Biodiversity – Ecosystem Function Relationships in Southern African Woodlands

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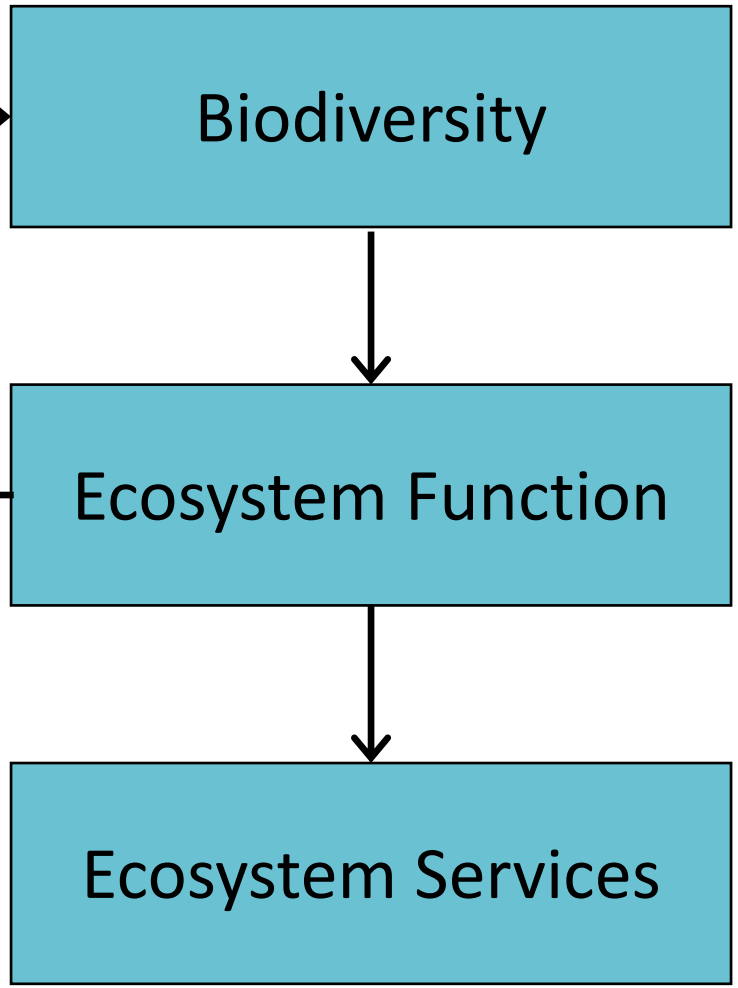
The biodiversity-ecosystem function relationship

Loreau & Mazancourt (2013)

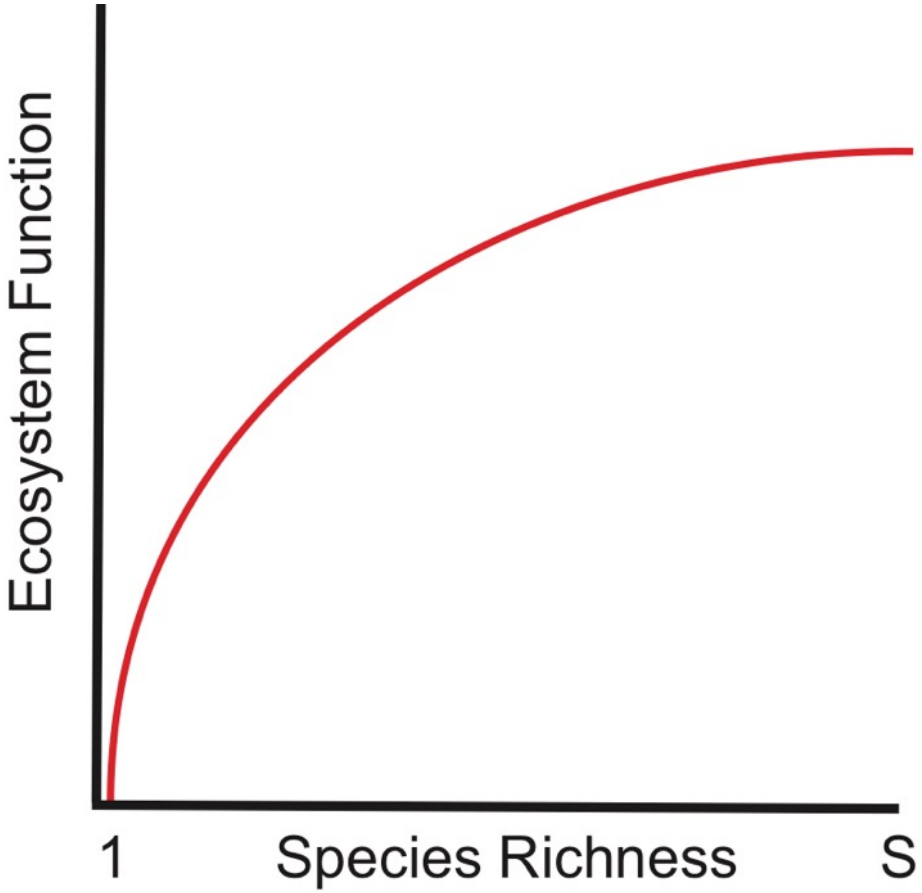


- Species richness
- Functional richness
- Abundance evenness

- Temporal growth stability
- Gross primary productivity
- Soil nutrient content

- Timber production
- Cattle fodder biomass
- Water availability

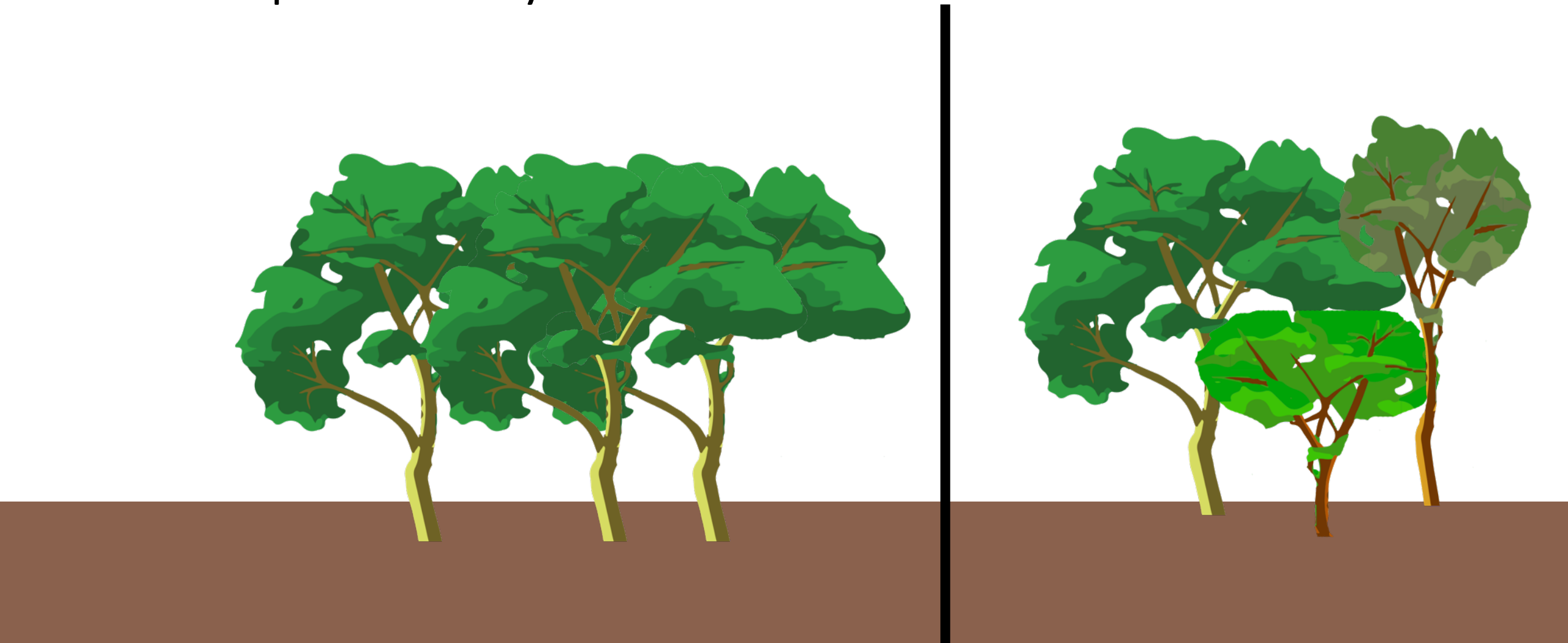
Turnbull et al. (2016)



