



Grassland Butterfly Index GBI

Reto Schmucki

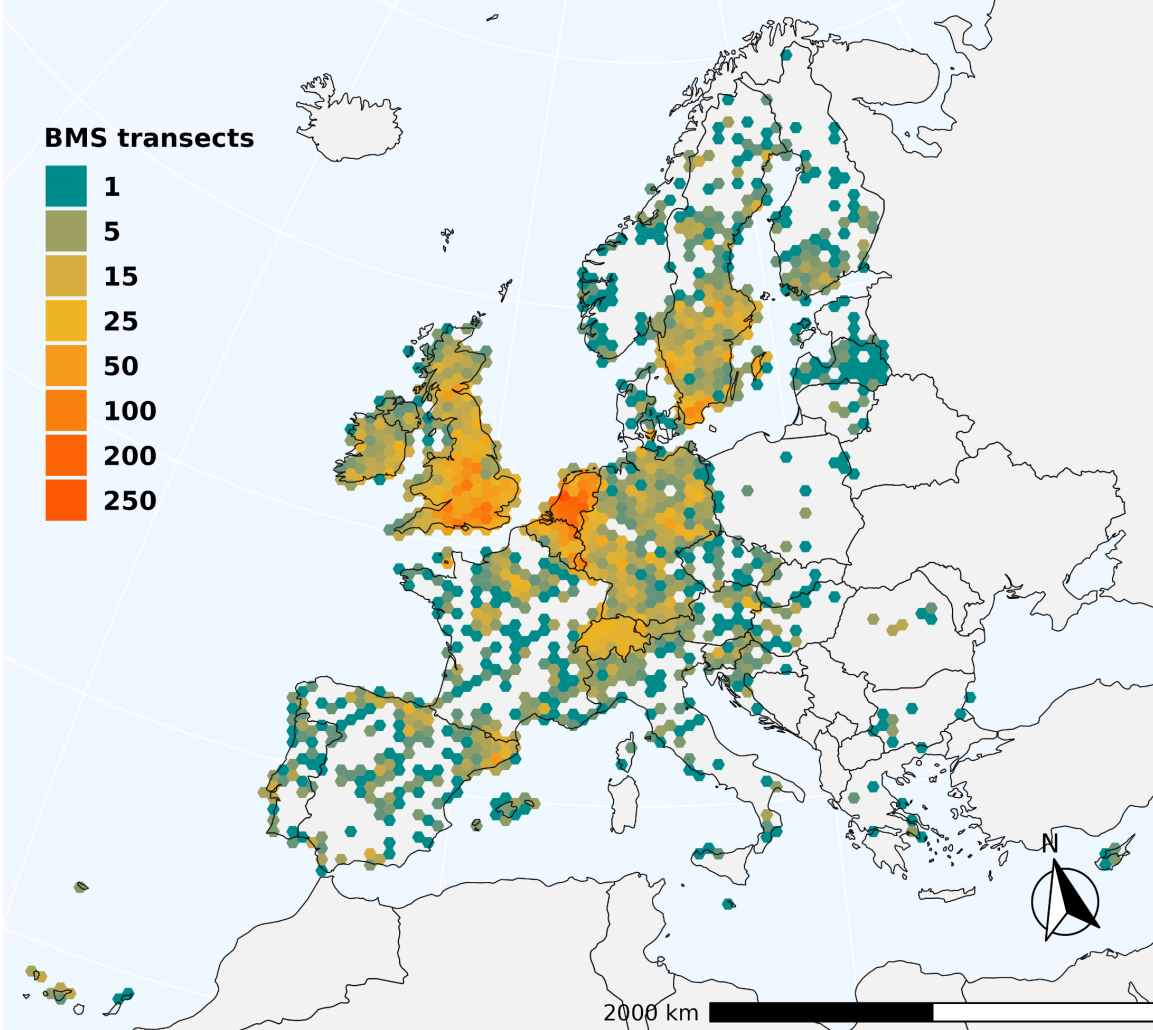
retoschm@ceh.ac.uk

28 Mars 2025

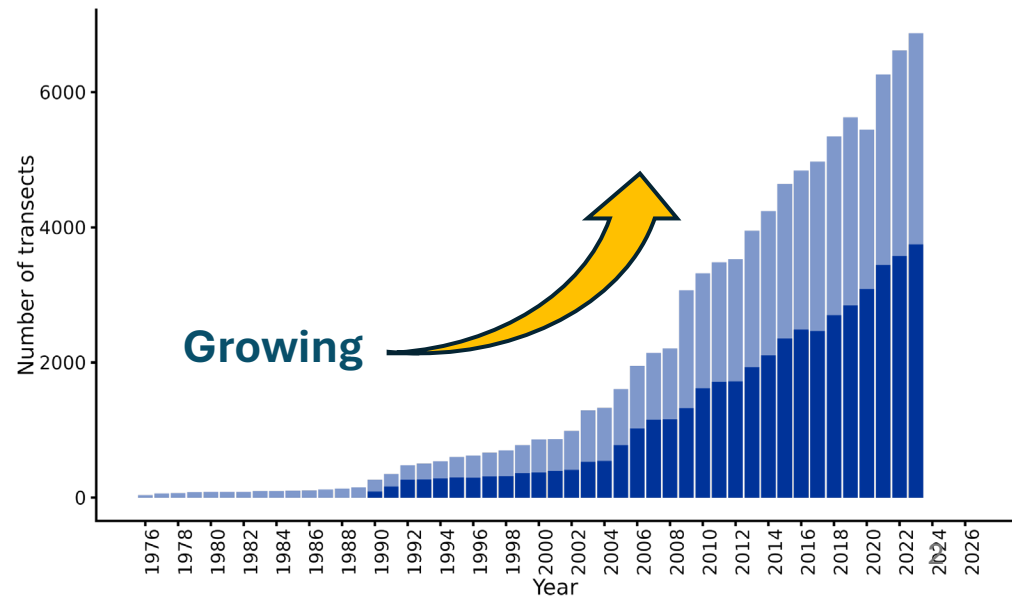
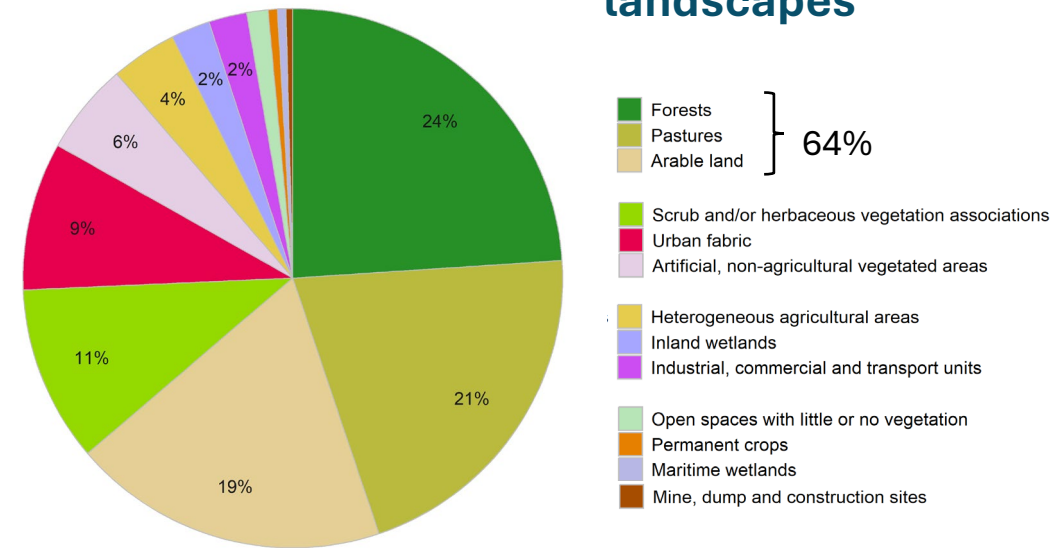


EMBRACE project: Call for tenders EC-ENV/2024/NP/0040: GRASSLAND BUTTERFLY INDICATOR AND EUROPEAN BUTTERFLY MONITORING SCHEME UPDATE (2021-2026)

