

Mixture models for multi-brooded butterfly species

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Abstract: Butterflies respond sensitively and rapidly to changes in habitat and climate, hence their population status is a valuable indicator for changes in biodiversity and phenology. The main source of count data for UK butterflies is the UK Butterfly Monitoring Scheme, which is used to derive abundance indices which form one of the UK Government's 18 indicators of general trends in biodiversity.

Butterflies have multi-stage life cycles and hence count data fluctuate within each year in response to their emergence as adults. Many species are also multivoltine, with up to two or three broods of adults emerging in a given year. The current approach for describing the seasonal variation in count data involves fitting non-parametric curves to estimate missing values in the calculation of abundance indices (Dennis et al., 2013). We present a parametric approach via a stochastic mixture of Normal distributions. The estimation of new parameters relating to emergence date can be used to assess changes in phenology.

A hierarchical structure treats individual site effects as random effects and provides a new method for generating indices of abundance. The model also accommodates particular features which will vary between species, such as weather and covariate dependence and spatial or temporal variation in the number of broods. The model is fitted to data available for a sample of species, and comparisons are made with the prediction of alternative models.

By accounting explicitly for multiple broods within a year, the model produces new insights relevant to the monitoring and conservation of invertebrates, and produces more efficient and accurate abundance indices than the current approach.

References

Dennis, E.B., Freeman, S.N., Brereton, T. and Roy, D.B. (2013) Indexing butterfly abundance whilst accounting for missing counts and variability in seasonal pattern. *Methods in Ecology and Evolution*, 4:637-645.