.013	0.026	0.040	0.045	0.121	0.202	0.147	0.100	0.076	0.061	0.039	0.034	0.025	0.015	0.011	0.007	0.006	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
1986	0.000	0.000	0.002	0.004	0.009	0.024	0.037	0.036	0.047	0.095	0.161	0.154	0.097	0.113	0.092	0.060	0.027	0.014	0.007	0.005	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1987	0.000	0.000	0.000	0.001	0.003	0.011	0.045	0.056	0.103	0.208	0.203	0.142	0.072	0.047	0.032	0.023	0.018	0.010	0.008	0.005	0.004	0.003	0.002	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1988	0.000	0.001	0.004	0.005	0.018	0.049	0.106	0.123	0.122	0.157	0.098	0.099	0.063	0.029	0.015	0.012	0.010	0.005	0.003	0.002	0.002	0.002	0.001	0.001	0.002	0.003	0.008	0.012	0.014	0.010	0.010	0.007	0.003	0.003	0.001	0.000	0.000	0.000	0.001
1989	0.000	0.001	0.006	0.011	0.012	0.023	0.070	0.086	0.063	0.084	0.119	0.137	0.137	0.088	0.034	0.023	0.016	0.017	0.016	0.015	0.011	0.008	0.004	0.004	0.002	0.002	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.000	0.000	0.000
1990	0.000	0.000	0.001	0.005	0.031	0.035	0.025	0.071	0.124	0.137	0.096	0.089	0.107	0.102	0.081	0.045	0.022	0.014	0.005	0.003	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

South coast spring survey, *M. paradoxus*

1986	0.000	0.000	0.000	0.002	0.020	0.067	0.039	0.054	0.045	0.137	0.239	0.095	0.032	0.062	0.074	0.051	0.036	0.022	0.010	0.007	0.002	0.002	0.002	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1987	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.009	0.088	0.239	0.257	0.134	0.058	0.038	0.017	0.029	0.039	0.027	0.025	0.005	0.006	0.008	0.004	0.004	0.004	0.003	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.016	0.055	0.110	0.173	0.187	0.162	0.102	0.061	0.057	0.034	0.018	0.018	0.004	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.001	0.000	0.002	0.055	0.276	0.310	0.110	0.165	0.047	0.020	0.001	0.002	0.002	0.004	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.030	0.055	0.098	0.137	0.154	0.134	0.060	0.024	0.011	0.007	0.005	0.011	0.022	0.032	0.044	0.048	0.045	0.028	0.020	0.012	0.006	0.003	0.003	0.004	0.002	0.001	0.000	0.000

South coast autumn survey, *M. paradoxus*

1988	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.006	0.012	0.022	0.010	0.012	0.029	0.129	0.160	0.164	0.121	0.107	0.067	0.042	0.041	0.026	0.018	0.009	0.006	0.007	0.004	0.002	0.002	0.002	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.000	0.000	0.000	0.000	0.000	0.038	0.013	0.000	0.000	0.013	0.013	0.038	0.122	0.084	0.204	0.206	0.178	0.053	0.013	0.013	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.007	0.038	0.141	0.306	0.199	0.083	0.070	0.040	0.037	0.013	0.012	0.003	0.004	0.004	0.001	0.007	0.002	0.010	0.002	0.004	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.001
2003	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.028	0.139	0.214	0.184	0.153	0.112	0.075	0.036	0.021	0.013	0.006	0.004	0.003	0.001	0.002	0.002	0.002	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.022	0.105	0.222	0.237	0.149	0.090	0.039	0.019	0.012	0.010	0.010	0.007	0.010	0.012	0.015	0.014	0.011	0.007	0.004	0.002	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.015	0.039	0.090	0.139	0.127	0.126	0.093	0.083	0.069	0.056	0.048	0.029	0.019	0.019	0.015	0.010	0.005	0.004	0.002	0.003	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.000

Table App.A.6b – corrected from Rademeyer and Butterworth (2006a): *M. capensis*, sex-aggregated, survey catch-at-length data (Fairweather, pers. commn).

