The development of a new OMP for the West Coast Rock Lobster fishery for recommending TAC allocations for the 2015+ seasons

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INTRODUCTION

This document provides the specifications as reported in Johnston *et al*. (2013) of the most recently adopted OMP for west coast rock lobster- "OMP 2011-re-tuned" - which was intended to be used to set allocations for various sectors and super-areas for the 2013+ seasons for the West Coast rock lobster fishery. The document provides details of the three main components of OMP 2011 re-tuned.

- 1) how data are combined across the five super-areas (Area 1-2, Area 3-4, Area 5-6, Area 7 and Area 8+) for input into the OMP;
- 2) the OMP formulae which provide the global TAC recommendation; and
- 3) the manner in which the global TAC is split amongst the super-areas and different sectors.

The document also lists the various scenarios assumed for the simulation process.

Due to various circumstances, such as Exceptional Circumstance being declared in Area 7, the TAC setting procedure has deviated from TACS being set automatically as per the OMP-2011 re-tuned specifications. TACs have instead been set in a somewhat *ad hoc* manner, based on constant catch projections for the 2013 and 2014 seasons.

At an earlier SWG meeting this year, it was agreed that a new OMP should be developed for setting of allocations for the various sectors and super-areas for the 2015+ season. It was however agreed that the new OMP would be along the lines of OMP-2011 re-tuned. It was also agreed that Exceptional Circumstances for Area 7 would be assumed for the 2015 season, but that the OMP simulations would assume that the resource would recover sufficiently in Area 7 for the new OMP to be used to set the allocations in Area 7 for the 2016+ season.

The SWG furthermore agreed that the new OMP would have as minimum targets a median resource recovery target of 1.35 and a lower 5^{th} %ile recovery target of 0.72 (where the exploitable male biomass, B75m, is the portion of the stock to be assessed).

Some key features of OMP 2011 re-tuned are as follows:

1) The inter-annual TAC downward constraint was changed from the baseline 10% to as much as 30% if circumstances require (RULE 1).
2) Exceptional Circumstances may be invoked for a particular super-area which for simulation purposes results in all fishing in that super-area being “suspended” (Low Abundance rule).
3) After the initial total offshore TACs by super-area are calculated, a further adjustment is made where 20% of the offshore A8+ TAC is transferred to A3+4, A5+6, and A7. This 20% removal from A8+ is phased in over four years (i.e. would be 5% only for the first season 2011). Each year a fixed 20 MT is given to A5+6, and the remainder of the tonnage transferred from A8+ is split between A3+4 and A7 in a ratio 30:70.
4) TACs are split between sector groups using the “alternative” sector split option (see Table 2 of Johnston *et al.* (2013)).

The idea underlying the “Low Abundance rule” in 2) is not to imply that this complete closure would occur in practice. Rather, what would then need to happen is an early OMP review with shifting of effort by some combination of the nearshore commercial and interim relief/subsistence sectors to other super-areas.

Exceptional Circumstances have been declared for Area 7 for the 2013 and 2014 seasons when an experimental TAC of 80 tons was allocated to this super-area to maintain a commercial CPUE index (and no recreational take was allowed in Area 7).

DESCRIPTION OF OMP 2011 RE-TUNED

1) The combination of data across super-areas

The OMP uses input data from all five super-areas where the data type concerned has been available in the past and is anticipated to continue being available in the future.

Combined CPUE and FIMS indices

The "global" OMP requires a single index for each data source (somatic growth, trap CPUE, hoop CPUE and FIMS) for each season in the future. The last three of these are combined across super-areas as follows.

STEP 1: For each super-area for which data are assumed to be available in the future, there will be for any season *Y* (here trap CPUE is used as an example):

$$CPUE_Y^{trap,A1-2}, CPUE_Y^{trap,A3-4}, CPUE_Y^{trap,A5-6}, CPUE_Y^{trap,A7}, CPUE_Y^{trap,A8}$$

STEP 2: Evaluate the geometric means of the CPUEs (and FIMS) for the super-area concerned (here we use A1-2 as an example) over the year period 2009[1]…*Y*-1.

STEP 3: Re-normalise the CPUE and FIMS series as follows (e.g. for traps in Area A1-2):

$$CPUE_Y^{trap,A1-2} \Rightarrow X_Y^{trap,A1-2} = \frac{CPUE_Y^{trap,A1-2}}{Geometric\ mean\ (CPUE_y^{trap,A1-2}:\ y = 2009...2013)} \qquad (1)$$

STEP 4: Calculate a combined CPUE (and FIMS) index as follows (here trap CPUE is used as an example):

$$I_Y^{trap} = w_{A1-2}^{trap} X_Y^{trap,A1-2} + w_{A3-4}^{trap} X_Y^{trap,A3-4} + ... + w_{A8}^{trap} X_Y^{trap,A8} \qquad (2)$$

where $w_{A1-2}^{trap} + w_{A3-4}^{trap} + ... + w_{A8}^{trap} = 1$.

