

Biodiversity and ecosystem services in and from cocoa

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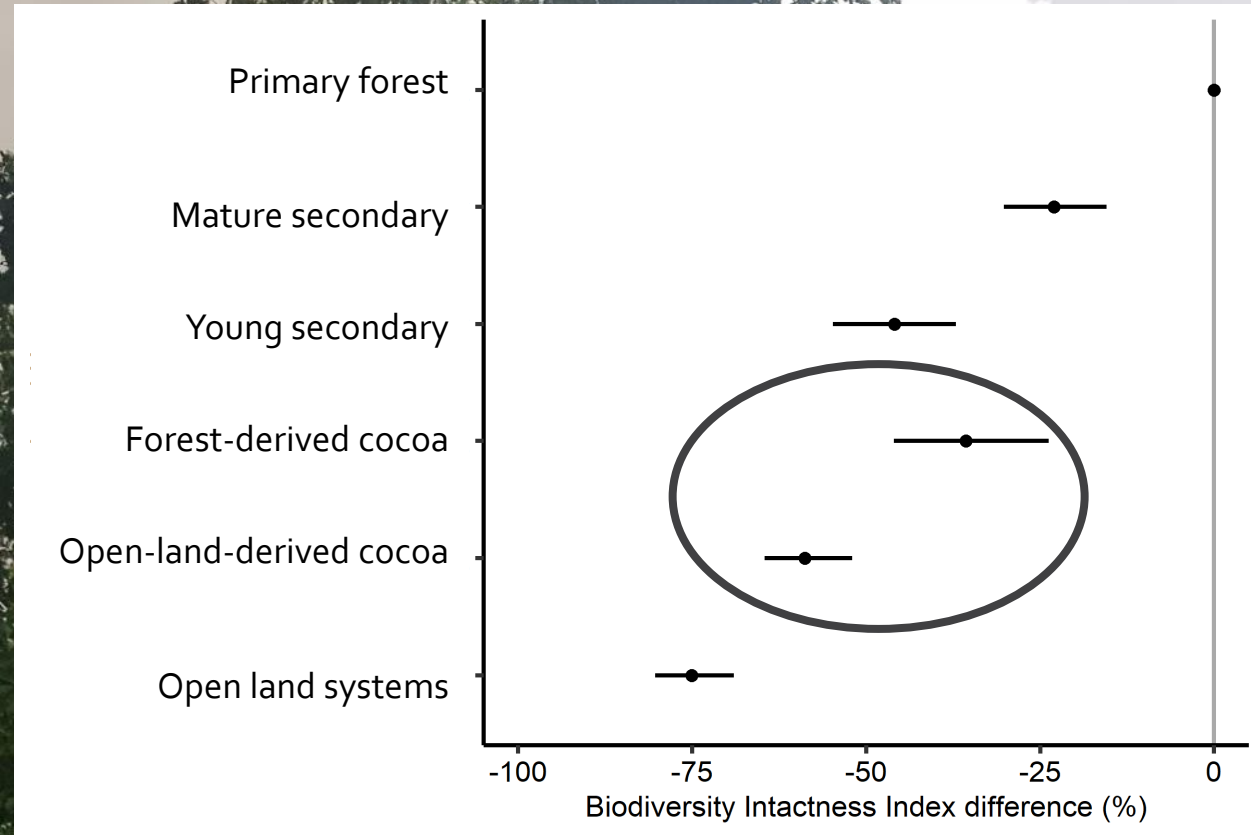
Background: biodiversity in cocoa

Why biodiversity in cocoa?

- Climate biodiversity co-benefits
- Connectivity/refugia for vulnerable species
- Ecosystem services to farmers & beyond

What biodiversity is in cocoa?

- Some debate – though see our paper for a synthetic summary
- Linked to system design, landscape, and historical context



Cocoa productivity, biodiversity and ecosystem services

Objectives:

