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Algorithmic vs. expert-based

species distribution models

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Algorithmic vs. expert-based species distribution models

A critical comparison using citizen science

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4 - School of Zoology, George S. Wise Faculty of Life Sciences, Tel Aviv University

5 – Israeli Lepidopterists Society, 4 D MicroRobotics

6 – GlueCAD-Biodiversity IT, BMS-IL web-portal

7 – Achva Academic College

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Introduction

- Biodiversity crisis
- Species distribution models

  - Describe distributions and their trends
  - Study environmental impacts on distribution
  - Predict distribution patterns based on environmental scenarios
  - Recommend policy for conservation

Large Wall Brown (*Lasiommata maera*)

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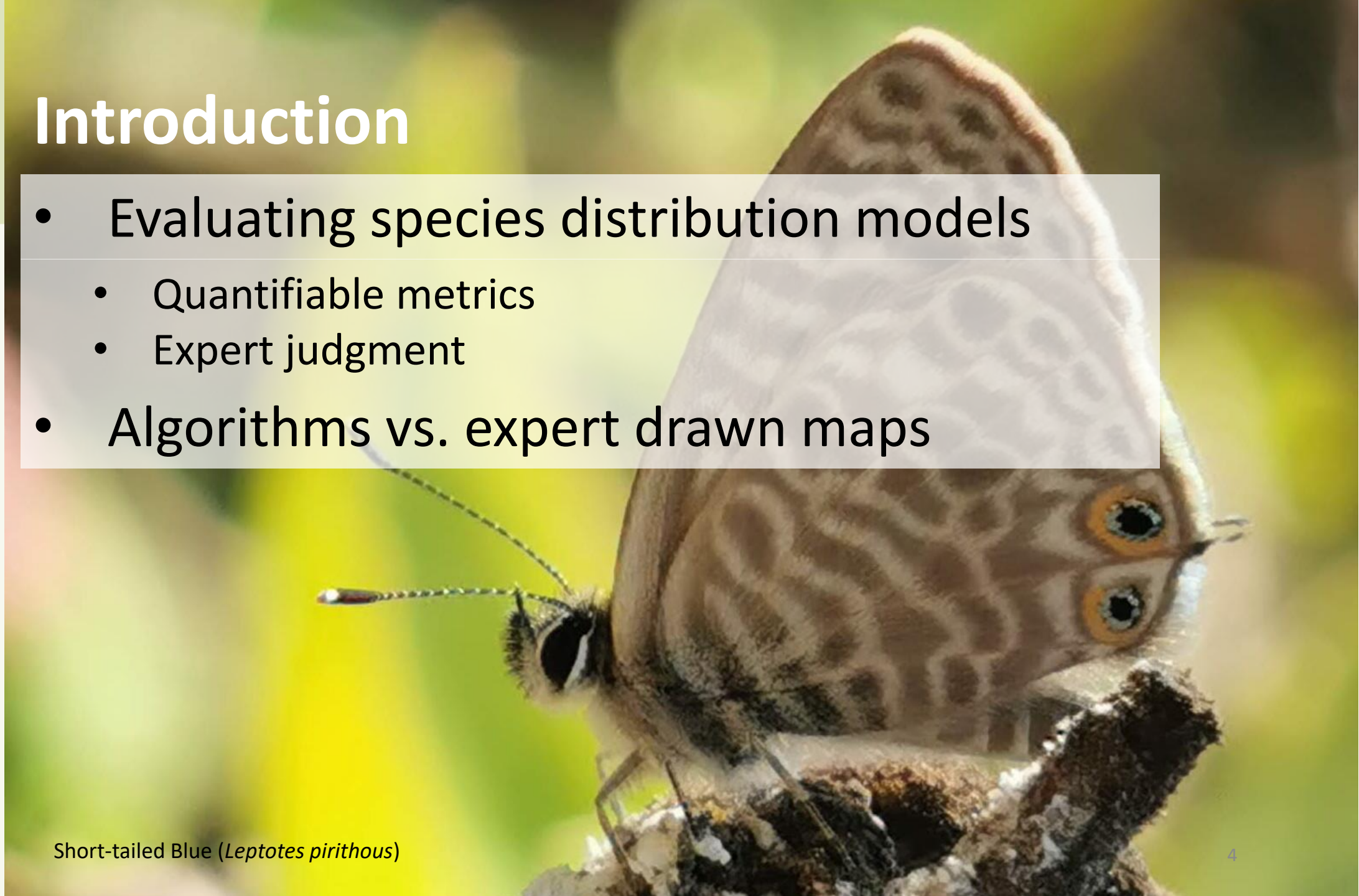
Introduction

- Evaluating species distribution models
  - Quantifiable metrics
  - Expert judgment
- Algorithms vs. expert drawn maps



Short-tailed Blue (*Leptotes pirithous*)

