ON PLANS FOR PENGUIN ANALYSES ARISING FROM SOME OF THE IWC PANEL: RECOMMENDATIONS

D.S. Butterworth

MARAM, Department of Mathematics and Applied mathematics, University of Cape Town

The first recommendation by the December 2014 IWS Panel related to the penguin analyses presented in respect of the GLM analyses of penguin response variables, and is to conduct a simulation study of the extent of bias that might be present in these analyses as a result of the "abundance affects catch" mechanism raised in MARAM/IWS/DEC14/Peng/A10:

> "MARAM/IWS/DEC14/Peng/A10 provides an analysis indicating that the application of fixed effects GLM-type models (such as those in MARAM/IWS/DEC14/Peng/B12) to a system in which both local biomass and catch can impact penguin populations will lead to biased outcomes. The Panel notes that the model on which MARAM/IWS/DEC14/Peng/A10 is based does not match exactly the error structure on which the analyses of MARAM/IWS/DEC14/Peng/B12 are based. In addition, some of the analyses in MARAM/IWS/DEC14/Peng/B12 are based on a random effects and not a fixed effects structure. It might be possible to evaluate potential biases for models such as those in MARAM/IWS/DEC14/Peng/B12 using analytical methods. However, a simpler way to examine this issue would be through simulations; and the Panel recommends that simulations to evaluate bias in estimation methods be explored, which are conditional of the types of scenarios reflected in MARAM/IWS/DEC14/Peng/A10."

In considering how best to address this and to proceed overall, it is also necessary to take account of the factors contributing to the differences between results obtained by Group A and Group B, as summarised in Table 1 of the IWS Panel's report. These include in particular (comparing Group A with Group B):

i) Use of individual data versus annual means

ii) Use of data from 2008 onwards only versus all data

iii) Use of closure versus use of catch size as an explanatory variable.

An extended version of Table 1 of the IWS Panel's report is shown below as Tables 1 and 2 to provide insight into the separate effects of these factors. The following patterns are evident (though there is less discrimination for Bird/St Croix than for Dassen/Robben islands given the fewer data types available for the former pair).

a) There is trend of closer agreement between the Group A and Group B results as one changes from "Catch/All years" towards "Closure/2008+ only". This is particularly so for Robben island, but Dassen Island is an exception. (See **Difference**)

b) The preponderance of GLM results for Dassen and Robben islands that suggest reduction of fishing would have a negative effect arise from considering a longer period of data. (See **Effect estimates**)

c) With **catch** as the explanatory variable, there are not that many cases where ability to detect a statistically significant result is forecast even given continued collection of data for the next 20 years. However with **closure**, the forecast for such successes in the next 20 years is NONE. (See **Detection**)

The result in c) must be considered with a number of caveats in mind.

I) Power would be higher if results for a 80% rather than 95% level had been reported.

II) However results for autocorrelation estimates in FISHERIES/2015/MAY/SWG-PEL/18 indicate that the results shown under **Detection** in Tables 1 and 2 below are over-optimistic.

III) Use of catch rather than closure clearly prides more contrast and hence better detection power. However the possible bias effect raised in MARAM/IWS/DEC14/Peng/A10 would be less for use of closure than for use of catch. This is amongst the reasons why the simulation study has been suggested by the IWS Panel.

In planning for this simulation study, which we would hope to undertake later in the year, the following aspects will need consideration.

1) The merits of focussing primarily on closure or on catch, and on all years or on 2008+ only.

2) If available, use of individual data rather than unstandardized means only is to be preferred. This can be effected in two ways.
    i) Use of a single step model, as for example in MARAM/IWS/DEC14/Peng/A3.
    ii) Use of a two step process as is conventional in stock assessments, but where, for example, rather than using a nominal value for the single mean CPUE index for each year, this is first GLM/GLMM standardised to take account of covariates such as the time within the year when each individual observation was made.

3) In a simulation testing context, approach 2)ii) would be enormously simpler to implement, but requires consideration of how best to model separate sampling and process errors and to choose appropriate distributions for each (though that would need to be discussed for approach 2)i) too).

4) While MARAM/IWS/DEC14/Peng/A10 pointed to the existence of a potential bias effect, it did not condition on the data available, as required to provide estimates of the likely size of this bias in practice. The simulations will need to be conditioned on the data, and in particular on the size of the "abundance affects catch" effect, for which the results in MARAM/IWS/DEC14/Peng/B9 should be helpful.

