2009 updated stock assessments for West Coast rock lobster

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Summary

The west coast rock lobster assessment of 2006[1] based on data to 2004 is updated to include data up to 2008. Over the last four years the exploitable biomass trend is upwards for Areas 7 and 8 and the resource as a whole, but downwards for Areas 5+6 and almost level for Areas 1+2 and 3+4. The overall increase since 2006 is significant at the 5% level. While better than median projections at the time the current OMP developed, the increase remains within the 95% probability intervals calculated at the time.

Introduction

The stock assessments for each of the five super-areas of the West Coast rock lobster fishery were last conducted in 2006 (Johnston and Butterworth 2006) using data to the 2004 season. This document reports updates of these assessments where data are now extended to the 2008 season. It should be noted that the 2006 assessments underlying the operating models for the current OMP were based on averages of the parameter values estimated by OLRAC and MARAM. Here we compare the MARAM 2006 assessment with the updated MARAM 2009 assessment.

Data

The 2006 assessment included data up to 2004. The 2009 assessment is extended to include data up to 2008. The data updates include:

- trap CPUE data (Glazer 2009a)
- hoopnet CPUE data (Glazer 2009b and c)
- FIMS data (Brandao and Butterworth 2009)
- Somatic growth data (OLRAC 2009)
- Commercial catch data (van Zyl 2009)
- Commercial trap and hoopnet catch-size structure data (van Zyl and Johnston 2009)
- Commercial trap and hoopnet F% (percent females in catch) data (van Zyl and Johnston 2009)

Figure 1 shows the somatic growth trends for each super-area as used as input into these assessments.

[1] The 2006 season refers to that commencing in Nov 2006 and extending into the following calendar year.

Note that 2009 assessment results include CV and 95% confidence interval estimates. These were obtained by bootstrapping, where pseudo data for abundance indices only were generated assuming log normally distributed error. Because the whole estimation takes too long in terms of computer time to carry out such a bootstrap exercise, all parameters except R_{1910}, R_{1975}, R_{1980}, R_{1985}, R_{1990}, R_{1995} and R_{2000} were fixed at their MLE values in this exercise. These recruitment parameters are the primary determinants of resource trend, which is why they were singled out. However, this calculation process does mean that the CV estimates will be negatively biased to some extent.

Differences between the 2006 and 2009 assessments

Table 1 provides details of the differences between the 2006 and 2009 assessments with respect to the periods for which data are available for input. One further difference between the two assessments is the somatic growth rates assumed for the pre- and post-data periods. The rule for both assessments is that the pre- and post-data somatic growth is set equal to the average of the available data. Thus:

2006 assessment

- historic average somatic growth (i.e. 1910-1967) = average of 1968-2004 values
- future (2005+) somatic growth = average of 1968-2004 values.

2009 assessment

- historic average somatic growth (i.e. 1910-1967) = average of 1968-2008 values
- future (2009+) somatic growth = average of 1968-2008 values.

Sensitivity Analysis

The reference case assessment for 2009 was implemented in an identical manner to that of the 2006 assessment, except for the increase in input data. The 2006 and 2009 reference case (RC) assessment fit the following recruitment parameters: R_{1910}, R_{1920}, R_{1950}, R_{1975}, R_{1980}, R_{1985}, R_{1990}, R_{1995} and R_{2000}. Recruitment for R_{2005} and beyond was assumed to be equal to the geometric mean of the recruitment values for 1975, 1980, 1985, 1990 and 1995. Annual recruitment is calculated by applying linear interpolation between the various estimated recruitment parameters.

Due to the fact there are now four further years of data to take into account in the model fitting procedure, and thus there is the ability to estimate recruitment for a longer time period, a sensitivity analyses is conducted where an extra recruitment parameter R_{2003} is added. Linear interpolation is used to calculated the annual recruitment values between 2000 and 2003, and between 2003 and 2007, where R_{2007} (and above) is set equal to the geometric mean of the recruitment values for 1975, 1080, 1985, 1990 and 1995 (as for the RC).

Results

Table 2 compares some key model output statistics between the 2006 and the now updated RC 2009 assessments for each super-area. Table 3a reports further details of the 2009 RC super-area assessments, with Table 3b reporting details of the sensitivity

analyses. Table 4 reports the 2009 RC and sensitivity updated assessment results for the resource as a whole (i.e. summed over all five super-areas). Figures 2a-e show the RC model fits to the various CPUE data for all super-areas. The fits to these indices of abundance are generally good, with the exceptions of the Area 5+6 hoopnet and Area 7 trap CPUE data.

Figure 3 shows the RC exploitable biomass trend for the resource as a whole as a proportion of its pre-exploitation level. Figure 4 shows plots of this biomass since 1980 for each of the five super-areas in absolute terms. Over the last four years these trends are upwards for Areas 7 and 8 and the resource as a whole, but downwards for Areas 5+6 and almost level for Area 1+2 and 3+4. The confidence interval estimates shown in Figure 4 suggest the recent trend in Areas 5+6 is definitely down, while only that in Area 8 is clearly upwards. Results in Table 4 indicate, as expected, that precision falls with the introduction of a further estimable recruitment parameter, but the overall increase in abundance since 2006 remains significant at the 5% level.

