Species distribution modelling in native and invasive ranges and the use of traits to predict species invasion potential?

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Chaetophiloscia sicula , native to Europe and introduced into North America
Picture: Spinicornis - Gert Arijs

Modeling invasive soil fauna

- Invasive species listed as major threat to biodiversity
- Predicting their spread remains a major challenge
- Species distribution models (SDM's) using high resolution distribution data
- Collection of large scale distribution data on soil fauna is challenging
  - ➔ Soil as a black box
  - ➔ Taxa are often diverse, small in size, high abundances and poorly known taxonomy
- Soil fauna distribution models of limited spatial extent and/or low spatial resolution





Urgent need for accurate models

Strong impacts on biodiversity and ecosystem functioning

The second wave of earthworm invasions in North America: biology, environmental impacts, management and control of invasive jumping worms

Chih-Han Chang · Marie L. C. Bartz · George Brown · Mac A. Callaham Jr. · Erin K. Cameron · Andrea Dávalos · Annise Dobson · Josef H. Görres · Bradley M. Herrick · Hiroshi Ikeda · Samuel W. James · Marie R. Johnston · Timothy S. McCay · Damhnait McHugh · Yukio Minamiya · Maryam Nouri-Aiin · Marta Novo · Jaime Ortiz-Pachar · Rebecca A. Pinder · Tami Ransom · Justin B. Richardson · Bruce A. Snyder · Katalin Szlavecz

Biol Invasions (2021) 23:3291–332

Earthworm invasion shifts trophic niches of ground-dwelling invertebrates in a North American forest

Olga Ferlian [a,b,*], Simone Cesarz [a,b], Alfred Lochner [a,b], Anton Potapov [c], Lise Thouvenot [a,b], Nico Eisenhauer [a,b]

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[b] Institute of Biology, Leipzig University, Puschstrasse 4, 04103, Leipzig, Germany
[c] J.F. Blumenbach Institute of Zoology and Anthropology, University of Göttingen, Untere Karspüle 2, 37073, Göttingen, Germany

Soil Biol Biochem (2022) 171:108730

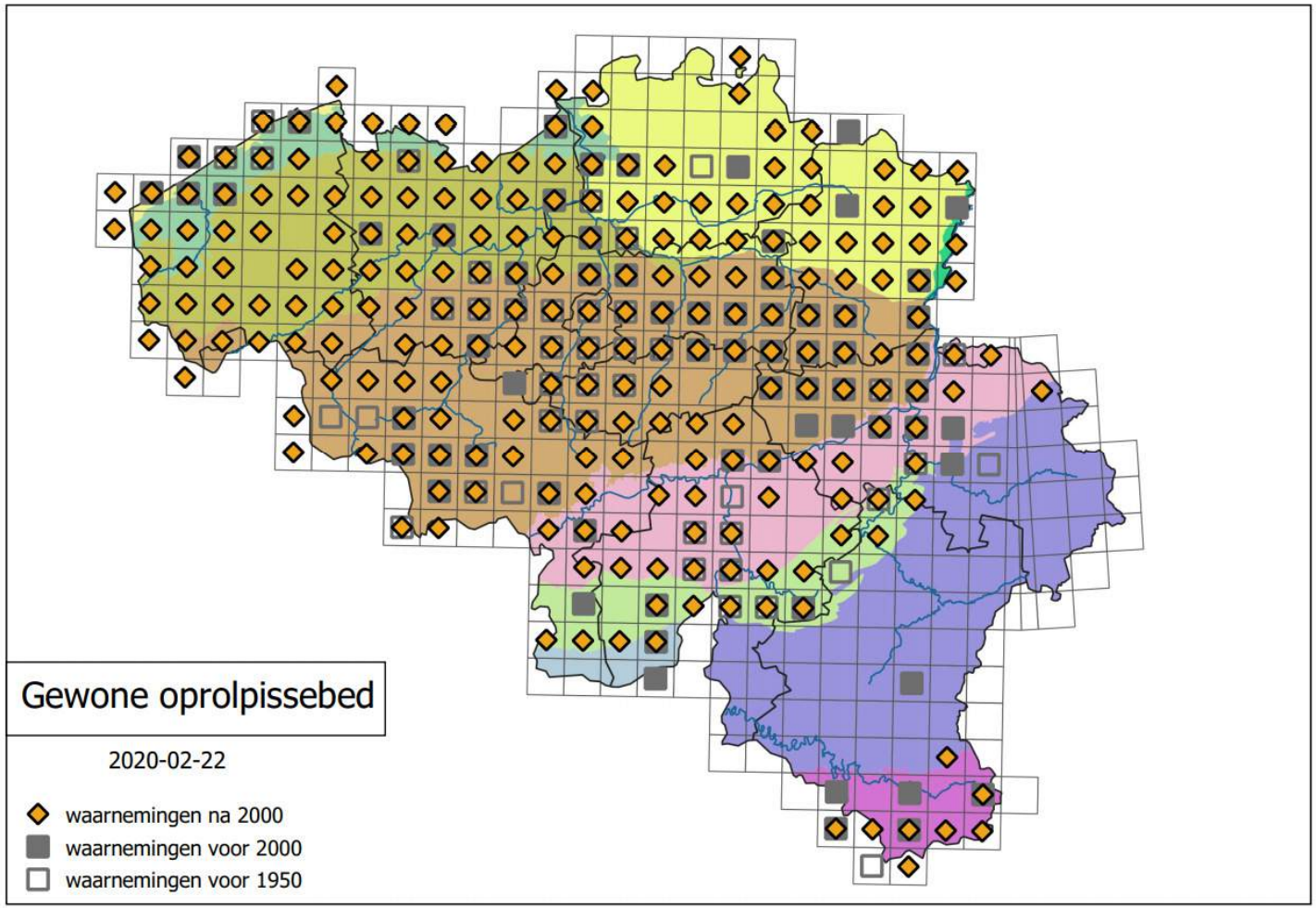
Need for well-studied taxa as model to predict soil fauna invasions!

Terrestrial isopods as models

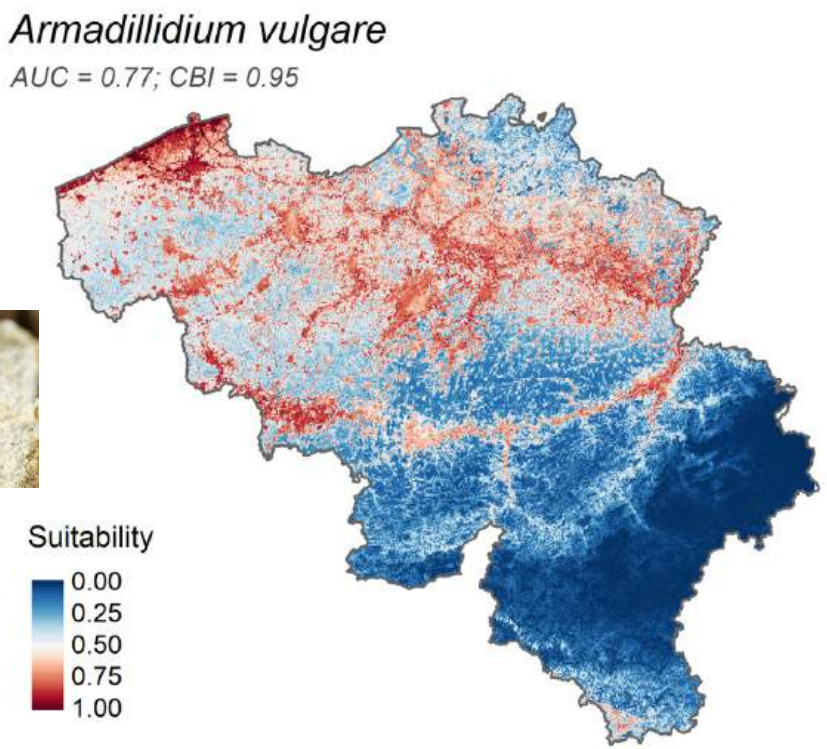
- Large proportion of invasive **European** species in different parts of the world
- They are large, taxonomically and ecologically relatively well-known
- Show strong response to temperature and humidity
- Unintendedly and no active management!
- Citizen science data can actually be useful!

