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TITLE: Variable vital rates and the risk of population declines in Adélie penguins from the Antarctic Peninsula region

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ABSTRACT:

Abstract Predicting population responses in changing environments is an important task for ecologists. In polar regions, climate warming, loss of sea ice, and more frequent anomalous events suggest that further reductions in ice?dependent animal populations are likely. We assess the risk of near?term (30?year) depletion of an Adélie penguin (Pygoscelis adeliae) population with a stochastic matrix model parameterized with 30 yr (1982?2011) of data from the Copacabana colony on King George Island, Antarctica. The model was fitted to nest census data by estimating correction factors for survival rates estimated from a multi?state mark?recapture model. We modeled future survival and fecundity scenarios during the projection period (2012?2041) based on a two?state Markov chain that randomly assigned survival rates and reproductive success from their respective historical distributions to represent ?good? and ?poor? years. Monte Carlo simulation was used to estimate population trajectories across a range of progressively worse survival conditions. The results suggest that, given historical distributions of survival and reproductive success, a limited scope for recovery of the population is present, commensurate with recent stabilization in population size at the study site. However, our projections mainly suggest that the Adélie penguin population will decline if the frequency of years with poor survival remains at, or increases above, its 30?year mean. The risk of local depletion within 30 yr, defined according to International Union for Conservation of Nature categories for endangered and critically endangered species, was 33% for >90% declines, but near 100% for 50% declines given status?quo conditions. As survival conditions worsen, the risk of substantive depletions rose rapidly. Given expectations of further environmental and ecosystem changes in the northern Antarctic Peninsula region, continued declines in Adélie penguin population size at the northern extent of their range should be expected.

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