Further analyses using the penguin model coupled to the pelagic OMP

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SUMMARY

Documents MCM-2008-SWG-PEL-27 and MCM-2008-SWG-PEL-28 described a so-called base-case model, but further analyses and consideration of the standard deviations associated with model parameter estimates showed that there was very weak support for some of the penguin-pelagic fish functional relationship parameters. Moreover, given that penguin data are available up until 2008, but pelagic fish biomass estimates from OMP-08 were only available up until 2006, it was necessary to fix a 2007 pelagic biomass estimate so that a consistent value was used across different model versions. The 2007 pelagic biomass values for anchovy and sardine were thus set equal to the median value of the 1000 future projected values from OMP-08. The model was highly sensitive to the change in this single pelagic biomass estimate, with a slight shift in this value producing a change in the Robben reproductive success slope parameter from a positive value to the lower bound of zero, and a similar change occurred for the Dassen adult survival slope (Table 1). Figs. 1-2 shows the resultant fitted horizontal lines for these two relationships, as well as the fitted positive relationships for the Robben adult survival and Dassen reproductive success relationships. This model version is hereafter termed the new "base case", and replaces the base case model described in MCM-2008-SWG-PEL-27 and MCM-2008-SWG-PEL-28. Selected results using the new base case model are presented in Figs. 3-6.

Noting the large level of uncertainty associated with model-predicted functional relationships, a number of sensitivity tests were conducted in which it was assumed that there is a) no relationship between penguin adult survival and pelagic biomass, but a relationship exists between reproductive success and pelagic biomass; b) no relationship between penguin reproductive success and pelagic biomass, but a relationship exists between penguin adult survival and pelagic biomass; and c) there is no relationship between penguin dynamics and pelagic abundance. The model estimated parameters, likelihoods, AIC and AICc for the base case model and this last model which includes no relationships between pelagic biomass and either adult survival S or reproductive success S_j are shown in Table 1. From a statistical perspective, the no-relationship model provides the most parsimonious explanation of the data (I.e. it has the lowest AIC and AICc values, which is the criterion conventionally used to select between models). Fig. 6 compares model results pertaining to the base case model and the model assuming no relationships between penguin dynamics and pelagic abundance.

Table 1: Comparison of estimated parameters, likelihoods, AIC and AICc for the base case model and an alternative model which includes no relationships between pelagic biomass and either adult survival *S* or reproductive success S_j.

	Base case	No relationship with biomass
a (Robben reproductive success intercept)	-0.74	-0.52
b (Robben reproductive success slope)	0.00	
α (Robben adult survival intercept)	0.80	2.14
β (Robben adult survival slope)	47.19	
a (Dassen reproductive success intercept)	-0.71	-0.43
b (Dassen reproductive success slope)	1.36	
α (Dassen adult survival intercept)	1.42	1.42
β (Dassen adult survival slope)	0.00	
-lnL	-133.088	-131.383
Number of parameters estimated	90	86
Number of observations	109	109
AIC	-86.176	-90.766
AICc	823.824	589.416

