MODIRISK

From spatial data to mosquito models
A case study in the Benelux

E.M. De Clercq, E. Goossens, V. Versteirt, W. Dekoninck, T. Hance, W. Takken, F. Jacobs, F. Schaffner, M. Coosemans, W. Van Bortel, and G. Hendrickx





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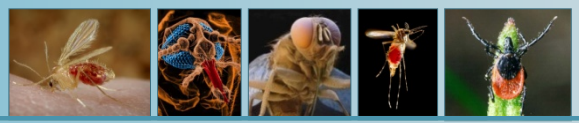
Introduction

Inventory endemic mosquito population

Monitoring mosquito co-occurrence

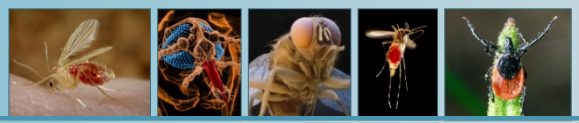


Modelling principle

Input: points

Result: continuous grid

Filling gaps between points



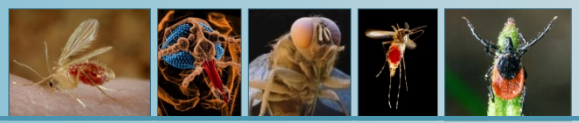
Methodology

P/A ~ predictor variables

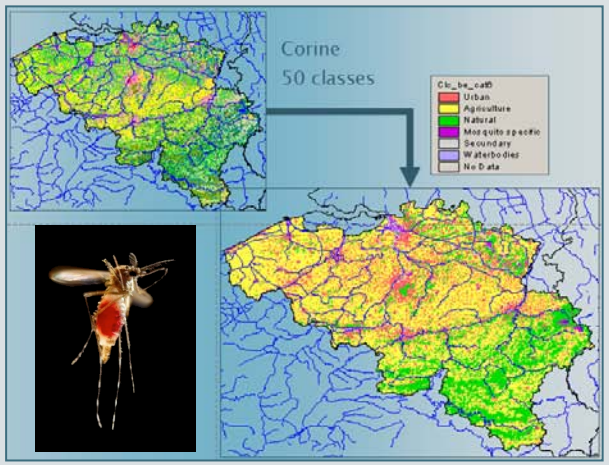
Balanced dataset:

→nr Presences (positive traps) = nr Absences (negative traps)

Random Forest: collection of CART-trees

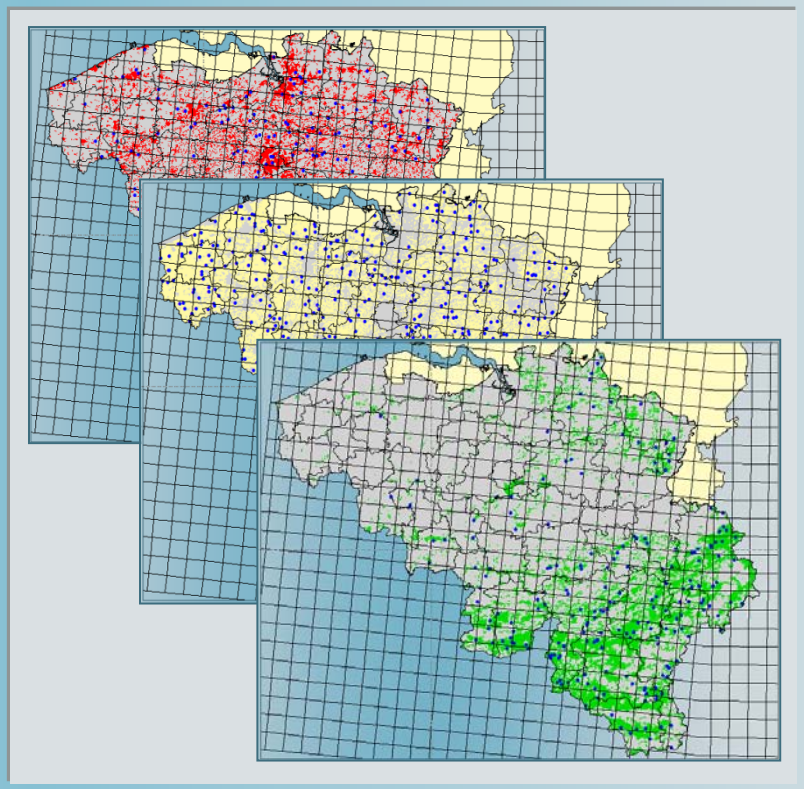


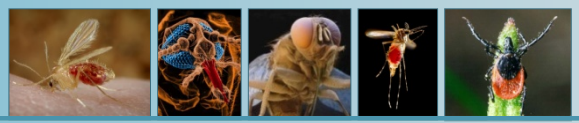
Random stratified sampling



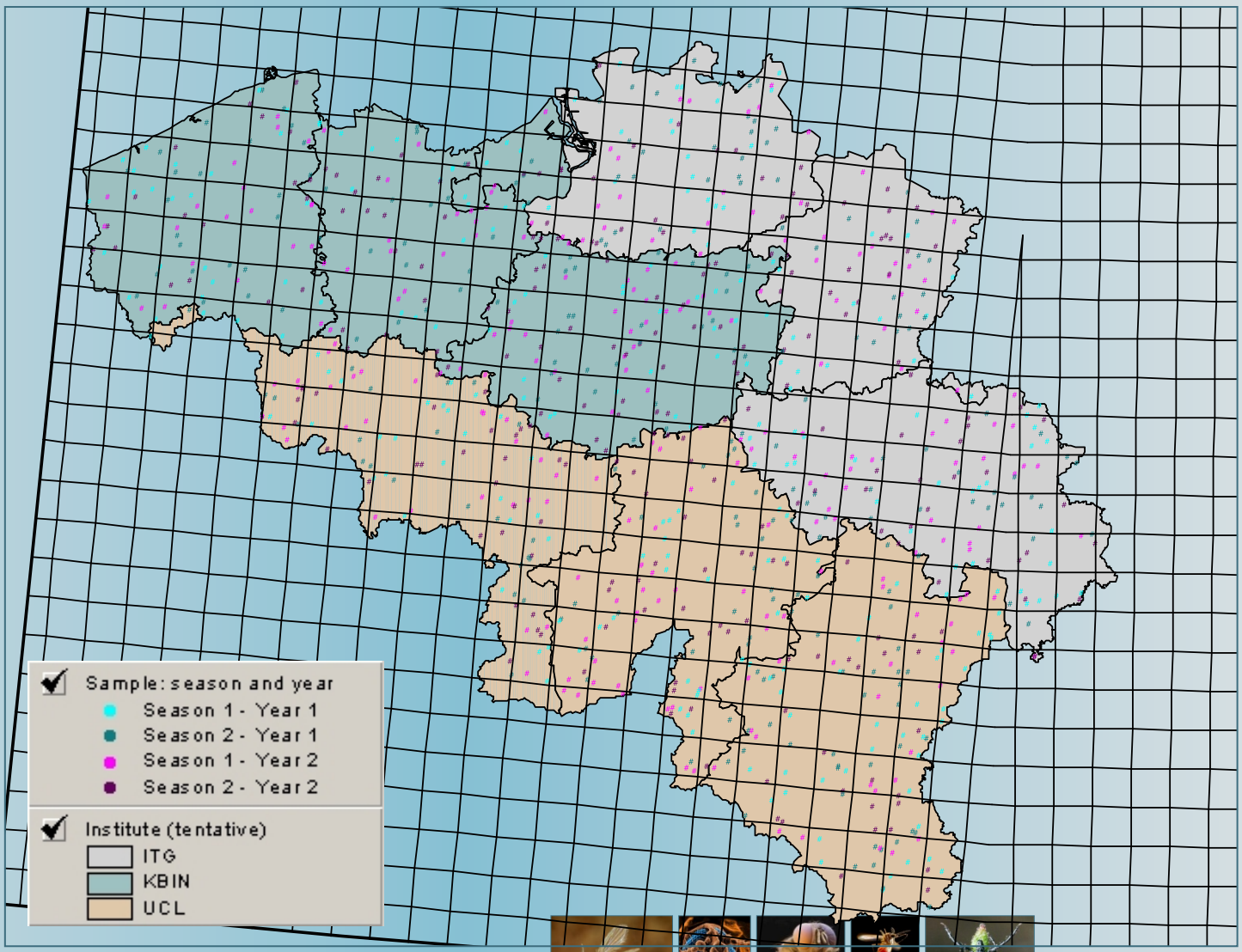
Class	Pixels	Percentage	Samples
Urban	769,723	17.7%	173
Agriculture	2,514,104	57.7%	564
Natural	888,272	20.4%	199
Specific	56,479	1.3%	13
Secondary	103,411	2.4%	23
Water bodies	28,285	0.6%	6
TOTAL	4,360,274	100.0%	978

