Notes on the development of the new 2011 Area-disaggregated OMP for west coast rock lobster

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Background

The current OMP (OMP 2007 re-cast) for West Coast Rock Lobster provides TACs for each of the five super-areas on an annual basis. This OMP has been used to advise management of suitable TACs for a three year period (2008-2010)[1].

This OMP uses data (trap and hoop CPUE, FIMS, somatic growth rate) from each area, combines these data into a single index (for each data type), produces a global TAC, and then uses a series of rules to split this global TAC into TACs at the super-area level. At the same time, estimates of recreational catch for each super-area are taken into account, as well as ensuring that super-area TACs will allow the allocations to the near-shore rights holders to be taken each year.

"OMP-2007 re-cast" summary

In early 2008 it was decided by the Rock Lobster Scientific Working Group to re-cast OMP-2007 before applying it to produce the TAC recommendation for the 2008 season. This re-casting was required to accommodate the Group's recommendation that nearshore rights holder allocations vary in similar fashion to recreational allocations. For the reason that this also required OMP re-tuning, the opportunity was taken to update two other aspects, i.e. three adjustments were made in all to OMP-2007:

i) During the 2006 season the full commercial TAC was not caught – "OMP-2007 re-cast" took this into account by updating the operating models of the resource (used for testing the OMP) with the actual catches made, and not the TACs. The catch values for each super-area used were as follows (the TAC value is in brackets):

Area 1-2:	8.4 MT	(30 MT)
Area 3-4:	1.3 MT	(100 MT)
Area 5-6:	0 MT	(40.25 MT)
Area 7:	526.8 MT	(821.75 MT)
Area 8:	1670.6 MT	(1565 MT)
Total:	2207.1 MT	(2557 MT)

The effective overall under-catch from the 2006 season was thus 2557 - 2207 = 350 MT.

[1] The convention used is that, e.g. 2008 refers to the 2008/09 season

These 2006 catches also took into account the amount that was caught in 2006 which was actually part of the "over-catch" allowed from 2005.

Note also that the 2007 TAC values were used in "OMP-2007 re-cast" (not the catches, as these were unknown at the time of the re-cast OMP tuning).

ii) During the 2007 season an additional catch in the form of an interim relief allocation was allowed by the Minister. The estimated additional amount to be attributed to this interim relief catch was 175.06 MT (Keulder and van Zyl 2008). This amount (175.06 MT) was taken into account in the re-cast OMP – in updating both the historic catches considered in operating models as well as the historic catches used in the OMP population model. The breakdown of the interim relief tonnage was as follows:

Area 1-2:	9.1 MT
Area 3-4:	27.3 MT
Area 5-6:	25.3 MT
Area 7:	0 MT
Area 8:	44.5 MT

iii) "OMP-2007 re-cast" also made a change to the way Nearshore Rights Holders (NRH) TACs are calculated. OMP-2007 had fixed these at the following values:

Super-Area	**Nearshore rights holders TAC**
Area 1-2	30 MT
Area 3-4	90 MT
Area 5-6	40 MT
Area 7	0 MT
Area 8	400 MT

"OMP-2007 re-cast" instead calculated the NRH TACs in a manner similar to that for recreational takes – see below for further details. The reason, as stated in previous recommendations made by the Working Group, was that was not scientifically defensible to maintain constant catch allocations in circumstances where resource abundance can drop as a result of recruitment fluctuations, and responsible management must allow for catch reductions in such circumstances (note also that for two of the five super-areas, the complete allocation is to NRHs only, after allowances for recreational takes).

OMP 2011

Note: New issues raised or suggestions made below are shown in *italics*. Those for immediate discussion are shown in ***bold+italics***.

The assessment models which form the "operating models" upon which alternate OMP candidates are tested are currently being updated for application in developing OMP 2011.

This document lists the various assumptions that need to be made by the SWG regarding future projections of the resource, as well as other fundamental decisions relating to the underlying structure of the OMP. These include:

- Future somatic growth rate scenarios
- Future recruitment scenarios
- ***Future recreational take splits by super-area***
- Future poaching levels (and super-area splits)
- Future trap:hoopnet ratios expected in each super-area
- ***Future basic Interim relief catches (and their super-area split) and how these might change inter-annually***
- ***Should the current procedures to split the global TAC amongst super-areas be changed?***
- ***Should the current procedures to split the super-area TAC into sectors (which now include offshore commercial, nearshore commercial, interim-relief fishers and recreational fishers) be changed?***
- ***Should the OMP set only a global TAC which is split into super-areas, or should the OMP continue to split the super-area TACs amongst the user groups? Note that his would not be comparable with previous practice of constraining inter annual TAC changes by sector.***
- ***What levels of future implementation errors (differences between allocations and actual takes, on a sector by sector basis) should be assumed?***
- What inter-annual change constraints should apply to the TAC to each sector?
- What output summary statistics should be reported?
- What would the management objective of the OMP be for re-building? The current objective is to recover the resource to its 1996 male 75+ abundance by 2016.

