Development of a new Baseline Assessment for the South African Hake resource, Incorporating catch-at-length information

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INTRODUCTION

Results are presented for a proposed new baseline assessment for the South African hake resource, incorporating catch-at-length (CAL) information in the fit of the model. In years for which age-length keys are not available, CAL information is used instead of catches-at-age (CAA) which had been previously based on averages of age-length keys for other years (a problematic and potentially biased approach). Further changes to the model and the data that have been made are described below.

DATA and METHODOLOGY

The data used in the new proposed baseline, but not in the 2008 baseline (as described in Rademeyer and Butterworth, 2008) are listed in Appendix A.

Updates to the model from the 2008 baseline assessment:

I. Using Pope's approximation

To speed model fitting, Pope's approximation for the catch equations was used rather than Baranov's equation.

II. Incorporating catch-at-length information

Appendix B sets out how CAL information is taken into account in the model fitting.

III. Estimating west coast winter survey selectivity for *M. paradoxus*

In previous assessments, the selectivity-at-age for this survey and species was assumed to be the same as that for the west coast summer survey because no west coast winter survey CAA data for *M. paradoxus* were available. Some age and length data are now available for these west coast surveys so that a different selectivity is estimated for the two seasons for *M. paradoxus* (as is done for *M. capensis*).

IV. Fitting to commercial coast-specific information

Previously, the model fit was coast-specific only for the survey data, while GLM-standardized CPUE, commercial catches and CAA information were combined across the two coasts and a single selectivity-at-age vector (for each fleet) was assumed to apply. The model is now fit to coast-specific commercial information. This was carried out by treating the offshore trawl fleet on the south and west coasts as two different fleets, with potentially different selectivities-at-age, and similarly for the longline fleet. The model therefore now includes six fleets:

1) west coast offshore fleet (catching *M. paradoxus* and *M. capensis*);
2) south coast offshore fleet (catching *M. paradoxus* and *M. capensis*);
3) south coast inshore fleet (catching *M. capensis* only);

4) west coast longline fleet (catching *M. paradoxus* and *M. capensis*);
5) south coast longline fleet (catching *M. capensis* only); and
6) south coast handline fleet (catching *M. capensis* only).

The annual catches of each species assumed for each of these six fleets are shown in Table App.A.1, while the commercial age and length information is shown in Tables App.A.11-15. As age/length information is not available disaggregated by species and therefore not available for each species/fleet combination, fishing selectivity-at-age cannot be estimated directly for all fleets and some assumptions have to be made. Details of the fishing selectivities used in the assessment are shown in Table 1.

V. Different selectivity for the *Africana* surveys with new gear

A different selectivity is estimated for the *Africana* with new gear, for the west coast summer and south coast (spring and autumn) surveys. As for the other survey selectivities, the *Africana* new gear selectivity is estimated separately for each age, from age 0 to 5+/7+ for *M. paradoxus* and *M. capensis* respectively. However, because the information available is length-based and only 3 or 4 years of data are available, a smoothing penalty was added to the negative log-likelihood in the fitting process to prevent unrealistically large variations in selectivity from one age to the next:

$$\text{S\_penalty} = \sum_{a=1}^{z-1} 3\left(S_{a-1} - 2S_a + S_{a+1}\right)^2 \qquad (1)$$

The initial 3 multiplicative factor is a somewhat arbitrary weighting to ensure reasonable smoothness of the selectivity. For consistency, this smoothing penalty was also used for the old gear selectivity.

VI. Further three years of offshore commercial catch-at-length

Offshore trawl (species combined) CAL information has become available for 2005 to 2007 and has been taken into account in fitting the model. This is however only available combined across coasts, and is therefore compared to the predicted coast combined CAL, weighted by the actual catch on each coast.

RESULTS AND DISCUSSION

Table 2 compares estimates of management quantities for the 2008 baseline and the proposed new baseline assessment, while Fig. 1 plots the spawning biomass trajectories. For both *M. paradoxus* and *M. capensis*, the spawning biomass in absolute terms is estimated to be larger in the proposed new baseline assessment than in the 2008 baseline assessment. Relative to pre-exploitation levels however, spawning biomass is not much affected by the changes made.

Fig. 2 plots the estimated selectivities-at-age for the commercial fleets and the surveys. The new gear on the *Africana* is estimated to catch slightly smaller fish than the old gear, particularly for *M. capensis*.

Figs 3 and 4 show the fits the CPUE and survey abundance series. The fits to these data are generally good.

The fits to the commercial CAA and CAL data are show in Fig. 5. The fits are poor for certain CAL (West Coast Offshore, Both Coasts Offshore particularly, and the inshore *M. capensis* CAA). The likely reason for this is a conflict between the CAA and CAL information. For example, for the offshore trawl fleet (west coast and both coasts) the observed length distribution of the catch is very narrow compared to a relatively wide range of ages observed in the CAA.

As described in Appendix B, a selectivity-at-length effect had to be incorporated to allow for a reasonable fit of the survey CAL data. The effects on the estimated CAL distributions by age are shown in Fig. 6 for each species and survey. For both species, the effect is negligible for the south coast spring survey and greatest on the west coast surveys. The actual fits to the survey CAA and CAL are shown in Fig. 7. The fits are particularly poor for the *M. capensis* west coast summer CAL and south coast *M. paradoxus*, again likely due to a conflict between the CAA and CAL information. Note that the selectivity on the south coast is assumed to be the same for the spring and autumn surveys.

Fig. 8 plots the standardised stock-recruitment residuals and the estimated stock-recruitment relationships for *M. paradoxus* and *M. capensis*. Note that the "SR2" option is still used, with σ_R linearly decreasing from 0.25 to 0.1 over the 2004 to 2008 period.

The spawning biomass trajectories for two retrospective assessments are compared to those estimated in the proposed new baseline assessment (Fig. 9). For the retrospective analysis, the assessments are still run to 2008 but are fitted to data up to 2007 ("data to 2007") and 2006 ("data to 2006"). A small retrospective pattern is apparent for *M. capensis* but not for *M. paradoxus*. There is a slight upturn in spawning biomass for both species from 2006 to 2007, which is likely a reflection of better recruitment indicated for recent years compared to the low values from the mid-1990s to 2003 (see Fig. 8).

An interesting feature of the new baseline assessment is that the estimates of natural mortality at age (see Table 2) are lower, which seems more realistic biologically.

The proposed new baseline assessment will be used for the sensitivities analyses to be conducted in the light of discussions during the WG meetings. While this new baseline is not entirely satisfactory given the misfits to some of the catch-at-length data, this does seem to be arising primarily from data conflicts which alternative models will not resolve at this stage. Further resolution attempts seem better to wait for analyses that treat the age readings in a better statistical manner, perhaps also distinguishing the sexes with their different growth curves.

REFERENCES

Rademeyer RA and Butterworth DS. 2008. 2008 routine update of the South African hake baseline assessment. Unpublished report, Marine and Coastal Management, South Africa. MCM/2008/SEPT/SWG-DEM/48. (13pp)

Table 1: Details for the commercial selectivity-at-age for each fleet and species combination, as well as indications of what data are available, for the proposed new baseline assessment.

	M. paradoxus	*M. capensis*	data available
1. West coast offshore 1917-1976	set equal to 1989	set equal to 1989	
1977-1984	logistic, two parameters estimated slope estimated	same shift as paradoxus zero slope	species combined
1985-1992	linear change between 1984 and 1993 selectivity		species combined
1993-2008	logistic, two parameters estimated slope estimated	same as SC inshore but shifted to the right by 1 year, zero slope	species combined
2. South coast offshore 1917-1976	set equal to 1989	set equal to 1989	
1977-1984	same shift as west coast slope as 1993-2008	same shift as paradoxus zero slope	species combined
1985-1992	linear change between 1984 and 1993 selectivity		species combined
1993-2008	logistic, two parameters estimated slope estimated	same as SC inshore but shifted to the right by 1 year, zero slope	species combined
3. South coast inshore		logistic, two parameters estimated slope estimated	capensis
4. West coast longline	logistic, two parameters estimated zero slope	same as South coast longline	species combined
5. South coast longline		logistic, two parameters estimated zero slope	capensis
6. South coast handline		average of South coast longline and inshore	

Table 2: Comparison of management quantities for the 2008 baseline assessment (D) and the proposed new baseline assessment. Note that the negative log likelihoods shown are not comparable as they are based on different data sets. Note that the fitting criteria used includes a penalty to encourage $M_2 > M_5$.

			2008 baseline (D)	new baseline
	-lnL total		-192.1	-40.9
M. paradoxus	K^{sp}		1407	1821
	h		0.95	0.95
	MSY		116	114
	Bsp_{2008}/Ksp		216	265
	B^{sp}_{2008}/K^{sp}		0.15	0.15
	$B^{sp}_{2008}/MSYL^{sp}$		0.64	0.82
	$MSYL^{sp}$		0.24	0.18
	M	0	0.52	0.36
		1	0.52	0.36
		2	0.52	0.36
		3	0.44	0.35
		4	0.38	0.34
		5+	0.35	0.33
M. capensis	K^{sp}		692	871
	h		0.95	0.95
	MSY		81	86
	B^{sp}_{2008}		434	501
	B^{sp}_{2008}/K^{sp}		0.63	0.57
	$B^{sp}_{2008}/MSYL^{sp}$		2.01	2.31
	$MSYL^{sp}$		0.31	0.25
	M	0	1.00	0.40
		1	1.00	0.40
		2	1.00	0.40
		3	0.73	0.40
		4	0.57	0.41
		5	0.46	0.41
		6	0.46	0.41
		7+	0.46	0.41
	SC survey q		0.59	0.49
	2008 species ratio	B^{sp}	2.07	1.89
	(*paradoxus/capensis*)	B^{2+}	1.84	1.66

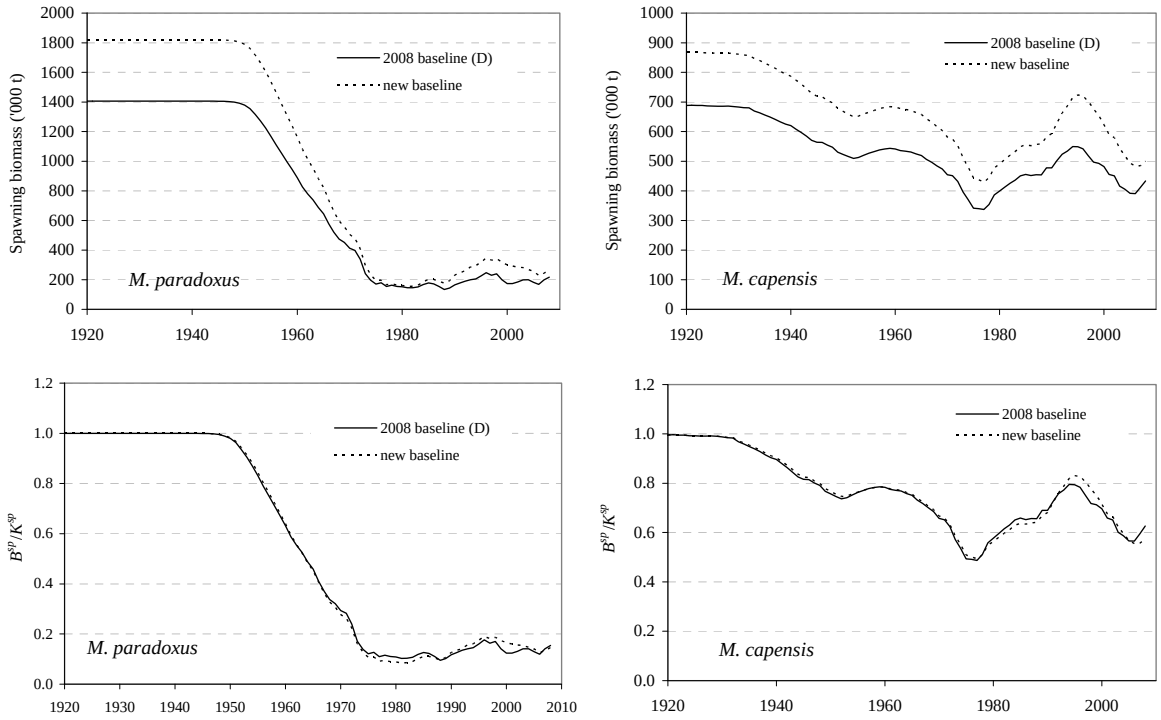

Fig. 1: *M. paradoxus* and *M. capensis* spawning biomass trajectories for the 2008 baseline and proposed new baseline assessments.

