Sensitivity of European native and alien freshwater bivalve species to climate related environmental factors

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RiverCare
Towards self-sustaining multifunctional rivers

Radboud University

Introduction

- Climate change:
  - Impacts physical habitat of bivalves

  - Extreme discharges
    - Frequency and intensity ↑
    - High discharges → flow velocity ↑
    - Low discharges → desiccation
      water depth ↓

  - High water temperature events
    - Frequency ↑
    - Intensity ↑
    - Dissolved oxygen ↓

- Bivalve biodiversity ↓ → ecosystem functioning ↓

Introduction

- Lack of comprehensive database concerning sensitivity
  - Limiting 1) sound biological conservation efforts of native species
    2) reliable impact assessment of climate change

- Therefore:
  - A systematic assessment of the range of occurrences of all native and alien European bivalves to climate change related environmental factors was performed

- Aim:
  - Do ranges differ between 1) alien and native bivalve species and 2) water body based and habitat based measurements
  - Which groups of species are most sensitive to climate change impacts?

Material and methods

- Literature review:
  - List of the 55 native and alien freshwater bivalves of Europe
  - Google scholar search term varied with environmental factor:
    - '*Pisidium pulchellum*' temperature
  - First 50 hits were assessed. (+ books available in library of RU)

- Acquired data:
  - 493 papers included; 8,405 entries

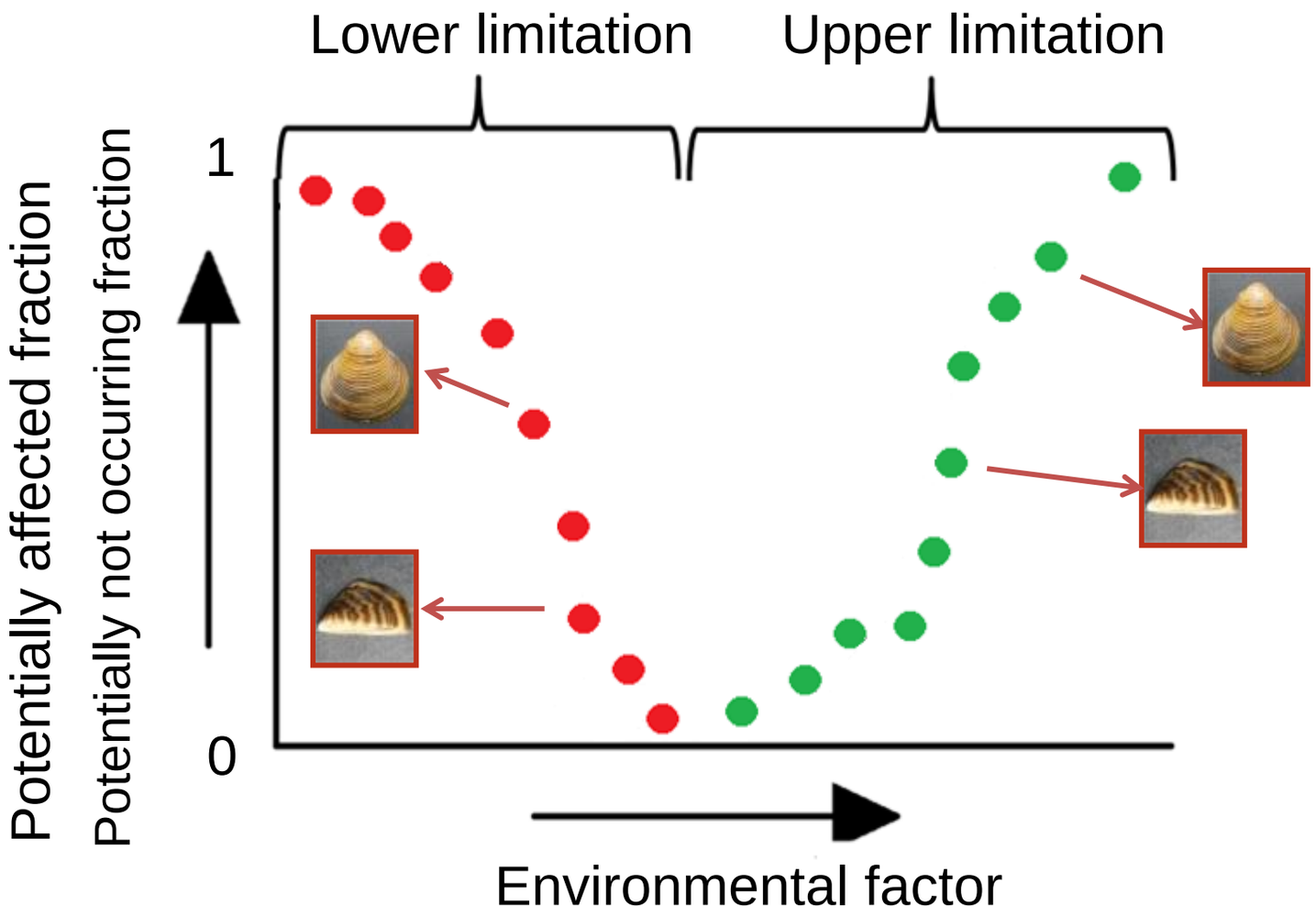
Environmental factor	Search term "Scientific species name" and	Database Included papers (n)	Database Entries (n)	Derived sensitivities Lower limit	Derived sensitivities Upper limit	Derived sensitivities Data source	Derived sensitivities Endpoint
Water temperature	Temperature	311	2009	x	x	Field	Habitat range
				x	x	Field	Water body range
			939		x	Laboratory	Tolerance
Water depth	Depth	257	2899	x	x	Field	Habitat range
Air exposure	Desiccation	16	518		x	Laboratory	Tolerance
Oxygen availability	Oxygen	178	1422	x		Field	Habitat range
				x		Field	Water body range
			72	x		Laboratory	Tolerance
Flow velocity	Flow velocity	84	546	x	x	Field	Water body range*

