Plant invasions in biased occurrence data

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Invasion research with herbarium records

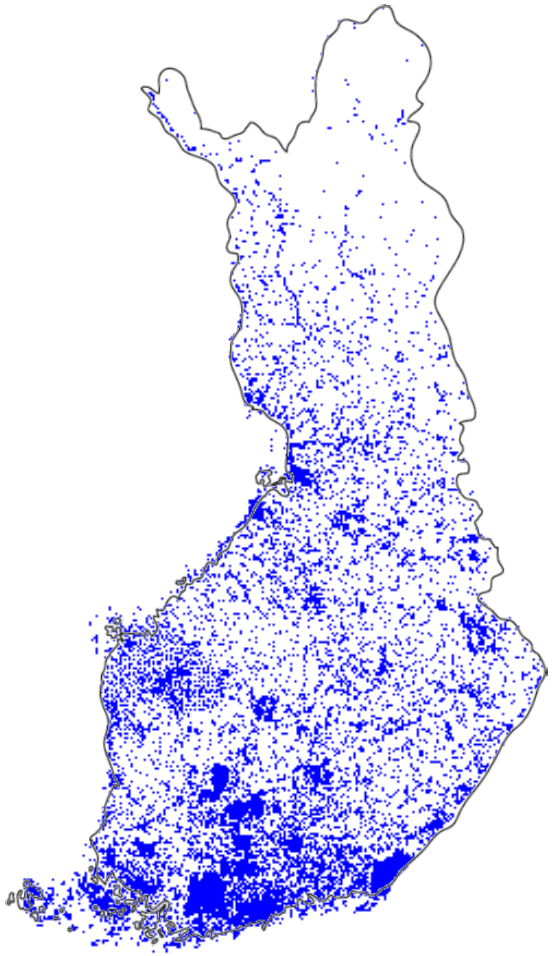
- Humans have assisted plant spread to new areas, leading to invasive species problems

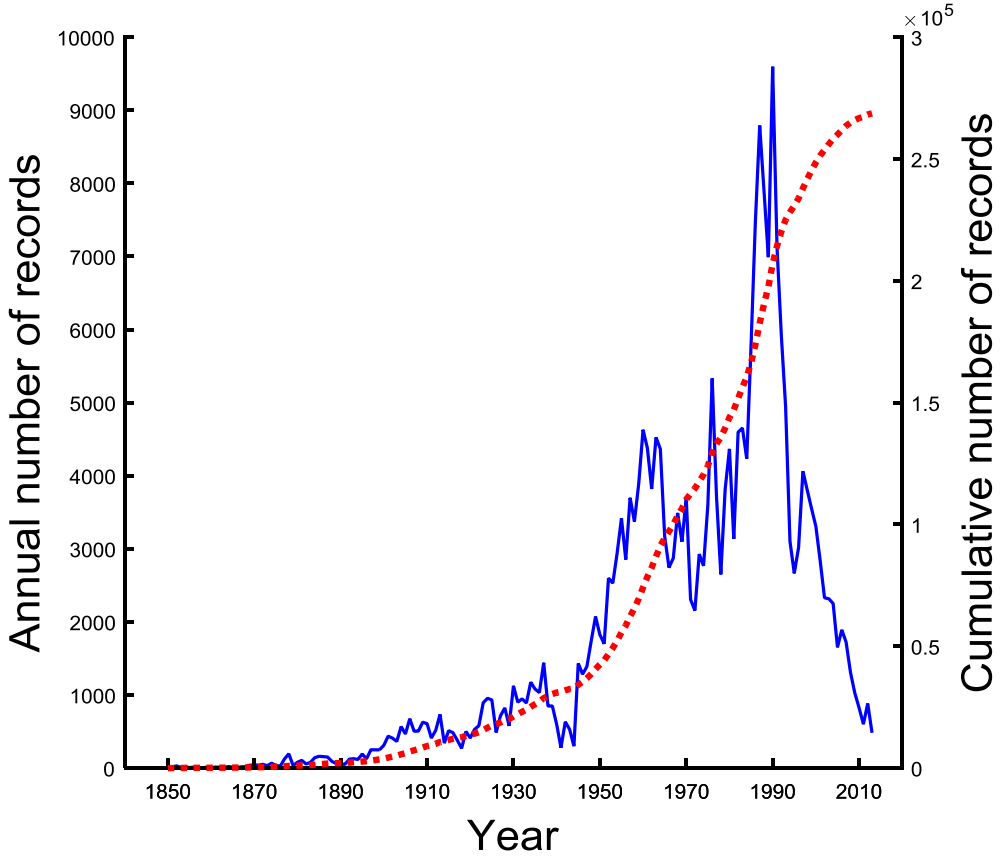
- Herbaria reflect changes in species distributions over recent decades or centuries

