**Suggestions, comments and questions on penguin-pelagic fish interaction modelling work.**

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1. There is a clear trend in penguin abundance at Robben and Dassen Islands which is not explained by the model in MCM/2010/SWG-PEL/35. At least some of this is attributable to an eastward shift in pelagic fish stocks, but there is no explicit modelling of this or alternate causes for these trends. Document 35 does not present the estimates of the random effects in equations 12 and 13 (reproduced here as appendix A) , but they are likely to follow the pattern of abundance trends, since there is little or no room for alternative explanation of these trends in the model.
2. MCM/2010/SWG-PEL/35 contains 90 estimable parameters fitted to 109 observations. It is very likely over-fitted and thus of doubtful predictive ability, especially considering that a large number of these parameters are “random effects” and thus are of little explanatory value in understanding the underlying causes for trend in the population. We suggest that some model selection process be followed, starting with few estimable parameters, and testing the significance of added complexity in a step-wise manner using the AIC or some other model-selection criterion.
3. Table 12 of MCM/2010/SWG-PEL/35 shows a degradation of the AIC when Biomass dependence is included in the model. This is against a base case model with 86 parameters however. Of interest would be how the AIC responds to inclusion of biomass dependence into a more parsimonious base case model, i.e. given the large degree of flexibility to estimate year by year deviations from expected survival rate (for example), an additional dependence on biomass is not justified by the AIC. However it may well be justified if fewer parameters are used.
4. **If**, as mentioned above, the MCM/2010/SWG-PEL/35 model is relatively insensitive to the inclusion or exclusion of penguin-pelagic biomass interdependence, then it is likely also insensitive to differing a-priori assumptions about the strength of biomass dependence. For example with a strong biomass effect on breeding success and survival assumed a-priori, the log-likelihood function will perhaps be not very different from that under an assumption of no biomass dependence. We suggest therefore that a range of plausible values for the parameters of the biomass dependence of penguin success (including some which represent strong penguin-pelagic biomass interdependence) ( and ) see equations (12) and (13) in Appendix A) be assumed as fixed input in order to determine the sensitivity of the likelihood function.
5. At present the model of MCM/2010/SWG-PEL/35 appears to attribute all fluctuation in the annual counts to changes in survival rate – whereas it may be more appropriate to attribute a proportion of this variance to observation error. At present the observation error is limited to a constant under-count rate. A further possibility is variability in the proportion of mature adults that breed.
6. Various papers allude to at least two additional demographic factors being sensitive to food which are not reflected in MCM/2010/SWG-PEL/35.  These are (a) the proportion of penguins that breed at 4 years old, and (b) the number of chicks produced per pair.  The model described in MCM/2010/SWG-PEL/35 links food abundance to fledgling success and adult survival rates.  While fledging success is ultimately a combination of the number of chicks per pair and first year survival, it is proposed that concatenated effects such as this be delinked if delinked demographic data/estimates becomes available and is incorporated into the model.  Furthermore, changes in the proportion breeding at 4 years old is not obviously viewed as a combination of other effects, and should perhaps be explicitly addressed in the modelling work.
7. Direct estimates of adult survival rates using mark-recapture data should be used to inform the model, probably as the centres of prior distributions in the Bayesian context.
8. There is poor correlation between penguin abundance with sardine and anchovy abundance in stratum B as a whole (see Figs 1 and 2). However there is a strong correlation with pelagic catches close to Dassen Island (Fig 3), less so at Robben Island (Fig. 4). See also Table 1. It is reasonable to assume that the catches are indicative of local abundance in the vicinity of the islands in which case it appears that the penguin population sizes are indeed responsive to local food availability.
9. It remains somewhat unclear how the local density of fish is likely to respond in future to (a) the large scale condition of pelagic fish stocks and (b) the intensity of fishing close to islands. It seems that the MCM/2010/SWG-PEL/35 does not address these questions at present.
10. The “River Model” (Document MCM/2010/SWG-PEL/ Island Closure Task Team/10) does on the other hand address (b) above. The reduction in food availability due to fishing as estimated by this model is small. This is however under the assumption that the entire “river” of recruits is available to foraging penguins as it passes the islands. If less than 100% is available to penguins, then the effect of fishing on local food density is greater.
11. Document MCM/2010/SWG-PEL/ Island Closure Task Team/19 fits a model relating penguin abundance to local pelagic catch. It determines a positive correlation between these quantities and concludes that fishing is good for penguin success. The underlying premise of this model is that the fishing activity is the cause of the penguin abundance. We believe that this premise is false, and that it is much more likely that both penguin abundance AND fishing activity are consequents of local fish density, i.e. penguins do well because food is available, not because the fleet is fishing.
12. It is unclear how much of the uncertainty from the penguin model and from the pelagic fish models are being carried forward into the Bayesian projections of penguin abundance. For example, are stochastic realisations of future projections all coupled to a common (median) view of the past, or to a variety of possible historic scenarios?
13. Can iterate by iterate pelagic/penguin forecasts for ‘OMP-08’ and ‘no-catch’ be paired, allowing for the distribution of the **difference** between pelagic biomasses at the end of the planning horizon to be shown?   (As a supplement to Fig.9 of MCM/2010/SWG-PEL/35 which shows the separate distributions).
14. Document 35 suggests that we are unable to reject the null hypothesis that there is only a small benefit that can be achieved for the penguin population size by limiting the pelagic catch.  An important quantity relevant to the validity of such a conclusion is the power of the test, i.e. if the true effect is large (i.e. penguins quite sensitive to pelagic catches) what is the chance that one would have rejected the null hypothesis?  The random effects structure of the model, which absorbs the trends observed into year specific survivorships, would most likely make it very difficult to reject this null hypothesis. We suspect therefore that the power of the test is very low.  Some insight about the power of the test is provided by reporting model diagnostics (e.g. log-likelihood of the effect) where a large effect is incorporated, as is requested in an earlier point.