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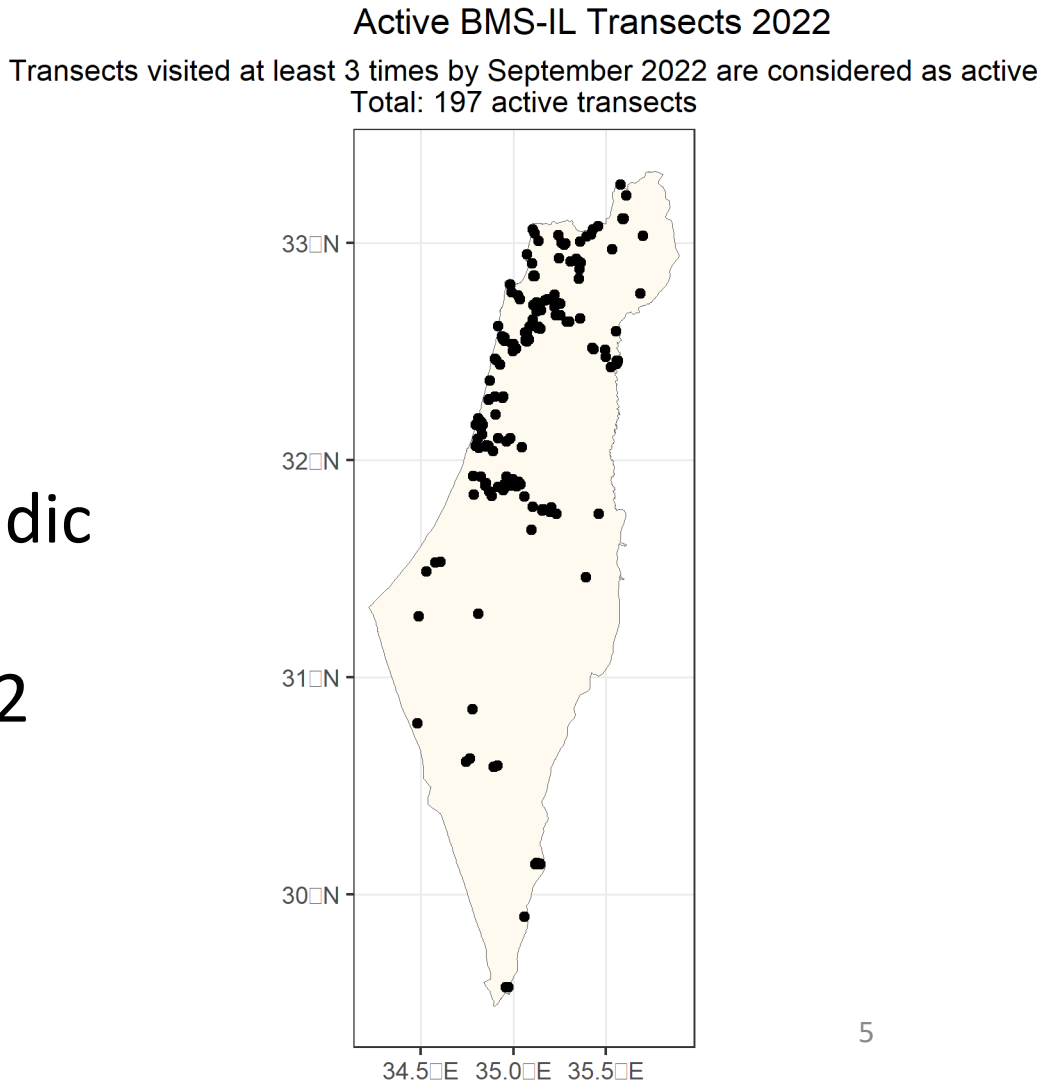
Introduction

- Israeli Butterfly Monitoring Scheme (BMS-IL)
  - Citizen Science
  - Founded in 2009
  - Pollard transects and sporadic observations
  - 197 active transects in 2022



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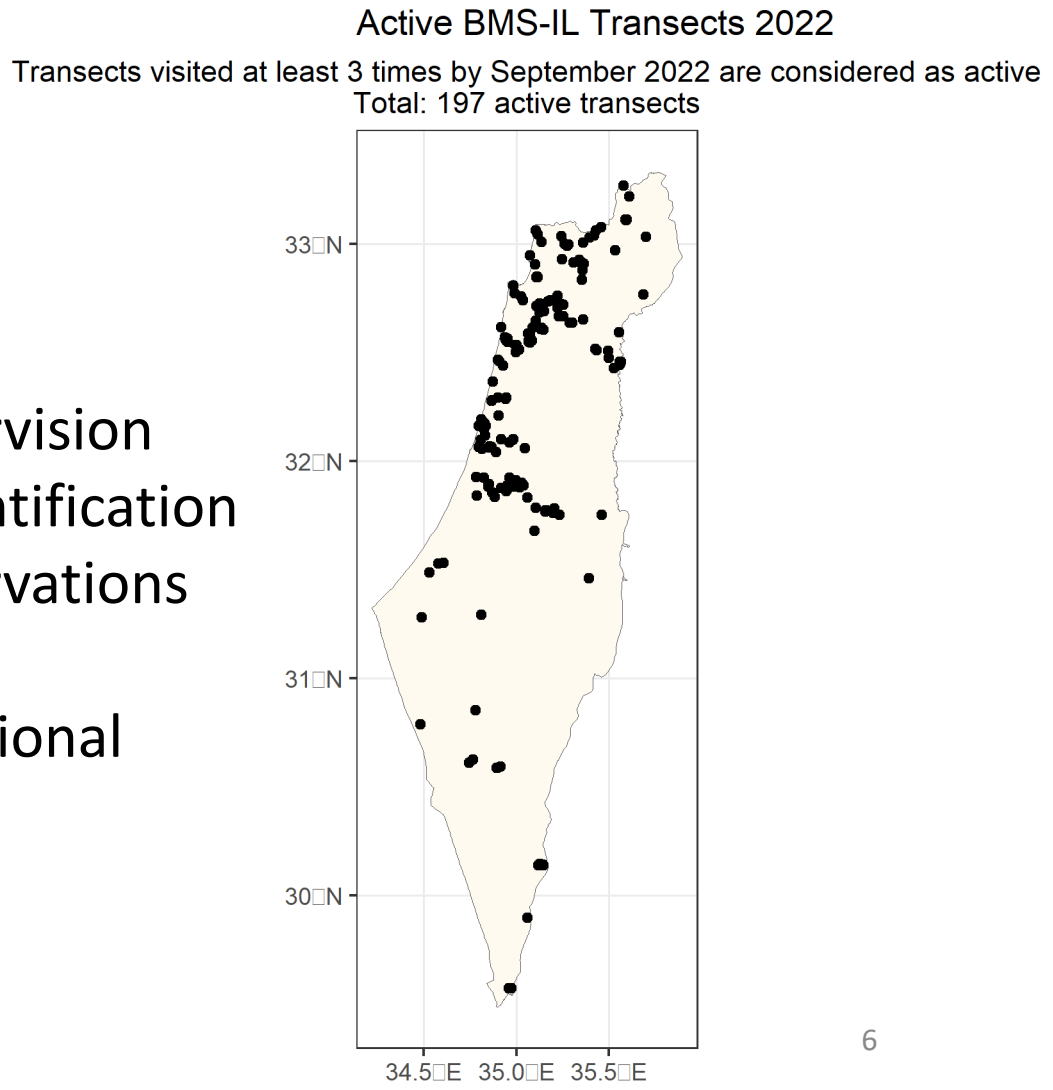
Introduction

