Monitoring forest species diversity

feedback from 15 years of experience in France

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Fontainebleau, France

October 2, 2015

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   - Reporting on long term changes
   - Renecofor: 15 years of experience in ecosystem monitoring
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   - Methodological issues
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   - Spatio-temporal patterns
     - Plant bioindication
     - Determinants of fungal communities
   - Fencing effects
3. Conclusion

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Monitoring forest changes & species diversity

Why monitoring forests ? a recent concern

- Recognise long-lasting trends in ecosystem dynamics, across forest cycles
- Providing explanations and identify causes of sudden forest dieback events
- Base policy on real science

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Measuring trends in biodivesity: a multifaceted challenge

- Global: Earth's sixth mass extinction (Barnosky et al. 2011)
- Social: links between biodiversity and ecosystem services
- Technical: how to assess (changes in) species diversity? (Chiarucci et al., 2011)
- Political: identify main drivers to set efficient policies

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Monitoring forest changes & species diversity

Options for assessing changes in species diversity

- Species richness is a typical indicator in conservation strategies
- Long-term trends in SR reported in many papers (see Vellend et al., 2013, PNAS)
- Community composition and species populations
- Common and exceptional biodiversity
- Use of bio-indication for environmental description

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Monitoring is a methodological issue in itself

- Ensure the temporal consistency of measurements
- Provide statistically relevant data, rigorous collection through homogeneous protocols,
- What trends can be detected? time spans

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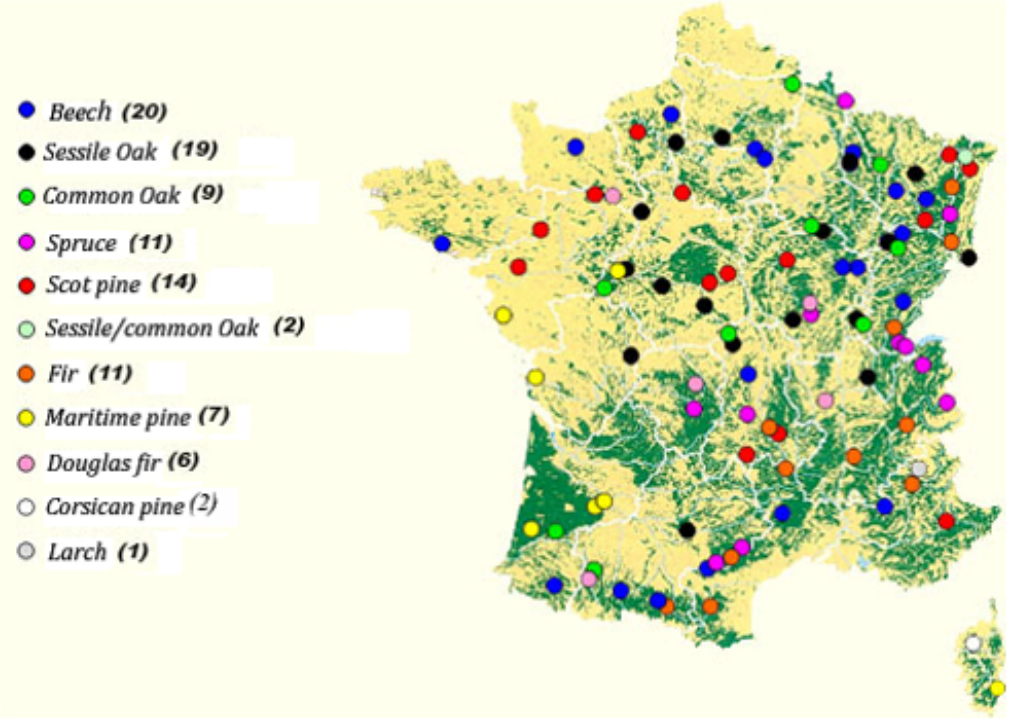
Renecofor: a nation-wide network of forest ecosystems



Network design

- Set up: early 90's
- Period: 1992-2022
- 102 permanent plots in mature forest stands
- stratified by common commercial tree species

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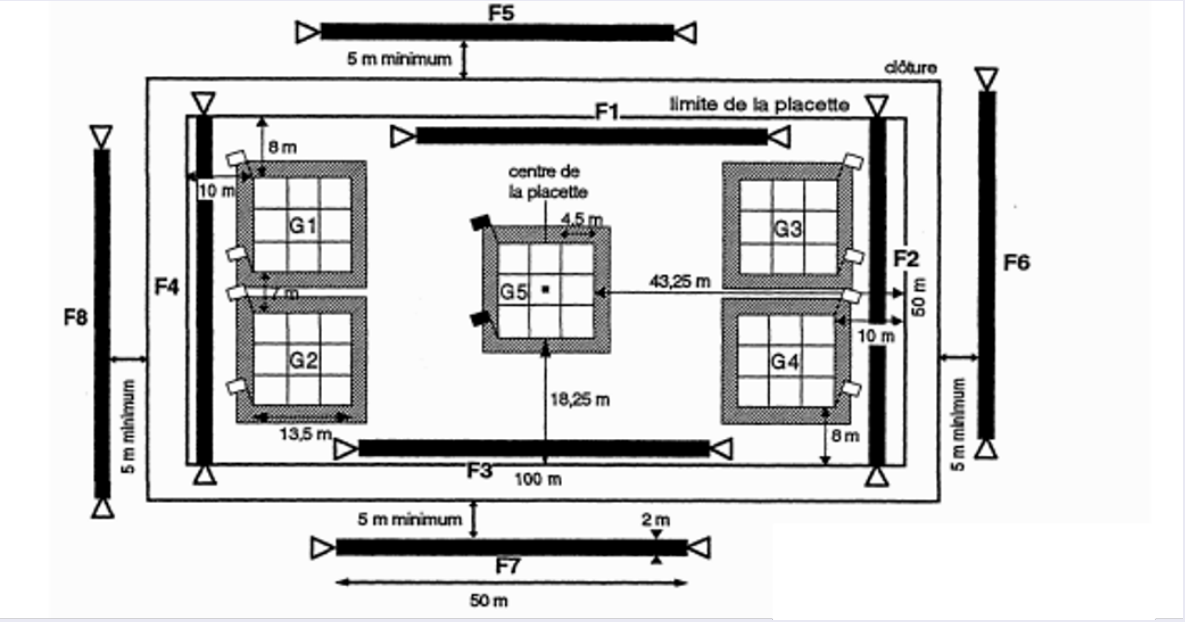
Sampling design

