The generalised abundance index approach

Butterfly Conservation Europe
Butterfly Conservation
CEH Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL
De Vlinderstichting
HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Overview of modelling steps

1. Estimate species flight curve

2. Estimate site indices

3. Combine to collated indices

Estimate species trends

Combine to multi-species indicators

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Biological Conservation
Volume 12, Issue 2, September 1977, Pages 115-134

A method for assessing changes in the abundance of butterflies

https://doi.org/10.1016/0006-3207(77)90065-9

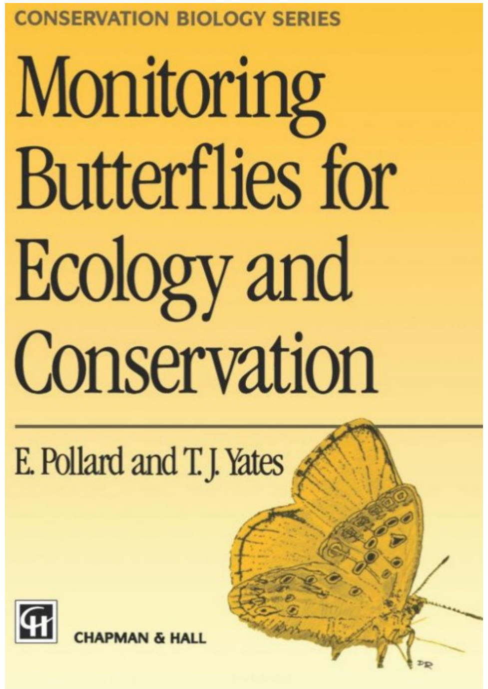
E. Pollard

Ecological Entomology

Calculation of collated indices of abundance of butterflies based on monitored sites

D. MOSS, E. POLLARD

First published:February 1993 | https://doi.org/10.1111/j.1365-2311.1993.tb01083.x



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Original Articles

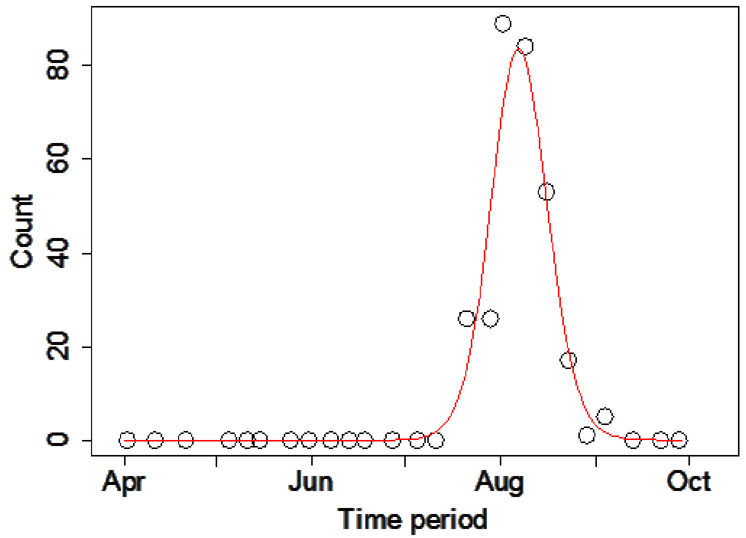
Application of generalized additive models to butterfly transect count data

Peter Rothery & David B. Roy

https://doi.org/10.1080/02664760120074979

Pages 897-909 | Published online: 02 Aug 2010

- A generalized additive model (GAM) is fitted to each site and year individually
- Excludes data where peak flight period is unrecorded or more than 30% data requires estimation
- For the UK, nearly 40% of monitored 10km grid squares were excluded



