TAC 2008 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 will be used 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).

Updated input data to the OMP

Four data sources 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 (2008a), Glazer (2008b), Glazer (2008c) and OLRAC (2008). 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.

TAC recommendations for 2008 using OMP 2007 re-cast

Using the data listed in Table 1 as input to OMP 2007 re-cast, the total commercial TAC for the 2008 season is 2083 MT. This is a 10% decrease from the 2007 commercial TAC of 2314 MT. The recreational allocation is 231 MT – also a reduction of 10% from the 2007/08 season. The detailed TAC breakdowns across offshore, near-shore and the recreational allocation are provided in Table 2. The near-shore total TAC is reduced to 451 MT for 2008 – down from 560 MT in 2007. Normally both the recreational and nearshore allocations would be held fixed, but the commercial TAC has now dropped below the respective levels at which these allocations are reduced by fixed percentages under the OMP.

Table 3 reports the TACs for the 2007 season for comparative purposes.

Appendix 2 provides the detailed calculations associated with TAC 2008 evaluation.

References

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

Glazer, J.P. 2008b. An index of abundance for Area 1+2 West Coast rock lobster. MCM document, MCM/2008/JUL/SWG-WCRL/09.

Glazer, J.P. 2008c. Area-disaggregated standardised CPUE indices in the West Coast rock lobster hoopnet fishery. MCM document, MCM/2008/JUL/SWG-WCRL/05.

Glazer, J.P., van Zyl, D and F. Keulder. 2008. Analysis of the 2008 West Coast Rock Lobster FIMS data. MCM document, MCM/2008/JUL/SWG-WCRL/02.

Johnston, S.J., D.S. Butterworth and Glazer, J.P. 2008. OMP 2007 re-recast to be used for setting TACs for the West Coast rock lobster fishery for the 2008+ seasons. MCM document, MCM/2008/AUG/SWG-WCRL/YY.

Johnston, S.J. and D.S. Butterworth. 2008. OMP 2007 re-cast results for West Coast rock lobster. MCM document, MCM/2008/JUL/SWG-WCRL/06.

Johnston, S.J., Butterworth, D.S. and J.P. Glazer. 2008. OMP 2007 re-cast to be used for setting TACs for the West Coast rock lobster fishery for the 2008+ seasons. MCM document, MCM/2008/AUG/SWG-WCRL/YY.

OLRAC. 2008. Corrected male somatic growth rate estimates for input into the OMP for West Coast rock lobster. MCM document, MCM/2008/AUG/SWG-WCRL/??.

Table 1: Combined data series to be used as input into the OMP 2007 re-cast to generate TAC recommendations for the 2008 season (see Appendix 1 for units).

	Somatic growth	Trap CPUE	Hoop CPUE	FIMS
1992	2.884			1.953
1993	3.455	0.725	0.942	1.300
1994	3.521	0.584	0.797	0.940
1995	3.901	0.801	1.078	1.602
1996	4.883	0.979	1.160	2.541
1997	3.512	1.074	1.129	0.771
1998	2.959	1.212	1.231	1.687
1999	3.152	1.133	1.167	1.336
2000	4.321	1.255	1.097	1.061
2001	3.685	1.732	1.754	1.527
2002	3.828	1.638	0.987	1.237
2003	2.804	1.289	0.999	1.092
2004	3.812	1.122	0.833	1.007
2005	2.996	0.838	0.944	1.395
2006	2.818	0.987	0.808	0.799
2007	2.130	0.691	1.032	1.026

Table 2: TAC recommendations for the 2008 season using OMP-2007 re-cast.

	Global TAC (Commercial + recreational)	**Commercial only**	**Offshore quotas**	**Near-shore quotas**	**Recreational**
Total	**2314**	**2083**	**1632**	**451**	**231**
A1-2	28.8	24.2	0	24.2	
A3-4	130.7	101.8	29.3	72.5	
A5-6	61.1	32.2	0	32.2	
A7	587.2	578.0	578.0	0	
A8+	1506.7	1347.3	1025.0	322.3	

Table 3: TAC recommendations for the 2007 season (using OMP-2007).