Standard plots



Inventories

- Plant
- Fungi
- Soil description and analyses

Years	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Plant species		n=102					n=102					n=102					n=48					n=102
Fungi species				n=12																		
Soil parameters																						

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Sampling scheme for exhaustive censuses

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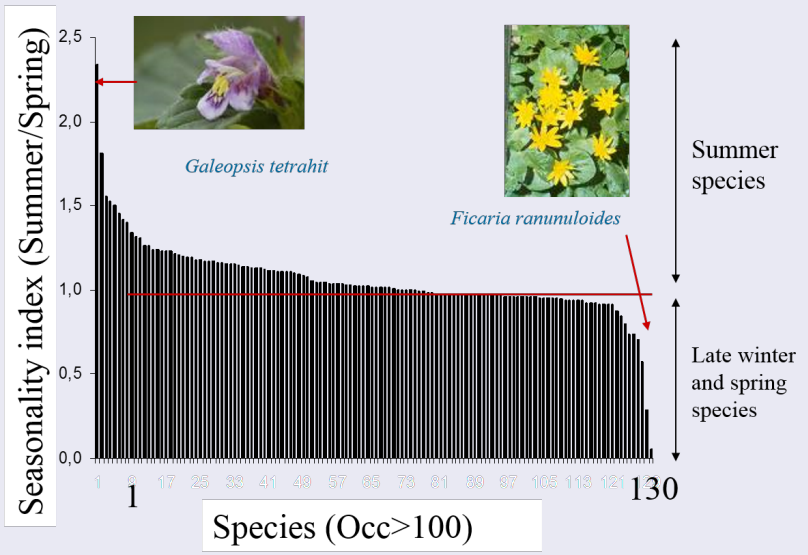
Vegetation seasonality



Archaux et al. 2008

- Autumn recording not needed
- Spring and summer required

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Sampling scheme for exhaustive censuses

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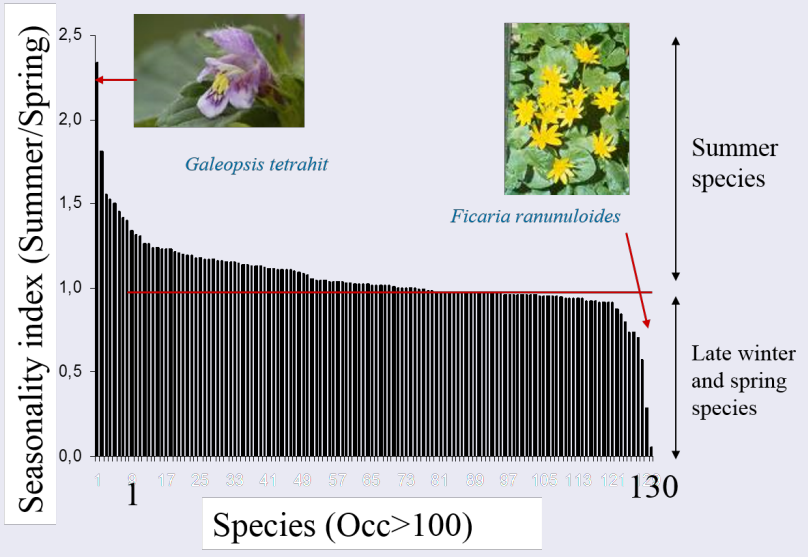

Archaux et al. 2008

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Botanists

- Local botanists
- Calibration training

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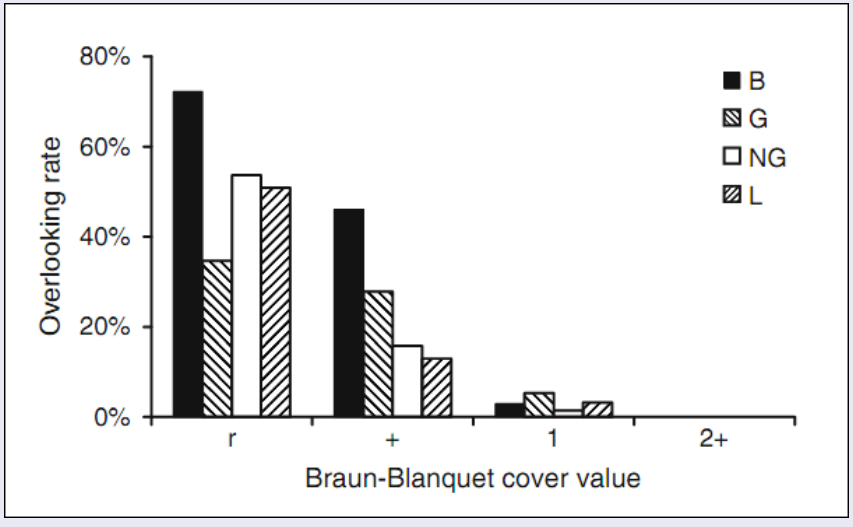
Observer effects