The weights have been calculated in the following manner. For trap and hoop CPUE for example, obtain $\overline{B}^{75}$, the average (male plus female) biomass above 75mm carapace length over the **2006-2014**[2] period for each super-area from the reference case operating model (Johnston 2015):

$$\overline{B}_{A1-2}^{75}, \overline{B}_{A3-4}^{75}, \overline{B}_{A5-6}^{75}, \overline{B}_{A7}^{75}, \overline{B}_{A8}^{75};$$

then:

[1] Was 2005 for OMP 2011
[2] Was 2000-2009 for OMP 2011

$$\overline{B}^{75}_{TOTAL} = \sum_{A=1..8} \overline{B}^{75}_{A} \text{ and} \tag{3}$$

$$w^{trap}_{A1-2} = w^{hoop}_{A1-2} = \frac{\overline{B}^{75}_{A1-2}}{\overline{B}^{75}_{TOTAL}} \text{ etc.}$$

For FIMS, the procedure is as above, but $\overline{B}^{60}$ is used instead of $\overline{B}^{75}$.

Since there will be a lack of certain data types for some super-areas, the summations above are adjusted accordingly:

Traps A7 and A8+ only

Hoops: A1+2, A3+4, A5+6 and A8+ only

FIMS: A3+4, A5+6, A7 and A8+ only.

Table 1 below lists the resultant weighting *w* values. (Note that '-' indicate that data are not expected from that super-area for that gear type in the future, and hence such data are omitted from the OMP.)

Table 1: The weighting (*w*) values for each gear and super-area, when combining abundance indices over super-areas.

	w^{trap}_{A}	w^{hoop}_{A}	w^{FIMS}_{A}
A1-2	-	0.087	-
A3-4	-	0.213	0.153
A5-6	-	0.172	0.109
A7	0.339	-	0.074
A8	0.661	0.528	0.663

Note: If there is a data value missing for a particular super-area in season *y* (for example tagging does not take place), then the average of the values for the $y-1$ and $y+1$ seasons values is to be used in its place. If the data value is missing for the most recent year, then the value for the preceding year is used.

Combined somatic growth index (β_y)

What is needed is an index, e.g. 70mm male annual somatic growth, as used in the assessment for each separate super-area (Johnston 2015).

The procedure is to use similar weighting factors, e.g. $w^{SG}_{A1-2} = \dfrac{\overline{B}^{m,70}_{A1-2}}{\overline{B}^{m,70}_{TOTAL}}$, as for trap and hoop CPUE (except that now weighting factors for all five super-areas are used – see Table 2). Note also that that here the biomass relates to total male biomass above 70mm only.

Thus $\beta_y = w^{SG}_{A1-2}\beta^{A1-2}_y + w^{SG}_{A3-4}\beta^{A3-4}_y + w^{SG}_{A5-6}\beta^{A5-6}_y + w^{SG}_{A7}\beta^{A7}_y + w^{SG}_{A8}\beta^{A8}_y$ (4)

where

β_y is the super-areas combined annual somatic growth in mm of a 70mm male lobster in season *y*, and

β^A_y is the super-area annual somatic growth in mm of a 70mm male lobster in season *y* in super-area *A*.

Table 2: The weighting (*w*) values for each super-area, when combining somatic growth over super-areas.

	w^{SG}_A
A1-2	0.032
A3-4	0.175
A5-6	0.128
A7	0.140
A8	0.524

Capping of input data

A maximum inter-annual increase in any one of the input indices from each super-area (prior to the combining over all five super-areas into a single index for input into the OMP) is imposed. The reason relates to the fact that for some simulations used in the OMP testing process, due to very large variances (σ values) being used to generate the “real” data for use in the OMP, some very large (and equally very low) CPUE or FIMS values occurred. To avoid the associated high output variance which could result, a cap was imposed in the simulations, and so is similarly imposed on real data for any input index value (from any of the five super-areas). Thus any value which is greater then 3.0 times the geometric average of the previous five years' values is capped at that average value multiplied by 3.0. This capped value continues to be used in the future. Similarly, any value which is less than 0.33 of this average is capped at that 33% level.

2. Method for calculating the global TAC

First, an initial global TAC is computed as:

$$TAC_y^{G,1} = \alpha\left(\bar{J}_y - J_{min}\right) \quad (5)$$

where

α and J_{min} are two tuning parameters, and

$\bar{J}_y$ is the combined abundance index – combined over both super-areas and gear-types:

$$\bar{J}_y = \sum_{gear=1}^{3} W^{gear} J_y^{gear} \quad (6)$$

where

J_y^{gear} is a relative measure of the immediate past level (2009-2013)[3] in the abundance index "gear" (I_y^{gear} - see equation (2), for gear type trap, hoop or FIMS) as available for use in calculation of the global TAC for year *y:*

$$J_y^{gear} = \frac{e^{\left[\sum_{y'=y-3}^{y'=y-1} \ln\left(I_{y'}^{gear}\right)\right]/3}}{e^{\left[\sum_{y'=2009}^{y'=2013} \ln\left(I_{y'}^{gear}\right)\right]/5}} \quad (7)$$

and

W^{gear} is the relative weight given to that gear type.