- Israeli Butterfly Monitoring Scheme (BMS-IL)
  - Data quality control tools
    - Volunteer training and supervision
    - Photographs for species identification
    - Automatic exceptional observations detection
    - Expert assessment of exceptional observations



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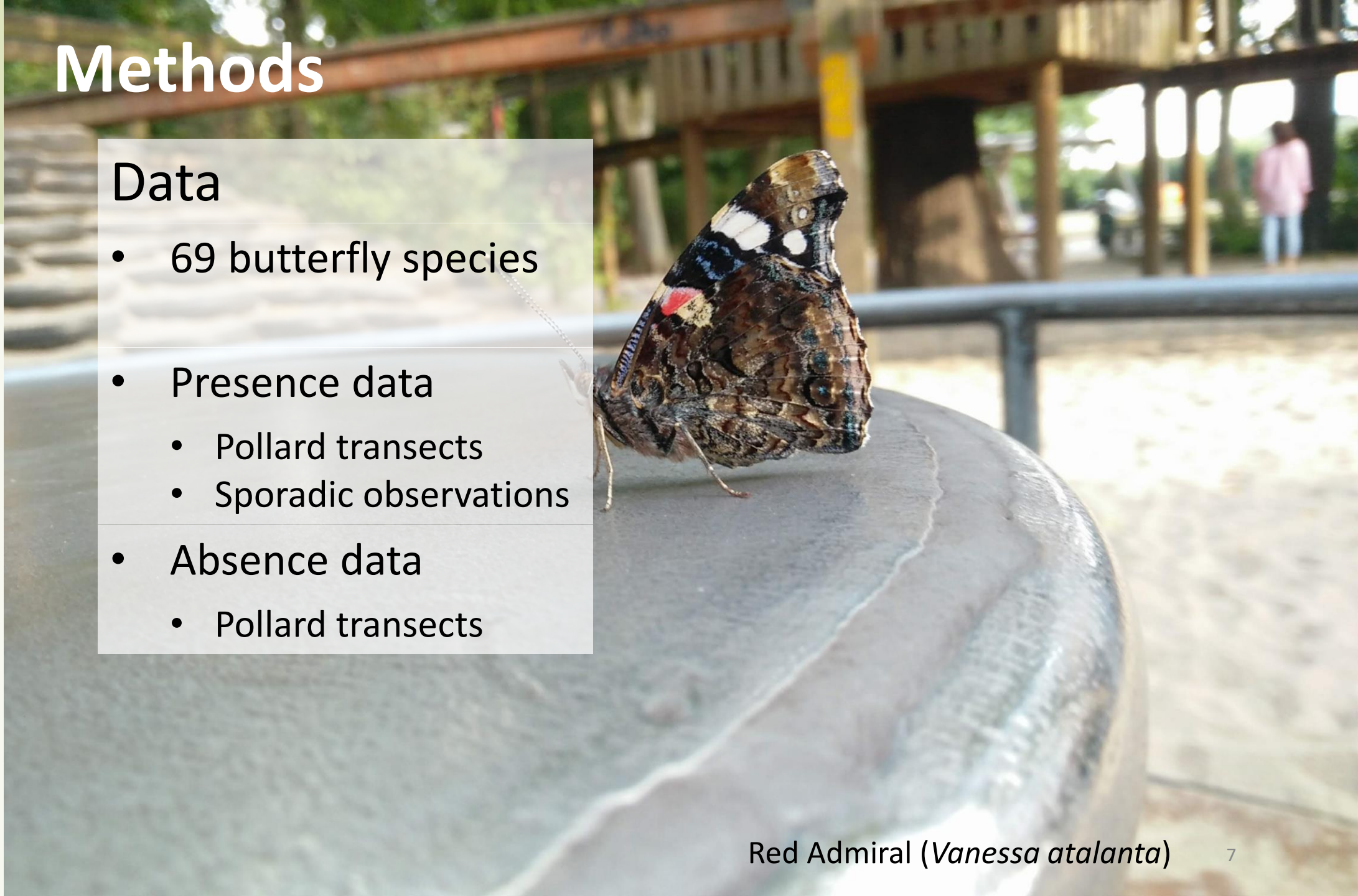
Methods

Data

- 69 butterfly species
- Presence data
  - Pollard transects
  - Sporadic observations
- Absence data
  - Pollard transects



Red Admiral (*Vanessa atalanta*)