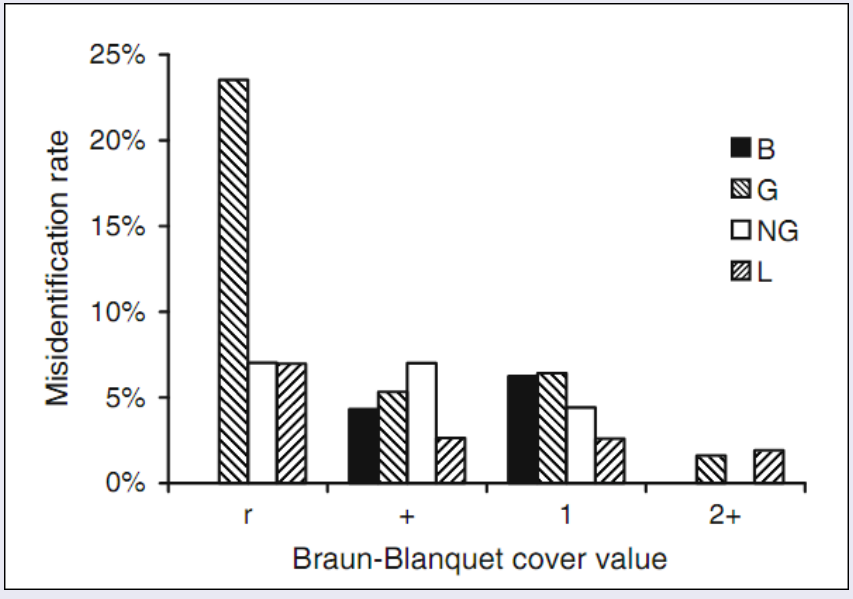
Observer effects

Overlooking species



Archaux et al. 2009

Misidentifying taxa



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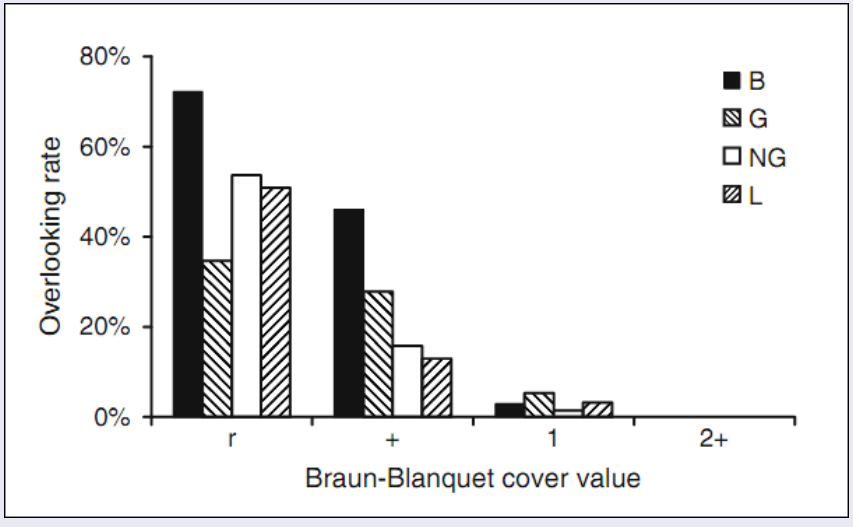

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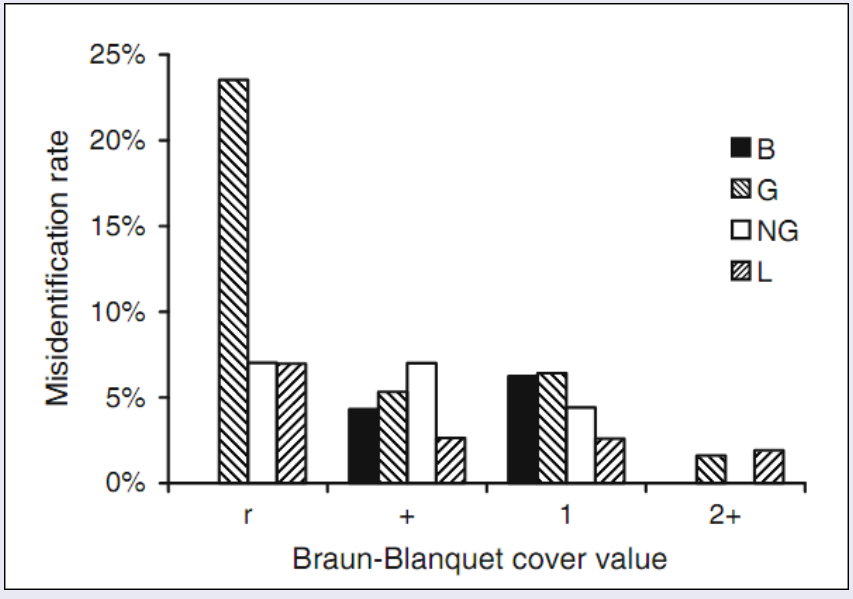

Archaux et al. 2009

- Awareness of plant census quality
- Recording: 2 botanists
- Keep the same observers/plot over time (if possible)

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Global trend in species richness