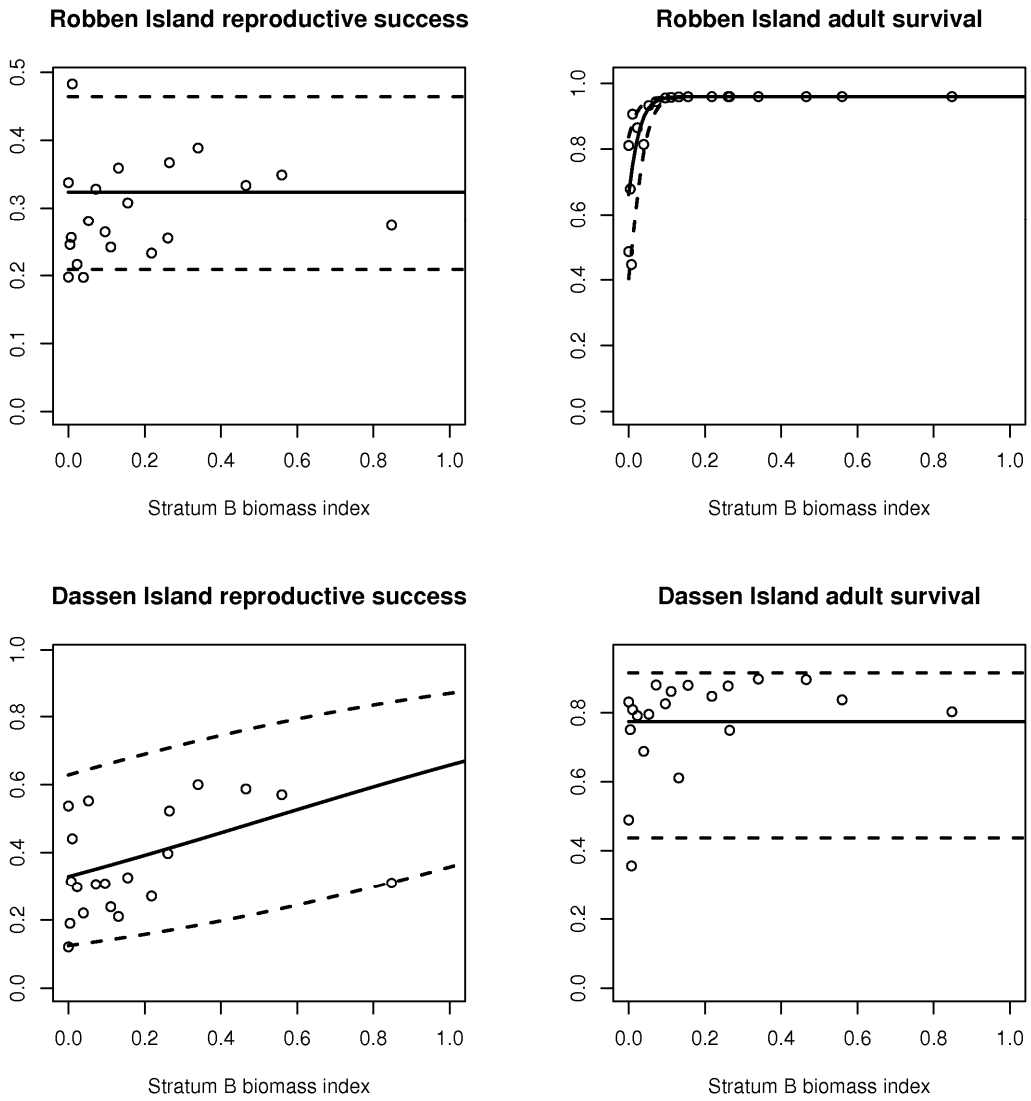

Fig. 1: Deterministic reproductive success (left) and adult survival (right) with 95% confidence intervals for Robben Island (top) and Dassen Island (bottom) for the new "base case" model. Circles indicate model-estimated survival values. The stratum B biomass index is calculated by multiplying the assessment model-predicted anchovy and sardine biomasses with the proportions observed in stratum B in the survey, summing, and dividing by the maximum of the derived series.

