Individuality in population dynamic IBMs: a simplifying assumption too far?

D. R. Cope[1] .

In simplifying individual-based models (IBMs), for ease of building and communication, individual animals may be assumed to be a member of a discrete class (e.g. age, size, stage), rather than a unique entity. I used an IBM that incorporates maternal effects to address the question of how population dynamics respond to changing assumptions about the distinctiveness of individuals.

Individuals in the model competed for access to food resources according to their "quality". Starvation occurred when daily access to food resources dropped below a starvation threshold. Background mortality (analogous to random predation) was also calculated on a daily basis. Reproduction occurred when an individuals access to food resources was above a breeding threshold during the breeding season. Quality was inherited from mother to daughter, mediated by environmental conditions.

Individuals were modelled as unique organisms in the full IBM, and the resultant population dynamics compared to a series of simplified models where individuals were treated as members of categorical quality classes. The number of classes varied from one to 32. The full IBM generated population time series that did not go extinct, but varied around an equilibrium level with a CV of less than 25%. When the model was simplified to the point where all individuals were found in a single class, the simulated populations went extinct within 10 years. Including individual variation, therefore, led to population persistence. Mean population size in the full IBM decreased as background mortality increased, and when the amplitude of seasonal fluctuations in food availability increased. The mean population size also decreased as the number of classes decreased

[1]The Macaulay Institute, Craigiebuckler, Aberdeen, AB15 8QH, UK (e-mail: d.cope@macaulay.ac.uk).

in the simplified models. Population variability in the full IBM was low, but increased slightly as background mortality increased. The strength of the seasonality in the environment did not affect population variability in this case. However, in the simplified models, there were complex interactions between background mortality, seasonality and the number of quality classes. As the number of quality classes decreased, the variability in population size increased.

The models presented in this paper demonstrate that making simplifying assumptions about the distinctiveness of individuals can affect the predicted population dynamics dramatically. If IBMs treat individuals as members of classes, rather than as unique organisms, predictions of population size and variability may be wrong.

References

[1] Bernardo, J. 1996. Maternal effects in animal ecology. - Amer. Zool. 36:83-105.

[2] Bjønstad, O.N. & Hansen, T.F. 1994. Individual variation and population dynamics. - Oikos 69: 167-171.

[3] Grimm, V. 1999. Ten years of individual-based modelling in ecology: what have we learned and what could we learn in the future? - Ecological Modelling 115: 129-148.

[4] Uchmanski, J. 2000. Individual variability and population regulation: an individual-based approach. Oikos 90: 539-548.