The W^{gear} values selected by the SWG are:

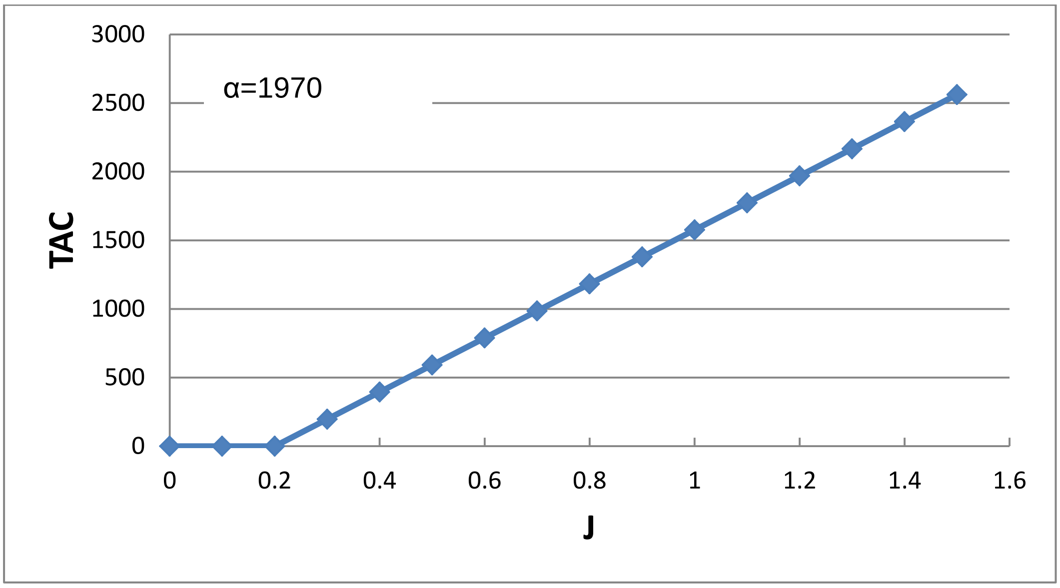
$W^{trap} = 0.45$; $W^{hoop} = 0.35$; and $W^{FIMS} = 0.20$.

[3] OMP 2011 used 2005-2009

The basis for these choices was the inverse of the variance of the assessment model residuals for each index, which the SWG then modified to reflect a more even allocation of weights.

For OMP 2011 re-tuned, α=1970 and J_{min}=0.2 were set to achieve the agreed recovery target (see Figure 1).

Figure 1: The figure below shows the initial global TAC as a function of the combined abundance index $\bar{J}$ (shown below as **J**), for the OMP where the value of α is 1970 and J_{min} is 0.2 in equation (5).



Adjusting TAC for recent somatic growth

Note that this part of OMP 2011 has not been modified or updated.

The initial global TAC value from equation (5) is then adjusted up or down by the addition (which could be a subtraction) of an amount "Z" such that:

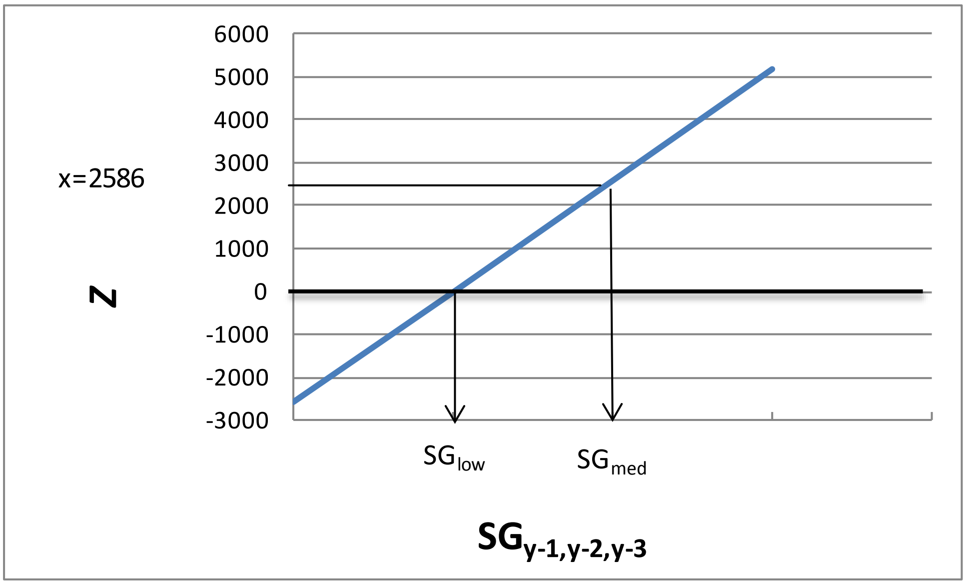
$$TAC_y^{G,2} = TAC_y^{G,1} + Z \tag{8}$$

where

$$Z = \bar{x}\frac{SG_{y-1,y-2,y-3} - SG_{low}}{SG_{med} - SG_{low}} \tag{9}$$

where $SG_{y-1,y-2,y-3}$ is the geometric mean of the combined somatic growth index for the three most recent seasons. The value of $\bar{x}$, which is 2586 MT, was calculated by comparing the tonnage differentials between the low and medium somatic growth rates that would result in the same male biomass level for the resource as a whole after 10 years, i.e. by 2021 in terms of the reference case operating model. Figure 2 below illustrates the dependence of *Z* on future values of $SG_{y-1,y-2,y-3}$.

Figure 2: The relationship between *Z* and future values of$SG_{y-1,y-2,y-3}$ (see Equation 9).