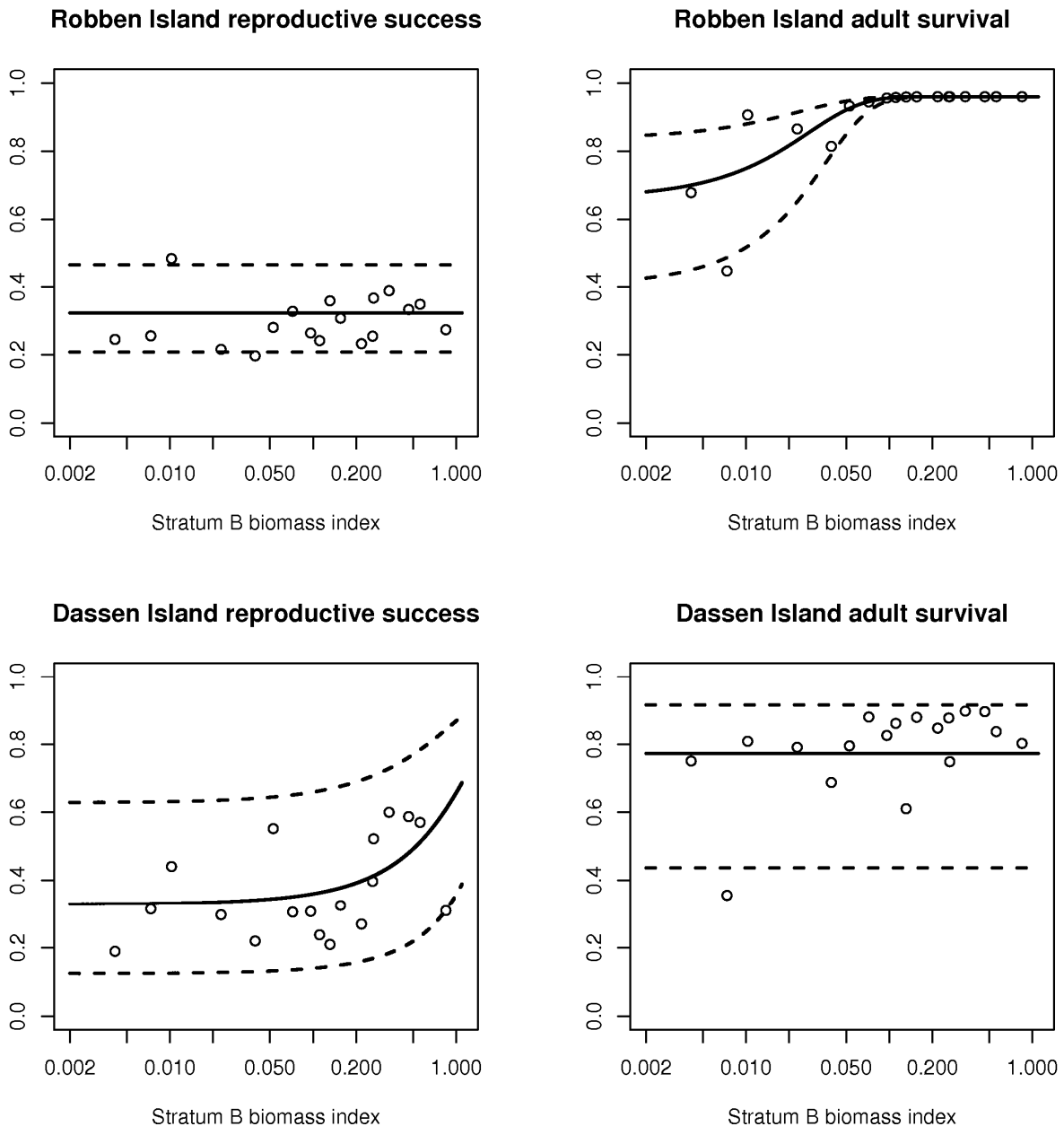

Fig. 2: Deterministic survival relationships in Fig. 1 re-plotted using a logarithmic scale on the *x*-axis in order to show the behaviour at low biomass indices more clearly.

