Update to the African Penguin population model taking account of new moult count information

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Summary

Refitting the penguin model to adjusted data taking into consideration possible undercounting of moulters in recent years, we have been able to obtain a better model fit. Also, analysis indicates that the depletion of penguins (expressed as abundance in 2008 relative to 2002) is about 5% less than previously estimated at the colony assumed to be the origin of the extra moulters at Stony Point. The calculated model likelihoods suggest that these birds are more likely to come from Dassen Island.

Introduction

The population model (Robinson et al., 2008) for Robben and Dassen Island African penguins has been updated as a result of information regarding a) the change in distribution of moulting birds at Robben Island (Crawford 2009) and b) the observation of a large number of birds moulting at Stony Point in the 2008/2009 moult season (Crawford *et al*., 2009).

Robben Island

Traditionally, counts of moulting birds at Robben Island have only been made around the coast. Since analysis of the 1996 moult season indicated that only 2.5% of adult birds were moulting inland, it had been assumed that coastal counts capture close to the complete population. However, a count taken in November 2008 indicated that moulting habits may have changed substantially, since 29% of all adults moulting at that time were found inland. These birds have not been included in the usual moult counts.

At a recent meeting of the Penguin Task Group, it was decided to adjust Robben Island moult counts by a percentage increasing linearly from 0% in 1995 to 30% in 2008. This adjustment results in an average increase of 1571 female birds to the moult counts since 2001. The model was fitted to the new data set. This resulted in an improved likelihood (see Table 1, column 2). Model fits to the old and new data sets are shown in Fig. 1.

Stony Point

A single count made in January 2009 identified 123 adult birds moulting at Stony Point, compared to 165 adults moulting at Robben Island during the same week. It was estimated that the total number of adults moulting at Robben Island in 2008/2009 would be about 4000 birds. Thus a very rough estimate for the total number of adult bird moulting at Stony Point was fixed at 3000.

The 2008 nest count at Stony Point was 310, from which one would expect about 1000 moulters at the colony. The result is that possibly 2000 adult penguins (1000 females) belonging to another colony decided to moult at Stony Point instead.

There seems to be no reliable information as to which year these extra moulters first appeared at Stony Point. As a first guess, we have assumed a linear increase from 0 birds in 2004 to 1000 birds in 2008. On the hypothesis that birds are moulting further east following the recent shift in distribution of prey, we consider two cases: that the extra birds either come all from Dassen or all from Robben Island.

The results of fitting the model indicate that the birds are more likely to come from Dassen Island (see Table 1). We show the new model trajectories in Fig. 2 and Fig. 3 (solid lines) with the old trajectories (dashed lines) for comparison. The ratio of abundance in 2008 relative to 2002, when abundance was near its peak, increases by about 5% for the colony from which the additional Stony Point moulters are assumed to originate.

Next Steps

Future work will include the re-estimation of the impacts of fishing on penguin depletion, and refining that estimation framework to a Bayesian rather than MLE form.

Literature cited

Crawford, R.J.M., 2009. On the proportions of adult African Penguins moulting inland and along the coast at Robben Island. Penguin Task Group document.

Crawford, R.J.M., Parsons, N., Makhado, A.B., 2009. On numbers of African Penguins moulting at Stony Point, Bettys Bay in 2008/2009. Penguin Task Group document.

Robinson, W., Plagányi, É., Butterworth, D, 2008. Illustrative outputs of the age-structured model of African penguin populations for linking to the pelagic OMP testing process. MCM/2008/SWG-PEL/27.

