SOME COMMENTS ON THE SUGGESTED USE OF THE "ONE THIRD FOR THE BIRDS" MEASURE AS A PELAGIC OMP PERFORMANCE STATISTIC THRESHOLD

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SUMMARY

Although Cury *et al.* (2011) provide valuable insight into seabird population dynamics, their suggested application of a "one third for the birds" threshold is considered premature for a number of reasons. Further research remains needed to develop population models for the seabird populations considered, to utilise the assessments of their prey species to infer their abundance distributions in the absence of harvesting, and to take account of size structure effects. Such thresholds are not pertinent when Management Procedures (MPs) are used to provide management advice; there the relevant performance statistics relate to projected seabird abundance trends. The role of analyses such as those by Cury *et al*. (2011) in such circumstances is to inform the specification of the predator-prey models included in the operating models used for testing those MPs.

Cury *et al*. (2011) put forward the suggestion of one-third of the maximum observed long term forage fish biomass as a practical indicator of a threshold above which this biomass should be maintained to sustain seabird productivity in the long term. Their suggestion followed from a meta-analysis of the relationship between breeding success and forage fish biomass for 14 bird species in seven ecosystems spread across the globe.

Meta-analyses of this nature are very valuable in moving multi-species modelling forward to inform EAF in circumstances (which usually apply) that the information available for a particular case considered in isolation is insufficient to provide estimates of management-related quantities that are sufficiently precise to be reliable and hence usable as a basis for management advice. The Cury *et al*. (2011) article is certainly valuable and persuasive in demonstrating a common pattern of non-linear response where the rate of decline of breeding success increases appreciably as forage fish abundance drops to lower levels. However, there are a number of other issues that require consideration before the Cury *et al.* (2011) suggestion might be accepted as an appropriate performance statistic threshold, including for the South African sardine-anchovy fishery.

First the response variable for the bird population which Cury *et al.* (2011) consider in all cases is breeding success. However the net reproduction component in the population dynamics equations depends on the combination of all effects from the proportion of adult females laying through various survival stages until the juvenile birds join the component of the population of particular interest (usually the mature component). Thus although data on breeding success may be suggestive, these are not definitive as descriptive of this complete period because of the possibility of negative correlations with effects in operation during the unmonitored portion of this period. Thus, for example, the Scientific Committee of the International Whaling Committee, which works with structurally similar population models for whales to those applied for birds such as penguins, has since the mid-1980s not been prepared to accept observations of changes in only some reproductive parameters (such as pregnancy rates, for example) as a basis to provide management advice related to projecting population trends under harvests, and focuses instead on fitting population models to measures of abundance.

It is this fitting of population models that should be the next step for the bird populations considered by Cury *et al.* (2011), to provide a basis for more reliable inferences. An example of the problem associated with considering breeding success alone is the Robben Island penguin population for which Cury *et al.* (2011) report a significantly positive correlation with the combined biomass of anchovy and sardine, but a full population model analysis by Robinson *et al.* (2015) indicates no dependence of the overall reproduction component of the population dynamics with anchovy recruitment (the dominant food source used to feed chicks during their fledging period). Instead the mechanism that dominates the population's behaviour is changes in adult mortality which can be linked to regional sardine abundance.

Further problems arise with Cury *et al.*'s (2011) use of the historic maximum of the forage fish abundance to standardise their index of forage fish depletion in arriving at their suggestion. First, basing standardisation on a single and "extreme" value is not a statistically robust procedure – the use of an upper percentile of some fitted distribution would be a more appropriate approach.

Further and more importantly, however, if a "one-third" type threshold is to be advanced as "universal", then evolutionarily one would expect it to refer to the forage fish population in the absence of harvesting. Cury *et al.* (2011) give no indication of the extent to which the various time series of forage fish population estimates that they consider have been impacted by harvesting (and this may differ appreciably amongst these populations). A further step needed in advancing their analyses would be consideration of assessments of the forage fish populations included in those analyses, to infer the distributions of their abundance over time without any fishing.

Another aspect omitted from the Cury *et al*. (2011) analyses, the implications of which are currently coming under international discussion, is the size structure of forage fish removals: specifically the implications of different size-specific selectivities of the birds and the fishery. In the main, small pelagic forage fish populations show little evidence of a downturn in surplus production as biomass is reduced (see Figure S1 of Essington *et al*., 2015). Consider then a situation where the birds take fish of smaller size than the fishery. The fact that the subsequent fishery catch may reduce spawning biomass is then of no consequence to future recruitment, so that consumption of forage fish by the birds impacts potential fishery catches, but **not** *vice versa*. In these circumstances, the fact that breeding success may have declined when abundance was low is a consequence only of natural variability in recruitment (and the impact the birds themselves (and other predators) make on the abundance of smaller fish by consuming them) – the fishery has no impact. Whether these arguments might apply for the South African pelagic fishery merits discussion. It would be helpful if data on the size composition of sardine and anchovy taken by penguins and other birds could be tabled for comparison to that for the fishery. The local sardine population does, however, seem a counter example to general pattern for the 44 stocks for which results are show in Figure S.1 of Essington *et al.* (2015), in that this manifests a clear indication of lower recruitments coincident with the lower spawning stock sizes in the 1980s through towards the end of the 1990s.

Utility for OMP selection

In what is an important difference from the best-assessment-based approach to fisheries management, Management Procedures are selected on the basis of the values of performance statistics for quantities of direct concern, and **not** on the basis of “design criteria”. Thus, for example, if the management concern relates to future trends in penguin abundance, then the pertinent performance statistic is that for predicted penguin abundance *per se*, not any measure of the abundance of the forage fish which the penguins consume.

This is not to say that predator-prey relationships of the type developed in Cury *et al*. (2011) are of no relevance. But they are not used in the form of a “third for the birds” type summary advanced as a threshold – instead the relationships estimated (as shown in Figure 3 of Cury *et al*., 2011) are utilised directly in the operating models used to provide predictions of future predator trends. This has already been done for Robben Island penguins by Robinson *et al*. (2015), with the results included in updated OMP calculations reported to the PWG by de Moor (2015).

Thus for Robben Island penguins, at least, there is no need to advance a performance statistic threshold such as “one third for the birds” in OMP selection – one considers instead the penguin population projections themselves. Indeed this is a more appropriate practice in any case, as occasional drops of forage fish abundance below such a threshold are not *per se* a concern – predator populations have evolved to be able to withstand the loss of an occasional year-class (as a result of poor breeding success) from the larger number that contribute to the mature population. The predator population dynamics component of the operating model ensures an appropriate averaging over these multiple year classes in projecting the predator population forward. (Incidentally, the Robinson *et al.* (2015) model predicts relatively more severe impacts on the Robben Island penguin population than would arise from occasional poor breeding success, as that model estimates the dominant impact of decreased regional forage fish abundance to be a reduction in the adult survival rate, which effects all year-classes.)

The current OMP has considered only the Robinson *et al* (2015) model, which applies to Robben Island penguins only. Penguins were selected as a representative species for the PWG’s predator-impact study of the implications of pelagic fishing, and analyses focussed on the Robben Island population because of the more comprehensive penguin data available for that colony. This is not, however, to suggest that similar consideration of other predators (gannets perhaps?) is excluded. But the appropriate approach for that would be to develop a model of that other predator’s dynamics similar to that developed by Robinson *et al*. (2015) for Robben Island penguins, for linkage to the pelagic OMP operating models. Results of analyses such as those in Cury *et al.* (2011) might contribute to the specification of such a model but, as with Robben Island penguins, the “one third for the birds” threshold suggestion would not be pertinent.

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