While the increase since 2006 is better than median projections at the time the current OMP was developed (Johnston and Butterworth 2007), the increase remains within the 95% probability intervals calculated at the time.

References

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Table 1: Comparison of the periods for which data are available between the 2006 and 2009 assessments. [For CPUE, Size and %F, H=hoopnet, T=trap and F=FIMS.]

Super-Area and Assessment year	**Catch**	**CPUE**	**Size and %F**	**Somatic growth**
A12 2006	1910-2006	H: 1976-2004	H: 1985-2004	1985-2004
2009	1910-2008	H: 1976-2008	H: 1985-2008	1985-2008
A34 2006	1910-2006	T: 1981-2001 H: 1981-2004 F: 1992-2004	T: 1976-2004 H: 1976-2004 F: 1992-2004	1967-2004
2009	1910-2008	T: 1981-2001 H: 1981-2008 F: 1992-2008	T: 1976-2008 H: 1976-2008 F: 1992-2004	1967-2008
A56 2006	1910-2006	T: 1981-2004 H: 1986-2004 F: 1992-2004	T: 1976-2002 H: 1976-2004 F: 1992-2004	1967-2004
2009	1910-2008	T: 1981-1997 H: 1986-2008 F: 1992-2008	T: 1976-2002 H: 1976-2008 F: 1992-2004	1967-2008
A7 2006	1910-2006	T: 1981-2004 F: 1992-2004	T: 1976-2004 H: 1978-2004 F: 1992-2004	1967-2004
2009	1910-2008	T: 1981-2008 F: 1992-2008	T: 1976-2008 F: 1992-2004	1967-2008
A8 2006	1910-2006	T: 1985-2004 H: 1986-2004 F: 1992-2004	T: 1976-2004 H: 1982-2004 F: 1992-2004	1967-2004
2009	1910-2008	T: 1985-2008 H: 1986-2008 F: 1992-2008	T: 1976-2008 H: 1982-2008 F: 1992-2004	1967-2008

Table 2: Comparison of key model statistics between the 2006 and the updated 2009 RC assessments. Values for B^{75}_{2009} in parentheses are the bootstrap CV (%) estimates.

	Super-Area	**2006 assessment**	**2009 assessment**
B^{75}_{2005} / K	Area 1+2	0.012	0.020
	Area 3+4	0.022	0.022
	Area 5+6	0.007	0.006
	Area 7	0.023	0.024
	Area 8	0.067	0.078
Egg_{2005} / K	Area 1+2	0.021	0.034
	Area 3+4	0.040	0.044
	Area 5+6	0.028	0.028
	Area 7	0.091	0.087
	Area 8	0.275	0.308
B^{75}_{2005}	Area 1+2	434	827
	Area 3+4	3207	3082
	Area 5+6	1016	809
	Area 7	4434	4535
	Area 8	9421	9901
B^{75}_{2009} / K	Area 1+2	-	0.022
	Area 3+4	-	0.020
	Area 5+6	-	0.004
	Area 7	-	0.030
	Area 8	-	0.099
Egg_{2009} / K	Area 1+2	-	0.041
	Area 3+4	-	0.034
	Area 5+6	-	0.019
	Area 7	-	0.087
	Area 8	-	0.301
B^{75}_{2009}	Area 1+2	-	892 (19.77)
	Area 3+4	-	2893 (27.83)
	Area 5+6	-	578 (4.74)
	Area 7	-	5762 (21.87)
	Area 8	-	12597 (10.12)

Table 3a: Comparative contributions to the –ln*L* value, sigma values, biomass and egg production estimates for each super-area for the 2009 RC assessment.

Model	**A1-2**	**A3-4**	**A5-6**	**A7**	**A8**
Female survivorship	0.884	0.890	0.890	0.890	0.890
R_{1910}	3.59×10^{7}	2.63×10^{8}	2.19×10^{8}	1.13×10^{8}	3.046×10^{8}
R_{1920}	5.018	0.914	0.932	0.544	0.396
R_{1950}	0.033	0.097	0.219	0.136	0.070
R_{1970}	0.077	0.105	0.138	0.113	0.122
R_{1975}	0.0002	0.199	0.218	0.188	0.313
R_{1980}	0.039	0.035	0.068	0.045	0.252
R_{1985}	0.034	0.112	0.028	0.047	0.688
R_{1990}	0.023	0.133	0.013	0.039	0.587
R_{1995}	0.013	0.036	0.006	0.013	0.509
R_{2000}	0.051	0.020	0.001	0.109	0.497
Trap CPUE σ	-	0.590	0.401	0.605	0.182
Hoop CPUE σ	0.181	0.531	0.767	0.150	0.227
FIMS CPUE σ	-	1.320	1.013	0.686	0.256
Male Trap Size σ	-	0.241	0.159	0.238	0.261
Female Trap Size σ	-	0.165	0.223	0.172	0.276
Male Hoop Size σ	0.312	0.341	0.162	0.355	0.189
Female Hoop Size σ	0.305	0.206	0.229	0.806	0.433
Male FIMS Size σ	-	0.210	0.244	0.174	0.150
Female FIMS Size σ	-	0.401	0.205	0.210	0.150
Male Sublegal size σ	-	-	-	-	0.158
Female Sublegal size σ	-	-	-	-	0.150
Trap F% σ	-	0.150	0.150	0.150	0.150
Hoop F% σ	0.150	0.150	0.150	0.150	0.150
FIMS F% σ	-	0.150	0.150	0.150	0.150
Total *–lnL*	-19.84	53.63	108.81	65.19	-59.51
B_{75}(1910)	41 105	141 276	145 237	192 275	127 685
B_{75}(2009)	892	2 893	578	5 762	12 597
B_{75}(2009)/B_{75}(1910)	0.022	0.020	0.004	0.030	0.099
B_{75}(2009)/B_{75}(1996)	1.102	1.470	0.291	1.152	0.99
Egg (2009)/Egg (1870)	0.041	0.034	0.019	0.087	0.301

