Macrofungal biodiversity in native and non-native Sitka spruce forests

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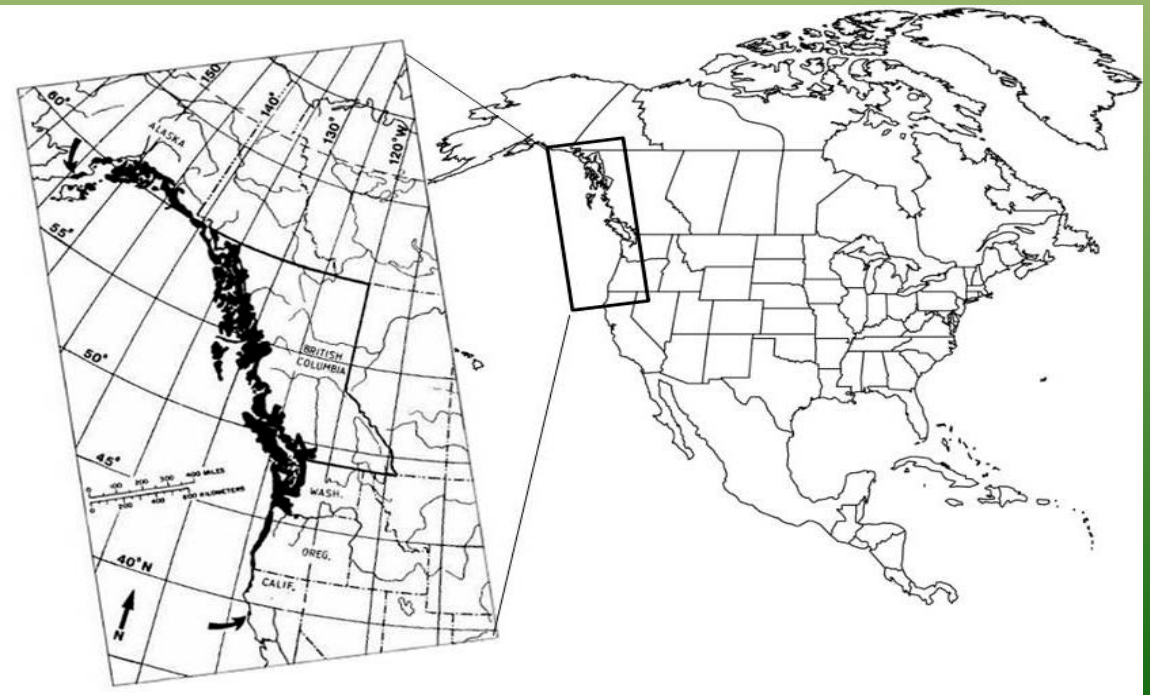
Why macrofungi?

- Important indicators of fungal biodiversity
- Important in food webs
- Important as non-wood forest products

Why Sitka spruce?

- Economically important species in Ireland and Britain
- Planted widely as introduced species (good opportunity for comparisons in native and non-native range
- Datasets readily available



SS in its native habitat: not normally managed

In non-native habitat: highly managed

Historical reason

- Alexander and Watling (1987) found SS in Scotland supported many native macrofungi
- Identified need for comparison of macrofungal communities of SS in native and non-native range
- 25 years later…

Research Question

Does Sitka spruce have similar macrofungal communities in its native and non-native range?

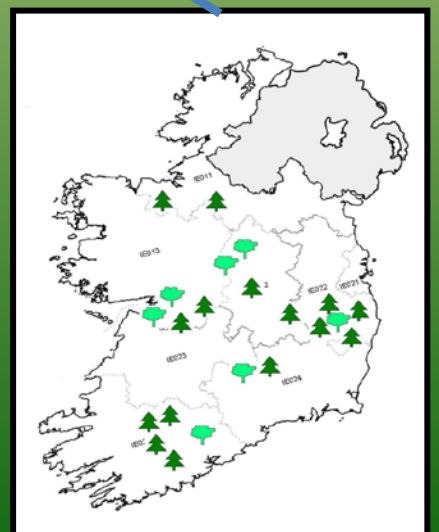
How to answer question

- Compare species richness and diversity using statistical tests: rarefaction and diversity indices
- Compare macrofungal communities using ordination tests: Non metric multi-dimensional scaling, Mantel correlograms