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Methods

Species Distributions

- Species distribution models (SDMs)
  - 20 algorithms from the literature
  - Geographic (environmentally naïve) model
- Expert drawn maps
- Ensemble models

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Bladder-Senna Blue (*Iolana alfierii*)

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Methods

Map evaluation

- Performance metrics
  - Sensitivity = true positive rate
  - Specificity = true negative rate
  - True Statistical Skill (TSS) = Sensitivity + Specificity – 1

Min: (-1); Max: +1

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Plain Tiger (*Danaus chrysippus*)

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Methods

Map evaluation

- Example:
- 10 presence cells ⟶ Model correctly identified 8 presence cells
  - Sensitivity = $\frac{Presences\ found}{All\ presences} = \frac{8}{10} = 0.8$
- 10 absence cells ⟶ Model correctly identified 6 absence cells
  - Specificity = $\frac{Absences\ found}{All\ absences} = \frac{6}{10} = 0.6$

- True Statistical Skill (TSS) = 0.8 + 0.6 – 1 = 1.4 – 1 = 0.4

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Glanville Fritillary (*Melitaea cinxia*)

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Methods

Map evaluation

- Compare 2 best performing models and an expert drawn map
- Independent expert map evaluation
  - Which map is the best and why?

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Lesser Fiery Copper (*Lycaena thersamon*)

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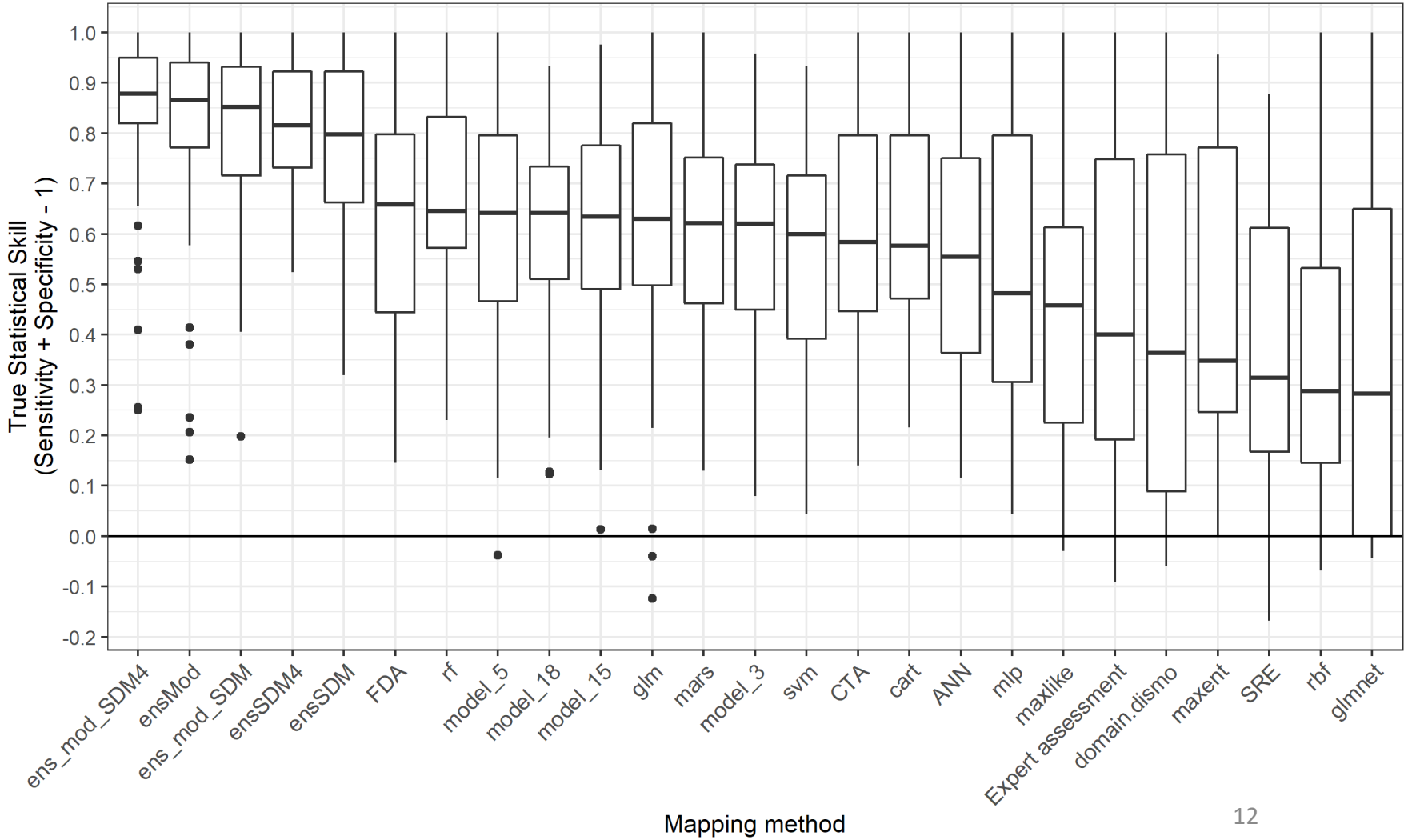
Results

