Tammy L. Wilson, James B. Odei, Mevin B. Hooten, and Thomas C. Edwards, Jr. 2010. Hierarchical spatial models for predicting pygmy rabbit distribution and relative abundance. Journal of Applied Ecology 47:401-409.

Summary

1. Conservationists routinely use species distribution models to plan conservation, restoration and development actions, while ecologists use them to infer process from pattern. These models tend to work well for common or easily observable species, but are of limited utility for rare and cryptic species. This may be because honest accounting of known observation bias and spatial autocorrelation are rarely included, thereby limiting statistical inference of resulting distribution maps.

2. We specified and implemented a spatially explicit Bayesian hierarchical model for a cryptic mammal species (pygmy rabbit *Brachylagus idahoensis*). Our approach used two levels of indirect sign that are naturally hierarchical (burrows and faecal pellets) to build a model that allows for inference on regression coefficients as well as spatially explicit model parameters. We also produced maps of rabbit distribution (occupied burrows) and relative abundance (number of burrows expected to be occupied by pygmy rabbits). The model demonstrated statistically rigorous spatial prediction by including spatial autocorrelation and measurement uncertainty.

3. We demonstrated flexibility of our modelling framework by depicting probabilistic distribution predictions using different assumptions of pygmy rabbit habitat requirements.

4. Spatial representations of the variance of posterior predictive distributions were obtained to evaluate heterogeneity in model fit across the spatial domain. Leave-one-out cross-validation was conducted to evaluate the overall model fit.

5. Synthesis and applications. Our method draws on the strengths of previous work, thereby bridging and extending two active areas of ecological research: species distribution models and multistate occupancy modelling. Our framework can be extended to encompass both larger extents and other species for which direct estimation of abundance is difficult.