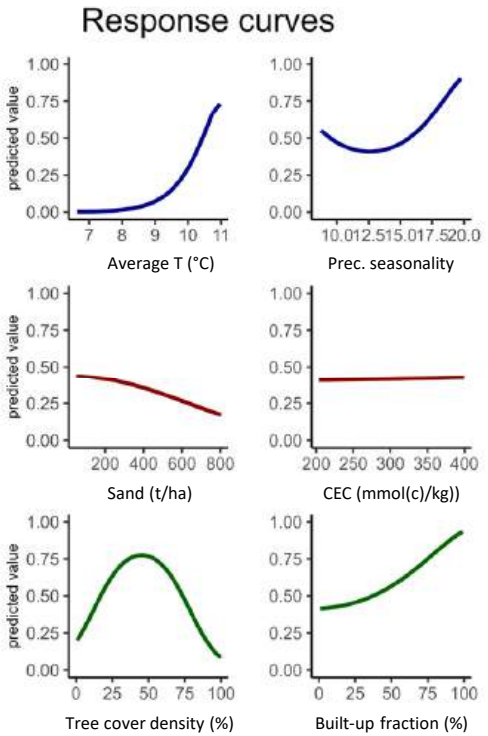
➔ Also for this taxon: distribution data is limited

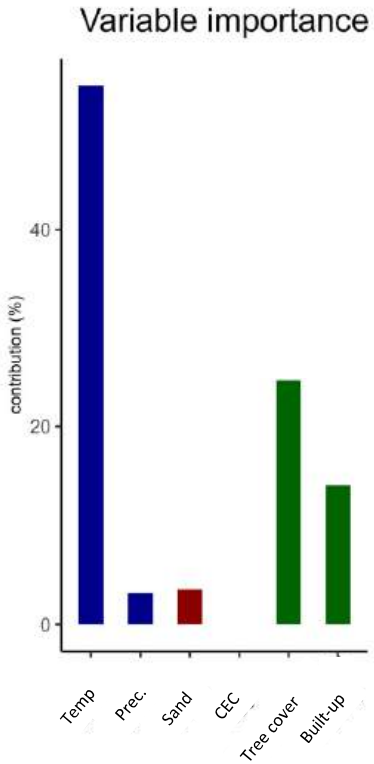
Armadillidium vulgare



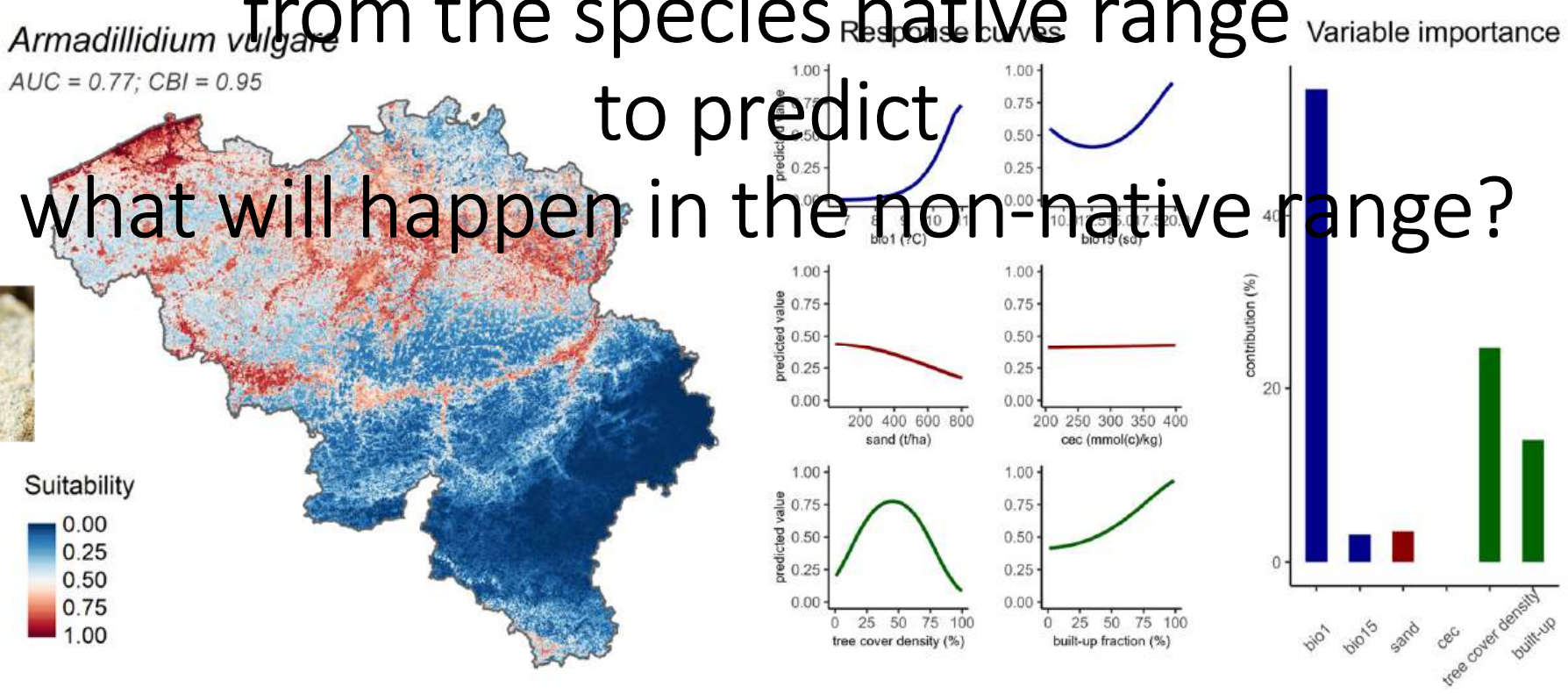
Species distribution models





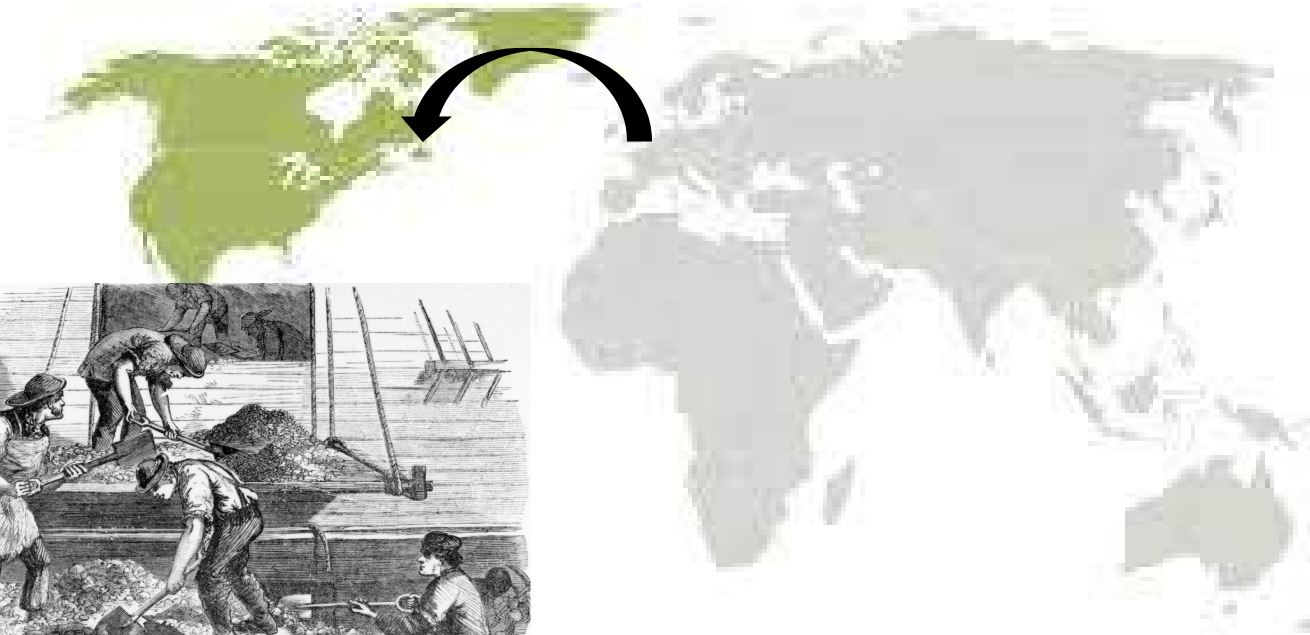


Use species distribution models from the species native range to predict what will happen in the non-native range?

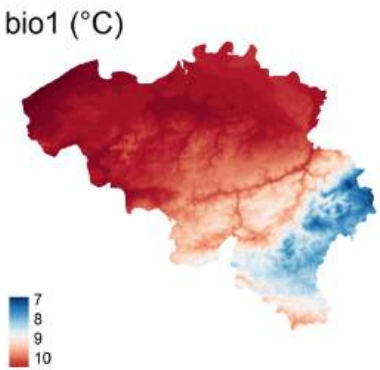


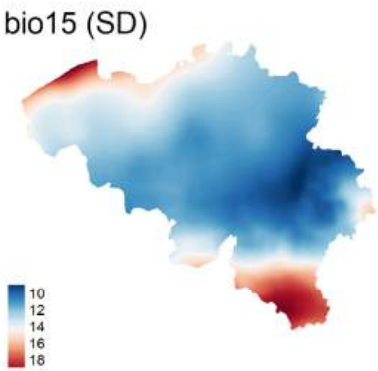
Using data from Belgium to predict distribution in non-native range? Case study in North-America

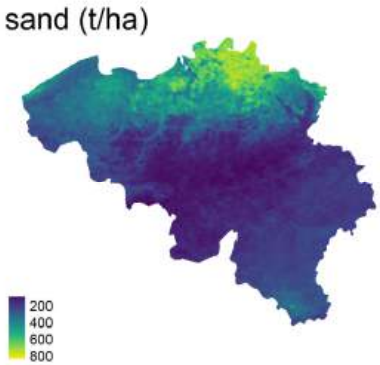
N-America is extremely species poor in terrestrial isopods.
Most species are introduced during colonial times.
Can we predict their distribution?

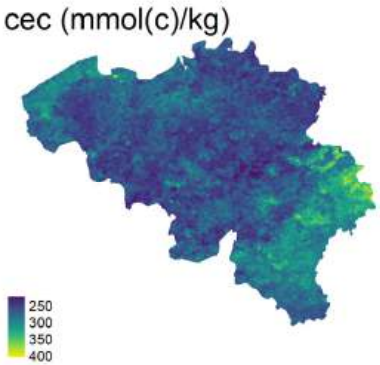


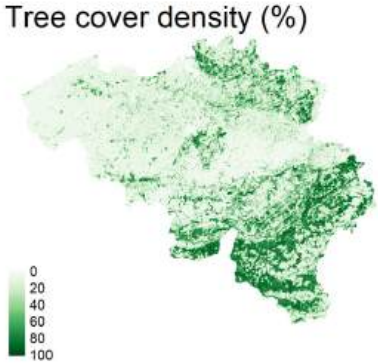
Maryland: the Belgium from the USA?

