TAC 2009 for West Coast rock lobster using OMP 2007 re-cast

S.J. Johnston[1], D.S. Butterworth[1] and J.P. Glazer[2]

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

[2]Marine and Coastal Management
Department of Environmental Affairs and Tourism
Private Bag X2
Roggebaai 8012

Introduction

OMP 2007 re-cast is an adjusted version of OMP-2007 which was developed to set the TACs for the West Coast rock lobster fishery for the 2008 to 2010 seasons (note: "2008" refers to the 2008/9 season) . The results for the anticipated outcomes from application of OMP-2007 re-cast were presented in Johnston and Butterworth (2008). Here we report the TAC 2009 values produced using OMP 2007 re-cast.

2009 input data to the OMP

Four indices are used as input data to the OMP in order to set the TAC – trap CPUE, hoop CPUE, FIMS and somatic growth. These data series have recently been updated given the most recent monitoring data from the resource. The updated data are reported in Glazer (2009a), Glazer (2009b), Glazer (2009c), Brandao and Butterworth (2009) and OLRAC (2009). These data are listed at a super-area level in Appendix 1. OMP 2007 re-cast combines these data across the relevant super-areas to produce a single input data series for each data type. The method for this combination across super-areas is described fully in Johnston *et al.* (2008), and the resultant input data series are listed here in Table 1 and illustrated in Figure 1.

Interim Relief Tonnage

Keulder (2009) reports extrapolated catch estimates of Interim Relief take for the 2007/08 and 2008/09 seasons. In conjunction with the Working Group recommendation, the estimates are calculated assuming each fisher would make 22 reports per season. The values to be used in the OMP calculation are as follows:

Season	Interim relief tonnage
2007/08	177 MT
2008/09	170 MT

TAC recommendations for 2009 using OMP 2007 re-cast

Table 2 provides the OMP 2007 re-cast allocations per super-area and per fishery, and which includes the TACS for the 2008 season for comparative purposes. In summary, adding over the super-areas:

1. the recreational allocation is unchanged at 257 MT
2. the near-shore allocation is unchanged at 451 MT
3. the offshore allocation is increased from 1632 MT to 1685 MT
4. the global TAC is increased from 2340 MT to 2393 MT, i.e. an increase of 53 MT or 2.3%

Appendix 2 provides the detailed calculations associated with TAC 2009 evaluation.

References

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Glazer, J.P. 2009a. Area-disaggregated standardised CPUE indices in the West Coast rock lobster trapboat fishery. MCM document, MCM/2009/JUL/SWG-WCRL/08.

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Glazer, J.P. 2009c. Area-disaggregated standardised indices in the West Coast rock lobster hoopnet fishery. MCM document, MCM/2008/JUL/SWG-WCRL/07.

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Keulder, F. 2009. Estimated WCRL catch for Interim Relief Phases II and III. MCM document, MCM/2009/AUG/SWG-WCRL/16.

OLRAC. 2009. Updated male somatic growth rate estimates for input into the OMP for West Coast rock lobster. MCM document, MCM/2009/AUG/SWG-WCRL/10.

Table 1: Combined data series to be used as input into the OMP 2007 re-cast to generate TAC recommendations for the 2009 season (see Appendix 1 for units). Note that the combined somatic growth rate series is re-scaled so that its average 1992-2005 value is the same as the series used in the initial assessments (i.e. a value of 3.463)

	Somatic growth	**Trap CPUE**	**Hoop CPUE**	**FIMS**
1992	2.891			2.521
1993	3.469	0.742	0.932	1.105
1994	3.526	0.593	0.796	0.974
1995	3.909	0.818	1.071	1.789
1996	4.902	1.008	1.146	2.999
1997	3.518	1.11	1.113	0.996
1998	2.949	1.255	1.217	1.747
1999	3.147	1.17	1.156	1.356
2000	4.33	1.294	1.083	1.01
2001	3.669	1.794	1.593	1.121
2002	3.819	1.686	0.975	0.659
2003	2.792	1.332	0.991	1.236
2004	3.814	1.156	0.826	0.979
2005	2.979	0.856	0.985	0.969
2006	2.853	1.009	0.799	0.742
2007	2.261	0.704	1.019	1.095
2008	3.638	0.733	1.254	1.139

Table 2: TAC recommendations for the 2009 season using OMP-2007 re-cast (the 2008 season values are shown in parentheses).