West coast summer survey, *M. capensis*

Year	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	81+
1985	0.000	0.000	0.000	0.000	0.000	0.001	0.029	0.262	0.466	0.147	0.036	0.014	0.008	0.006	0.004	0.004	0.004	0.003	0.003	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.000	0.000	0.000	0.000	0.001	0.005	0.040	0.193	0.270	0.165	0.073	0.040	0.031	0.026	0.024	0.021	0.018	0.018	0.016	0.012	0.008	0.006	0.005	0.004	0.004	0.003	0.004	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.000	0.000
1987	0.000	0.000	0.000	0.002	0.001	0.001	0.002	0.024	0.091	0.127	0.087	0.060	0.059	0.071	0.084	0.090	0.086	0.063	0.040	0.022	0.013	0.009	0.007	0.007	0.008	0.007	0.006	0.006	0.006	0.005	0.003	0.004	0.002	0.002	0.001	0.001	0.000	0.001	0.001
1988	0.000	0.000	0.000	0.002	0.001	0.004	0.033	0.128	0.195	0.072	0.036	0.047	0.037	0.031	0.031	0.036	0.043	0.047	0.047	0.039	0.025	0.028	0.024	0.025	0.021	0.011	0.011	0.006	0.004	0.003	0.003	0.002	0.002	0.002	0.001	0.001	0.000	0.000	0.001
1990	0.000	0.000	0.001	0.001	0.062	0.166	0.129	0.281	0.222	0.064	0.025	0.013	0.008	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.000	0.001	0.001	0.001	0.006	0.034	0.071	0.102	0.092	0.110	0.209	0.127	0.054	0.025	0.018	0.017	0.016	0.012	0.012	0.009	0.008	0.008	0.008	0.009	0.009	0.009	0.008	0.006	0.005	0.003	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.000	0.001
1992	0.000	0.000	0.002	0.016	0.046	0.039	0.034	0.036	0.036	0.075	0.177	0.180	0.127	0.064	0.034	0.019	0.015	0.015	0.013	0.012	0.011	0.009	0.007	0.005	0.005	0.005	0.004	0.004	0.003	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.000	0.035	0.372	0.202	0.142	0.107	0.033	0.011	0.006	0.003	0.006	0.010	0.012	0.010	0.007	0.004	0.002	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.000	0.001	0.003	0.023	0.052	0.096	0.092	0.196	0.226	0.091	0.051	0.041	0.021	0.013	0.008	0.008	0.006	0.005	0.005	0.006	0.006	0.006	0.005	0.006	0.006	0.006	0.006	0.005	0.003	0.002	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000
2004	0.002	0.001	0.011	0.035	0.125	0.124	0.091	0.075	0.062	0.069	0.084	0.073	0.050	0.033	0.022	0.013	0.009	0.006	0.005	0.004	0.004	0.005	0.007	0.008	0.009	0.010	0.010	0.010	0.012	0.009	0.008	0.004	0.003	0.003	0.002	0.001	0.001	0.000	0.000
2005	0.000	0.000	0.008	0.008	0.011	0.038	0.098	0.134	0.286	0.234	0.099	0.036	0.016	0.008	0.005	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

West coast winter survey, *M. capensis*

1985	0.000	0.000	0.001	0.010	0.021	0.022	0.049	0.032	0.028	0.135	0.325	0.202	0.073	0.034	0.019	0.012	0.007	0.005	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.000	0.000	0.001	0.006	0.010	0.010	0.013	0.025	0.040	0.093	0.122	0.142	0.162	0.136	0.102	0.051	0.016	0.008	0.009	0.009	0.007	0.008	0.007	0.006	0.004	0.002	0.002	0.002	0.002	0.002	0.003	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
1987	0.000	0.000	0.000	0.005	0.012	0.006	0.003	0.008	0.027	0.030	0.041	0.050	0.104	0.150	0.116	0.076	0.042	0.040	0.045	0.052	0.056	0.046	0.031	0.019	0.009	0.006	0.006	0.004	0.003	0.003	0.003	0.001	0.002	0.002	0.001	0.000	0.000	0.000	0.000
1988	0.000	0.002	0.019	0.072	0.330	0.182	0.041	0.033	0.035	0.023	0.018	0.024	0.036	0.034	0.032	0.023	0.017	0.014	0.010	0.007	0.005	0.006	0.006	0.004	0.005	0.004	0.006	0.005	0.003	0.002	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
1989	0.000	0.000	0.002	0.012	0.025	0.013	0.011	0.057	0.173	0.236	0.179	0.078	0.040	0.022	0.011	0.007	0.008	0.009	0.015	0.014	0.014	0.014	0.012	0.008	0.008	0.008	0.007	0.004	0.005	0.003	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
1990	0.000	0.000	0.000	0.000	0.002	0.007	0.015	0.124	0.298	0.297	0.158	0.044	0.013	0.009	0.005	0.006	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