REFERENCES

FISHERIES/2015/MAY/SWG-PEL/18: Butterworth, D.S. and Moosa, N. A note on the extent of aiutocorrelation of residuals in the GLM analyses of penguin response variables in the simulation study 8pp.

MARAM/IWS/DEC14/Peng/A3: Hagen, C. *et al.*. Annex 2: An evaluation of the evidence of the impact of fishing closures around breeding colonies of African Penguins. 20pp.

MARAM/IWS/DEC14/Peng/A10: Bergh, M. Further clarification of the biases in and interpretation of regressions where catch is a predictor of penguin response. 21pp.

MARAM/IWS/DEC14/Peng/B9: Butterworth, D.S., Moosa, N. and Johnston S.J. Do catch-based indices provide a reliable index of annual recruitment for the South African anchovy population? 21pp.

MARAM/IWS/DEC14/Peng/B12rev: Butterworth, D.S., Furman, L.B., Robinson, W.M.L. and Johnston, S.J. 2014. Updated analyses of the results from the Island Closure Feasibility Study for the Dassen/Robben and St Croix/Bird Island pairs given revised data and responses to matters raised in documents. International Stock Assessment Review Workshop document. 68pp.

Extension of Table 1 of the December IWS Report: Penguin response to closure from consideration of data from the period from 2008 onwards by Group A, and to reduction of catches from consideration of data for all years from Group B. Results shown are self-reported by the two groups. Symbols refer to the effect on penguins, rather than the effect directly on the trait measured.

Extensions are as follows, and follow from results given for the random effects model in MARAM/IWS/DEC14/PENG/B12rev:

a) Group B results, originally given for results based on "**catches**" and for data from "**all**" years, are extended to all combinations of **catches/closure** and **all years/2008+ only**. Note that the original Group B results are modified slightly given use of a more objective algorithm for categorisation.
b) **Difference** refers to a measure of the combined comparable results for Group A compared to those for various Group B applications, counting one unit for each difference along the scale: +* / + / 0 / - / -* .
c) **Effect estimates** refers to a count of the signs of the fishing effect estimates as regards a penguin response to closure/catch reduction. Note that these refer to pairs of colonies (Dassen/Robben or Bird/St Croix) analysed in combination.
d) **Dectection** refers to the power analysis, and gives the number of cases where an effect statistically significant at the 5% level either has already been detected, is projected to be detected within the next 20 years, or would not be detected within the next 20 years.

Table 1: Extension of Table 1 of the December 2014 IWS Report for Dassen and Robben Island

	Dassen Island					Robben Island				
	Group A	Group B				Group A	Group B			
		Closure/2008+	Closure/All	Catch/2008+	Catch/All		Closure/2008+	Closure/All	Catch/2008+	Catch/All
Chick Condition	-	+	+	-	0	+*	+	+	0	-
Chick Growth	+	-	-*	+	0	+	-	-	-	-
Foraging Trip Duration	-*	-*	-*	+	-*	+	+	-	-	-*
Foraging Path Length	-	+	-	+	-	+	-	-	-	-*
Maximum Foraging Distance	+					+				
Active Nest Proportion		-	-*	0	-*		-*	-*	-*	-*
Fledging Success		+	-	+	-	+*	+	+	0	+*
Difference		6	5	5	2		5	8	10	11
Effect estimates + : -		18 : 18	9 : 27	51 : 57	22 : 86					
Detection Already		3	9	2	5		3	3	2	5
≤ 20 years		0	0	2	5		0	0	3	2
>20 years		15	9	14	8		15	15	13	11

Table 2: Extension of Table 1 of the December 2014 IWS Report for Bird and St Croix Island

	Bird Island					St Croix Island				
	Group A	Group B				Group A	Group B			
		Closure/2008+	Closure/All	Catch/2008+	Catch/All		Closure/2008+	Closure/All	Catch/2008+	Catch/All
Chick Condition	+					-*				
Chick Growth	+					-				
Foraging Trip Duration	+*	+	+	-*	-	+	+	+	+*	+
Foraging Path Length	+	-	-	-*	-	+*	+*	+*	+*	+*
Maximum Foraging Distance	+*					+				
Active Nest Proportion										
Fledging Success										
Difference		2	3	7	5		0	0	1	0
Effect estimates + : -		1 : 3	1 : 3	6 : 6	6 : 7					
Detection Already		0	0	1	0		1	1	1	1
≤ 20 years		1	1	0	0		0	1	0	0
>20 years		1	1	1	2		1	0	1	1