

Managing invertebrate diversity in contrasting forest environments: lessons from natural forests in Canada and Irish plantations

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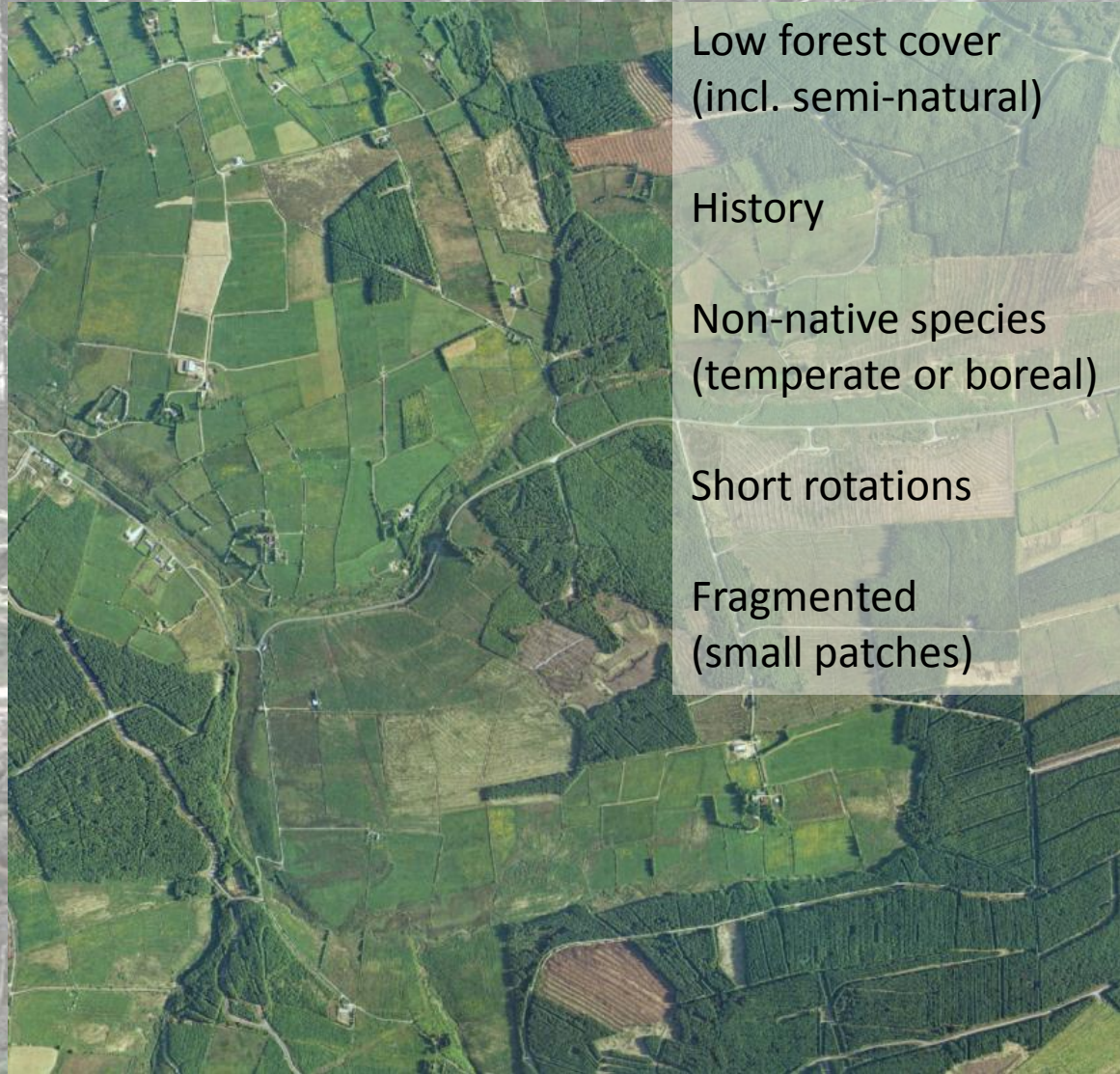
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Traits as proxies of species functional roles in two very different forested areas

Traits as proxies of species functional roles in two very different forested areas...



Irish plantation forests



Low forest cover
(incl. semi-natural)

History

Non-native species
(temperate or boreal)

Short rotations

Fragmented
(small patches)



Alberta: boreal mixedwoods



Big!

Succession cycle; fire

Longer rotations



Measuring ecosystem function

- Species responses to disturbance are becoming better known
- The impact on ecosystem function is less well known
- Difficult to measure processes
- Proxies: species traits

Species traits: what do they tell us?

- Body size
 - Resources available to support larger individuals
 - Variability in body size suggests varied food supply for predators of those individuals
- Dispersal ability
 - Movement between suitable patches
 - Good dispersers may be habitat generalists
- Feeding strategy
 - Trophic levels supported in an ecosystem
- Environmental tolerance (e.g. shade, moisture)
 - Specialisation
 - Resilience to environmental change

The challenge of Sustainable Forest Management.....

- Maintaining ecosystem function:
 - Successive rotations
 - Short rotations
- What is an appropriate benchmark for Irish forests?
- What functional groups/diversity should they have?
- Can studying ecosystems elsewhere inform this?



Hypotheses

1) Plantations support different species traits compared to boreal forests:

- a) Greater proportion of good dispersers [fragmentation]
- b) Lower proportion of shade tolerant species
[historical low forest cover = more generalists]
- c) Smaller body size [disturbed/newer habitats; fewer resources to support large body sizes]

Hypotheses

2) Plantations have less variability in species traits than boreal forests.

