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Marine no-take zone rapidly benefits endangered penguin
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Abstract Full Text Full Text (PDF)

Claim by Pichegru et al. that marine no-take zone benefits penguins remains premature

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Pichegru et al. (2010) (henceforth for brevity referenced as "PGCR"), based on the results from two years of measuring foraging behaviour of African penguins (Spheniscus demersus) in the vicinity of breeding colonies at the St Croix and Bird islands off the South African south coast, strongly make the claim that: "Marine no-take zone rapidly benefits endangered penguin". Coetzee (2010) gives reasons to suggest that this claim is premature, to which Ryan et al. (2010) (henceforth referenced as "RPG") respond by arguing, inter alia, that a number of Coetzee's assertions are flawed.

Unfortunately, however, we consider that there remain flaws in the original PGCR paper and also in the arguments offered by the RPG commentary, which need to be corrected.

PGCR and RPG frequently emphasise the firmness of their conclusions, for example that their results show "that closing the waters around breeding islands does confer an advantage on breeding penguins". They then proceed to implicitly castigate the Pelagic Scientific Working Group (PSWG) of the Department of Agriculture, Forestry and Fisheries: Fisheries Branch, which Coetzee chairs, for seemingly failing to apply a precautionary approach and take "urgent action to improve the conservation status of the African penguin".

The Precautionary Principle as developed in Rio by UNCED (1992) states that: "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." Thus in debating, say, whether to recommend closures around islands with penguin breeding colonies to fishing, the PSWG has to consider whether on the balance of all the evidence available, the effectiveness (in terms of both the extent to which penguin population trends would be improved and the reliability of such an estimate) of such closures outweighs potentially considerable costs in terms of revenue and employment losses in the fishing industry.

When in 2007 the PSWG first evaluated whether the available evidence did suggest that fishing in the vicinity of penguin breeding colonies was disadvantageous to penguin reproductive success, the results obtained for two major breeding colonies on the west coast, Robben and Dassen islands, for which time series of indices of reproductive success were available, were not clear. Point estimates for impacts on fledging success and breeders per adult moulter suggested that these variables had increased rather than declined under greater pelagic catches, but the results were not statistically significant (Brandao and Butterworth, 2007). The PSWG considered commencing a programme of experimental closures around certain breeding colonies to better estimate these impacts. However power analyses in Brandao and Butterworth (2007) suggested that such an experiment might take up to two decades to yield reliable results because of the large "additional variance" (a CV of some 20%) in the relationship between the impact on reproductive success and the extent of fish catches. Accordingly a feasibility study was initiated to better determine this additional variance for two pairs of island colonies (Robben/Dassen and St Croix/Bird with pelagic fishing suspended around one of each pair) for indices related to reproductive success. These included both indices for which data had

already been collected, and potential new indices with promise. The latter included the measures of foraging trip distance and duration based on satellite telemetry that are reported in PGCR. This was to better inform the design of a possible future fuller scale experiment.

Given these indications of relatively weak power to determine the impact of fishing, the claim by PGCR to have firmly determined this within a period as short as two years comes as a surprise. RPG in any case suggest that the positive correlations between penguin reproductive success and fish catches referenced above are explained by the "simpler and more plausible inference that penguins, like fisheries, do well in years when pelagic fish are more abundant". But this effect is already incorporated in the analyses of Brandao and Butterworth (2007) through the inclusion of an estimable year effect in their GLMs. Their (and the PSWG's consequent) conclusions relate to a residual effect after account has been taken of this factor. The broad methodology applied in those earlier analyses has subsequently been endorsed (with some recommended extensions) by a recent

international review (Parma et al., 2010), as the basis for analyses of further data forthcoming from the feasibility study.