Material and methods

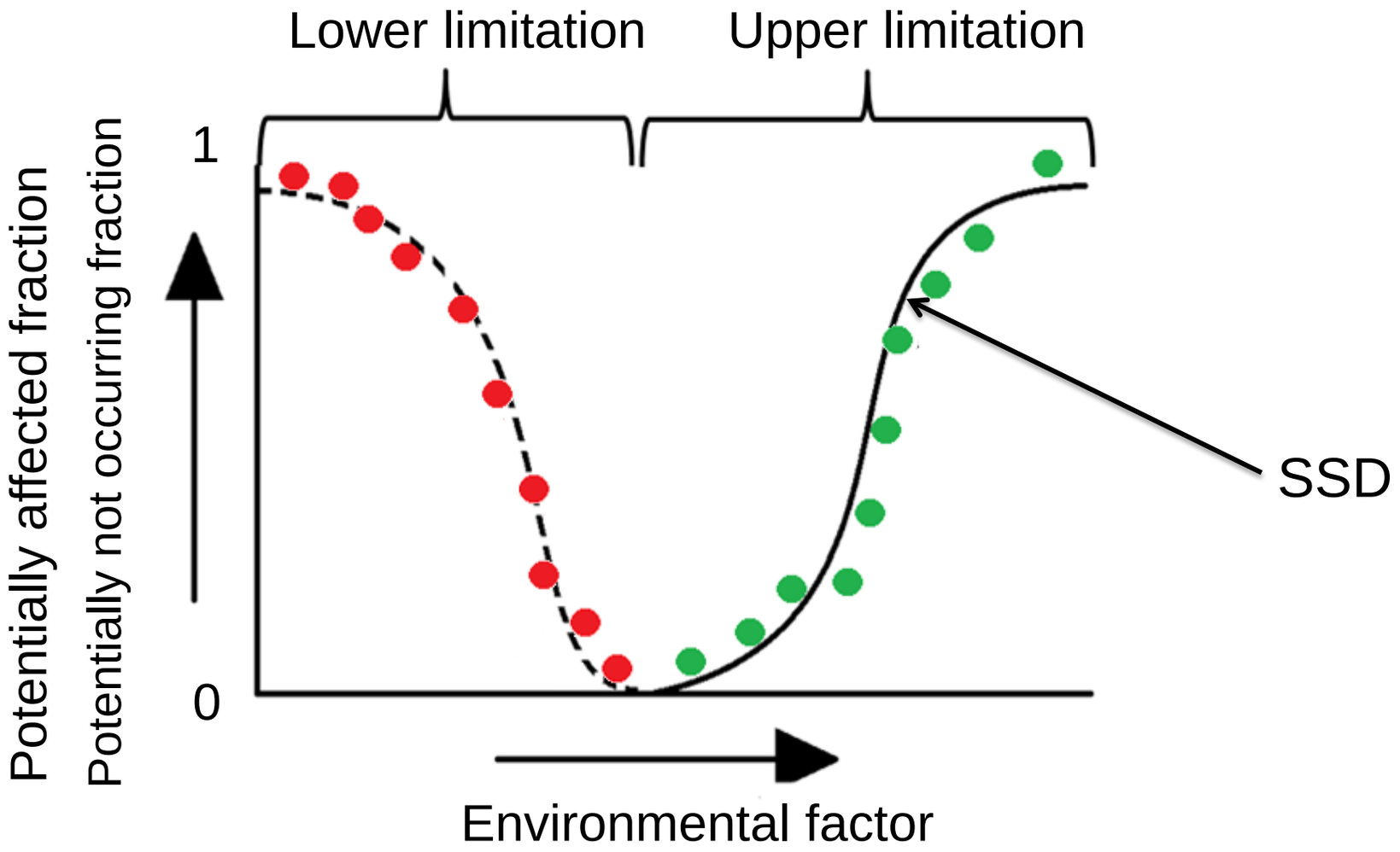
- Deriving occurrences:
  - Habitat occurrence:
    - Measurement performed at the same sampling site and data where a species was found
  - Water body occurrence:
    - Measurement characterising environmental conditions of a water body where a species occurred
  - Laboratory data (when available).

→ Derived sensitivities used for species sensitivity distributions (SSDs)

Species sensitivity distributions (SSDs)

