Final area-disaggregated assessments results for west coast rock lobster

S.J. Johnston and D.S. Butterworth

MARAM
Department of Mathematics and Applied Mathematics
University of Cape Town
Rondebosch, 7701

Assessment model results

Table 1 reports the MARAM Reference Case (RC) area-disaggregated assessment results, along with updated area-aggregated assessment results.

Table 2 reports the corresponding results as obtained by OLRAC.

After much discussion, a task group (consisting of Bergh, Butterworth, Jacobs and Johnston) decided that the most desirable method for producing two alternate models reflecting recent recruitment uncertainty for each super-area would be as follows:

run the RC model with the following penalty function added to the –lnL (this reflects "shrinkage to the mean". or in Bayesian terms using a prior that reflects the recent past distribution of recruitments):

$$pen = \frac{1}{2}\left(\ln R_{2000} - \ln \overline{R}\right)^2 / \sigma^2 \qquad (1)$$

where

$$\ln \overline{R} = \frac{1}{5}\sum_{y=1975}^{1995} \ln R_y \qquad (2)$$

$$\sigma^2 = \frac{1}{4}\sum_{y=1975}^{1995}\left(\ln \overline{R} - \ln R_y\right)^2 \qquad (3)$$

The two alternate models (Alt1 and Alt2) are virtually identical to the RC model, except with regards to the R_{2000} value. For the RC model R_{2000} is an estimable parameter, although it was found to be estimated with very low precision (for Area 8 the 95% CI was 0.0001-1.65), and so is demonstrated in the estimation by the contribution from equation (1). For this reason, Alt1 and Alt2 models would correspond almost exactly to the RC best fit parameter values except for R_{2000} which would be fixed at the (approximate) upper and lower 25%iles of this distribution as follows:

$$\ln R_{2000}^{alt1} = \ln \hat{R}_{2000}^{RC} + \sigma\alpha \quad (4)$$

and

$$\ln R_{2000}^{alt2} = \ln \hat{R}_{2000}^{RC} - \sigma\alpha \quad (5)$$

where σ is from equation (2) above, and the α value (0.741) corresponds to the 25%iles of a *t*-distribution with the appropriate number of degrees of freedom.

Replacement yields are reported at the bottom of both Table 1 and Table 2. The usual method of calculating the RY is to calculate the future (2006+) constant catch (commercial+recreational) which will result in the biomass above 75mm (male+female) remaining constant, that is $B_{2016}^{75,m+f} = B_{2006}^{75,m+f}$. Because the RC model results reported in Tables 1 and 2 for A56 and A7 show unrealistic current female biomass proportions, RYs for these two super-areas have been calculated where the sustainability refers to only the male portion of the biomass, i.e. a RY is calculated such that the male biomass above 75mm remains constant, that is $B_{2016}^{75,m} = B_{2006}^{75,m}$.

Constraining the female survivorship parameter for A56 and A7

Table 3 shows that the RC A56 and A7 assessments result in very large percentage females in the current population biomass. These are associated with high S^f values (around 0.94). MARAM therefore explored constraining S^f to either a maximum of 0.90 or 0.88. Table 4 shows that constraining S^f at a maximum 0.88 results in current female biomass ratios more in line with those observed in the commercial and FIMS catch samples. The RYs are also increased as S^f is reduced.

Replacement Yield estimates

The MARAM RY estimates are reported in Table 5a and OLRACS RY's in Table 5b. The MARAM results show that if we were to accept an upper constraint on S^f of 0.88 is acceoted, then for the RC model, the total RYs over the five super-areas would total 1935 MT. The MARAM RC RY for the updated area-aggregated assessment is 2126 MT.

Table 5a shows that the RY totals for the Alt1 and Alt2 models approximately 20% smaller and larger than estimated for the RC model.

Table 1: MARAM super-area and area-aggregated assessment results.