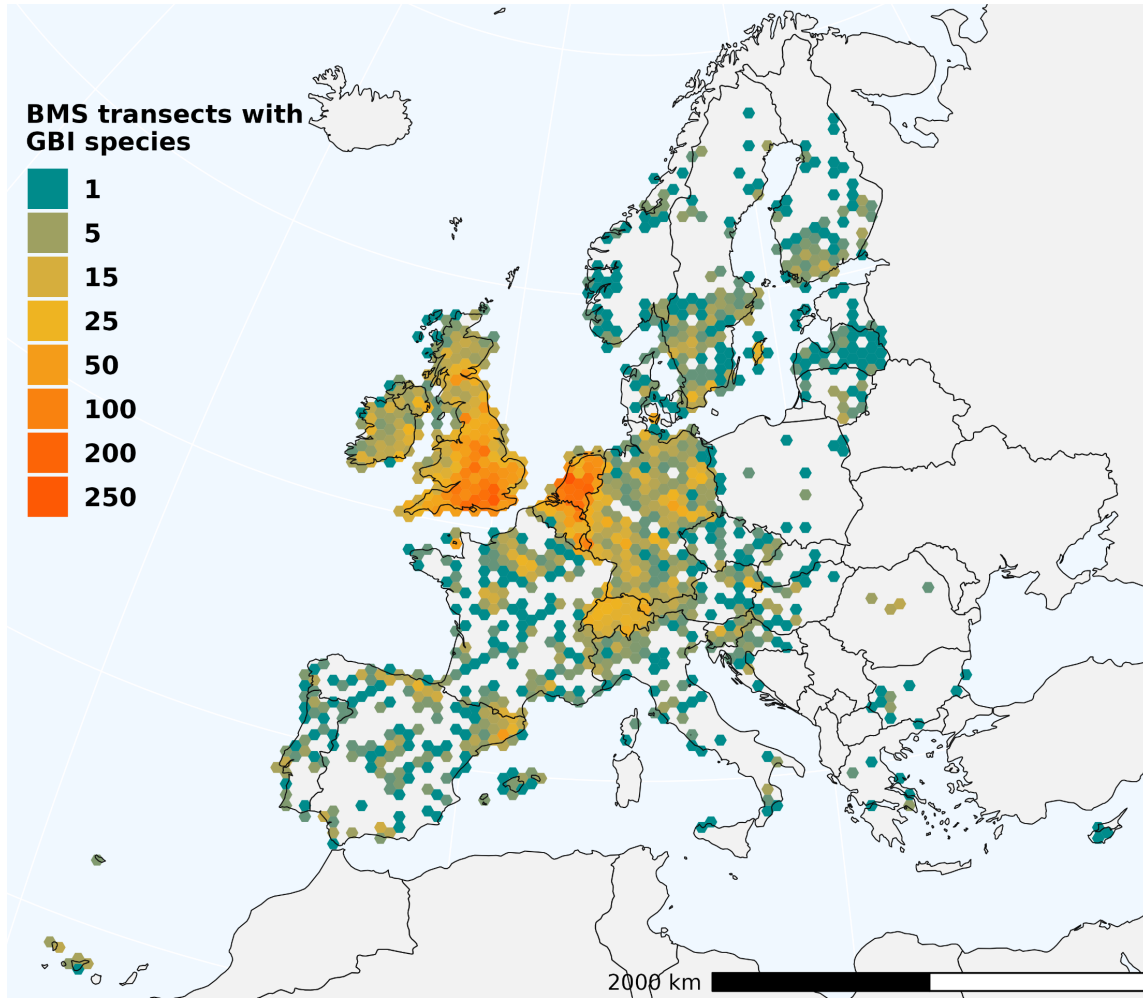
eBMS database and Butterfly counts



Wide coverage across European landscapes



eBMS database and Grassland Butterfly Indicator



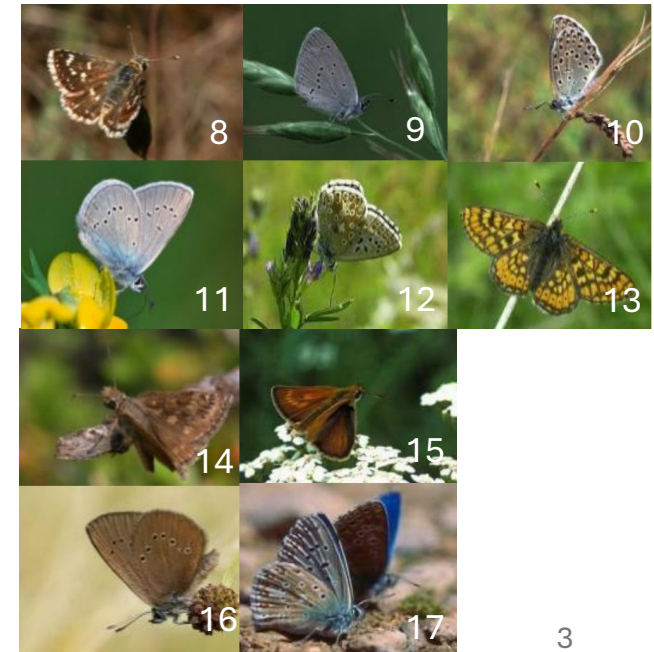
Widespread species

- 1) *Ochlodes 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 Indicator

Aim: Inform about the change in the abundance of this group of 17 species in a given space over a given period.

Data: Count of individuals observed in given locations recorded at multiple time in the year and monitored over several years.

Model: integrated the information contained in the counts and the context when and where the individual have been observed/monitored.

- ✓ Improve population trend estimates
- ✓ Reduce biases

Widespread species

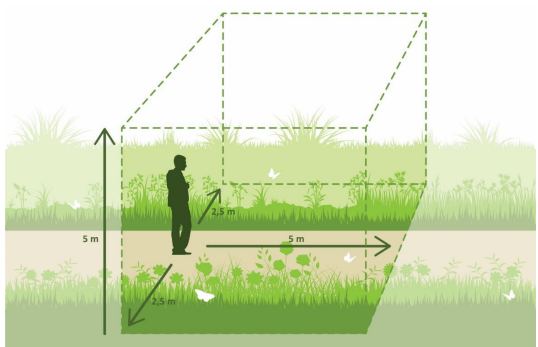
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Specialist species

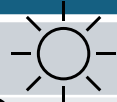
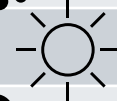
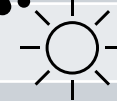
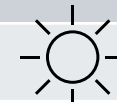
- 8) *Spialia Sertorius*
- 9) *Cupido minimus*
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- 17) *Polyommatus bellargus*

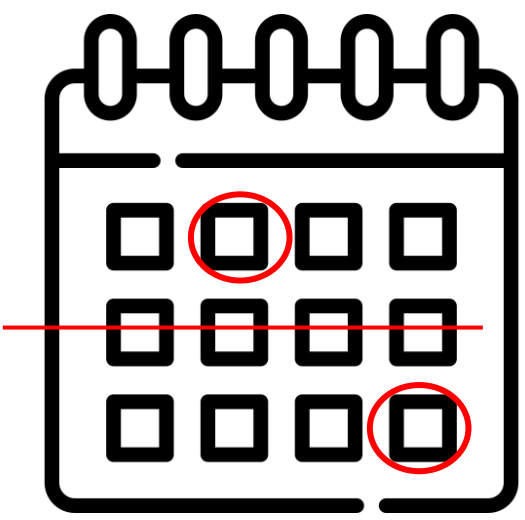


Counting butterflies - informing local population

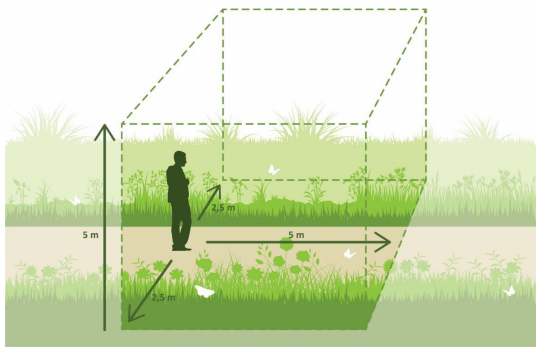


Anthocharis cardamines
(Orange Tip)

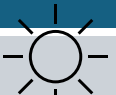
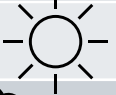
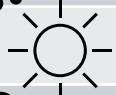
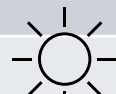
Site	Date	Total Individual	
FR.23	03/05/2025	4	
FR.23	10/05/2025	Na - missing	
FR.23	17/05/2025	6	
FR.23	24/05/2025	Na - missing	
FR.23	31/05/2025	Na - missing	
FR.23	07/06/2025	0	
...	...	...	
FR.23	25/07/2025	0	

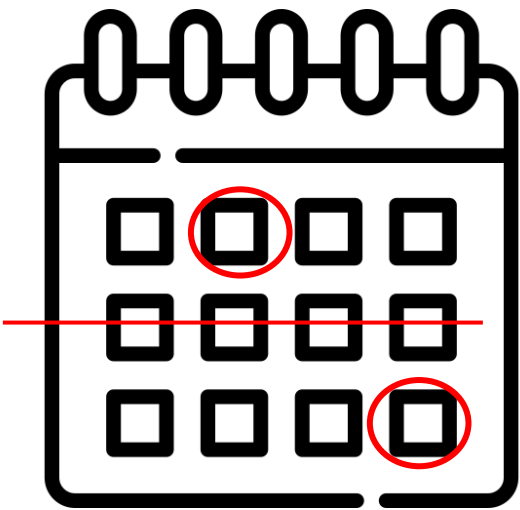


Counting butterflies - informing local population



Anthocharis cardamines
(Orange Tip)

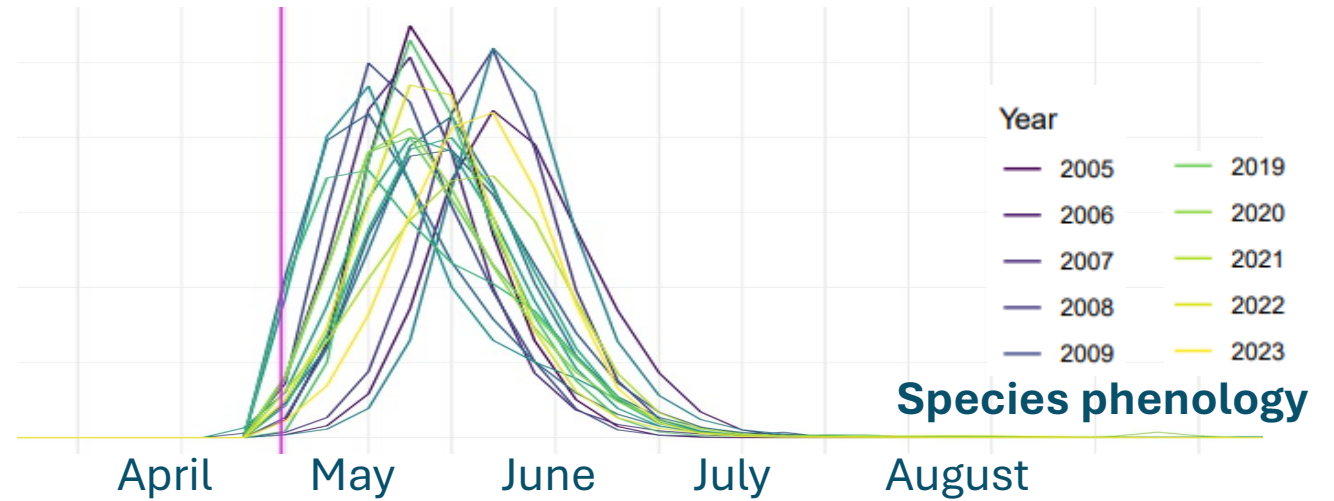
Site	Date	Total Individual	
FR.5	05/05/2025	1	
FR.5	12/05/2025	3	
FR.5	19/05/2025	Na - missing	
FR.5	22/05/2025	5	
FR.5	30/05/2025	Na - missing	
FR.5	08/06/2025	0	
...	...	...	
FR.5	18/07/2025	0	