However, though RPG implicitly criticize the analyses of Brandao and Butterworth (2007) for omitting consideration of year effects linked (in part) to pelagic fish abundance when they do in fact take them into account, PGCR omit this same factor, and essentially assume that additional variance is zero. It is this basic flaw in their methodology that leads to their spuriously firm conclusion that they have shown a clear positive and statistically significant effect on penguins of closure of the neighbourhood of a colony to fishing on small pelagic fish. This is not to say that there is no such effect, only that the analyses in PGCR certainly do not confirm it. Estimates of additional variance from the results in PGCR need certain simplifying assumptions because of the limited (two year) duration of their time series, and suggest CVs in the region of 20%, which are similar to the different indices with longer time series available for Robben and Dassen islands. That suggests that using this foraging information to detect the impact of fishing close to colonies will also have low power, coupled to the further difficulty that these measures do not relate directly to the parameters reflecting reproductive success in penguin population dynamics models (as do the fledging success and breeders per adult moulter series). However, these additional variance estimates from the St Croix/Bird island foraging information results are coarse and themselves of very high variance - hopefully the acquisition of further data as the feasibility study proceeds will lead to more optimistic results regarding experimental power.

A further problem with the analyses of PGCR is their characterization of the situation which they evaluate as "treatments" (no fishing) and "controls" (fishing). Any analysis needs to quantify the extent of fishing when it occurs - it cannot be treated as an "off/on" co-variate when annual fishery catches vary considerably. In particular over the two year (2008-2009) period to which their analysis refers, annual catches of sardine in the area around St Croix which was nominally closed in 2009 were very similar (at 491 and 320 tons respectively), and about an order of magnitude less than typical annual sardine catches over the preceding decade (J. van der Westhuizen, Fisheries Branch, pers. commn). Hence data from St Croix for these two years can hardly be expected to typify the distinction of the effects on penguins of fishing or of an absence of fishing, as the analysis of PGCR assumes.

RPG query Coetzee's (2010) assertion that penguin abundance remained stable at Robben island, but dropped at Dassen island, while pelagic fishing was prohibited within 20 km of the latter (but not restricted for the former) during 2008 and 2009. RPG are correct in pointing to similar reductions in terms of counts of occupied nests at these two colonies from 2007 to 2009, but in terms of counts of moulting birds the reduction at Dassen island is much larger at about an order of magnitude (Robinson and Butterworth, 2010a, Tables 1 and 2). Neither measure gives support to the hypothesis that penguins at Dassen island around which fishing was prohibited over this period would be expected to have fared better than those at Robben island where this prohibition did not apply.

PGCR and RPG also demonstrate misunderstanding of the facts and distributional dynamics of sardine and anchovy in their respective comments that "these fish stocks have decreased markedly during the last decade, owing to changing environmental conditions and a lack of spatial management of the competing purse-seine fishery" and that "Dassen island is farther north than Robben island, and given the generally south and eastward shift in the fish stocks, penguins there are likely to have suffered from reduced prey availability more than on the colony on Robben island".

First, the dominant aspect of the dynamics of these fish during the peak penguin breeding season in autumn is the migration of the bulk of the recruits of the year for both species southward down the west coast and past both the Dassen and Robben island colonies towards the Agulhas Bank. It would seem unlikely that this has a differential effect on the two colonies for the reason RPG suggest, as the impact of the fishery is low. Butterworth and de Moor (2010) estimate that fishing decreased the density of anchovy that would otherwise have been available to penguins at Robben and Dassen islands in the absence of any fishing by at most about 20% in the years following 2000. This proportion is less than in the years before 2000, as anchovy abundance in this region (see Robinson and Butterworth, 2010a, Table 8) has generally been appreciably larger since the turn of the century, contrary to PGCR's statement. With the declines in the penguin colonies at Robben and Dassen islands after 2003, the high abundance of anchovy available to these colonies over that period argues against poor feeding conditions for breeding birds with a consequent impact on reproductive success being a major cause of these declines.

Secondly PGCR provide no analysis or reference to support their claim that the fish stocks are in poor condition because of a "lack of spatial management". Spatial management potentially has substantial benefit only when, say, the abundance surveys on whose results Total Allowable Catches (TACs) are set cover more than one breeding stock, with catches being taken disproportionately to the abundances of those stocks. There is no compelling evidence that this is the case for anchovy. For sardine there has been a sustained period of poor recruitment subsequent to the population boom across the turn of the century; the possibility of multiple breeding stocks is under consideration in the review of the basis for management of this resource which is currently in progress.

