A pattern-oriented modelling approach to simulating populations of grey partridge.

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ABSTRACT

A number of wildlife species including the grey partridge (*Perdix perdix*) have shown dramatic post-war population declines. Multiple drivers have been proposed as reasons for the declines, for example agrochemical use and intensification of agricultural practices, climate, predation, and changes in landscape structure. These drivers may interact in non-linear ways and are inherently spatio-temporal in nature. Therefore models used to investigate mechanisms should be spatio-temporal, of proper scale, and have a high degree of biological realism. Here we describe the development and testing of an agent-based model (ABM) of grey partridge using a well documented pre-decline historical data set in conjunction with a pattern-oriented modelling (POM) approach. Model development was an iterative process of defining performance criteria, testing model behaviour, and reformulating as necessary to emulate system properties whilst ensuring that internal mechanisms were biologically realistic. The model was documented using ODdox, a new protocol for describing large agent-based models. Parameter fitting in the model was achieved to within ±2% accuracy for 15 out of 17 field data patterns used, and within 5% for the remaining two. Tests of interactions between input parameters showed that 62% of parameter pairs tested had significant interactions underlining the complex nature of the model structure. Sensitivity analysis identified chick mortality as being the most sensitive factor, followed by adult losses to hunting and adult overwinter mortality, agreeing in general with previous partridge models. However, the ABM used here could separate individual drivers, providing a better understanding of the underlying mechanisms behind population regulation, and allowing factors to be compared directly. The ABM used is rich in output signals allowing detailed testing and refinement of the model. This approach is particularly suited to systems such as the partridge system where data for comparison to model outputs is readily available. Despite the accurate fit between historical data and model output, making use of the predictive power of the approach the model requires further calibration and testing under modern field conditions.

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