1. Future Scenarios – what was assumed for current OMP

In 2007 the reference set of operating models used for basic OMP testing comprised of 27 possible scenarios (see Table 1), which resulted as combinations of uncertainties regarding future recruitment, future somatic growth and current abundance. The various scenarios and their weights that were used in 2007 are shown below.

1.1 Median Future recruitment	**WT**
• FRM: Geometric Mean of $R_{75}, R_{80}, R_{85}, R_{90}$ and R_{95}	0.60
• FRH: Maximum of $R_{75}, R_{80}, R_{85}, R_{90}$ and R_{95}	0.30
• FRL: Minimum of $R_{75}, R_{80}, R_{85}, R_{90}$ and R_{95}	0.10

Future recruitment (for FRM)

Future R_y: where y = 2005, 2010, 2015, 2020, 2025 and 2030; linearity between each of these years (and between 2000 and 2005).

Deterministic: $R_y = \overline{\mathrm{Re}}^{\frac{1}{2}\sigma^2}$ (1)

Stochastic: R_y randomly selected from $\overline{\mathrm{Re}}^{\varepsilon_y}$, where,

$$\ln \bar{R} = \frac{1}{5}\left(\ln R_{75} \ldots \ln R_{95}\right)$$
$$\sigma = \text{SD of } \left(\ln R_{75}, \ldots \ln R_{95}\right) \quad (2)$$
$$\varepsilon_y \sim N(0, \sigma^2)$$

For FRH and FRL, the $\bar{R}$ was replaced by either the maximum or minimum R between $R_{75}, R_{80}, R_{85}, R_{90}$ and R_{95}. Note that for A1-2, the minimum R was selected from the R_{80}, R_{85}, R_{90} and R_{95} range only, as it was found in the model fitting process that the R_{75} was unrealistically small for some super-areas.

1.2 Future Somatic growth (2005+)	**WT**
• FSGL: = FSGM for 3 years (2005, 2006, 2007) then will equal the 1989-2004 average (see Figure 1)	0.50
• FSGM: ↑ linearly to 1968-2004 ave over 10 yrs	0.40
• FSGH: ↑ linearly to 1968-2004 ave over 3 yrs	0.10

[The above applied to the growth rates for Areas 3+4, 5+6, 7 and 8+. The somatic growth rate for Area 1-2 was assumed to remain constant in the future at the 1989-2004 average level for all scenarios.]

1.3 Current (2005) Abundance (B75)	**WT**
• RC: Best Estimate (from current RC1-like model)	0.50
• ALTL: Estimated lower 12.5%ile	0.25
• ALTH: Estimated upper 12.5%ile	0.25

For 2011, it is suggested that the following modifications be considered.

1. *Future somatic growth will now apply to 2010+. There has been no indication of a return towards pre-1989 somatic growth levels for some considerable time now. It is suggested to drop the FSGH scenario, and downweight the FSGM scenario to 20%, so that FSGL would get an 80% weight.*
2. *For future recruitment, add R_{2000} to the estimable parameters considered in each test.*
3. *Current abundance will now refer to 2010.*

Table 1: The 2007 OMP combinations of the uncertainties resulting in 27 possible scenarios.

Scenario	Recruitment	Somatic growth	Current Abundance	R WT	G WT	A WT	Total WT	Cum WT
1	FRM	FSGL	RC	0.6	0.5	0.5	0.15	0.15
2	FRM	FSGL	ALTL	0.6	0.5	0.25	0.075	0.225
3	FRM	FSGL	ALTH	0.6	0.5	0.25	0.075	0.3
4	FRM	FSGM	RC	0.6	0.4	0.5	0.12	0.42
5	FRM	FSGM	ALTL	0.6	0.4	0.25	0.06	0.48
6	FRM	FSGM	ALTH	0.6	0.4	0.25	0.06	0.54
7	FRM	FSGH	RC	0.6	0.1	0.5	0.03	0.57
8	FRM	FSGH	ALTL	0.6	0.1	0.25	0.015	0.585
9	FRM	FSGH	ALTH	0.6	0.1	0.25	0.015	0.6
10	FRH	FSGL	RC	0.3	0.5	0.5	0.075	0.675
11	FRH	FSGL	ALTL	0.3	0.5	0.25	0.0375	0.7125
12	FRH	FSGL	ALTH	0.3	0.5	0.25	0.0375	0.75
13	FRH	FSGM	RC	0.3	0.4	0.5	0.06	0.81
14	FRH	FSGM	ALTL	0.3	0.4	0.25	0.03	0.84
15	FRH	FSGM	ALTH	0.3	0.4	0.25	0.03	0.87
16	FRH	FSGH	RC	0.3	0.1	0.5	0.015	0.885
17	FRH	FSGH	ALTL	0.3	0.1	0.25	0.0075	0.8925
18	FRH	FSGH	ALTH	0.3	0.1	0.25	0.0075	0.9
19	FRL	FSGL	RC	0.1	0.5	0.5	0.025	0.925
20	FRL	FSGL	ALTL	0.1	0.5	0.25	0.0125	0.9375
21	FRL	FSGL	ALTH	0.1	0.5	0.25	0.0125	0.95
22	FRL	FSGM	RC	0.1	0.4	0.5	0.02	0.97
23	FRL	FSGM	ALTL	0.1	0.4	0.25	0.01	0.98
24	FRL	FSGM	ALTH	0.1	0.4	0.25	0.01	0.99
25	FRL	FSGH	RC	0.1	0.1	0.5	0.005	0.995
26	FRL	FSGH	ALTL	0.1	0.1	0.25	0.0025	0.9975
27	FRL	FSGH	ALTH	0.1	0.1	0.25	0.0025	1