Cardinale et al. (2009)
Liang et al. (2016)

Mechanisms of the biodiversity-function relationship

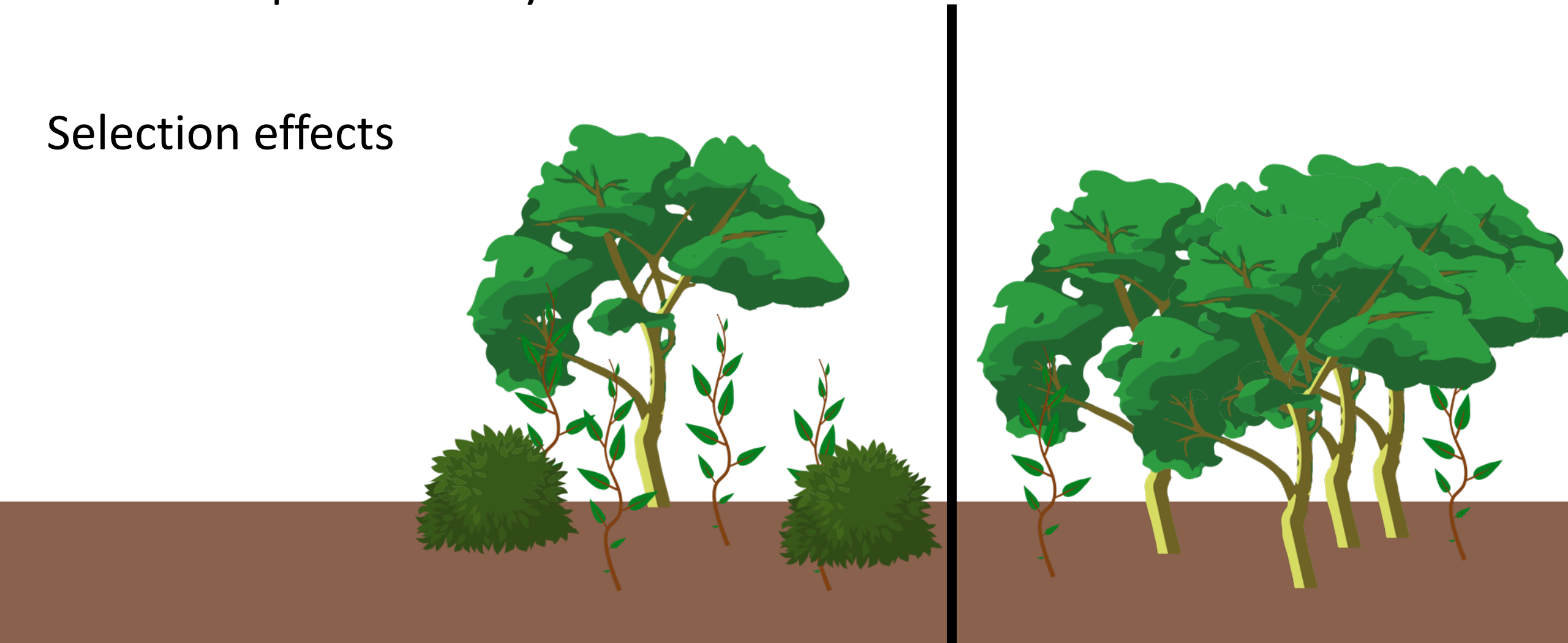
Niche complementarity



The biodiversity-ecosystem function relationship

Niche complementarity

Selection effects



The biodiversity-ecosystem function relationship

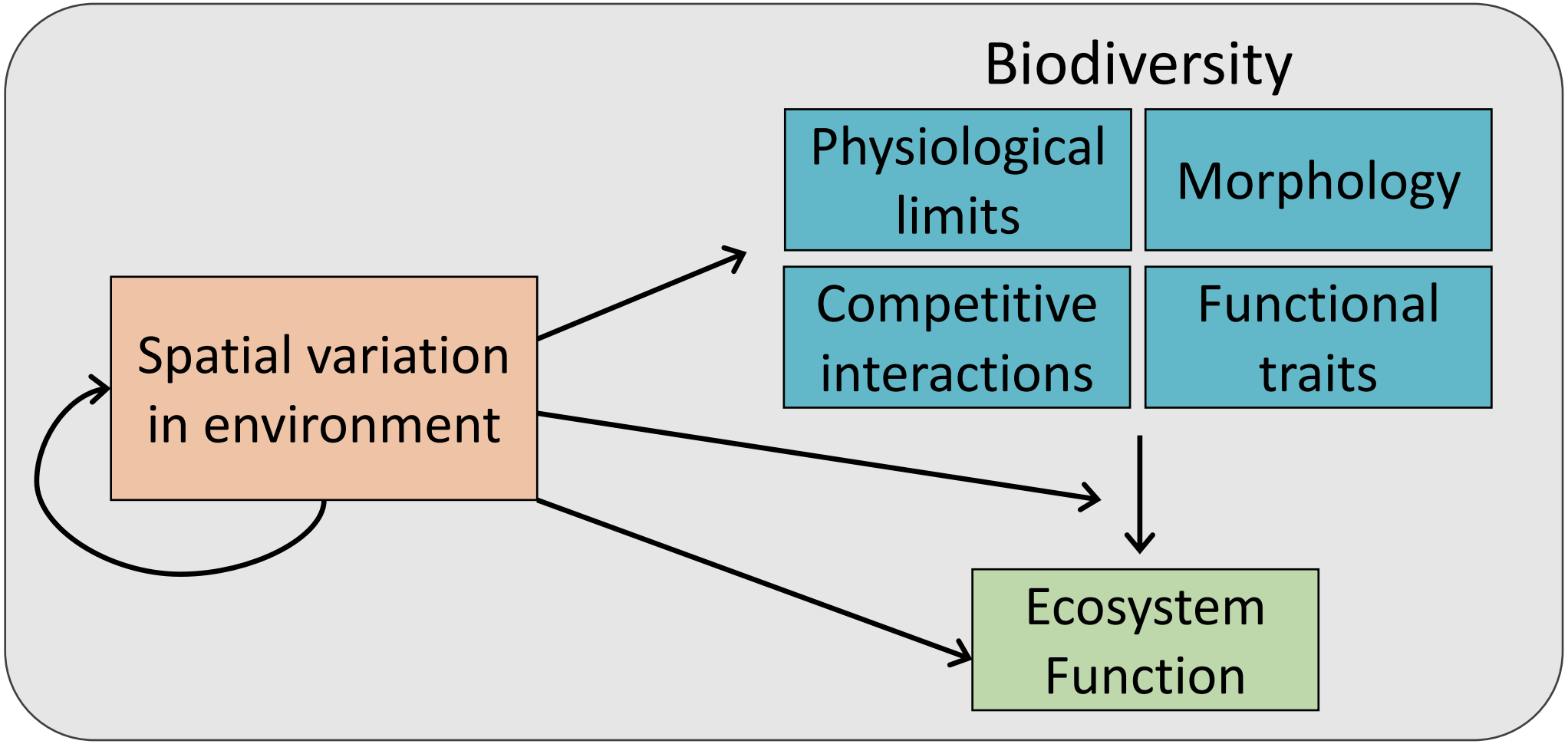
Niche complementarity

Selection effects

Facilitation effects

The biodiversity-ecosystem function relationship

1. How does the biodiversity-function relationship vary over environmental space?
2. What are the biotic mechanisms which drive observed biodiversity function effects?

