

2012 Routine Update of the South African Hake Reference Case Assessment

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This paper presents a routine update of the South African hake Reference Case assessment (RS1) (Rademeyer and Butterworth, 2010), including new commercial (catches and CPUE) and survey (abundance estimates and length distribution) data. This analysis does not include post-2009 commercial length distribution data whose finalisation is still in progress.

METHODOLOGY and DATA

The methodology is as detailed in Rademeyer and Butterworth (2010). The updated data are listed in Appendix A.

Four assessments are compared:

- 1) **RS1-2009**: the Reference Case assessment (RC: the first member of the Reference Set RS) , with data to 2009;
- 2) **RS1-2011**: the routine update presented last year (Rademeyer, 2011) with additional CPUE data and survey abundance estimates to 2011;
- 3) **RS1-2012**: the comparable assessment to RS1-2011 with CPUE and survey abundance estimates to 2012;
- 4) **RS1-2012-SCAL**: the final 2012 assessment, fitted to CPUE and survey abundance estimates as for RS1-2012, as well as to survey catch-at-length (SCAL) data from 2010 to 2012 from Fairweather (2012).

Should “current best assessment” results be required, those for RS1-2012-SCAL would be the most appropriate to quote.

RESULTS AND DISCUSSION

Table 1 compares estimates of management quantities for these four assessments, while Fig. 1 plots the spawning biomass trajectories. Fig. 2 compares the recruitment trajectories and Fig. 3 plots the estimated stock-recruitment relationships.

Figs 4 and 5 compare the fits to the CPUE and survey abundance indices for RS1-2009 and RS1-2012-SCAL. Figs 6 and 7 plot the fits of the survey length distributions for RS1-2012-SCAL. The fits to the gender-disaggregated survey CAL distributions for *M. paradoxus* in the south coast spring survey (first column of Fig. 7b) are the only indications of appreciable model misspecification. Although some misspecification is evident in the original RS1 (RS1-2009) too (see Fig. 8), the lack of fit was not as appreciable.

REFERENCES

- Fairweather T. 2012. Research Survey Hake Data - 2012 Update. Unpublished report, DAFF/2012/OCT/SWG-DEM/20.
- Glazer JP. 2012a. Separating the offshore hake catches by coast and species. Unpublished report: FISHERIES/2012/OCT/SWG-DEM/19.
- Glazer JP. 2012b. Offshore hake species-specific standardized CPUE indices. Unpublished report: FISHERIES/2012/OCT/SWG-DEM/18.
- Rademeyer RA. 2011. 2011 routine update of the South African hake Base Reference Case assessment. Unpublished report: FISHERIES/2011/AUGUST/SWG/DEM/
- Rademeyer RA and Butterworth DS. 2010. Proposed Reference Set for the South African hake resource to be used in OMP-2010 testing. Unpublished report: MCM/2010/FEB/SWG-DEM/05.

Table 1: Comparison of estimates of management quantities of the *M. paradoxus* and *M. capensis* coast-combined resources for the four assessments. *MSY* and associated quantities are given for the offshore trawl fleet. Biomass units are thousand tons. Note that the $-\ln L$ values are not comparable given that different data are used. K^{sp} , B_y^{sp}/K^{sp} , B_{MSY}^{sp}/K^{sp} and B_y^{sp}/B_{MSY}^{sp} are all in terms of the female component of the spawning biomass only.

	RS1-2009	RS1-2011	RS1-2012	RS1-2012-scal
-lnL total	-94.5	-103.0	-110.0	-58.1
CPUE historic	-37.1	-37.2	-37.6	-38.1
CPUE GLM	-136.1	-143.4	-148.2	-143.0
Survey	-34.3	-34.5	-35.4	-38.0
Commercial CAL	-50.1	-50.0	-49.9	-51.9
Survey CAL (sex-aggr.)	-6.7	-6.7	-6.3	-2.3
Survey CAL (sex-disaggr.)	20.4	20.3	18.8	66.7
ALK	124.3	124.2	124.1	124.0
Recruitment penalty	8.6	8.3	8.7	8.8
Selectivity smoothing penalty	16.2	15.5	15.6	15.5
<hr/>				
<i>M. paradoxus</i>				
K^{sp}	729	711	704	586
h	1.08	1.09	1.09	1.23
B^{sp}_{2009}/K^{sp}	0.14	0.16	0.16	0.16
B^{sp}_{2011}/K^{sp}	-	0.21	0.22	0.21
B^{sp}_{2012}/K^{sp}	-	-	0.23	0.22
B^{sp}_{MSY}/K^{sp}	0.24	0.24	0.24	0.23
$B^{sp}_{2009}/B^{sp}_{MSY}$	0.59	0.66	0.66	0.69
$B^{sp}_{2011}/B^{sp}_{MSY}$	-	0.88	0.91	0.92
$B^{sp}_{2012}/B^{sp}_{MSY}$	-	-	0.97	0.98
<i>MSY</i>	113	113	112	113
<hr/>				
<i>M. capensis</i>				
K^{sp}	254	257	260	251
h	1.41	1.37	1.37	1.40
B^{sp}_{2009}/K^{sp}	0.50	0.52	0.52	0.51
B^{sp}_{2011}/K^{sp}	-	0.65	0.66	0.64
B^{sp}_{2012}/K^{sp}	-	-	0.75	0.71
B^{sp}_{MSY}/K^{sp}	0.36	0.36	0.35	0.36
$B^{sp}_{2009}/B^{sp}_{MSY}$	1.39	1.45	1.47	1.43
$B^{sp}_{2011}/B^{sp}_{MSY}$	-	1.82	1.88	1.79
$B^{sp}_{2012}/B^{sp}_{MSY}$	-	-	2.14	2.00
<i>MSY</i>	70	70	69	70