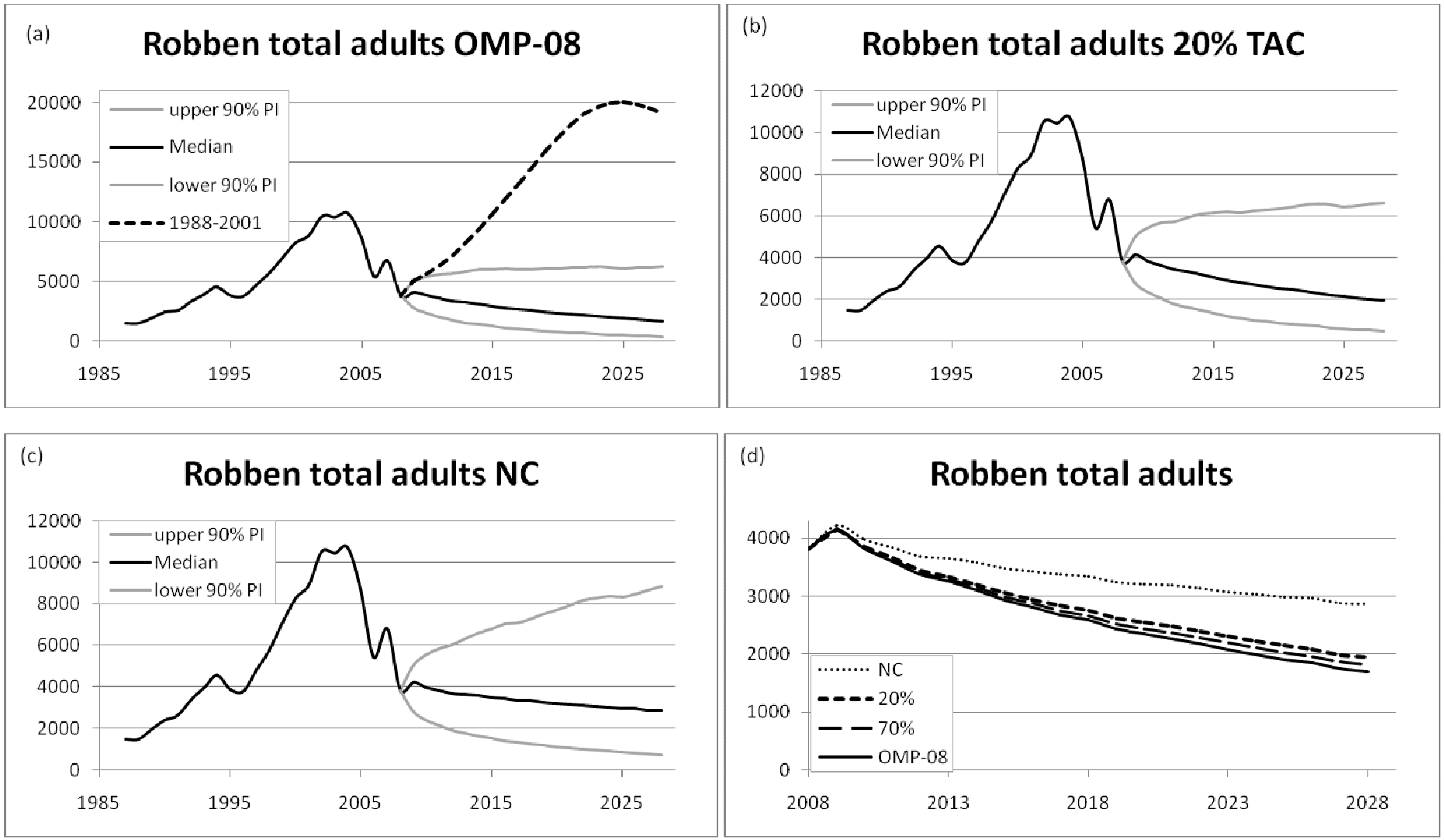

Fig. 3: Robben island population projections with probability intervals under various fishing management procedures: (a) OMP-08 TAC unchanged, (b) 20%-100% of TAC allocated when biomass drops below the median, and (c) no fishing. (d) Projections for four cases are shown together. Future stratum B proportions are drawn from the 2002-2006 set, except for the dashed line in (a) which indicates a projection sampling from the 1988-2001 set.