If $SG_{y-1,y-2,y-3}$ is equal to SG_{low}, then the value of *Z* will be zero. If the value of $SG_{y-1,y-2,y-3}$ is equal to SG_{med}, then the value of *Z* will be 2586 MT. If $SG_{y-1,y-2,y-3}$ drops below SG_{low}, then the value of *Z* will be negative, and the TAC will be adjusted downwards.

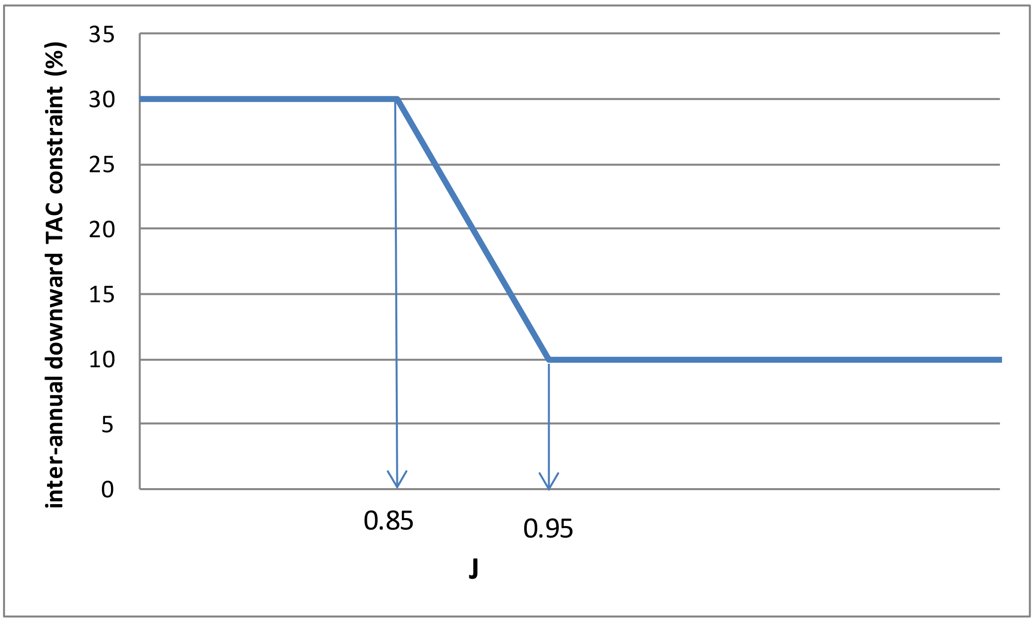
Inter-annual TAC constraints

Both the global TAC and total Offshore TAC values are constrained by the amount they can vary from the previous year's value. This amount has been set at 10%. However, a further rule, "RULE 1", allows for the TAC values to decrease by as much as 30% under certain conditions of poor resource performance, as indexed by $\bar{J}_y$. Figure 3 below shows how this TAC decrease constraint will be set. The amount of TAC decrease permitted is dependent on the $\bar{J}_y$ value and is set equal to 10% for values of $\bar{J}_y > 0.95$ and to 30% for values of $\bar{J}_y < 0.85$, with linear interpolation for $\bar{J}_y$ values between 0.85 and 0.95.

Following implementation of these constraints, the global TAC calculated may change:

$$TAC_y^{G,2} \rightarrow TAC_y^{G,3}$$

Figure 3: RULE 1 - inter-annual downward TAC constraint calculation based on value of $\bar{J}$ (shown below as **J**).



3. Method for calculating the sector splits of the global TAC

The global TAC is split into allocations to the different sectors using what was agreed at the April 8 2015 joint SWH/Management meeting (see and Table 3 of FISHERIES/2015/MAR/SWG-WCRL/10).

Recreational Allocation

$$TAC_y^{REC} = TAC_{y-1}^{REC} \tag{10}$$

$$if \ \frac{TAC_y^{REC}}{TAC_y^{G,3}} < 0.03 \quad \text{then} \quad TAC_y^{REC} = 0.0384\, TAC_y^{G,3} \tag{11}$$

$$if \ \frac{TAC_y^{REC}}{TAC_y^{G,3}} > 0.05 \quad \text{then} \quad TAC_y^{REC} = 0.0384\, TAC_y^{G,3} \tag{12}$$

$$if \ TAC_y^{REC} > 400\ MT \quad \text{then} \quad TAC_y^{REC} = 400\ MT \tag{13}$$

Subsistence/IR allocation

$$TAC_y^{IR} = TAC_{y-1}^{IR} \tag{14}$$

$$if\ \frac{TAC_y^{IR}}{TAC_y^{G,3}} < 0.10 \quad \text{then} \quad TAC_y^{REC} = 0.1307\, TAC_y^{G,3} \tag{15}$$

$$if\ \frac{TAC_y^{IR}}{TAC_y^{G,3}} > 0.16 \quad \text{then} \quad TAC_y^{REC} = 0.1307\, TAC_y^{G,3} \tag{16}$$

$$if\ TAC_y^{IR} > 600\ MT \quad \text{then} \quad TAC_y^{IR} = 600\ MT \tag{17}$$