Table 3b: Comparative contributions to the –ln*L* value, sigma values, biomass and egg production estimates for each super-area for the 2009 sensitivity assessment.

Model	**A1-2**	**A3-4**	**A5-6**	**A7**	**A8**
Female survivorship	0.872	0.890	0.890	0.890	0.890
R_{1910}	3.60×10^{7}	2.61×10^{8}	2.19×10^{8}	1.17×10^{8}	3.046×10^{8}
R_{1920}	5.011	0.933	0.929	0.488	0.403
R_{1950}	0.031	0.096	0.219	0.140	0.069
R_{1970}	0.073	0.106	0.139	0.106	0.122
R_{1975}	0.00001	0.205	0.225	0.179	0.309
R_{1980}	0.040	0.030	0.072	0.045	0.258
R_{1985}	0.034	0.116	0.021	0.048	0.685
R_{1990}	0.020	0.136	0.012	0.058	0.603
R_{1995}	0.014	0.037	0.006	0.102	0.504
R_{2000}	0.051	0.020	0.001	0.104	0.503
R_{2003} (new parameter)	**0.002**	**0.010**	**0.001**	**0.115**	**0.364**
Trap CPUE σ	-	0.586	0.431	0.694	0.179
Hoop CPUE σ	0.179	0.535	0.907	0.150	0.275
FIMS CPUE σ	-	1.329	1.271	0.658	0.190
Male Trap Size σ	-	0.243	0.159	0.236	0.270
Female Trap Size σ	-	0.170	0.222	0.175	0.275
Male Hoop Size σ	0.304	0.345	0.158	0.330	0.190
Female Hoop Size σ	0.308	0.203	0.229	0.807	0.433
Male FIMS Size σ	-	0.215	0.225	0.163	0.150
Female FIMS Size σ	-	0.398	0.199	0.212	0.150
Male Sublegal size σ	-	-	-	-	0.161
Female Sublegal size σ	-	-	-	-	0.150
Trap F% σ	-	0.150	0.150	0.150	0.150
Hoop F% σ	0.150	0.150	0.150	0.150	0.150
FIMS F% σ	-	0.150	0.150	0.150	0.150
Total –*lnL*	-19.92	53.71	111.67	69.40	-59.44
B_{75}(1910)	39 448	140 342	145 452	198 846	127 669
B_{75}(2009)	647	2 970	502	5 938	12 818
B_{75}(2009)/B_{75}(1910)	0.017	0.021	0.003	0.030	0.100
B_{75}(2009)/B_{75}(1996)	1.198	1.485	0.255	1.069	1.00
Egg (2009)/Egg (1870)	0.028	0.033	0.018	0.088	0.302

Table 4: 2009 RC and sensitivity updated assessment results for B^{75} where all five super-areas are added (i.e. the resource as a whole). The maximum likelihood best estimate is reported, with the bootstrap 95% CIs in square parentheses, and the CV (as %) in round parentheses.

	RC	**Sensitivity**
B^{75}_{2005}	19 155 MT [15038; 20318] (7.62%)	19 316 MT [14 892; 20196] (7.715)
B^{75}_{2009}	22 724 MT [18895; 26119] (8.19%)	23 122 MT [18 283; 26 221] (9.10%)
B^{75}_{2009} / K	0.035 [0.029; 0.040] (8.19%)	0.035 [0.028; 0.040] (9.07%)
$B^{75}_{2009} / B^{75}_{2006}$	1.33 [1.28; 1.58] (5.26%)	1.35 [1.23; 1.61] (6.89%)
$B^{75}_{2006} / B^{75}_{1996}$	0.76 [0.66; 0.86] (6.80%)	0.74 [0.65; 0.86] (7.09%)
$B^{75}_{2009} / B^{75}_{1996}$	1.01 [0.94; 1.23] (6.93%)	1.00 [0.91; 1.25] (7.98%)

Figure 1: Somatic growth rate plots (SG here is the mean annual somatic growth rate of a 70mm male lobster – see OLRAC 2009).