	Global TAC (Commercial + recreational)	**Commercial only**	**Offshore allocation**	**Near-shore allocation**	**Recreational allocation**
Total	**2393 (2340)**	**2136 (2083)**	**1685 (1632)**	**451 (451)**	**257**
A1-2	29 (29)	24 (24)	0 (0)	24 (24)	
A3-4	157 (130)	138 (102)	65 (29)	73 (73)	
A5-6	64 (64)	32 (32)	0 (0)	32 (32)	
A7	381 (588)	421 (578)	421 (578)	0 (0)	
A8+	1761 (1525)	1521 (1347)	1199 (1025)	322 (322)	

Figure 1: Input data combined across super-areas, to be used as input into OMP 2007 re-cast for setting the 2009 TAC.

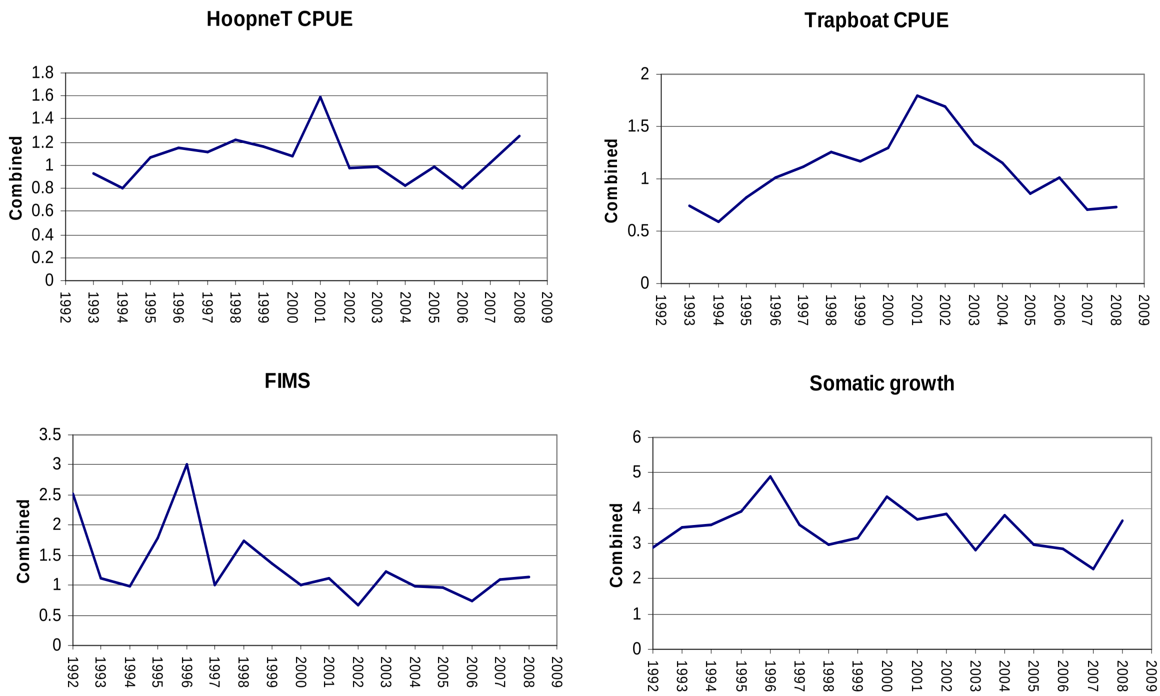
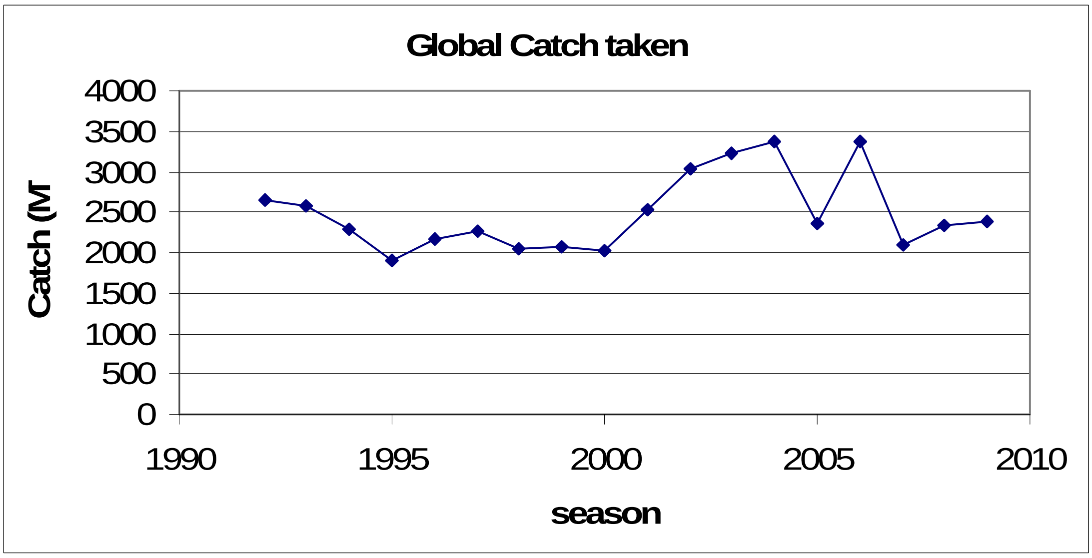