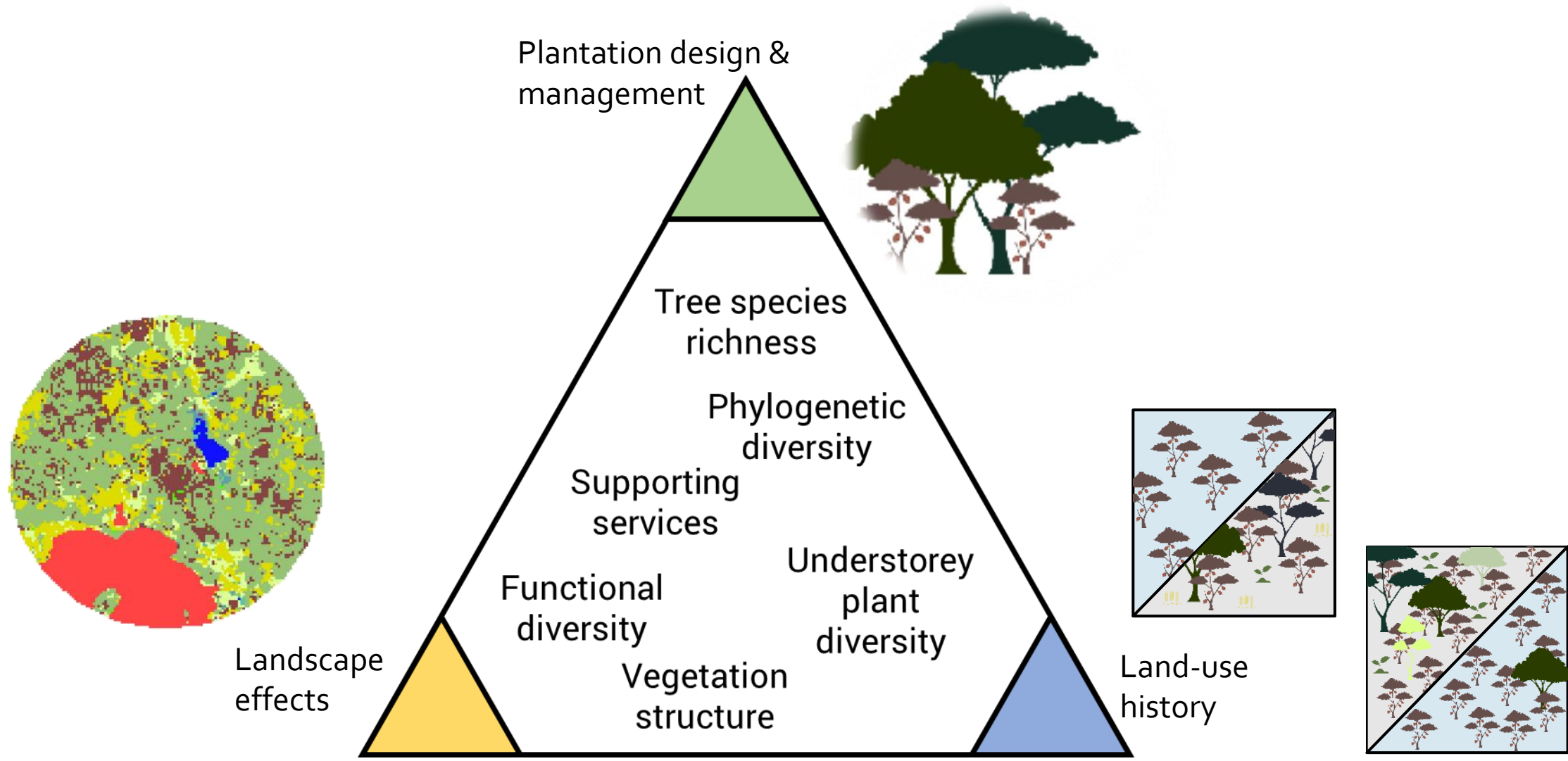
- To understand the links between productivity, biodiversity, ecosystem services and management in cocoa systems
- -> opportunities for sustainable cocoa from a biodiversity and ecosystem services perspective under a changing climate
- To improve the biodiversity impact model including more cocoa (agroforestry) management types across agroclimatic zones (Maney *et al.* 2021)

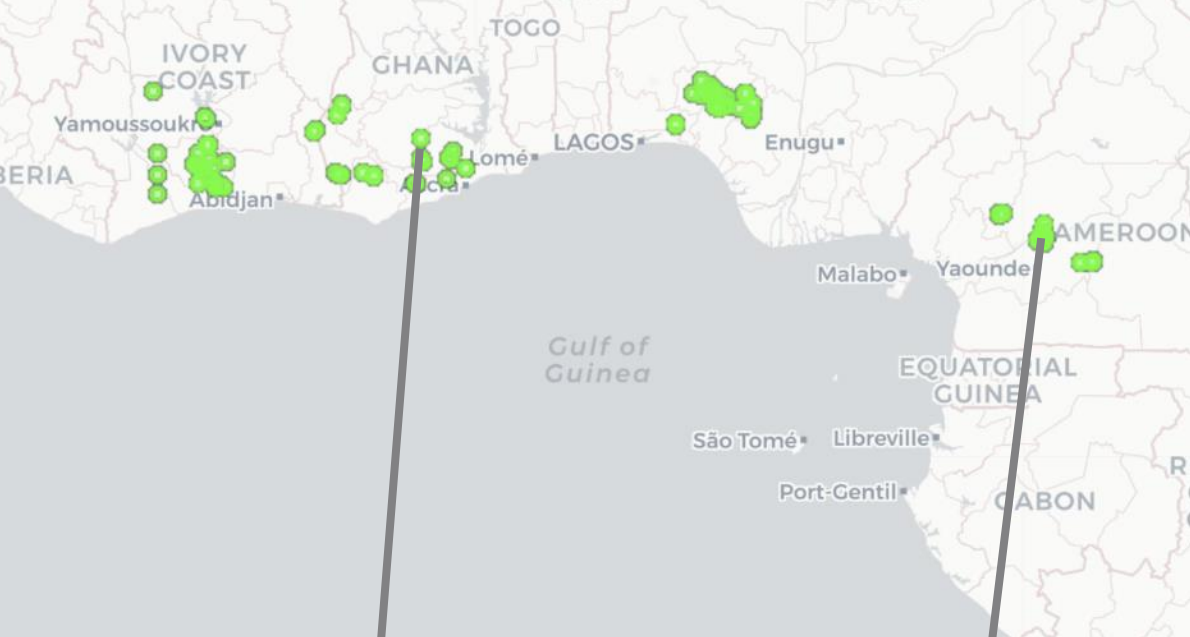
Satellite trials opportunities

Biodiversity surveys are often small-scope, at a few locations and within one climatic zone/country

Agronomic information (management, conditions, outcomes) is often not available to pair with ecological information

Conceptual framework: what drives biodiversity?