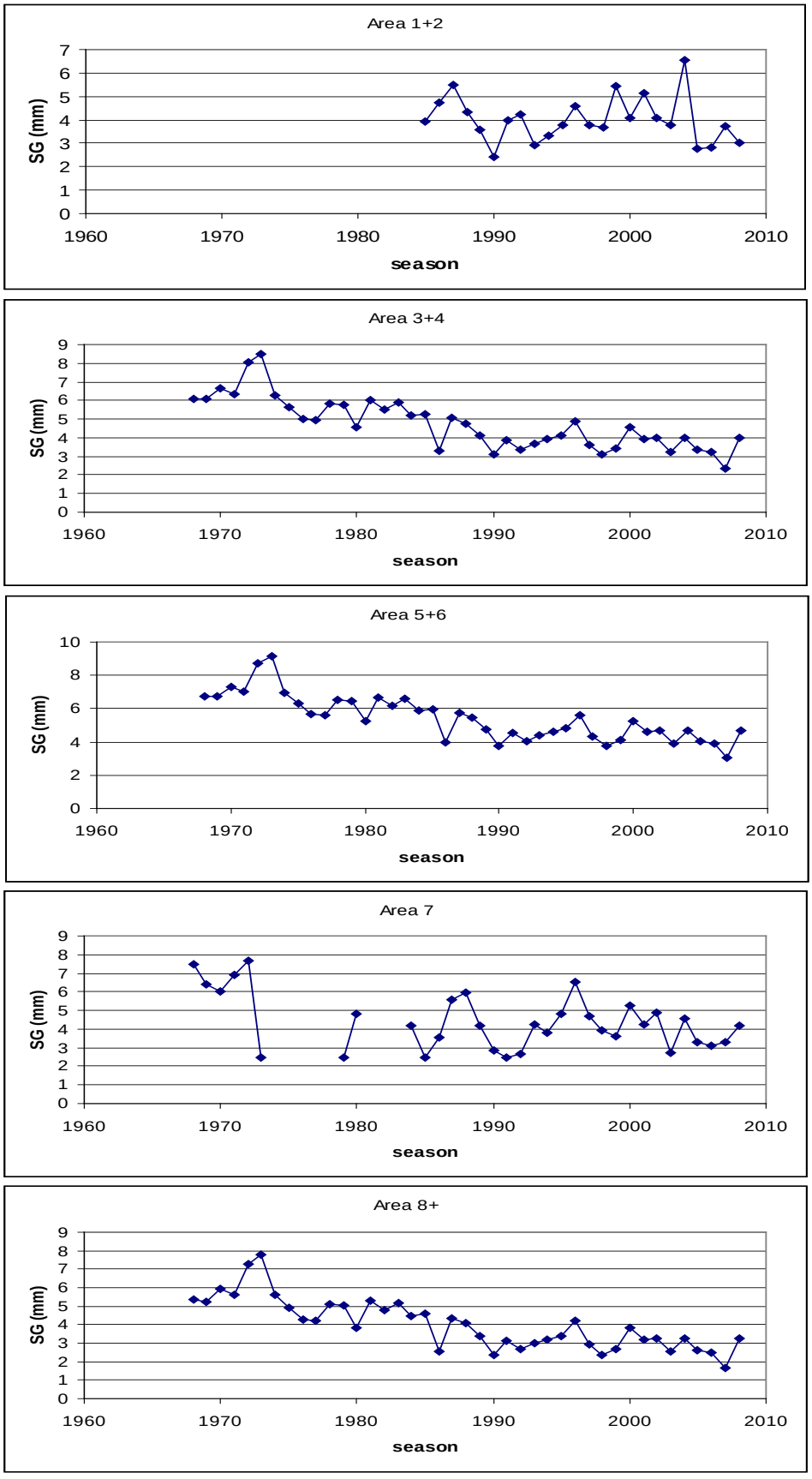


Figure 2a: RC Area 1+2 fits to CPUE data.