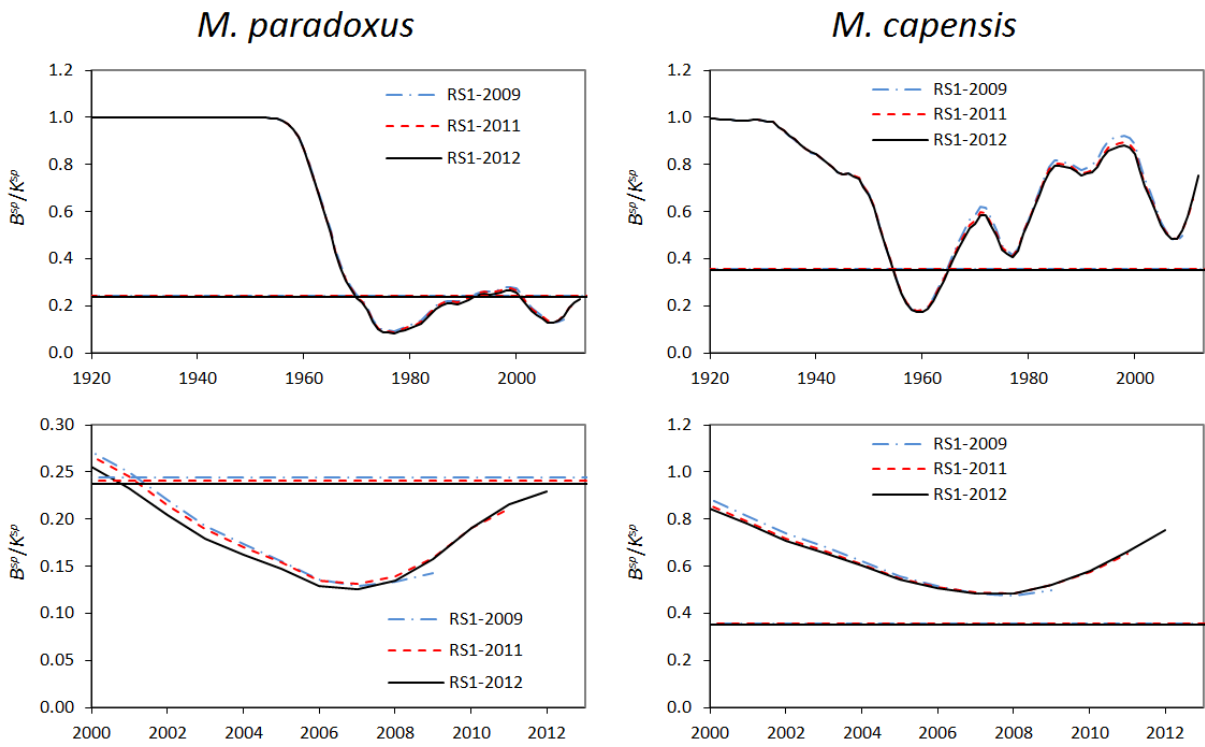


Fig. 1a: Trajectories of female spawning biomass (in terms of its pre-exploitation level) for the RS1-2009, RS1-2011 and RS1-2012 assessments. The horizontal lines represent *MSYL*.

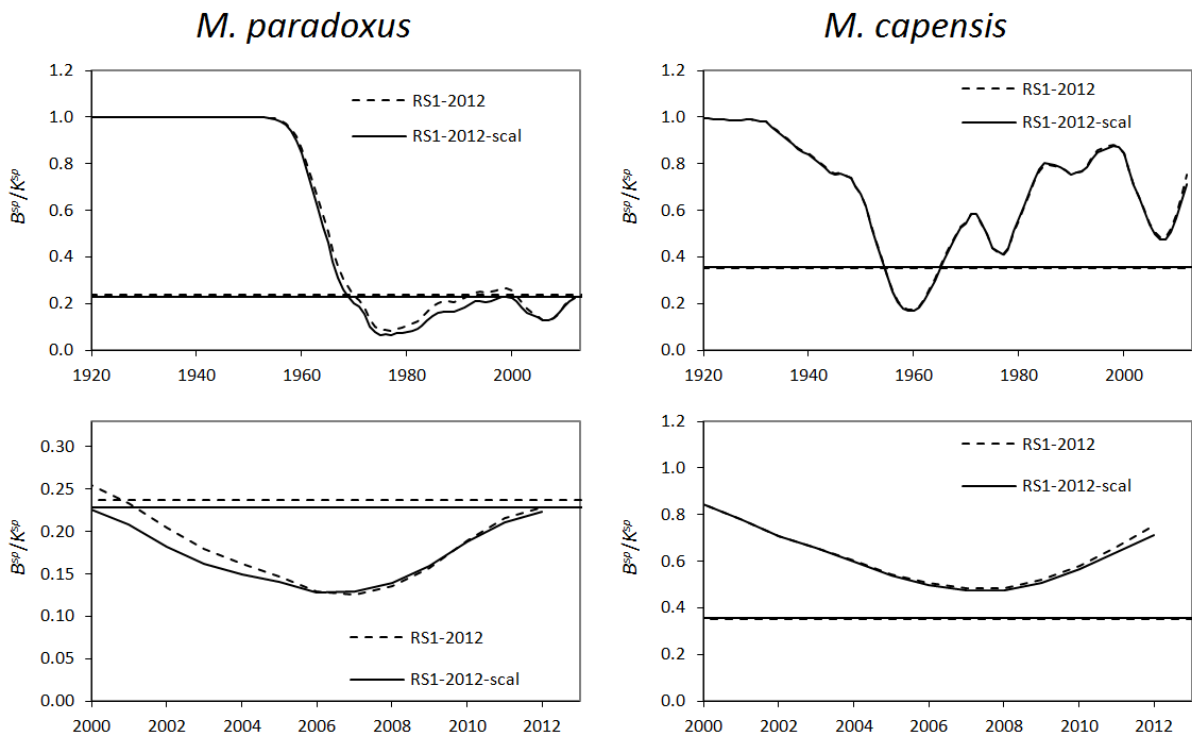


Fig. 1b: Trajectories of gender-aggregated spawning biomass (in terms of the pre-exploitation level) for the RS1-2012 and RS1-2012-SCAL assessments. The horizontal lines represent *MSYL*.