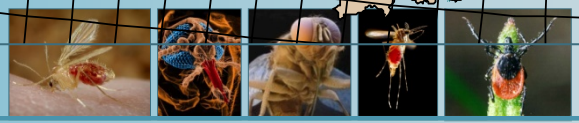
In **blue** = automated random assignment
In **red** = manual attribution in selected areas





Sample: institute / year / season





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Predictor variables

CORINE land cover : (1) urban, (2) agriculture, (3) natural, (4) risk areas referred to as *specific*, (5) secondary and (6) water bodies

Available water capacity of topsoil

Digital Elevation Model

Yearly/monthly Precipitation

Distance to particular features: (1) Waterways , (2) Protected areas

Percentage cover (% in 1 km²): (1) Broadleaved, Coniferous, Mixed forest, (2) Urban, Agriculture, Natural

Population density (inhabitants/km²)

MODIS derivates: (1) Day/Night Temperature ; (2) Vegetation greenness

Fourier analysis on data of last 5 years: (1) Mean ; (2) Interannual variation

Nr of freezing days/nights

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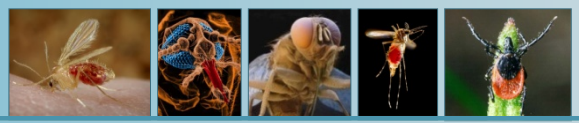
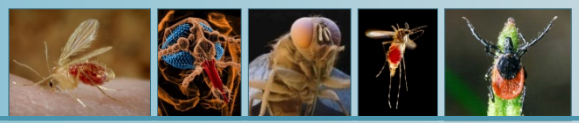
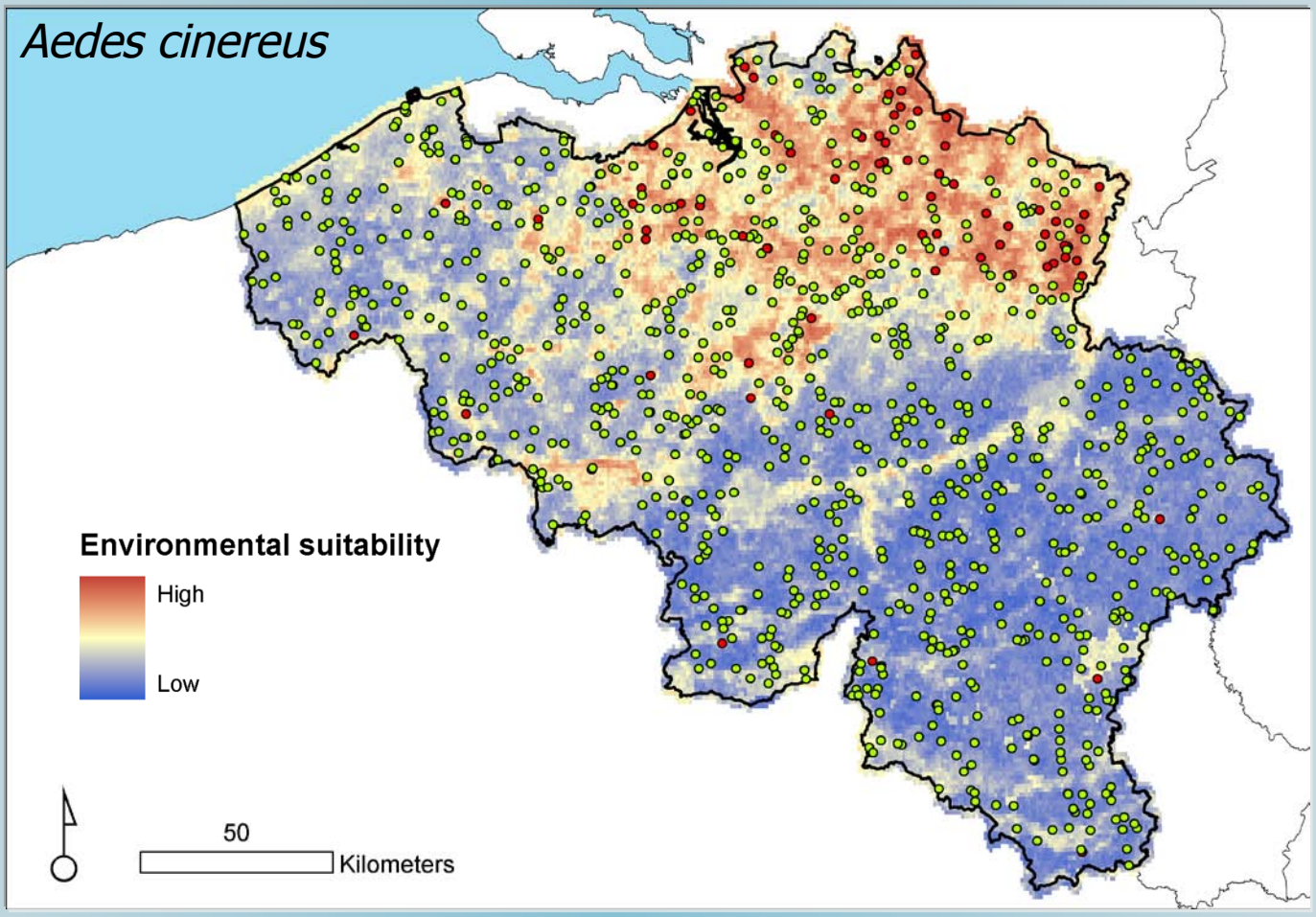


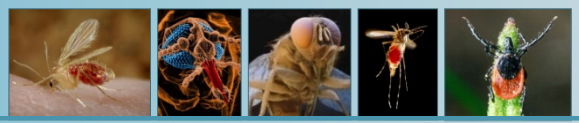
Most frequent species

Species	Total	%	Positive traps N	Positive traps N/+Tr
Aedes vexans	**29**	2.97%	776	**26.76**
Coquillettidia richiardii	**38**	3.89%	4,095	**107.76**
Aedes cinereus/geminus	**74**	7.57%	1,328	**17.95**
Culex pipiens	**698**	71.37%	16,338	**23.41**



Model results for 14 mosquito sp.