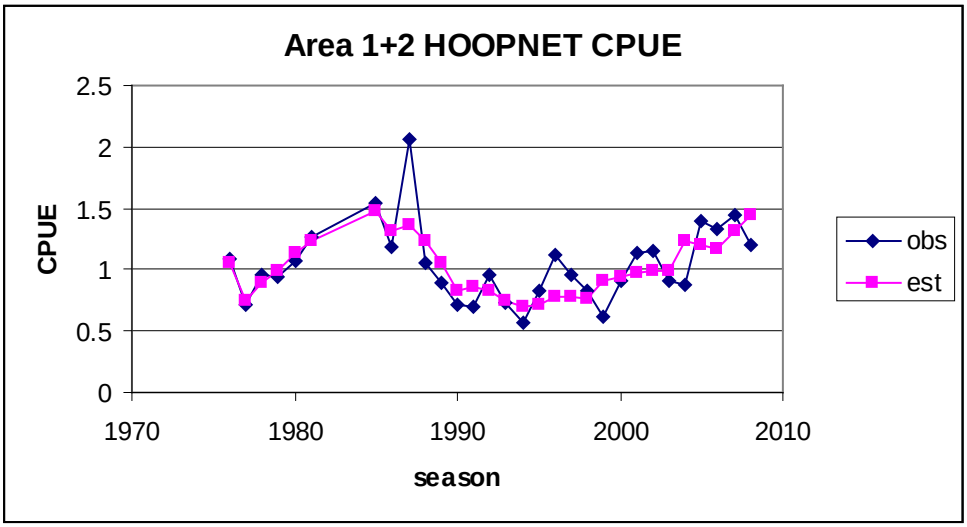


Figure 2b: RC Area 3+4 fits to CPUE data.

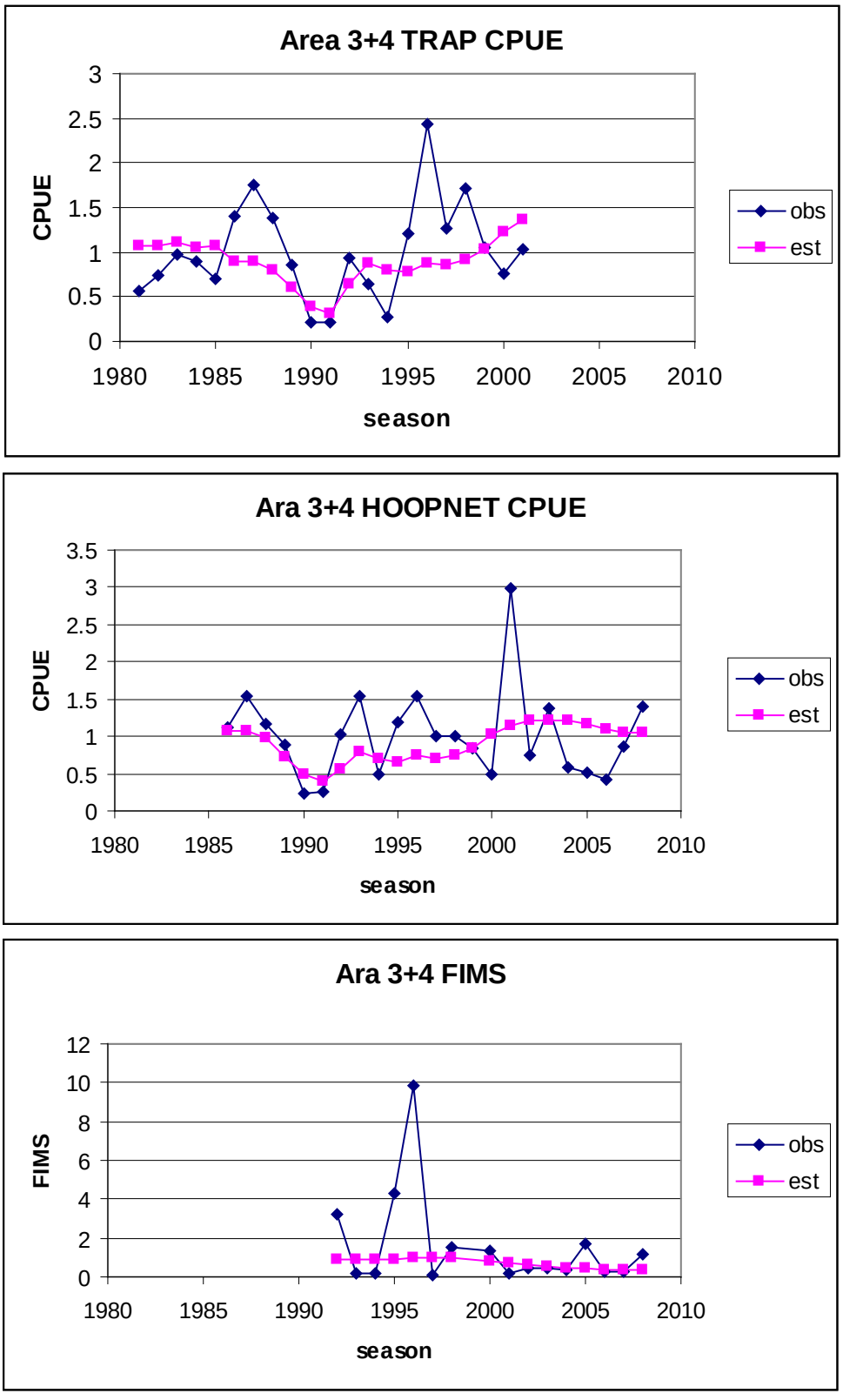


Figure 2c: RC Area 5+6 fits to CPUE data.

