Underlying assumptions for the area-disaggregated stock assessment of west coast rock lobster

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Introduction

The West Coast resource is divided into the following "super" areas:
Area 1-2: The most Northern region – only a very small tonnage is currently caught in this area.
Area 3-4 (Areas 3 and 4 only)
Area 5-6 (Areas 5 and 6 only)
Area 7 (Dassen Island), and
Area 8+ (areas to the south and east of Dassen Island, which include Area 8 (Cape Point), Area 10 (Hout Bay), Area 11 (False Bay), and Areas 12-14 (East of Hangklip).

Figure 1 illustrates the West Coast rock lobster fishing zones and areas.

Comments for SWG:

a) What about Area 9 (Robben Island)? Should we be making some allowance for it?
b) What about an inshore/offshore split for Area 8?
c) Are we happy handling East of Hangklip as before. Is there evidence that CPUE has dropped there?

Note that the convention used here for referring to split seasons is to quote only the first of the two years for each split season, i.e. the 1992/93 season is referred to here as "1992".

A size-structured modelling approach (as described fully in FISHERIES/2010/AUG/SWG-WCRL/23) is used to model the dynamics of each super-areas independently.

The area-disaggregated modelling approach assumes that recruitment from each area remains in that area and that there is no immigration or emigration between areas (of larvae or adults).

Comment for SWG: Do we need to consider alternatives to or even change this assumption?

General model features

A number of recommendations were made at the December 2005 Rock Lobster International Workshop relating to improving the current assessment model. Most of

the suggestions were aimed at simplifying the population dynamics model in order to speed up the time it takes the model to fit to data.

The area-disaggregated models have thus been modified to include:

1) Sparse matrix multiplication

Programming efficiency can be improved when multiplying sparse matrices. The authors modified the code so that this was achieved.

2) Increasing the first year of the model from 1870 to 1910

The authors explored changing the existing 1870+ model into a 1910+ model, since very little catch occurred between 1870-1910. For each area, the 1870-1910 catches were summed, and then divided by 10. These catches were then added to each year from 1910-1919, thus the total catch over the 1910-1919 period is identical to the 1870-1919 period.

3) Placing lower bounds on the residual variances

The residual variances for several of the data sources for several of the areas in the spatially-disaggregated assessment are unrealistically low, indicating the possibility of over-fitting. The authors thus imposed a lower bound of 0.15 on all the σ values for all data sources in the model fitting procedure.

Note also that:

- The recruitment in 2000, R_{2000}, is now an estimable parameter
- R2005+ is calculated from the geometric mean of R_{75}, R_{80}, R_{85}, R_{90} and R_{95}.

Comment for SWG: In the 2009 updated assessments (see MCM/NOV/2009/SWG-WCRL/24) a sensitivity was examined where a further estimable parameter R_{2003} was added. The results w.r.t. current abundance levels were very similar to the reference case model. Implications for the future could be more substantive. If the RC operating model is updated to include R_{2003} as an estimable parameter, then updates to the highlighted sections below will be required.

Reference case and alternate models

After much discussion, a task group (consisting of Bergh, Butterworth, Jacobs and Johnston) decided that the most desirable method for producing two alternate models reflecting recent recruitment uncertainty for each super-area would be as follows:

To run the reference case model with the following penalty function added to the $-ln$L (this reflects "shrinkage to the mean". or in Bayesian terms using a prior that reflects the recent past distribution of recruitments):

$$pen = \frac{1}{2}\left(\ln R_{2000} - \ln \overline{R}\right)^2 / \sigma^2 \qquad (1)$$

where

$$\ln \overline{R} = \frac{1}{5}\sum_{y=1975}^{1995} \ln R_y \qquad (2)$$

$$\sigma^2 = \frac{1}{4}\sum_{y=1975}^{1995}\left(\ln \bar{R} - \ln R_y\right)^2 \quad (3)$$

The two alternate models (Alt1 and Alt2) are virtually identical to the RC model, except with regards to the R_{2000} value. For the RC model R_{2000} is an estimable parameter, although it was found to be estimated with very low precision (for Area 8 the 95% CI was 0.0001-1.65), and so is dominated in the estimation by the contribution from equation (1). For this reason, Alt1 and Alt2 models would correspond almost exactly to the RC best fit parameter values except for R_{2000} which would be fixed at the (approximate) upper and lower 25%iles of this distribution as follows:

$$\ln R_{2000}^{alt1} = \ln \hat{R}_{2000}^{RC} + \sigma\alpha \quad (4)$$

and

$$\ln R_{2000}^{alt2} = \ln \hat{R}_{2000}^{RC} - \sigma\alpha \quad (5)$$

where σ is from equation (2) above, and the α value (0.741) corresponds to the 25%iles of a *t*-distribution with the appropriate number of degrees of freedom.

