

**INTERNATIONAL REVIEW PANEL REPORT FOR THE 2010
INTERNATIONAL FISHERIES STOCK ASSESSMENT WORKSHOP¹
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The Panel wishes to recognize the world-leading quality of the research presented at the 2010 International Fisheries Stock Assessment Workshop. The amount of work conducted by the small group of biologists and modellers would be the envy of any management agency worldwide. The Panel was presented with research related to West Coast rock lobster, African penguins, sardine and anchovy, Cape hake, and humpback whales. It also considered research related to management procedures for data-poor stocks, and methods to evaluate approaches for estimating time-varying selectivity.

This report begins with some comments which pertain to all of the resources and problems reviewed. The remainder of the report lists the recommendations and conclusions of the Panel for West Coast rock lobster, African penguins, sardine and anchovy, Cape hake, and data-poor management procedures. The Panel deliberations were guided by a set of key questions (see Appendix 1) and the text in square parentheses at the end of some of the recommendations pertains to these key questions. The Panel did not address all of the key questions. The recommendations are annotated by their priorities (H, M, L and conclusions are indicated by asterisks). For rock lobster, penguins and sardine-anchovy, the high priority items should be completed as part of the current round of OMP revisions.

General comments

The best outcomes in terms of the provision of scientific advice for South African marine resource management will occur when all parties involved in the advisory process collaborate fully. The Panel highlights the importance of the continuing involvement of MARAM staff in the DAFF working groups, but also wishes to emphasize the long-term benefits of having DAFF staff more directly involved in technical analyses. The recommendations below identify several areas where the Panel believes that enhanced collaboration among the various scientific groups would be beneficial.

The Panel wishes to re-emphasize the comments by previous Panels regarding the importance of continuing to collect the key monitoring data needed to apply management procedures and construct operating models. Given a consistent approach to risk, the lack of key monitoring data (e.g. surveys indices, catch-at-age and at-length data, etc.) will lead to lower catches. In this respect, the Panel is particularly concerned with suggestions that observer programmes, which include sampling of length-frequency for West Coast rock lobster may be scaled back. This length frequency information is a key input for the rock lobster assessment and provides the primary basis for estimating annual recruitment strength.

¹ Kindly jointly sponsored by DAFF, Branch Fisheries and an NRF award to D S Butterworth; documents reviewed at the workshop may be downloaded from the following website:

<http://www.mth.uct.ac.za/maram/workshops.php>

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The Panel wishes to thank the participants for the (many) well-written documents, clear presentations, rapid responses to requests for further information and data, as well as for the excellent atmosphere which made the review feasible.

A. West Coast Rock Lobster

A. Updated assessments and projections

AA.1 (H). The Panel is concerned that the software used to implement the assessment model on which the operating models will be based may at times be failing to converge to the global minimum of the objective function. At present the analyst is using heuristics to find an appropriate set of initial values for the parameters. However, it is not clear if this is a sufficiently reliable approach given that there are many robustness tests which involve re-fitting the model. Possible ways to overcome this problem include: (a) using several minimization algorithms simultaneously (e.g. simulated annealing to get close to the minimum, followed by another method such as simplex), (b) use of phases in the estimation so that only a sub-set of the parameters are estimated in the initial stages of the minimization (e.g. those which determine the scale of the population are estimated first), and (c) reparameterizing the model so that the parameters are as orthogonal and normalized as possible. Convergence concerns can be explored by starting the minimization algorithm at various initial values.

AA.2 (H). In relation to the specifications of the reference case models, the Panel recommends that: (a) the parameters which determine the rate of decline of growth increment with size for males and females, and the ratios of the expected growth increments for females relative to those for males, should be considered as free parameters of the assessment model [each of these should be introduced in turn in case some parameters are confounded] because this may lead to better fits, and selectivity patterns which are more biological realistic, (b) the current scenarios which admit future increases in somatic growth rates should be dropped from the reference case set and treated as robustness tests, and (c) consideration should be given to adding one of the existing robustness tests into the reference set to capture a wider range of scenarios in this set. [*Assumptions for projecting into the future.*]

AA.3 (H). The set of robustness tests is adequate. There is no need to conduct additional robustness tests where the area east of Hangklip is taken to be a separate area, because indications are that the abundance there relative to the remainder of super-area 8 is small. [*Assumptions for projecting into the future; What are the key robustness tests to conduct?*]

AA.4 (H). Drop any percentage female and length-frequency data as input to the model-fitting procedure for years and gear types for which it has been agreed that the corresponding CPUE data are likely unrepresentative of abundance due to very limited sampling. Examine all percentage female and length-frequency data for which the corresponding sample size is low and develop rules for excluding data for which the sample size is likely too small to provide meaningful information.