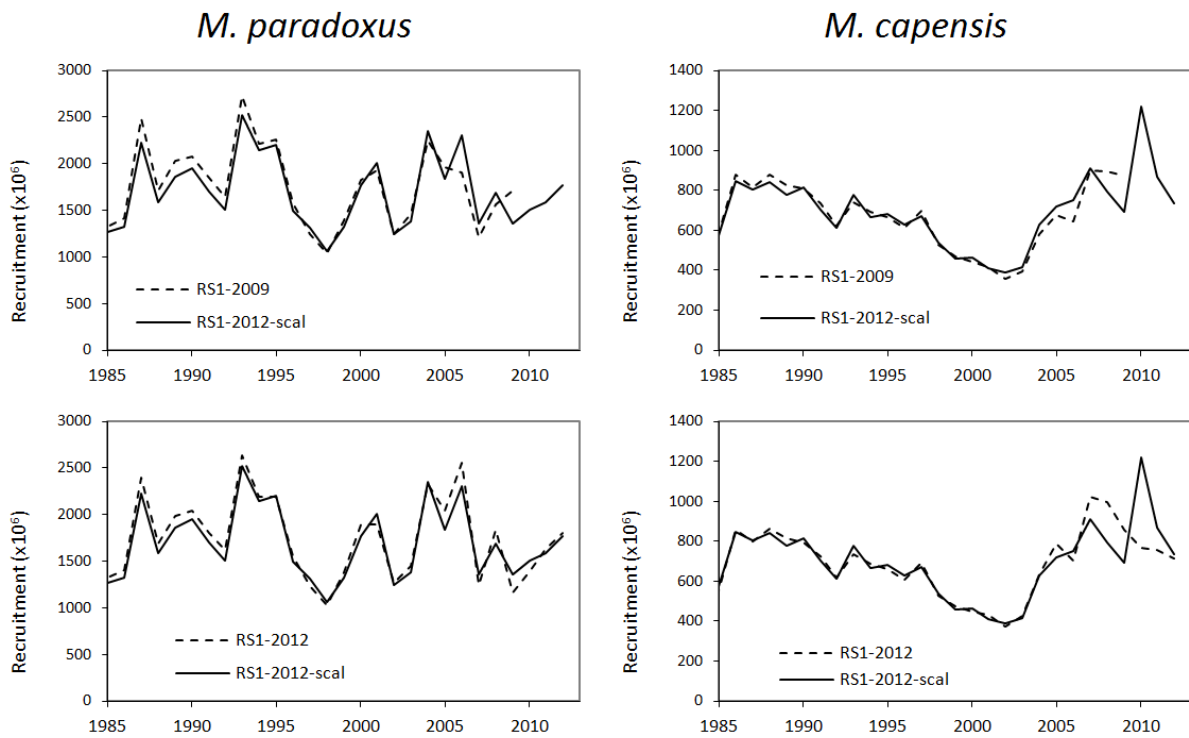


Fig. 2: Time series of recruitment for RS1-2012-SCAL compared to RS1-2009 (top plots) and to RS1-2012 (bottom plots). Note that the decrease in σ_R from 0.25 to 0.1 has been moved three years forward for RS1-2012-SCAL (and RS1-2012) compared to RS1-2009.

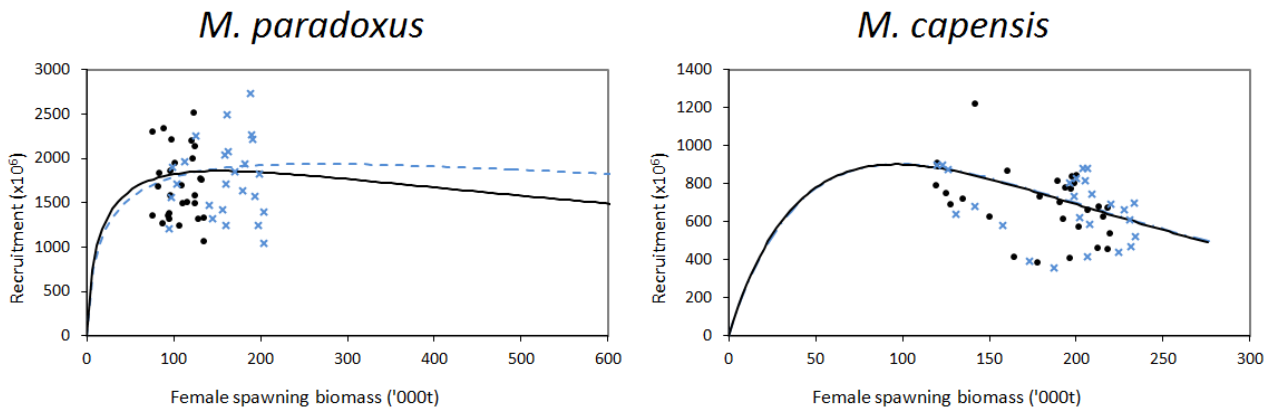


Fig. 3: Estimated stock-recruitment relationships for RS1-2009 (dashed blue line and blue crosses) and RS1-2012-SCAL (solid black line and black dots).

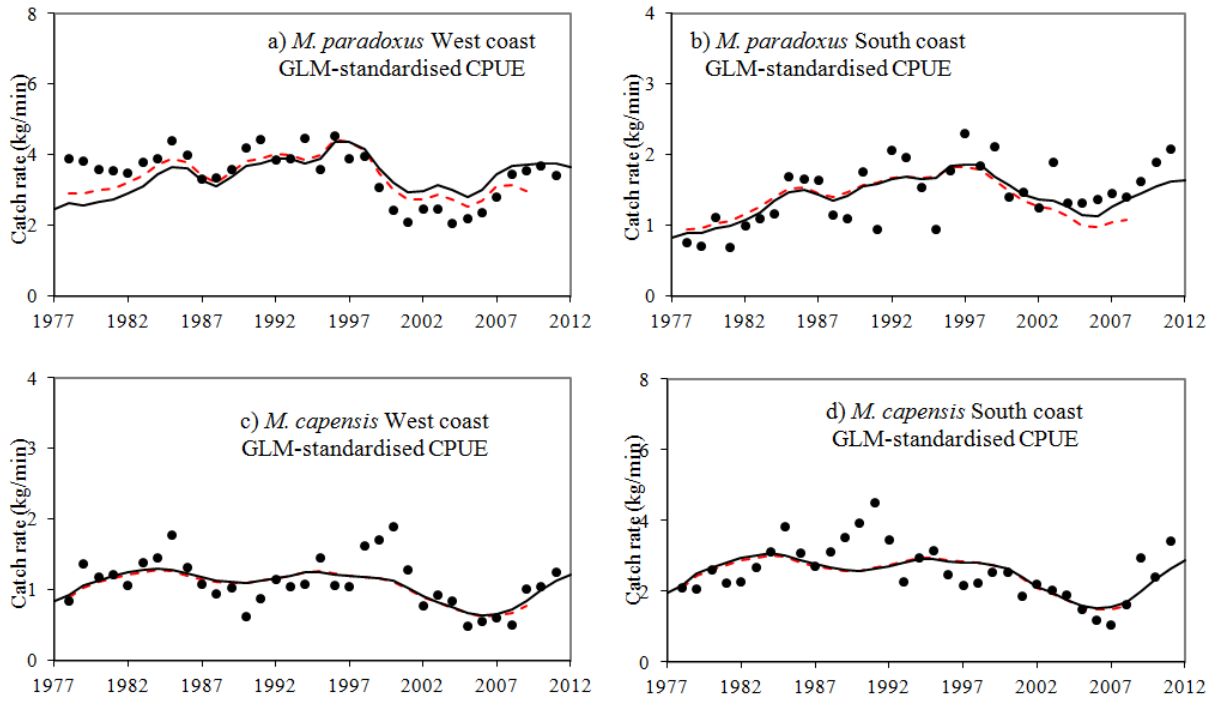


Fig. 4: Fits to the CPUE abundance indices for the RS1-2009 (dashed blue line) and RS1-2012-SCAL (solid black line).

