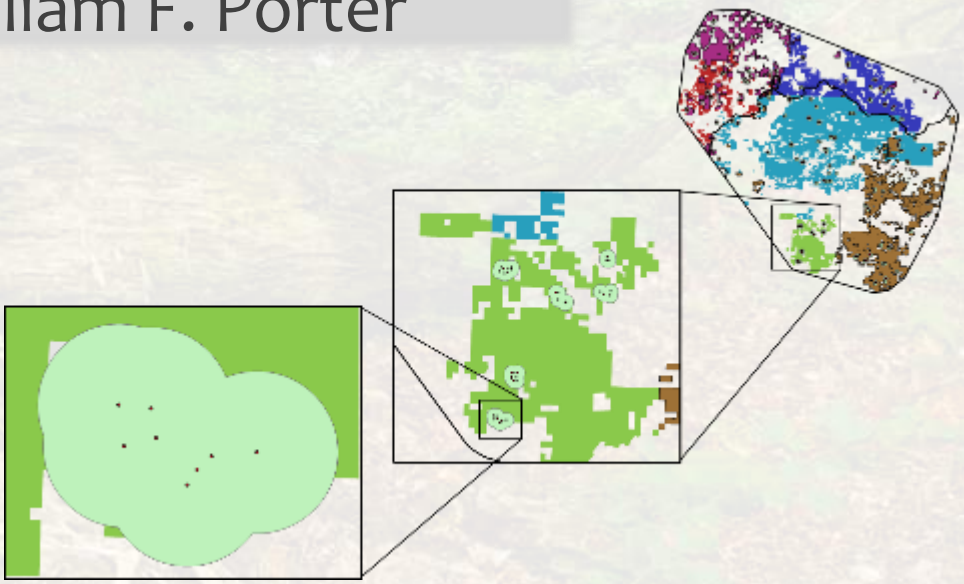
Context Matters: Forest Management Impacts Wildlife and Biodiversity at Multiple Spatial Scales

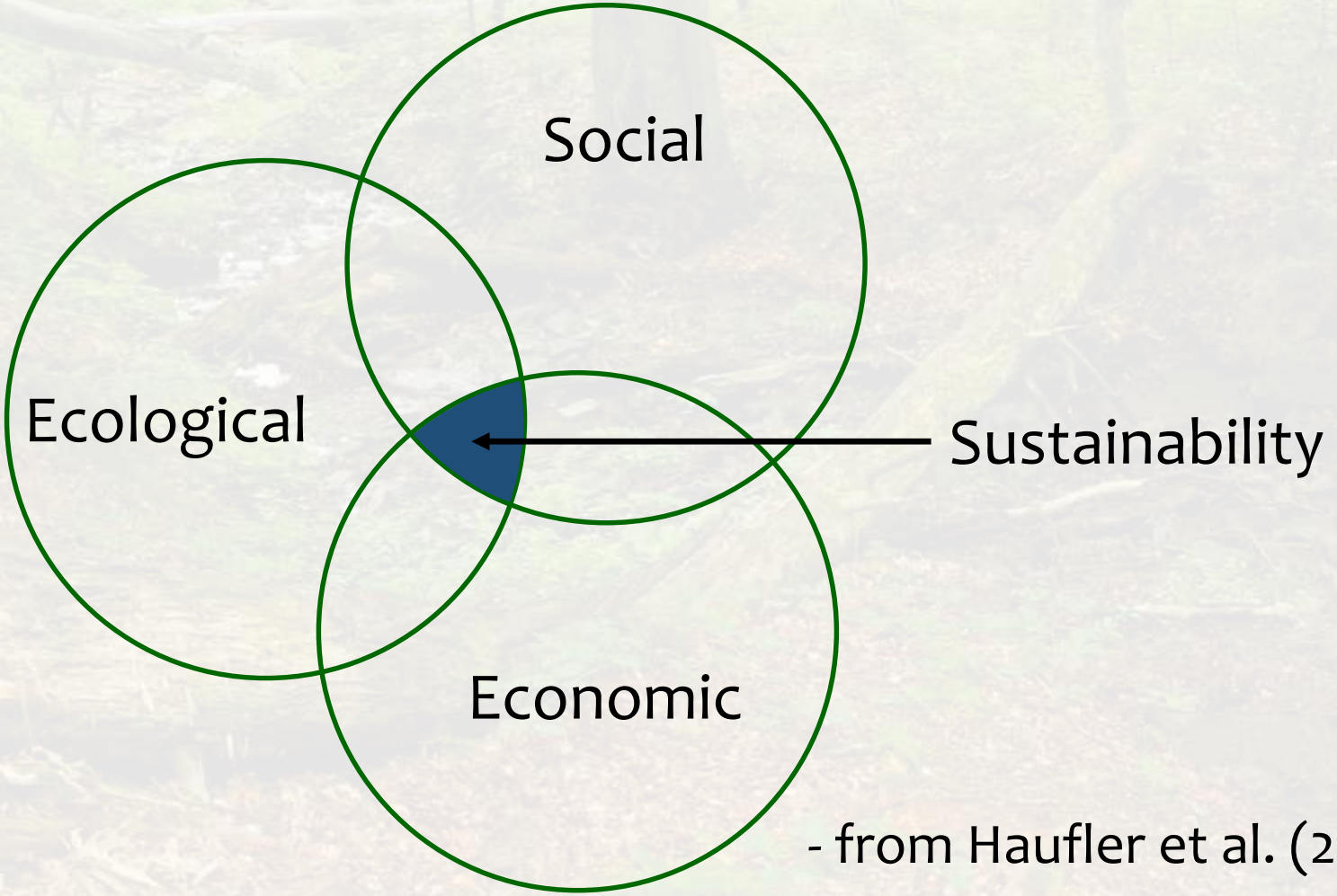
Andrew D. Crosby
and
William F. Porter



Shift in Forest Management Goals

- “Daydreaming” by Thomas F. Gross

The Ecosystem Management Paradigm



- from Haufler et al. (2002)

The Ecosystem Management Paradigm

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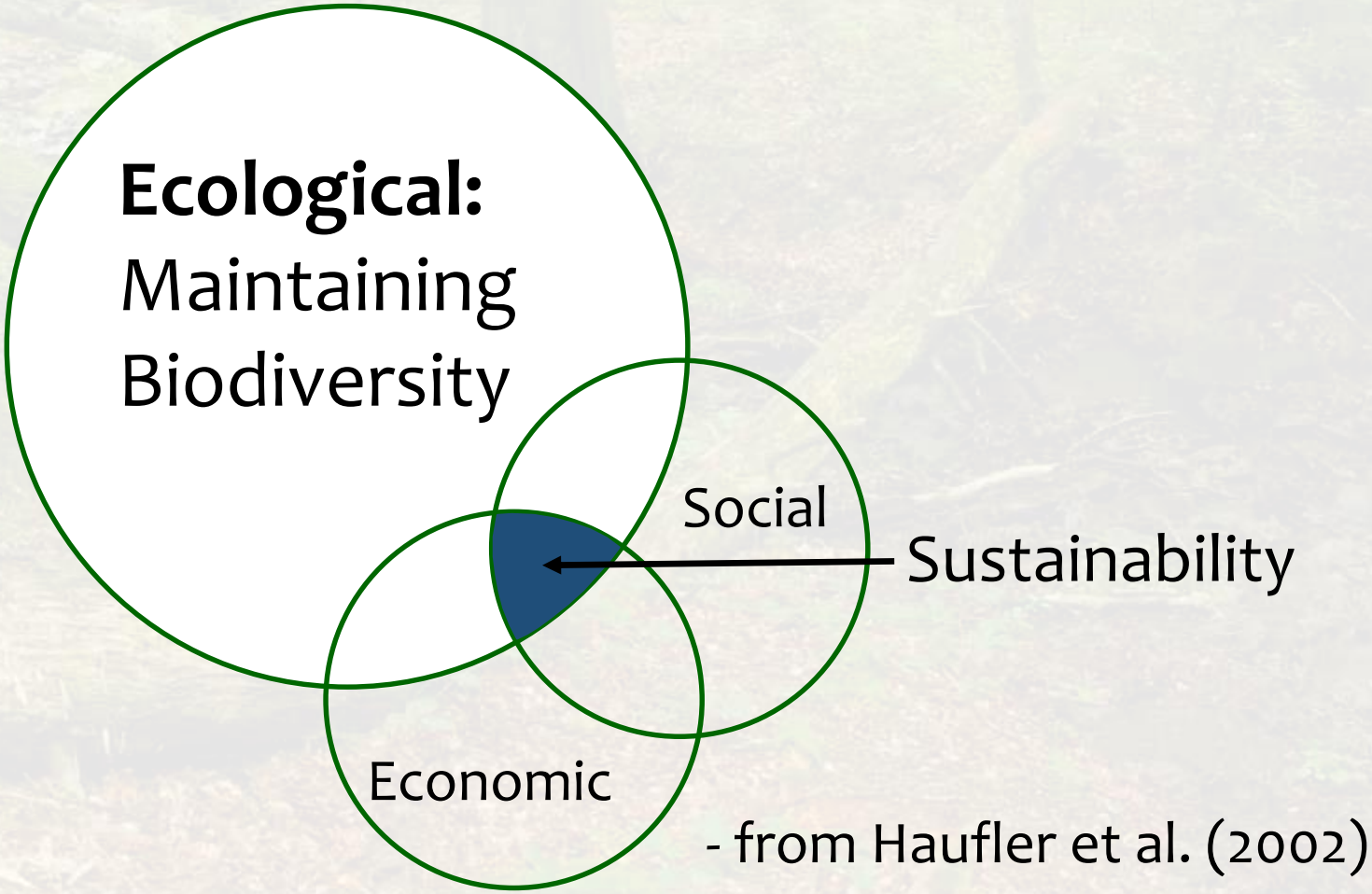

