Risk-related Aspects of the west coast rock lobster and of the joint sardine and anchovy OMPs to be developed this year

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WEST COAST ROCK LOBSTER

In 2006, the west coast rock lobster scientific working group moved from assessing the resource as a single stock, to assessing the stock at a spatially disaggregated "super-area" level, to take better account of different resource monitoring trends in different areas which indicated area-specific dynamics. The resource was divided into five super-areas by combining the existing eights areas (A1 to A8): A1-2, A3-4, A5-6, A7 and A8. Stock assessment updates at the super-area level have now been completed, and work is underway in developing a new OMP for the resource which inputs data on an area-disaggregated basis. This OMP is scheduled for finalisation early during the second half of this year.

Some points with respect to defining risk and how to assess risk that have come to light include:

1. The biological risk criterion, now B_{75}(16/06), corresponding to the ratio of the projected biomass above 75mm carapace length in 2016 to that at present, needs to be considered for all five super-areas. Different levels of re-building may be appropriate for different super-areas given their different starting levels relative to 1996. Note that the objective of the OMP adopted in 1997 was to secure a 10% increase in B_{75} by 2006 – for most of this period, assessments indicated achievement of this objective to be more than on-track, but poor catch-rates in the last few years have led to current assessments reflecting a failure (typically by some 10-20%) to meet this 2006 target. The table below provides some preliminary results of an OMP candidate under development. Here the *B*(16/06) statistic is reported. Note that the "*B*" in this statistic now refers to the male-only portion of the stock.

Super-area	**median**	**Lower 5%ile**	**Upper 95%ile**
A1-2	0.78	0.50	1.32
A3-4	0.95	0.54	2.44
A5-6	1.77	0.62	11.29
A7	1.35	0.49	3.40
A8	1.00	0.45	2.62
Area-aggregated	1.23	0.68	2.84

   There appears to be wide-probability intervals on the recovery levels for all super-areas. A particular problem we face now, is how low a lower 95%ile should be acceptable?

2. The B_{75}(16/06) criterion will most likely relate to the male portion of the stock only, given that there is much greater uncertainty associated with the assessment of the stock dynamics of the female portion of the resource given their lower somatic growth and hence small contribution to the catches which comprise mainly male lobsters (there is a 75mm carapace length minimum size limit).

3. Economic risk criteria have yet to be discussed with the industry, and may well vary between super-areas.

4. Key uncertainties are the current resource biomass, future somatic growth and future recruitment. Three options for each have been identified with an associated weight for each. Twenty-seven possible scenarios are thus now to be considered to integrate over for the Reference Set of trials.

PELAGICS – ANCHOVY AND SARDINE

1. Assessments of the sardine and anchovy resources are due to be carried out within the next few months, following which a new joint OMP will be developed and tested for finalisation towards the end of this year.

2. Previously the sardine assessments have assumed a single southern Benguela sardine population, while the updated assessment will consider both a single and a two-population hypothesis. In addition the assessments will be spatially disaggregated into "western", "southern" and "eastern" areas. A key factor in this spatial disaggregation is to relate the sardine abundance to models of groups of penguin colonies.

3. The anchovy population will continue to be assessed as a single stock as before.

4. A key uncertainty to be addressed, which in turn has important implications for risk computations, is the modelling of the sardine and anchovy stock-recruitment relationships. Figure 1 gives the most recently computed model-predicted recruitment time series, while Figure 2 shows the hockey-stick stock-recruitment models used for OMP-04. Given the recent poor sardine recruitment following record biomass levels, a Ricker stock-recruitment relationship may be more suited to this resource (Figure 2c). Other alternatives include updating the hockey-stick model or extending this hockey stick model to a mixture distribution in which the recent good recruitment years are treated as part of a different "regime". For the last scenario, the probability given to a change of "regime" would need to be specified. Cunningham and Butterworth (2005) found that the periodicity between peaks in South African sardine landings and the duration of such peaks was atypical of that for sardine stocks elsewhere in the world, so that the information for those other stocks could hardly be used as the basis to specify a Bayesian prior (say). The duration between the two observed peaks in South African sardine landings is about 40 years (see Figure 3). Thus one might assume the probability of a change to a more productive "regime" may be 1/40, with a switch back to the "poorer regime" after 5 to 7 years (Cunningham and Butterworth 2005).