Counting butterflies



Anthocharis cardamines
(Orange Tip)



Site	Date	Total Individual observed	Site	Date	Total Individual
FR.5	05/05/2022	2	FR.23	03/05/2022	4
FR.5	12/05/2022	3	FR.23	10/05/2022	Na - missing
FR.5	19/05/2022	Na - missing	FR.23	17/05/2022	6
FR.5	22/05/2022	5	FR.23	24/05/2022	Na - missing
FR.5	30/05/2022	Na - missing	FR.23	31/05/2022	Na - missing
FR.5	08/06/2022	0	FR.23	07/06/2022	0
...	...	...	...	...	...
FR.5	18/07/2022	0	FR.23	25/07/2022	0
FR.5	TOTAL	<u>10</u> observations	FR.23	TOTAL	<u>10</u> observations

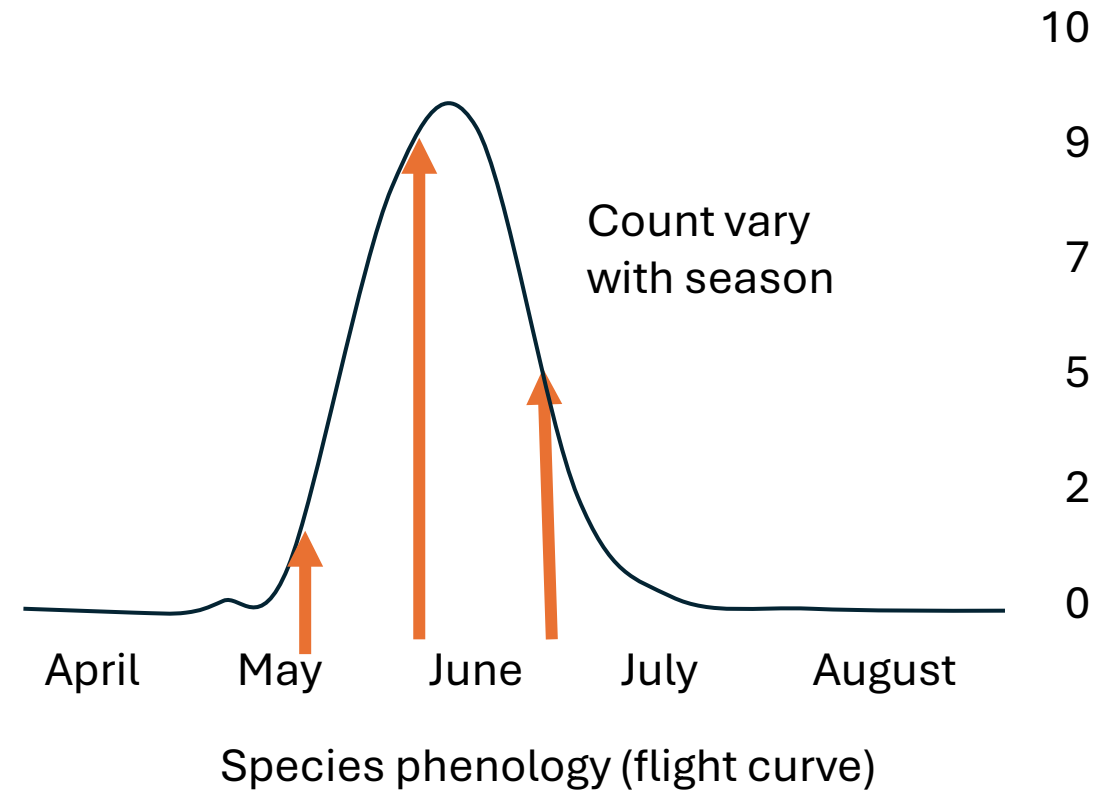
Counting butterflies



*Anthocharis
cardamines*
(Orange Tip)

Site	Date	Total Individual observed
FR.5	05/05/2022	2
FR.5	12/05/2022	3
FR.5	19/05/2022	Na - missing
FR.5	22/05/2022	5
FR.5	30/05/2022	Na - missing
FR.5	08/06/2022	0
...	...	...
FR.5	18/07/2022	0
FR.5	TOTAL	<u>10</u> observations

Raw counts reported vary
in time (season)

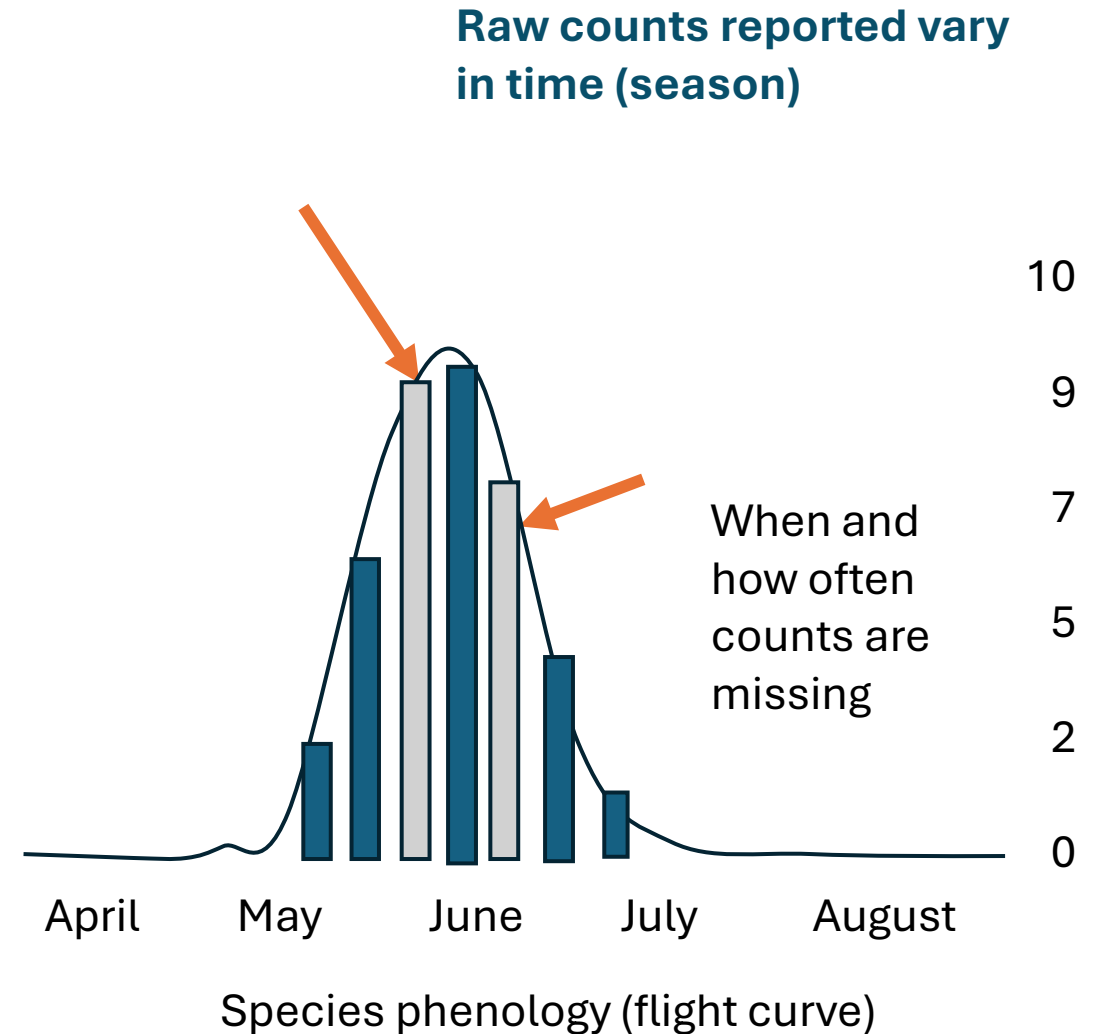


Counting butterflies



*Anthocharis
cardamines*
(Orange Tip)

Site	Date	Total Individual observed
FR.5	05/05/2022	2
FR.5	12/05/2022	3
FR.5	19/05/2022	Na - missing
FR.5	22/05/2022	5
FR.5	30/05/2022	Na - missing
FR.5	08/06/2022	0
...	...	...
FR.5	18/07/2022	0
FR.5	TOTAL	<u>10</u> observations