2. Other Assumptions for the Future

2.1 Future trap:hoop ratios

The previous (i.e. pre-2007) OMP testing process assumed a trap:hoop ratio of 0.70:0.30 for all years in the future. Now different ratios are assumed for each super-area (these are based on actual trap and hoopnet catches). These trap:hoop ratios are:

Area 1-2 = 0:100
Area 3-4 = 10:90
Area 5-6 = 0:100
Area 7 = 100:0
Area 8 = 78:22

We suggest it be assumed that these ratios will continue unchanged into the future.

2.2 Future Poaching level

The previous OMP testing process assumed future annual poaching levels to remain constant at 500 MT (for the entire resource). Currently the following levels of future poaching are assumed for each super-area:

Area 1-2 = 5 MT
Area 3-4 = 12.5 MT
Area 5-6 = 12.5 MT
Area 7 = 70 MT
Area 8 = 400 MT

We suggest careful re-consideration of:

- ***i) whether this level of 500 tons is appropriate:***
- ***ii) whether it has changed in the recent past;***
- ***iii) whether there is a likely trend for the medium term future; and***
- ***iv) whether the previous super-area split should be maintained?***

2.3 Future Recreational take

The OMP will need to allocate a certain amount "globally", i.e. for all areas combined, for the recreational take each year.

The following algorithm was applied in the past:

$$
\begin{aligned}
& C_t^{rec} = 320 \text{ MT initially} \\
& \text{If } C_t^{rec} / TAC_t^G > 0.12 TAC_t^G \quad \text{then} \quad C_t^{rec} = 0.10 TAC_t^G \\
& \text{If } C_t^{rec} / TAC_t^G < 0.08 TAC_t^G \quad \text{then} \quad C_t^{rec} = 0.10 TAC_t^G \\
& \text{If } C_t^{rec} > 450 \text{ MT} \quad \text{then} \quad C_t^{rec} = 450 \text{ MT}
\end{aligned}
\tag{3}
$$

where C_t^{rec} is the overall recreational take for year *t*, and TAC_t^G is the "total" or "global" (commercial plus recreational) TAC for year *t* as output by the OMP.

The following % breakdown of the overall recreational take (C_t^{rec}) by super-area was assumed; these %'s remain unchanged over time:

Area 1-2 = 2%
Area 3-4 = 12.5%
Area 5-6 = 12.5%
Area 7 = 4%
Area 8 = 69%

For the 2010/2011 season the recreational take was reduced to 107 tons. We note that consideration needs to be given to specifying compensatory changes to the constraints above on inter-annual changes.

2.4 Near-shore allocations

The total nearshore allocation varied up and down over time in a similar manner to the recreational take. Thus, first the total nearshore TAC each season, NSQ_y, was calculated as follows:

$NSQ_y = NSQ_{y-1}$ initially (i.e. for the 2007 season)

$$\begin{aligned} &\text{If } NSQ_y / TAC_y^G > 0.24 \quad &&\text{then} \quad NSQ_y = 0.195\ TAC_y^G \\ &\text{If } NSQ_y / TAC_y^G < 0.16 \quad &&\text{then} \quad NSQ_y = 0.195\ TAC_y^G \end{aligned} \qquad (4)$$

$$\text{If } NSQ_y > 800 \text{ MT} \quad \text{then} \quad NSQ_y = 800 \text{ MT}.$$

The proportional inter-super-area split of the NSQ_y remained the same as for 2006, i.e.:

Area 1-2 NSQ_y^{A1-2} = 5.36% of NSQ_y
Area 3-4 NSQ_y^{A3-4} = 16.07% of NSQ_y
Area 5-6 NSQ_y^{A5-6} = 7.14% of NSQ_y
Area 7 NSQ_y^{A7} = 0% of NSQ_y
Area 8 NSQ_y^{A8} = 71.43% of NSQ_y

We assume that the above should remain unchanged. Note that the current NSQ allocation is 451 MT.

2.5 Interim Relief Catches

The new OMP 2011 will need to take into account a new group of users – the interim relief fishers (apparently some 1500 fishers).