Methods in Ecology and Evolution BRITISH ECOLOGICAL SOCIETY

Butterfly Conservation Europe

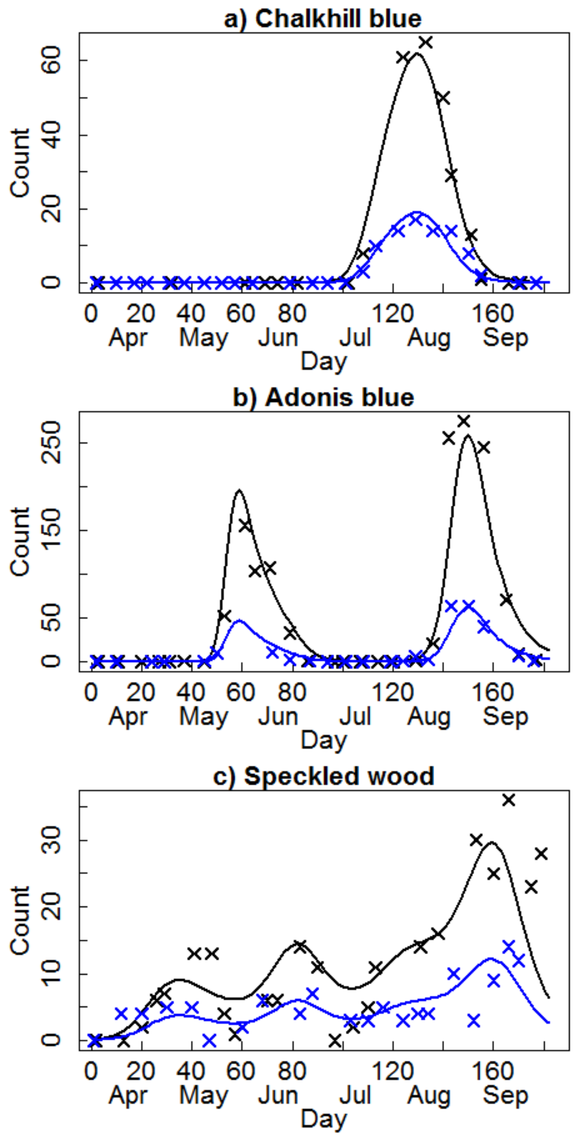
Standard Paper | Free Access

Indexing butterfly abundance whilst accounting for missing counts and variability in seasonal pattern

Emily B. Dennis, Stephen N. Freeman, Tom Brereton, David B. Roy

First published:26 March 2013 | https://doi.org/10.1111/2041-210X.12053 (open)

- A GAM is used to estimate a common flight period across sites for each year.
- More robust indices and trends than single-site GAM or linear interpolation
- Greater use of data
- Disadvantage – can be slow when there are lots of data



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Journal of Applied Ecology
BRITISH ECOLOGICAL SOCIETY