Survey locations

Total farms – 169; 49 in Côte d'Ivoire, 38 in Ghana, 40 in Nigeria, 42 in Cameroon

Selection stratified by

- Region

- Rainfall

- Landscape tree cover

- (Practicality!)

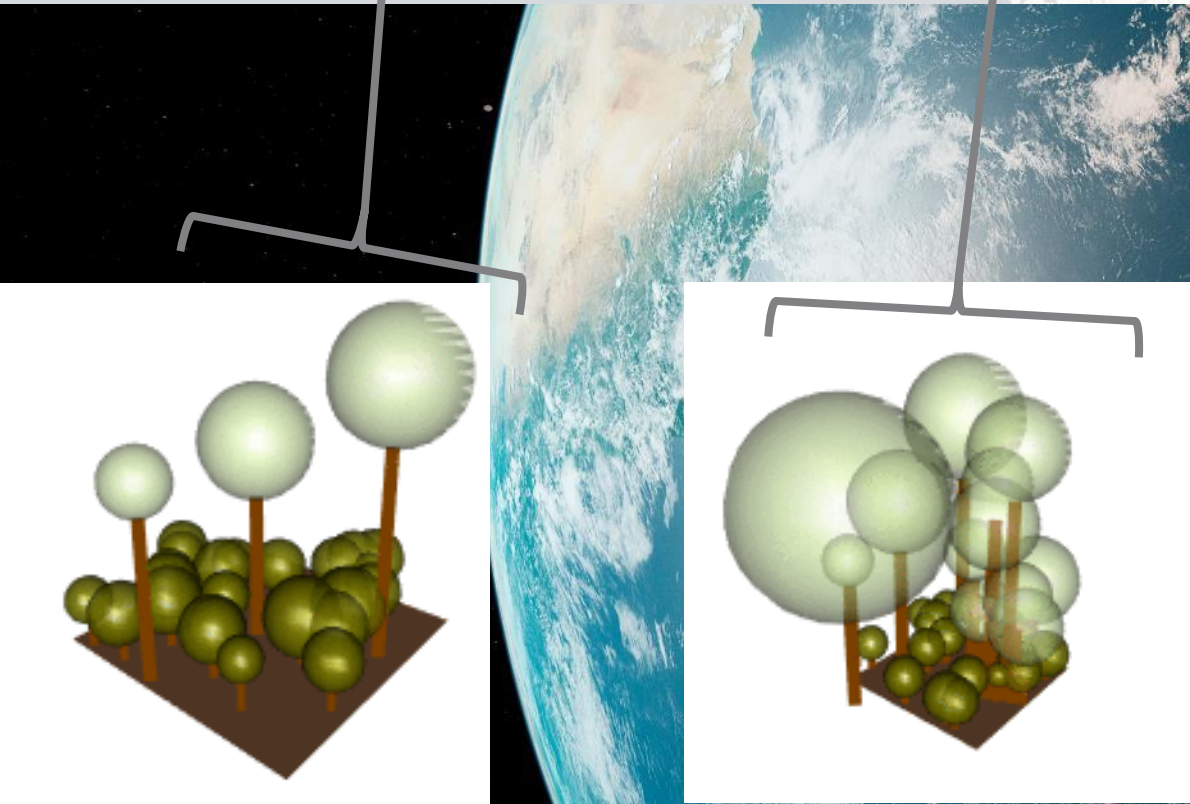
Surveys at each site

- Tree survey

- Understorey plant survey

- Leaf litter measurements

- Interviews



Basemap: OpenStreetMap.

The designations employed and the presentation of material on the above map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Protocols: biodiversity

Tree diversity

- All trees above cocoa canopy
- Measurements taken and placement recorded (for spatial modelling)
- Benefits, disadvantages, and origins discussed with farmer

Understorey (herb) diversity

- 21m x 5 m transects
- Benefits, disadvantages, and origins discussed with farmer

3,340 depth
measurements...

...2,258 shade
trees...