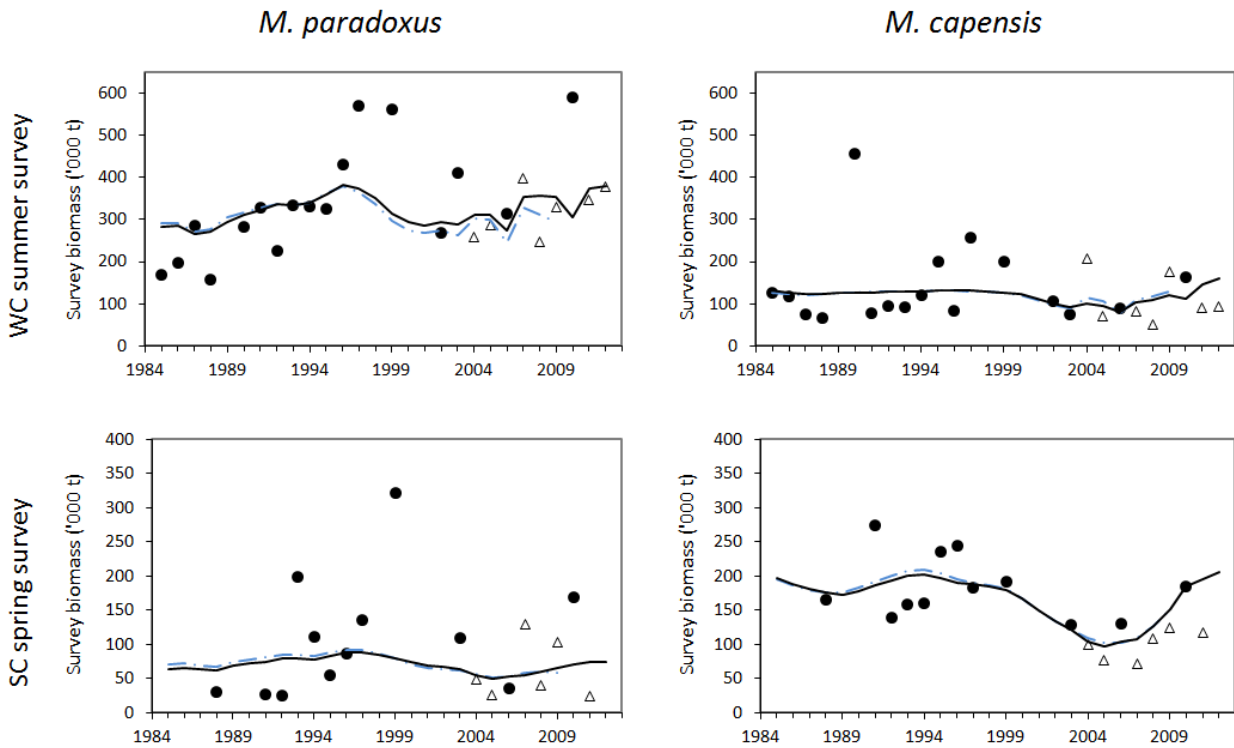


Fig. 5: Fits to the west coast summer and south coast autumn abundance series from surveys by *Africana* (the two longest series) for the RS1-2009 (dashed blue line) and RS1-2012-SCAL (solid black line) assessments. The observed values shown as Δ were conducted by the *Africana* with the new gear and have been rescaled by the agreed calibration factor for the species concerned.

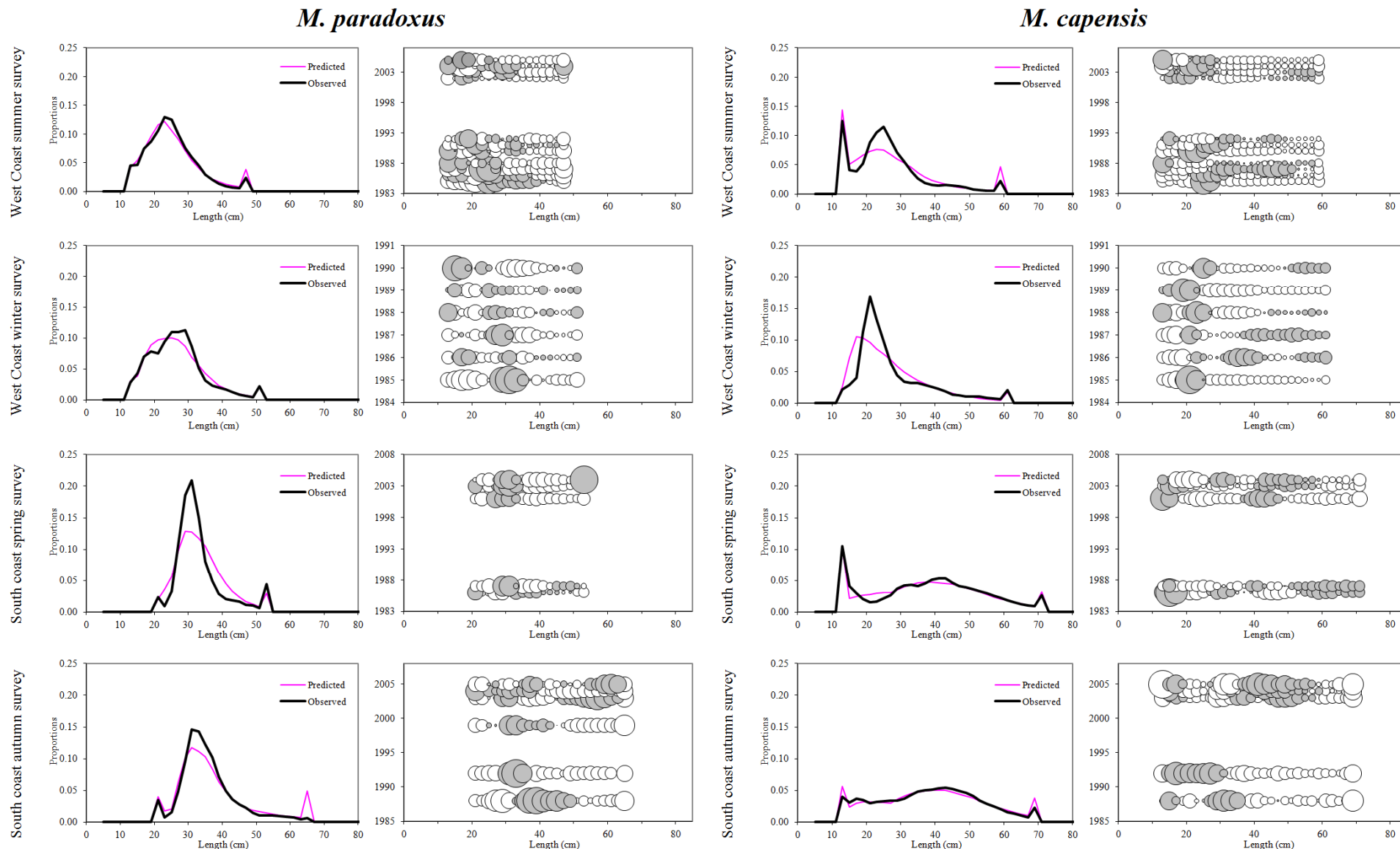


Fig. 6: Fit of RS1-2012-SCAL to the survey gender-aggregated surveys proportion-at-length data, aggregated over years for which data are available. Bubble plots of the corresponding residuals are shown. Here and in the figures following, the area of the bubble is proportional to the magnitude of the corresponding residuals. For positive residuals the bubbles are grey, whereas for negative residuals the bubbles are white.

