Drawings: Lisa Nicvert (CC-BY 4.0)

How are dragonflies doing in Europe?

A quantitative assessment of dragonflies distribution trends over the last 25 years

Lisa Nicvert, Aletta Bonn, Diana Bowler, Jason Bried, Aurélie Coulon, Geert De Knijf, Thore Engel, Maxime Fajgenblat, Roy van Grunsven, Alienor Jeliazkov, Marie Lamouille-Hébert, Colin Fontaine, Martin Jeanmougin, Reto Schmucki

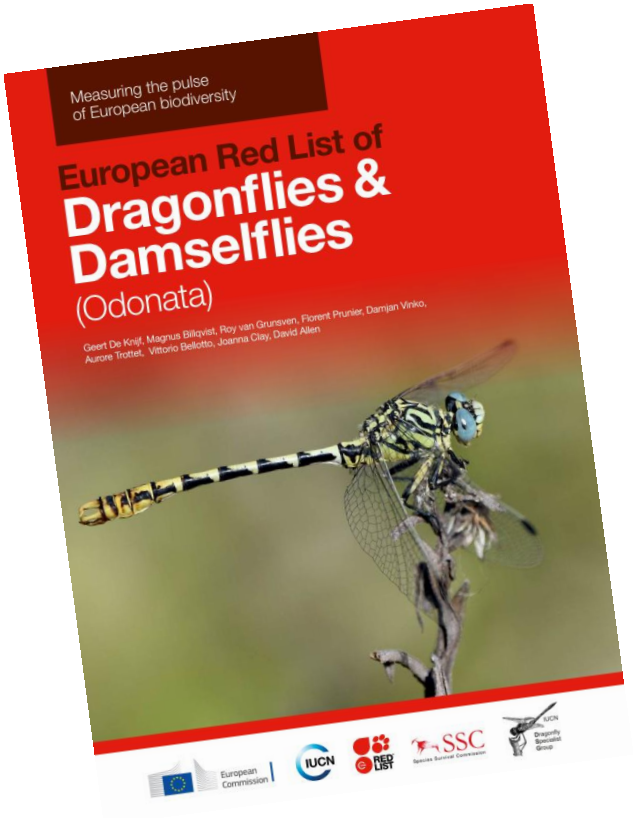
DRAGON consortium



European Congress on Odonatology 2026 – Teresin

Introduction

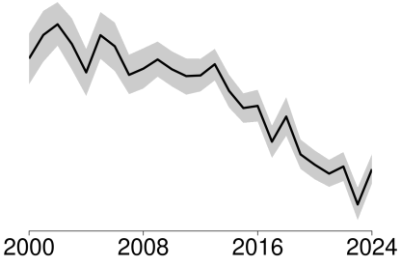
How are dragonflies doing in Europe?



Snapshot



Can we be more precise?



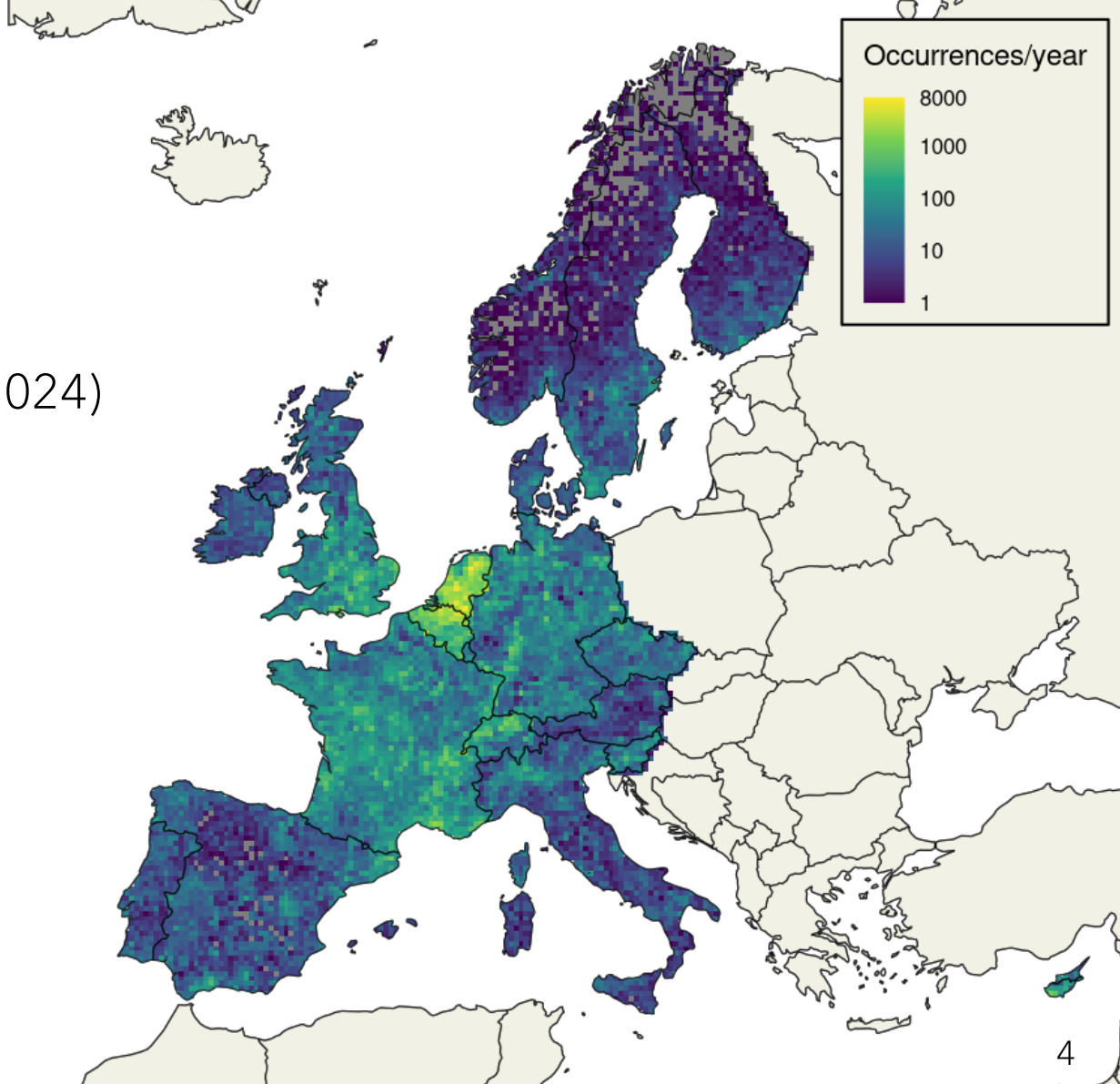
Introduction

DRAGON research project (2023-2026)



DRAGON database

- 14.9 million occurrences (2000-2024)
- 27 datasets (17 countries)
- 123 species



Opportunistic data
= no sampling protocol

- 96% is opportunistic
- Data has biases



Methods in Ecology and Evolution
Methods in Ecology and Evolution 2014, 5, 1052–1060
doi: 10.1111/2041-210X.12254

Statistics for citizen science: extracting signals of change from noisy ecological data

Nick J. B. Isaac[1]*, Arco J. van Strien[2], Tom A. August[1], Marnix P. de Zeeuw[2] and David B. Roy[1]
[1]NERC Centre for Ecology & Hydrology, Crowmarsh Gifford, Maclean Building, Wallingford, OX10 8BB, UK; and [2]Statistics Netherlands, PO Box 24500, 2490 HA The Hague, The Netherlands

Summary

1. Policy-makers increasingly demand robust measures of biodiversity change over short time periods. Long-term monitoring schemes provide high-quality data, often on an annual basis, but are taxonomically and geographically restricted. By contrast, opportunistic biological records are relatively unstructured but vast in quantity. Recently, these data have been applied to increasingly elaborate science and policy questions, using a range of methods. At present, we lack a firm understanding of which methods, if any, are capable of delivering unbiased trend estimates on policy-relevant time-scales.
2. We identified a set of candidate methods that employ da... with variation in recorder activity. We designed... these methods under a suite of re... method–scenario comb...
3. We ...

50 YEARS WITH IMPACT
Journal of Applied Ecology
Journal of Applied Ecology 2013, 50, 1450–1458
doi: 10.1111/1365-2664.12158

Opportunistic citizen science data of animal species produce reliable estimates of distribution trends if analysed with occupancy models

Arco J. van Strien[1,2]*, Chris A.M. van Swaay[3] and Tim Termaat[3]
[1]Statistics Netherlands, P.O. Box 24500, 2490 HA The Hague, The Netherlands; [2]Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands; and [3]Dutch Butterfly Conservation, P.O. Box 506, 6700 AM Wageningen, The Netherlands

Summary

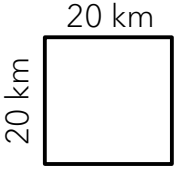
1. Many publications documenting large-scale trends in the distribution of species make use of opportunistic citizen data, that is, observations of species collected without standardized field protocol and without explicit sampling design. It is a challenge to achieve reliable estimates of distribution trends from them, because opportunistic citizen science data may suffer from changes in field efforts over time (observation bias), from incomplete and selective recording by observers (reporting bias) and from geographical bias. These, in addition to detection bias, may lead to spurious trends.
2. We investigated whether occupancy models can correct for the observation, reporting and detection biases in opportunistic data. Occupancy models use detection/nondetection data and yield estimates of the percentage of occupied sites (occupancy) per year. These models take the imperfect detection of species into account. By correcting for detection bias, they may simultaneously correct for observation and reporting bias as well. We compared trends in occupancy (or distribution) of butterfly and dragonfly species derived from opportunistic data with those derived from standardized monitoring data. All data came from the same grid squares and years, in order to avoid any geographical bias in this comparison.
3. Distribution trends in opportunistic and monitoring data were well-matched. Strong trends observed in monitoring data were rarely missed in opportunistic data.
4. *Synthesis and applications.* Opportunistic data can be used for monitoring purposes if occupancy models are used for analysis. Occupancy models are able to control for the common biases encountered with opportunistic data, enabling species trends to be monitored for species groups and regions where it is not feasible to collect standardized data on a large scale. Opportunistic data may thus become an important source of information to track distribution trends in many groups of species.