The past levels of interim relief catches that have been assumed for the updated 2010 operating models are (in MT):

Season	2006/2007	2007/2008	2008/2009	2009/2010
Phase	**I**	**II**	**III**	**IV**
Area 1-2	2.075	4.356	7.040	9.158
Area 3-4	12.841	33.814	36.960	56.664
Area 5-6	15.285	41.272	43.010	67.447
Area 7	0	0	0	0
Area 8+	31.830	94.215	81.617	140.457
Total	**62.031**	**173.657**	**168.627**	**273.726**

Though 200 tons has been allocated for interim-relief for the 2010/2011 season, under the current season length if some 1500 fishers are permitted, the allowed take will amount to 285 tons (see Appendix). The following need to be clarified:

- ***i) the number of fishers and hance likely take for 2010/2011;***
- ***ii) whether any change to this number in the future should be considered (alternative options might be specified);***
- ***iii) what constraints (presumably similar to those for recreationals and near-shore rights holders, and are to be effected through changes in season length) should apply to inter-annual changes to allocations to interim relief?***

2.6 Implementation error for catch allocations

Distributions for likely annual differences between allocations and takes need to be agreed for each of the four sectors: offshore commercial, nearshore commercial, interim relief, and recreational.

2.7 Other

It is proposed the issues such as spatial re-allocations given a forecast of lobster walkouts be handled under Exceptional Circumstances provisions.

3. Future Data

3.1 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 2010 onwards, and future TAC levels apply to seasons from 2011 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: $$\hat{CPUE}_y^{trap} = q^{trap} \sum_{l \geq l_{\min}}^{180} \left[w_l^m b_l^{m,trap}(y) N_l^m(y) + w_l^f b_l^{f,trap}(y) N_y^f(y) \right] \quad (5)$$

Stochastic: For simulation *S*, $$\hat{CPUE}_y^{trap,S} = \hat{CPUE}_y^{trap} e^{\varepsilon_y^S}, \quad (6)$$

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: σ =0.293 (will be updated)
A8: σ =0.150 (will be updated)

b) Future commercial Hoop CPUE estimates

Deterministic: $$\hat{CPUE}_y^{hoop} = q^{hoop} \sum_{l \geq l_{\min}}^{180} \left[w_l^m b_l^{m,hoop}(y) N_l^m(y) + w_l^f b_l^{f,hoop}(y) N_y^f(y) \right] \quad (7)$$

Stochastic: For simulation *S*, $$\hat{CPUE}_y^{hoop,S} = \hat{CPUE}_y^{hoop} e^{\varepsilon_y^S}, \quad (8)$$

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: σ =0.296 (will be updated)
A3-4: σ =0.479 (will be updated)
A5-6: σ =0.118 (will be updated)
A7: σ =N/A
A8: σ =0.150

c) Future FIMS estimates

Deterministic: $$\hat{FIMS}_y = q^{FIMS} \sum_{l \geq 40}^{180} \left[b_l^{m,FIMS}(y) N_l^m(y) + b_l^{f,FIMS}(y) N_y^f(y) \right] \quad (9)$$

Stochastic: For simulation *S*, $\hat{FIMS}_y^S = \hat{FIMS}_y e^{\varepsilon_y^S}$,where (10)

$\varepsilon_y^S \sim N(0,\sigma^2)$, 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: σ =1.594 (will be updated)
A5-6: σ =1.072 (will be updated)
A7: σ =0.785 (will be updated)
A8: σ =0.150 (will be updated)

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 (11)

$\varepsilon_y^S \sim N(0,\sigma^2)$, and the σ values for each super-area (as calculated from the 1990-2004 observed values) are as follows:

A1-2: σ =0.79 (will be updated)
A3-4: σ =0.51 (will be updated)
A5-6: σ =0.51 (will be updated)
A7: σ =1.18 (will be updated)
A8: σ =0.51 (will be updated)

Note that due to the fact that future somatic growth data from A5-6 are unlikely to eventuate, and that the moult probability model treats the A3-4, A5-6 and A8 somatic growth as the same, then 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.

General Note: Some σ values above are rather high and will result in the generation of highly variable future data. It is proposed to consider some further limitations, such as restriction of future residuals to lie between the minimum and maximum residuals for that series evident from past analyses.

4. The split of the global (combined) TAC generated from the OMP split amongst the super-areas

The following procedure was used for OMP2007 (re-cast).

The final OMP TAC setting rule produces a recommended global TAC each season - TAC_y^G.

For the recreational take component, the following algorithm is applied:

$$C_y^{rec} = C_{y-1}^{rec} \text{ initially (i.e. for the 2007 season)}$$

$$\begin{aligned} &\text{If } C_y^{rec} / TAC_y^G > 0.12 \quad \text{then} \quad C_y^{rec} = 0.10\ TAC_y^G \\ &\text{If } C_y^{rec} / TAC_y^G < 0.08 \quad \text{then} \quad C_y^{rec} = 0.10\ TAC_y^G \end{aligned} \tag{12}$$

$$\text{If } C_y^{rec} > 450 \text{ MT} \quad \text{then} \quad C_y^{rec} = 450\,\text{MT}$$

where C_y^{rec} is the overall recreational take for season *y*, and TAC_y^G is the "global" (commercial plus recreational) TAC for season *y* as output by the OMP. (Note that recreational take limits are not imposed directly. Rather if a change in this take is indicated, recommendations for changes to the extent of the recreational season will be made which are chosen with the intent of achieving the change in take sought.)

