The influence of Inbreeding Depression and Immigration on the Stability of a Small Insular Population: Modeling Inbreeding-Stress Interactions

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In a small population that fluctuates in size and experiences inbreeding depression, a manager may wish to assess the vulnerability of the population to reduced immigration. We investigated this scenario using an individual-based population model that traces a pedigree and determines the inbreeding coefficient, *f*, of each individual. The model was structured and parameterized using data from an island population of Song Sparrows (*Melospiza melodia*), monitored closely since 1975, with a continuous pedigree from 1981. The population has varied from 4 to 72 adult females (mean: 42) and immigration averages one bird per year. ID in annual survival rate is about 25% for *f*=0.25. Due to factors such as uncertainty in paternity, the exact severity of ID in this and other populations is rarely known. Therefore, we investigated extinction rate over a range of severity of ID, and included the potential for linear and curvilinear interactions between ID and stress. We also explored sensitivity to varied immigration rate under three scenarios for ID and stress: no interaction, linear interaction and curvilinear interaction. With constant immigration, little variability in the population trajectory occurred at ID of 25% to 75% under 'no interaction', and only slightly more under 'linear interaction'. However, a steeply truncating 'curvilinear interaction' produced regular crashes of ~80% in the population trajectory at an average interval of ~12 years. Sensitivity to reduction in immigration rate was greatest for the curvilinear model and least under 'no interaction'. Under 'curvilinear interaction', for ID=50%, half of model runs went extinct when average immigration dropped below 0.62, or ~2 immigrants in 3 years. Immigration could drop to 0.25 under 'linear interaction', and 0.19 under 'no interaction' before half of runs went extinct. Only 5% of runs went extinct if immigration was increased to 0.70, 0.28 and 0.25 for the scenarios respectively. Under the 'curvilinear interaction', the highest extinction rate occurred with no ID at low stress and high ID at high stress. Moderate ID at low stress removed inbred individuals gradually and reduced crash severity. These results demonstrate increased vulnerability to extinction if immigration rates fall or if stress greatly intensifies inbreeding depression.