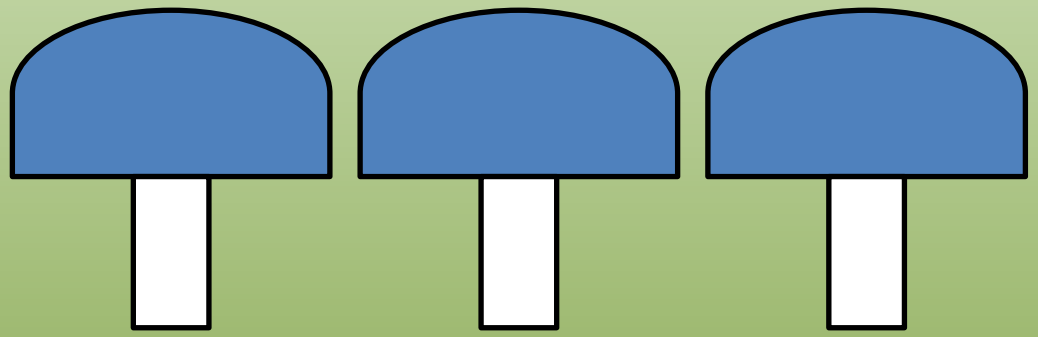
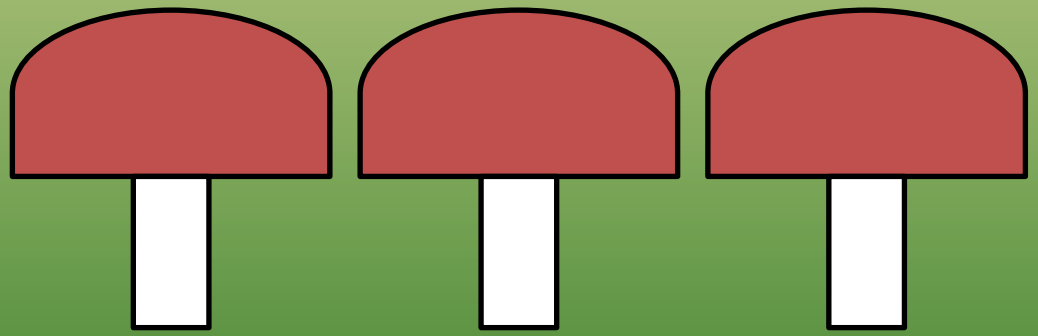
Methods