5. Another key issue to be addressed is the recent "eastward shift" of the sardine distribution. Figure 4b shows the proportion of the total sardine biomass found west of Cape Agulhas during the November spawner biomass survey. These data clearly show an eastward shift of the distribution over recent years. In a two-stock hypothesis this increase in biomass to the east of Cape Agulhas could be explained by an increase in the "eastern" stock, with an unchanged stock-recruitment relationship for the "western" stock. However for the alternative (and current) single stock hypothesis difficulty will arise with the lack of information currently available to guide how to model the probability of a possible shift in the distribution back west in the future.

6. This eastward shift of the sardine distribution also gives rise to an additional economic risk which needs to be considered. If the industry invest in new factories on the south coast of South Africa the cost of transporting landed catch to canning factories (currently mostly on the west coast) will be substantially reduced while the sardine are distributed more to the east. However, the bulk of such investment would be wasted should the peak of the sardine distribution then shift back to the west coast.

7. Of further interest is that the data suggest that there has also been an earlier eastward shift in the anchovy abundance over time (Figure 3a). These data suggest the need for a re-evaluation of whether or not a multi-stock or shifting distribution hypothesis will be required for anchovy as well as for sardine.

8. Given the move towards adopting an ecosystem approach to fisheries in the pelagic sector, the new joint OMP will need to be tested in the light of not only the risk parameters as considered previously, along with catch statistics, but also parameters denoting risk to the African penguin population(s) *Spheniscus demersus.* Functional relationships between sardine and anchovy abundance and penguin populations need to be determined prior to such risk statistics being developed. Penguins have been chosen as a key predator species to consider because of their conservation status ("vulnerable" on the IUCN red list), and because of their sensitivity to changes in pelagic fish abundance and distribution as a consequence of their land-based breeding sites. Two sets of penguin colonies are to be modelled, corresponding to the "western" and "eastern" areas of the sardine model as there are virtually no penguins in the "southern" area.

9. A spatial model of penguin population dynamics, fitted to data in the form of annual counts of numbers of breeding and moulting penguins, is currently under development (Figure 5). Such a model obviously first needs to satisfactorily fit past data (which is proving problematic) before it can be used with some confidence to predict future penguin population size as a function of fish abundance (at a spatially disaggregated level). A penguin model of this form will be used in the OMP testing process to assess the risk to penguins associated with alternative management strategies. It is envisaged that risk will be quantified as the probability of penguin abundance (either in terms of the numbers of breeding pairs or total population size) dropping below some threshold abundance under different OMP variants. It is not envisaged that penguin-related data will be used directly as inputs to the OMP's TAC formula. One current difficulty still being debated relates to the definition of risk for penguins: what is an appropriate choice of a threshold abundance level for penguins and what probability of dropping below that level constitutes unacceptable risk? Relative depletion cannot simply be based on historic estimates of carrying capacity because of the possibility that penguin numbers at the turn of the 19th century may have been artificially high due to a competitive release effect as a result of the heavily reduced seal numbers at the time following intensive harvesting. Moreover, Crawford *et al*. (in press) propose a change in carrying capacity from a very high level in the 1920s to a much lower value over the period 1978-2006. It thus seems that risk will need to be defined in terms of some yet to be agreed probability of the population of penguin adult breeders dropping below a pre-determined percentage of the 1980's abundance levels.

References

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Crawford, R.J.M., Underhill, L.G., Upfold, L. and B.M. Dyer. In press. An altered carrying capacity of the Benguela upwelling ecosystem for African penguins (*Spheniscus demersus*). ICES J. Mar. Sci.