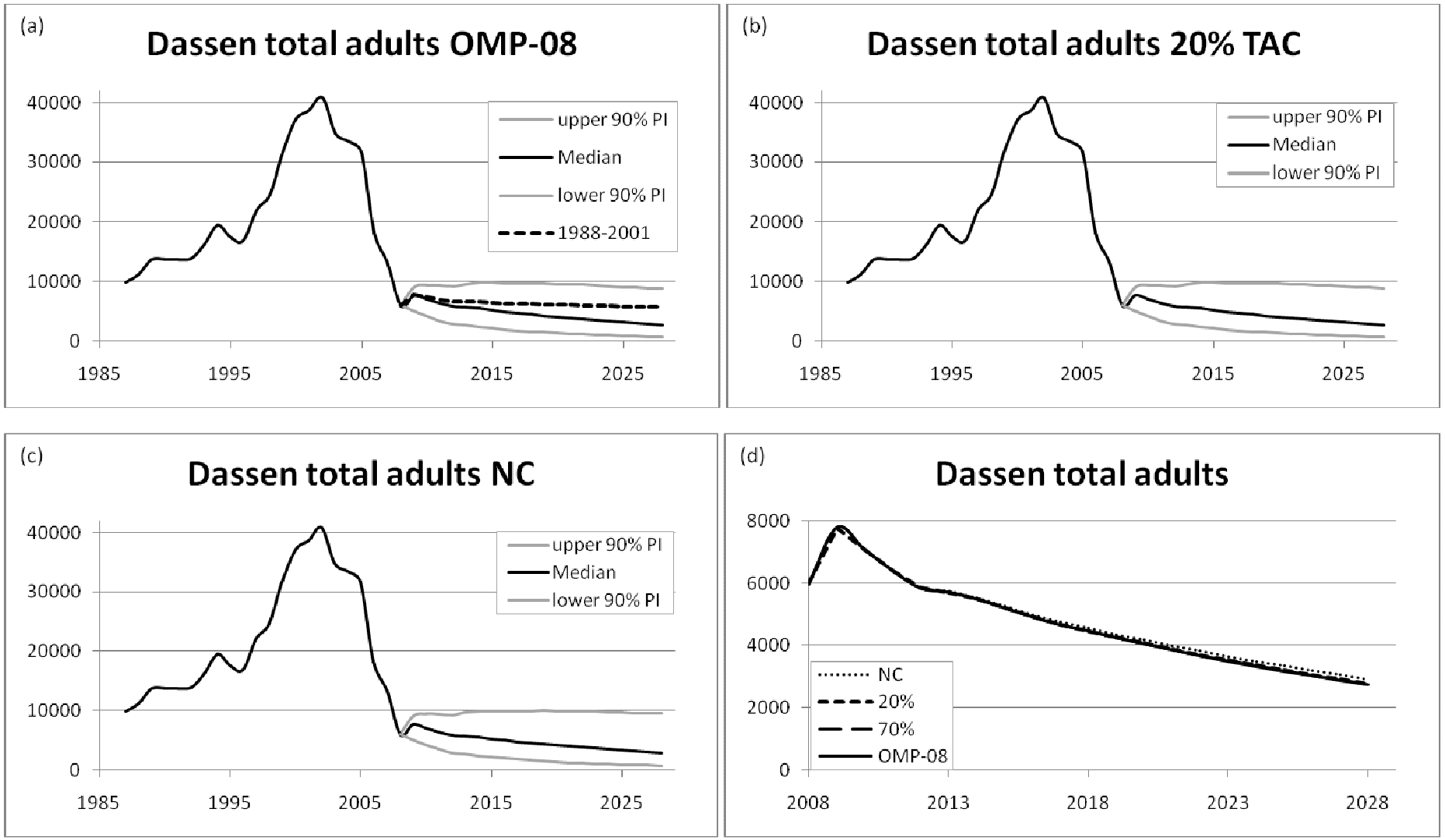

Fig. 4: Dassen island population projections with probability intervals under various fishing management procedures: (a) OMP-08 TAC unchanged, (b) 20%-100% of TAC allocated when biomass drops below the median, and (c) no fishing. (d) Projections for four cases are shown together. Future stratum B proportions are drawn from the 2002-2006 set, except for the dashed line in (a) which indicates a projection sampling from the 1988-2001 set.