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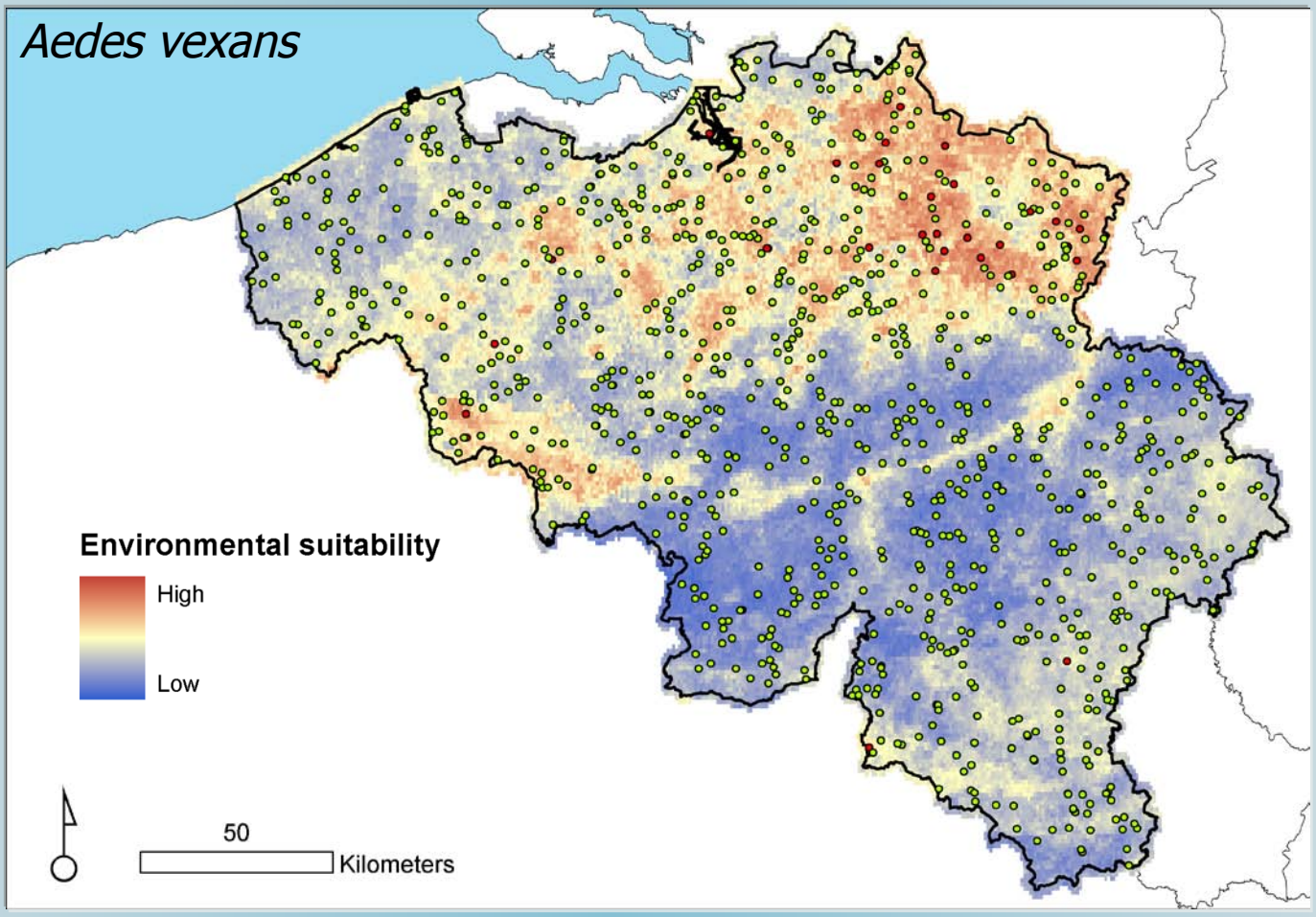

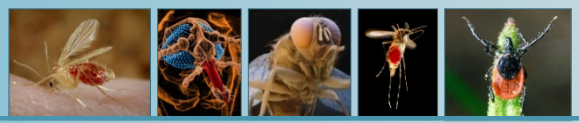

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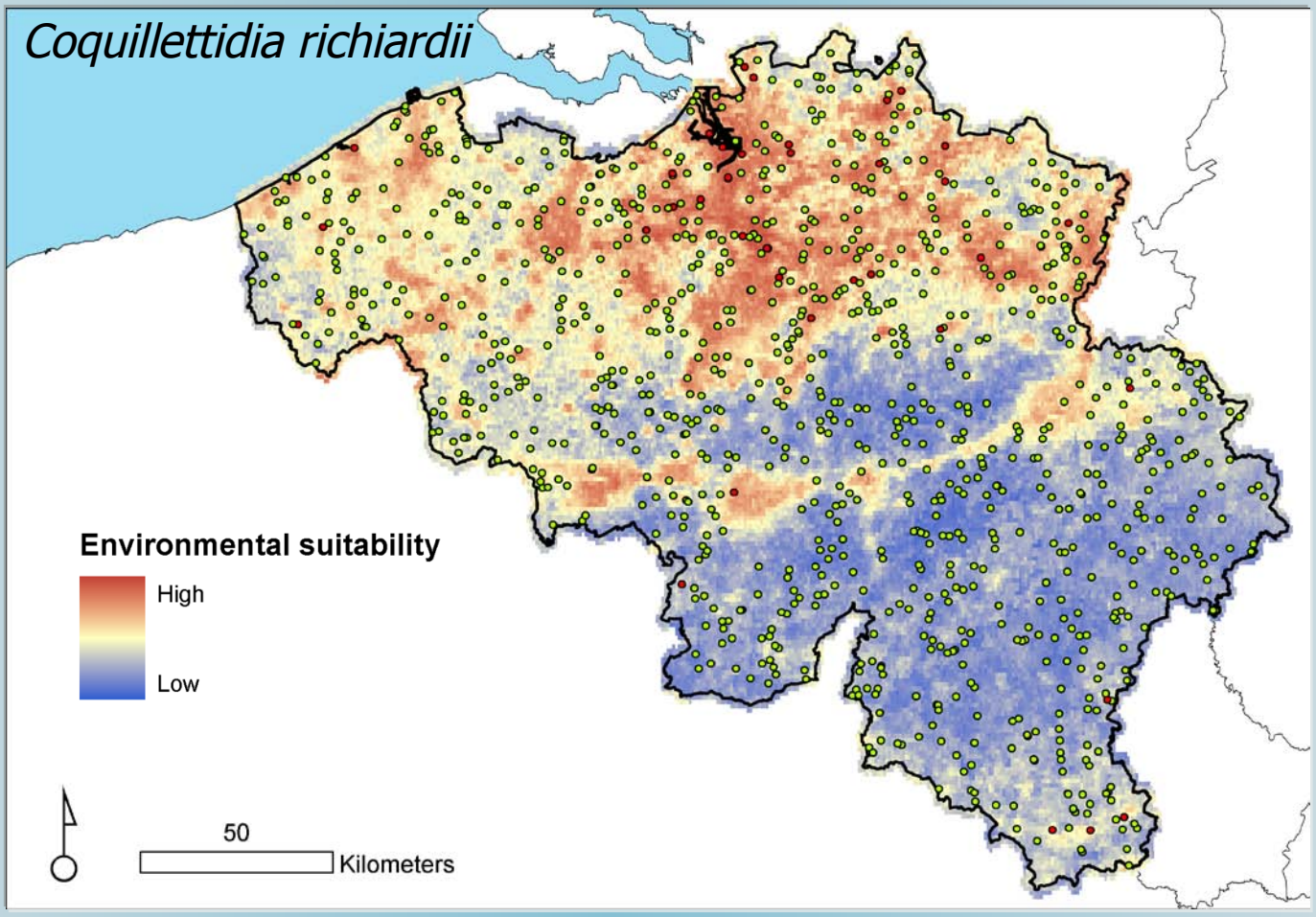

