CHAIR'S INTRODUCTION TO DOCUMENTS FROM THE TECHNICAL TEAM ON THE PENGUIN ISLAND CLOSURE EXPERIMENT

Kevern Cochrane, Chair, Penguin Island Closure Task Team[1]

1. Introduction and Structure of Overall Report

This report and the associated documents report on the work undertaken and results obtained by the penguin island closure Technical Team (TT) in accordance with the recommendations from the 2015 IWS meeting, in particular recommendation A2, as well as on some preliminary work on A5.

The report includes the following documents in which the details are provided:

MARAM/IWS/DEC16/Peng Clos/P1a and P1b - 'Penguin power analyses using the approach recommended by the international panel: methods and results'.

This includes the methods and results from the statistical power analysis of the island closure experiment undertaken as the response to recommendation A.2 of the 2015 international panel. The power analysis reported in the document is the culmination of work undertaken under the auspices of the TT since its formation in mid-2015.

MARAM/IWS/DEC16/Peng Clos/P2 - 'A Bayesian approach to understand the effect sizes, uncertainty and demographic impact associated with purse-seine fishing closures around African penguin colonies'.

This is a report submitted by Richard Sherley in response to the request by the TT to determine objective thresholds for penguin response variables for use in the power analysis, and as a start towards following-up on Panel recommendation A.5 to use Bayesian methods to fit operating models.

MARAM/IWS/DEC16/Peng Clos/P3 - On the use of aggregated vs individual data in assessment models.

MARAM/IWS/DEC16/Peng Clos/P4 – "Additional analysis suggested in response to differences in variance estimates in Sherley (2016) and Ross-Gillespie & Butterworth (2016)" by Richard Sherley has been provided as background document. It describes a number of analyses that were undertaken to facilitate comparison between the estimates of precision arising from different treatments of data in the analyses described in documents P1 and P2.

Sensitivity of the power analyses reported in P1a and b to the differing estimates of precision (obtained from P4) will be reported as WP1 during the course of the workshop.

[1]The Task Team consisted of M.O. Bergh, D.S. Butterworth, K.L. Cochrane (chair), T.L. Morris, R.B. Sherley and H. Winker. A. Ross-Gillespie undertook, on behalf of the Team, all the analyses and tests, under the supervision of D.S. Butterworth.

Appendix 1. Relationship between Changes in Penguin Population Growth Rate and Changes in the Fledging Success Response Variable leading to a value for the corresponding Threshold

2. The Process followed by the Technical Team

Implementation of the Panel recommendations involved the following steps:

a. Finalisation of data to be used and standardisation of raw means for co-variates.

No new data were made available for the power analysis further to those listed in FISHERIES/2015/OCT/SWG-PEL/PENG/DATA1 (Janet Coetzee, October 2015). The standardisation exercises conducted are detailed in MARAM/IWS/DEC16/Peng Clos/P1a.

b. Use of OBM to indicate redistribution of catch on closure.

This is addressed in a separate document MARAM/IWS/DEC16/Peng/BG2 (see specific response there to recommendation A.2.10).

c. Identification of effect sizes.

MARAM/IWS/DEC16/Peng Clos/P2 includes a report on investigations into thresholds for chick condition and chick survival data for use in the power analysis. While those analyses provided interesting information on the relationships between effect sizes and mean population growth rate (λ), the TT concluded that the previously agreed value of 1% as the pre-specified change in population growth rate should be retained. MARAM/IWS/DEC16/Peng Clos/P1a describes the relationship between changes in fledgling success and changes in the growth rate of the penguin population and how this provides the basis for estimation of the corresponding threshold given the pre-specified change of 1%.

d. Conduct of computations and results.

These are described in MARAM/IWS/DEC16/Peng Clos/P1a and b

e. The 2015 IWS made recommendation A.5 "Fit the operating models (not necessarily the estimation models) using Bayesian methods…."

MARAM/IWS/DEC16/Peng Clos/P2 reports on initial work undertaken by Richard Sherley to implement this recommendation.

3. A question on use of data for the power analysis: aggregated or individual data?

An important difference between the analyses reported in MARAM/IWS/DEC16/Peng Clos/P1a and b and MARAM/IWS/DEC16/Peng Clos/P2 is in the data that were used in each. In the case of the power analysis (MARAM/IWS/DEC16/Peng Clos/P1a and b**)**, the approach used fits the operating model and the estimation model to the annual means of the data, as had been agreed by the TT and Panel. For the analyses reported in MARAM/IWS/DEC16/Peng Clos/P2, the individual observations were used. Opinions within the TT differ on which approach is better but, for the case for which a comparison was possible from the original documents, it seems likely that the different approaches lead to considerable differences in the measure of precision for the closure effects. This would be

likely to influence the results of a power analysis. The TT noted, based on the results available in these two documents for which comparisons are possible, that the two approaches seem likely to lead to similar general conclusions.

Documents MARAM/IWS/DEC16/Peng Clos/P3 and P4 address this issue.

Appendix 1. Relationship between Changes in Penguin Population Growth Rate and Changes in the Fledging Success Response Variable leading to a value for the corresponding Threshold

If penguin reproductive maturity is assumed to occur at age 4, the equation for the mature female component of the population (numbering N in year y) may be written:

$$N_{y+1} = N_y S + H_{y-3} S^3 N_{y-3} \quad (1)$$

where S is the mature female annual survival proportion and H is a measure related to the product of egg production and chick survival to the end of the first year (which incorporates fledging success). In a situation where the population is changing at a steady rate:

$$\eta = N_{y+1}/N_y \quad (2)$$

then

$$\eta^4 = \eta^3 S + HS^3 \quad (3)$$

which if H changes by ΔH leads to a corresponding change in penguin growth rate $\Delta\eta$ given by:

$$\Delta\eta = \frac{S^3}{4\eta^3 - 3\eta^2 S}\Delta H \quad (4)$$

The Task Team decided on 1% as the pre-specified change in population growth rate (management objective), effectively then setting $\Delta\eta$ = 0.01. Table 1 below gives values of $\Delta H/H$ for ranges of plausible values for S and η which yield feasible solutions – note then that if changes in fledging success dominate any changes in η, then $\Delta H/H$ becomes equivalent to a change in the value of *ln*(fledging success). For much of the Table, the value 0.1 provides a good approximation to $\Delta H/H$. Accordingly power computations were performed for a Threshold value of -0.1 in λ/δ (the effect of fishing parameters) space.

Table 1: $\Delta H/H$ values when $\Delta\eta$ = 0.01

η \ S	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
0.7	0.143	0.244	N/A	-	-	-	-	-
0.75	0.107	0.140	0.241	N/A	-	-	-	-
0.8	0.088	0.104	0.137	0.237	N/A	-	-	-
0.85	-	0.085	0.102	0.135	0.235	N/A	-	-
0.9	-	-	0.083	0.100	0.133	0.232	N/A	-
0.95	-	-	0.072	0.082	0.098	0.132	0.231	N/A
1	-	-	-	0.070	0.080	0.097	0.130	0.230
1.05	-	-	-	-	0.069	0.079	0.095	0.129
1.1	-	-	-	-	0.061	0.067	0.077	0.094
1.15	-	-	-	-	-	0.059	0.066	0.076
1.2	-	-	-	-	-	-	0.058	0.065