	Global TAC (Commercial + recreational)	**Commercial only**	**Offshore quotas**	**Near-shore quotas**	**Recreational**
Total	**2571**	**2314**	**1754**	**560**	**257**
A1-2	35	30	0	30	
A3-4	127	95	5	90	
A5-6	72	40	0	40	
A7	874	863	863	0	
A8+	1463	1286	886	400	

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

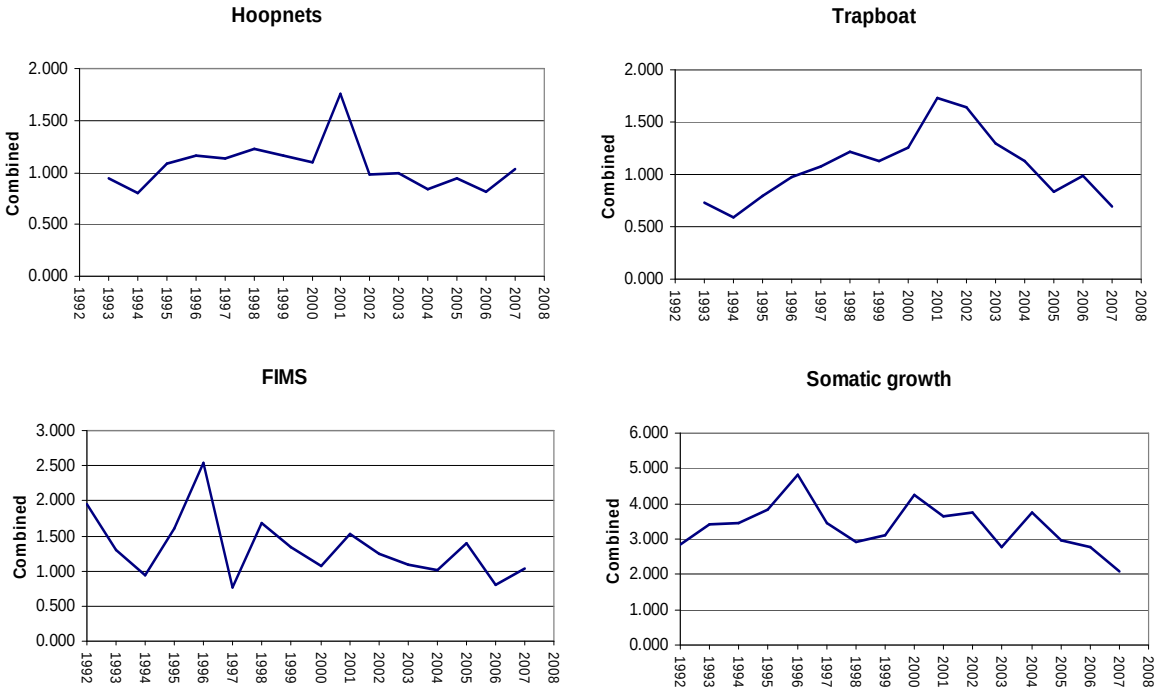
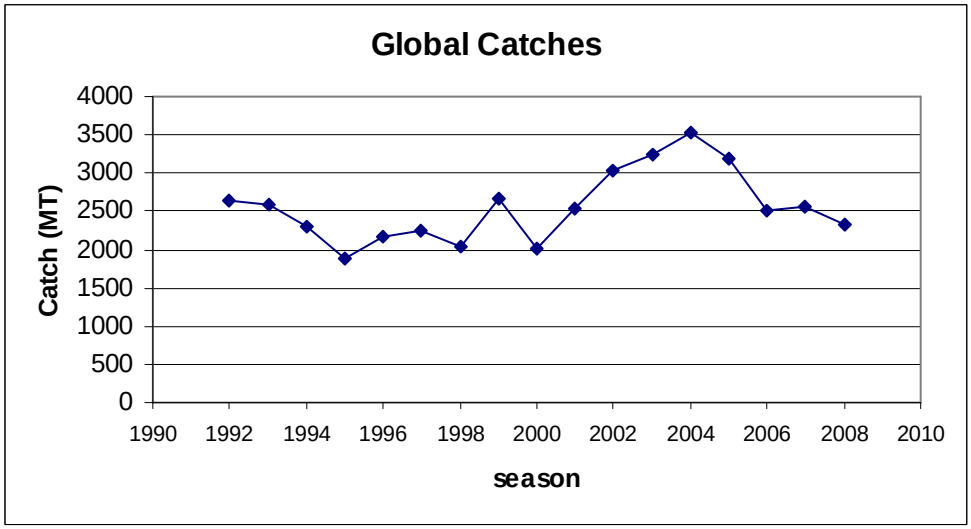