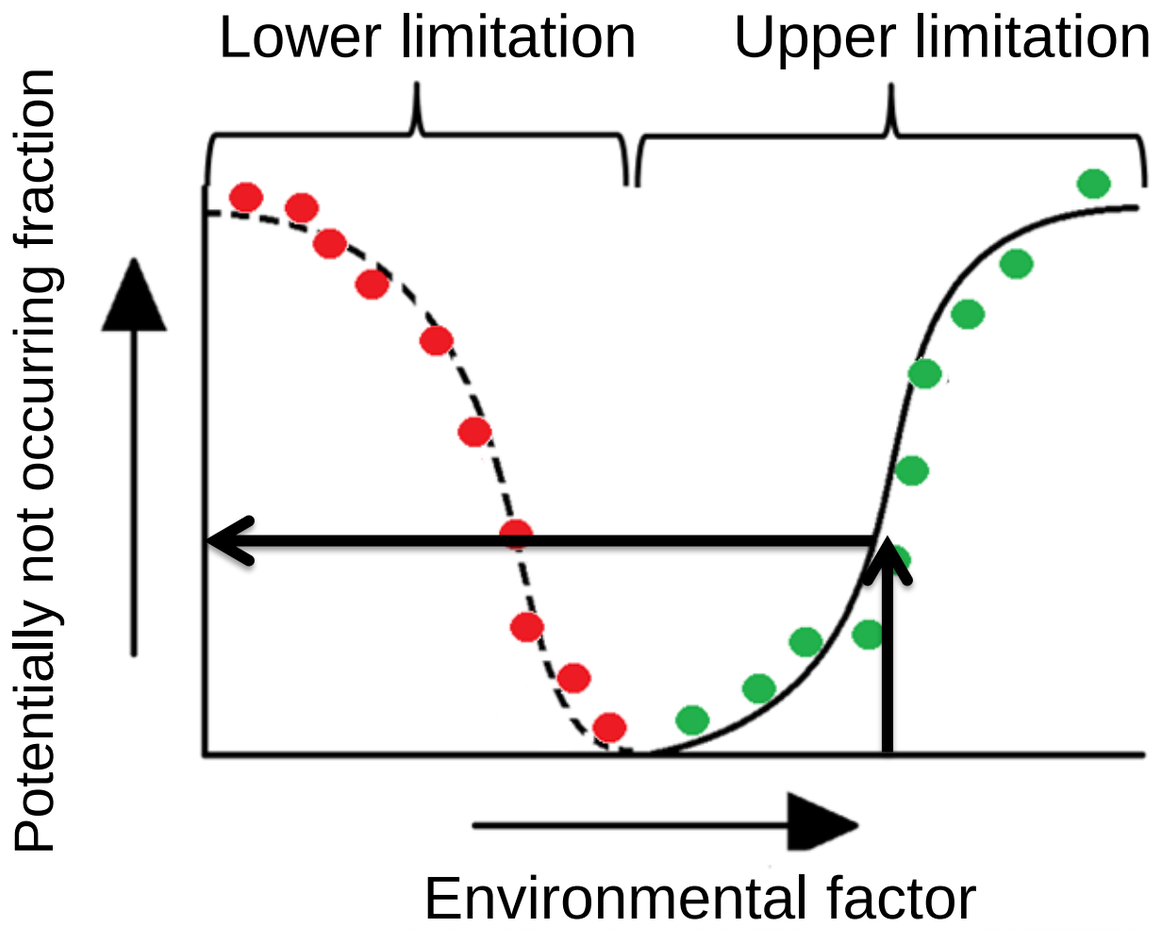


Species sensitivity distributions (SSDs)



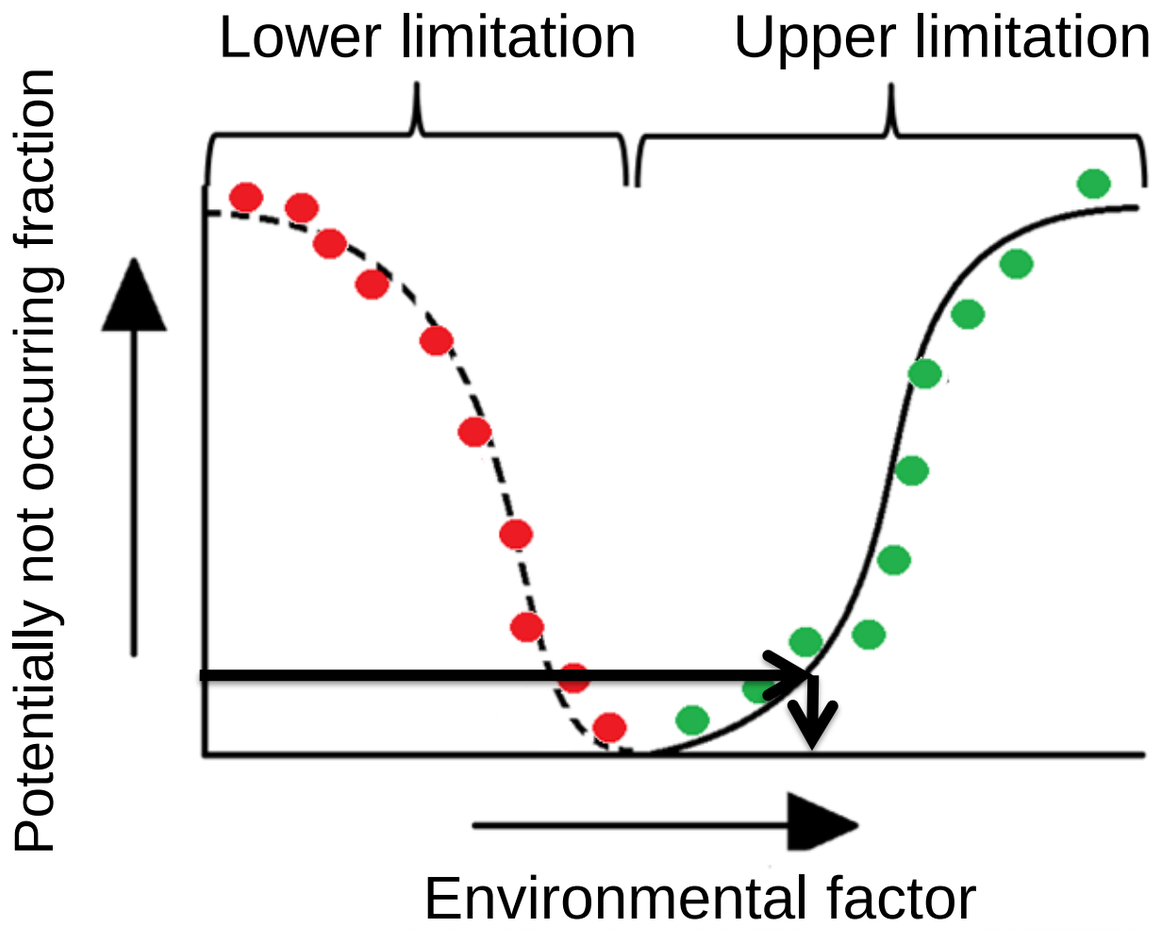
Application SSDs

- The variance among species in their sensitivity to an environmental factor
- Suitable for models
  - Prediction of biodiversity



