REPORT OF THE NRF/SA PELAGIC AND ROCK LOBSTER INDUSTRIES INTERNATIONAL STOCK ASSESSMENT WORKSHOP

University of Cape Town – Monday 9 to Friday 13 July 2007

The Workshop focussed on the South African Pelagic (Sardine-Anchovy) and West and South Coast Rock Lobster resources, and particularly on Operational Management Procedure (OMP) revisions for the first two due to be completed later in 2007, and assessment approaches for the last. Some other issues were also discussed, including penguin-pelagic fish interactions and the inclusion of environmental data in resource assessments. The Workshop was funded jointly by the National Research Foundation (through a research grant to D S Butterworth), the South African Pelagic Fishing Industry Association and the South African West and South Coast Rock Lobster Associations.

An External Review Panel of four invited scientists participated in the Workshop. These were Tony Smith (CSIRO, Australia) who chaired the event, Ray Conser (NMFS, USA), Mark Maunder (IATTC, USA) and André Punt (University of Washington, USA and CSIRO, Australia). The event was well attended by both local industry and marine scientists, with up to 50 present on some occasions.

This report does not cover all the discussions that took place. Instead it is comprised of two primary Annexes related to key elements of these discussions, as follows:

Annex 1: *Report by the External Review Panel*

This comprises some views of the Panel in addition to those expressed in the agreed research recommendations of Annex 2. The first draft of the Panel's report was discussed by the Workshop, after which the Panel finalised their commentary taking account of those discussions. The views expressed in this Annex nevertheless remain those of the Panel, and do not necessarily reflect the agreed conclusions of all Workshop participants.

Annex 2: *Agreed Workshop Research Recommendations*

This contains a prioritised list of recommendations for further research related to improved assessment and management of the South African Pelagic and West and South Coast rock lobster resources. The list was formally agreed and adopted on the final afternoon of the Workshop by the Panel and other Workshop participants then present, and is subdivided as follows:

A: General Issues
B: Sardine and Anchovy
C: Penguin-Pelagic Fish Interactions
D: West and South Coast Rock Lobster
E: West Coast Rock Lobster
F: South Coast Rock Lobster
G: Guidance regarding the Inclusion of Environmental Data in Assessments

The Report concludes with two further Annexes:

Annex 3: *The Announcement and Programme for the Workshop*

Annex 4: *The List of Workshop Documents*

Electronic copies of the documents listed in Annex 4 may be obtained from:

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Annex 1

Report by the External Review Panel[*] to the SA Sardine-Anchovy and Rock Lobster Resources Assessment Workshop, Cape Town, 9-13 July 2007

As in previous years, the Panel was impressed with the quality of the science presented through the background papers and at the Workshop. South Africa remains at the forefront of OMP design and implementation, and many aspects of the broader research and monitoring in support of fishery management are also of world standard. The Panel was also very impressed with the level of industry participation in the Workshop and the thoughtful contributions they made, not only in commenting on the science, but also in presenting a wider viewpoint on the particular economic and management issues facing fisheries in South Africa. This Panel report does not seek to repeat the more detailed recommendations contained in the research recommendations section of the overall Workshop report, but focuses instead (briefly) on several important aspects underlying the fishery management process – data quality and incentives.

Successful fisheries management depends on adequate data. In general, South Africa is well served by its programs of monitoring and fishery independent surveys, but some areas of concern were also noted and highlighted in the research recommendations section. The Panel members noted with some concern a tendency for the more tactical and modelling specific recommendations from previous reviews to be well implemented, but for some of the more strategic and data quality recommendations to languish at times. The Panel noted further that the OMP framework provides a very useful vehicle for testing not only control rules and assessment methods, but also monitoring programs. The information content of the data with respect to meeting management objectives can be evaluated using the OMP framework and different future data collection approaches can be evaluated. Improved data collection schemes should enable finer tuning of the OMP and corresponding reductions in risk and increases in yield. Another approach could be to include measures of data or model uncertainty directly in the control rules (such that reductions in uncertainty lead to higher TACs). The efficacy of such rules would, of course, need to be tested in the OMP framework, but this approach would also provide a direct incentive to collect better data.

The Workshop discussed a number of issues related directly or indirectly to the idea of incentives. The Panel noted that there is a widespread literature and increasing recognition that the right incentive structures are a pre-requisite for achieving sustainable utilization (e.g. Grafton *et al*., 2006; Hilborn, 2007). Much of this literature points to the important role of rights-based systems and security of rights in providing the incentive to take a long term view of resource protection. OMPs can make an important contribution by providing security of process, provided attention is also paid to implementation and compliance. However, long-term rights need to be secure so that objectives of OMPs developed in consultation with user groups give due weight to the longer-term sustainability of resource utilisation.

The Workshop reviewed the use of targets and thresholds in OMPs from an international perspective. In general, biological targets and thresholds are explicit in the OMPs used in Australia and the USA (e.g. F_{MSY}, B_{MSY}, B_{Limit}, etc.[1]); international instruments such as the 1995 UN Fish Stocks Agreement make reference to these, and the World Summit on Sustainable Development in Johannesburg in 2002 agreed to seek recovery of depleted fish stocks to B_{MSY} by 2015 if possible. The objectives in the South African OMPs give relatively greater weight to maintaining socio-economically viable catch levels and minimizing fluctuations in TACs from year to year. This is quite acceptable so long as appropriate attention is given to the trade-off between biological risk to the resource and socio-economic risk. Socio-economic risk is addressed implicitly through rules in the OMP which attempt to avoid reducing TACs below levels that will lead to severe economic hardship and by restricting the amount by which TACs vary from one year to the next; these rules can be evaluated in part through performance statistics used in testing OMPs, such as average catch and year to year variability in catch. Attention should be given to expressing biological targets and risks in ways which are more easily understood by stakeholders.

The Panel also noted that implementation of OMPs in South Africa has generally focused on TAC controls. However, there are many other controls available to fishery managers (e.g. effort controls, closed seasons or areas, minimum legal size) and these alternatives can also be tested using the OMP framework. In most cases these controls will be in addition to, rather than as a replacement for, existing TAC-based control rules.

Finally, the Panel noted that the work addressing the possible impact of the anchovy and sardine fishery on penguin dynamics (including paper ASWS/JUL07/PENG/ASS/2) represented a positive and practical move towards adopting an ecosystem approach to fisheries.

[*]Panel Members

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Ray Conser, National Marine Fisheries Service, USA
Mark Maunder, Inter-American Tropical Tuna Commission, USA
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Grafton, R.Q., Arnason, R., Bjorndal, R., Campbell, D., Campbell, H.F., Clark, C.W., Connor, R., Dupont, D.P., Hanneson, R., Hilborn, R., Kirkley, J.E., Kompas, T., Lane, D.E., Munro, G.R., Pascoe, S., Squires, D., Steinshamn, S.I., Turis, B.R. and Q. Weninger. 2006. Incentive-based approaches to sustainable fisheries. *Canadian Journal of Fisheries and Aquatic Sciences* 63: 699-710.

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[1] B_{MSY}: The resource abundance (usually expressed in terms of biomass) at which Maximum Sustainable Yield is achieved.

F_{MSY}: The fishing mortality rate (catch as a fraction of abundance) which will lead to abundance eventually stabilising at B_{MSY}.

B_{Limit}: A threshold level of abundance which management seeks to avoid the resource dropping below; typically stringent management restrictions are imposed in such circumstances.

Annex 2

Agreed Workshop Research Recommendations

The following represent the agreed recommendations arising from the discussions held during the Workshop. Each recommendation was ranked High, Medium or Low by the Workshop participants based on the importance of the recommendation in terms of its likely impact on management decisions, and its feasibility. The Workshop did not rank research recommendations within the H, M and L categories. Some of the recommendations for west and south coast rock lobster made at the December 2005 Workshop have yet to be fully addressed and have been included in Sections D, E and F below. Items indicated by asterisks (*) relate to OMP revisions with imminent deadlines for finalisation, so should desirably be completed by August 2007 (rock lobster) / November 2007 (sardine / anchovy).

A. General Issues

A.1 (H*). Recovery statistics should be reported in the form of biomass levels relative to those approached asymptotically by projecting the operating model forward under zero future catches (from all sources) as well as under the types of control rules used in other jurisdictions.
The choice of appropriate target levels and recovery rates involves more than purely scientific considerations, and may reasonably differ among jurisdictions. However, comparisons with projections under zero catches and under control rules used in other jurisdictions may provide information which could be used to compare the performance of alternative candidate OMPs.

A.2 (H). Show the time-trajectories of exploitation rate.
Most of the outputs of assessments and OMP evaluations provided to the Workshop pertain to biomass-related reference points. However, there would be value in presenting the time-trajectories of exploitation rate (or fishing mortality) and perhaps defining thresholds based on exploitation rate.

A.3 (H). Plot exploitation rate versus biomass and show risk versus biomass.
The ability to understand the nature of the control rules underlying OMPs will be enhanced by showing how the exploitation rate relates to different biomass levels and to the probability of the biomass being driven below different levels. Fig. 1 shows these plots qualitatively for sardine in the US, Australia and South Africa.

A.4 (H). Add an ecosystem section when reporting to MCM management giving scientific advice of measures such as TACs.
Although information on ecosystem impacts is not currently used directly in OMPs in South Africa, such information is increasingly becoming a focus for fisheries management and should be included in reports providing management advice.

A.5 (M). The approach in ASWS/JUL07/GEN/MP/3 provides a way in which to interpret robustness tests and should be considered further in a South African context.
The results of robustness tests are currently interpreted somewhat arbitrarily and a more structured approach will assist in the development and selection of OMPs. The approach in ASWS/JUL07/GEN/MP/3 provides useful guidelines for how to interpret the results of robustness tests and should be considered further by the relevant Working Groups.

A.6 (M). The current OMP frameworks could be used to evaluate alternative monitoring schemes.
OMP testing frameworks can be used to indicate the extent of improved performance (in terms of greater catches or reduced risk levels, as indicated by increased lower percentiles for resource recovery statistics) that might be achieved for different levels of improvement in the precision of the indices used to monitor abundance.