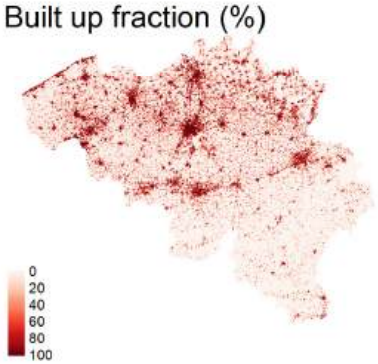

bio1 (°C)
7
8
9
10

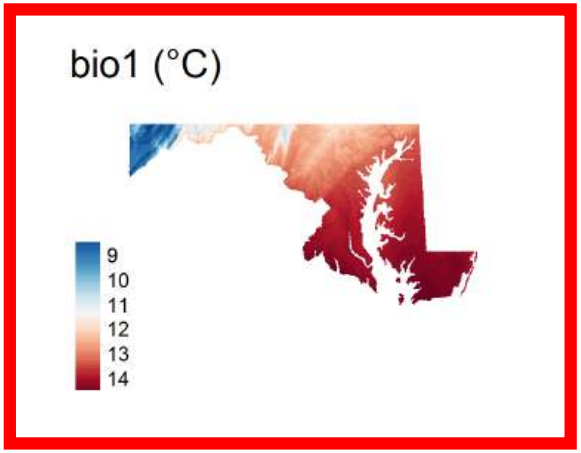

bio15 (SD)
10
12
14
16
18

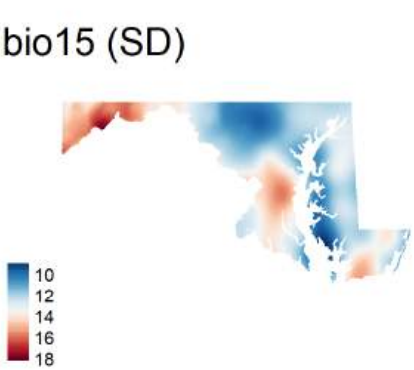

sand (t/ha)
200
400
600
800

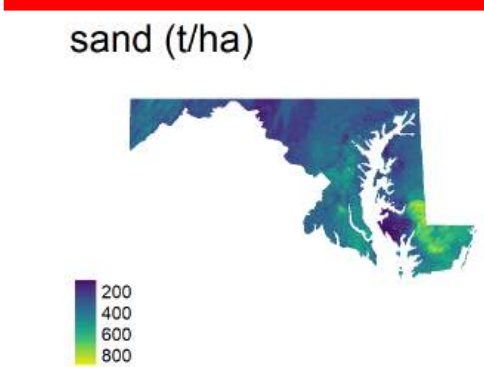

cec (mmol(c)/kg)
250
300
350
400

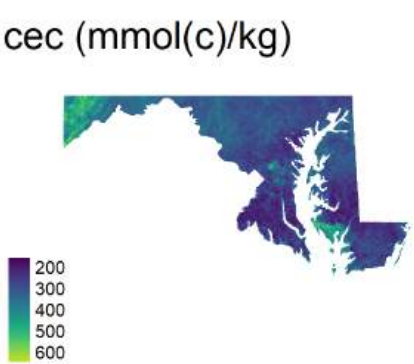

Tree cover density (%)
0
20
40
60
80
100

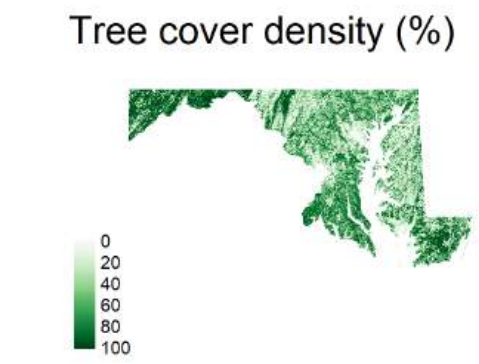

Built up fraction (%)
0
20
40
60
80