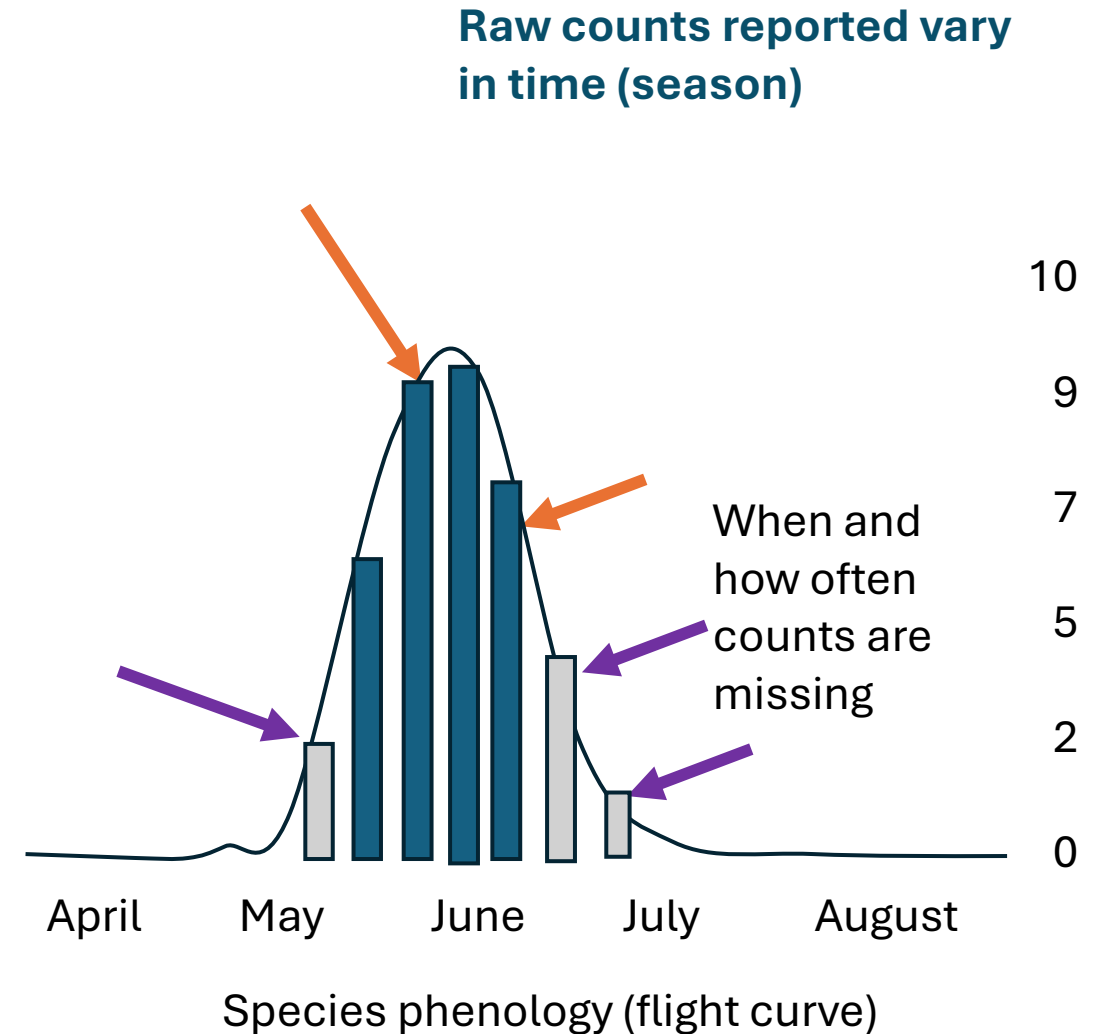


Counting butterflies



*Anthocharis
cardamines*
(Orange Tip)

Site	Date	Total Individual
FR.23	03/05/2022	4
FR.23	10/05/2022	Na - missing
FR.23	17/05/2022	6
FR.23	24/05/2022	Na - missing
FR.23	31/05/2022	Na - missing
FR.23	07/06/2022	0
...	...	...
FR.23	25/07/2022	0
FR.23	TOTAL	<u>10</u> observations



Calculate site abundance indices

Integrate raw count and species regional flight curves

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^{1,2*}, Stephen N. Freeman², Tom Brereton³ and David B. Roy²

¹National Centre for Statistical Ecology, School of Mathematics, Statistics and Actuarial Science, University of Kent, Canterbury, Kent, CT2 7NF, UK; ²NERC Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB, UK; and ³Butterfly 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^{1,2*}, Guy Pe'er^{3,4}, David B. Roy⁵, Constantí Stefanescu^{6,7}, Chris A.M. Van Swaay⁸, Tom H. Oliver^{5,9}, Mikko Kuussaari¹⁰, Arco J. Van Strien¹¹, Leslie Ries^{12,13}, Josef Settele^{4,14}, Martin Musche¹⁴, Jofre Carnicer^{6,15}, Oliver Schweiger¹⁴, Tom M. Brereton¹⁶, Alexander Harpke¹⁴, Janne Heliölä¹⁰, Elisabeth Kühn¹⁴ and Romain Julliard¹

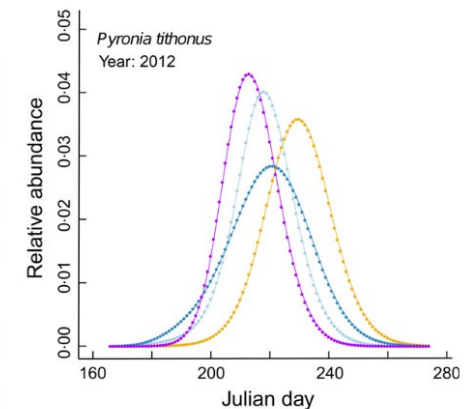
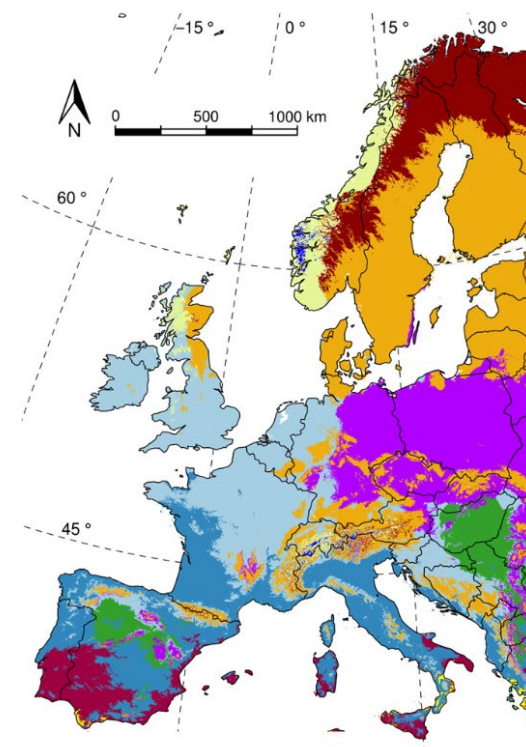


Authors

Reto Schmucki. Author, maintainer.

Colin A. Harrower. Author.

Emily Dennis. Contributor.



- 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

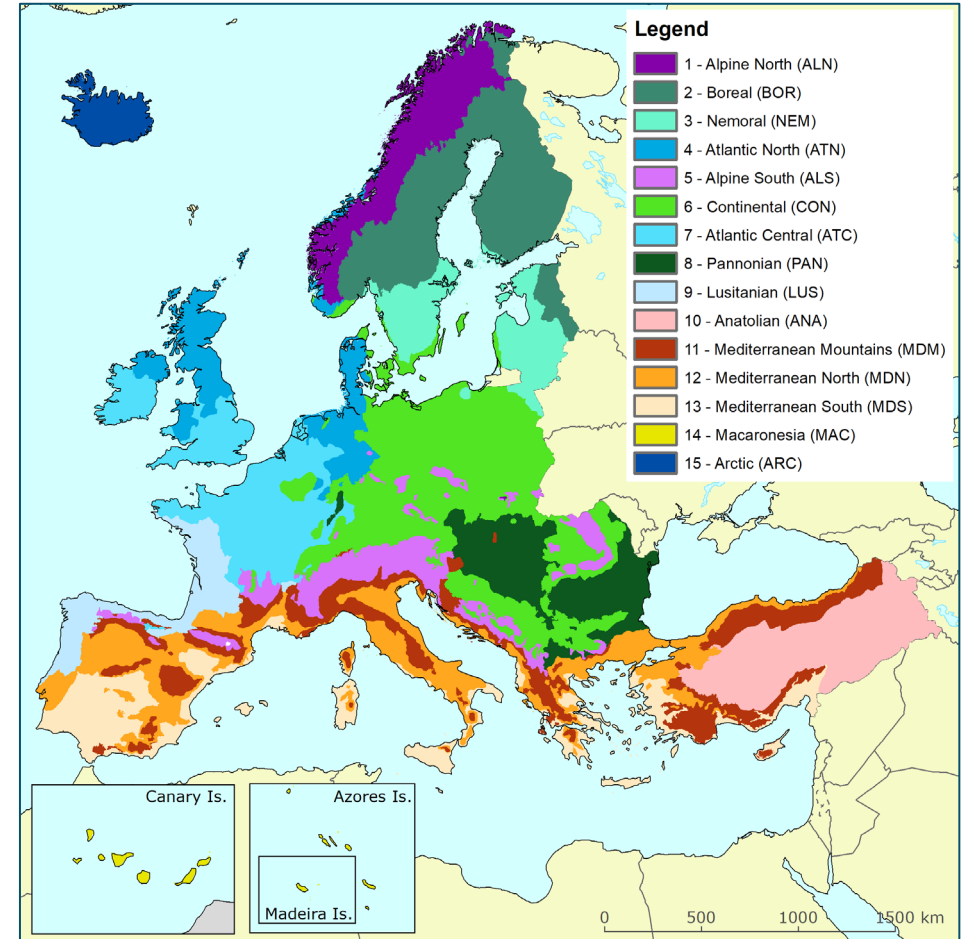
This dataset is based on the Environmental Stratification of Europe (EnS) dataset from the University of Edinburgh, a statistically derived land classification which provides a novel global spatial framework for the integration and analysis of ecological and environmental data (Metzger, Marc J. 2018). 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)

