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Matrix Models for Population & Evolutionary Dynamics: Climate Change Studies on Protection Island Wildlife Refuge

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Significant behavioral and life history strategy changes have been observed and correlated with climate change (mean sea surface temperature (SST) rise) in glaucous-winged gull colonies on Protection Island National Wildlife Refuge during recent ENSO events. In view of the recorded steady and on-going rise in SST over the last half century in the Strait Juan de Fuca, questions arise about the viability of the gull populations should these El Niño related changes become permanent. To test various hypotheses concerning the mechanisms involved in these changes and their long-term population and evolutionary dynamic consequences, we derive models using matrix methodology for the dynamics of structured populations. Because extinction is of primary concern, model analysis is focused on the bifurcations that occur when the extinction equilibrium destabilizes as R_0 (the population's inherent net reproduction number) increases through 1. I will describe a set of models of increasing complexity as more mechanisms are incorporated (motivated by the particular behavior and ecology of the gulls). Each model is of a new mathematical form that requires a new mathematical investigation into the fundamental bifurcation that occurs at $R_0 = 1$ (thus providing some fun for mathematicians). Using these mathematical results, I will describe some circumstances, at least as provided by these "test-of-concept" models, under which changes in certain life history strategies could be adaptive to long term climate change (which, in the case of the gulls, include increased egg cannibalism and adjustments to the timing of reproductive events).