100

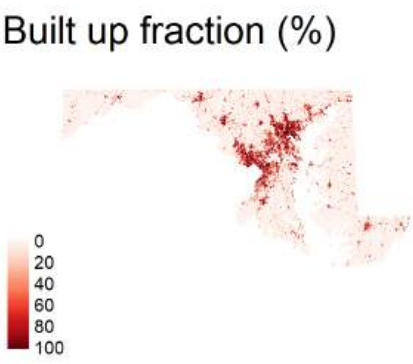

bio1 (°C)
9
10
11
12
13
14


bio15 (SD)
10
12
14
16
18

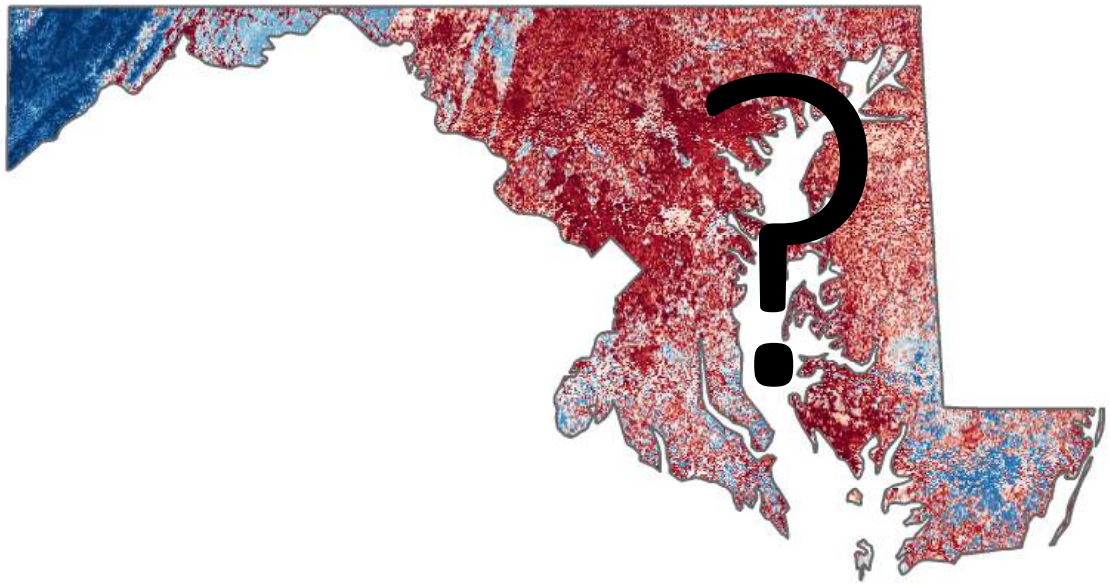

sand (t/ha)
200
400
600
800


cec (mmol(c)/kg)
200
300
400
500
600


Tree cover density (%)
0
20
40
60
80
100


Built up fraction (%)
0
20
40
60
80
100

Predicted distribution *A. vulgare* in Maryland based on Belgian records

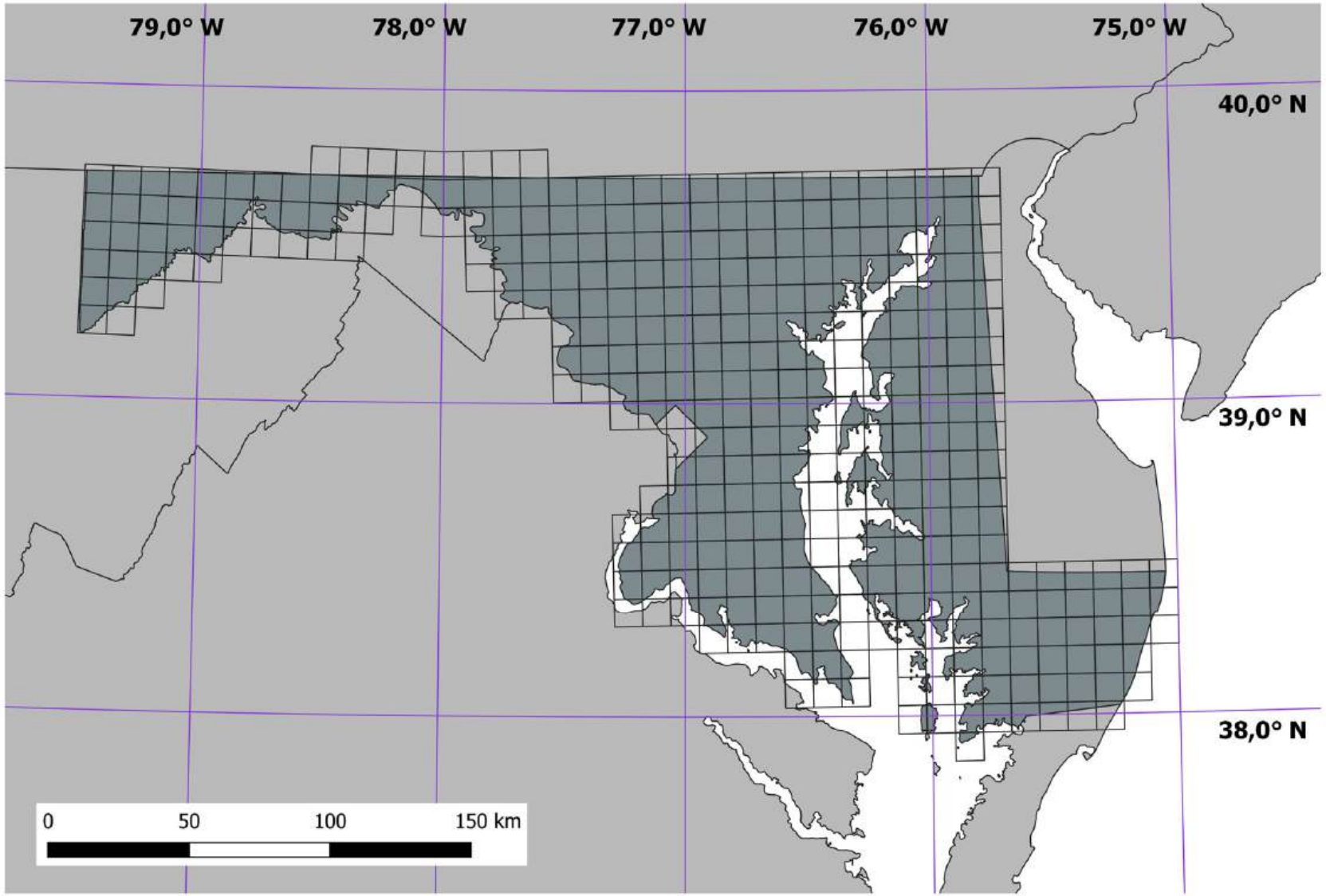


Suitability