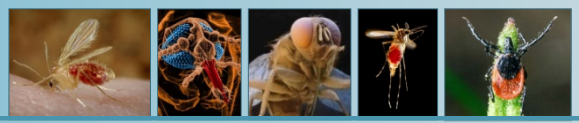

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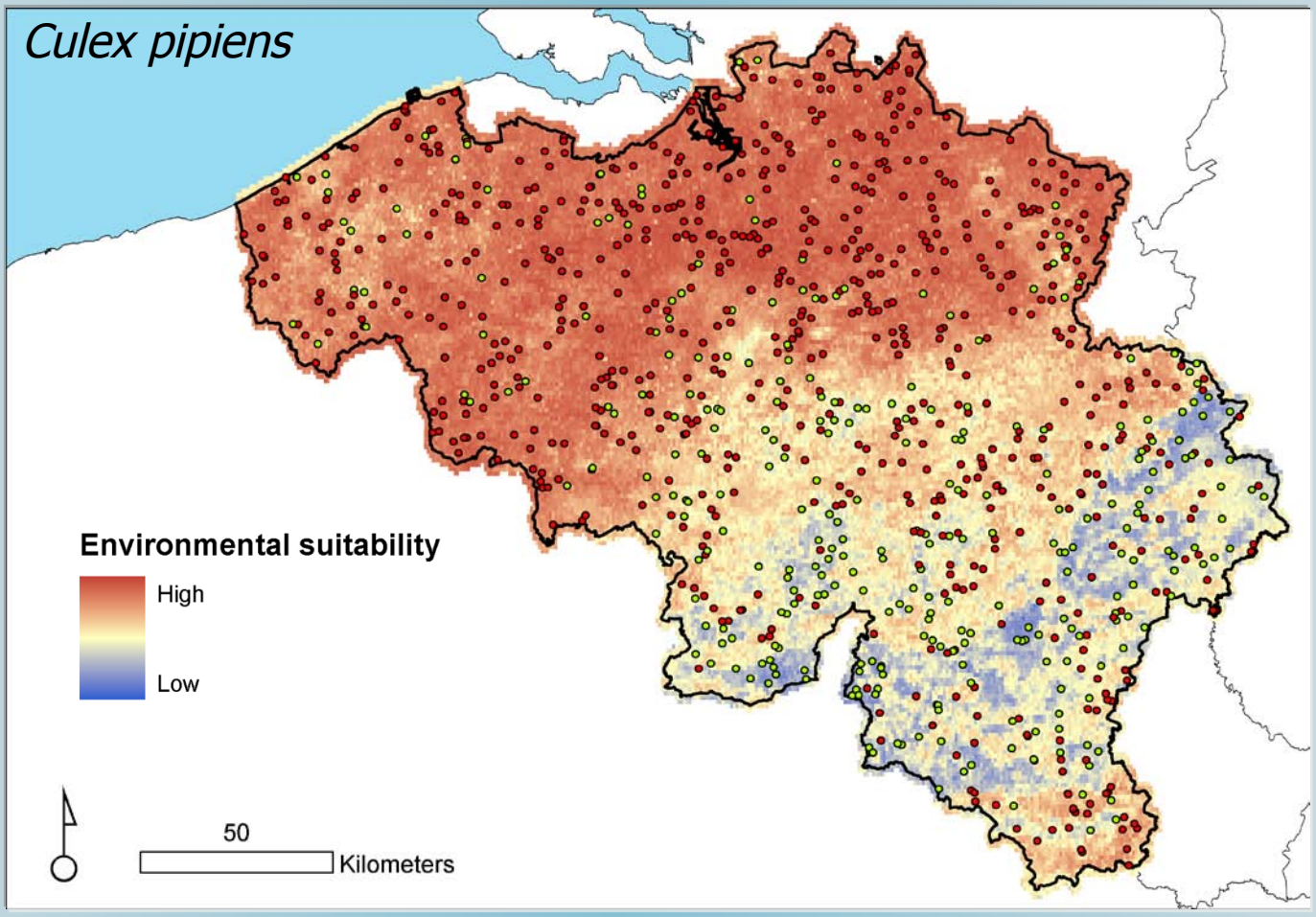
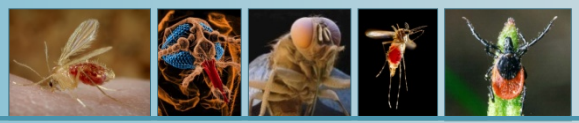
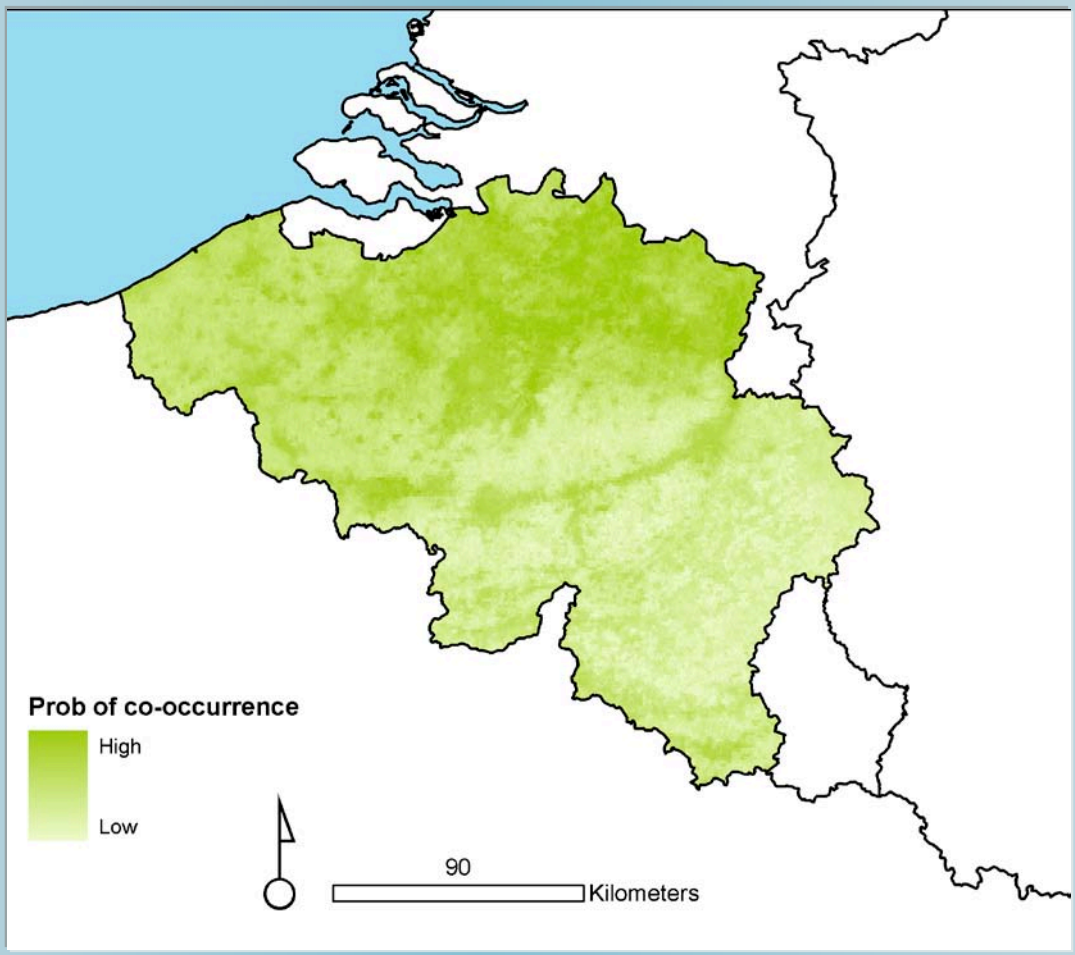
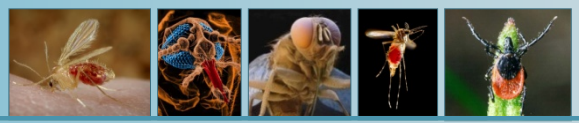