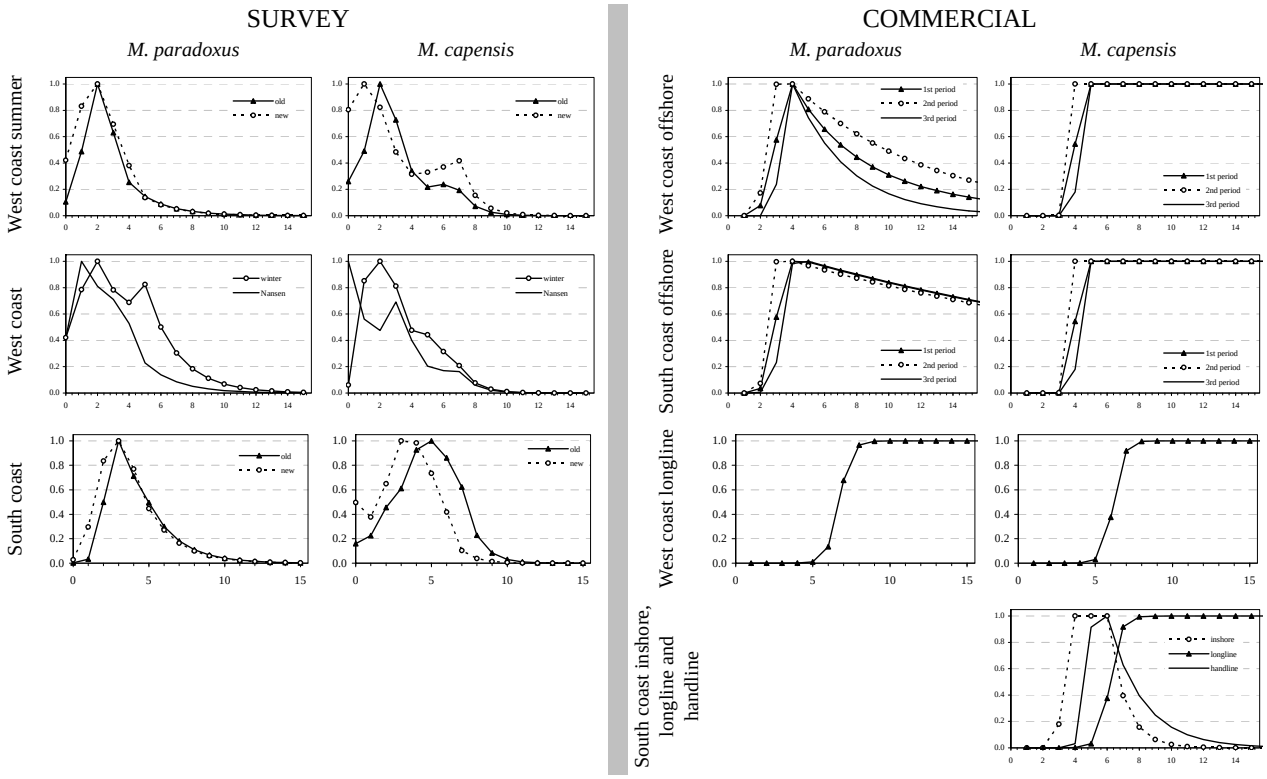

Fig. 2: Estimated survey and commercial fishing selectivities-at-age for the proposed new baseline assessment.

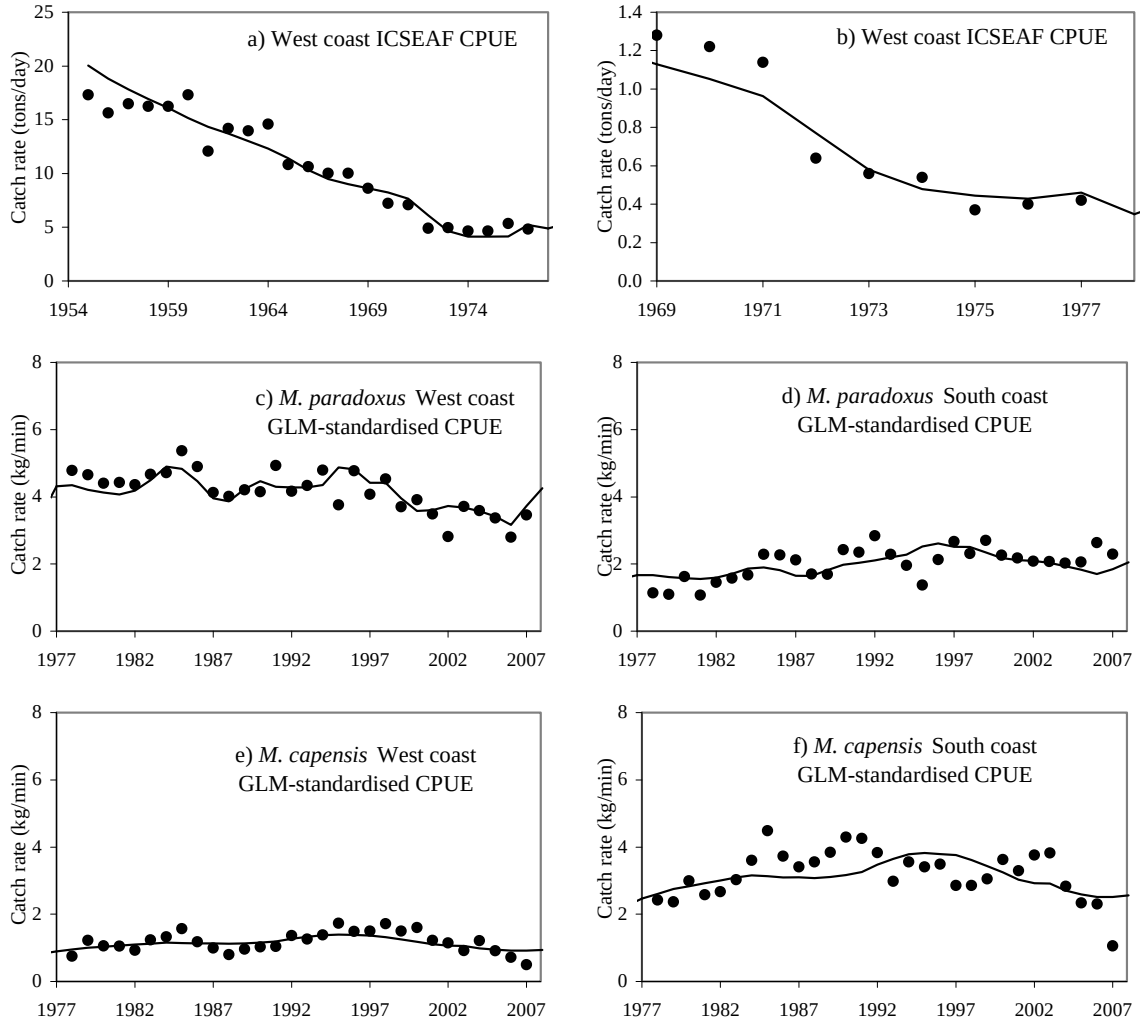

Fig. 3: Fits to the CPUE abundance indices for the proposed new baseline assessment. The historic (pre-1978) CPUE data are for both *M. capensis* and *M. paradoxus* combined.

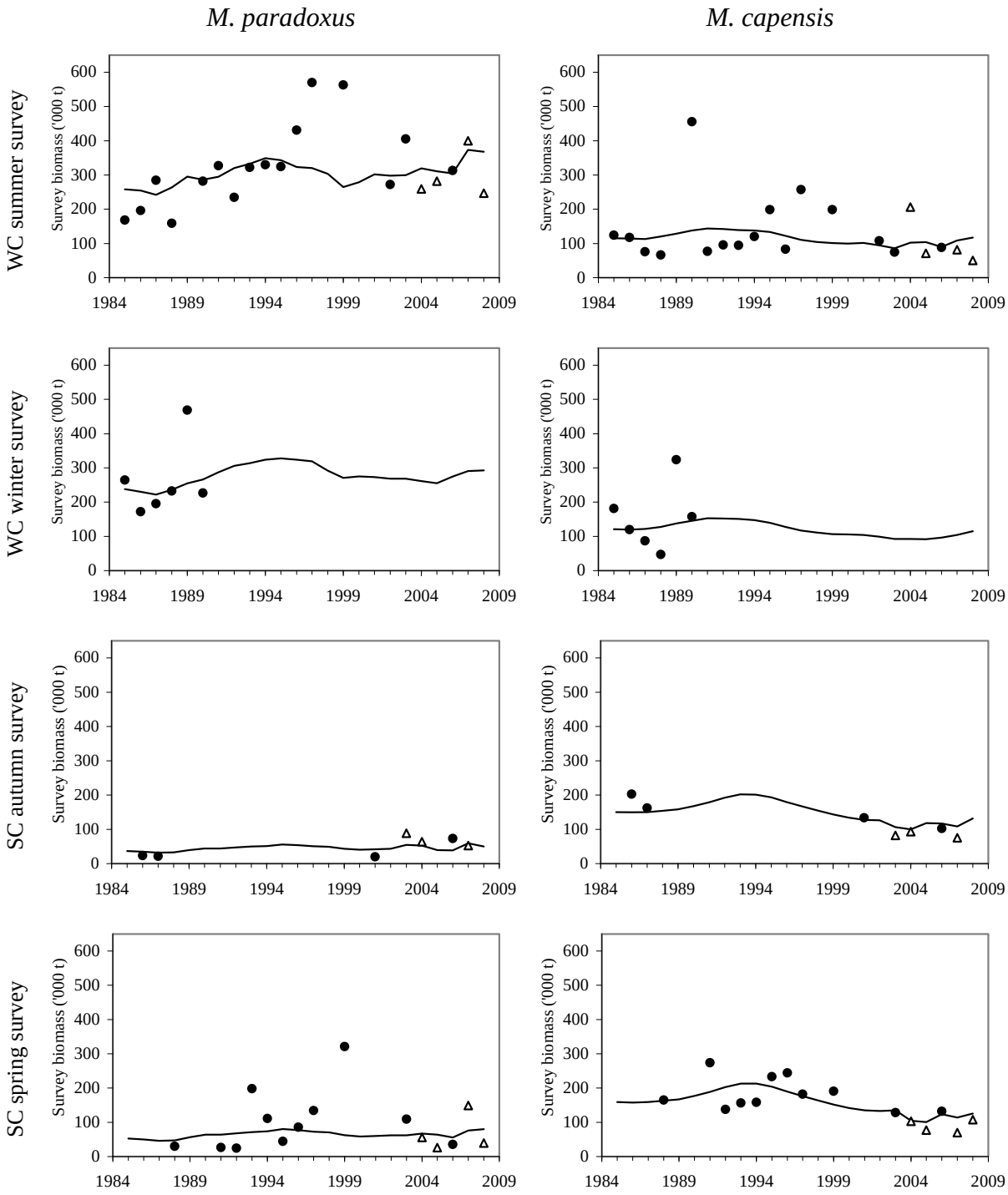

Fig. 4: Fits to the west coast summer and south coast autumn abundance series from surveys by *Africana* (the two longest series) for the proposed new baseline assessment. The observed values shown as Δ were conducted by the *Africana* with the new gear and have been rescaled by the agreed calibration factor for the species concerned (0.95 and 0.8 for *M. paradoxus* and *M. capensis* respectively). Note: the estimated survey biomass trends incorporate the change in selectivity between the old and new *Africana* gear.

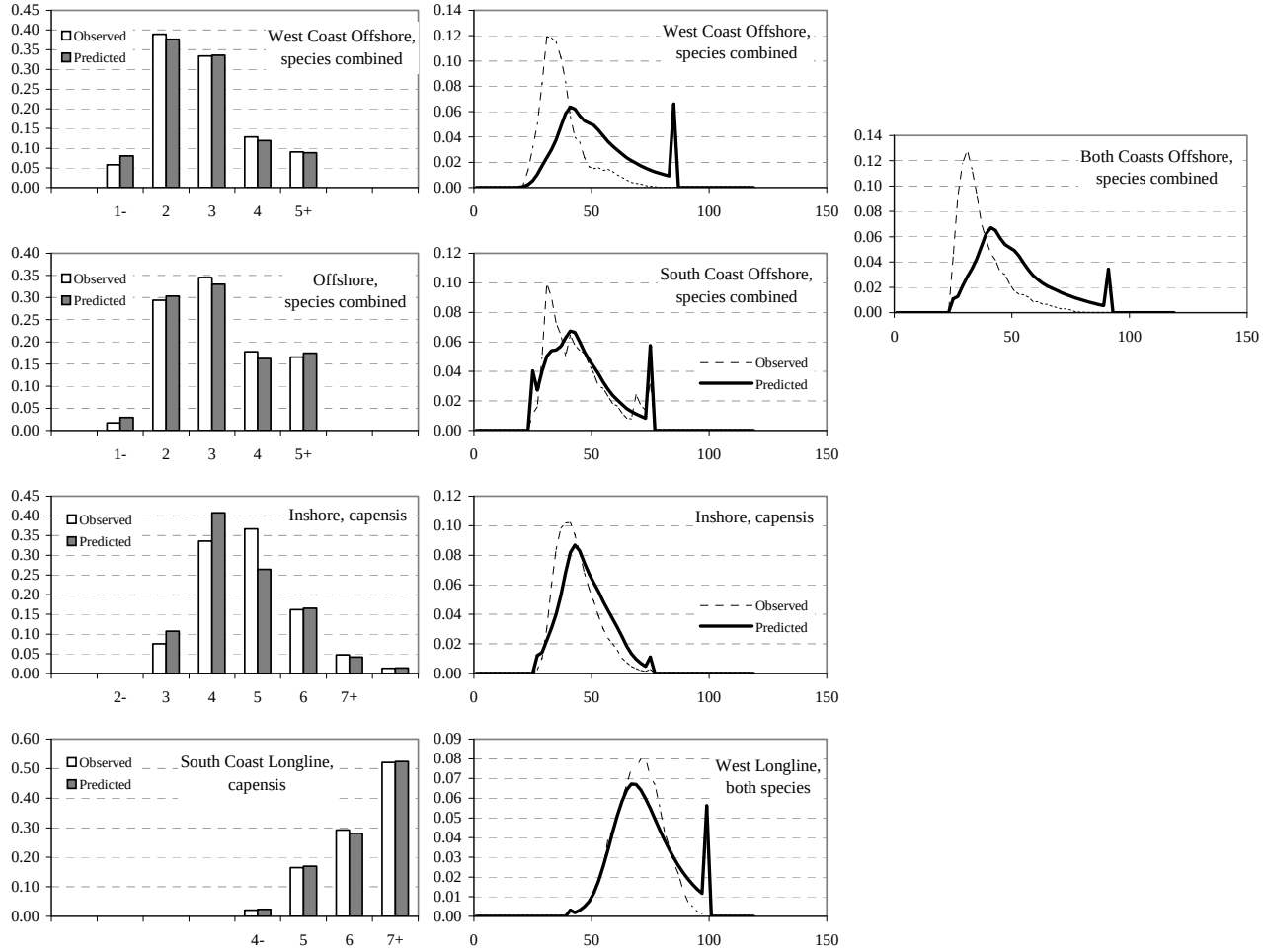

Fig. 5: Fit to the commercial CAA and CAL data for the proposed new baseline assessment.

