Ecological niche shifts of understory plants along a latitudinal gradient of temperate deciduous forests

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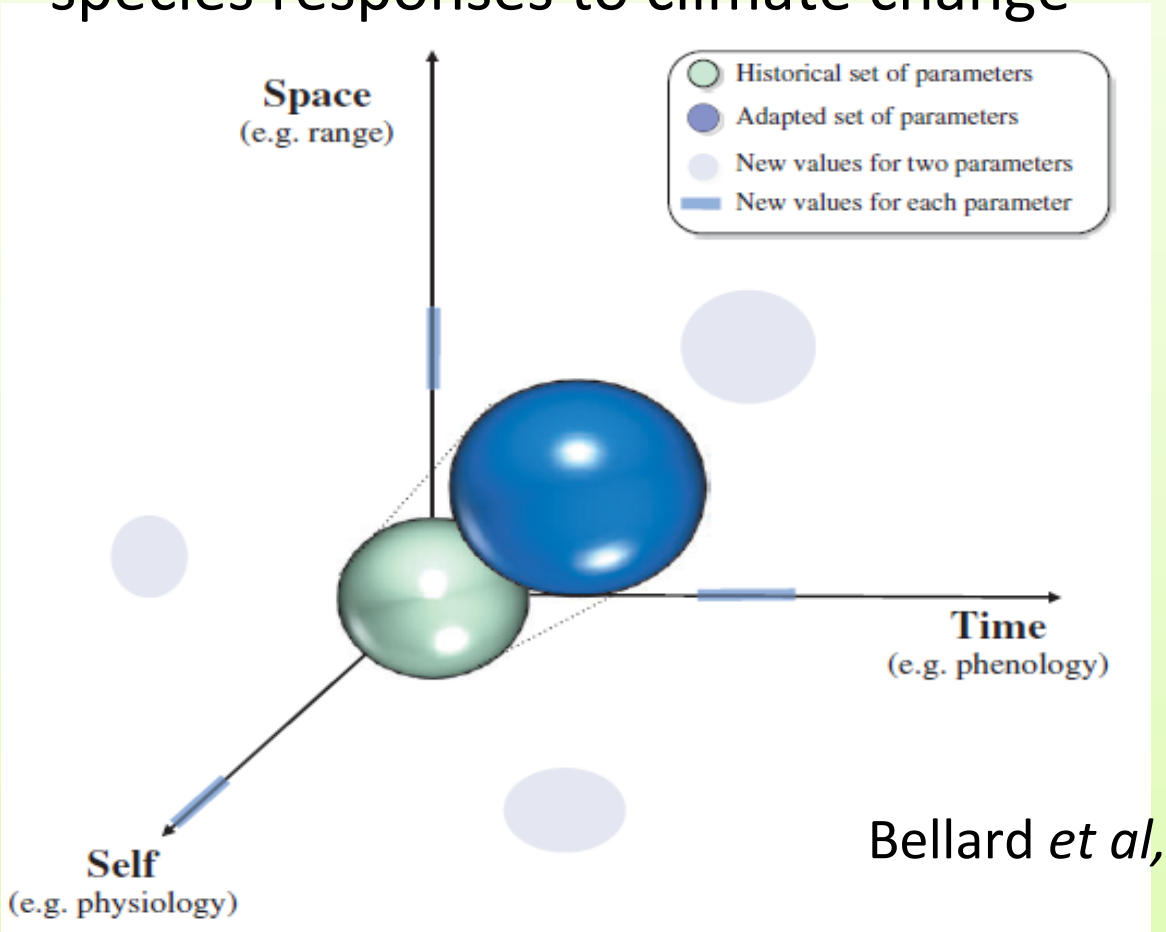
Research question :

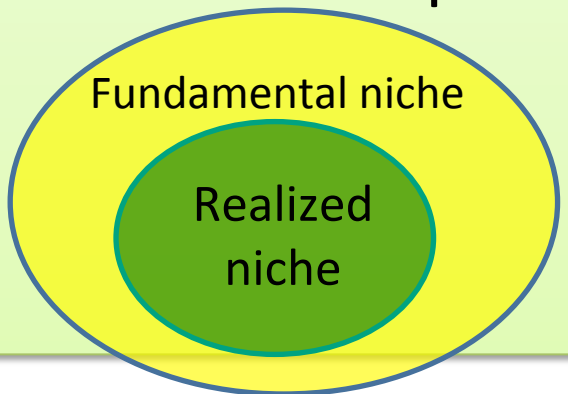
- climate change and biological diversity
- species responses to climate change



Bellard *et al, 2012, Ecology lettre*

Research question :

- Ecological niche:
  - role it plays in ecosystem
  - n-dimensional hyper-volume (Hutchinson 1957)
- Fundamental niche: full potential range of conditions and resources it could theoretically use if there were no direst competition from other species
- Realized niche: when a species usually occupies only part of its fundamental niche in a particular ecosystem



Research question :

- climate change affects distributional range of plant species (Lenoir *et al*, 2008)
- modifications within the ecological niche species are unlikely to happen

↳ amplitude

↳ optimum

⇓

IS IT TRUE??