Probability of co-occurrence for 14 species





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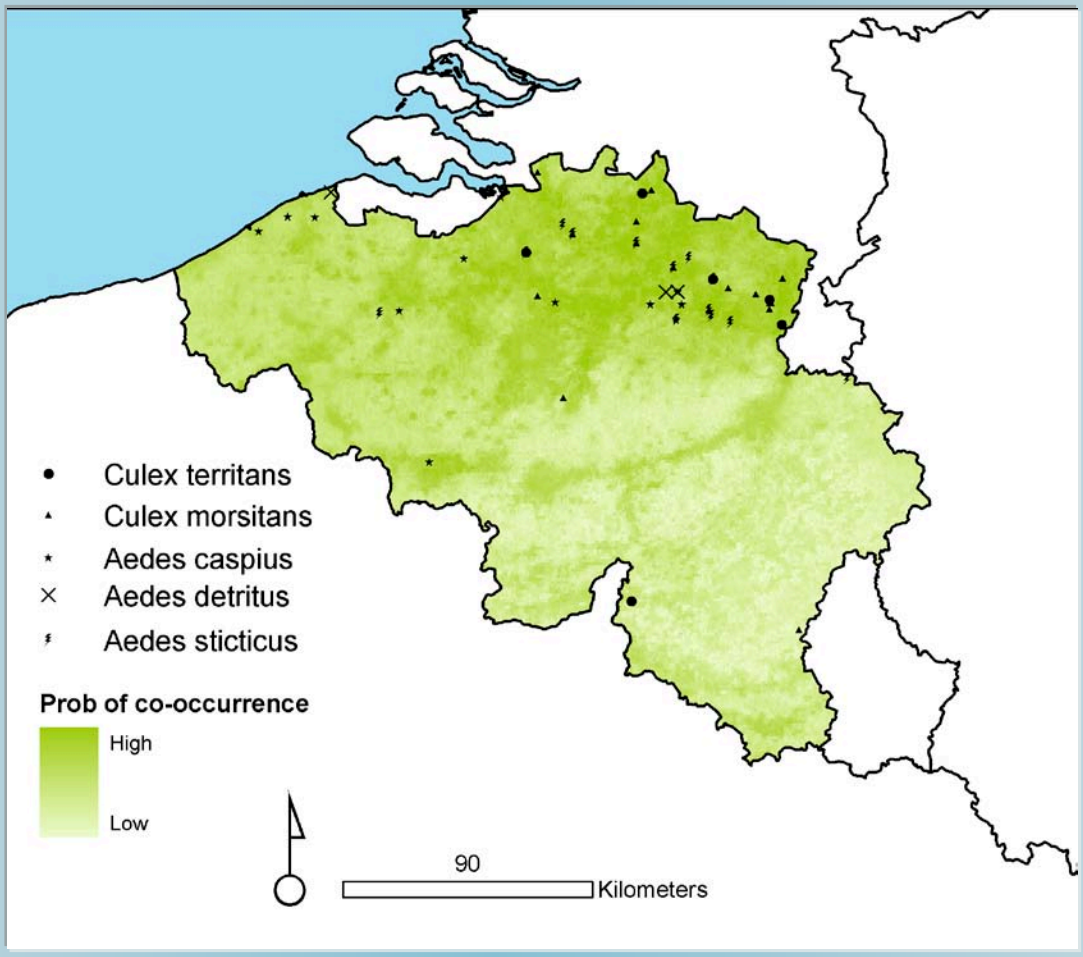

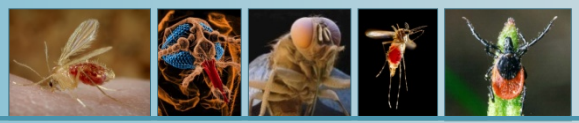

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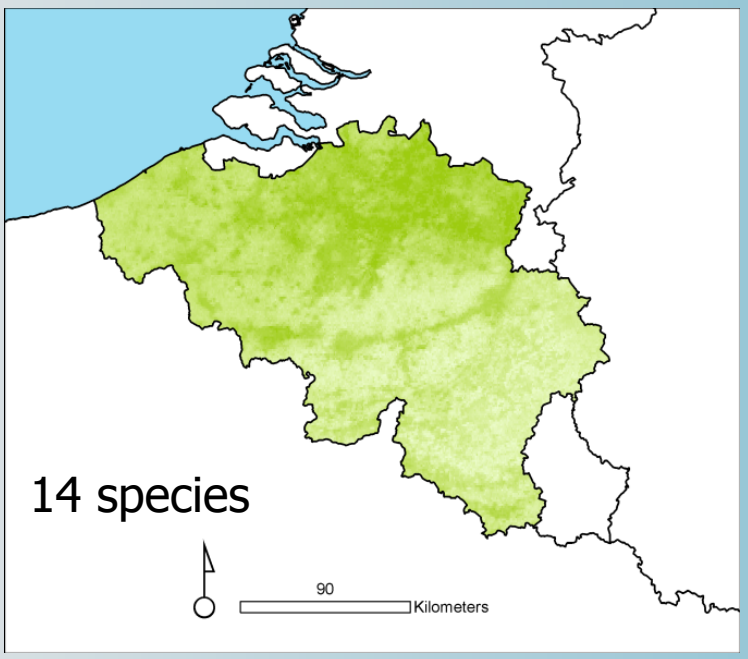

