Proposed Performance Statistics for evaluating the effects of pelagic fishing on African Penguin populations

Éva Plagányi and William Robinson
Department of Mathematics and Applied Mathematics, UCT

INTRODUCTION

Given the move towards adopting an ecosystem approach to fisheries in the pelagic sector, the new pelagic OMP needs to be tested in the light of not only the risk parameters as considered previously, along with catch statistics for the anchovy and sardine populations, but also parameters denoting risk to the African penguin population(s) *Spheniscus demersus.* Penguins have been chosen as a key predator species to consider because of their conservation status, and because of their potential sensitivity to changes in pelagic fish abundance and distribution as a consequence of their land-based breeding sites. A model of penguin dynamics has been developed for use as a penguin Operating Model to be coupled to the pelagic fish OMP. This paper summarises the proposed implementation and suggests performance statistics for use in evaluating the impact on penguins of predicted future pelagic fish trajectories under alternative harvest strategies (OMPs).

COUPLING THE PELAGIC OMP AND PENGUIN MODEL

For a given management procedure, 1000 future plausible biomass and recruitment trajectories are produced for each of sardine and anchovy. Assuming functional relationships between these quantities and penguin parameters (as described in an accompanying document MCM-2008-SWG-PEL-21b), the penguin model can be projected forwards under each of these 1000 scenarios, and the risk to penguins evaluated as described below.

EVALUATING RISK TO WHICH PENGUIN POPULATIONS?

Two sets of penguin colonies have been proposed, corresponding to the “western” and “eastern” areas of the sardine model as there are virtually no penguins in the “southern” area. Work described here focuses on the “western” area only. Previous analyses have shown that past trends in penguin abundance at Robben, Dassen, Boulders and Dyer Island (and perhaps even Nelson Mandela Bay) are best explained when taking movement of juvenile birds between these colonies into account. However, numbers at Boulders have now steadied and the numbers at Dyer Island are relatively small, so that these two colonies will be ignored in projecting forwards.

Given likely different functional relationships between penguins and their fish prey at Dassen and Robben Islands, we propose to simulate penguin populations separately for each of these two colonies when doing forward projections, and to assume no future movement between these two colonies. However, we propose summing the

resultant numbers at each of Dassen and Robben, and using the following as our penguin variables:

a) The total (Dassen and Robben) number of penguin moulters per year.
b) The total (Dassen and Robben) number of breeding pairs per year.

Although results will be presented in terms of both these variables as indices of penguin abundance, we propose using the first as the primary variable because it indexes the population as a whole, which is the unit of conservation concern, rather than a component that may vary appreciably in relation to factors driving the proportion of birds choosing to breed each year in ways that are not fully understood.

DEFINING RISK METRICS FOR PENGUINS

Risk can be quantified as the probability of penguin abundance (either in terms of the numbers of breeding pairs or total population size, with the latter approximated most closely by the number of moulters) dropping below some threshold abundance under different OMP variants. However, relative depletion cannot simply be based on historic estimates of carrying capacity because of the possibility that penguin numbers at the turn of the 19th century may have been artificially high, e.g. 1.5-3.0 million adult birds Crawford *et al*. (2007), due to a competitive release effect as a result of the heavily reduced seal numbers at the time following intensive harvesting. Moreover, Crawford *et al*. (2007) propose a change in carrying capacity from a very high level in the 1920s to a much lower value over the period 1978-2006.

As a starting point for discussions, we propose the following reference levels for evaluating predicted future penguin abundance:

a) K i.e. the carrying capacity predicted by the model for the recent period;
b) $N^{median}_{1990-1999}$ i.e. the median abundance level during the 1990s; and
c) N_{2008} i.e. the current abundance level.

However, consistent with the approach adopted during the development of the new pelagic OMP, we recommend assessing risk by comparing distributions of penguin abundance under different fish harvesting strategies to those under comparable no-fishing trials (Butterworth 2008).

It is important that discussions take place *a priori* as to what constitutes an unacceptable risk level for penguins. As argued above, we suggest that this be considered in the same way as for the anchovy and sardine, and hence that projected penguin abundance distributions are compared with and without fishing. If analyses of such projected changes in distribution suggest that the new OMP encompasses an unacceptable level of risk to penguin populations, then adjustments to the tuning parameters of this IMP will need to be considered.

REFERENCES

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