Best performing models

Ensemble models



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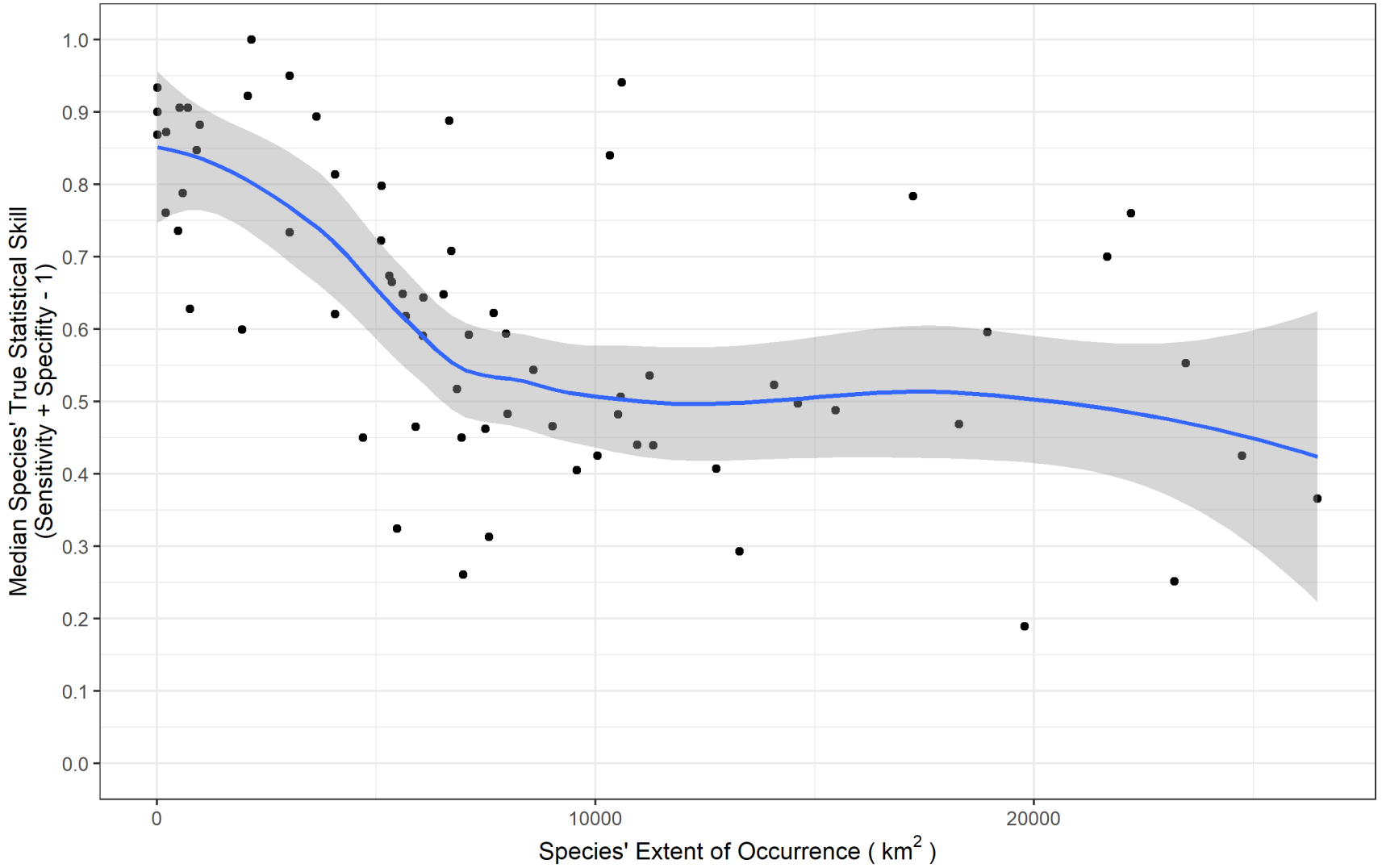
Results

Restricted distributions are easier to model



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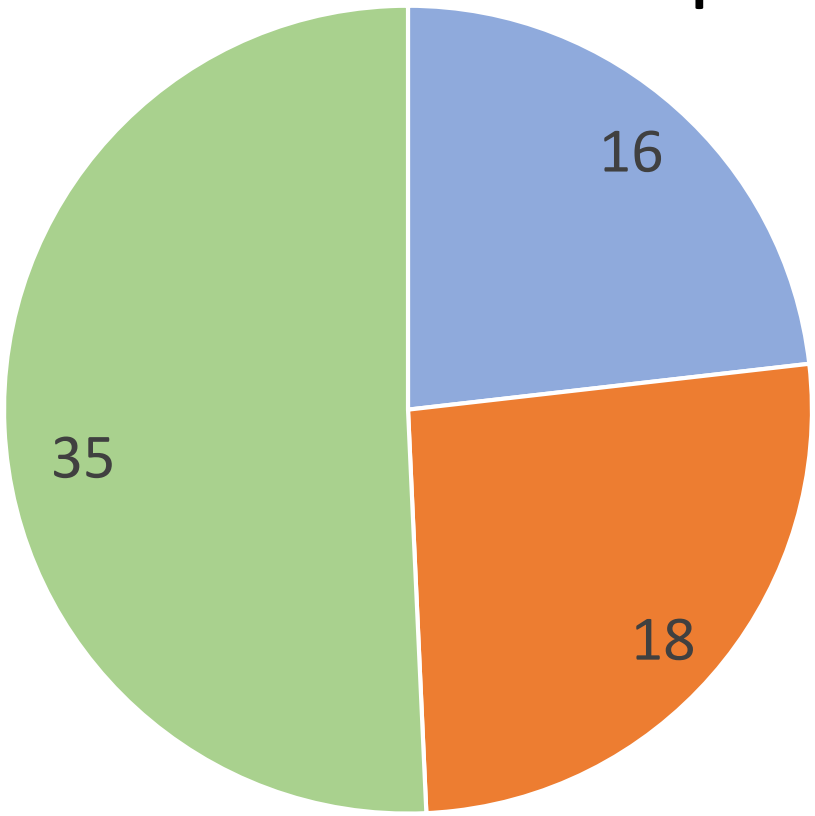
Results