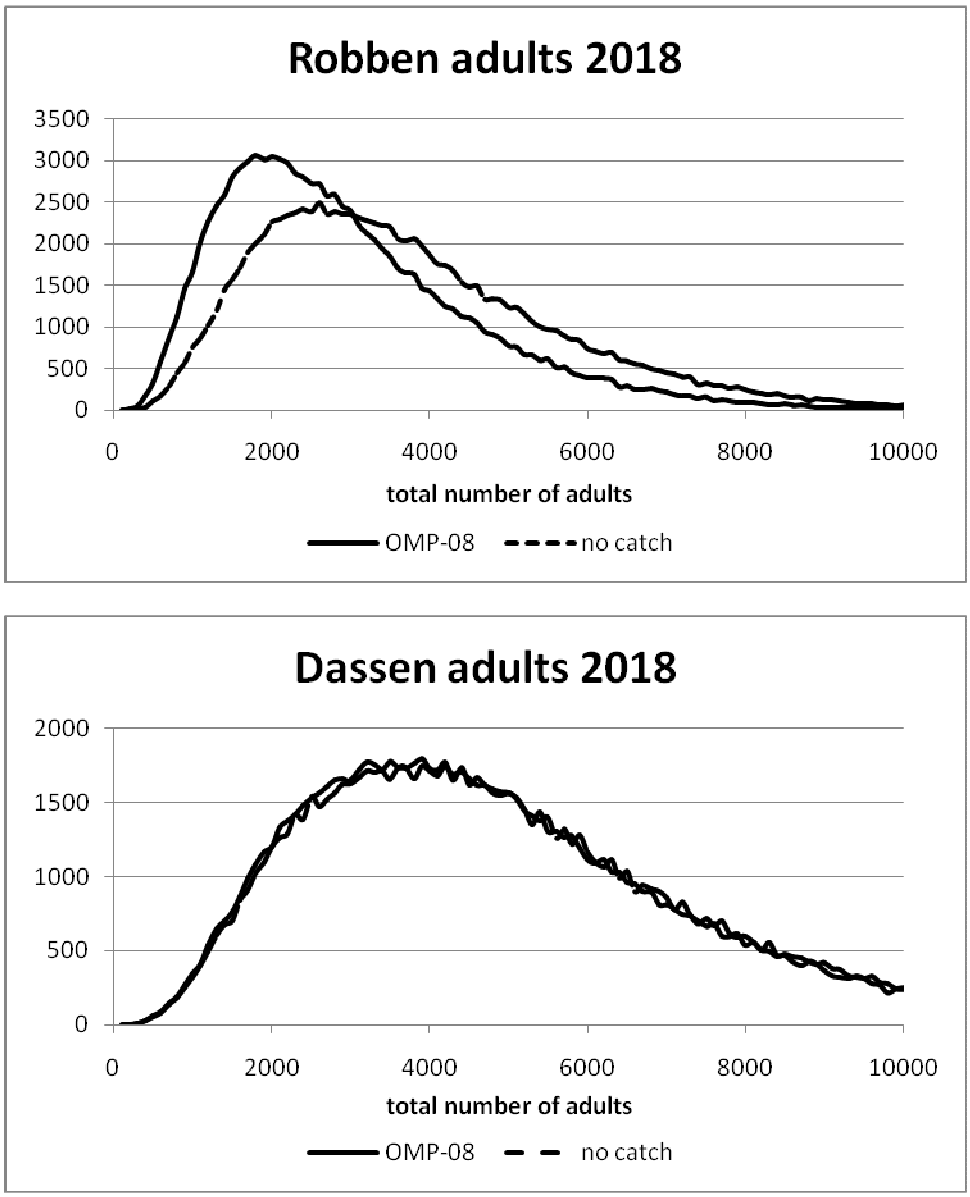

Fig. 5: Distributions of 2018 penguin populations over 100,000 runs. The top plot shows a shift to the right (higher penguin abundance) in the absence of fishing, but the distributions are very broad. The bottom plot shows that in the model fishing has no effect on the Dassen Island population, which is consistent with Fig. 4.