A.7 (M). Include retrospective analyses in assessment / OMP reports.
It is not easy to evaluate the impact of changes over time (e.g. from one revision of the OMP to the next) to assumptions / data on model outputs in the documents presented to the Workshop. This impact can be judged more straightforwardly if the results of retrospective analyses are reported (e.g. leaving out recent data for the current operating model or showing the results of previous base-models along with those for the current operating model). In particular, it is necessary to show retrospective results each time the OMP is revised.

B. Sardine and Anchovy

B.1 (H*). Exclude the survey age- and length-composition data from the likelihood function for the sardine assessment on which the 2007 update to the anchovy-sardine OMP will be based.
The Workshop had concerns about the inter-annual variability of these data, and, in particular, the inability to detect the strong year-classes in the age-composition data. The Workshop agreed that the estimates of spawning biomass and recruitment from the acoustic surveys were more reliable than the age/length data (even though the former depend to an extent on the latter) and that modelling should therefore focus on mimicking these data. See also recommendation B.9.

B.2 (H*). Include a relationship between the survey CV and abundance in the operating models used when developing OMPs for anchovy and sardine.
The CVs of the November hydroacoustic surveys are inversely correlated with the estimates of abundance for these surveys while there also seems to be a relationship between survey effort and survey CV. A model should be developed that relates the survey CV (separately for the November and May surveys and for sardine and anchovy) to the survey effort (measured, for example, as total survey transect length) and the (expected) abundance. This relationship should form part of the base-case specifications of the operating model for the OMP evaluations.

B.3 (H*). Consider sensitivity tests in which the value of the hydroacoustic *q* is modified.

Given the concerns with the survey length-frequency data, the Workshop agreed that there is greater uncertainty now about the extent to which the hydroacoustic surveys provide estimates of absolute abundance than when OMP-04 was developed, and hence that sensitivity to a range of fixed values for the hydroacoustic survey multiplicative bias *q*, based, for example, on a probability distribution developed for this parameter using expert judgement, needs to be examined during OMP development.

B.4 (H*) Conduct additional robustness testing to quantify the possible effects of underestimating biomass in the inshore areas.

The results from an exploratory inshore survey indicate that inshore biomass may be underestimated. While it is not practical to extend the standard hydroacoustic surveys to operate inshore, the possible effects of uncertainty in the estimates of the inshore biomass, along the possible density-dependence in the proportion of the population that is inshore, on the performance of the OMP should be explored during robustness testing.

B.5 (H*). A Ricker stock-recruitment relationship should be considered in addition to the "hockey stick" stock-recruitment relationships for the sardine assessment.

The sardine resource may have entered a different "regime" during the "boom" of the early 2000s. Standard statistical approaches (e.g. AIC_c) could be used to select among alternative stock-recruitment relationships. The results of analyses presented to the Workshop suggest that the Ricker stock-recruitment fits the data better than the "hockey-stick" stock-recruitment according to AIC and a model in which a "regime shift" occurred in 2000. OMP evaluations should consider both the Ricker stock-recruitment relationship and an alternative two-regime model where one of these regimes corresponds to the "boom-bust" scenario of the early 2000's. The OMP evaluations will need to consider alternative assumptions regarding the duration of each "regime" for the two-regime model.

B.6 (H*). Revise the sardine control rule by maintaining the form of the constraints that buffer economic risk, but modifying their parameter values to reduce biological risk in light of information from the new stock assessment (particularly poor recent recruitment).

The current OMP for sardine balances risk to the resource and economic risk. The economic constraints include: a) a minimum TAC (90 kt) unless the biomass drops below 250kt; b) a maximum TAC reduction from one year to the next (15%); c) a maximum exploitation rate (14.7%); d) a maximum TAC (500 kt); e) a two-tier threshold TAC (with bifurcation at 240 kt above which the 15% maximum reduction rate does not apply); and f) an anchovy bycatch allowance.

B.7 (M*). Explore the implications of the "eastward shift" of sardine.
Sensitivity tests during OMP evaluations should consider the implications of possible multiple stocks for an OMP which provides coastwide TACs.

B.8 (M*). Allow the adult natural mortality to vary with time.
The ability of the model to fit the data on spawning biomass and recruitment might be meaningfully improved if allowance was made for adult natural mortality to vary over time. However, the ability to estimate natural mortality itself may be compromised by the lack of, for example, age-composition data.

B.9 (H). Conduct a thorough review of the sampling scheme for the collection of length-frequency data from the hydroacoustic surveys.
The length-frequency data from the acoustic surveys are highly variable from one year to the next (which impacts the age-composition data from these surveys). There is a need to conduct a thorough review of how the length-frequency data are collected during the surveys and to quantify the uncertainty associated with these data. This review would involve *inter alia*: (a) fully documenting the sampling strategy used during the surveys, (b) using bootstrapping to obtain a better impression of uncertainty, (c) examining the relationship between the mean fish length of a trawl catch and the weight given to it based on the acoustic signal, and (d) determining the extent to which the mean length of the surveyed population is related to distance from the coast (e.g. using GLMs or GAMs). The Workshop noted that one outcome of this review might be a recommendation for additional trawling during the acoustic surveys, if practical.

B.10 (H). Validate the ageing for sardine.
The Workshop strongly endorses the need for a study to validate the technique used for the ageing of sardine.

B.11 (H). Continue to examine the survey age-composition data.
Additional work related specifically to ageing includes: (a) continuing to age otoliths that have yet to be aged, and (b) conducting additional comparisons of survey age-compositions based on survey and commercial fishery age-length keys.

B.12 (M). Explore alternative approaches to estimate the raised length-frequency for a survey stratum in the hydroacoustic survey.
Spatial modelling methods that could reduce the variance of the length-composition data on which mean target strengths for the hydroacoustic surveys are based (at the possible expense of some bias) should be examined (see recommendation B.9).

B.13 (M). Consider including a relationship between the survey CV and abundance in the OMP.
Consideration should be given to testing OMPs in which the TAC is related (inversely) to the survey CV (for example, by reducing the TAC by a function that depends on the survey CV). Alternatively, it may be possible to achieve the same goal by making the OMP more conservative at low stock sizes as the survey CV is highest at low stock size. Irrespective of whether an OMP includes an adjustment for uncertainty, any final OMP

should be based on performance in simulation trials, and not whether it incorporates "features" which seem *a priori* desirable.

B.14 (L). Modify the sardine assessment so that selectivity is length-specific.
The current assessment for sardine (ASWS/JUL07/PEL/ASS/4a) assumes that selectivity is age-specific. However, all of the catch composition measurements for the commercial fishery are in terms of length. Consideration should be given to estimating a (time-invariant) length-specific selectivity pattern (e.g. estimate a separate parameter for each length-class) as this should lead to better fits to the data. Age-specific selectivity can be computed from length-specific selectivity using the length-age transition matrix.

B.15 (L). Estimate the growth curve in the assessment model.
Most of the parameters of the growth curve are currently estimated externally to the assessment. Consideration should be given to including the estimation of the growth curve directly in the assessment (in addition to perhaps treating the age-length keys as conditional age-at-length information, *sensu* SS2; Stock Synthesis 2; Methot 2007). The approach used to determine weight-at-age could then be formulated so that the observed weights-at-age (from the survey) are treated as data and the model is used to predict weight-at-age using the length-age transition matrix and the length-weight relationship.

B.16 (L). Investigate the impact of continuous recruitment on the performance of candidate OMPs.
Sardine spawn throughout the year. Lack of annual recruitment pulses could impact how operating models are conditioned and the performance of OMPs. Sensitivity tests should be conducted in which allowance is made in the OMP for continuous recruitment.

B.17 (L). Explore the stock structure of sardine.
There is a need to apply appropriate methods to identify stock structure (e.g. genetic, morphometric, and biochemical) to sardine off southern Africa.

<u>C. Penguin-Pelagic Fish Interactions</u>

C.1 (H*). The general "best practice" guidelines for experimental design outlined below should be followed for any African penguin experiment.
The Workshop highlighted the importance of following a structured approach to developing an experiment attempting to ascertain the effects on penguins of restricting pelagic fishing in the neighbourhood of some penguin breeding colonies so as to ensure that the results can be analysed using standard statistical methods, with the nominal Type I error rate and a predictable Type II error rate. The Workshop noted that power analyses can be quite difficult to conduct when there are multiple covariates so that the use of covariates should, if possible, be avoided when deciding how the results of an experiment should be analysed. The following questions should be addressed when developing experiments (see also Appendix 1):

- What are the specific alternative hypotheses?
- What are the predictions under each hypothesis?
- What past data are available for the case under investigation?

- What size of an effect would be considered "of consequence" and what is the desirable probability of detecting an effect of this size?
- What needs to be monitored to detect an effect?
- How can past data inform the amount of process and observation error for each variable that could be monitored?

C.2 (H). Refine the model of the penguin-pelagic fish interaction and estimate its parameters using a scheme that starts with a simple (single island) model and systematically increases the complexity of the model.

The model in ASWS/JUL07/PENG/ASS/2 is intended as a component of the operating model used for OMP evaluations for sardine and anchovy so that these evaluations can take account of the food needs of penguins; as such, it is important that this model fits the existing data adequately so that it can be used reliably in predictive mode. This model is fairly complicated (many parameters and functional forms). However, it does not as yet fit all of the available data sources well. The Workshop agreed that a systematic approach to refining the model of the penguin-pelagic fish interaction and estimating its parameters is warranted. One potential approach would be:

1. Empirical analyses: correlate direct measurements of penguin demographic parameters (e.g. fledgling success, number of breeders per moulter, proportion of juvenile moulters, proportional change in breeders, moulters or juvenile moulters) with survey estimate of fish abundance (perhaps by region)).
2. Island models without fish impacts: construct a model for each island separately in which fish abundance is not directly related to demographic processes, but rather the impacts on demographic processes (e.g. adult mortality, proportion mature-at-age / fledgling success / juvenile survival) which are treated as annual estimable parameters. The annual recruitments to each island (and / or survival) are therefore treated as separate parameters for each year and estimated by fitting to the data on numbers of breeders, moulters and the proportion of juvenile moulters (see Appendix 2). Consideration could be given in this model to density-dependence in the probability of observing moulting animals.
3. Multi-island model without fish impacts: as for stage 2, except that account is taken of emigration as well as the relationship between the number of breeders and the resultant number of fledglings.
4. Multi-island model with fish impacts: examine whether the model developed at stage 3 can be simplified by replacing the annual estimable parameters by functional forms in which impacts on demographic parameters are determined by fish abundance.