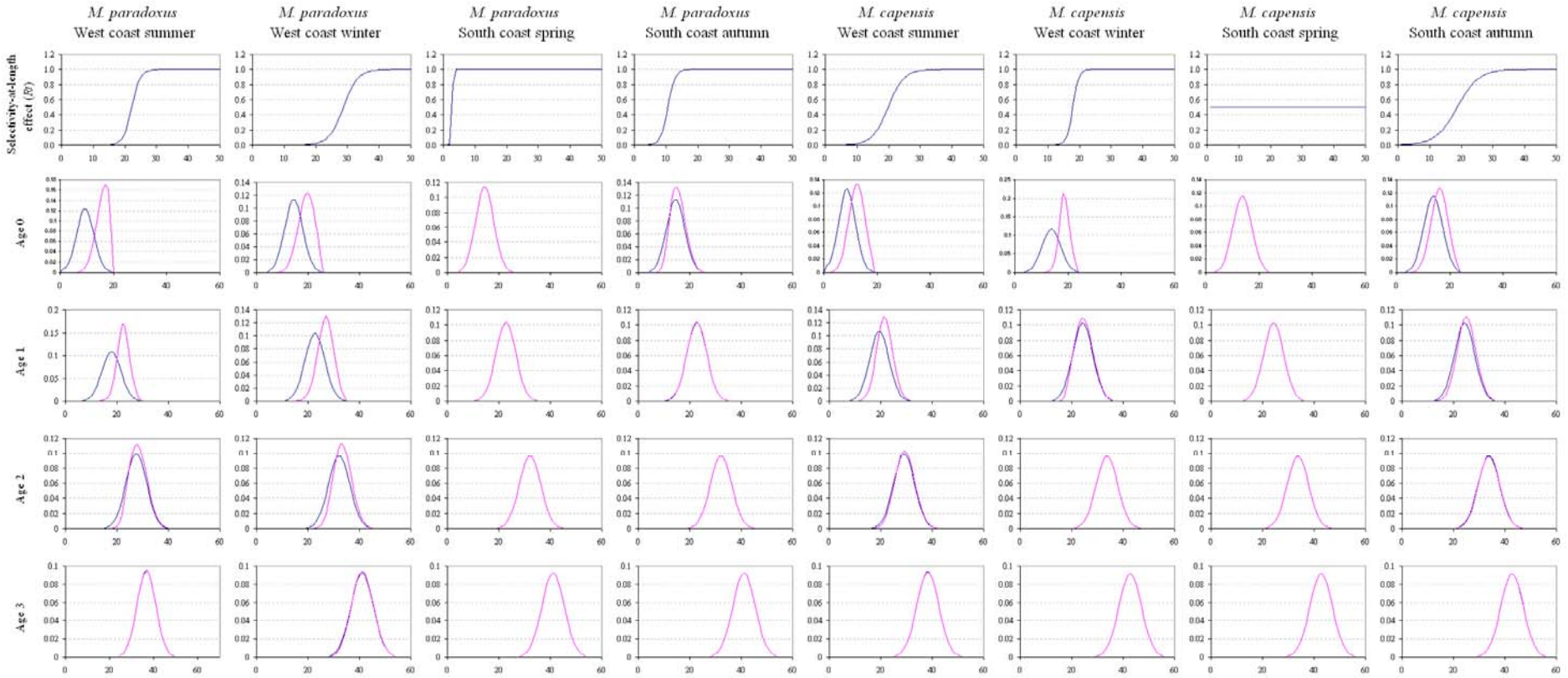

Fig 6: Survey selectivity-at-length effect in the proposed new baseline assessment (see Appendix B for details). The first row shows the R_l factor (see equation B.7), and the remaining rows show the consequent shifts in the catch-at-length distributions by age. The length units are cm.

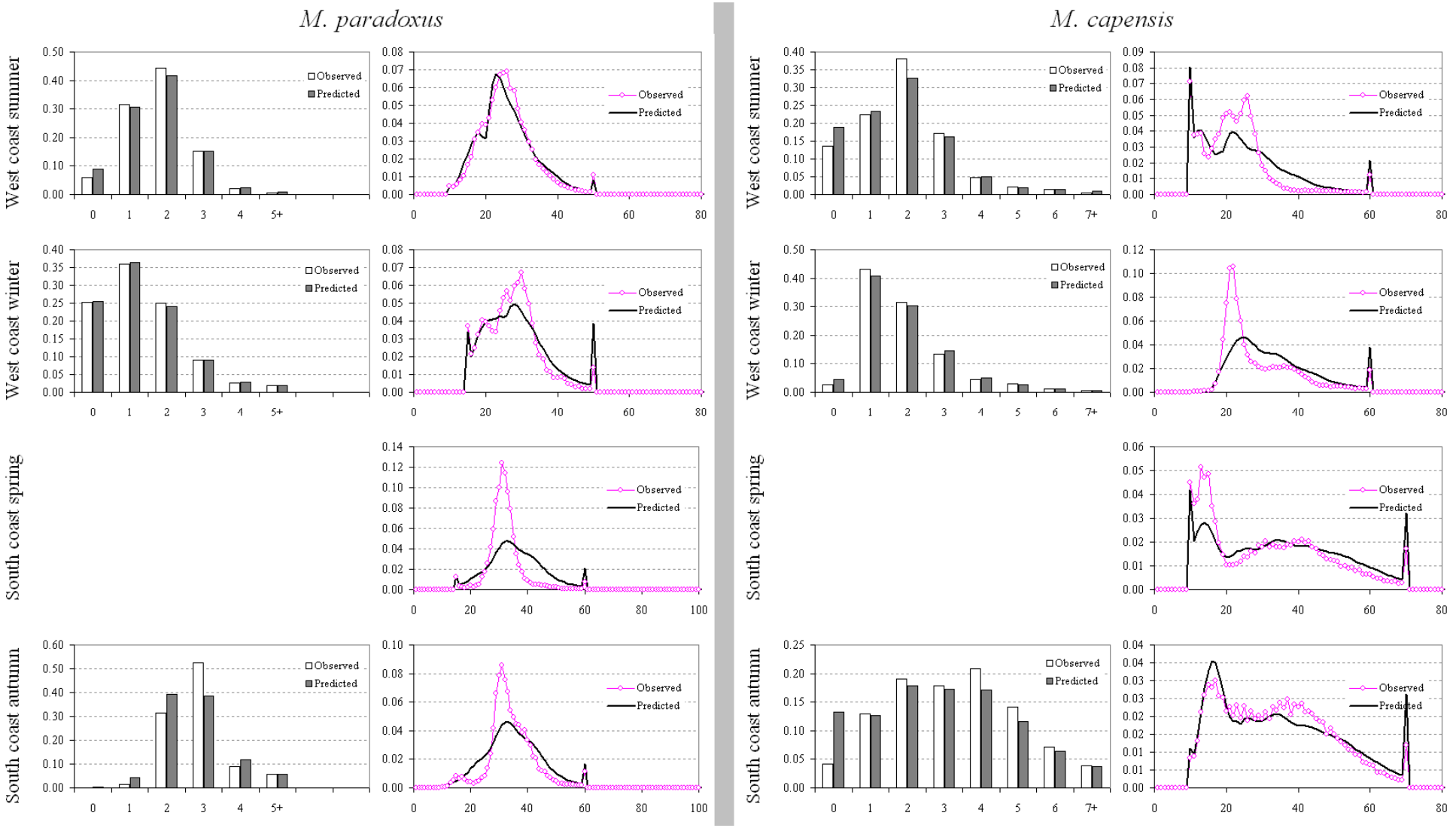

Fig. 7: Fit to survey CAA and CAL for *M. paradoxus* for the proposed new baseline assessment.

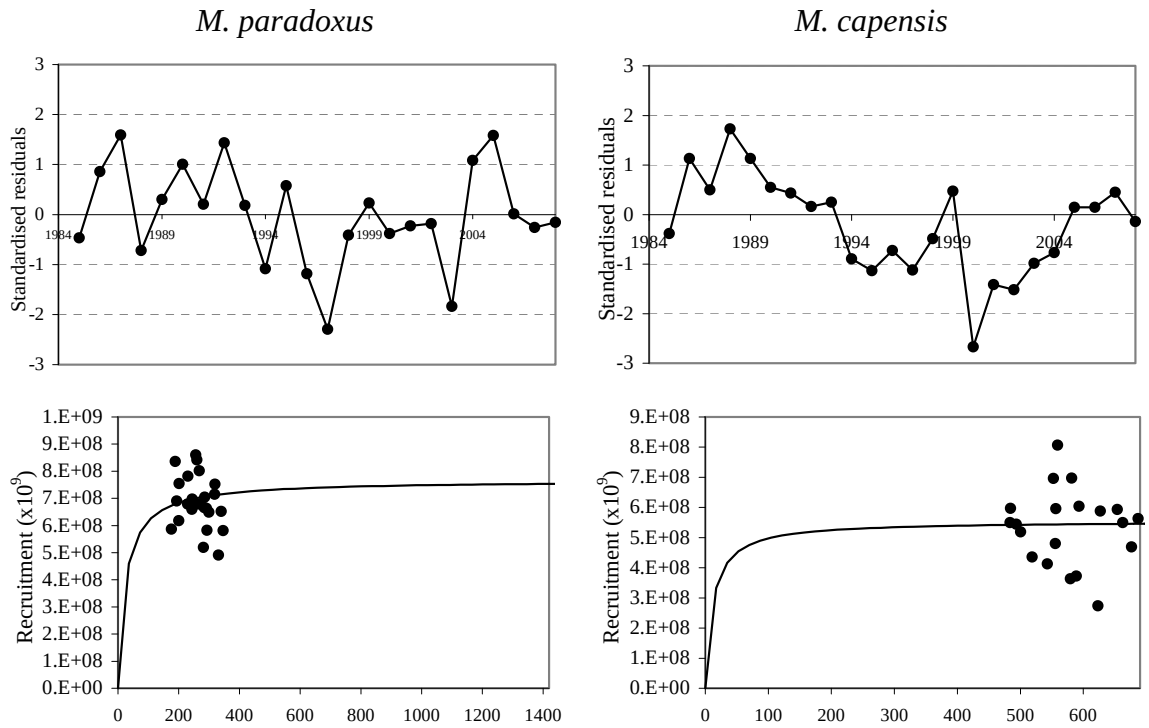

Fig. 8: Time series of standardised stock-recruitment residuals and estimated stock-recruitment relationships for the proposed new baseline assessment.

