



# Grassland Butterfly Index (GBI) Calculation

**Reto Schmucki**  
[retoschm@ceh.ac.uk](mailto:retoschm@ceh.ac.uk)

2 April 2025



EMBRACE project: Call for tenders EC-ENV/2024/NP/0040: GRASSLAND BUTTERFLY INDICATOR AND  
EUROPEAN BUTTERFLY MONITORING SCHEME UPDATE (2021-2026)

# Grassland Butterfly Index (GBI)

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Sofia – Moscow

E. Kühn, R. Feldmann, J.A. Thomas & J. Settele (Eds) 2005  
Studies on the Ecology and Conservation of Butterflies in Europe  
Vol. 1: General Concepts and Case Studies, pp. 106-108

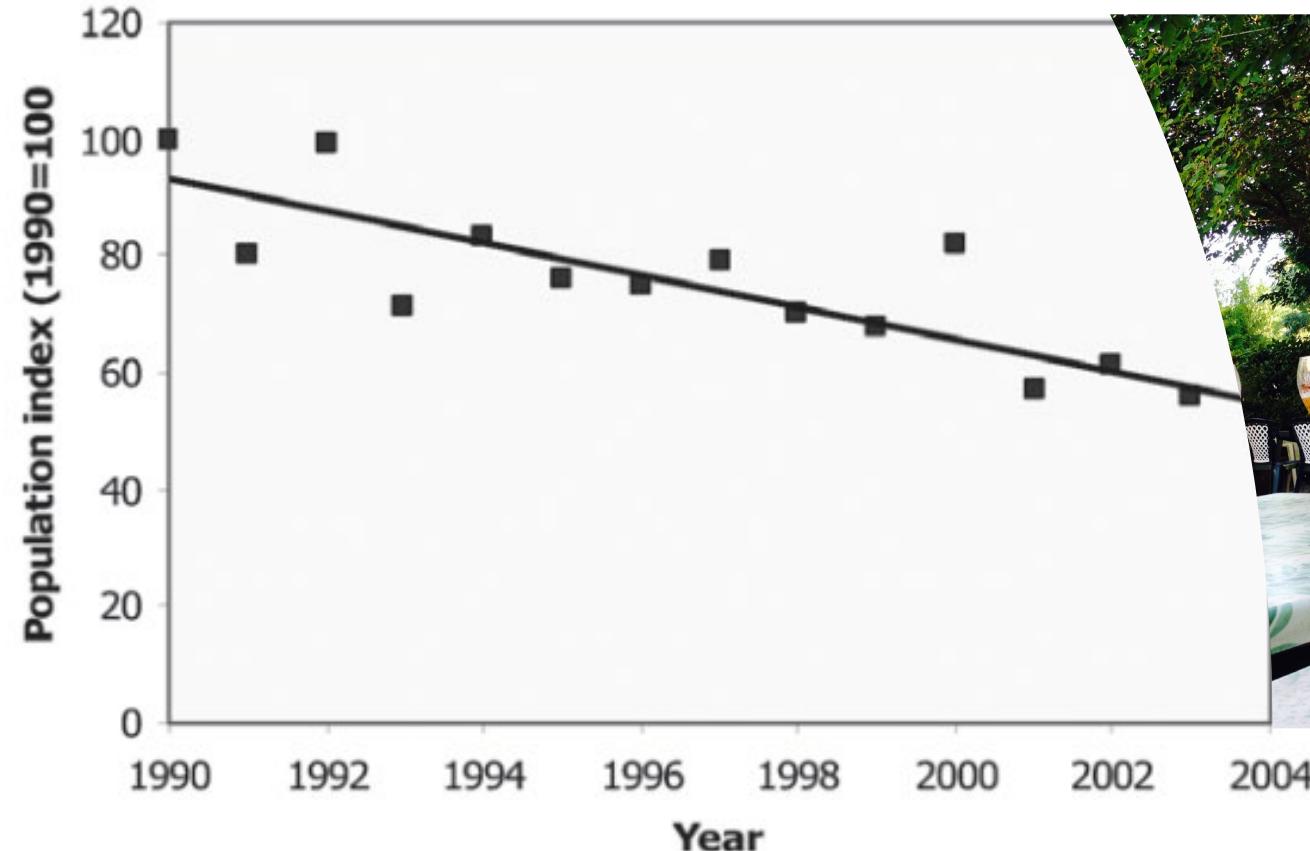
## Using butterfly monitoring data to develop a European grassland butterfly indicator

Chris Van Swaay<sup>1</sup> & Arco van Strien<sup>2</sup>

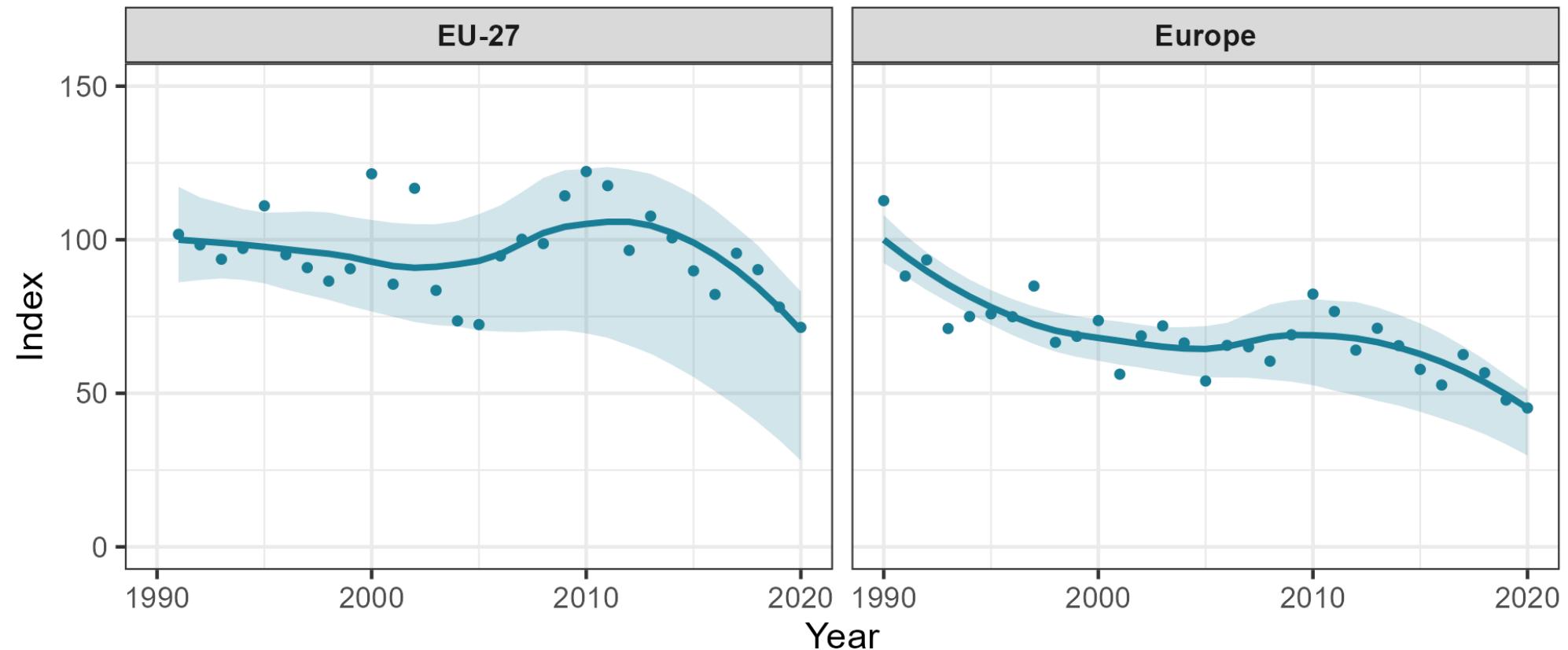
<sup>1</sup> De Vlinderstichting/Dutch Butterfly Conservation & Butterfly Conservation Europe,  
P.O. Box 506, NL-6700 AM Wageningen, Netherlands

<sup>2</sup> Statistics Netherlands, P.O. Box 4000, 2270 JM Voorburg, Netherlands  
Contact: chris.vanswaay@vlinderstichting.nl

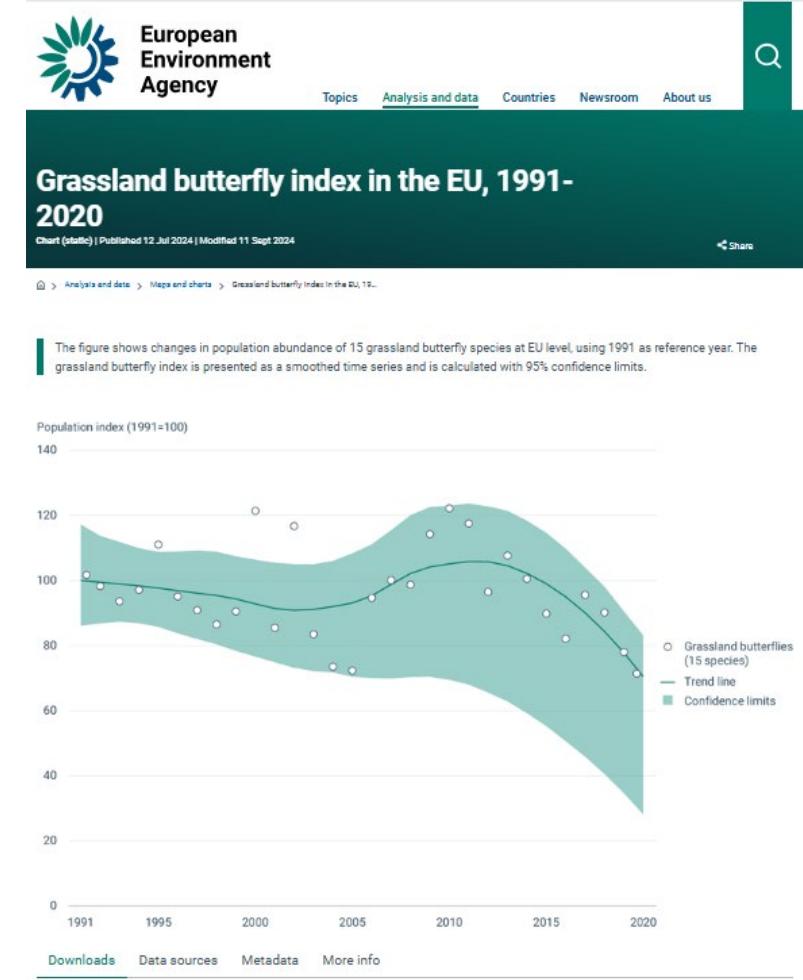
# Grassland Butterfly Index (GBI)