Nearshore commercial allocation

$$TAC_y^{Nearshore} = TAC_{y-1}^{Nearshore} \tag{18}$$

$$if\ \frac{TAC_y^{Nearshore}}{TAC_y^{G,3}} < 0.17 \quad \text{then} \quad TAC_y^{Nearshore} = 0.2088\, TAC_y^{G,3} \tag{19}$$

$$if\ \frac{TAC_y^{Nearhsore}}{TAC_y^{G,3}} > 0.25 \quad \text{then} \quad TAC_y^{Nearshore} = 0.2088\, TAC_y^{G,3} \tag{20}$$

$$if\ TAC_y^{Nearshore} > 800\ MT \quad \text{then} \quad TAC_y^{Nearshore} = 800\ MT \tag{21}$$

Offshore commercial allocation

$$TAC_y^{Offshore} = TAC_y^{G,3} - TAC_y^{REC} - TAC_y^{IR} - TAC_y^{Nearshore} \tag{22}$$

$$if\ TAC_y^{Offshore} > 1.10\ TAC_{y-1}^{Offshore} \ \text{then}\ TAC_y^{Offshore} = 1.10\, TAC_{y-1}^{Offshore} \tag{23}$$

As for the global TAC downward constraint “RULE 1” applies, i.e. “RULE 1”, allows for the $TAC_y^{Offshore}$ value to decrease by as much as 30% under certain conditions of poor resource performances, as indexed by $\bar{J}_y$. Figure 3 above shows how this TAC decrease constraint will be set. The amount of TAC decrease permitted is dependent of the $\bar{J}_y$ value and is set equal to 10% for values of $\bar{J}_y > 0.95$ and to 30% for values of $\bar{J}_y < 0.85$, with linear interpolation for $\bar{J}_y$ values between 0.85 and 0.95.

Final global TAC

$$TAC_y^{G,final} = TAC_y^{REC} + TAC_y^{IR} + TAC_y^{Nearshore} + TAC_y^{Offshore} \quad (24)$$

Note that this means that the final global TAC may change by more than 10% from the previous year's value.

In the event of a change to the allocation to the Subsistence/IR, Nearshore commercial or Offshore commercial sector, the quota to each rights holder in that sector will be adjusted by the same proportion as the allocation to that whole sector has been adjusted.

For the Recreational sector, the adjustment will be effected by changing the duration of the season by the same proportion as the allocation is changed, starting from a baseline of 80 days for the 2007-2009 allocations each of 257 tons. This will be kept under review in the light of telephone survey and permit sale records, and adjusted if necessary in proportion to changes in these.

Note that no upward adjustment will be considered to sector allocations should that sector undercatch its allocation for the preceding season. The undercatch will be considered as a desirable contribution to an improved recovery rate, and rights holders will in due course benefit through a consequent improvement in the $\bar{J}$ combined abundance index upon which the TAC depends. Should a sector allocation be overcaught by a non-trivial amount, the situation will be dealt with under Appendix 6 of general Exceptional Circumstances provisions.

Table 3: Agreed sector splits of global TAC for the revised OMP.

Sector	2014/15 TAC	Baseline % of global TAC	Range of global TAC allowed before revert to baseline	Maximum allowed
Recreational	69.20	3.84%	3% - 5%	400
Subsistence/IR	235.30	13.07%	10% - 16%	600
Nearshore commercial	376.10	20.88%	17% - 25%	800
Offshore commercial	1120.25	62.21%	max increase 10% pa min decrease 10-30% pa (RULE 1)	

For the 2016 season, with the presumed removal of Exceptional Circumstances provisions for Super-Area 7, the catch allowed there will likely increase above the 80 MT currently allowed. This increased catch will be shared amongst sectors in accordance with the Baseline % splits in Table 3.

4. Method for splitting the sector allocations amongst super-areas

For each sector, the catch allocation needs to be split amongst the five super-areas. Table 4 below provides the proportions to be used to achieve these splits (which correspond to the proportions agreed for the OMP testing). The splitting of the Offshore allocation is described below.

In practice, recreational permit allocation/usage cannot be restricted on a super-area basis, but ongoing annual telephone surveys will be used to monitor these proportions and how they change. If the change is substantial, implementation of general exceptional circumstance provisions will be considered.

If one duplicates the 2014 season sector allocations amongst Super-Areas for the future, these splits would be as shown in Table 4. The re-allocation of the recreational catch from A8+ to A7 in 2016 compared to 2015 is as per previous decision of the SWG.

Table 4: Agreed Super-Area splits of the Nearshore, Subsistence and Recreational allocations for the 2015+ seasons.

	Neashore		**Subsistence**		**Recreational**	
	2015	**2016+**	**2015**	**2016+**	**2015**	**2016+**
A1+2	0.064	0.064	0.057	0.057	0.024	0.024
A3+4	0.175	0.175	0.177	0.177	0.135	0.135
A5+6	0.007	0.007	0.192	0.192	0.135	0.135
A7	0.000	0.040	0.000	0.040	0.000	0.040
A8+	0.685	0.645	0.574	0.534	0.706	0.666

<u>Splitting of Offshore Allocation</u>

The Offshore allocation is split between the super-areas based on a method (as used for OMP 2007 recast) that uses the slopes of the recent resource indices, e.g. trap and hoop CPUE and FIMS where available. The Offshore allocation is split between A3+4, A5+6, A7 and A8+ as follows.

