The Proposed Issues to be Addressed in the Revision of the Pelagic OMP

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A number of discussions have taken place over the past 9 months to clarify the issues to be addressed in the revision of the pelagic OMP this year. This document serves as a record to the decisions made during such discussions. For the reader's convenience, text that has been modified from Cunningham and Butterworth (2007) is highlighted. It was agreed at the February PWG meeting that no new key structural uncertainties would be added to this document for the 2007 assessments. All proposals are now taken as agreed to by the PWG.

Underlying (i.e. Operating) Models for Sardine and Anchovy

Broad Conceptual Issues:

- The present models all assume a single southern Benguela **sardine** population. Is there sufficient evidence to consider as plausible an alternative that there could be two populations, with one distributed more towards the east and of a size that is not trivially small compared to the "conventional" population fished off the west coast? For a two-population scenario, would the May recruit survey be regarded as indexing recruitment for the "west" population only; further, need the model attempt to incorporate spatial distribution shifts over time for the two populations (see Figures 1 and 4)?

Proposal: Two basic scenarios for **sardine** population structure are to be considered: a single population, and two partially overlapping populations (see Figure 2). When two populations are discussed, they will for the purposes of this document, be referred to as "west" and "east" populations. In the two population model, the "east" population will not contribute to either recruits or older fish found on the west coast. The distributions of the two populations will be without trend over time, so that the current apparent "eastward shift" of **sardine** will be taken to be the consequence of a recent increase in the "east" population (unless the survey data prove to be inconsistent with such an assumption).

For subsequent linkage to models for groups of penguin colonies, three areas along the coast have been identified through discussions amongst PWG members and the model would output time series of abundances for both populations in each of these areas:

"Western" area: corresponding to the coastline northwest of Cape Agulhas. The penguin colonies modelled would correspond to the area between Cape Columbine and Cape Agulhas, while the **sardine** model would correspond to the area as far north as the spawner biomass survey extends in each year (eg Hondeklip since 1987). As the proportion of **sardine** north/south of Cape Columbine at the time of the survey varies throughout the year, it is proposed that the state of the penguin colonies in this area be matched to that of the combined **sardine** biomass for both north and south of Cape Columbine, and not just the proportion of biomass observed between Cape Columbine and Cape Agulhas at the time of the survey.

"Southern" area: corresponding to the coastline between Cape Agulhas and Cape St Francis. This area will be distinguished as part of the sardine spatially-disaggregated model, but no penguin colonies will be modelled in this area (as none occur there).

"Eastern" area: corresponding to the coastline between Cape St. Francis and Port Alfred. In the years for which the spawner biomass survey has extended east of Port Alfred, only the biomass up to Port Alfred will be included in analyses (see third bullet point below).

Thus the proposal envisages two penguin models of "western" and "eastern" colonies (Pláganyi 2006). For this two population hypothesis, past catches and bycatches will need to be split between the two populations and this will require information on past catches disaggregated by the three areas; furthermore, assumptions about the future distributional pattern of fishing will need to be developed. In addition, **sardine** age-length-keys (ALKs) for the spawner biomass surveys and possibly catches too will be split by these areas.

Note that the MP developed will not, indeed cannot be population-specific, because it must be applicable whether there are either one or two populations present. Thus the MP will output TACs for the full SA coastline; it may, however, have a spatial allocation component.

Initial computations will need to be carried out prior to any decision being taken as to whether the MP developed and/or underlying models used to test the MP will need to treat **sardine** bycatch on the west coast (reflecting harvesting of the "west" population only) differently from that on the south and east coasts.

- The present models also assume only one **anchovy** population. Need alternatives also be considered, as perhaps for **sardine**?

<u>Proposal</u>: Only one **anchovy** population will be considered as in the past, with a distribution without trend over time. The model will output time series of abundances for the population in each of the three areas identified in the response to the previous bullet point. The proportional distributional of **anchovy** by area will be taken to be time independent, unless the survey data prove to be inconsistent with such an assumption. As the **anchovy** has an explicit spatial distribution, the **anchovy** recruits, together with **sardine** in the finalised "western area", will be used to try to determine a functional relationship with penguins from the "western" colonies, while **anchovy** adults, together with **sardine** in the finalised "eastern area", will be used to try to determine a functional relationship with penguins from the "eastern" colonies (cf EAF discussions on pages 3/4).

<u>Query</u>: The above decision may need to be revisited in the light of a potential eastward shift in the anchovy distribution. Figure 4a shows the proportion of observed anchovy November biomass west of Cape Agulhas which has shown some decline over time. Should a shift in the distribution of anchovy be considered?

Proposal: The sardine distribution extends further east (and west) than anchovy, with the anchovy distribution being more concentrated in the 'middle'. Anchovy eggs have rarely been found on the west coast in contrast to sardine. Only a single anchovy population will be considered. If data allow, some spatial disaggregation of the anchovy assessment will be attempted, allowing for a shift in the distribution over time.