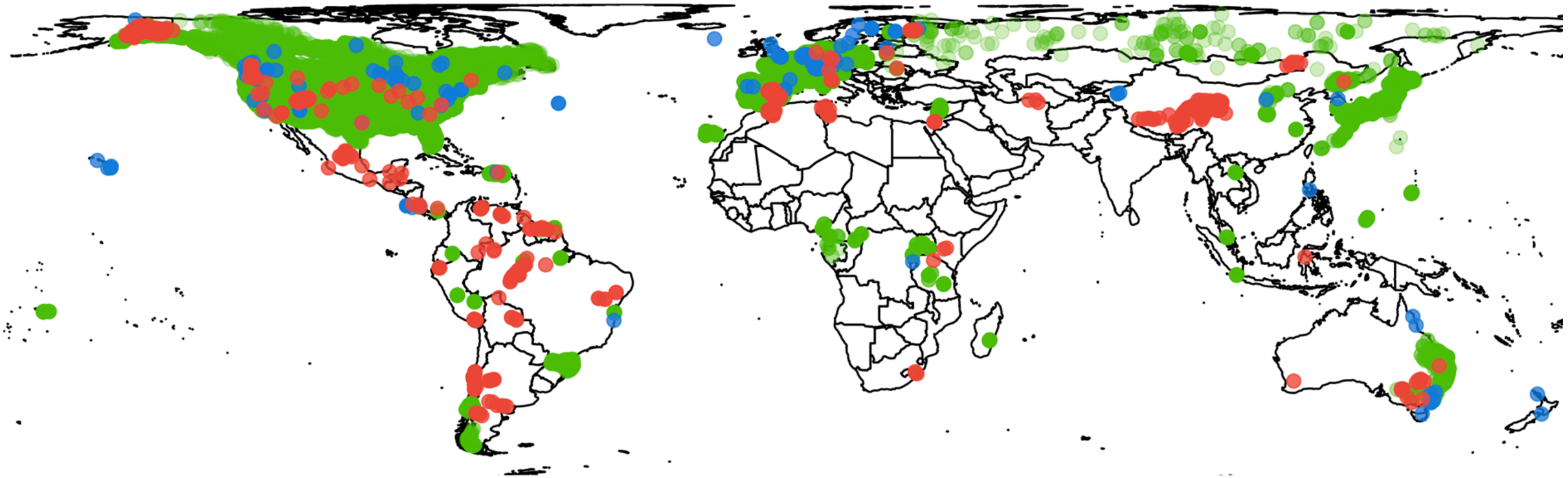


Biodiversity-ecosystem function research in Africa

Clarke et al. 2017
135 studies

Duffy et al. 2017
535 plots

Liang et al. 2016
773100 plots



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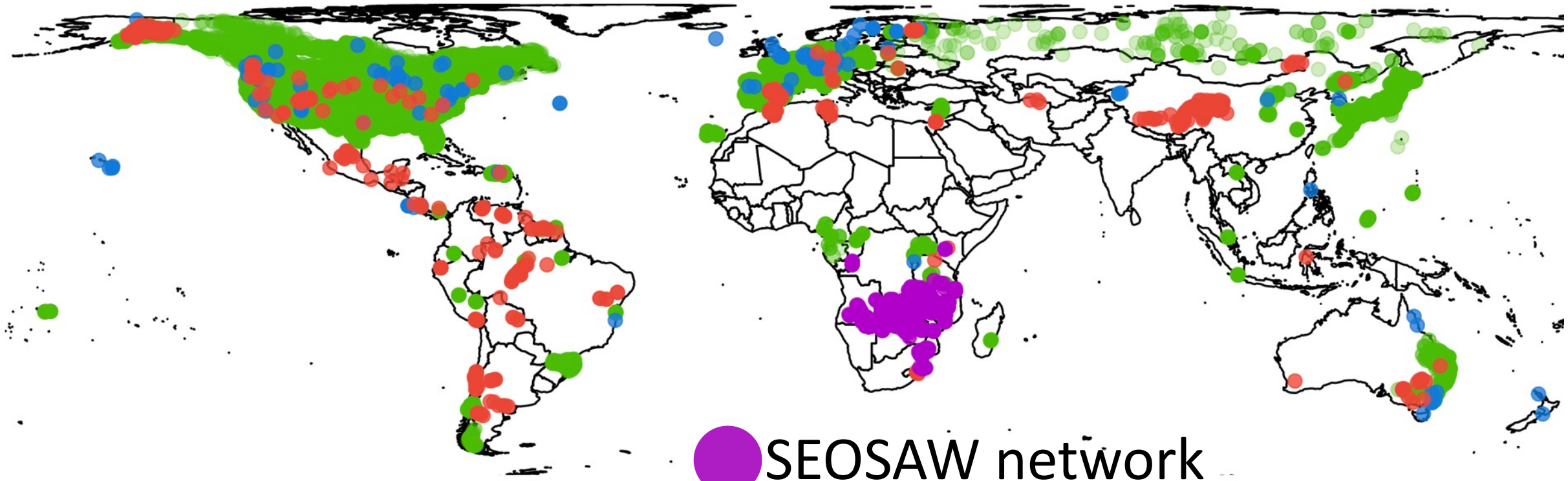
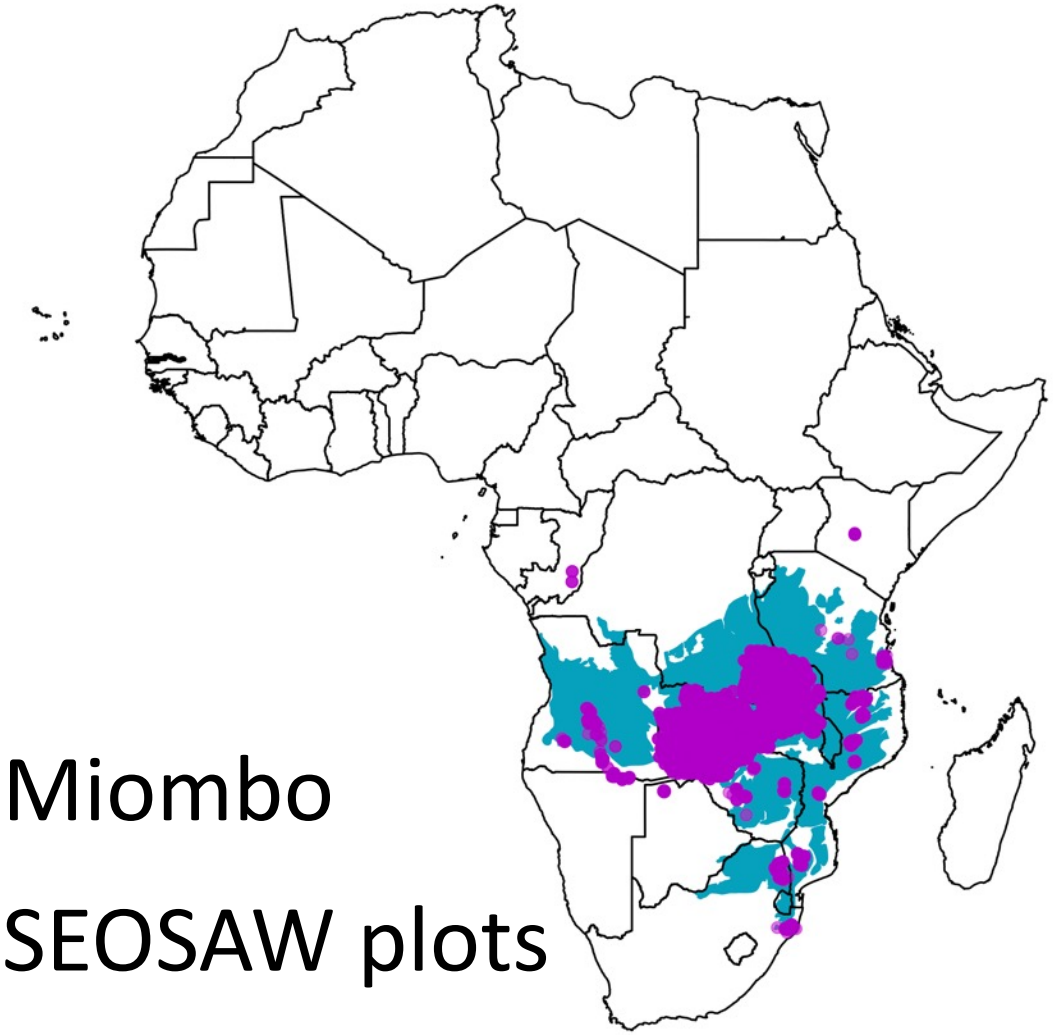


SEOSAW network
5120 plots (… ish)

