# TAC 2010 for West Coast rock lobster using OMP 2007 re-cast

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## 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 2010 value, and its allocation by super-area and by fishing sector, produced using OMP 2007 re-cast.

## 2010 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 (2010a), Glazer (2010b), Glazer (2010c), Brandao and Butterworth (2010) and OLRAC (2010). 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.* (2010), 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. Van Zyl and Johnston (2010) report the Interim Relief take estimate for the 2009/10 season. The values to be used in the OMP calculation (see Appendix 2 equation 2) are as follows:

| Season | Interim relief tonnage |
|---|---|
| 2007/08 | 174 MT |
| 2008/09 | 170 MT |
| 2009/10 | 278 MT |

## TAC recommendations for 2010 using OMP 2007 re-cast

Table 2 provides the OMP 2007 re-cast allocations per super-area and per fishery, and includes the TACs for the 2009 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 decreased from 1684.86 MT to 1578.22 MT
4. the global TAC is decreased from 2392.86 MT to 2286.22 MT, i.e. a decrease of 107 MT or 4.5%. The reason for this net decrease is primarily that although Hoopnet (slightly) and Trap CPUE for 2009 show an increase over 2008, the opposite applies for FIMS and somatic growth (see Figure 1).

Note that OMP 2007 re-cast make no allowance for an Interim Relief take; any such allocation would have to be subtracted, at a super0area level, from one of the fishing sectors listed above.

Appendix 2 provides the detailed calculations associated with TAC 2010 evaluation.

## References


Brandao, A. and D.S. Butterworth. 2010. FIMS indices for the rock lobster resource of South Africa: updated to include the 2009/2010 season. Branch Fisheries document, FISHERIES/AUG/SWG-WCRL11.

Glazer, J.P. 2010a. Area-disaggregated standardised CPUE indices in the West Coast rock lobster trapboat fishery. Branch Fisheries document, FISHERIES/2010/JUL/SWG-WCRL4.

Glazer, J.P. 2010b. An index of abundance for Area 1+2 West Coast rock lobster. Branch Fisheries document, FISHERIES/2010/JUL/SWG-WCRL5.

Glazer, J.P. 2010c. Area-disaggregated standardised indices in the West Coast rock lobster hoopnet fishery. Branch Fisheries document, FISHERIES/2010/JUL/SWG-WCRL6.

Johnston, S.J., 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. 2010. OMP 2007 re-cast to be used for setting TACs for the West Coast rock lobster fishery for the 2008+ seasons. Branch Fisheries document, MCM/2010/AUG/SWG-WCRL/13.

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

OLRAC. 2010. Updated male somatic growth rate estimates for input into the OMP for West Coast rock lobster. Branch Fisheries document, FISHERIES/2010/JUL/SWG-WCRL07.

Van Zyl, D. and Johnston, S.J. 2010. Interim relief phase IV (2009/2010 season). Branch Fisheries document, FISHERIES/2010/AUG/SWG-WCRL18.

Table 1: Combined data series to be used as input into the OMP 2007 re-cast to generate TAC recommendations for the 2010 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 | 2.887 | | | 2.725 |
| 1993 | 3.468 | 0.749 | 0.915 | 1.117 |
| 1994 | 3.523 | 0.597 | 0.788 | 0.984 |
| 1995 | 3.908 | 0.826 | 1.058 | 2.069 |
| 1996 | 4.899 | 1.021 | 1.129 | 3.639 |
| 1997 | 3.515 | 1.125 | 1.101 | 1.009 |
| 1998 | 2.952 | 1.275 | 1.206 | 1.849 |
| 1999 | 3.151 | 1.186 | 1.149 | 1.445 |
| 2000 | 4.334 | 1.311 | 1.070 | 1.098 |
| 2001 | 3.668 | 1.822 | 1.570 | 1.157 |
| 2002 | 3.820 | 1.709 | 0.963 | 0.699 |
| 2003 | 2.793 | 1.350 | 0.977 | 1.288 |
| 2004 | 3.814 | 1.172 | 0.818 | 1.022 |
| 2005 | 2.981 | 0.830 | 0.944 | 1.070 |
| 2006 | 2.853 | 1.018 | 0.788 | 0.766 |
| 2007 | 2.300 | 0.710 | 1.004 | 1.125 |
| 2008 | 3.756 | 0.754 | 1.230 | 1.218 |
| 2009 | 3.012 | 0.869 | 1.244 | 0.821 |