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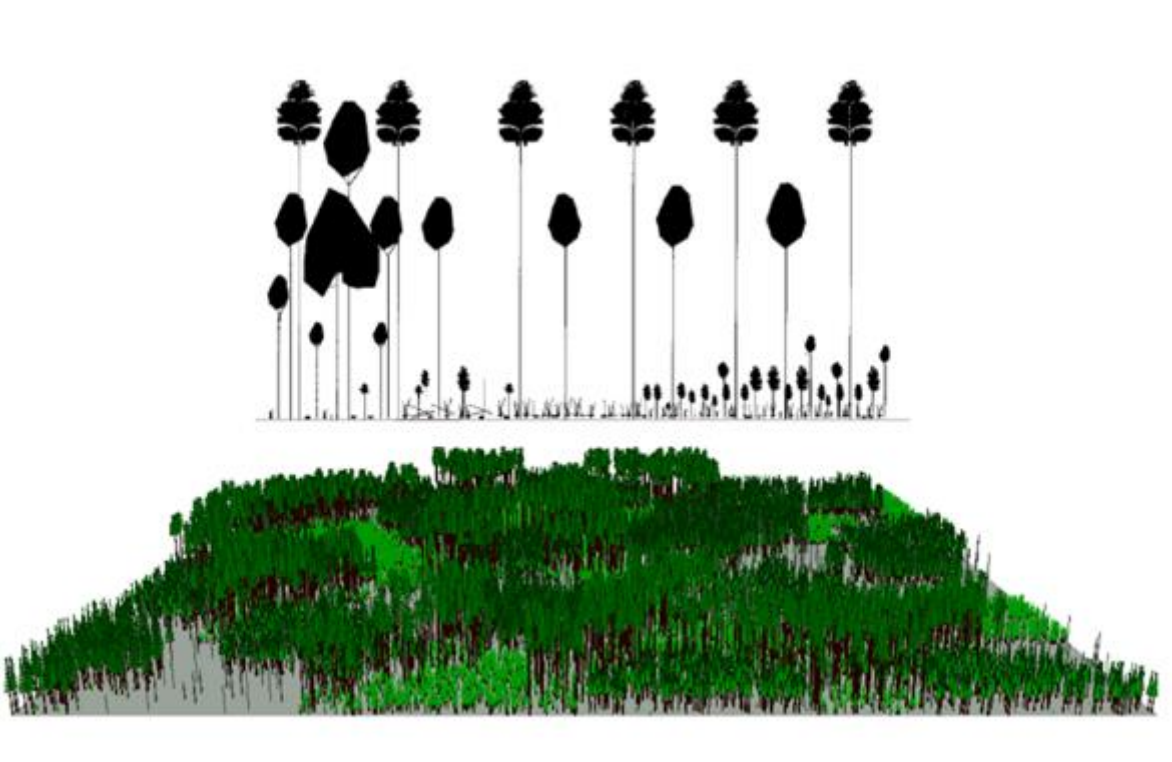
Variability and Biodiversity

Maintaining patterns of variability



Scales of Natural Disturbance

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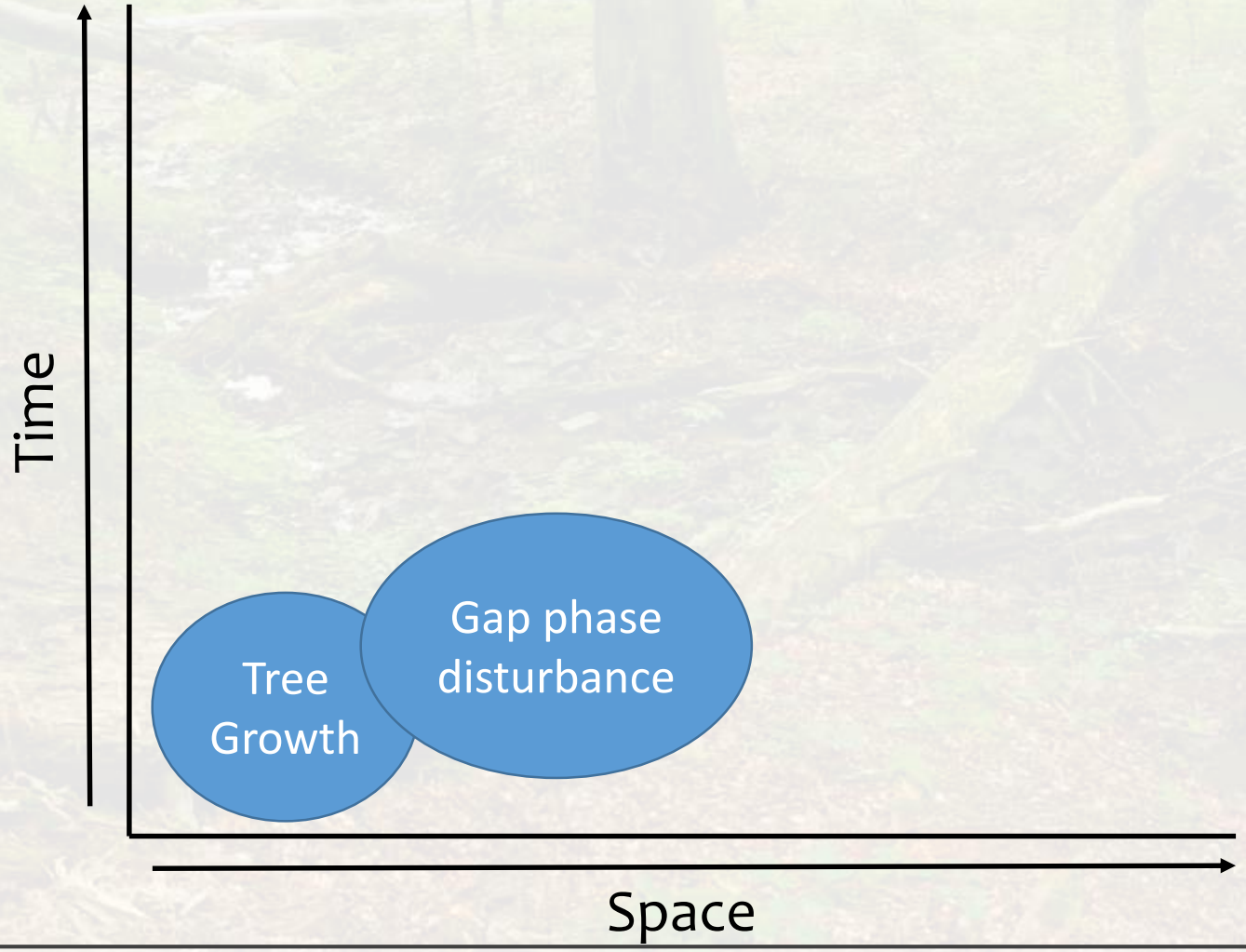

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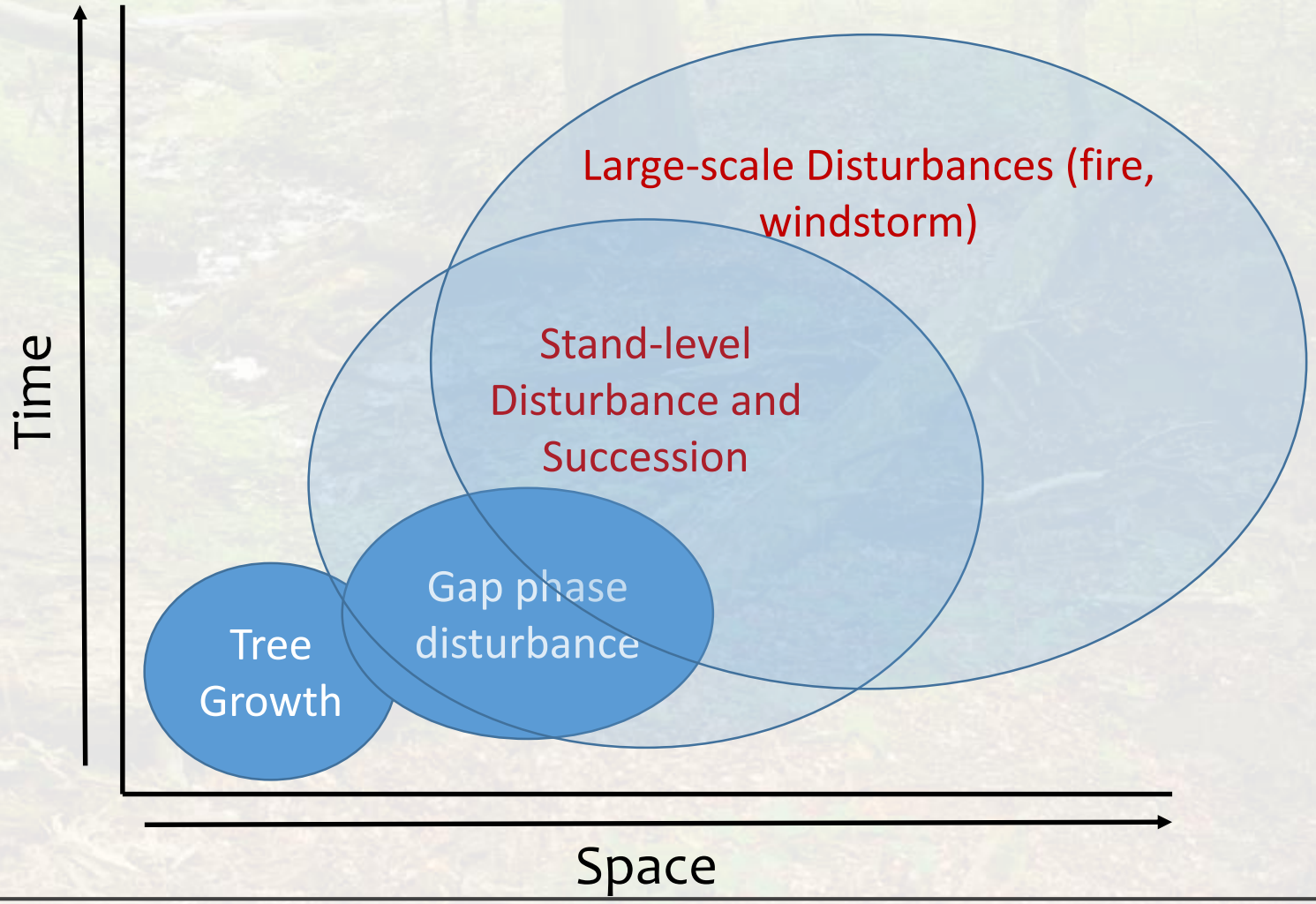