- Lower habitat heterogeneity
- Restricted niche availability

3) Spruce plantations have less variability in species traits than mixed and deciduous plantations

- Non-native trees
- Fewer specialist species

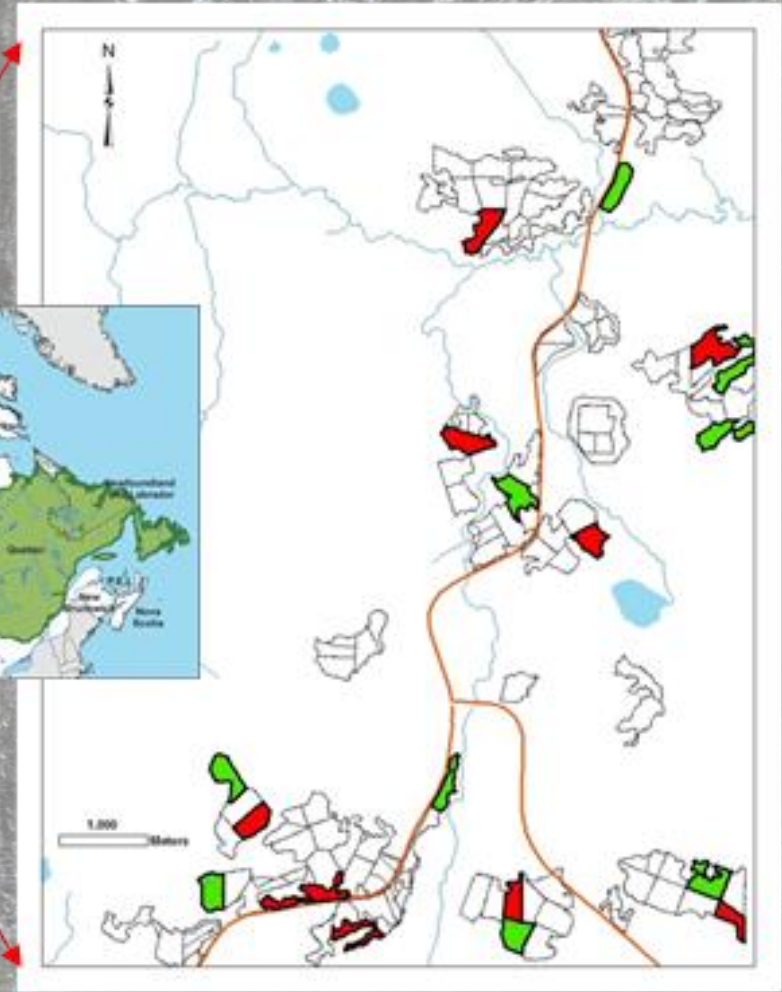
Experimental design and sampling

- Range of forest types in both locations:
 - Deciduous dominated
 - Conifer dominated
 - Mix
- Plots of pitfall traps
- 12 weeks; summer



Sampling in Alberta

- 3 replicates of each forest type
- Trembling aspen (*Populus tremuloides*)
- Balsam poplar (*Populus balsamifera*)
- White spruce (*Picea glauca*)
- Balsam fir (*Abies balsamea*)
- 3 sampling plots per site formed of 3 traps

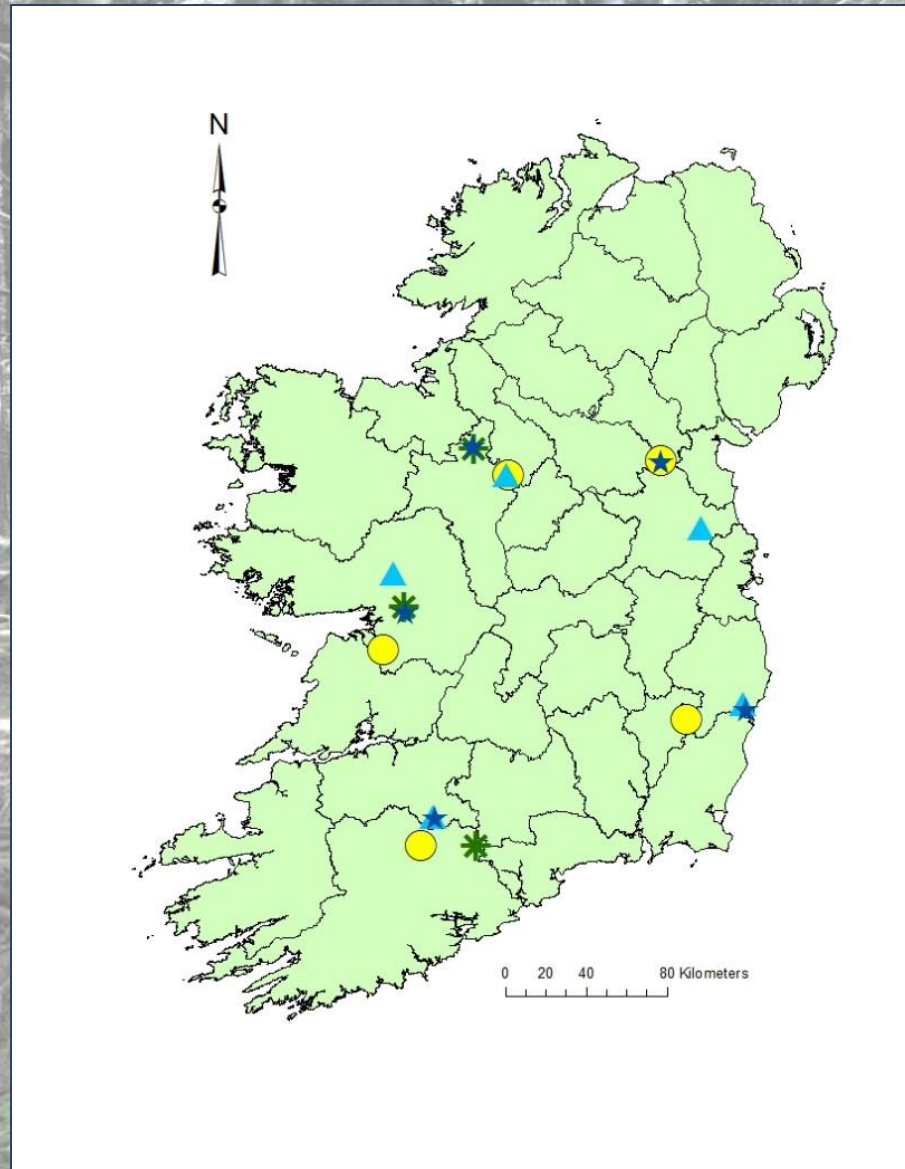


EMEND project

<http://www.emend.rr.ualberta.ca/>

Sampling in Ireland

- 5 replicates of each forest type
- Norway spruce (*Picea abies*)
- Ash (*Fraxinus excelsior*)
- 3 sampling plots per site formed of 5 traps
- Pitfall trap area the same across locations