Table 2: TAC recommendations for the 2010 season using OMP-2007 re-cast (the 2009 season values are shown in parentheses).

| | **Global TAC (Commercial + recreational)** | **Commercial only** | **Offshore allocation** | **Near-shore allocation** | **Recreational allocation** |
|---|---|---|---|---|---|
| **Total** | **2286.22 (2392.86)** | **2029.22 (2135.86)** | **1578.22 (1684.86)** | **451 (451)** | **257 (257)** |
| A1-2 | 29.31 (29) | 24.17 (24) | 0 (0) | 24.17 (24) | |
| A3-4 | 146.32 (157) | 126.07 (138) | 53.60 (65) | 72.48 (73) | |
| A5-6 | 64.33 (64) | 32.20 (32) | 0 (0) | 32.20 (32) | |
| A7 | 359.34 (381) | 396.55 (421) | 396.55 (421) | 0.0 (0) | |
| A8+ | 1686.92 (1761) | 1450.22 (1521) | 1128.07 (1199) | 322.15 (322) | |

Figure 1: Input data combined across super-areas, to be used as input into OMP 2007 re-cast for setting the 2010 TAC.

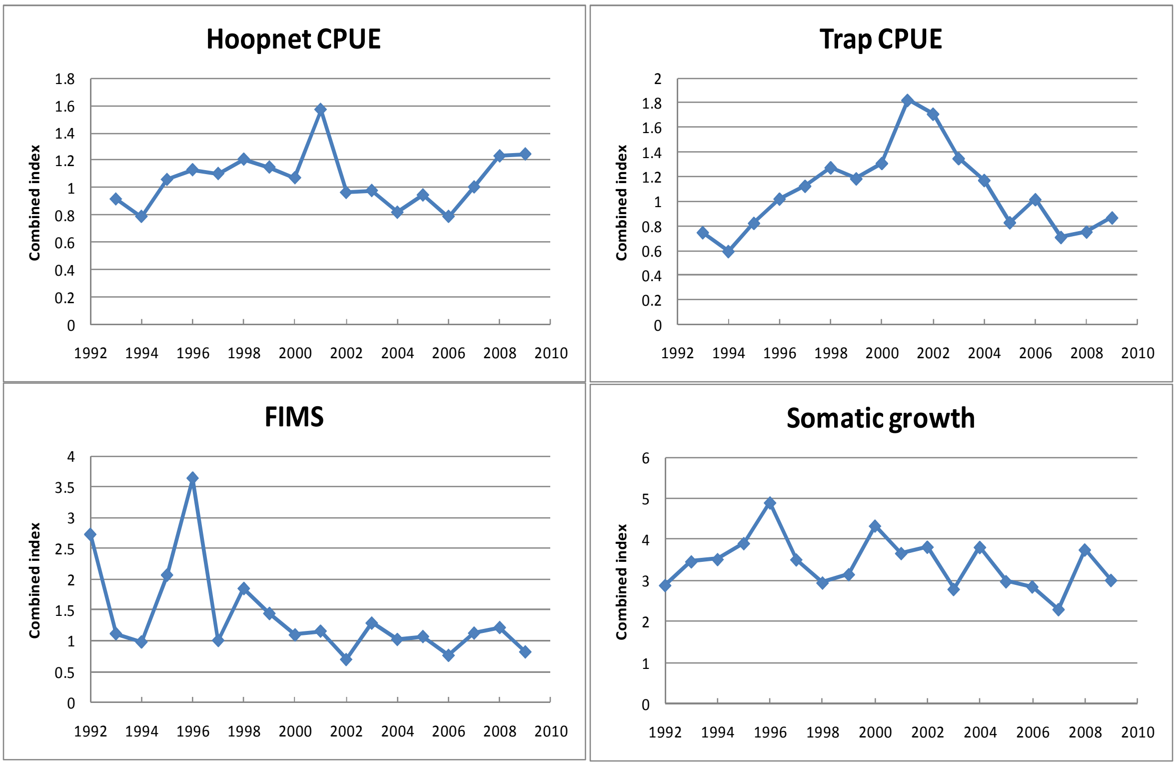
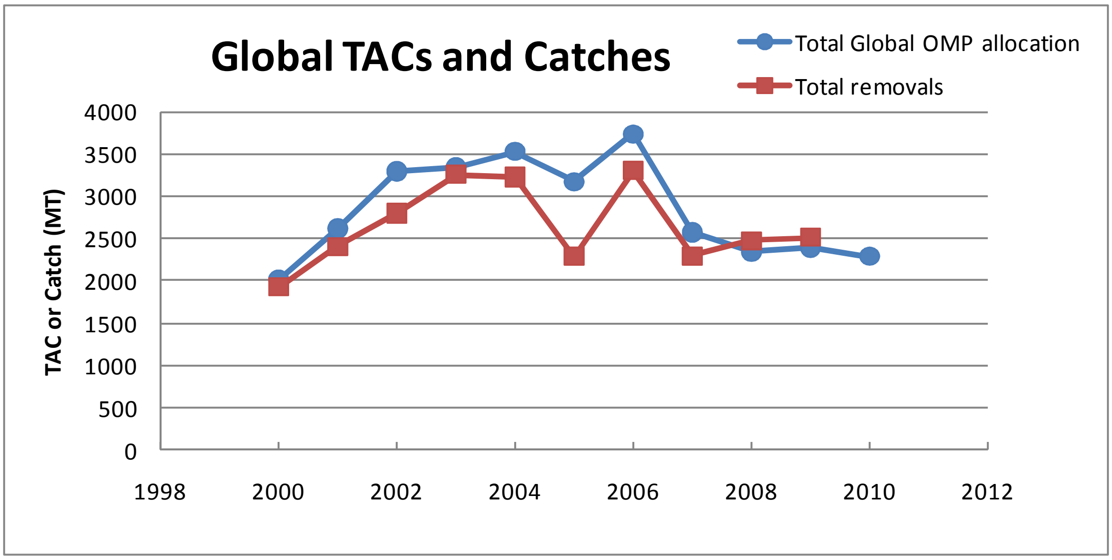