- The present models assume that the proportions of the **sardine and anchovy** spawning stocks to the west of Port Alfred, as surveyed in the November cruises, have remained unchanged over time. Is distributional evidence from more recent surveys sufficient to suggest a systematic trend that invalidates this assumption? If so, what alternative "standardisation" boundary should be considered; and how are estimates from some earlier surveys, which may not have been extended to such a limit, to be extrapolated?

Proposal: The biomass west of Port Alfred will be used, retaining the assumption that the proportion of **sardine and anchovy** west of Port Alfred has been unchanged over time. Only once in the past three years when the November cruises have extended east of Port Alfred was a substantial **sardine** biomass found east of Port Alfred (26% of total observed biomass in 2003, compared to <3% in 2004 and 2005). A model of a single **sardine** population whose distribution changes over time will be considered. The model will output time series of abundances for the population in each of the three areas identified in response to the first bullet point. The distributional shifts with time will be determined by fitting to available survey data disaggregated for these three areas. Hypotheses for alternative possible future distributional shifts will need to be developed by the PWG. For this single population hypothesis, no information on the past or future distribution of the catch by area is required, as catches wherever taken have the same impact on the population. Note that changes in the growth rate should be incorporated through the ALKs. Possible changes in natural mortality over time will not be taken into account in the base case, but this may be considered for robustness tests.

- The current models do not account for slippage. Should this be incorporated? (If so, in due course, alternative plausible levels and their trends over time will need to be specified.)

Proposal: Slippage will be accounted for in a sensitivity test to the chosen base case hypothesis (or, if necessary, some alternative hypotheses as well). An estimated fixed percentage of the **anchovy** and **sardine** slipped annually will be required in due course, or alternatively a fixed (or varying) annual tonnage slipped is required. A task group has been appointed to discuss this slippage and report to the PWG; the PWG will in due course be required to provide input into the proposed scenarios for possible slippage in the future. The size distribution of slipped catch may be different from the distribution of the catch which is landed. Information regarding this likely difference will be required for the sensitivity test. This proposal was agreed in principle – figures will come after discussion.

- Explicit inclusion of predator-interaction effects in the models in an EAF context:

- Impacts of changes in the abundance of pelagics (total biomass or individual species?) on predators, such as penguins and gannets (and any others? – seals?). Which specific colonies are going to be considered, and what associated data are available, and will be collected in future?

Proposal: A dynamic model of the SA penguin populations (with colonies divided into two of the three areas, see Pláganyi 2006) is to be developed. Possible functional relationships between the model predicted estimates of **sardine and anchovy** abundance and the penguin demographic parameters (fledging rates, survival rates, etc.) will be explored. The penguin models will be incorporated into the testing of the OMP so that the risk of depletion of these penguin populations to undesirably low levels can be examined.

Query: Should a model be developed for penguins in the western area only, or in both the western and eastern areas?

Proposal: Given some complications that have arisen while trying to fit the penguin model for the western area to available data, this model will be pursued and the issues addressed prior to a model for penguins in the eastern area being developed. This may result in a simpler model for penguins in the eastern than in the western area.

- There are currently no major areas modelled as closed to the pelagic fishery for predator conservation purposes. Should such possibilities be considered? Note that this would require spatial disaggregation of the model at a much finer scale.

Proposal: Areas that some have previously proposed to be closed to the fishery include parts of Algoa Bay around St. Croix island (for the entire year) and the Cape Point to Cape Columbine region (during summer only). These proposed areas are at a much finer scale than that to be considered in the assessment models. It is proposed that any analyses to evaluate the effectiveness of proposed closed areas of this nature be carried out on a separate basis to this OMP testing exercise, and include experimental design considerations. The August PWG meeting noted that east of Cape Agulhas had effectively been "closed" to the fishery in the past. A separate task group chaired by George Branch has now been appointed to address this and has met.

- Need consideration be given to possible appreciable changes in the extent of fishing on red-eye in the near future, and consequently on the associated bycatch of adult **sardine**?

Proposal: The typical proportion of **sardine** bycatch with red-eye needs to be re-visited, given updated data. The proposed OMP will be tested under alternative scenarios of the amount of bycatch assumed caught with red-eye during the projection period. The currently assumed 10 000t originated from 12.5% of 80 000t which was predicted a number of years ago to be the average red-eye catch (Steve Malherbe pers. comm.) The historical bycatch maximum has, however, been < 3000t. Note that the red-eye population will NOT for this OMP revision be included in the operating models in the same way as the **sardine and anchovy** populations (and the penguin populations are proposed to be). Two options will be pursued: i) red-eye catch remains at its recent average with an adult sardine bycatch of 3500t (rounded-up from 3227t to be conservative) over the projection period, and ii) the average red-eye catch doubles over the next 5 years such that the adult sardine bycatch reaches 7000t and then remains at that level for the remainder of the projection period.

- Future recruitments are at present assumed to follow a hockey stick relationship for the base case model, with levels of variability as estimated from past data. Does a wider range of plausible scenarios need to be considered in an expanded set of base case models, e.g. a Beverton-Holt or Ricker model (given recent low recruitments at large spawning biomass); also perhaps regime shifts at decadal+ time scales (but on what basis are these to be specified?).