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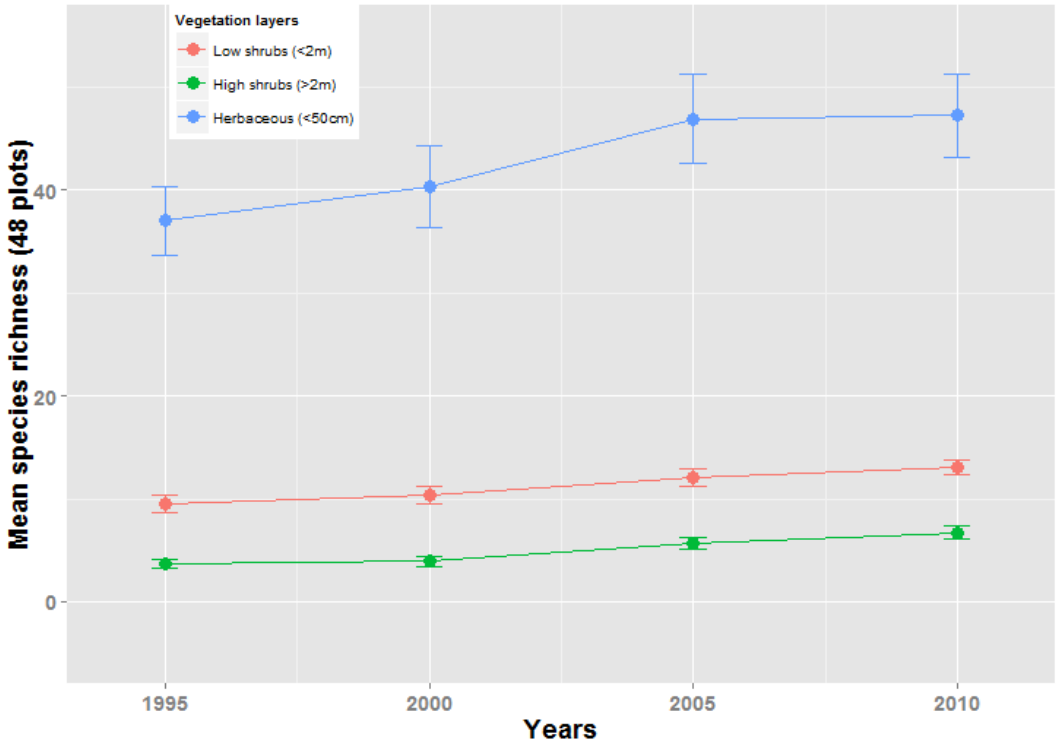
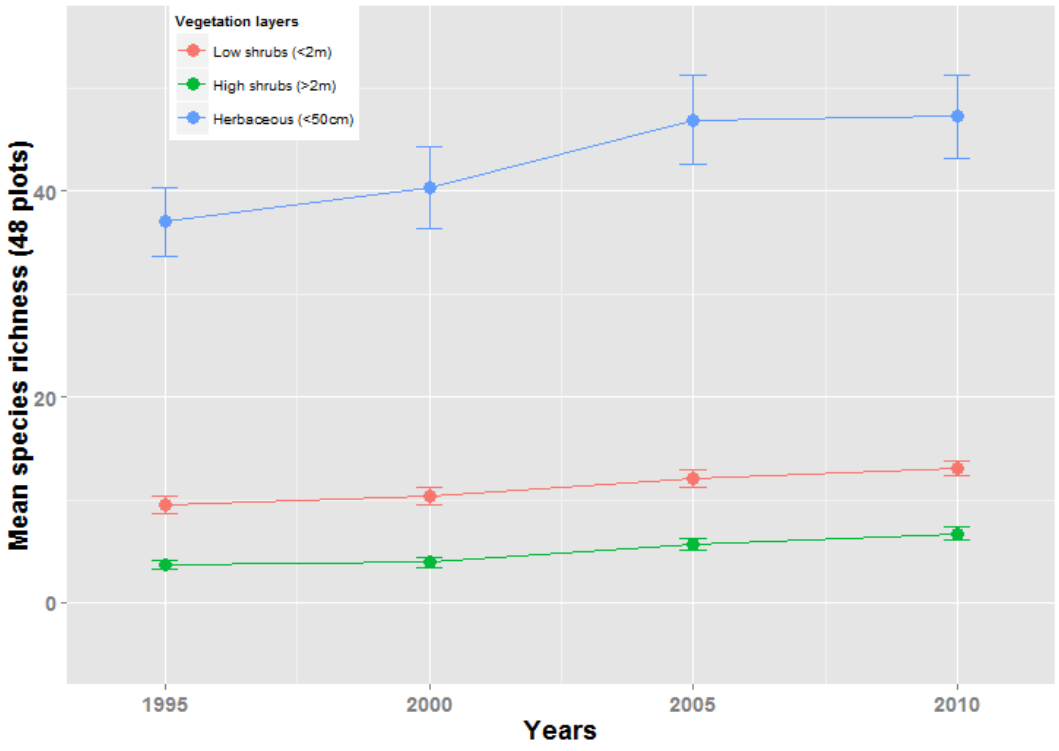


Global trend in species richness



- Increase in species richness over the first 10 years
- Turnover VS nestedness
- Can monitoring detect signs of "biodiversity erosion"?

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How many fungus inventories to pool and when ?

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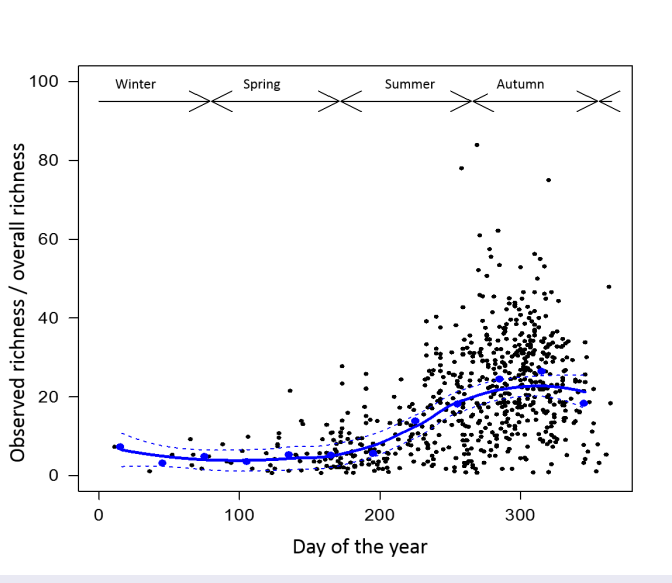
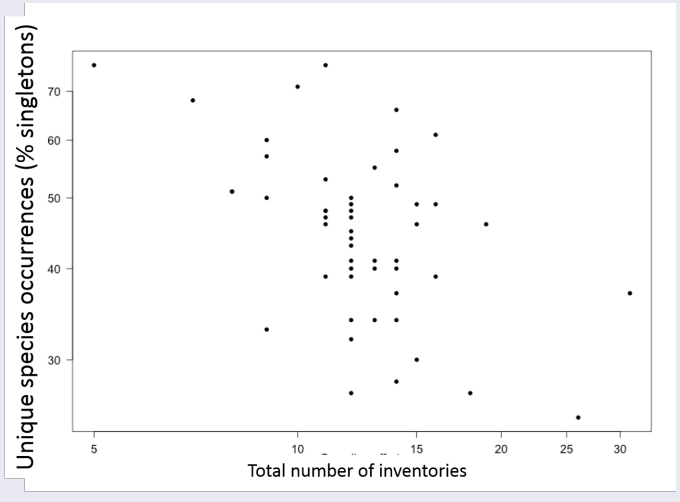
A highly seasonal group