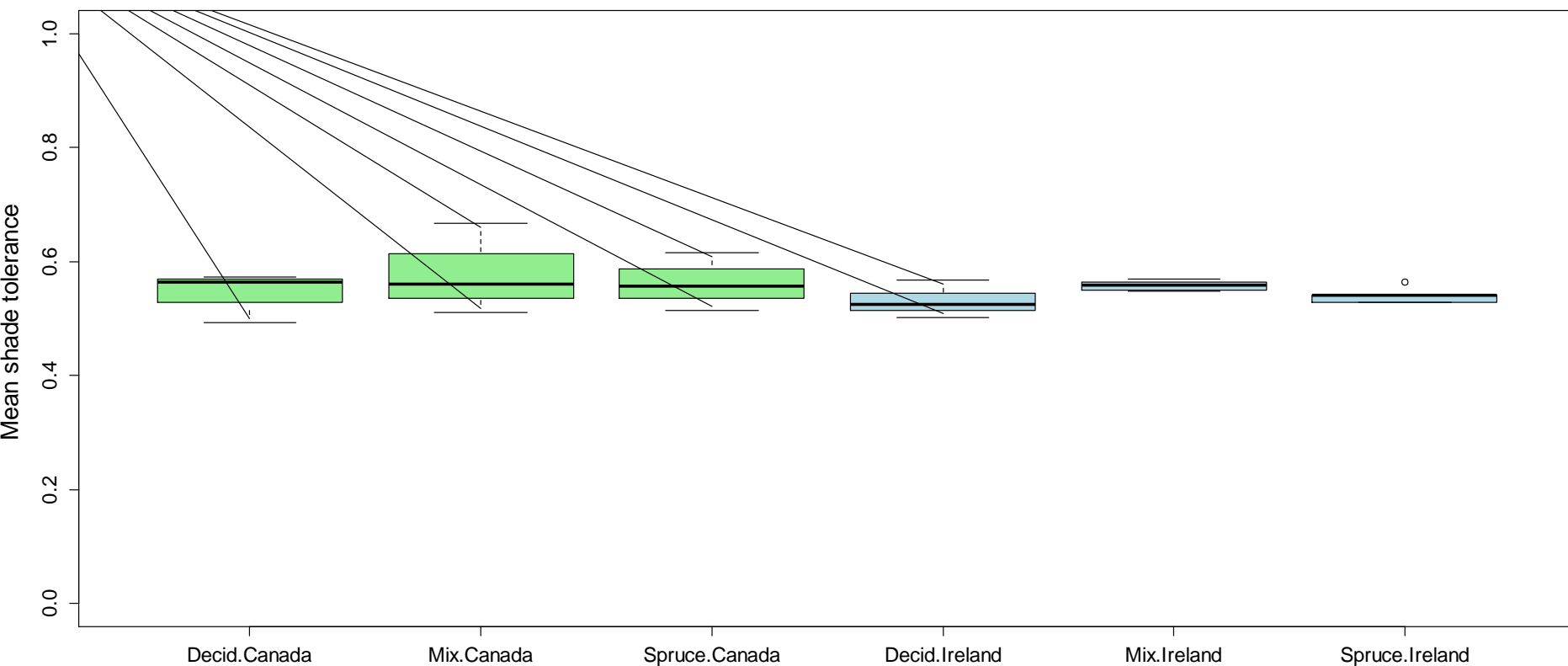
Species traits

Taxon group	Trait	Data source
Spiders Araneae	Body size (mm): median length from clypeus to abdomen apex (not including spinners)	Roberts 1996; Paquin and Duperre 2003; Pinzon 2011
	Dispersal ability: proportion of ballooning species compared to ground only dispersal	Bell et al 2005: synthesised over 500 papers on ballooning
	Shade tolerance: preference for open or shaded habitats on a standardised scale of 0-1: using PCoA scores [Ireland] or relative abundance scale [Canada]	Entling et al 2007, Nolan 2008; Pinzon 2011, Pinzon et al 2012
	Food strategy: proportion of web spinning species compared to active hunters	Uetz <i>et al</i> 1999
Ground beetles Coleoptera: Carabidae	Body size (mm): median length from clypeus to abdomen apex	Luff 2007; Various taxonomic papers
	Dispersal ability: proportion of brachypterous species compared to dimorphic & macropterous	Luff 2007; Lin <i>et al</i> 2007 Various taxonomic papers
Rove beetles Coleoptera: Staphylinidae	Shade tolerance: preference for open or shaded habitats on a standardised scale of 0-1 using PCoA scores	Work <i>et al</i> ; EMEND data
	Food strategy: proportion of predators ; proportion of herbivores	Harvey <i>et al</i> 2008; Ribera <i>et al</i> 2001; various papers