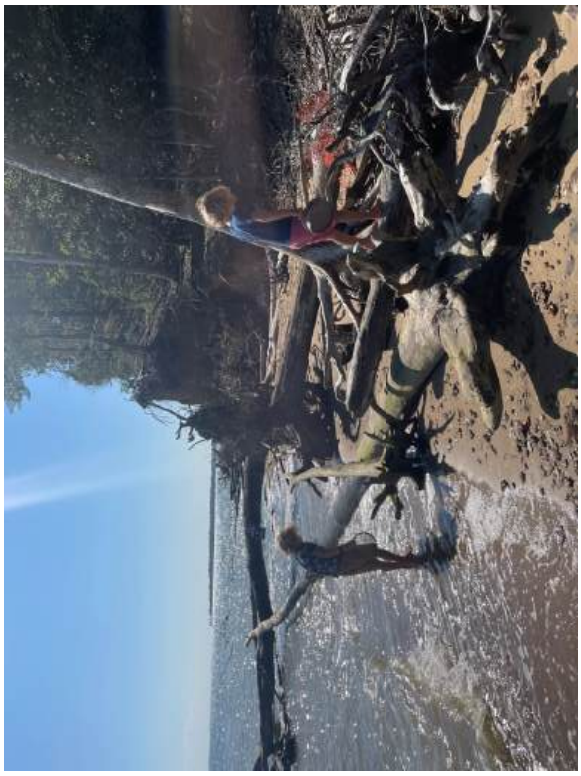
0.00
0.25
0.50
0.75
1.00

Almost no distribution data available…

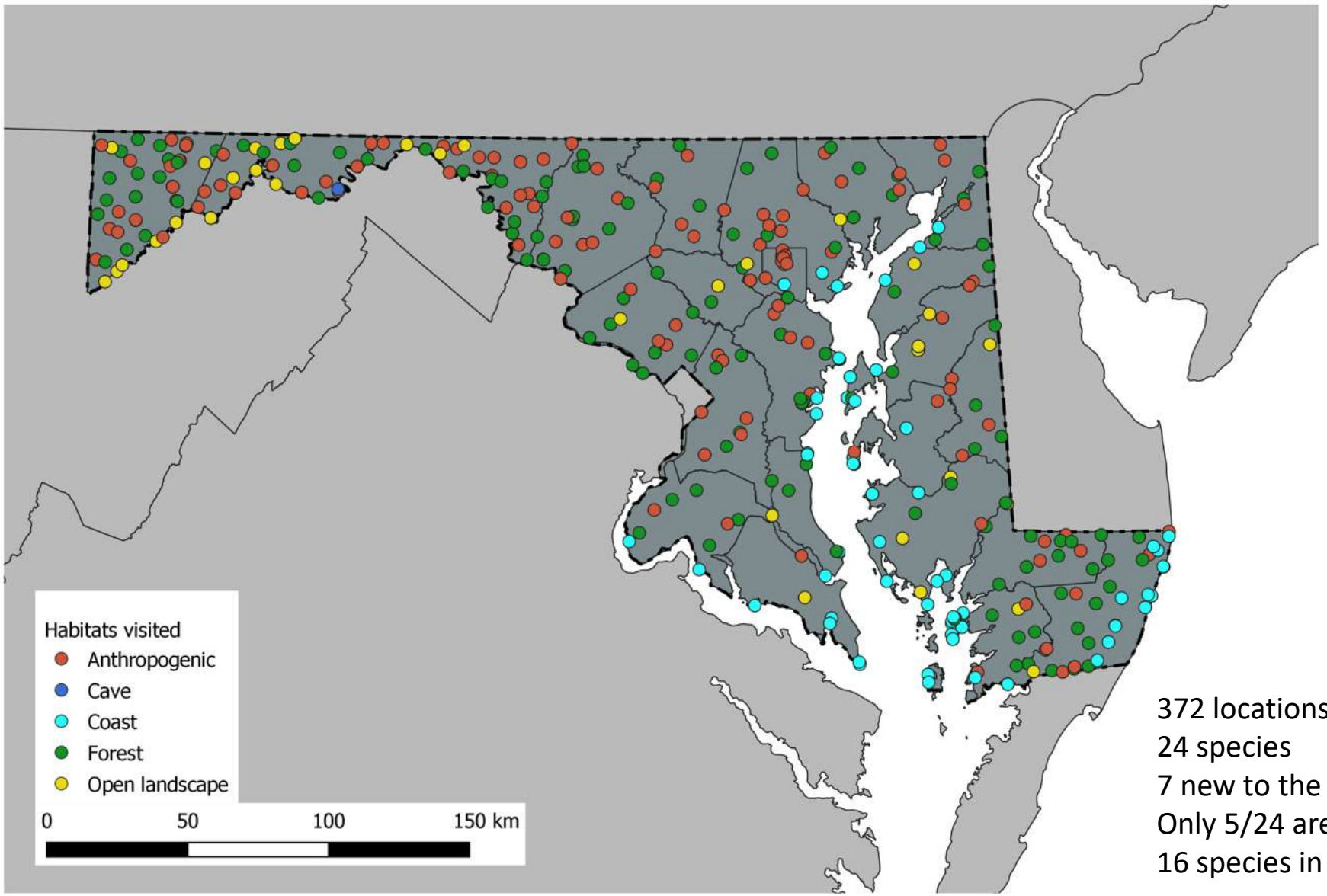
JOHNS HOPKINS
UNIVERSITY


79,0° W
78,0° W
77,0° W
76,0° W
75,0° W
40,0° N
39,0° N
38,0° N
0
50
100
150 km

Habitat types



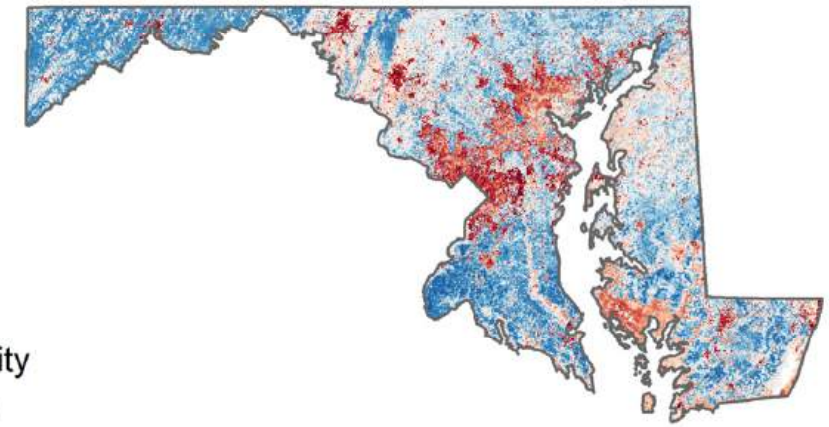




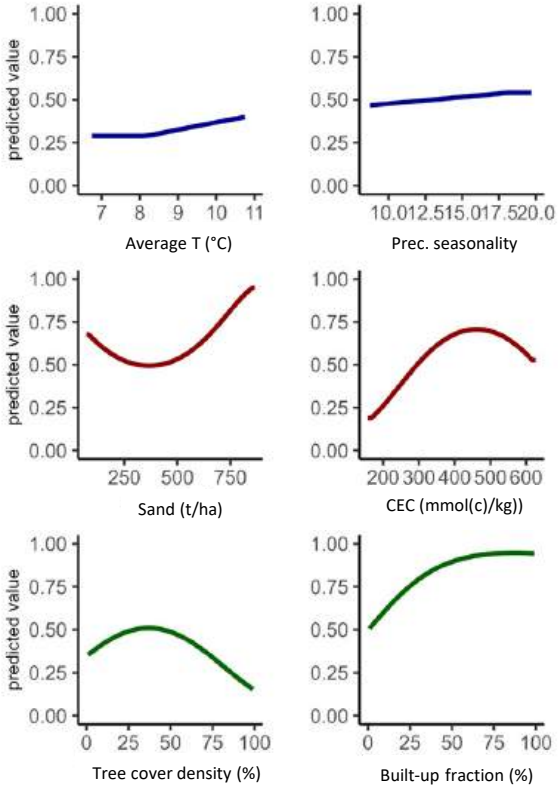
372 locations
24 species
7 new to the state
Only 5/24 are native
16 species in common with Belgium