Proposal: Three hypotheses will be considered for the **anchovy** assessment (single population) and each (single and two-population) of the **sardine** assessments: the Hockey-stick, Beverton-Holt and Ricker stock recruitment models. In addition the Hockey-stick model may be extended to a mixture model in which the recent good recruitment years are treated as part of a different "regime". For this last scenario, the probability given to a change of "regime" would need to be specified (eg 1/40 – roughly the periodicity between peaks in South African sardine catches, see Cunningham and Butterworth (2005b)), with a switch back to the "poorer regime" after 5 to 7 years (Cunningham and Butterworth (2005b)).

- The present models take no account of data from the pre-recruit survey or the SARP monitoring line? Should this be attempted (and such data perhaps also be used as input to the OMP formulae)?

Proposal: No, not as yet.

- The present models assume no within-year variation in the pattern of recruitment for either species (the 1 Nov birthday assumption). Thus no allowance is made for early or late recruitment (either in the model or the OMP). Does this variation need to be incorporated (for the first year of life only, in the interests of simplicity), and how best is such an effect to be matched to available data (e.g. perhaps a normal distribution for spawning each year, with random inter-annual peak shifts which themselves are drawn from another normal distribution?)

Proposal: We propose that the average birthday for recruits each year changes from being fixed at 1 Nov to being drawn from a distribution centred on 1 Nov. Mean weight of recruits at the time of the recruit survey will be required to fit the associated distribution parameter in the model. Note, this may have an impact on the rules to adjust the mid-season **anchovy** TAC, in that the mean weight of recruits at this time may play a more explicit role.

Note: Daily ageing information that could inform this exercise needs to be provided. This is available for 2000 and also possibly for between 1992 and 1995. Deon Durholz is to follow up on this.

Note: Results here will relate only to the mean weighted recruits at the time of the survey. They will not be used to modify the algorithms proposed for separating past catches by month into adults and recruits (see Cunningham and Butterworth 2007).

Detailed Issues:

- The models currently assume equal selectivity over all ages in the survey for both **sardine and anchovy**. Recent selectivity of **sardine** in the commercial catch is assumed to remain unchanged when projecting into the future in testing candidate management procedures. This selectivity has in the past been estimated for each age from the ratio of the average fishing mortality over the most recent 5 years for that age to the maximum of the average fishing mortalities for each age over all the ages over the same period. But over recent years for **sardine**, selectivity has increased for 1-2 year olds compared to older fish. Is this pattern expected to continue into the future? What are the plausible alternative scenarios?

Proposal: The updated models will fit to catch-at-age data. Two commercial selectivity curves will be estimated i) for all years prior to November 2001 and ii) for all years from, and including, November 2001. The OMP will need to be tested under the assumption that future selectivity remains at ii), returns to i), or is governed by some relationship to **sardine** abundance or distribution.

- The models currently assume **sardine** mature at age 1. Should alternative hypotheses (maturity ogive, density dependence, changes over time), and/or an alternative base case be used for testing the next OMP?

Proposal: An annual maturity ogive derived along the lines of that in Cunningham and Butterworth (2005a), using for example, annual length at maturity from Fairweather *et al*. (2006) and van der Lingen (2006) will be assumed. Past density-dependence will be incorporated explicitly (through the external specification of these maturity ogives for each year) or implicitly within the model; for the future the implied relationships of the ogive parameters to abundance will be assumed to continue. A sensitivity test to the selected base case hypothesis will assume all **sardine** mature at age 1 (to maintain a comparison with past work).

- The productivity-related factors are currently assumed not to change over time. Should changes in, e.g. growth and condition factor be taken into consideration (are adequate data available for this)?

Proposal: As the **sardine** assessment uses an age-structured model, the direct use of, for example, condition factor or standardized gonad mass is not straightforward. However, if density-dependent growth has occurred, this should reflect in the age-length-keys used in the updated assessment. In the two-population hypotheses, the same ALKs will be used for both populations and thus both populations will be assumed to be affected by density-dependence in a similar manner.

- It is assumed at present that adult **sardine** natural mortality is constant over time at $M = 0.4$ year^{-1} and juvenile $M = 1$ year^{-1} (estimates based weakly on maximum likelihood considerations for past assessments, and also on plausible proportions of recruits available to the May survey. Is there reason to suspect temporal changes, and if so how are alternative possibilities to be plausibly quantified? Do 1 and/or 2 year olds have a natural mortality closer to that of juveniles than adults?

Proposal: Alternative combinations of adult and juvenile natural mortality, constant over time, will be tested. Worldwide, sardine M estimates range from 0.3 to 1 year^{-1} (Barange *et al.* in press). Bayesian posterior mode and plausible proportions of recruits available to the May survey will be taken into consideration in determining a suitable choice of M. Juvenile natural mortality will apply to the recruits only. Another alternative that could be considered is whether M is a function of population size, with predator needs saturating when the population increases above a threshold.