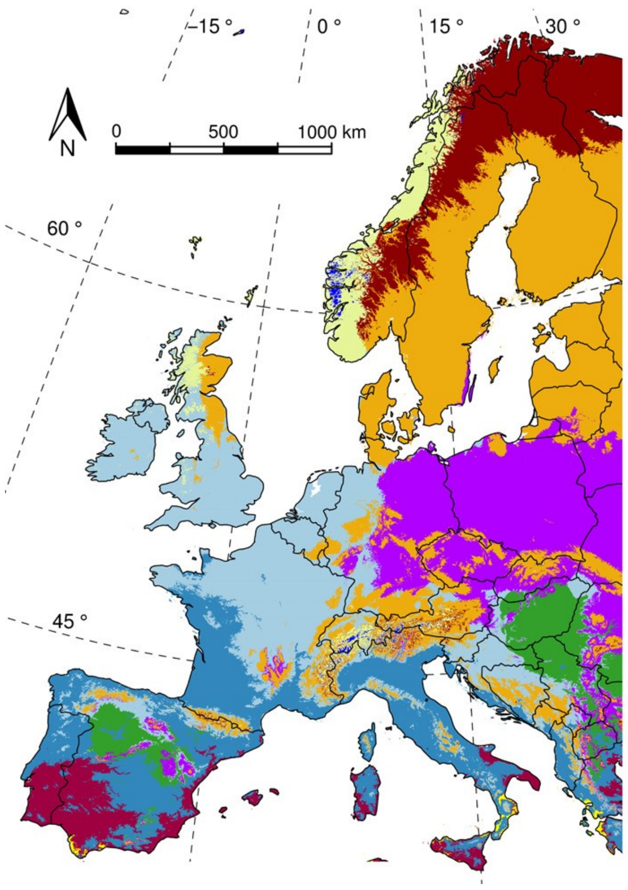
Standard Paper | Open Access

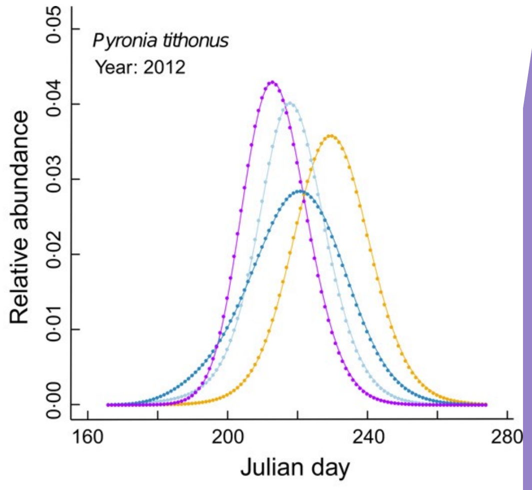
A regionally informed abundance index for supporting integrative analyses across butterfly monitoring schemes

Reto Schmucki, Guy Pe'er, David B. Roy, Constantí Stefanescu, Chris A.M. Van Swaay, Tom H. Oliver, Mikko Kuussaari, Arco J. Van Strien, Leslie Ries, Josef Settele, Martin Musche ... See all authors

First published:28 October 2015 | https://doi.org/10.1111/1365-2664.12561 | Citations: 14

https://doi.org/10.1111/1365-2664.12561 (open)





Biometrics 72, 1305–1314
December 2016

DOI: 10.1111/biom.12506

A Generalized Abundance Index for Seasonal Invertebrates

Emily B. Dennis,[1,3,*] Byron J. T. Morgan,[1] Stephen N. Freeman,[2] Tom M. Brereton,[3] and David B. Roy[2]

[1]School of Mathematics, Statistics and Actuarial Science, University of Kent, Canterbury, Kent, U.K.
[2]Centre for Ecology & Hydrology, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, U.K.
[3]Butterfly Conservation, Manor Yard, East Lulworth, Wareham, Dorset, U.K.
*email: E.B.Dennis@kent.ac.uk

Summary. At a time of climate change and major loss of biodiversity, it is important to have efficient tools for monitoring populations. In this context, animal abundance indices play an important rôle. In producing indices for invertebrates, it is important to account for variation in counts within seasons. Two new methods for describing seasonal variation in invertebrate counts have recently been proposed; one is nonparametric, using generalized additive models, and the other is parametric, based on stopover models. We present a novel generalized abundance index which encompasses both parametric and nonparametric approaches. It is extremely efficient to compute this index due to the use of concentrated likelihood techniques. This has particular relevance for the analysis of data from long-term extensive monitoring schemes with records for many species and sites, for which existing modeling techniques can be prohibitively time consuming. Performance of the index is demonstrated by several applications to UK Butterfly Monitoring Scheme data. We demonstrate the potential for new insights into both phenology and spatial variation in seasonal patterns from parametric modeling and the incorporation of covariate dependence, which is relevant for both monitoring and conservation. Associated R code is available on the journal website.

Key words: Butterflies; Citizen science; Concentrated likelihood; Normal mixtures; Phenology; UKBMS.

https://doi.org/10.1111/biom.12506 **(open)**

GAI approaches offers three options for describing seasonal variation:

- Flexible spline/GAM across sites each year
- Parametric description for each brood using Normal distributions
  - Phenology estimation, using covariates
- "Stopover model"
  - Mechanistic description with certain assumptions – estimates adult lifespan
  - Relevant paper: https://doi.org/10.1111/1365-2664.12208 (open)