...and 200,000
understorey plants



Approach: modelling

Path analysis approach – identify direct and indirect effects on biodiversity

Piecewise Structural Equation Modelling (local estimation)

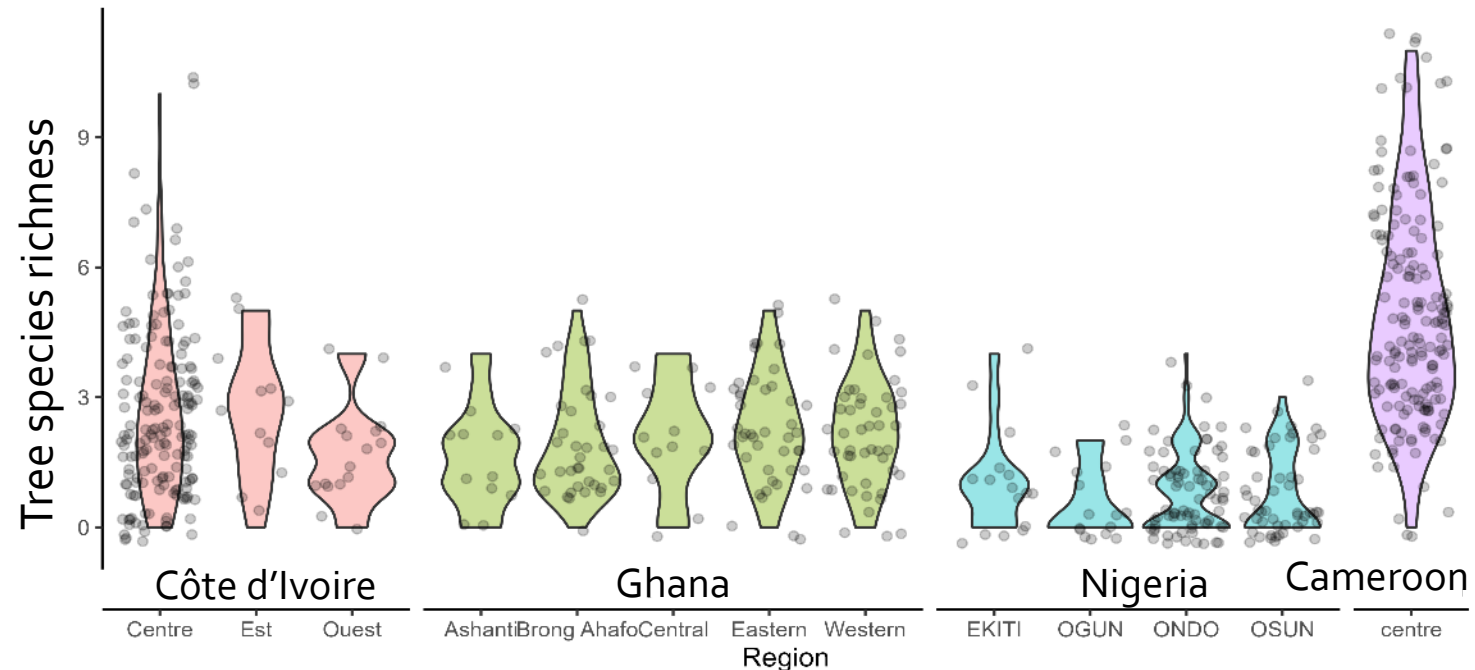
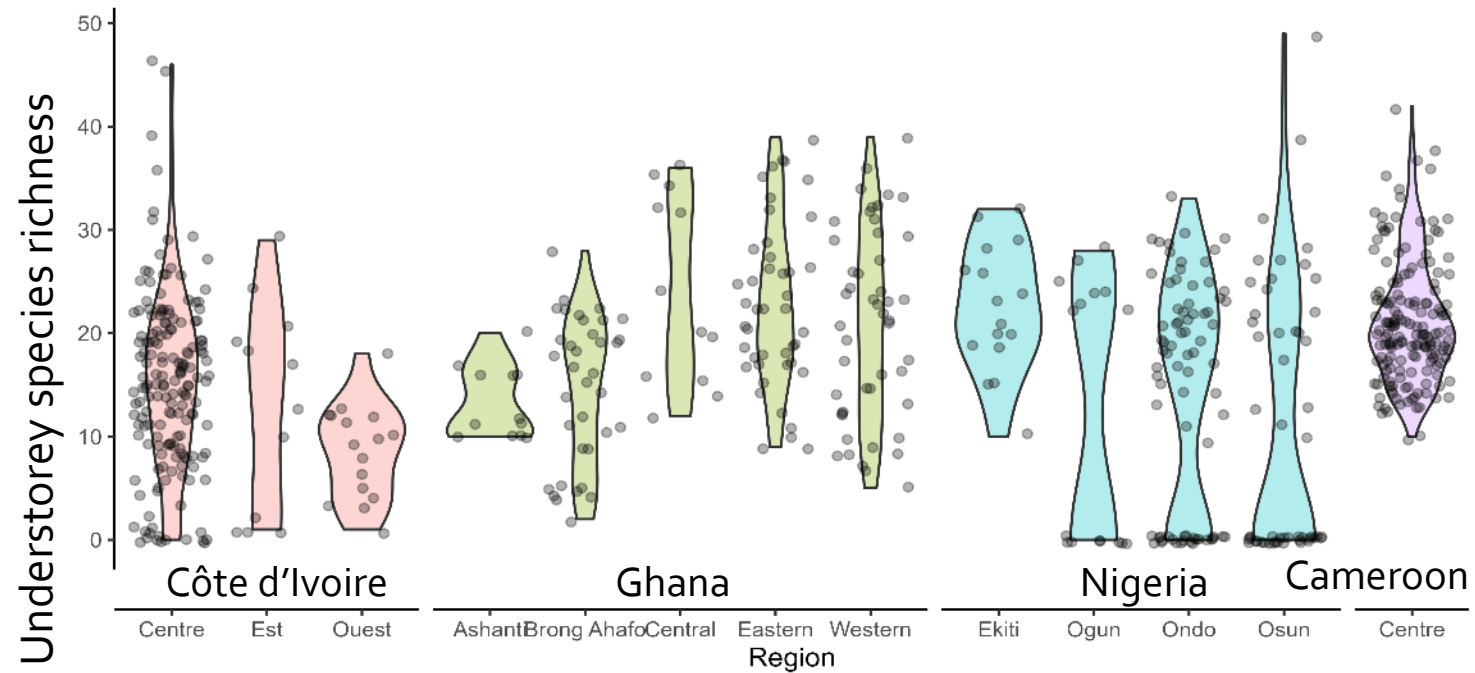
Hypothesis-based approach, starting with most confident/direct relationships and building up