Recently suggestions have been made that M for sardine has increased over time. Written contributions on the basis for this were requested to allow their evaluation and possible incorporation amongst alternatives to be considered. No analyses related to a change in M over time have been put forward.

- It is assumed at present that adult and juvenile **anchovy** natural mortality is constant over time at $M = 0.9$ year^{-1} (estimates again based weakly on past maximum likelihood considerations, 'biologically probable' cases of juvenile M being greater than or equal to adult M, and also on plausible proportions of recruits available to the May survey). Is there reason to suspect temporal changes, and if so how are alternative possibilities to be plausibly quantified?

Proposal: Alternative combinations of adult and juvenile natural mortality, constant over time, will be tested. Bayesian posterior mode and plausible proportions of recruits available to the May survey will be taken into consideration in determining a suitable choice of M. Juvenile natural mortality will apply to the recruits only.

- Somatic growth rate is assumed constant over time at present. What are plausible scenarios for recent changes over time, and how might these continue into the future?

Proposal: As mentioned above, if density-dependent growth has occurred, this should reflect in the age-length-keys used in the updated age-structured assessment models. In the two-population hypotheses, the same ALKs will be used for both populations and thus both populations will be assumed to be affected by density-dependent growth in a similar manner.

- The only age data used in the **anchovy** assessment model are age length keys (ALKs) derived by Prosch (unpublished data, MCM) for the 1992-1995 November surveys. A combined 1992-1995 Prosch key was applied to raised length frequencies from the November surveys for all other years to obtain mean masses. The proportions of 1-year-olds in the November survey were obtained using this Prosch key. The alternative is to use a cut-off length (10cm, 10.5cm, or 11cm) for the raised length frequencies from the surveys. Are there any new data available to improve on the current assumption?

Proposal: No new data are available. Sensitivity tests to the selected base case **anchovy** assessment will consider these alternative cut-off lengths for the raised length frequencies.

Very detailed issues

- The model currently assumes **sardine** live to age 5 and then die. Should a plus group be modelled? (Note, inclusion of plus group will probably require retesting of the currently assumed fixed *M* value.)

Proposal: Yes.

- The model currently assumes **anchovy** live to age 4 and then die. Should a plus group be modelled? (Note, inclusion of plus group will probably require retesting of the currently assumed fixed *M* value.)

Proposal: Yes.

- **Sardine** catch is approximated as taken 6 months after birthdate = 1 May. Should catch rather be modelled to be taken on a quarterly basis?

Proposal: No. Catch will continue to be modelled on an annual basis, as it seems likely that the further complexity that this would introduce would be analytically burdensome without providing commensurate improvement to the model's predictive capabilities.

- Juvenile **sardine** catch taken prior to the survey is currently assumed to be taken halfway from 1 Jan to the start of survey. Should this rather be halfway from 1 Nov to the start of the survey?

Proposal: **Sardine** recruit catch in November and December is generally low in comparison to that from January to May, though recent years (2001-2004) have seen high recruit landings during November and December, possibly due to sardine being used for fishmeal. We propose that no change be made to the current assumption, given that the highest **sardine** recruit landings generally occur in April and May.

- In previous operating models, the anchovy caught from 1 November to 31 March were assumed to be adults (1 year olds) and anchovy caught from 1 April to 31 October were assumed to be recruits. It is now proposed that a cut-off length be applied to split the catches in each month into recruits and adults. Preliminary work has involved using a cut-off length of 10.5cm in each month, but this may not be adequate as adults caught between November and March may be < 10.5cm. Further explorations of these data are required, for example to check whether use of a month-dependent cut-off could address this issue adequately.

Proposal: A monthly cut-off length is to be used as follows (from Cunningham and Butterworth (2007)): January: 7cm; February: 8cm; March: 9cm; April: 9.5cm; May: 10cm; June – September: 10.5cm; October: 10.5cm; November: 5cm; December: 6cm.

- In OMP testing, 30% of normal season **anchovy** catch is assumed to be taken between Jan and March, and to comprise 1 year olds. Is this an adequate approximation?

<u>Proposal</u>: Given the new method of splitting juvenile and adult **anchovy** catch, the average proportion of the annual catch biomass that has been adult (1-year-old) between 1984 and 2006 is 24%, while the average proportion of the catch biomass between January and July that has been adult (1-year-old) between 1984 and 2006 is 29%. As the 1-year-old catch is assumed to be a proportion of the <u>normal season</u> **anchovy** TAC during OMP testing, the assumption of 30% will be retained as an adequate approximation.

- It is currently assumed that juvenile **anchovy** caught from 1 April – 31 Oct can be approximated as taken on 1 June (7 months after birthdate). Should this rather be split between halfway through the normal season and halfway through the additional season, or should another date, e.g. 1 May, be used?