Figure 2: The historic series of Global (commercial plus recreational) catch for the West Coast rock lobster. Note that in 2006 the commercial TAC was not caught, and the global catch was only 2507 MT (the TAC was 2857 MT). The 2008 value shown here is the recommended new TAC from OMP 2007 re-cast.



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 2008b and 2000c).

	A12	A34	A56	A8
1993	0.727	1.551	0.623	0.827
1994	0.583	0.485	0.239	1.253
1995	0.834	1.198	0.45	1.355
1996	1.125	1.556	0.887	1.148
1997	0.974	1.023	0.852	1.389
1998	0.848	1.003	0.555	1.729
1999	0.62	0.857	0.884	1.56
2000	0.926	0.507	1.043	1.525
2001	1.159	3.027	1.1315*	1.488
2002	1.156	0.756	1.22	1.086
2003	0.923	1.381	0.765	0.968
2004	0.898	0.578	0.673	1.092
2005	1.422	0.522	1.415	1.032
2006	1.344	0.427	1.068	0.944
2007	1.458	0.869	1.308	1.068

* average of 2000 and 2002

Table A2. Trap CPUE data at super-area level (from Glazer 2008a).

	A7	A8
1993	0.576	0.937
1994	0.297	0.888
1995	0.577	1.083
1996	1.056	1.043
1997	1.269	1.056
1998	1.606	1.052
1999	1.311	1.136
2000	1.411	1.291
2001	2.28	1.516
2002	1.746	1.761
2003	1.562	1.236
2004	1.195	1.208
2005	0.602	1.133
2006	0.739	1.311
2007	0.448	0.974

Table A3. FIMS data at super-area level (from Glazer *et al.* 2008).