⇓

➤ Latitudinal gradient

❑ amplitude = ∫ (latitude) ?

❑ optimum = ∫ (latitude) ?

Materiels

- study area
- Common species pool across the 14 studied windows
- Richness gradient
- Climatic gradient
- Environmental gradients

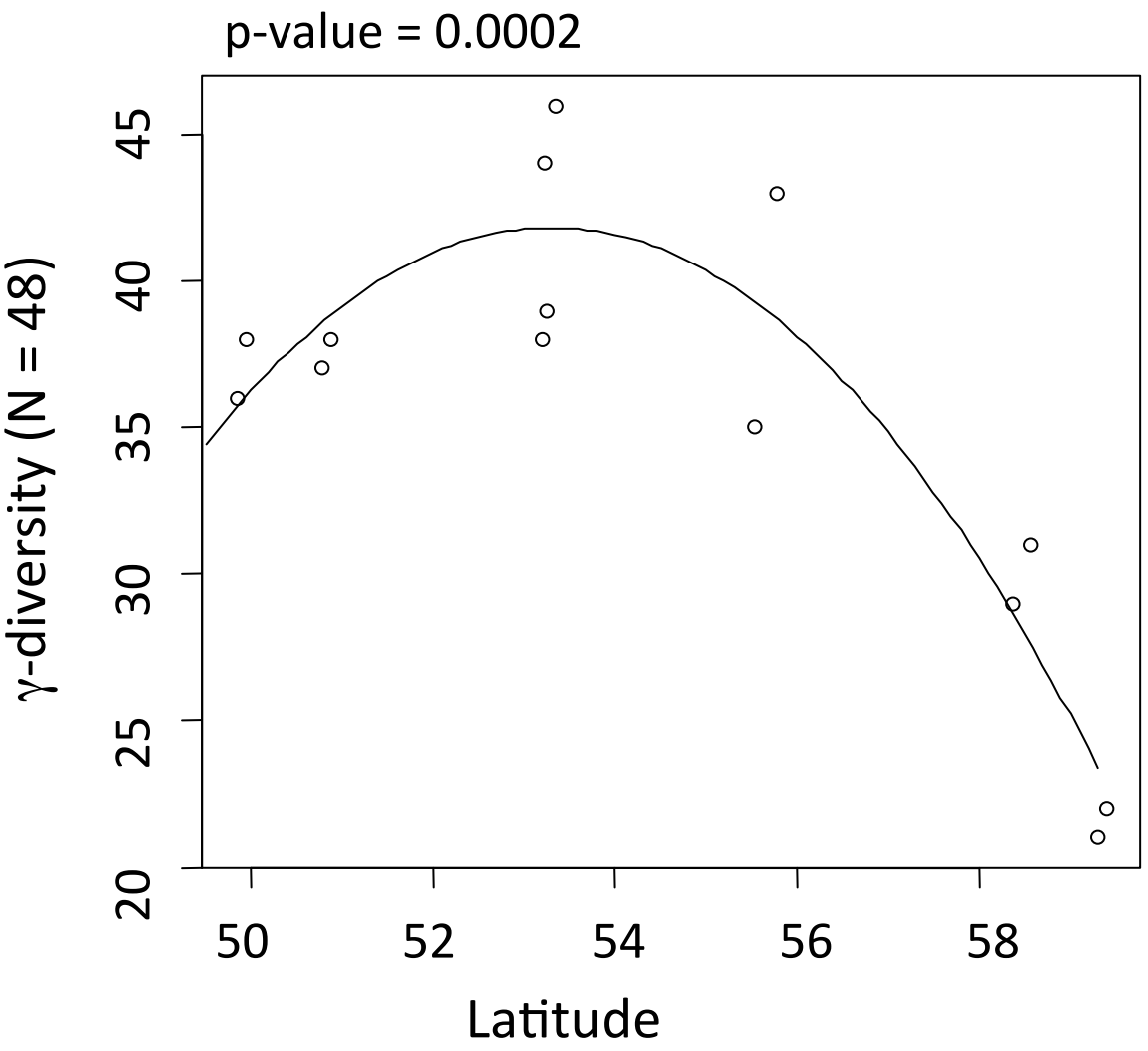
Location of windows study

Common species pool

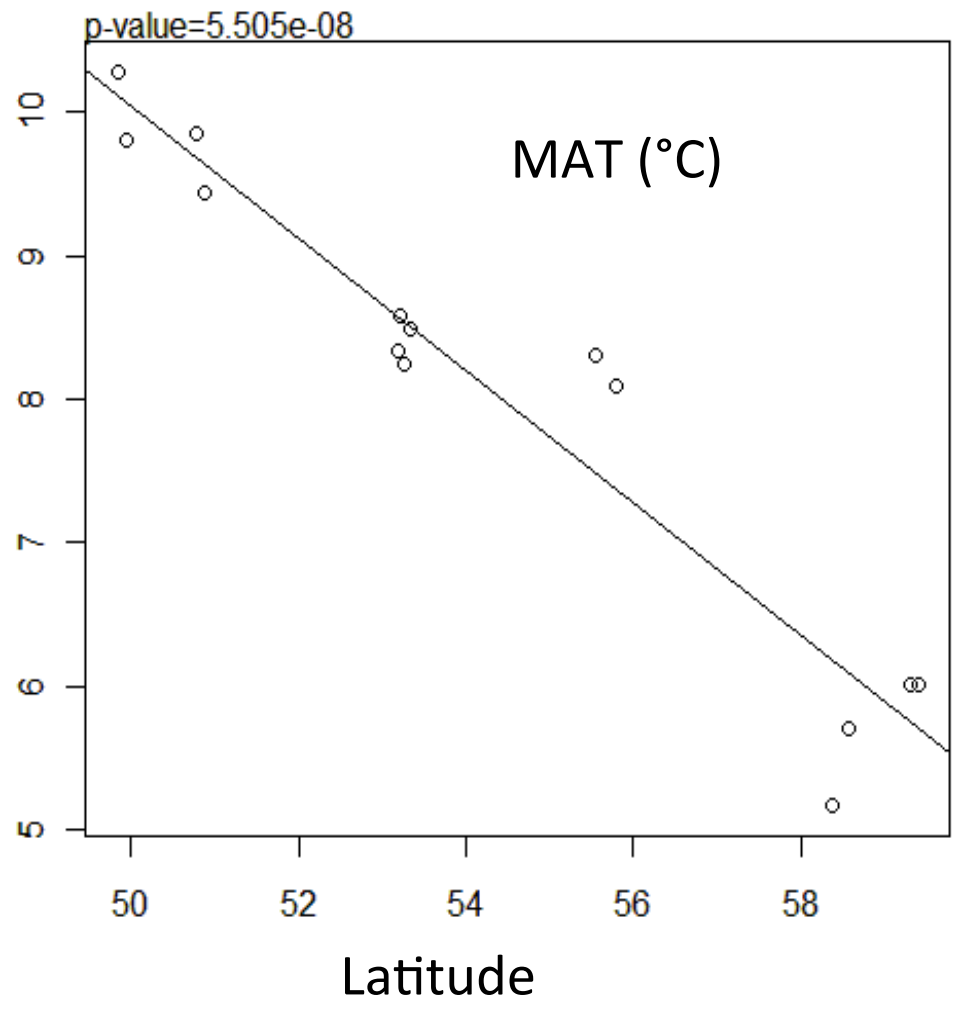
- 48 common species across the windows
- 26 species present in at least 10 windows