Richard et al., in prep

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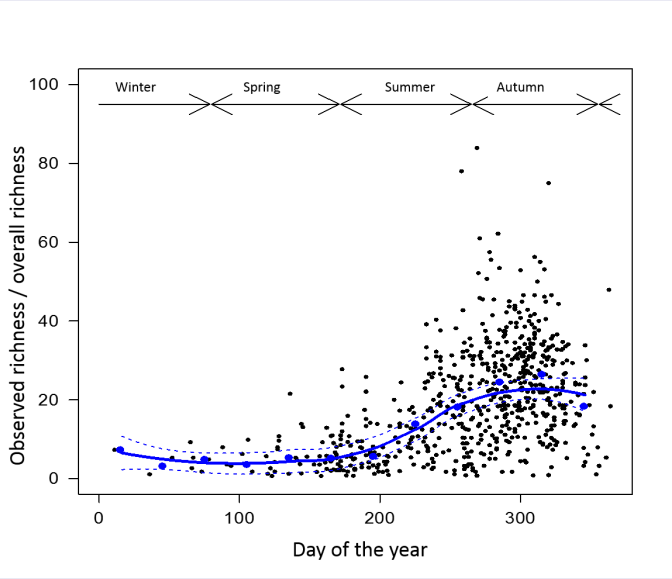

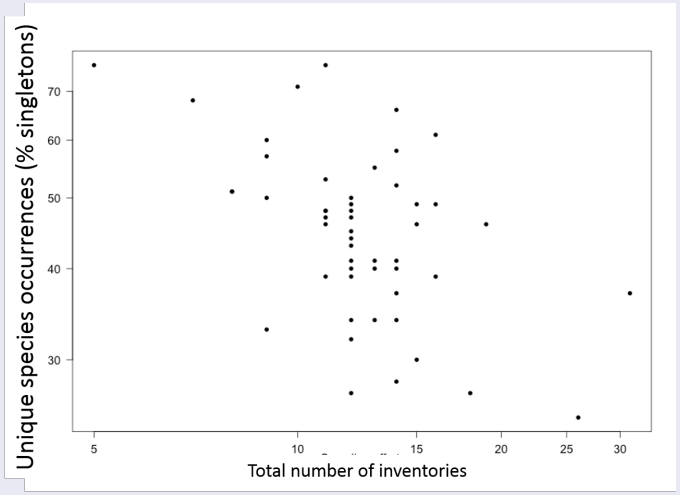

Richard et al., in prep

- Better knowledge of fungal phenology (mushroom occurrence)
- New species detected at each sampling
- Multiple samplings to reach exhaustiveness ?

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How many fungus inventories to pool and when ?

Sampling coverage

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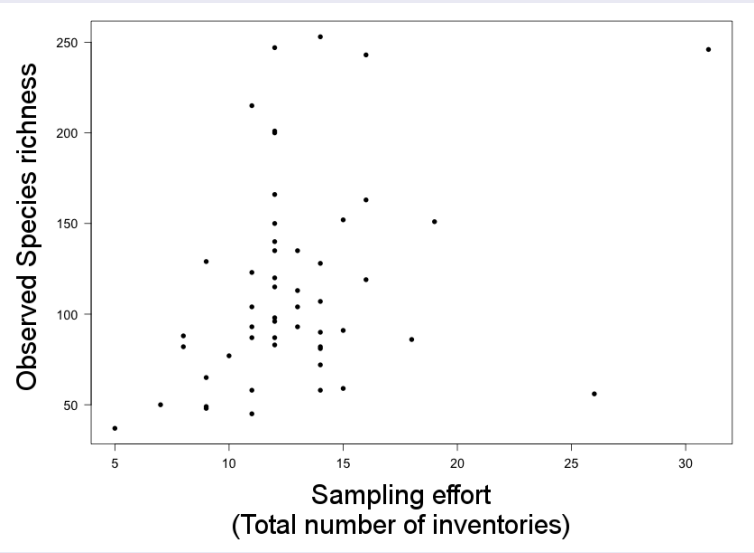