Spider data only

Following Pedley & Dolman 2014

Mean tolerance to shaded conditions of spider species

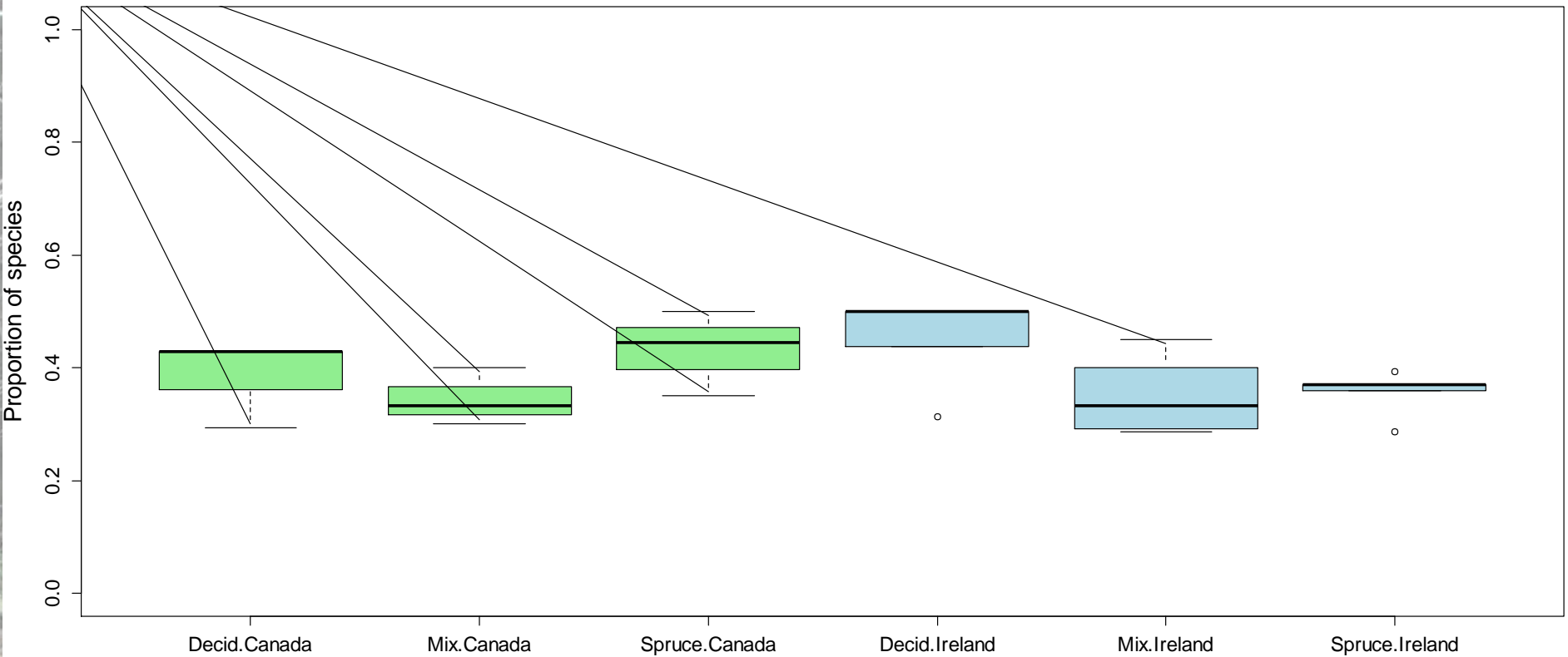


Permutational ANOVA	<i>F</i>	<i>P</i> (n.Perm = 4999)
Forest Type	$F_{2,18} = 1.31$	n.s.
Location	$F_{1,18} = 1.43$	n.s.
Forest type * Location	$F_{2,18} = 0.04$	n.s.

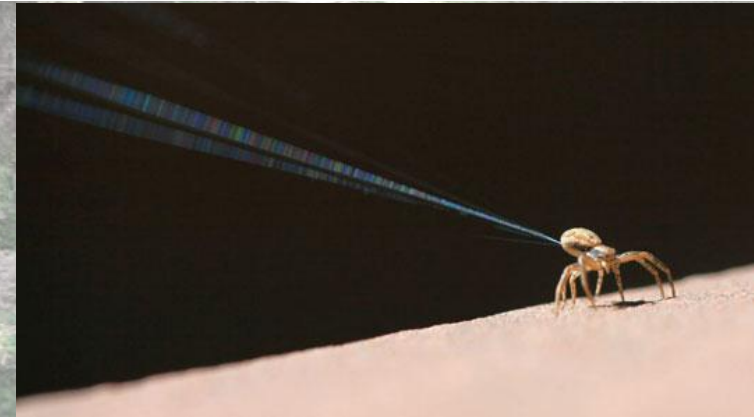


0 = only associated with open habitats;
1 = only associated with closed canopy forests

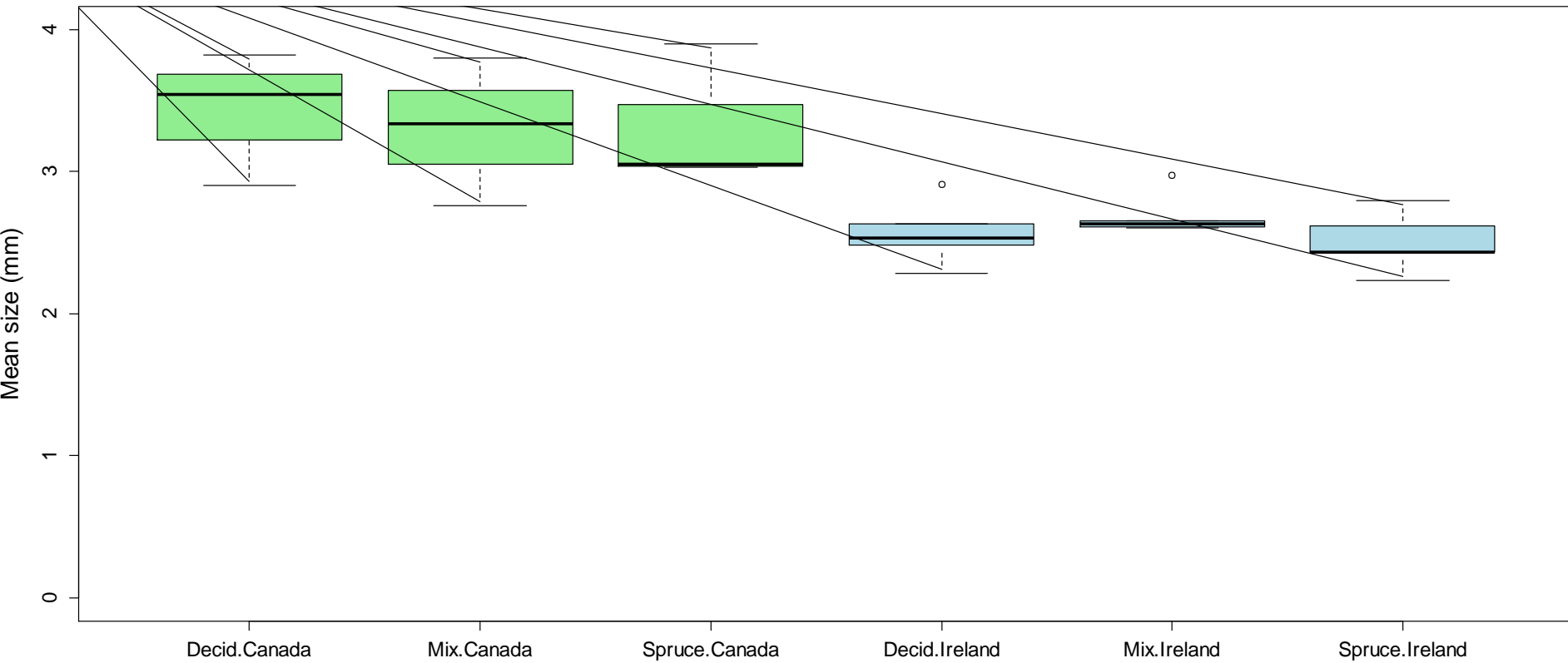
Proportion of ballooning spider species



Permutational ANOVA	<i>F</i>	<i>P</i> (n.Perm = 4999)
Forest Type	$F_{2,18} = 2.92$	n.s.
Location	$F_{1,18} = 0.001$	n.s.
Forest type * Location	$F_{2,18} = 2.08$	n.s.