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UK Centre for  
Ecology & Hydrology

retoschm@ceh.ac.uk

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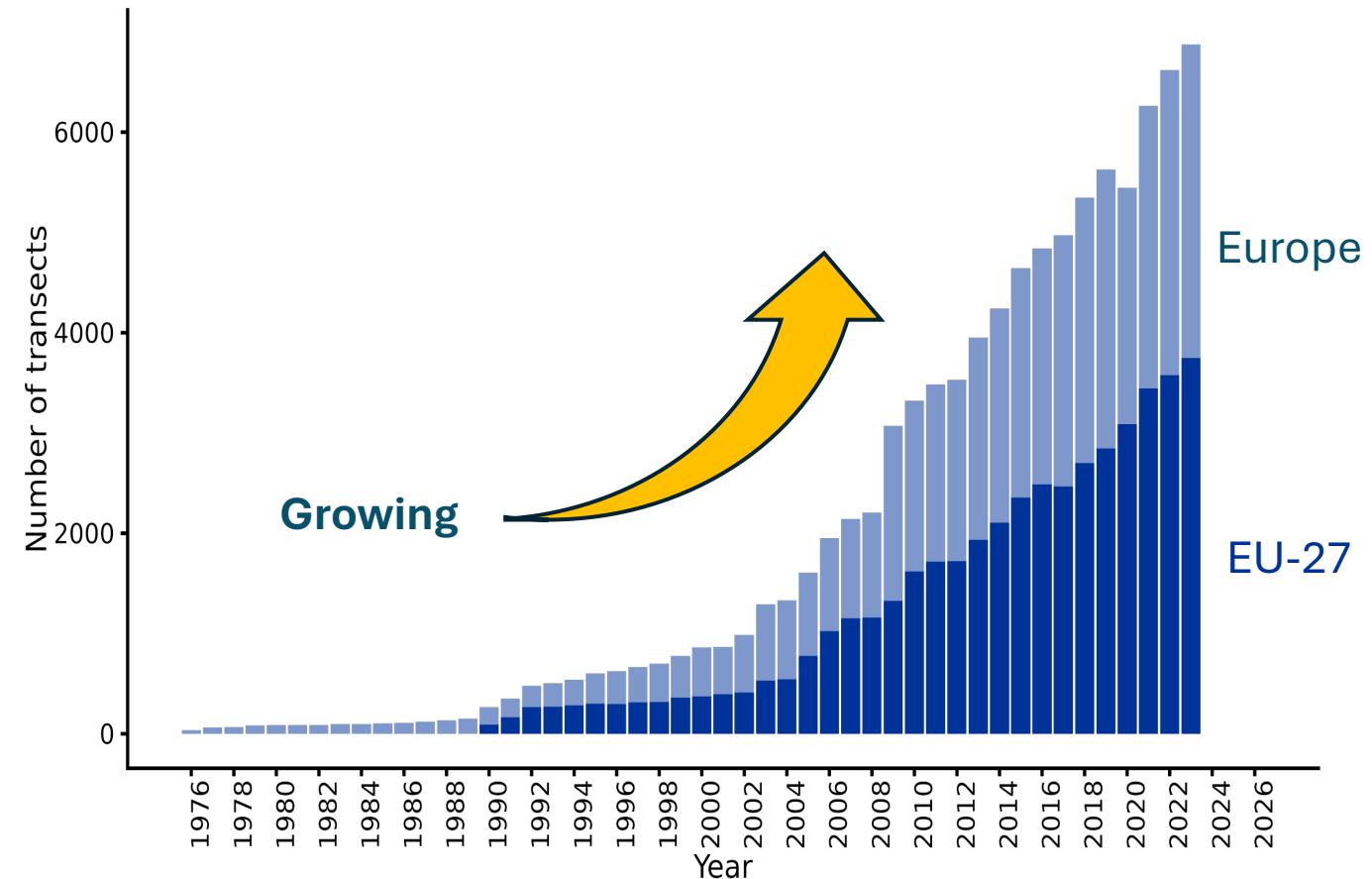


- EMBRACE project
  - 24 months (Dec. 2024 to Dec. 2026)
  - Streamline GBI calculation – 2021-2025 (EU-27)
  - Support National BMS in EU Member States
  - Build capacity for GBI calculation
    - ❖(eBMS network, monitoring, statistical tools, technical advises)



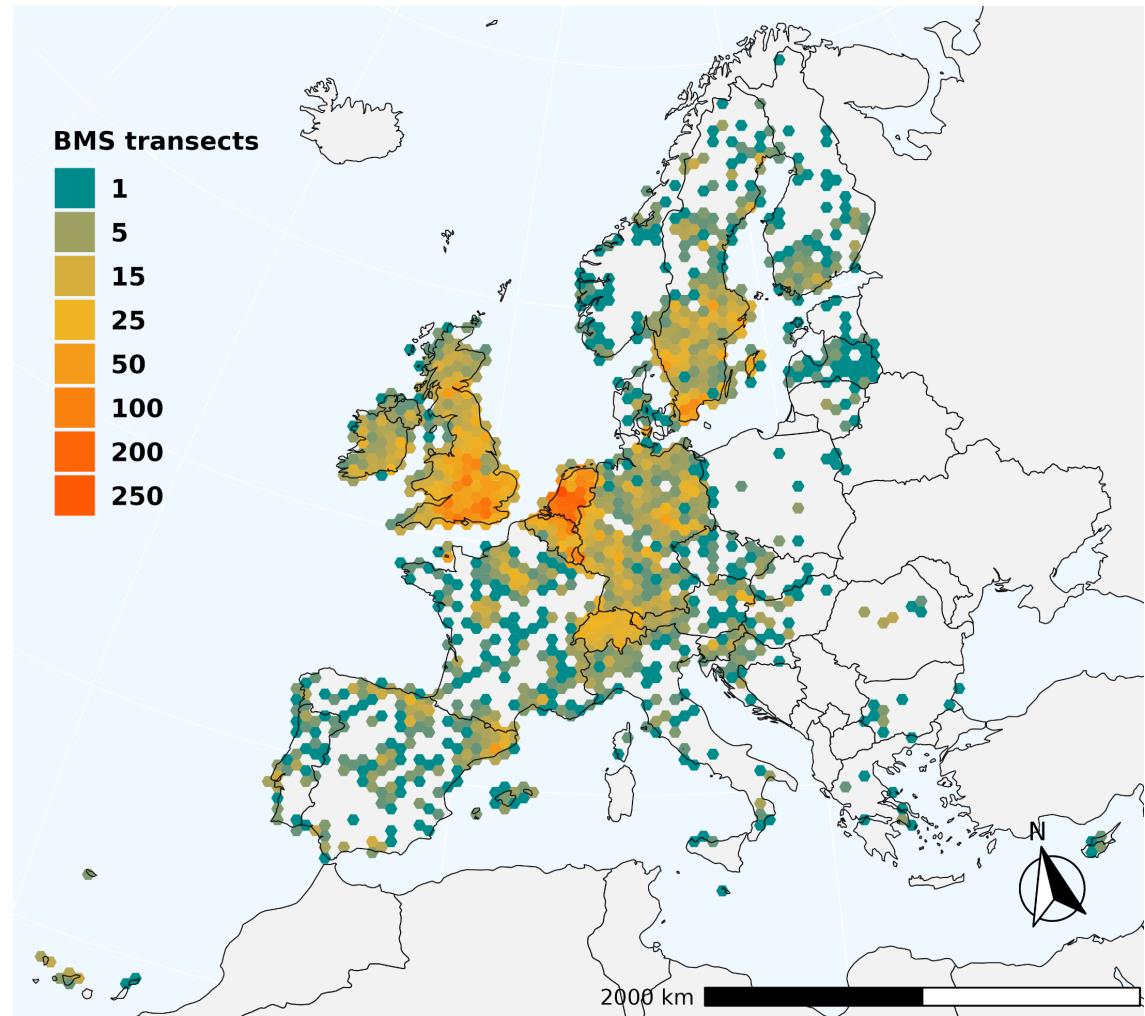
# Grassland Butterfly Index (GBI) – data quantity & quality

- National BMS data
  - ❖ National expert and volunteer network
- ButterflyCount app
  - ❖ Systematic data recording
  - ❖ National and regional species list
- eBMS online data systems
  - ❖ Verification and validation tool
- eBMS centralised database
  - ❖ Systematic quality check
  - ❖ Taxonomy harmonisation
  - ❖ Date harmonisation
  - ❖ Spatial harmonisation
  - ❖ Consistency in data type
  - ❖ Unique ID and standardised coding
  - ❖ Traceability to original data source