STEP 1: For each of these super-areas there are 1-3 abundance index time series. For each index, linearly regress *ln*(index) *vs* season for the last seven seasons with data, and calculate the slope. Note that as A56 trap series only recently re-started in 2010, A56 trap data are excluded from the combined data for A56 – i.e. this is based on hoops and FIMS only.

STEP 2: If there is more than one series for a super-area, take the average of the slopes for each series, using inverse variance weighting, as follows:

$$slope^A = \frac{\left(\frac{slope^A_{trap}}{\sigma^2_{slope^A_{trap}}} + \frac{slope^A_{hoop}}{\sigma^2_{slope^A_{hoop}}} + \frac{slope^A_{FIMS}}{\sigma^2_{slope^A_{FIMS}}}\right)}{\frac{1}{\sigma^2_{slope^A_{trap}}} + \frac{1}{\sigma^2_{slope^A_{hoop}}} + \frac{1}{\sigma^2_{slope^A_{FIMS}}}} \quad \text{(assuming three series),} \qquad (25)$$

where

$\sigma^2_{slope^A} = \frac{1}{n-2}(slope^A)^2 \frac{1-r^2}{r^2}$ from each regression, where *r* is the correlation coefficient and *n* = 7 given that seven seasons of data are used.

STEP 3: If these resultant slopes are above 0.15 or below -0.15, replace them with the corresponding bound.

STEP 4: Take the previous season's Offshore commercial allocation for the super-area and multiply it by (1+$slope^A$) for that super-area, giving a new set of commercial allocations by super-area, which will not necessarily total to the new overall Offshore commercial allocation (TAC_y^{off}). If the allocations do not total to the total Offshore commercial allocation, simply scale them all by the same proportion so that they do total to match this required allocation.

Note: For the 2015 season, a fixed amount of 80 MT for Offshore for Area 7 will be allocated (due to expected Exceptional Circumstances) and Step 4 above used to split the remaining Offshore TAC between A3+4, A5+6 and A8+. For 2016+, where it is assumed for now that Exceptional Circumstance will not apply for Area 7, STEP 4 above will be applied for splitting the Offshore TAC amongst A3+4, A5+6, A7 and A8+.

5. Low Abundance rule

$J_{\text{area,y}}$ is an index of recent resource performance for that super-area, relative to recent (**2009-2013**[4]) levels, which is calculated for each super-area using the resource indices available for that super-area. The equations used for calculating $J_{\text{area,y}}$ are given below.

If $J_{area,y} < X^{area}_{crit}$ then Exceptional Circumstances are invoked for that super-area and year (*y*). Evaluations will then be carried out by the Working Group which

[4] Was 2005-2009 for OMP 2011

a) will ensure that catches in the super-area concerned are set appreciably lower than would have been the case under the OMP; and
b) will examine whether any of the catch left from that super-area can be safely transferred to other super-areas until the time of the next OMP review.

The values of X_{crit}^{area} to be used are:

X_{crit}^{A1+2} =0.7

X_{crit}^{A3+4} =0.85

X_{crit}^{A5+6} =0.7

X_{crit}^{A7} =0.8

X_{crit}^{A8+} =0.7

Method used for calculating $J_{area,y}$ values for input to the Low Abundance rule

The EC rule requires a single index for each super-area using the available trap CPUE, hoop CPUE and FIMS for each season in the future.

STEP 1: For each super-area for which data are assumed to be available in the future, there will be for each season *Y* (here trap CPUE is used as an example):

$$CPUE_Y^{trap,A1-2}, CPUE_Y^{trap,A3-4}, CPUE_Y^{trap,A5-6}, CPUE_Y^{trap,A7}, CPUE_Y^{trap,A8}$$

STEP 2: Evaluate the geometric means of the CPUEs (and FIMS) for the super-area concerned (here we use A1-2 as used as an example) over the year period 2009…2013.

STEP 3: Re-normalise the CPUEs series as follows (e.g. for traps in Area A1-2):

$$CPUE_Y^{trap,A1-2} \Rightarrow X_Y^{trap,A1-2} = \frac{CPUE_Y^{trap,A1-2}}{Geometric\ mean\ (CPUE_y^{trap,A1-2}:\ y = 2009...2013)} \tag{26}$$

STEP 4: Calculate a combined index for each area as follows (including only the pertinent indices):

$$J_{area,Y}^{*} = (w_{area}^{trap} X_Y^{trap,area} + w_{area}^{hoop} X_Y^{hoop,area} + w_{area}^{FIMS} X_Y^{FIMS,area}) / (w_{area}^{trap} + w_{area}^{hoop} + w_{area}^{FIMS}) \tag{27}$$

where the weights are as given in Table 1a.