1. Biodiversity reinforcing
2. Abiotic conditions
3. Landscape effects
4. Management interventions
5. Land-use history mediation

Results: biodiversity patterns

Understorey diversity differed less among countries, though Nigeria had a larger proportion of samples with no understorey plants present.

Tree biodiversity was richest in Cameroon. Côte d'Ivoire and Ghana had intermediate tree richness, with the Central region particularly rich. Nigeria had relatively low tree richness.

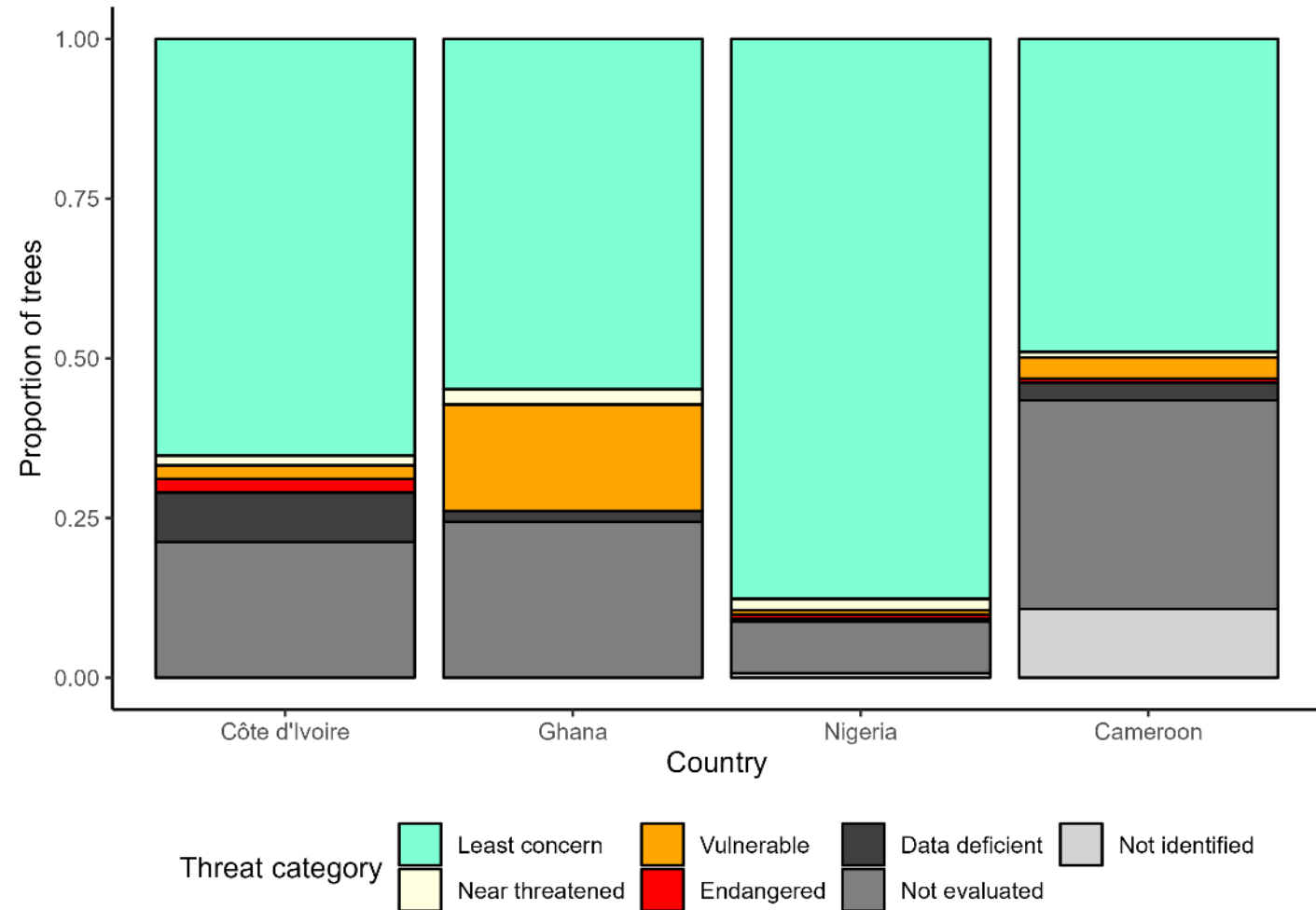


Results: biodiversity patterns

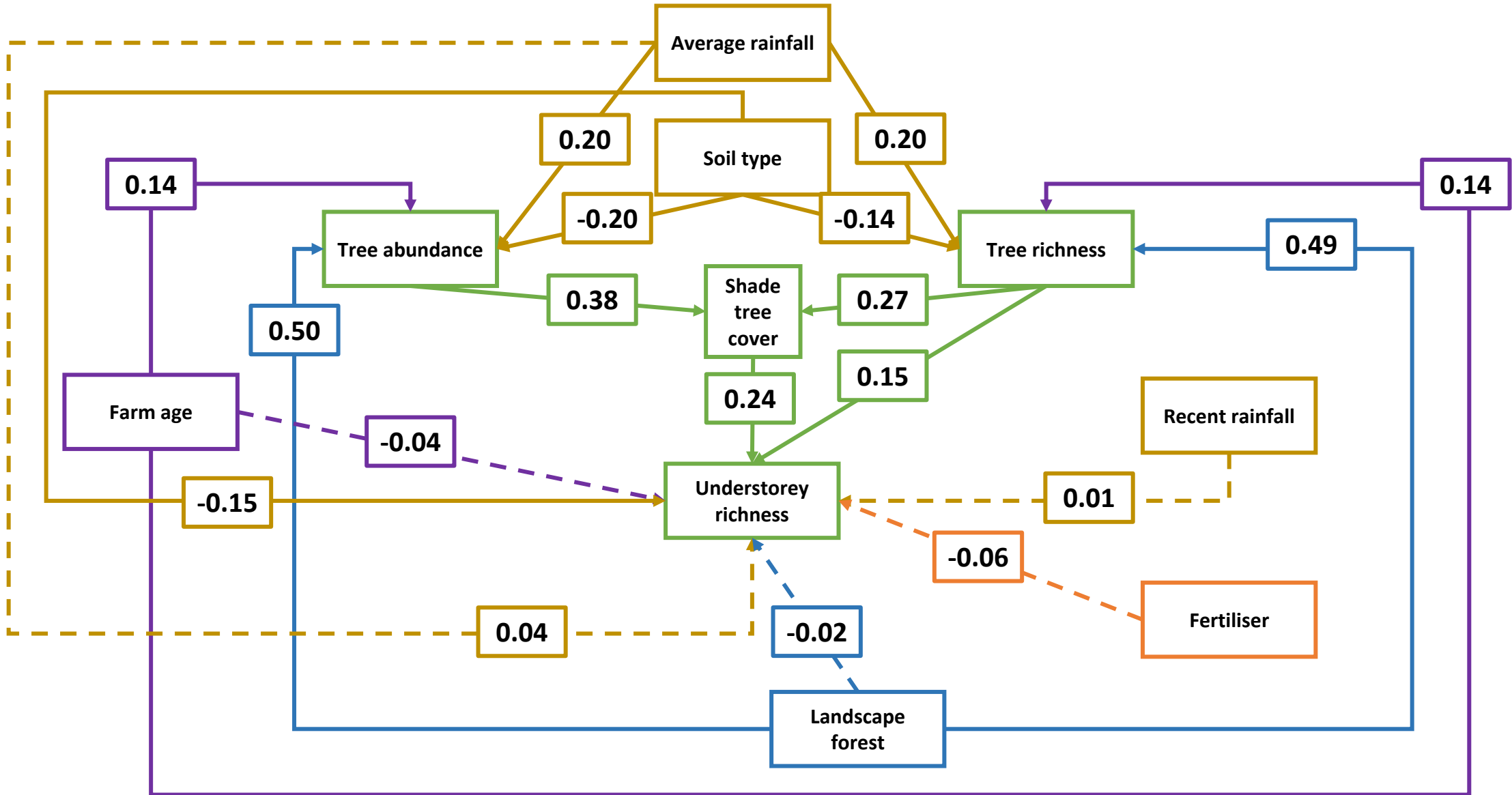
Over half of trees “Least Concern”; higher than averages across all of the Red List

But – 24 species are threatened to some degree

Terminalia ivorensis, *Entandrophragma angolense*, and *Sterculia oblonga* were among the most prevalent threatened tree species.