C.3 (M). The mark-recapture data used by Altwegg should be made available and an attempt made to integrate the survival rate estimator developed by Altwegg into the likelihood function of the population model.

The data on survival analysed by Altwegg could potentially inform the survival rates included in stages 3 and 4 (see recommendation C.2). If the location of the birds concerned can be established, the estimator in Appendix 1 of ASWS/JUL07/PENG/DAT/2 could be included in the likelihood function used when estimating the parameters of penguin models. The possibility of extensions to include other mark-recapture data sets should be considered.

C.4 (M). Conduct sensitivity tests in which there is emigration from / immigration to areas outside of the model.
The base-case model should be based on the Western Cape islands only. However, the impact of possible exchanges with other areas should be considered during tests of sensitivity (even though the evidence for such exchanges is relatively weak).

C.5 (L). Obtain the basic data and analyses on which Table 4 of ASWS/JUL07/PENG/DAT/1 is based and determine whether these data could be included in the likelihood function.
There are several "direct" estimates of survival rate for South African penguins in addition to those of Altwegg, and, in principle at least, these estimates could be included in the likelihood function for a population dynamics model. However, before this can be done, the estimates, and the basis for their estimation, needs to be determined. Inclusion of these data in a likelihood function is preferably achieved using the raw data on which the original analyses were based rather than the values in Table 4 of ASWS/JUL07/PENG/DAT/1.

D. West and South Coast Rock Lobster

D.1 (H). The basis for developing standardized catch-rate indices should be revisited starting with model selection. During this exercise, it is necessary to: a) compare the standardized and nominal catch-rate series and determine which factors cause the standardized catch-rate indices to differ from the nominal catch-rate series, and b) examine all of the standard regression diagnostics (e.g. standardized residuals versus predicted values; q-q plots; residual trends with time).
The models and methods used for catch-rate standardization were selected by the MCM Rock Lobster Working Group several years ago and it is now appropriate to revisit these given new information and techniques. Consideration should be given to treating the logarithm of catch as the dependent variable if measures of effort are to be included in the catch-effort standardization. In addition, the number of years that each vessel has used GPS and plotter should be considered as a factor if the relevant data are available.

D.2 (H). Convene a meeting of local experts to discuss the logistical considerations (including issues related to education, type of traps, etc.) related to implementing an at-sea programme to collect length-frequency information.
This is an additional data source that would enhance the assessment of South and West Coast rock lobster. It is possible that an at-sea sampling programme could augment the currently shore-based sampling programme.

D.3 (H). Continue discussion on the best way to expand the data recorded in logbooks.
The effort to improve data collection to cover the full range of relevant data (operational and environmental) should be continued. A pilot project of expanded logbook collection

on 10 West Coast Rock Lobster vessels was implemented early this year. This effort should be expanded to more vessels and other fisheries. Catch data should include: location (at a level sufficient to determine depth), soak time, and the catch in numbers (in addition to that in mass).

E. West Coast Rock Lobster

E.1 (H*). Candidate OMP's under current consideration need modification to show improved lower percentiles for resource recovery statistics in robustness tests.
The current candidate OMPs exhibit poor performance for such tests.

E.2 (H*). The OMP testing framework requires modification to set maximum exploitation rate constraints which might limit catches to lesser amounts than TACs set for the superarea concerned by an OMP candidate.
This will better reflect reality and exclude unrealistic aspects of current projections, such as extinction.

E.3 (H*). The sensitivity of OMP outputs to allowing some variation in the current fixed allocations to nearshore commercial rights holders in response to resource trends should be evaluated.
At present, the OMP evaluations assume that the tonnage allocation from the TAC to nearshore commercial rights holders is fixed. OMP variants which allow these allocations to vary over time in response to the resource monitoring data collected from the fishery may lead to better overall performance.

E.4 (H). There is an urgent need to improve the precision of the current CPUE and FIMS indices of abundance for the West Coast rock lobster resource so that TACs might be set in a manner that responds to resource trends more closely.
Approaches which should be considered in this regard include: (a) improving the CPUE indices by collecting the data on a finer spatial scale as well as relevant environmental data (e.g. oxygen levels) at catch sites; and (b) improving the FIMS indices by reducing the intensity of sampling on each of the two current legs in each area to allow the number of legs to be increased (to better average over spatially-correlated catchability variations), and by collecting environmental data (e.g. oxygen levels) at catch sites. The improvement of the FIMS programme could be facilitated by a workshop of scientists and other stakeholders.

E.5 (H). Continue to use a spatially-structured operating model for west coast rock lobster.
At the December 2005 Workshop, the Panel recommended that a spatially-disaggregated operating model be used for evaluating candidate OMPs for the West Coast fishery. This approach remains appropriate because there are clear spatial differences in the dynamics of the resource, and the present Workshop endorsed continued use of a spatially-structured operating model for West Coast rock lobster.

E.6 (H). Modify the areas used when calculating the FIMS indices of abundance so that these include all of the area within the relevant strata.
The areas currently used when calculating the FIMS index of abundance exclude areas in MPAs and that north of the Olifants River. However, the biomass in the assessment pertains to entire resource so that these additional areas need to be taken into account.

E.7 (H). Conduct a systematic evaluation of the factors which lead to reductions in estimates of recruitment prior to 1970 for the RC1 model.
The standard RC1 assessment model results imply a large decline in recruitment before 1970. It is important to understand the reasons for this. The factors that should be considered in this investigation include: a) the early length-frequencies (ignore the earliest length-frequencies in sequence), b) levels and trends in somatic growth, and c) the survival rate for males.

E.8 (M). The implications of a possible reversal of the trend of eastwards movement of rock lobsters for the standardisation for CPUE indices for Area 8 for input to assessment models and OMP computations needs consideration by the MCM Rock Lobster Working Group.
Reports of declining CPUEs east of Cape Hangklip may reflect the start of a reversal of the trend of eastward movement of rock lobsters over the last 1-2 decades.

E.9 (M). Additional features to be considered when developing OMPs.
OMP performance might be enhanced by using mean length as an index of abundance.

E.10 (M). The assessment should examine the sensitivity of the results to alternative assumptions regarding the magnitude and spatial split of the historical catches.
If the assessment is to be spatially-structured, it is necessary to disaggregate the historical catches spatially. However, there is considerable uncertainty regarding both the magnitude and spatial distribution of the historical catches, and it is clear that the pattern of catches today is very different from that in the past.

E.11 (M). The sensitivity of the results of assessments to ignoring the data on somatic growth for the years for which the data set is small should be examined.
The tag-recapture sample sizes for some years are small (particularly when the data set is pruned to capture a 'moult window'), which results in estimates of somatic growth for those years that are very imprecise. The implications of exclusion of data need to be considered by the MCM Rock Lobster Working Group.

E.12 (L). Examine the sensitivity of the results to starting the model in recent years.
There is uncertainty about the dynamics of the population in the years prior to the first year for which length-frequency data are available. The robustness of the performance of the OMP to starting the operating model in a recent year (e.g. 1975) should be evaluated. It is necessary to specify a method to determine the initial abundance and length-structure of the population in the first year considered in the model for a complete specification.

E.13 (L). Plot the time-sequence of selectivity-at-length patterns.
Selectivity-at-length changes over time, but the documents presented to the December 2005 Workshop did not show the annual selectivity-at-length patterns. These should be plotted and checked for realism.

F. South Coast Rock Lobster

F.1 (H*). Continue to explore alternative approaches of modelling time-varying selectivity.
Several approaches to parameterizing time-varying selectivity / availability were provided to the Workshop in ASWS/JUL07/SCRL/ASS/4 and ASWS/JUL07/SCRL/ASS/6. An alternative approach, based on the concept of allocation of fishing effort to age-classes, was developed during the Workshop (Appendix 3). This method is conceptually appealing, but needs to be explored further. In particular, the implications of different ways of modelling the relationship between the proportion of effort directed at each age-class and age, should be explored. In addition, the simple averaging approach outlined in ASWS/JUL07/SCRL/ASS/6 should be included in the tests of sensitivity. Reporting the average selectivity over ages 8-12 would enhance the ability to compare the results between alternative methods of defining time-varying selectivity.

F.2 (H*). Conduct four analyses as the basis for the 2007 assessment.
The 2007 assessment for South Coast rock lobster should be based on four model runs: (a) the current reference case (age-structured production model fitted to cohort-sliced catch data; ASWS/JUL07/SCRL/ASS/1), (b) downweighting the catch-at-age data, (c) allowing for effort saturation, and (d) allowing for time-varying selectivity. Weights should be assigned to each model, taking account of their ability to fit the data.

F.3 (H). Development of an OMP for South Coast rock lobster.
Development of an OMP for South Coast rock lobster should be based on a spatially-disaggregated operating model. The time to develop an OMP for this resource therefore depends on how long it will take to finalize such an operating model. In principle, the area-designations in the spatially-structured model may need to be modified. In addition, model specifications may need to be developed so that the model is able to fit the data (e.g. by assuming that some of the historical data are unrepresentative), i.e. the operating models should be selected to represent alternative hypotheses regarding the various (potentially conflicting) data sources. The South Coast rock lobster OMP to be developed should focus on determining overall TACs / TAEs (rather than any spatial management considerations, which could be considered in future OMP revisions). Consideration should also be given to other management actions such as alternative minimum sizes.

F.4 (H). Continue exploratory model analyses.
The analyses in ASWS/JUL07/SCRL/ASS/3 implement several of the suggestions from past review meetings and have helped to better understand the dynamics of the South Coast rock lobster resource. Such analyses could form the basis for operating models to evaluate candidate OMPs for South Coast rock lobster. The Workshop highlighted the

following possible modifications to the methods in ASWS/JUL07/SCRL/ASS/3: (a) allow for time-varying selectivity, (b) integrate the tagging data into the analyses (this better allows for the impact of fishing effort on the probability of recapturing a tagged lobster), (c) allow for time-varying growth, (d) impose constraints on movement rates based on the expert judgement of biologists and fishers familiar with South Coast rock lobster, and (e) allow for size- (and possibly sex-) specific growth rates.