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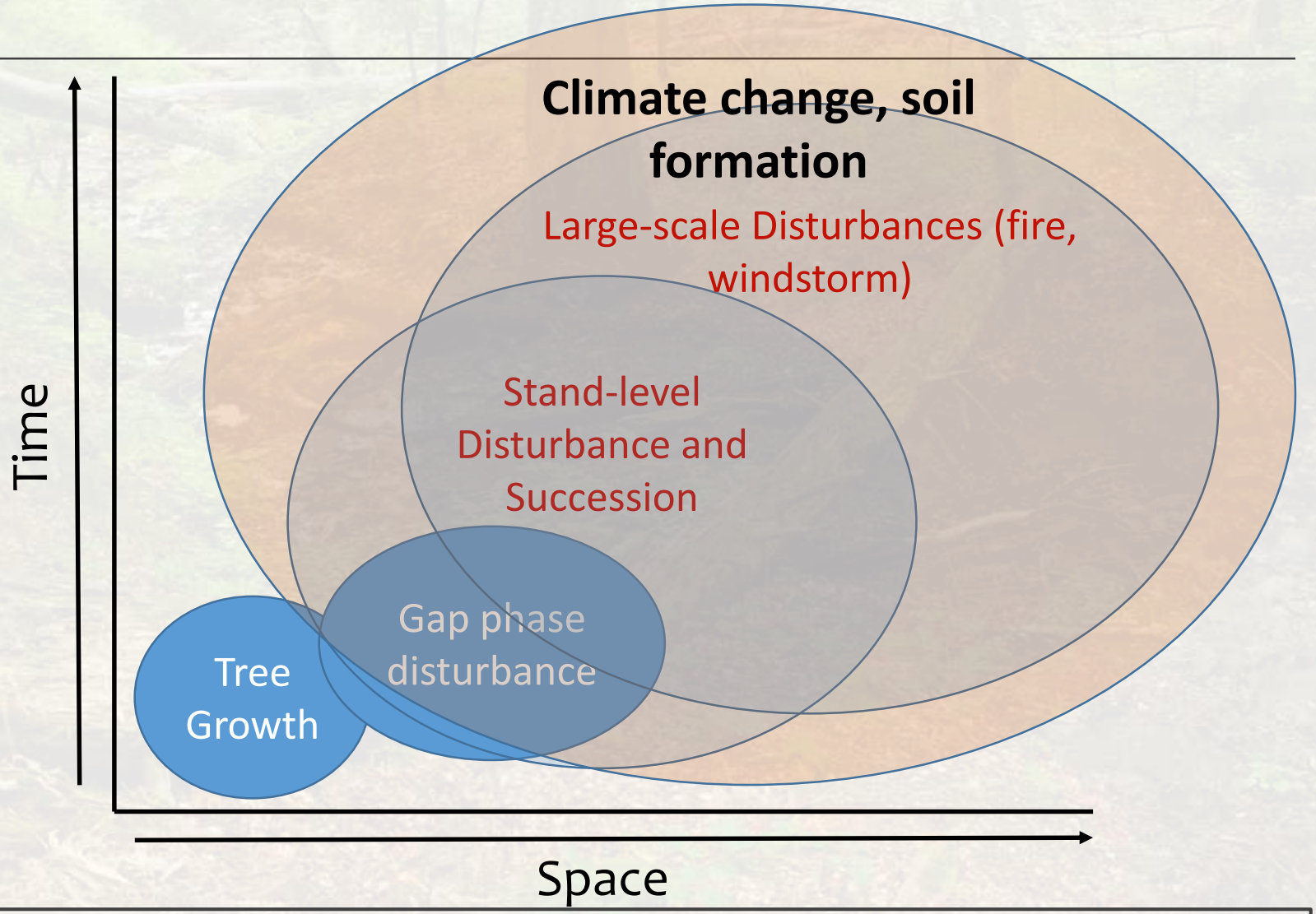
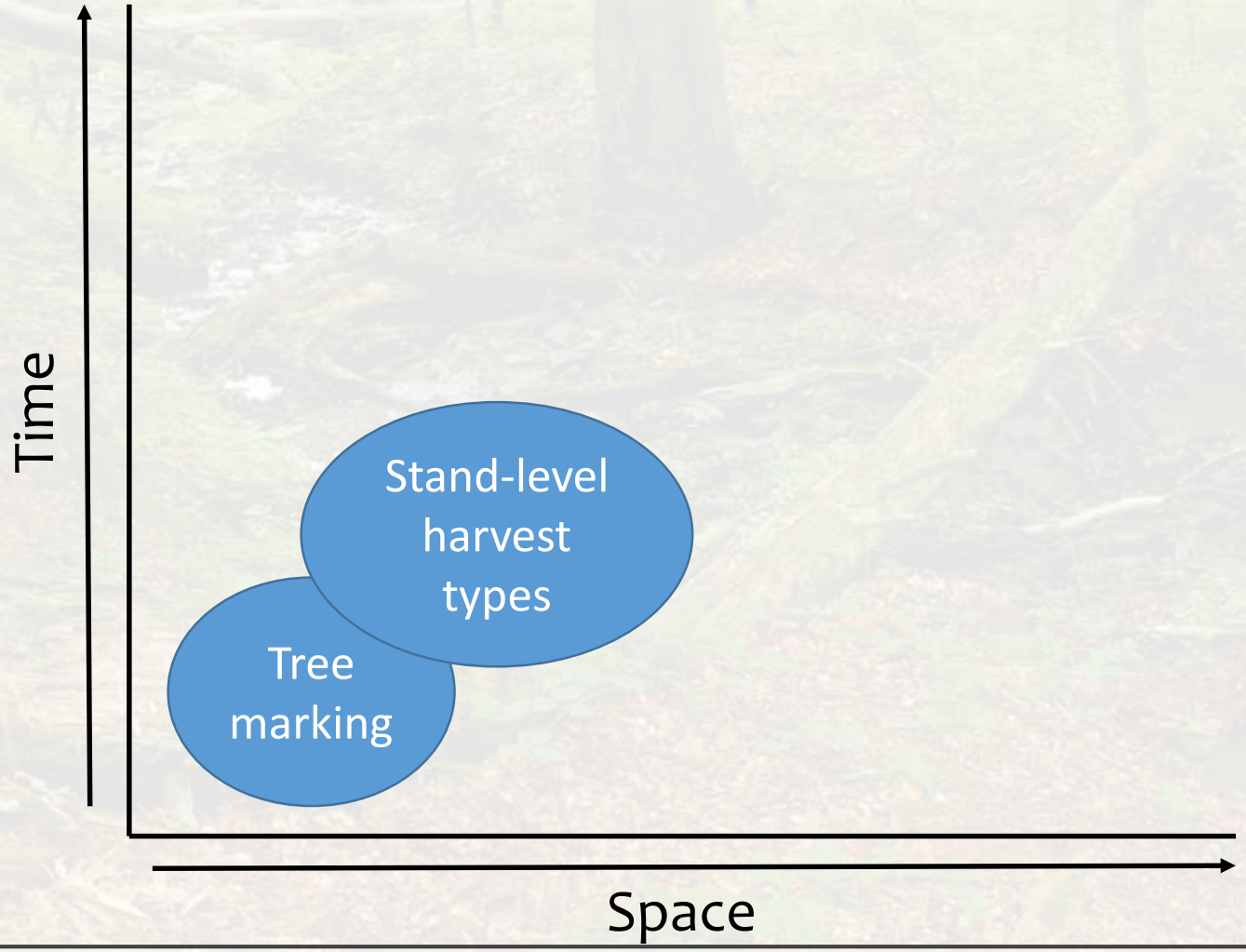


Large-scale Management Systems



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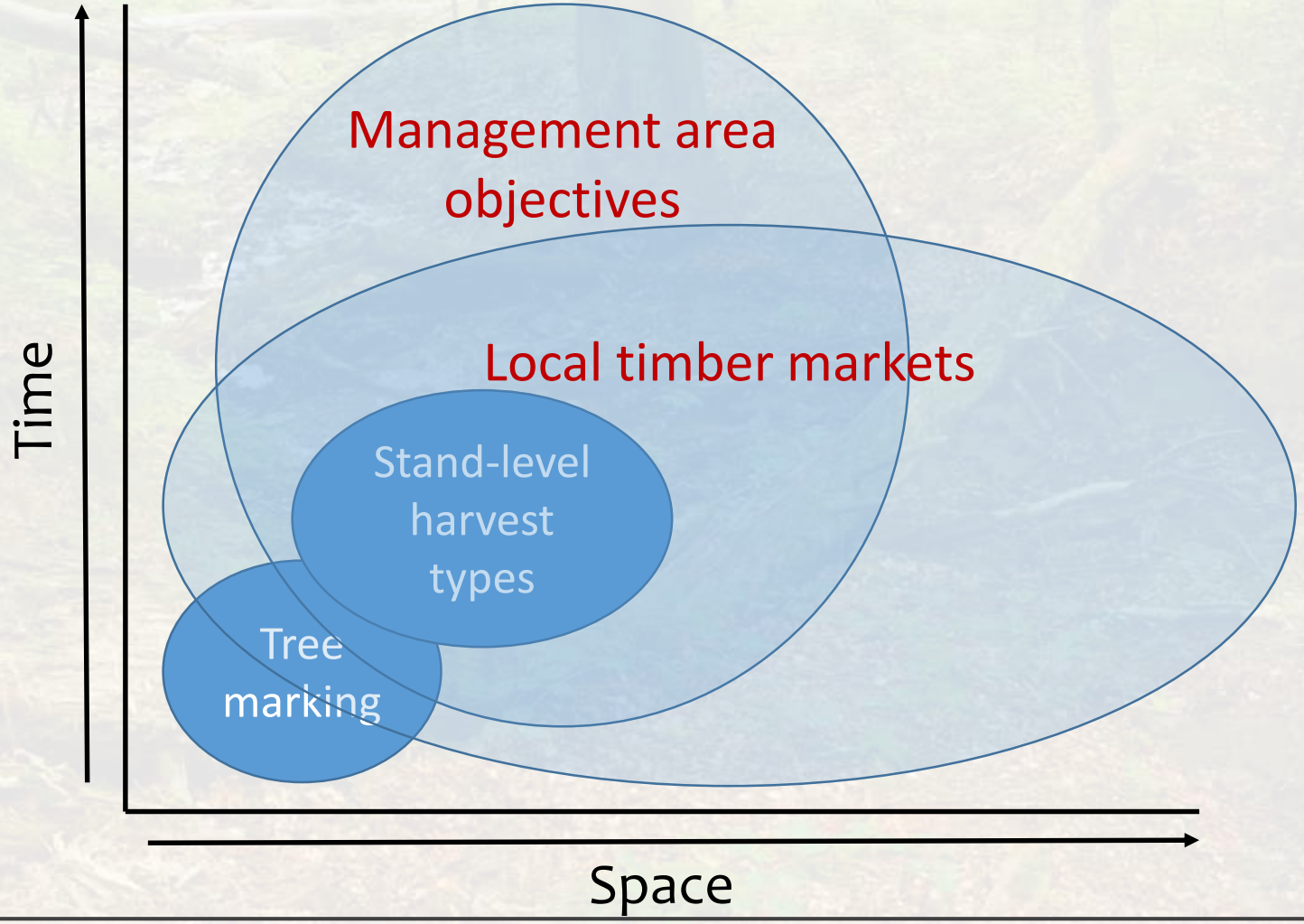