- Complicated data
  - Presence only
  - Precision varies
  - Sampling is biased

Sampling varies over time and space

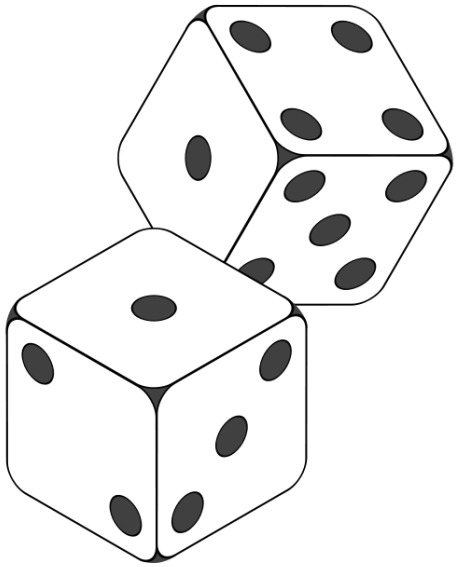
268 748 records of 1329 vascular plant species





Bias correction with a null model

- What would invasion look like if species were randomly distributed across sampling sites and years?



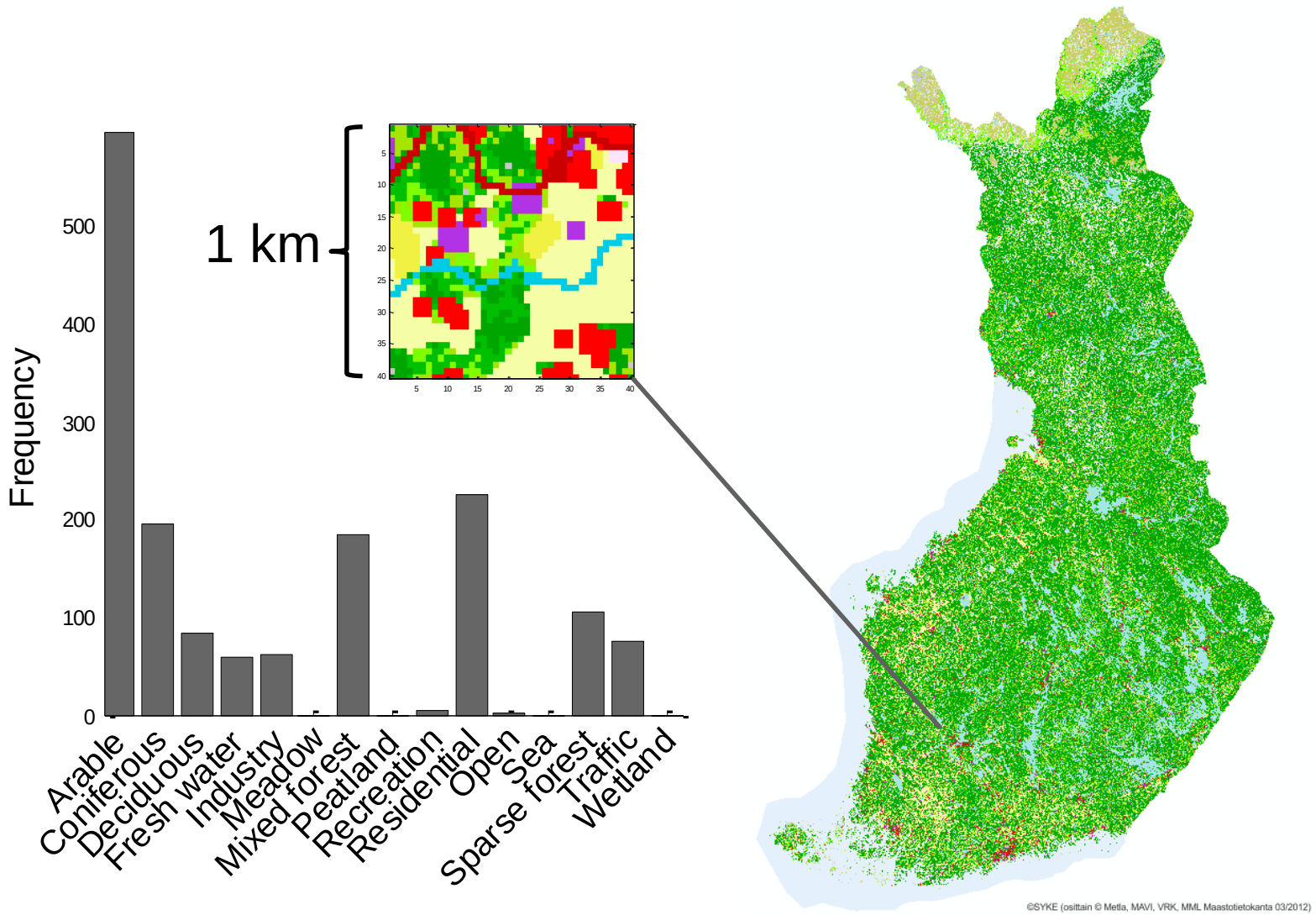
- Comparison of metrics between similarly biased null model and data → unbiased metrics

- **Two examples with plant occurrence data**
  1. Habitat occupancy in Finland
  2. Vertical spread rate along Mt. Baldo, Italy