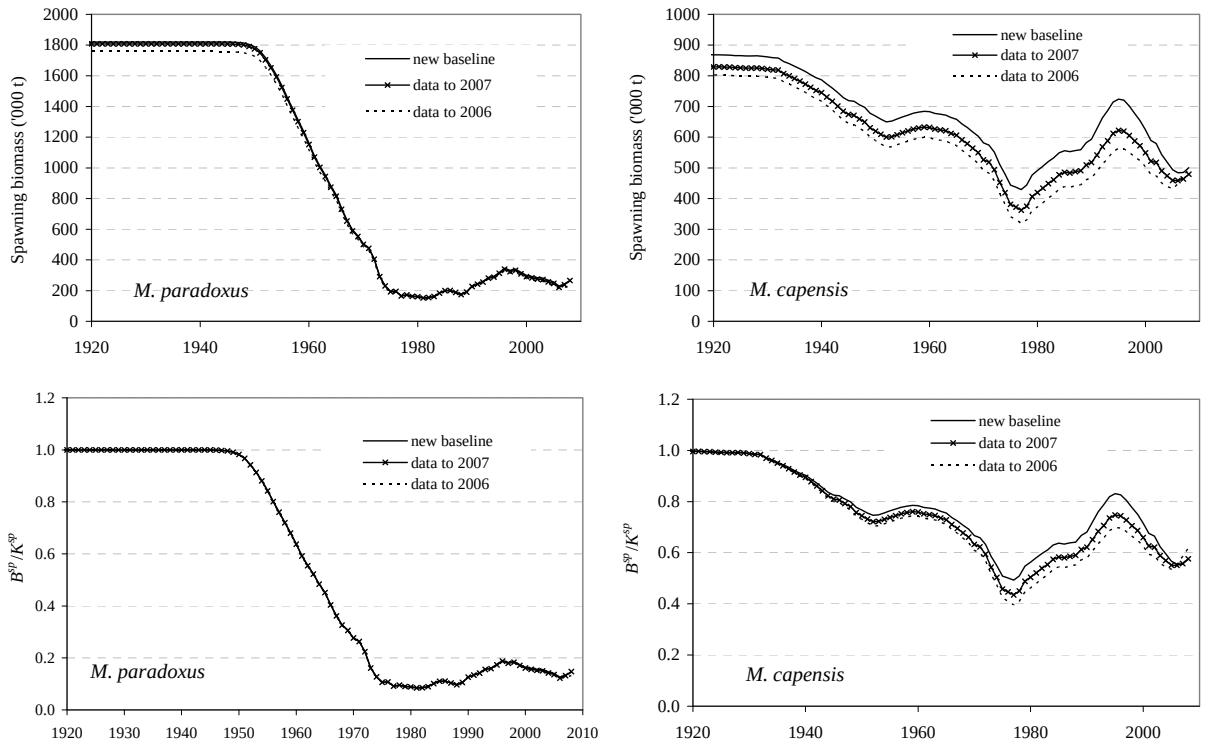

Fig. 9: *M. paradoxus* and *M. capensis* spawning biomass trajectories for the proposed new baseline and two retrospective assessments.

Appendix B – Age data used

Table App.A.1: Assumed annual catches disaggregated by species, fleet and coast in thousand tons.

	M. paradoxus			*M. capensis*					
	Offshore		Longline	Offshore		Inshore	Longline		Handline
	West Coast	South Coast	West Coast	West Coast	South Coast	South Coast	West Coast	South Coast	South Coast
1917	-	-	-	1.000	-	-	-	-	-
1918	-	-	-	1.100	-	-	-	-	-
1919	-	-	-	1.900	-	-	-	-	-
1920	-	-	-	0.000	-	-	-	-	-
1921	-	-	-	1.300	-	-	-	-	-
1922	-	-	-	1.000	-	-	-	-	-
1923	-	-	-	2.500	-	-	-	-	-
1924	-	-	-	1.500	-	-	-	-	-
1925	-	-	-	1.900	-	-	-	-	-
1926	-	-	-	1.400	-	-	-	-	-
1927	-	-	-	0.800	-	-	-	-	-
1928	-	-	-	2.600	-	-	-	-	-
1929	-	-	-	3.800	-	-	-	-	-
1930	-	-	-	4.400	-	-	-	-	-
1931	-	-	-	2.800	-	-	-	-	-
1932	-	-	-	14.300	-	-	-	-	-
1933	-	-	-	11.100	-	-	-	-	-
1934	-	-	-	13.800	-	-	-	-	-
1935	0.001	-	-	14.999	-	-	-	-	-
1936	0.001	-	-	17.699	-	-	-	-	-
1937	0.003	-	-	20.197	-	-	-	-	-
1938	0.005	-	-	21.095	-	-	-	-	-
1939	0.010	-	-	19.990	-	-	-	-	-
1940	0.028	-	-	28.572	-	-	-	-	-
1941	0.057	-	-	30.543	-	-	-	-	-
1942	0.126	-	-	34.374	-	-	-	-	-
1943	0.268	-	-	37.632	-	-	-	-	-
1944	0.465	-	-	33.635	-	-	-	-	-
1945	0.763	-	-	28.437	-	-	-	-	-
1946	1.991	-	-	38.409	-	-	-	-	-
1947	3.743	-	-	37.657	-	-	-	-	-
1948	9.304	-	-	49.496	-	-	-	-	-
1949	14.770	-	-	42.630	-	-	-	-	-
1950	27.306	-	-	44.694	-	-	-	-	-
1951	44.856	-	-	44.644	-	-	-	-	-
1952	53.304	-	-	35.496	-	-	-	-	-
1953	62.466	-	-	31.034	-	-	-	-	-
1954	74.752	-	-	30.648	-	-	-	-	-
1955	84.517	-	-	30.883	-	-	-	-	-
1956	88.043	-	-	30.157	-	-	-	-	-
1957	94.982	-	-	31.418	-	-	-	-	-
1958	98.660	-	-	32.040	-	-	-	-	-
1959	110.468	-	-	35.532	-	-	-	-	-
1960	121.131	-	-	38.769	-	1.000	-	-	-
1961	112.716	-	-	35.984	-	1.308	-	-	-
1962	111.918	-	-	35.682	-	1.615	-	-	-
1963	128.545	-	-	40.955	-	1.923	-	-	-
1964	123.095	-	-	39.205	-	2.231	-	-	-
1965	153.970	-	-	49.030	-	2.538	-	-	-
1966	147.905	-	-	47.095	-	2.846	-	-	-
1967	134.026	5.661	-	42.674	8.525	3.154	-	-	-
1968	108.921	11.136	-	34.679	16.772	3.462	-	-	-
1969	125.229	15.136	-	39.871	22.795	3.769	-	-	-
1970	108.087	9.466	-	34.413	14.257	4.077	-	-	-
1971	153.218	12.017	-	48.782	18.098	4.385	-	-	-
1972	185.025	18.633	-	58.908	28.062	4.692	-	-	-
1973	119.679	28.873	-	38.103	43.483	5.000	-	-	-
1974	93.296	36.254	-	29.704	54.599	10.056	-	-	-
1975	67.975	26.920	-	21.642	40.543	6.372	-	-	-
1976	109.144	20.722	-	34.750	31.208	5.740	-	-	-
1977	77.616	14.753	-	24.712	22.219	3.500	-	-	-
1978	104.093	4.017	-	23.414	3.574	4.931	-	-	-
1979	95.374	2.759	-	38.149	4.161	6.093	-	-	-
1980	100.766	2.948	-	32.766	3.508	9.121	-	-	-
1981	91.599	1.301	-	29.333	4.182	9.400	-	-	-
1982	84.990	4.240	-	28.359	7.118	8.089	-	-	-
1983	71.202	6.124	0.161	23.231	6.392	7.672	0.069	-	-
1984	81.804	4.843	0.256	29.451	6.092	9.035	0.110	0.016	-
1985	91.090	10.442	0.817	33.980	9.574	9.203	0.350	0.292	0.065
1986	103.405	10.214	0.965	30.401	5.751	8.724	0.413	0.302	0.084
1987	94.724	9.269	2.500	22.801	6.415	8.607	1.071	0.353	0.096
1988	82.964	7.424	3.628	23.601	7.108	8.417	1.555	0.331	0.071
1989	82.543	7.619	0.203	24.653	11.355	10.038	0.087	0.032	0.137
1990	76.684	11.995	0.270	26.884	10.865	10.012	0.116	-	0.348
1991	86.151	13.997	-	20.288	8.087	8.206	-	3.000	1.270
1992	81.782	20.020	-	21.503	6.444	9.252	-	1.500	1.099
1993	101.964	11.086	-	16.100	3.175	8.870	-	-	0.278
1994	104.326	7.601	1.130	19.541	3.451	9.569	0.484	0.626	0.449
1995	93.332	4.552	0.670	27.564	2.598	10.630	0.287	0.650	0.756
1996	109.817	9.759	1.676	19.358	3.530	11.062	0.718	1.828	1.515
1997	99.873	11.904	1.806	17.281	3.932	8.834	0.774	1.872	1.404
1998	110.854	10.796	0.647	16.799	3.357	8.283	0.277	1.471	1.738
1999	87.507	12.435	1.963	16.254	2.911	8.595	0.841	4.144	2.749
2000	96.180	7.800	3.456	23.058	4.193	10.906	1.481	2.077	5.500
2001	108.121	6.107	2.793	16.693	2.832	11.836	1.197	1.688	7.300
2002	89.560	12.637	4.772	19.223	2.095	9.581	2.045	3.945	3.500
2003	98.976	16.342	4.668	11.837	3.255	9.883	2.000	4.878	3.000
2004	91.749	23.254	3.758	14.067	3.931	10.004	1.611	4.429	1.600
2005	89.185	21.896	4.172	9.712	3.720	7.881	1.788	4.559	0.700
2006	90.074	14.524	3.592	9.192	3.142	5.524	1.539	4.032	0.400
2007	97.210	15.675	3.151	9.920	3.391	6.350	1.350	3.834	0.400
2008	89.792	14.479	2.910	9.163	3.132	5.865	1.247	3.541	0.369

Table App.A.2: South and west coast historic and GLM standardized CPUE data (Glazer, 2008) for *M. paradoxus* and *M. capensis*. The historic CPUE series are for *M. capensis* and *M. paradoxus* combined.

	ICSEAF CPUE (tons/hr)			**GLM CPUE (kg/min)**		**GLM CPUE (kg/min)**	
	Species-aggregated			*M. capensis*	*M. paradoxus*	*M. capensis*	*M. paradoxus*
Year	South Coast	West Coast	Year	West coast		South coast	
1955		17.31	1978	0.75	4.79	2.42	1.14
1956		15.64	1979	1.22	4.66	2.37	1.10
1957		16.47	1980	1.06	4.40	3.00	1.63
1958		16.26	1981	1.05	4.43	2.58	1.07
1959		16.26	1982	0.93	4.36	2.67	1.45
1960		17.31	1983	1.24	4.67	3.03	1.58
1961		12.09	1984	1.32	4.72	3.61	1.68
1962		14.18	1985	1.57	5.37	4.49	2.29
1963		13.97	1986	1.18	4.90	3.73	2.27
1964		14.60	1987	0.99	4.13	3.41	2.13
1965		10.84	1988	0.80	4.01	3.56	1.70
1966		10.63	1989	0.96	4.21	3.85	1.70
1967		10.01	1990	1.03	4.15	4.30	2.42
1968		10.01	1991	1.04	4.93	4.25	2.36
1969	1.28	8.62	1992	1.37	4.16	3.83	2.84
1970	1.22	7.23	1993	1.26	4.34	2.98	2.29
1971	1.14	7.09	1994	1.38	4.80	3.56	1.96
1972	0.64	4.90	1995	1.73	3.76	3.41	1.38
1973	0.56	4.97	1996	1.49	4.78	3.49	2.14
1974	0.54	4.65	1997	1.50	4.08	2.86	2.67
1975	0.37	4.66	1998	1.72	4.54	2.85	2.31
1976	0.40	5.35	1999	1.50	3.70	3.06	2.70
1977	0.42	4.84	2000	1.60	3.91	3.63	2.27
			2001	1.22	3.50	3.30	2.18
			2002	1.15	2.82	3.76	2.08
			2003	0.92	3.72	3.82	2.08
			2004	1.21	3.59	2.83	2.02
			2005	0.91	3.37	2.33	2.06
			2006	0.71	2.80	2.31	2.64
			2007	0.50	3.46	1.06	2.29

Table App.A.3: Summer survey catches-at-age (proportions) of *M. capensis* and *M. paradoxus* on the west coast for the 0-500m depth range. Here and in the following tables, the data to which the proposed new baseline assessment (with CAL) is NOT fitted to are shown in light grey. Data that were not included in the 2008 baseline assessment (D) (Rademeyer and Butterworth, 2008) are shaded.

	M. capensis								*M. paradoxus*					
Age	0	1	2	3	4	5	6	7+	0	1	2	3	4	5+
1986	0.034	0.230	0.603	0.085	0.023	0.014	0.008	0.003	-	-	-	-	-	-
1987	0.024	0.113	0.465	0.223	0.139	0.022	0.010	0.004	-	-	-	-	-	-
1988	0.280	0.483	0.135	0.059	0.018	0.015	0.009	0.002	0.234	0.568	0.171	0.014	0.004	0.009
1989	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	0.004	0.325	0.635	0.023	0.009	0.003	0.001	0.000	0.029	0.310	0.492	0.158	0.009	0.002
1991	0.072	0.122	0.644	0.097	0.038	0.017	0.009	0.002	0.018	0.278	0.561	0.107	0.024	0.008
1992	0.131	0.260	0.313	0.162	0.078	0.025	0.019	0.010	0.010	0.383	0.485	0.082	0.023	0.012
1993	0.038	0.176	0.207	0.399	0.088	0.057	0.024	0.011	0.009	0.200	0.547	0.187	0.044	0.010
1994	0.081	0.253	0.208	0.262	0.075	0.054	0.048	0.020	0.011	0.244	0.551	0.166	0.017	0.008
1995	0.001	0.147	0.739	0.066	0.021	0.018	0.005	0.003	0.065	0.191	0.444	0.258	0.028	0.010
1996	0.065	0.368	0.205	0.237	0.066	0.023	0.025	0.011	0.057	0.394	0.302	0.210	0.030	0.005
1997	0.036	0.141	0.384	0.407	0.014	0.010	0.004	0.003	0.006	0.171	0.546	0.256	0.016	0.003
1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999	0.867	0.059	0.024	0.026	0.011	0.008	0.005	0.001	0.161	0.410	0.336	0.081	0.008	0.003
2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002	0.198	0.441	0.230	0.070	0.032	0.019	0.007	0.002	0.076	0.373	0.380	0.132	0.028	0.012
2003	0.247	0.209	0.254	0.156	0.046	0.047	0.032	0.009	0.063	0.322	0.400	0.181	0.023	0.012
2004	0.110	0.457	0.359	0.064	0.007	0.002	0.001	0.001	0.175	0.307	0.321	0.152	0.035	0.011
2005	0.679	0.092	0.133	0.076	0.012	0.005	0.002	0.001	0.218	0.493	0.208	0.069	0.009	0.003
2006	0.446	0.325	0.169	0.042	0.008	0.005	0.003	0.001	0.073	0.321	0.440	0.144	0.017	0.005
2007	0.057	0.144	0.533	0.236	0.018	0.006	0.003	0.003	0.074	0.341	0.372	0.175	0.031	0.008

Table App.A.4: Winter survey catches-at-age (proportions) of *M. capensis* and *M. paradoxus* on the west coast for the 0-500m depth range.