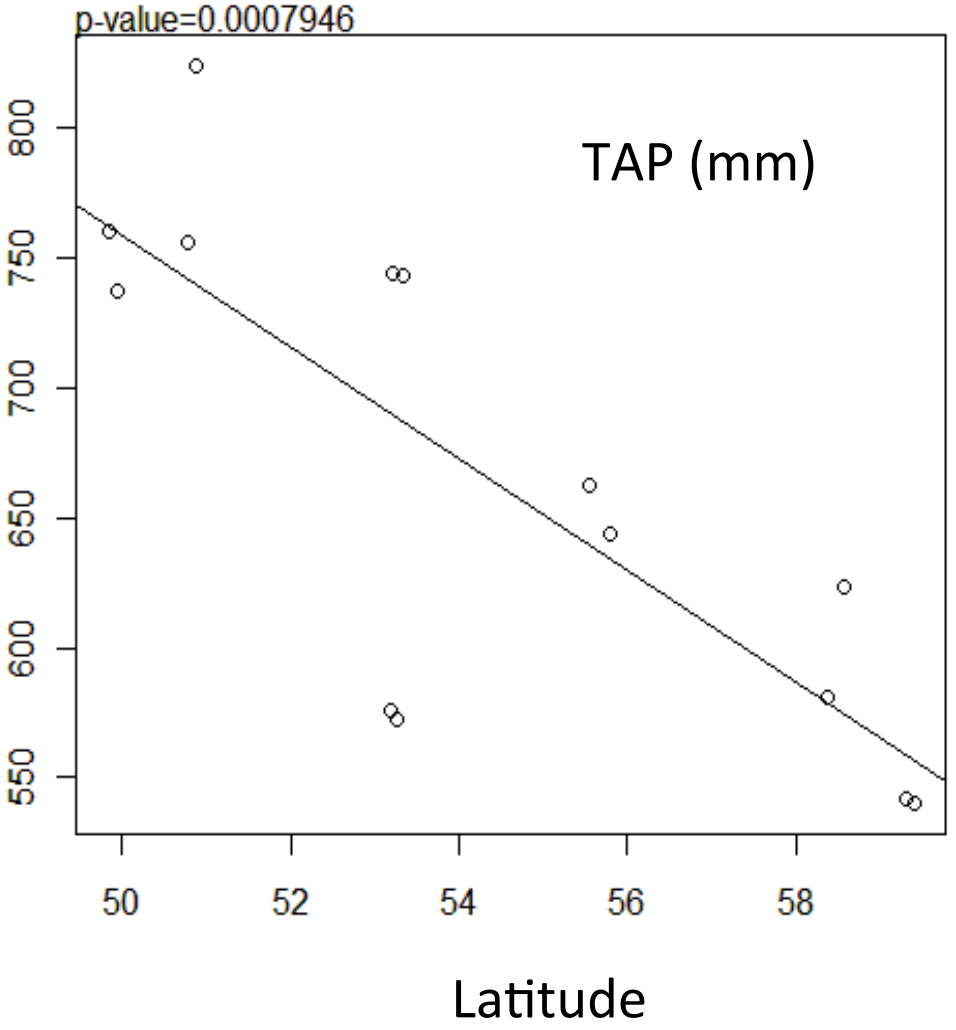
Adoxa moschatellina	*Allium ursinum*
Anemone nemorosa	***Athyrium filix-femina***
Brachypodium sylvaticum	*Campanula trachelium*
Cardamine flexuosa	*Carex remota*
Carex sylvatica	*Chrysosplenium alternifolium*
Circaea lutetiana	***Convallaria majalis***
Deschampsia flexuosa	***Dryopteris carthusiana***
Dryopteris filix-mas	***Epipactis helleborine***
Equisetum sylvaticum	***Festuca gigantea***
Galium odoratum	*Hedera helix*
Impatiens noli-tangere	*Impatiens parviflora*
Lamium galeobdolon	*Listera ovata*
Luzula pilosa	*Lysimachia nemorum*
Maianthemum bifolium	*Melampyrum pratense*
Melica uniflora	*Mercurialis perennis*
Milium effusum	***Moehringia trinervia***
Mycelis muralis (Lactuca muralis)	***Oxalis acetosella***
Paris quadrifolia	*Platanthera chlorantha*
Poa nemoralis	***Polygonatum multiflorum***
Primula elatior	*Rumex sanguineus*
Sanicula europaea	***Scrophularia nodosa***
Silene dioica (Melandrium dioicum)	***Stachys sylvatica***
Stellaria holostea	*Stellaria nemorum*
Vaccinium myrtillus	*Veronica montana*