Finally, $J_{area,Y}$ is calculated as the geometric mean of the three most recent years,

$$J_{area,Y} = e^{[\sum_{T=Y-1}^{T=Y-3} \ln(J^*_{area,T})]/3} \tag{28}$$

The simulation framework

The baseline future scenarios, which result as combinations of uncertainties regarding future recruitment, future somatic growth, historic poaching, future poaching and current abundance are defined in Johnston and Butterworth (2014). The following are the various possible options for each scenario, with the associated weights (WT) given:

Median Future recruitment **WT**

- FRM: Geometric Mean of $R_{75}, R_{80}, R_{85}, R_{90}, R_{95}, R_{98}, R_{01}, R_{04}$ 0.60
- FRH: Maximum of $R_{75}, R_{80}, R_{85}, R_{90}, R_{95}, R_{98}, R_{01}, R_{04}$ 0.30
- FRL: Minimum of $R_{75}, R_{80}, R_{85}, R_{90}, R_{95}, R_{98}, R_{01}, R_{04}$ 0.10

Note however that the FRL excludes certain extreme estimates which are A12 R_{01} and $R_{04,}$ and A7 $R_{80.}$ [These exclusions were updated slightly from the 2014 assessments.]

Future recruitment

For FHM future R_y: where y = 2008, 2010, 2015 and 2020; linearity between each of these years (and between 2008 and 2010).

Stochastic: R_y randomly selected from $\bar{R}\, e^{\varepsilon_y}$, where,

$$\ln \bar{R} = \frac{1}{8}\left(\ln R_{75} \ldots \ln R_{04}\right)$$

σ = SD of $\left(\ln R_{75}, \ldots \ln R_{04}\right)$

$$\varepsilon_y \sim N(0, \sigma^2)$$

or for FRH and FRL, the $\bar{R}$ was replaced by either the maximum or minimum R between $R_{75}, R_{80}, R_{85}, R_{90}, R_{95}, R_{98}, R_{01}, R_{04}$ (with the exceptions noted above).

Future Somatic growth (2014+)

WT

- FSGL: = the 1989-2013 average 0.80
- FSGM: ↑ linearly to 1968-2013 by 2020 0.20

[The above applied to the growth rates for Areas 3+4, 5+6, 7 and 8+. The somatic growth rate for Area 1-2 is assumed to remain constant in the future at the 1989-2013 average level for all scenarios.]

Current Abundance levels

- For the RC model R_{2004} is an estimable parameter, although it is found to be estimated with very low precision. ALTL and ALTH models correspond exactly to the RC model, except for R_{2004} which is fixed at the (approximate) upper and lower 25%iles of this distribution as follows:

  $$\ln R_{2004}^{ALTH} = \ln \hat{R}_{2004}^{RC} + \sigma\alpha \qquad (29)$$

  and

  $$\ln R_{2004}^{ALTL} = \ln \hat{R}_{2004}^{RC} - \sigma\alpha \qquad (30)$$

  where σ is from equation (4) below, and the α value (0.741) corresponds to the 25%iles of a *t*-distribution with the appropriate number of degrees of freedom.

  $$\ln \overline{R} = \frac{1}{8}\sum_{y=1975}^{2004} \ln R_y \qquad (31)$$

  $$\sigma^2 = \frac{1}{7}\sum_{y=1975}^{2004} \left(\ln \overline{R} - \ln R_y\right)^2 \qquad (32)$$

	WT
• RC: Best Estimate of R_{2004}	0.50
• ALTL: Estimated lower 12.5%ile for R_{2004}	0.25
• ALTH: Estimated upper 12.5%ile for R_{2004}	0.25

Historic Poaching

	WT
• HP1: Total historic poaching levels from 1990 to 2008 are 500 MT	0.65
• HP2: Total historic poaching levels from 1990 to 2008 are 250 MT	0.35

Future poaching scenarios – relate to the % change in the poaching level for each super-area between 2008 and 2012. Poaching for 2013+ is assumed to remain at the 2012 level.

The six scenarios to cover different options (with different weights) defined are:

	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**	**Scenario6**	**Weighted Average**
Weighting	40	10	20	20	5	5	100
4-yr % change for A3-6	-50	-50	-50	0	0	0	-35%
4-yr % change for A8+	+75	+25	+125	+75	+25	+125	+80
% change in total amount poached	+50	+10	+90	+60	+20	+100	+57

Note: The Super-Area breakdowns of future poaching levels are assumed to be unchanged and are:

Super-area 1+2 = 1%

Super-area 3+4 = 2.5 %

Super-area 5+6 = 2.5%

Super-area 7 = 14%

Super-area 8+ = 80%

Table 4: The TAC/allocation values (all MT) for the 2011+ seasons. For 2013 and 2014 seasons, allocations were not based on OMP 2011 re-tuned, but rather on constant catch projections that were assessed by the SWG.