Figure 2: The historic series of Global (commercial plus recreational) catch for the West Coast rock lobster. The 2008 value of 2083 MT is the TAC for that season. The 2009 value shown here is the recommended new TAC from OMP 2007 re-cast of 2393 MT.



Appendix 1: Input data to the OMP at a super-area level

Where units are not specified, this is because the values shown are outputs from a GLM for which such specification is complex; details are given in the original references cited for the data concerned.

Table A1. Hoop CPUE data at super-area level (from Glazer 2009b and 2009c).

	Area 1+2	Area 3+4	Area 5+6	Area 8
1993	0.724	1.538	0.591	0.823
1994	0.573	0.480	0.228	1.246
1995	0.820	1.188	0.427	1.346
1996	1.115	1.542	0.841	1.139
1997	0.965	1.014	0.805	1.370
1998	0.833	0.994	0.524	1.706
1999	0.611	0.849	0.835	1.551
2000	0.912	0.501	0.986	1.510
2001	1.142	2.995	1.075*	1.481
2002	1.146	0.748	1.164	1.083
2003	0.907	1.367	0.727	0.972
2004	0.883	0.573	0.639	1.086
2005	1.400	0.519	1.794	0.969
2006	1.330	0.423	1.007	0.946
2007	1.437	0.857	1.250	1.067
2008	1.200	1.394	1.549	1.162

* average of 2000 and 2002 value

Table A2. Trap CPUE data at super-area level (from Glazer 2009a).

	Area 7	**Area 8**
1993	0.591	0.933
1994	0.305	0.884
1995	0.592	1.078
1996	1.083	1.038
1997	1.304	1.052
1998	1.647	1.048
1999	1.347	1.131
2000	1.448	1.285
2001	2.338	1.510
2002	1.791	1.754
2003	1.603	1.230
2004	1.228	1.203
2005	0.617	1.131
2006	0.760	1.306
2007	0.460	0.968
2008	0.371	1.097

Table A3. FIMS data at super-area level (from Brandao and Butterworth 2009).

	A3+4	A5+6	A7	A8
1992	3.228	2.720	24.89	140.75
1993	0.137	0.615	13.16	128.18
1994	0.204	0.821	6.057	112.43
1995	4.341	0.185	2.543	120.07
1996	9.855	0.647	9.295	75.5
1997	0.068	0.106	12.84	132.26
1998	1.495	3.403	22.97	141.64
1999	1.420*	1.790*	13.89*	86.6
2000	1.344	0.176	4.809	100.71
2001	0.214	0.075	58.66	105.01
2002	0.473	0.192	14.49	52.02
2003	0.420	0.276	35.78	98.67
2004	0.375	0.071	25.36	89.05
2005	1.725	0.241	15.79	62.71
2006	0.238	0.119	13.96	79.18
2007	0.277	1.267	21.88	106.65
2008	1.207	0.756	9.665	101.43

* average of the 1998 and 2000 values

Table A4. Somatic growth data at super-area level (from OLRAC 2009). Values are the mean annual growth increments of a 70 mm male lobster (mm).