	M. capensis								*M. paradoxus*					
Age	0	1	2	3	4	5	6	7+	0	1	2	3	4	5+
1986	0.005	0.305	0.267	0.318	0.051	0.027	0.017	0.010	-	-	-	-	-	-
1987	0.010	0.477	0.202	0.171	0.072	0.048	0.011	0.009	-	-	-	-	-	-
1988	0.031	0.432	0.388	0.063	0.042	0.029	0.012	0.004	0.176	0.431	0.298	0.077	0.013	0.006
1989	0.079	0.676	0.213	0.022	0.008	0.001	0.001	0.000	-	-	-	-	-	-
1990	0.006	0.267	0.514	0.098	0.052	0.042	0.013	0.008	0.329	0.290	0.202	0.105	0.041	0.032

Table App.A.5: *Nansen* summer survey catches-at-age (proportions) of *M. capensis* and *M. paradoxus* on the west coast for the 0-500m depth range.

	M. capensis								*M. paradoxus*					
Age	0	1	2	3	4	5	6	7+	0	1	2	3	4	5+
2000	0.393	0.336	0.147	0.111	0.007	0.004	0.002	0.001	0.261	0.460	0.204	0.056	0.015	0.004
2001	0.493	0.109	0.157	0.157	0.050	0.018	0.009	0.007	0.199	0.378	0.237	0.143	0.031	0.011

Table App.A.6: Spring survey catches-at-age (proportions) of *M. capensis* and *M. paradoxus* on the south coast for the 0-500m depth range.

	M. capensis								*M. paradoxus*					
Age	0	1	2	3	4	5	6	7+	0	1	2	3	4	5+
2001	0.158	0.106	0.091	0.171	0.264	0.139	0.039	0.033	0.007	0.085	0.518	0.369	0.015	0.006
2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003	0.192	0.139	0.151	0.163	0.170	0.117	0.039	0.029	0.000	0.026	0.448	0.463	0.035	0.029
2004	0.457	0.103	0.109	0.122	0.104	0.067	0.021	0.016	0.034	0.034	0.358	0.499	0.042	0.033

Table App.B.7: Autumn survey catches-at-age (proportions) of *M. capensis* and *M. paradoxus* on the south coast for the 0-500m depth range.

	M. capensis								*M. paradoxus*					
Age	0	1	2	3	4	5	6	7+	0	1	2	3	4	5+
1991	0.011	0.111	0.126	0.173	0.215	0.181	0.112	0.073	0.004	0.010	0.522	0.292	0.116	0.056
1992	0.015	0.203	0.358	0.145	0.118	0.110	0.038	0.014	0.000	0.001	0.370	0.541	0.065	0.024
1993	0.001	0.083	0.120	0.171	0.373	0.143	0.068	0.042	0.000	0.005	0.416	0.544	0.026	0.010
1994	0.061	0.140	0.123	0.219	0.137	0.159	0.116	0.045	0.005	0.090	0.656	0.186	0.017	0.046
1995	0.019	0.121	0.225	0.189	0.202	0.149	0.066	0.029	0.000	0.000	0.124	0.773	0.089	0.014
1996	0.005	0.104	0.188	0.192	0.288	0.131	0.061	0.031	0.000	0.000	0.097	0.749	0.100	0.054
1997	0.064	0.134	0.105	0.187	0.216	0.175	0.067	0.052	0.000	0.001	0.111	0.581	0.105	0.202
1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999	0.159	0.140	0.281	0.145	0.117	0.087	0.040	0.030	0.000	0.014	0.216	0.527	0.190	0.054
2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	0.149	0.112	0.085	0.175	0.279	0.137	0.036	0.027	0.006	0.053	0.444	0.462	0.027	0.007
2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003	0.109	0.214	0.195	0.142	0.161	0.116	0.035	0.028	0.008	0.023	0.385	0.530	0.034	0.020
2004	0.130	0.103	0.132	0.187	0.228	0.141	0.045	0.034	0.029	0.115	0.350	0.438	0.060	0.008
2005	0.110	0.159	0.169	0.161	0.216	0.126	0.035	0.023	0.065	0.142	0.240	0.370	0.130	0.053
2006	0.030	0.072	0.194	0.264	0.232	0.123	0.047	0.037	0.001	0.012	0.314	0.582	0.073	0.018
2007	0.250	0.250	0.169	0.157	0.112	0.044	0.011	0.008	0.050	0.039	0.191	0.501	0.197	0.022

Table App.A.8: Offshore trawl fleet catches-at-age (*M. capensis* and *M. paradoxus* combined*)* for west and south coasts.

	West coast, species combined								South coast, species combined							
Age	0	1	2	3	4	5	6	7+	0	1	2	3	4	5	6	7+
1978	0.000	0.072	0.716	0.152	0.039	0.016	0.005	0.001	0.000	0.058	0.570	0.249	0.073	0.028	0.013	0.009
1979	0.000	0.114	0.545	0.215	0.064	0.046	0.013	0.004	0.000	0.000	0.077	0.235	0.256	0.240	0.111	0.082
1980	0.000	0.056	0.472	0.289	0.112	0.048	0.017	0.008	0.000	0.027	0.419	0.272	0.144	0.067	0.039	0.032
1981	0.004	0.235	0.492	0.158	0.068	0.026	0.011	0.006	0.000	0.024	0.270	0.331	0.227	0.085	0.040	0.024
1982	0.037	0.290	0.484	0.114	0.040	0.023	0.009	0.003	0.000	0.056	0.399	0.205	0.128	0.106	0.070	0.035
1983	0.001	0.121	0.488	0.238	0.085	0.044	0.016	0.007	0.000	0.031	0.376	0.302	0.136	0.088	0.049	0.017
1984	0.000	0.063	0.483	0.275	0.097	0.046	0.024	0.012	0.009	0.085	0.387	0.232	0.154	0.071	0.040	0.022
1985	0.000	0.008	0.350	0.395	0.133	0.069	0.030	0.016	0.000	0.005	0.339	0.343	0.139	0.099	0.049	0.027
1986	0.000	0.014	0.339	0.467	0.104	0.040	0.022	0.015	0.000	0.003	0.226	0.366	0.177	0.115	0.077	0.035
1987	0.000	0.023	0.524	0.276	0.103	0.048	0.016	0.009	0.000	0.002	0.398	0.258	0.135	0.111	0.065	0.032
1988	0.000	0.021	0.589	0.266	0.059	0.036	0.021	0.009	0.000	0.009	0.414	0.264	0.136	0.103	0.053	0.021
1989	0.000	0.014	0.434	0.402	0.090	0.036	0.018	0.006	0.000	0.002	0.352	0.392	0.114	0.082	0.045	0.013
1990	0.000	0.002	0.313	0.496	0.137	0.034	0.013	0.005	0.000	0.002	0.216	0.416	0.233	0.084	0.035	0.015
1991	0.000	0.003	0.253	0.357	0.233	0.087	0.049	0.019	0.000	0.003	0.281	0.414	0.181	0.066	0.040	0.015
1992	0.000	0.012	0.405	0.303	0.145	0.088	0.035	0.013	0.000	0.005	0.333	0.377	0.156	0.077	0.035	0.017
1993	0.000	0.003	0.146	0.378	0.307	0.128	0.029	0.009	0.000	0.000	0.166	0.485	0.229	0.070	0.035	0.016
1994	0.000	0.001	0.140	0.464	0.200	0.157	0.030	0.008	0.000	0.001	0.209	0.477	0.165	0.091	0.039	0.019
1995	0.000	0.001	0.109	0.552	0.207	0.075	0.044	0.012	0.000	0.002	0.100	0.473	0.252	0.070	0.067	0.037
1996	0.000	0.002	0.120	0.554	0.221	0.063	0.029	0.011	0.000	0.000	0.054	0.477	0.342	0.073	0.037	0.018

Table App.A.9: Longline fleet catches-at-age (assumed to consist of *M. capensis* only) on the south coast.

	M. capensis							
Age	0	1	2	3	4	5	6	7+
1994	0.000	0.000	0.000	0.001	0.030	0.248	0.404	0.318
1995	0.000	0.000	0.000	0.000	0.006	0.093	0.262	0.638
1996	0.000	0.000	0.000	0.000	0.007	0.134	0.297	0.561
1997	0.000	0.000	0.000	0.002	0.036	0.201	0.298	0.464
1998	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-
2000	0.000	0.000	0.001	0.003	0.020	0.148	0.203	0.626

Table App.A.10: Inshore fleet catches-at-age (assumed to consist of *M. capensis* only) on the south coast.

	M. capensis							
Age	0	1	2	3	4	5	6	7+
1989	0.000	0.000	0.081	0.478	0.285	0.109	0.039	0.008
1990	0.000	0.000	0.055	0.279	0.439	0.171	0.045	0.011
1991	0.000	0.000	0.053	0.281	0.367	0.219	0.067	0.014
1992	0.000	0.001	0.151	0.371	0.237	0.184	0.048	0.009
1993	0.000	0.000	0.026	0.332	0.457	0.139	0.039	0.006
1994	0.000	0.000	0.060	0.380	0.304	0.183	0.067	0.007
1995	0.000	0.000	0.015	0.232	0.455	0.209	0.072	0.018
1996	0.000	0.000	0.024	0.327	0.457	0.140	0.043	0.008
1997	0.000	0.000	0.034	0.369	0.394	0.159	0.034	0.011
1998	0.000	0.008	0.166	0.377	0.284	0.116	0.034	0.015
1999	0.000	0.012	0.190	0.365	0.248	0.116	0.044	0.024
2000	0.000	0.000	0.022	0.244	0.476	0.196	0.034	0.028

Table App.A.11: Summer survey catches-at-length of *M. capensis* and *M. paradoxus* on the west coast for the 0-500m depth range.