Figure 2: The historic series of Global (commercial plus recreational) catches and TACs for the West Coast rock lobster.



**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 2010b and 2010c).

| | **Area 1+2** | **Area 3+4** | **Area 5+6** | **Area 8** |
|---|---|---|---|---|
| **1993** | 0.701 | 1.511 | 0.590 | 0.814 |
| **1994** | 0.554 | 0.472 | 0.226 | 1.233 |
| **1995** | 0.792 | 1.167 | 0.429 | 1.333 |
| **1996** | 1.077 | 1.515 | 0.851 | 1.126 |
| **1997** | 0.934 | 0.997 | 0.811 | 1.357 |
| **1998** | 0.808 | 0.976 | 0.535 | 1.689 |
| **1999** | 0.593 | 0.833 | 0.844 | 1.543 |
| **2000** | 0.885 | 0.494 | 0.990 | 1.488 |
| **2001** | 1.108 | 2.942 | 1.069* | 1.473 |
| **2002** | 1.110 | 0.735 | 1.148 | 1.078 |
| **2003** | 0.878 | 1.341 | 0.726 | 0.965 |
| **2004** | 0.854 | 0.566 | 0.639 | 1.075 |
| **2005** | 1.357 | 0.510 | 1.567 | 0.987 |
| **2006** | 1.286 | 0.416 | 0.993 | 0.938 |
| **2007** | 1.392 | 0.842 | 1.231 | 1.060 |
| **2008** | 1.144 | 1.371 | 1.516 | 1.151 |
| **2009** | 1.528 | 1.457 | 1.273 | 1.207 |

* average of 2000 and 2002 values

Table A2. Trap CPUE data at super-area level (from Glazer 2010a).