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1. Estimate species flight curve

$$\lambda_{i,j} = N_i a_{i,j}$$

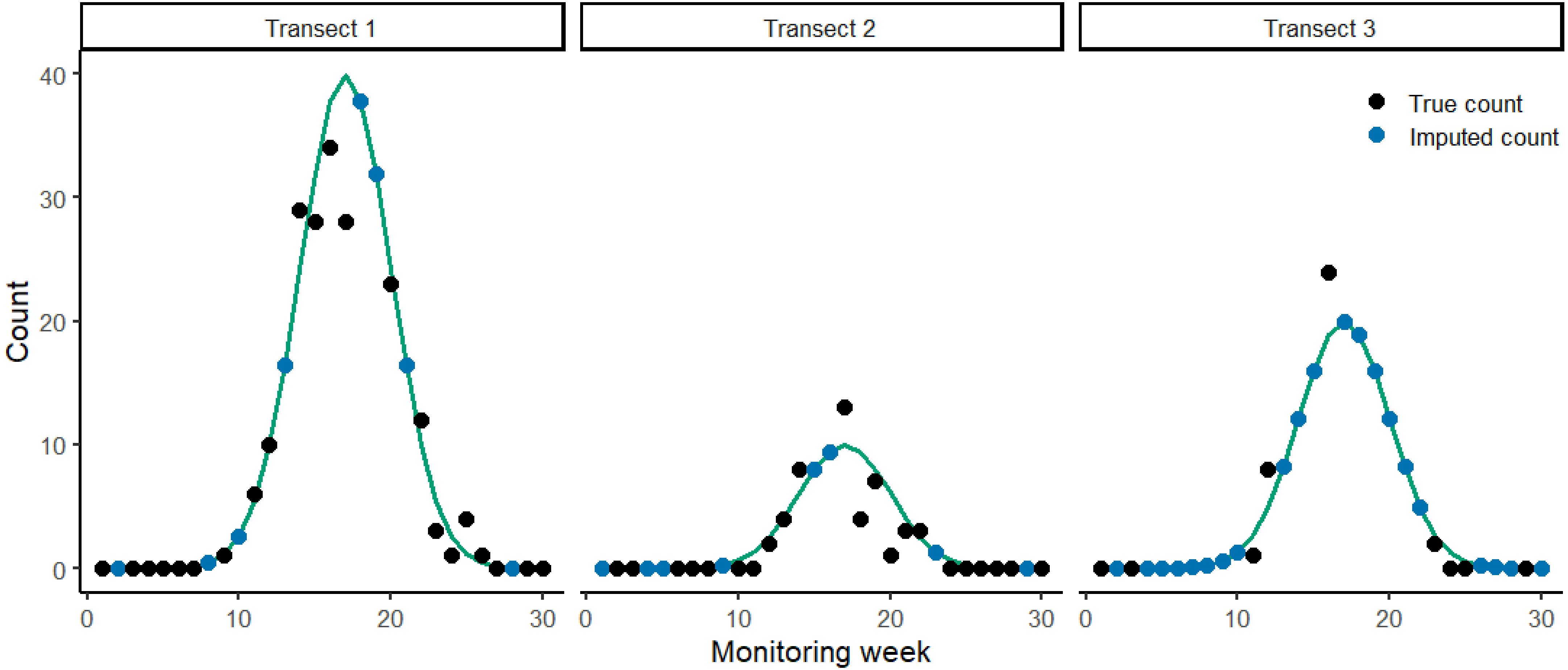
Expected count (Poisson)

Site abundance

Seasonal variation

- We use a flexible curve to describe the species flight curve across sites
- The “height” of the curve is reflected by the site effect
- Efficient modelling of the site effects N_i - concentrated likelihood – up to 75 times faster

1. Estimate species flight curve



2. Combine to site indices

For each year:

$$N_i = \frac{\sum_j y_{i,j}}{\sum_j a_{i,j}}$$

Real counts, summed across visits

Site index

Estimated season pattern, summed across visits

Site indices for each site and year for a given species

3. Combine to collated indices

We fit a Poisson generalised linear model (GLM):

$$N_{i,k} \sim \alpha_i + \beta_k$$

Site index

Site effect

Year effect

- Also weight by the proportion of the flight curve sampled
    - Well sampled sites contribute more
- We can then obtain expected total butterfly counts
- And convert to collated indices to consider changes in relative abundance over time

Other points to add/for later

- Trends
- Bootstrapping
- Indicator methodology