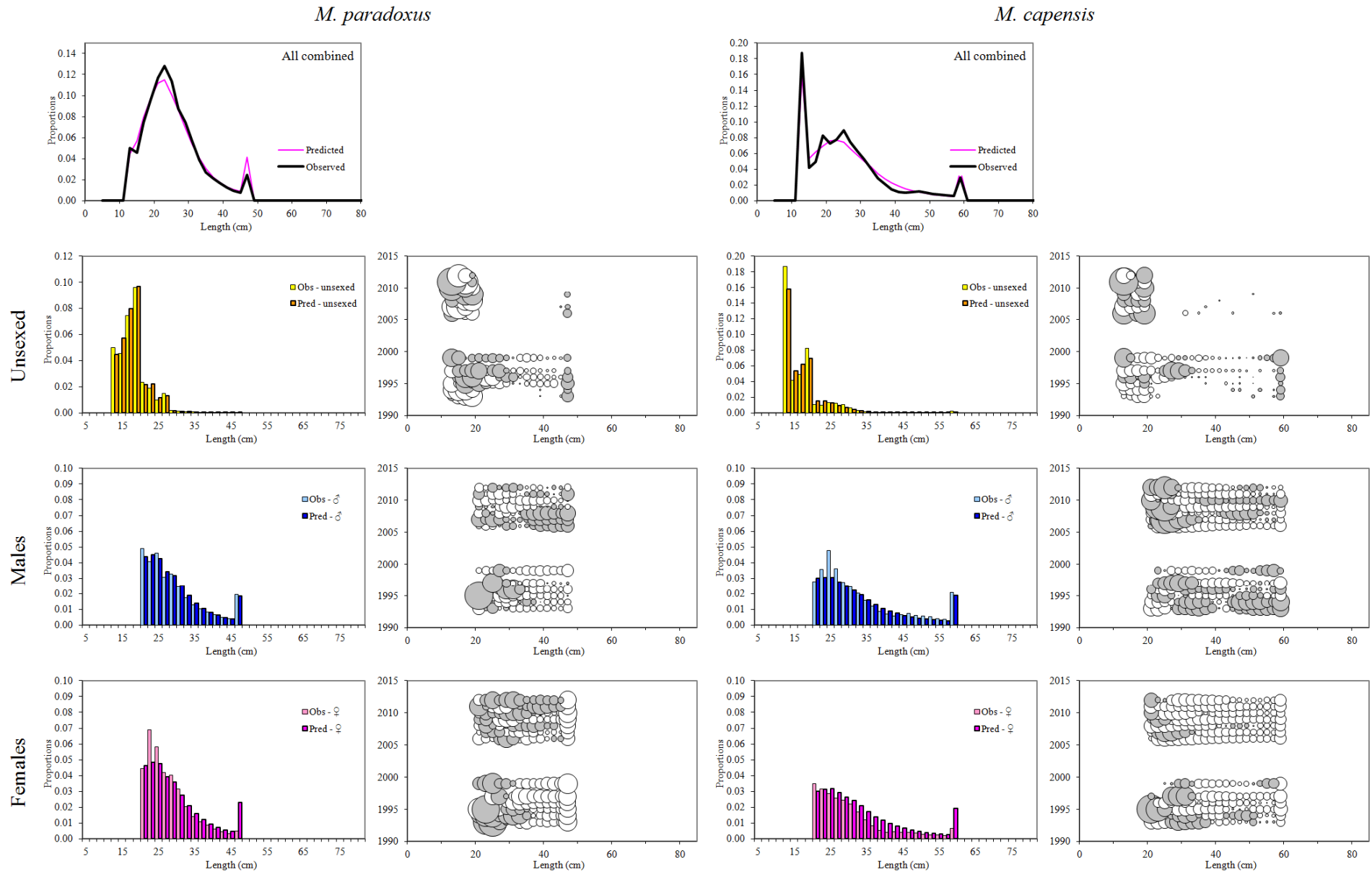


Fig. 7a: Fit of RS1-2012-SCAL to the west coast summer survey gender-disaggregated proportion-at-length data (in some plots, aggregated over years for which data are available).