| | **Area 7** | **Area 8** |
|---|---|---|
| **1993** | 0.598 | 0.928 |
| **1994** | 0.310 | 0.879 |
| **1995** | 0.599 | 1.072 |
| **1996** | 1.096 | 1.033 |
| **1997** | 1.319 | 1.046 |
| **1998** | 1.667 | 1.042 |
| **1999** | 1.363 | 1.125 |
| **2000** | 1.465 | 1.278 |
| **2001** | 2.367 | 1.502 |
| **2002** | 1.815 | 1.745 |
| **2003** | 1.622 | 1.223 |
| **2004** | 1.243 | 1.197 |
| **2005** | 0.625 | 1.060 |
| **2006** | 0.768 | 1.299 |
| **2007** | 0.466 | 0.963 |
| **2008** | 0.376 | 1.122 |
| **2009** | 0.593 | 1.161 |

Table A3. FIMS data at super-area level (from Brandao and Butterworth 2010).

| | 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 |
| 2009 | 0.008 | 0.706 | 5.089 | 101.19 |

* average of the 1998 and 2000 values

Table A4. Somatic growth data at super-area level (from OLRAC 2010). Values are the mean annual growth increments of a 70 mm male lobster (mm).

| | A1+2 | A3+4 | A5+6 | A7 | A8 |
|---|---|---|---|---|---|
| **1992** | 4.272 | 3.386 | 4.072 | 2.663 | 2.660 |
| **1993** | 2.970 | 3.712 | 4.398 | 4.265 | 2.987 |
| **1994** | 3.368 | 3.929 | 4.615 | 3.770 | 3.203 |
| **1995** | 3.821 | 4.126 | 4.812 | 4.794 | 3.400 |
| **1996** | 4.598 | 4.910 | 5.597 | 6.659 | 4.184 |
| **1997** | 3.802 | 3.636 | 4.322 | 4.659 | 2.911 |
| **1998** | 3.715 | 3.095 | 3.781 | 3.948 | 2.370 |
| **1999** | 5.498 | 3.416 | 4.102 | 3.636 | 2.691 |
| **2000** | 4.124 | 4.550 | 5.236 | 5.262 | 3.825 |
| **2001** | 5.213 | 3.931 | 4.617 | 4.260 | 3.206 |
| **2002** | 4.103 | 3.974 | 4.660 | 4.881 | 3.248 |
| **2003** | 3.829 | 3.248 | 3.934 | 2.732 | 2.522 |
| **2004** | 6.596 | 3.996 | 4.682 | 4.584 | 3.271 |
| **2005** | 2.721 | 3.362 | 4.048 | 3.281 | 2.636 |
| **2006** | 2.808 | 3.240 | 3.926 | 3.103 | 2.515 |
| **2007** | 3.809 | 2.419 | 3.105 | 3.272 | 1.693 |
| **2008** | 3.500 | 4.082 | 4.768 | 4.287 | 3.356 |
| **2009** | 6.117 | 3.445 | 4.131 | 2.874 | 2.720 |

Table A5: Commercial catches and recreational allocations (in MT) assumed in the OMP.

| | Commercial | Recreational |
|---|---|---|
| **1990** | 2996 | 441 |
| **1991** | 2480 | 455 |
| **1992** | 2176 | 469 |
| **1993** | 2197 | 391 |
| **1994** | 1966 | 336 |
| **1995** | 1516 | 379 |
| **1996** | 1674 | 496 |
| **1997** | 1918 | 340 |
| **1998** | 1792 | 249 |
| **1999** | 2315 | 360 |
| **2000** | 1610 | 404 |
| **2001** | 2073 | 468 |
| **2002** | 2462 | 583 |
| **2003** | 2917 | 320 |
| **2004** | 3040 | 320 |
| **2005** | 1998 | 320 |
| **2006** | 3091 | 300 |
| **2007** | 1863 | 257 |
| **2008** | 2062 | 257 |
| **2009** | 2136 | 257 |

# 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

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

Note that $\beta$ refers to the somatic growth rate of a 70mm male lobster, and that $\overline{\beta}_{89-04}^{historic}$ refers to the geometric mean $\beta$ 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 $\beta$ 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.:

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

where

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

$G_T$ = annual "growth" of resource in season *T*,

$C_T$ = annual commercial + recreational catch in season *T*[1], and

[1] Note than extra tonnage is added for the 2007, 2008 and 2009 seasons to take into account the best estimates of interim relief tonnage taken.

$P_T$ = annual estimate of poaching for season $T$.

$B_{1992}^{p}$ is a parameter estimated in fitting this model to the data.

