A COMPOSITE PROPOSAL RELATED TO THE PENGUIN COLONY CLOSURE PROGRAMME[1]

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PROPOSAL

A: Dassen and Robben islands

1) The feasibility study should be concluded immediately.

2) Closures around either island should be brought to an end immediately.

3) The hydroacoustic surveys of small pelagic fish in the near vicinities of these islands should end immediately, and the results to date should be analysed. [See also B 2) below.]

4) Monitoring of measures related to penguin reproductive success should continue at these islands, with priority being given to those measures for which the feasibility study has indicated the greatest power to provide statistically significant results in the near future.

5) The situation should be kept under review, allowing *inter alia* for the possible resumption of a closure programme should future evidence indicate that this would benefit penguins to a meaningful extent.

B: St Croix and Bird islands

1) The feasibility study should continue until a power analysis has been completed, following which culmination of the study followed possibly by a closure experiment should be considered.

2) At present the regions off St Croix are open and off Bird island closed for 2014. This situation should be reversed immediately.

3) Resources currently used for surveys of fish in the near vicinities of Dassen and Robben islands should immediately be focussed instead on St Croix and possibly also Bird island.

4) The situation should be kept under review, with possible revisions for 2015 and beyond to be considered before the end of 2014.

[1] The ICTT meeting on 10 March failed to reach the stage where a full set of alternatives proposals for the way forward on island closures had been developed. I consider that certainly one of these differing proposals – specifically that to lift the current closure around Dassen island – requires urgent decision; this is because we are entering the relative brief part of the year when recruiting anchovy are available to the fishery on the west coast and fishing opportunities are less hampered by inclement weather. Accordingly I advised the ICTT that I would, as a member of the PWG, be putting certain penguin-related proposals directly to the PWG; the ICTT Chair confirmed to that meeting that I was entitled to do so.

MOTIVATIONS

A: Dassen and Robben islands

The feasibility study should be concluded immediately.

The purpose of the feasibility study has been to estimate the residual variances associated with penguin response variables with sufficient precision that experimental power can be determined with adequate reliability. This is to be able to decide on whether an experimental closure programme could yield definitive conclusions regarding the impact of fishing close to island colonies on penguin demographics within a realistic time span (which would realistically be considered to be within one or possibly two decades).

The results in Robinson and Butterworth (2014a) indicate clearly that such a determination is now possible for Dassen and Robben islands for the chick condition and active nest proportion monitoring variables. This remains the case when improved (though larger) estimates of these variances are considered, as reported in the new Addendum to that document. The estimates of residual variance and the associated precision for the other four variables (see Table 1 of that Addendum) are sufficiently similar (indeed also generally rather lower, which enhances this argument) to those for these two variables as to indicate that the same conclusion would apply for the other four as well.

The PWG's 2010 recommendations concerning extension of the feasibility study envisaged its continuation until the end of 2014, but included the statement:

> "The feasibility study may be terminated before the end of 2014 should the data allow sufficiently precise estimation of variance parameters to allow the power of a possible subsequent closure experiment to be reasonably estimated before then."

Given that this requirement of adequate precision has been achieved, it accordingly follows that the feasibility study can now be concluded and an island closure experiment commenced for these two islands.

Closures around either island should be brought to an end immediately.

The purpose of the island closure experiment is to determine whether and to what extent suspension of pelagic fishing in the neighbourhood of penguin breeding colonies might impact penguin dynamics. The monitoring indices to be considered for this purpose were most recently agreed at the ICTT meeting on 12 November 2012. The GLM method of analysis to be used was endorsed by International Review Panel for the 2010 International Fisheries Stock Assessment Workshop (Parma *et al.*, 2010). The results are reported in Robinson (2013).

These results (see Table 3.10 of Robinson, 2013) indicate that for 144 GLMs conducted across six monitoring indices, 16 indicate statistically significant positive effects at the 5% level for aspects related to penguin reproductive success, while none indicate similarly significant negative effects. Overall some 80% of the GLMs indicate positive (though not

always statistically significant) effects. While the proportion of statistically significant results is overstated somewhat because of the Bonferroni correction associated with multiple tests has not been effected, and the tests themselves are not independent because of the use of common or positively correlated data, nevertheless overall these indications are sufficiently strong to conclude at this time from these results that in terms of the feasibility study alone together with the pre-agreed (at the 2010 International Workshop) analysis method, closure of the neighbourhoods around these two islands to pelagic fishing is unlikely to benefit penguin reproduction and may even disadvantage this.

From this it follows that there is no need to continue with a closure experiment at these two islands, and both islands should be immediately opened to pelagic fishing, given advice (though these need documented quantitative support) that these closures impact negatively on the pelagic fishing industry.