Armadillidium vulgare

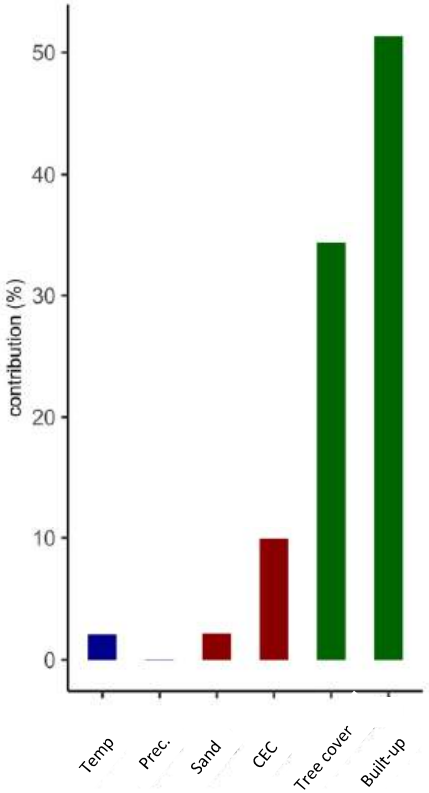
N = 108; AUC = 0.7; CBI = 0.72



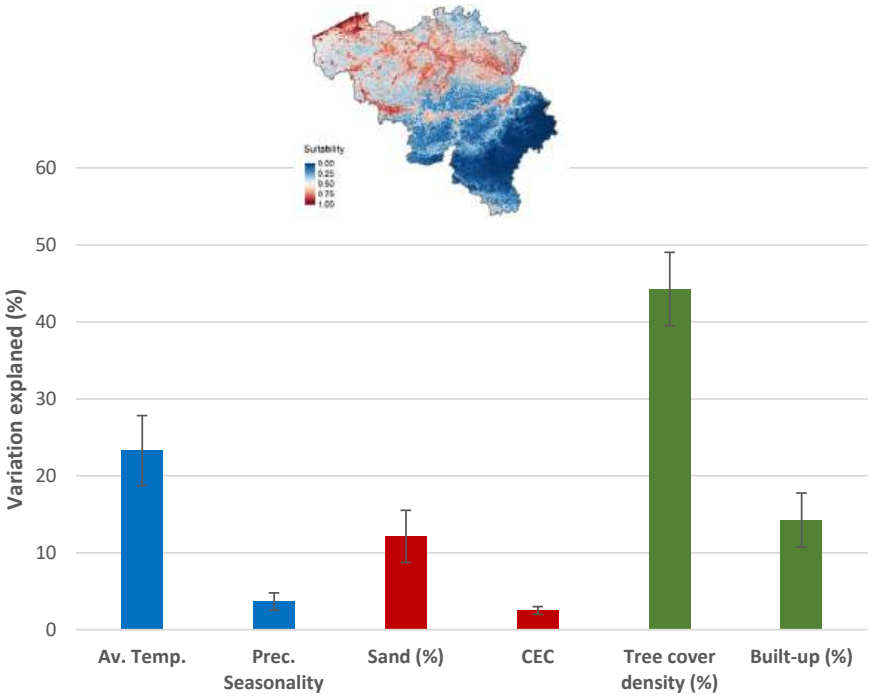
Response curves



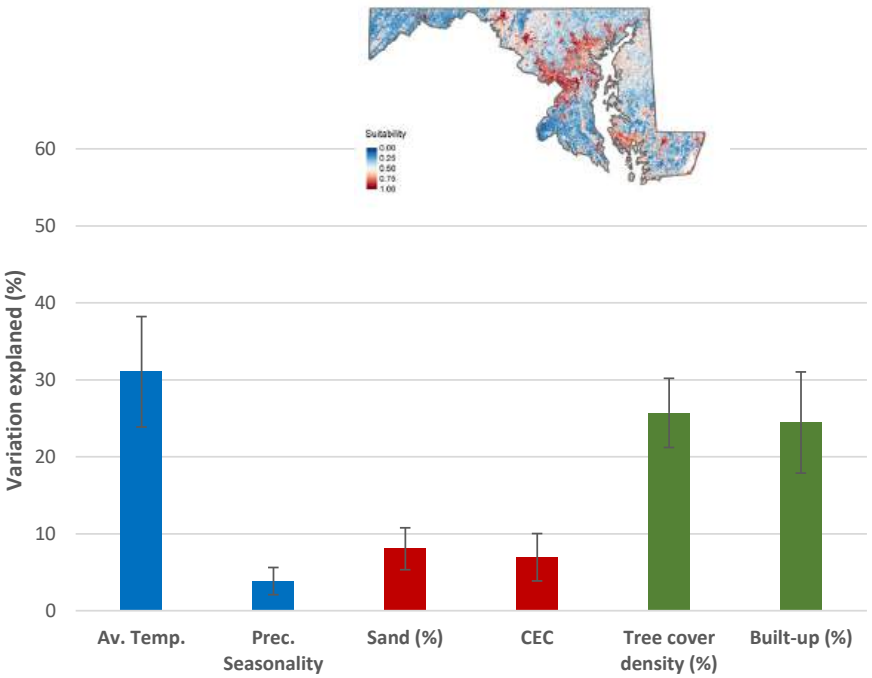
Variable importance



Variable importance

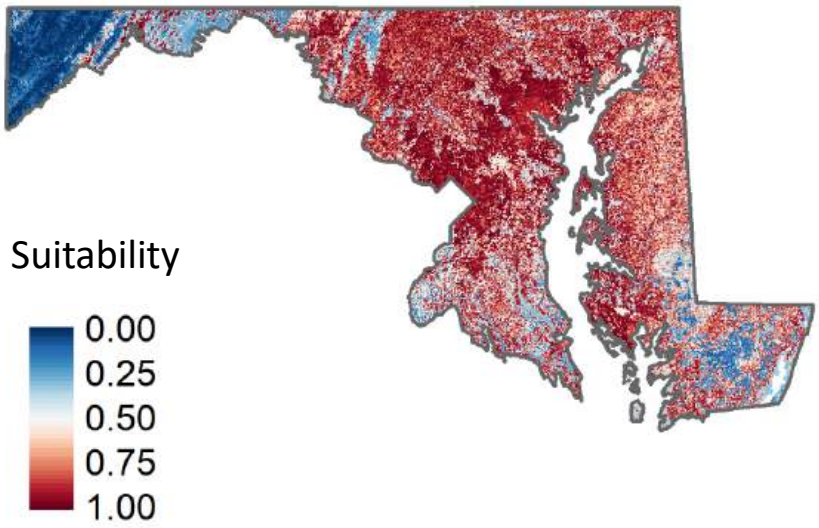


Average explained variation (± SE) of the SDM's of the 26 most common (> 10 observations) species in Belgium



Average explained variation (± SE) of the SDM's of the 14 most common (> 10 observations) species in Maryland, US

