South Coast Rock Lobster OMP 2008 re-tuned

S.J. Johnston[#], D.S. Butterworth[#] and J.P. Glazer[&]

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

[&] Branch Fisheries
Department of Agriculture, Forestry and Fisheries

1. Introduction

An OMP for recommending the TAC for South Coast rock lobster resource was developed and first implemented for 2008[1] (Johnston and Butterworth 2008). This OMP was intended to be implemented for two years, following which a review of the underlying operating models would decide whether this OMP could be implemented "as is" for a further two years (2010 and 2011) or if updates/retuning of this OMP would be required. In April 2010 the Rock Lobster Scientific Working Group (SWG) reviewed the 2010 updated assessment models of the resource (Johnston and Butterworth 2010a) and decided that these assessments showed some important changes with respect to the possible productivity of the resource compared to the 2008 operating models upon which the existing OMP-2008 had been simulation tested. A set of five updated operating models (OMs) were then selected against which to re-test a revised OMP. These OMs are reported in Johnston and Butterworth (2010b), and are:

- Model 3 (MARAM time varying selectivity).
- Model 4 (OLRAC time varying selectivity).
- Model 3ES (effort saturation).
- Model 3 CDW(down-weight of catch-at-length data by a factor of 0.1).
- Model 3 h=0.8 (h fixed at value of 0.8).

The revised OMP, "OMP-2008 re-tuned", has the same structural form as OMP-2008, except that it is re-tuned so that median $B^{sp}_{2025}/B^{sp}_{2006}$ remains 1.20 when simulation tested with Model 3, i.e. a spawning biomass increase in median terms of 20% over the 2006-2025 period, as had been the objective when the original OMP-2008 was chosen.

2. OMP 2008 re-tuned

OMP 2008 re-tuned consists of an algorithm that calculates the TAC for the resource using CPUE data collected from each of three areas.

Note that the TAC for season y+1 is to be based upon the CPUE series that ends in season y-1, i.e. the TAC recommendation for 2010 would be based on a CPUE series

[1] The convention used here is that 2008 refers to the 2008/2009 season

that ended with the most recent CPUE value available at the time a recommendation was requested which would be for 2008.

2.1. TAC setting algorithm

The algorithm used to recommend the TAC for the South Coast Rock Lobster fishery for season *y*+1 is:

$$TAC_{y+1} = TAC_y[1 + \alpha(s_y - \delta)]h(r_y) \quad (1)$$

where:

TAC_y is the TAC set (note NOT the catch taken) in season *y* ;

the value of α is set at 3.0;

s_y^A is the slope parameter from a regression of $\ln CPUE_y^A$ against *y* over the last five seasons' data (these will be for seasons *y*-5 to *y*-1 as data for season *y* will not be available at the time the recommendation is required) for each area *A*, and

$$s_y = \sum_{A=1}^{3} w^A s_y^A \quad (2)$$

where $w^A = \dfrac{\dfrac{1}{\sigma_S^{A^2}}}{\sum_{A'=1}^{3}(\dfrac{1}{\sigma_S^{A'^2}})}$ (3)

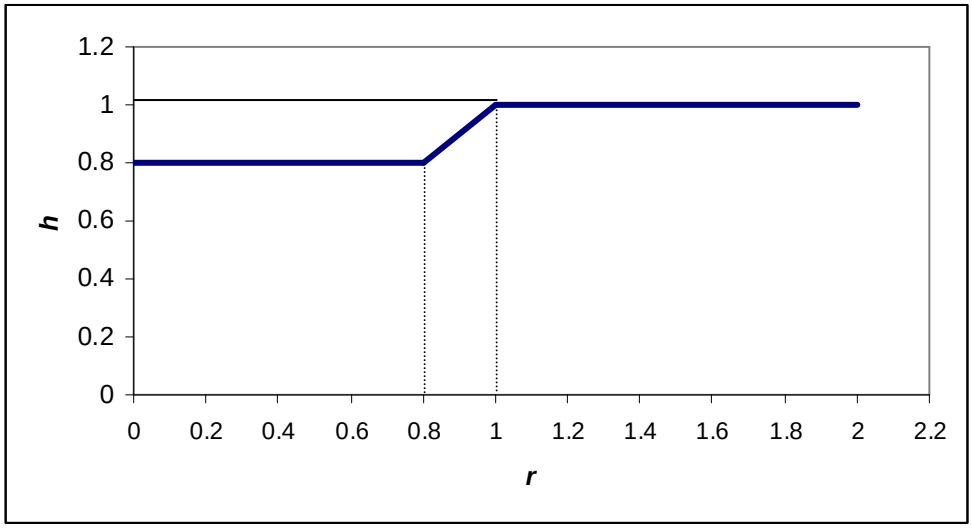
and σ_S^A is the standard error of the regression estimate of s_y^A subject to a lower bound of 0.15; and