	Merluccius capensis								*Merluccius paradoxus*									
Size	1985	2002	2003	2004	2005	2006	2007	2008	1985	1986	1987	2002	2003	2004	2005	2006	2007	2008
5	0	0	0	0	1459	829	0	12	0	0	0	0	0	0	262	179	1	134
6	0	33	145	263	567	114	126	40	0	0	0	53	114	25	625	83	6	192
7	0	264	194	263	2775	3109	142	1013	66	46	0	97	114	340	1887	552	14	914
8	0	207	121	790	29016	10776	271	5140	99	0	28	112	73	3020	6125	841	31	1479
9	33	322	1134	5267	61400	77981	1036	24126	0	501	69	376	406	7697	11844	1891	135	3730
10	874	1997	1849	12082	98507	142083	2119	22989	0	1123	27	391	994	19017	11316	3062	262	5137
11	3768	6757	3442	9476	148231	98087	2928	11297	462	1230	524	710	2413	30499	21238	7874	632	5911
12	4291	8323	2865	6478	181576	48989	4077	14412	2937	1567	1402	1451	3359	34618	31895	12237	727	6440
13	6156	12044	6148	10305	154653	36423	6809	16917	2310	2719	1717	4315	7608	44643	57570	20104	1246	9992
14	9085	19963	8028	12471	44648	24123	3705	15809	2624	3977	1920	9503	18332	42228	98045	20334	1081	11794
15	6930	27476	10334	26543	16120	18795	3156	12136	2943	7388	3620	20343	35838	59307	152402	31172	1812	18558
16	9554	33810	8865	51689	8503	29516	3261	20700	4067	10857	11996	35649	45088	51215	199473	32572	2908	24195
17	19185	27711	7814	104378	4013	56105	4594	22589	5704	13894	24785	64498	68632	44736	313472	42462	6327	30860
18	18716	31263	4804	101521	5713	104067	5021	20684	7429	16269	36591	73398	79475	39644	353043	45898	7244	32651
19	12828	50054	4455	120375	2474	129719	9260	29992	7475	18377	35915	92989	106960	39986	312403	65672	10800	42940
20	10120	73365	4244	164185	3028	115425	8953	23158	13508	16129	43171	96974	125805	54835	190489	85065	9920	46108
21	7025	85993	6141	258401	3687	66152	12256	13407	9878	16632	55617	102797	135974	73065	146668	112530	11986	52942
22	12510	54843	5357	343338	5976	66556	13819	5379	20763	30772	101281	117648	162204	86290	109809	123524	11352	88706
23	27118	35261	8528	304247	9010	23327	24246	4542	28038	41038	156442	127712	154510	95674	107701	136442	11521	91839
24	74648	22216	8089	192796	10592	38688	45507	3831	60711	61058	180095	120136	129395	96728	117153	142667	10352	109501
25	128636	19594	11548	130971	20765	24364	57076	2840	72235	71954	182512	120053	119462	94182	140720	151954	11331	70570
26	140536	14012	10598	82630	31827	43519	63067	3534	97571	95753	173105	99996	103738	74908	130094	139877	11411	66646
27	107548	14480	10824	48469	38928	13826	49281	2988	66682	81678	146862	93348	124981	77431	106727	131033	11746	40452
28	66789	12426	8564	30845	33528	21935	37885	4394	63808	69172	118232	83682	173777	63075	69212	174646	11457	43962
29	38360	7824	8080	20374	22637	6434	29192	3564	44600	48456	82836	65711	184740	60510	56174	145090	9924	48905
30	24232	5765	5563	13899	14802	6594	19243	4585	44401	43928	55436	50064	139379	48651	48281	126561	7824	53069
31	14032	4524	5411	8766	9624	4671	19441	4065	32551	51787	45092	35412	132428	43659	39005	91340	8525	49025
32	12268	3500	3250	6819	6358	3705	10426	3727	33759	48761	48826	26914	89752	33988	32577	58327	5786	45090
33	6696	2729	3542	6506	4805	2997	10335	2997	27802	41115	37705	24908	73602	36805	29647	34126	5596	38395
34	7972	2504	2664	4002	3855	2448	5591	3142	24661	40665	27616	18601	46877	26108	25990	24418	3464	29433
35	4547	2912	2908	3437	3072	2251	5223	2434	15682	31242	25885	18391	39610	22297	22470	15071	3622	34255
36	4242	2635	1041	1958	1816	1939	2786	2033	17569	25224	22031	15117	23652	18351	21503	13256	2585	31016
37	4053	2326	1350	1985	1905	1714	2620	1717	13227	17113	17309	13382	23139	21789	17511	12317	2877	31707
38	1871	1971	1300	1732	1707	1362	1320	1621	14276	11811	20288	10592	18188	16061	11544	9271	1972	27601
39	2324	1747	1041	1625	1361	1325	1163	1497	9882	7076	10872	7666	15330	17237	10035	8511	2022	24643
40	1720	1883	605	1885	984	1110	710	2041	10041	6231	10686	8415	11942	12906	7425	6641	1460	17071
41	2150	1601	674	1603	816	1192	575	1929	6185	4119	8611	5821	8438	10777	5117	6560	1581	12685
42	1321	1413	658	1513	1043	1204	413	3113	6113	3064	8571	5367	7654	9331	3761	6279	1003	11282
43	1502	2012	653	1598	766	897	370	2340	3859	2201	5291	5051	6960	6959	3433	4688	1258	12663
44	1867	1951	520	1395	905	762	353	2662	3998	2805	4132	3860	4998	5732	2468	5082	737	7545
45	723	2043	579	1363	1049	629	426	3771	2439	1646	4390	4025	5487	5399	2489	4204	840	4971
46	1730	2043	600	973	1139	456	319	2768	3410	1228	3464	3512	4010	5736	2110	3273	536	4358
47	1110	2302	749	1149	1257	736	378	2677	2077	1157	2671	4186	4293	4672	1911	2766	524	5021
48	1203	1581	721	1042	1182	714	298	2363	2280	890	2574	2869	3445	3529	1365	2527	327	2204
49	1018	2061	1036	1001	1278	643	263	2121	1599	833	2535	3346	3191	2386	1595	1801	339	1952
50	1013	1773	993	1019	941	616	231	2237	1130	783	2166	2586	2790	2333	772	1711	319	1931
51	743	2040	1358	833	1078	1008	375	1414	1417	612	790	2448	2509	2064	890	1657	277	864
52	813	1585	993	659	934	1060	220	1140	1112	641	792	2065	2795	1558	738	1207	214	829
53	670	1431	1206	666	745	777	328	917	1043	679	581	1644	2677	1447	604	999	185	1071
54	739	2010	1312	568	621	657	313	505	1214	423	962	1342	2242	1258	757	970	190	413
55	319	1818	1461	489	560	723	384	482	751	407	530	1902	2909	1105	610	904	123	425
56	232	1718	1320	345	422	509	245	246	890	750	555	1436	2313	1133	563	941	117	333
57	248	1959	1411	369	429	577	344	234	751	321	782	1533	3135	1066	458	599	112	616
58	274	1445	1241	345	251	495	232	167	709	333	737	1178	1792	921	392	684	126	320
59	249	1469	1415	215	352	455	234	78	369	378	351	1345	2275	885	394	595	73	383
60	359	1316	1339	227	290	496	155	114	688	460	262	911	1477	1011	346	432	75	492
61	210	1112	1835	250	333	1237	245	68	367	731	233	830	1893	713	329	488	55	329
62	115	487	1359	242	307	541	129	22	337	178	111	501	1094	599	200	231	50	154
63	74	652	1280	270	366	580	226	58	351	329	98	637	1339	955	178	349	21	204
64	277	399	1257	328	220	510	83	45	412	239	186	544	1105	374	207	210	31	208
65	242	406	1172	180	257	268	189	57	333	327	387	403	1441	772	223	276	30	188
66	263	319	922	256	189	337	274	124	236	445	70	345	910	442	289	154	51	326
67	243	230	692	315	132	285	241	77	276	151	70	269	829	337	174	179	14	164
68	68	188	549	325	145	176	140	67	279	233	63	237	335	230	253	207	18	113
69	55	170	524	215	135	94	189	78	343	225	199	314	608	318	90	171	11	298
70	40	154	378	212	103	147	94	47	424	286	62	201	392	173	101	83	7	74
71	97	174	504	222	67	81	106	102	144	139	49	207	441	252	150	133	29	51
72	52	97	261	224	34	309	167	34	212	346	90	213	245	264	124	14	10	91
73	55	90	375	223	65	151	45	33	133	147	57	134	250	166	58	127	7	51
74	44	56	156	116	0	13	37	45	72	198	82	163	135	66	76	51	6	11
75	37	112	123	33	76	29	73	58	124	51	215	150	184	140	27	59	2	94
76	73	100	76	183	74	27	35	45	137	45	396	105	78	23	86	26	3	31
77	111	128	179	70	22	28	48	11	9	55	499	82	123	119	29	22	2	100
78	15	51	38	36	11	13	24	34	119	31	68	68	78	32	27	14	4	11
79	32	44	65	44	42	0	13	11	12	20	289	53	102	0	39	26	2	20
80	15	12	25	24	47	27	13	11	12	20	27	29	60	0	39	0	0	11
81	16	96	57	56	31	0	0	11	0	35	14	30	85	22	18	22	0	0
82	16	72	0	23	45	29	0	11	61	20	14	24	28	0	27	0	3	0
83	16	34	50	55	11	68	0	11	18	35	109	19	28	11	27	0	1	0
84	0	20	13	0	57	13	13	11	0	45	14	10	61	32	0	0	0	0
85	15	0	0	0	22	27	0	136	9	10	14	14	57	57	0	0	1	0
86	16	14	0	0	21	0	0	24	0	84	0	0	0	11	0	0	0	0
87	30	34	13	0	11	0	0	11	9	0	0	0	0	0	0	0	0	0
88	0	0	13	0	11	0	0	0	0	20	0	0	0	12	0	0	1	0
89	0	10	25	0	0	0	11	0	61	0	0	0	0	22	0	0	0	0
90	0	0	0	0	0	147	0	12	9	14	0	39	0	12	9	0	0	0
91	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
92	0	10	13	11	0	0	0	0	0	10	14	0	0	0	0	0	0	0
93	0	0	0	22	0	0	0	11	0	0	0	0	0	0	0	0	0	0
94	0	10	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0
95	0	10	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0
96	0	22	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0
97	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0	0	0	65	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table App.A.12: Winter survey catches-at-length of *M. capensis* and *M. paradoxus* on the west coast for the 0-500m depth range.

	Merluccius capensis			*Merluccius paradoxus*			
Size	1985	1986	1987	1985	1986	1987	1989
5	0	0	0	0	0	0	0
6	0	0	0	14	0	0	0
7	0	0	0	28	16	0	58
8	42	0	0	196	112	0	87
9	0	32	0	211	272	37	192
10	42	96	0	98	784	223	1203
11	156	352	295	190	1536	1443	2510
12	28	384	463	364	1453	4512	7771
13	113	288	166	1067	2579	7926	27694
14	453	160	626	3036	3733	12290	58366
15	1076	162	886	4643	7828	20410	99068
16	2633	129	795	4754	15670	23759	107783
17	10716	146	2459	6828	28611	32773	83410
18	21541	480	7725	9365	45754	53277	61986
19	75443	1370	13706	14197	68036	59200	59923
20	109270	7704	24043	21577	59250	58377	55435
21	152455	12362	32234	32146	45989	54724	57052
22	132880	22549	30631	34215	41562	43618	59486
23	98769	25638	15389	37210	42842	35457	61196
24	76139	23449	8757	44965	53271	54048	96122
25	44864	17376	5934	54962	52078	63029	127838
26	31247	13985	5336	57436	48345	63657	167468
27	17301	11061	7082	55353	40357	56770	158154
28	22426	9362	6128	62718	44408	75713	167888
29	15838	9344	5544	83998	42374	71586	157416
30	12597	10093	4438	96043	43062	85780	156045
31	10718	10808	4044	99807	42731	55477	126820
32	11336	11435	3680	83911	35546	42091	121659
33	11287	12443	3876	80392	27926	24361	81775
34	9455	13405	3137	57443	18722	18881	59161
35	8321	13932	3435	41560	10836	15575	53662
36	8332	13654	4646	31001	11419	13753	55573
37	6549	13295	4298	25788	8763	7190	28920
38	7453	12145	5146	22051	9084	6764	25202
39	7522	10249	5352	11000	5891	9196	23189
40	6963	8412	4952	12556	6926	8346	16221
41	6370	6986	4943	14604	5455	7448	21931
42	6142	5045	4769	13469	5355	7224	13944
43	5293	3701	4599	8864	4111	4400	9128
44	4268	2953	3519	6337	4751	4139	8927
45	3454	2451	2682	3762	2841	2661	6153
46	3386	1541	2615	3003	2587	5578	8658
47	2482	1532	2689	2542	1777	2189	5835
48	2720	1315	3072	1828	1896	2454	5000
49	2175	1019	2257	1764	1585	1959	4553
50	2397	1248	2578	1138	1261	1726	4784
51	1954	931	2901	778	962	1301	3009
52	2021	1227	2253	842	906	1715	3959
53	1505	1273	2186	898	1053	1009	1469
54	1845	1305	2185	673	872	1138	1553
55	1674	1289	1300	715	970	1056	1743
56	1538	1297	1112	575	635	782	1143
57	1743	1024	1386	358	1036	540	1362
58	1729	1189	904	481	848	743	1373
59	1192	1139	891	323	807	675	1154
60	1484	885	481	393	610	531	2009
61	862	1015	570	516	602	361	773
62	847	849	308	386	651	388	1764
63	587	693	435	291	651	259	1589
64	479	708	388	235	614	302	582
65	367	558	346	186	463	345	1317
66	503	396	386	249	696	263	850
67	302	483	211	309	344	217	990
68	461	510	195	253	356	68	1680
69	323	253	236	270	344	187	602
70	285	444	253	130	246	133	1612
71	158	292	194	67	270	254	622
72	449	287	230	60	258	189	296
73	320	187	223	161	184	144	58
74	242	261	70	49	111	146	0
75	169	130	116	42	110	131	25
76	227	144	17	84	98	41	38
77	188	103	97	42	98	98	0
78	146	33	17	53	49	168	0
79	263	66	48	35	86	123	0
80	193	119	49	18	61	59	0
81	135	90	132	18	86	41	0
82	33	91	48	18	0	0	0
83	67	58	17	0	131	29	0
84	14	33	50	0	37	14	0
85	25	25	17	25	49	14	0
86	14	29	52	0	49	14	0
87	0	82	17	0	0	0	0
88	0	17	0	0	0	0	0
89	0	17	17	0	0	0	0
90	19	0	17	18	0	0	0
91	14	12	32	0	0	0	0
92	83	0	19	0	25	14	246
93	0	0	31	0	0	0	0
94	0	0	0	0	0	0	0
95	0	0	17	0	0	16	0
96	0	0	17	0	0	0	0
97	0	0	0	0	0	0	0
98	0	29	0	0	0	0	0
99	0	0	0	0	17	0	0
100	14	0	0	0	0	0	0
101	0	0	50	0	0	0	0

Table App.A.13: Spring survey catches-at-length of *M. capensis* and *M. paradoxus* on the south coast for the 0-500m depth range.