<u>Proposal</u>: Given the new method of splitting juvenile and adult **anchovy** catch, the cumulative proportion of juvenile catch taken each month was calculated to find the average annual mid-point of juvenile anchovy landings. There was a clear change in the cumulative proportion landed by June in 1999 (Figure 5). This was in response to the introduction of the additional season, resulting in greater anchovy juvenile catch occurring later in the year compared to former years. The average cumulative proportion of juvenile anchovy landed between 1984 and 1998 at the end of May was 0.35 rising to 0.62 at the end of June. In contrast, the average between 1999 and 2006 at the end of June was 0.36, rising to 0.59 at the end of July. As the additional season is subject to a "staggered-start", it will not be possible to accurately split the juvenile catch to be taken halfway through the normal season and halfway through the additional season. Thus the juvenile anchovy catch between 1981 and 1998 will be modelled to occur in a pulse on 15th June, (7½ months after birthdate) while the juvenile anchovy catch from 1999 onwards (i.e. also in OMP testing) will be modelled to occur in a pulse on 15th July.

- Commercial sardine ALKs are available from 1980 to 1999 from Michael Kerstan (see De Oliveira 2003 for the months for which ALKs are available and the ALKs used for months for which no readings were taken). ALKs are applied to the monthly RLFs to calculate monthly catch-at-age data. In the most recent sardine assessment, birthdays were assumed to occur in November each year, in contrast to previous assumptions of birthdays in January each year. To compensate for this, catch-at-age *a* for year *y* was assumed to consist of catch-at-age *a* in November and December of year *y-1* and catch-at-age *a* in January to October of year *y*.
- ALKs for July to December are constructed on the basis of what age a fish is expected to be by June of the following year, while ALKs for January to June are constructed on the basis of what age a fish is expected to be by June of that year. Thus the above assumption of combining November and December catch-at-age *a* in year *y-1* to the January to October catch-at-age *a* in year *y* to obtain an annual catch-at-age *a* for year *y* is reasonable.

<u>Proposal:</u> However, recent inspection of the November commercial ALKs (which are also used for December) have revealed a number of fish aged 0 that are greater than 13cm and therefore most likely

recruits from the previous November, i.e. 1-year-olds. It has therefore been decided that ALL catch-at-age 0 in November and December calculated using these commercial ALKs will instead be added to the catch-at-age 1 (not 0) for the following year. Although in practice some recruits may have been caught during November and December between 1980 and 1999, these are likely very few. [DISCUSS]

Important Changes in Data available to Condition new Operating Models:

- New series of acoustic survey estimates (and associated variances-covariances) of spawner biomass in November and recruitment in May following capping calibration analyses. Note that the November estimates will remain estimates of 1+ population, rather than SSB. These estimates will be spatially disaggregated by the areas referenced earlier in this document.
- The May recruit numbers have been updated from previous assessments to allow for annual revision of the cut-off length for recruits based on the length frequencies from the surveys (see Coetzee 2006, 2007).
- The CVs for the recruit estimates have been updated from previous assessments to reflect the CV of recruits only, rather than that of adults and recruits (see Coetzee 2007).
- ALKs for **sardine** from November surveys for 2000 onwards. ALKs up to 1999 are available, together with spatially disaggregated ALKs from 2001 to 2003. No spatial disaggregation of ALKs prior to 2000 is available. The ALK for 2000 has "disappeared" and the samples in 2005 were inadequate resulting in no ALK for November 2005 being available. A combined area commercial November ALK has been provided for 2000, as suggested at a previous PWG meeting. Deon Durholtz is still to provide spatially disaggregated survey ALKs for 2004 and 2006 and a combined area commercial November ALK for 2005. Initial analyses of these ALKs (comparisons between readers, comparisons between using survey ALKs on commercial data and using commercial ALKs on survey data) raised some concerns that are currently being addressed.
- ALKs for **sardine** commercial catches for selected months from 2000 onwards. It is highly unlikely that these will be available in time, given the priority to obtain ALKs from the November surveys. Thus it is suggested that we extrapolate between the ALK from November of one year and the ALK from November of the next year to obtain an estimated ALK for the commercial catches. The availability of recruit survey ALKs for 2001 and 2002 may be useful. The possible differences between ALKs during the survey and in commercial catches in November (if sufficient catch was taken in November) for past years need to be investigated.
- RLFs for the commercial catch will need to be spatially disaggregated from 1987. (Note that for scenarios with two **sardine** populations present in an area, the catch by age-class will be allocated to population in the same ratio as the numbers of the respective age-classes present in the area.) The area disaggregated sardine RLFs from 1987 to 2006 have been based on both field station and observer data and are now finalised. The area disaggregated commercial anchovy RLFs are also finalised from 1987 to 2006. The anchovy and sardine catch-at-age from 1980 to 1983 will remain unchanged from the last assessment and the sardine RLFs from 1984 to 1986 will remain

unchanged from the last assessment. A RLF for anchovy in 1984 is now available, while the anchovy RLFs in 1985 and 1986 are unchanged from those used in the previous assessment. Catch prior to 1987 cannot be spatially disaggregated.

- No spatially disaggregated biological data are available.