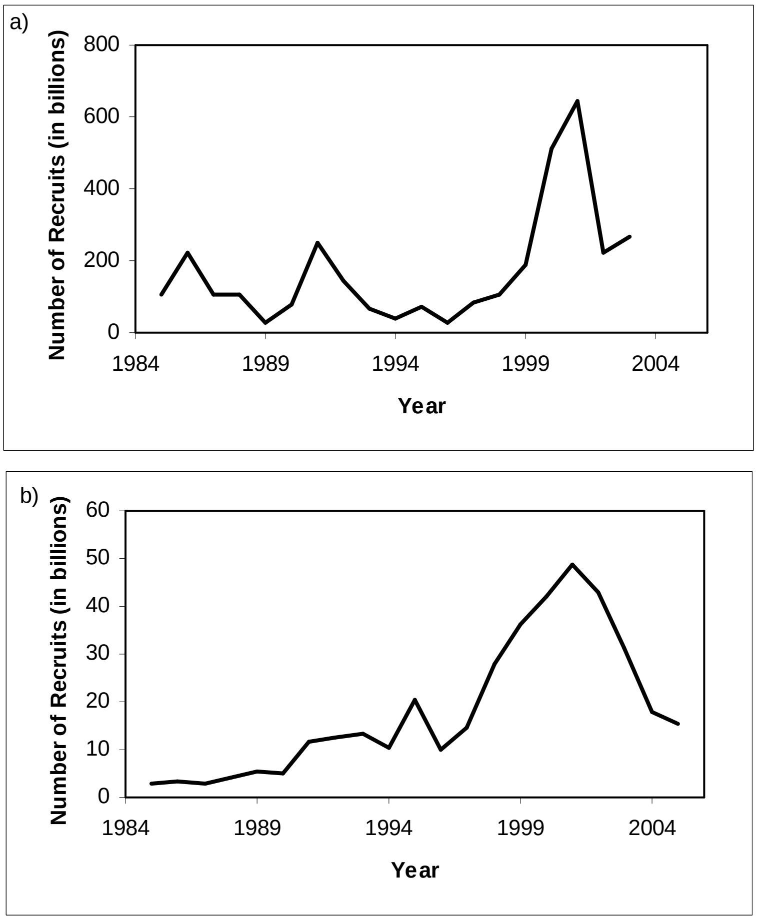

Figure 1. The most recently computed assessment model predictions of May recruitment for a) anchovy and b) sardine.