Experts favored hand-drawn maps



No. of species by mapping method

- Ensemble of the 4 best SDMs
- Ensemble of the 4 best geographical models and SDMs
- Expert Assessment

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Results

Desert Babul Blue (*Azanus ubaldus*)
Photo: Yaron Mishan

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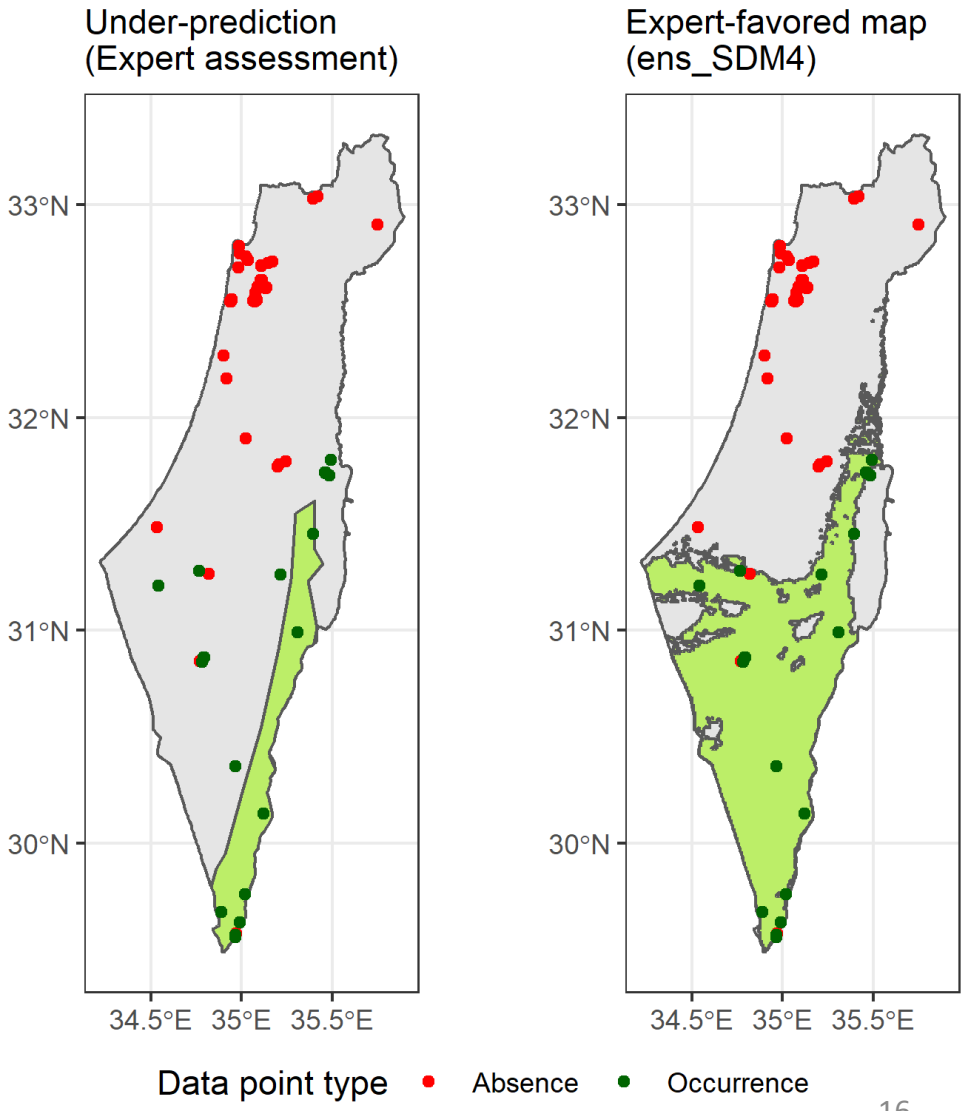
Results

Expert criticism

- Under-prediction
  - Species' host plant was planted outsides its original range