Assessment Model	**Area 1-2**	**Area 3-4**	**Area 5-6**	**Area 7**	**Area 8+**	**Area aggregated**	
Female Survivorship	0.867	0.899	0.937	0.940	0.887	0.914	
Recruitment Scale	0.322	2.296	2.187	1.107	2.905	7.586	
R1920	5.315	0.827	0.801	0.517	0.354	0.839	
R1950	0.019	0.096	0.211	0.126	0.072	0.269	
R1970	0.073	0.125	0.139	0.101	0.131	0.129	
R1975	0.007	0.199	0.220	0.164	0.300	0.308	
R1980	0.040	0.058	0.064	0.054	0.258	0.097	
R1985	0.035	0.111	0.039	0.063	0.706	0.277	
R1990	0.017	0.168	0.016	0.075	0.549	0.314	
R1995	0.020	0.015	0.003	0.173	0.437	0.240	
R2000	**0.019**	**0.045**	**0.003**	**0.096**	**0.420**	**0.260**	
sigma F% TRAP	-	**0.150**	**0.150**	**0.150**	**0.150**	**0.150**	
sigma F% HOOP	**0.150**	**0.150**	**0.150**	**0.150**	**0.150**	**0.150**	
sigma F% FIMS	-	**0.150**	**0.150**	**0.150**	**0.150**	**0.150**	
sigma CPUE TRAP	-	0.542	0.262	0.232	0.187	0.184	
sigma CPUE HOOP	0.179	0.499	0.360	-	0.239	0.180	
sigma CPUE FIMS	-	1.568	0.865	0.783	0.182	0.308	
sigma CAS TRAP M	-	0.207	**0.150**	0.232	0.263	0.158	
sigma CAS TRAP F	-	0.162	0.193	**0.150**	0.261	**0.150**	
sigma CAS HOOP M	0.243	0.173	0.164	0.346	0.162	0.163	
sigma CAS HOOP F	0.263	0.186	0.326	0.783	0.361	0.313	
sigma CAS FIMS M	-	0.199	0.237	**0.150**	**0.150**	**0.150**	
sigma CAS FIMS F	-	0.398	0.223	0.201	**0.150**	0.162	
sigma CAS TRAPSUBL M	-	-	-	-	**0.150**	**0.150**	
sigma CAS TRAPSUBL F	-	-	-	-	**0.150**	**0.150**	
-*lnL* F% TRAPS	-	5.664	7.250	6.261	3.194	4.135	
-*lnL* F% HOOPNETS	7.329	5.122	8.041	1.564	3.022	8.851	
-*lnL* F% FIMS	-	3.387	0.611	5.281	2.926	2.744	
-*lnL* CPUE TRAP	-	-2.339	-14.243	-27.953	-23.521	-28.605	
-*lnL* CPUE HOOP	-31.727	-4.704	-8.867	-	-16.711	-29.139	
-*lnL* CPUE FIMS	-	11.398	4.259	3.070	-15.682	-8.806	
-*lnL* CAS TRAP M	-	7.473	-42.760	47.337	13.486	-27.899	
-*lnL* CAS TRAP F	-	-20.075	48.027	-6.536	-0.115	7.124	
-*lnL* CAS HOOP M	35.593	-12.202	-4.520	33.036	-6.697	5.696	
-*lnL* CAS HOOP F	7.041	-2.425	111.463	13.661	10.521	57.627	
-*lnL* CAS FIMS M	-	45.219	59.788	-23.556	-51.252	-55.064	
-*lnL* CAS FIMS F	-	55.269	12.940	-7.428	-29.786	-20.044	
-*lnL* CAS TRAPSUBL M	-	-	-	-	-2.835	-7.045	
-*lnL* CAS TRAPSUBL F	-	-	-	-	-15.639	-16.737	
-*lnL* R2000	0.002	0.154	1.004	0.001	0.000	0.034	
-*lnL* total (incl -lnL R2000)	**-20.131**	**26.007**	**16.549**	**-6.125**	**-55.004**	**-56.387**	A12+A34+A56 +A7+A8
B_{75}(1910)	35792	152007	214661	266376	139670	552873	808506
B_{75}(2002)	528	3620	9980	14085	13424	29936	41637
B_{75}(2005)	434	3266	8061	10568	9421	24027	31750
B_{75}(2002) / B_{75}(1910)	0.015	0.023	0.046	0.053	0.096	0.054	
B_{75}(2005) / B_{75}(1910)	0.012	0.021	0.038	0.040	0.067	0.043	
Egg(2002) / Egg(1910)	0.025	0.051	0.086	0.097	0.303	0.179	
Egg(2005) / Egg(1910)	0.021	0.040	0.071	0.091	0.275	0.169	
RY (based on total B)	22	196	0	482	969	2126	1669
RY (based on male B)			158	678			2023

Table 2: OLRAC super-area and area-aggregated assessment results.