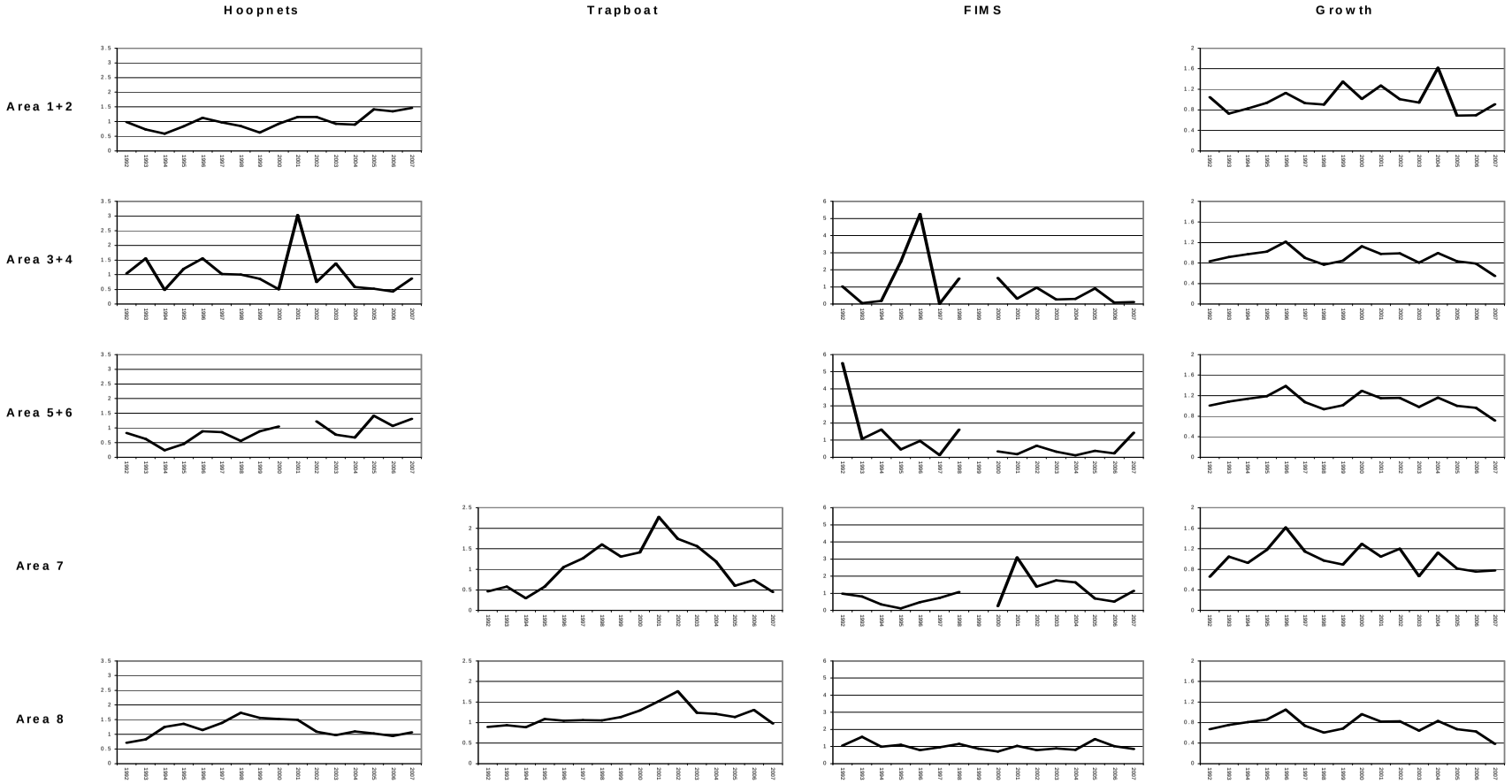
	A34	A56	A7	A8
1992	3.5	7.5	23.2	125.7
1993	0.2	1.45	19.3	187
1994	0.6	2.2	8.2	116
1995	8.5	0.63	2.6	130.3
1996	18	1.3	11.2	94.3
1997	0.1	0.16	17.4	112.3
1998	5.1	2.2	25.6	137.2
1999	5.175*	1.33*	15.74*	103.3
2000	5.25	0.46	5.88	84.43
2001	1.11	0.24	73.51	122.63
2002	3.27	0.92	33.11	93.27
2003	0.89	0.44	41.55	103.84
2004	1.01	0.14	39.1	95.47
2005	3.12	0.51	16.55	170.74
2006	0.3	0.31	12.33	121.67
2007	0.4	1.96	27.36	101.3

* average of the 1998 and 2000 values

Table A4. Somatic growth data at super-area level (from OLRAC 2008). Values are the mean annual growth increments of a 70 mm male lobster (mm).

	A1-2	A3-4	A5-6	A7	A8
1992	4.223	3.367	4.058	2.654	2.716
1993	2.936	3.693	4.383	4.241	3.041
1994	3.32	3.921	4.611	3.755	3.269
1995	3.787	4.116	4.806	4.777	3.464
1996	4.56	4.903	5.593	6.518	4.251
1997	3.756	3.63	4.32	4.637	2.978
1998	3.653	3.096	3.787	3.926	2.445
1999	5.436	3.411	4.101	3.613	2.759
2000	4.082	4.538	5.228	5.241	3.886
2001	5.138	3.952	4.643	4.24	3.301
2002	4.064	3.987	4.677	4.853	3.335
2003	3.796	3.253	3.943	2.707	2.601
2004	6.532	4.002	4.692	4.537	3.35
2005	2.762	3.362	4.052	3.286	2.711
2006	2.802	3.188	3.878	3.062	2.536
2007	3.666	2.205	2.895	3.149	1.553

Figure A1: Input data at a super-area level.