F.5 (H). Continue to examine growth rates for south coast rock lobster.
The analyses in ASWS/JUL07/SCRL/DAT/2 could be extended by considering alternative error models and / or fitting non-linear models for growth increment developed from first principles. One aim of the analyses should be to fully characterize the variance of the growth increment as well as the mean growth increment.

F.6 (H). Fit a growth model and variance structure using a non-linear estimation procedure.
The growth increment tagging data should be modelled directly using a growth model (e.g. von Bertalanffy) fit to the growth increment data using likelihood functions in a non-linear estimation procedure (e.g. AD Model Builder). The variance in growth increments should be appropriately modelled as a function of length and time at liberty.

F.7 (H). Use Pope's approximation to save computational time.
The use of Pope's approximation in population dynamics models can substantially reduce the computational burden of the calculations and is unlikely to lead to misleading results unless fishing mortality is very high. Consideration should therefore be given to using Pope's approximation to allow additional assumptions regarding model structure to be examined (e.g. ASWS/JUL07/SCRL/ASS/1).

F.8 (M). Exclude further catch and effort data for the Hout Bay Fishing Company when standardizing CPUE data.
Only the 1997/98-2000/01 data were excluded from the catch-effort standardization, but it seems that the data for earlier years may also have been contaminated.

F.9 (M). Exclude data from the Hout Bay Fishing Company from the effort saturation experiment data used when fitting models.
The Hout Bay Fishing Company is known to have misreported catches. It seems plausible that this may have also impacted the data reported during the effort saturation experiment. Sensitivity tests should therefore be conducted in which the data from this Company are omitted from those on which the results of gear saturation experiment are based.

F.10 (L). Modify the approach used for pro-rating the historical catches.
At present illegal catches are allocated to area in proportion to the legal catches. More realistic catch histories by area could be obtained by allocating the illegal catches based on the information recorded in the logbooks for those companies known to have misreported catches.

G. Guidance regarding the Inclusion of Environmental Data in Assessments

The Workshop agreed the following comments regarding detecting and confirming relationships between environmental variables and fish dynamics:

- When examining relationships between the environment and population dynamics processes (such as recruitment), the first step is to conduct a correlative study. However, the state-of-the-art in terms of relating environmental variables to population dynamic processes is to integrate those variables directly into the assessment and to apply full cross-validation techniques (i.e. including model selection) (e.g. Mosteller and Tukey, 1977; Francis 2006[2]) to determine the predictive ability of any resulting relationship.
- It may be easier to detect relationships between availability and environmental variables as the data sets concerned are usually very large.
- Care should be taken when extrapolating (e.g. into the future or outside the range of stock sizes / environmental conditions observed historically) as there is no guarantee that simple (e.g. linear) relationships which may fit existing data will apply outside of the range of those data.
- The relationship between environmental variables and population dynamic quantities (such as recruitment) need not be linear (breakpoint models may be more appropriate in some cases).

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Figure 1. Form of harvest control rules for sardines for South Africa, the US and Australia, showing the relationship between catch and biomass (upper panels) and harvest rate and biomass (lower panels).

References

Francis, R.I.C.C. 2006. Measuring the strength of environment-recruitment relationships: the importance of including predictor screening within cross-validations. *ICES Journal of Marine Science* 63: 584-599.

Methot, R.D. 2007. User manual for the integrated analysis program Stock Synthesis 2 (SS2): Model version 2.00a.

Mosteller, F., and J.W. Tukey. 1977. Data Analysis and Regression. Addison-Wesley, Reading, Massachusetts, 588 pp.

[2] In addition, appropriate account should be taken of the effect of applying multiple statistical tests to the same data set on the nominal Type I error rate (e.g. by using the Bonferoni correction).

Appendix 1

Penguin experiments

Tony Smith, CSIRO

Experimental management

- Often proposed, rarely conducted
- Effects of trawling on Australia's north west shelf
- Effects of line fishing on coral trout on the Great Barrier Reef

What to monitor

- Fishing→Prey abundance→Penguins
  - – Fishing effort and catch around experimental islands
  - – Prey abundance around islands???
  - – Penguin demographics
    - Survival
    - Breeding success
    - Other?

Steps to design

- What are the specific alternative hypotheses?
- What are the predictions under each hypothesis?
- What do you need to monitor to detect an effect?
- What can confound the interpretation of the results?

Confounding effects

- Observation error (how accurately can you measure effort, prey abundance, penguin survival and breeding)
- Process error (what else could be affecting penguin survival and breeding – how much natural variation is there?)
  - – PENG/DAT1 Table 3, page 11
  - – Compare with Table 6b page 14

Specific hypotheses and predictions

- Fishing→Prey abundance→Penguins
- Prey abundance→Penguins
  - – Adult survival, juvenile survival, breeding success
  - – Area of impact (foraging area)
  - – Functional form (threshold?)
- Fishing→Prey abundance
  - – At stock level (fishing vs envt)
  - – Locally (abundance vs availability)

Summary

- Designing an effective experiment not straightforward
- How many experimental units (islands) with good historical data?
- Lessons from GBR

Appendix 2

Penguin Model

Mark Maunder, IATTC

Methods

A simple population dynamics model is fit to data for the Robben Island population of African penguin. The data include number of breeders (assumed here to be age 3+), number of moulters (assumed here to be age 2 juveniles and breeders), and the proportion (age 2) juveniles in the moulters. Temporal variability in egg and adult survival is modeled by using random effects and a correlation with prey abundance. In this case, egg survival represents many factors including the probability of breeding, hatching rates, fledging rates, and survival from egg to age 1. The prey abundance is taken as survey estimates of sardine and anchovy between Cape Columbine and Cape Point. Juvenile (age 1 to 2 and 2 to 3) survival is assumed to equal adult survival. The model equations are given in Adjunct 1 and the AD Model Builder code is available from the Workshop organisers.

Results

The results suggest that there is a relationship between juvenile/adult survival and prey abundance (significant at the 95% level based on a single tailed likelihood ratio test), but not between egg survival and prey abundance. The amount of total variation in survival explained by the relationship with prey abundance is high for juvenile/adult survival (Figure 1). The lower bound of the one sided 90% and 95% confidence intervals for the parameter relating the prey abundance to juvenile/adult survival are 1.19 and 0.85, respectively (Figure 2).

The fit to all data sets is good (Figure 3). The fit degrades somewhat if a random effect is included in only one of either juvenile/adult survival or egg survival while still including the prey relationship (Figures 4 and 5), but degrades substantially if no random effects are included (Figure 6).

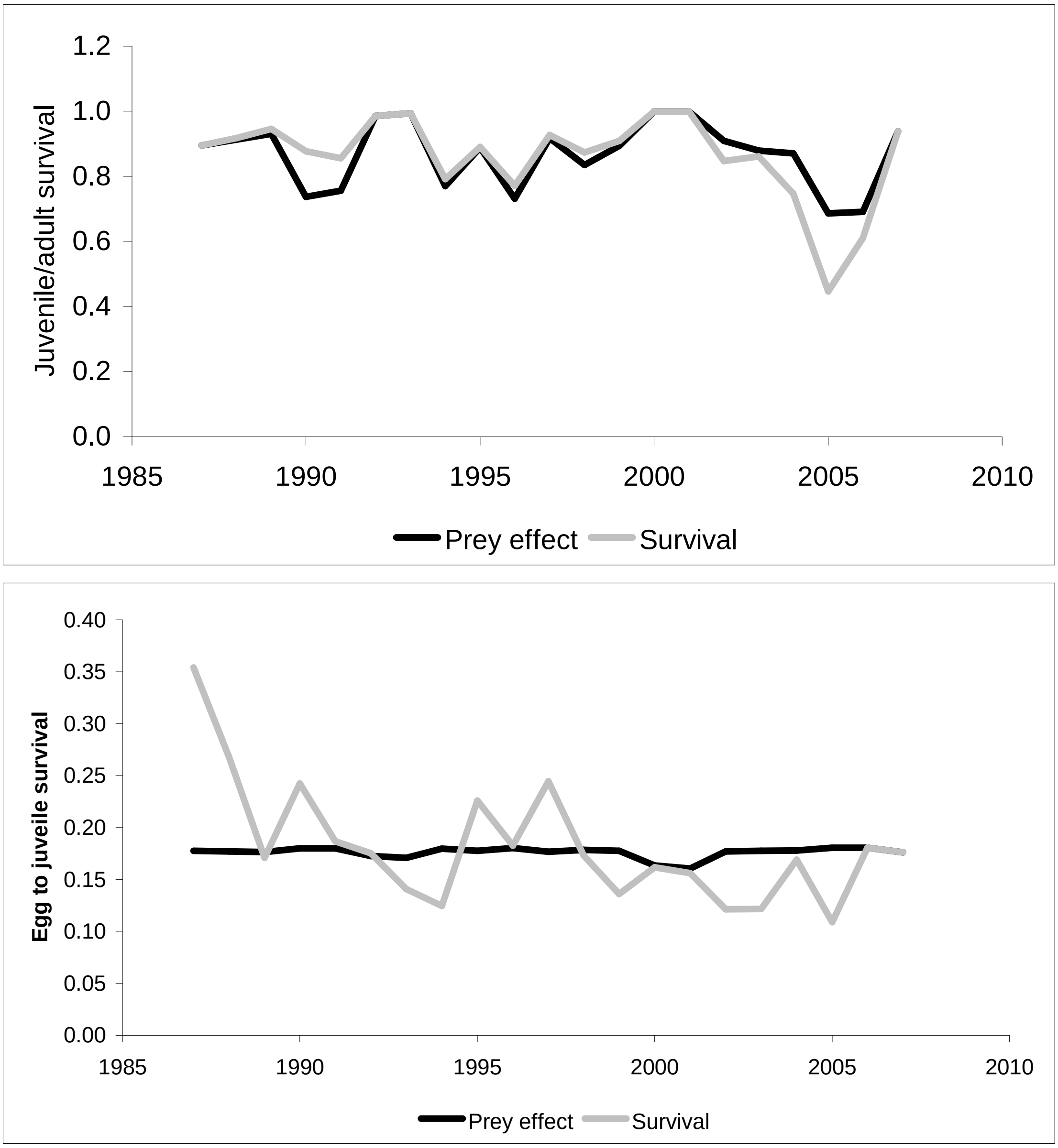


Figure 1. Estimates of juvenile/adult (top) and egg (bottom) survival with the amount of variation explained by the relationship with prey.