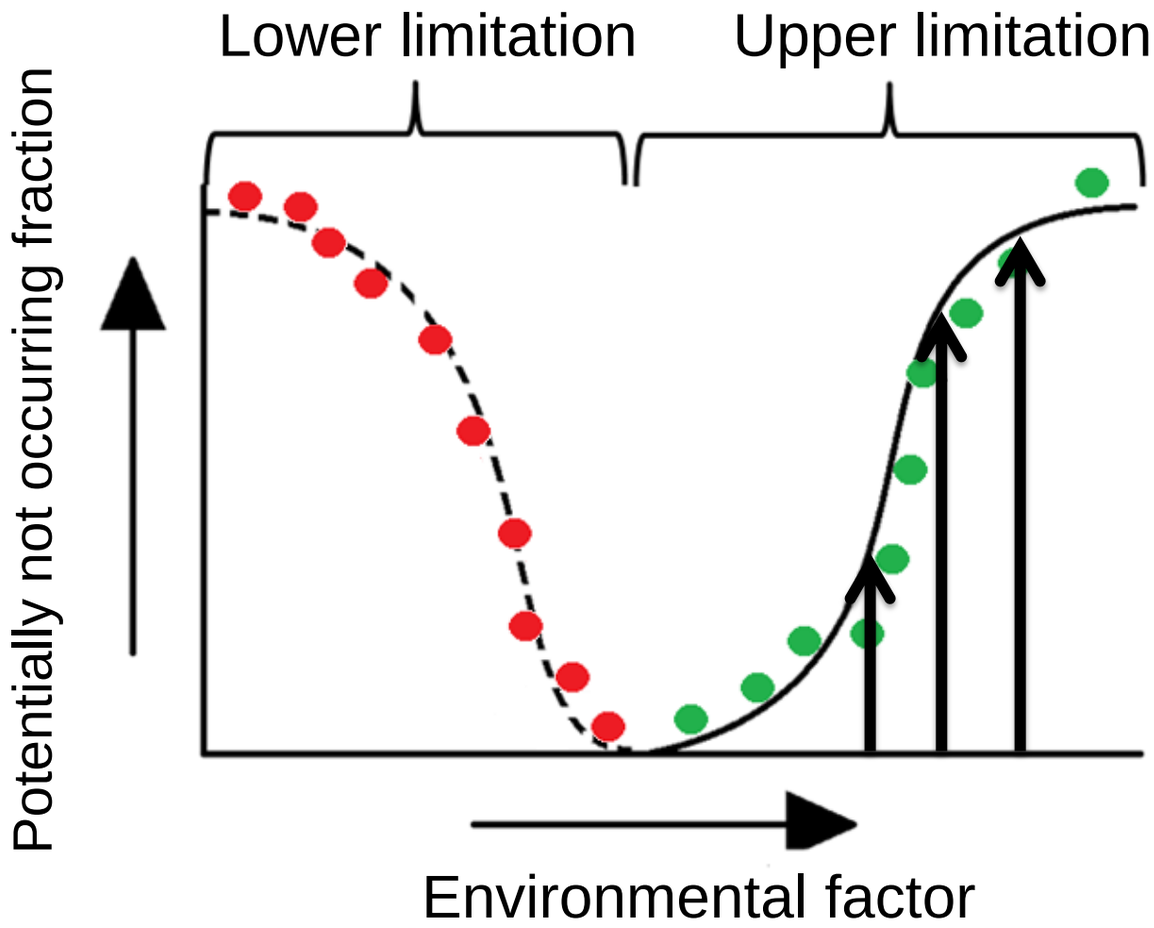
Application SSDs

- The variance among species in their sensitivity to an environmental factor
- Suitable for models
  - Prediction of biodiversity
  - Determining legislative protection levels



Application SSDs

- The variance among species in their sensitivity to an environmental factor
- Suitable for models
  - Prediction of biodiversity
  - Determining legislative protection levels
  - Ranking of environmental factors



Material and methods

- Species sensitivity distributions (SSDs):
  - Species with less then 5 occurrences were not included
  - Data was checked for normality
  - Using the fitdistrplus package a normal distribution was fitted
  - Bootstrapping to acquire 2.5% and 97.5% confidence interval
- Separate SSDs constructed
  - Native versus Invasive/Alien
  - Habitat versus Water body based
- Assessment of relative sensitivity using ranks