Biodiversity-ecosystem function research in Africa



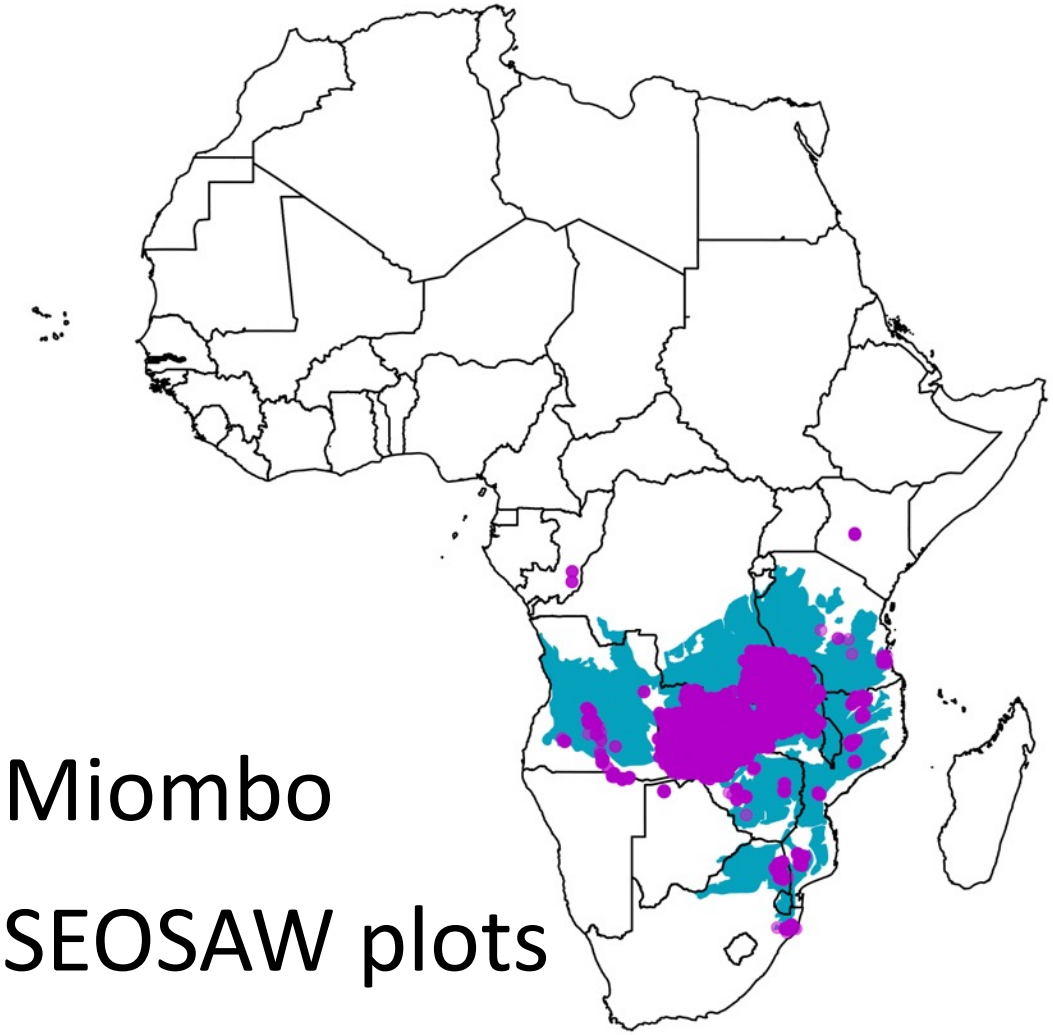
White et al. (1983)

Miombo woodlands:

- Large spatial variation in tree cover
- Low tree species richness
- Affected by disturbance:
  - Fire
  - Herbivory
  - Human resource extraction

Frost (1996)

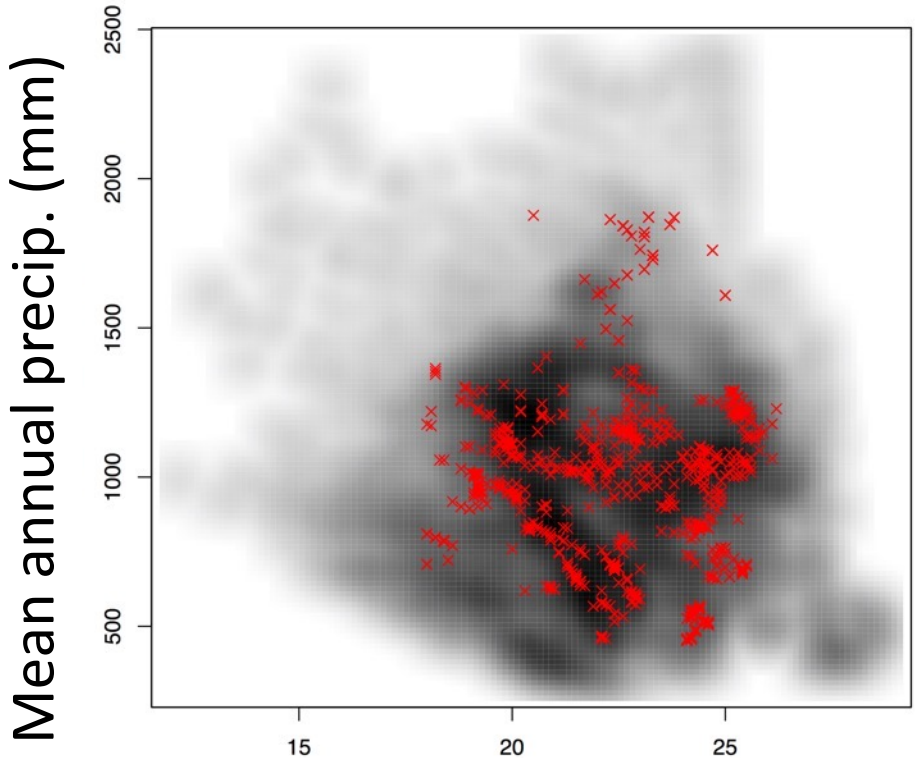
Biodiversity-ecosystem function research in Africa



Miombo

SEOSAW plots

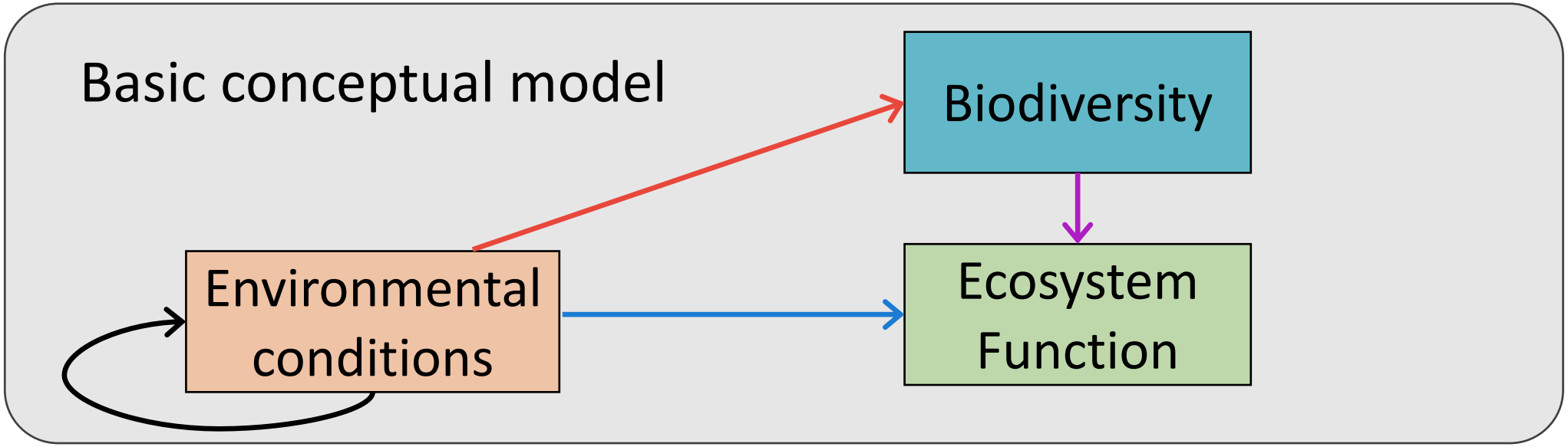
White et al. (1983)



- Increased aridity -> More facilitation effects
  Ratcliffe et al. (2017)

- Higher variation precip. -> Greater biodiversity effect
  De Boeck et al. (2017)