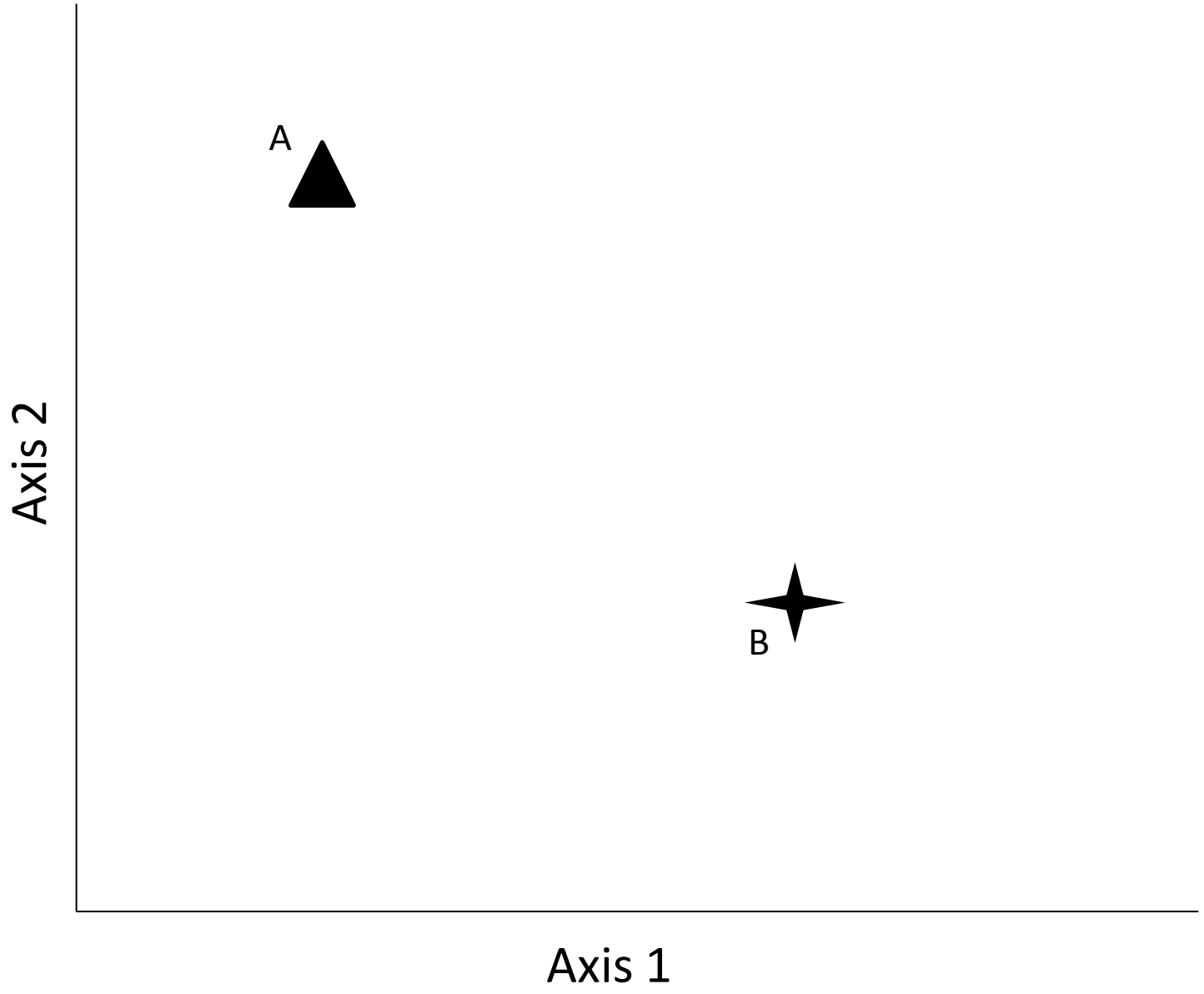
3 regions, 93 plots

1. Vancouver Island (VI) from Outerbridge (2002)
2. Ireland (IE) from O'Hanlon (2011)
3. Britain (BR) from Humphrey et al. (2003)

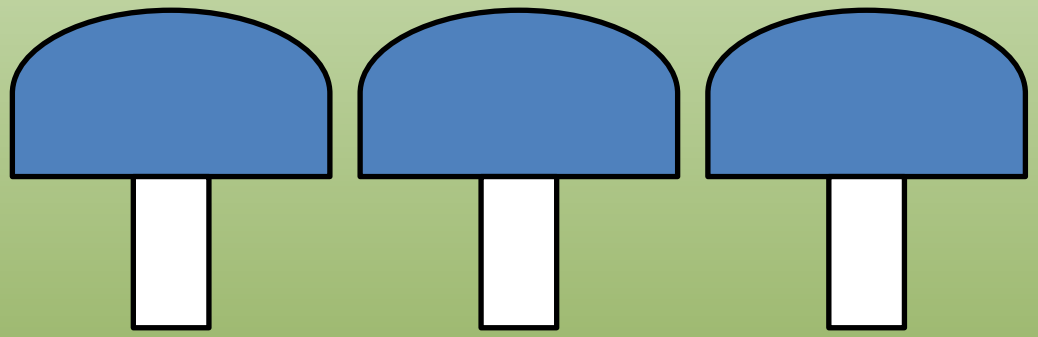
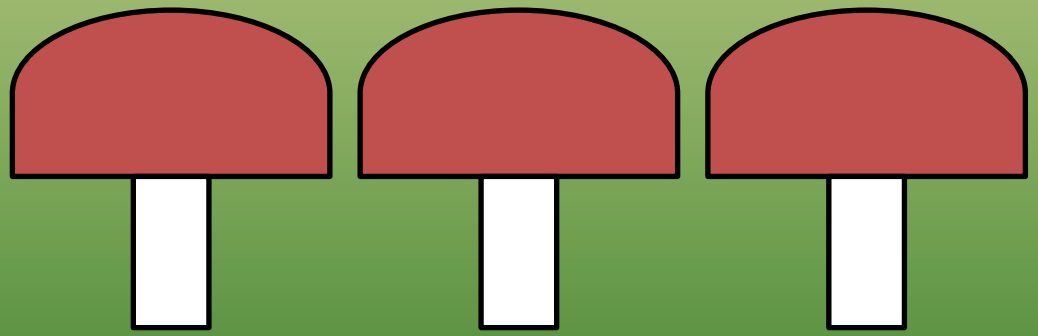
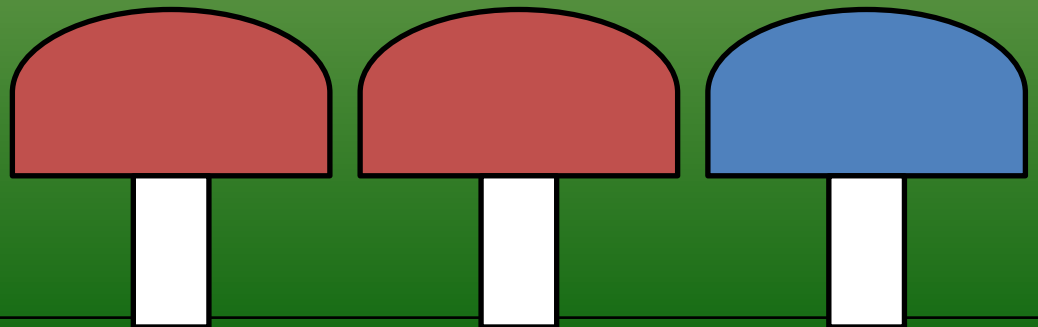