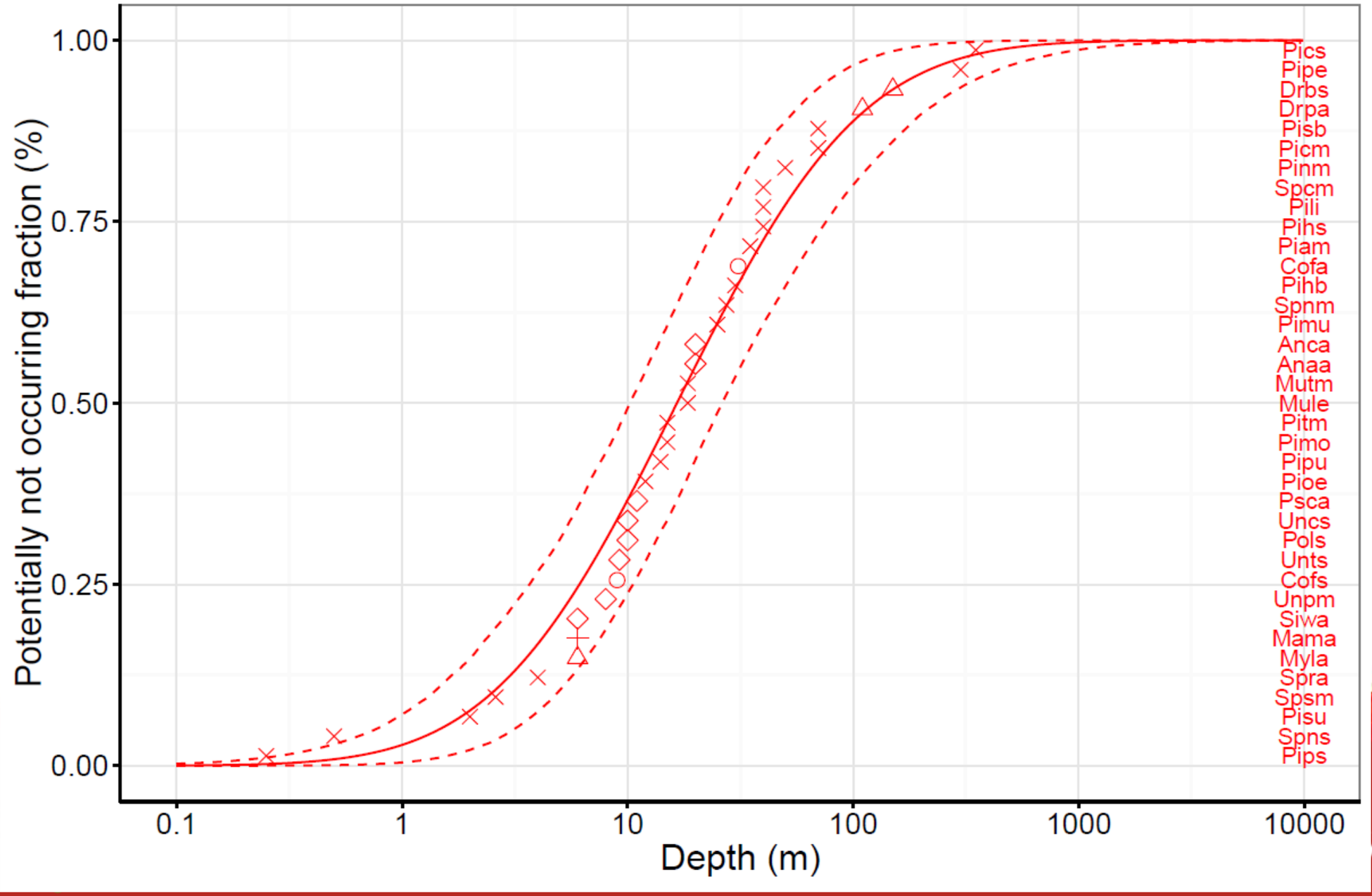
Results

- Sensitivity database

Species	Water temperature (°C) Habitat occurrence Minimum	Maximum	Depth of occurrence (m) Habitat occurrence Minimum	Maximum	Dissolved oxygen (mg/l) Habitat occurrence Minimum	Flow velocity (cm/s) Occurrence Minimum	Maximum
Dreissena rostriformis bugensis	3.5	30.5	0.0	150		0	140
Mytilopsis leucophaeata	5.0	26.1	0.5	6.0	0.0		
Margaritifera auricularia							
Margaritifera margaritifera	8.1	23.5	0.0	6.0	7.74	0	125
Musculium lacustre	8.0	29.5	0.0	18.5	3.5	0	35
Musculium transversum	12.1	22.1	0.05	18.5	5.6	3	40
Pisidium amnicum	0.0	29.5	0.0	35.0	4.6	1	200
Pisidium casertanum	1.5	29.5	0.0	70.0	0.2	0	80
Pisidium conventus	1.0	23.8	0.0	350			
Pisidium henslowanum	2.4	29.5	0.0	40.0	2.6	3.5	33
Pisidium hibernicum			0.0	30.0			
Pisidium lilljeborgii			0.2	40.0			
Pisidium milium	13.1	27.2	0.0	25.0	5.6		
Pisidium moitessierianum	1.0	29.5	0.0	15.0	8.33		
Pisidium nitidum	8.1	29.5	0.0	50.0	10.0	0	200
Pisidium obtusale	8.0	19.6	0.0	12.0			
Pisidium personatum	8.1	15.5	0.0	300		0	25
Pisidium subtruncatum	7.6	29.5	0.0	70.0	0.2	0	50
Pisidium supinum	10.1	29.5	0.3	2.00	6.2	2	90
Pisidium tenuilineatum			0.0	15.0			
Sphaerium corneum	0.0	27.0	0.0	40.0	2.6	0	200
Sphaerium nitidum	4.9	26.2	0.15	27.4	6.4		
Sphaerium nucleus			0.1	0.5			
Sphaerium rivicola	11.8	18.0	0.5	4.0	7.35	2	200
Sphaerium solidum			0.0	2.60		3.5	100