Assessment Model	Area 1-2	Area 3-4	Area 5-6	Area 7	Area 8+	Area-aggregated	
Female Survivorship	0.906	0.881	0.934	0.946	0.909	0.915	
Recruitment Scale	0.514	2.529	2.028	1.093	3.295	7.736	
R1920	3.297	0.959	1.012	0.562	0.205	0.739	
R1950	0.001	0.046	0.159	0.113	0.096	0.284	
R1970	0.045	0.122	0.150	0.124	0.127	0.123	
R1975	0.005	0.180	0.222	0.149	0.291	0.304	
R1980	0.024	0.049	0.065	0.068	0.203	0.092	
R1985	0.019	0.111	0.043	0.056	0.655	0.293	
R1990	0.012	0.161	0.021	0.075	0.503	0.315	
R1995	0.010	0.039	0.013	0.165	0.375	0.240	
R2000	**0.015**	**0.115**	**0.081**	**0.105**	**0.415**	**0.261**	
sigma F% TRAP	-	**0.150**	**0.150**	**0.150**	**0.150**	0.344	
sigma F% HOOP	**0.150**	**0.150**	**0.150**	**0.150**	**0.150**	0.791	
sigma F% FIMS	-	**0.150**	**0.150**	**0.150**	**0.150**	**0.150**	
sigma CPUE TRAP	-	0.529	0.274	0.187	0.186	0.184	
sigma CPUE HOOP	0.169	0.500	0.310	-	0.225	0.178	
sigma CPUE FIMS	-	1.614	1.146	0.781	0.186	0.309	
sigma CAS TRAP M	-	0.211	**0.150**	0.213	0.262	0.158	
sigma CAS TRAP F	-	**0.150**	0.190	**0.150**	0.259	**0.150**	
sigma CAS HOOP M	0.245	0.169	**0.150**	0.252	0.164	0.164	
sigma CAS HOOP F	0.237	**0.150**	0.362	0.788	0.314	0.313	
sigma CAS FIMS M	-	0.223	0.307	**0.150**	**0.150**	**0.150**	
sigma CAS FIMS F	-	0.401	0.254	0.191	**0.150**	0.160	
sigma CAS TRAPSUBL M	-	-	-	-	**0.150**	**0.150**	
sigma CAS TRAPSUBL F	-	-	-	-	**0.150**	**0.150**	
-*lnL* F% TRAPS	-	6.785	8.491	5.620	3.375	-14.184	
-*lnL* F% HOOPNETS	8.393	7.032	10.406	1.432	2.699	6.916	
-*lnL* F% FIMS	-	3.866	1.679	5.644	2.954	-18.324	
-*lnL* CPUE TRAP	-	-2.885	-13.525	-28.226	-23.603	-28.638	
-*lnL* CPUE HOOP	-33.207	-4.644	-11.417	-	-17.814	-29.424	
-*lnL* CPUE FIMS	-	11.746	7.631	3.041	-15.338	-8.771	
-*lnL* CAS TRAP M	-	8.256	-41.454	40.183	11.657	-27.193	
-*lnL* CAS TRAP F	-	-28.720	44.161	-0.410	-2.575	6.907	
-*lnL* CAS HOOP M	36.139	-14.452	-27.455	23.687	-3.558	7.694	
-*lnL* CAS HOOP F	0.964	-16.335	112.296	14.880	7.698	59.800	
-*lnL* CAS FIMS M	-	51.584	71.178	-23.317	-57.320	-55.795	
-*lnL* CAS FIMS F	-	49.441	31.047	-7.559	-35.577	-19.996	
-*lnL* CAS TRAPSUBL M	-	-	-	-	-3.285	-6.036	
-*lnL* CAS TRAPSUBL F	-	-	-	-	-11.596	-13.490	
-*lnL* total (excl -*lnL* SR and -lnL R2000)	**-21.104**	**26.877**	**22.243**	**-7.742**	**-57.184**	**-97.236**	
-*lnL* R2000	0.021	0.119	0.034	0.219	0.988	0.486	
-*lnL* total (incl -lnL R2000)	**-21.082**	**26.996**	**22.277**	**-7.523**	**-56.196**	**-96.750**	**A12+A34+A56**
							+A7+A8
B_{75}(1910)	70740	157895	197133	284904	175789	566715	886460
B_{75}(2002)	1573	4145	8565	13511	14293	29958	42087
B_{75}(2005)	1234	3951	7000	10218	9910	24197	32313
B_{75}(2002) / B_{75}(1910)	0.022	0.026	0.043	0.047	0.081	0.053	
Egg(2002) / Egg(1910)	0.029	0.075	0.085	0.086	0.274	0.179	
RY (based on total B)	**0**	**301**	**44**	**511**	**949**	**2180**	**1805**
RY (based on male B)			**273**	**671**			**2193**

Table 3: MARAM estimates of current (2005) male and female biomass above 75mm.