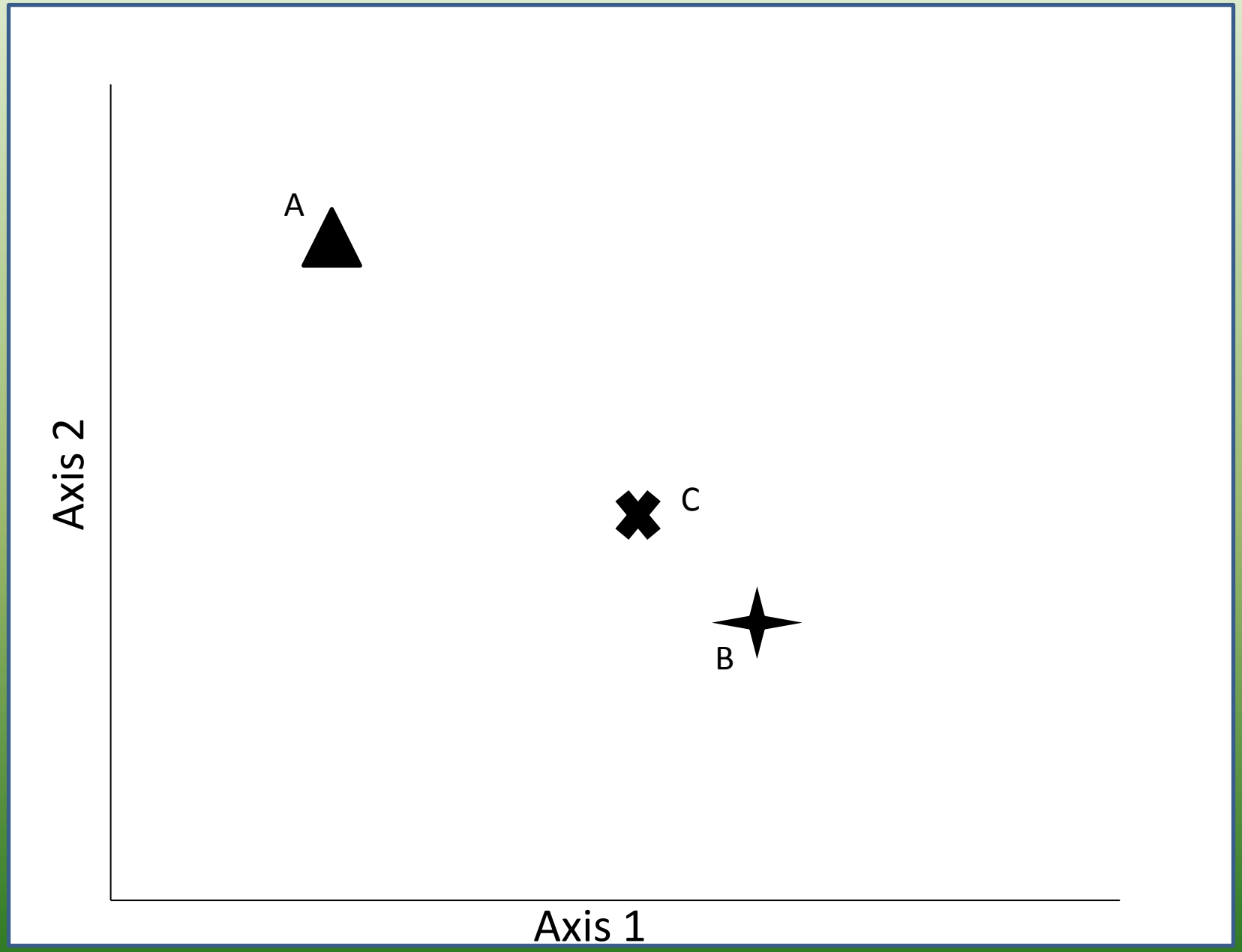
Community analysis

Forest	Community
A 	
B 	
C	


A
B
Axis 2
Axis 1

Community analysis

Forest	Community
A 	
B 	
C 	



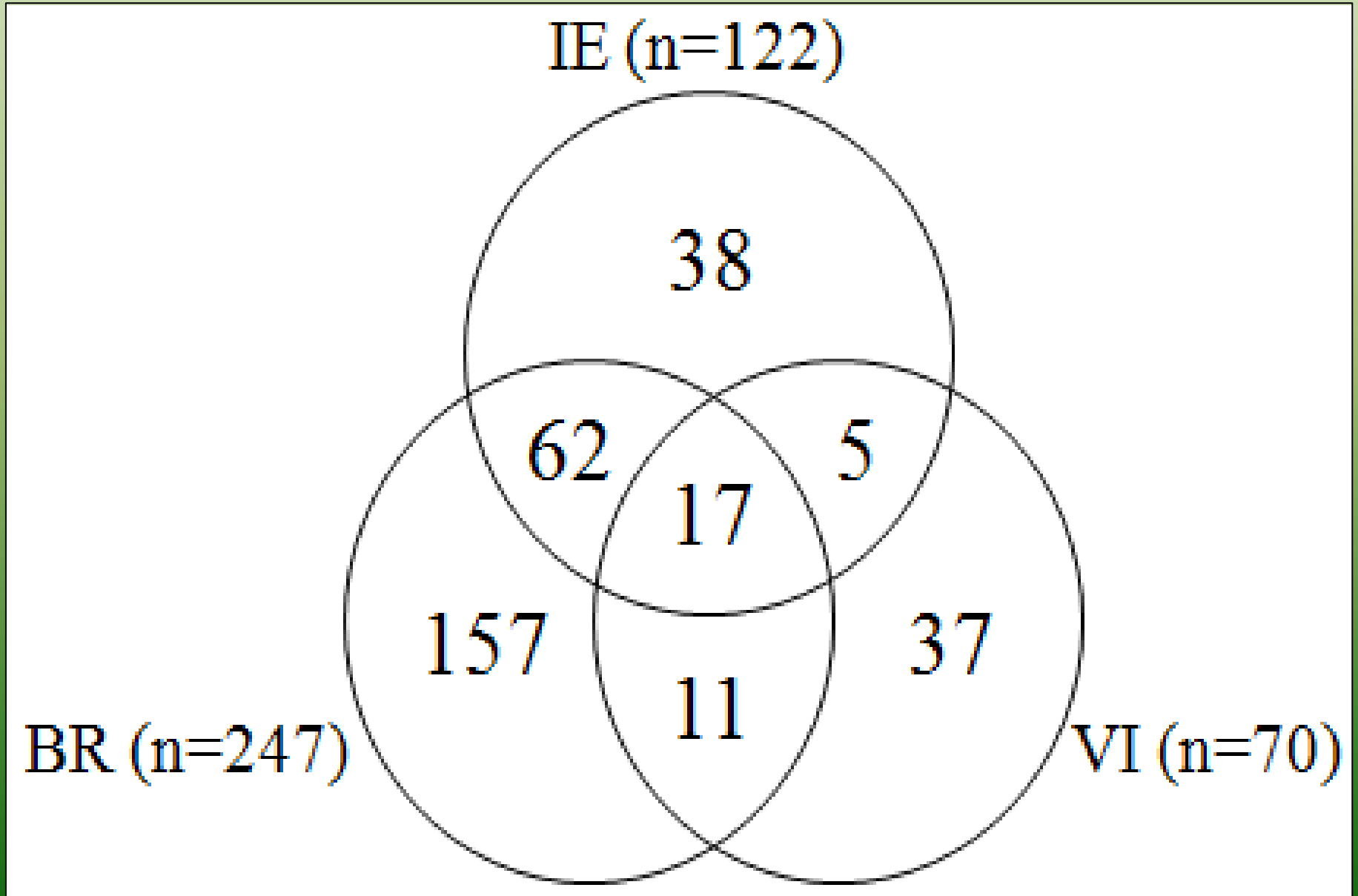
Closer together = more similar communities

Results

- 439 species from 92 plots were analysed.
- SS was as species rich and diverse (Shannon's diversity index) as other trees in each region

	BR	IE	VI
Oak	4.65 (236)	3.67 (91)	-
Scots pine	4.8 (305)	3.8 (83)	-
Sitka spruce	4.5 (247)	4.2 (122)	3.2 (70)
Western red-cedar	-	-	3 (72)
Douglas fir	-	-	3.5 (83)
Western Hemlock	-	-	3.1 (59)

Few species shared between all regions



Anti clockwise from left: *Cantharellus tubaeformis, Clavulina rugosa, Mycena epiptygeria*

Anti clockwise from left: *Hypholoma fasciculare, Mycena rorida, Lycoperdon nigrescens*

Results

The 10 most frequent species in each region were broadly different

Community analysis found that the communities were different in each region