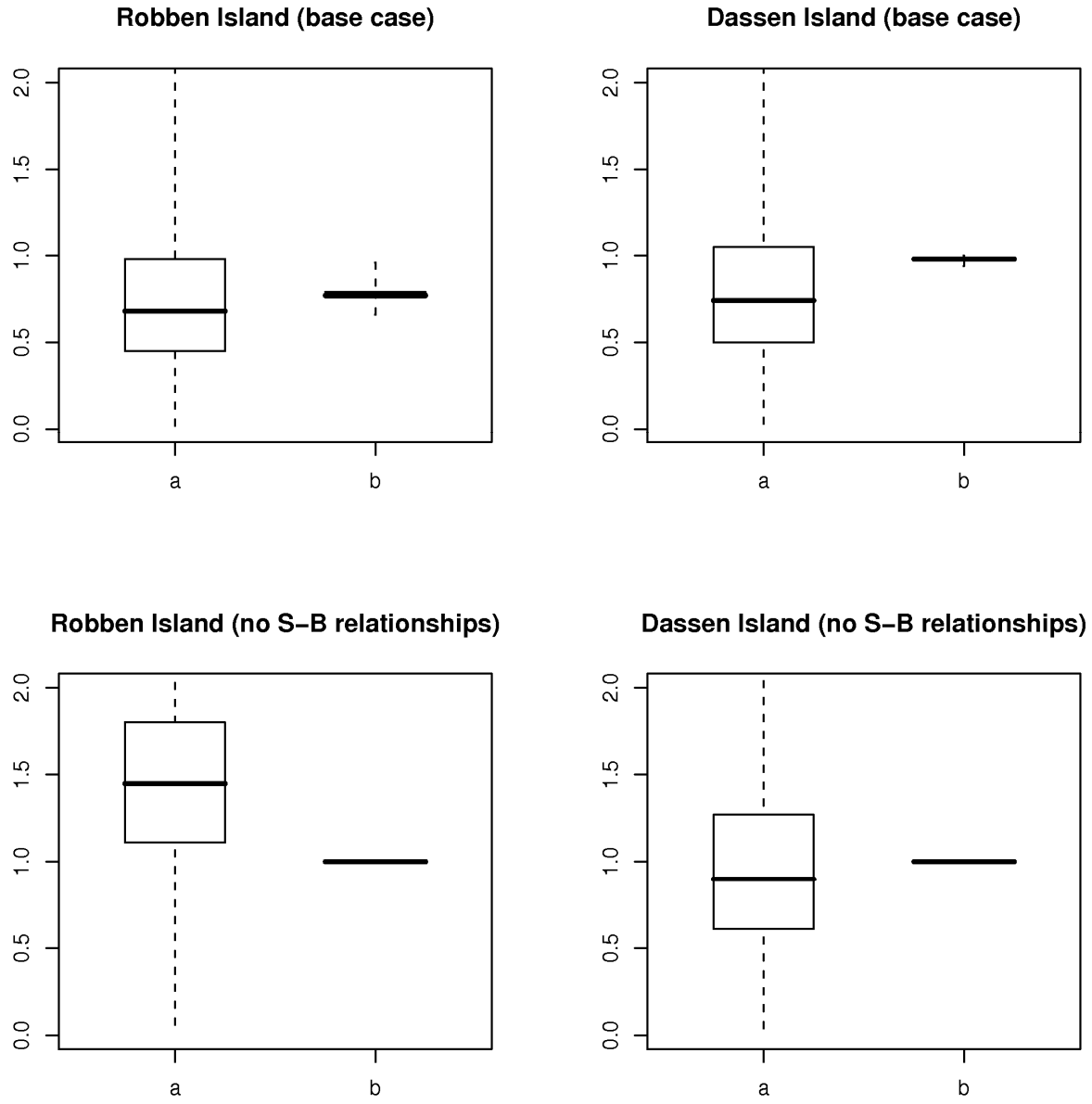

Fig. 6: Results pertaining to the base case model (top) and the model stating no relationships between penguin dynamics and pelagic abundance (bottom). The labelled box plots in each subplot show:

a) The ratio of penguin abundance in 2018 to 2008 under OMP-08. Values less than 1 indicate a decrease in penguins.

b) The ratio of penguin numbers in 2018 under OMP-08 to numbers in 2018 under no fishing. Values of 1 indicate that fishing has no effect.