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Population models with rapidly varying carrying capacities

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In modelling single-species populations, the “carrying capacity” is a constant limiting value to which the population tends over time. Rather than looking at cases where the carrying capacity is constant, we focused on looking at the effect of a time-varying carrying capacity, specifically a carrying capacity varying logistically between constant limits. In such a case, the resulting population variation can display ‘bi-logistic’ growth, comprising two logistic growth pulses in sequence. Our goal was to see the effect of this carrying capacity on the Gompertz model of population growth.

Initially, we examined the basic logistic model of population growth. Since an exact solution was not available with time-varying carrying capacities, we opted for an approximation. When the carrying capacity varied as above, but slowly in time, we used a multi-timing approach to give us an approximate expression for the solution of the logistic model. This proved to be a very accurate approximation when compared to the numerical solution.

We then applied this carrying capacity to our area of interest, the single species Gompertz model. Again, the multi-timing approach yielded an approximation to the solution of the Gompertz model displaying bi-logistic behaviour. We note that this procedure also produceded a general approximate expression for the Gompertz model suitable for any carrying capacity which varies slowly with time.

We are currently continuing our research in this area, as we also hope to investigate the effects of rapidly time-varying carrying capacities on population growth.

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See www.ice-em.org.au/students.html#scholarship.