NRF - MCM STOCK ASSESSMENT WORKSHOP
30 November - 4 December 2009, UCT

INTERNATIONAL SCIENTIFIC REVIEW OF ASSESSMENTS OF THE SOUTH AFRICAN HAKE AND ABALONE RESOURCES

Summary Remarks by External Panel (A E Punt, A D M Smith (Chair) and G Stefansson)

The External Panel reviewed the assessments of the South African hake and abalone resources against the terms of reference for the workshop. Additional general remarks follow the summary remarks against the terms of reference. More detailed technical recommendations (which include also some comments regarding sardine and penguin analyses which were also discussed during the workshop) are given in Appendix 1.

Hake Stock Assessment and OMP Development

There were two terms of reference for the hake stock assessment and OMP development:

1) *Consideration of refined assessments of the hake resource, leading to recommendations for final conditioning of Operating Models for revised OMP testing, currently scheduled to be achieved in January 2010*

In reviewing the new reference case hake assessment, which incorporated gender-disaggregation and fitting directly to conditional age-at-length data as recommended by a similar review in December 2008, an error was detected in the computer code used to implement the assessment. As this was only discovered late in the workshop, there was insufficient time to revise and update the assessment for further review. Specific comments on the assessment, which apart from the coding error, conforms to a high international standard, are included in the detailed technical recommendations of this report. The Panel generally endorses the suggested specifications for the reference set and robustness tests for the OMP development (Appendix 2), noting that the number of combinations in the reference set will have to be reduced substantially in the interests of implementation practicality, and that the final selection depends on finalising the development of the new reference case.

2) *Consideration of subsequent aspects of the OMP revision process, currently scheduled for completion in August 2010, leading to the provision of advice in that regard*

The decision on whether empirical or population model-based rules are used in the OMP should be determined pragmatically and on the basis of performance. There is merit in exploring a (limited) set of alternative empirical rules, over and above those used in OMP2006, including rules that incorporate targets and/or progress in achieving targets. Concerns over inappropriate control responses arising from outliers in empirical data could be addressed in several ways, including use of robust regression methods. Where possible, performance against implicit economic objectives (such as increases in CPUE) should be measured against performance statistics that capture the intent of the objective. The Panel suggests that selection of performance statistics take into account international norms with regard to target and limit reference points, risk standards, and recovery times.

Abalone Stock Assessment and Management Advice

There were two terms of reference for the abalone assessment, the first of which included 6 specific issues:

1) *Comment with regard to the assessment of the abalone resource in Zones A-D on the following:*

   a) *the appropriateness of FIAS (Fishery Independent Abalone Survey) design to provide reliable time series of indices of abundance;*

The Panel noted that the FIAS is a fairly standard method for obtaining abundance indices for species such as abalone and is largely appropriate. However, it must also be noted that the FIAS covers only a portion of the distribution of abalone in the various zones. This portion is principally the shallow (0-5m depth) waters containing a higher proportion of smaller abalone. This needs to be accounted for when these data are analysed and interpreted.

   b) *the reliability of the estimates of the time series of illegal removals by poachers;*

The estimated time series of illegal removals by poachers is a time series of model-based estimates which can be obtained due to the availability of data on confiscated catches as well as policing effort which, in combination, provide indices of poaching levels. It is not customary to estimate such outputs in fishery stock assessments, and difficulties of estimating catches are well-known. In this case estimation of removals is made feasible through the index of (illegal) catches that is available and the contrast in indices of abundance, and as such the methodology appears quite reasonable. Some measures of uncertainty in these indices are available. These measures should be carried through into projections in order to indicate the effects of this uncertainty on stock trends. Such measures are conditional on several assumptions and are almost certainly underestimates of the true uncertainty involved.

   c) *the reliability of the estimates per Zone provided of current abundance relative to pristine*;