The data to be used in updating the pelagic OMP will be fully recorded in a separate document (see Cunningham and van der Westhuizen 2007 for an initial draft).

Management Procedure

Broad Conceptual Issues:

- Thresholds for invoking Exceptional Circumstances currently depend on the individual biomass of **sardine and anchovy**. Should a combined threshold biomass (**sardine** + **anchovy** + redeye) also be considered (e.g. w.r.t. EAF / predator risk)?

Proposal: Separate thresholds will remain for **sardine and anchovy**. If possible, the question of providing an Exceptional Circumstance threshold based on penguin numbers will be examined.

- Does the current OMP protect **sardine** too much at the expense of **anchovy** catches? Is the current **sardine-anchovy** trade-off to be re-considered (but what are the implications for current rights allocations)?

Proposal: As a default the current directed **sardine-anchovy** trade-off will be used, although other options may be considered at a later stage.

- The current risk definitions are:

  $risk_S$ - the probability that adult **sardine** biomass falls below the average adult **sardine** biomass over November 1991 and November 1994 at least once during the projection period of 20 years.

  $risk_A$ - the probability that adult **anchovy** biomass falls below 10% of the average adult **anchovy** biomass between November 1984 and November 1999 at least once during the projection period of 20 years.

  Need these be redefined?

Proposal: These should be re-checked for appropriateness.

- The present OMP uses essentially only abundance estimates from the May and November surveys. Should further input data also be considered, e.g. age or length information, measures of early/late recruitment, pre-recruit surveys, etc.

Proposal: The calculation of the TACs in the absence of Exceptional Circumstances will remain dependent on these survey observations. If Exceptional Circumstance thresholds are developed based on penguin numbers, these thresholds and the rules to be followed in the event that Exceptional Circumstances are invoked will incorporate data relating to the penguin population abundance.

- Provision needs to be made for deviation from the OMP when the conditions encountered fall outside that used in the initial design of the OMP.

Proposal: Follow the metarule process as outlined in MCM (2006) (as updated).

Detailed Issues:

- Should the constraints on inter-annual change in the TACs be readdressed? (Industry to comment.)

Proposal: Not at this stage, although input from the industry will be required in due course.

- Should the thresholds and rules for Exceptional Circumstances be reconsidered?

Proposal: Threshold levels and rules for **sardine and anchovy** will remain unchanged unless evaluations based upon the updated operating models indicate a need for substantial revision. A threshold level for penguin abundance may be proposed and accompanying Exceptional Circumstance rules developed.

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Table 1. Proposed Hypotheses and Robustness Tests for the Update to the Sardine Assessment. (Blank cells refer to no change from the above cell). In addition, two options for each hypothesis will be used when testing the OMP; one assuming the red-eye catch, and consequently the sardine bycatch associated with red-eye, remains at its recent average level over the projection period and one assuming the average red-eye catch will double over the next 5 years.

Hypotheses / Robustness Test	Number of Populations	Stock-Recruitment Model	Distributional Shift Over Time	Maturity Assumptions	Future Selectivity Assumptions
H1a	One	Hockey Stick	Option 1	Annual Maturity Ogives	Same as that prior to 2001
H1b			Eg. Option 2		
H1c			E.g. Option 3		
H2a-c		Beverton Holt	Options 1-3		
H3a-c		Ricker	Options 1-3		
H4	Two	Hockey Stick	N/A		
H5		Beverton Holt	N/A		
H6		Ricker	N/A		
H7a-c	One	Hockey Stick	Options 1-3		Same as that after 2001
H8a-c		Beverton Holt	Options 1-3		
H9a-c		Ricker	Options 1-3		
H10	Two	Hockey Stick	N/A		
H11		Beverton Holt	N/A		
H12		Ricker	N/A		
R1	Applied to selected one or two of above hypotheses			Maturity at Age 1	Depending on above hypotheses chosen

Table 2. Proposed Hypotheses and Robustness Tests for the Update to the ***Anchovy*** *Assessment. (Blank cells indicate no change from the above cell.)*

Hypotheses / Robustness Test	Number of Populations	Stock-Recruitment Model	Ageing Assumptions
H1	One	Hockey Stick	Prosch ALK
H2	One	Beverton Holt	Prosch ALK
H3	One	Ricker	Prosch ALK
R1	One	Applied to one of the above hypotheses	10cm cut-off in RLFs
R2	One	Applied to one of the above hypotheses	10.5cm cut-off in RLFs
R3	One	Applied to one of the above hypotheses	11cm cut-off in RLFs