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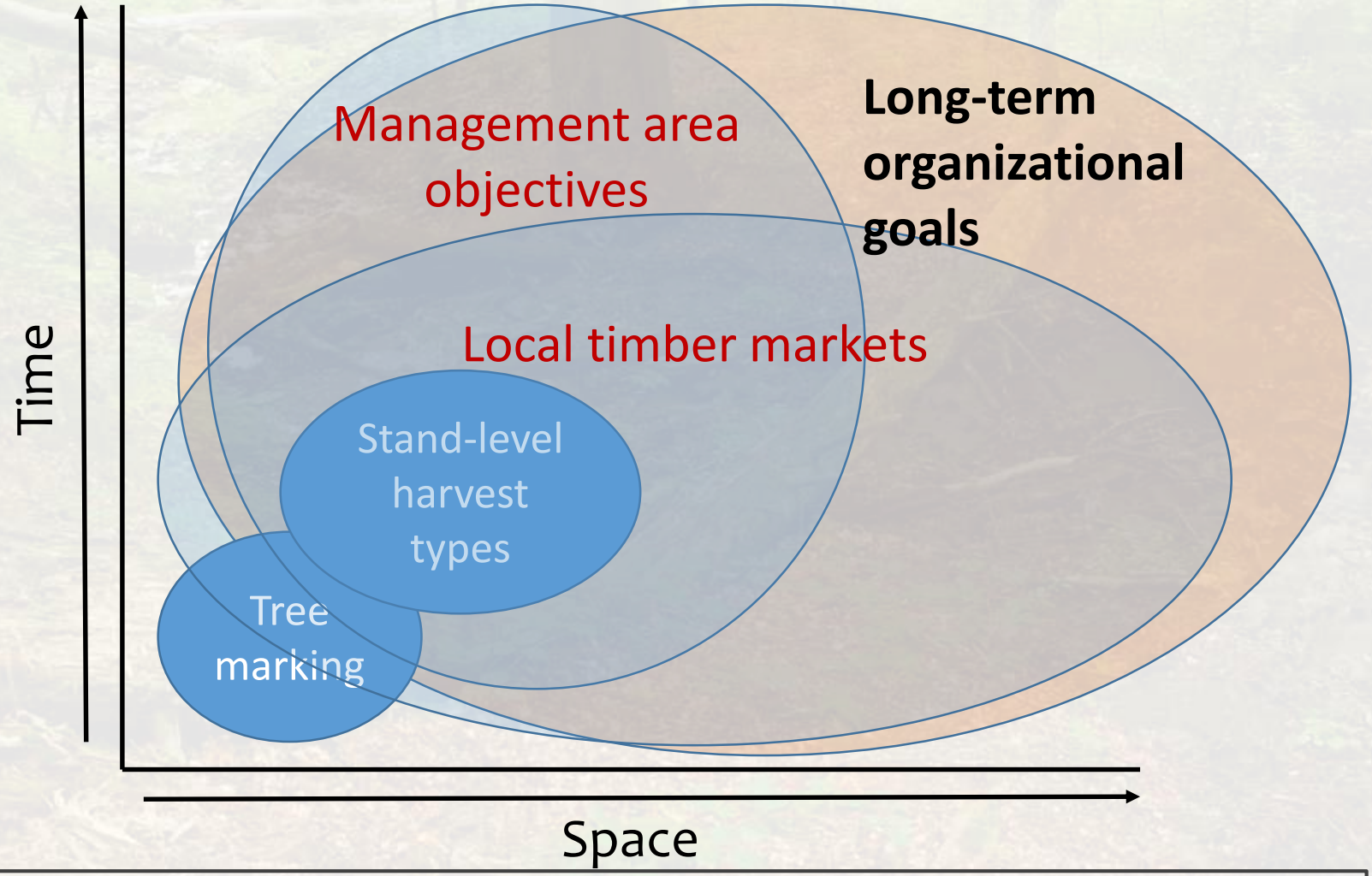


Bird Species Diversity on Managed Forests

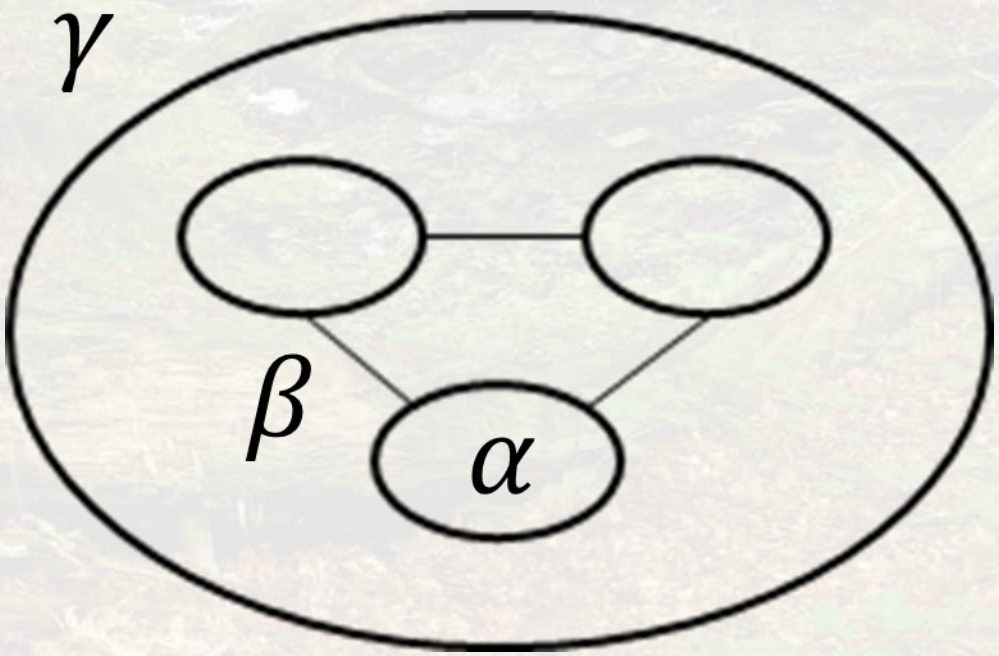
Components of Diversity

(Whittaker 1960)