Richness gradient

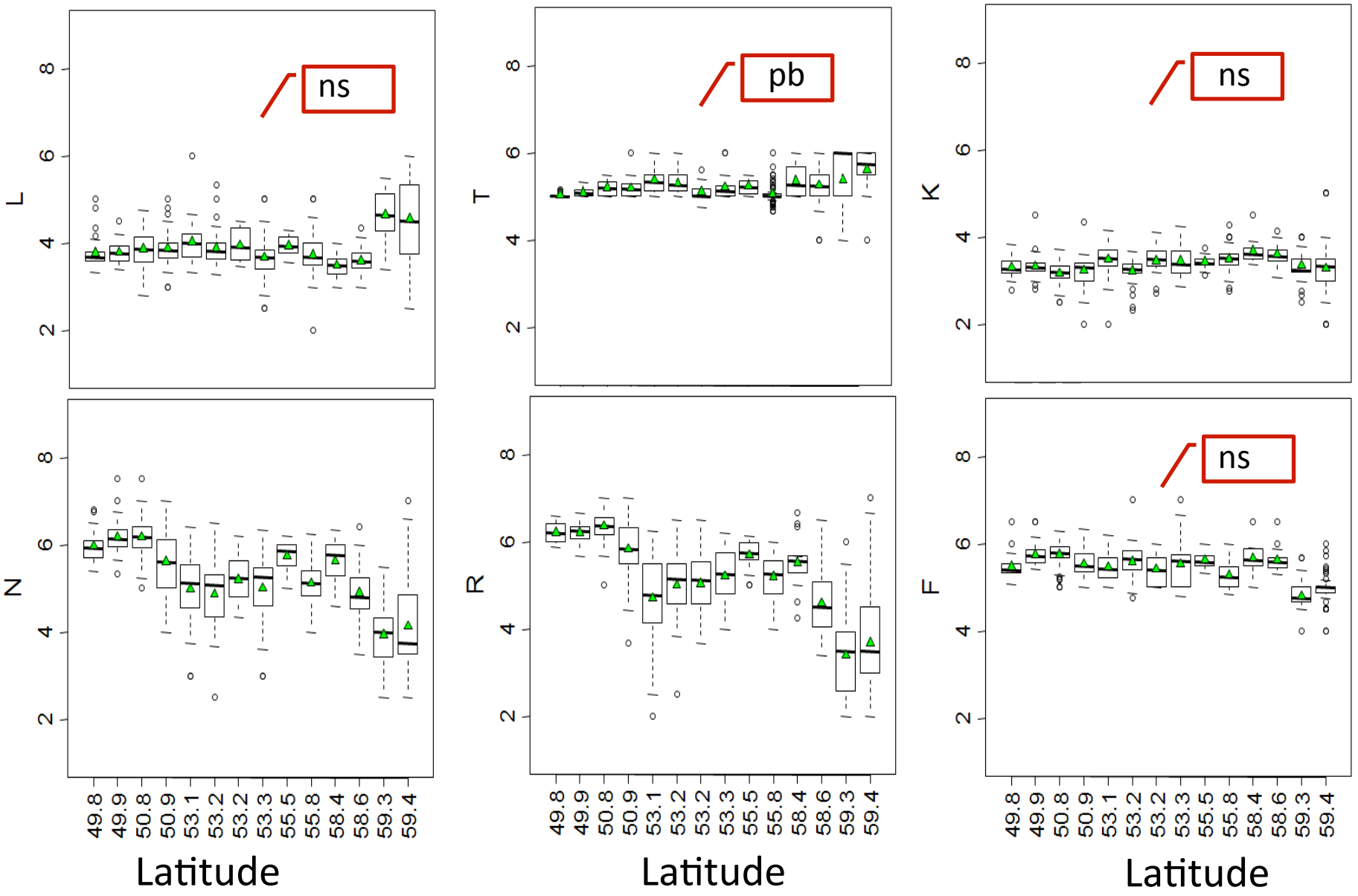


Climatic gradients: NewLocClim 1.10 (FAO 2005)