Occupancy-detection models *MacKenzie et al. 2002*

what is truly present ≠ what is observed

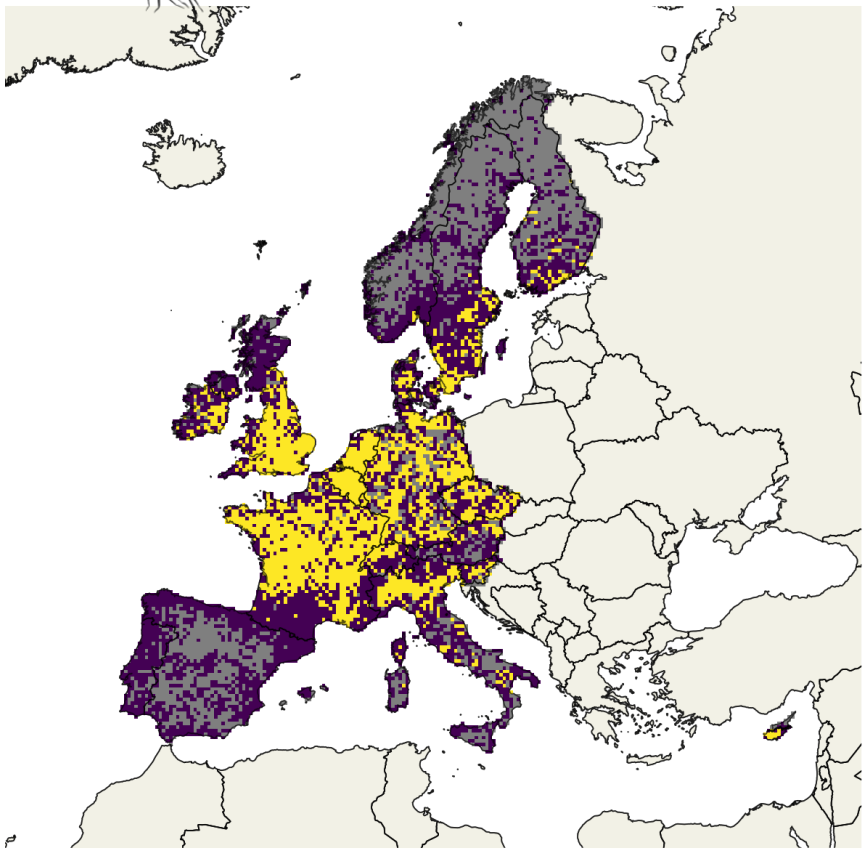


Occupancy-detection models

each site = 



Calopterxy splendens in 2020



Status

seen → was present

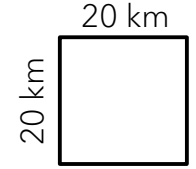
not seen → was present, but not detected (or reported)

not seen → was absent

not visited

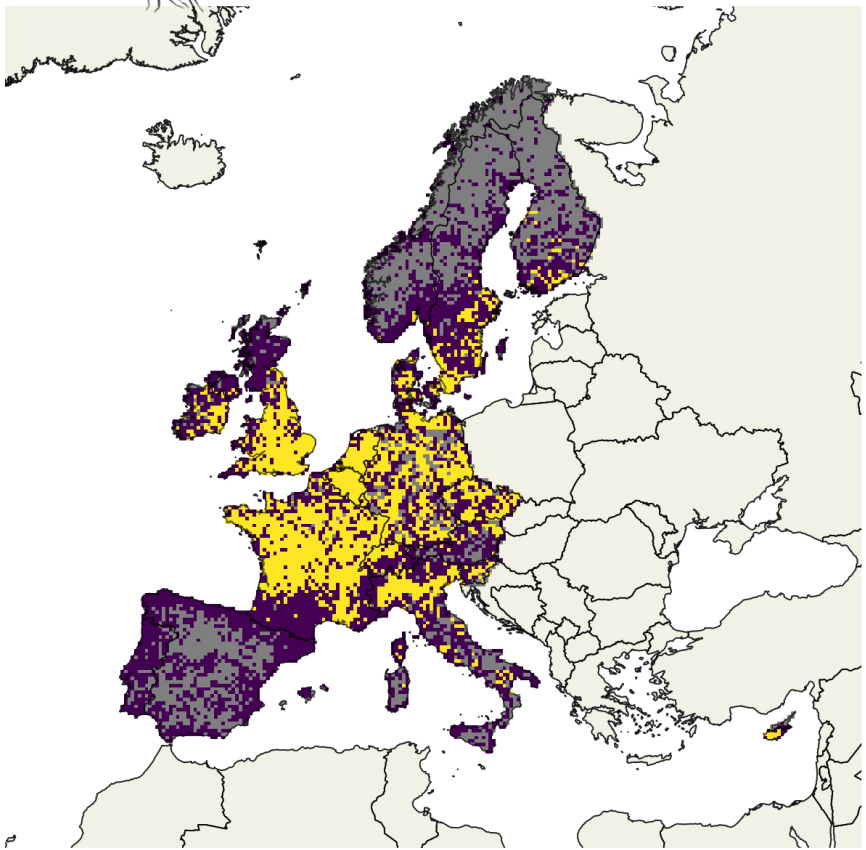
Occupancy-detection models

each site =





Calopterxy splendens in 2020

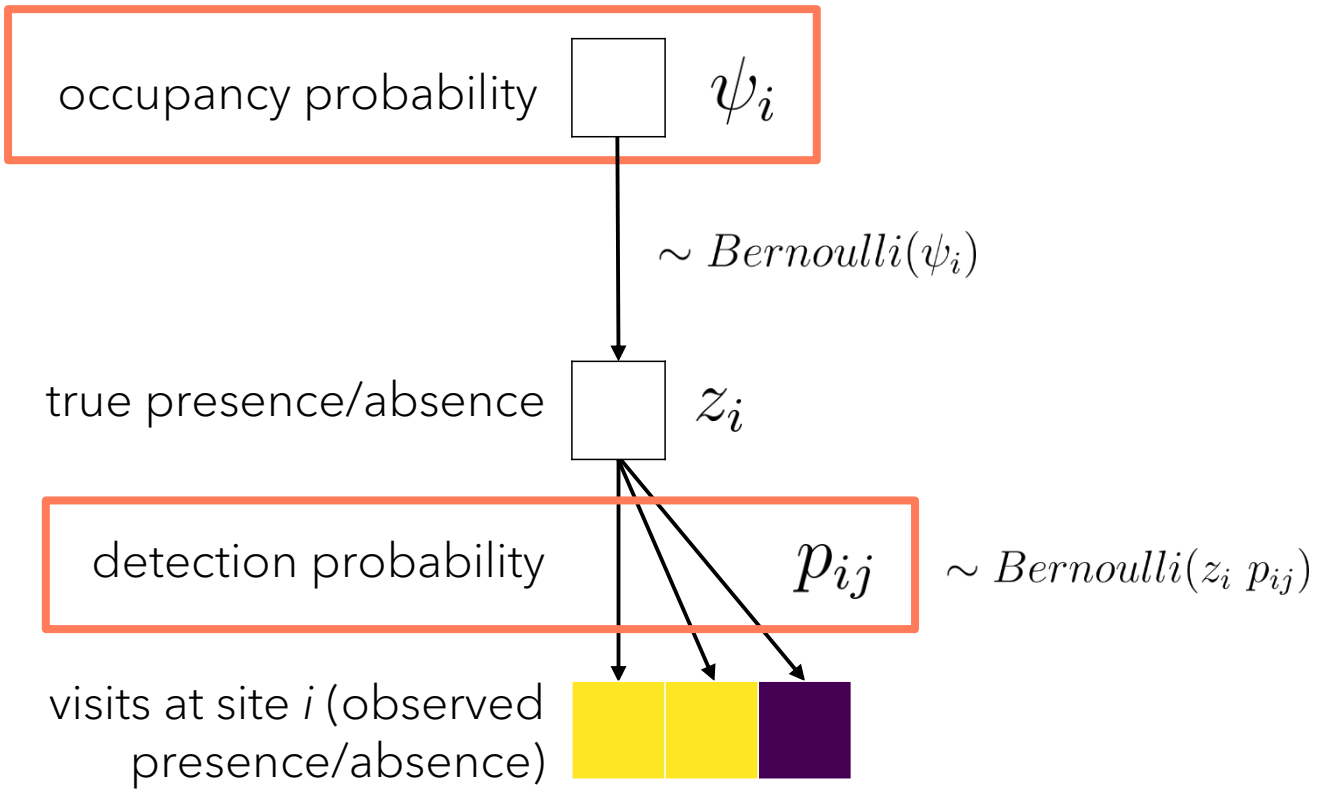


Visits for one site



one day

Occupancy-detection models

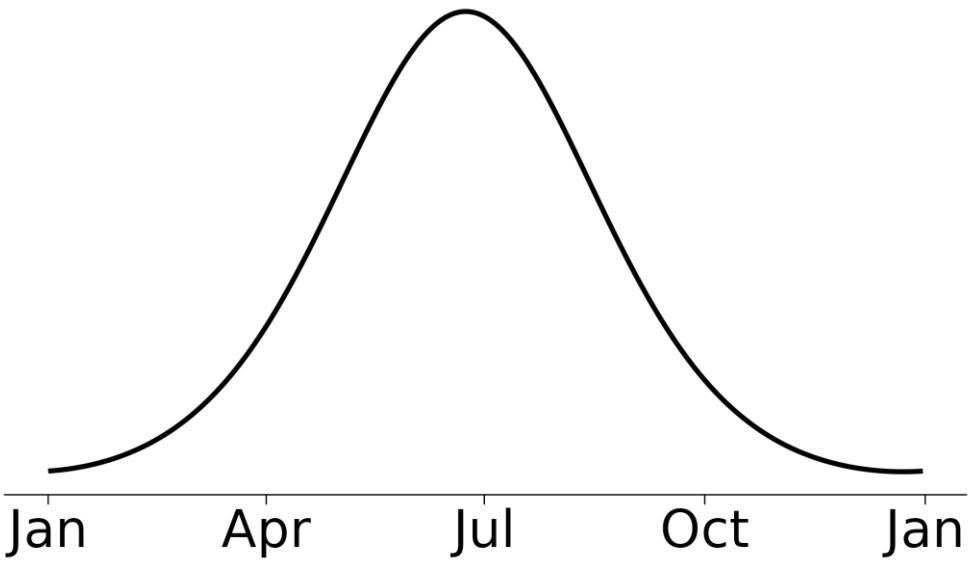


Detection probability

Calopteryx splendens



Phenology



$$\text{logit}(p_{ij}) = \beta_{\text{intercept}} + ll_{ij} + \exp(\kappa \cos(d_{ij} - \mu_0)) - \exp(\kappa) + \beta_{\text{spread}}\text{spread}_{ij}$$