The estimates per Zone provided of current abundance relative to pristine are robust to some important assumptions such as the weight given to the CPUE index which would be expected to be a primary driver in the estimated relative abundance. The extensive size-composition data also provide some evidence about levels of depletion. The availability of the fishery-independent abalone survey data in shallower water (FIAS) leads to greater confidence in the estimated state of the near-shore part of the population.

d) whether and if so how the model might need to be adjusted to take account of a possible Allee effect on abalone recruitment at low densities;

A depensation[1] effect on abalone recruitment at low densities is a plausible scenario and should be evaluated by including a critical depensation effect in sensitivity tests which includes this effect, but which is also consistent with the observation that this resource has recovered from an earlier decline caused by fishing which focused on the larger animals (rather than essentially all sizes as would be the case for catches due to illegal fishing). This observation sets bounds on where an Allee effect might occur, and existing information on plausible densities corresponding to such effects available for the South Australian greenlip abalone resource may be used when specifying the sensitivity tests. Current abundance levels estimated in Zones A and B are above the level of critical depensation derived from the South Australian study.

e) the reliability in the short term of the model as a basis to predict the likely consequences for the resource under different possible levels of future legal and illegal takes, and any immediate model adjustments that might be desirable to improve this reliability and practical to implement on a short time scale;

As it stands, the model is a reasonable approach to include important processes in the system and use available data. Naturally there are potential improvements to the model and data sets. For example, the model uses an internal stock-recruitment function to generate recruitment. Although this is tuned to existing data sets, it is no substitute for actual measurements on recruitment in the form of a recruitment index, which should both have a stabilizing effect on model estimates and provide much better information on the status of the stock with respect to possible recruitment failure. Repetitions of the 2002 joint industry-MCM extractive survey which included sampling of the small (>15mm shell length) abalone would be useful in this respect.

f) the reliability in the medium term of the model as a basis to predict the likely consequences for the resource under different possible levels of future legal and illegal takes, and any model adjustments that might be desirable to improve this reliability.

This reliability would be considerably enhanced with the availability of a fishery independent survey in deeper waters.

2) Comment on the appropriateness of the existing decision rules used to provide catch limit advice for the data-poor Zones E, F and G.

The Panel noted the approach taken, but was not able to undertake a technical review given the information and time available.

General Remarks

The Panel noted that approaches used internationally for stock assessment range from use of standard software (such as SS3, CASAL, and GADGET) to case-specific

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[1] Defined as the per-capita recruitment rate dropping with reductions in spawning biomass. Critical depensation occurs when recruitment is less than losses to natural mortality.

models and code. The Panel generally endorsed the latter approach, particularly where there are non-standard features of the dynamics or data as is the case for the assessments of the major South African fisheries including hake and abalone, but notes that the benefits also come at a potential cost. This includes the potential for coding and other errors. Potential solutions such as independent coding of parallel assessments add to the expense and may not be affordable in all situations, but at least independent checking of code should be undertaken.

The workshop discussed difficulties associated with data management. The Panel noted that such problems are widespread internationally. While they are expensive to fix near-completely, it is crucial that steps are taken in South Africa to ensure substantial improvements. A first step would be to develop a data strategy, including appointment of a scientific data manager, with appropriate resources. The Panel re-emphasised the recommendations from past reviews of the need to fully document data used in assessments.

Finally, the Panel noted that the material provided to the workshop was once again extensive, well-written, and well-organized, which facilitated the review process. The Panel also expressed its appreciation to the participants many of whom conducted additional analyses during the workshop to address queries raised by the Panel. In this respect, the Panel recognized in particular the considerable work undertaken by Rebecca Rademeyer who was tasked with making major changes to the assessment method for hake and then conducting a large number of assessment runs at very short notice. Having rapid responses to queries allowed the Panel to identify key recommendations for future work. While some of the extra work arose from issues identified during the workshop, the Panel noted that the need for extra work also arose from late provision of data, and noted the benefits of ensuring timely delivery of data well prior to such analyses and reviews.