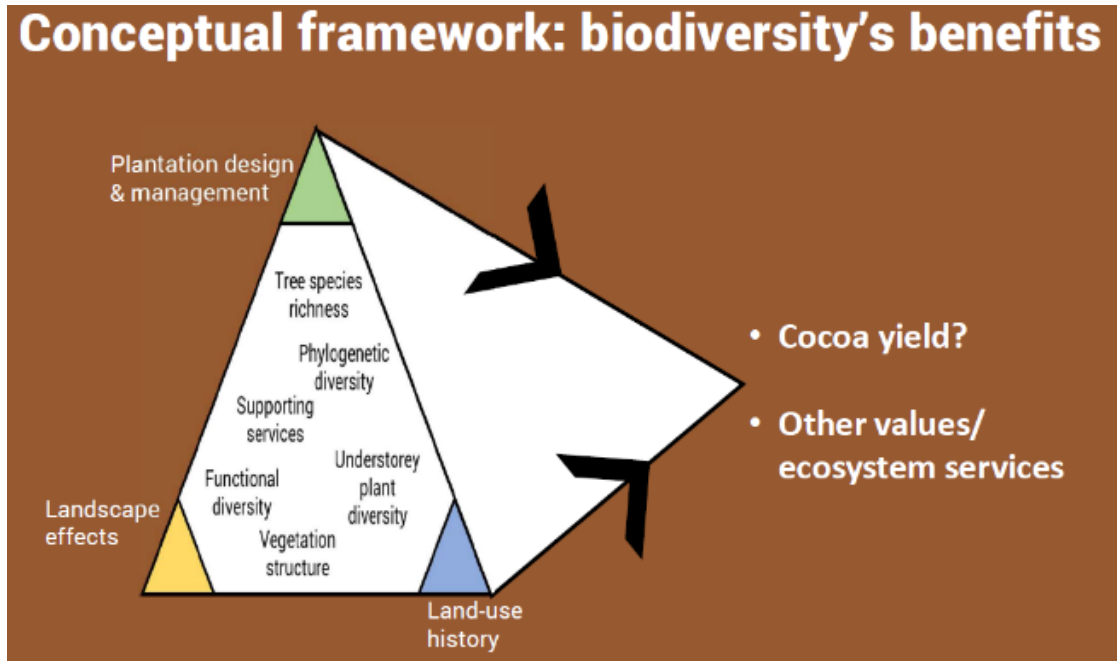


Model results (preliminary):

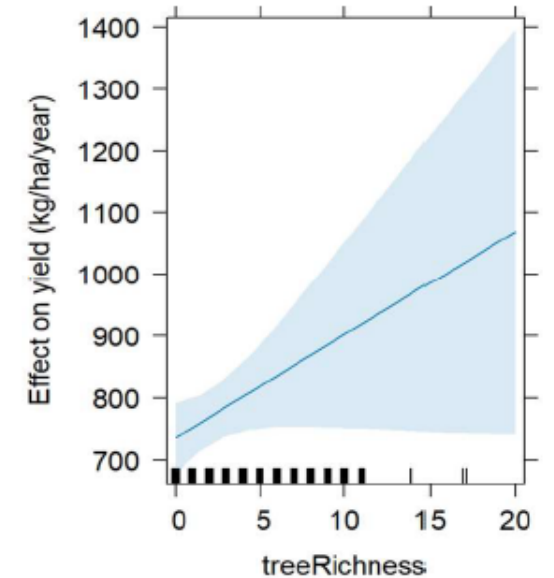
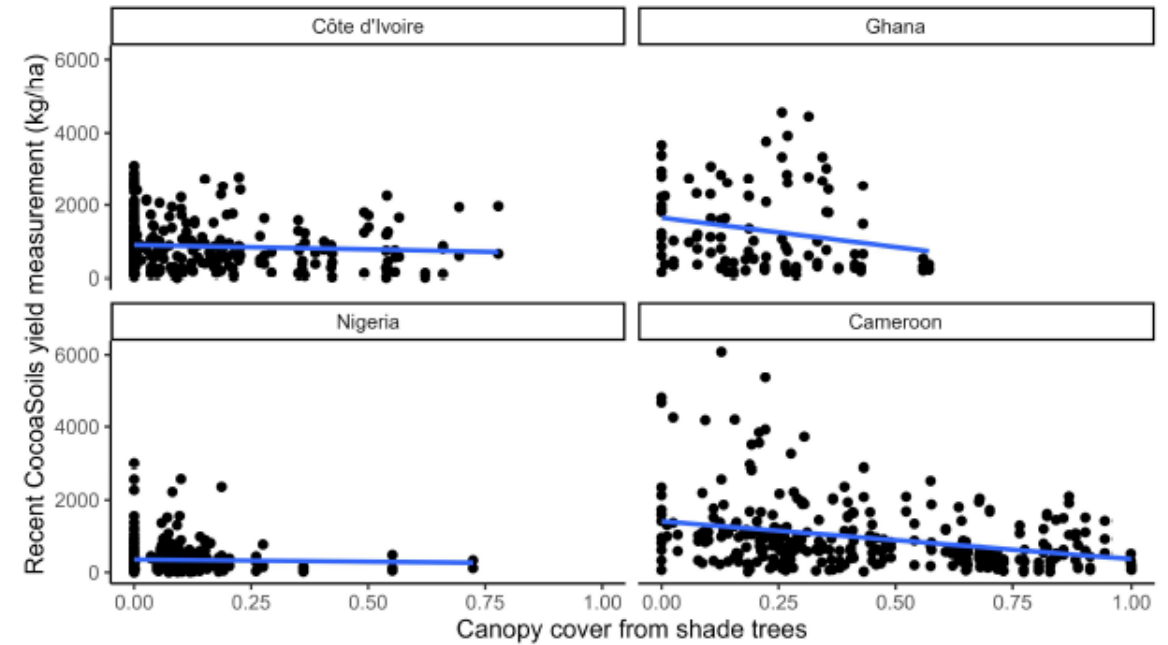