South coast spring survey

M. paradoxus

South coast spring survey

M. capensis

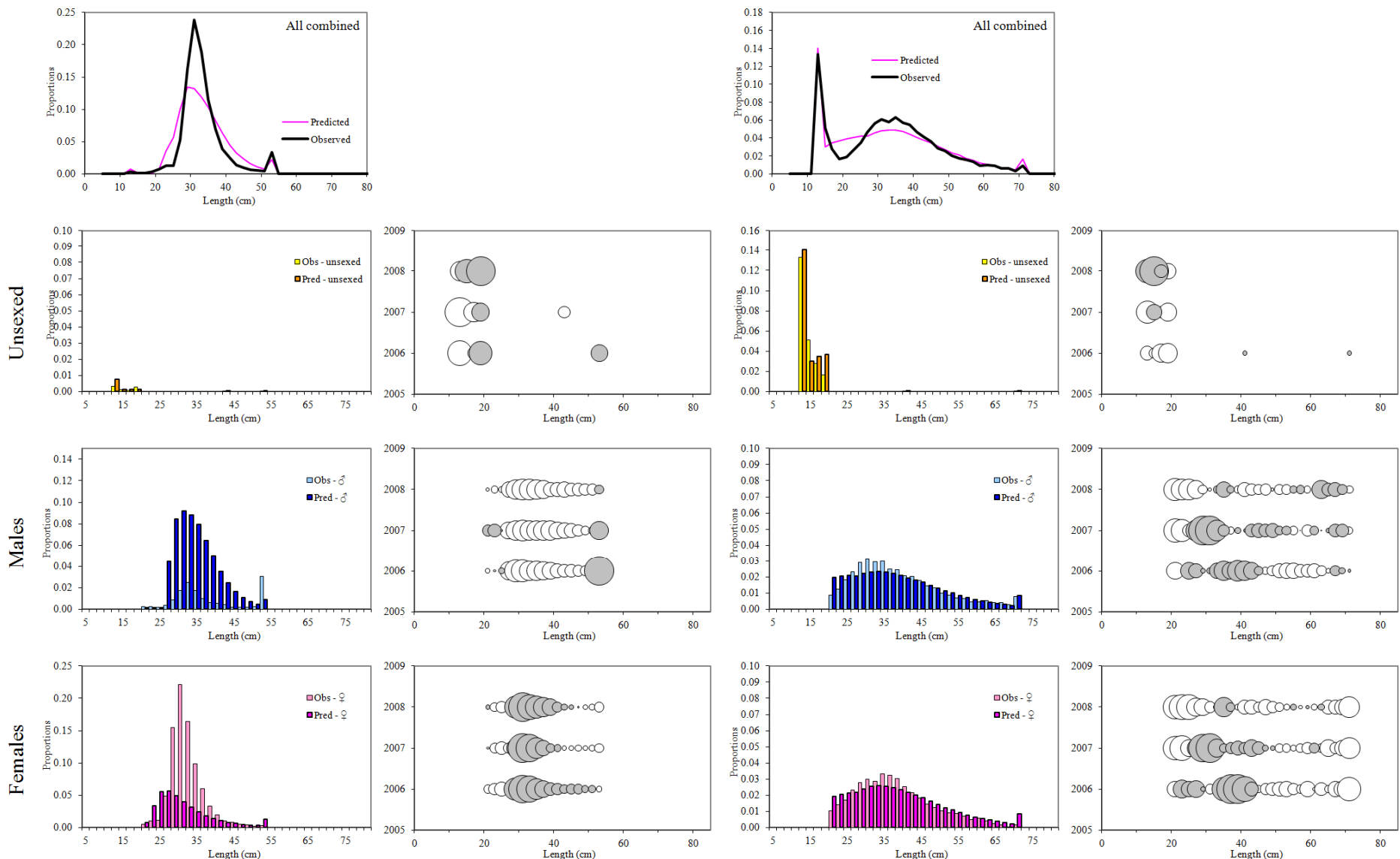


Fig. 7b: Fit of RS1-2012-SCAL to the south coast spring survey gender-disaggregated proportion-at-length data (in some plots, aggregated over years for which data are available).

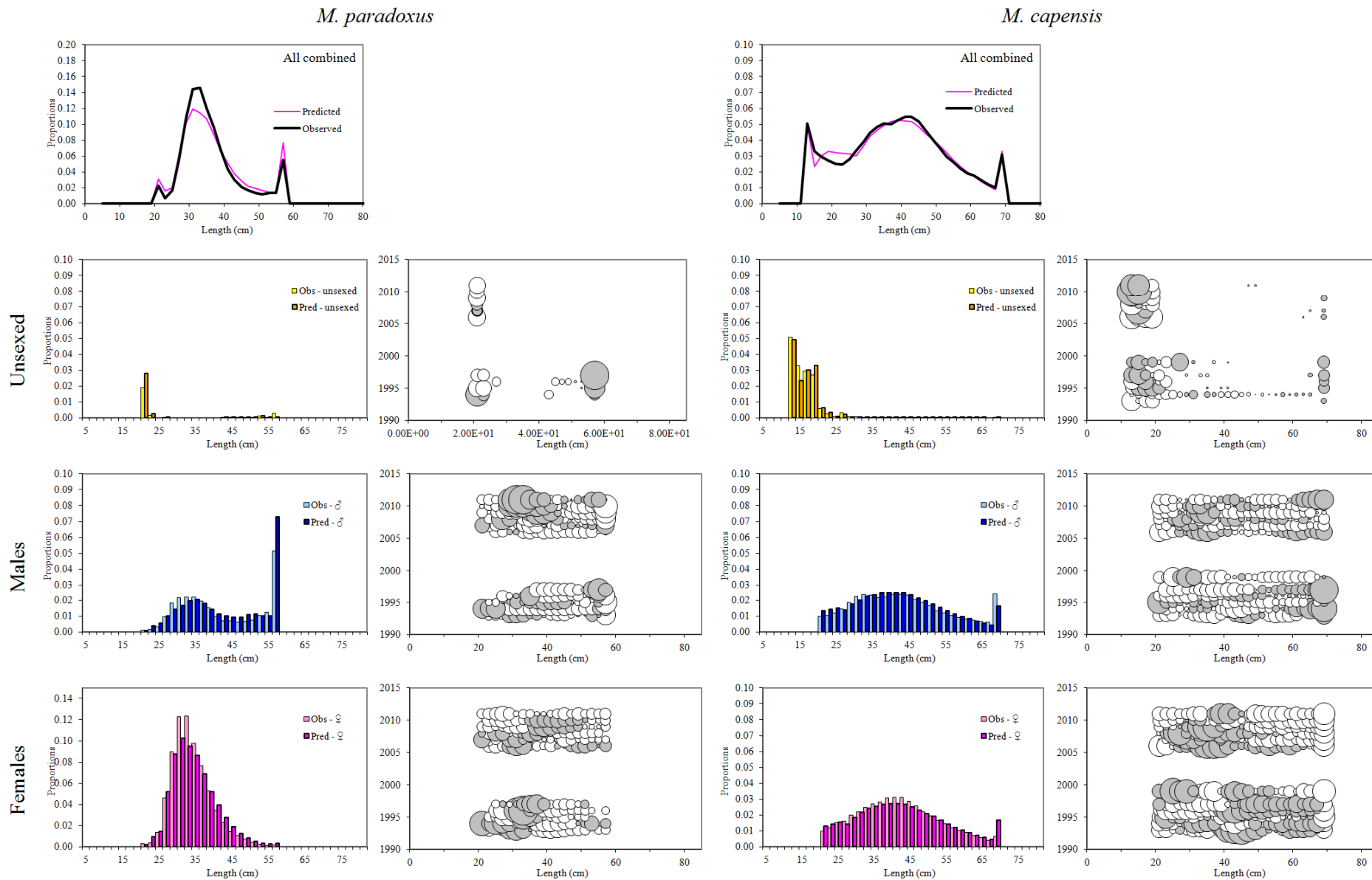


Fig. 7c: Fit of RS1-2012-SCAL to the south coast autumn survey gender-disaggregated proportion-at-length data (in some plots, aggregated over years for which data are available).