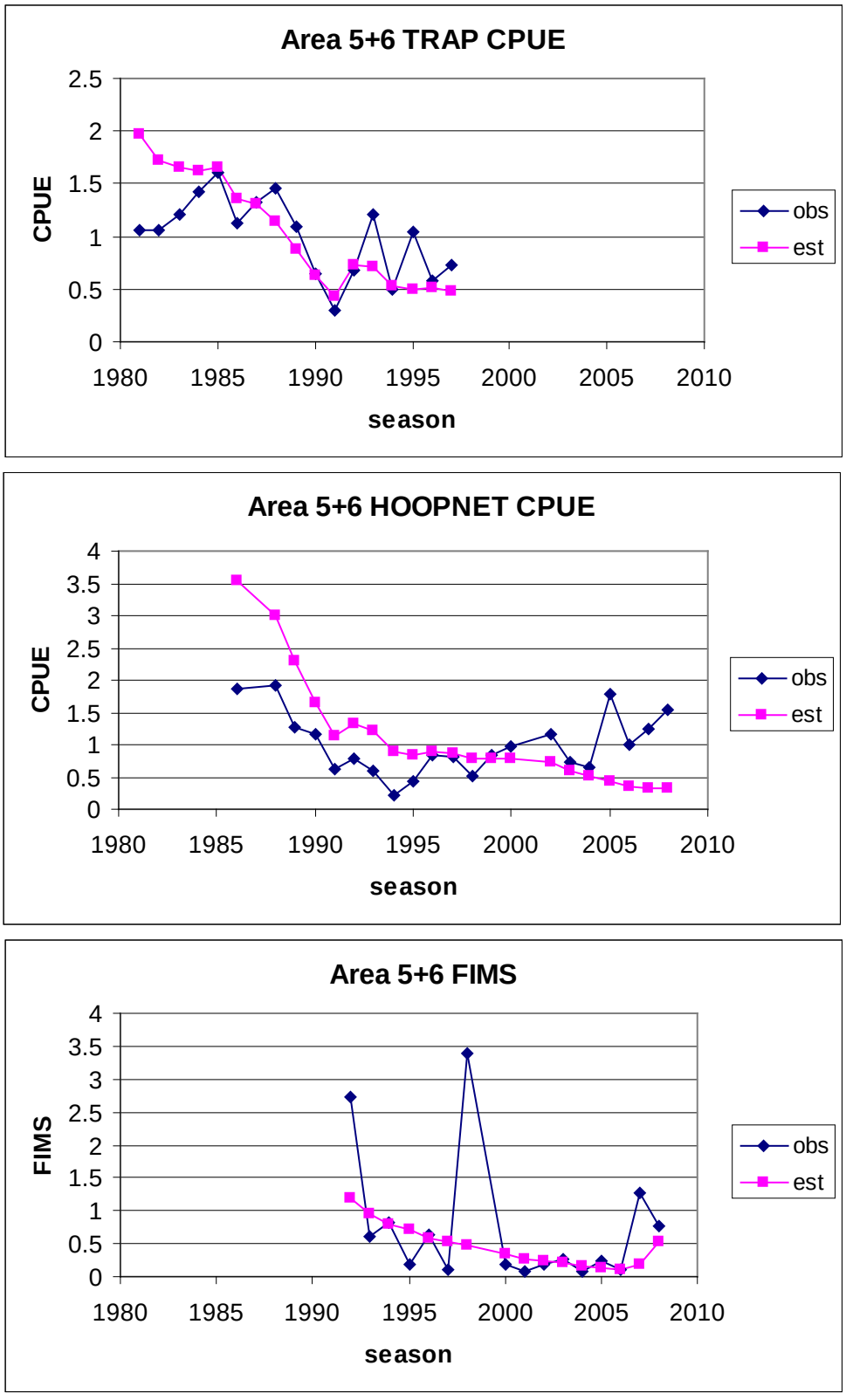
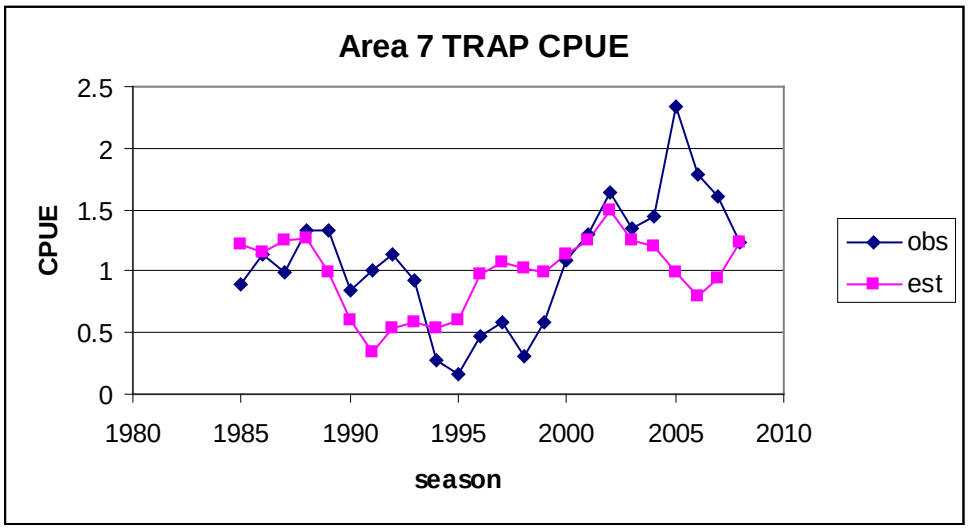


Figure 2d: RC Area 7 fits to CPUE data.