Note that the following proportional breakdown of the overall recreational take (C_y^{rec}) by super-area is assumed for the purposes of OMP trials; these proportions are taken in the trials to remain unchanged over time:

Area 1-2	=	2%
Area 3-4	=	12.5%
Area 5-6	=	12.5%
Area 7	=	4%
Area 8	=	69%

(13)

The remaining (commercial) TAC ($TAC_y^{comm} = TAC_y^G - C_y^{rec}$) (adjusted if necessary at this stage to conform to inter-annual TAC change constraints) must then be split into super-area allocations. First the nearshore allocations are calculated, and then subtracted as indicated below.

The total nearshore allocation may vary up and down over time in a similar manner to the recreational take. Thus, first the total nearshore TAC each season, NSQ_y, is calculated as follows:

$$NSQ_y = NSQ_{y-1} \text{ initially (i.e. for the 2007 season)}$$

$$\begin{aligned} &\text{If } NSQ_y / TAC_y^G > 0.24 \quad \text{then} \quad NSQ_y = 0.195\ TAC_y^G \\ &\text{If } NSQ_y / TAC_y^G < 0.16 \quad \text{then} \quad NSQ_y = 0.195\ TAC_y^G \end{aligned} \tag{14}$$

$$\text{If } NSQ_y > 800 \text{ MT} \quad \text{then} \quad NSQ_y = 800\,\text{MT}.$$

The proportional inter-super-area split of the NSQ_y remains the same as for 2006, i.e.:

$$\text{Area 1-2 } NSQ_y^{A1-2} = 5.36\% \text{ of } NSQ_y$$

$$\begin{aligned}
&\text{Area 3-4} \quad NSQ_y^{A3-4} = 16.07\% \text{ of } NSQ_y \\
&\text{Area 5-6} \quad NSQ_y^{A5-6} = 7.14\% \text{ of } NSQ_y \\
&\text{Area 7} \quad NSQ_y^{A7} = 0\% \text{ of } NSQ_y \\
&\text{Area 8} \quad NSQ_y^{A8} = 71.43\% \text{ of } NSQ_y
\end{aligned} \tag{15}$$

Finally the TAC allocation to offshore rights holders in each super-area A, $TAC_y^{off} = TAC_y^{comm} - NSQ_y$, is divided between super-areas A3-4, 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 of data, and calculate the slope.

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:

$$slope^A = \frac{\left(\frac{slope^A_{trap}}{\sigma^2_{slope^A_{trap}}} + \frac{slope^A_{hoop}}{\sigma^2_{slope^A_{hoop}}} + \frac{slope^A_{FIMS}}{\sigma^2_{slope^A_{FIMS}}}\right)}{\frac{1}{\sigma^2_{slope^A_{trap}}} + \frac{1}{\sigma^2_{slope^A_{hoop}}} + \frac{1}{\sigma^2_{slope^A_{FIMS}}}} \quad \text{(assuming three series),} \tag{16}$$

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 TAC (TAC_y^{off}) for the super-areas concerned. If the allocations do not total to that offshore commercial TAC, simply scale them all by the same proportion so that they do total to match that offshore commercial TAC.

STEP 5: Transfer of 5% of the offshore commercial TAC (TAC_y^{off}) from A8 to A3-4 and A7 in the ratio 1:4.

The commercial rights holders TAC allocations by super-area are then simply calculated as:

$$TAC_y^{comm,A} = TAC_y^{off,A} + NSQ_y^A. \tag{17}$$

Summary of the order of the TAC calculations

1. The OMP generates the global (all super-areas combined) commercial (offshore+nearshore rights holders)+recreational TAC = TAC_y^G recommendation.
2. Check for inter-annual TAC constraint violations (at a global level) and adjust TAC_y^G if necessary.
3. Remove the total recreational take component (which would then be split into super-areas as per the specified proportions for subsequent computations in any simulation testing):
   $$TAC_y^{comm} = TAC_y^G - C_y^{rec} \ .$$
4. Re-check that the remaining commercial (offshore+nearshore rights holders) TAC_y^{comm} does not violate inter-annual TAC constraints; if it does, adjust it to the bound concerned.
5. Calculate the total nearshore TAC, NSQ_y.
6. Split the total nearshore TAC component into super-areas according to fixed proportions – note no nearshore TAC allocation for super-area A7. This gives: $NSQ_y^{A1-2}, NSQ_y^{A3-4}, NSQ_y^{A5-6}, NSQ_y^{A8}$. Note NSQ_y^{A7}=0.
7. Remove the total nearshore TAC component from the total commercial TAC to give the amount to be split into offshore TAC for super-areas A3-4, A7 and A8 (note no offshore TAC allocations for A1-2 and A5-6), i.e.:
   $$TAC_y^{off} = TAC_y^{comm} - NSQ_y \ .$$
8. Split the offshore TAC into A3-4, A7 and A8 (using the slopes method above– this gives initial $TAC_y^{off,A3-4}, TAC_y^{off,A7}, TAC_y^{off,A8}$). Note that $TAC_y^{off,A1-2}$ and $TAC_y^{off,A5-6}$ are both equal to zero.
9. Transfer 5% of offshore TAC from A8 into A3-4 (20%) and A7 (80%):
   $$TAC_y^{off,A3-4} = TAC_y^{off,A3-4} + (0.2)(0.05)TAC_y^{off,A8}$$
   $$TAC_y^{off,A7} = TAC_y^{off,A7} + (0.8)(0.05)TAC_y^{off,A8}$$
   $$TAC_y^{off,A8} = 0.95TAC_y^{off,A8} \ .$$
10. The final commercial TAC allocations are then:
    $$TAC_y^{comm,A1-2} = TAC_y^{off,A1-2} + NSQ_y^{A1-2}$$
    $$TAC_y^{comm,A3-4} = TAC_y^{off,A3-4} + NSQ_y^{A3-4}$$
    $$TAC_y^{comm,A5-6} = TAC_y^{off,A5-6} + NSQ_y^{A5-6}$$
    $$TAC_y^{comm,A7} = TAC_y^{off,A7} + NSQ_y^{A7}$$
    $$TAC_y^{comm,A8} = TAC_y^{off,A8} + NSQ_y^{A8}$$