Supporting evidence

Supporting evidence for this conclusion, and rationale for the associated action, are provided by three other sources.

a) The penguin-fish interaction model for Robben island developed by Robinson (2013 – see Fig. 4.8) shows effectively no dependence of reproductive success on the magnitude of anchovy recruitment. This result is perhaps of even greater importance than those above which relate only to components of the reproduction process, as there may be negative correlations amongst measured and unmeasured components of that process, whereas Robinson's model of the dynamics provides results for the overall net effect on the laying-to-end-of-first-year-survival process.

b) The "river" model of anchovy recruitment reported by Butterworth and de Moor (2010) indicates that fishing since 2000 decreased the density of anchovy that would otherwise have been available to the penguins at Robben island by typically only some 10% (and at most 20%), so that any related negative impact on penguins would be expected to be small at most.

c) Results in Robinson and Butterworth (2014a – see addendum Table 3) indicate that even if the closure program stops, the data contrasts in forthcoming years would be sufficient that achievement of statistical significance at the 5% level for results from certain monitoring indices regarding the impact of fishing on penguins would likely be delayed by only rather few years.

Queries and responses

a) The variant of the GLM analyses of Robinson (2013) that include biomass estimates as well as catch close to an island as explanatory variables has been queried in principle because of potential high correlation between these two quantities. However this correlation is typically only about 0.3, and not such as might render the estimates from the analyses conducted unstable (see Robinson, 2013, Fig. 2.4 and discussion on pg. 81).

b) The Weller *et al.* (2014) model of the Robben island penguin population argues that "although restricting fishing around the island was on average beneficial to the

penguin population, variability in population growth introduced by fluctuations in prey biomass tended to mask the outcome" – a conclusion completely contrary to that indicated in the two quite different types of analyses in Robinson (2013) which are discussed above. Robinson and Butterworth (2014b) drew attention to the fact that these conclusions by Weller *et al*. depended critically on single parameters for the effects of food availability on egg and on chick survival, and that the values of each of these parameters had been set to 0.5 based on "expert opinion". They pointed out that evaluation of the credibility of the selection of those values required an explanation of how these experts were able to estimate the magnitudes of these effects, and with results which must differ appreciably from most of the corresponding effects estimated directly from data by Robinson (2013), because of the diametrically opposed conclusions of the two analyses. In response, at the ICTT meeting on 10 March, it was advised that these selections had been made based on relationships between measurements of these survival rates and the "availability" of fish near Robben island, as reported in Sherley *et al*. (2013) – on subsequent investigation it became evident that the measure used for this "availability" was catch in the vicinity of the island - see Table 2 and Fig. 3 of the paper. However, there are several problems with this explanation:

i) There remains no clarification of exactly how the information in, for example, Fig. 3 of Sherley *et al.* is converted into the form and core parameter value selected for the penguin egg survival *vs* prey abundance used in the Weller *et al.* model, as shown in Fig. 1 of Robinson and Butterworth (2014b).

ii) Fundamentally Sherley *et al.* are arguing that the positive correlation between penguin egg survival at and the anchovy catch near to Robben island shows that penguin survival is better when anchovy abundance is higher. But equally, had a negative correlation been found, it could have been argued that higher catches had a negative effect on penguins through reduction of the prey abundance that would otherwise have been present. Given only monitoring index and local catch information, **neither** inference is defensible, because the two possible effects are confounded and cannot be distinguished. It is removal of this confounding that necessitates the GLM approach applied to nearby island pairs that was originally put forward by Brandão and Butterworth. (2007), and subsequently endorsed by the International Review Panel (Parma *et al*., 2010). Accordingly it is this approach which is applied by Robinson (2013).

iii) Robinson (2013 – see Fig. 2.4 and discussion on pg. 81) reports that correlation between catches close to islands and survey estimates of abundance of the prey species concerned is typically only about a low value of 0.3, which would render the ability of the process referenced in i) above to achieve a precise estimate of the parameter in question all the more difficult.

iv) Essentially Sherley *et al.* are arguing that abundance of a pelagic fish species is (near) proportional to CPUE (where in this instance the effort remains constant over time). Yet assuming such relationships is generally shunned worldwide (including in South Africa) in the assessments of populations of stocks of small pelagic species, because of known likely biases and general unreliability.

v) Alternatively one can view the Sherley *et al.* approach as one reflecting endorsement of a catch-only based assessment. The reliability of such methods has been seriously questioned for many reasons (e.g. Daan *et al.*, 2011; Carruthers et al., 2012).

In summary then, it is now clear what the approach that underlay the expert opinion used to determine the core parameter value for the egg survival *vs* prey abundance relationship adopted by Weller *et al.* (2014) is one which is completely flawed (the same conclusion would follow for the chick survival relationship). This is fatal to the results claimed by that paper in regard to the positive impact of restricting fishing around Robben island on penguins[2].

c) Pichegru *et al.* (2014) claim that the results [of the GLM analyses] from the feasibility study have been compromised by closure periods of inadequate length. However those authors have been unable to provide the requested specifications of the mechanisms they hypothesise to lead to this in the mathematical form needed to clarify exactly what they are and how they are proposed to operate, so that their plausibility could be properly assessed.