AA.5 (H). Refine the basis for the selectivity patterns by starting with simple (and biologically plausible) selectivity patterns and adjust these if needed. The Panel has the following specific recommendations in regard to selectivity: (a) assume that the selectivity patterns for males and females in hoop and trap catches as well as in the FIMS surveys are logistic functions of length, (b) fix the asymptote of the male selectivity functions to one but

estimate the asymptote for the female selectivity patterns, (c) examine if estimation of growth parameters improves diagnostics (e.g. residual patterns), (d) if necessary, allow the selectivity pattern for the FIMS surveys to be domed-shaped (it was observed that a dome-shaped selectivity pattern is plausible for the FIMS surveys given the ability of small, but not large, lobsters to enter traps through the meshes), but ensure that selectivity asymptotes to a non-zero value, and (e) determine the selectivity for sub-legal sized lobsters based on the data for super-area 8 (for which size-composition data for sub-legal sized lobsters are available). [*Selectivity functions – are these acceptable?*]

AA.6 (H). Set rather than estimate survival for females (set the survival rate for females equal to that for males).

AA.7 (H). Focus initial efforts at fitting the model on super-area 8 which constitutes the area from which the largest catches are taken and for which there are data on sub-legal sized animals.

B. OMP Development

AB.1 (*). There are several ways in which flexibility in the TACs around those provided by the OMP can be introduced (see MARAM IWS/DEC10/WCRLB/P2). The impact of carryover / carryunder of TAC (by super-area) from year to year is perhaps the only one of these which needs to be simulated to determine their consequences. In contrast, random differences between the TAC and the catch are unlikely to be consequential when dealing with a relatively long-lived species because the effects will tend to cancel out. In the extreme, if the OMP provides a range instead of a single TAC and decision makers consistently set the TAC to the high end of the range, the effect is equivalent to a management procedure which provides only the high end of the range (and can be evaluated as such).

AB.2 (*). There could be value in developing exceptional circumstance provisions based on socio-economic as well as biological considerations. These need to be carefully considered like any other part of the OMP.

AB.3 (*). The current OMP includes rules which specify the split of the TAC (by super-area) among sectors. This split is needed to conduct the projections to evaluate the performance of candidate OMPs and reflects an attempt to constrain inter-annual variability in catches in different ways for different sectors. The biological outcomes of the projections will, however, be insensitive to changes to the actual split of the TAC among sectors (within a super-area) unless implementation error is such that some splits lead to a consistent difference between the annual TAC and the corresponding catch.

AB.4 (H). The populations in the super-areas must be independent to a non-trivial extent because the trends in abundance for the various super-areas are not the same. The Panel therefore continues to endorse the use of a spatially-structured operating model and reporting of performance statistics by super-area. In addition, the Panel supports continued evaluation of OMPs which provide TACs by super-area.

AB.5 (H).

The bounds on absolute biomass (and productivity) should be chosen to ensure that the results of past reference case assessments fall within the bounds of the new reference set.

AB.6 (H). The extent of implementation error (the relative difference between the catch and the TAC) should be estimated by sector and super-area, and incorporated into the operating models.

B. Penguins

B.1 (*). The Panel highlights the considerable value of collaboration among scientists with a diverse range of skills. In the specific case of penguins, the best outcomes will occur when modellers, population ecologists, penguin specialists, and pelagic species specialists all collaborate to ensure that models are realistic biologically, and the appropriate data are available and cleaned.

B.2 (*). The recommendations outlined below require the availability of several data sources which are not currently included in the models. The Panel highlights the importance of providing these data to the modellers as quickly as possible, if key deadlines for OMP development are to be met. In addition, it is important that any data included in the model be fully documented to ensure that the data are analysed appropriately.