Appendix 1 : Specific Research Recommendations

A. Hake

The items indicated using asterisks should be completed for the current hake OMP revision (although ideally as many recommendations as possible should be completed). Items indicated by ampersands are revisions (or repeats) of recommendations from the 8-12 December 2008 workshop.

General

A.1. Stock structure for both hake species remains uncertain and several hypotheses are available. The Panel recommends that (a) the biologists developing stock structure hypotheses should integrate their work more closely with the modellers to ensure that these hypotheses can contribute to future OMP evaluations, and (b) the current development of “box models”, which could form the basis for a spatially-structured assessment and better represent alternative stock structure hypotheses, should continue and be extended. The aim of collaboration between modellers and biologists should be to better specify and reduce the set of scenarios to be modelled and to identify methods for testing postulated stock structure hypotheses.

Data-related

A.2. The data from on-board observers could provide the basis for estimating the species- and sex-split of the hake catch. However, the sampling design for these data is at present not specified to provide design-based estimates of the sex-split of the catch. This data collection should be continued and expanded. The sampling design should be refined so that design-based estimation methods can be applied.

A.3[&]. The description of the basis for how the age and length data are collected from surveys and the commercial fishery needs to be finalized.

A.4[*]. The age-composition data used in the assessment should be restricted to one reading only for each otolith. The use of all readings will lead to double-counting of the age estimates for those otoliths which have been read twice.

A.5[*]. The age-composition data appear to contain outlying observations. Unfortunately, the likelihood function used to include these data in the assessment does not account well for outliers. The age-composition data should be reviewed, criteria for identifying outlying observations should be developed, and any outlying observations removed from the data set.

A.6[*]. Further analyse the observer data (e.g. using the data to estimate sex-ratios by area and depth-class and weighting these sex-ratios by the catches by area and depth-class) as a basis to evaluate the model predictions of catch sex-ratio.

A.7. Examine the age reading data to assess how often one reader can assign an age to an otolith when another reader cannot. Use these data to estimate the age-specific probability that an otolith in a given length-class cannot be read. If a significant effect is found, the likelihood function may need to be adjusted to account for this second form of age-reading error.

A.8. Estimate the relationship between maturity and length using a non-linear mixed effects model.

A.9[&]. A study to relate survey catch rates to environmental variables should be undertaken with a view to reducing the coefficients of variation for the survey estimates.

A.10[&]. The existing data on histology should be used as the basis to fit a logistic curve relating maturity to age and length. This curve should be included in future assessments.

A.11[&]. The data from longline sampling could be used to estimate differences in density and age-structure between trawlable and untrawlable areas.

Model-related

A.12[*]. The reference case set of models should (a) define the fully-selected fishing mortality for each fleet based on the age-sex combination for which selectivity is highest for that fleet, (b) estimate the length-at-age standard deviations as a linear function of expected length, and (c) base male spawning biomass on the maturity ogive estimated for males and not that estimated for females.

A.13[*]. The assessment is based on modelling dome-shaped selectivity using the combination of a logistic curve and a declining exponential function. Consider alternative formulations for dome-shaped selectivity, such as the double-logistic or the double-normal as the basis for the right-hand side of selectivity curve.

A.14[*]. The model does not fit the recent catch-rate indices particularly well. Consider a sensitivity test in which the weight assigned to recent catch-rates is increased substantially.

A.15[*]. Assumptions regarding error models for the conditional age-at-length and the length-frequency data in the likelihood used to fit the population model will always be approximations. Uncertainty about the appropriate error model should ideally involve a detailed examination of residuals and raw data. However, changing the weights (increasing / decreasing substantially) and tabulating the impact of management quantities and the likelihood components for other data sources is often sufficient.

A.16[*]. The plots provided to the workshop to evaluate whether the model fits the conditional age-at-length data are uninformative. Develop alternative approaches to assess whether there are systematic patterns in the fits to the age-at-length data, for example, based on the expected and observed age-at-length by length-class, fleet and sex.