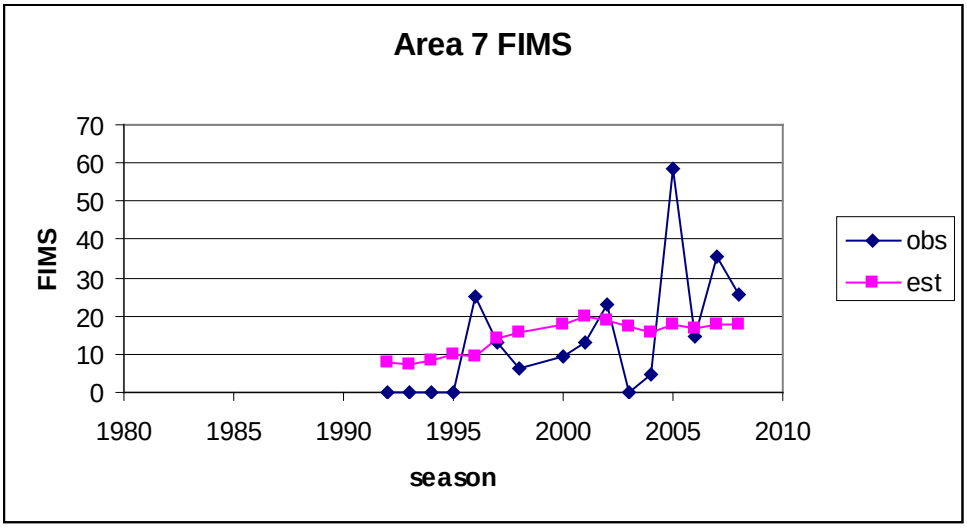


Figure 2e: RC Area 8 fits to CPUE data.