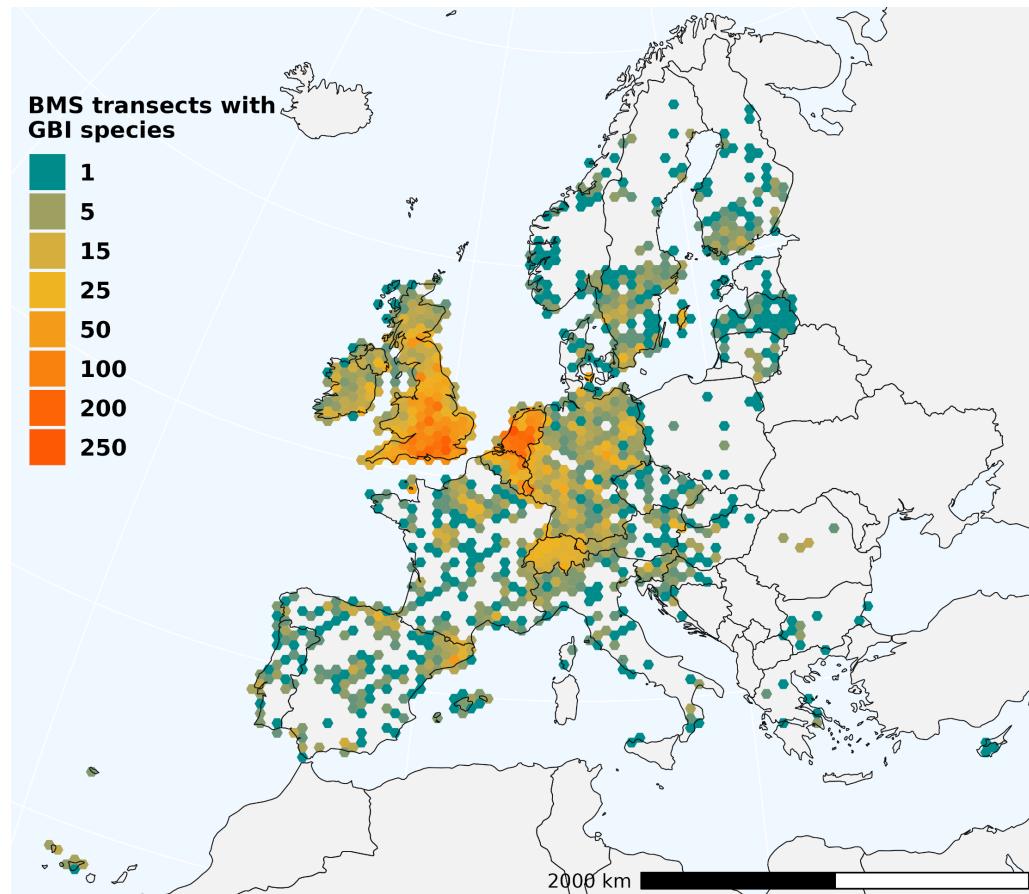


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# Grassland Butterfly Index (GBI) – 17 indicator species



## Widespread species

- 1) *Ochloides sylvanus*
- 2) *Anthocharis cardamines*
- 3) *Lasiommata megera*
- 4) *Coenonympha pamphilus*
- 5) *Maniola jurtina*
- 6) *Lycaena phlaeas*
- 7) *Polyommatus icarus*

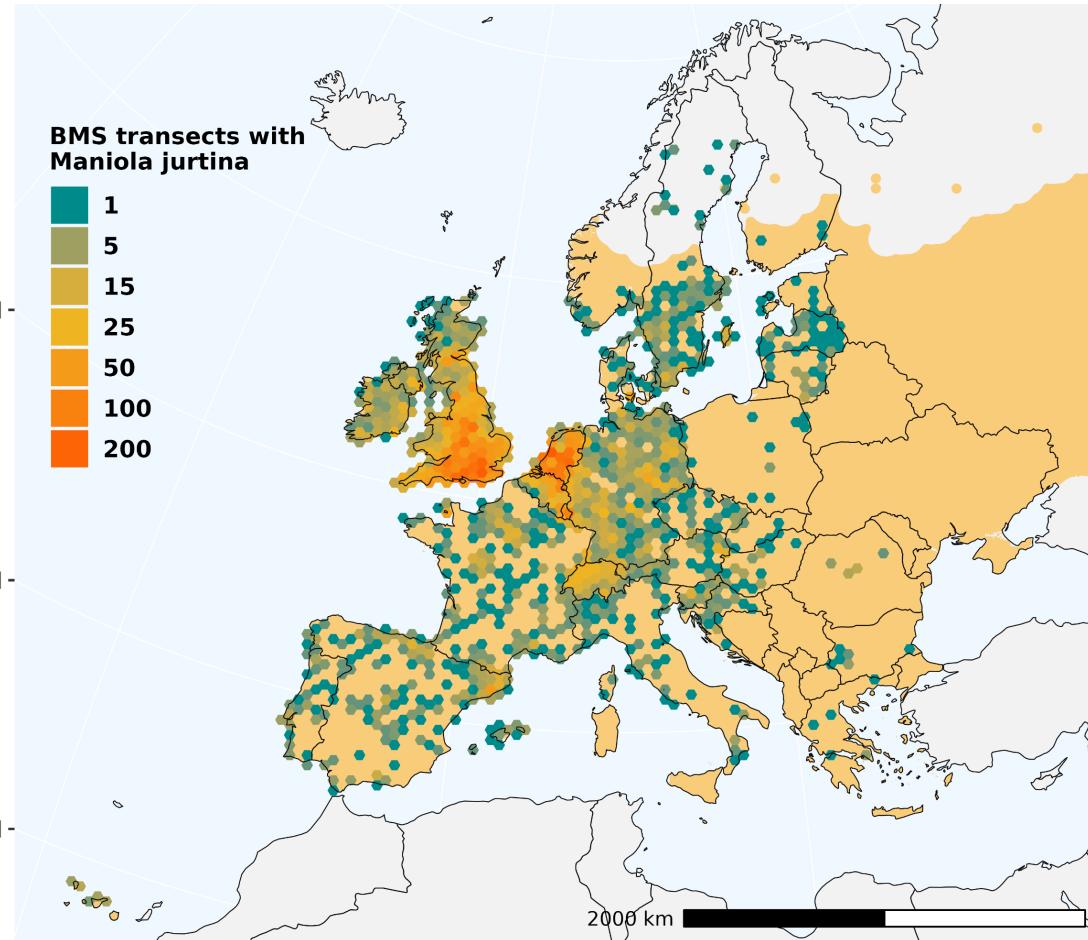


## Specialist species

- 8) *Spialia Sertorius*
- 9) *Cupido minimus*
- 10) *Phengaris arion*
- 11) *Cyaniris semiargus*
- 12) *Polyommatus coridon*
- 13) *Euphydryas aurinia*
- 14) *Erynnis tages*
- 15) *Thymelicus acteon*
- 16) *Phengaris nausithous*
- 17) *Polyommatus bellargus*



# Grassland Butterfly Index (GBI) – species distribution



## Widespread species

- 1) *Ochlodes sylvanus*
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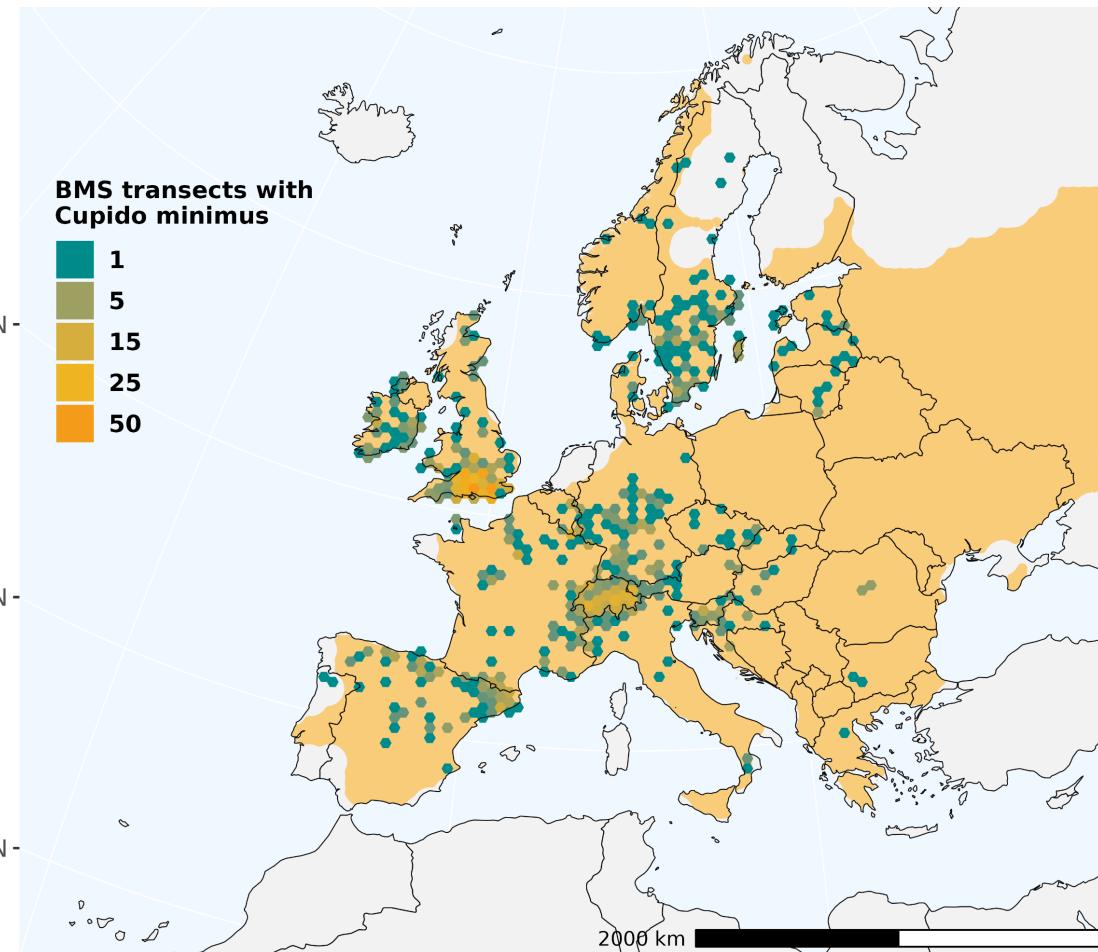