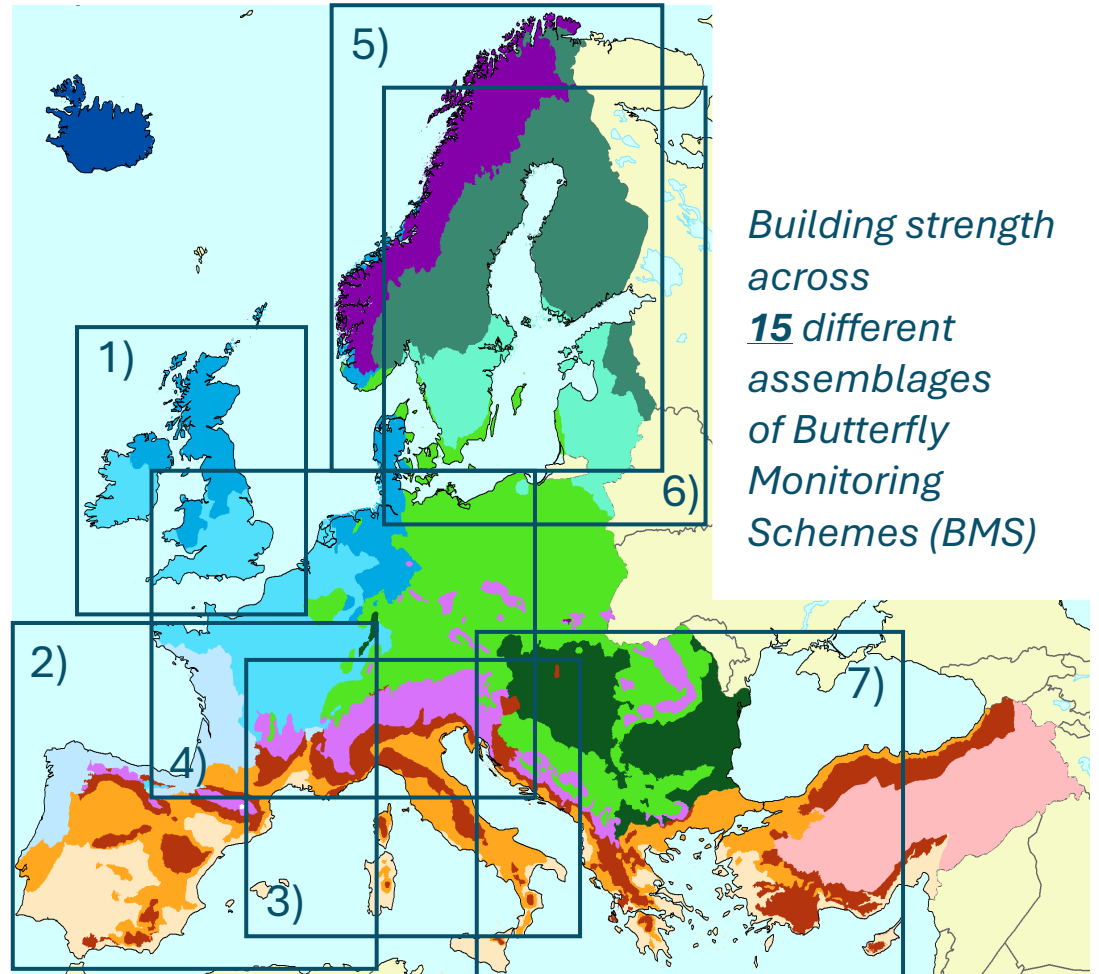
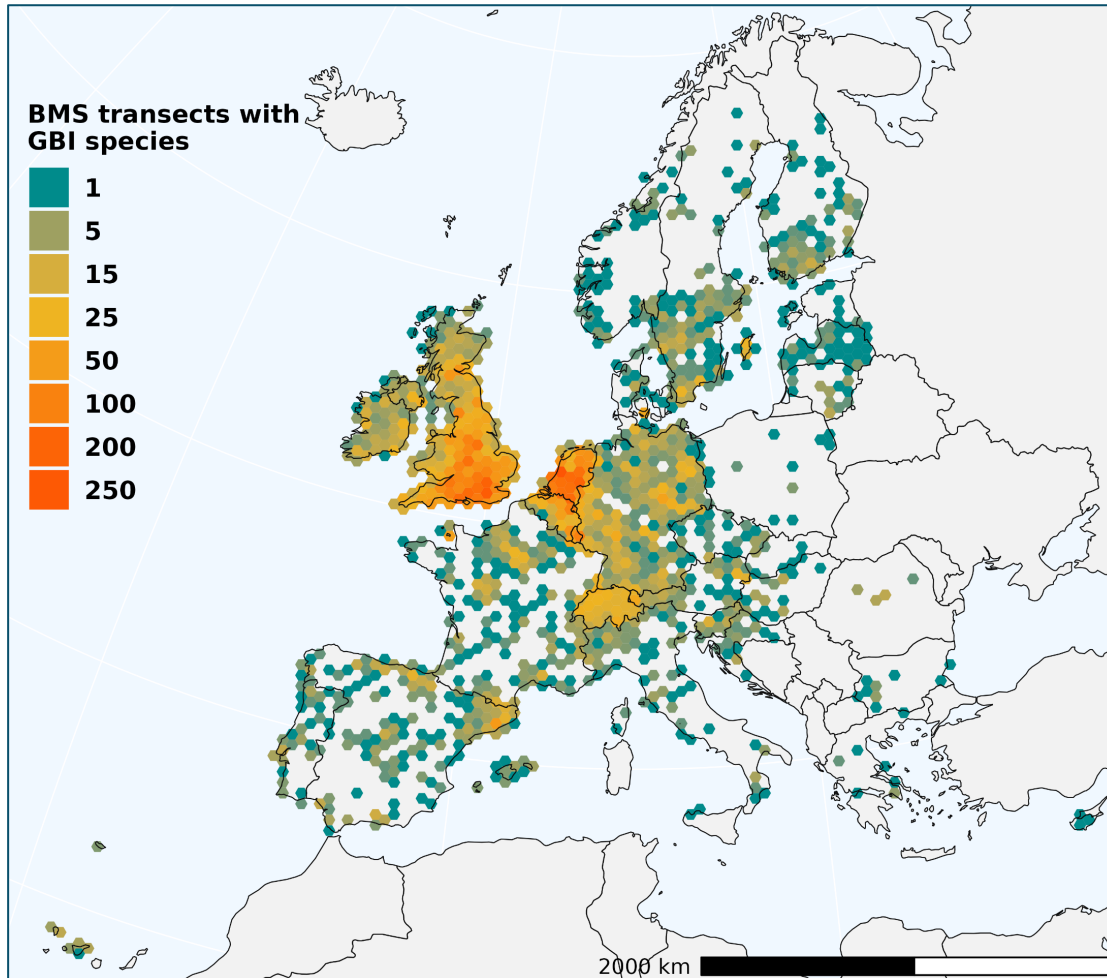


EEA geospatial data catalogue



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

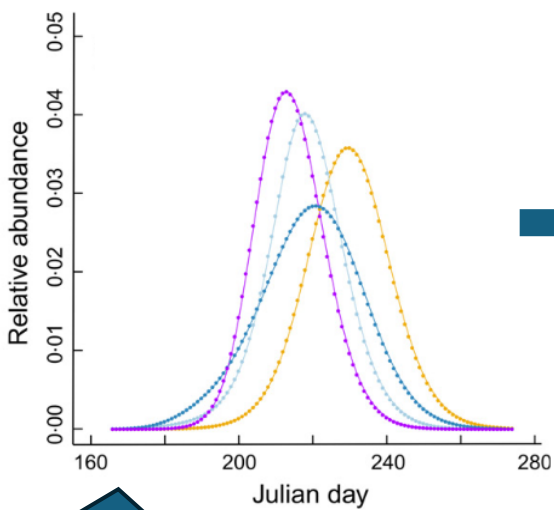
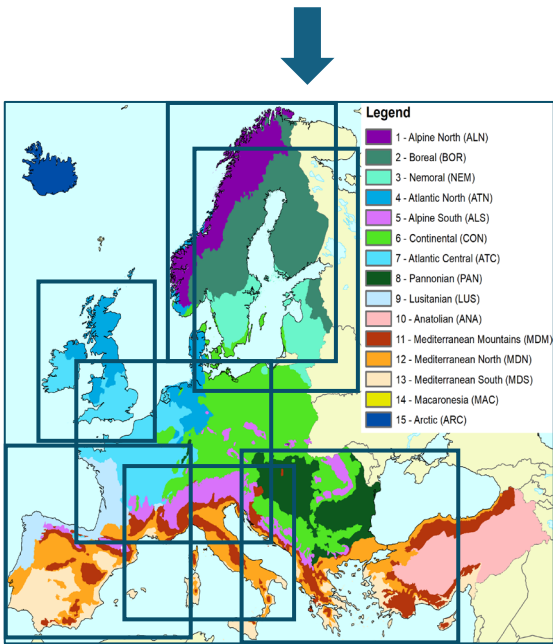
Calculate site abundance indices (EEA climate regions)



Calculate site abundance indices (EEA climate regions)

Raw counts reported for 17 grassland species

Site	Date	Total Individual observed	Site	Date	Total Individual
FR.5	05/05/2022	2	FR.23	03/05/2022	4
FR.5	12/05/2022	3	FR.23	10/05/2022	Na - missing
FR.5	19/05/2022	Na - missing	FR.23	17/05/2022	6
FR.5	22/05/2022	5	FR.23	24/05/2022	Na - missing
FR.5	30/05/2022	Na - missing	FR.23	31/05/2022	Na - missing
FR.5	08/06/2022	0	FR.23	07/06/2022	0
...	...	...	...	...	...
FR.5	18/07/2022	0	FR.23	25/07/2022	0
FR.5	TOTAL	10 observations	FR.23	TOTAL	10 observations



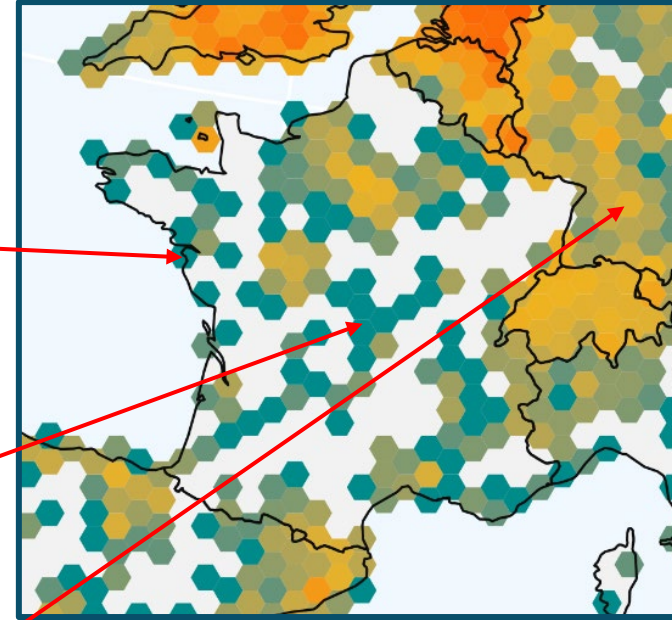
Phenology (flight curve)

Standardised site indices for 17 grassland species

Site	Date	Annual Site Index	Grassland Ind. sp
FR.23	2019	30	Sp 1
FR.23	2020	23	Sp 1
FR.23	2021	21	Sp 1
FR.23	2022	18	Sp 1
FR.5	2019	5	Sp 1
FR.5	2020	11	Sp 1
FR.5	2021	13	Sp 1
FR.5	2022	15	Sp 1
DE.10	2019	38	Sp 1
DE.10	2019	40	Sp 1
...	...	...	...