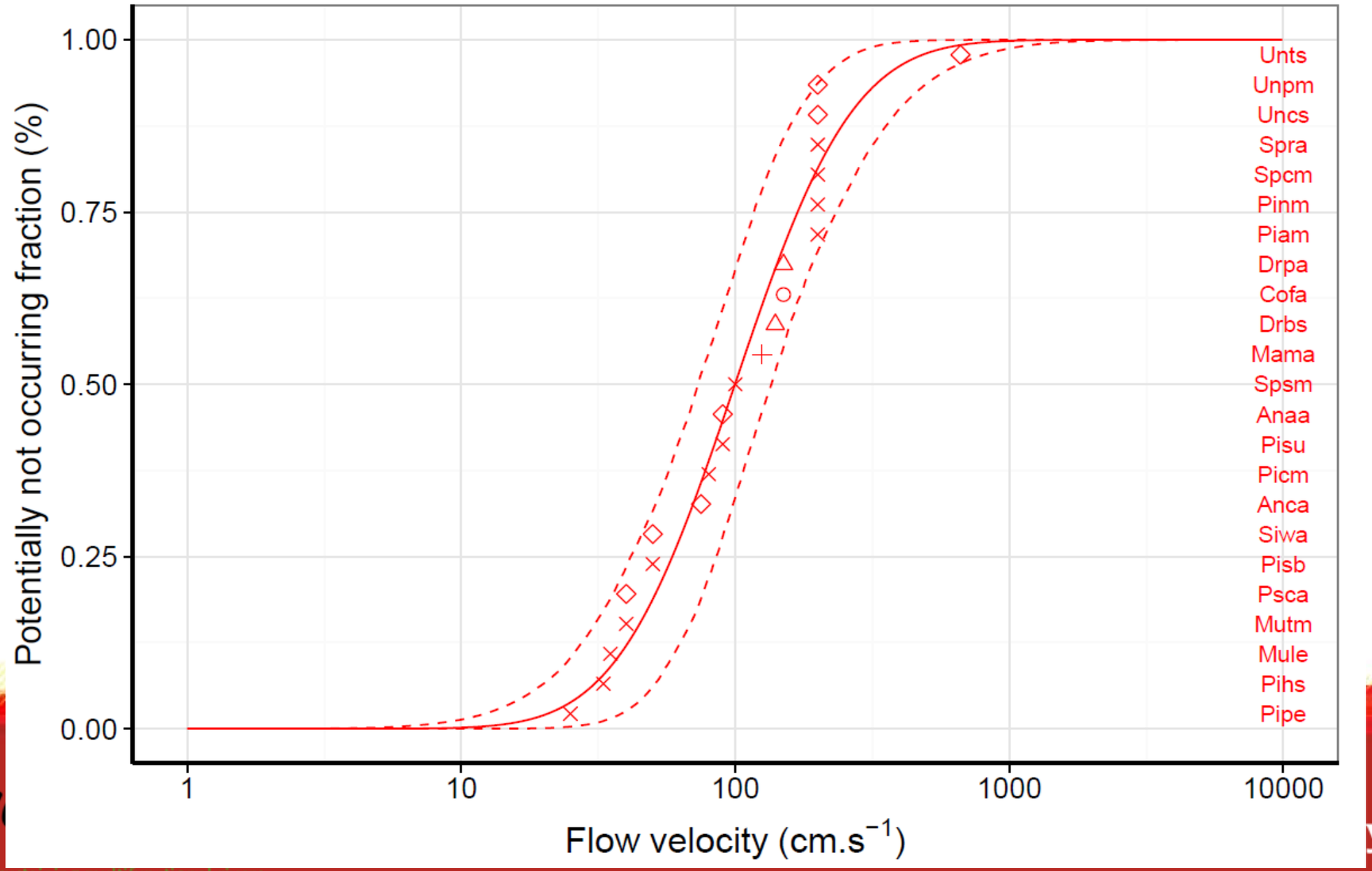
Results

- Species sensitivity distributions (SSDs)
  - Depth: maximum habitat occurrence



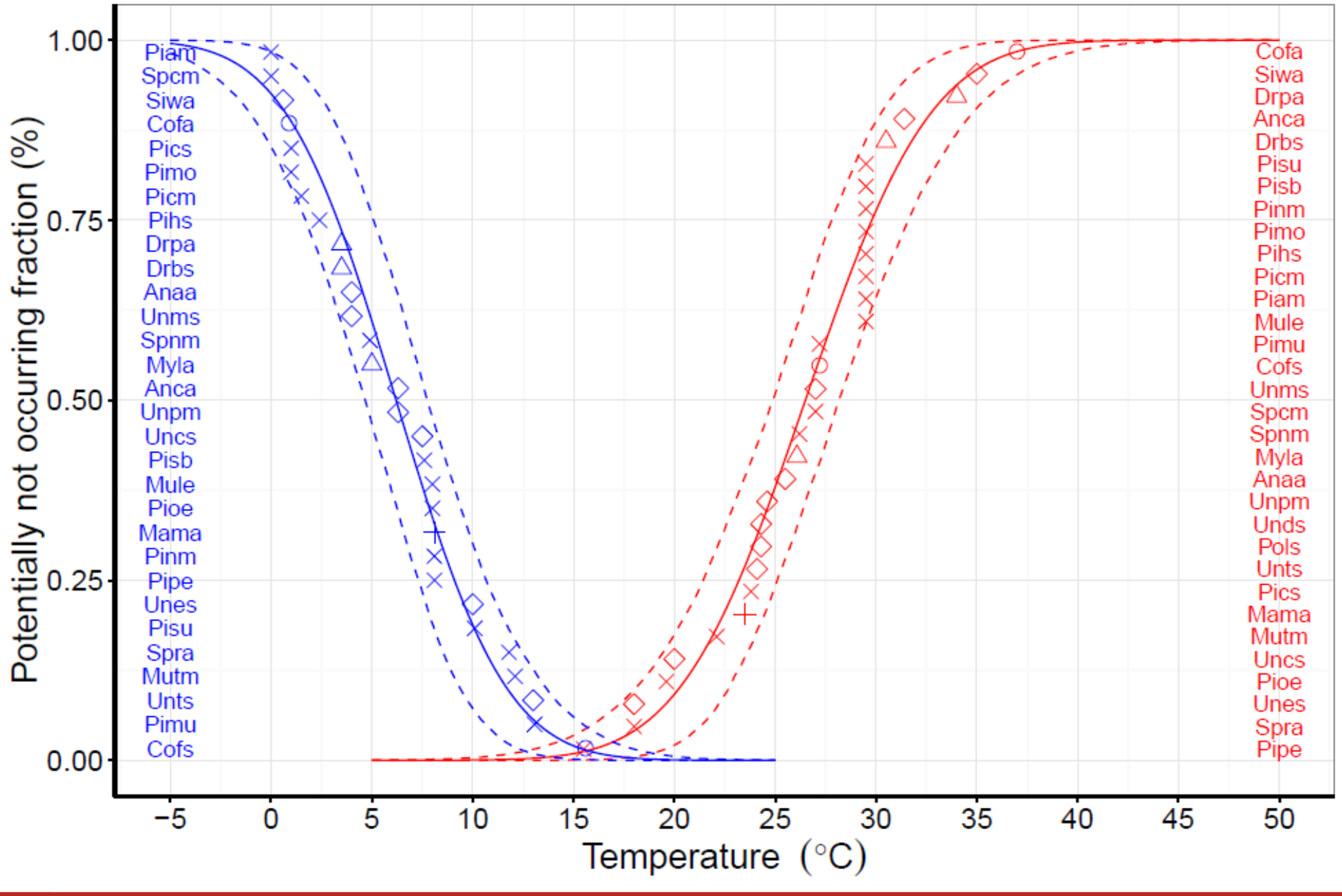
Results