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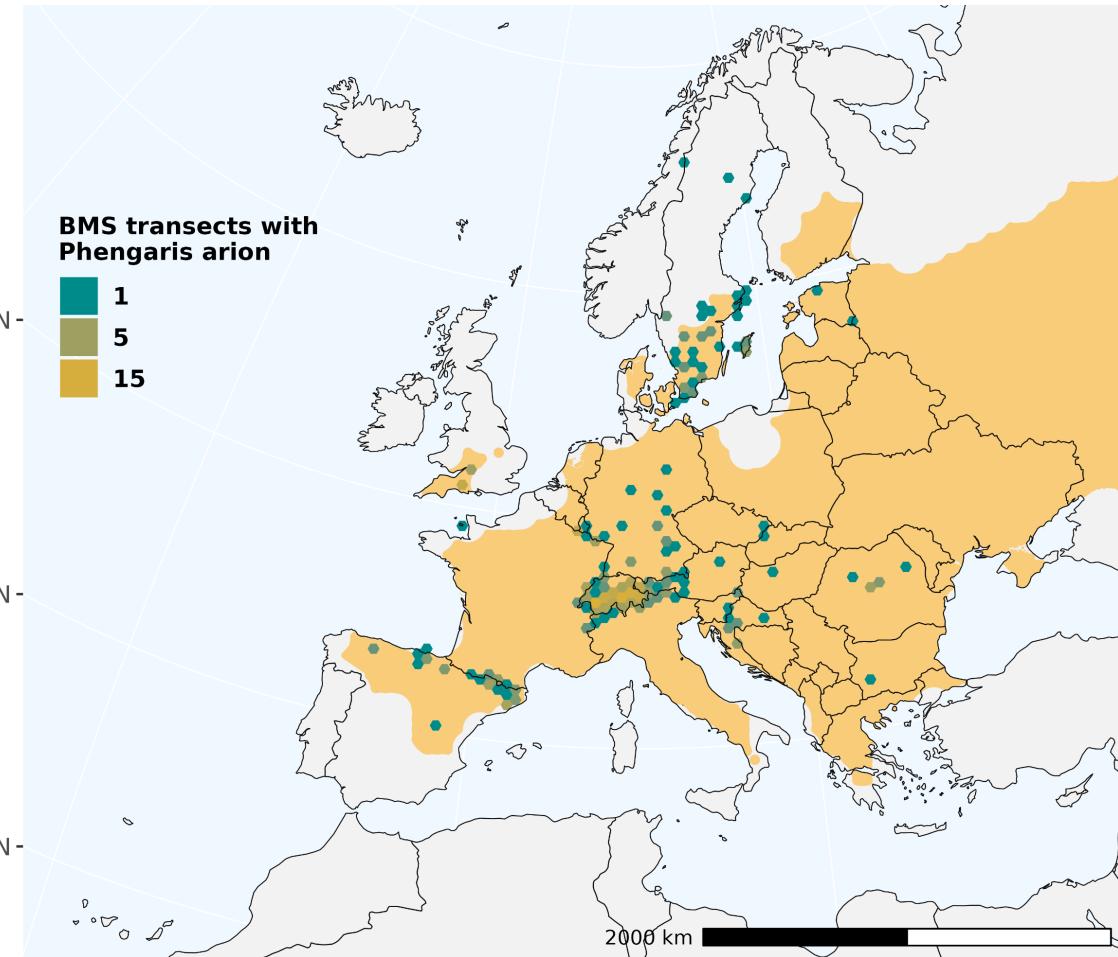
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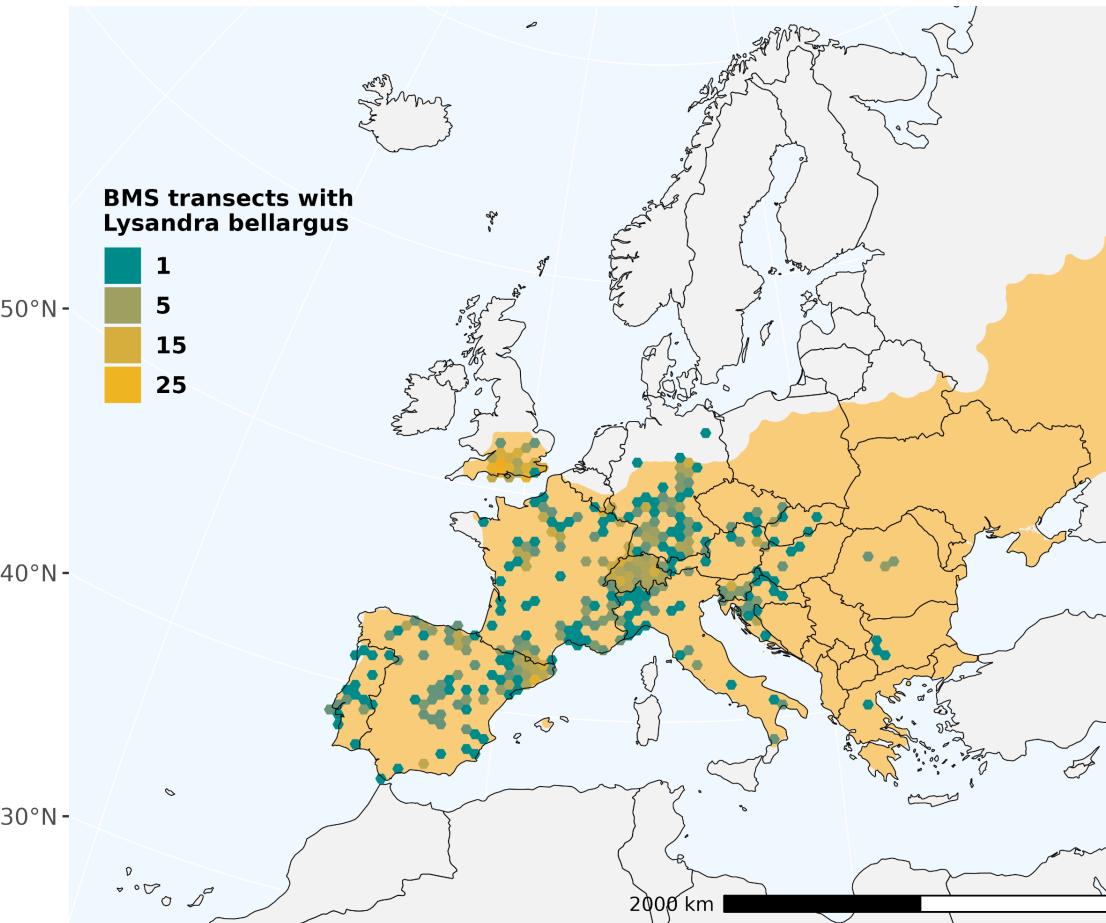
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# Grassland Butterfly Index (GBI) - tools



rbms 1.1.3 Reference Articles ▾

## Authors

Reto Schmucki. Author, maintainer. [id](#)

Colin A. Harrower. Author. [id](#)

Emily Dennis. Contributor. [id](#)

## Citation

Source: [inst/CITATION](#)

Schmucki R., Harrower C.A., Dennis E.B. (2022) rbms: Computing generalised abundance indices for butterfly monitoring count data. R package version 1.1.3. <https://github.com/RetoSchmucki/rbms>



# Grassland Butterfly Index (GBI) – method/tutorial

The screenshot shows a web browser window with the URL [butterfly-monitoring.github.io/bms\\_workshop/index.html](https://butterfly-monitoring.github.io/bms_workshop/index.html) in the address bar. The page content is as follows:

**BMS Workshop**

**Motivation**

- Schedule
- Before the workshop
- Computer and software
- Download Data
- Update
- Reading