Calculate site abundance indices (EEA climate regions)

Site	Date	Annual Site Index
FR.23	2019	30
FR.23	2020	23
FR.23	2021	21
FR.23	2022	18
FR.5	2019	5
FR.5	2020	11
FR.5	2021	13
FR.5	2022	15
DE.10	2019	38
DE.10	2019	40
...	...	...



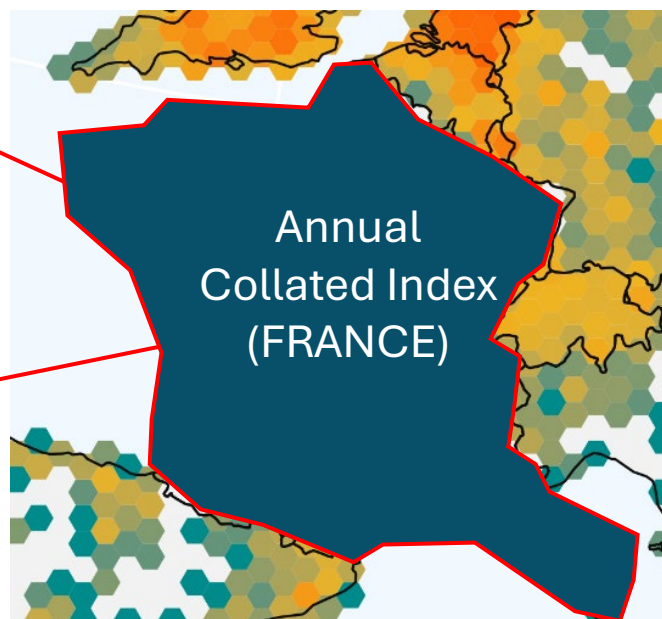
**Standardised site indices
for 17 grassland species**

Calculate collated abundance indices

Standardised site indices for 17 grassland species

Site	Date	Annual Site Index
FR.23	2019	30
FR.23	2020	23
FR.23	2021	21
FR.23	2022	18
FR.5	2019	5
FR.5	2020	11
FR.5	2021	13
FR.5	2022	15
FR....	2019	...
FR...	2020	...
...	...	...

The expected density of butterflies
observed over a given year



- ❖ corrected for missing counts
- ❖ variation transect length

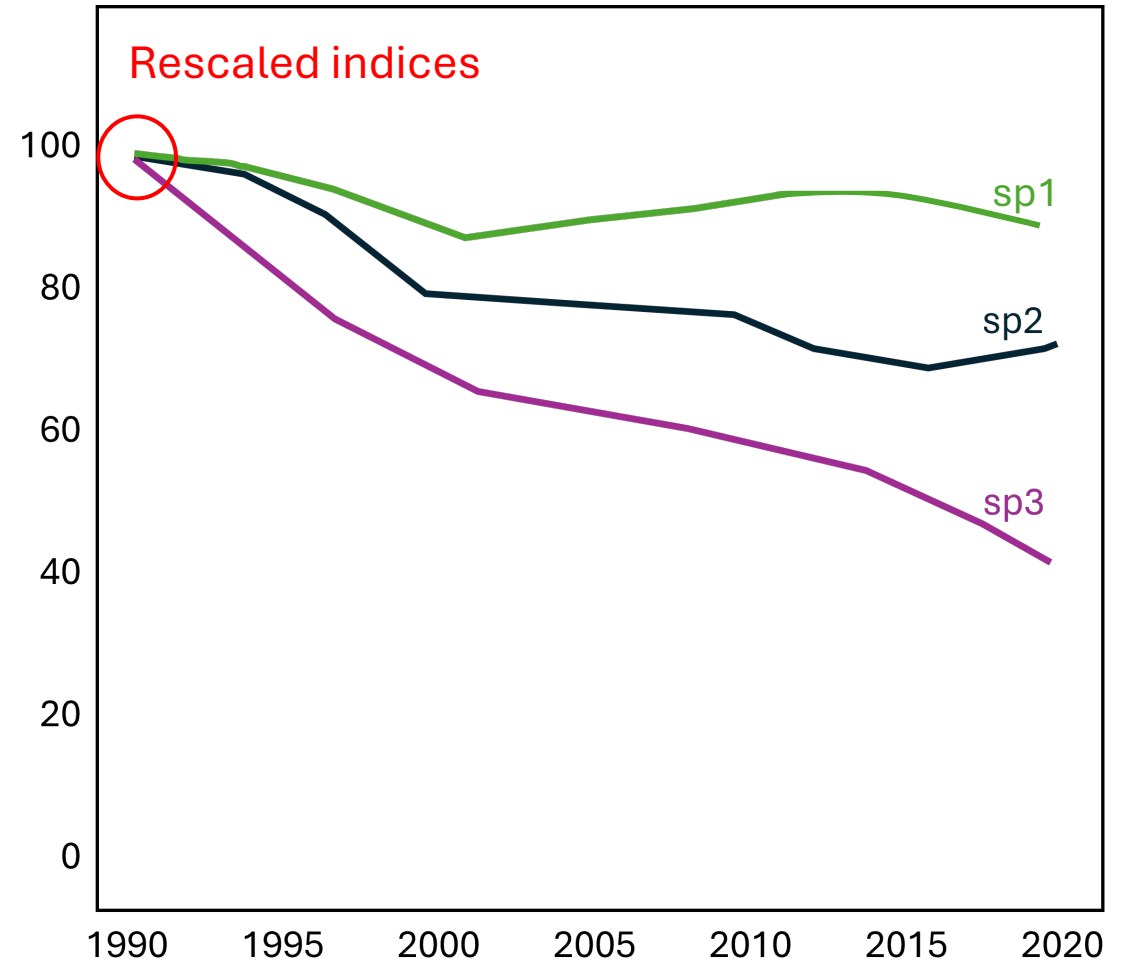
Standardised national indices for 17 grassland species

Site	Date	Annual Site Index	Grassland Ind. species
FRA	2019	43	Sp 1
FRA	2020	35	Sp 1
FRA	2021	22	Sp 1
FRA	2022	23	Sp 1
FRA	2019	50	Sp 2
FRA	2020	45	Sp 2
FRA	2021	43	Sp 2
FRA	2022	46	Sp 2
FRA	2019	...	Sp 3
FRA	2020	...	Sp 3
...	...	...	...

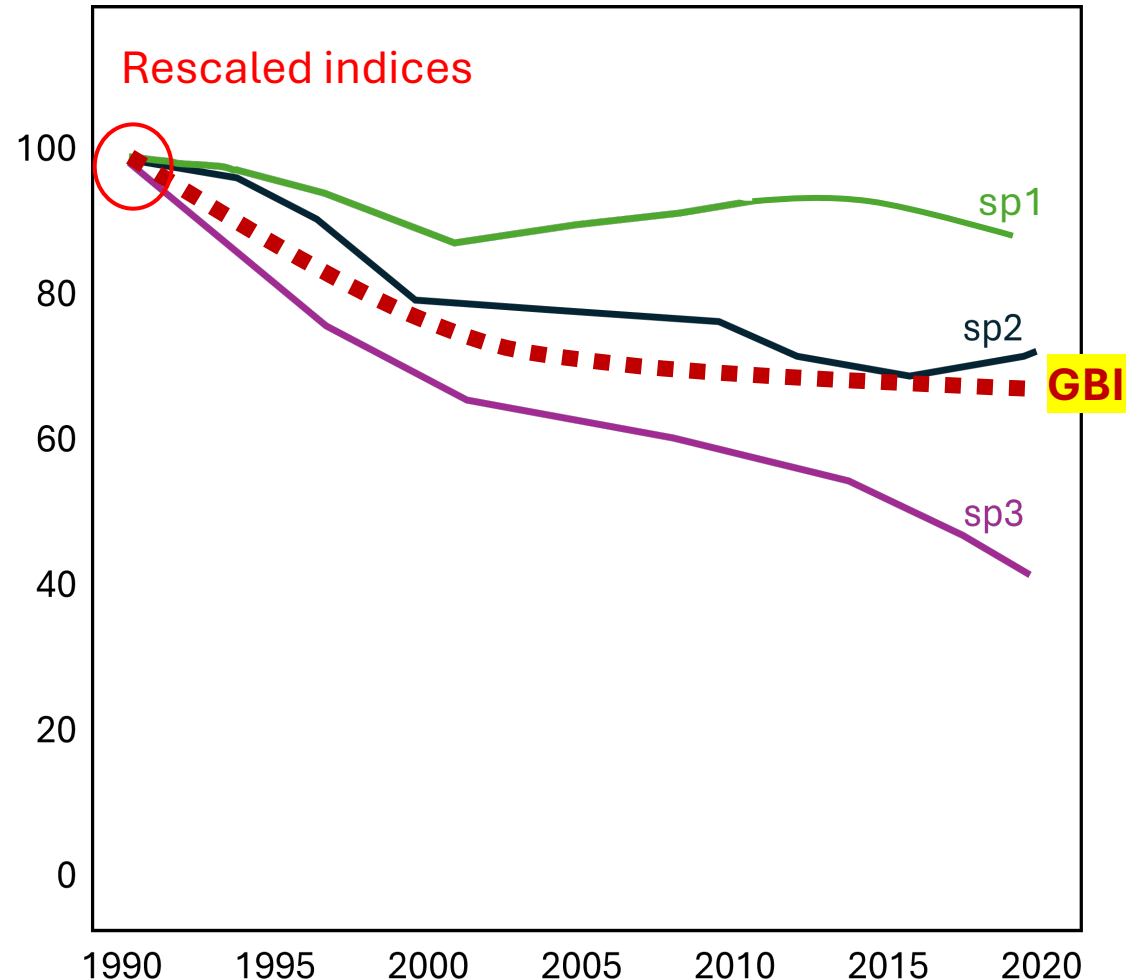
Calculate trends from collated abundance indices

Standardised national indices

Site	Date	Annual Site Index	Grassland Indicator Species
FRA	2019	43	Sp 1
FRA	2020	35	Sp 1
FRA	2021	22	Sp 1
FRA	2022	23	Sp 1
FRA	2019	50	Sp 2
FRA	2020	45	Sp 2
FRA	2021	43	Sp 2
FRA	2022	46	Sp 2
FRA	2019	...	Sp 3
FRA	2020	...	Sp 3
...	...	...	...



