State-space modelling reveals multiple drivers of rapid population decline in macaroni penguins

Abstract

Recent changes in the population trends of Antarctic mega fauna have been extensively linked to parameters of climate change. However, little is known about the relative importance of these drivers in the context of other processes. In order to investigate this, we used a state-space model to disentangle the processes driving a population of macaroni penguins (*Eudyptes chrysolophus*) to rapidly decline between 1985 and 2012. Principally, the population trajectory was most sensitive to regulation of survival rates associated with predation pressure. However, as trends in predation pressure remained stable across the study period, we infer that the observed trajectory was primarily driven by a change in the relationship between fecundity and the El Ni*ñ*o Southern Oscillation. More broadly, this study highlights the importance of considering multiple causal effects across different demographic rates in order to decipher population trends.