Area-disaggregated modelling assumptions

Historic Catch Record

For the area-disaggregated assessments, the Roy Melville-Smith catch record (i.e. pre-1968 period) is to be split for the different areas as follows:

$$C_{c,t}^{1-2} = 0.20 * C_{c,t}^{T}$$
$$C_{c,t}^{3-4} = 0.20 * C_{c,t}^{T}$$
$$C_{c,t}^{5-6} = 0.30 * C_{c,t}^{T}$$
$$C_{c,t}^{7} = 0.20 * C_{c,t}^{T}$$
$$C_{c,t}^{8} = 0.10 * C_{c,t}^{T}$$

where $C_{c,t}^{T}$ is the total commercial (Melville-Smith) catch for season *t*. Figure 2 shows the MCM reported catches (expressed as proportion of the total west coast catch) for each "super-area" (1968+) upon which the above "historic" divisions were based, in conjunction with the knowledge that there has been a "fishing-down" of the resource from the North to the South over time.

The MCM database catch record is to be used for the period 1968-2009. This database provides commercial catches for each area.

Recreational catch data

Estimates, based upon telephone surveys, of the percentage breakdown for the "super" areas of the total annual recreational catches are as follows:

Area 1-2: 0 %
Area 3-4: 7.5%
Area 5-6: 7.5%
Area 7: 5%

Area 8: 80%

Comment for SWG: do the more recent telephone surveys suggest any changes? Table 11 of the most recent recreational telephone survey report (MCM/2010/AUG/SWG/WCRL12) provides the following estimates for the 2009/2010 season:

Area 1-2: 1.7%
Area 3-4: 2.5%
Area 5-6: 13.1%
Area 7: 10.5%
Area 8+: 72.2%

Poaching

The total poaching take from the resource is assumed to be divided into the super-areas as follows:

Area 1-2:	0%
Area 3-4:	2.5%
Area 5-6:	2.5%
Area 7:	15%
Area 8+:	80%

Interim Relief

The SWG had agreed to use the following GLOBAL Interim relief estimates:

2007/08: 174 MT
2008/09: 170 MT
2009/10: 278 MT.

Table 1a reports the super-area breakdown of Interim Relief as reported in Keulder (2009). Using information in Table 1a and assuming the average % breakdown for phases II and II can be applied for phase IV, interim relief catch estimates for each of the five super-areas are provided in Table 1b.

Comment for the SWG: The SWG need to confirm the super-area breakdown of these catches. The SWG also need to agree a plausible IR tonnage for phase I (the IR taken for the initial 2006/07 season).

Somatic Growth rate

Somatic growth data used in the assessments are from a moult probability model which provides a somatic growth series for each of the "super" areas for the 1968-2008 period. For the historic period (1910-1967) the average of the available data (1968-2009 is assumed. Note that for super-area A1-2 future somatic growth, the 1985-2009 average is used (the somatic growth series for this region starts only in 1985).

Reference

Keulder, F. 2009. Estimated west coast rock lobster catch for Interim Relief Phases II and III. MCM/2009.Aug.SWG/WCRL/16.

Table 1a: Interim relief super-area splits.

Season	2006/07*	2007/08*	2008/09*	2007/08	2008/09		2009/10
Phase	I	II	III	II	III	average of II and III	IV extrapolated
	Catch kg	Catch kg	Catch kg	% total	% total	Ave % total	Catch kg
Zone A	?	4356	7040	2.46	4.13	3.29	9158
Zone B	?	33814	36960	19.08	21.69	20.38	56664
Zone C	?	41272	43010	23.29	25.24	24.26	67447
Zone D	?	29946	36590	16.90	21.47	19.18	53328
Zone E	?	8169	5227	4.61	3.07	3.84	10670
Zone F	?	56100	39800	31.65	23.35	27.50	76459
Unknown	?	3573	1804	2.02	1.06	1.54	4274
Total	?	177230	170431	100.00	100.00	100.00	278000

*these data are provided by Keulder (2009).