Mean body size of spider species



Permutational ANOVA

Forest Type

Location

Forest type * Location

F

$$F_{2,18} = 0.23$$

$$F_{1,18} = 29.8$$

$$F_{2,18} = 0.32$$

P (n.Perm = 4999)

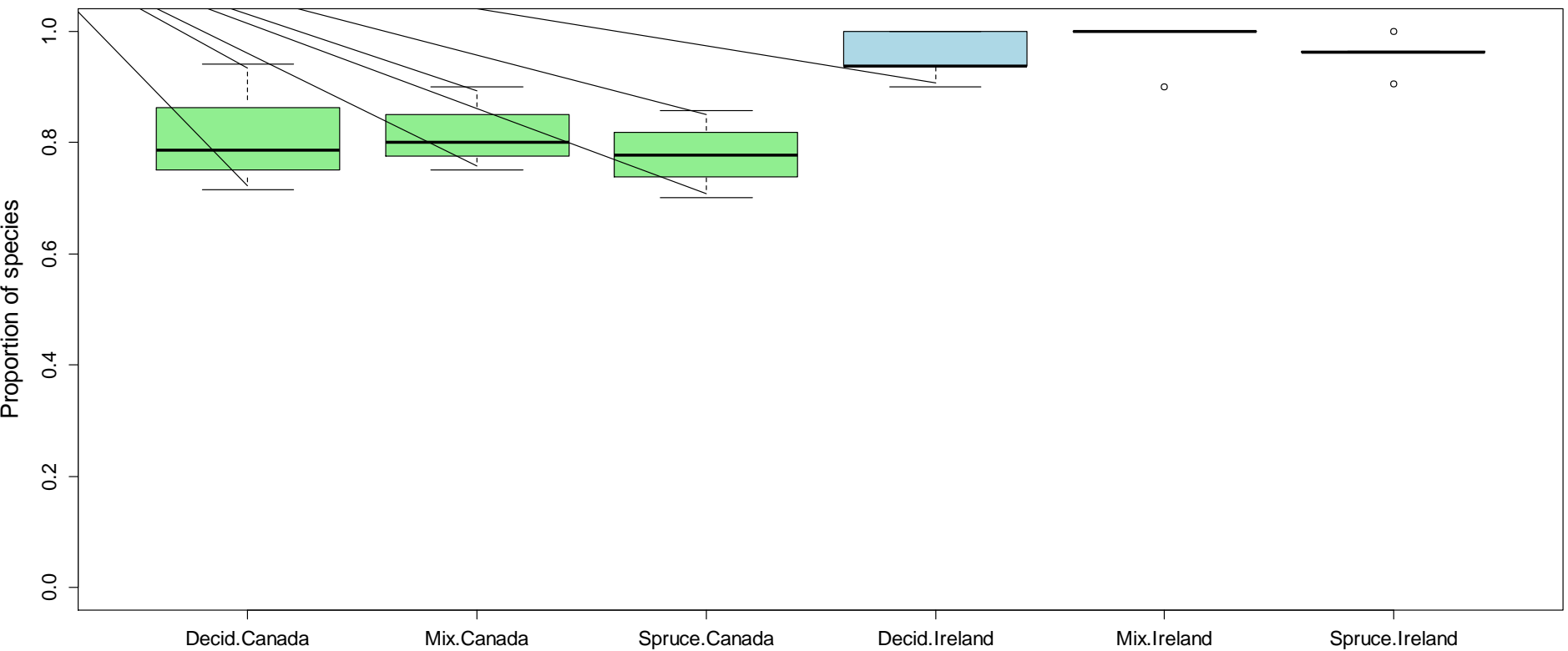
n.s.

0.0002***

n.s.