A. Models of the impact of fishing on penguins through reducing overall prey abundance

BA.1 (H). Some of the annual moult counts (and hence the proportion of juvenile birds at the time of moult counts) have estimates of associated precision (e.g. MARAM IWS/DEC10/PA/P4). These measures should be used to weight the data in the likelihood function. There will likely be sources of uncertainty not captured by these measures of precision which should be accounted for (if necessary) using an “additional variance” term. [*Consideration of basic model structure and Bayesian estimation procedure proposed.*]

BA.3 (H). The tagging data should be included explicitly in the likelihood function along the lines of MARAM IWS/DEC10/PA/P3. These data have the potential to reduce the uncertainty associated with estimates of survival and should tighten the relationship between survival and measures of sardine and anchovy abundance. Moreover, use of the tagging data will provide a link with previous work, e.g. by Altwegg⁵. Implementation of this recommendation will require access by the MARAM analysts to all of the available tagging data. Altwegg and the MARAM analysts should collaborate to identify an appropriate set of specifications for how the tagging data are to be included in the likelihood function (i.e. whether a separate survival term is to be estimated for the first year after tagging, whether some parameters are to be shared between Dassen and Robben Islands, etc.) Inclusion of the tagging data should reduce the number of point estimates of survival rate which end up at the upper bounds for their priors. [*Extension of model to incorporate further penguin-related data (e.g. tag-recapture).*]

BA.4 (H). Penguin biologists should identify a set of hypotheses to relate specific measures of sardine and anchovy abundance/density (temporal and spatially aspects) with population processes for penguins (ideally fledging success, juvenile survival, age-at-first breeding, and adult survival). An attempt should then be made to identify whether there are data that could be used to quantify these measures of abundance/density. In cases in which data do not currently exist to quantify the measures, collection of such data should be identified as a

⁵ Altwegg R. 2009. Survival of African penguins at Robben and Dassen islands from 2002 to 2006. *MCM/2009/SWG-PEL/16*: 11–17.

research priority. [*Extension of model to incorporate further penguin-related data (e.g. tag-recapture).*]

BA.5 (H). The uncertainty in the biomass trajectories for sardine and anchovy should be accounted for when evaluating the relationships between penguin demographic parameters and sardine/anchovy abundances. This can be achieved by (a) selecting a small number (e.g. 10) of sardine and anchovy biomass trajectories from the posteriors estimated using the sardine and anchovy assessment models and using these trajectories as input data to the penguin model, with application of the Markov Chain Monte Carlo (MCMC) algorithm conditioned on each of the trajectories, (b) selecting a representative number of parameter vectors for the penguin model from each of the MCMC chains to construct the parameter vectors for the penguin model, and (c) basing the inferences regarding the impact of alternative OMPs for anchovy and sardine on these parameter vectors.

BA.6 (H). The credibility of the work will be considerably enhanced by further simulation testing. The initial simulations conducted (MARAM IWS/DEC10/PA/P7) suggest that there is little bias if there is no model-misspecification. However, the only source of variability included in these simulations was that associated with the moult count data. The Panel have the following recommendations in regard to simulation testing: (a) consider further simulations in which there is an impact of sardine and anchovy on the dynamics of the penguin population via, for example, impacts on fledging success, participation in, and age-at-first, breeding, juvenile survival and adult survival even if the current model suggests that this is not the case, (b) allow for error when measuring the covariates related to sardine and anchovy abundance, and (c) generate values for the random effects for survival and reproductive success. The distributions of estimates for key parameters (e.g. μ_S and μ_H) from the simulations should be compared with those from the posteriors based on the actual data. The distributions for estimates of the impact of reduced pelagic fish catches on future penguin population trends should be similarly compared. [*Simulation testing of estimation process.*]