Table 1b: Super-area Interim relief splits.

Season	2006/2007	2007/2008	2008/2009	2009/2010
Phase	I	II	III	IV
Area 1-2	?	4356	7040	9158
Area 3-4	?	33814	36960	56664
Area 5-6	?	41272	43010	67447
Area 7	?	0	0	0
Area 8+	?	94215	81617	140457

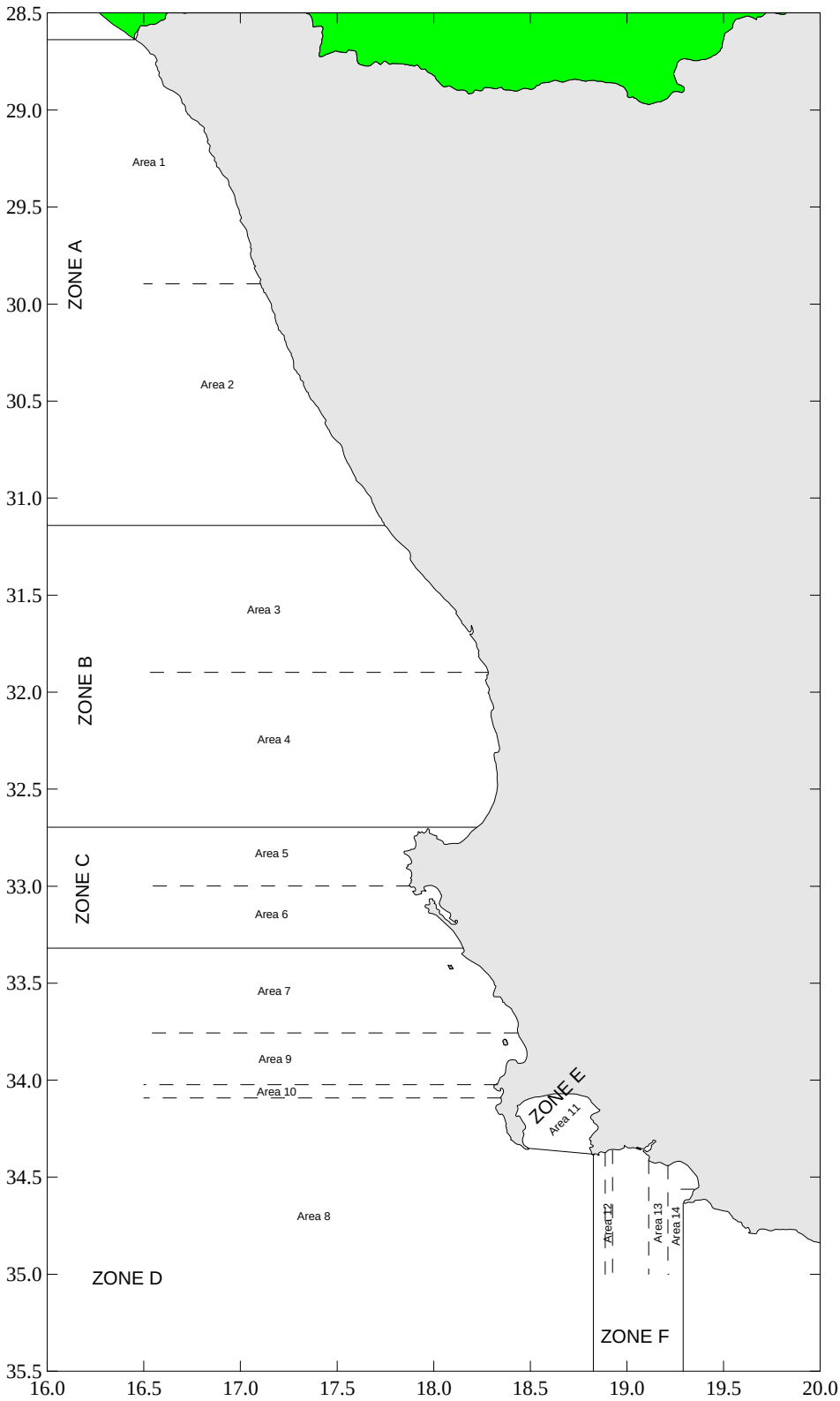

Figure 1: West coast rock lobster fishing zones and areas.

Figure 2: Super-area proportional breakdown of the total west coast catch for the 1967-2009 period.