Azanus ubaldus



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Results

Eastern Festoon (*Allancastria cerisyi*)
Photo: Yaron Mishan

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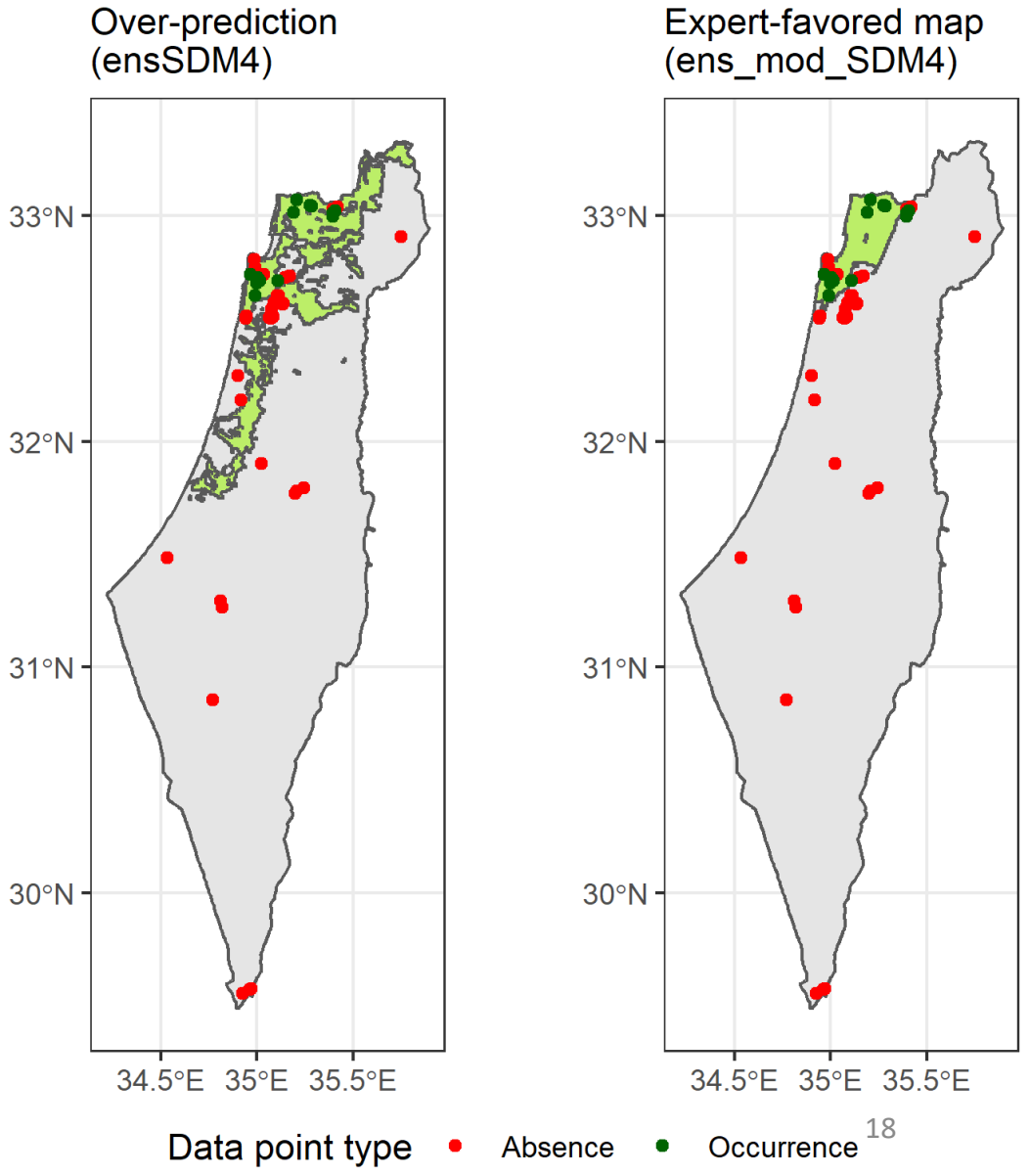
Results

Expert criticism

- Over-prediction
  - Due to deduction based on environmental variables

Allancastria cerisyi



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Results

Dappled White (*Euchloe ausonia*)
Photo: Yaron Mishan

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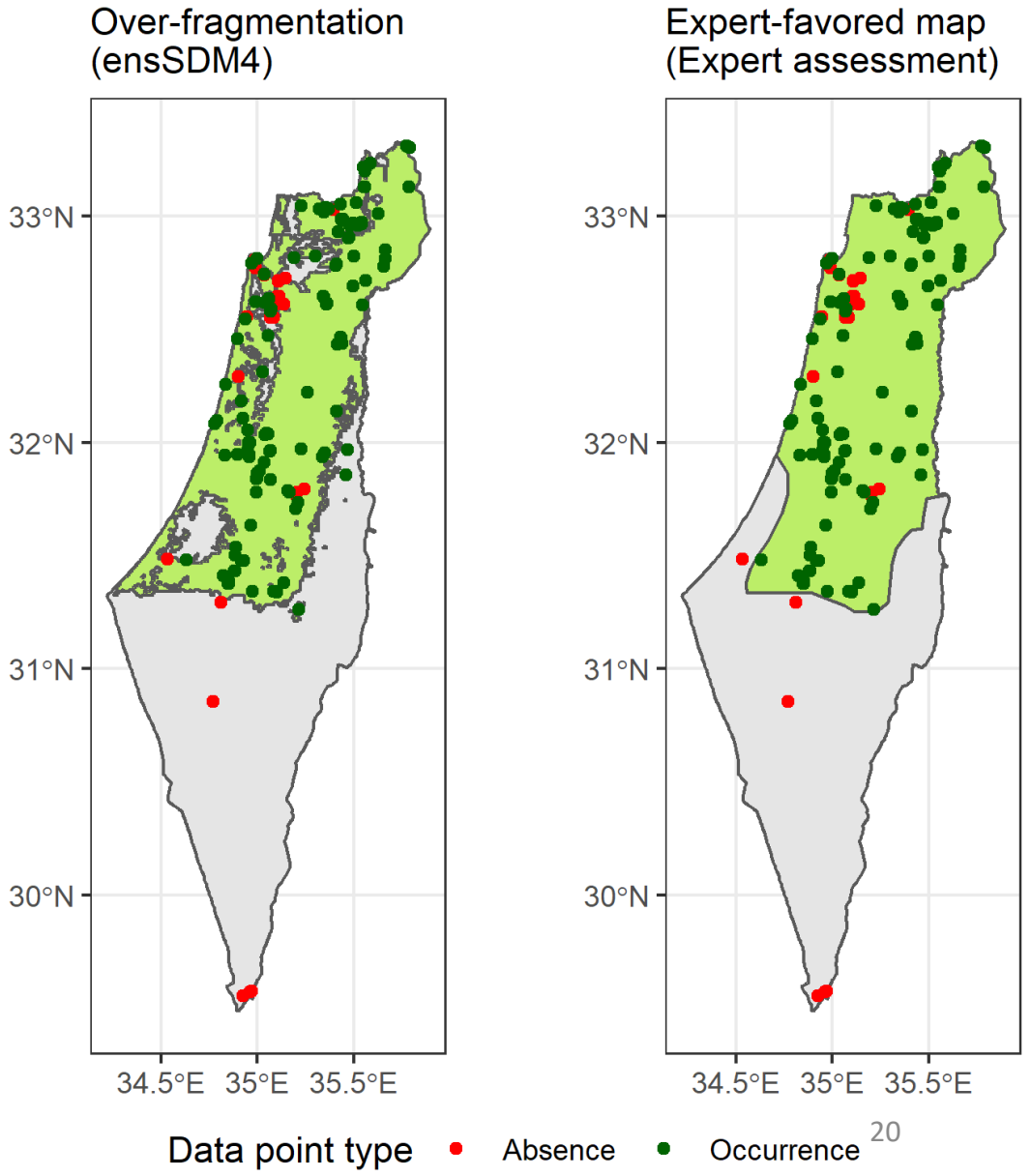
Results