Species	BR	IE	VI
Cantharellus formosus	-	-	3
Entoloma cetratum	7	+	+
Gymnopus androsaceus	1	+	-
Hypholoma fasciculare var. fasciculare	+	1	+
Hypholoma marginatum	3	+	-
Laccaria amethystina	+	10	-
Laccaria laccata	5	5	-
Mycena alcalina	-	-	10
Mycena amicta	+	+	7
Mycena aurantiidisca	-	-	5
Mycena epipterygia	+	4	+
Mycena filopes	6	+	+
Mycena galericulata	8	-	-
Mycena galopus var. galopus	4	+	2
Mycena leptocephala	9	2	-
Mycena metata	+	6	6
Mycena rorida	10	8	9
Mycena rosella	+	+	8
Mycena sanguinolenta	2	+	-
Mycena tenax	-	-	1
Mycena vitilis	+	7	-
Nidula candida	-	-	4
Rhodocollybia butyracea	+	3	-
Russula ochroleuca	+	9	-

Fungi differentiating Irish SS

Cortinarius obtusus : Absent from BR and VI yet 16th most frequent in IE

Rhodocollybia butyracea: 3rd most frequent in IE, less common in BR, absent from VI

Fungi differentiating British SS

Cortinarius bataillei: 17th in BR yet absent from IE and VI
Mycena galericulata: 8th most frequent in BR yet absent from IE and VI