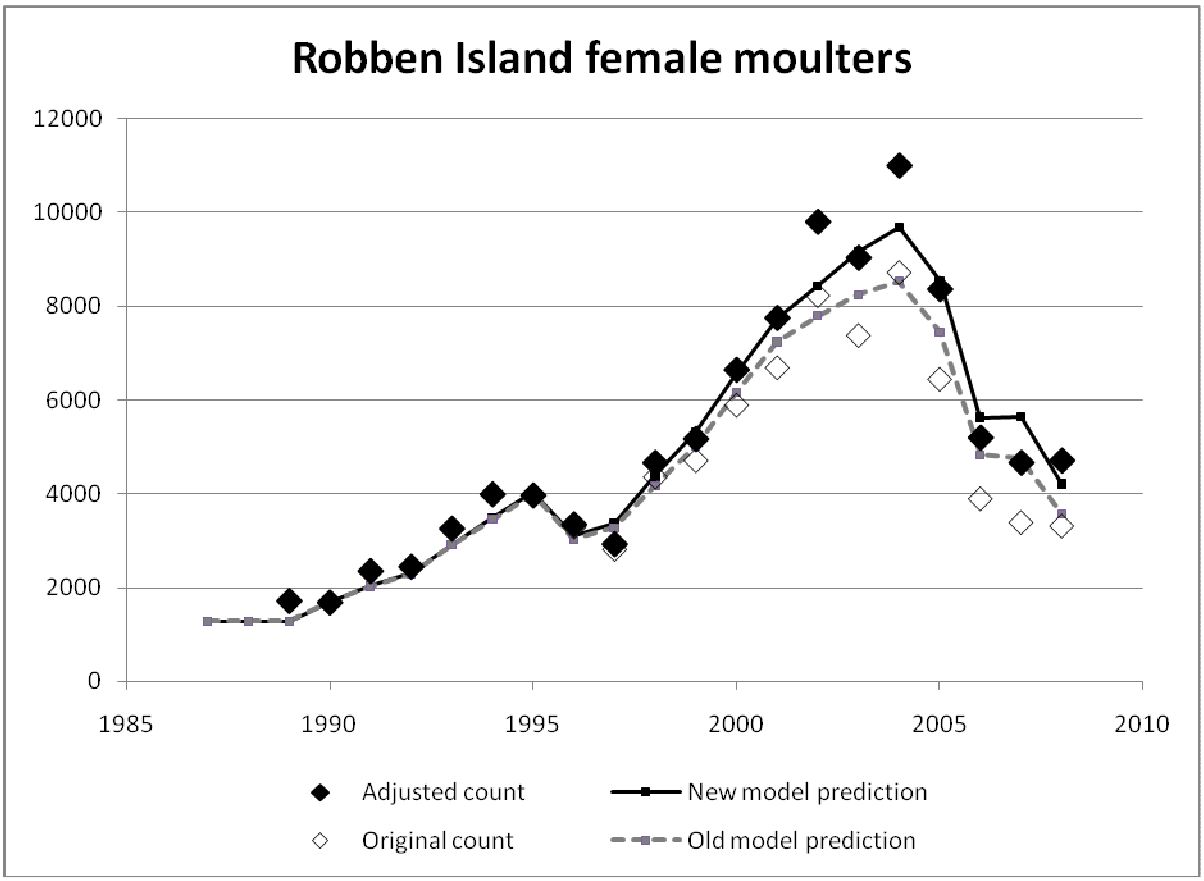

Fig. 1: The original data set is shown with open diamonds. Adjusted values taking into account birds moulting inland are shown with dark diamonds. The original model fit is indicated with a grey dashed line, and the new fit is indicated with a solid black line.