A.17. Re-evaluate the assumed error model for the length and conditional age-at-length data by (a) evaluating the covariance structure of the residuals, and (b) analysing the raw data on which the compositions are based (see, for example, Hrafnkelsson and Stefansson (2004) [CJFAS 61: 1135-2]).

A.18[*]. Estimate management reference points (such as B_{MSY} and population size relative to B_{MSY}) by sex. The Panel notes that standard practice for marine fisheries assessment (with some exceptions such as for protogynous hermaphrodites) is to define management reference points in terms of female spawning biomass (as a proxy for reproductive output). A recent average of fishing mortality by fleet should be used to determine the relative fishing mortality by species, fleet, and age when calculating management reference points.

A.19*. Fishing strategies may change with the implementation of no-take Marine Protected Areas (MPAs) depending how large they are, and where they are located, and this may impact the relationship between standardized catch-rates and abundance. Examine the robustness of the performance of any OMPs to scenarios in which there are no future CPUE data and in which a new CPUE series starts following the implementation of MPAs (both with and without an associated prior on the extent of change in catchability) as a measure of the one of the potential costs of MPAs.

A.20*. Include a maximum fishing mortality rate to mimic the limits on fishing effort.

A.21*. Examine the robustness of the performance of any OMPs to: (a) changes in discarding rates, and (b) scenarios in which it becomes possible to target (i) the different hake species, and (ii) each sex.

A.22*. Evaluate the benefits (or otherwise) of using partial CPUE data for the year before that for which a TAC is to be set by evaluating an OMP variant which uses such data.

A.23. Link the length-at-age standard deviations for ages 0 and ages 1+ using a functional form to avoid the current discontinuity.

A.24. Repeat the exploration of the reasons for the relative depletion of the two species using the gender-disaggregated model. The model used in these analyses should include catch data, pre-specify natural mortality and selectivity, and set the recruitment deviations to 0. The approach taken in HP/1 examines the impact of data on depletion levels, but not structural factors, so include the choice of the year in which the 50% of the catch is *capensis* / *paradoxus* in the analyses. Also, consider how the slopes of the selectivity curves impact the estimates of depletion, and whether the length/age data are sufficient to estimate selectivity slope parameters for all fleets and species.

A.25. Consider conducting a sensitivity test in which the choice of which age reader is considered to be unbiased is changed.

A.26. Estimate the age-reading error matrix parameters simultaneously with those of the population dynamics model.

B. Abalone

B.1. One cause for an Allee effect is density dropping below a “threshold” level. However, density should not be computed over the range of the species to assess whether this is occurring, but rather at a local level. Analyse the FIAS data to estimate trends in the fraction of the abalone which are found in “aggregations”. Show results for different definitions of an “aggregation” (e.g. density > 0.1m^{-2}, 0.2m^{-2}).

B.2. Further review the software on which the estimation method is based to identify why convergence to local minima is occurring and then recalculate the 2-dimensional likelihood profile (*h* and μ), with a view towards selecting a base-case choice for *h*.

B.3. Conduct a sensitivity test in which allowance is made for an Allee effect (and use this as the basis for projections). Consider two scenarios: (A) the stock-recruitment relationship follows the Beverton-Holt form, $BH(SB)$, for stock sizes above 0.4*K*, and $\max(0, BH(SB)(SB/K-0.08)/(0.4-0.08))$ for lower stock sizes, and (B) as for (A), except that the thresholds are defined in term of densities of 0.19m^{-2} and 0.03m^{-2} respectively. A density of 0.19m^{-2} corresponds to the point at which recruitment started to decline for greenlip abalone in Waterloo Bay, South Australia, while 0.03m^{-2} corresponds to point at which recruitment was predicted to be zero for this population using a stock-recruitment relationship (Shepherd and Partington, 1995; Mar. Freshw. Res. 1995; 46:669-680).