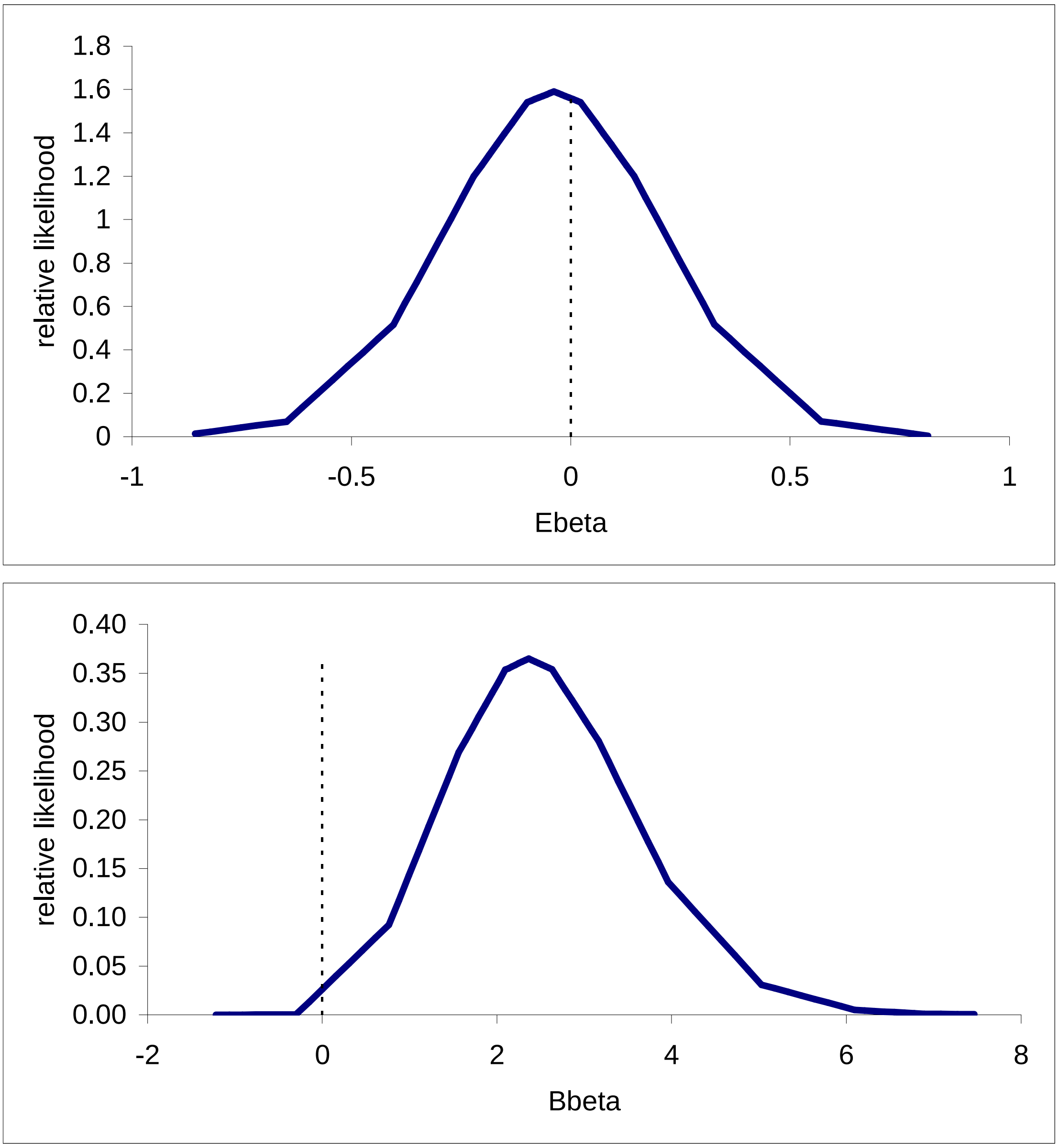


Figure 2. Profile likelihoods of the slope parameter β relating juvenile/adult (bottom) and egg (top) survival to prey abundance.

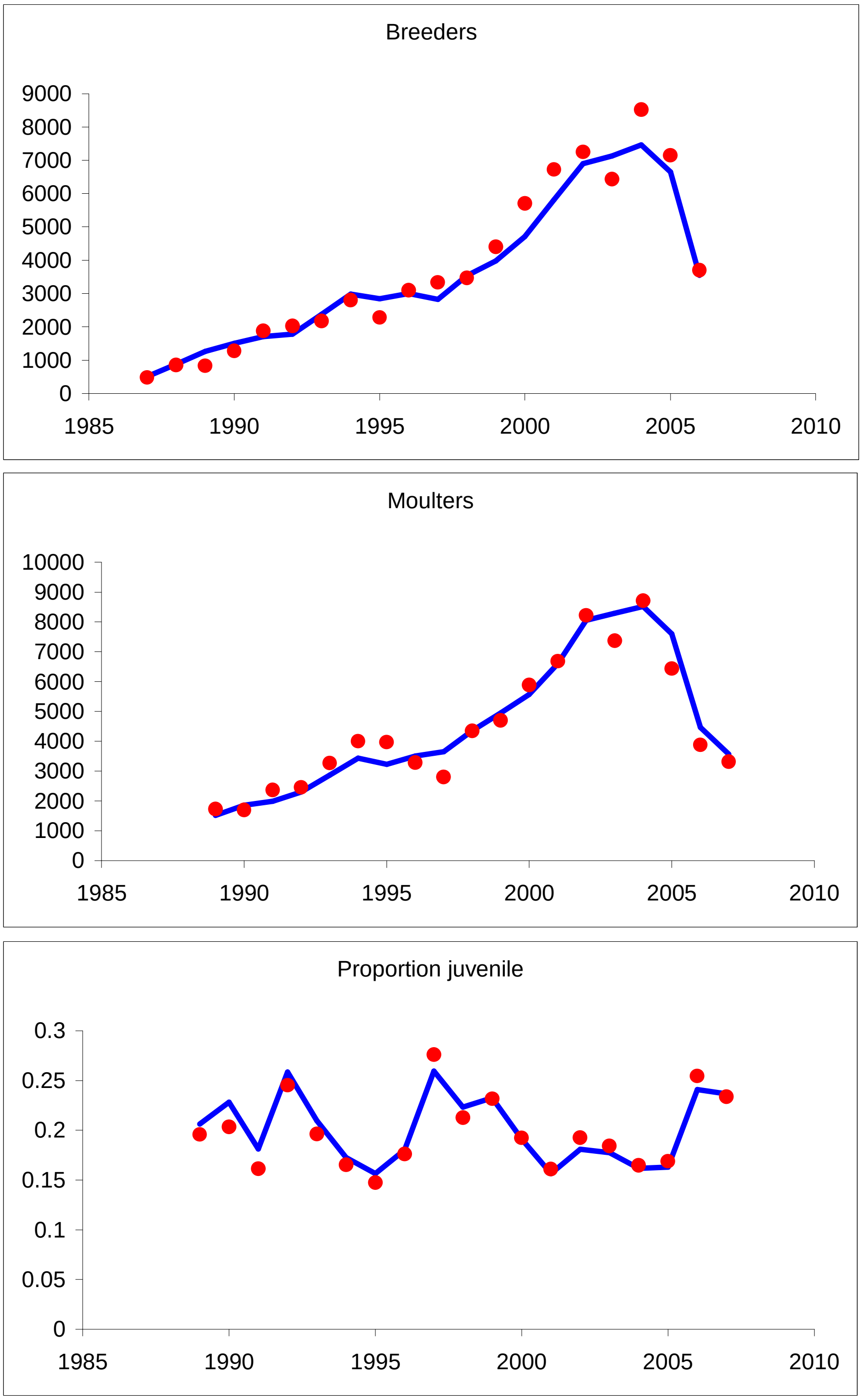


Figure 3. Fit to the data from the model with random effects for both egg survival and juvenile/adult survival.

