Possible robustness and other tests for the 2007 area-disaggregated OMP testing for west coast rock lobster

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Robustness tests used in previous 2003 OMP

Table 1 provides the list of the proposed robustness tests which were used in evaluating the performance of various candidate OMPs in the previous selection process. This list was a result of discussions held at both the working group and task group level (note the W tests relating to walkouts awaited further discussion). The list can be divided into two categories:

CATEGORY A: One (or several) of the assumptions of the underlying operating model itself, or the data to which it was fitted, are altered, thus requiring the model to be re-fitted to the data by maximising the likelihood function.

CATEGORY B: These tests examine the robustness to assumptions relating to the future of the resource and monitoring data. During the OMP testing, it was assumed that the OMP was not "aware" of the associated changes.

The final set of OMP candidates were run for each of these robustness tests and the performance assessed as "tick" tests. The idea was to ascertain if performance for any of the robustness tests was substantially out of the expected range as estimated from the reference case "full-stochastic" simulation tested results.

Possible robustness tests for the area-disaggregated 2007 OMP

First, robustness to future somatic growth trends and future recruitment trends, as well as to estimated current biomass levels are already taken into account in the stochastic simulation method currently being used. To recap:

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 Somatic growth (2005+)	**WT**
• FSGL: = FSGM for 3 years (2005, 2006, 2007) then will equal the 1989-2004 average	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 apply to the growth rates for Areas 3-4, 5-6, 7 and 8. The somatic growth rate for Area 1-2 will be assumed to remain constant in the future at the 1989-2004 average level for all scenarios.]

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

There are four possible categories of further tests that could be considered for evaluating final candidate OMPs. First, robustness tests as for 2003:

CATEGORY A: One (or several) of the assumptions of the underlying operating models themselves, or the data to which they were fitted, would be altered, thus requiring the models to be re-fitted to the data by maximising the likelihood function.

CATEGORY B: These tests examine the robustness to assumptions relating to the future of the resource and monitoring data. During the OMP testing, it would assumed that the OMP was not "aware" of the associated changes.

Two new categories, essentially related to alternative options within the OMP could be:

CATEGORY C: Tests that explore alternate methods of collating the input data from the individual super-areas into a single input index value for each season in circumstances where some information is not available.

CATEGORY D: Tests that explore alternate methods of splitting the "combined" OMP TAC into the individual super-areas.

Appendix 1 reports the current methods used for both combining the super-area data into single indices for input into the OMP, as well as the method used to split the global TAC into super-area TACs.

It must be realised though that CATEGORY A robustness tests will each require re-fitting all five of the super-area assessment models, which is a considerably length process. We suggest therefore that these tests be limited to the RC option for current (2005) abundance, which would achieve a two-thirds reduction of the computation required.

Rather than simply treat robustness tests as tick tests, it is suggested that the working group considers moving to a more formal incorporation of these results by an approach along the following lines:

a) agree a resource-wide target $B(16/06)$ level (in either median or lower 5%ile terms);
b) rank the robustness tests as of high/medium/low (H/M/L) plausibility; and
c) require that all H tests meet the agreed criterion in a), and that all M tests meet a similar criterion with the $B(16/06)$ level set somewhat lower (by an extent to be agreed); L tests (if any) would purely be inspected to check that performance was not "outrageously" poor.

Table 1: Robustness tests evaluated in 2003 (at the time these were chosen as the more important from a larger set).

CATEGORY A TESTS	Description
F3	Shorter time period for F selectivity change: use 1985-1992 as period over which linear change occurs
NS1	Male natural survivorship = 0.88
NS2	Male natural survivorship = 0.92
D2	Discard mortality = 0.2
D3	Discard mortality increases 5 yrs prior to min size change
SG1	Adult growth is 0.5mm more than thought
SG2	1870-1967 growth = 68-88 average
SG3	Pre-1990 growth shifted down to 1990+ average level
SG4	1990+ growth shifted up to pre-1990 average level
NewG2,3	Somatic growth. estimated by "linear" function with time
W1	1990+ 225 MT walkout each yr
W2	Once every decade 1870-1990 500 MT walkout
MCM1	Female natural survivorship <= to male (0.90) – (RC2 only)
B4	Hoop and trap CPUE 99-01 negatively biased by a factor of 1.3
CATEGORY B TESTS	
E1	R drops 50% for 3 years, on one occasion in 1995-2003
E3	25% all lobsters die once 2003-2012
P1	Poaching reduced next 5 years to 200 MT
TH1	Future trap:hoop 60:40
B1	CPUE 2003+ stays constant
B2	Future adult somatic growth 0.5mm than thought
B3	Future adult somatic growth 0.5mm less than thought
W1 future	Future walkouts continue at 1990s rate
W3	W1 above, but 400 MT walk-out annually 2003+
M1	FIMS index missing
M2	Somatic growth index missing
COMP	Hard combination of tests

Appendix 2 reports the results of the robustness testing presented for the 2003 OMP.