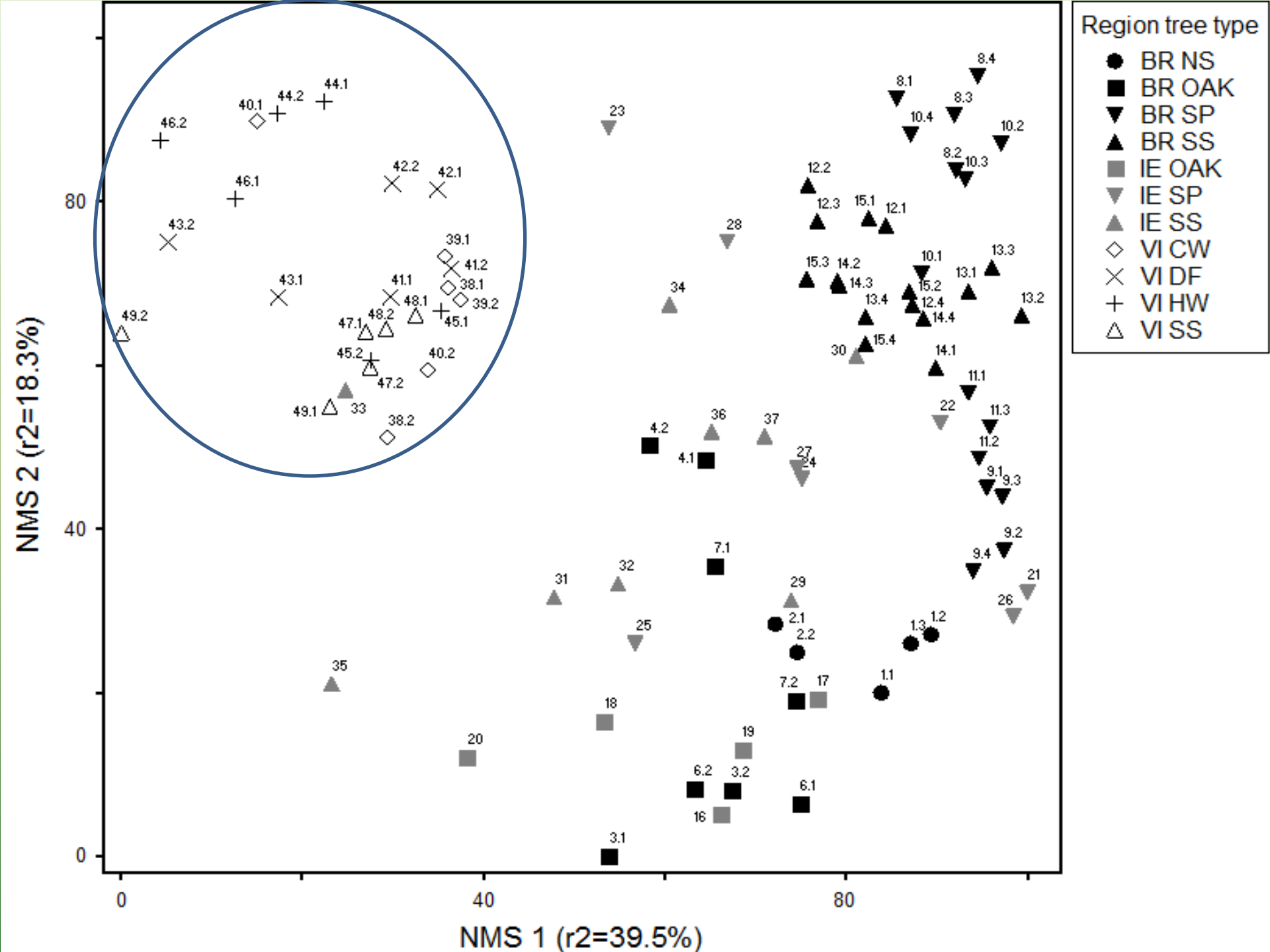
Fungi differentiating VI SS

Mycena tenax: 1st most frequent in VI, absent IE BR
Cantharellus formosis: 3rd most frequent in VI absent from IE and BR