Calculate multispecies trends (GBI)



Standardised national indices for 17 species

Year	Sp1	Sp 2	Sp 3	...	Sp17
1990	100	100	100	...	100
1991	98	98	98	...	96
1992	96	97	93	...	93
1993	94	96	89	...	85
....	...	...	...	...	...
2000	85	80	65	...	70
2001	83	80	63	...	69
....	...	...	...	...	...
2019	93	75	45	...	58
2020	92	75	44	...	57
2021	...	...	...	...	...

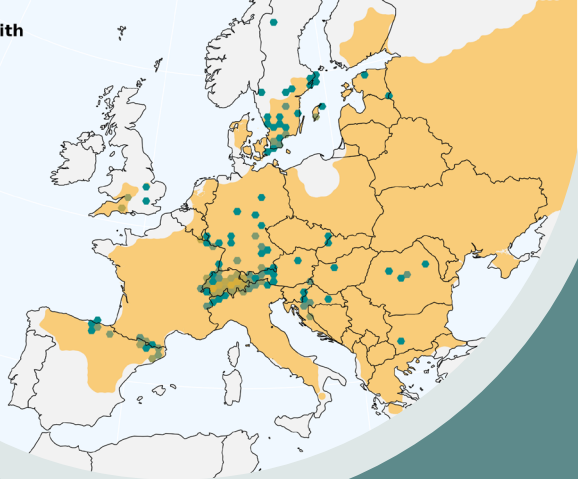
Geometric Mean across 17 species

GBI
100
97.5
94.7
90.9
...
74.5
73.3
...
65.3
64.5
...

BMS transects with
Phengaris arion

50°N -

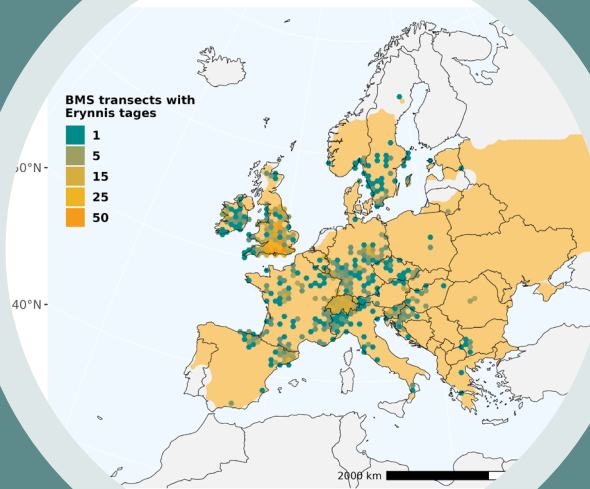
1
5
15



BMS transects with
Erynnis tages

50°N -
40°N -

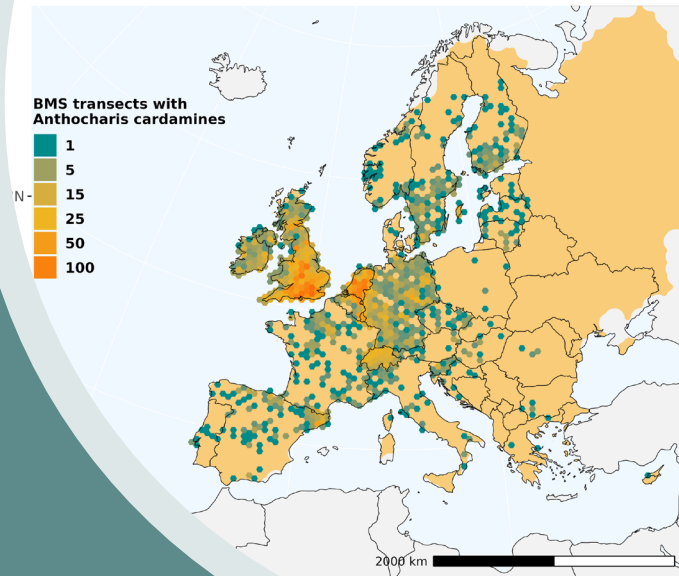
1
5
15
25
50



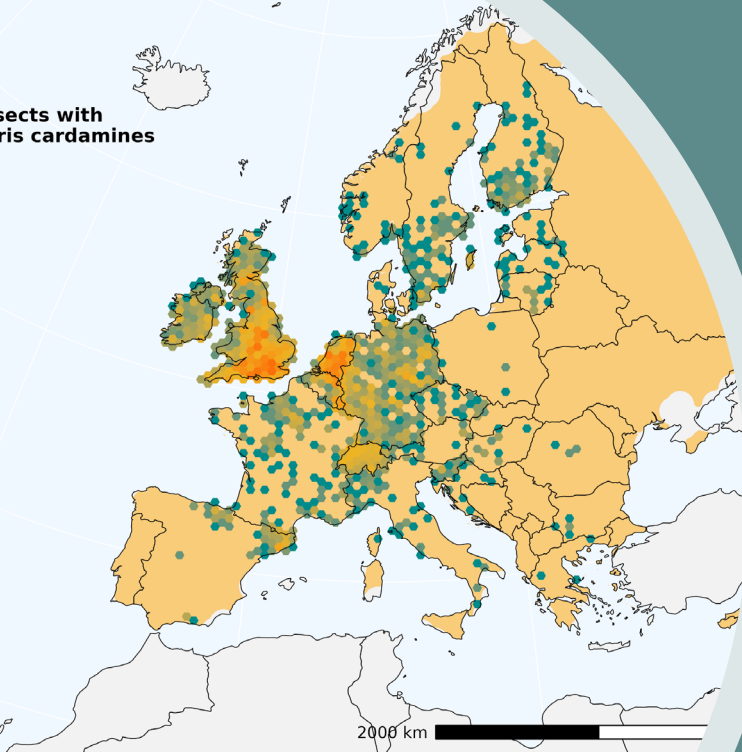
BMS transects with
Anthocharis cardamines

N -

1
5
15
25
50
100



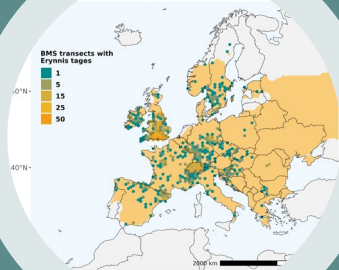
BMS transects with
Anthocharis cardamines



BMS transects with
Erynnis tages

50°N -
40°N -

1
5
15
25
50

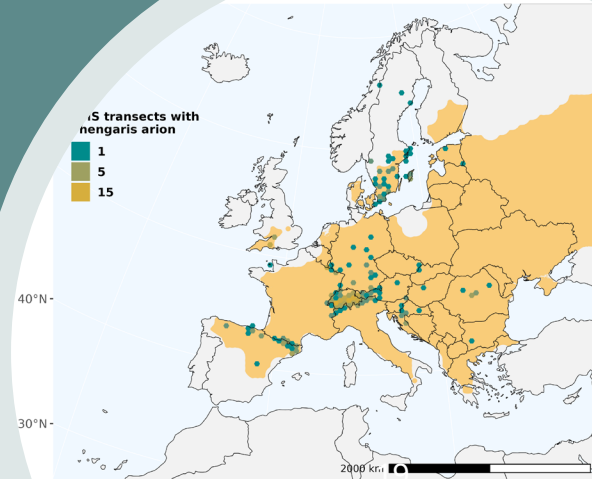


eBMS Counts (Europe) Site Indices and Weighting

BMS transects with
Phengaris arion

40°N -
30°N -

1
5
15



Calculate multispecies trends across countries (GBI)

Year	France Spain Germany Finland					Sp1 (EU)
	Sp1	Sp 1	Sp 1	...	Sp1	
1990	100	100	100	...	100	100
1991	98	98	98	...	96	97.5
1992	96	97	93	...	93	94.7
1993	94	96	89	...	85	90.9
....	...	...	...	...	...	...
2000	85	80	65	...	70	74.5
2001	83	80	63	...	69	73.3
....	...	...	...	...	...	...
2019	93	75	45	...	58	65.3
2020	92	75	44	...	57	64.5
2021	...	...	...	...	...	...



Geometric Mean across 17 species						
Year	Sp1	Sp 2	Sp 3	...	Sp17	GBI
1990	100	100	100	...	100	100
1991	98	98	98	...	96	97.5
1992	96	97	93	...	93	94.7
1993	94	96	89	...	85	90.9
....	...	...	...	...	...	...
2000	85	80	65	...	70	74.5
2001	83	80	63	...	69	73.3
....	...	...	...	...	...	...
2019	93	75	45	...	58	65.3
2020	92	75	44	...	57	64.5
2021	...	...	...	...	...	...