Q1 - Regional biomass – species richness relationship



Biodiversity → Eco. Function

Environment → Eco. Function

Environment → Biodiversity

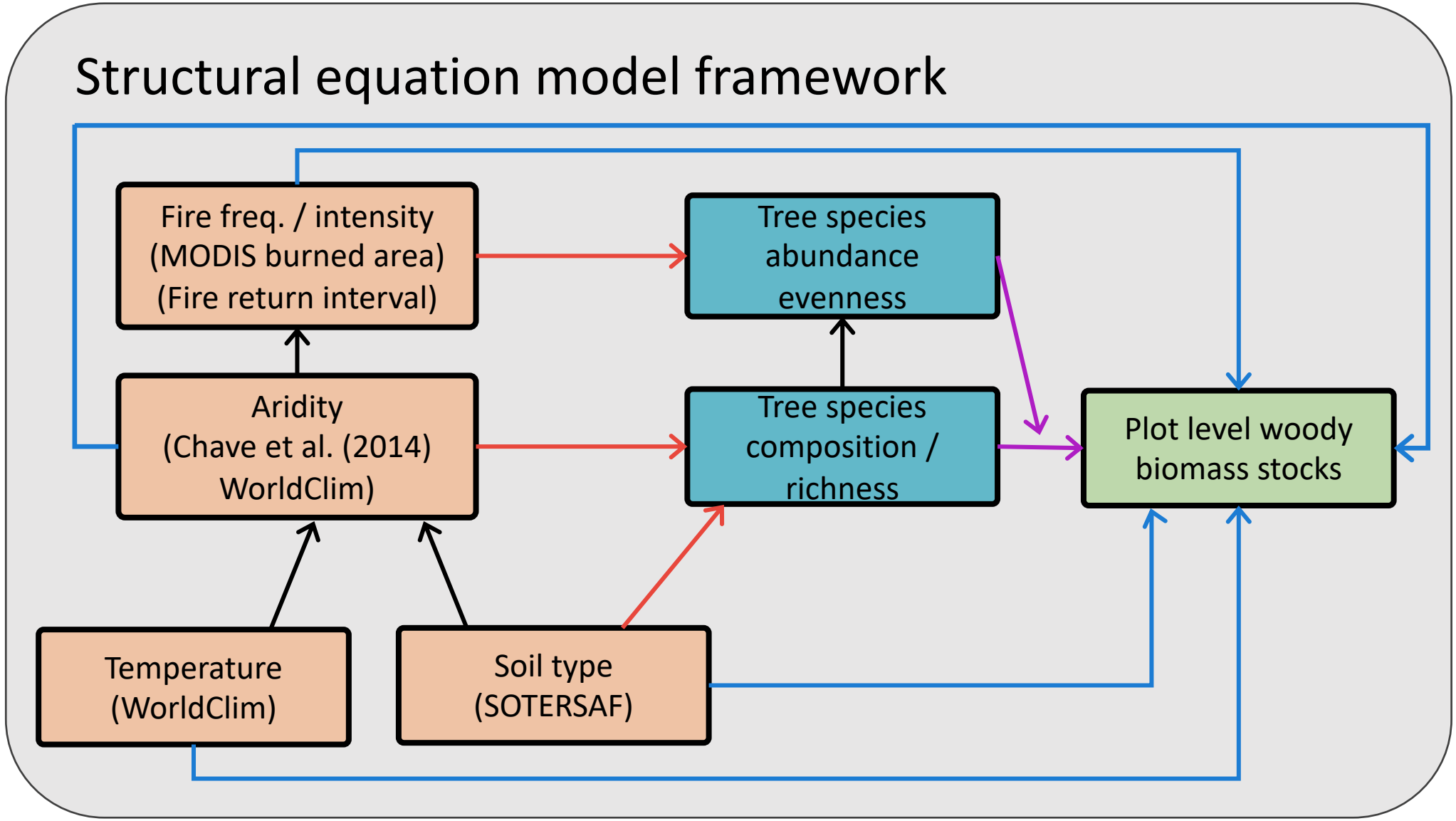
1. Higher species richness will result in higher biomass stocks (niche comp.)