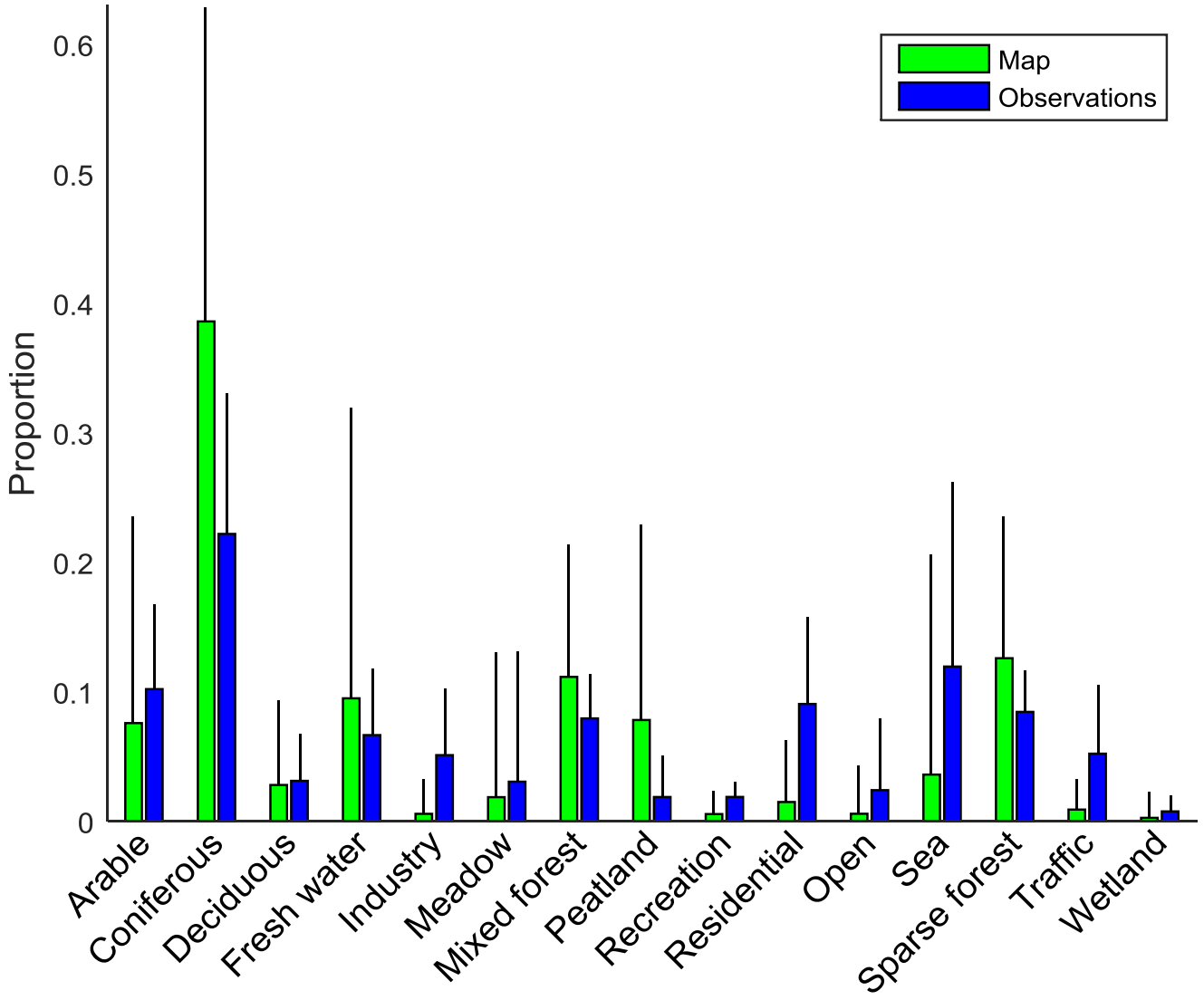
Steaphan Greene
Wikimedia Commons

Example 1: Habitat occupancy

Ocurrence and Corine Land Cover data compared by species status



Biased sample of habitats



Non-natives in human-modified habitats

MANOVA on observed–expected habitat use

	Least concern native	Non-native	Endangered (climate)	Endangered (other)
Arable	–1.21	1.92	–6.37	–1.37
Coniferous	–3.36	–8.59	–11.56	0.59
Deciduous	0.07	–1.25	0.97	–0.36
Fresh water	–0.84	–0.88	–3.16	–1.25
Industry	0.96	4.62	–2.69	–0.91
Meadow	1.26	–1.52	9.16	–0.05
Mixed forest	–0.65	–1.38	–3.58	1.01
Peatland	–0.45	–1.96	–1.32	–0.03
Recreation	–0.03	0.27	–0.25	–0.04
Residential	0.62	7.3	–5.69	–1.74
Open	0.69	–0.95	8.91	0.69
Sea	–0.37	–1.89	10.21	0.22
Sparse forest	–0.42	–2.02	–0.32	0.22
Traffic	0.87	4.24	–2.6	–0.47
Wetland	–0.05	0.08	–0.24	–0.02

MANOVA coefficients (x 100) : $\log(\mathbf{y}+1) \sim \mathbf{a} \cdot \mathbf{x}_{status}$