Results - Community analysis

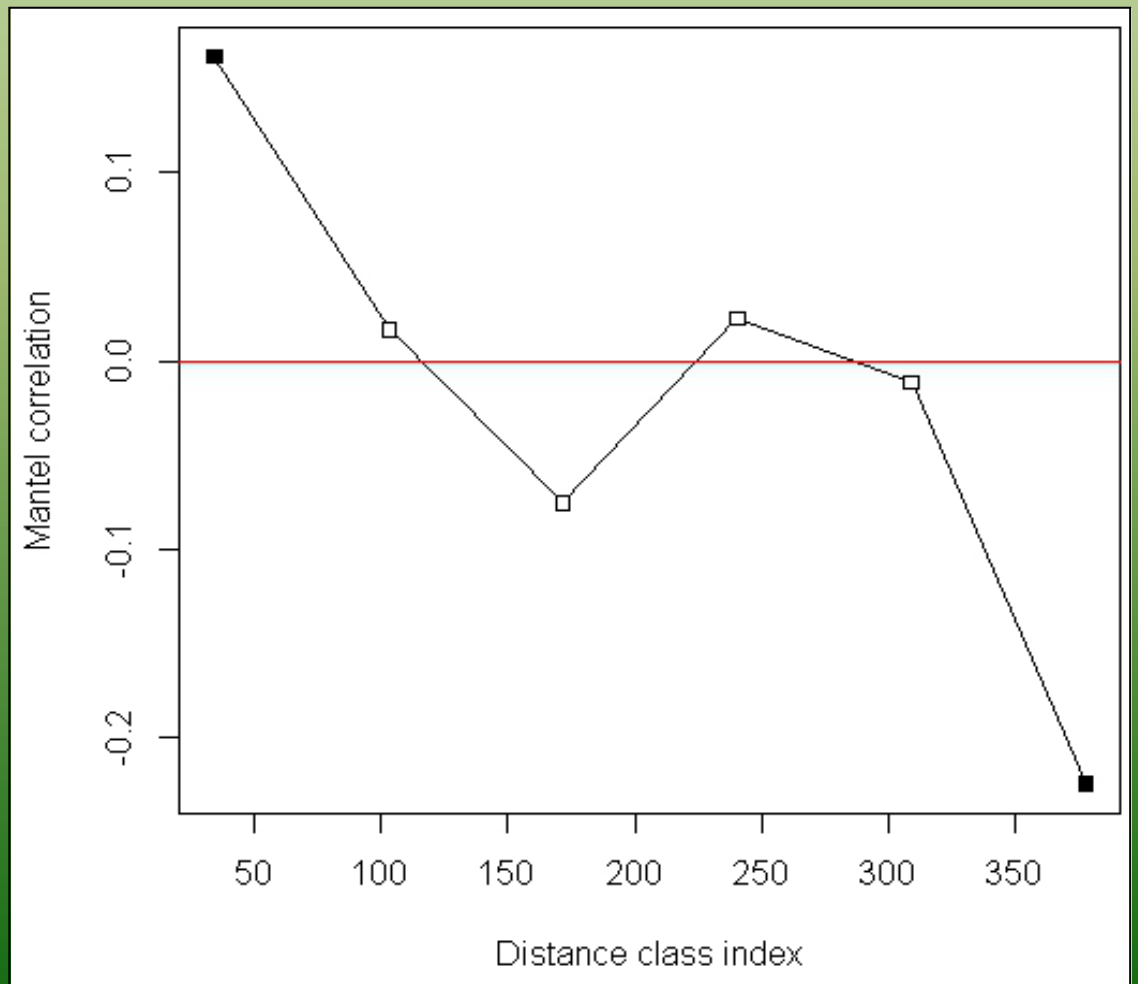
SS in each region was more similar to another tree species from the same region than from another region

	Sitka spruce		
	Ireland	Britain	Vancouver Island
Oak - Ireland	58 (64)	45 (50)	16 (18)
Oak - Britain	78 (33)	101 (43)	24 (10)
Scots pine - Ireland	58 (70)	55 (66)	14 (17)
Scots pine - Britain	85 (28)	158 (52)	29 (10)
Western red-cedar - Vancouver Island	22 (31)	28 (39)	37 (51)
Douglas fir - Vancouver Island	27 (33)	34 (41)	47 (57)
Western hemlock - Vancouver Island	19 (32)	25 (42)	34 (58)


Region tree type
BR NS
BR OAK
BR SP
BR SS
IE OAK
IE SP
IE SS
VI CW
VI DF
VI HW
VI SS
NMS 2 (r2=18.3%)
NMS 1 (r2=39.5%)
0
40
80
0
40
80

Results

Plots closer together are more similar in their macrofungal communities (Britain only)



Discussion

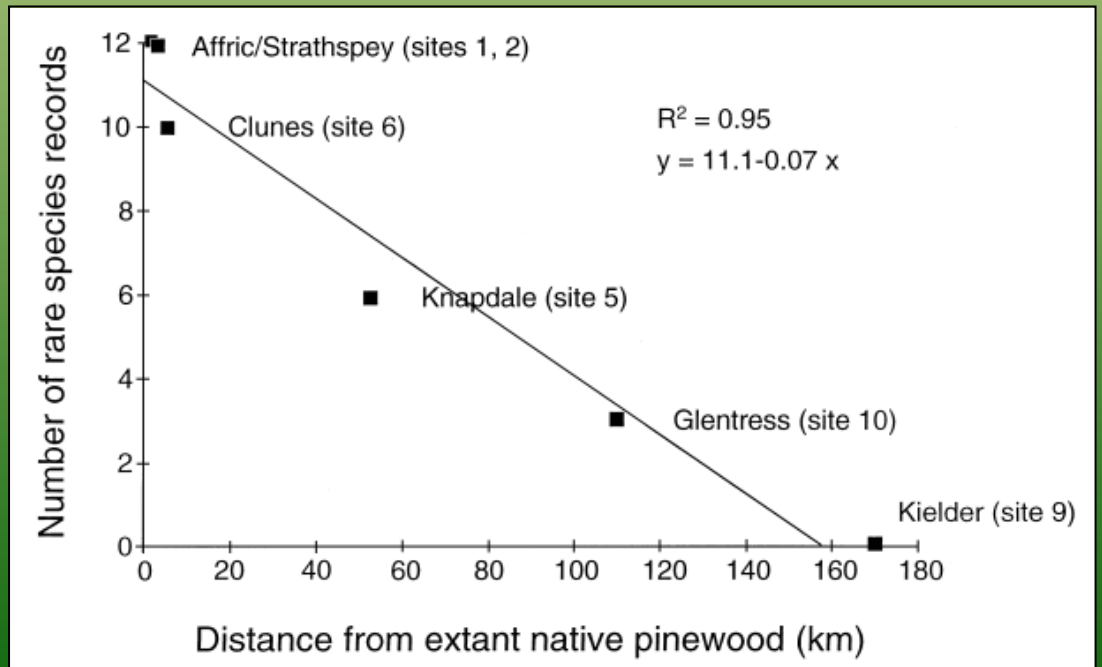
- SS in Ireland, Britain and Vancouver Island was just as species rich as other forest types tested
  - This has conservation implications . It indicates that the SS forests in Ireland and Britain are useful for conserving fungal biodiversity
  - SS as an ectomycorrhizal generalist host — (a) give advantage to SS in competitive habitat, or (b) late successional stage hosts typically generalists (Molina et al. 1992)
  - SS as a decay fungi habitat — low levels of fungal inhibiting compounds (e.g. monoterpenes) in SS wood and needles (Ludley et al. 2008)