Table 2: Possible list of robustness and other tests for evaluation in 2007. Some preliminary thoughts are offered for the first of the last two columns.

CATEGORY A TESTS	Description	Inclusion Yes/Maybe/ No	Plausibility weighting H/M/L
NS1	Male natural survivorship = 0.88	Y	
NS2	Male natural survivorship = 0.92	Y	
D2	Discard mortality = 0.2		
D3	Discard mortality increases 5 yrs prior to min size change		
SG1	Adult growth is 0.5mm more than thought	Y	
SG2	1910-1967 growth = 68-88 average	M	
SG3	Pre-1990 growth shifted down to 1990+ average level	M	
SG4	1990+ growth shifted up to pre-1990 average level	Y	
W1	1990+ 225 MT walkout each yr* (but not in future)	Y	
W2	Once every decade 1910-1990 500 MT walkout		
B4	Hoop and trap CPUE 99-01 negatively biased by a factor of 1.3		
CATEGORY B TESTS			
E1	R drops 50% for 3 years, once in 1998-2006	Y	
E3	25% all lobsters die once during 2006-2015	Y	
P1	Poaching reduced next 5 years to 200 MT	M	
TH1	Future trap:hoop changes? (see bottom for details)	N	
B1	CPUE 2007+ stays constant	M	
B2	Future adult somatic growth 0.5mm than reported	Y	
B3	Future adult somatic growth 0.5mm less than reported	Y	
W1 future	Future walkouts continue at 1990s rate	Y	
W3	W1 above, but 400 MT walk-out annually 2006+*		
COMP	Hard combination of tests	Y	
RECR1	Future recreational take is ?		
CATEGORY C TESTS	**(How to combine super-area data when some are not available)**		
M1	FIMS index missing	Y	
M2	Somatic growth index missing	Y	
M3	Trap CPUE index is missing	Y	
M4	Hoop cpue index is missing	Y	
CATEGORY D TESTS	**(How to split global TAC into super-area TACs)**		
DD1	Split global TAC at current (2006) TAC proportions throughout the period		

* Super-area division to be specified after discussion

For M1-M4: the OMP would assume the average of the previous 3 years' data.

Current assumption regarding future trap:hoop ratios: Area 1-2 = 0:100, Area 3-4 = 10:90, Area 5-6 = 0:100, Area 7 = 100:0 and Area 8 = 78:22.

Appendix 1

1. How to combine super-area data into single indices for input to the OMP

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 year in the future.

STEP 1: For each area for which data are assumed available, there will be for any year (for trap CPUE as example):

$$CPUE_{2006}^{trap,A1-2}, CPUE_{2006}^{trap,A3-4}, CPUE_{2006}^{trap,A5-6}, CPUE_{2006}^{trap,A7}, CPUE_{2006}^{trap,A8}$$

STEP 2: Evaluate the average CPUEs (and average FIMS) for the super-area concerned over the last five years (i.e. over 2000…2004),

STEP 3: Express the values for CPUE generated in Step 1 as fractions of these averages, e.g:

$$CPUE_{2006}^{trap,A1-2} \Rightarrow X_{2006}^{trap,A1-2} = \frac{CPUE_{2006}^{trap,A1-2}}{Ave\ of\ 2000...2004\ values}$$

STEP 4: Calculate a combined CPUE index as follows:

$$X_{2006}^{trap,TOTAL} = w_{A1-2}^{trap} X_{2006}^{trap,A1-2} + w_{A3-4}^{trap} X_{2006}^{trap,A3-4} + ...w_{A8}^{trap} X_{2006}^{trap,A8}$$

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

e.g.: for trap and hoop CPUE get B^{75} for 2000-2004 for each super-area: $\overline{B}_{A1-2}^{75}, \overline{B}_{A3-4}^{75}, \overline{B}_{A5-6}^{75}, \overline{B}_{A7}^{75}, \overline{B}_{A8}^{75}$. Note that these are selectivity-weighted biomasses.

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

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

For FIMS, as above, but use B^{60} instead of B^{75} (again, use the selectivity weighted biomass).

Remember there will be a lack of data types for some super-areas, so that 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.

Combined somatic growth index:

All that is needed is an index e.g. 70mm male somatic growth as used in each separate assessment.

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

Thus $\beta_t = w^{SG}_{A1-2}\beta^{A1-2}_t + w^{SG}_{A3-4}\beta^{A3-4}_t + w^{SG}_{A5-6}\beta^{A5-6}_t + w^{SG}_{A7}\beta^{A7}_t + w^{SG}_{A8}\beta^{A8}_t$
where:
β_t is the combined somatic growth rate of a 70mm male lobster in year *t*.

Since the assessments are now finalised, the above biomasses are all available and hence also the weighting factors which are now fixed. The table below lists these *w* values. [Note that the blanks indicate that data are not expected from that super-area for that gear type in the future, and are hence omitted from the OMP.]

