Predicting the fate of a seabird colony: an integrated population modelling approach

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In recent years many UK seabird populations have been experiencing hard times, as indicated by consistently below-average survival and productivity rates and a number of more severe mortality events and breeding failures. Although the exact causes remain unclear, this is widely thought to be due to a combination of over-fishing and environmental change affecting the availability of their primary prey species, the lesser sandeel *Ammodytes marinus*. In this study we investigate the implications of these events for the future of seabird populations using an integrated analysis of count, mark-recapture-recovery (MRR) and productivity data from a long-term study of common guillemots *Uria aalge* on the Isle of May, southeast Scotland. We use a state-space model for the count data, which separates observation error from process uncertainty so that we model the true underlying population rather than the estimates, and we adopt a hierarchical framework for the demographic parameters. Model-fitting is via a Bayesian approach using Markov chain Monte Carlo (MCMC), and posterior predictions of future population sizes are obtained as part of the MCMC algorithm and fully account for all parameter uncertainty. We assume that adult survival, juvenile survival and productivity may either maintain the mean levels of the entire study period, remain at their current levels or decline further, and we determine the effects of these scenarios on the predicted population trajectory by calculating the posterior probability of the population decreasing. We also conduct a sensitivity analysis to determine which demographic parameter has the greatest influence on population growth rate.