	Merluccius capensis							*Merluccius paradoxus*						
Size	1986	1987	2001	2003	2004	2006	2007	1986	1987	2001	2003	2004	2006	2007
5	0	0	0	0	248	562	64	0	0	0	0	10	0	0
6	0	10	35	41	328	633	96	0	0	0	0	21	0	0
7	212	27	189	249	1283	1815	721	0	0	0	27	42	0	0
8	0	68	215	570	4257	3494	989	0	0	0	0	106	0	0
9	121	301	1114	1472	12946	5977	3459	0	0	0	54	125	0	0
10	298	618	2226	3003	30434	6248	4940	0	0	0	53	102	0	0
11	925	2004	4543	5469	39084	8158	9783	0	0	67	299	337	0	13
12	2591	5156	6514	6768	28934	9486	10682	133	0	67	292	392	0	26
13	10704	8576	9127	6111	22470	14704	26015	213	0	245	439	2078	0	13
14	18941	9346	6964	5163	14178	14548	22072	1010	0	67	699	3293	55	0
15	28348	7012	7406	5277	7065	15565	25247	2154	0	83	487	2219	0	0
16	32129	4866	5173	4122	4138	10445	11588	1915	0	16	284	933	0	0
17	29698	3446	4431	3735	2793	7026	8316	1250	45	0	176	122	0	26
18	20937	2527	3176	3325	1511	4268	4677	1117	0	0	27	202	22	13
19	9114	2946	2698	3307	1569	3644	3887	1250	134	0	149	0	556	497
20	4860	2628	2316	2425	1648	3061	2126	2043	0	0	41	42	584	549
21	3490	2481	1771	2246	1692	4464	2604	948	67	0	150	0	266	666
22	2566	2946	1837	2146	1750	4667	2584	1808	45	0	111	200	441	1032
23	1467	2195	1225	2627	2195	6663	2795	2454	0	289	146	484	811	327
24	2462	2378	1060	2977	2323	7406	2382	6312	89	588	314	1319	697	627
25	2030	1829	1007	3004	3835	9027	4702	7103	89	1682	1977	1262	3598	693
26	2633	2316	1580	3154	3942	7969	3429	8251	911	3730	2915	3354	3377	209
27	3009	1915	1573	3030	4680	8638	6876	4275	2636	6254	11697	7334	12268	2509
28	5259	2666	1939	2604	4794	6654	5494	3028	5450	7538	16166	15002	20587	3444
29	5327	2962	2223	2560	5759	7576	8769	2325	8316	8244	29715	19470	36512	7947
30	6706	3867	2196	2261	6522	5471	7520	2741	10351	7971	31326	25330	34253	14401
31	6960	4095	2669	3048	6523	6214	9244	4218	10454	8417	51083	30996	43203	19000
32	7621	4059	2789	2411	5892	4388	7179	4700	9026	9435	47244	26635	26485	23332
33	6169	3958	2942	3517	5114	5649	7565	5634	6292	7171	42205	20634	27196	17630
34	7477	4108	3616	2623	5044	4837	5765	5416	3894	6278	26324	17851	17153	22075
35	6548	3839	3793	3428	3649	6431	5468	3994	2308	4197	17522	16330	11729	10630
36	7878	3865	4310	2797	3129	5885	4939	4575	1256	2569	9386	8419	5202	10262
37	6892	3916	5301	3351	3044	7460	4797	3467	1211	1033	4705	6065	3740	7988
38	8380	4818	6103	2155	3078	5570	4305	3305	974	1256	2409	3013	2363	4625
39	7041	5323	6875	3035	3249	7020	4416	1752	569	312	1355	2547	1527	3789
40	7074	6611	7343	2388	3203	5556	3943	2739	387	277	1181	1250	1128	1829
41	6439	5845	8180	3547	3068	6287	3779	1442	636	178	776	545	840	1863
42	5604	5967	8506	2888	3516	4910	2970	1096	622	223	379	1165	629	810
43	4887	5111	9203	3741	3777	4930	3703	861	857	111	486	1436	618	395
44	4691	4656	8093	3007	4182	3999	2583	924	776	178	459	668	284	836
45	3489	3920	7518	3369	3701	4032	3195	588	1059	45	565	824	270	287
46	3705	3930	6892	2548	3923	2908	1930	675	1013	134	534	229	247	157
47	3297	3294	6340	2948	3406	3363	2238	380	901	0	551	261	205	157
48	4093	4216	4921	2206	3467	1987	1651	380	598	178	354	386	191	157
49	3131	3545	4499	2707	3277	2526	2011	283	617	0	770	469	124	235
50	4265	4097	3745	2617	3164	1783	1388	349	490	111	534	146	90	105
51	3509	3698	3819	2807	2761	2066	1460	131	294	0	551	219	157	118
52	4277	3541	2877	2025	2191	1219	1000	109	283	22	508	188	126	39
53	4226	3352	2911	2255	2177	1667	1258	22	194	22	503	198	104	131
54	4551	3422	2387	1563	1960	1217	843	65	237	0	647	219	135	91
55	4789	3068	2536	1947	1880	1606	1012	109	178	22	384	219	124	78
56	4043	3006	2478	1481	1448	1017	700	109	122	0	551	323	124	91
57	4346	2737	2148	1862	1495	1437	916	44	83	22	408	449	194	91
58	3913	2639	1579	1161	1161	1050	602	0	99	0	312	490	146	118
59	3827	2380	1660	1205	1283	966	461	44	128	22	360	449	79	78
60	3919	2360	1135	1024	2279	667	508	0	99	0	360	480	11	39
61	3176	2288	940	827	862	962	782	0	150	0	264	501	112	157
62	3287	2209	887	730	742	780	428	65	39	45	288	417	112	26
63	2707	2089	961	736	969	778	586	22	22	0	324	407	34	105
64	2752	1742	690	410	597	592	323	0	61	22	252	449	90	91
65	1889	1383	873	656	578	691	260	44	0	0	204	522	79	52
66	1732	1414	697	558	479	683	242	65	0	22	108	323	101	13
67	1601	1817	629	575	619	618	365	22	16	0	144	469	292	13
68	1457	1151	398	384	330	511	330	0	0	22	120	271	56	39
69	1572	1266	636	368	438	415	221	0	45	0	84	198	0	26
70	1107	1086	512	354	322	397	200	44	22	45	36	94	45	13
71	1205	872	465	297	242	289	142	22	0	0	48	115	34	13
72	989	903	269	284	317	329	118	0	22	0	24	115	45	0
73	1093	843	267	394	176	369	185	22	0	111	12	219	22	13
74	1158	662	292	282	290	253	73	0	0	45	36	63	0	0
75	472	778	152	305	121	184	76	0	0	22	12	63	0	13
76	741	575	171	225	334	149	146	44	0	0	60	31	45	13
77	271	403	241	167	45	137	127	0	0	0	60	83	11	13
78	581	288	136	126	164	180	54	0	0	0	12	42	34	13
79	296	294	104	51	155	80	45	0	0	0	12	63	0	0
80	306	446	66	75	57	56	38	0	0	22	36	52	0	0
81	392	298	143	61	25	37	38	0	0	0	12	21	0	0
82	27	120	50	51	23	75	16	0	0	0	36	52	0	0
83	117	221	91	50	82	0	16	0	0	0	0	10	22	0
84	136	193	0	39	55	59	0	0	0	0	0	0	0	0
85	123	165	67	51	21	37	0	0	0	0	0	0	0	0
86	152	122	16	0	12	0	0	0	0	0	0	0	0	0
87	75	70	0	12	0	23	0	0	0	0	0	10	0	0
88	97	141	28	27	36	7	32	0	0	0	0	0	11	0
89	80	45	16	0	48	0	0	0	0	0	12	10	0	0
90	102	120	16	0	11	0	0	0	0	0	0	10	0	0
91	80	39	38	27	0	0	0	0	0	0	0	0	0	0
92	48	104	28	0	12	0	0	0	0	0	0	10	0	0
93	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94	47	67	0	0	0	0	0	0	0	0	0	0	0	0
95	27	10	16	0	0	11	0	0	0	0	0	0	0	0
96	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	27	22	0	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	14	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	16	0	0	0	0	0	0	0

Table App.A.14: Autumn survey catches-at-length of *M. capensis* and *M. paradoxus* on the south coast for the 0-500m depth range.

	Merluccius capensis							*Merluccius paradoxus*						
Size	1988	2003	2004	2005	2006	2007	2008	1988	2003	2004	2005	2006	2007	2008
5	0	0	0	170	0	176	0	0	0	0	20	0	0	0
6	165	0	34	268	0	22	139	0	0	0	0	0	0	0
7	688	39	169	133	29	33	80	0	0	0	139	0	0	0
8	682	39	65	518	0	493	115	0	0	0	0	0	0	0
9	711	58	350	729	14	1121	286	0	13	0	139	14	0	0
10	767	299	560	894	35	2505	224	0	0	69	41	0	47	0
11	1276	1248	1664	1814	197	6575	570	0	27	54	41	0	239	128
12	2944	1605	2838	1339	289	10998	1041	0	0	236	111	0	508	224
13	5454	2506	5026	1503	875	17226	1523	0	0	201	497	18	4055	336
14	7455	4088	4621	2287	1753	19737	2247	0	13	646	567	14	7907	304
15	8824	6220	3960	3041	2556	19115	3208	0	13	3264	1353	0	7848	416
16	8687	7135	4062	4061	2427	14569	3523	0	27	3897	1223	0	3705	96
17	8296	11514	3939	4839	3187	11698	2837	0	44	4641	2039	0	1430	160
18	8445	9808	2185	4316	1946	11486	2284	39	54	3334	1790	0	438	112
19	9180	12560	1561	4129	2561	7431	2380	97	0	1871	1263	32	438	96
20	7507	9262	1761	4181	2247	4625	3256	19	0	1280	1194	0	729	240
21	7395	9594	1886	4092	2544	4853	4316	136	40	1962	448	0	1634	0
22	8153	6101	1541	3832	2676	4504	4520	97	42	3932	557	0	1284	32
23	9134	6732	1879	4290	3353	5002	5111	234	523	5014	239	0	875	80
24	8761	5190	2387	2735	2873	3805	5022	175	188	7467	656	57	934	306
25	7777	6576	2482	3123	3854	4722	6625	136	1998	6461	877	252	636	722
26	7483	4041	2298	1980	3979	3315	6317	58	3799	6477	1852	482	1237	2333
27	6757	3796	2656	2596	4849	4558	7633	195	10862	6092	3038	1676	4353	3919
28	7006	3284	2185	1906	5028	4263	6588	331	33436	10965	3312	3829	5846	5634
29	8007	2505	2160	1688	5803	5511	6577	457	60606	21570	3214	7076	13431	5872
30	8673	1853	2119	1277	5187	5348	6676	951	75364	28940	2746	9121	13833	5812
31	9570	2247	1980	1610	6201	6600	5984	2250	69515	27204	2935	11804	20782	6298
32	10136	1965	2369	1059	5617	5188	5515	2977	46696	21155	1739	12764	19994	7582
33	10659	2387	3357	1636	7275	6502	4744	3649	24458	14909	2451	12390	24137	6944
34	10739	3078	3133	1357	6952	4517	4978	3610	14269	11445	2310	9899	16790	6248
35	9644	3822	3157	2486	7710	5309	5054	4181	7949	11083	2888	6717	18179	6141
36	8607	4260	3591	2505	7017	3871	4645	4714	6620	8955	2474	4798	16108	6092
37	7187	4614	3885	3282	7619	5134	5229	4521	4914	7658	3354	3572	18010	6383
38	6284	3666	3465	3308	5733	3167	4632	5280	2710	8091	2608	2752	16808	4134
39	5247	4240	3425	3867	6658	4921	5891	4699	2205	4813	2758	2110	27592	5160
40	5150	3653	4039	3483	6453	3840	6189	4447	1447	5054	2632	1525	21425	3055
41	4910	3555	4120	4440	6092	4126	6399	3372	1037	3448	1681	810	24057	4128
42	4961	3030	4151	3593	5732	3073	5998	2935	955	1846	1014	646	20195	2380
43	5247	2908	4091	3905	4993	3318	6207	2163	1135	1474	1165	820	19827	2678
44	5292	3629	4764	3435	4692	2806	5212	1977	983	1751	653	572	5555	2132
45	4805	3861	4237	3261	4301	3106	4314	1784	619	724	696	307	8566	1678
46	5832	3795	3725	2804	3952	2563	4521	2184	1356	912	578	586	3985	1214
47	5519	4215	4209	2758	3487	2654	3966	1252	697	179	676	602	3063	1282
48	4685	3690	3209	2538	2700	1764	3424	1275	1255	211	588	404	1575	842
49	4358	4003	3825	3085	3408	1722	3369	776	981	244	549	322	764	1062
50	4415	3588	3581	2491	2988	1498	3249	1022	1207	116	250	387	969	466
51	4194	3849	2658	2148	2651	1811	2939	565	626	85	179	301	286	470
52	4424	3092	3041	1961	2341	1080	2784	370	1007	35	239	258	525	352
53	3372	2700	2922	1921	2461	978	2570	285	829	164	209	158	694	242
54	3667	2657	2457	1567	2293	828	2158	347	1123	244	169	186	566	144
55	3284	2365	2291	1551	2528	1010	2262	409	614	15	328	229	496	176
56	3258	1937	2147	1712	1820	731	2045	234	1320	0	280	158	321	80
57	2827	2000	2252	1416	2116	852	1714	156	850	12	269	315	438	18
58	2839	1715	1201	1058	1884	489	1506	211	1310	15	279	229	292	32
59	2546	1267	1630	1089	2116	637	936	117	777	107	398	215	263	64
60	2337	1292	1751	823	1840	491	818	117	858	46	179	229	379	112
61	1964	1242	1317	789	2167	594	902	19	506	122	338	158	233	0
62	1557	869	981	556	1421	265	676	136	473	0	279	244	467	0
63	1418	968	837	640	1450	461	676	74	381	107	224	143	233	16
64	1379	905	879	541	1190	237	740	58	404	107	149	164	117	32
65	1321	650	743	433	998	293	648	97	296	46	91	143	117	32
66	1383	734	682	229	818	319	399	19	205	15	60	57	584	32
67	953	554	486	373	998	253	317	19	134	0	70	72	233	32
68	849	526	610	315	485	193	189	19	107	0	90	43	321	32
69	594	438	479	317	870	209	277	19	67	46	70	57	146	48
70	529	473	461	105	525	121	248	58	67	46	50	86	29	0
71	471	352	472	151	549	173	169	0	40	0	20	29	88	16
72	351	291	250	213	330	100	72	0	67	183	30	57	175	0
73	404	304	233	81	345	124	143	0	13	46	0	43	117	80
74	397	219	286	67	208	46	12	0	27	0	0	14	58	0
75	350	157	180	167	231	13	116	0	0	0	10	14	88	0
76	213	199	152	95	144	93	84	0	13	0	0	29	88	32
77	135	158	219	82	122	69	53	0	0	46	21	29	29	0
78	128	158	494	68	101	67	49	0	27	0	0	0	0	0
79	242	56	88	22	82	44	0	0	0	0	0	0	29	0
80	105	133	128	12	87	35	42	0	0	0	0	0	0	0
81	243	74	87	23	198	33	24	0	0	0	0	0	88	0
82	210	15	38	35	68	11	0	0	0	46	0	14	0	0
83	70	132	88	48	58	22	0	0	0	0	0	14	0	0
84	32	58	13	35	72	11	0	0	13	0	0	0	0	0
85	32	73	36	0	43	11	0	0	0	0	0	0	29	0
86	35	30	36	12	14	22	0	0	0	0	10	0	29	0
87	67	0	15	12	0	0	12	0	13	0	0	29	0	0
88	72	73	28	24	14	0	0	0	0	0	0	0	0	0
89	24	74	38	24	21	24	12	0	0	0	0	0	0	0
90	63	41	28	0	0	0	0	0	15	0	0	14	0	0
91	56	30	13	35	14	0	24	0	0	0	0	0	0	0
92	16	15	28	0	0	0	12	0	0	0	0	0	0	0
93	48	29	0	11	0	0	0	0	0	0	0	0	0	0
94	32	15	0	0	0	0	0	0	0	0	0	0	0	0
95	32	0	0	0	0	11	0	0	0	0	0	0	0	0
96	24	0	0	11	0	0	12	0	0	0	0	0	0	0
97	0	0	0	0	0	0	12	0	0	0	0	0	0	0
98	0	0	13	0	14	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	12	0	0	0	0	0	0	0	0	0	0	0	0
101	0	15	0	12	0	0	0	0	0	0	0	0	0	0