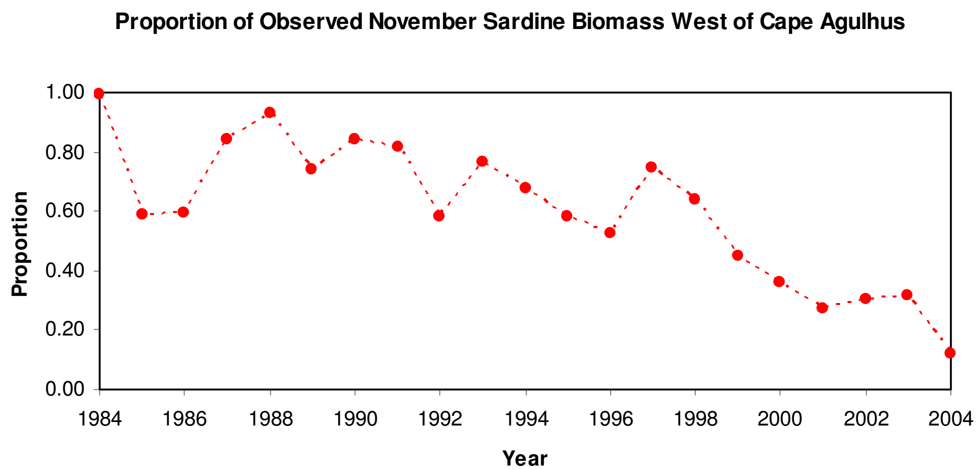


Figure 1. Proportion of observed uncapped (new target strength) November ***sardine*** *biomass west of Cape Infanta over time.*

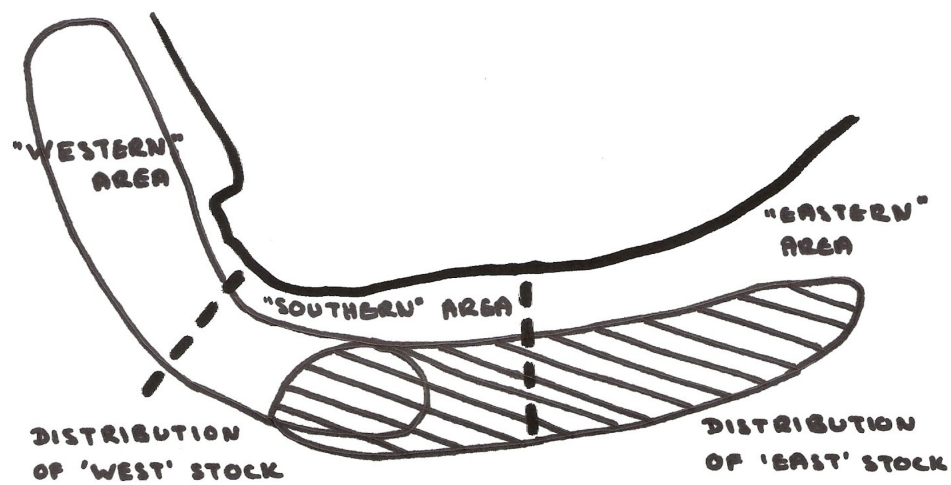
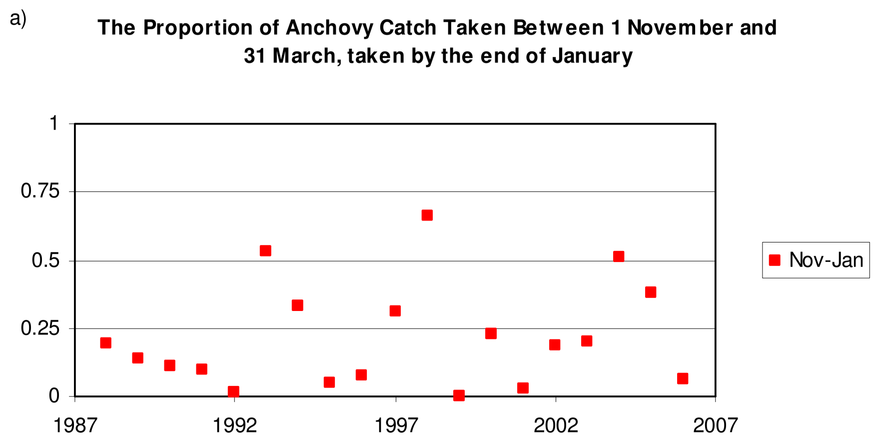


Figure 2. Schematic diagram indicating the single and two-population ***sardine*** *hypotheses, with the proposed "western", "southern" and "eastern" areas for spatial disaggregation. Boundaries between these areas need to be discussed. Given that the areas will be chosen in relation to penguin distribution, the "west" population might also overlap into the "eastern" area.*