δ is a control parameter value which has now been re-tuned to a value of -0.029 to achieve the median recovery target of $B_{2025}^{sp}/B_{2006}^{sp}$ of 1.20 specified for Model 3.

Further:

$$\begin{aligned} h(r) &= 0.8 \quad \text{for} \quad r \le 0.8 \\ &= r \quad \text{for} \quad 0.8 \le r \le 1.0 \\ &= 1.0 \quad \text{for} \quad r \ge 1.0 \end{aligned} \quad (3)$$

i.e.:



where r is the ratio of recent area-averaged CPUE to that at the time the OMP commenced:

$$\overline{\overline{CPUE}}_{init} = \frac{1}{3}\sum_{y'=2003}^{2005}\sum_{A=1}^{3}\lambda_A CPUE^{A}_{y'} \quad (4)$$

$$\overline{\overline{CPUE}}_{y} = \frac{1}{3}\sum_{y'=y-3}^{y-1}\sum_{A=1}^{3}\lambda_A CPUE^{A}_{y'} \quad (5)$$

$$r_y = \frac{\overline{\overline{CPUE}}_{y}}{\overline{\overline{CPUE}}_{init}} \quad (6)$$

and

$\lambda_1 = 0.08$

$\lambda_2 = 0.87$

$\lambda_3 = 0.05$.

The CPUE weighting factors, λ_1, λ_2 and λ_3 relate to relative biomass in each area, and were calculated as follows. Using the estimated values of q and B^{exp} for 2010 from operating Model 3 (Johnston and Butterworth 2010b):

	q	B^{exp} (MT)
Area 1	0.00218412	565
Area 2	0.000571185	1598
Area 3	0.0023918	375

The relative weightings for the biomass are thus: Area 1 = 565/2537 = 0.22
Area 2 = 1598/2537 = 0.63
Area 3 = 375/2537 = 0.15

In terms of CPUE what is therefore required is:

$$\begin{aligned} & 0.22\ B^1 + 0.63\,B^2 + 0.15\ B^3 \\ & = 0.22\frac{CPUE^1}{q_1} + 0.63\frac{CPUE^2}{q_2} + 0.15\frac{CPUE^3}{q_3} \\ & = 100.7\,CPUE^1 + 1103\,CPUE^2 + 63\,CPUE^3 \end{aligned}$$

Renormalising so that the CPUE weights must sum to 1, it follows that the appropriate weighted average for CPUE is given by:

$$0.08\,CPUE^1 + 0.87\,CPUE^2 + 0.05\,CPUE^3$$

Inter-annual TAC constraint
A rule to restrict the inter-annual TAC variation to no more than 5% up or down from season to season is applied, i.e.:

$$\begin{aligned} &\text{if } TAC_{y+1} > 1.05\,TAC_y \qquad TAC_{y+1} = 1.05\,TAC_y \\ &\text{if } TAC_{y+1} < 0.95\,TAC_y \qquad TAC_{y+1} = 0.95\,TAC_y \end{aligned} \tag{7}$$

2.2. The Generalized Linear Model applied to the South Cost rock lobster CPUE data to obtain area-specific indices of abundance

The nominal CPUE data for South Coast rock lobster are (re-)standardized each season by means of a Generalized Linear Model (GLM) to obtain area-specific standardized indices of abundance for input to the OMP.