BA.7 (H). As currently formulated, fledging success and juvenile survival are lumped in a single time-varying parameter. This is appropriate given that the data used in MARAM IWS/DEC10/PA/P6 would not allow these processes to be distinguished. However, there are data to inform some of the processes involved in reproduction. Figure 1 outlines the penguin dynamics, which biological processes impact the various life stages, and the data available for each process / life-stage. The Panel recommends: (a) modelling fledging success and juvenile survival as separate processes, (b) including the data on fledging success [initially as relative indices but as absolute measures in sensitivity tests], on total nest counts, and on juvenile survival rates from tag-recapture data in the likelihood function, (c) including relationships between fledging success and juvenile survival and measures of sardine and/or anchovy abundance in the model, (d) calculating the rates of immigration based on the differences between the estimated annual number of age-1 animals and the numbers expected given the number of breeders, the fledging success rate, and the juvenile survival rate (c.f. MARAM IWS/DEC10/PA/P5). In the longer term, models could consider participation in, and age-at, first breeding (see below). [*Consideration of basic model structure and Bayesian estimation procedure proposed; Extension of model to incorporate further penguin-related data (e.g. tag-recapture); Incorporation of immigration effects.*]

BA.8 (L) Consideration should be given to the use of juvenile tagging data to estimate migration rates independently.

BA.9 (H). The Panel expects that many model runs (e.g. based on different density-dependence assumptions, relationships between population processes and measures of sardine and anchovy abundance, etc.) will be conducted. It highlights the need to assign weights to the different models using objective approaches. For example, the model-estimates of immigration can be validated using inferences based on trends at Dyer Island. In addition, models in which parameter estimates hit biologically-based bounds should be downweighted. [*Specification of robustness tests, particularly as regards the functional form of the penguin parameter-fish abundance relationships.*]

BA.10 (H). The survival and reproductive success parameters should be assumed to be beta-distributed. [*Consideration of basic model structure and Bayesian estimation procedure proposed.*]

BA.11 (H). With regard to moult counts, the current estimation method is treating the moult counts for Robben Island as absolute (with a known bias). The Panel supports this assumption. In regard to Dassen Island where an appreciable proportion of the population is not covered in the moult counts, the Panel recommends that these counts be treated as relative counts, and that sensitivity be evaluated with respect to different assumed values for the constant of proportionality. In very recent years, there is evidence of substantial numbers of penguins from these two colonies moulting at locations further south before returning to these colonies to breed; the Panel recommends that moult counts for this period be omitted when fitting the model.

BA.12 (H). Standard diagnostics for MCMC analyses (e.g. Gelman-Rubin R, Geweke statistic, trace plots for multiple chains, etc.) should be provided for the final reference case model(s). MCMC diagnostics should be provided for parameters and derived variables. [*Consideration of basic model structure and Bayesian estimation procedure proposed.*]

BA.13 (H). The sensitivity of the model results to different assumptions regarding the age-at-first-breeding, including ogives relating the probability of first breeding with age, should be examined in tests of sensitivity. Such assumptions should, at least initially, assume time independence, given the technical complexities of incorporating such possible dependence. [*Consideration of basic model structure and Bayesian estimation procedure proposed.*]

BA.14 (L). Data on time-trends in age-at-first breeding should be collated and analysed for incorporation in the model. Care needs to be taken when analysing these data to account for the probability of missing the first time an animal breeds. [*Extension of model to incorporate further penguin-related data (e.g. tag-recapture).*]

BA.15 (L). A model which includes multiple Western Cape colonies should be developed. [*Extension to multiple Western Cape colonies.*]

B. Consideration of analyses related to the impact of pelagic fishing close to breeding colonies

BB.1 (*). The Panel considered how open/closure alternatives should be implemented in the near future with the objective to maximize the probability of determining whether pelagic fishing near colonies has an impact on penguins. In regard to this question, the Panel drew the following conclusions:

- 1) Within the current set of models, the ability to estimate the extent of additional (residual) variance will not be impacted by which islands are open or closed to fishing.