Table App.A.15: Commercial catches-at-length (species combined).

	Offshore trawl West Coast Both species			Offshore trawl South Coast Both species			Offshore trawl Both Coasts Both species			Inshore trawl South coast *M. capensis*								Longline West Coast Both species			
Length	1997	1998	1999	1975	1976	1977	2005	2006	2007	1981	1982	1983	1984	1985	1986	1987	1988	1994	1995	1996	1997
19	36	26	16	0	0	0	15320	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	575	418	265	0	753275	8256	146700	340993	0	0	0	0	0	0	0	0	0	0	0	0	0
23	3109	2281	1406	0	1027193	4128	1947301	2420009	329913	0	0	0	0	0	201	0	812	0	0	0	0
25	7080	5322	3394	149765	2602221	74306	13414502	10114184	3341151	14616	16062	1284	0	313	1602	0	7356	0	0	0	0
27	10636	8525	5780	688919	5409881	90818	33275953	19878889	12886979	43847	96373	4397	7510	1731	6750	3785	68805	0	0	0	0
29	16979	13788	9978	1597494	16914437	499501	36836651	25382280	21131296	204618	497928	43819	42362	17424	49482	34644	256192	0	0	0	0
31	22842	21168	15156	3504502	31158173	1515017	37150093	28909583	24166107	540775	1365287	191172	235286	63890	208646	113552	622506	0	0	0	0
33	20830	22423	15365	4193421	24858059	1671885	30298498	25782332	22961329	1023088	2136273	419654	681695	174492	520621	329855	1148827	7	0	0	0
35	19531	22565	15069	3584377	16982916	1948468	23060176	20993022	21195853	1476170	2312957	683207	1180629	381287	880580	688169	1190681	55	0	68	0
37	17087	20516	13485	4263312	9929528	2423201	14081990	15576440	18526775	1710019	2007775	873549	1564328	580814	1100662	1124012	1143296	145	0	68	0
39	14006	16694	10952	3424628	4999004	2472738	11226958	11396663	16293899	1739250	1798966	960018	1817904	725458	1039693	1247484	1043460	290	151	204	0
41	9239	11404	7376	5032106	7464266	2617222	8381432	9452470	13611807	1505401	1413474	1011188	1906240	878907	975200	1534650	1015551	642	227	511	668
43	6425	8039	5235	5181871	5478360	2299358	9589056	8144595	10702986	1373861	1076167	1064233	1666818	1068546	779643	1274141	995372	980	113	1498	3339
45	5769	7292	4825	5181871	4999004	2055799	7778592	7113076	7348419	1096166	835234	1088795	1138668	1233793	720842	969945	844254	1180	605	2519	2893
47	3693	4738	3289	5711041	5957717	1407686	8649677	6120703	6379690	876933	610364	995056	803947	1130354	642917	735431	761449	1477	794	2927	7345
49	2428	3219	2394	5101996	4725086	1205408	5482530	4830979	5267271	716162	465804	830025	592794	1030908	585256	623045	637884	1801	1852	4867	10906
51	2177	2906	2268	5181871	2739180	1003131	4637750	4108786	3334680	526160	369431	632843	479697	924507	596237	524386	580651	2423	3591	7897	15135
53	2254	3050	2374	4193421	1232631	891672	4123671	3555076	2520877	453082	256995	479038	382114	667560	563458	455587	438897	3299	6993	13105	26264
55	1927	2588	2064	4193421	684795	875160	4033206	3250875	2605755	306926	192746	330390	306103	483651	511108	355258	378324	4728	8278	20831	27822
57	2069	2780	2201	3354737	479357	747188	3821585	3002475	1908180	248464	160622	233878	242642	345335	453663	292439	301004	6074	16782	31315	45405
59	1804	2358	1958	2366288	273918	730676	2943441	1978579	1299511	219233	112435	160384	214044	270558	390459	282002	263996	6937	15837	44896	46296
61	1438	1844	1570	1827134	342398	800854	2808123	1804417	1470292	160771	96373	111543	158277	208466	269362	261303	238268	7716	20071	56299	45183
63	1169	1438	1288	1218089	205439	606832	1947249	1680277	1084712	116924	64249	87219	118168	153740	180754	153010	119120	8579	24455	63039	58760
65	847	976	965	988449	136959	367402	2089726	1394477	1105531	87693	48187	61463	79663	108274	114094	108928	91704	9525	21696	84959	67218
67	602	681	682	988449	205439	317865	1451537	1210351	859275	58462	32124	43058	49378	67904	74811	63570	63129	11816	28273	80228	74340
69	472	517	545	838684	136959	2064055	1138007	905966	815793	43847	32124	28891	33978	45175	47366	40858	38916	13514	26799	80704	70334
71	409	440	471	459279	136959	1490248	775412	757464	524991	29231	16062	19882	18260	28132	30239	30355	22497	13935	28689	83870	76121
73	206	219	230	459279	68480	1168255	614793	439740	919148	14616	16062	16144	12982	20409	20971	18270	18390	14660	31372	73216	77456
75	159	169	177	379405	68480	1498504	306312	293611	782060	14616	0	10668	8631	11917	13171	11837	10979	13983	23624	68757	68553
77	88	89	105	379405	0	722419	217081	154424	152939	14616	0	6510	5822	9037	11994	11188	8588	12424	26081	58988	65437
79	66	69	75	379405	0	24769	105159	83279	128618	14616	0	5112	4413	4880	7442	6010	4509	10588	22603	50342	49857
81	46	48	54	379405	0	33025	174162	72984	62199	0	0	2908	2150	4141	4872	4690	3368	7710	18370	39859	38283
83	25	27	29	229640	0	0	19449	44491	35991	0	0	1704	1512	3724	3107	3669	3477	7026	15535	30736	29603
85	12	11	14	229640	0	4128	27914	31774	29354	0	0	466	1553	2164	2250	1254	155	4410	12020	25222	25819
87	8	8	10	149765	0	0	7397	9825	25463	0	0	704	905	866	864	1233	1150	3037	10508	15726	24038
89	6	6	6	149765	0	12384	56178	9428	32283	0	0	648	658	358	477	328	283	2015	6312	11062	11574
91	5	6	5	79875	0	8256	15428	26237	5740	0	0	136	288	478	693	394	0	1256	3251	7761	6010
93	3	4	3	0	0	0	2497	1318	0	0	0	114	82	119	37	430	73	1001	2419	4119	3561
95	1	1	1	0	0	0	0	2277	10401	0	0	57	237	30	521	0	0	435	983	2757	2003
97	1	2	1	0	0	0	0	2936	0	0	0	80	0	97	0	0	0	242	643	1123	668
99	0	0	0	0	0	0	0	0	4661	0	0	0	134	97	0	0	0	97	189	579	668
101	0	0	0	0	0	0	0	563	0	0	0	0	0	0	0	0	0	69	113	374	0
103	1	1	1	0	0	0	0	0	0	0	0	0	0	119	0	0	0	7	0	204	0
105	1	1	1	0	0	0	0	2277	0	0	0	0	0	0	0	0	0	7	0	34	0

Appendix B – Incorporation of catch-at-length information in fitting an ASPM

To be able to incorporate the proportion at length information, the proportions at age predicted by the model ($\hat{p}_{y,a}$) (with is based upon age-specific selectivity) are converted to proportions at length ($\hat{p}_{y,l}$) using the von Bertalanffy growth equation, assuming that the length-at-age distribution remains constant over time:

$$\hat{p}_{y,l} = \sum_a \hat{p}_{y,a} A_{a,l} \qquad \text{(B.1)}$$

where $A_{a,l}$ is the proportion of fish of age *a* that fall in the length group *l* (i.e., $\sum_l A_{a,l} = 1$ for all ages *a*). The matrix *A* is calculated under the assumption that length-at-age is normally distributed about a mean given by the von Bertalanffy equation, i.e.:

$$L_a \sim N\left[L_\infty\left(1-e^{-\kappa(a-t_0)}\right); \theta_a^2\right] \qquad \text{(B.2)}$$

where θ_a is the standard deviation of length-at-age *a*, which is modelled as a function of the expected length at age *a*, i.e.:

$$\theta_a = \beta\left[L_\infty\left(1-e^{-\kappa(a-t_0)}\right)\right]^\gamma \qquad \text{(B.3)}$$

β and γ are estimated in the fitting process. The resultant term added to –ln*L* in the fitting process is:

$$-\ell\mathrm{n}\, L^{\text{length}} = 0.1\sum_y\sum_l\left[\ell n\left(\sigma_{len}/\sqrt{p_{y,l}}\right) + p_{y,l}\left(\ell n p_{y,l} - \ell n\,\hat{p}_{y,l}\right)^2/2\left(\sigma_{len}\right)^2\right] \qquad \text{(B.4)}$$

where σ_{len} is the standard deviation associated with the length-at-age data , which is estimated in the fitting procedure by:

$$\hat{\sigma}_{len} = \sqrt{\sum_y\sum_l p_{y,l}\left(\ln p_{y,l} - \ln\hat{p}_{y,l}\right)^2 / \sum_y\sum_l 1} \qquad \text{(B.5)}$$

The initial 0.1 multiplicative factor is a somewhat arbitrary downweighting to allow for correlation between proportions in adjacent length groups.

Age 0 correction:

To allow for the fact that zero-year old fish are not available to the trawl fishery throughout their first year of life the mean length at age 0 is computed as:

$$L_0 = L_\infty\left(1-e^{-\kappa(A_0-t_0)}\right) \qquad \text{(B.6)}$$

where A_0 is estimated in the model fitting procedure (for each species separately).

Selectivity-at-length effect for the surveys

Although the model, and therefore the fishing selectivity, is age-based, many selectivity effects are in fact length-based. This applies particularly to the small fish that can escape through the mesh. A selectivity-at-length effect was therefore included when fitting to the survey catch-at-length information. This correction was applied only to the survey data, as the commercial fleets do not catch enough of the very young fish for this effect to be important.

The selectivity-at-length effect is included by estimating a logistic function to model the proportion of fish of length *l* actually retained by the gear:

$$R_l = \frac{1}{1+e^{-(l-L_1)/\Delta}} \qquad \text{(B.7)}$$

where L_1 and L_2 are estimated in the model fitting procedure for each survey and species separately.

The proportion of fish of age *a* caught that fall in length group *l* is computed as:

$$A'_{a,l} = \frac{A_{a,l}R_l}{\sum_l A_{a,l}R_l} \qquad \text{(B.8)}$$