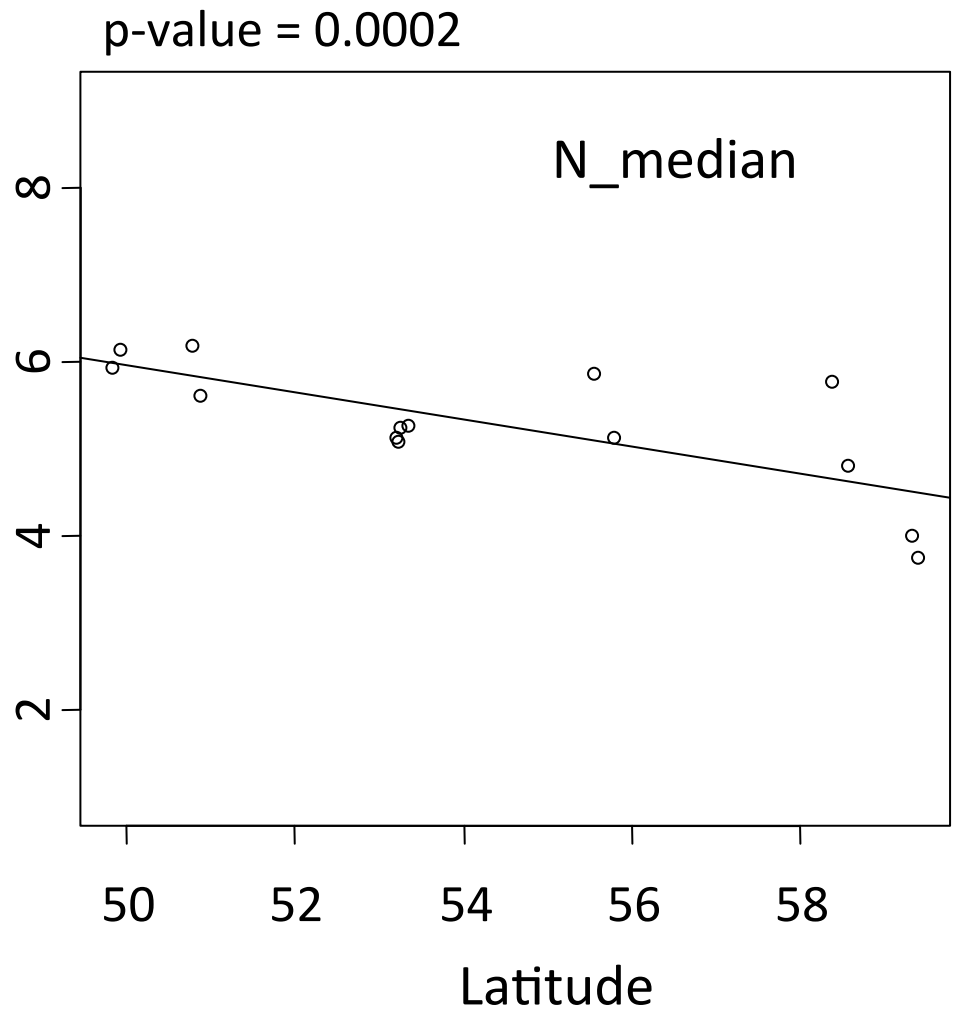


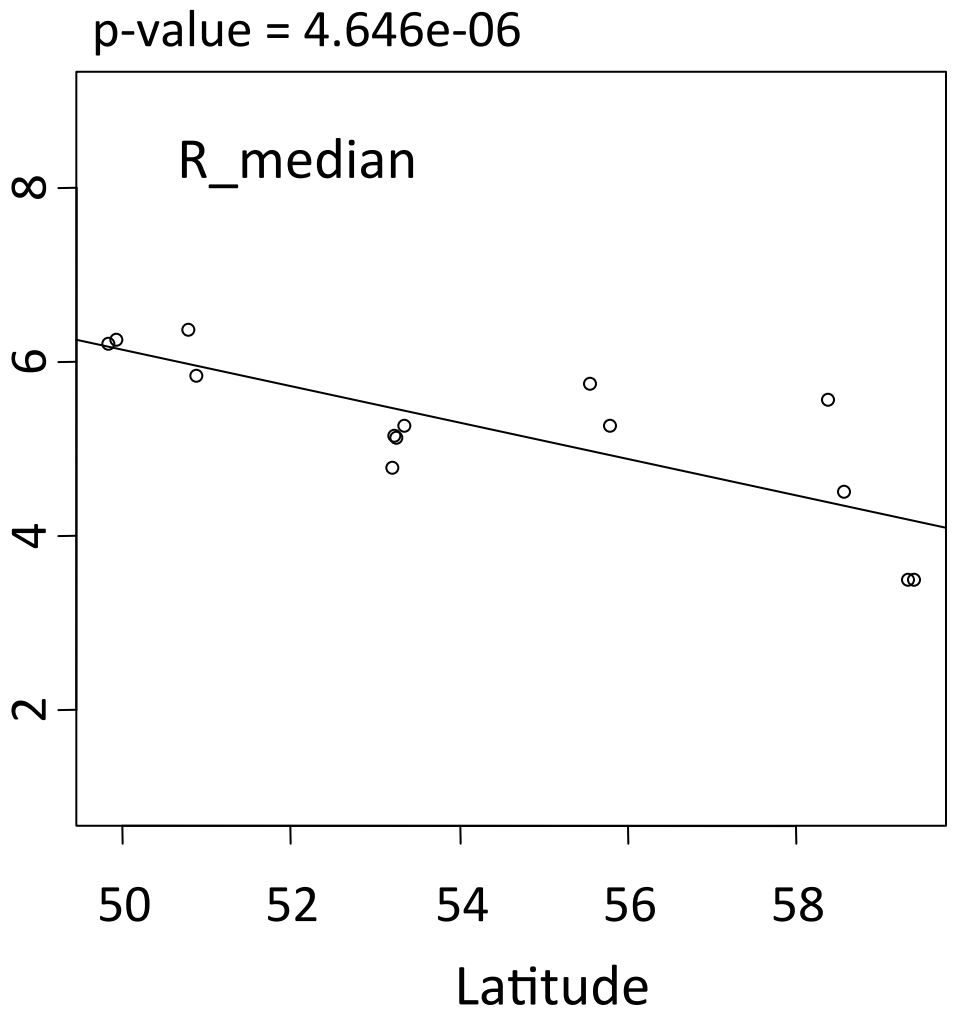


Environmental gradients: EIVs from 48 species



Environmental gradients: EIVs from 48 species





methods

- Amplitude: θ Fridley + target species

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Co-occurrence based assessment of habitat generalists and specialists: a new approach for the measurement of niche width