Note for OMP 2011:
The above will need to be reconsidered for OMP 2011 to include interim relief and to take account of such revised TAC change constraints per sector as may be agreed.
Alternative constraint levels on inter-annual TAC variations for the offshore commercial fishery (currently maximum change exception in special circumstances is 10% p.a.) will be considered by reviewing the associated trade-offs in performance statistics in the OMP revision.

5. TAC values used for 2010/11 season

The OMP trials will use the actual 2010/11 season's TAC and its super-area allocation. The values allocated and their presumed areal splits are:

	Offshore allocation^{+}	**Near-shore allocation**	**Recreational Allocation**$^{+}$	**Interim Relief***	**Total**	**Total as recommended**
Total	**1528.22**	**451**	**107**	***200***	***2286.22***	**2286.22**
A1-2	0	24.17	2.14	***6.69***	***33.00***	29.31
A3-4	51.90	72.48	13.38	***41.40***	***179.16***	158.20
A5-6	0	32.20	13.38	***49.28***	***94.86***	64.33
A7	383.99	0	4.28	***0.0***	***388.27***	406.84
A8+	1092.33	322.15	73.83	***102.62***	***1590.93***	1627.57

** past proportional areal-split assumed to apply*
+ pro-rated down to revised allocation

Notes: ***i) A concern is that the interim relief allocation has apparently violated the intended super-area split of the overall TAC.***
ii) Given the number of interim relief permits apparently allocated, these values above of interim relief catch are too low.

6. Output Statistics

The following superscripts are used in the summary statistic notation:

comm	refers to commercial catches (offshore plus limited rights holders)
off	refers to the "offshore" quota (commercial less limited rights holders)
T	refers to total or global, i.e. results are summed over all five super-areas

Catch related statistics:

C_{ave}^{comm} :	the 10-year average (2006-2015) annual commercial catch in MT for each super-area.
C_{ave}^{off} :	the 10-year average (2006-2015) annual offshore catch in MT for each super-area.
$REC^{T}(t)$	the total (i.e. sum over all 5 super-areas) recreational take for year *t*.
$TAC_{11-13}^{T,comm}$	the average total (i.e. sum over all 5 super-areas) commercial TAC for the first three years (2011, 2012 and 2013).
$TAC_{11-13}^{T,off}$	the average total (i.e. sum over all 5 super-areas) offshore TAC for the first three years (2010, 2012 and 2013).

$TAC^{T,comm}_{11-20}$ the average total (i.e. sum over all 5 super-areas) annual commercial TAC for the full ten years (2011 - 2020).

$TAC^{T,off}_{11-20}$ the average total (i.e. sum over all 5 super-areas) annual offshore TAC for the full ten years (2011 - 2020).

V^{comm}: the 10-year (2011-2020) average inter-annual commercial catch variation for each super-area.

V^{off}: the 10-year (2011-2020) average inter-annual offshore catch variation for each super-area.

Biomass related statistics:

$B_{75,m+f}$ refers to the biomass of male and female lobsters above 75mm for each super-area

$B^{T}_{75,m+f}$ refers to the biomass of male and female lobsters above 75mm for all five super-areas combined

$B_{75,m}$ refers to the biomass of male only lobsters above 75mm for each super-area

$B^{T}_{75,m}$ refers to the biomass of male only lobsters above 75mm for all five super-areas combined

$B_{60,f}$ refers to the biomass of female lobsters above 60mm for each super-area

$B^{T}_{60,f}$ refers to the biomass of female lobsters above 60mm for all five super-areas combined

Results to be reported as ratios for 2016/2006 and 2006/1996;
and 2021/2010 and 2021/1990.

Comparative B(16/06) results assuming the resource is managed using a future CC = zero harvesting strategy to be produced. The $B_{75,m+f}$ (2016)(with catch/zero catch), $B_{75,m}$ (2016)(with catch/zero catch) and $B_{60,f}$ (2016)(with catch/zero catch) values are reported. *These statistics will also be produced for the year 2021*.