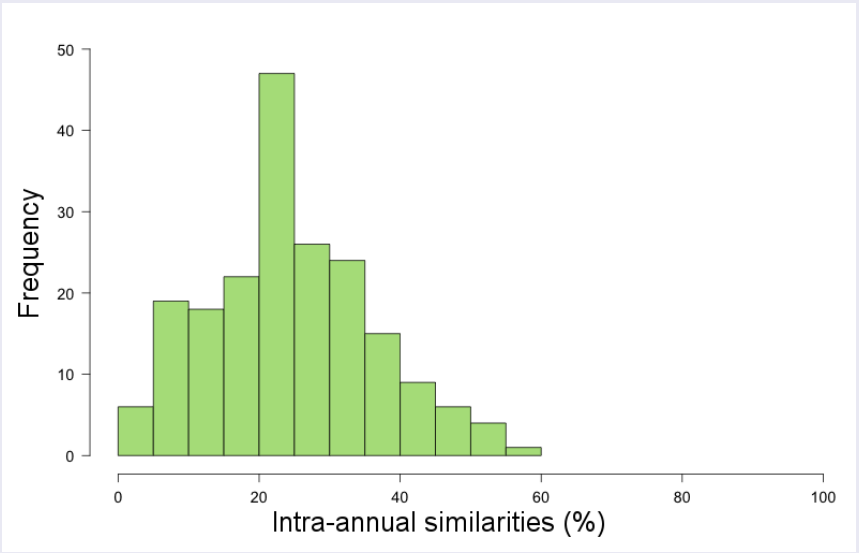

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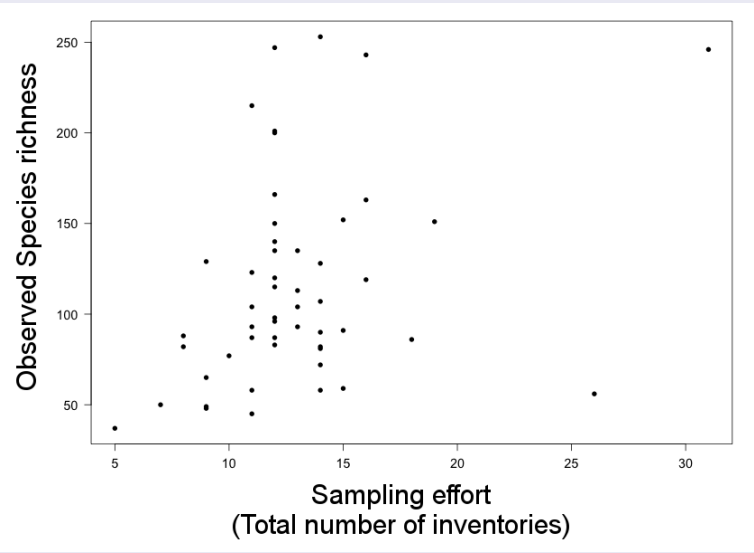

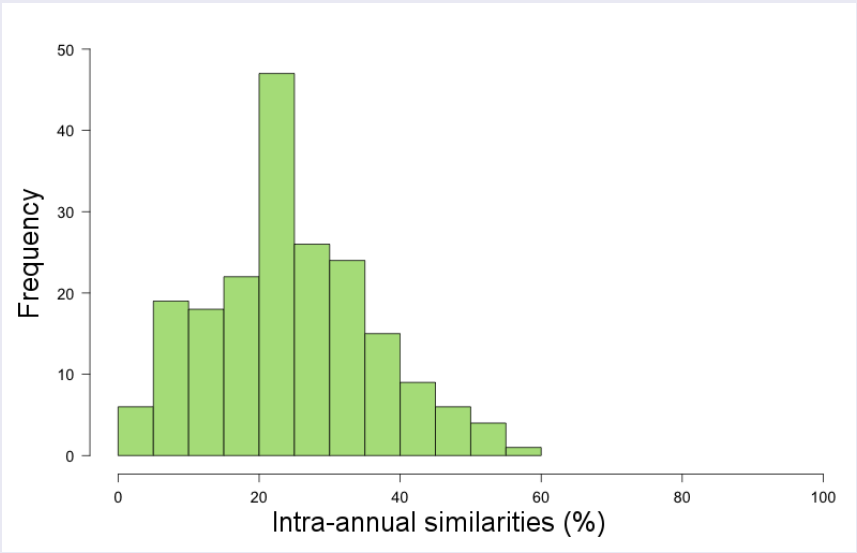

Richard et al., in prep

- Cumulated species richness does not level off
- High variability in community composition over time
- Is it possible to define species richness for fungi?

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National trends in chemical parameters of forest soils

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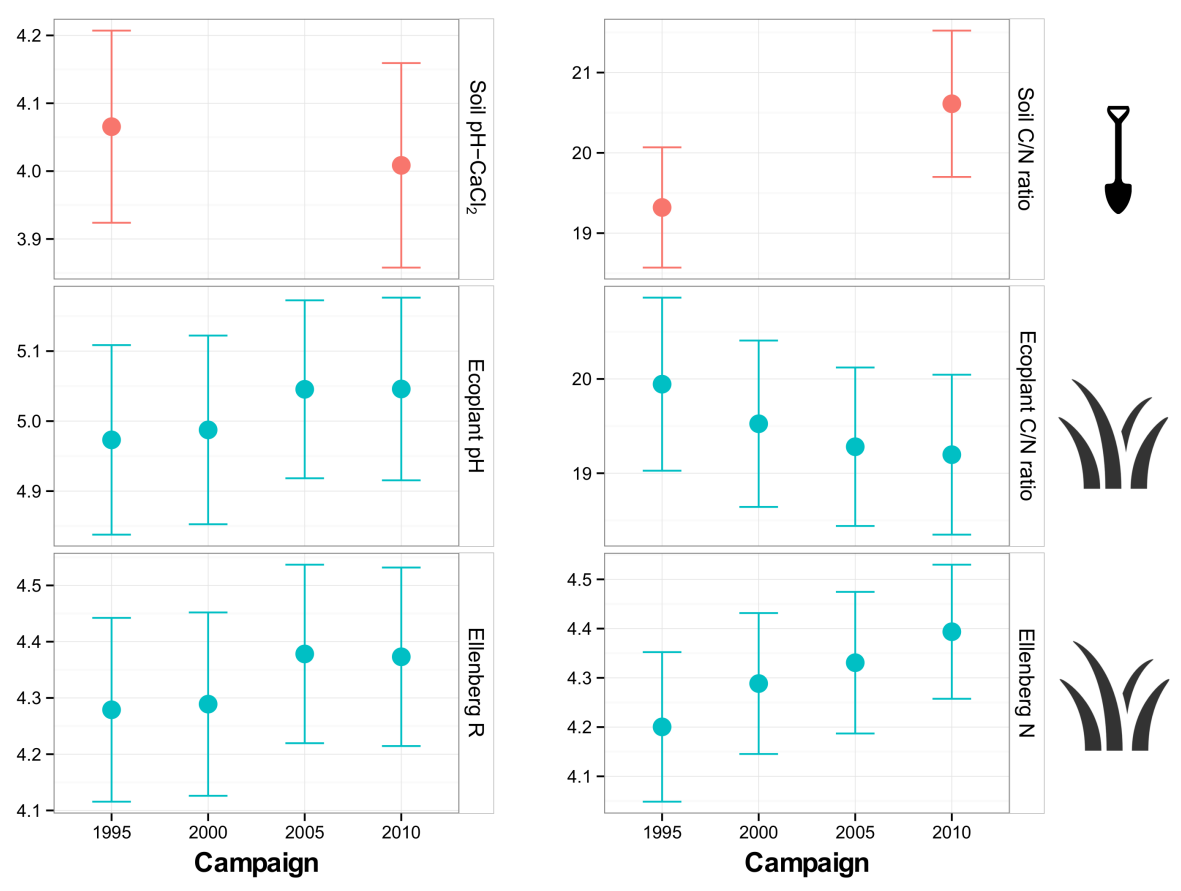
Plant bioindication of soil measurements