Biodiversity-productivity interactions

Conceptual framework: biodiversity's benefits

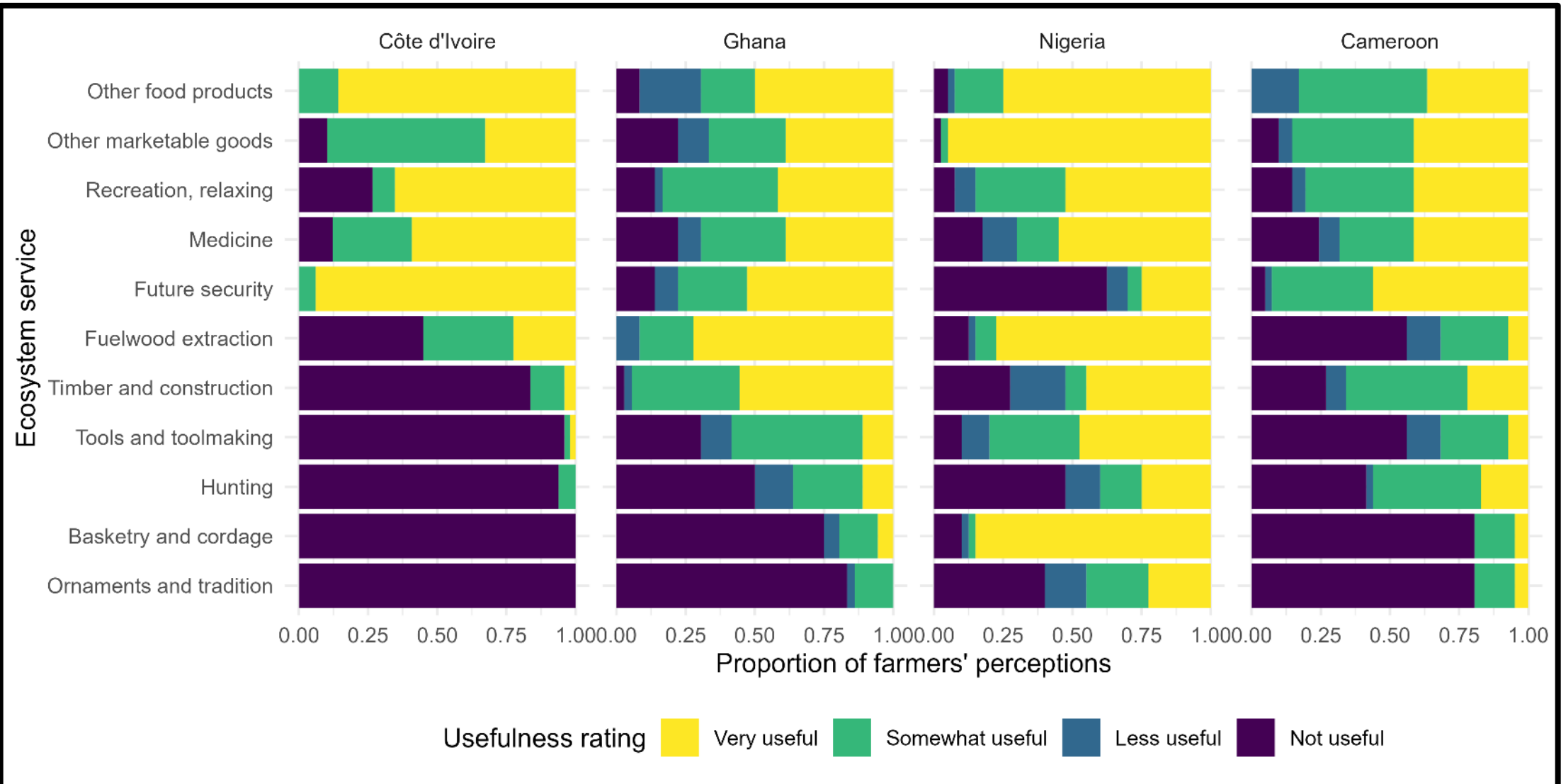


- Shade cover and yields



Ecosystem services

What types of multifunctionality are important to farmers in each country?



Takeaways and extensions

We can picture what “biodiversity-friendly” cocoa looks like in terms of design and management, landscape, and context-specificity

Further, specific types of biodiversity lead to benefits.

Extension: Going beyond plants now may tell us more about contributions to ecosystem services.

Thought: what are the implications of the EU Deforestation Regulation for cocoa and biodiversity?



Thank you!