	A1+2	A3+4	A5+6	A7	A8
1992	4.239	3.382	4.063	2.672	2.668
1993	2.938	3.707	4.388	4.267	2.994
1994	3.332	3.925	4.606	3.774	3.212
1995	3.794	4.119	4.801	4.797	3.406
1996	4.57	4.907	5.588	6.549	4.194
1997	3.768	3.633	4.314	4.662	2.92
1998	3.668	3.085	3.767	3.948	2.372
1999	5.454	3.403	4.084	3.64	2.69
2000	4.091	4.539	5.22	5.261	3.826
2001	5.161	3.925	4.607	4.263	3.212
2002	4.07	3.965	4.647	4.882	3.252
2003	3.801	3.239	3.921	2.735	2.526
2004	6.545	3.99	4.672	4.585	3.277
2005	2.763	3.347	4.028	3.289	2.634
2006	2.814	3.234	3.914	3.102	2.52
2007	3.737	2.358	3.039	3.279	1.645
2008	3.032	3.967	4.647	4.155	3.254

Appendix 2: Details of the TAC calculation

OMP 2007 re-cast:

$$TAC_y^G = w_y TAC_{y-1}^G + (1-w_y)\alpha\left(\frac{\beta_{y-5,y-4,y-3,y-2,y-1}}{\overline{\beta}_{89=04}^{historic}}\right)^{\lambda}\left(\frac{\hat{B}_y}{\hat{B}_{1992}}\right) \quad x$$

$$\left[f_1\left(\frac{CPUE_{y-1,y-2,y-3}^{trap}}{CPUE_{93,94,95}^{trap}}\right)+f_2\left(\frac{CPUE_{y-1,y-2,y-3}^{hoop}}{CPUE_{93,94,95}^{hoop}}\right)+(1-f_1-f_2)\left(\frac{FIMS_{y-3,y-2,y-1}}{FIMS_{92,93,94,95}}\right)\right]^p$$

where (1)

$w_y = 0.50$ for all years,

$p = 0.5$,

$f_1 = 0.40$;

$f_2 = 0.40$; and

α is the primary tuning parameter, which for "OMP-2007 re-cast" is 4560.

Note that β refers to the somatic growth rate of a 70mm male lobster, and that $\overline{\beta}_{89-04}^{historic}$ refers to the geometric mean β over the 1989-2004 period of historic growth (and has a value of 3.504). Note also that it is the multiplicative factor in equation (1) related to the β parameters that is changed under modification ii) below.

The choice of parameter values f_1 and f_2 for the final term means a TRAP:HOOP:FIMS weighting of 0.4:0.4:0.2.

Estimation of $\hat{B}_t$ and $\hat{B}_{1992}$

The underlying approach is to fit a simple population model to available $CPUE^{trap}$, $CPUE^{hoop}$, *FIMS* and somatic growth data to model the dynamics from 1992 to season *t*-1, the most recent season for which data are available, i.e.:

$$B_{T+1}^p = B_T^p + G_T - (C_T + P_T) \quad (2)$$

where

B_T^p = population model biomass in season *T*,

G_T = annual "growth" of resource in season *T*[1],

C_T = annual commercial + recreational catch in season *T*, and

[1] Note than extra tonnage is added for the 2007 and 2008 seasons to take into account the best estimates of interim relief tonnage taken.

P_T = annual estimate of poaching for season T.

B^p_{1992} is a parameter estimated in fitting this model to the data.

The annual somatic growth parameter β_T is the moult-probability model (OLRAC 2005) estimated somatic growth of a male rock lobster of 70mm carapace length (renormalized as detailed in the preceding text). For any season t for which a TAC is required, β_T is known for all preceding seasons.