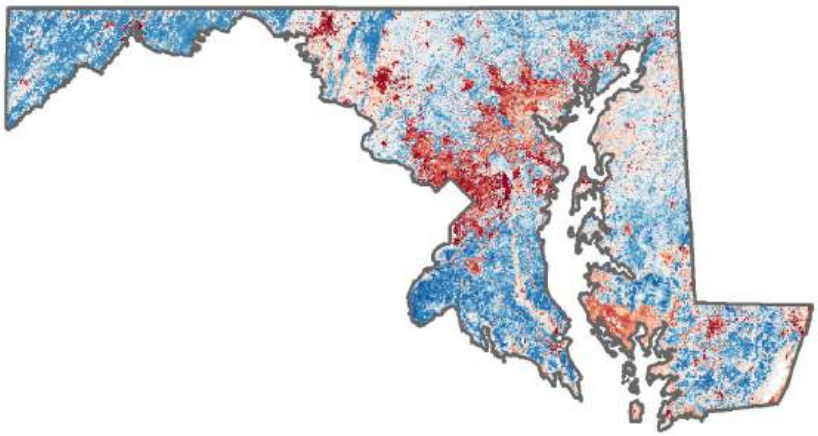
Predictions native range SDM



Suitability

0.00
0.25
0.50
0.75
1.00

Predictions non-native range SDM

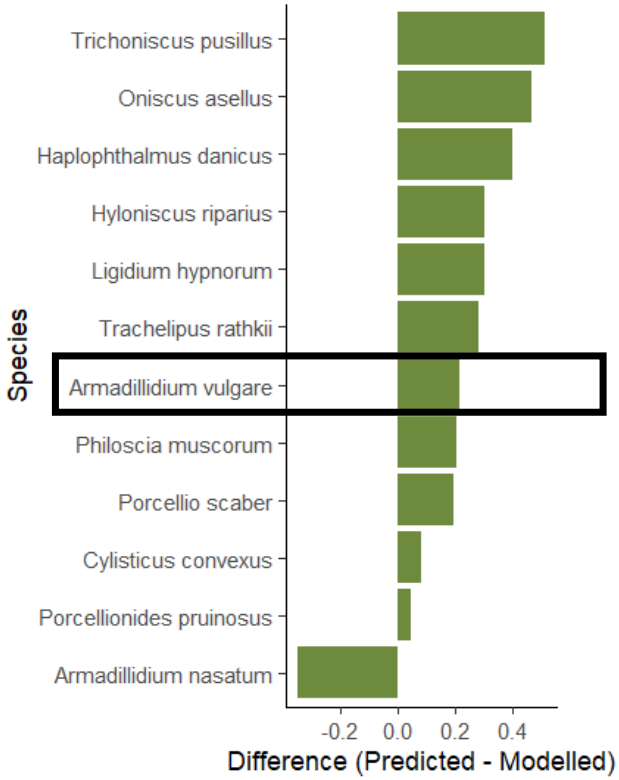


Difference (non-native SDM – native SDM)

-1.0
-0.5
0.0
0.5
1.0

Difference in suitability

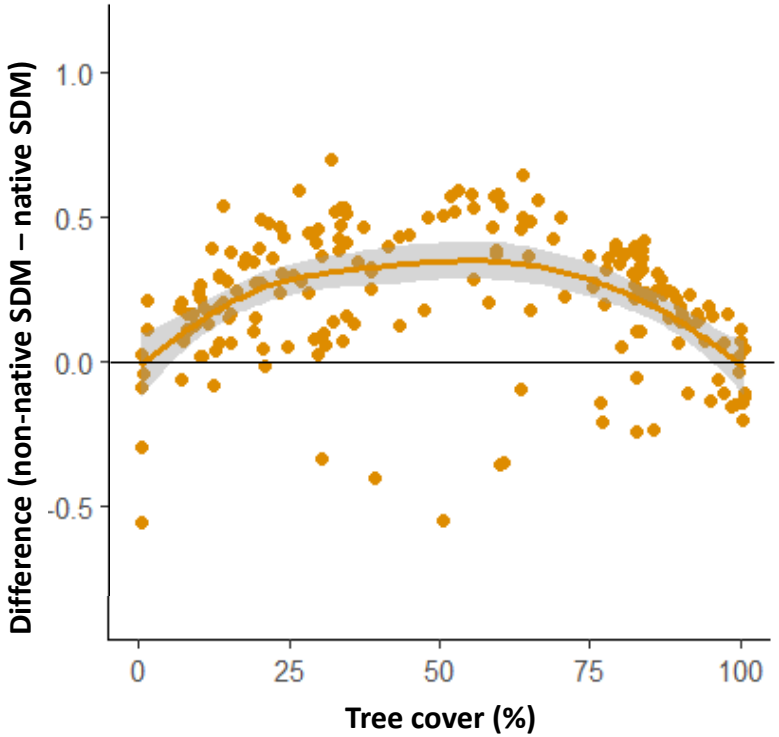
Difference per species



- Most species distributions are overestimated
- Species still expanding?