NB: the w_A calculation is based on the best (RC1-like) assessment, and yields the following:

	w^{trap}_A	w^{hoop}_A	w^{FIMS}_A	w^{SG}_A
A1-2	-	0.025	-	0.018
A3-4	-	0.234	0.157	0.176
A5-6	-	0.152	0.075	0.082
A7	0.400	-	0.188	0.229
A8	0.600	0.588	0.580	0.495

2. How to split the global (combined) TAC generated from the OMP

The OMP TAC setting rule will produce a global TAC each year - TAC^G_t.

The adjustment to be made is that 320 MT (or related amount – see rules described below for modifications to the recreational catch) must be removed for the recreational catch.

The remaining (commercial) TAC must then be split into super-area TACs.

Rules for recreational catch:

$C^{rec}_t = 320$ 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

STEP 1: For each super-area we have 1-3 abundance index time series. For each time index, linearly regress *ln*(index) *vs* year for the last seven years 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:

$$slope = \frac{(\frac{slope_{trap}}{\sigma^2_{slope_{trap}}} + \frac{slope_{hoop}}{\sigma^2_{slope_{hoop}}} + \frac{slope_{FIMS}}{\sigma^2_{slope_{FIMS}}})/3}{\frac{1}{\sigma^2_{slope_{trap}}} + \frac{1}{\sigma^2_{slope_{hoop}}} + \frac{1}{\sigma^2_{slope_{FIMS}}}}$$ (assuming three series), where

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

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

STEP 4: Take previous year's allocation for the super-area and multiply it by (1+*slope*), giving a new set of allocations by super-area, which will not necessarily total to the new overall commercial TAC. If they do not, simply scale them all by the same proportion so that they do total to match that.

Step 5: Ensure that the commercial TAC for each super-area is at least as large as the amount proposed for allocation to the limited rights holders. These amounts are

Super-Area	Limited 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

For a certain area's commercial TAC is less that the limited rights holders allocated amount, then this TAC is increased to equal the limited rights holders allocation for that super-area. The TACs for the remaining areas are then re-scaled using the same ratios as for Step 4. This process continues until the TACs for all super-areas comply with the criteria of being equal or larger than the limited rights holders allocation, and that the sum of the TAC over the super-areas equals the newly calculated commercial TAC.

Appendix 2: 2003 Robustness tests results (from WG/08/03/WCRL25)

Table A1.1. Results of the robustness trials run for the deterministic middle option VAR5 (in conjunction with RC1 scenario 2 assumptions regarding future somatic growth and recruitment.)

Test	Description	B(13/03)	C_{ave}(10)	V(10)	FE(12/03)	TAC(03)	TAC(04)	TAC(05)
RC	Reference Case*	1.00	2864	5.28	0.74	3206	3527	3221
F1	Change fishing selectivity	1.02	2555	7.86	0.56	3206	3527	3174
NS1	Male s = 0.88	0.93	2395	8.53	0.48	3206	3351	3016
NS2	Male s = 0.92	1.06	2493	7.33	0.56	3606	3343	3009
D2	Disc mort d = 0.2	1.00	2539	7.99	0.55	3206	3509	3158
D3	Disc mort decr. 5 yrs prior 1992	1.01	2517	7.69	0.55	3206	3460	3114
SG1	Adult sg 0.5mm more	1.08	2377	7.82	0.46	3206	3296	2966
SG2	1870-1967 sg = 68-88 ave	0.99	2372	7.89	0.49	3206	3291	2962
SG3	Pre-1990 sg = 1990+ level	0.98	3409	2.86	0.91	3206	3527	3512
SG4	1990+ sg = pre-1990 level	0.66	5043	9.03	2.92	3206	3527	3880
W1	1990+ 225 MT walkout, 112 MT for 2003+	1.01	2492	7.42	0.57	3206	3360	3024
W2	Same as W1, but also 1870-1990 500 MT walkout each decade	1.01	2544	7.53	0.56	3206	3470	3123
B4	Hoop and trap CPUE 1999-2001 negatively biased by a factor of 1.3	0.89	3710	4.35	1.15	3206	3527	3878
E1	In 2000 R drops 50% for 3 yrs	0.87	2560	9.49	0.48	3206	3527	3221
E3	In 2007 25% all lobsters die	0.72	2576	9.36	0.61	3206	3527	3221
P1	Poaching reduced to 200 MT over next 5 yrs	1.04	2897	5.46	0.75	3206	3527	3221
TH1	Use 60:40 trap:hoop ratio	1.00	2864	5.29	0.74	3206	3527	3221
B1	CPUE 2003+ stays constant	0.96	2898	5.09	1.01	3206	3527	3185
B2	Future adult sg is 0.5mm more than thought	1.28	3146	5.24	0.78	3206	3527	3248
B3	Future adult sg is 0.5mm less than thought	0.84	2611	7.33	0.66	3206	3527	3174
M1	2005 FIMS missing – use 2004	1.00	2870	5.32	0.74	3206	3527	3221
M2	2005 sg missing – use 2004	1.00	2864	5.28	0.74	3206	3527	3221

* Note: VAR5 results deterministic results for RC1 scenario 2.