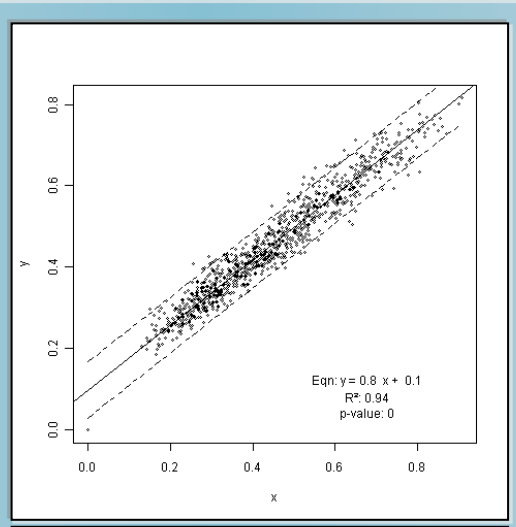

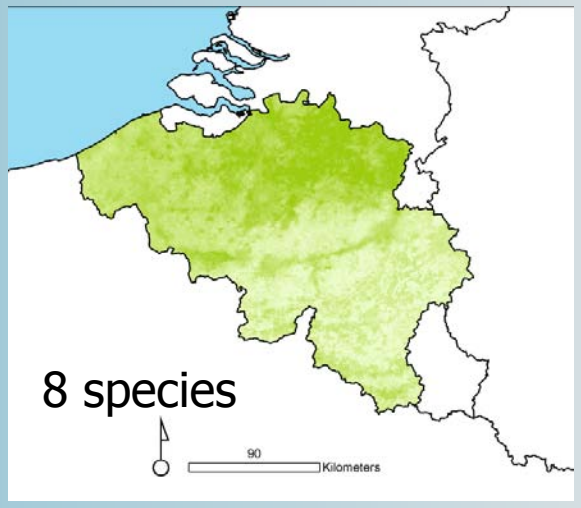

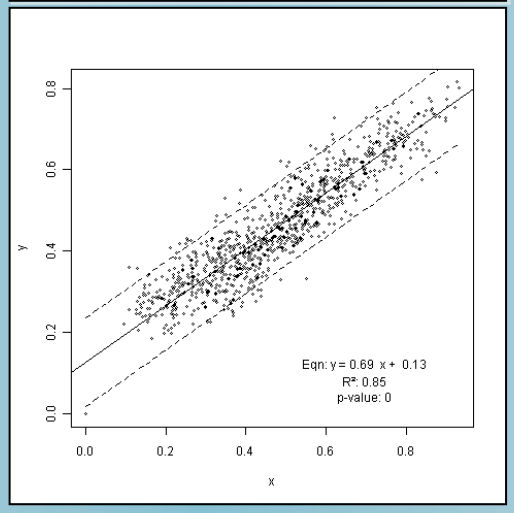

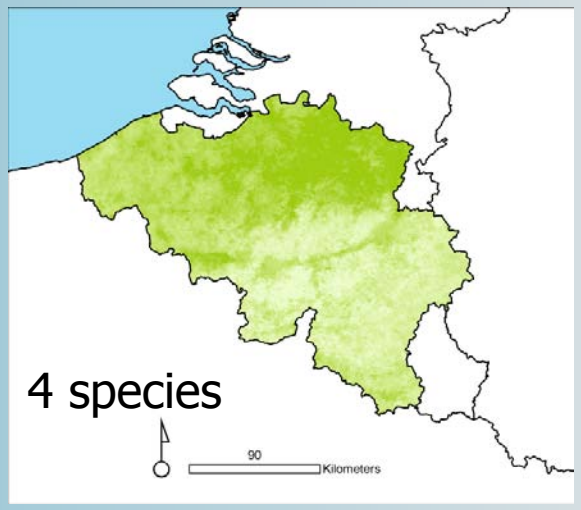

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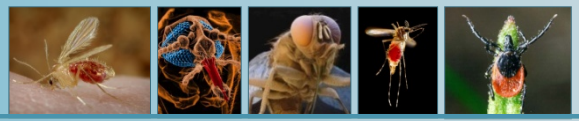
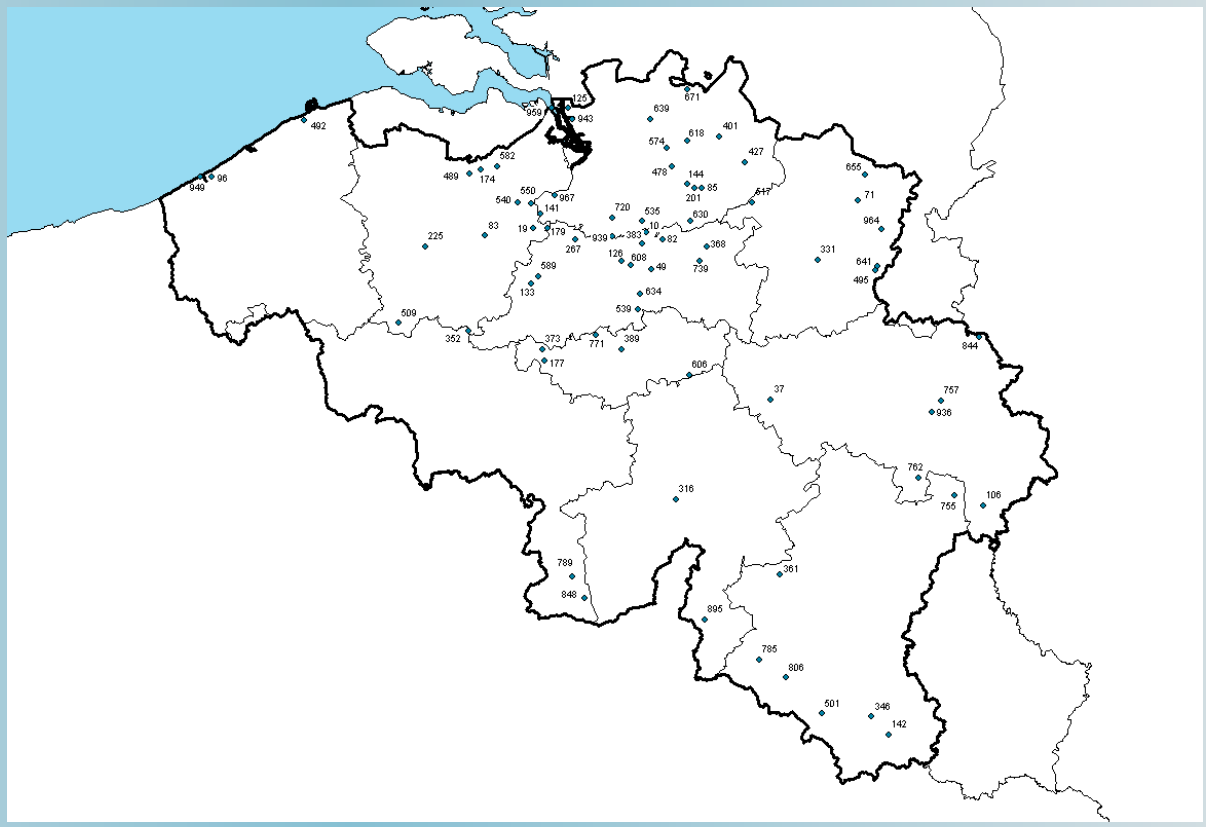
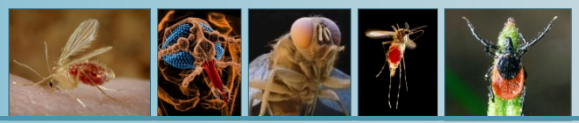


Validation of models in Belgium

75 sites in 2009

75 sites in 2010

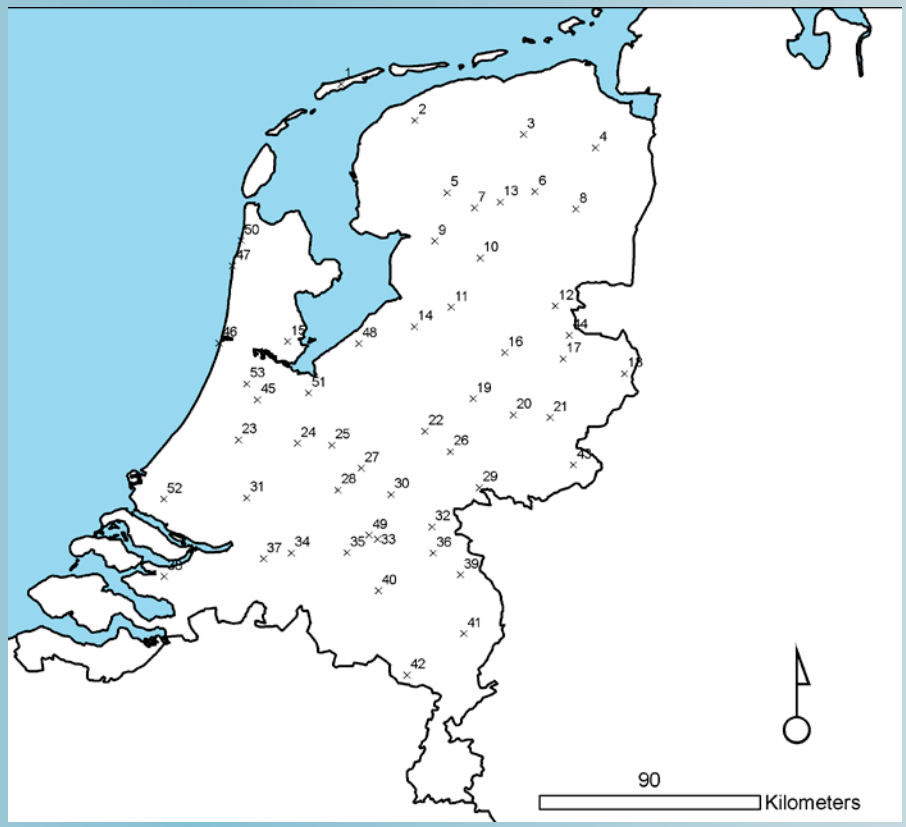


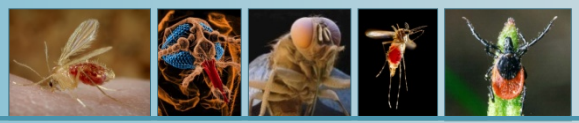


Validation of models in the Netherlands

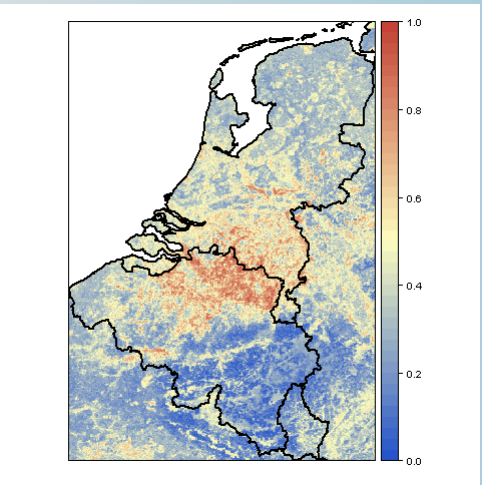
53 sites in 2009

53 sites in 2010



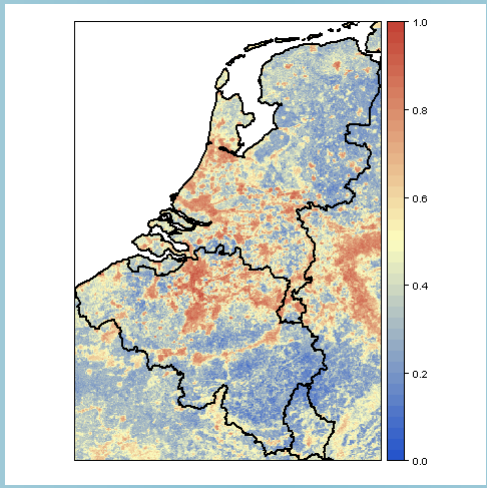


Validation of models in Netherlands (53 sites)