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- Generalist : many co-occurring species → occur in many different
- Specialist: few co-occurring species → occur the same habitat

Amplitude conserve but optimum shift

- Optimum → target species + Ellenberg

Results and discussion

❖ 4 major groups of response:

- Species whose θ increase along the gradient
- Species whose θ follow a concave relationship along the gradient
- Species whose θ follow a convex relationship along the gradient
- Species whose θ is invariant along the gradient

species	Theta ~ latitude	SR of community hosting target species ~ latitude	Median EIVs	
			N	R
Athyrium filix-femina	Niche expansion	∩***	ns	***
Convallaria majalis		∩*	ns	**
Luzula pilosa		ns	***	***
Oxalis acetosella		∩***	*	*
Equisetum sylvaticum		∩*	∩*	∩*

species	Theta ~ latitude	SR of community hosting target species ~ latitude	Median EIVs	
			N	R
Athyrium filix-femina	/*	∩***	ns	***
Convallaria majalis	/***	∩*	ns	**
Luzula pilosa	/**	ns	**	***
Oxalis acetosella	/**	∩***	*	*
Equisetum sylvaticum	/***	∩*	∩*	∩*

Local adaptation

species	Theta ~ latitude	SR of community hosting target species ~ latitude	Median EIVs	
			N	R
Carex sylvatica	Niche modification	ns	ns	*
Brachypodium sylvaticum		ns	ns	ns
Lamium galeobdolon		ns	ns	∪**
Epipactis helleborine		ns	ns	ns

species	Theta ~ latitude	SR of community hosting target species ~ latitude	Median EIVs	
			N	R
Carex sylvatica	∪**	ns	ns	*
Brachypodium sylvaticum	∪**	ns	ns	ns
Lamium galeobdolon	∪**			
Epipactis helleborine	∩**	ns	ns	ns

No local adaptation

species	Theta ~ latitude	SR of community hosting target species ~ latitude	Median EIVs	
			N	R
Adoxa moschatellina	Conserved niche width	ns	ns	*
Anemone nemorosa		∩***	*	***
Circaea lutetiana		ns	ns	**
Deschampsia flexuosa		∩***	ns	***
Dryopteris carthusiana		∩***	ns	***
Dryopteris filix-mas		∩**	ns	**
Maianthemum bifolium		∩***	ns	**
Milium effusum		∩***	*	**
Moehringia trinervia		∩*	ns	**
Paris quadrifolia		*	*	**
Poa nemoralis		∩*	***	**
Polygonatum multiflorum		∩***	***	ns
Scrophularia nodosa		∩*	**	**
Stachys sylvatica		∩**	***	ns
Stellaria holostea		**	***	∪**
Festuca gigantea		∩***	∪***	∪*

species	Theta ~ latitude	SR of community hosting target species ~ latitude	Median EIVs	
			N	R
Adoxa moschatellina	ns	ns	ns	*
Anemone nemorosa	ns	∩***	*	***
Circaea lutetiana	ns	ns	ns	**
Deschampsia flexuosa	ns	∩***	ns	***
Dryopteris carthusiana	ns	∩***	ns	***
Dryopteris filix-mas	ns	∩**	ns	**
Maianthemum bifolium	ns	∩***	ns	**
Milium effusum	ns	∩***	*	**
Moehringia trinervia	ns	∩*	ns	**
Paris quadrifolia	ns	*	*	**
Poa nemoralis	ns	∩*	**	**
Polygonatum multiflorum	ns	∩***	**	ns
Scrophularia nodosa	ns	∩*	**	**
Stachys sylvatica	ns	∩**	***	ns
Stellaria holostea	ns	**	***	∪**
Festuca gigantea	ns	∩***	∪***	∪*
Vaccinium myrtillus	ns	ns	∩*	*

Local adaptation

species	Theta ~ latitude	SR of community hosting target species ~ latitude	Median EIVs	
			N	R
Adoxa moschatellina	ns	ns	ns	*
Anemone nemorosa	ns	∩***	*	***
Circaea lutetiana	ns	ns	ns	**
Deschampsia flexuosa	ns	∩***	ns	***
Dryopteris carthusiana	ns	∩***	ns	***
Dryopteris filix-mas	ns	∩**	ns	**
Maianthemum bifolium	ns	∩***	ns	**
Milium effusum	ns	∩***	*	**
Moehringia trinervia	ns	∩*	ns	**
Paris quadrifolia	ns	*	*	**
Poa nemoralis	ns	∩*	***	**
Polygonatum multiflorum	ns	∩***	***	ns
Scrophularia nodosa	ns	∩*	**	**
Stachys sylvatica	ns		***	ns
Stellaria holostea	ns			
Festuca gigantea	ns	∩***		
Vaccinium myrtillus	ns	ns	∩*	*