Nevertheless there has as yet been no analysis presented which suggests that this poor recruitment is the result primarily of the higher catches of sardine that were permitted during the period of the boom, rather than environmental effects which typically do cause major fluctuations in the abundances of such species (Schwartzlose et al., 1999; Barange et al., 2009).

Furthermore, given the low levels of fishing mortality that follow from the Operational Management Procedures used to set TACs for the South African sardine and anchovy resources (de Moor and Butterworth, 2008), RPG's tacit implication that the current South African pelagic fishery situation near mimics the collapse of the Namibian sardine resource in the 1970s, likely as a result of overfishing, with its consequent negative impact on the penguins in that region, is hardly justified. Certainly if the abundance of penguins' major food resource is reduced by well over an order of magnitude as in Namibia at that time, their abundance is going to be adversely impacted. But for the typical range of pelagic fish abundance in South Africa at the present time, other factors such as habitat availability may also play important roles, so it is by no means clear that the relationship of penguin population dynamics parameters to prey abundance should be expected to be one of linear proportionality over this range. Indeed current analyses of penguin dynamics (e.g. Robinson et al., 2010; Robinson and Butterworth, 2010b; Altwegg and Crawford, 2010), though these are still under refinement, clearly suggest that it is increased adult mortality rather than diminished reproductive success that is the main reason for the recent declines in penguin numbers, which again indicates that MPAs around breeding colonies are not obviously going to ameliorate the underlying cause of these declines.

Finally, although of lesser pertinence to the main topic at issue here, RPG make a number of further somewhat sweeping statements which cannot be left uncontested:

a) "Unlike the crude estimates of fish stocks, there are robust counts of penguins from all their main breeding sites for the last few decades": Naturally penguin moulter and nest counts have the advantage of targets potentially visible rather than beneath the surface of the sea, and being closer to censuses than sampling surveys. But the quality of time series of indices of abundance rests on the bias and precision of their elements. Here considerable research has been conducted to minimize the bias in the now near three-decade long time series of acoustic estimates of anchovy and sardine abundance (e.g. Hampton 1992, 1996; Barange et al., 1998; Coetzee et al., 2008; de Moor et al,, 2008). In contrast, though clearly penguin counts have been pursued with dedication and enthusiasm, often aided by volunteers, there is little to indicate that similar attempts to reduce bias have been attempted as would be standard practice for fisheries assessments. Thus, for example, there has been no standardization across different counters, and at Dassen island in particular, there is an unknown trend in bias of the counts as estimates of total numbers because these cover only the near-coast areas while varying numbers of penguins moult further inland in different years. It is also clear (from occupied nest counts exceeding adult moulter counts) that the reason for especially low counts over the last few years at Dassen island is because of variable numbers of birds moulting elsewhere before returning to the colony to breed. Limited attention has also been given to the problem of estimating variance for penguin counts. A coarse attempt (Robinson and Butterworth, 2010a,c) suggests that these are typically about 5% for adult penguin moult counts, though nearer to 10% for juvenile counts and well into double figures for Dassen island for the last three years; this compares with the average of 14% achieved for anchovy November spawning biomass surveys over recent years (de Moor et al., 2008; Coetzee et al., 2010)

b) "As to the core argument that relatively little fishing took place in these [St Croix] waters, it might be trivial to the fishing industry, but the 250 tons 'saved' for penguins in the core area of the closure is roughly half the amount of fish required to raise a brood of chicks by the 7000 pairs of penguins breeding at St Croix in 2009": Estimates of the annual consumption of anchovy and sardine off South Africa by natural predators since the turn of the century range from about 2.5 to 5 million tons (de Moor and Butterworth, 2010), with catches by the industry only some 10-15% of such amounts. It hardly seems possible, given fish species that do move considerable distances, that reliable conclusions could be drawn about differential utilization of a component of their production that constitutes less than 0.01% of this overall mortality.