B.4. Investigate a model configuration in which the inshore area corresponds to the area surveyed during inshore FIAS, assume that selectivity for inshore FIAS is asymptotically flat, and estimate the proportion of the commercial and illegal catch in the inshore area.

B.5. The outputs available to the workshop related to trends in spawning biomass and the fits to the data. However, these outputs are not sufficient to fully understand the changes over time in the size- and age-structure of the population. Revise the diagnostics produced by the model to show changes over time in the age- / length-structure by zone.

B.6. Report estimates of depletion for the inshore and offshore strata.

B.7. Reconfigure the assessment so that either (a) it is based on fitting to the length-frequency data (where the length-frequency data are predicted using the model estimates of population age-composition), or (b) it is based on a size-structured population dynamics model. Implementation of this suggestion will require the existing growth data to be re-analysed (and perhaps augmented).

B.8. Evaluate, using simulation, the ability of the estimation method to reliably estimate the magnitude of illegal catches.

C. Sardine

C.1. The modelling framework implements suggestions from the last Panel and represents substantial progress towards an area-structured operating model. However, the assumption of completely separate east and west stocks seems unrealistic and focus should be on model formulations in which allowance is made for movement between the east and west (but also see C.3).

C.2. Examine the length-composition data from the November surveys to identify whether any cohorts are evident.

C.3. The value of the current modelling work will be enhanced once more data on length-frequency and age-at-length become available.

C.4. Estimate the proportion of the recruitment estimates that occur east of the current eastern boundary for the recruitment survey.

D. Penguins

D.1 The approach used to include the mark-recapture data in the assessment for penguins should be based on the negative binomial distribution rather than the overdispersed Poisson distribution; alternatively the results from a MARK-based analysis should be used to provide a joint prior on natural mortality by year and the mark-recapture data dropped from the likelihood function in a Bayesian updating process to incorporate moult count abundance data in a population model.

D.2. Natural mortality, *M*, should be treated as a random effect rather than a separate parameter for each year when fitting the penguin population dynamics model.

D.3. The evaluation of potential experiments to detect fishery effects on penguin dynamics should focus on evaluating experiments in which adults are tagged. This is because there is more uncertainty regarding the dynamics of chicks than adults (such as due to first-year mortality and emigration) and these sources of uncertainty are not currently quantifiable. Consideration should be given to tagging chicks so that data can be collected which could be used to quantify these sources of uncertainty and hence evaluate experiments in which the focus is on tagging chicks.

D.4. The sensitivity of the results of the assessment and the simulations to evaluate power should be explored with respect to the assumed observation error standard deviations.

D.5. Use an individual-based model to simulate future tag-recapture data.

Appendix 2 : Robustness Tests

Reference Set

1) Central year cap -> para change	1960, 1965, 1970	3
2) Natural mortality	upper bound low; upper bound high; upper bound low/sex-dependent	3
3) Fixed steepness (or fixed depletion ?)	cap| est 0.7 0.5 0.7 para| est est est 0.7	4
4) Trends in *q* / efficiency change	none; …???	2
5) Alternative slope assumption	estimated; …???	2
		144*

* Full cross – too high, needs reduction

Robustness

To be done for best fit amongst Reference Set.

1) Discards
2) CPUE – alt depth
3) Ricker S/R
4) σ_R = 0.25
5) Assessments commence in 1978
6) Changes in *K*
7) Alternative weights: ALK
   CAL
8) Non 50/50 sex ratio at birth
9) Alternative species-split algorithms

Omit:

i) Various other CPUE
ii) Survey calibration
iii) Ageing

Data and assumption changes

1) Species split inshore catch – no change
2) Further ageing data
3) Routine update species split
4) Further catch effort revision
5) σ_R: 0.25 -> 0.45
6) CPUE from "selected" to all companies
7) Single use of each otolith read