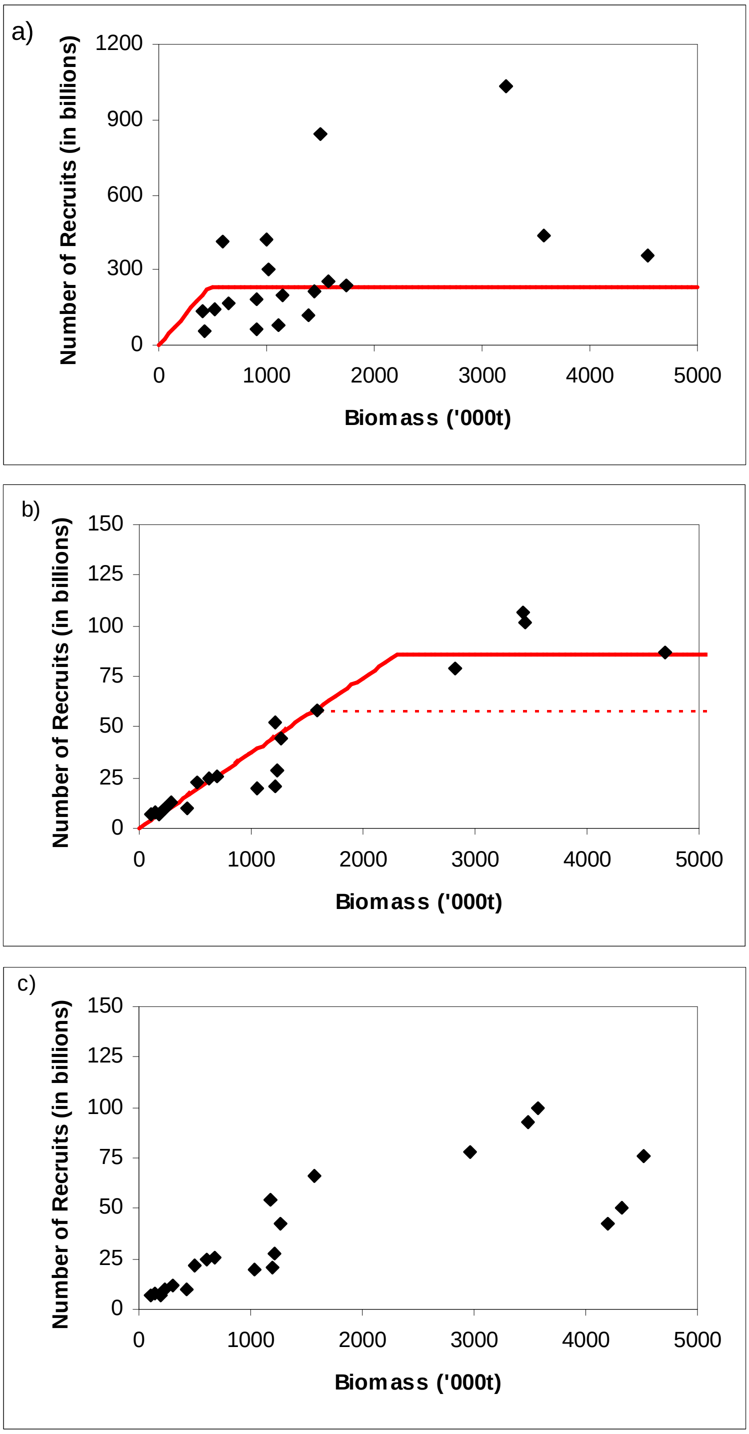

Figure 2. The model predicted November stock-recruitment relationship with fitted hockey-stick curve for a) anchovy and b) sardine used when testing OMP-04. The dashed line in b) represents the more conservative stock-recruitment model assumed from 2005 onwards when testing OMP-04, to factor in the possibility that the then recent recruitments were at an atypical level unlikely to continue. The model predicted November stock-recruitment estimates from an updated sardine assessment in 2006 is given in c).

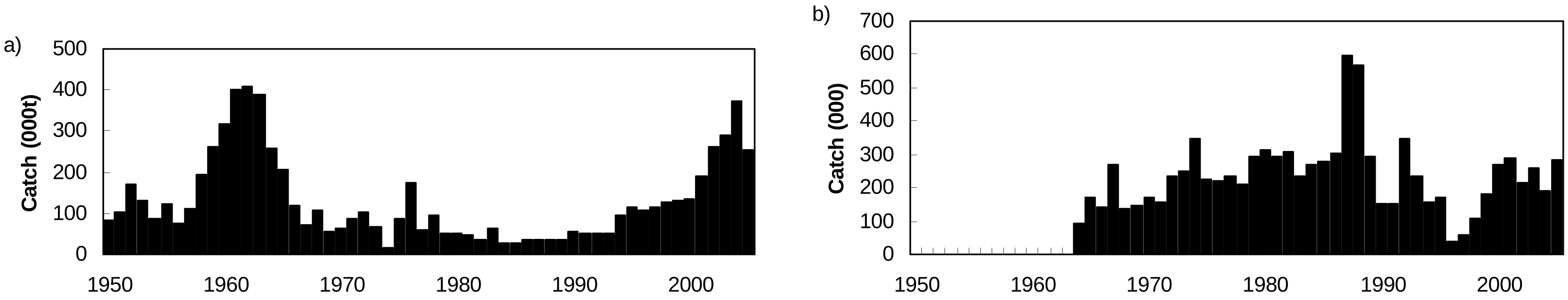

Figure 3. Historic annual commercial catch record for a) sardine and b) anchovy.