- 2) There is no reason not to start opening closed islands and closing open islands in the short term because doing so will allow data collected from the feasibility study to be part of the experiment (in the event an experiment is conducted) and hence reduce the time needed to draw conclusions.
- 3) Keeping islands closed (or open) for three-year periods is appropriate to balance two conflicting goals: (a) maximizing contrast and hence minimizing the confounding between treatment effects and the impact of long-term trends in environmental conditions by changing the closure status annually, and (b) allowing use of indices of penguin dynamics which might be impacted by fishing effects in previous years by not changing closure status over a long period of time.
- 4) A power analysis to decide on whether a full experiment should take place can be conducted at any time, but its reliability will be greater (particularly for new indices) in the future (see Table 1).
- 5) Monitoring of penguin populations and pelagic fish abundance (the latter ideally through an enhanced programme of surveys in the neighbourhood of key penguin colonies at regular intervals during the penguins' breeding period) is vital to an effective experiment.

Table 2 lists the implications of these recommendations in terms of which islands would be open and closed to fishing from 2011 onwards. [*What open/close alternation (if any) scheme within each colony pair might be most appropriate, and what interval for alternation should be considered (single or multiple year periods)?*]

BB.2 (H). The presented analyses related to power are based on two indices only: fledging success and breeders per moult count. The ability to improve the estimates of the additional variation in the indices will be greatest for those indices which have not been monitored in the past (see Table 1 for an estimate of the extent to which three additional years of data will impact the standard deviation of unexplained variation in fledging success and breeders per moult). To the extent possible, the types of analyses on which MARAM IWS/DEC10/PB/P2 are based should be extended to other indices. [*Can methods put forward to estimate experiment power be improved?*]

BB.3 (H). Models relating indices of penguin dynamics to measures of sardine and anchovy abundance should consider the biomass at the local level as a potential covariate (perhaps expressed as density to compare or estimate jointly effects for Robben and Dassen Islands). In addition, the GLM model used to estimate additional variation should include biomass as a covariate and a random year factor, evaluated in a stepwise manner. [*What alternative GLM (or other) model formulations, including ones with multiple dependent variables, might be considered to analyse results from the experiment of opening and closing to fishing around pairs of penguin colonies?*]

BB.4 (H). Examine the relationship between sardine and anchovy local abundance estimates from surveys around island colonies and the recruitment and spawning biomass surveys (this relationship may need to be used if only an incomplete set of local estimates of abundance are available).

C. Data-Poor Generic Management Procedures

C.1 (*) The Panel finds that the Southern Hemisphere Collaboration initiative will strengthen the already strong South African management procedure development and implementation process by pooling experience of the management procedure approach for data-poor fisheries. In particular, the meeting was advised that CSIRO (Australia) have received FAO funding to

develop guidelines for the development and testing of management procedures. South African and New Zealand participants in the Collaboration should provide peer-review for any resulting document. [*Suggested initial Southern Hemisphere Collaboration initiatives; Development of guidelines for development and testing of management procedures*]

C.2 (*) A Wiki site should be established to provide a means to share documents, results and methods. The Wiki site should allow participants in the Collaboration to record comments on the work presented and suggestions for additional analyses. [*Suggested initial Southern Hemisphere Collaboration initiatives*]

C.3 (*). The Panel supports collation of information on the biological parameters (and measures of their uncertainty) which will form the basis for future evaluation of generic management procedures. Information available from local sources as well as from databases such as RAM II and Fishbase should be collated. Data on the uncertainty associated with monitoring data should be also be collated to the extent possible.

C.4 (*). The Panel sees considerable value in evaluating the performances of the approaches used in practice for providing management advice using simulation. This is because MSE analyses have shown in the past that approaches which *a priori* may seem likely to perform adequately given their construction, sometimes perform very poorly.

C.5 (*) Consideration should be given to the use of a tier system in which stocks are assigned to tiers based on data availability and where there are “discounts” for uncertainty for stocks in lower tiers to ensure that comparable risk levels are afforded by the different management procedures independently of the uncertainty involved. In addition, discounting for uncertainty should prevent “tier shopping” and provide incentives for the collection of better data. The system needs to include rules for how a closed fishery may be reopened.

C.6 (*) In addition to a tier system based on uncertainty levels, it is important to recognize that data-poor fisheries may differ markedly over a number of axes: (1) the biology of the species (e.g. degree of movement, recruitment patterns, etc.), (2) the type of fishery (multiple gears, commercial versus recreational, etc.), (3) the type of data that may be collected to inform an OMP and their information content, and (4) the types of management controls that are realistic (e.g. TACs, effort controls, size limits, etc.). Different categories of fisheries will pose different types of problems to be addressed with different tools. While the Panel sees merit in the investigation of generic approaches, some categorization of fisheries will be necessary to tailor the OMP evaluation to specific kinds of fisheries and management frameworks.