site visit

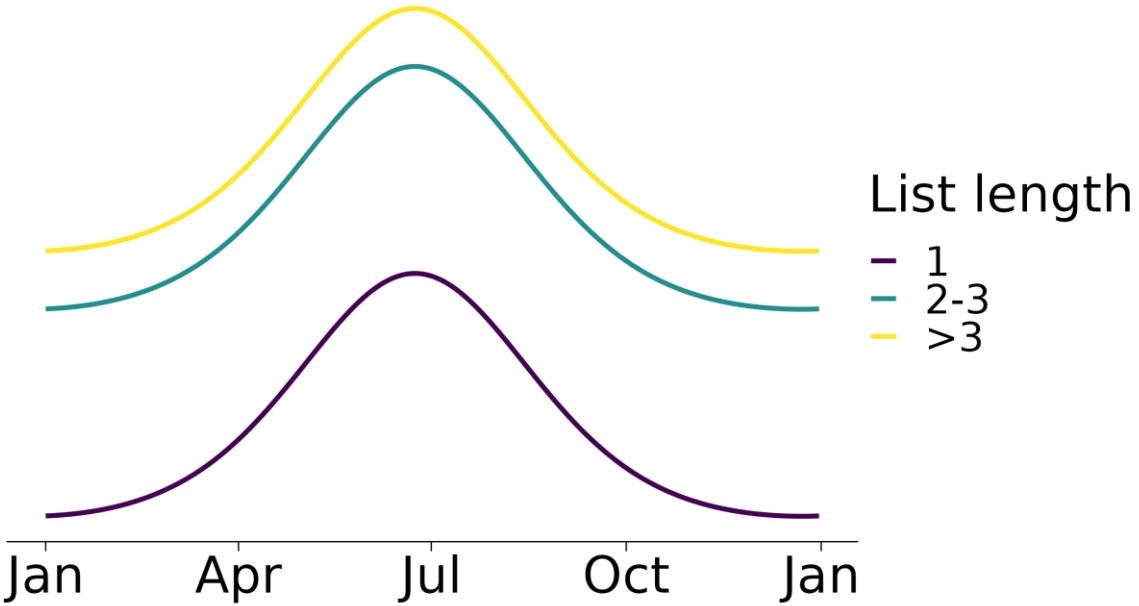
Drawing: Lisa Nicvert (CC-BY 4.0)

Detection probability

Calopteryx splendens



List length = number of other species



$$\text{logit}(p_{ij}) = \beta_{\text{intercept}} + ll_{ij} + \exp(\kappa \cos(d_{ij} - \mu_0)) - \exp(\kappa) + \beta_{\text{spread}}\text{spread}_{ij}$$

site visit

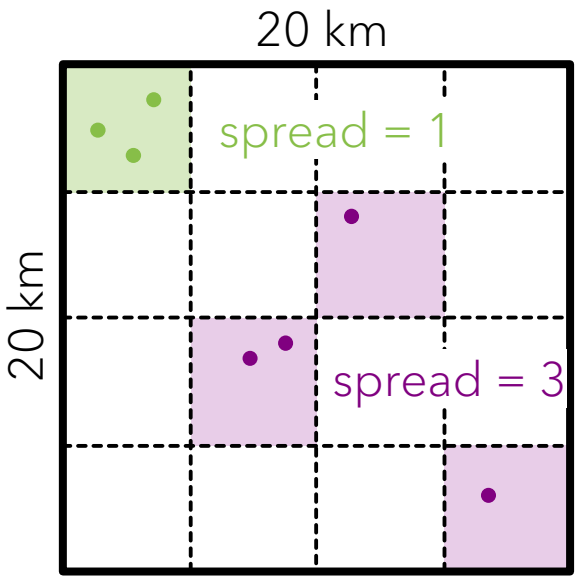
Drawing: Lisa Nicvert (CC-BY 4.0)

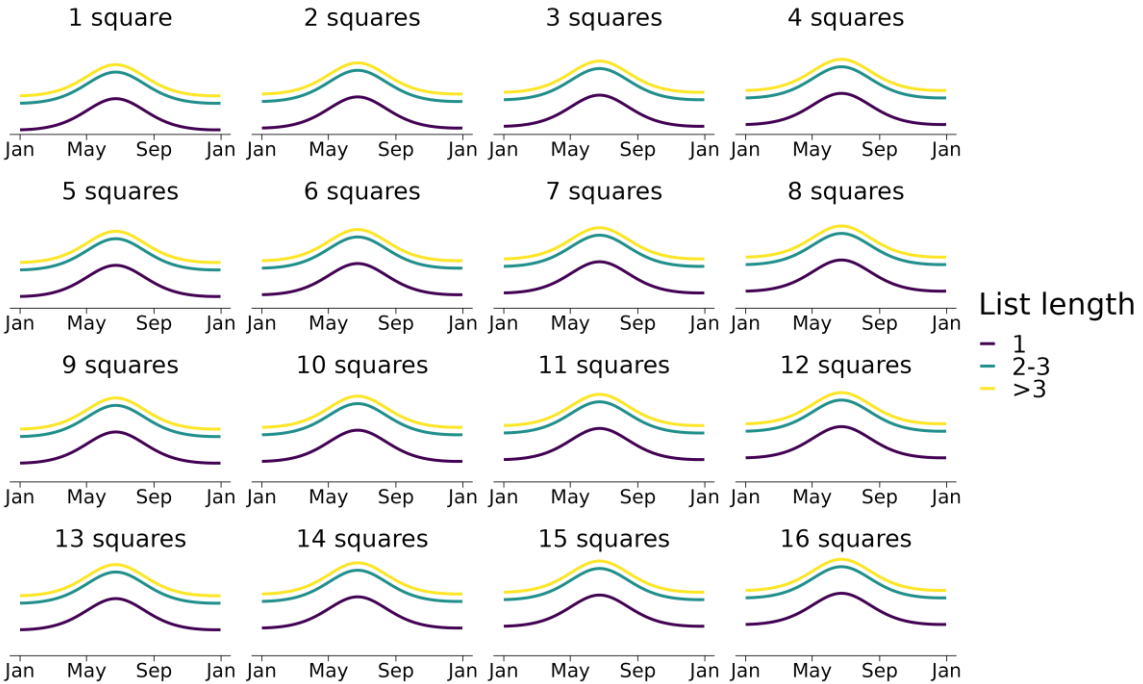
Detection probability

Calopteryx splendens



Spatial coverage





$$\text{logit}(p_{ij}) = \beta_{\text{intercept}} + ll_{ij} + \exp(\kappa \cos(d_{ij} - \mu_0)) - \exp(\kappa) + \beta_{\text{spread}}\text{spread}_{ij}$$

site visit

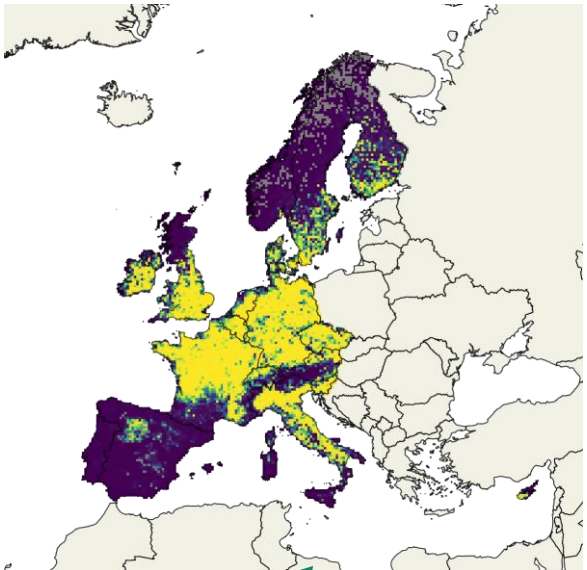
Drawing: Lisa Nicvert (CC-BY 4.0)

Occupancy probability

Calopteryx splendens



Species distribution



$$\text{logit}(\psi_{it}) = \beta_{\text{intercept}} + \mathbf{B_{i\cdot}}\boldsymbol{\beta}_{\mathbf{climate}} + \mathbf{C_{i\cdot}}\boldsymbol{\beta}_{\mathbf{landcover}} + \beta_{\text{site } i} + \beta_{\text{year } t} + \beta_{\text{site-time } i y_t}$$

site year

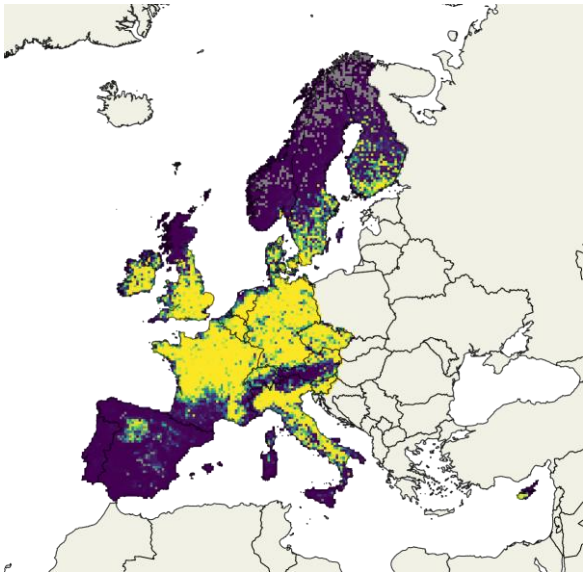
Drawing: Lisa Nicvert (CC-BY 4.0)