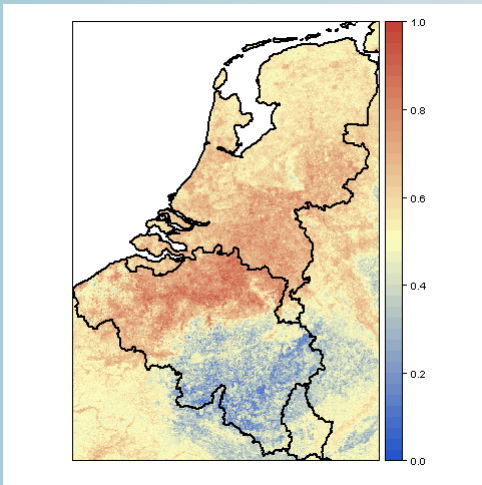
Ae. cinereus (58% PCC)

	prediction	
trap	PRES	ABS
PRES	3	3
ABS	19	28



Cq. richardii (57% PCC)

prediction	
PRES	ABS
6	10
13	24



Cx. pipiens (77% PCC)

prediction	
PRES	ABS
41	10
2	0

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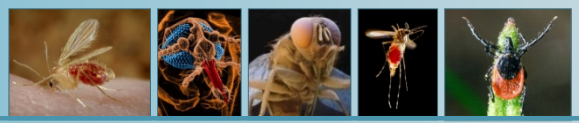
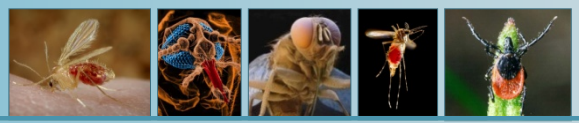


Cost-efficient sampling strategy

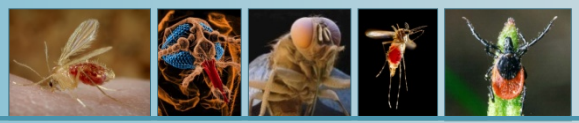
- Stratified random sampling:
  - 1000 points => 100 points
  - 100% => 10%
  - 1 trap/30 km² => 1 trap/300 km²



Evaluation

Is modelling output satisfactory

- AUC
- PCC, Sensitivity, Specificity
- Spatial pattern



Accuracy measures

PCC

species	1/30km²	1/40km²	1/50km²	1/75km²	1/150km²
Ae cinereus	0.75	0.79	0.77	0.75	0.71
Ae vexans	0.75	0.71	0.65	0.60	0.54
Cq richardii	0.73	0.70	0.69	0.67	0.65
Cx pipiens	0.87	0.83	0.80	0.75	0.71

Sensitivity

species	1/30km²	1/40km²	1/50km²	1/75km²	1/150km²
Ae cinereus	0.99	0.96	0.91	0.85	0.89
Ae vexans	1.00	0.97	0.95	0.92	0.90
Cq richardii	1.00	0.94	0.88	0.82	0.76
Cx pipiens	0.82	0.79	0.76	0.72	0.67

Specificity

species	1/30km²	1/40km²	1/50km²	1/75km²	1/150km²
Ae cinereus	0.73	0.77	0.76	0.74	0.70
Ae vexans	0.74	0.70	0.64	0.59	0.53
Cq richardii	0.72	0.69	0.69	0.67	0.65
Cx pipiens	1.00	0.93	0.88	0.82	0.79

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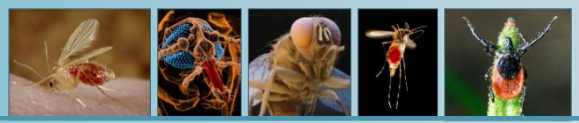
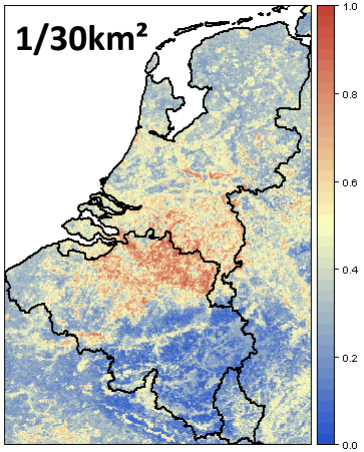
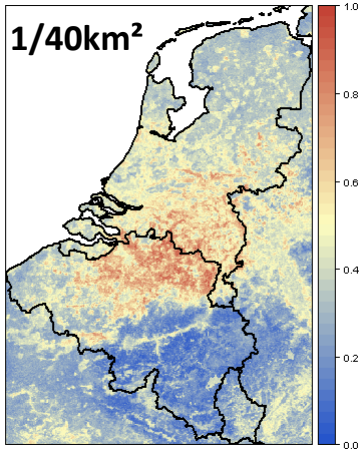
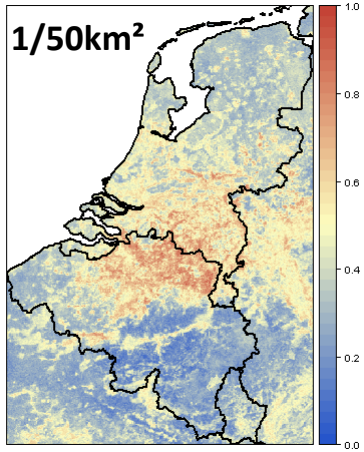
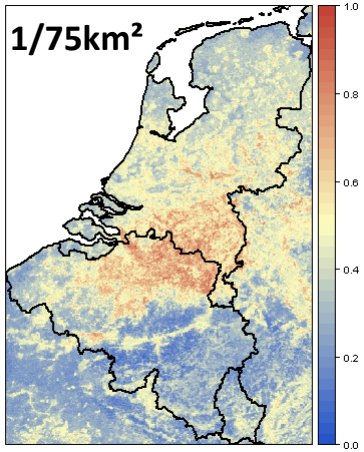


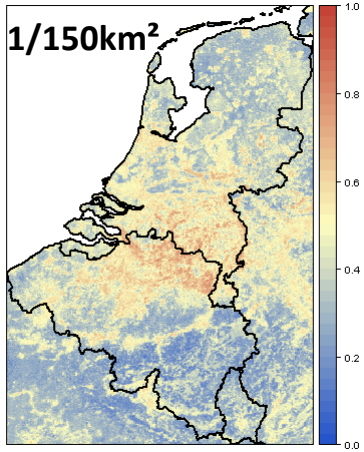
Ae. cinereus











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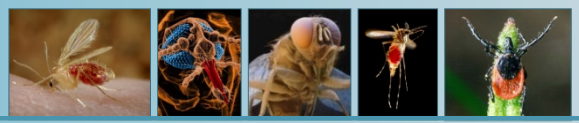
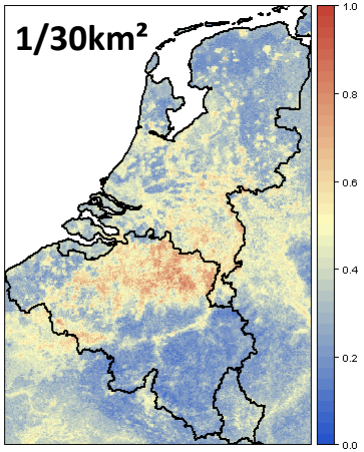
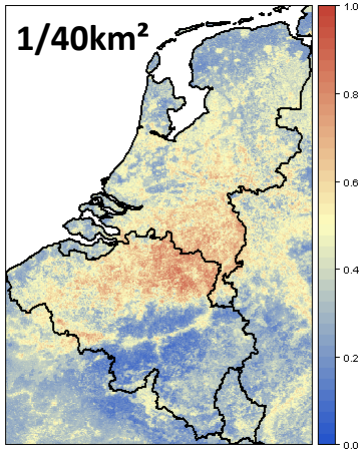
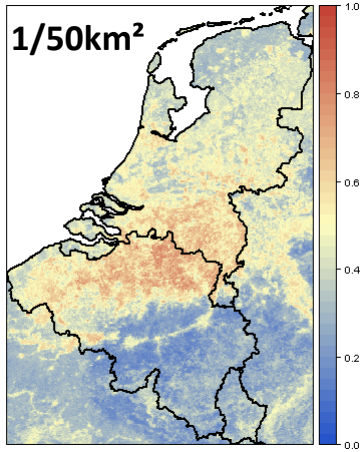
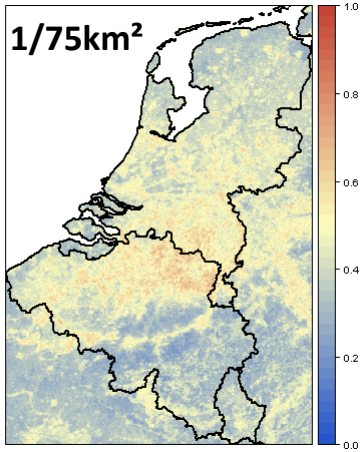