In the population model, the annual "growth" of the resource, G_T, is set to be:

$$G_T = a(\beta_T + b) \tag{3}$$

The value of b is set externally by regressing against β the equilibrium sustainable yield for the RC1, ALTL and ALTH assessment models' estimates of the biomass in 2005 (for the case where all the super-areas are considered together) for different values of β (this relationship is near linear). The intercept of this regression with the horizontal axis (β), averaged over these three area-aggregated assessments, yields a value of b = -2.5636 for use in equation (3).

Each season (from t = 2007), as new data become available, the population model (see equation 1) is fitted by minimising the following negative log-likelihood:

$$\begin{aligned} -\ln L = & \sum_{T=1993}^{t-1}\left\{\ln\sigma_{CPUE^{trap}} + \frac{1}{2\sigma^2_{CPUE^{trap}}}\left(\ln CPUE_T^{trap} - \ln q_{CPUE^{trap}} - \ln B_T^P\right)^2\right\} \\ & + \sum_{T=1993}^{t-1}\left\{\ln\sigma_{CPUE^{hoop}} + \frac{1}{2\sigma^2_{CPUE^{hoop}}}\left(\ln CPUE_T^{hoop} - \ln q_{CPUE^{hoop}} - \ln B_T^P\right)^2\right\} \\ & + \sum_{T=1992}^{t-1}\left\{\ln\sigma_{FIMS} + \frac{1}{2\sigma^2_{FIMS}}\left(\ln FIMS_T - \ln q_{FIMS} - \ln B_T^P\right)^2\right\} \end{aligned} \tag{4}$$

where

$CPUE_T^{trap}$	is the trap CPUE for year T
$CPUE_T^{hoop}$	is the hoop CPUE for year T
$FIMS_T$	is the FIMS CPUE for year T
$q_{CPUE^{trap}}$	is the trap catchability coefficient

$q_{CPUE^{hoop}}$ is the hoop catchability coefficient

q_{FIMS} is the FIMS catchability coefficient

TAC 2009: here *y* = 2009

Population model fit to input data:

α =2918 ………. Eqn (3)
B^{p}_{1992} =38390 ………..Eqn (2)
-lnL=-40.91 ……….. Eqn (4)

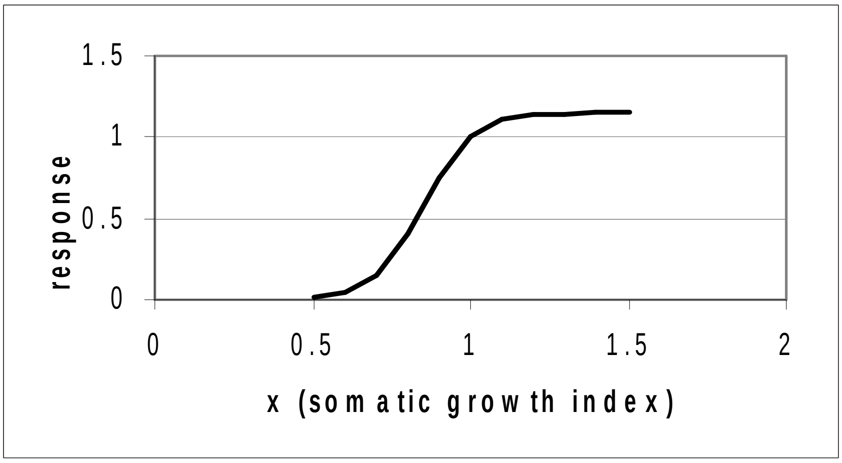
Somatic growth index = *x* in modification below:

If $x = \dfrac{\overline{\beta}_{y-5,y-4,y-3,y-2,y-1}}{\overline{\beta}^{historic}_{89-04}}$, (where $\overline{\beta}^{historic}_{89-04} = 3.504$) then the response to the annual somatic growth rate index in the basic TAC algorithm (equation (1)) is given by x^{λ}, with λ set at 1 so that this term varies linearly with recent somatic growth rate.