Note that for each statistic, the median and the 5th and 96th %iles will be reported. The 5th and 96th percentiles are estimated by fitting a regression line through the 8th - 12th values, and the 188th - 193th values respectively of the ordered set of results from 200 replicates, and using the midpoints as the final 5th and 95th percentiles. This method is implemented in order to aid smoothing of distributions in circumstances where sudden jumps may occur as scenarios switch over the 200 replicates.

TAC (commercial) and B_{75} trajectories are also presented for each super-area, as well as for the combined "total" resource.

References

Johnston, S.J., Butterworth, D.S. and J.Glazer. 2010. OMP 2007 re-cast to be used for setting the TACs for the West Coast rock lobster fishery for the 2008+ season. Fisheries/2010/Aug/SWG-WCRL/13.

Figure 1: Figure showing the somatic growth rate of a 70mm male lobster for each of the five super-areas.

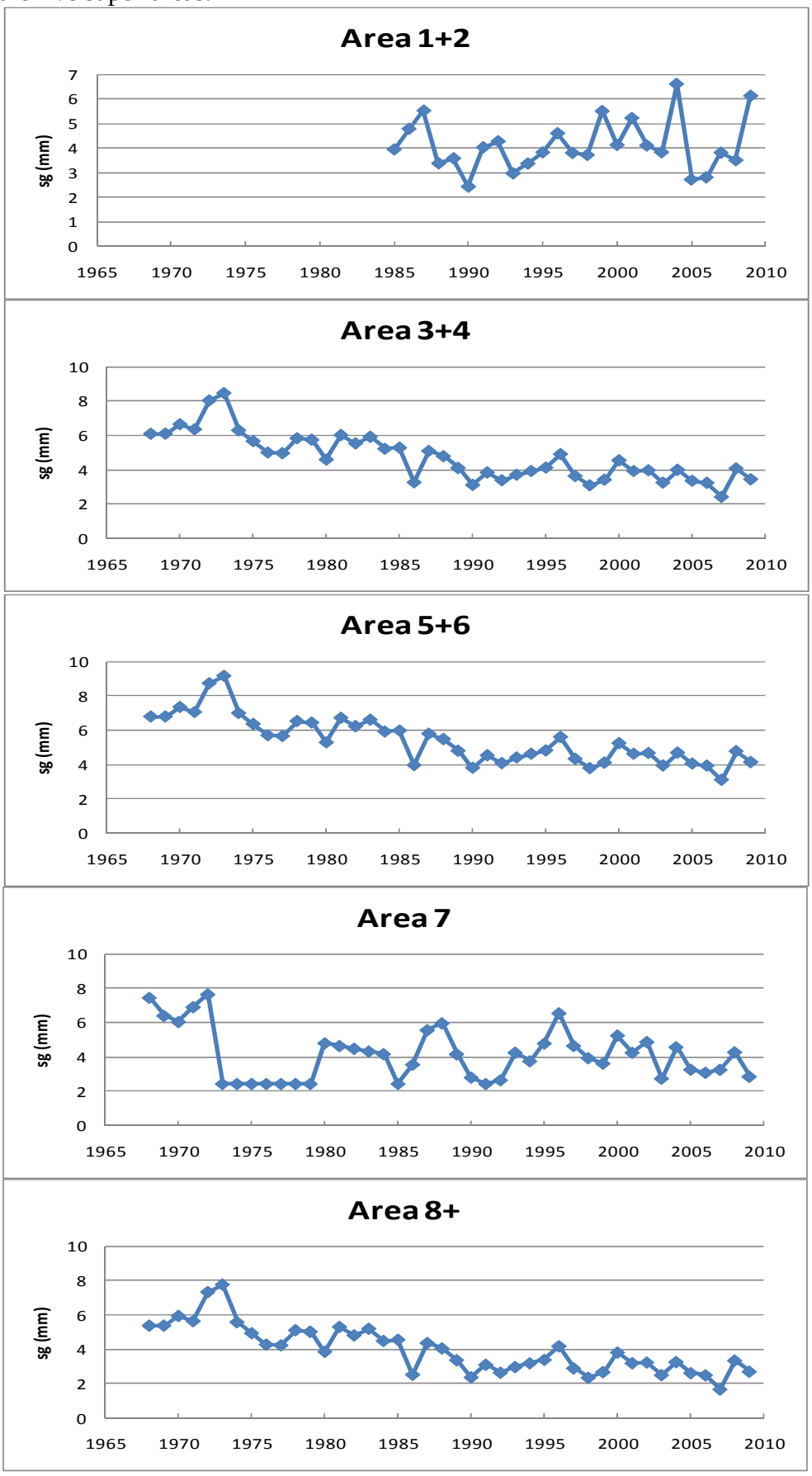
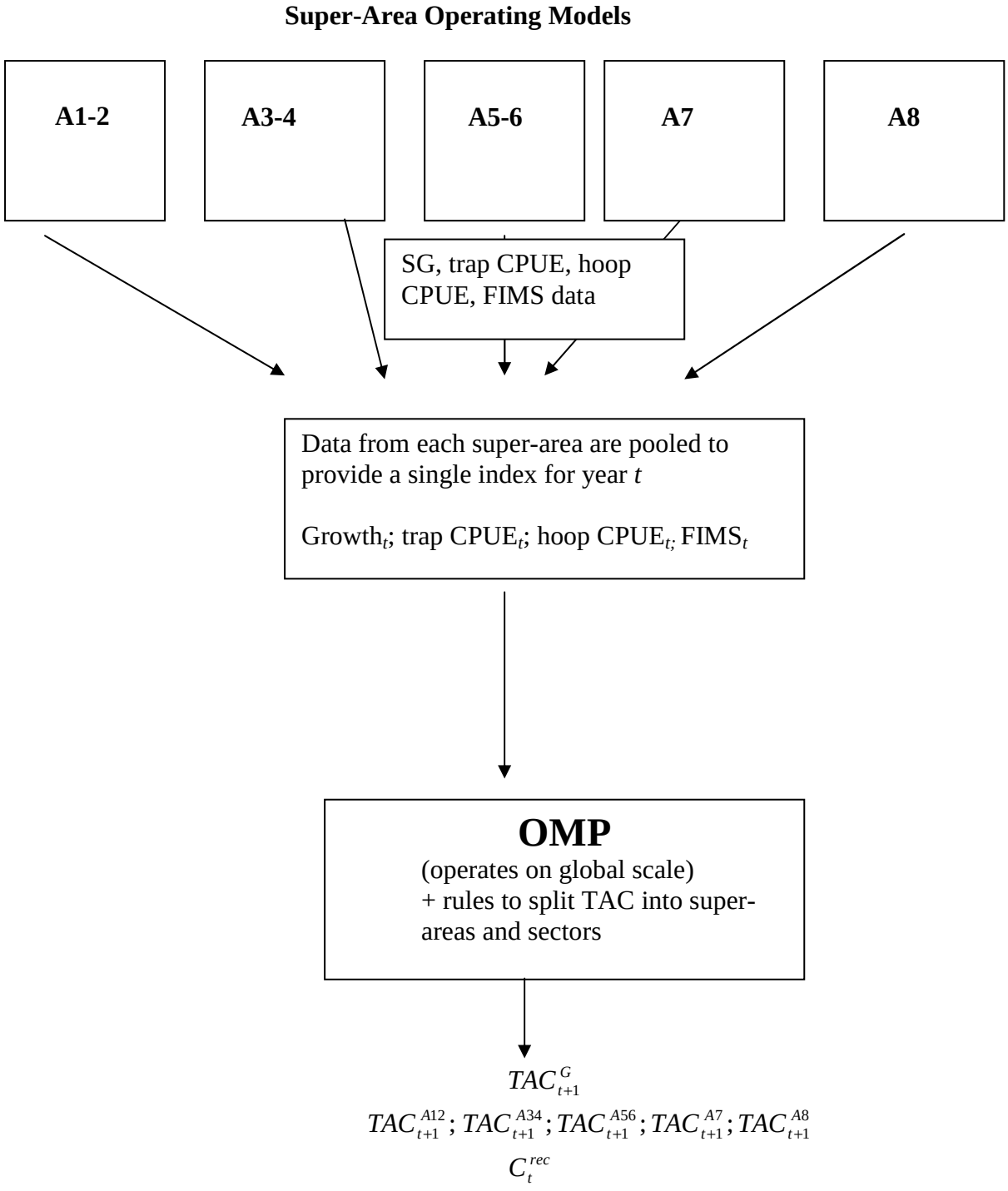