**Calculating butterfly trends, indexes and indicators**

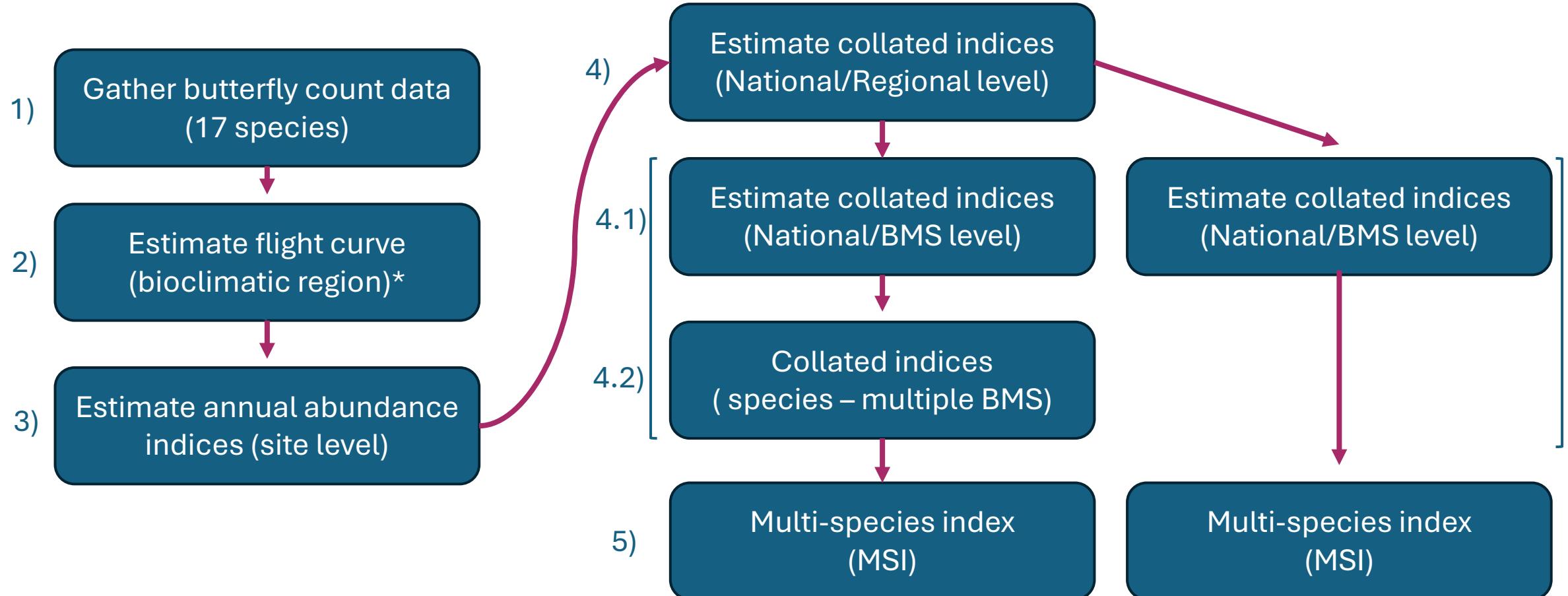
Reto Schmucki, Emily Dennis, David Roy and Chris Van Swaay  
April 1<sup>st</sup>, 2020

**Motivation**

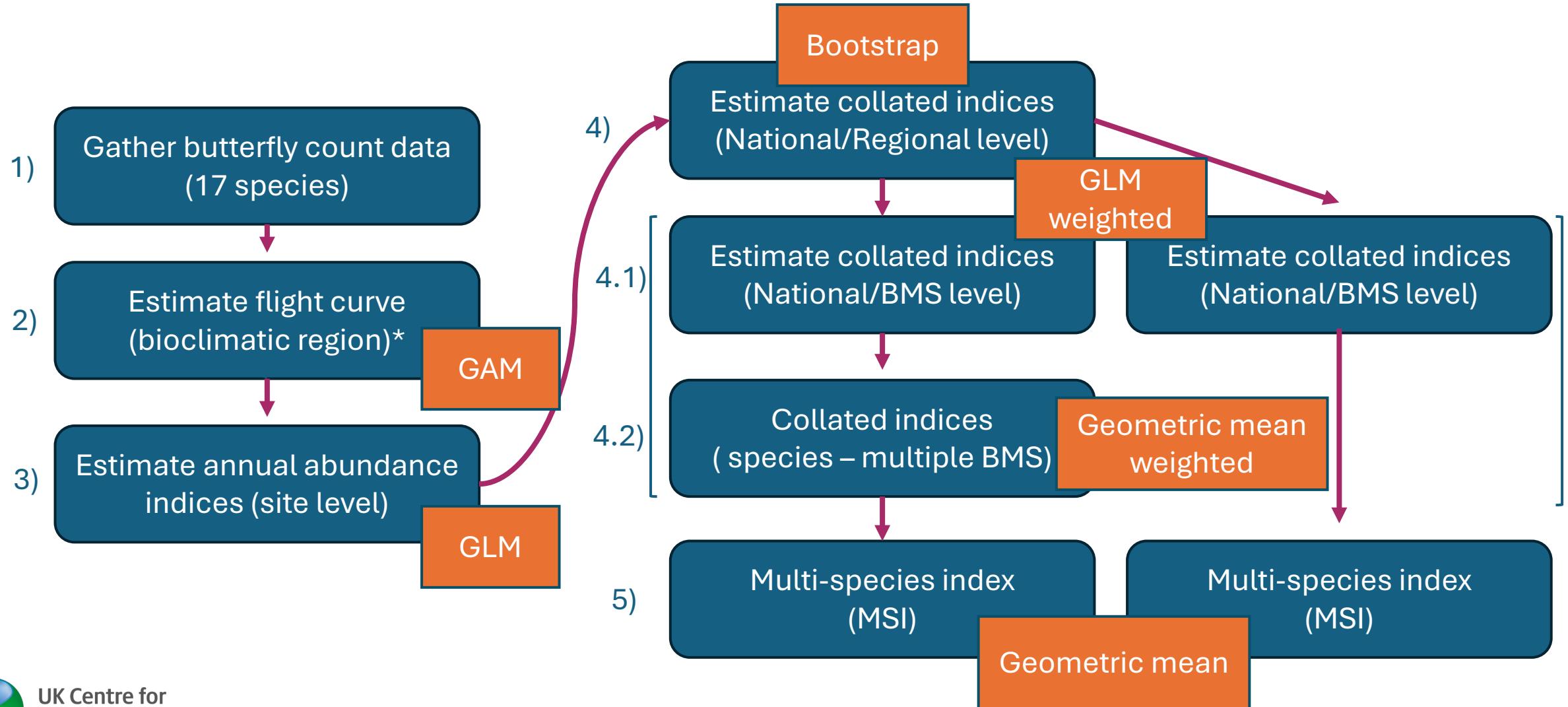
In the ABLE project new tools have been developed to make it easier for regional and national coordinators of Butterfly Monitoring Schemes to calculate indexes and trends as well as build indicators. This workshop will focus on the background of the method and learning how to use the tools. This workshop is open by invitation only to all co-ordinators of European Butterfly Monitoring Schemes as well as other people actively involved in the analysis and assessment of butterfly monitoring.



# Grassland Butterfly Index (GBI) – in a nutshell



# Grassland Butterfly Index (GBI) – in a nutshell



# Grassland Butterfly Index (GBI) – Flgith curve (GAM)

## Methods in Ecology and Evolution

Methods in Ecology and Evolution 2013, 4, 637–645



doi: 10.1111/2041-210X.12053

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

Emily B. Dennis<sup>1,2\*</sup>, Stephen N. Freeman<sup>2</sup>, Tom Brereton<sup>3</sup> and David B. Roy<sup>2</sup>

<sup>1</sup>National Centre for Statistical Ecology, School of Mathematics, Statistics and Actuarial Science, University of Kent, Canterbury, Kent, CT2 7NF, UK; <sup>2</sup>NERC Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB, UK; and <sup>3</sup>Butterfly Conservation, Manor Yard, East Lulworth, Wareham, Dorset, BH20 5QP, UK

## Journal of Applied Ecology

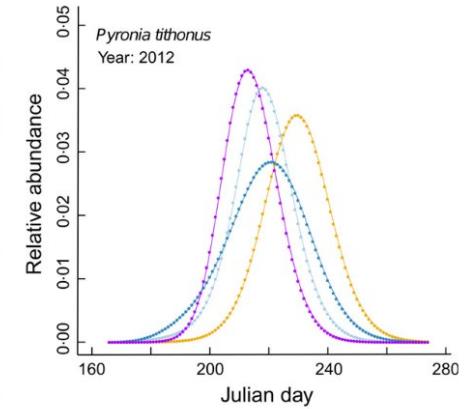
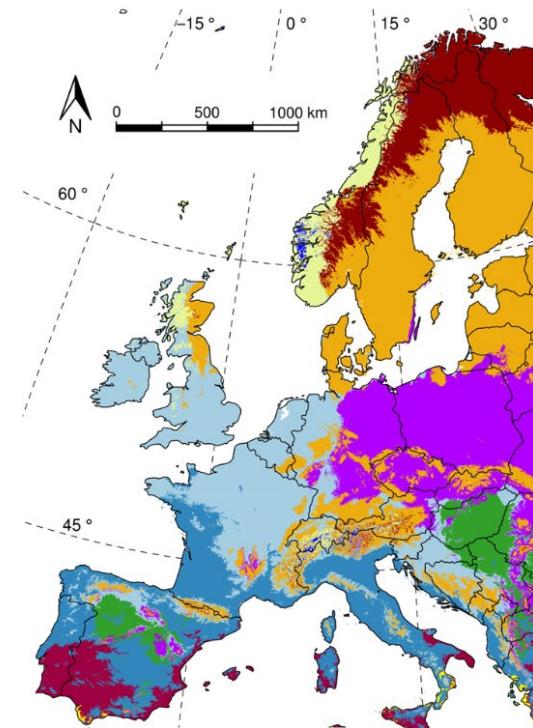
Journal of Applied Ecology 2016, 53, 501–510



doi: 10.1111/1365-2664.12561

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

Reto Schmucki<sup>1,2\*</sup>, Guy Pe'er<sup>3,4</sup>, David B. Roy<sup>5</sup>, Constantí Stefanescu<sup>6,7</sup>, Chris A.M. Van Swaay<sup>8</sup>, Tom H. Oliver<sup>5,9</sup>, Mikko Kuussaari<sup>10</sup>, Arco J. Van Strien<sup>11</sup>, Leslie Ries<sup>12,13</sup>, Josef Settele<sup>4,14</sup>, Martin Musche<sup>14</sup>, Jofre Carnicer<sup>6,15</sup>, Oliver Schweiger<sup>14</sup>, Tom M. Brereton<sup>16</sup>, Alexander Harpke<sup>14</sup>, Janne Heliölä<sup>10</sup>, Elisabeth Kühn<sup>14</sup> and Romain Julliard<sup>1</sup>



- Extremely cold & wet
- Extremely cold & mesic
- Cold & wet
- Cold & mesic
- Cold temperate & moist
- Cold temperate & dry
- Cool temperate & xeric
- Warm temperate & mesic
- Warm temperate & xeric
- Hot & dry