The final OMP incorporates a more sharply changing response for *x* (in the sense that the TAC drops more sharply for values of *x* < 1), which is as follows:

$$x^{\lambda} \text{ changed to } \frac{1+P_1}{1+P_1 e^{-(x-P_2)/P_3}}$$

For values $P_1 = 0.15$, $P_2 = 1.0$ and $P_3 = 0.08$ (which were selected for optimal OMP performance), the following somatic growth rate response function then applies:



$x = \dfrac{\overline{\beta}_{y-5,y-4,y-3,y-2,y-1}}{\overline{\beta}^{historic}_{09-04}}$ **=3.056/3.504 = 0.872**

“response” to *x* = 0.660

$\dfrac{\hat{B}_y}{\hat{B}_{1992}} = \dfrac{\hat{B}_{2008}}{\hat{B}_{1992}}$ **of Eqn (1) = 0.8047**

$\dfrac{CPUE^{trap}_{y-1,y-2,y-3}}{CPUE^{trap}_{93,94,95}}$ **of Eqn (1)=1.131**

$\dfrac{CPUE^{hoop}_{y-1,y-2,y-3}}{CPUE^{hoop}_{93,94,95}}$ **of Eqn (1)=1.087**

$\dfrac{FIMS_{y-1,y-2,y-3}}{FIMS_{92,93,94,95}}$ **of Eqn (1) =0.656**

Thus

$$\left[f_1\left(\frac{CPUE^{trap}_{y-1,y-2,y-3}}{CPUE^{trap}_{93,94,95}}\right) + f_2\left(\frac{CPUE^{hoop}_{y-1,y-2,y-3}}{CPUE^{hoop}_{93,94,95}}\right) + (1-f_1-f_2)\left(\frac{FIMS_{y-3,y-2,y-1}}{FIMS_{92,93,94,95}}\right)\right] = 1.0186$$

and
1.01860.5 = 1.00923**

To calculate the initial TAC (before constraints) using Eqn (1):

$$TAC^G_y = w_y TAC^G_{y-1} + (1-w_y)\alpha\left(\frac{\beta_{y-5,y-4,y-3,y-2,y-1}}{\overline{\beta}_{89-04}}\right)^{\lambda}\left(\frac{\hat{B}_y}{\hat{B}_{1992}}\right) \quad x$$

$$\left[f_1\left(\frac{CPUE^{trap}_{y-1,y-2,y-3}}{CPUE^{trap}_{93,94,95}}\right) + f_2\left(\frac{CPUE^{hoop}_{y-1,y-2,y-3}}{CPUE^{hoop}_{93,94,95}}\right) + (1-f_1-f_2)\left(\frac{FIMS_{y-3,y-2,y-1}}{FIMS_{92,93,94,95}}\right)\right]^p$$

results in the Global (commercial plus recreational) TAC before any constraints of **2393 MT**.

No constraints were violated (i.e. the TAC increase is less than the maximum inter-annual change constraint of 10%), thus the final Global TAC = 2393 MT.

Recreational quota:
For the recreational take, the following algorithm is applied:

$C^{rec}_t = C^{rec}_{t-1}$ =257 MT initially, where t = 2009

If $C^{rec}_t / TAC^G_t > 0.12$ then $C^{rec}_t = 0.10\,TAC^G_t$
If $C^{rec}_t / TAC^G_t < 0.08$ then $C^{rec}_t = 0.10\,TAC^G_t$

If $C^{rec}_t > 450$ MT then $C^{rec}_t = 450$ MT

where C^{rec}_t is the overall recreational take for year t, and TAC^G_t is the "global" (commercial plus recreational) TAC for year t as output by the OMP.

Here $C^{rec}_{2009} / TAC^G_{2009} = 257/2393 = 0.107$ so that the recreational allocation is unchanged.

Thus the total commercial quota = 2393 MT – 257 MT = 2136 MT

Nearshore allocation total:
For the total nearshore allocation the following algorithm is applied:

$NSQ_t^T = NSQ_{t-1}^T$ = 451 MT initially, where t = 2009

If $NSQ_t^T / TAC_t^G < 0.16$ then $NSQ_t^T = 0.195\, TAC_t^G$
If $NSQ_t^T / TAC_t^G > 0.24$ then $NSQ_t^T = 0.195\, TAC_t^G$

If $NSQ_t^T > 800$ MT then $NSQ_t^T = 800$ MT

Here $NSQ_{2009}^T / TAC_{2009}^G = 451/2393 = 0.188$ so that the nearshore allocation is unchanged.

Thus: Offshore allocation total = 1685 MT (=2136 MT - 451 MT)