Figure 2: Flowchart of the area-disaggregated OMP approach for west coast rock lobster.



Appendix: Estimate of Interim Relief take for the 2010/2011 season:
Assuming that the average catch rate of phases II and III (seasons 2007/08 and 2008/09) will apply to the 2010/2011 season, i.e. phase V, a total Interim Relief catch estimate of **285 MT** for the 2010/2011 season results.
i.e.:

$$C_{2010} = T_{2010} P_{2010} \bar{R}$$

where

C_{2010} is the Interim relief catch estimate to be taken for the 2010/2011 season;

T_{2010} is the season length in weeks for the 2010/2011 season (23 weeks);

P_{2010} is the estimated (minimum) number of permits allocated for the 2010/2011 season (we assume 1500 here); and

$\bar{R}$ is the average catch per permit holder per week over the 2007/08 and 2008/09 seasons (i.e. average of the weekly catch rates for the 2007/08 and the 2008/09 seasons).

Thus for the 2010/2011 season:

$$C_{2010} = (823).(1500).(0.008259) = 285 \text{ MT}$$

Note: The estimate of 285 MT is 85 MT above the intended 200 MT.

Assuming the same super-areal split of the IR catch over the five super areas as for previous season, the estimated IR catches per super-area for 2010/2011 season are:

Area 1+2: 9.54 MT
Area 3+4: 59.00 MT
Area 5+6: 70.23 MT
Area 7: 0 MT
Area 8+: 146 MT
Total = 285 MT