α = within-unit diversity

β = among-unit diversity

γ = total diversity



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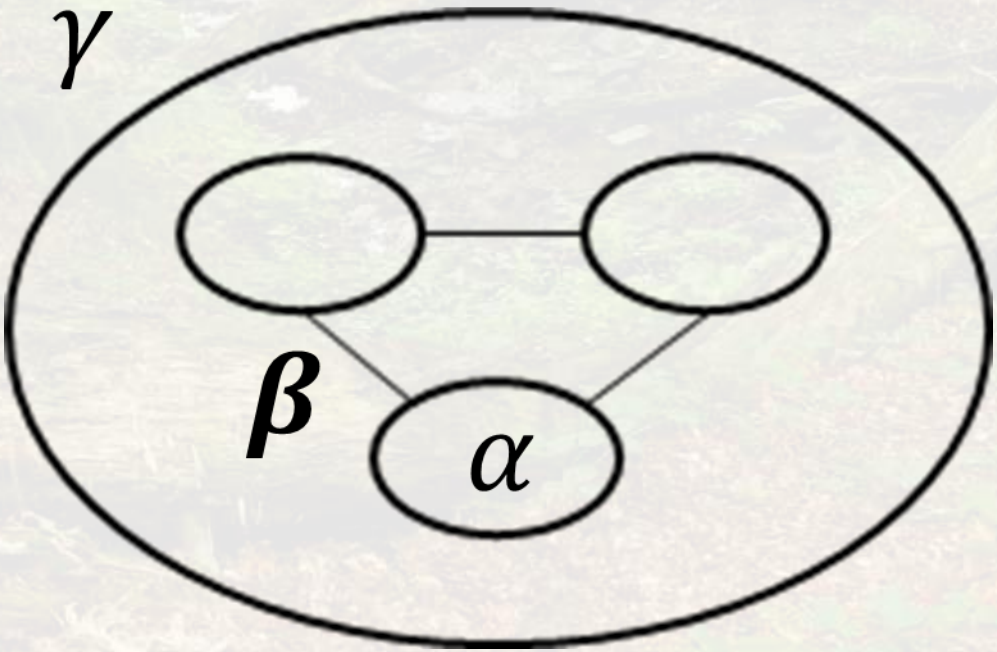
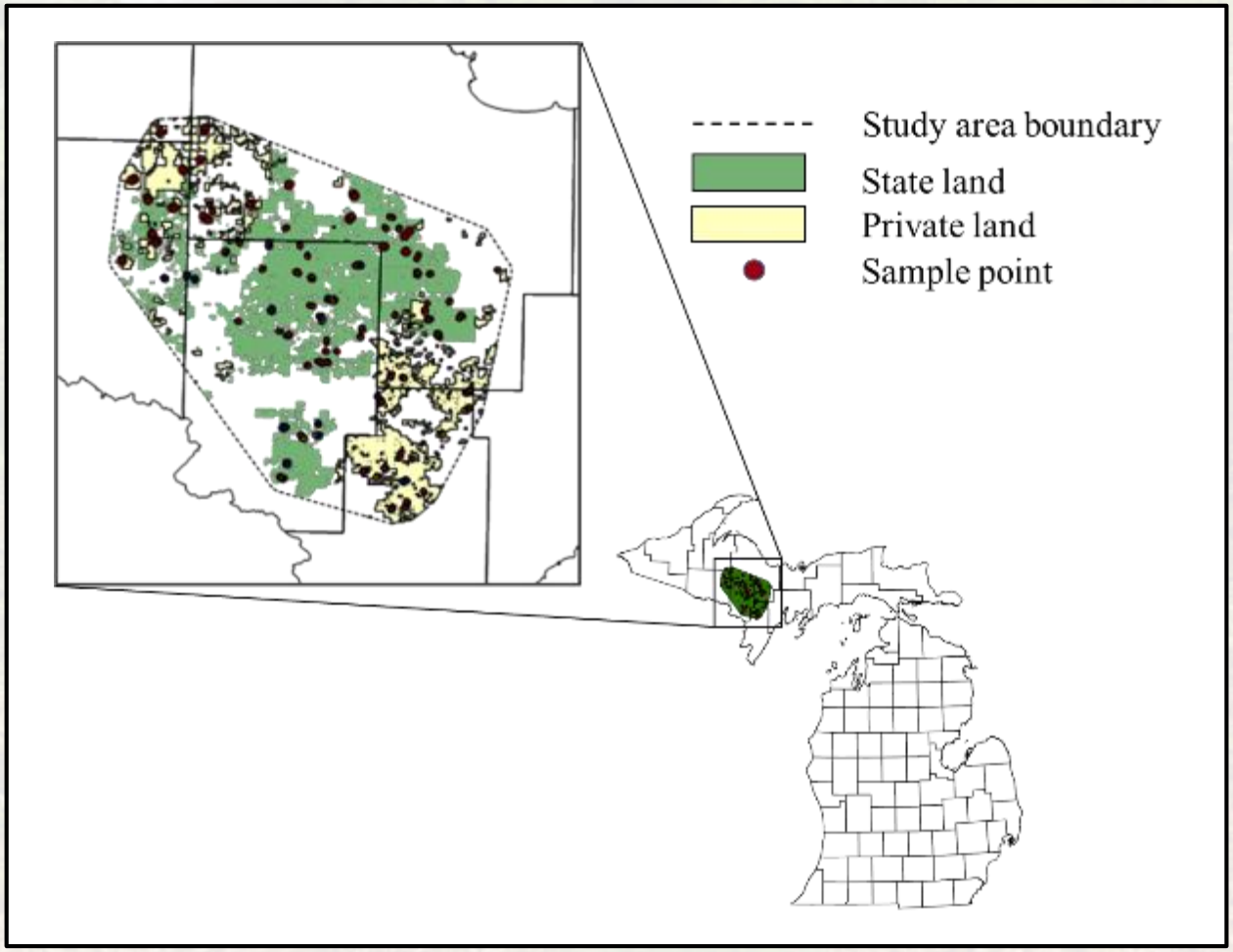


Objectives:

1. Determine management scales important for driving regional bird species diversity

2. Investigate factors that make units important contributors to regional diversity

Study Area:
Western UP of Michigan



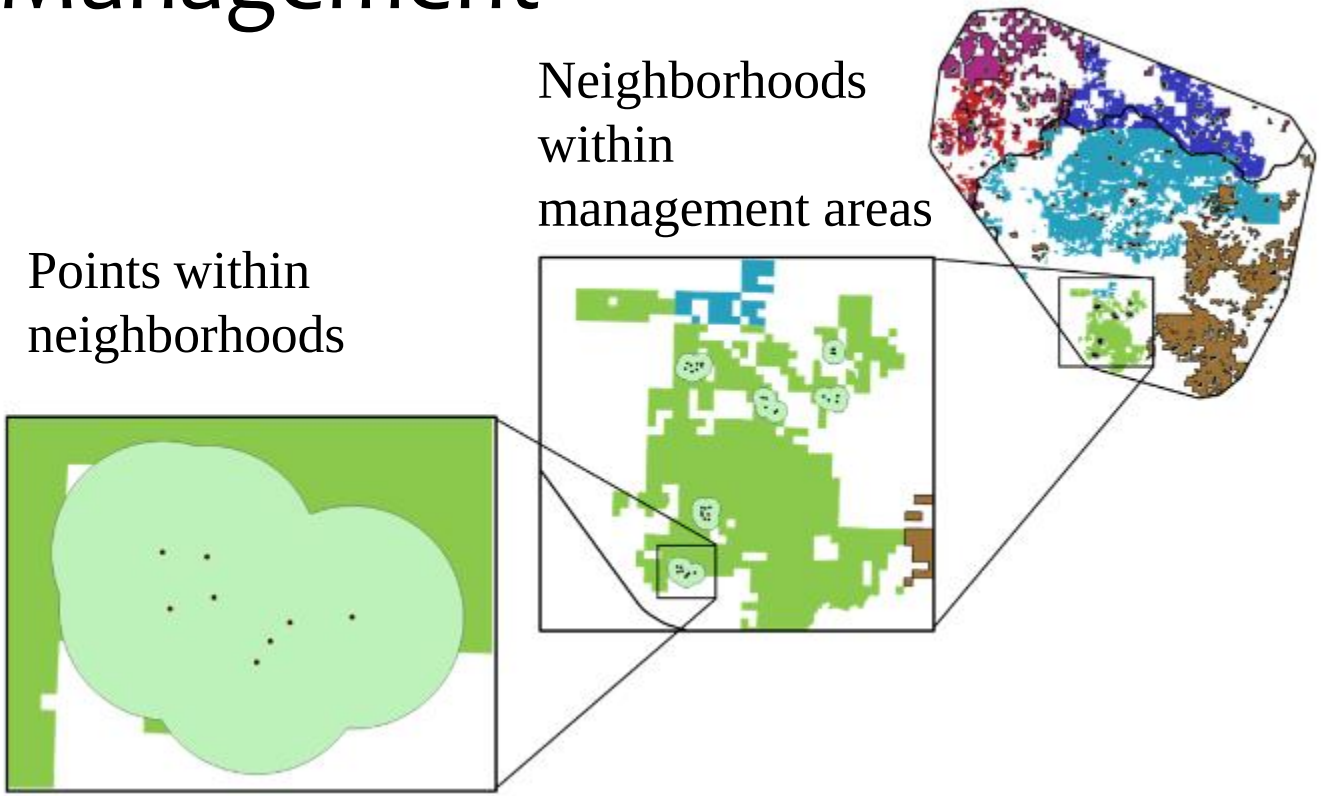
Study Design:

Scales of Management

Management areas within ecoregions

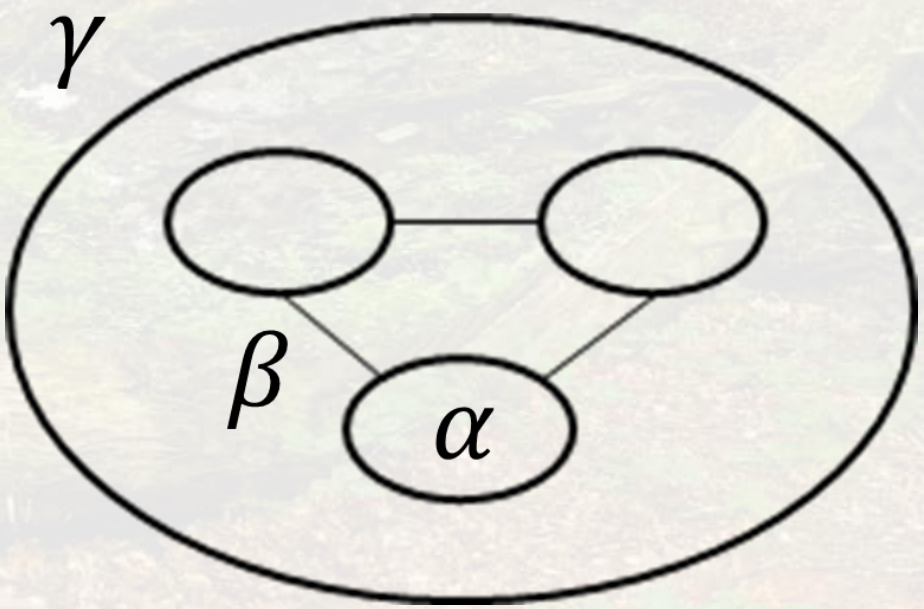
Neighborhoods within management areas

Points within neighborhoods



Additive Partitioning of Diversity

$$\alpha + \beta = \gamma$$



Objective 1: Determine scales driving regional diversity

α Within point diversity

Objective 1: Determine scales driving regional diversity

$+ \beta_1$ Diversity among points

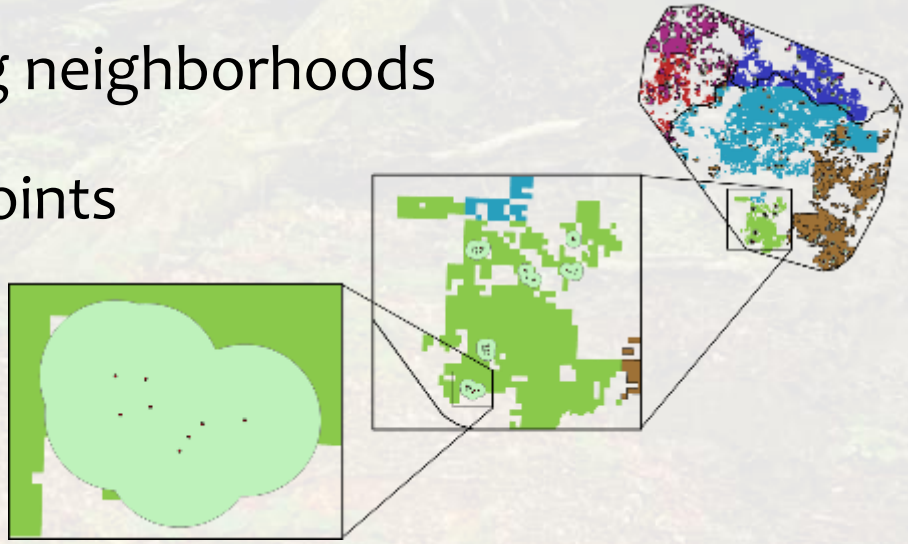
α Within point diversity

Objective 1: Determine scales driving regional diversity

$+ \beta_2$ Diversity among neighborhoods

$+ \beta_1$ Diversity among points

α Within point diversity



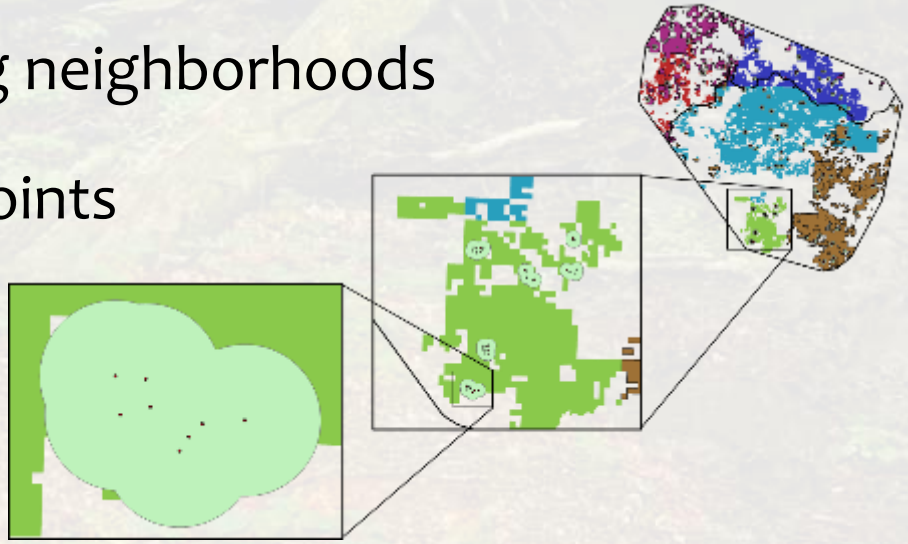
Objective 1: Determine scales driving regional diversity

$+ \beta_3$ Diversity among management areas

$+ \beta_2$ Diversity among neighborhoods

$+ \beta_1$ Diversity among points

α Within point diversity



Objective 1: Determine scales driving regional diversity

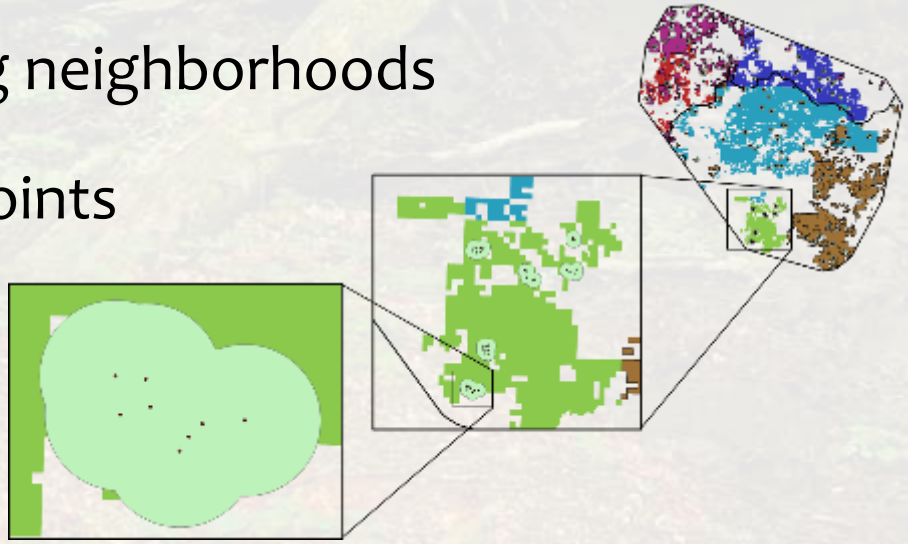
$+ \beta_4$ Diversity among ecoregions

$+ \beta_3$ Diversity among management areas

$+ \beta_2$ Diversity among neighborhoods

$+ \beta_1$ Diversity among points

α Within point diversity



Objective 1: Determine scales driving regional diversity

$= \gamma$ Total regional diversity

$+ \beta_4$ Diversity among ecoregions

$+ \beta_3$ Diversity among management areas

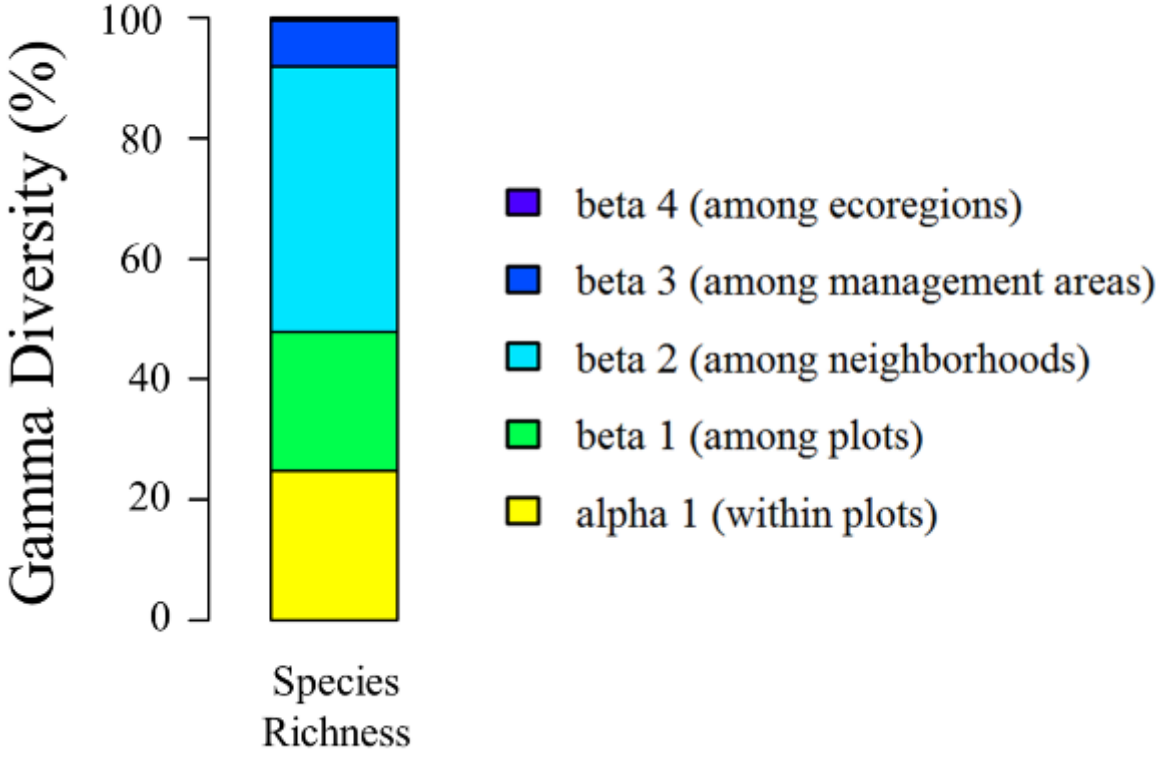
$+ \beta_2$ Diversity among neighborhoods