Occupancy probability

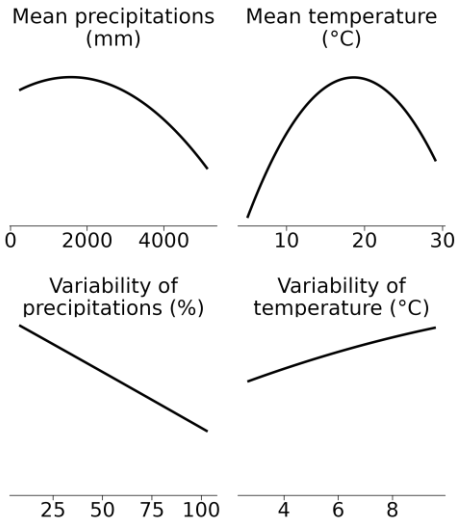
Calopteryx splendens



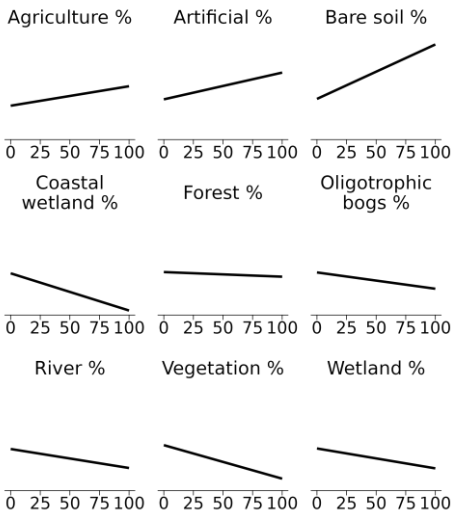
Species distribution



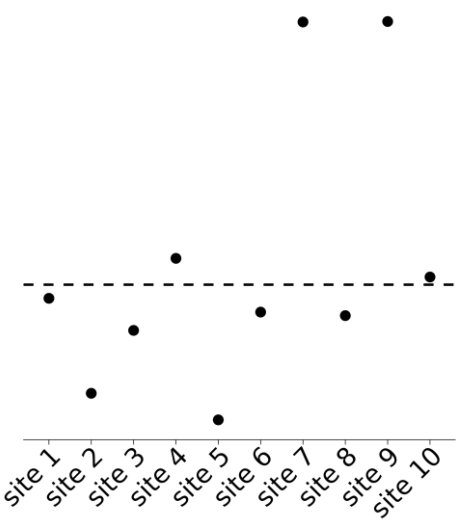
4 bioclimatic variables



9 landcover classes



site effect



$$\text{logit}(\psi_{it}) = \beta_{\text{intercept}} + \mathbf{B_{i\cdot}}\boldsymbol{\beta}_{\mathbf{climate}} + \mathbf{C_{i\cdot}}\boldsymbol{\beta}_{\mathbf{landcover}} + \beta_{\text{site } i} + \beta_{\text{year } t} + \beta_{\text{site-time } i y_t}$$

site year

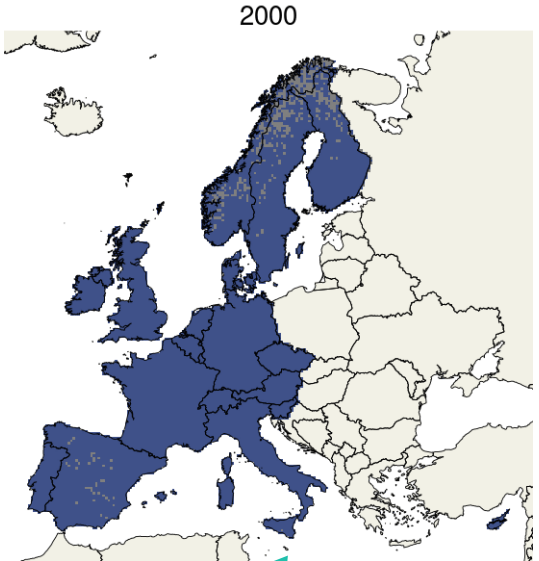
Drawing: Lisa Nicvert (CC-BY 4.0)

Occupancy probability

Calopteryx splendens



General trend





$$\text{logit}(\psi_{it}) = \beta_{\text{intercept}} + \mathbf{B_i}.\boldsymbol{\beta}_{\mathbf{climate}} + \mathbf{C_i}.\boldsymbol{\beta}_{\mathbf{landcover}} + \beta_{\text{site } i} + \beta_{\text{year } t} + \beta_{\text{site-time } i} y_t$$

site year

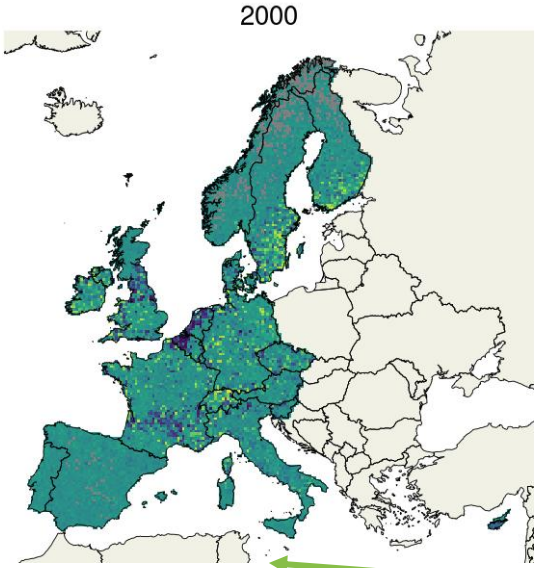
Drawing: Lisa Nicvert (CC-BY 4.0)

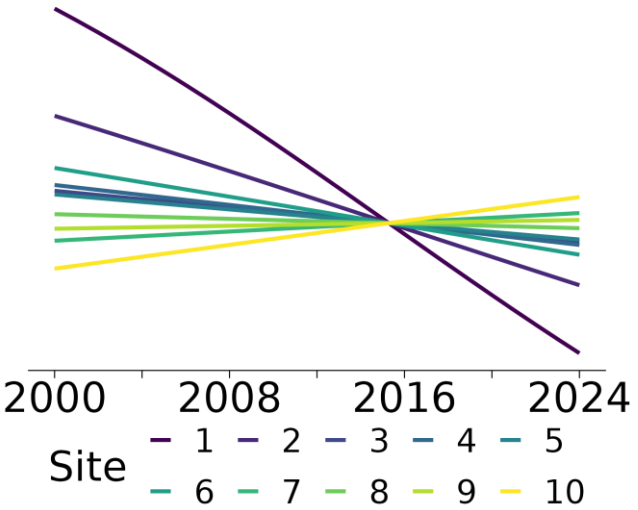
Occupancy probability

Calopteryx splendens



Space-varying trend





$$\text{logit}(\psi_{it}) = \beta_{\text{intercept}} + \mathbf{B_{i\cdot}}\boldsymbol{\beta}_{\mathbf{climate}} + \mathbf{C_{i\cdot}}\boldsymbol{\beta}_{\mathbf{landcover}} + \beta_{\text{site } i} + \beta_{\text{year } t} + \beta_{\text{site-time } i y_t}$$