C.7 (*). If mean length is to be used as a part of an OMP, considerable data analyses need to be undertaken to evaluate how much mean length is likely to change in actual stocks in response to fishing, given the potential impact of effects such as gear changes and spatial factors, and that expected changes in response to fishing have sometimes not occurred in actual populations.

C.8 (H). The first steps in evaluating generic management procedures for data-poor fisheries off South Africa should focus on two categories of fishes: (a) reef-associated linefish, and (b) species caught during inshore demersal trawling. The first category should involve extensive collaboration with the DAFF linefish section scientists and focus on the types of uncertainties and possible control measures most pertinent to fisheries for reef-associated fish (e.g. effort controls, spatial heterogeneity, infrequent changes in management arrangements). Involvement of the analyst in the relevant DAFF working group should help to ensure that

the operating models are realistic for the problem concerned. The current work (MARAM IWS/DEC10/DPA/P2) provides an excellent start on addressing several of the types of issues pertinent to the second category. [*Primary candidates for application amongst local fisheries.*]

C.9 (H). Further work on the approach of MARAM IWS/DEC10/DPA/P2 should report results for different fixed values for steepness, not just averages or summaries across all steepness values. At a minimum, sensitivity needs to be explored to the implications of multiple fisheries (particularly with respect to using mean length as a part of an OMP), as well as temporal autocorrelation in recruitment.

C.10. (H). Given that it may be impossible to allocate data-poor stocks to even broad ranges of depletion, it is necessary to identify OMPs which perform adequately over a broad range for depletion. This also applies to several other biological parameters so it is important that OMPs work reasonably in quite general settings, even though, as noted above, they cannot be made completely generic.

C.11 (H). An initial step in the process of evaluating OMPs for linefish species is to assemble a table for each species containing the following information: (a) available monitoring data (length, CPUE, catch, density, etc.), (b) available biological information, (c) existing management measures and the frequency with which they are changed, and (d) species caught with the species under consideration.

C.12 (H) Meta-evaluations across sets of biological parameters are useful to develop robust OMPs. When evaluating procedures specifically for linefish, it must be ensured that these evaluations are based on prior distributions which correspond well to parameters for linefish, and that the operating models capture some of the key characteristics of these fisheries (e.g. spatial heterogeneity).

D. Sardine-Anchovy OMP Revision

D.1 (*) The approach outlined in MARAM IWS/DEC10/S/P1 is an appropriate way to handle situations in which future survey data are not available. This approach is similar to that applied in other jurisdictions (e.g. historically for capelin off Iceland). [*How do we best calculate the TAC if abundance estimates from the most recent hydroacoustic survey, upon which computations are highly dependent, are unavailable (e.g. because of a survey vessel breakdown)?*]

D.2 (*) The management procedures for the 2011 sardine-anchovy OMP should be tuned to risk measures in a similar manner to OMP-2008. However, the tuning should be based on an integral from a percentile of 0.05 to the median because this should be a more robust approach. [*How do we best calculate the risk to the resources, which is used to tune the OMP?*]

D.3 (H). The operating models on which the 2011 sardine-anchovy OMP revision will be based should include one set in which it is assumed that there is a single stock off South Africa and another set in which it is assumed that there are two stocks (east and west). This is because there is sufficient biological evidence (separate spawning sites and morphometrics) to justify consideration of a two-stock operating model. [*How do we best determine relative plausibility for alternative sardine stock structure hypotheses?*]

D.4 (H). The results for the single- and two-stock operating models should not be pooled, but rather examined separately because the results of these two classes of operating model may

be qualitatively different. [*How do we best determine relative plausibility for alternative sardine stock structure hypotheses?*]

D.5 (H). Management procedures which treat the entire South Africa sardine population as a single management unit should be considered as well as management procedures incorporating spatial structure which explicitly allow for two stocks (even if there is only one stock in the operating model). Comparison of the results from these two sets of management procedures could be used to estimate the value of resolving uncertainty regarding stock-structure.