# Calculate site abundance indices (EEA climate regions)

 Environmental zones 2018 - version 1.0, June 2020

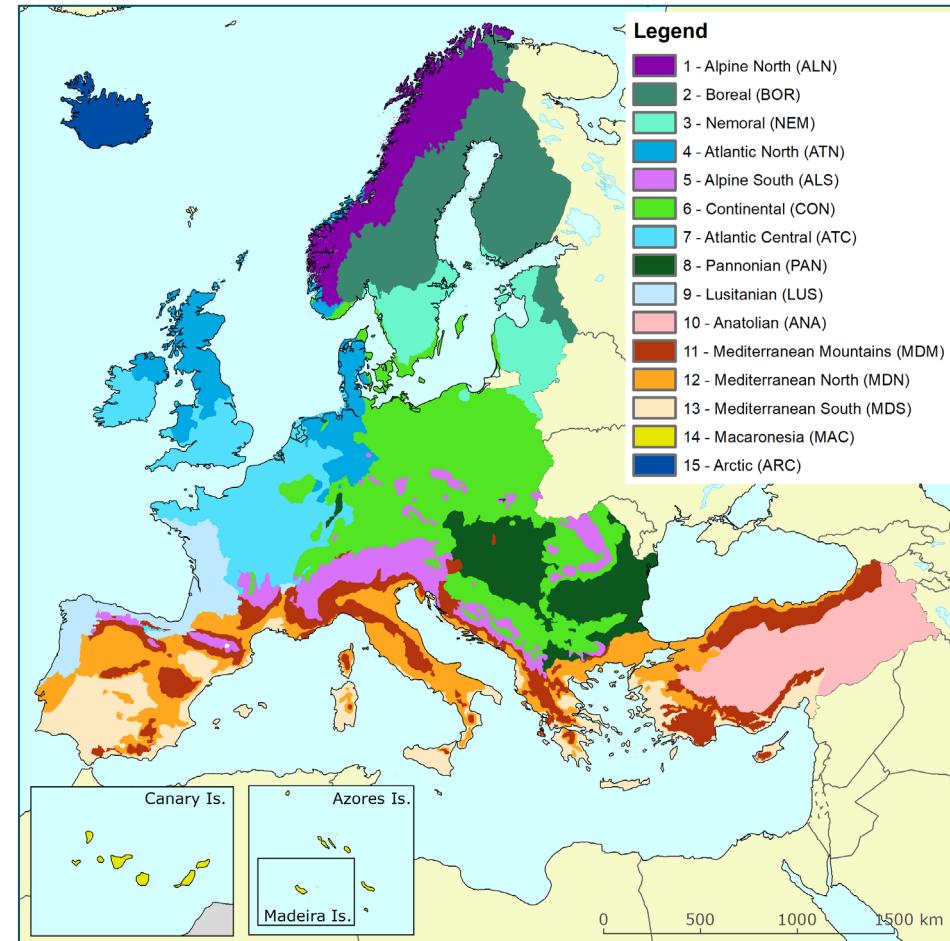
**Environmental zones in Europe**

This dataset is based on the Environmental Stratification of Europe (EnS) dataset from the University of Edinburgh, a statistically derived land classification which provides a novel global spatial framework for the integration and analysis of ecological and environmental data (Metzger, Marc J. 2018). It provides a robust spatial analytical framework for the aggregation of local observations, identification of gaps in current monitoring efforts and systematic design of complementary and new monitoring and research.

The version 8 of the source EnS dataset, used for the creation of this dataset, distinguishes 84 strata that are relatively homogeneous in environmental conditions and can be aggregated into 13 environmental zones:

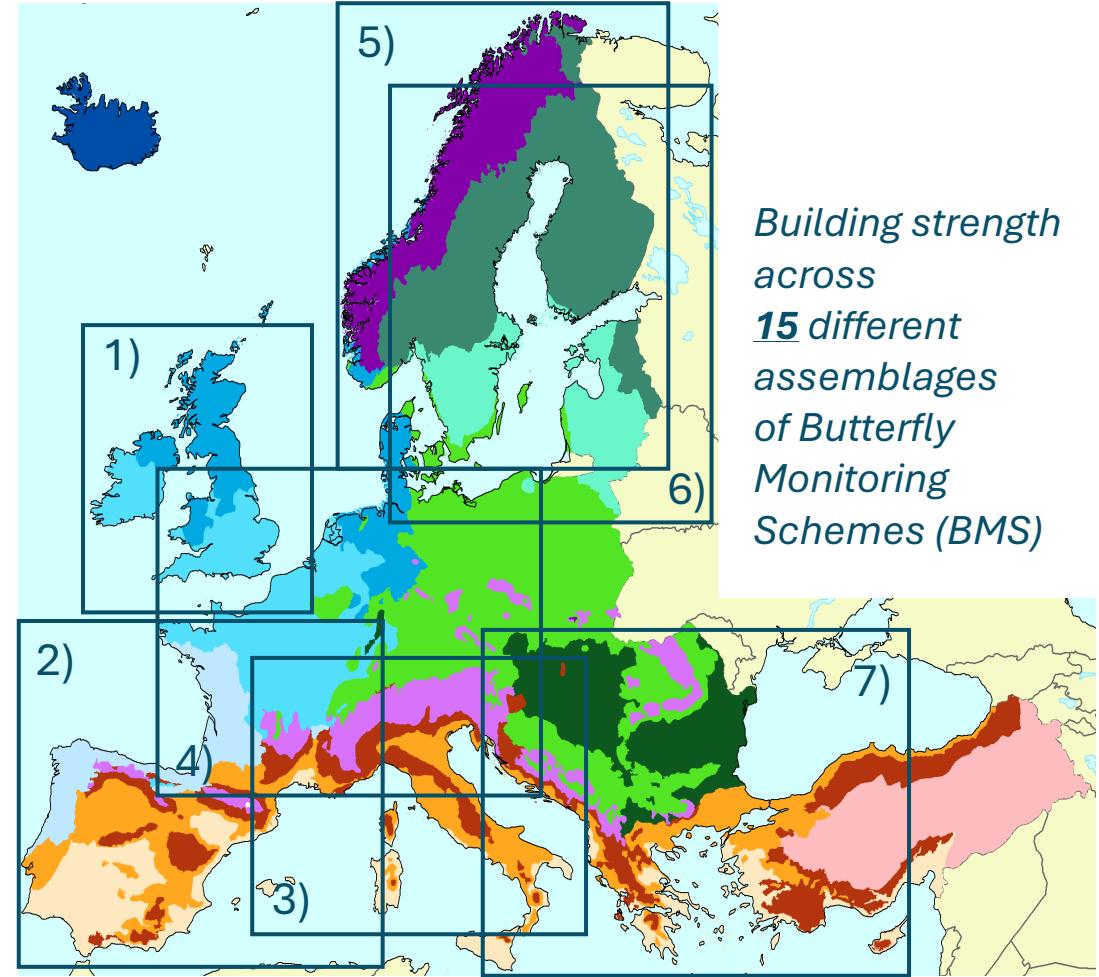
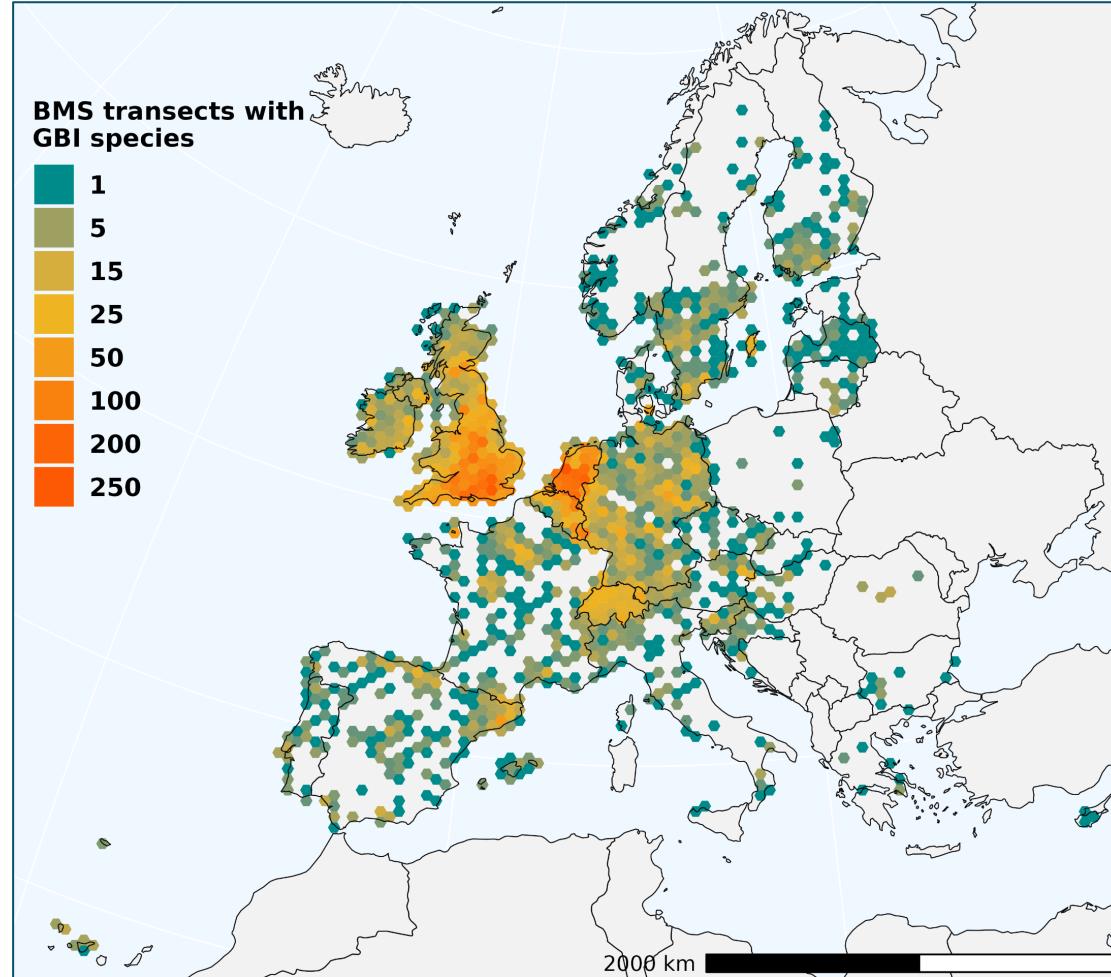
- Alpine North (ALN)
- Boreal (BOR)
- Nemoral (NEM)
- Atlantic North (ATN)
- Alpine South (ALS)
- Continental (CON)
- Atlantic Central (ATC)
- Pannonian (PAN)
- Lusitanian (LUS)
- Anatolian (ANA)
- Mediterranean Mountains (MDM)
- Mediterranean North (MDN)
- Mediterranean South (MDS)