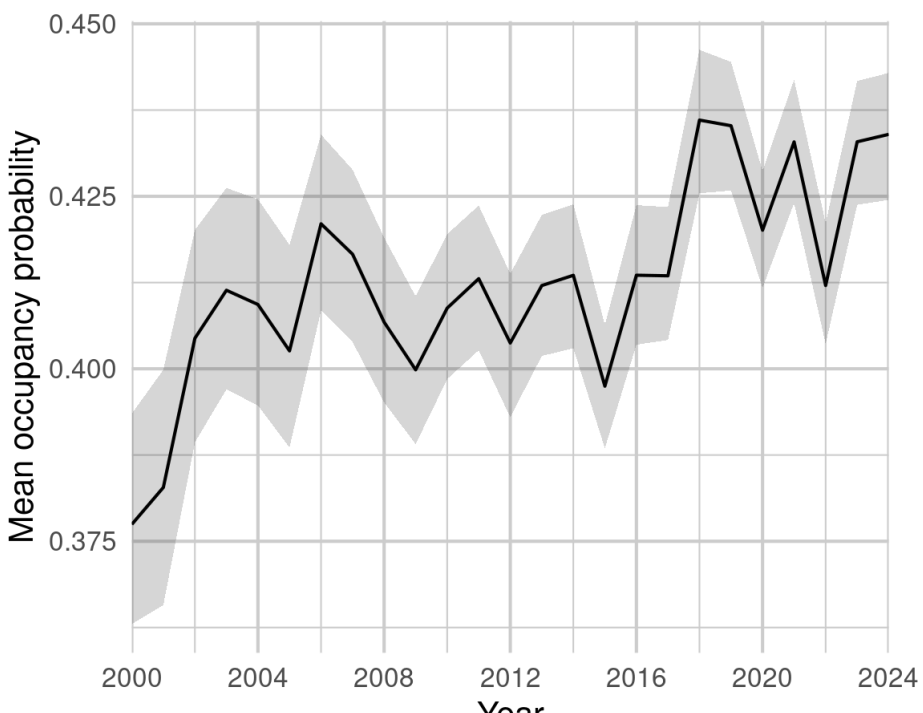
site year

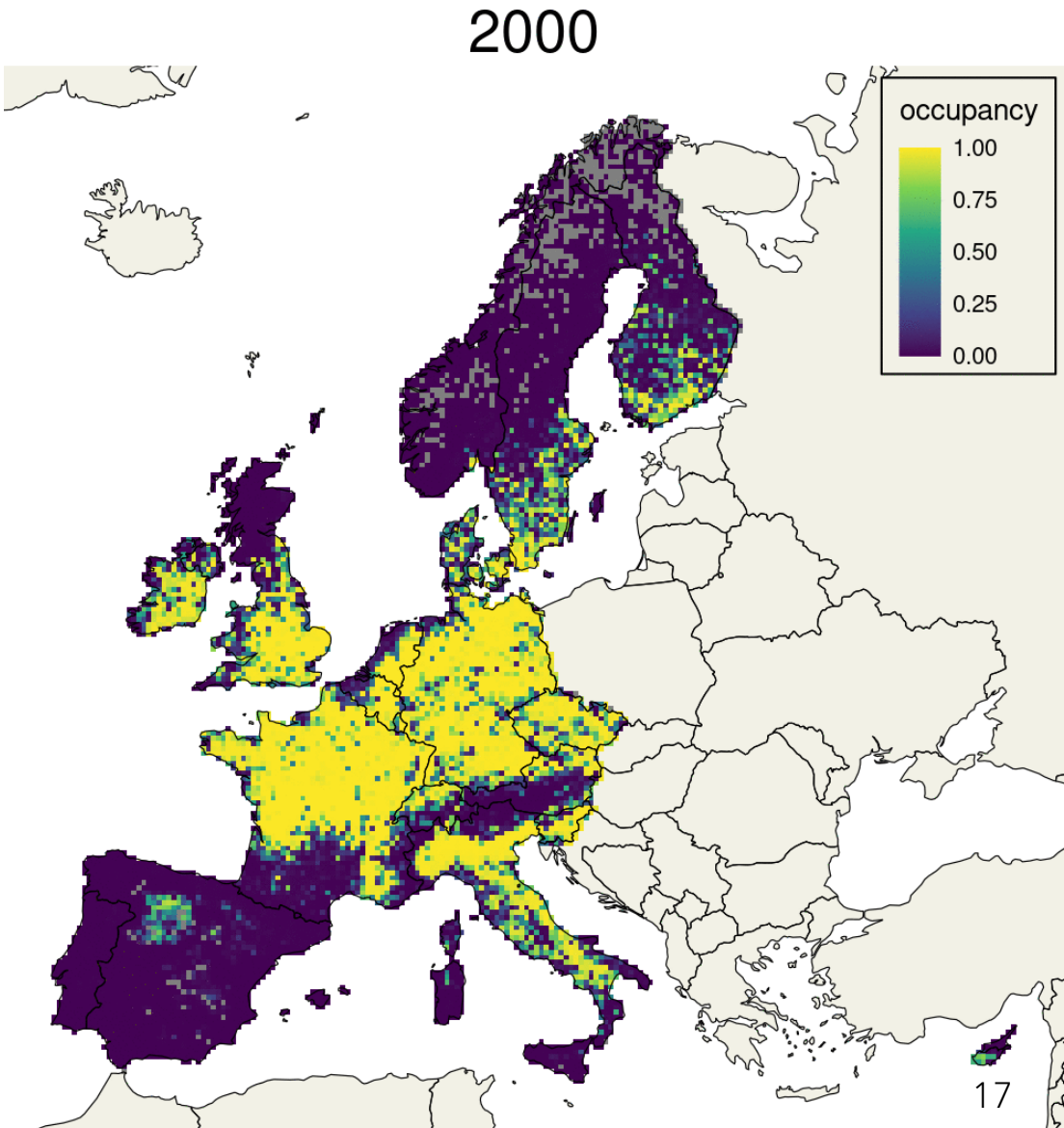
Drawing: Lisa Nicvert (CC-BY 4.0)

Results

Calopteryx splendens





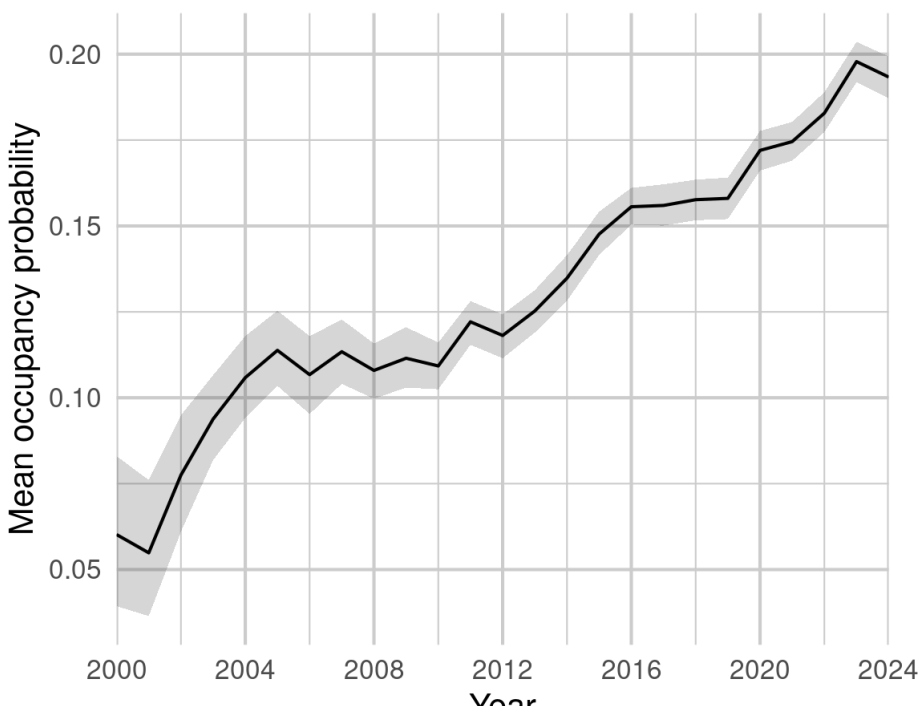


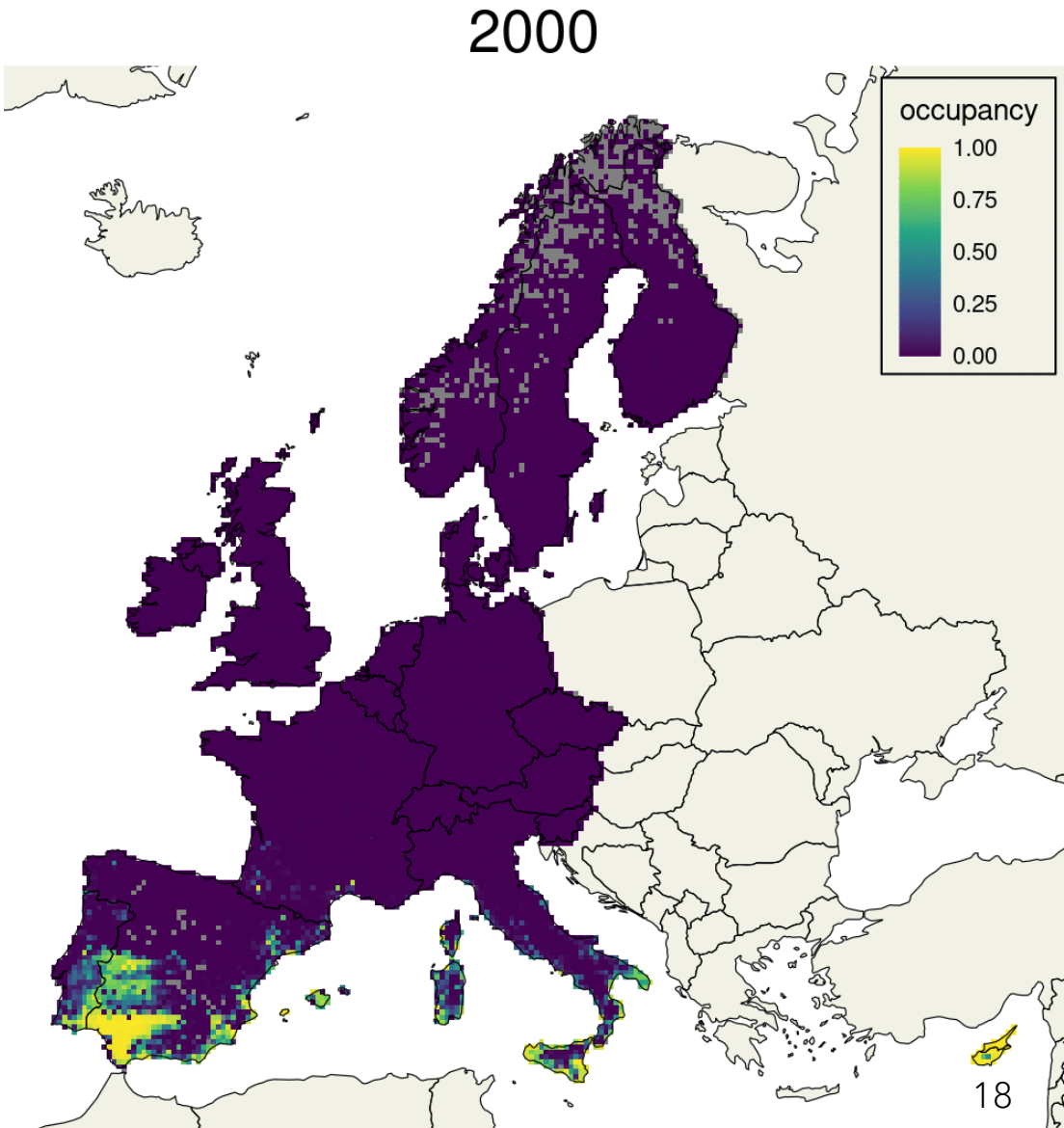
Drawing: Lisa Nicvert (CC-BY 4.0)