2. Species composition will have more effect on biomass than species richness (selection effects).

3. Increased aridity will result in stronger richness – biomass relationship due to abiotic facilitation effects.

4. Positive effect of abundance evenness on biomass stocks (Mass ratio).

Q1 - Regional biomass – species richness relationship



Biodiversity

↓

Eco. Function

Environment

↓

Eco. Function

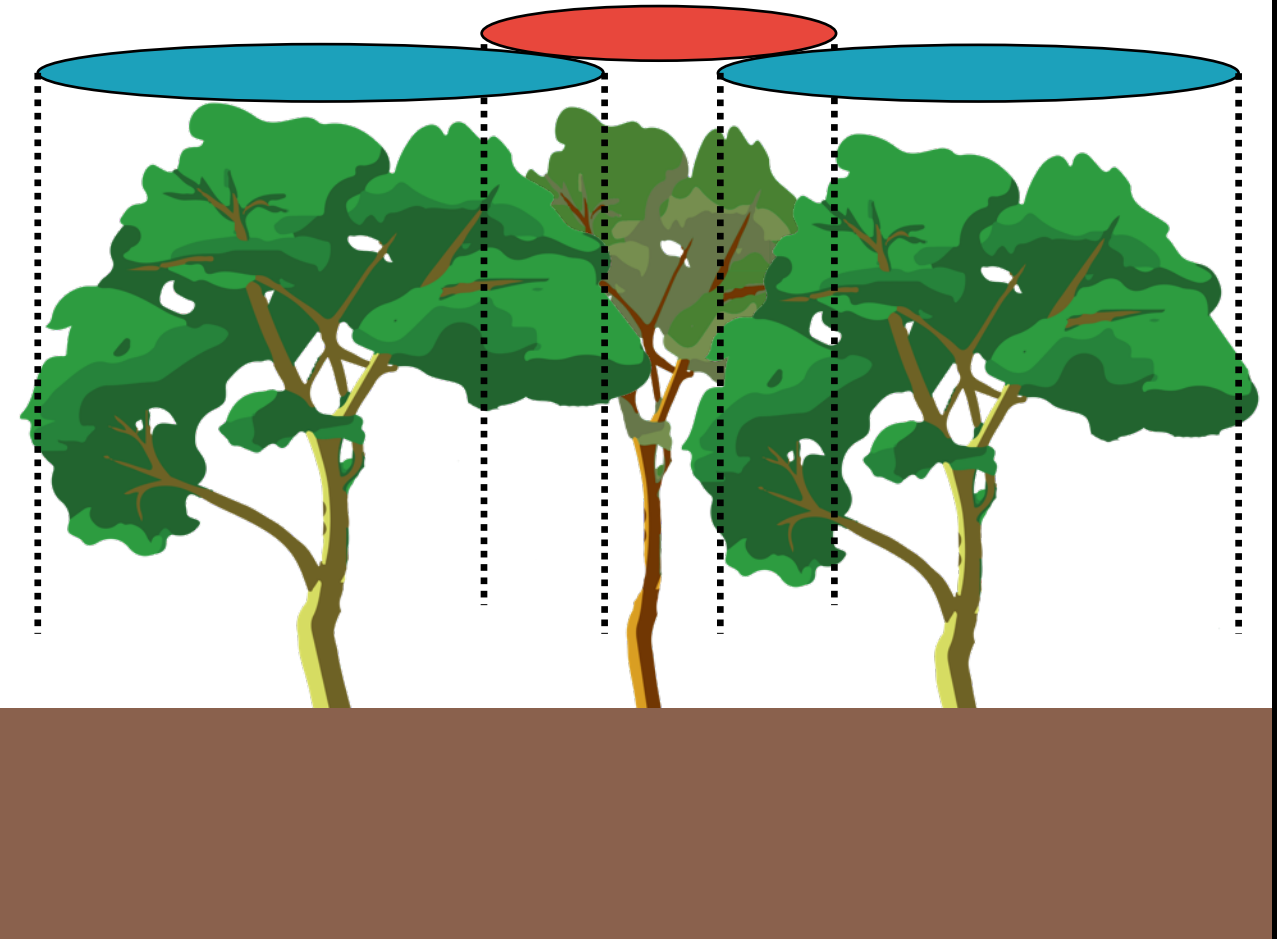
Environment

↓

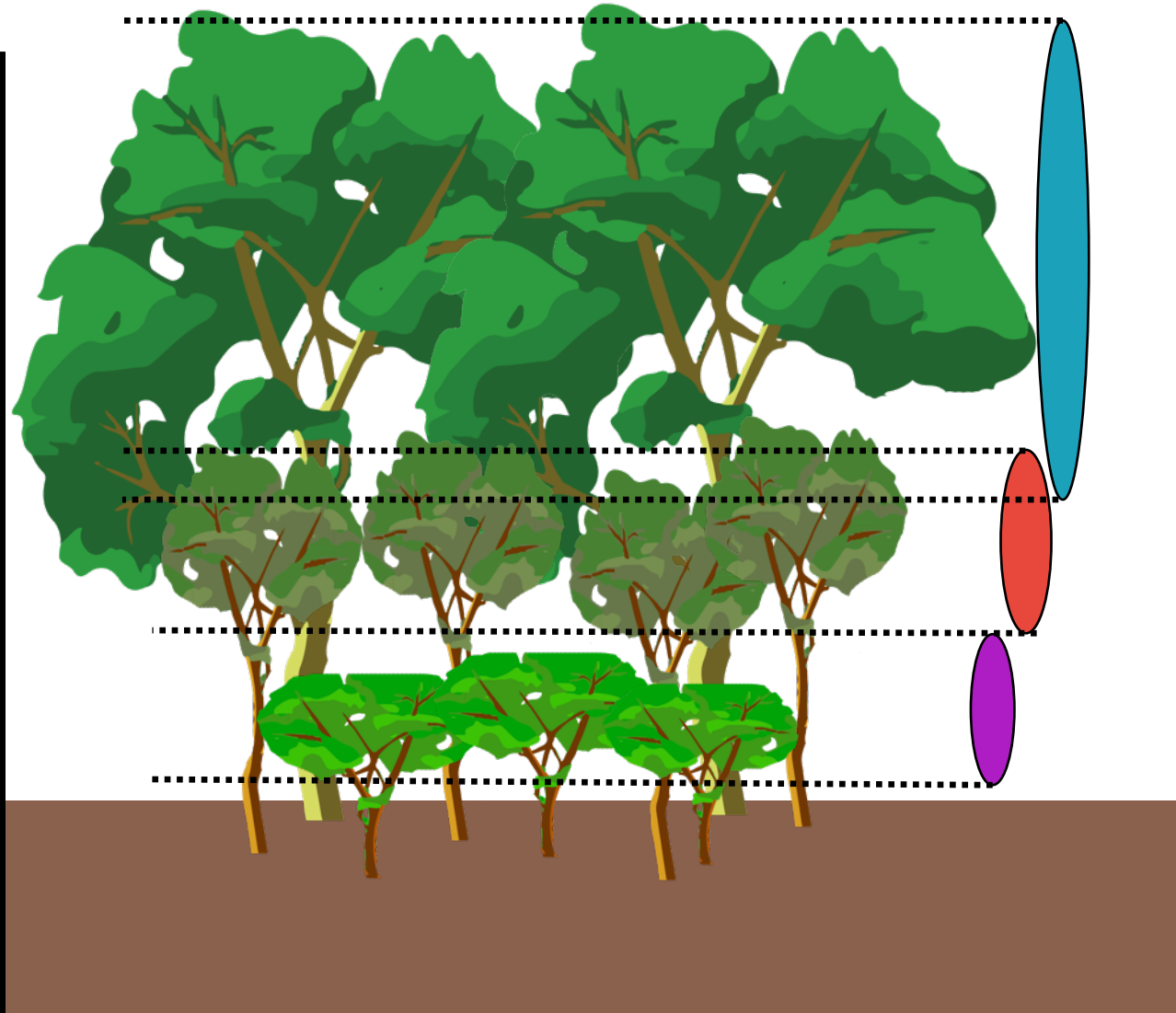
Biodiversity

Q2 - Canopy structure and woody biomass

Horizontal canopy packing



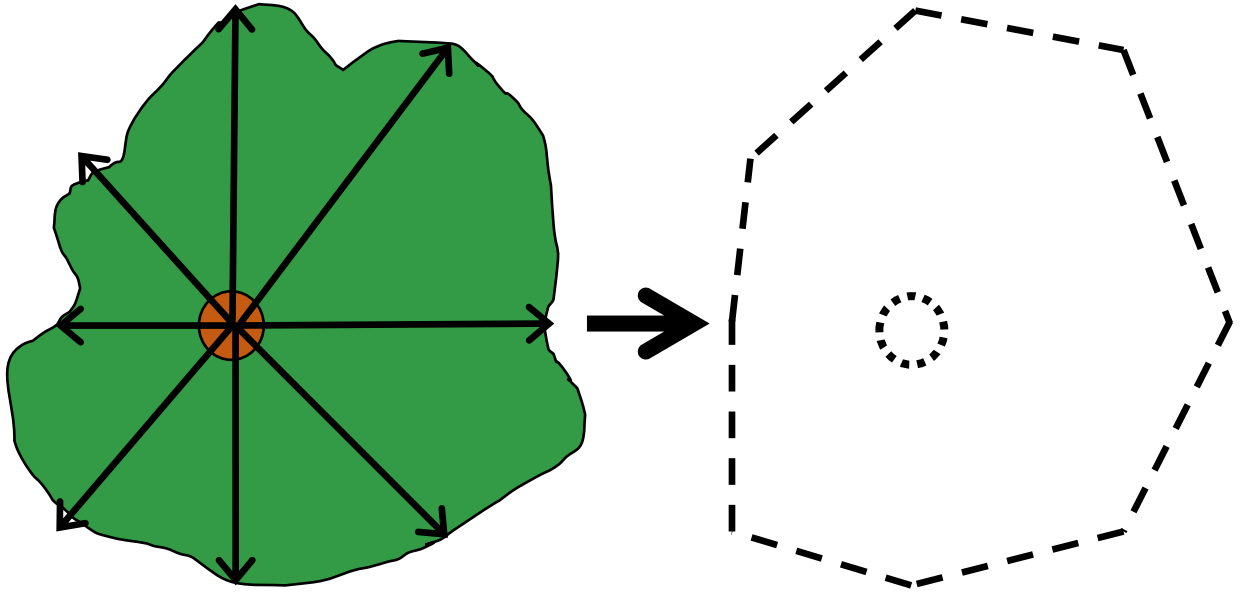
Vertical canopy profile



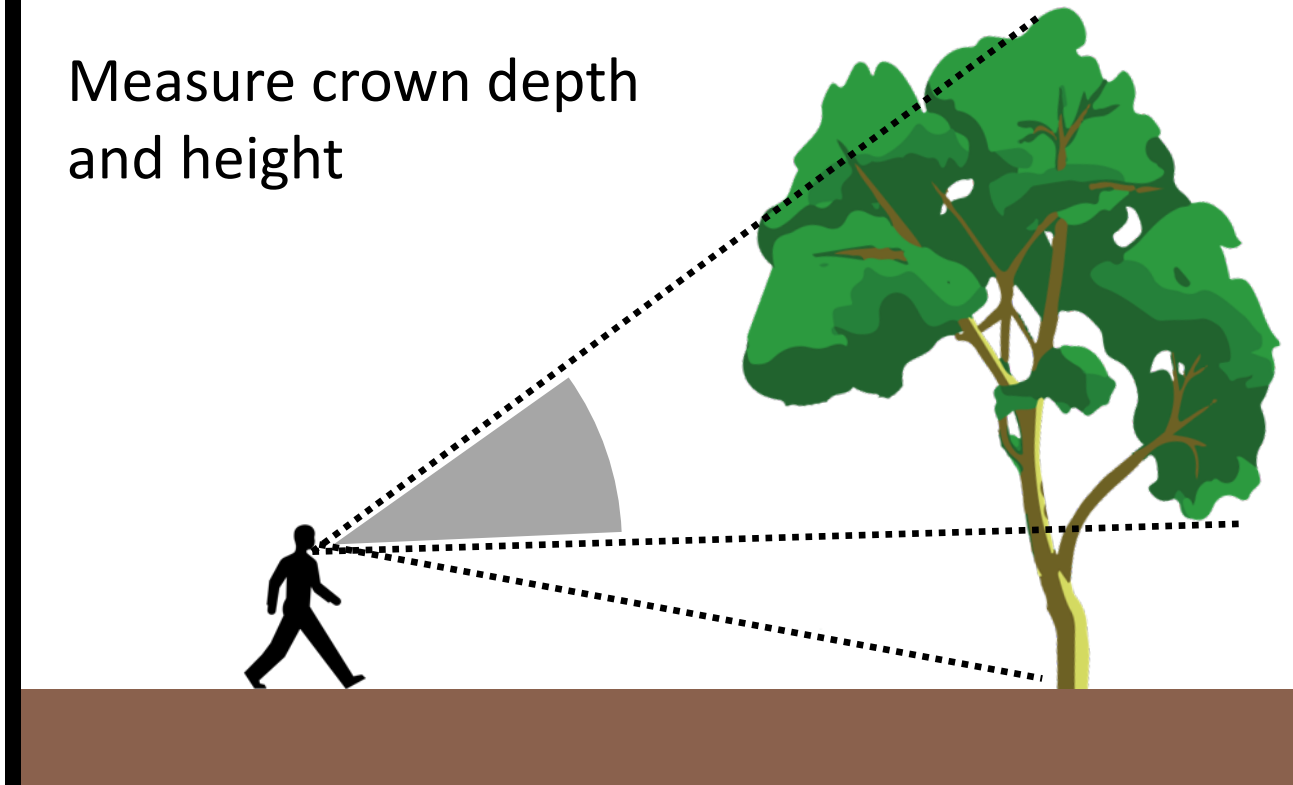