c) "The extension of fishing closures around key penguin breeding islands is likely to be a more palatable measure than cutting fishing quotas, although the latter measure may also have to be considered if penguin numbers continue to fall": This possibility has already been considered by the PSWG in 2008 in the light of analyses addressing this issue, which were later summarized in Robinson et al. (2010). The indications then were that there was a linkage of the drop in survival rates for penguins at Robben and Dassen islands to the reduction in abundance of sardine in the survey stratum in which those colonies fall. However that reduction is much more the result of an eastward shift in the sardine distribution, than of the impact of catches of sardine by the industry. Consequently simulations indicated that catch reductions would offer little benefit to penguins, which rather require a return of the sardine distribution to its earlier pattern with greater proportions to the west. These though were initial calculations, and this matter remains under investigation alongside improvements to models of penguin dynamics (see, e.g., Parma et al., 2010).

Altwegg, R. and Crawford, R.J.M. 2010. Estimates of survival of African penguins at Dassen and Robben islands, 1993?2007. Available as document MARAM IWS/DEC10/P/WP2 at http://www.mth.uct.ac.za/maram/workshops.php

Barange, M., Hampton, I. and Roel, B. A. 1999. Trends in the abundance and distribution of anchovy and sardine on the South African continental shelf in the 1990s. South African Journal of Marine Science, 21: 367-391.

Barange, M., Bernal, M., Cergole, M.C., Cubillos, L.A., Daskalov, G.M., de Moor (formerly Cunningham), C.L., De Oliveira, J.A.A., Dickey- Collas, M., Gaughan, J., Hill, K., Jacobson, L.D., Koster, F.W., Masse, J., Niquen, M., Nishida, H., Oozeki, Y., Palomera, I., Saccardo, S.A., Santojanni, A., Serra, R., Somarakis, S., Stratoudakis, Y., Uriarte, A., van der Lingen, C.D. and Yatsu, A. 2009. Current trends in the assessment and management of stocks. Chapter 9. In: Checkley, D., Alheit, J., Oozeki, Y. and Roy, C. (eds) Climate Change and Small Pelagic Fish, pp 191-225, Cambridge University Press.

Brandao, A. and Butterworth, D.S. 2007. An initial analysis of the power of monitoring certain indices to determine the effect of fishing on penguin reproductive success from an experiment where pelagic fishing is prohibited in the neighbourhood of Robben Island, but continues around Dassen Island. Unpublished Marine and Coastal Management document EAFWG/OCT2007 /STG/04 (12 pp). Available as document MARAM IWS/DEC10/PB/P2 at http://www.mth.uct.ac.za/maram/workshops.php

Butterworth, D.S. and de Moor, C.L. 2010. An extension to the simple implementation of the "River Model" to estimate the impact of fishing on the amount of anchovy available to west coast penguin colonies which takes account of within season variability in recruitment. Unpublished Department of Agriculture, Forestry and Fisheries: Fisheries Branch document MCM/2010 /SWG-PEL/Island Closure Task Team/20 (12 pp). Available as document MARAM IWS/DEC10/P/BG3 at http://www.mth.uct.ac.za/maram/workshops.php

Coetzee, J.C., Chair: Pelagic Scientific Working Group. 2010. Claim by Pichegru et al that marine no-take zone benefits penguins is premature. http://rsbl.royalsocietypublishing.org/content/early/2010/02 /04/rsbl.2009.0913.abstract/reply#roybiolett_el_15

Coetzee, J.C., Merkle, D., de Moor (formerly Cunningham), C.L., Twatwa, N.M., Barange, M. and Butterworth, D.S. 2008. Refined estimates of South African pelagic fish biomass from hydro-acoustic surveys: quantifying the effects of target strength, signal attenuation and receiver saturation. African Journal of Marine Science 30(2):205-217.