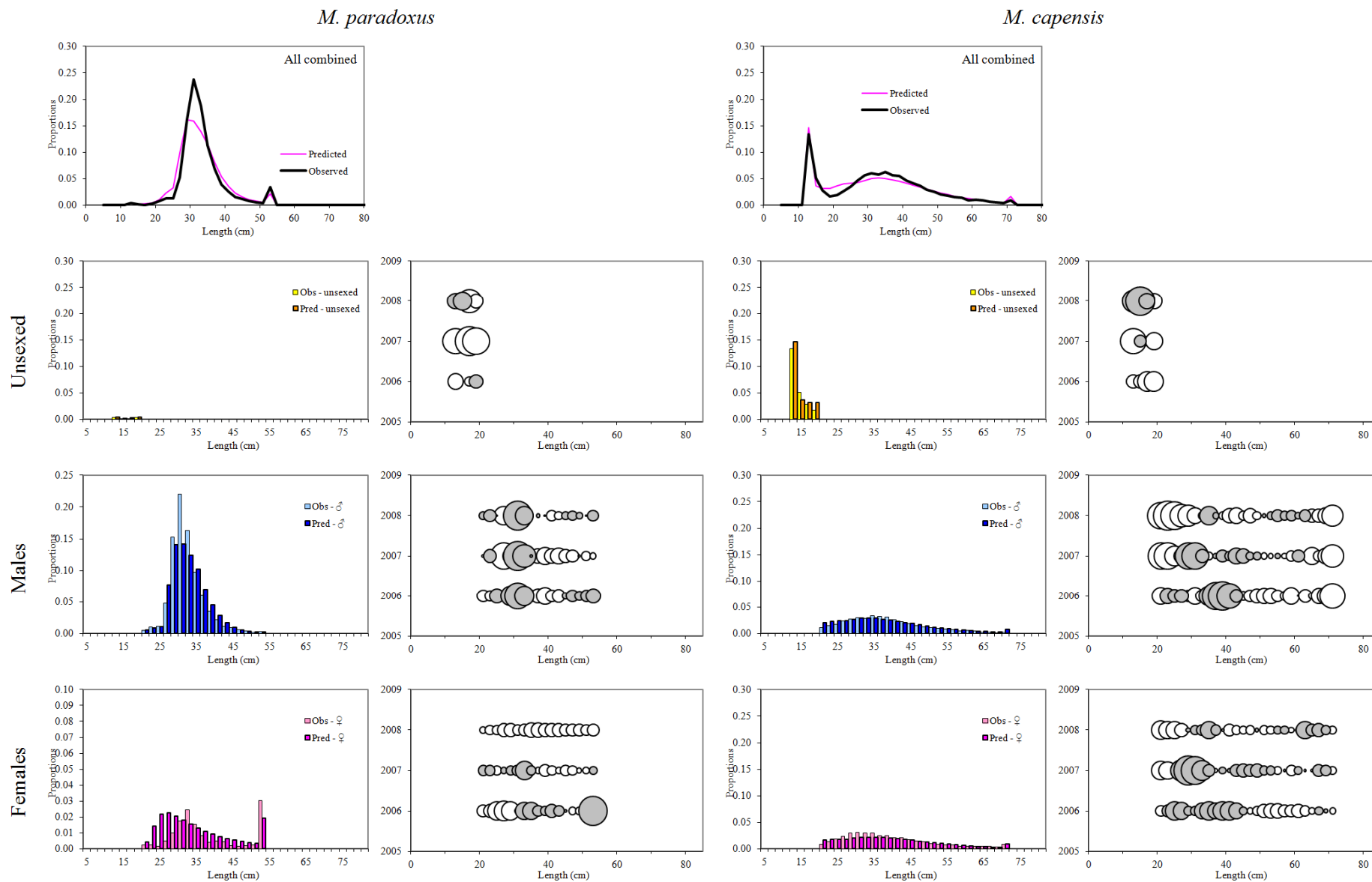


Fig. 8: Fit of RS1-2009 to the south coast spring survey gender-disaggregated proportion-at-length data (in some plots, aggregated over years for which data are available).

Appendix A - Data Tables

Only the data series that have been updated from the Rademeyer and Butterworth (2010) assessment are presented. An exception is the survey catch-at-length (SCAL) data, which are not shown here because of the size of the tables.

Table App.A.1: Species-disaggregated catches (in thousand tons) by fleet of South African hake from the south and west coasts. Here and in the rest of the document, data that are shaded represent new or revised information since the 2011 assessment (Rademeyer, 2011). The new/revised offshore trawl catches are from Glazer (2012a) and the new/revised inshore, longline and handline catches are from Rob Cooper (pers. commn). The baseline assessment assumes 1958 as the centre year of the shift from a primarily *M. capensis* to a primarily *M. paradoxus* in the offshore trawl catches. For 2012, the catches are taken as the 2012 TAC with the same proportion by species and fleet as in 2011.

	<i>M. paradoxus</i>			<i>M. capensis</i>					
	Offshore		Longline	Offshore		Inshore	Longline		Handline
	WC	SC	WC	WC	SC	SC	WC	SC	SC
1978	103.665	3.830	-	23.847	3.755	4.931	-	-	-
1979	93.711	2.653	-	39.811	4.266	6.093	-	-	-
1980	100.723	2.833	-	32.805	3.628	9.121	-	-	-
1981	90.572	1.208	-	30.358	4.277	9.400	-	-	-
1982	84.030	4.063	-	29.319	7.294	8.089	-	-	-
1983	71.628	5.920	0.161	22.805	6.596	7.672	0.069	-	-
1984	82.940	4.689	0.256	28.316	6.246	9.035	0.110	0.016	-
1985	93.192	10.054	0.817	31.878	9.962	9.203	0.350	0.292	0.065
1986	105.097	9.974	0.965	28.708	5.991	8.724	0.413	0.302	0.084
1987	95.954	9.495	2.500	21.571	6.189	8.607	1.071	0.353	0.096
1988	83.910	7.184	3.628	22.672	7.332	8.417	1.555	0.331	0.071
1989	84.719	6.919	0.203	22.541	11.993	10.038	0.087	0.032	0.137
1990	89.976	11.636	0.270	13.660	11.155	10.012	0.116	-	0.348
1991	92.787	9.604	-	13.663	12.470	8.206	-	3.000	1.270
1992	89.638	19.260	-	13.649	7.202	9.252	-	1.500	1.099
1993	107.370	11.143	-	10.694	3.117	8.870	-	0.000	0.278
1994	112.355	7.842	1.130	11.512	3.210	9.569	0.484	0.626	0.449
1995	104.842	4.486	0.670	16.055	2.664	10.630	0.287	0.650	0.756
1996	119.889	10.467	1.676	9.286	2.822	11.062	0.718	1.828	1.515
1997	108.917	12.902	1.806	8.237	2.934	8.834	0.774	1.872	1.404
1998	115.290	11.165	0.647	12.363	2.988	8.283	0.277	1.471	1.738
1999	90.030	12.749	1.963	13.731	2.597	8.595	0.841	4.144	2.749
2000	91.437	8.772	3.456	26.264	4.758	10.906	1.481	2.077	5.500
2001	98.133	8.226	2.793	19.463	7.931	11.836	1.197	1.688	7.300
2002	95.115	13.630	4.772	9.815	4.954	9.581	2.045	3.945	3.500
2003	95.035	20.503	4.668	10.342	4.530	9.883	2.000	4.878	3.000
2004	85.893	28.817	3.758	12.338	5.953	10.004	1.611	4.429	1.600
2005	88.595	24.383	4.172	6.673	4.863	7.881	1.788	4.559	0.700
2006	84.902	19.915	3.592	8.595	4.712	5.524	1.539	4.032	0.400
2007	96.408	14.916	3.151	12.461	2.328	6.350	1.350	3.834	0.400
2008	92.405	13.862	2.170	6.970	3.644	5.496	0.930	2.740	0.231
2009	73.183	12.534	2.434	7.316	3.166	5.639	1.043	3.841	0.265
2010	72.069	16.746	2.403	7.826	2.766	5.472	1.030	3.829	0.275
2011	76.329	17.775	3.346	12.040	2.653	6.013	1.434	3.693	0.005
2012	89.567	20.858	3.926	14.128	3.113	7.056	1.683	4.334	0.006

Table App.A.2: South and west coast GLM standardized CPUE data (Glazer, 2012b) for *M. paradoxus* and *M. capensis*.