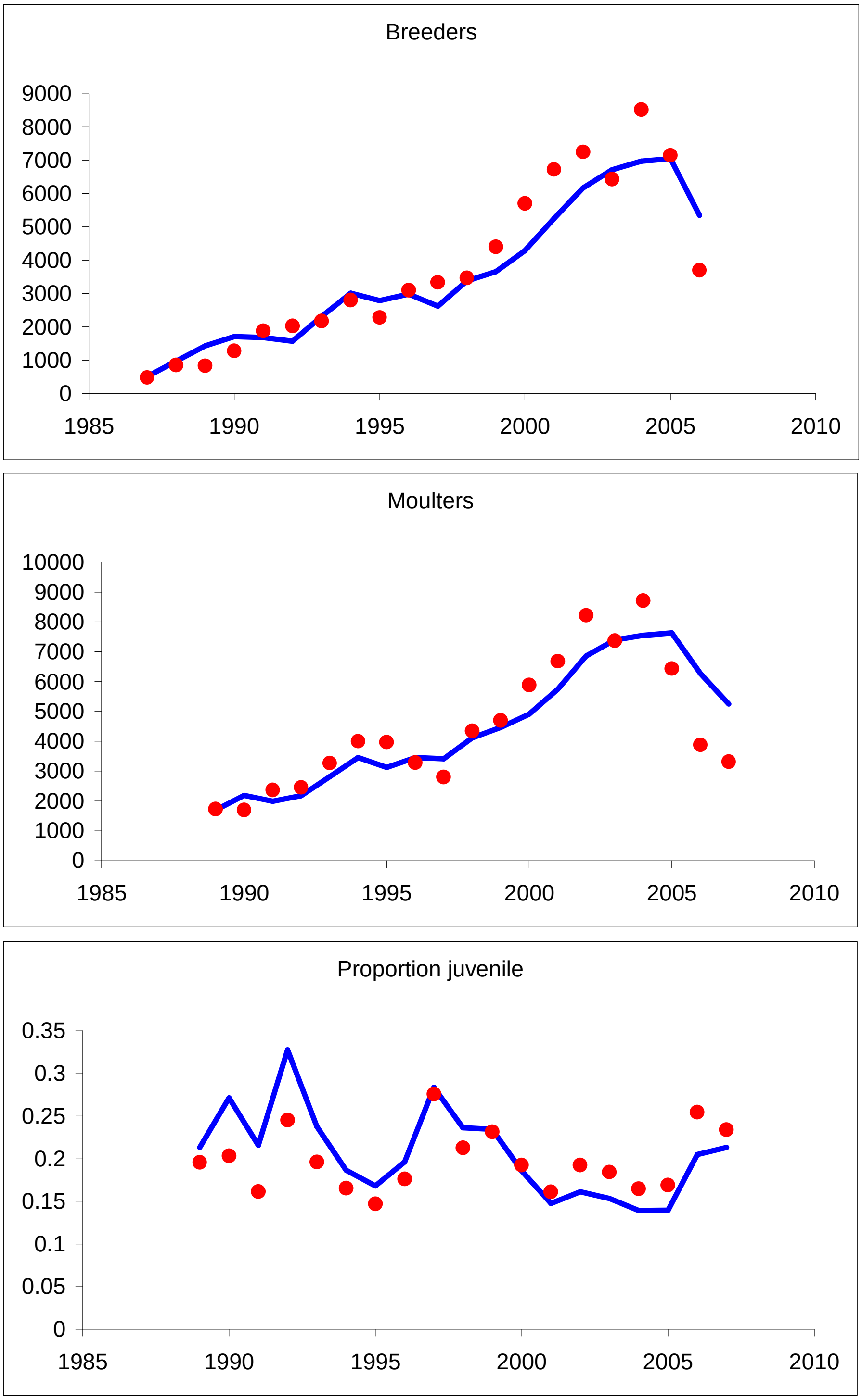


Figure 4. Fit to the data from the model with random effects only in egg survival.

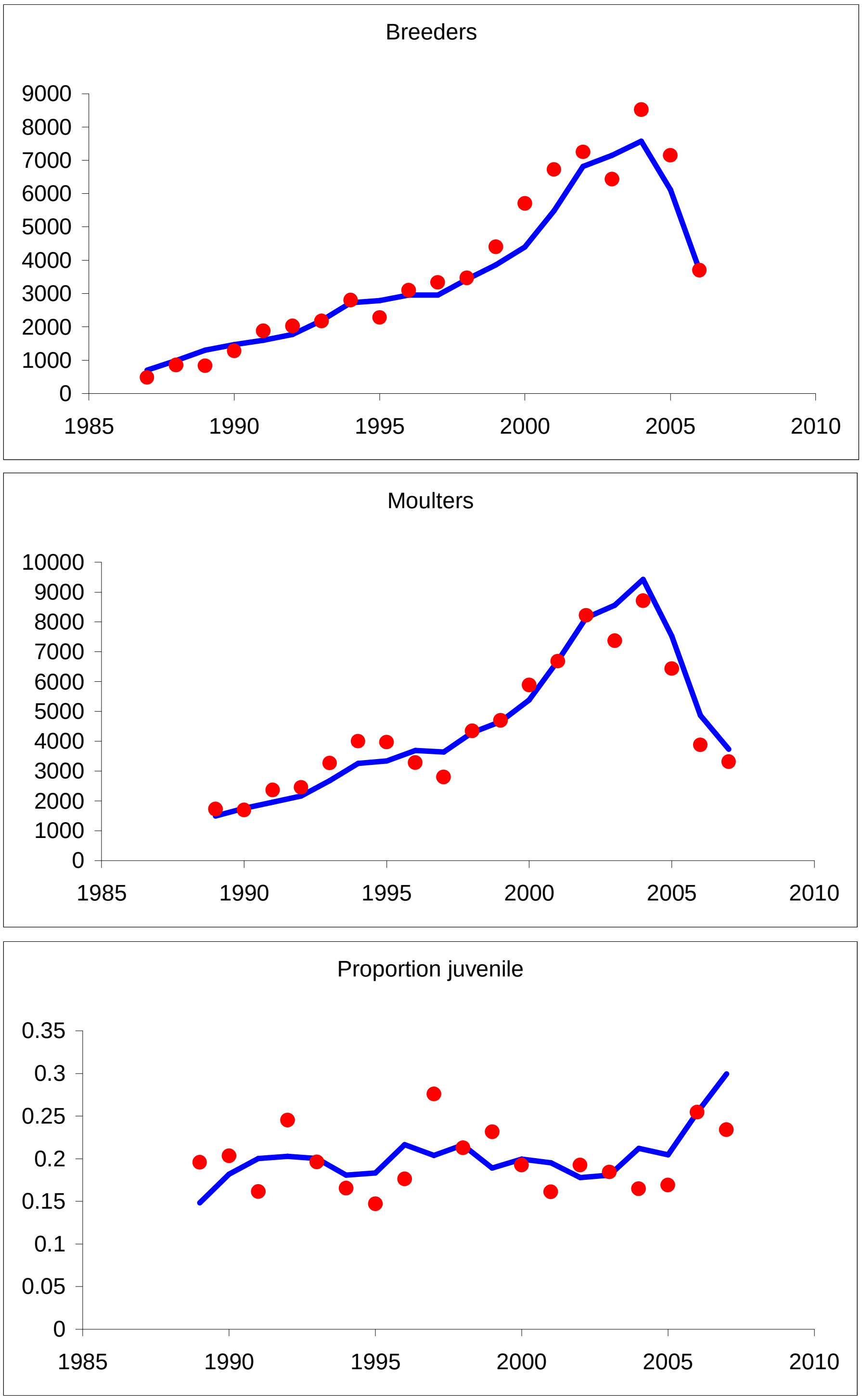


Figure 5. Fit to the data from the model with random effects only in juvenile/adult survival.

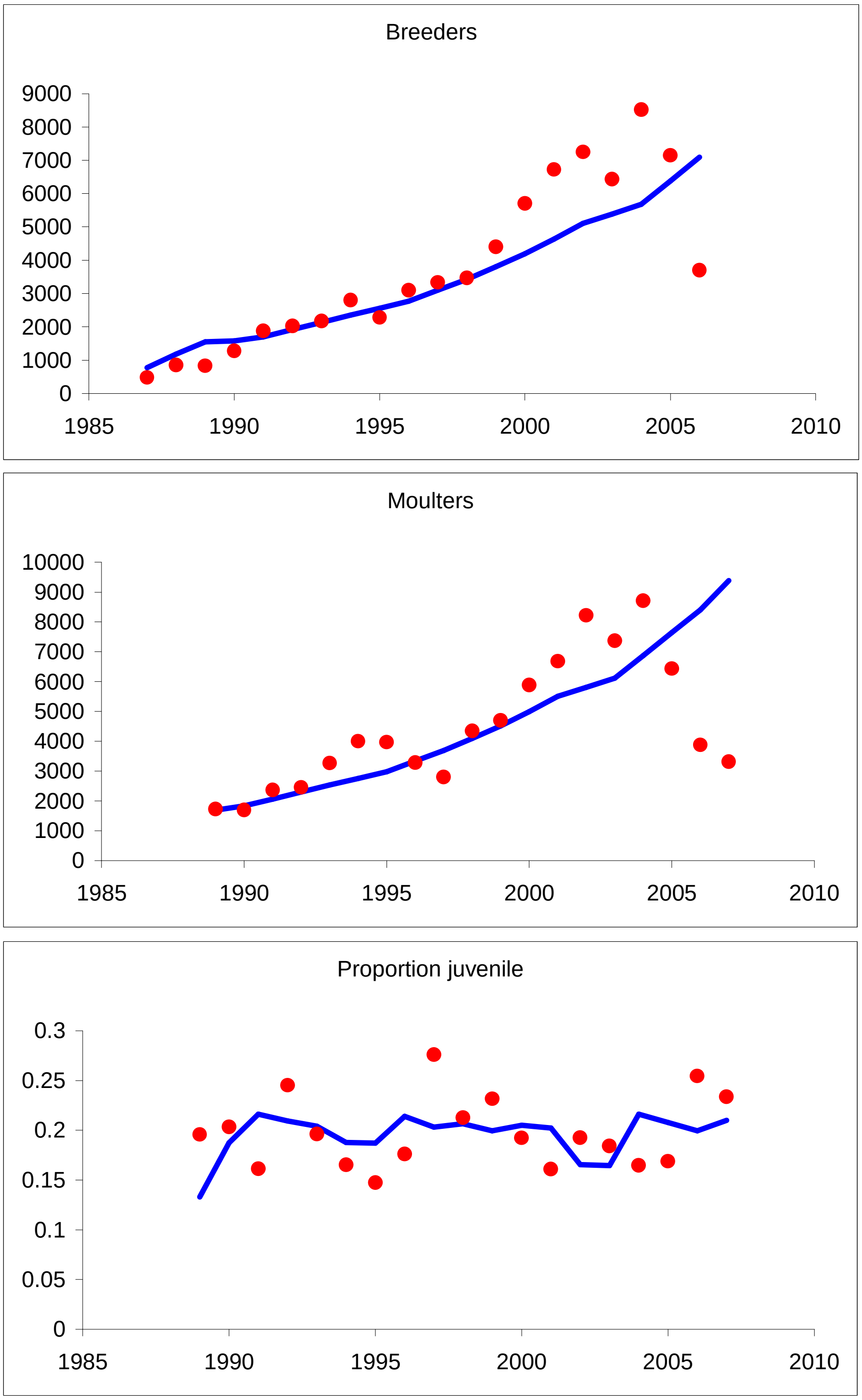


Figure 6. Fit to the data from the model with no random effects.