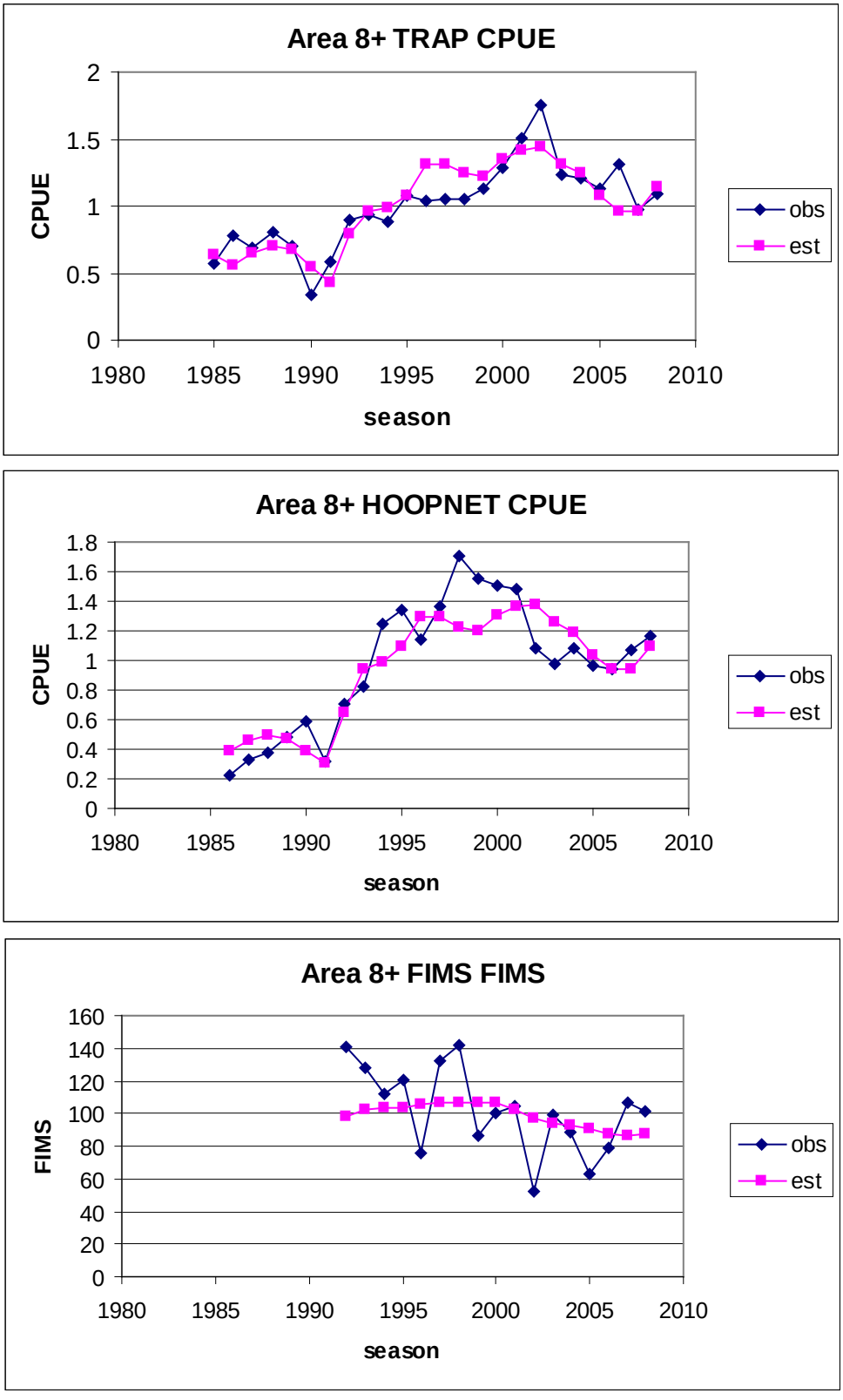


Figure 3: RC B^{75}/K values for the resource as a whole (i.e. summed over the five super-areas). The bottom plot shows values for 1980+ only. The 95% CIs are shown for 1996 and 2000+ years.

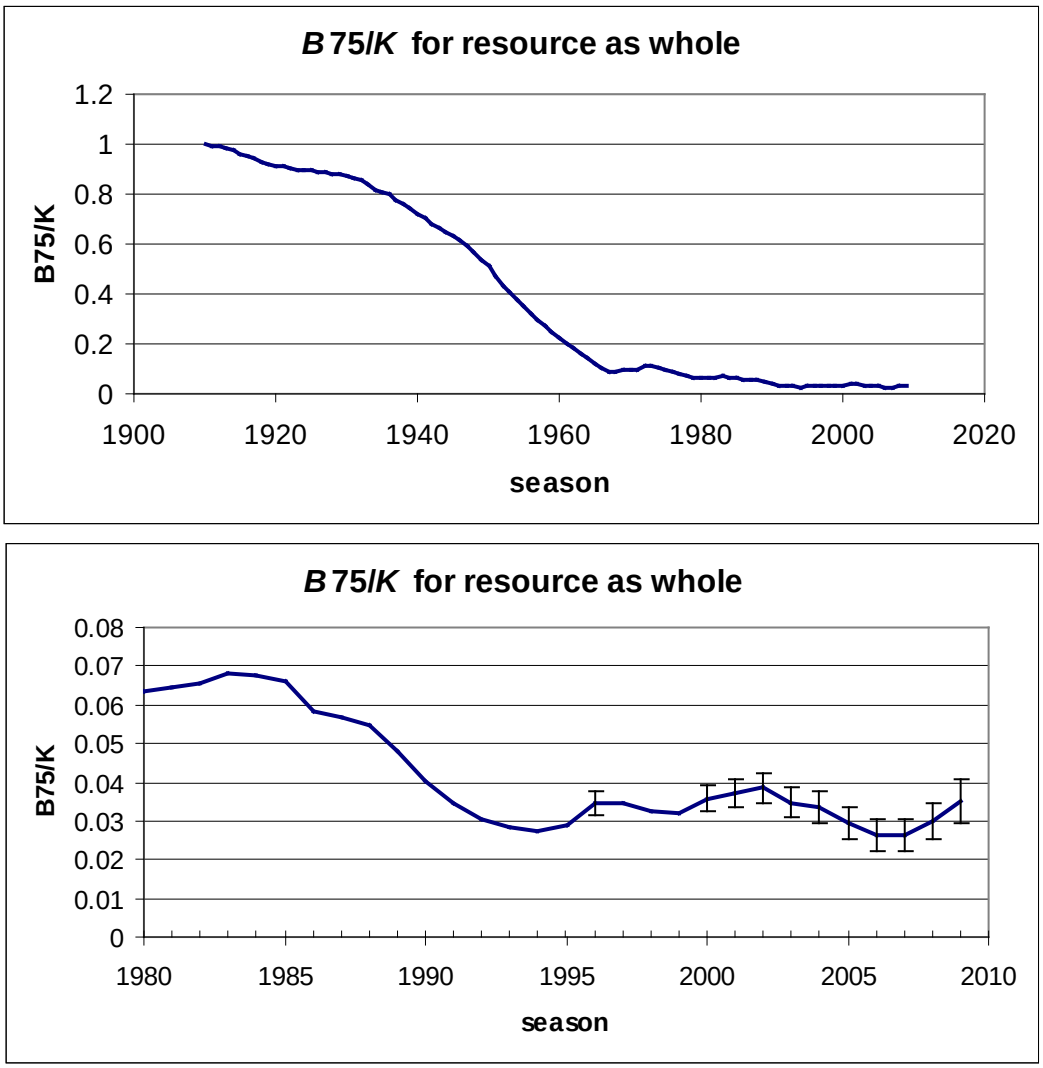


Figure 4: RC B^{76} trajectories in absolute abundance terms (MT) for each of the five super-areas for the period 1980-2009. The 95% CIs are shown for 1996, and 2000+ years.