The annual somatic growth parameter $\beta_T$ is the moult-probability model (OLRAC 2010) 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, $\beta_T$ is known for all preceding seasons.

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

$$G_T = a(\beta_T + b) \qquad (3)$$

The value of $b$ is set externally by regressing against $\beta$ 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 $\beta$ (this relationship is near linear). The intercept of this regression with the horizontal axis ($\beta$), 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:

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

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 2010: here *y* = 2010

**Population model fit to input data:**

$\alpha$ =3086 ………. Eqn (3)
$B^{p}_{1992}$ =40645 ………..Eqn (2)
-lnL=-41.38 ……….. Eqn (4)

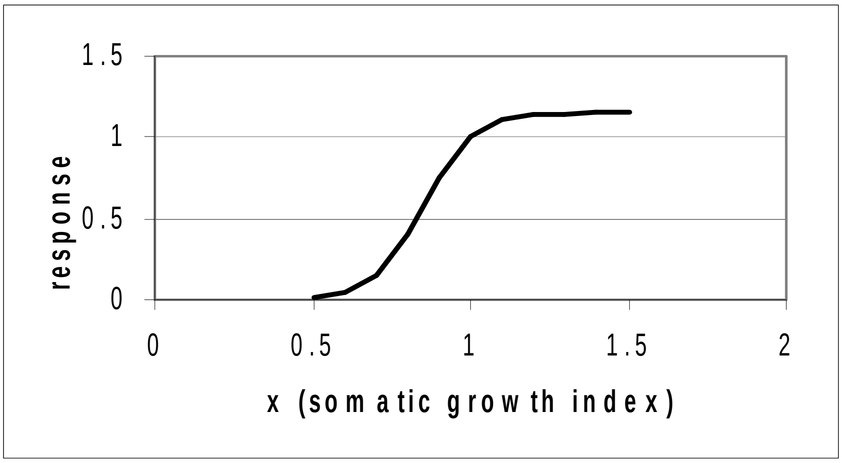
Somatic growth index = *x* in modification below:

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 $x^{\lambda}$, with $\lambda$ 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:

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

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:




$x = \dfrac{\overline{\beta}_{y-5,y-4,y-3,y-2,y-1}}{\overline{\beta}^{historic}_{89-04}}$ **=2.944/3.504 = 0.840**

**"response" to *x* = 0.546**

$\frac{\hat{B}_y}{\hat{B}_{1992}} = \frac{\hat{B}_{2010}}{\hat{B}_{1992}}$ **of Eqn (1) = 0.8462**

$\frac{CPUE^{trap}_{y-1,y-2,y-3}}{CPUE^{trap}_{93,94,95}}$ **of Eqn (1)=1.0799**

$\frac{CPUE^{hoop}_{y-1,y-2,y-3}}{CPUE^{hoop}_{93,94,95}}$ **of Eqn (1)=1.262**

$\frac{FIMS_{y-1,y-2,y-3}}{FIMS_{92,93,94,95}}$ **of Eqn (1) =0.6593**

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

**=1.0687**

**and**

**1.0687**0.5 = 1.0338**

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

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

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

results in the Global (commercial plus recreational) TAC before any constraints of **2286.22 MT**.

No constraints were violated (i.e. the TAC decrease is less than the maximum inter-annual change constraint of 10%), thus the final Global TAC = 2286.22 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 $C^{rec}_{2010} / TAC^{G}_{2010} = 257/2286 = 0.112$ so that the recreational allocation is unchanged.

**Thus the total commercial quota = 2286.22 MT – 257 MT = 2029.22 MT**

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

$NSQ^T_t = NSQ^T_{t-1}$ = 451 MT initially, where $t$ = 2010

If $NSQ^T_t / TAC^G_t < 0.16$ then $NSQ^T_t = 0.195\, TAC^G_t$
If $NSQ^T_t / TAC^G_t > 0.24$ then $NSQ^T_t = 0.195\, TAC^G_t$

If $NSQ^T_t > 800$ MT then $NSQ^T_t = 800$ MT

Here $NSQ^T_{2009} / TAC^G_{2009} = 451/2286 = 0.197$ so that the nearshore allocation is unchanged.

**Thus: Offshore allocation total = 1578.22 MT (=2029.22 MT - 451 MT)**