Le Roncé, 2015

Soil bioindication: at the plot scale

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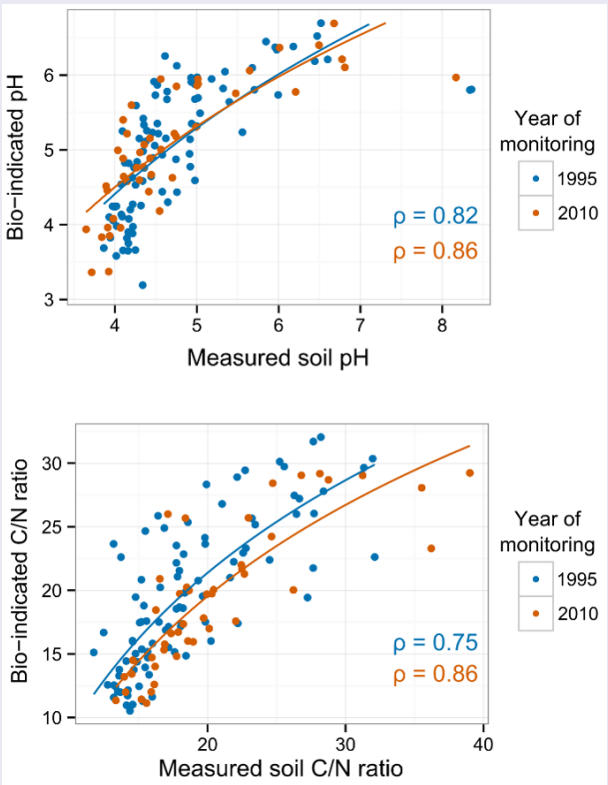
Spatial relationship



Le Roncé, 2015

- Relevance of plant bioindication

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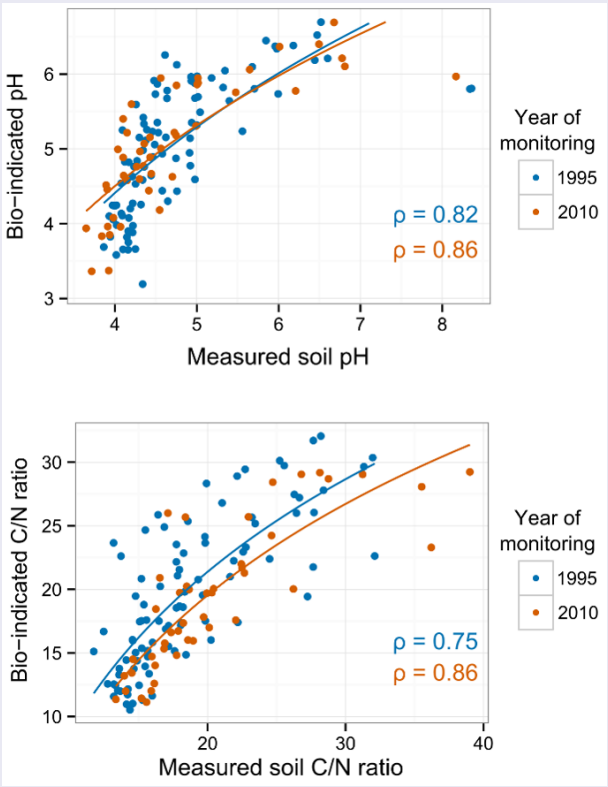
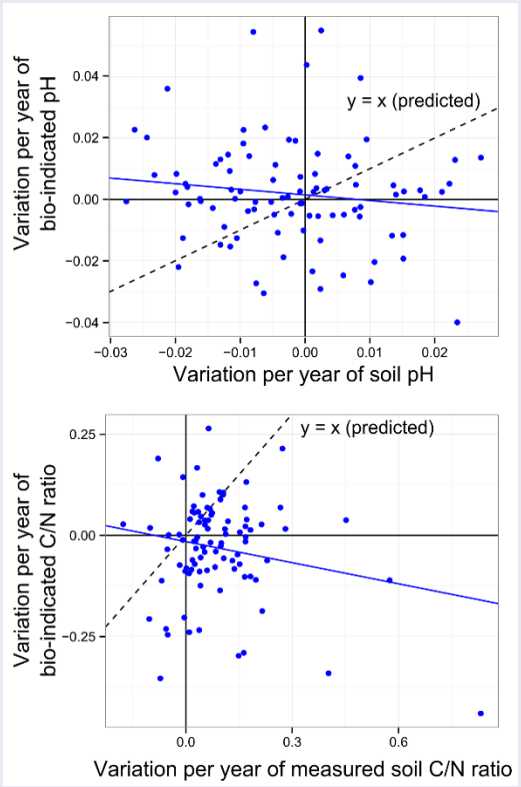


Le Roncé, 2015

Temporal relationship



Le Roncé, 2015

- Relevance of plant bioindication
- No inference possible over 10 years

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What shapes fungal communities?