Climate-sensitive species at open habitats

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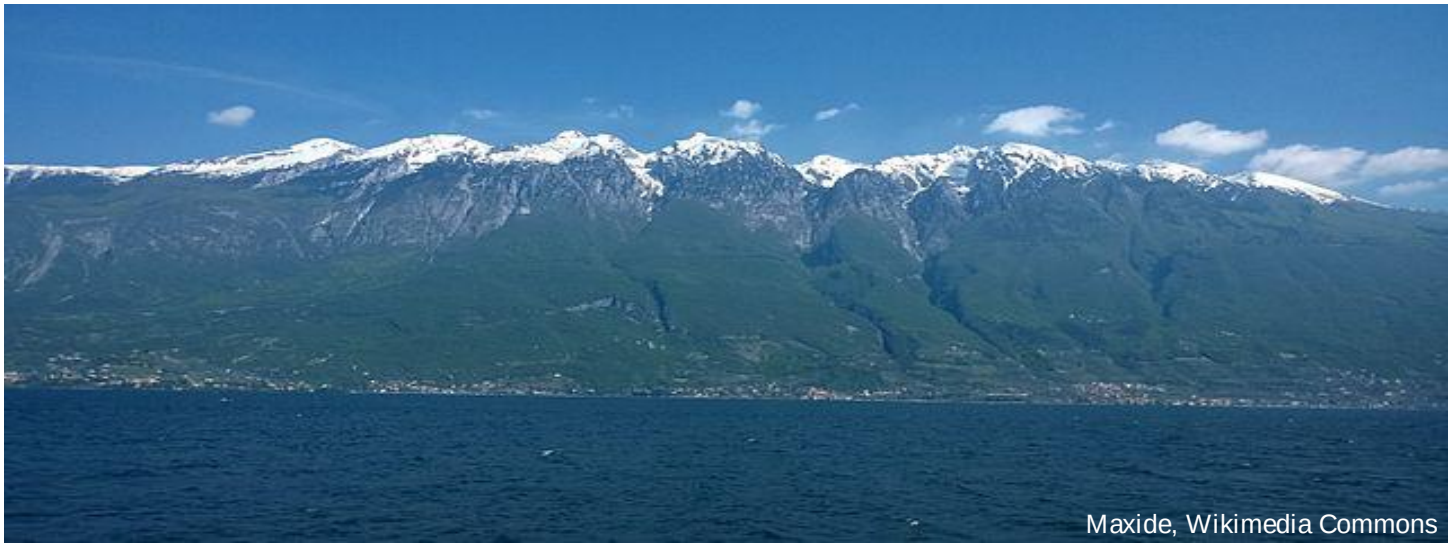
Relevance to species management

- Most non-native plants occupy human-modified habitats
- Climate sensitive plants occupy open, seashore and alpine habitats
- Dissimilarity of alien and climate-sensitive species suggests that the invasion risk of assisted migration is low