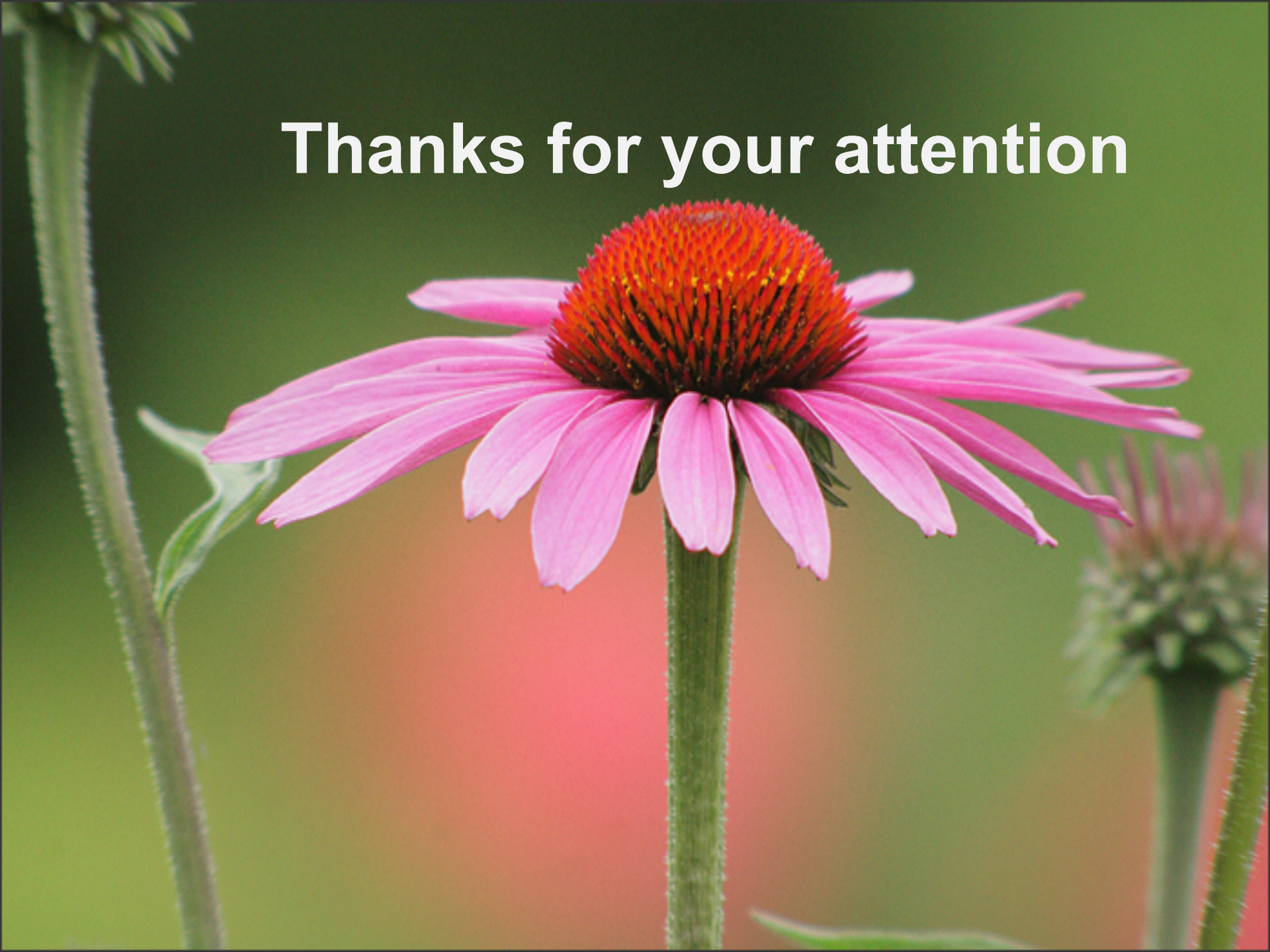
Niche modification

conclusion

- Species would be able to modify their ecological niche to cope with environmental changes??

- Adaptation potential of many forest understory species to climate change will likely be a key feature for their short- and long-term persistence

- Difference in species responses to environmental changes could alter future understory community dynamics by changing relative abundance of species and their inter-specific relationships


Thanks for your attention