Adjunct 1: Model equations

Initial conditions

$B_1 = B_{init}$

$J_{1,1} = J_{init} \qquad J_{1,2} = J_{init} S^J_{init}$

$E_1 = B_1 c$

Dynamics

$B_{t+1} = B_t S^B_t + J_{t,2} S^J_t$

$E_t = B_t c$

$J_{t+1,1} = E_t S^E_t \qquad J_{t+1,2} = J_{t,1} S^J_t$

Survival

$$S^k_t = \frac{\exp\left[\alpha^k + \beta^k P_t + \varepsilon^k_t\right]}{1 + \exp\left[\alpha^k + \beta^k P_t + \varepsilon^k_t\right]}$$

Likelihoods

$$-\ln L\left(I^B\right) = \sum_t \left(\ln\left[\sigma_B\right] + \frac{\left(\ln\left[B_t q_B\right] - \ln\left[I^B_t\right]\right)^2}{2\sigma^2_B} \right)$$

$$-\ln L\left(I^M\right) = \sum_t \left(\ln\left[\sigma_M\right] + \frac{\left(\ln\left[\left(B_t + J_{t,2}\right) q_M\right] - \ln\left[I^M_t\right]\right)^2}{2\sigma^2_M} \right)$$

$$-\ln L\left(p\right) = \sum_t \left(\ln\left[\sigma_p\right] + \frac{\left(\ln\left[J_{t,2} / \left(B_t + J_{t,2}\right)\right] - \ln\left[p_t\right]\right)^2}{2\sigma^2_p} \right)$$

Random effects

$$-\ln p\left(\varepsilon^B\right) = 0.5 \sum_t \frac{\left(\varepsilon^B_t\right)^2}{\sigma^2_{\varepsilon_B}}$$

$$-\ln p\left(\varepsilon^E\right) = 0.5 \sum_t \frac{\left(\varepsilon^E_t\right)^2}{\sigma^2_{\varepsilon_E}}$$

Not used

$$-\ln p\left(\varepsilon^{J}\right)=0.5\sum_{t}\frac{\left(\varepsilon_{t}^{J}\right)^{2}}{\sigma_{\varepsilon_J}^{2}}$$

Parameters

Estimated

$\left\{B_{init}, J_{init}, \alpha_E, \alpha_S, \beta_E, \beta_B, \varepsilon^E, \varepsilon^B, q_B\right\}$

Fixed

$\varepsilon^J = \varepsilon^B$

$\alpha^J = \alpha^B$

$\beta^J = \beta^B$

$c = 2$

$\sigma_{\varepsilon_B}, \sigma_{\varepsilon_E} = 1$

$\sigma_B, \sigma_M, \sigma_p = 0.2$

$q_M = 1$

Parameter	**Description**
E_t	Number of eggs at time t
$J_{t,a}$	Number of juveniles at time t and age a (ages 1 and 2)
B_t	Number of adults (2+) at time t
S^k	Survival for stage k (*E*, *J* or *B* for ages 0-1, 1-2 and 2-3, or 3+ respectively)
c	Number of eggs per breeding pair
α^k	Intercept of the relation between survival and prey for stage k
β^k	Slope of the relation between survival and prey for stage k
ε_t^k	Annual deviate of the relation between survival and prey for stage k
I^B	Counts of breeders
q_B	Constant of proportionality for the breeder counts
σ_B	Standard deviation of the likelihood for the breeder counts
I^M	Counts of moulters (age 2 juveniles and breeders)
q_M	Constant of proportionality for the moulter counts
σ_M	Standard deviation of the likelihood for the moulter counts
p_t	Proportion of moulters that are (age 2) juveniles
σ_p	Standard deviation of the likelihood for the proportion of moulters that are juveniles
σ_{ε_k}	Standard deviation of the random effect for survival for stage k
P_t	The prey (anchovy and sardine) at time t

Appendix 3

An alternative approach to modelling time-varying selectivity

J.D. Gaylard and M.O. Bergh, OLRAC

Models of time-varying selectivity presented at the SA sardine-anchovy and rock lobster resources assessment workshop, namely equation 3 of Butterworth and Johnston (2007):

$$CPUE_y = q\sum_a w_a S_{y,a} N_{y,a} \tag{1}$$

where to maintain a constant catchability coefficient q, the selectivity function is renormalised in some way:

$$S_{y,a} \to S^*_{y,a} = S_{y,a} / X_y \tag{2}$$

with a simple approach being :

$$X_y = \sum_{a1}^{a2} \frac{S_{y,a}}{a2 - a1 + 1} \tag{3}$$

i.e., normalising selectivity by its average over a certain age range,

and equation 5 of OLRAC (2007):

$$CPUE_y = \frac{\sum_a w_a S_{y,a} N_{y,a}}{\sum_a S_{y,a} / q_a} \tag{4}$$

with different suggestions made concerning specification of the q_a, raised considerable discussion, particularly on the question of how such normalisation could be achieved while avoiding bias. We present here an alternative approach to this issue.

Methods

The OLRAC equation (4) is based on the idea that the total effort in the fishery may be thought of as the sum of components, each of which is directed at a particular age (or size) class of fish and that the distribution of effort between age(or size) classes may differ from year to year. It is useful to consider a different formulation based on this same principle, as follows:

Let $\alpha_{y,a}$ be the proportion of effort E_y in year y which is directed at age class *a* so that

$$\sum_a \alpha_{y,a} = 1 \tag{5}$$

Let q_a be defined as the (year-invariant) "catchability" or catch per unit (age-directed) effort per unit biomass in age class a.

Then the catch in year *y* is given by

$$C_y = \sum_a q_a.\alpha_{y,a}.E_y.N_{y,a}.w_a \tag{6}$$

and the CPUE is

$$CPUE_y = \sum_a q_a.\alpha_{y,a}.N_{y,a}.w_a \tag{7}$$

Note that in equation (7) the year-invariant nature of q_a means that the "normalisation" or "scaling" of the selectivity from year to year is taken care of by the constraint of equation (5).

There is scope for several parametric formulations of the q_a and $\alpha_{y,a}$. Note however that the traditional notion of selectivity is, apart from some time-invariant scalar, a product of these 2 quantities. Hence if a uniform distribution of effort is accepted as the base case, then presumably q_a should be formulated in the same way as selectivity would otherwise be in equation (1).

Fig.1 below illustrates an example where the catchability is modelled as logistic and the effort distribution as linear in age *a*.

$$q_a = \frac{q}{1 + \exp[\frac{-\ln(19).(a - a_{50})}{(a_{95} - a_{50})}]} \tag{8}$$

$$\alpha_{y,a} = \frac{1 + m_y(a - a_{piv})}{\sum_{a'} [1 + m_y(a' - a_{piv})]} \tag{9}$$

The parameters of equation (9) are:

- a_{piv} a "pivot" age class whose proportion of effort remains constant)
- m_y the "slope" of the distribution which directs effort towards older or younger animals for positive or negative values respectively.

This particular formulation of $\alpha_{y,a}$ has obvious limitations and thought should be given to alternatives.

Conclusions

The above approach seems to hold some promise for resolving the question of unbiased scaling of year-varying selectivity, but it has yet to be tested within an assessment framework. The formulation of the effort distribution to be estimated within an assessment needs particular attention. The authors anticipate conducting this work in the near future as part of the ongoing development of a size-structured assessment for South Coast rock lobster.

References

OLRAC. 2007. Summary of methods and some results for dealing with time varying selectivities for South Coast rock lobster. ASWS/JUL07/SCRL/ASS/4.

Butterworth,D.S. and S.J.Johnston, 2007. Allowing for time-varying selectivity in South Coast rock lobster assessments. ASWS/JUL07/SCRL/ASS/6.

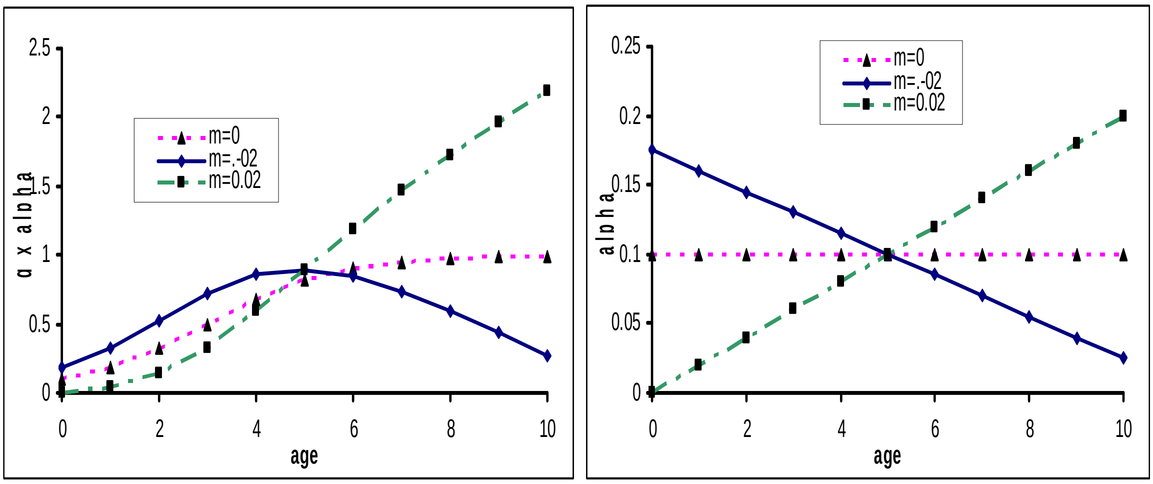
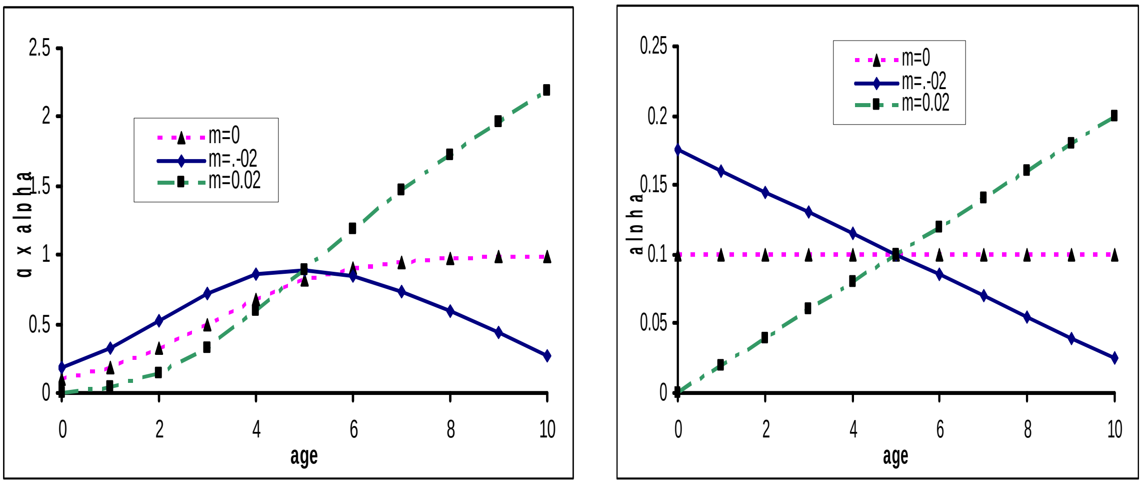


Figure 1. The upper panel shows realisations of the selectivity (q_a x $\alpha_{y,a}$) under three possible values of the effort slope m_y using equations (6) and (7) with a_{50} = 3, a_{95} = 7, a_{piv}=5. Note that the case m=0 leads to the same shape as the catchability q_a. The corresponding effort distributions are shown in the lower panel.