- Species sensitivity distributions (SSDs)
  - Flow velocity: maximum



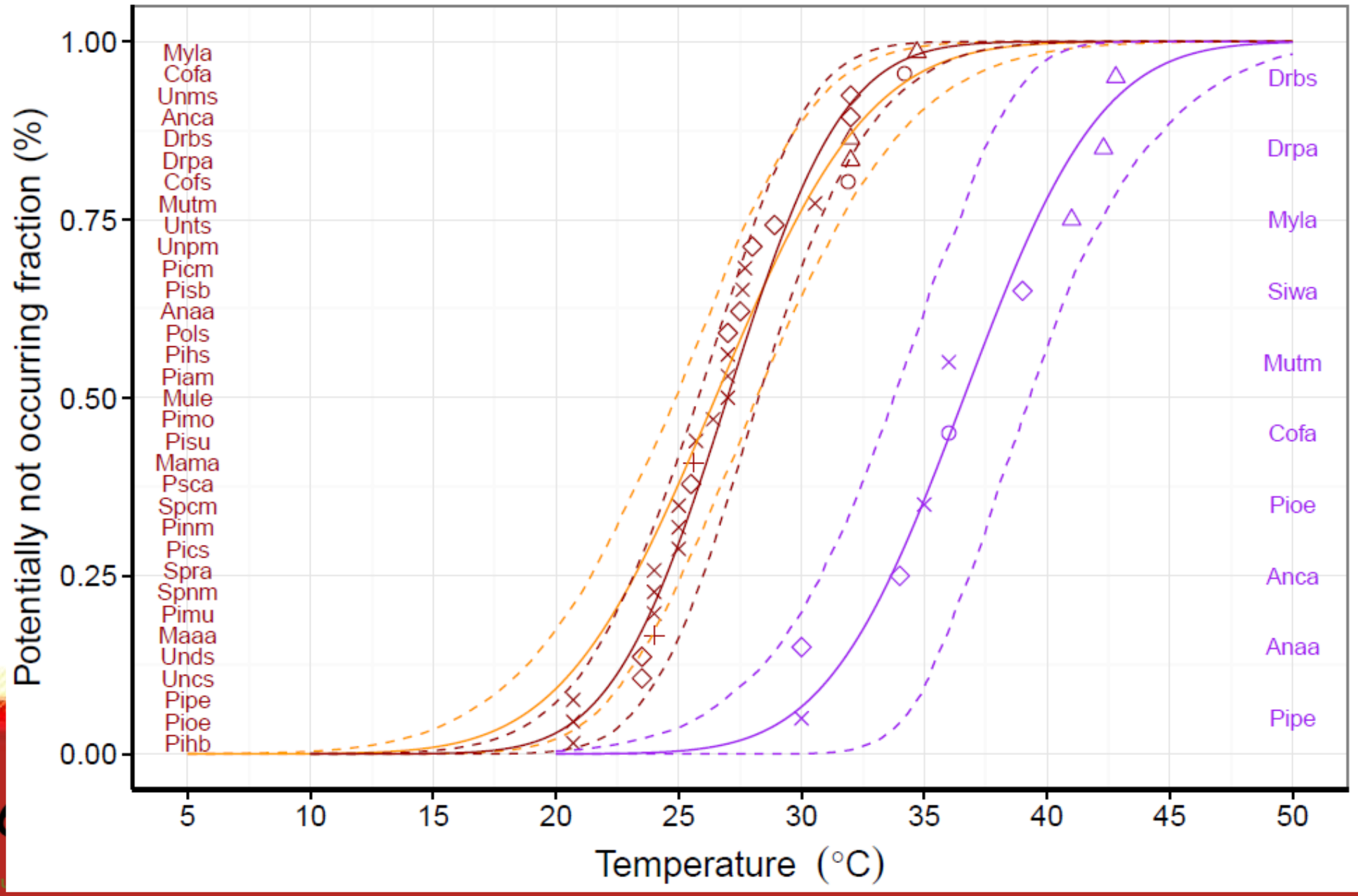
Results

- Species sensitivity distributions (SSDs)
  - Temperature: minimum and maximum habitat occurrence