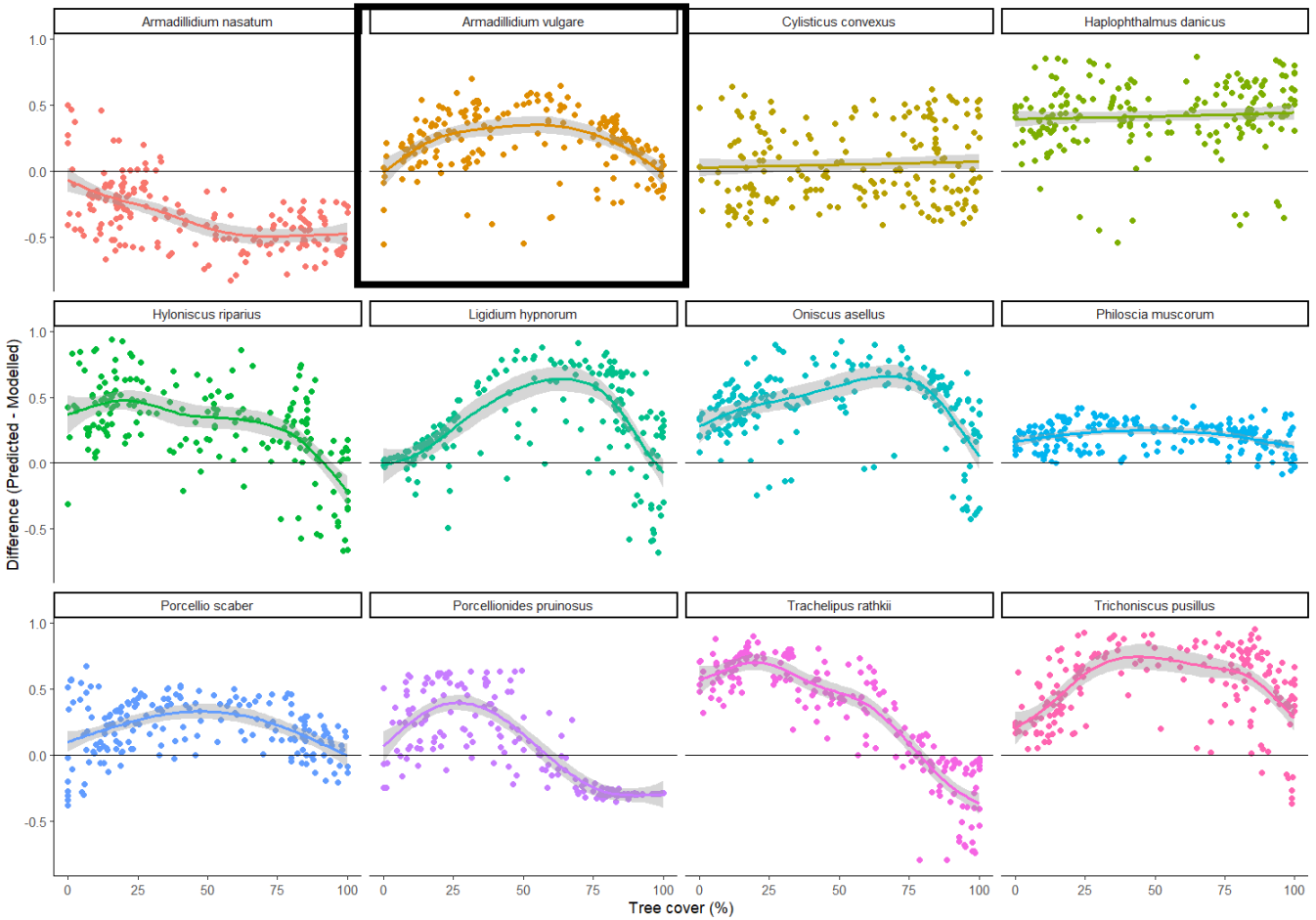
Armadillidium nasatum © Spinicornis – Gert Arijs

Prediction based upon environmental variables



Difference between predicted and modelled data for *Armadillidium vulgare* according to tree cover density (%)

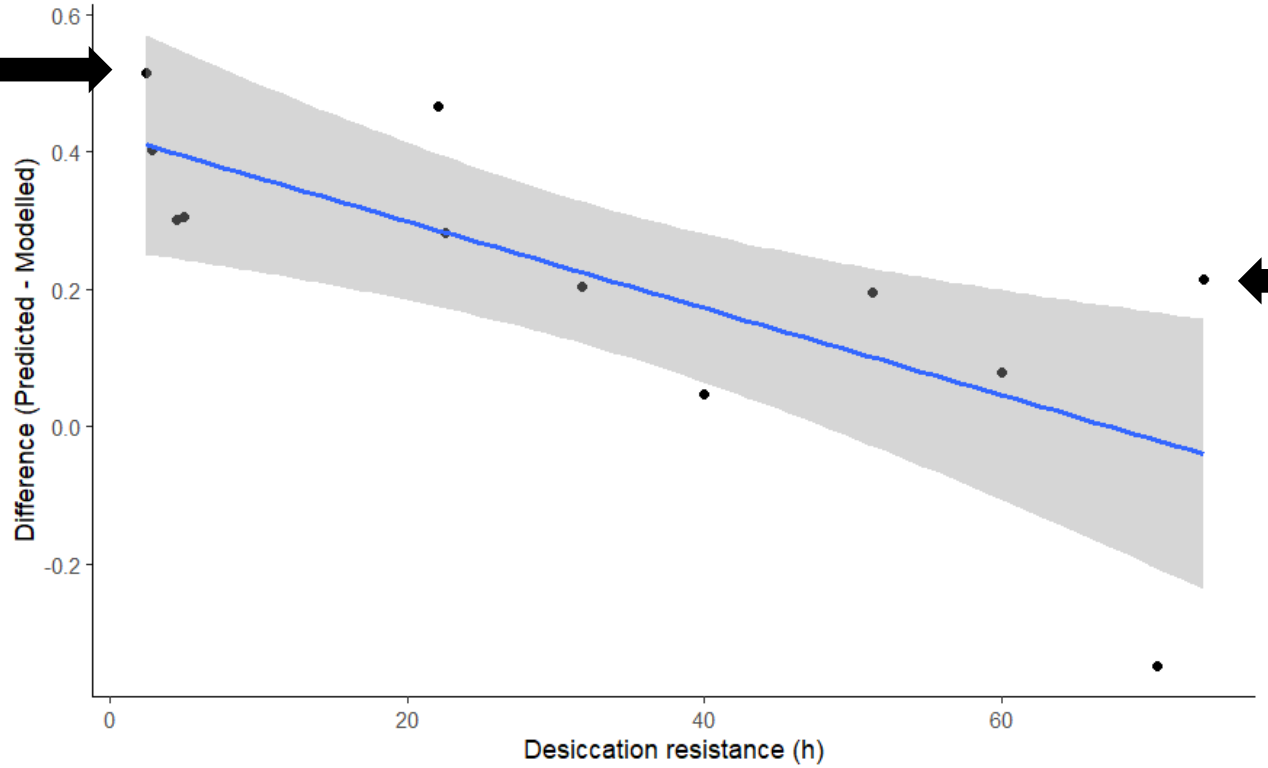
Prediction according to environmental variables



Measuring desiccation resistance

Traits to explain predictability?

Trichoniscus pusillus
© Spinicornis – Gert Arijs



Armadillidium vulgare
© Spinicornis – Gert Arijs

Conclusion

Terrestrial isopods can serve as models to understand invasive soil fauna distribution

- Same drivers determine large-scale distribution (Belgium vs. Maryland)
- Distribution predictability depends on landscape and climatic variables
- Predictability of distribution can be linked to species traits
- Next: Test for consistency across soil fauna taxa and at continental scale?

August 22nd, 2025 Karaganda

Acknowledgements







Questions?

Contact:
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Pallieter.desmedt@ugent.be

Haplphthalmus danicus © Spinicornis - Gert Arijs