	2011	2012	2013	2014
Global T[#]	**2425.78**	**2424.58**	**2157**	**1801**
Global A1+2	36.13	38.12	42	42
Global A3+4	222.36	272.12	264	238
Global A5+6	176.93	169.69	244	220
Global A7	308.10	258.64	80	80
Global A8+	1682.26	1686.02	1527	1221
Offshore T	**1540.65**	**1540.70**	**1557**	**1120.25**
Offshore A1+2	0	0	0	0
Offshore A3+4	74.96	124.95	132	118.80
Offshore A5+6	60	60	138	124.20
Offshore A7	300.78	258.64	80	80
Offshore A8+	1104.91	1097.11	1007	805.25
Nearshore T	**451**	**450.71**	**451**	**376.10**
Nearshore A1+2	24.17	19.76	24	24
Nearshore A3+4	72.48	72.52	73	65.70
Nearshore A5+6	32.20	32.20	32	28.80
Nearshore A7	0	0	0	0
Nearshore A8+	322.15	326.23	322	257.60
Subsistence T	**251.48**	**250.17**	**276**	**235.30**
Subsistence A1+2	8.30	14.70	16	16
Subsistence A3+4	52.06	51.77	49	44.10
Subsistence A5+6	61.86	54.61	64	57.60
Subsistence A7	0	0	0	0
Subsistence A8+	129.00	129.00	147	117.60
Recreational T [$]	**183**	**183**	**83.5**	**69.20**
Recreational A1+2	3.66	3.66	1.66	1.66
Recreational A1+2	22.88	22.88	10.38	9.34
Recreational A1+2	22.88	22.88	10.38	9.34
Recreational A1+2	7.32	7.32	0.00[&]	0.00[&]
Recreational A1+2	126.27	126.27	61.08	48.86

[#] Global T refers to offshore+nearshore+inter relief+recreational.

[&] A7 recreation amount is set to zero and moved to A8+.

[$] The recreational breakdown by Super-Area is nominal and as agreed based upon data providing previous catch patterns.

Generation of "Future Data"

These assumptions are largely unchanged from those set up in 2011 (see Johnston and Butterworth 2011).

Future data available each year

This refers to data which it can reliably (i.e. almost certainly) be assumed will be available, based on recent years. The following was assumed in 2007:

Area	Trap CPUE	Hoop CPUE	FIMS	Somatic growth
1-2	No	Yes	No	Yes
3-4	No	Yes	Yes	Yes
5-6	No	Yes	Yes	Yes
7	Yes	No	Yes	Yes
8	Yes	Yes	Yes	Yes

Future data apply to seasons from 2014 onwards, and future TAC levels apply to seasons from 2015 onwards.

Data that are input to the OMP (for the super-areas for which they are available) are generated as follows:

a) Future commercial Trap CPUE estimates

Deterministic: $$C\hat{P}UE_y^{trap} = q^{trap} \sum_{l \geq l_{\min}}^{180} \left[w_l^m b_l^{m,trap}(y) N_l^m(y) + w_l^f b_l^{f,trap}(y) N_y^f(y) \right] \qquad (33)$$

Stochastic: For simulation S, $$C\hat{P}UE_y^{trap,S} = C\hat{P}UE_y^{trap} e^{\varepsilon_y^S}, \qquad (34)$$

where $\varepsilon_y^S \sim N(0, \sigma^2)$, and where σ is taken from the model fit to the trap CPUE data for that super-area and is as follows:

A1-2: N/A

A3-4: N/A

A5-6: N/A

A7: $\sigma=0.410$

A8: $\sigma=0.189$

b) Future commercial Hoop CPUE estimates

Deterministic: $$C\hat{PUE}_y^{hoop} = q^{hoop} \sum_{l \geq l_{\min}}^{180} \left[w_l^m b_l^{m,hoop}(y) N_l^m(y) + w_l^f b_l^{f,hoop}(y) N_y^f(y) \right] \quad (35)$$

Stochastic: For simulation *S*, $$C\hat{PUE}_y^{hoop,S} = C\hat{PUE}_y^{hoop} e^{\varepsilon_y^S}, \quad (36)$$

where $\varepsilon_y^S \sim N(0,\sigma^2)$, and where σ is taken from the model fit to the hoopnet CPUE for that super-area and is as follows:

A1-2: $\sigma=0.218$

A3-4: $\sigma=0.479$

A5-6: $\sigma=0.336$

A7: $\sigma=$N/A

A8: $\sigma=0.164$

c) Future FIMS estimates

Deterministic: $$FI\hat{M}S_y = q^{FIMS} \sum_{l \geq 40}^{180} \left[b_l^{m,FIMS}(y) N_l^m(y) + b_l^{f,FIMS}(y) N_y^f(y) \right] \quad (37)$$

Stochastic: For simulation *S*, $$FI\hat{M}S_y^S = FI\hat{M}S_y e^{\varepsilon_y^S}, \quad (38)$$ where

$\varepsilon_y^S \sim N(0,\sigma^2)$, and where σ is taken from the model fit to the FIMS CPUE data for that super-area which is as follows:

A1-2: N/A

A3-4: $\sigma=1.605$

A5-6: σ =1.040

A7: σ =0.812

A8: σ =0.335

d) Future somatic growth

The β_y^m value (being the growth of a 70mm male rock lobster) is used as the index of somatic growth rate for each super-area.

Stochastic: $\beta_y^{m,S} = \beta_y^m + \varepsilon_y^S$, where (39)

$\varepsilon_y^S \sim N(0, \sigma^2)$, and the σ values for each super-area (as calculated from the 1990-2013 observed values) are as follows:

A1-2: σ =1.09

A3-4: σ =0.56

A5-6: σ =0.56

A7: σ =1.05

A8: σ =0.56

The moult probability model treats the A3-4, A5-6 and A8 somatic growth trends as the same, thus when generating random error (as described above) for the somatic growth rates for these three super-areas, the same error will be applied to each of these super-areas (although varying from year to year). This will ensure that somatic growth observations will either go up or down in tandem for these three super-areas.

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