Coetzee, J.[C.], Merkle, D., Twatwa, N., Mushanganyisi, K., Phillips, M. and Shabangu, F. 2010. Results of the 2010 spawner biomass survey. Unpublished Department of Agriculture, Forestry and Fisheries: Fisheries Branch document MCM/2010/SWG-PEL/61 (9pp).

de Moor, C.L. and Butterworth, D.S. 2008. OMP-08. Unpublished Marine and Coastal Management document MCM/2008/SWG-PEL/23 (15pp).

de Moor (formerly Cunningham), C.L., Butterworth, D.S. and Coetzee, J.C. 2008. Revised estimates of abundance of South African sardine and anchovy from acoustic surveys adjusting for echosounder saturation in earlier surveys and attenuation effects for sardine. African Journal of Marine Science 30(2):219-232.

de Moor, C.L. and Butterworth, D.S. 2010. Catch to natural predation ratios for sardine and anchovy. Unpublished Department of Agriculture, Forestry and Fisheries: Fisheries Branch document MCM/2010/SWG-PEL/Island Closure Task Team/15 (5 pp).

Hampton, I. 1992. The role of acoustic surveys in the assessment of pelagic fish resources on the South African continental shelf. In: Payne, A.I.L., Brink, K.H., Mann,

K.H. and Hilborn, R. (eds) Benguela Trophic Functioning. South African Journal of Marine Science 12: 1031-1050. Hampton, I. 1996. Acoustic and egg-production estimates of South African anchovy biomass over a decade: comparisons, accuracy and utility. ICES Journal of Marine Science 53: 493-500.

Parma, A., Punt, A.E. and Stefansson, G. 2010. International review panel report for the 2010 International Fisheries Stock Assessment Workshop, 29 November - 3 December 2010

University of Cape Town (14 pp). Available as document MARAM IWS/DEC10 /REP/1 at http://www.mth.uct.ac.za/maram/workshops.php

Pichegru, L., Gremillet, D., Crawford, R.J.M. and Ryan, P.G. 2010. Marine no-take zone rapidly benefits threatened penguin. Biol. Lett. doi: 10.1098/rsbl.2009.0913

Robinson, W. and Butterworth, D.[S.]. 2010a. Data inputs to the African penguin model. Unpublished Department of Agriculture, Forestry and Fisheries: Fisheries Branch document MCM/2010/SWG-PEL/54 (7 pp). Available as document MARAM IWS/DEC10/PA/P4 at http://www.mth.uct.ac.za/maram/workshops.php

Robinson, W. and Butterworth, D.S. 2010b. Penguin population models for Robben island (17 pp). Available as document MARAM IWS/DEC10/PA/P6 at http://www.mth.uct.ac.za/maram/workshops.php

Robinson, W. and Butterworth, D.S. 2010c. A proposed new method for obtaining penguin moult count estimates. Unpublished Department of Agriculture, Forestry and Fisheries: Fisheries Branch document MCM/2010/SWG-PEL/Island Closure Task Team/05 (13 pp). Available as document MARAM IWS/DEC10/P/BG1 at http://www.mth.uct.ac.za/maram/workshops.php

Robinson, W., Plaganyi, E., Butterworth, D.S. and de Moor, C.L. 2010 Summary of penguin-pelagic fish interaction modelling during 2008. Unpublished Department of Agriculture, Forestry and Fisheries: Branch Fisheries document MCM/2010/SWG-PEL/35 (39 pp). Available as document MARAM IWS/DEC10 /PA/P1 at http://www.mth.uct.ac.za/maram/workshops.php

Ryan, P.G., Pichegru, L. and Gremillet, D. 2010. Parlous conservation status of African Penguins provides the correct wider context. http://rsbl.royalsocietypublishing.org/content/early/2010/02 /04/rsbl.2009.0913.abstract/reply#content -block

Schwartzlose, R.A., Alheit, J., Bakun, A., Baumgartner, T.R., Cloete, R., Crawford, R.J.M., Fletcher, W.J., Green-Ruiz, Y., Hagen, E., Kawasaki, T., Lluch-Belda, D., Lluch-Cota, S.E., MacCall, A.D., Matsuura, Y., Nevarez-Martinez, M.O., Parrish, R.H., Roy, C., Serra, R., Shust, K.V., Ward, M.N., and Zuzunaga, J.Z. 1999. Worldwide large-scale fluctuations of sardine and anchovy populations. South African Journal of Marine Science, 21: 289-347.

UNCED. 1992. Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992. Annex I: Rio Declaration on Environment and Development. http://www.un.org/documents/ga/conf151 /aconf15126-1annex1.htm

Conflict of Interest:

None declared

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