Geometric Mean across Countries (BMS)

Weighting country/region contribution based on species range (relative area covered)

A small portion of the distribution range

❖ Fully sampled

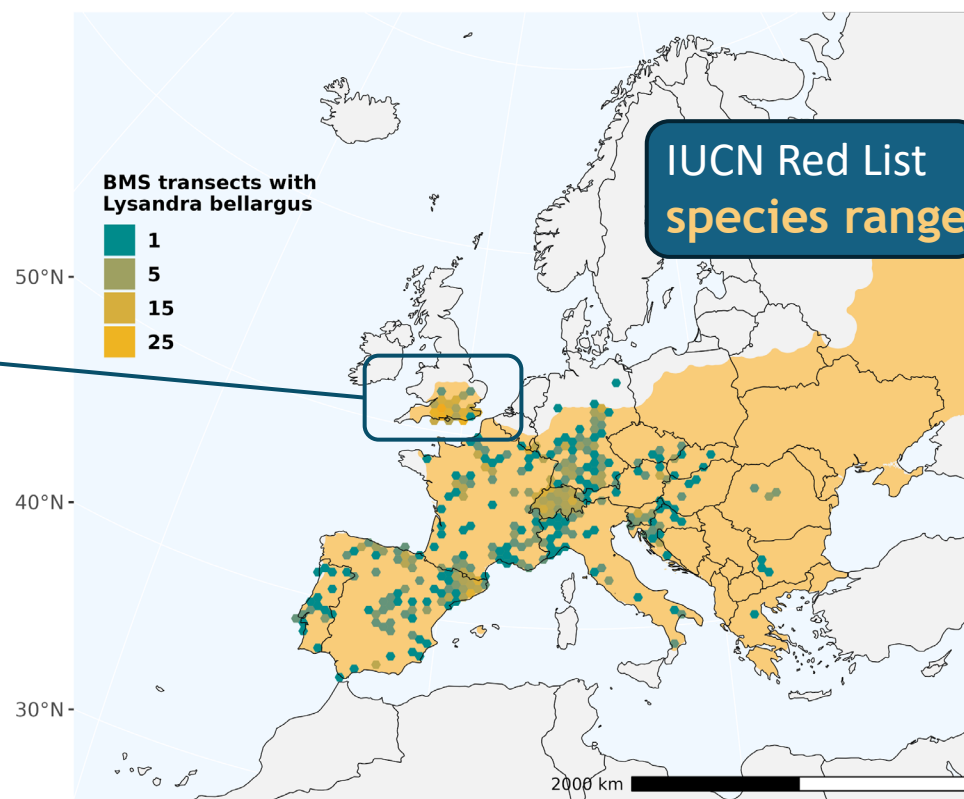


Photo credit: www.eurobutterflies.com

Lysandra Belargus
(Adonis Blue)

Weighting country/region contribution based on species range (relative area covered)

A large portion of the distribution range

➤ Partially sampled

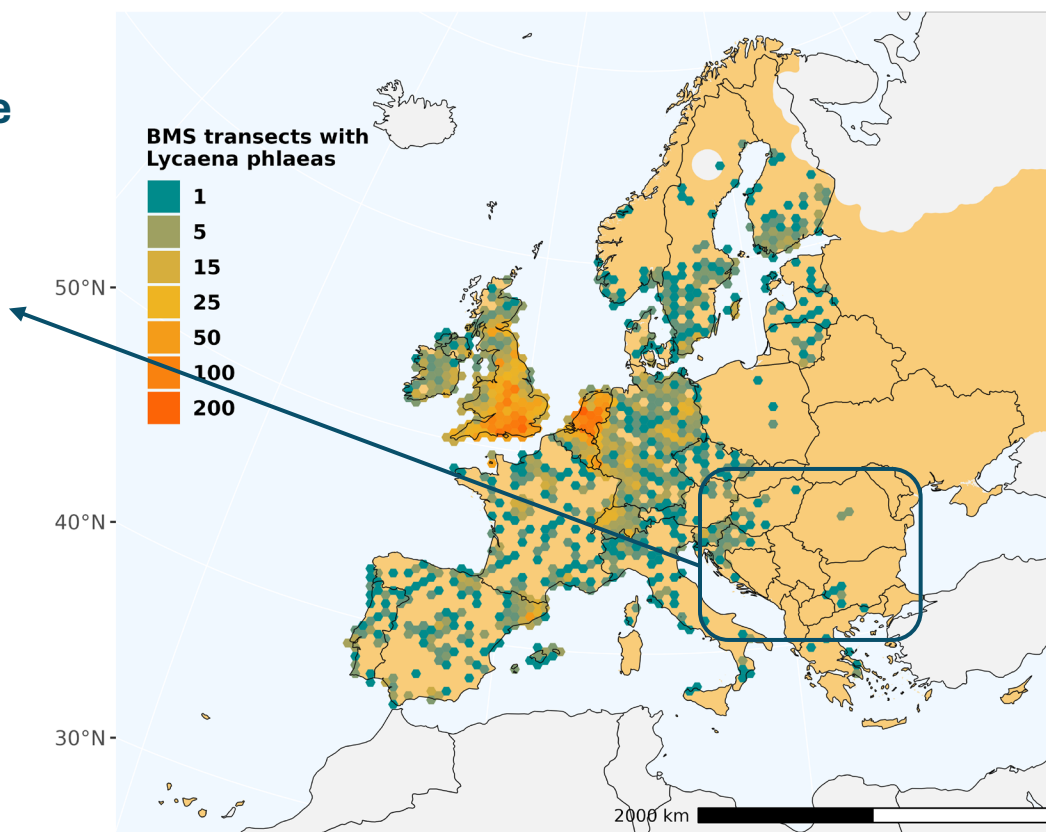


Photo credit: Bob Eade

Lycaena phlaeas
(Small copper)

Challenges of calculating trends across countries for rare species

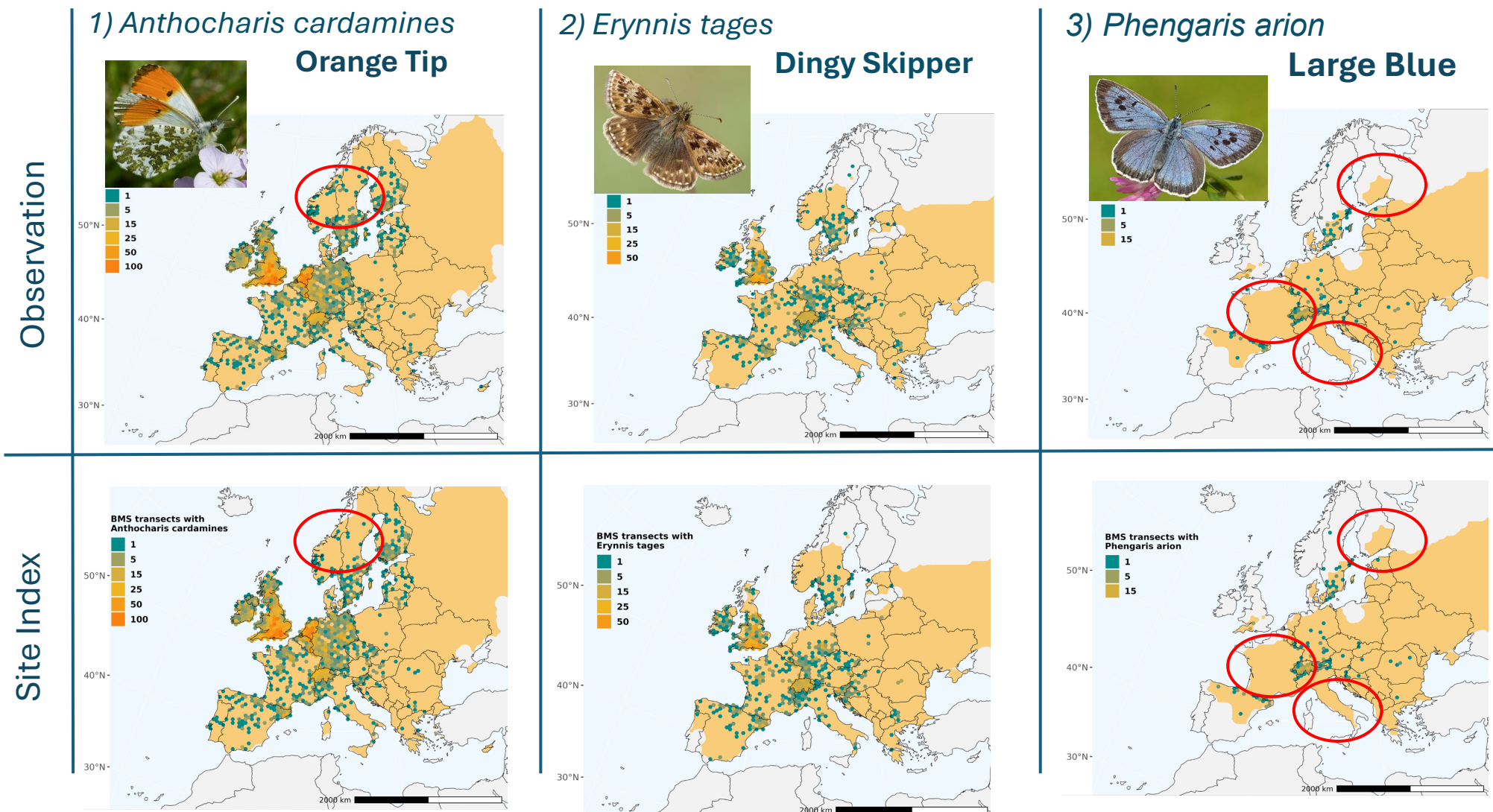


Photo credit: 1) Brian Arnol, 2) Iain Leach, 3) Pete Withers



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