<u>The hydroacoustic surveys of small pelagic fish in the near vicinities of these islands should end immediately, and the results to date should be analysed.</u>

The proposal for an immediate cessation arises from resource limitations and priority considerations. As discussed below, St Croix island is seen as the highest priority for any surveys of this nature which available resources might admit.

These surveys at Robben and Dassen islands have continued for some years now, so that a time series of data is available. Before perhaps later considering extending these surveys, there is a need to ascertain what power they might have to answer the questions which they were initiated to address:

a) How well does local prey abundance correlate with that in the larger corresponding stratum in the mid-year recruit and November biomass surveys for small pelagic fish?

b) What are the prospects that such data might enable improved estimation of the impact of fishing near these islands on penguin reproductive success – possibly through application of GLM methods similar to those applied by Robinson (2013)?

<u>Monitoring of measures related to penguin reproductive success should continue at these islands, with priority being given to those measures for which the feasibility study has indicated the greatest power to provide statistically significant results in the near future.</u>

[2] This is not to say that there is not some valuable work in Weller *et al.* (2013), though equally the aspect elaborated here is not the only serious problem in that paper. This one problem only has been discussed here, as that alone is sufficient to demonstrate that the approach put forward in the paper **<u>cannot</u>** provide any reliable information on the issue of pertinence here – specifically the impact on penguin dynamics of pelagic fishing close to breeding colonies.

For the reasons given immediately below, some monitoring of penguin indices related to reproduction should continue at the two islands There is though a core consideration of efficiency, given resource limitations which might render continuation of all existing monitoring series not possible. In such circumstances prioritisation will be needed, and results from the power analysis would seem the most obvious and appropriate primary basis to assign such priorities.

The situation should be kept under review, allowing *inter alia* for the possible resumption of a closure programme should future evidence indicate that this would benefit penguins to a meaningful extent.

Although considered in their totality, the results from the feasibility study point clearly towards a conclusion of little if any benefit for penguin reproductive success arising from pelagic fishing closures around islands, one cannot exclude the possibility (though currently slight) that further results might provide a basis to reverse this inference. Thus at least some monitoring series should continue, with their results regularly reviewed.

In this context one again notes the results in Robinson and Butterworth (2014 – see addendum Table 3) which indicate that even if the closure program stops, the data contrasts in forthcoming years would be sufficient that achievement of statistical significance at the 5% level for results from certain monitoring indices regarding the impact of fishing on penguins would likely be delayed by only rather few years.

B: St Croix and Bird islands

The feasibility study should continue until a power analysis has been completed, following which culmination of the study followed possibly by a closure experiment should be considered.

A power analysis similar to that conducted by Robinson and Butterworth (2014a) for monitoring indices for Dassen and Robben islands has not yet been conducted for the indices available for St Croix and Bird islands. Consistent with the PWG's 2010 recommendation on the feasibility study, these analyses would need to be conducted and reviewed before a decision as to whether or not the feasibility study has been satisfactorily completed could be made.

At present the regions off St Croix are open and off Bird island closed for 2014. This situation should be reversed immediately.

In contrast to the GLM results for Dassen and Robben island in Robinson (2013), those for St Croix (see Table 3.8) suggest negative impacts (though not significantly so) of fishing around the colony for 11 out of 12 scenarios examined. In contrast, all 12 estimates for Bird island are positive. These results are consistent with those from a similar GLMM approach applied by Pichegru *et al*. (2014), which yields statistically significant negative estimates for St Croix island.

Given these quite strong indications of a negative impact of pelagic fishing on penguins at St Croix island, but none at Bird island, the appropriate precautionary action would clearly be to immediately reverse the current position for 2014 which has the near vicinity of St Croix island open but of Bird island closed to pelagic fishing. The computations in Robinson and Butterworth (2014a) indicate that this would not seriously compromise attainment of the objectives of the feasibility study.

Resources currently used for surveys of fish in the near vicinities of Dassen and Robben islands should immediately be focussed instead on St Croix and possibly also Bird island.

Despite the clear statistical evidence cited above, it remains mysterious that the fish catches made near St Croix island are almost entirely of sardine (an average of 95% over the last five years), whereas the penguin diet reportedly consists almost entirely of anchovy (97%). The explanation offered by Pichegru *et al.* (2014) that adult penguins first eat sardine to sustain themselves, and then target anchovy to feed their chicks, is hardly convincing *a priori*.

For this reason, it seems that St Croix island should be the priority choice for attempts to advance understanding of the penguin-pelagic fishing interaction, and accordingly resources available for small scale pelagic fish surveys around islands with penguin colonies should first be targeted at St Croix.

The situation should be kept under review, with possible revisions for 2015 and beyond to be considered before the end of 2014.

The paragraphs immediately preceding evidence that there is not as yet a very clear understanding of the penguin-pelagic fishery interaction at St Croix island . Accordingly it would be inappropriate to make decisions on closure programs for the longer term immediately, but rather the situation should be kept under review, with subsequent decisions informed by the results of further scientific studies at St Croix (and Bird) islands and their vicinities.

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