D.6 (H). The approach used previously to generate future sardine recruitment (i.e. a stock-recruitment relationship with the estimates for 2000-2004 ignored) should be used to develop the 2011 sardine-anchovy OMP. The stock-recruitment relationship for anchovy should be based on fitting a curve to all of the available data points because there is relatively weak support for the possibility of a regime-shift change in the stock-recruitment relationship. [*How do we best model recruitment and its variability in the future for both sardine and anchovy?*]

D.7 (M). The performance of management procedures which treat the entire South African sardine population as a single management unit until data collected during monitoring (e.g. survey estimates and age data) suggest that there are two stocks should be examined.

D.8 (M). Migration rates between the two putative stocks, and the life stages at which migration occurs, should be estimated. Otolith microchemistry is probably the most feasible way to obtain these estimates. [*How do we best determine relative plausibility for alternative sardine stock structure hypotheses?*]

D.9 (M) Management procedures in which a greater proportion of the anchovy TAC is allocated for the first part of the season should be examined as this may provide a means to reduce undercatch of anchovy. The trade-off between anchovy and sardine catch should be quantified to evaluate the impact of trying to reduce this undercatch. [*How do we best account for implementation uncertainty in the OMP, particularly as regards likely undercatch of anchovy?*]

E. Hake – potential impact of MPAs

E.1 (*). MPAs may impact the ability to provide fishery management advice (e.g. through changes in catchability) as well as have economic impacts on a fishery. These impacts depend on the size and placement of the MPAs as well as the life history strategies of the species being caught (e.g. sedentary, viscous or highly mobile). The impact of MPAs on the productivity and CPUE of the hake fishery will likely be less than would be the case for species that do not move as extensively. However, evidence elsewhere does not provide a basis to determine specific sizes / locations at which MPAs will have a “substantial” impact on the CPUE for the hake fishery. [*In what ways have MPAs elsewhere influenced fishing fleet behaviour and how has CPUE been affected? What sizes/locations of MPAs are likely to have a non-trivial impact on CPUE?*]

E.2 (*) Analyses to evaluate the potential impact of MPAs on the CPUE indices and hence the OMP for the hake fishery should await clearer specifications of the MPAs planned to be implemented off South Africa (placement and size). Decreases in catchability are more likely than increases. Advice provided to the Panel suggests that future MPAs are likely to be placed so as to be representative of various habitats, and account will be taken of existing

fishing grounds. [*What are appropriate robustness tests to evaluate the potential impacts on the new hake OMP of the introduction of offshore MPAs?*]

E.3 (*) Management procedures which split the CPUE series when the MPAs are implemented and attempt to calibrate the CPUE indices before and after MPA implementation should be considered if management procedure variants are to be developed for scenarios in which MPAs lead to (potential) changes in the relationship between CPUE and abundance. [*How is this OMP appropriately retuned to adjust for the impact of MPAs on CPUE, and what are the implications for performance statistics?*]

Table 1: For the index time series already available for monitoring the impact of pelagic fishing near to colonies on the reproductive success of penguins, 95% confidence intervals for the parameter estimate of the standard deviation of the error together with the available data, as well as CIs that would be obtained with three extra years of data given that the point estimate remains the same.

Fledging success		Breeders per moulters ratio	
$\hat{\sigma}_e = 0.182$	95% CI	$\hat{\sigma}_e = 0.209$	95% CI
df = 4	(0.109; 0.523)	df = 11	(0.148; 0.355)
df = 7	(0.120; 0.370)	df = 14	(0.153; 0.330)

Table 2: Specifications for which islands with penguin colonies should be closed (X) and open () to fishing under the approach recommended.

	2008	2009	2010	2011	2012	2013	2014
Dassen	X	X					X
Robben				X	X	X	
St Croix		X	X	X			
Bird					X	x	X



Figure 1. Outline of the dynamics of breeding and juvenile survival.