Q2 - Canopy structure and woody biomass

1. Higher crown shape and canopy layer diversity will result in higher woody biomass.
2. Biomass stocks of lower canopy trees will be sensitive to variation in upper canopy layer density.
3. Different groups of species will occupy distinct canopy profile layers and will have distinct crown shapes.

Model tree crowns as polygons



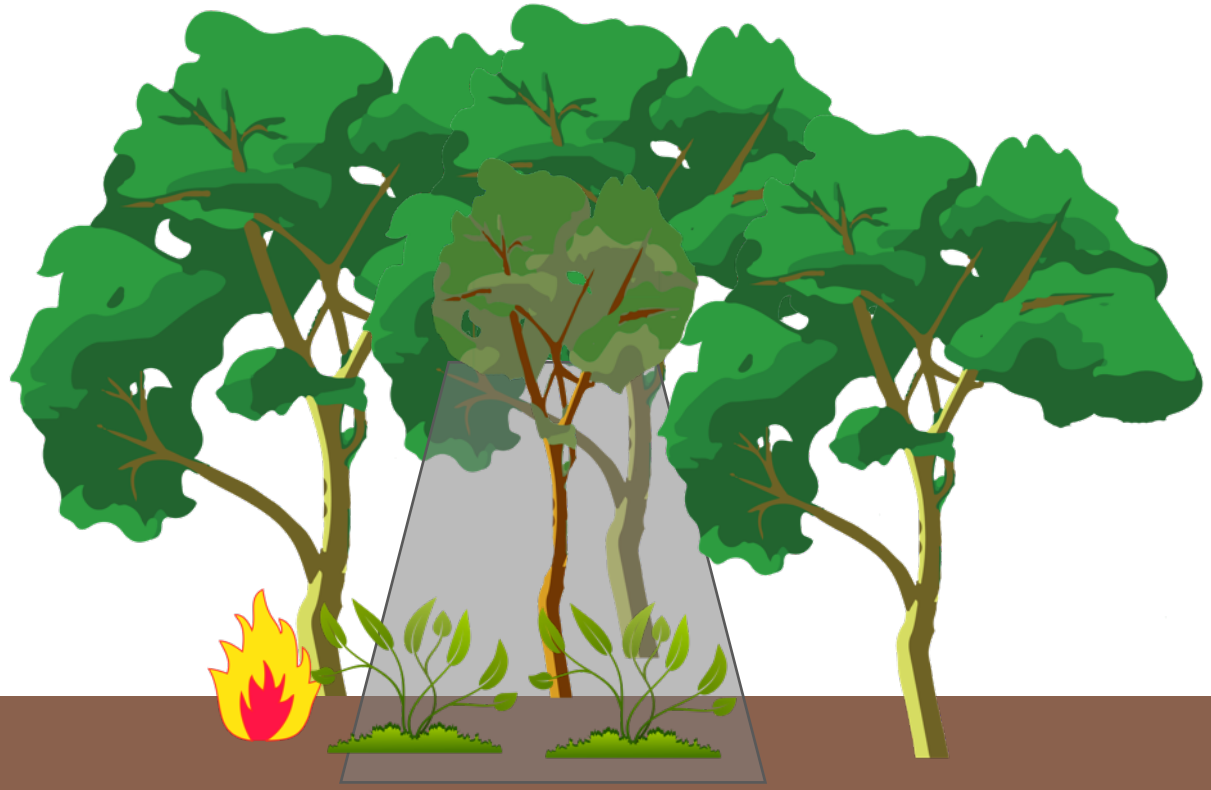
Measure crown depth and height



Q3 - Canopy architecture and herbaceous biomass

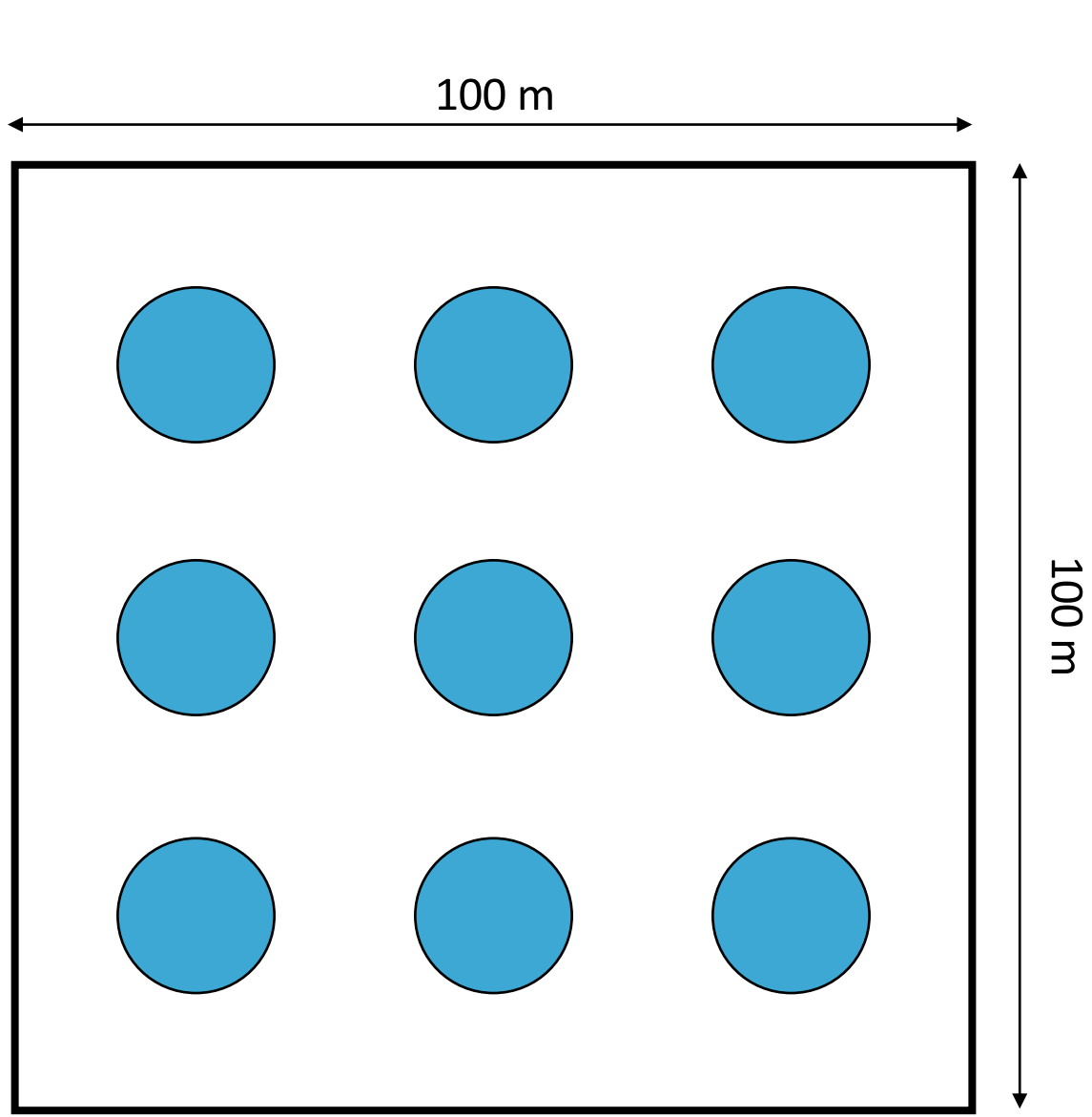
1. Higher diversity of canopy trees will lead to greater shading of the understorey.
2. Higher diversity of canopy trees will lead to lower herbaceous biomass.