Results

Trithemis annulata





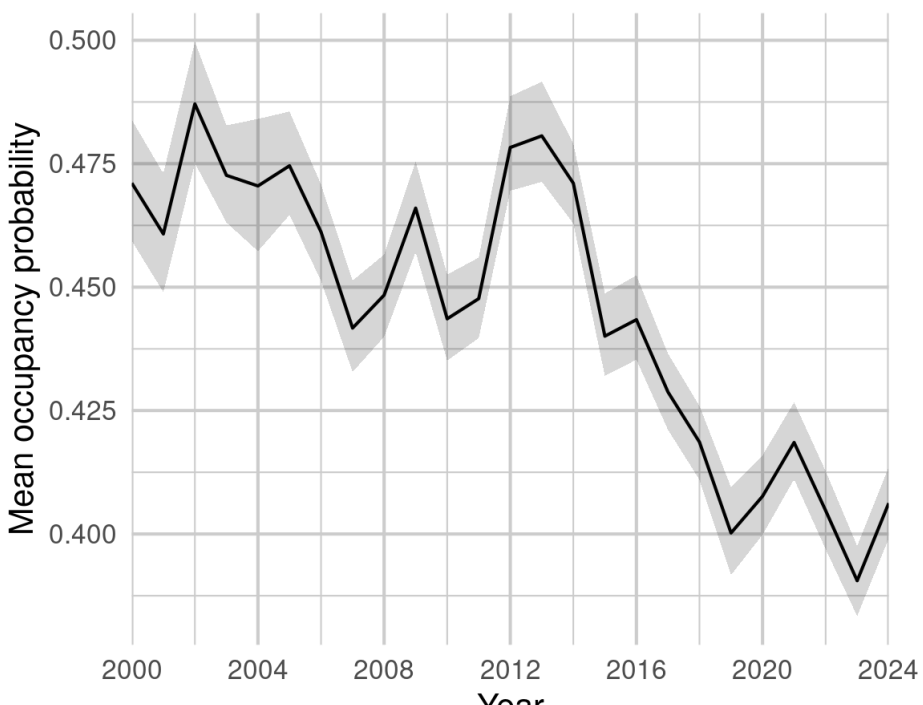


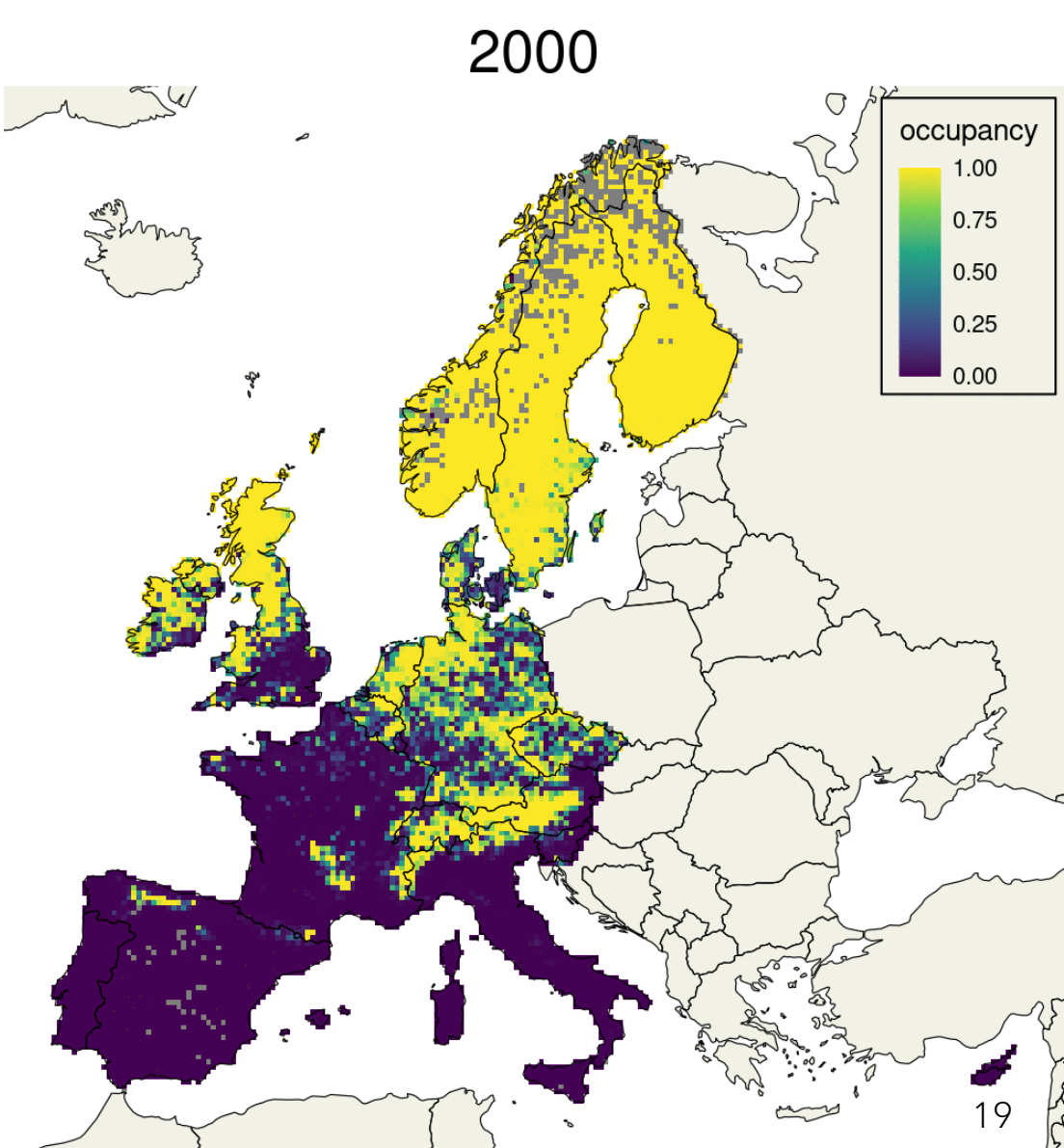
Drawing: Lisa Nicvert (CC-BY 4.0)

Results

Sympetrum danae





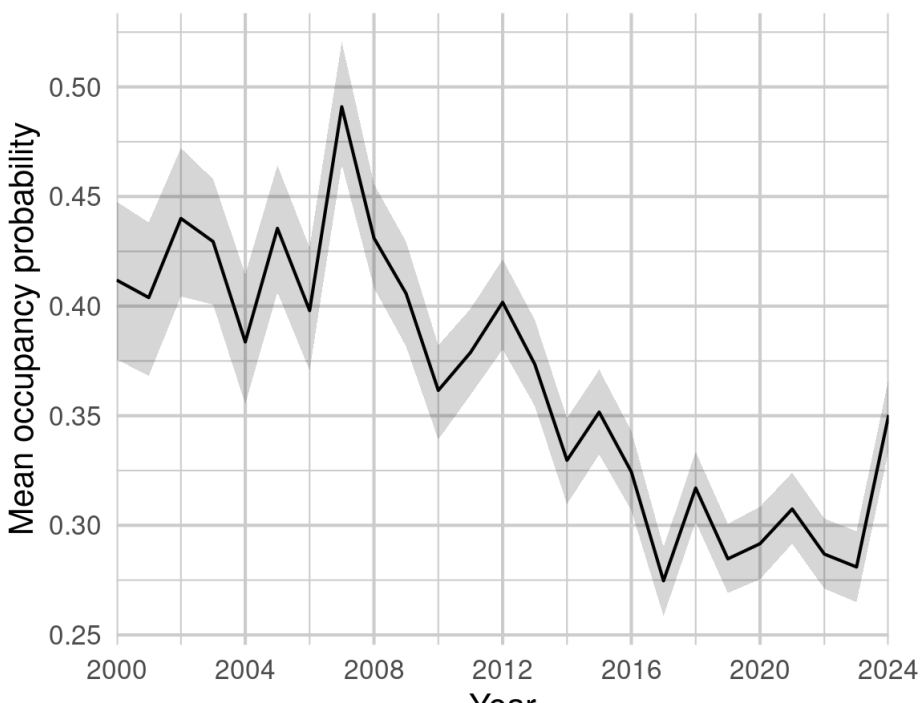


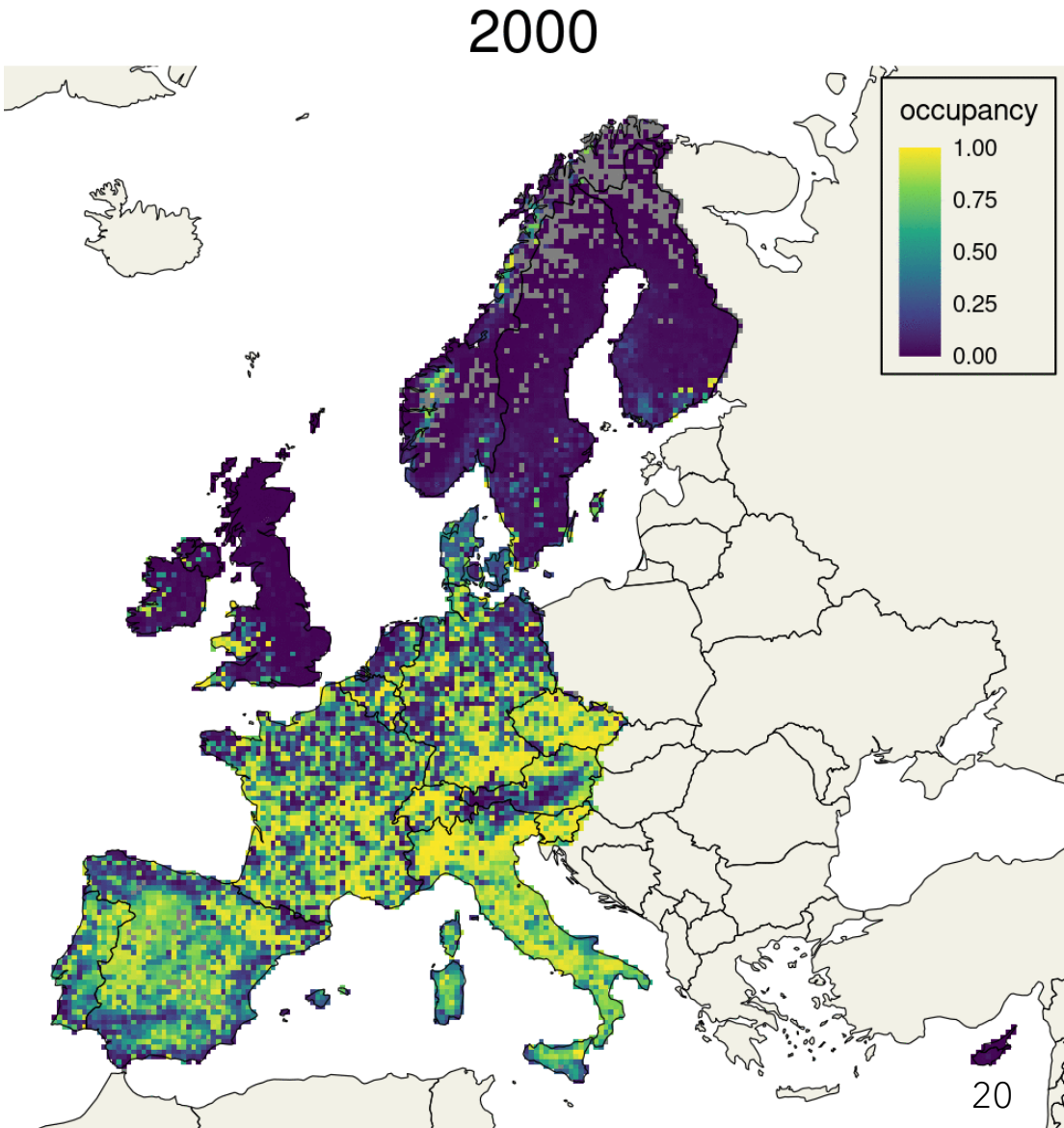
Drawing: Lisa Nicvert (CC-BY 4.0)