Certain records are excluded from the analyses; these are as follows:

- Data from companies other than the four major companies for years prior to and including 1997.
- Data pertaining to Hout Bay Fishing vessels over the period 1997–2000, since they are considered to be unreliable.
- Sets with zero effort.
- Sets with zero catch.
- One record with a CPUE value of > 9kg/trap (this was considered an outlier).

The fishing grounds have historically been separated into four areas. However, based on recent analyses conducted by Gaylard and Bergh (2007), these four areas have been revised to three. It is these revised "new areas" upon which the analyses are based.

The GLM

The base case GLM applied to obtain area-specific indices of abundance is:

$$\ell n(CPUE) = I + \alpha_y + \beta_{seas} + \gamma_{depth} + \eta_{soak} + \kappa_{vess} + \lambda_{grid} + \varpi_{echo} + \theta_{gps} + \varsigma_{video} + \tau(traps) + (y \times area) + \varepsilon \tag{8}$$

where I is the intercept,
α_y is the split-year fishing season effect (1977 to the season prior to the year for which the CPUE value is being calculated),
β_{seas} is the season effect
season 1 = October – December
season 2 = January – March
season 3 = April – June
season 4 = July – September,
γ_{depth} is the depth effect
d75 : depth < 100
d125 : 100 ≤ depth < 150
d175 : 150 ≤ depth < 200
d225 : 200 ≤ depth < 250
d275 : depth ≥250,
η_{soak} is the soak time effect
soak1 : soak ≤ 24 hours
soak2 : 24 < soak ≤ 48
soak3 : 48 < soak ≤ 72
soak4 : 72 < soak ≤ 96
soak5 : soak > 96 hours,
κ_{vess} is the vessel effect (42 vessels to 2006),
λ_{grid} is the grid effect (290 grid squares),
ϖ_{echo} is the echo-sounder effect,
θ_{gps} is the GPS effect,
ς_{video} is the video plotter effect,
traps is a measure of effort provided by the number of traps set and is treated as a continuous variable,
(*y*×*area*) is a fixed effect interaction term where *area* relates to one of the three areas), and
ε is assumed to be normally distributed.

Note that both grid and area cannot be included as main effects in the model because of confounding.

The standardized CPUE indices per area are calculated by applying the equation $CPUE_{y,a} = e^{(\alpha_y + (y \times area) + median(\lambda_{grid}))}$, where *median*($\lambda_{grid}$) is the median value amongst those for the grids specific to each area.

3. Methodology for calculating the TAE (total allowable effort)

A procedure for control of effort in the South Coast rock lobster fishery, as agreed by the Rock Lobster Working Group at its meeting on 31 July 2008. This method is reported in OLRAC(2008) and reproduced below.

3.1. Fishing day allocations

3.1.1 Effort will be controlled by the allocation to each company in the fishery of a number of ***fishing days*** for each season.

3.1.2 The number of fishing days used for any single ***trip*** is calculated as the number of ***seadays*** used less 1.5. This definition applies, both in administration of effort control for the current season and in calculation of performance in previous seasons (see section 3.2 below).

3.1.3. A day is included as a ***seaday*** for a trip if any part of that day is spent at sea. Thus the sailing day and landing day are both counted as seadays. However if a vessel spends a full day in port, e.g. for repairs, and does not spend any part of that day at sea, it will not be counted as a seaday.

3.1.4 A ***trip*** is deemed to end when fish are offloaded and a landing report is completed.

3.1.5 The ***fishing day*** allocation $E_{c,y}$ for rights holder *r* in season *y* will be calculated as:

$$E_{r,y} = Q_{r,y} / BCR_y \qquad (9)$$

where

$Q_{r,y}$ is the quota in kilograms for rights holder *r* in season *y*, and

BCR_y is the ***base catch rate*** (in kg per fishing day) for season *y* (see section 3.2 below).

3.1.6 A fishing day ***pool*** will be available from which companies may draw if needed, at the discretion of South Coast Rock Lobster Industry Association. The number of fishing days allocated to the pool will be:

$$E_{pool,y} = 0.1\sum_r E_{r,y} \qquad (10)$$

i.e. the pool is 10% of the total effort allocation to all rights holders.