Proportion of web spinning spider species



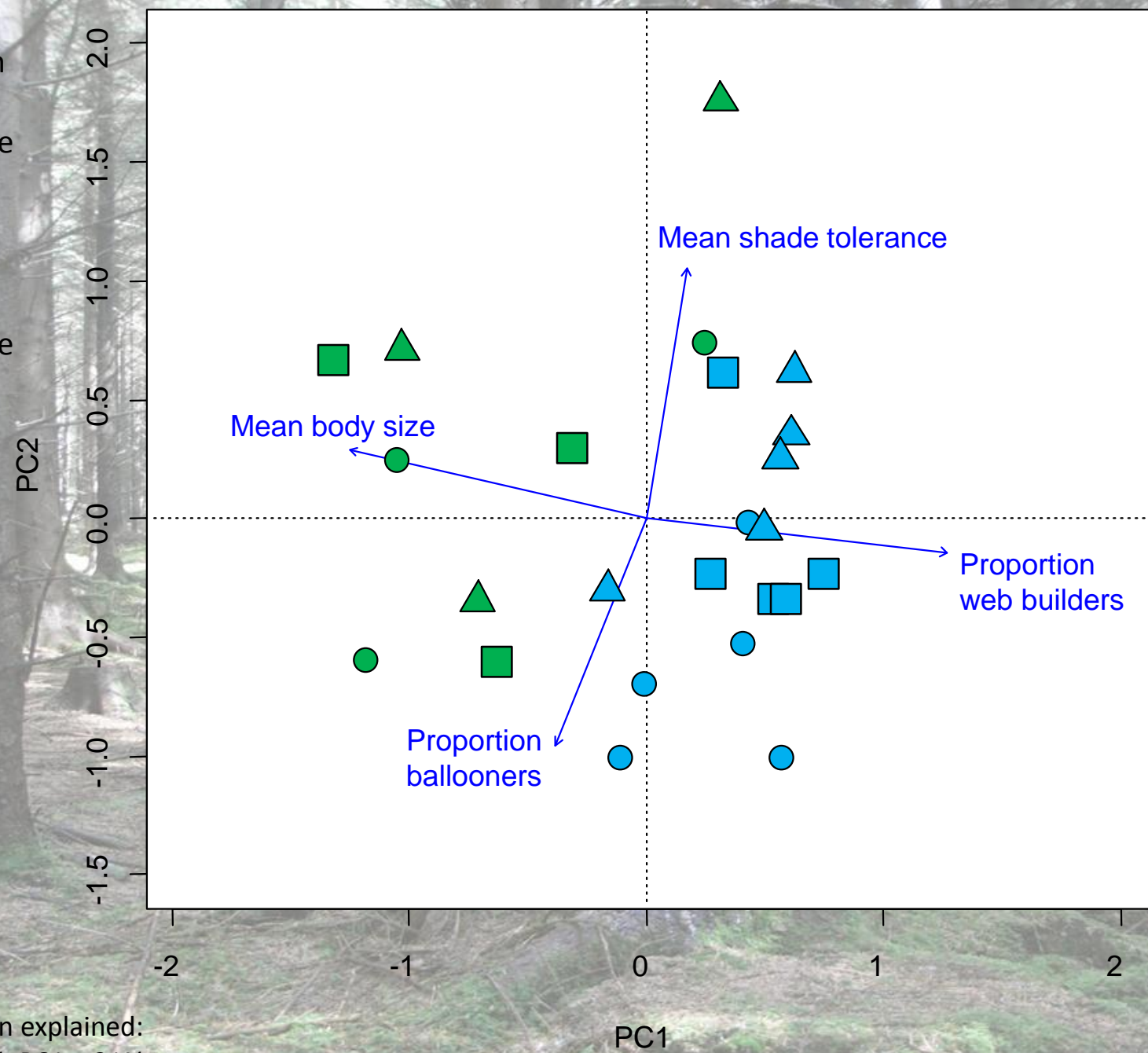
Permutation ANOVA	F	P (n.Perm = 4999)
Forest Type	$F_{2,18} = 0.39$	n.s.
Location	$F_{1,18} = 37.2$	0.0002***
Forest type * Location	$F_{2,18} = 0.19$	n.s.



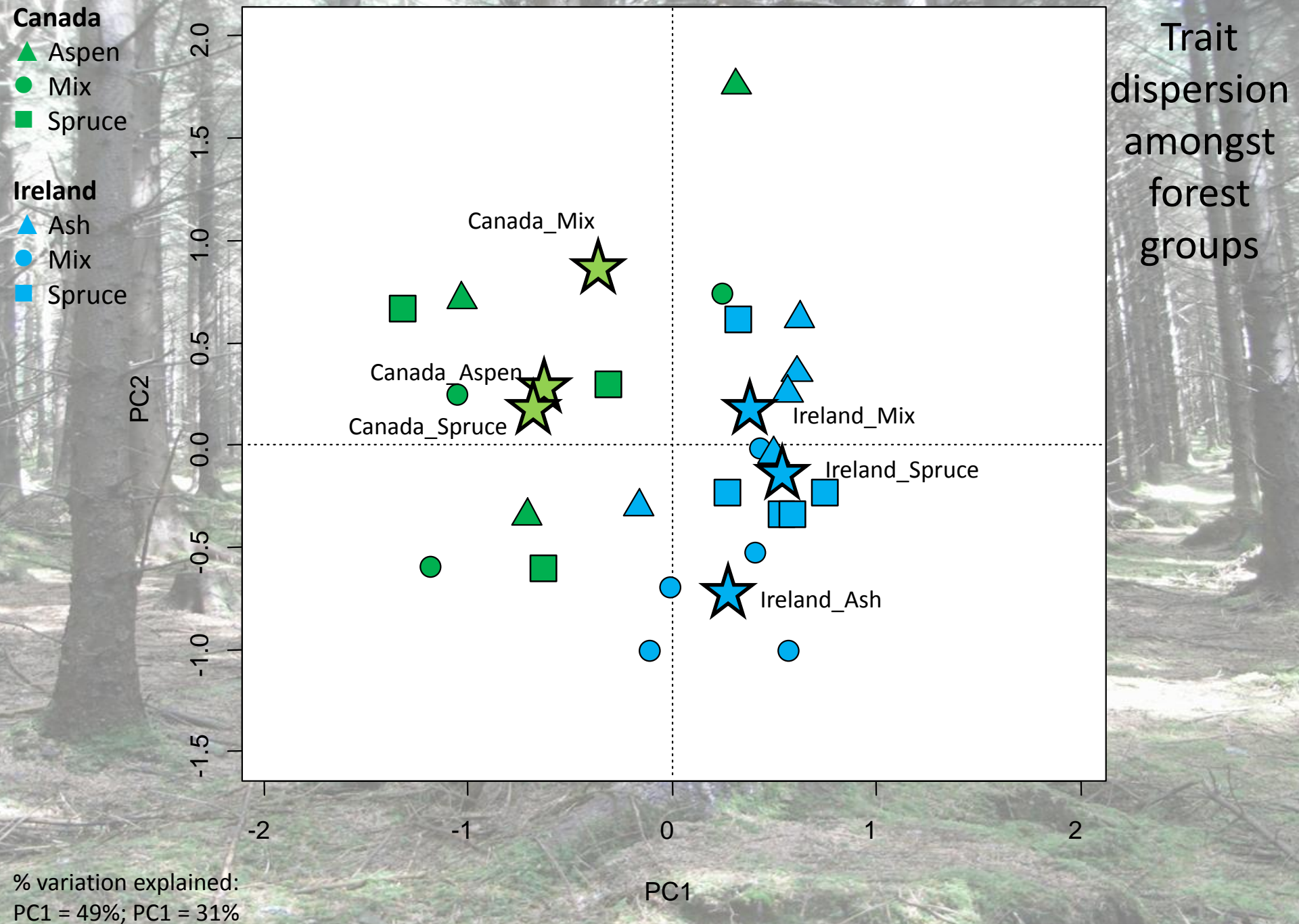
PCA of spider species traits among forests