Results

Ischnura pumilio

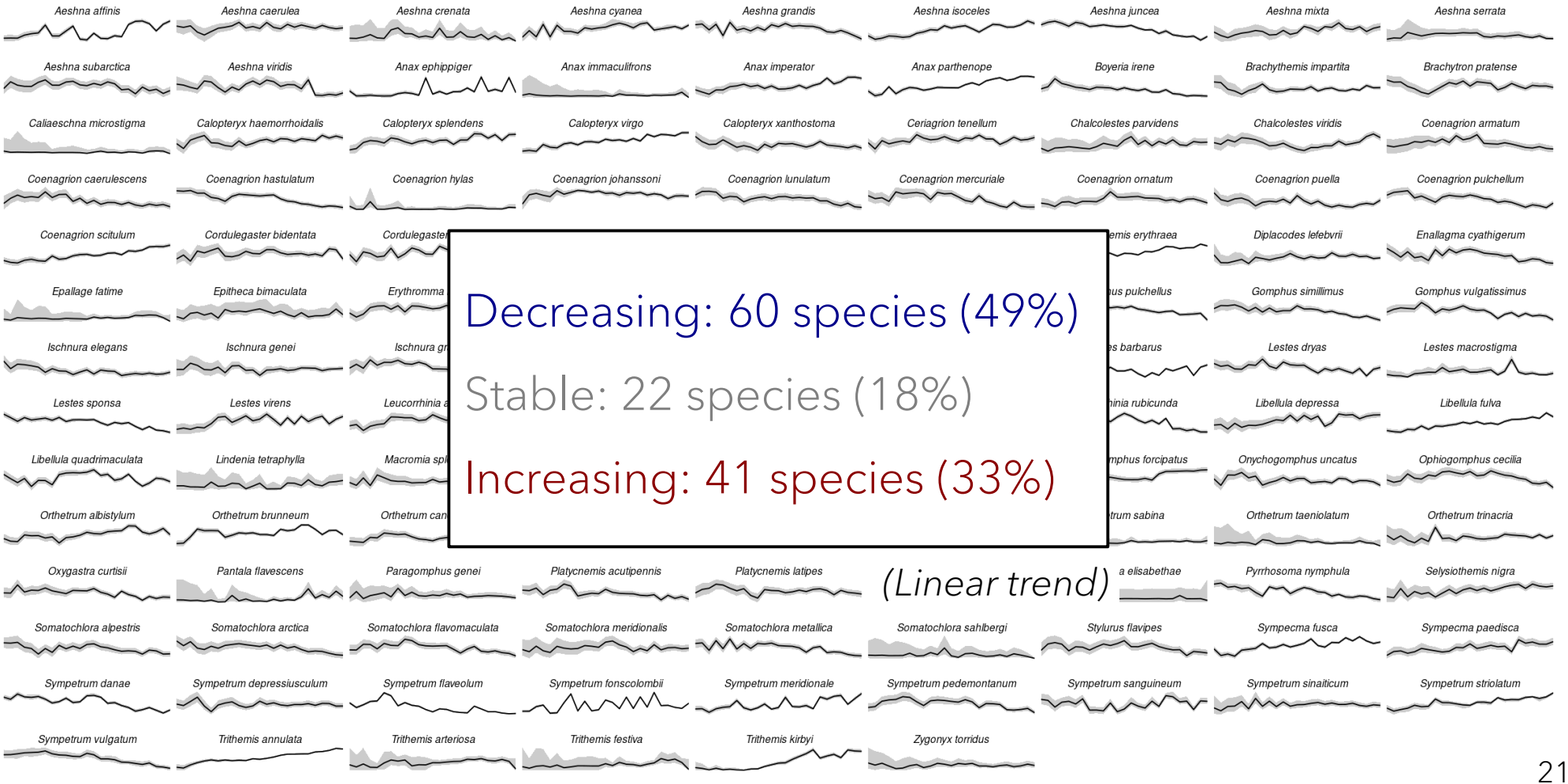






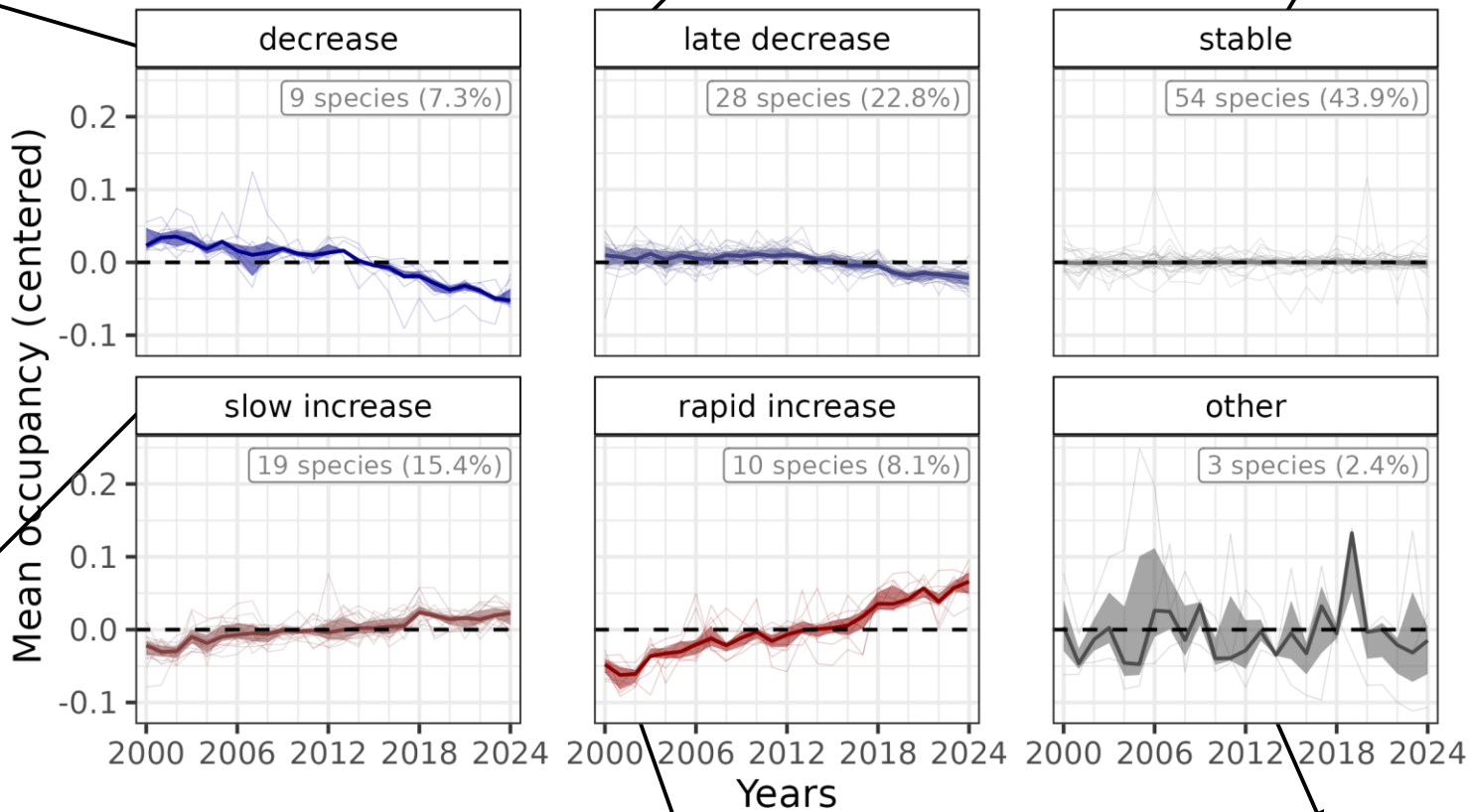
Drawing: Lisa Nicvert (CC-BY 4.0)

Results


Aeshna affinis
Aeshna caerulea
Aeshna crenata
Aeshna cyanea
Aeshna grandis
Aeshna isoceles
Aeshna juncea
Aeshna mixta
Aeshna serrata
Aeshna subarctica
Aeshna viridis
Anax ephippiger
Anax immaculifrons
Anax imperator
Anax parthenope
Boyeria irene
Brachythemis impartita
Brachytron pratense
Caliaeschna microstigma
Calopteryx haemorrhoidalis
Calopteryx splendens
Calopteryx virgo
Calopteryx xanthostoma
Ceriagrion tenellum
Chalcolestes parvidens
Chalcolestes viridis
Coenagrion armatum
Coenagrion caerulescens
Coenagrion hastulatum
Coenagrion hylas
Coenagrion johanssoni
Coenagrion lunulatum
Coenagrion mercuriale
Coenagrion ornatum
Coenagrion puella
Coenagrion pulchellum
Coenagrion scitulum
Cordulegaster bidentata
Diplacodes lefebvrii
Enallagma cyathigerum
Epallage fatime
Epitheca bimaculata
Gomphus simillimus
Gomphus vulgatissimus
Ischnura elegans
Ischnura genei
Lestes dryas
Lestes macrostigma
Lestes sponsa
Lestes virens
Libellula depressa
Libellula fulva
Libellula quadrimaculata
Lindenia tetraphylla
Onychogomphus uncatus
Ophiogomphus cecilia
Orthetrum albistylum
Orthetrum brunneum
Orthetrum taeniolatum
Orthetrum trinacria
Oxygastra curtisii
Pantala flavescens
Paragomphus genei
Platycnemis acutipennis
Platycnemis latipes
Pyrrhosoma nymphula
Selysiothemis nigra
Somatochlora alpestris
Somatochlora arctica
Somatochlora flavomaculata
Somatochlora meridionalis
Somatochlora metallica
Somatochlora sahlbergi
Stylurus flavipes
Sympecma fusca
Sympecma paedisca
Sympetrum danae
Sympetrum depressiusculum
Sympetrum flaveolum
Sympetrum fonscolombii
Sympetrum meridionale
Sympetrum pedemontanum
Sympetrum sanguineum
Sympetrum sinaiticum
Sympetrum striolatum
Sympetrum vulgatum
Trithemis annulata
Trithemis arteriosa
Trithemis festiva
Trithemis kirbyi
Zygonyx torridus
Decreasing: 60 species (49%)
Stable: 22 species (18%)
Increasing: 41 species (33%)
(Linear trend)

Results

grouping by trends (k-means)



Aeshna juncea
Coenagrion lunulatum
Coenagrion pulchellum
Gomphus pulchellus
Ischnura pumilio
Lestes sponsa
Pyrrhosoma nymphula
Sympetrum danae
Sympetrum vulgatum

Aeshna subarctica
Gomphus graslinii / simillimus / vulgatissimus
Leucorrhinia dubia / rubicunda
Coenagrion puella, Ischnura elegans...