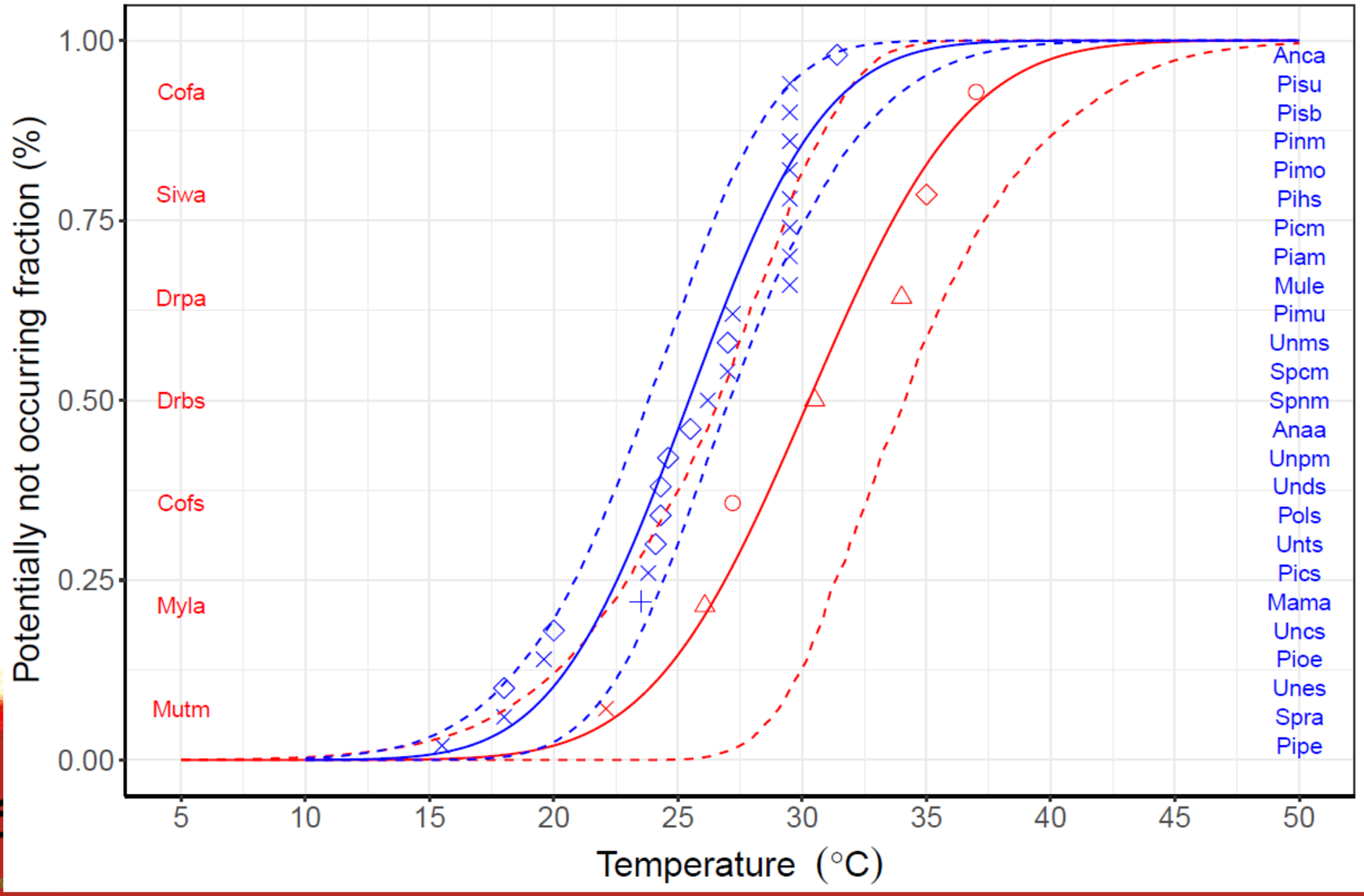
Results

- Species sensitivity distributions (SSDs)
  - Temperature: maximum lab versus field



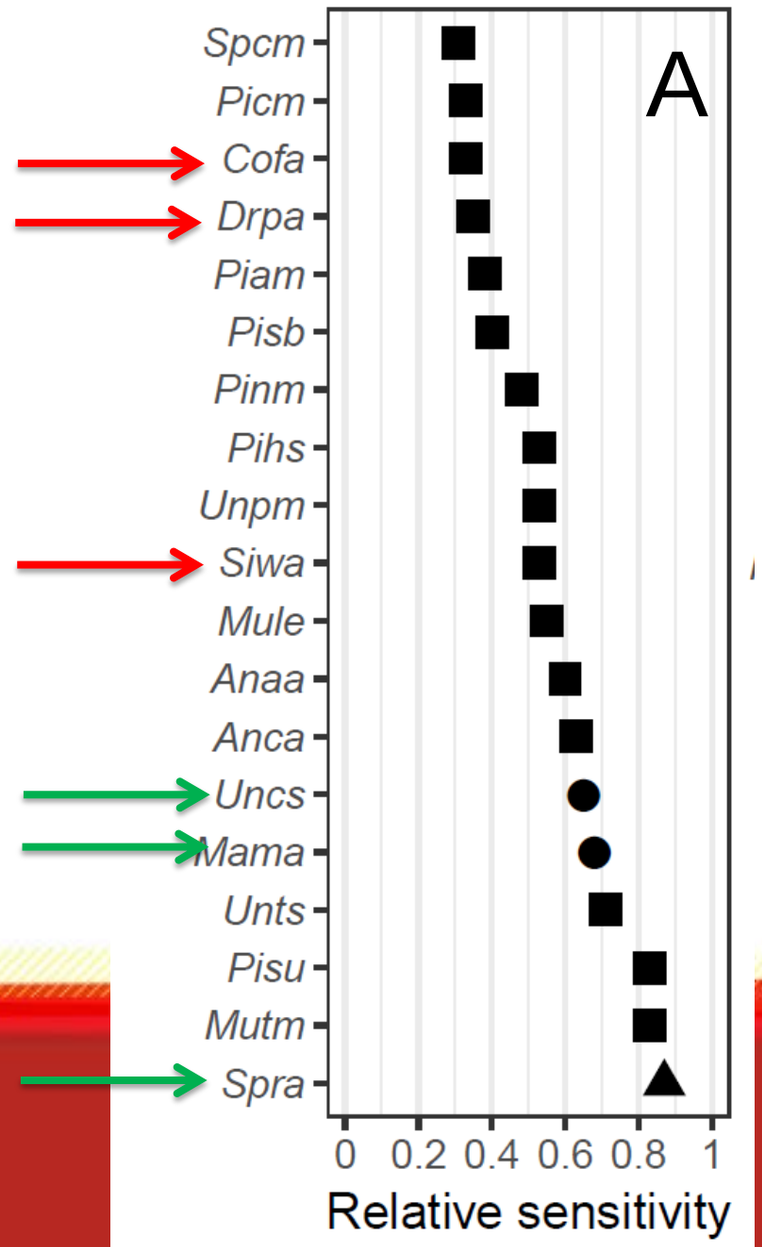
Results

- Species sensitivity distributions (SSDs)
  - Temperature: maximum invasive/alien vs native



Results

- Relative sensitivity
  - All environmental factors assessed (18 n)



Conclusion

- Maximum temperature: invasive/alien > native

  →Expected increase in global temperatures affects native species more than alien species

- Relative sensitivity: alien > endangered

  →Endangered species will be more affected by climate change

- Future research:
  - Acquiring data for more alien and native European riverine species (Fish, Crayfish, Aquatic macrophytes)
  - PNOF prediction based on climate models and field data
  - Application in management

Questions?