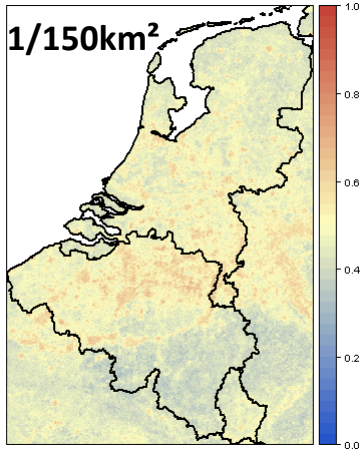
Ae. vexans











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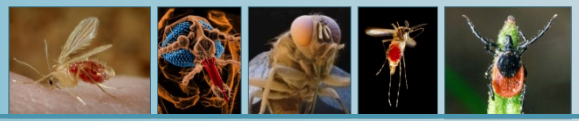
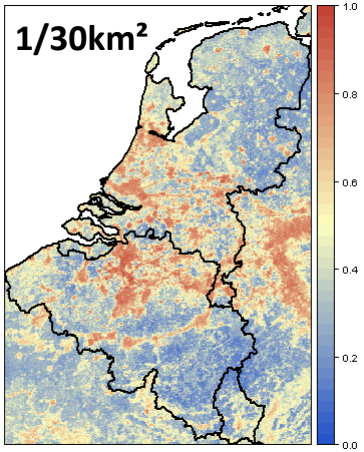
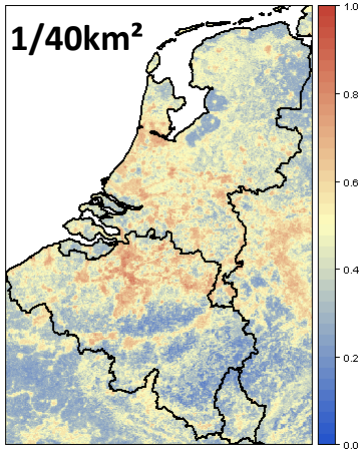
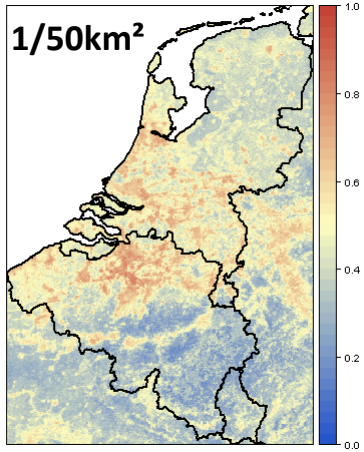
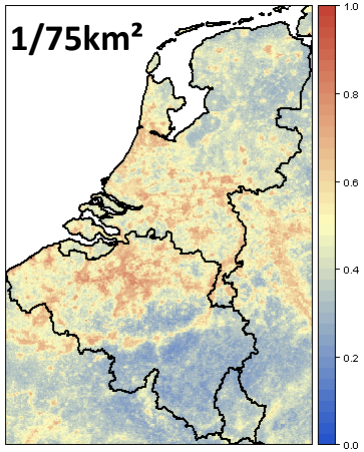


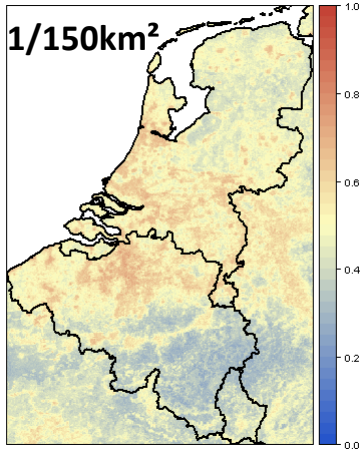
Cq. richardii











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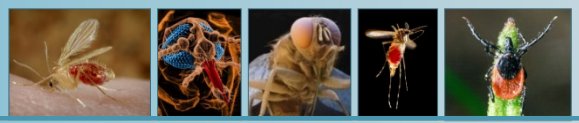
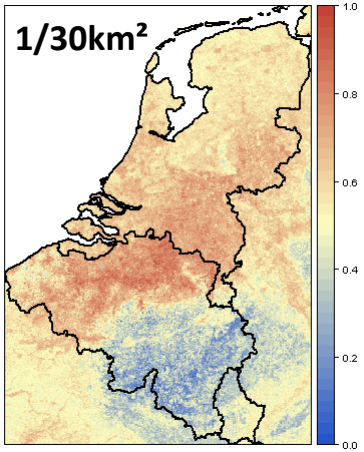
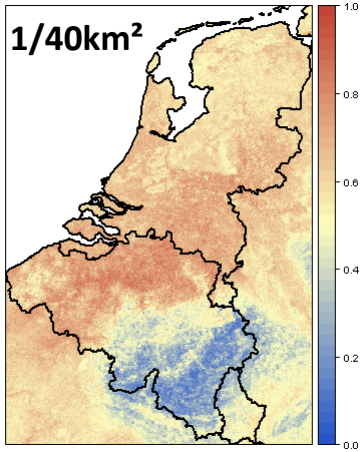
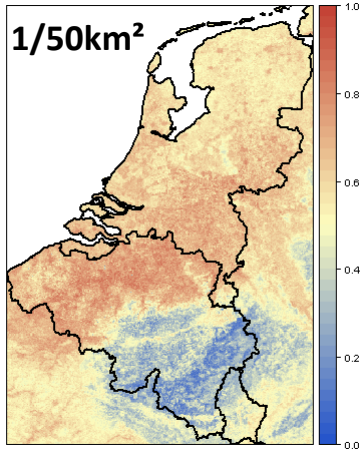
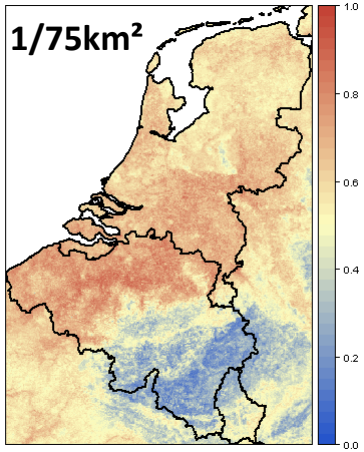


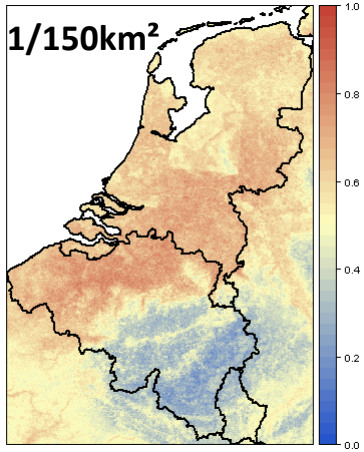
Cx. pipiens











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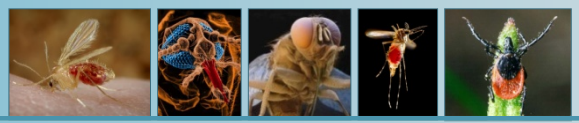


Conclusions

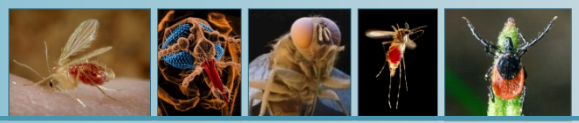
Hotspot for species co-occurrence

Four indicator species:

- Wide-spread
- Easy to catch

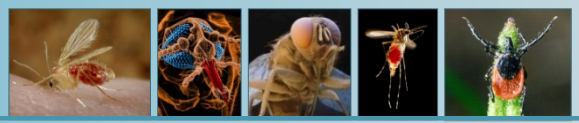
Stratified random sampling:

- Good results up to 1 trap/150 km² at a 1km resolution



Ongoing

- False absences
- Uncertainty
- Resolution



Thank you for your questions

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