3.2. Calculation of base catch rate

The base catch rate, BCR_y, for season *y* is determined by:

$$BCR_y = \tfrac{1}{3}(CR_{y-4} + CR_{y-3} + CR_{y-2}) / D \qquad (11)$$

where

CR_{y-n} is the recorded catch in kg per fishing day in season *y-n*,

calculated as $CR_{y-n} = C_{y-n} / E_{y-n}$,

E_{y-n} is the total number of fishing days used by all participants in season *y-n*,

C_{y-n} is the total catch in kg by all participants in season *y-n*, and

D = 1.555369 is a constant (see section 3.3 below).

3.3. Calculation of the divisor D in equation (11)

$$D = e^{-2\sigma} \tag{12}$$

where

σ^2 is the expected variance in: $[\ln(CR_y) - \ln(\frac{1}{3}(CR_{y-4} + CR_{y-3} + CR_{y-2}))]$ which is estimated as:

$$\sigma^2 = \frac{1}{17} \sum_{y'=1990}^{2006} [\ln(CPUE_{y'}) - \ln(\overline{CPUE_{y'}})]^2 \tag{13}$$

where

$CPUE_{y'}$ is the GLM standardised catch per trap in season *y'*, and

$$\overline{CPUE_{y'}} = \frac{1}{3}(CPUE_{y-4} + CPUE_{y-3} + CPUE_{y-2}) . \tag{14}$$

The data used in equations (13) and (14) are shown in Table 1.

3.4. Base catch rate for the 2008 season.

Using equation (11) the base catch rate for 2008 is

$$BCR_{2008} = \frac{1}{3}(CR_{2004} + CR_{2005} + CR_{2006}) / D$$
$$= \frac{1}{3}(260.471 + 234.819 + 201.236) / 1.555369$$

<u>= 149.273 kg per fishing day</u>

The data used in this calculation are shown in Table 2.

References

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OLRAC. 2008. A revised proposal for controlling effort in the South Coast rock lobster fishery. MCM document MCM/2008/JUL/SWG/SCRL/27.

Table 1: GLM Standardised Catch per Trap used in equations (13) and (14). These are calculated as the average of GLM-standardised CPUE in the three areas, from Glazer and Butterworth (2008).

1977	2.786	1992	1.742
1978	2.228	1993	1.477
1979	2.095	1994	1.427
1980	2.350	1995	1.547
1981	2.268	1996	1.158
1982	1.982	1997	1.035
1983	2.261	1998	1.106
1984	2.169	1999	1.003
1985	2.010	2000	1.136
1986	2.542	2001	1.291
1987	2.421	2002	1.261
1988	2.569	2003	1.274
1989	2.491	2004	1.675
1990	2.043	2005	1.402
1991	1.802	2006	1.075

Table 2: Data used for calculation of base catch rate for the 2008/2009 season.

		Lusitania	Ruwekus	Premier	Total
2004	**catch (kg)**	150161	63928	166546	380635
	sea-days used	888	222	687	1797
	# trips	183	6	33	222
	avg trip length (sea-days)	4.8	37.0	19.9	8.0
	fishing-days used	613	213	635	1461
	catch rate per fishing-day	245.0	300.1	262.1	**260.5**
2005	**catch (kg)**	127777	45528	180539	353844
	sea-days used	843	260	721	1824
	# trips	168	7	26	201
	avg trip length (sea-days)	5.0	37.1	20.0	8.1
	fishing -days used	590.4	249.5	667.0	1506.9
	catch rate per fishing -day	216.4	182.5	270.7	**234.8**
2006	**catch (kg)**	141203	48978	190973	381154
	sea-days used	1027	314	900	2241
	# trips	182	10	35	227
	avg trip length (sea-days)	5.7	31.4	22.8	9.4
	fishing -days used	754.3	299.0	840.7	1894.1
	catch rate per fishing -day	187.2	163.8	227.2	**201.2**