Expert criticism

- Over-fragmentation
  - Due to absences surrounded by presences

Euchloe ausonia



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Discussion

Algorithms

Ensemble models had the best performance
Environmentally naïve models performed well
Not prone for over or under prediction
Over-fragmentation

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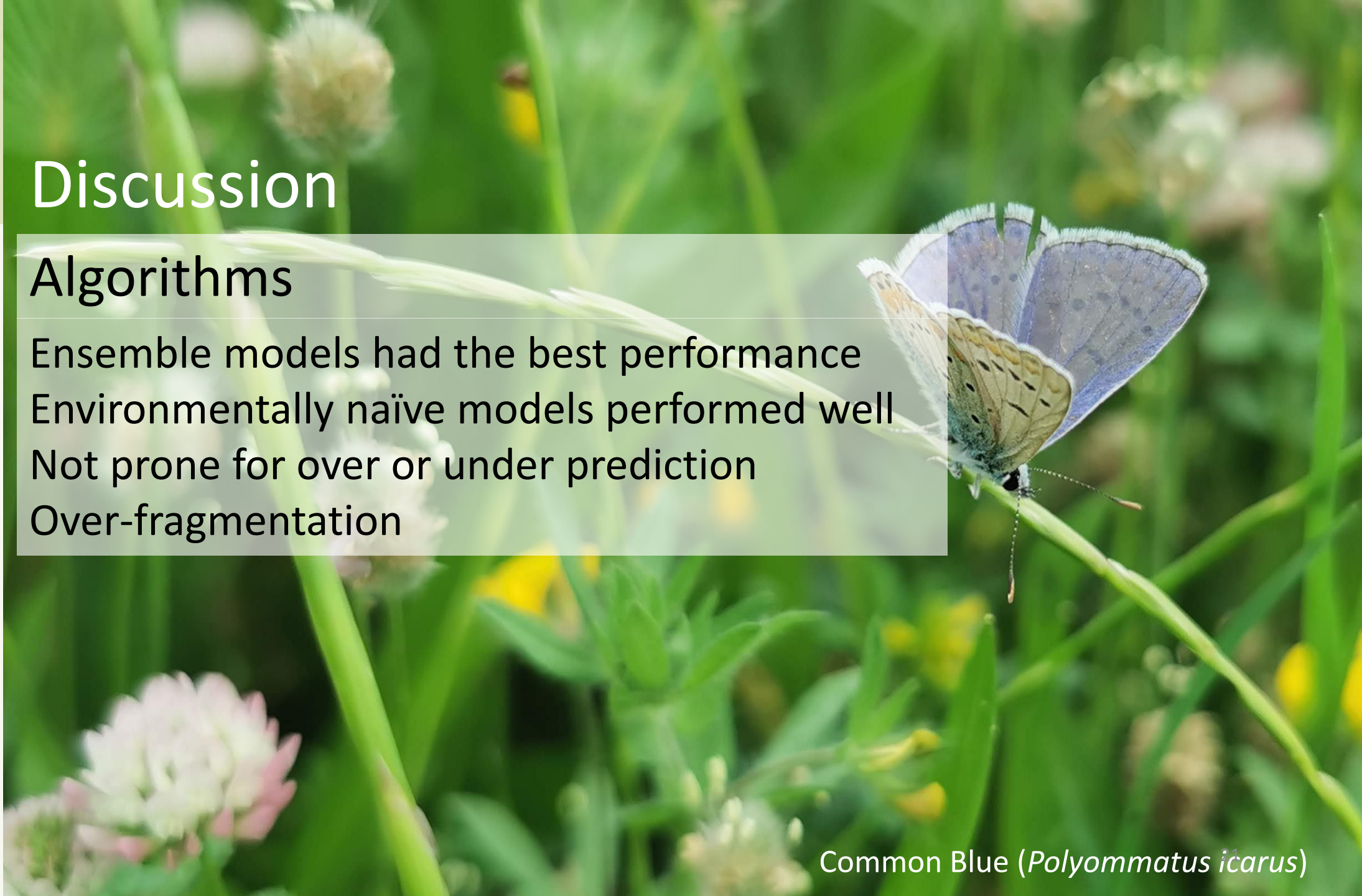

Common Blue (*Polyommatus icarus*)

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Discussion

Expert drawn maps

Experts emphasized sensitivity over specificity

Expert drawn maps are never over-fragmented

Levantine Silverline
(*Apharitis cilissa*)

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Discussion

A way forward?

Simple algorithms offer a starting point

Experts can improve algorithms' results

Cardinal
(*Argynnis pandora*)

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Caper White
(*Anaphaeis aurota*)

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Questions?

Swallowtail (*Papilio machaon*)

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