Appendix 2: Details of the TAC calculation

OMP 2007 re-cast:

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

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

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 $\overline{\beta}^{historic}_{89-04}$ 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.:

$$B^p_{T+1} = B^p_T + G_T - (C_T + P_T) \quad (2)$$

where

B^p_T = 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 an extra 175,06 MT is added for the 2007 season to take into account the 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:

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

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 2008: here *y* = 2008

Population model fit to input data:

α =2931.25 ……. Eqn (3)
B^{P}_{1992} =20437.58 ……..Eqn (2)
-lnL=-44.85 …….. Eqn (4)

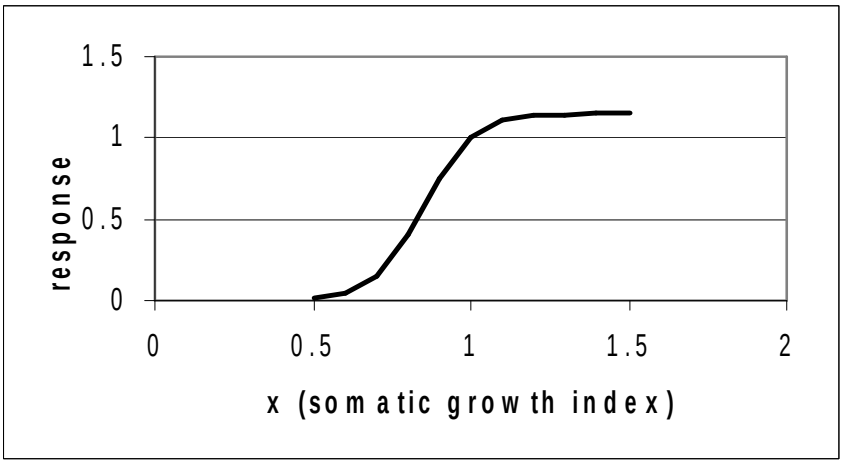
Somatic growth index = *x* in modification below:

If $x = \frac{\overline{\beta}_{y-5,y-4,y-3,y-2,y-1}}{\overline{\beta}^{historic}_{89-04}}$, (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^{λ} 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:



$x = \frac{\overline{\beta}_{y-5,y-4,y-3,y-2,y-1}}{\overline{\beta}^{historic}_{09-04}}$ **=2.863/3.504 = 0.8168**

"response" to *x* = 0.4636

$\frac{\hat{B}_y}{\hat{B}_{1992}} = \frac{\hat{B}_{2008}}{\hat{B}_{1992}}$ **of Eqn (1) = 0.5233**

$\frac{CPUE^{trap}_{y-1,y-2,y-3}}{CPUE^{trap}_{93,94,95}}$ **of Eqn (1)=1.1900**

$\frac{CPUE^{hoop}_{y-1,y-2,y-3}}{CPUE^{hoop}_{93,94,95}}$ **of Eqn (1)=0.9908**

$\frac{FIMS_{y-1,y-2,y-3}}{FIMS_{92,93,94,95}}$ **of Eqn (1) =0.7478**

Thus

$$\left[f_1\left(\frac{CPUE^{trap}_{y-1,y-2,y-3}}{CPUE^{trap}_{93,94,95}} \right) + f_2\left(\frac{CPUE^{hoop}_{y-1,y-2,y-3}}{CPUE^{hoop}_{93,94,95}} \right) + (1 - f_1 - f_2)\left(\frac{FIMS_{y-3,y-2,y-1}}{FIMS_{92,93,94,95}} \right) \right]$$ **=1.0218**

and

1.02180.5 = 1.0109**

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 = **1844.7 MT**.

After 10% down constraint: global TAC = 2314 MT (=0.9*2571)

Recreational quota:

For the recreational take, the following algorithm is applied:

$C^{rec}_t = 320$ MT initially

If $C^{rec}_t / TAC^{G}_t > 0.12 TAC^{G}_t$ then $C^{rec}_t = 0.10 TAC^{G}_t$

If $C^{rec}_t / TAC^{G}_t < 0.08 TAC^{G}_t$ 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.

320/2314 = 0.138 this is > than the 0.12 constraint imposed, thus Recreational allocation (2008) = 0.10*2314 = 231 MT

Total commercial quota = 2314 MT – 231 MT = 2083 MT

Nearshore quota total:
The total nearshore allocation varies up and down over time in a similar manner to the recreational take. Thus, first the total nearshore TAC each year, NSQ^T, is calculated as follows:

$NSQ_t^T = 560$ MT initially

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

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

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

thus,
560/2314=0.242 this is > than the 0.24 constraint imposed, thus
Nearshore quota(2008) = 0.195 *2314 = 451 MT

Offshore quota total = 1632 MT (=2083 MT - 451 MT)