**References.**

Robinson W, Butterworth DS. 2010. Summary GLMs relating penguin demographics to pelagic catches close to islands and to pelagic abundance. Document MCM/2010/SWG-PEL/Island Closure Task Team/19.

Robinson W, Butterworth DS, Plaganyi EE, de Moor CL. 2010. Summary of penguin–pelagic fish interaction modelling during 2008. Document MCM/2010/SWG-PEL/35.

Butterworth DS, de Moor CL. 2010. A Very Simple Implementation of the “River Model” to estimate the Impact of Fishing on the Amount of Anchovy Available to West Coast Penguin Colonies. Document MCM/2010/SWG-PEL/ Island Closure Task Team/10.

**Table 1. Pearson correlation coefficients between pelagic fish catches at 5, 10 and 15 nautical mile radii, Stratum B biomass estimates and Penguin abundance at Dassen and Robben Islands 1987 to 2009. Coefficients with dark shading are significant at the 1% level, those with light shading are significant at the 5% level.**

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| --- | --- | --- | --- | --- | --- | --- |
|  | Dassen Female Moulters | Dassen Breeding pairs |  |  | Robben Female Moulters | Robben Breeding pairs |
| Dassen Female Moulters | 1 | **.770\*\*** |  | Robben Female Moulters | 1 | **.893\*\*** |
| Dassen Breeding pairs | **.770\*\*** | 1 |  | Robben Breeding pairs | .893\*\* | 1 |
| Dassen Sardine Catch 5 | .421 | .326 |  | Robben Sardine Catch 5 | .361 | .248 |
| Dassen Sardine Catch 10 | .366 | .223 |  | Robben Sardine Catch 10 | .389 | .268 |
| Dassen Sardine Catch 15 | .338 | .176 |  | Robben Sardine Catch 15 | .400 | .275 |
| Dassen Anchovy Catch 5 | .328 | **.628\*\*** |  | Robben Anchovy Catch 5 | .116 | .071 |
| Dassen Anchovy Catch 10 | .406 | .510\* |  | Robben Anchovy Catch 10 | .044 | .024 |
| Dassen Anchovy Catch 15 | .447 | .466\* |  | Robben Anchovy Catch 15 | .013 | .007 |
| Dassen S&A Catch 5 | .452 | **.690\*\*** |  | Robben S&A Catch 5 | .225 | .144 |
| Dassen S&A Catch 10 | **.567\*** | **.577\*\*** |  | Robben S&A Catch 10 | .201 | .131 |
| Dassen S&A Catch 15 | **.630\*** | **.526\*** |  | Robben S&A Catch 15 | .199 | .135 |
| Biomass Anch StrB | .507 | .013 |  | Biomass Anch StrB | .117 | .142 |
| Biomass Sard StrB | .181 | -.088 |  | Biomass Sard StrB | -.023 | .023 |
| Biomass A+S StrB | .416 | -.051 |  | Biomass A+S StrB | .052 | .098 |

AppendixA: The Robinson et al Model of Penguin adult survival (12) and breeding success (13)) as presented in Doc.35.

   (12)

   (13)

**Figure 1. Pelagic Biomass (Sardines+ Anchovies) in Stratum B (Cape Point to Cape Columbine) in thousands of tons as estimated by the acoustic surveys and Number of breeding pairs of penguins counted at DASSEN ISLAND**

**Figure 2. Pelagic Biomass (Sardines+ Anchovies) in Stratum B (Cape Point to Cape Columbine) in thousands of tons as estimated by the acoustic surveys and Number of breeding pairs of penguins counted at ROBBEN ISLAND**

**Figure 3. Pelagic Catch (Sardines+ Anchovies) taken within a 5 mile radius of DASSEN ISLAND, and number of breeding pairs of penguins counted at DASSEN ISLAND.**

**Figure 4. Pelagic Catch (Sardines+ Anchovies) taken within a 5 mile radius of ROBBEN ISLAND, and number of breeding pairs of penguins counted at ROBBEN ISLAND.**