Discussion

- SS in Ireland, Britain and Vancouver Island had different fungal communities
  - This indicates that local fungal inoculum source was the most important factor structuring macrofungal communities in these forests.
  - Of 346 species examined from SS native range (BC & OR), 122 not found in BR.

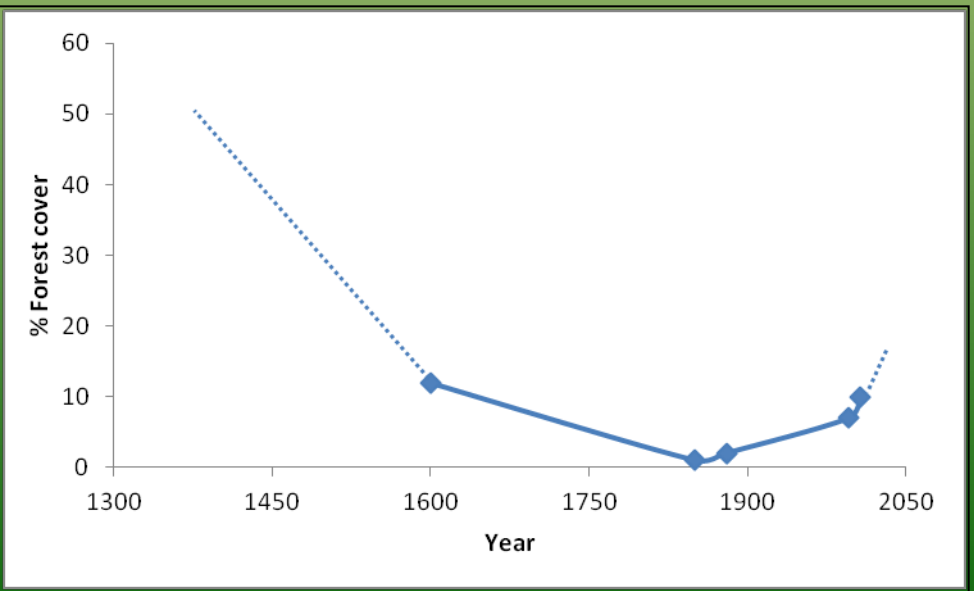
Discussion

- The mantel test indicated that forest closer together are more similar
  - Planting forests near existing forests provides important inoculum source (Humphrey *et al.* 2000)
  - Retention of mature trees after harvest provides important inoculum source (Luoma *et al.* 2006)



Discussion

- So where does SS in Britain and Ireland get its fungi?
- In Ireland, historic deforestation and lack of historic fungal records (O'Hanlon and Harrington 2011,O'Hanlon 2012) makes it difficult to trace origin of SS fungal communities



Country	Genera	Species
ROI	249	1012
NI	254	1155
Wales	314	1638
Scotland	336	2128
England	429	2941

Discussion

- In Britain, SS gets its fungi from a combination of Scots pine and birch (Orton 1987; Watling 1984). Many of the species in British SS are known from Scots pine forests e.g. *L. Rufus, C. rubellus*

Conclusions

- SS macrofungal communities can be very species rich, indicating it as a useful conservation species
- Its communities are more structured by local available inoculum than any specificity patterns

Acknowledgements

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Thanks for your attention

Questions?

References
Alexander and Watling (1987) Proc. Roy. Soc. Edin.
Humphrey et al. (2003) Biodiversity in Britain planted forests
Ludley et al. (2008) Soil Biol. Biochem.
Luoma et al. (2006) Can. J. For. Res.
Molina et al. (1992) Mycorrhizal Functioning
O'Hanlon (2012) Forestry Source
O'Hanlon and Harrington (2011) Biology and Environment
Orton (1987) Trans. Brit. Mycol. Soc.