References

OLRAC. 2007. Summary of methods and some results for dealing with time varying slectivities for South Coast rock lobster. ASWS/JUL07/SCRL/ASS/4.

Butterworth,D.S. and S.J.Johnston, 2007. Allowing for time-varying selectivity in South Coast rock lobster assessments. ASWS/JUL07/SCRL/ASS/6.



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Annex 3

SA SARDINE-ANCHOVY AND ROCK LOBSTER RESOURCES ASSESSMENT WORKSHOP

Dates: Monday 9 to Friday 13 July, 2007
Venue: Room M212, Mathematics Building, University of Cape Town
Times: 9-00 am to 5-30 pm each day

External Review Panel Invitees

Ray Conser - Southwest Fisheries Science Center, La Jolla, USA
Mark Maunder - Inter-American Tropical Tuna Commission, La Jolla, USA
Andre Punt - University of Washington, USA
Tony Smith (Chair) - CSIRO, Hobart, Australia

Terms of Reference

Sardine and Anchovy

Review of updated assessments, and initial specifications of operating models to be used for testing a revised OMP to be implemented before the end of the year, in time to provide recommendations for TACs for 2008

West Coast Rock Lobster

Brief review of area-disaggregated assessments, together with OMP test outputs to date (a revised OMP is to be finalised in August 2007 in time to provide TAC recommendations for the 2007/8 season).

South Coast Rock Lobster

Review of progress towards new area-disaggregated assessment methods, with a view towards these methods assisting provision of advice by late August on a TAC for the 2007/8 season, and further serving as the basis for providing operating models for the subsequent development of an OMP for this resource (hopefully to be completed by mid-2008)

Additional topics

Proceedings will also include discussions on:

i) the development of a penguin-pelagic fish interaction model to provide a basis for taking account penguin food needs in the sardine-anchovy OMP
ii) management objectives and constraints for the sardine-anchovy and rock lobster OMPs
iii) procedures for possibly taking quantitative account of robustness test results in finalising selection amongst candidate OMPs
iv) general approaches to take account of environmental data in fish stock assessments (while this will focus on methodology, the potential applications in mind would be wider than sardine-anchovy and rock lobster, in particular including hake).

Workshop Outputs

i) A set of agreed prioritised research recommendations on issues discussed, to be finalised during the final afternoon session on Friday 13th.

ii) Independent commentary on issues discussed by the External Review Panel (they will finalise this amongst themselves following discussion of their initial draft during the final afternoon session on Friday 13th).

Schedule (unless otherwise indicated, sessions will be held in plenary)

There will be four 1.5 hour sessions each day, commencing at 9-00 am, 11-00 am, 2-00 pm and 4-00 pm, with 30 minutes breaks for morning and afternoon tea, and a 90 minute break for lunch.

Clearly some flexibility will need to be exercised with the programme as set out below, in the light of progress made, but given that different people have interest in different topics and may not wish to attend throughout, the broad topics indicated for each morning and afternoon will remain as indicated.

Monday 9:
Morning – Brief registration session for 30 minutes, followed by presentation and broad discussion on work to date towards pelagic OMP revision (this will include review of updated assessments)

Afternoon (before tea) - Presentation and broad discussion of penguin-pelagic fish interaction model, together with associated data available

Afternoon (after tea) - Small group for in-depth pelagic modeling discussions

Tuesday 10:
Morning - Continuation of pelagic modelling sub-group discussions

Afternoon – Brief report back on progress by sub-group to plenary for broad input as required, followed by further sub-group discussions

Wednesday 11:
Morning (before tea) – Pelagic assessment and OMP development discussions

Morning (after tea) - Further discussion of penguin-pelagic fish interaction model

Afternoon - West coast rock lobster discussions

Thursday 12:
Morning - South coast rock lobster discussions

Afternoon (before tea) - Round-up of sardine-anchovy OMP discussions, including discussion focussing on inter-annual TAC change constraints desirable for industrial stability

Afternoon (after tea) –

i) Broad discussion on appropriate management objectives (particularly as related to catch levels, resource risk, and catch level variability) for fisheries, and their relation to trade-off decisions to be made in the final selection of the revised sardine-anchovy and rock lobster OMPs

ii) Discussion of procedures for possibly taking quantitative account of robustness test results in finalising selection amongst candidate OMPs

iii) Discussion of general approaches to take account of environmental data in fish stock assessments (while this will focus on methodology, the potential applications in mind would be wider than sardine-anchovy and rock lobster, in particular including hake).

Friday 13:
<u>Morning</u> - West and south coast rock lobster (division of time as appropriate given progress made in earlier discussions

<u>Afternoon</u> –
i) Discussion of draft panel commentary
ii) Review and agreement of prioritised research recommendations concerning issues discussed.

Note: The small sub-group to meet from late Monday afternoon and throughout Tuesday is for detailed mathematical discussions on the pelagic models/assessment, and in particular specifications for future projections (stock-recruitment relationships, etc.). The probable composition of the sub-group is the four external panelists, Cunningham, Butterworth, van der Lingen, Coetzee and Badenhorst, though this will be finalised later.

Annex 4

DOCUMENT LIST

Administration

ASWS/JUL07/ADM/ANNOUNCE: Announcement of workshop and discussion schedule

ASWS/JUL07/ADM/DOCLIST: Document list

ASWS/JUL07/ADM/SUM: Summary of key issues to be addressed

Sardine and Anchovy

ASWS/JUL07/PEL/DAT/1: D. Durholtz and C.L. Cunningham. 2007. Pelagic assessment data and key problems encountered in compiling these data, including sardine ageing.

ASWS/JUL07/PEL/DAT/2: J. Coetzee. 2007. Acoustic survey methodology and associated background information on anchovy and sardine off South Africa.

ASWS/JUL07/PEL/ASS/1: C.L. Cunningham and D.S. Butterworth. 2007. The proposed issues to be addressed in the revision of the pelagic OMP.

ASWS/JUL07/PEL/ASS/2: C.L. Cunningham and D.S. Butterworth. 2004. Appendix extracted from OMP-04 development and testing document WG/PEL/APR04/03.

ASWS/JUL07/PEL/ASS/3: C.L. Cunningham and D.S. Butterworth. 2007. Preliminary results from the base case assessment of the South African anchovy resource.

ASWS/JUL07/PEL/ASS/4a: C.L. Cunningham and D.S. Butterworth. 2007. Base case assessment of the South African sardine resource.

ASWS/JUL07/PEL/ASS/4b: C.L. Cunningham and D.S. Butterworth. 2007. Preliminary results from the base case assessment of the South African sardine resource.

ASWS/JUL07/PEL/MP/1: C.L. Cunningham and D.S. Butterworth. 2005. Re-revised OMP-04.

ASWS/JUL07/PEL/MP/2: C.L. Cunningham and D.S. Butterworth. 2005. A review of world sardine catch patterns: what can be said about the likely duration of the current peak in the SA sardine fishery.

ASWS/JUL07/PEL/MP/3: K.T. Hill. 2007. Application of environmental information to assessment and management of California sardine (ICES-WKEFA case study).

Penguin-Pelagic Fish Interactions

ASWS/JUL07/PENG/BAC/1: 2007. Draft Report from Seabird Task Group to Pelagic Working Group on desirability and practicality of closing to purse-seine fishing areas around breeding colonies of African penguins.

ASWS/JUL07/PENG/DAT/1: E.E. Plaganyi and D.S. Butterworth. 2007. Summary of available data for modelling African penguin *Spheniscus demersus* populations.

ASWS/JUL07/PENG/DAT/2: R.J.M. Crawford. 2007. Further information on the African Penguin *Spheniscus demersus*.

ASWS/JUL07/PENG/ASS/1: D.S. Butterworth and E.E. Plaganyi. 2007. Leslie matrix based estimates of maximum growth rate for the African penguin population.

ASWS/JUL07/PENG/ASS/2: E.E. Plaganyi and D.S. Butterworth. 2007. Spatial age-structured model of African penguin colonies at Robben, Dassen and Dyer islands, and at Boulders.

ASWS/JUL07/PENG/ASS/3: A.E. Punt and G. Fay. 2006. Can experimental manipulation be used to determine the cause of the decline of western stock of Steller sea lions (*Eumetopias jubatus*)?

ASWS/JUL07/PENG/ASS/4: D.S. Butterworth. 2007. Some initial thoughts on evaluation of the power of an experiment to detect the effect on penguin reproductive success of closure of areas around breeding colonies to pelagic fishing.

West Coast Rock Lobster

ASWS/JUL07/WCRL/BAC/1: S.J. Johnston, J.P. Glazer and D.S. Butterworth. 2007. December 2005 rock lobster international workshop recommendations pertaining to West Coast rock lobster – progress made.

ASWS/JUL07/WCRL/BAC/2: S.J. Johnston and D.S. Butterworth. 2005. Evolution of operational management procedures for the South African West Coast rock lobster (*Jasus lalandii*) fishery. New Zealand Journal of Marine and Freshwater Research 39:687-702.

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