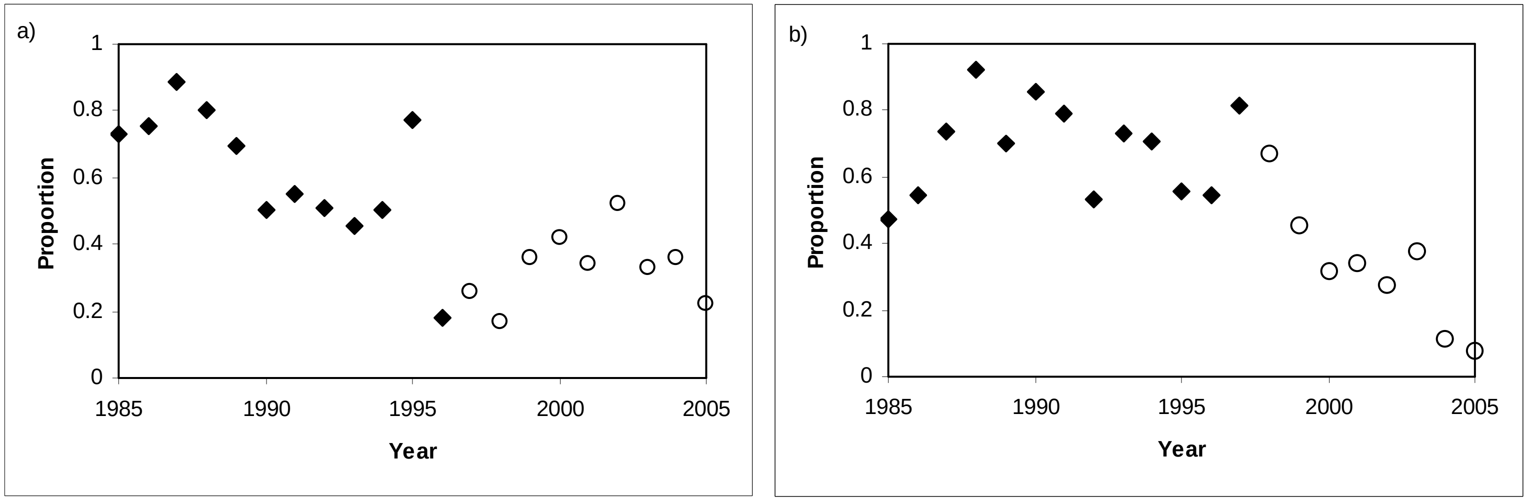

Figure 4. Proportion of observed a) anchovy and b) sardine November biomass west of Cape Agulhas. The closed diamonds are from a series of data observed with the old echo sounder (i.e. capped data) with an old target strength assumption, while the open circles are from a series of data observed with the new echo sounder (i.e. uncapped data) with a new target strength expression and accounting for attenuation at high densities.

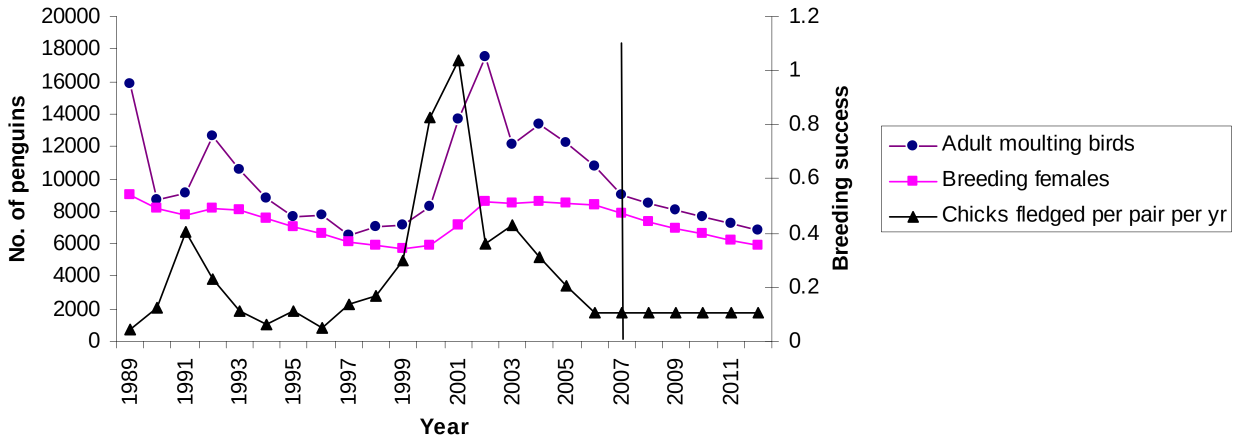

Figure 5. Illustrative model trajectory of the numbers of moulting and breeding female penguins at Robben and Dassen Islands, when breeding success (no. of chicks per pair per year) is modelled as dependent on the abundance of anchovy recruits.