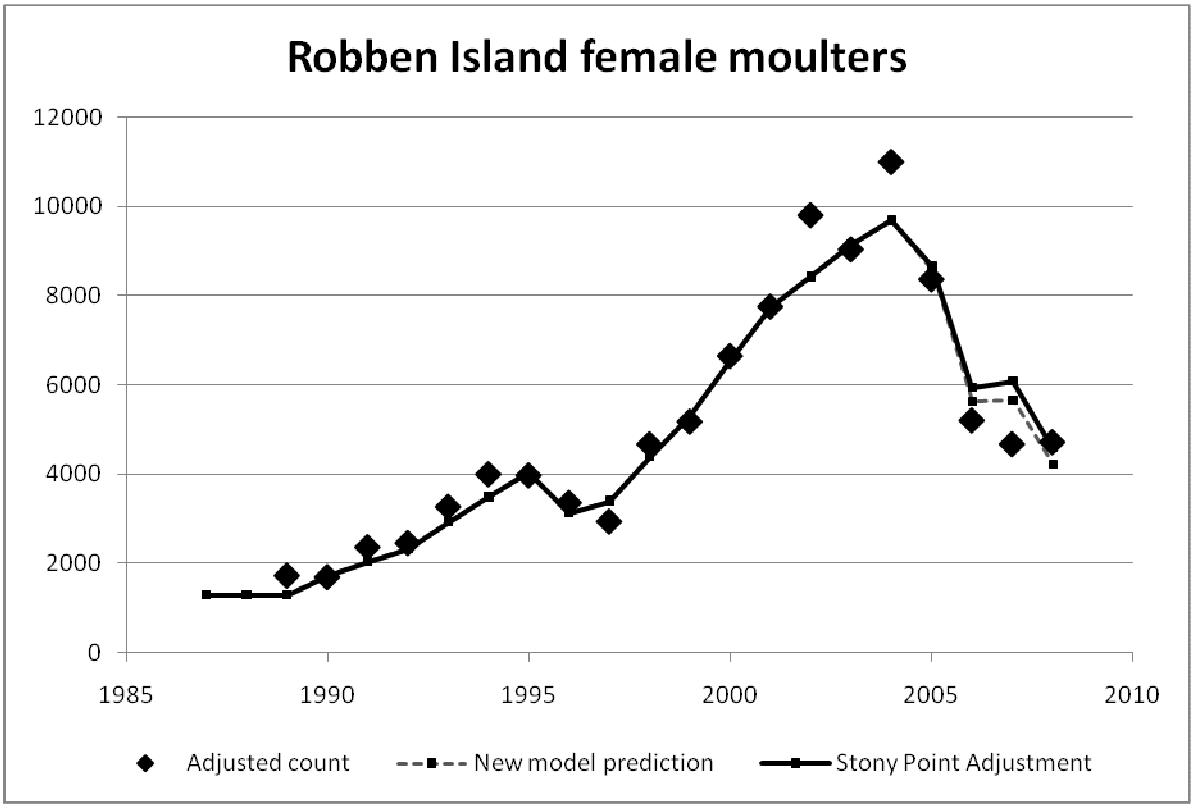

Fig. 2: Assuming extra Stony Point moulters come from Robben Island.