Example 2: Vertical spread on Mt. Baldo

Native and alien species response to climate change



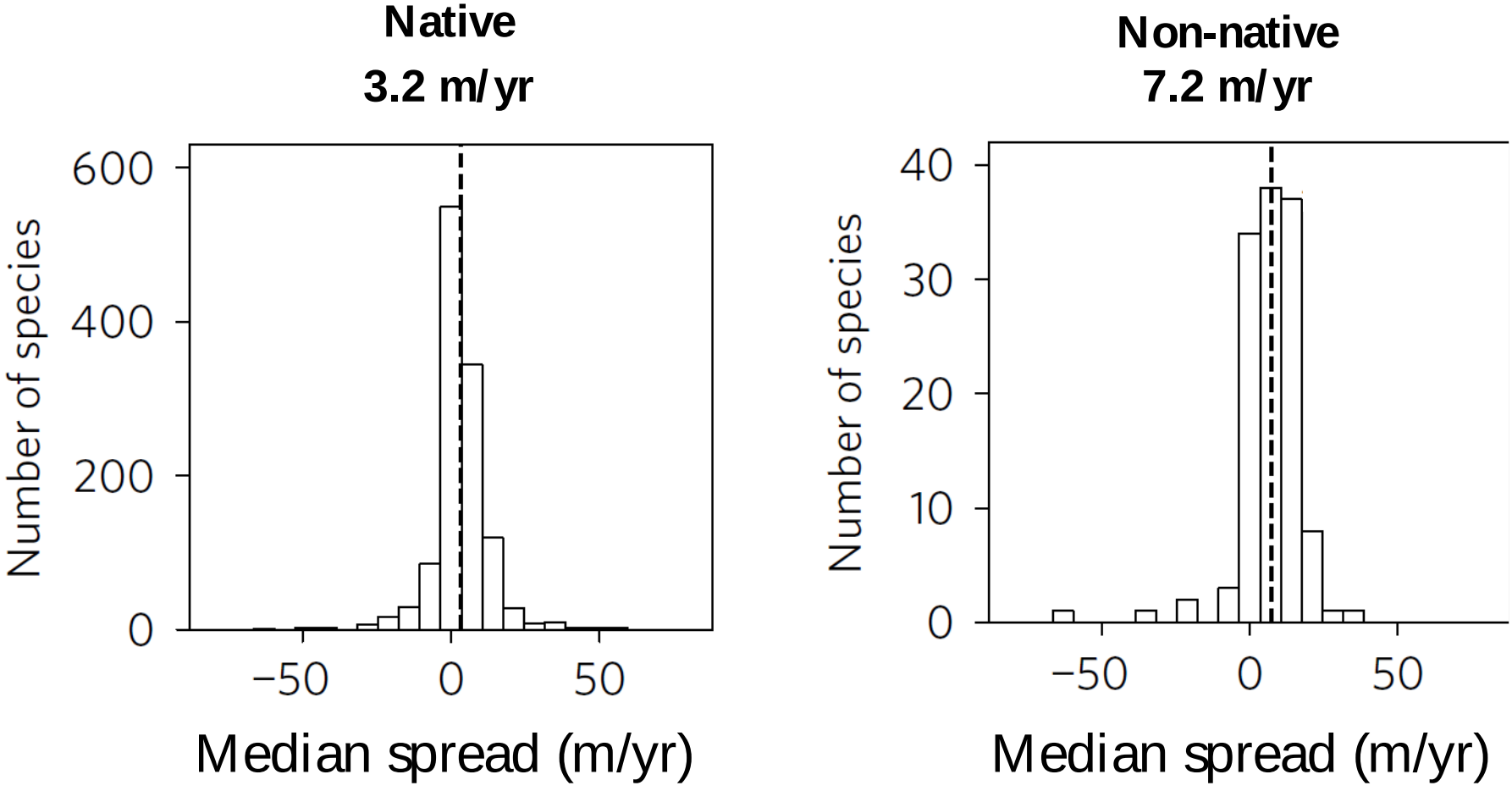
- Projected rate of climate change for this part of Alps in NE-Italy
  - Before 2050, 0.26°C/decade ~ **3.85 m/yr**
  - After 2050, 0.36°C/decade ~ **5.54 m/yr**

- Nearest neighbor vertical spread rates calculated from 131 394 records of 1334 plant species, collected over 20 years