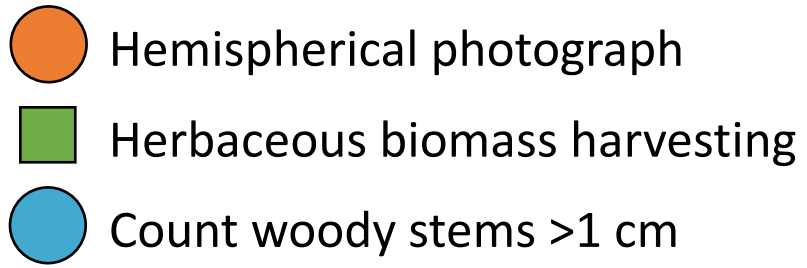
- High diversity canopy
- Low grassy biomass

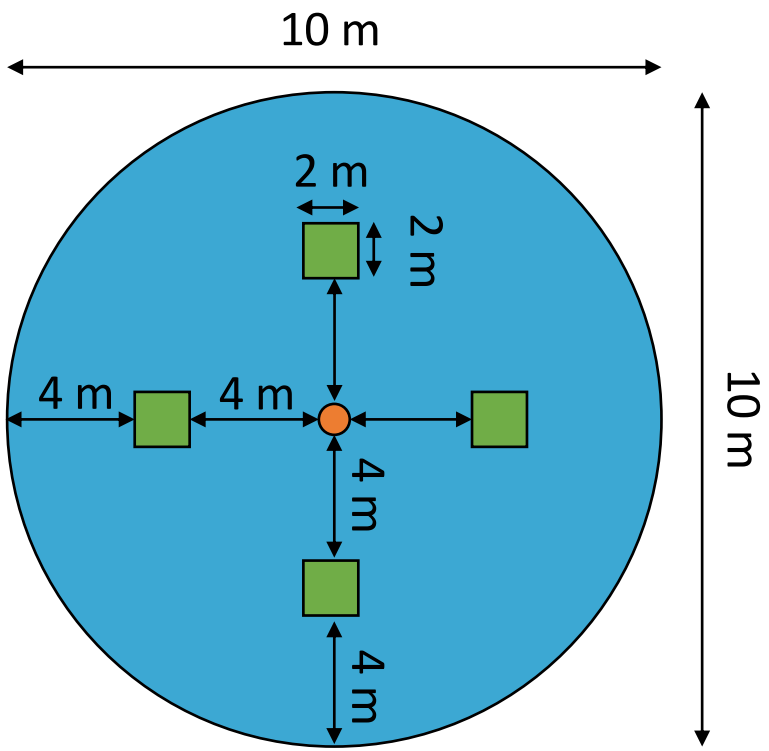


- Low diversity canopy
- High grassy biomass

Q3 - Canopy architecture and herbaceous biomass



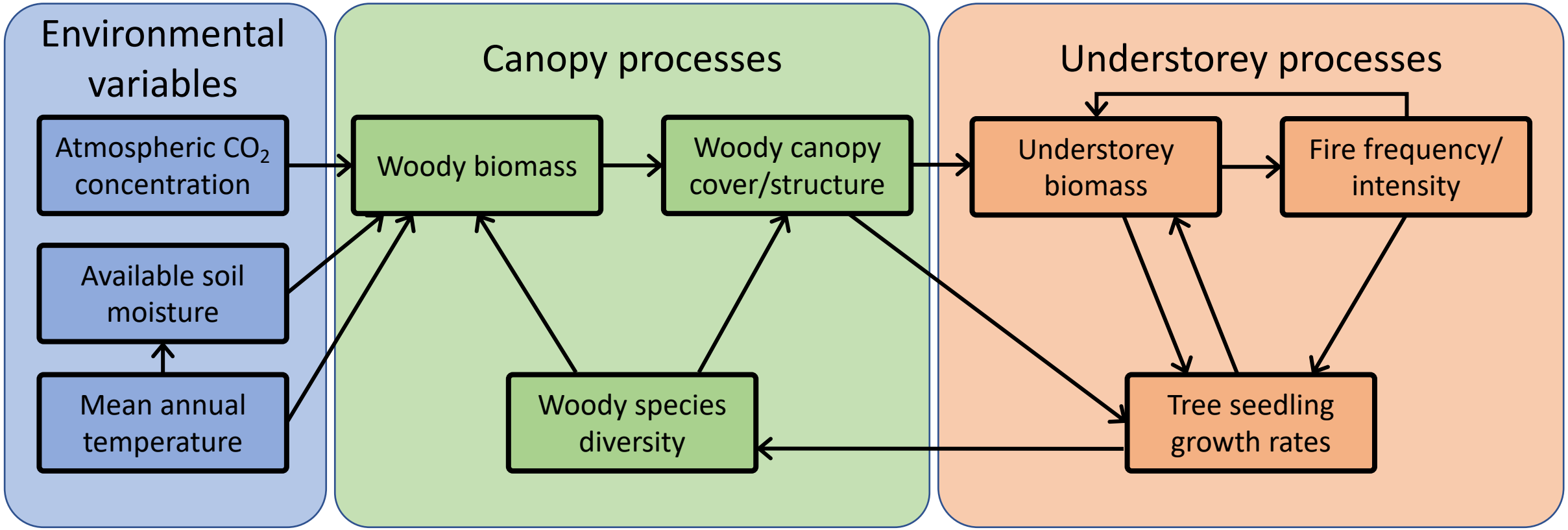




Q4 – Modelling woodland structural development

1. What is the threshold of tree density which excludes herbaceous biomass?
   a. How does this threshold vary under different tree species compositions and environmental conditions?

2. Can variation in tree diversity affect the development of a woodland over time?



Summary

Four questions:

1. How does the BEFR vary over environmental gradients?

2. Does canopy structural complexity affect woody biomass?

3. How does canopy cover affect understorey biomass?

4. Can I simulate woodland structural development under different diversity scenarios?

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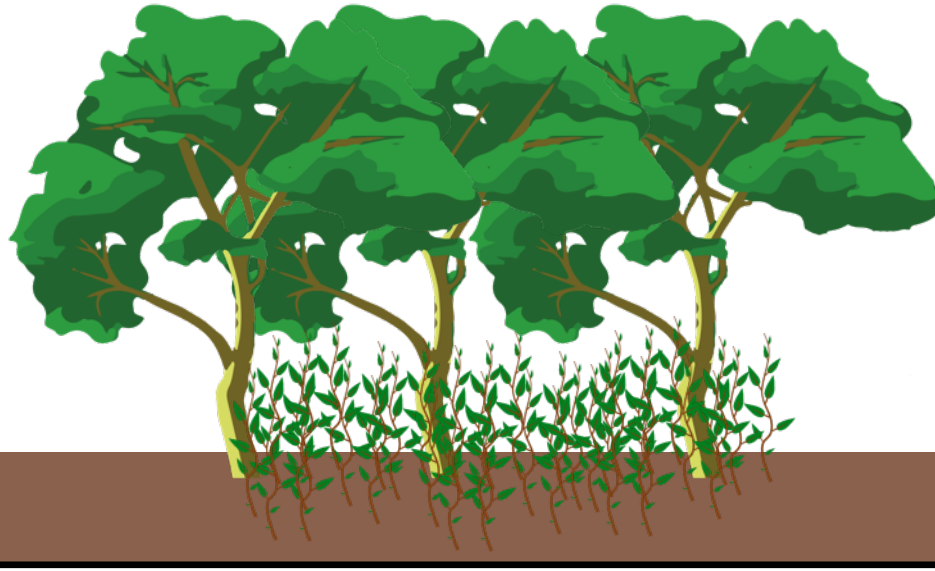
The biodiversity-ecosystem function relationship

Reduced species diversity



Reduced ecosystem complexity