Aeshna caerulea / crenata / serrata / viridis
Lestes barbarus
Cordulegaster bidentata / boltonii / heros...

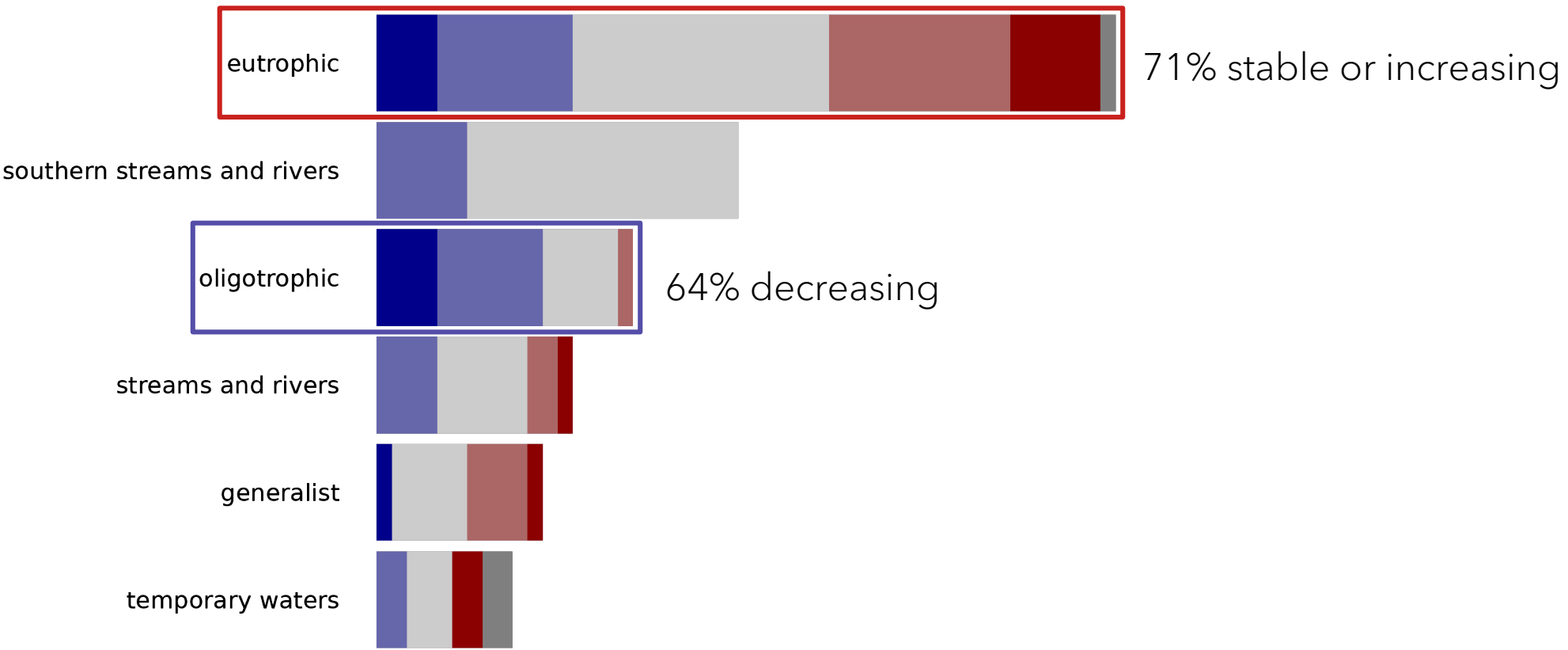
Aeshna cyanea / isosceles / mixta
Anax imperator
Leucorrhinia albifrons / caudalis / pectoralis
Orthetrum albistylum / cancellatum / brunneum...

Aeshna affinis
Anax parthenope
Calopteryx virgo
Coenagrion scitulum
Crocothemis erythraea

Libellula fulva
Sympecma fusca
Sympetrum meridionale
Sympetrum striolatum
Trithemis annulata

Anax ephippiger
Sympetrum flaveolum
Sympetrum fonscolombii

Results *link with habitat*



Discussion



Drawings: Lisa Nicvert
(CC-BY 4.0)

How are dragonflies doing?

- 49% declining | 18% stable | 33% increasing
- Oligotrophic ≠ eutrophic species
- Most declines accelerated from 2018

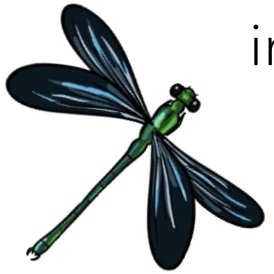
Perspectives

- Improve the model (less biases)
- Improve monitoring in Europe

Drawings: Lisa Nicvert
(CC-BY 4.0)



Thank you for your attention!



Thank you to all organizations and volunteers involved in data collection across Europe

DRAGON form

Lisa Nicvert
lisa.nicvert@fondationbiodiversite.fr

DRAGON consortium

References

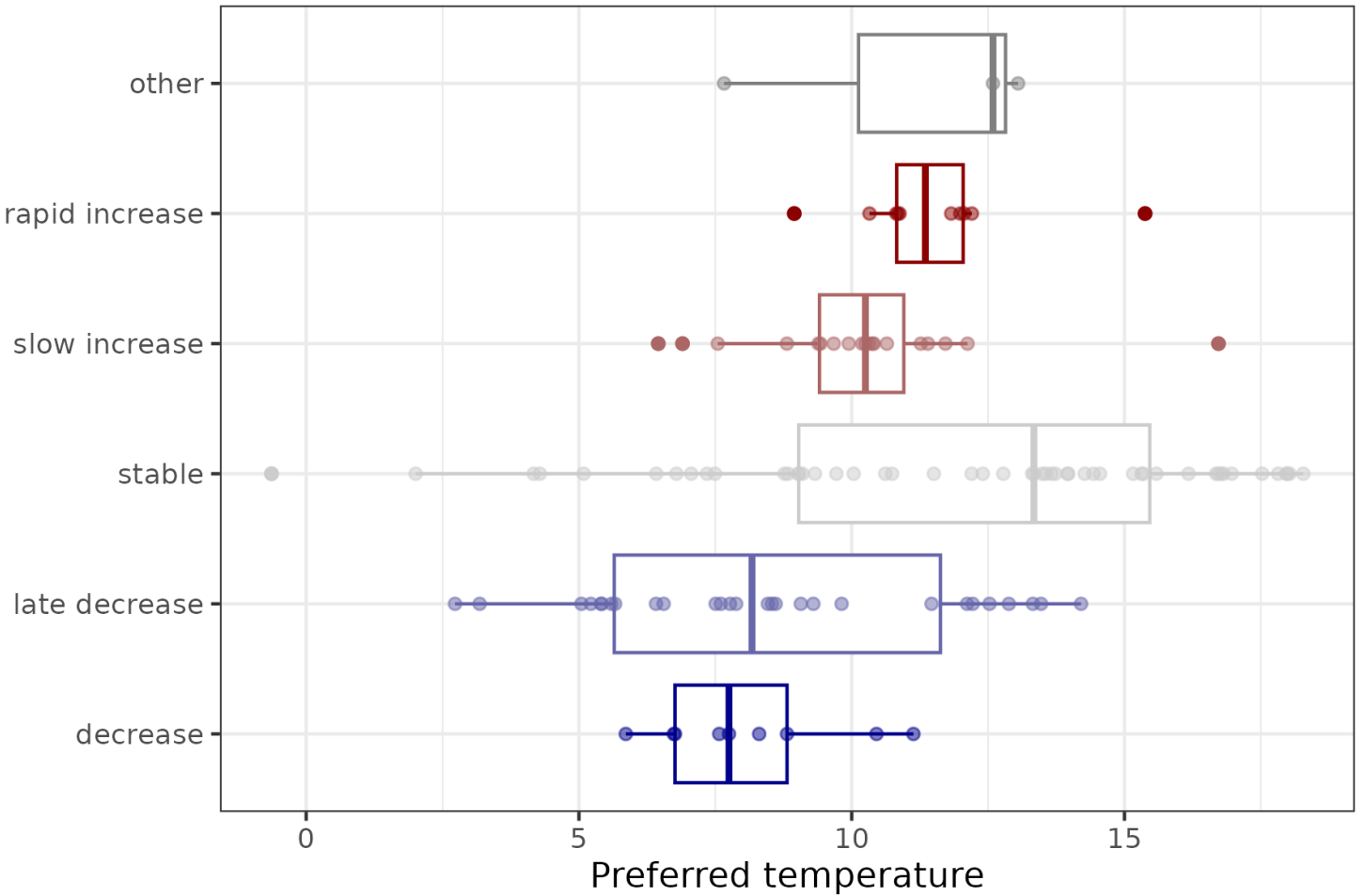
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Link between trend type and preferred temperature



Hotspots of change

- Decreasing in Northern Europe
- Increasing in Southern Europe