 EEA geospatial data catalogue



<https://sdi.eea.europa.eu/catalogue/srv/eng/catalog.search#/metadata/6ef007ab-1fcd-4c4f-bc96-14e8afbc688>

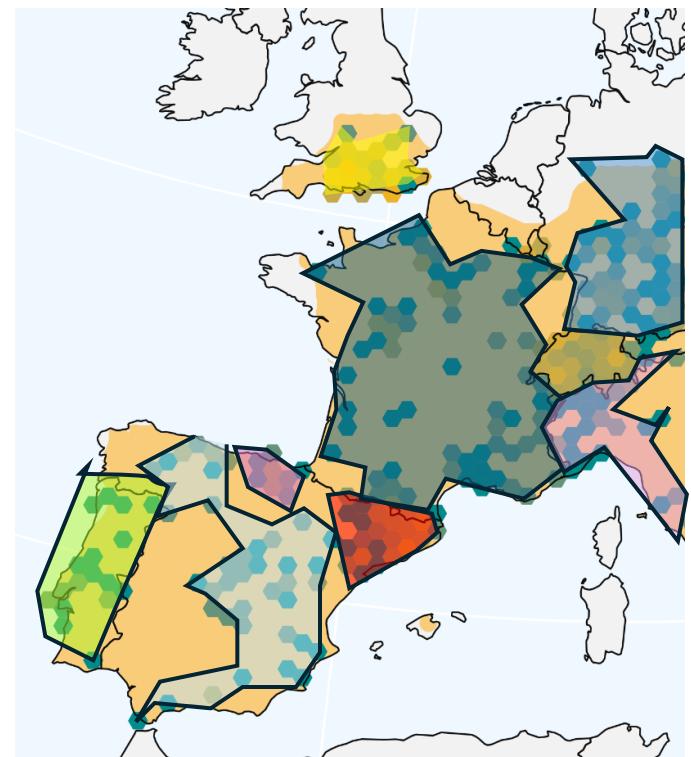
# Calculate site abundance indices (EEA climate regions)



# Grassland Butterfly Index (GBI) – Collated index (multiple BMS)

Collated index is weighted by the proportion of total area covered by each BMS

- Convex hull over the monitoring site (transect).
- One collated index estimated across all BMS, using the collated index calculated at the BMS level.

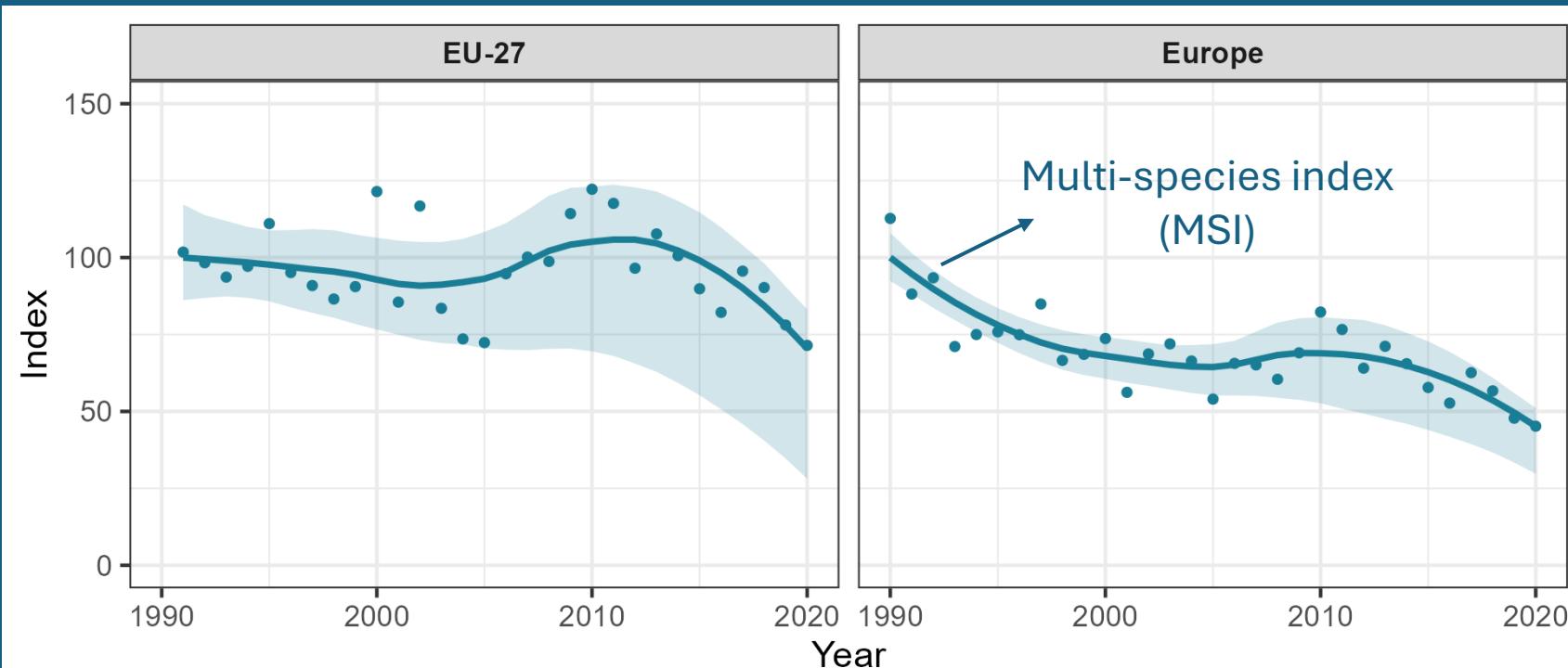


For each species => `AREA_WEIGHT := (area_km2 / sum(area_km2))]`



# Grassland Butterfly Index (GBI) – in a nutshell

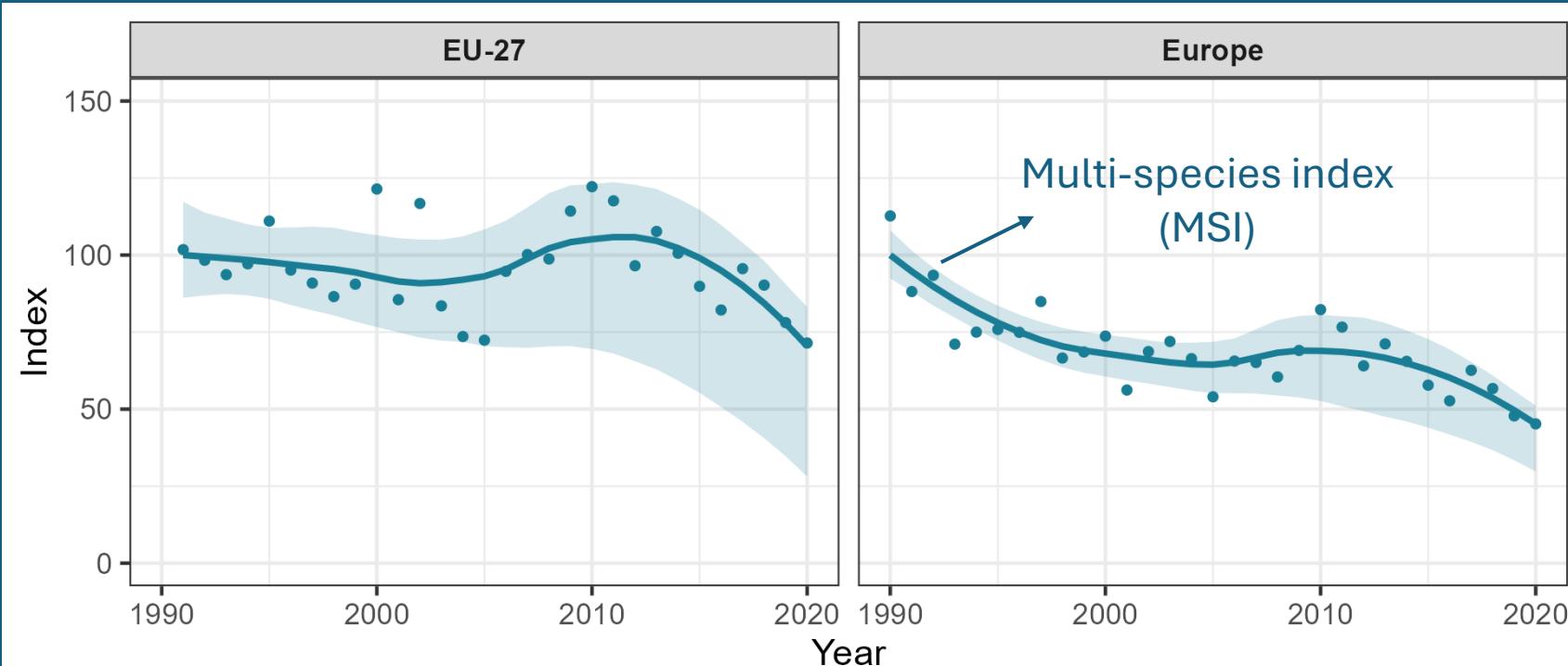
Estimate trend  
and confidence intervals