Appendix 1

Key Issues to be discussed at International Fisheries Stock Assessment Review Workshop

West Coast Rock Lobster

Updated Assessments and Projections (A sessions)

- How do these compare with previous assessments?
- Selectivity functions – are these acceptable?
- What are the key robustness tests to conduct?
- Assumptions for projecting into the future:
 1. Somatic growth (is a future increase still plausible?)
 2. Recruitment
- What are key focus areas for future research?

OMP development (A and B sessions)

- Summary of past OMPs and management targets
- Where are we now w.r.t. resource recovery levels
- Where do we want to go – what are appropriate management targets?
- How should OMP take implementation error (particularly as regards takes in sectors effectively under effort control, and for which the resource monitoring data are of poorer quality) into account?
- Should a model-based OMP be retained, or move to an empirical OMP? If the latter, should estimates of recent catches be included?

Management Related Issues (B sessions)

- Should we continue to manage at a spatial level?
- Should OMP continue to split global TAC not only into five super-areas, but also into different user groups? Pros and Cons.
- How might the OMP be adjusted to provide more flexibility, and what would be the associated “costs”?

Penguins

Models of the impact of fishing on penguins through reducing overall prey abundance (A sessions)

- Consideration of basic model structure and Bayesian estimation procedure proposed
- Simulation testing of estimation process
- Treatment of estimates close to demographic constraint boundaries
- Specification of robustness tests, particularly as regards the functional form of the penguin parameter-fish abundance relationships
- Extension of model to incorporate further penguin-related data (e.g. tag-recapture)
- Specification of priors
- Incorporation of immigration effects
- Extension to multiple Western Cape colonies

Consideration of analyses related to the impact of pelagic fishing close to breeding colonies (B session)

- What alternative GLM (or other) model formulations, including ones with multiple dependent variables, might be considered to analyse results from the experiment of opening and closing to fishing around pairs of penguin colonies?
- What open/close alternation (if any) scheme within each colony pair might be most appropriate, and what interval for alternation should be considered (single or multiple year periods)?

- Can methods put forward to estimate experiment power be improved?

Data-Poor Fisheries Generic Management Procedures

Generic issues and Southern Hemisphere (Aus, NZ & SA) Collaboration aspects

- Testing of generic MPs – appropriate choices for operating models, candidate procedures and performance statistics
- Development of guidelines for development and testing of management procedures
- Development of a database of resource parameters and monitoring indices with their key statistical properties (e.g. variances and autocorrelation)
- Suggested initial Southern Hemisphere Collaboration initiatives

Potential local application particularly to line fisheries

- Primary candidates for application amongst local fisheries
- Potential associated monitoring indices for associated management procedures
- Best methods to obtain index data: surveys *vs* observers *vs* skippers.

Sardine-anchovy OMP revision

- How do we best model recruitment and its variability in the future for both sardine and anchovy?
- How do we best account for implementation uncertainty in the OMP, particularly as regards likely undercatch of anchovy?
- How do we best calculate the TAC if abundance estimates from the most recent hydroacoustic survey, upon which computations are highly dependent, are unavailable (e.g. because of a survey vessel breakdown)?
- How do we best calculate the risk to the resources, which is used to tune the OMP?
- How do we best determine relative plausibility for alternative sardine stock structure hypotheses?

Hake OMP - potential impact of MPAs

- In what ways have MPAs elsewhere influenced fishing fleet behaviour and how has CPUE been affected?
- What sizes/locations of MPAs are likely to have a non-trivial impact on CPUE?
- What are appropriate robustness tests to evaluate the potential impacts on the new hake OMP of the introduction of offshore MPAs?
- How is this OMP appropriately retuned to adjust for the impact of MPAs on CPUE, and what are the implications for performance statistics?

Miscellaneous

Humpback whale modelling - how best to handle Borel paradox problems

- Recently specified models for the west African humpback stock complex are hitting genetic constraints on minimum population abundance; how are priors on biological parameters best sampled to deal with the resultant instance of Borel's paradox?

Estimator robustness to account for the impact of year-dependent selectivity variations on catchability q

- How might the “spatial” operating model proposed to lead to apparent temporal changes in selectivity be improved?
- What are the most appropriate performance statistics to consider in comparing the performance of alternative estimators for standardising for q ?