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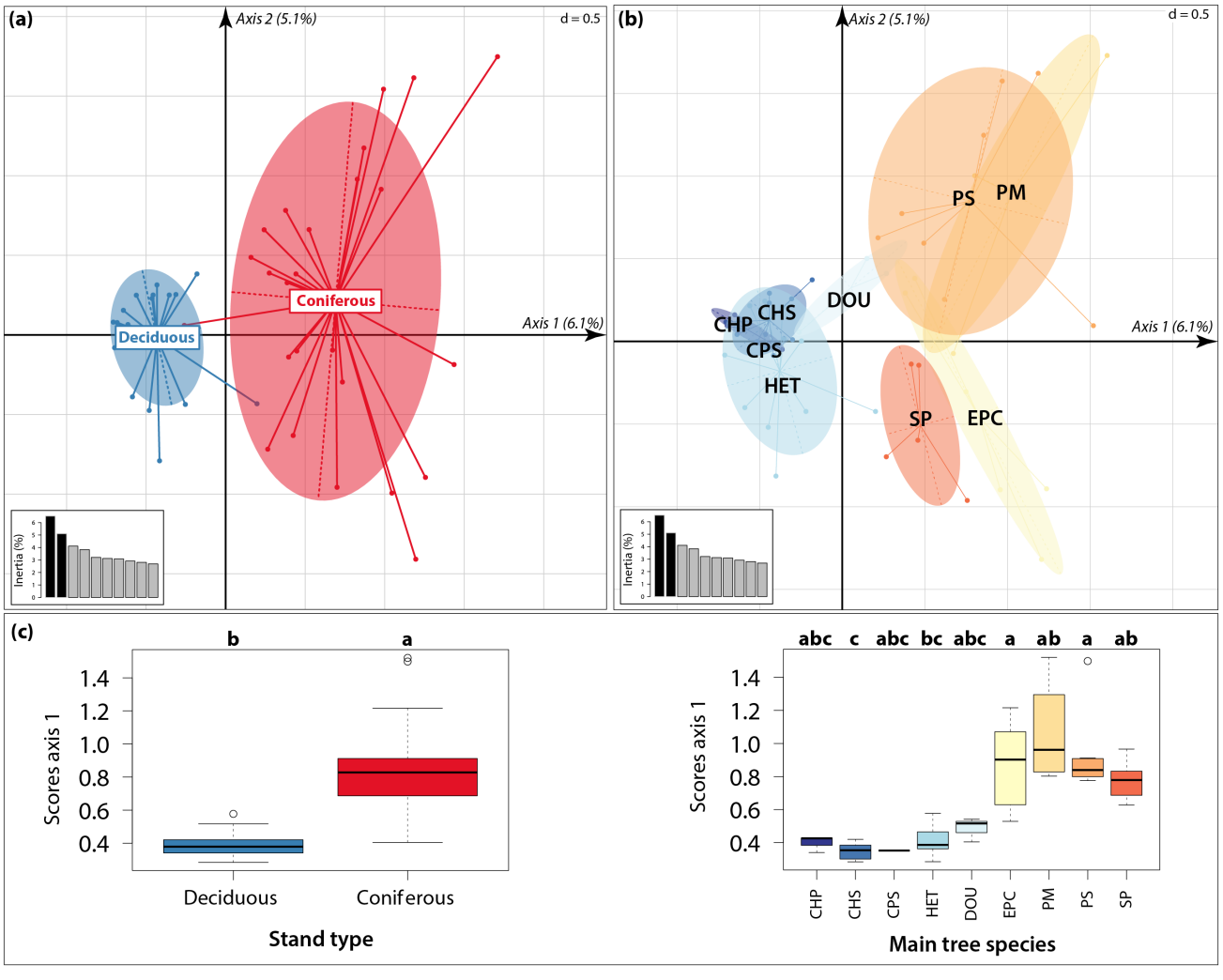

Richard et al., in prep

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Plant - Herbivore interactions

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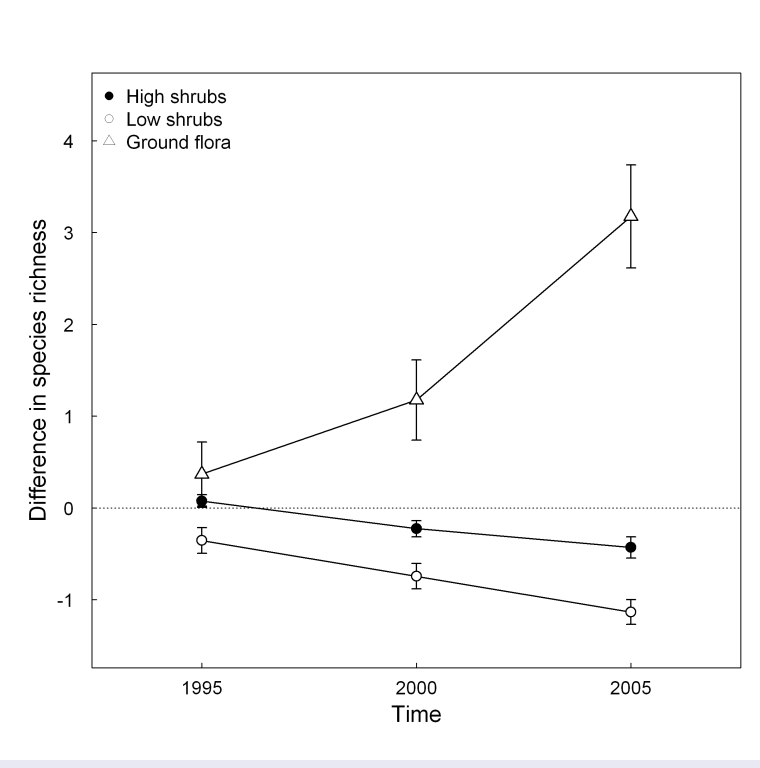
Trends in differences (unfenced - fenced) in species richness



Boulanger et al., in prep

- Paired plant inventories (inside and outside the fence) reduce observer effects
- Decrease in shrub species richness
- Increase in ground flora species richness
- Changes in species composition: more generalist species outside

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Issues in biodiversity monitoring

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Requirements for plant sampling

- Rigorous protocol take advantage of past experience
- Calibration training: large scale, multiple observers
- More accurate assessment of inventory quality in monitoring networks

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Sampling fungi

- Exhaustiveness nearly impossible through observation
- How to disentangle temporal changes and additional observed species?
- Meta-genomics (DNA barcoding)as an option?

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Are taxonomists endangered species?

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The issue of generality

- Experiments are designed to test a specific set of questions.
- Should long-term monitoring be restricted to the original questions?
- Identify not only topics and variables to be monitored, but also thouse to NOT monitor.

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Long-term monitoring takes time

- Mistaken beliefs and excessive expectations about network results
- Could the starting lag / maturing period could be shortened by more frequent samplings early on?
- Sustainable funding is required and must be maintained until the network produces the desired results!