	A12	**A34**	**A56**	**A7**	**A8**	**Area-aggregated**
S^f	0.867	0.899	0.937	0.940	0.887	0.914
B^m_{2005}	284	3205	598	3705	9109	17744
B^f_{2005}	149	61	7462	6863	311	6284
B^{m+f}_{2005}	434	3267	8061	10569	9421	24028
% female	34%	2%	93%	65%	3%	26%

Table 4: Male, female and total biomass above 75mm in 2005 for A56 and A7 where either the female survivorship is constrained to be less that 0.95, 0.90 or 0.88.

	A56			**A7**		
	RC $S^f = 0.94$	constraint $S^f = 0.90$	constraint $S^f = 0.88$	RC $S^f = 0.94$	constraint $S^f = 0.90$	constraint $S^f = 0.88$
B^m_{2005}	598	570	483	3705	3291	3252
B^f_{2005}	7462	861	286	6864	1666	957
B^{m+f}_{2005}	8061	1432	769	10569	4957	4209
% female in 2005	93%	60%	37%	65%	34%	23%
-*ln*L	16.55	29.41	52.21	-6.126	0.059	11.00
RY (m+f)	0	126	121	482	610	627
Obs trap 2004 F%	50%			4%		
Obs hoop 2004 F%	40%			2%		
Obs FIMS 2004 F%	52%			27%		

Table 5a: MARAM RYs for three models: RC (best fit), Alt1 (upper R_{2000}) and Alt2 (lower R_{2000}). Values in brackets are for constraint on S^f <=0.88.

	Alt1 Lower R_{2000}	**RC Best fit R_{2000}**	**Alt2 Upper R_{2000}**
A12	18	22	28
A34	150	196	292
A56	0	0 (121)	0
A7	451	482 (627)	528
A8	777	969	1224
A12+A34+A56+A7+A8	1396	1669 (1935)	2072
Area-aggregated	1658	2126	2784

Table 5b: OLRAC RYs for three models: RC (best fit), Alt1 (upper R_{2000}) and Alt2 (lower R_{2000}). **Values in brackets are for RYs based on sustainability for male biomass.**

	Alt1 Lower R_{2000}	**RC Best fit R_{2000}**	**Alt2 Upper R_{2000}**
A12	0	0	0
A34	206	301	455
A56	44 (198)	44 (273)	131 (435)
A7	479 (649)	511 (671)	557 (706)
A8	720	949	1264
A12+A34+A56+A7+A8	1449 (1773)	1805 (2193)	2407 (2859)
Area-aggregated	1677	2180	2909

Figure 1a: Comparison of B75(2005) values between OLRAC and MARAM results, as well as the results for S^f <= 0.88.

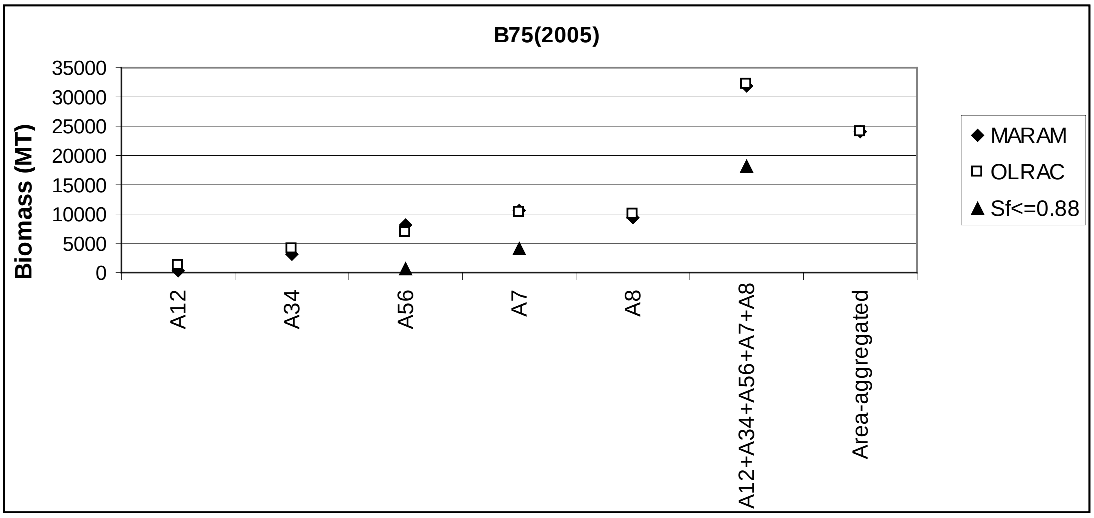

Figure 1b: Comparison of RY values between OLRAC and MARAM results, as well as the results for S^f <= 0.88.