# Grassland Butterfly Index (GBI) – in a nutshell

Estimate trend  
and confidence intervals

Linear Model (95%CI)  
Quantile 2.5-97.5 bootstraps



# Grassland Butterfly Index (GBI) – Online material

The screenshot shows a web browser window with the URL [butterfly-monitoring.github.io/bms\\_workshop/index.html](https://butterfly-monitoring.github.io/bms_workshop/index.html). The page title is "Calculating butterfly trends, indexes and indicators" by Reto Schmucki, Emily Dennis, David Roy and Chris Van Swaay, dated April 1<sup>st</sup>, 2020. The left sidebar has a blue header "Motivation" and links to "Schedule", "Before the workshop", "Computer and software", "Download Data", "Update", and "Reading". The main content area has a "Home" button and dropdown menus for "WS1", "WS2", "WS3", and "WS4". The footer contains the UK Centre for Ecology & Hydrology logo and the email address [retoschm@ceh.ac.uk](mailto:retoschm@ceh.ac.uk).

## Calculating butterfly trends, indexes and indicators

Reto Schmucki, Emily Dennis, David Roy and Chris Van Swaay  
April 1<sup>st</sup>, 2020

### Motivation

In the ABLE project new tools have been developed to make it easier for regional and national coordinators of Butterfly Monitoring Schemes to calculate indexes and trends as well as build indicators. This workshop will focus on the background of the method and learning how to use the tools. This workshop is open by invitation only to all co-ordinators of European Butterfly Monitoring Schemes as well as other people actively involved in the analysis and assessment of butterfly monitoring.



# Grassland Butterfly Index (GBI) – Online material

Home WS1 ▾ WS2 ▾ WS3 ▾ WS4 ▾ Hide

```
ts_flight_curve <- rbms::flight_curve(ts_season_count,
                                         NbrSample = 500,
                                         MinVisit = 3,
                                         MinOccur = 2,
                                         MinNbrSite = 5,
                                         MaxTrial = 4,
                                         GamFamily = "nb",
                                         SpeedGam = FALSE,
                                         CompltSeason = TRUE,
                                         SelectYear = NULL,
                                         TimeUnit = "w"
                                         )

saveRDS(ts_flight_curve, file.path("bms_workshop_data", paste(gsub(" ", "_", s_sp), paste(region_bms, collapse="_"))
```

For rare species, the number of site should be reduced



# Grassland Butterfly Index (GBI) – Online material

BMS Workshop

Home WS1 ▾ WS2 ▾ WS3 ▾ WS4 ▾ TRUE

- Generalized Abundance Index (2)
- Impute & Site index
- Collated index
- Bootstrap CI**
- Figure with CI

```
co_index <- collated_index(data = sindex[substr(SITE_ID, 1, 5) == bms_id, ],  
                           s_sp = s_sp,  
                           sindex_value = "SINDEX",  
                           glm_weights = TRUE,  
                           rm_zero = TRUE)  
  
co_index$col_index  
  
## Key: <M_YEAR>
```

This function will be augmented with a « `glm predict` method »



# Grassland Butterfly Index (GBI) – Online material

BMS Workshop

Home WS1 ▾ WS2 ▾ WS3 ▾ WS4 ▾

## Multi-species indicators

Code ▾

Emily Dennis

31 March 2020

Source trend functions required that you can download from [this link](#).

Show

Read in collated indices for two species and filter to one BMS

Hide

```
bms <- "UKBMS"
co_index <- rbind(readRDS("./bms_workshop_data/Maniola_jurtina_co_index_boot.rds"),
                     readRDS("./bms_workshop_data/Polyommatus_icarus_co_index_boot.rds"))
co_index <- co_index[BMS_ID == bms]
co_index
```



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Ecology & Hydrology

retoschm@ceh.ac.uk

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# Grassland Butterfly Index (GBI) – Online material

BMS Workshop

Home WS1 ▾ WS2 ▾ WS3 ▾ WS4 ▾

Now we add a confidence interval to the indicator based on quantiles from the bootstrapped indicators

Hide

```
msi <- add_indicator_CI(msi, msi_boot)
msi
```

```
##   year indicator ind_gam0      SMOOTH NSPECIES LOWsmooth1 UPPsmooth1
## 1  2008  93.06434 63.45042 100.00000      2  88.14009 111.0803
## 2  2009 128.66868 78.32167 123.43759      2 112.91961 134.9132
## 3  2010 159.79842 79.71374 125.63153      2 114.83919 136.8903
## 4  2011  93.27168 64.26747 101.28769      2  92.73150 110.9626
## 5  2012  79.35512 63.13894  99.50909      2  89.62639 109.2745
## 6  2013 164.67445 87.10999 137.28827      2 125.17660 149.9729
## 7  2014 135.27982 95.79242 150.97207      2 140.38601 161.6547
## 8  2015 131.30396 79.97811 126.04818      2 116.72898 134.7303
## 9  2016  89.99077 79.85997 125.86200      2 120.03092 131.7026
## 10 2017 157.60336 89.84621 141.60064      2 139.70652 143.4271
```

Plot the indicator

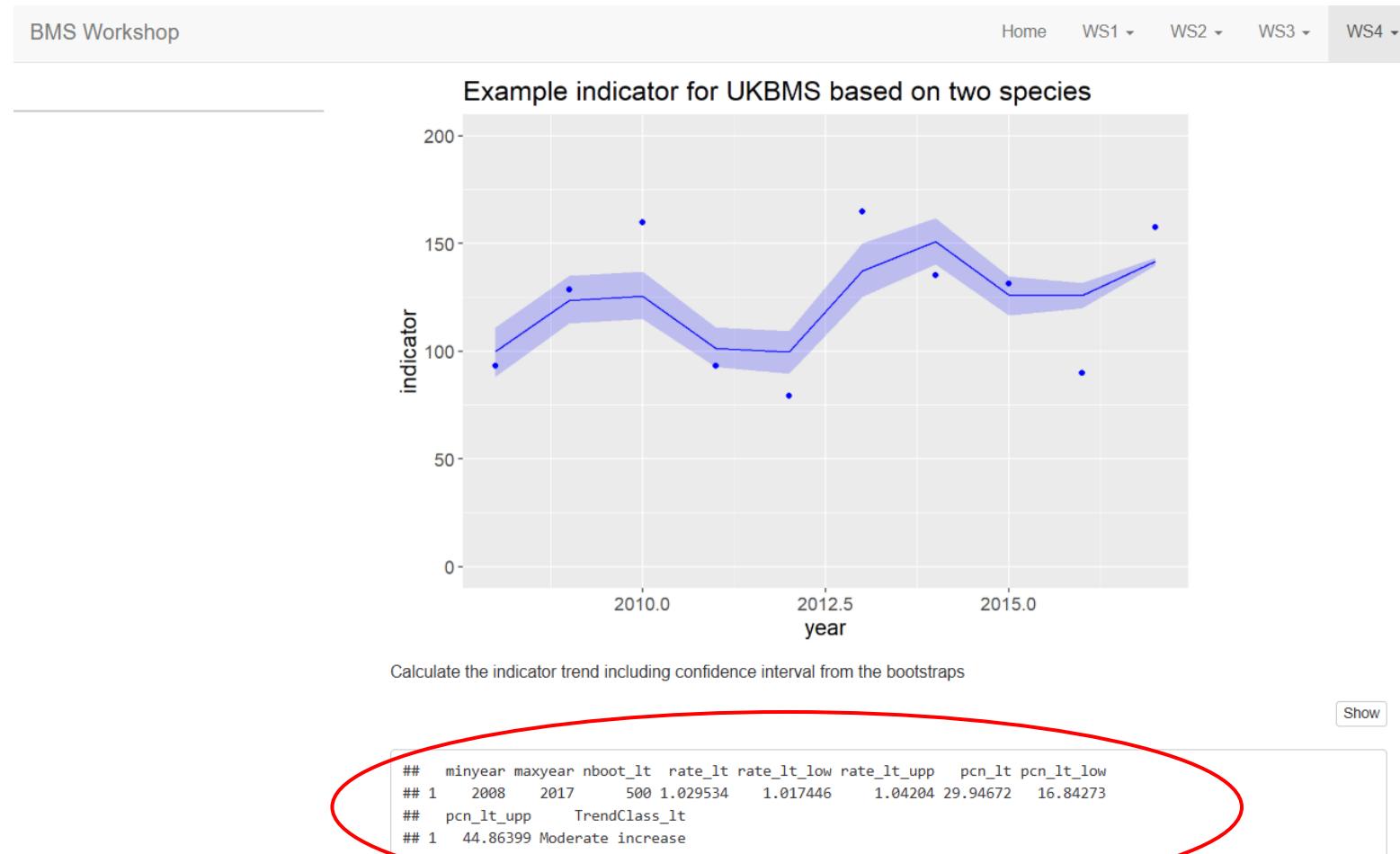


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# Grassland Butterfly Index (GBI) – Online material



# Grassland Butterfly Index (GBI) – Online material

Latest update/verification: 30 March 2025

Further material for Grassland Indicator?

Integration of wrapper function is rbms package?

Other training material or online workshop?