Year	GLM CPUE (kg min ⁻¹)			
	<i>M. paradoxus</i>		<i>M. capensis</i>	
	West Coast	South Coast	West Coast	South Coast
1978	3.89	0.76	0.85	2.09
1979	3.82	0.71	1.36	2.06
1980	3.59	1.11	1.17	2.60
1981	3.55	0.68	1.21	2.24
1982	3.48	0.99	1.05	2.27
1983	3.77	1.10	1.38	2.67
1984	3.90	1.16	1.46	3.11
1985	4.38	1.68	1.77	3.81
1986	3.98	1.66	1.32	3.08
1987	3.32	1.64	1.08	2.72
1988	3.34	1.15	0.94	3.10
1989	3.57	1.09	1.03	3.54
1990	4.19	1.75	0.62	3.94
1991	4.43	0.95	0.87	4.51
1992	3.84	2.06	1.14	3.46
1993	3.89	1.96	1.04	2.25
1994	4.46	1.54	1.08	2.95
1995	3.58	0.95	1.45	3.13
1996	4.52	1.77	1.06	2.46
1997	3.89	2.30	1.04	2.15
1998	3.96	1.85	1.61	2.23
1999	3.09	2.11	1.71	2.54
2000	2.42	1.40	1.89	2.52
2001	2.09	1.47	1.29	1.87
2002	2.46	1.25	0.78	2.20
2003	2.48	1.89	0.93	2.04
2004	2.05	1.32	0.83	1.90
2005	2.19	1.31	0.49	1.50
2006	2.35	1.37	0.56	1.18
2007	2.81	1.45	0.60	1.04
2008	3.45	1.40	0.51	1.61
2009	3.53	1.61	1.01	2.94
2010	3.68	1.90	1.04	2.39
2011	3.41	2.08	1.26	3.40

Table App.A.3a: Survey abundance estimates and associated standard errors in thousand tons for *M. paradoxus* for the depth range 0-500m for the south coast and for the west coast (updated values from Fairweather, 2012). Values in bold are for the surveys conducted by the *Africana* with the new gear.

Year	West coast				South coast			
	Summer		Winter		Spring (Sept)		Autumn (Apr/May)	
	Biomass	(s.e.)	Biomass	(s.e.)	Biomass	(s.e.)	Biomass	(s.e.)
1985	169.959	(36.680)	264.839	(52.949)	-	-	-	-
1986	196.111	(36.358)	172.477	(24.122)	13.758	(3.554)	-	-
1987	284.805	(53.101)	195.482	(44.415)	21.554	(4.605)	-	-
1988	158.758	(27.383)	233.041	(64.003)	-	-	30.316	(11.104)
1989	-	-	468.780	(124.830)	-	-	-	-
1990	282.174	(78.945)	226.862	(46.007)	-	-	-	-
1991	327.020	(82.180)	-	-	-	-	26.638	(10.460)
1992	226.687	(32.990)	-	-	-	-	24.304	(15.195)
1993	334.151	(50.234)	-	-	-	-	198.849	(98.452)
1994	330.270	(58.319)	-	-	-	-	111.469	(34.627)
1995	324.554	(80.357)	-	-	-	-	55.068	(22.380)
1996	430.908	(80.604)	-	-	-	-	85.546	(25.484)
1997	569.957	(108.200)	-	-	-	-	135.192	(51.031)
1998	-	-	-	-	-	-	-	-
1999	562.859	(116.302)	-	-	-	-	321.478	(113.557)
2000	-	-	-	-	-	-	-	-
2001	-	-	-	-	19.929	(9.956)	-	-
2002	267.487	(35.068)	-	-	-	-	-	-
2003	411.177	(69.431)	-	-	88.442	(36.051)	108.857	(37.528)
2004	259.527	(56.021)	-	-	63.900	(17.894)	48.898	(20.343)
2005	286.416	(39.849)	-	-	-	-	26.605	(7.952)
2006	315.310	(49.490)	-	-	72.415	(15.500)	34.799	(8.325)
2007	397.049	(71.564)	-	-	52.287	(19.231)	129.646	(60.661)
2008	246.542	(51.973)	-	-	24.816	(8.775)	39.505	(11.408)
2009	330.235	(28.526)	-	-	-	-	102.834	(28.670)
2010	589.533	(85.686)	-	-	-	-	169.560	(67.650)
2011	347.082	(92.540)	-	-	-	-	24.105	(7.089)
2012	377.515	(50.690)	-	-	-	-	-	-

Table App.A.3b: Survey abundance estimates and associated standard errors in thousand tons for *M. capensis* for the depth range 0-500m for the south coast and for the west coast (updated values from Fairweather, 2012). Values in bold are for the surveys conducted by the *Africana* with the new gear.

Year	West coast				South coast			
	Summer		Winter		Spring (Sept)		Autumn (Apr/May)	
	Biomass	(s.e.)	Biomass	(s.e.)	Biomass	(s.e.)	Biomass	(s.e.)
1985	124.647	(22.707)	181.487	(27.476)	-	-	-	-
1986	117.810	(23.636)	119.587	(18.489)	121.197	(16.625)	-	-
1987	75.693	(10.241)	87.391	(11.198)	159.088	(17.233)	-	-
1988	66.725	(10.765)	47.120	(9.568)	-	-	165.939	(21.871)
1989	-	-	323.833	(67.295)	-	-	-	-
1990	455.798	(135.237)	157.800	(23.561)	-	-	-	-
1991	77.357	(14.995)	-	-	-	-	274.298	(44.395)
1992	95.407	(11.744)	-	-	-	-	138.085	(15.357)
1993	92.598	(14.589)	-	-	-	-	158.340	(13.733)
1994	121.257	(35.951)	-	-	-	-	160.555	(23.701)
1995	199.142	(26.812)	-	-	-	-	236.025	(31.840)
1996	83.337	(9.285)	-	-	-	-	244.410	(25.107)
1997	257.293	(46.056)	-	-	-	-	183.087	(18.906)
1998	-	-	-	-	-	-	-	-
1999	198.716	(32.467)	-	-	-	-	191.203	(14.952)
2000	-	-	-	-	-	-	-	-
2001	-	-	-	-	133.793	(20.858)	-	-
2002	106.253	(15.813)	-	-	-	-	-	-
2003	75.960	(13.314)	-	-	82.928	(9.010)	128.450	(20.062)
2004	205.939	(33.216)	-	-	106.119	(15.596)	99.902	(12.027)
2005	70.983	(13.845)	-	-	-	-	76.932	(5.965)
2006	88.420	(22.851)	-	-	99.867	(9.803)	130.900	(14.816)
2007	82.270	(11.441)	-	-	74.615	(7.383)	70.940	(5.615)
2008	50.877	(5.355)	-	-	94.232	(11.456)	108.195	(9.978)
2009	175.289	(39.920)	-	-	-	-	124.004	(11.808)
2010	163.545	(34.444)	-	-	-	-	184.960	(37.720)
2011	89.392	(23.218)	-	-	-	-	117.222	(11.857)
2012	92.588	(11.926)	-	-	-	-	-	-