South coast spring survey, *M. capensis*

1986	0.000	0.001	0.001	0.009	0.073	0.154	0.127	0.036	0.015	0.009	0.010	0.019	0.028	0.034	0.032	0.033	0.034	0.032	0.026	0.025	0.020	0.020	0.023	0.025	0.027	0.028	0.024	0.023	0.019	0.017	0.013	0.014	0.012	0.011	0.010	0.005	0.003	0.002	0.001
1987	0.000	0.000	0.004	0.034	0.091	0.058	0.030	0.026	0.025	0.021	0.020	0.022	0.034	0.040	0.039	0.036	0.040	0.053	0.050	0.042	0.034	0.032	0.033	0.031	0.030	0.026	0.024	0.021	0.019	0.016	0.012	0.013	0.010	0.007	0.006	0.005	0.003	0.003	0.002
2001	0.000	0.000	0.025	0.102	0.089	0.034	0.011	0.008	0.008	0.009	0.017	0.036	0.049	0.048	0.044	0.047	0.057	0.053	0.045	0.036	0.043	0.041	0.035	0.032	0.026	0.023	0.014	0.011	0.012	0.009	0.010	0.007	0.006	0.004	0.002	0.002	0.001	0.001	0.001
2003	0.000	0.001	0.007	0.031	0.076	0.119	0.111	0.056	0.040	0.032	0.025	0.029	0.032	0.031	0.029	0.031	0.033	0.034	0.035	0.031	0.027	0.026	0.027	0.028	0.024	0.019	0.014	0.012	0.010	0.008	0.006	0.006	0.003	0.003	0.002	0.001	0.001	0.001	0.000
2004	0.000	0.001	0.011	0.041	0.056	0.099	0.106	0.102	0.082	0.048	0.027	0.025	0.035	0.048	0.054	0.044	0.032	0.024	0.018	0.019	0.018	0.015	0.016	0.013	0.012	0.011	0.010	0.007	0.007	0.004	0.004	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.000

South coast autumn survey, *M. capensis*

1988	0.001	0.004	0.005	0.013	0.038	0.052	0.049	0.050	0.049	0.057	0.048	0.042	0.051	0.061	0.065	0.055	0.040	0.031	0.029	0.031	0.031	0.029	0.026	0.026	0.021	0.020	0.017	0.014	0.011	0.008	0.009	0.005	0.004	0.003	0.002	0.001	0.001	0.001	0.001
1992	0.000	0.000	0.002	0.011	0.036	0.087	0.096	0.051	0.033	0.032	0.029	0.031	0.034	0.048	0.057	0.055	0.040	0.032	0.027	0.029	0.039	0.044	0.040	0.032	0.026	0.022	0.017	0.013	0.009	0.008	0.005	0.004	0.004	0.002	0.002	0.001	0.001	0.001	0.000
2003	0.001	0.002	0.008	0.018	0.024	0.033	0.054	0.054	0.048	0.037	0.033	0.034	0.035	0.044	0.048	0.044	0.043	0.033	0.027	0.020	0.025	0.029	0.033	0.030	0.031	0.032	0.028	0.026	0.026	0.022	0.020	0.016	0.013	0.008	0.005	0.004	0.003	0.003	0.002
2004	0.000	0.001	0.008	0.010	0.019	0.039	0.051	0.054	0.054	0.056	0.046	0.040	0.037	0.043	0.051	0.063	0.056	0.039	0.035	0.035	0.037	0.033	0.031	0.027	0.025	0.019	0.018	0.015	0.011	0.011	0.009	0.006	0.005	0.003	0.004	0.002	0.001	0.001	0.001
2005	0.000	0.001	0.002	0.008	0.019	0.045	0.067	0.057	0.037	0.029	0.029	0.026	0.027	0.041	0.050	0.049	0.054	0.065	0.071	0.062	0.048	0.038	0.030	0.028	0.022	0.018	0.015	0.012	0.011	0.009	0.007	0.006	0.004	0.003	0.003	0.002	0.001	0.001	0.001