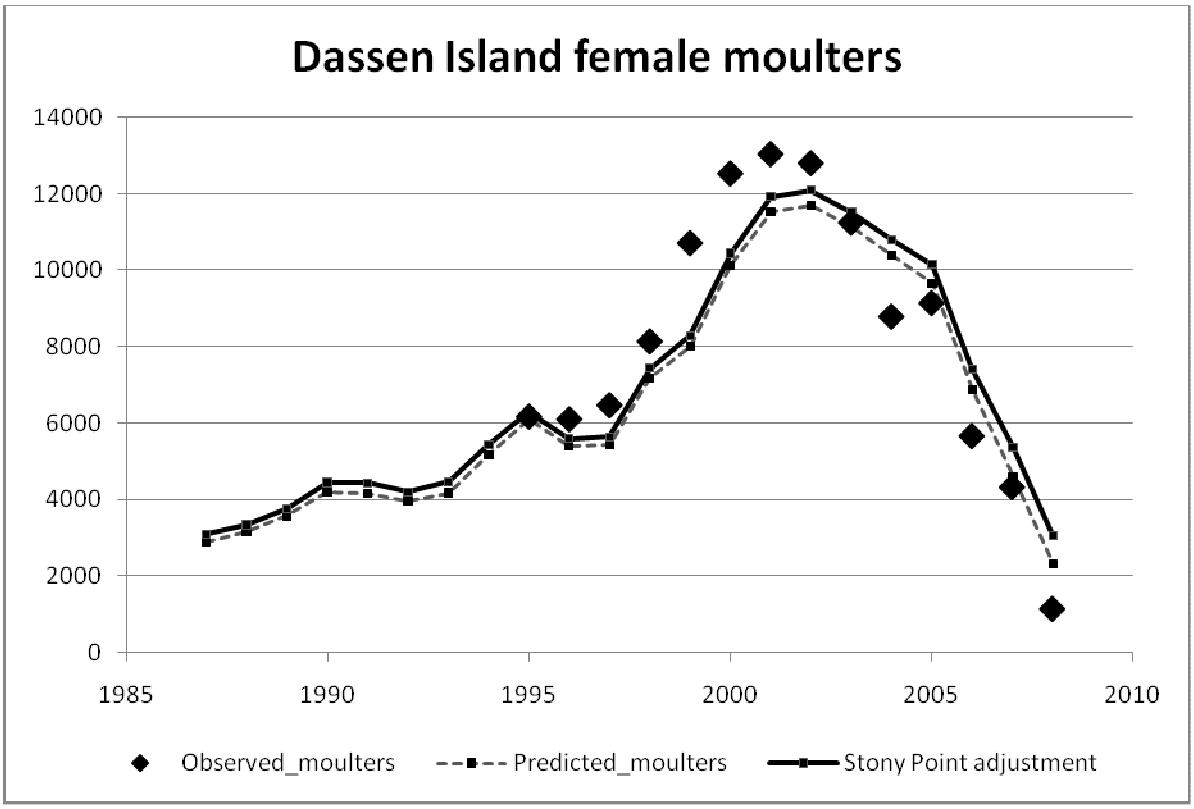

Fig. 3: Assuming extra Stony Point Moulters come from Dassen Island.

	Previous model	Robben adjustment for inland moulters	Robben -> Stony	Dassen -> Stony
$N_{0,m}$ (ROB)	138	138	137	138
$N_{0,m}$ (DAS)	3195	3195	3195	3086
a (ROB)	-0.737	-0.740	-0.729	-0.740
b (ROB)	0.000	0.000	0.000	0.000
α (ROB)	0.801	0.814	0.850	0.814
β (ROB)	47.187	50.007	49.180	50.007
a (DAS)	-0.713	-0.713	-0.713	-0.736
b (DAS)	1.365	1.365	1.365	1.289
α (DAS)	1.424	1.424	1.424	1.487
β (DAS)	0.000	0.000	0.000	0.000
q_M (DAS)	0.349	0.349	0.349	0.375
σ_{in} (random effects)	1.5	1.5	1.5	1.5
σ_{out} (Robben reproduction)	0.303	0.309	0.310	0.309
σ_{out} (Dassen reproduction)	0.632	0.632	0.632	0.583
σ_{out} (Robben adult survival)	0.573	0.578	0.573	0.578
σ_{out} (Dassen adult survival)	0.819	0.819	0.819	0.782
-lnL Robben	-81.366	-85.013	-84.912	-85.013
-lnL Dassen	-58.862	-58.862	-58.862	-67.273
Robben penalty	2.005	2.073	2.064	2.073
Dassen penalty	5.135	5.135	5.135	4.588
-lnL TOTAL	**-133.088**	**-136.666**	**-136.575**	**-145.625**
Robben 2002 Population	10511	11806	11427	
Robben 2008 Population	3817	4430	4815	
Depletion (2002-2008)	**63.7%**	**62.5%**	**57.9%**	
Dassen 2002 Population	40838			39166
Dassen 2008 Population	5976			7618
Depletion (2002-2008)	**85.4%**			**80.5%**

Table 1: Comparison of alternative model parameter estimates and summary statistics. Population numbers refer to 2+ abundance at the start of the year.