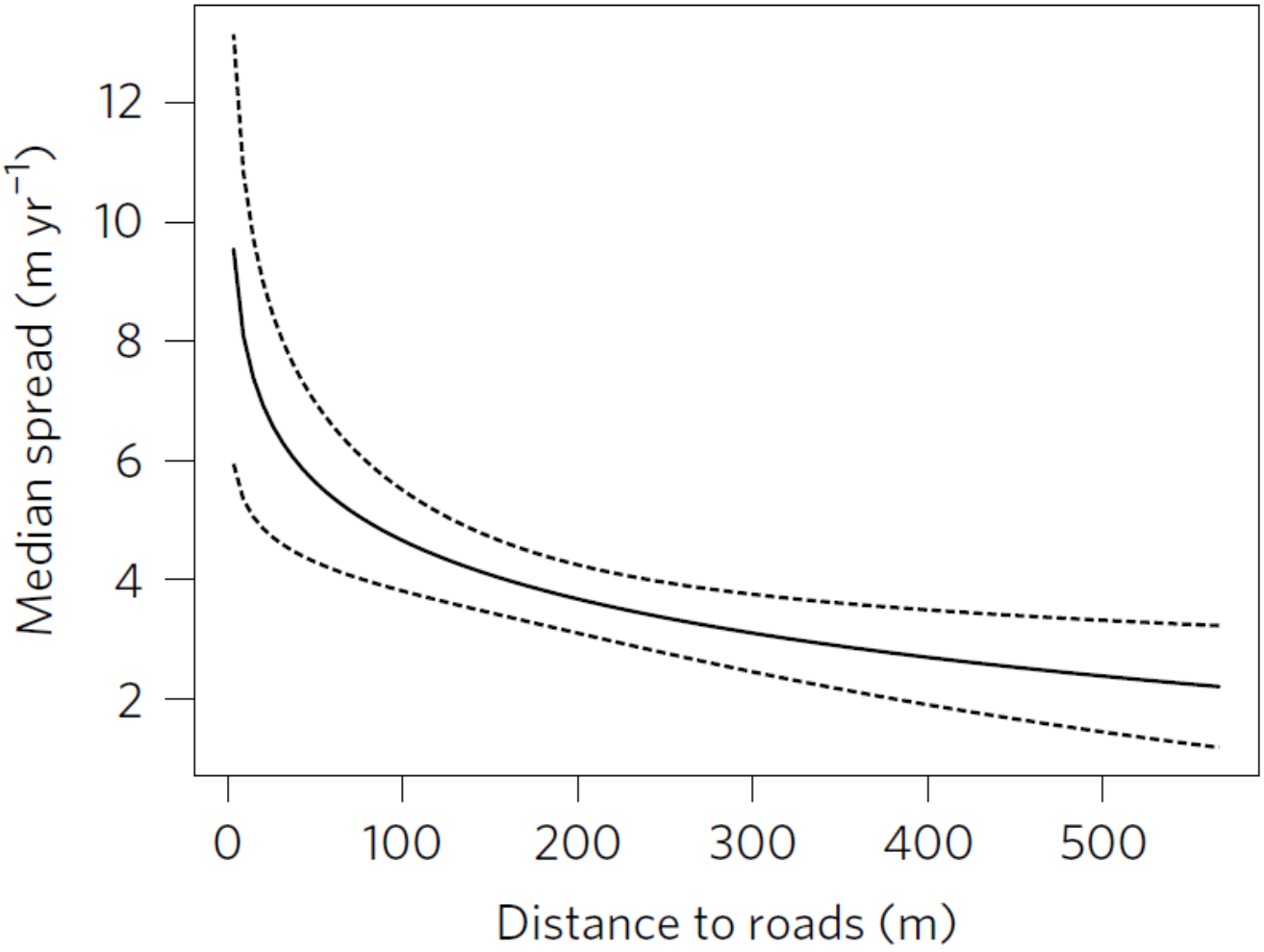
- Dainese et al. (2017) Nature Climate Change 7: 577-580

Vertical spread rate

Climate change 3.85 - 5.54 m/yr



Roads facilitate plant spread



Multiple threats to a mountain ecosystem

- Both native and non-native plants are spreading up on Mt. Baldo
- Native species may struggle to keep up with the rate of climate change
- Roads and human activities facilitate spread, which favors non-native species

Summary

- Even biased occurrence data can be used to quantify habitat occupancy and spread rate
- Sampling bias is a tricky, but data quantity can make up for lack in quality
- Invasive species occupy different habitats and spread faster than native species

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