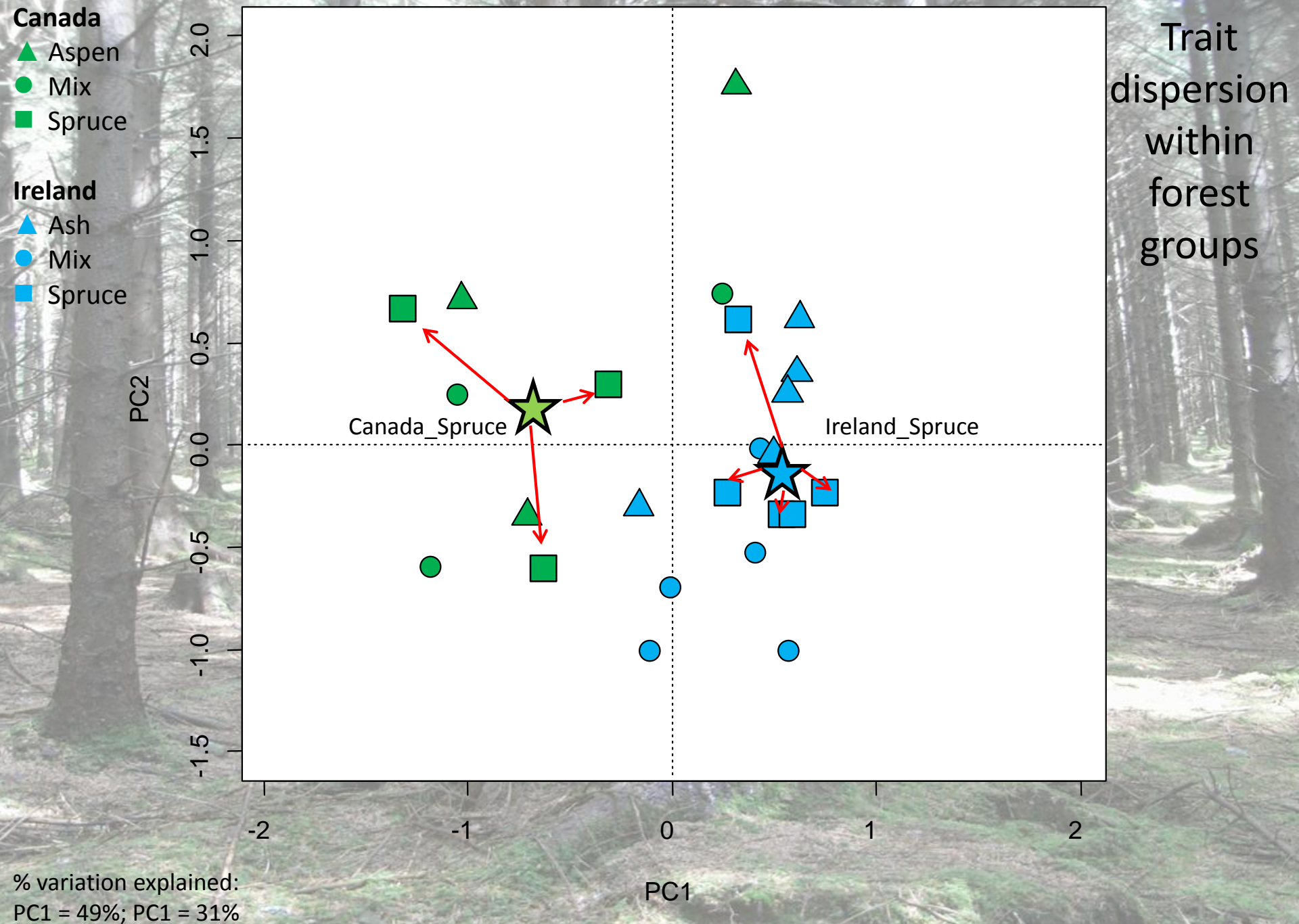
- Canada**
- ▲ Aspen
 - Mix
 - Spruce

- Ireland**
- ▲ Ash
 - Mix
 - Spruce

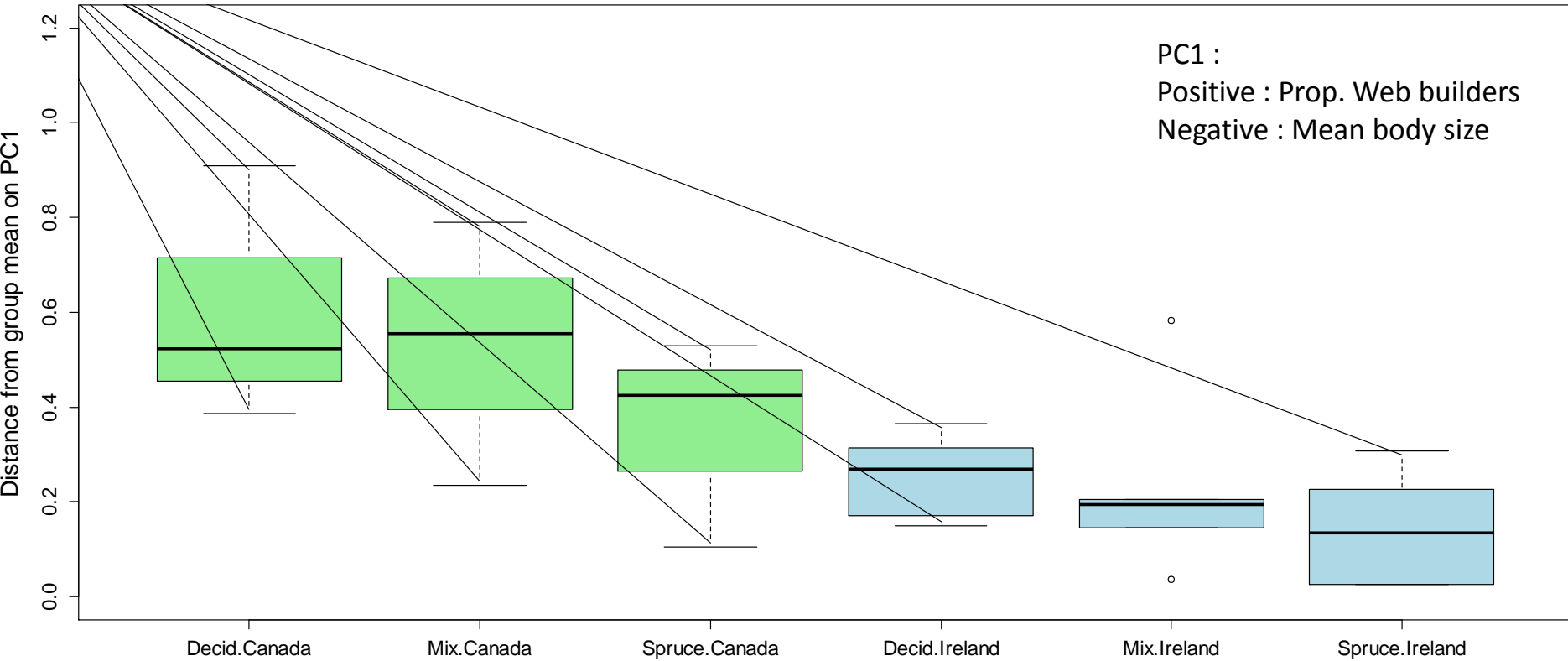


% variation explained:
PC1 = 49%; PC2 = 31%



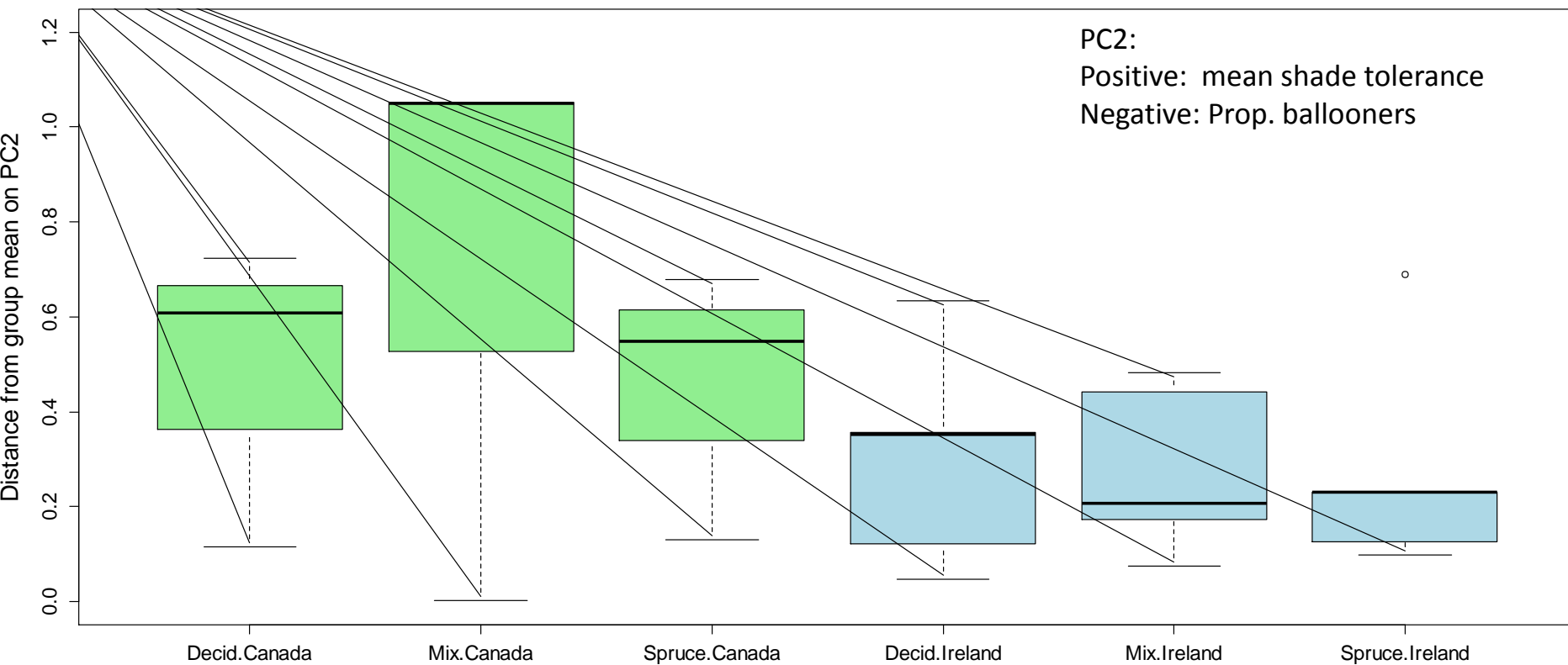


Dispersion of site scores for spider species traits on PC1



Permutational ANOVA	F	P (n.Perm = 9999)
Forest Type	$F_{2,18} = 1.55$	n.s.
Location	$F_{1,18} = 12.34$	0.002**
Forest type * Location	$F_{2,18} = 0.26$	n.s.

Dispersion of site scores for spider species traits on PC2



Permutational ANOVA	<i>F</i>	P (n.Perm = 4999)
Forest Type	$F_{2,18} = 0.19$	n.s.
Location	$F_{1,18} = 4.11$	n.s.
Forest type * Location	$F_{2,18} = 0.41$	n.s.

Synthesis and summary

Trait	Among forest types	Between locations	Agree with hypothesis?
Body size	-	↑ Canada	Yes
Ballooning	-	No difference	No
Shade tolerance	-	No difference	No
Web spinners	-	↑ Ireland	Yes
Trait dispersion	No difference	↑ Canada	No/ Yes

- Plantations lack large bodied active hunters common in boreal forest
- Species tolerant to shade are similar despite Ireland's forest fragmentation and historical cover
- Ballooning dispersal ability are similar → mixedwood patchwork?
- Boreal forests support a greater variability in traits
- Spruce plantations are similar to mix and deciduous plantations in trait variability

What next?

- Beetle traits
- Environmental data (habitat structure)
 - Fourth corner analysis
- Metrics of ‘functional’ diversity using traits
- Young forests?

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