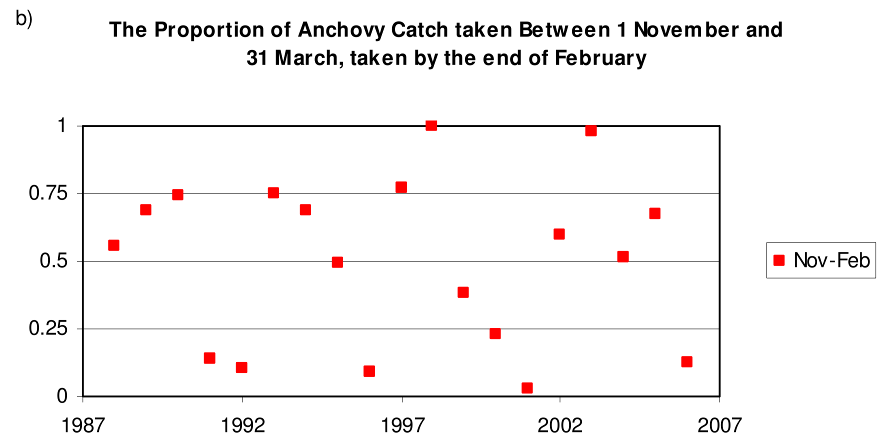
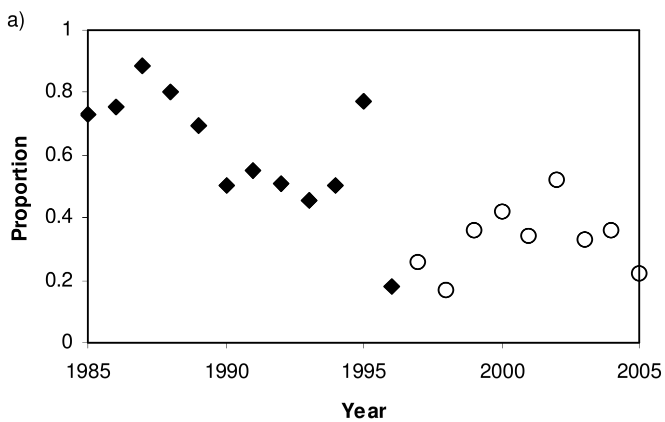


Figure 3. The proportion of anchovy catch which is taken from 1 November to 31 March each year split a) at 1 February and b) at 1 March.



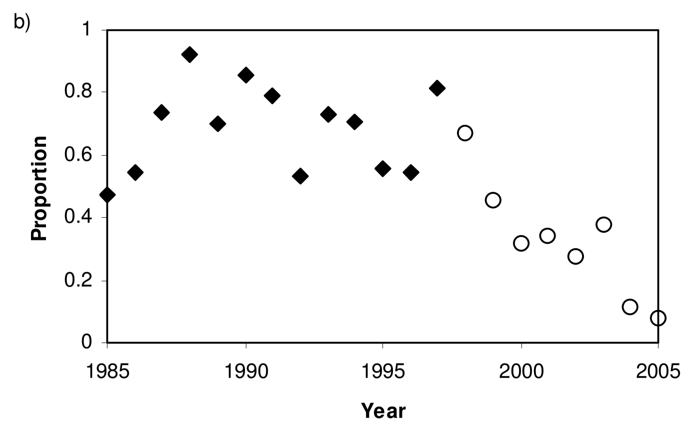


Figure 4. The proportion of observed capped (closed diamonds) and uncapped (open circles) a) anchovy and b) sardine biomass west of Cape Agulhas

Note: These figures will be updated to include a bar graph of the annual biomass once the capping calibration analysis is complete. This is to test whether the biomass was further east in years of large biomass only, i.e. as an "overflow".

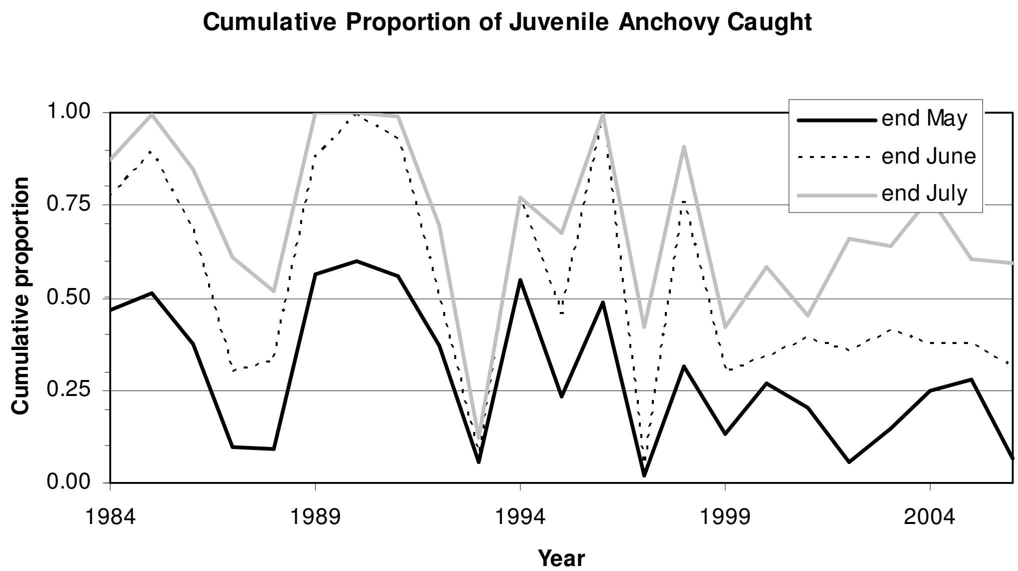


Figure 5. The annual (from 1 Nov to 31 Oct) cumulative proportion of juvenile anchovy caught by the end of May, June and July.