$+ \beta_1$ Diversity among points

α Within point diversity

$= \gamma$ Total regional diversity

Additive Partitioning Results

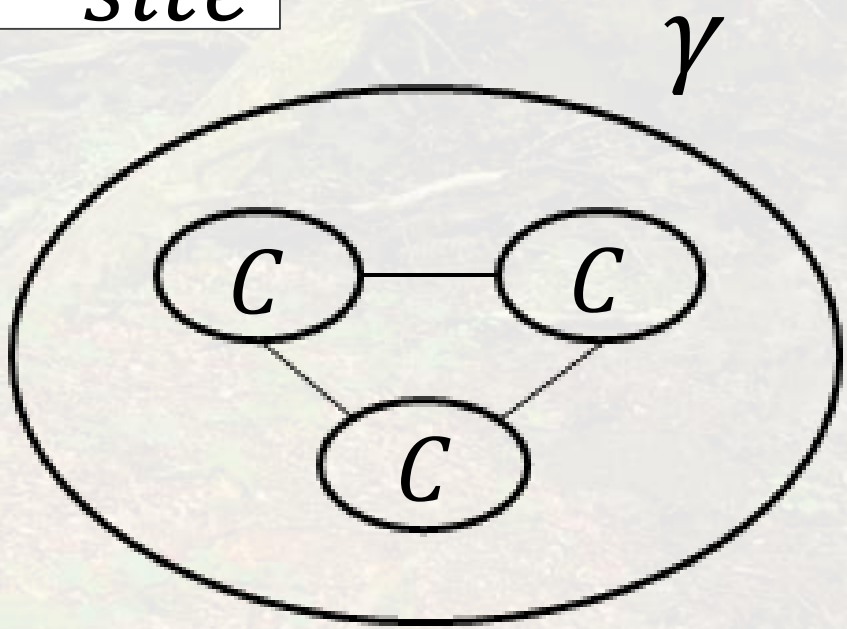


Objective 2: Diversity Contribution of Each Site

- We can calculate the contribution of individual sites to overall diversity

$$\alpha_{site} + R_{site} = C_{site}$$

$$C + C + C = \gamma$$



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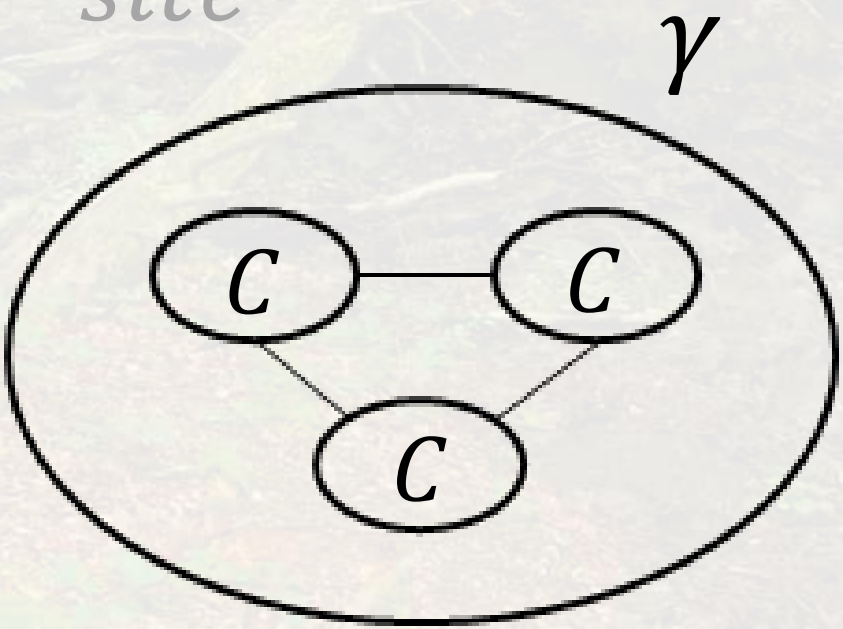
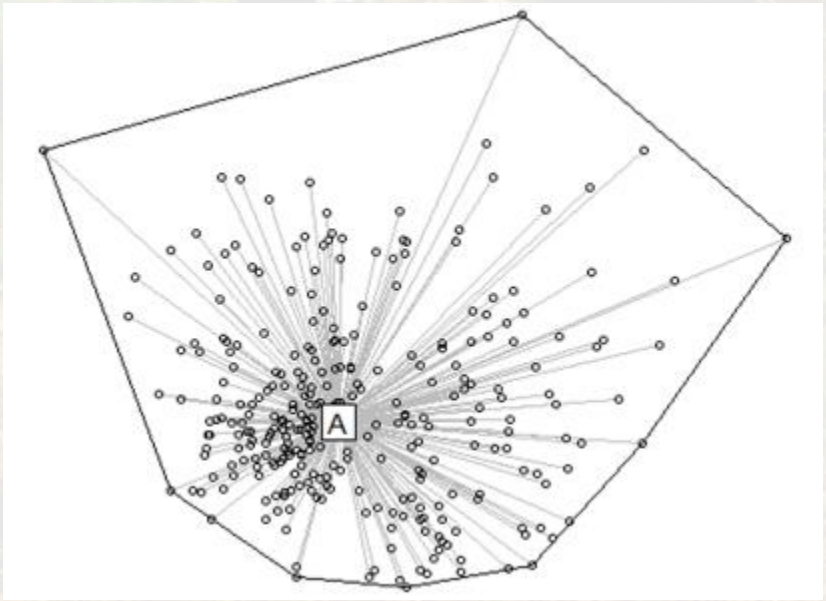
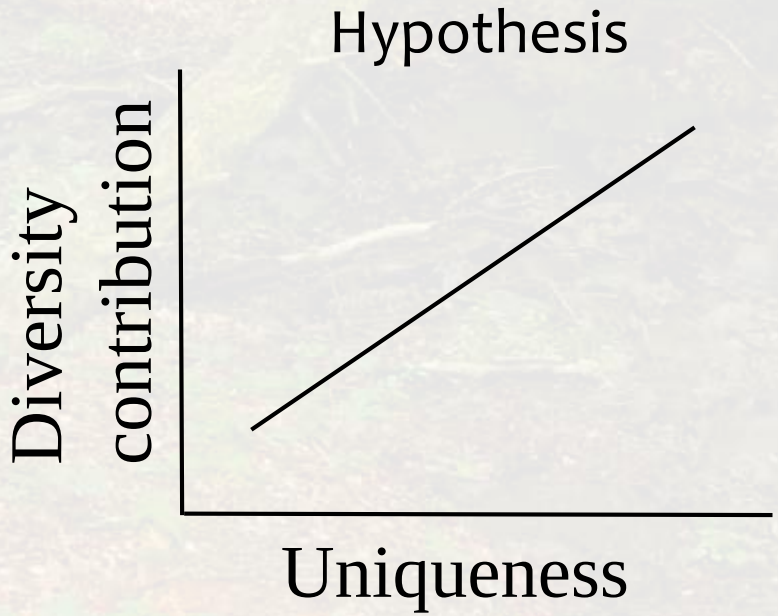


Objective 2: Diversity Contribution of Each Point

- Estimated "Uniqueness" of each point based on compositional and structural variables





Objective 2: Diversity Contribution of Each Point

- Used 11 variables at each site describing forest composition and structure:

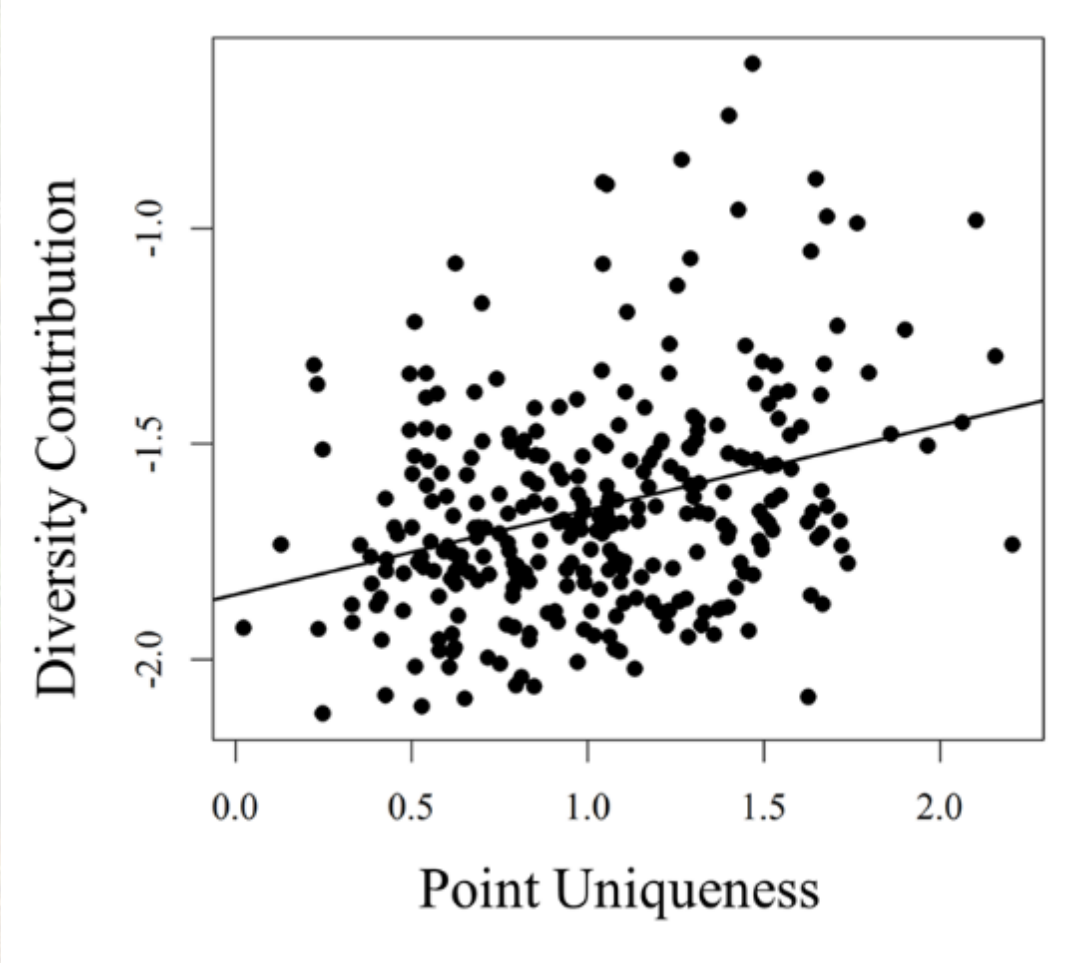
Basal Area	Density	Other
Total basal area	Large trees (>50cm DBH) per ha	% Canopy openness
% BA in conifer	Snags (>25 cm DBH) per ha	Topographic Wetness Index
% BA in Deciduous non-maple	Pole-sized trees per m^2	Diameter distribution
	Saplings per m^2	
	Proportion saplings in conifer	

Point-level Diversity Contribution:

$\beta = 0.195$

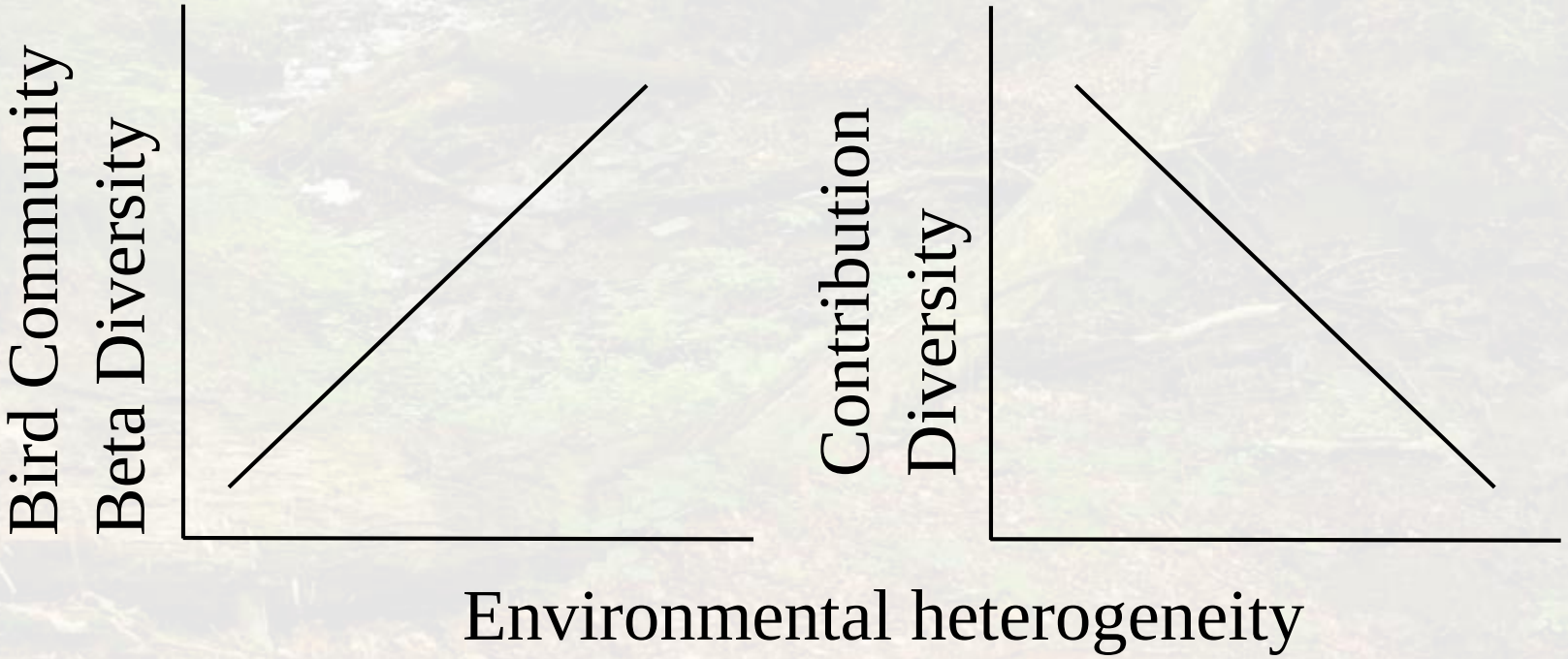
$p < 0.005$

$df = 294$

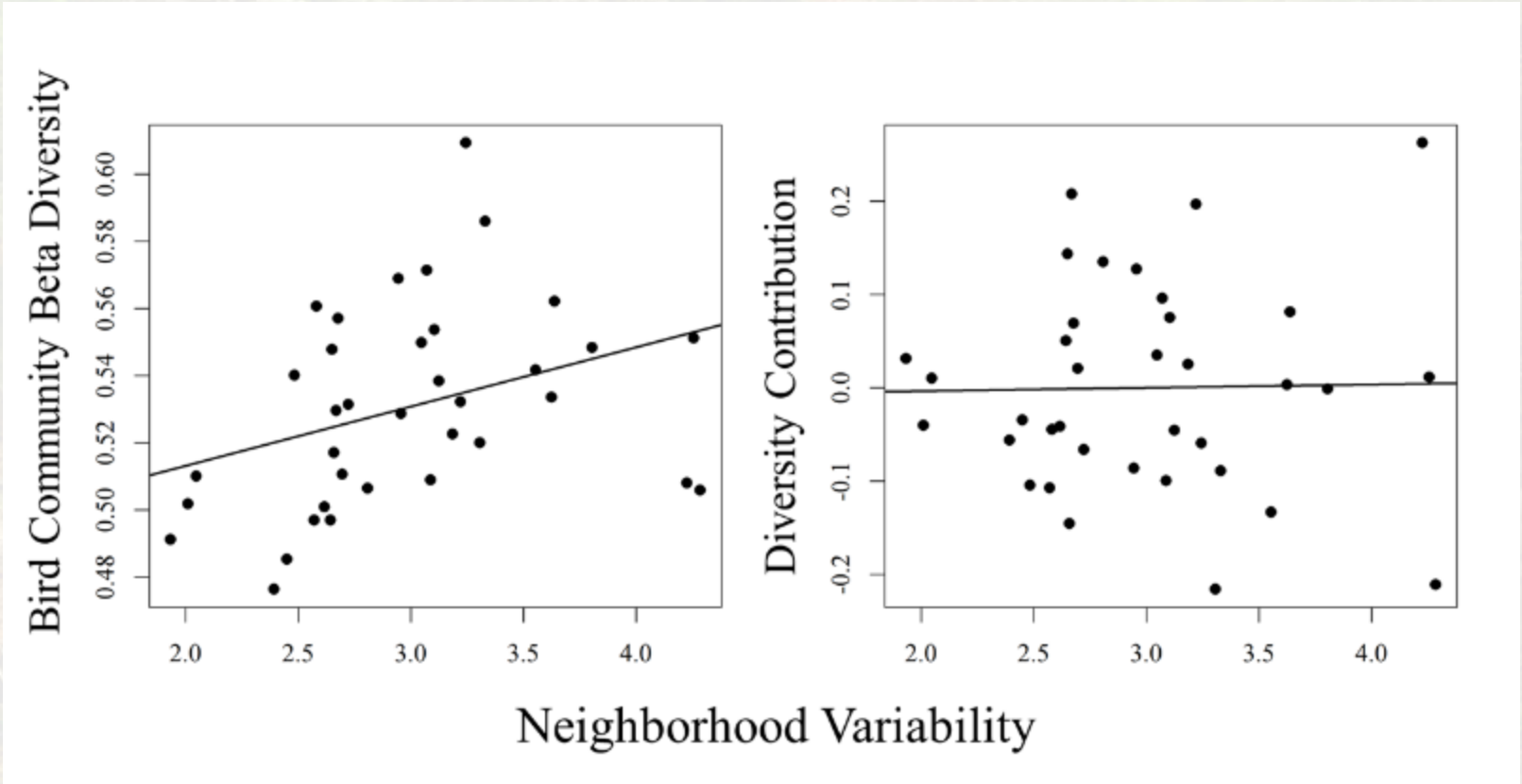


Environmental variability and Diversity Contribution

- Hypotheses:



Environmental Variability and Diversity Contribution



Discussion

- Scale matters in biodiversity conservation
  - Bird species diversity is being driven primarily at smaller spatial scales – among points and neighborhoods
  - Management areas and ecoregions are largely similar in their species composition and relative abundance

Discussion

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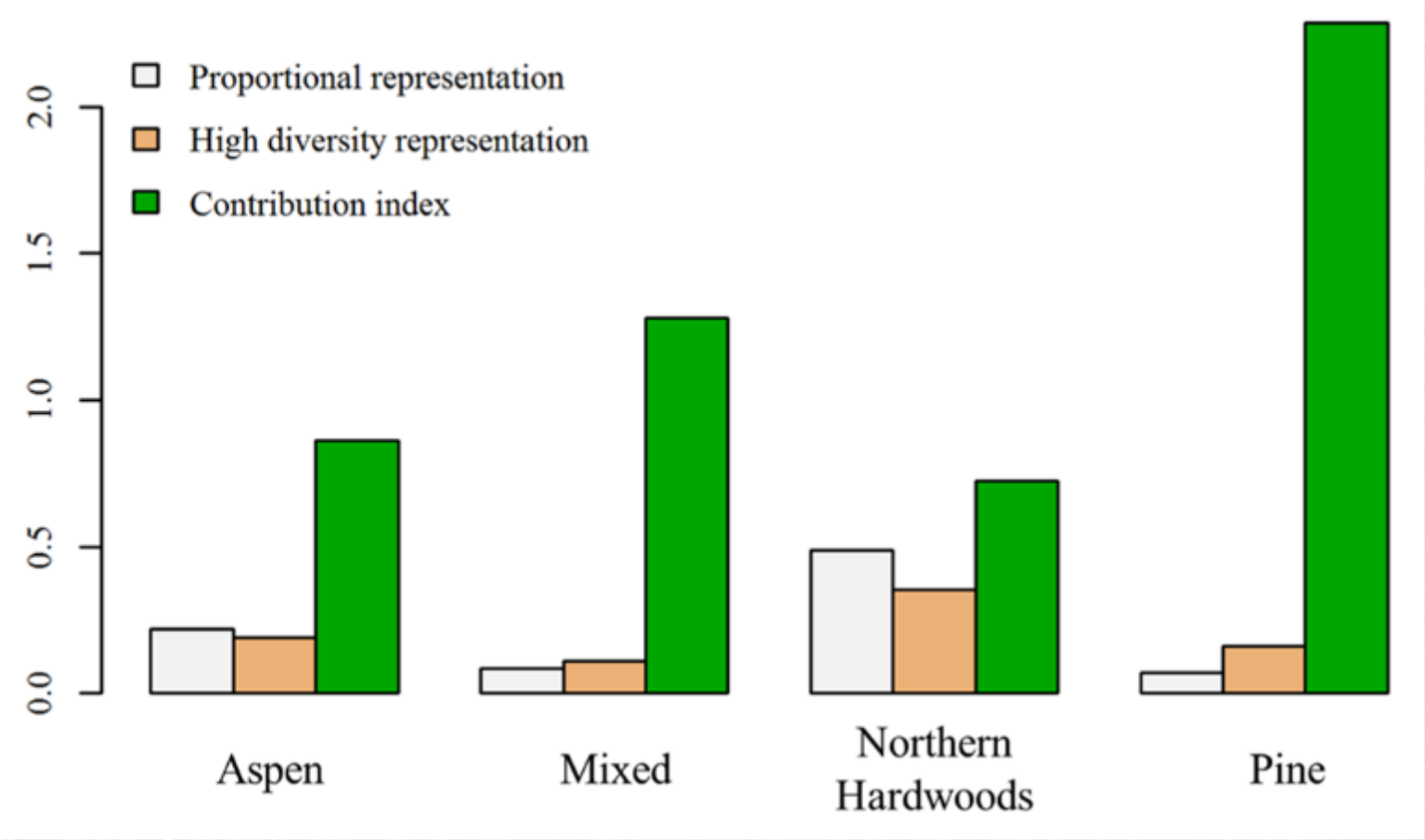
Discussion

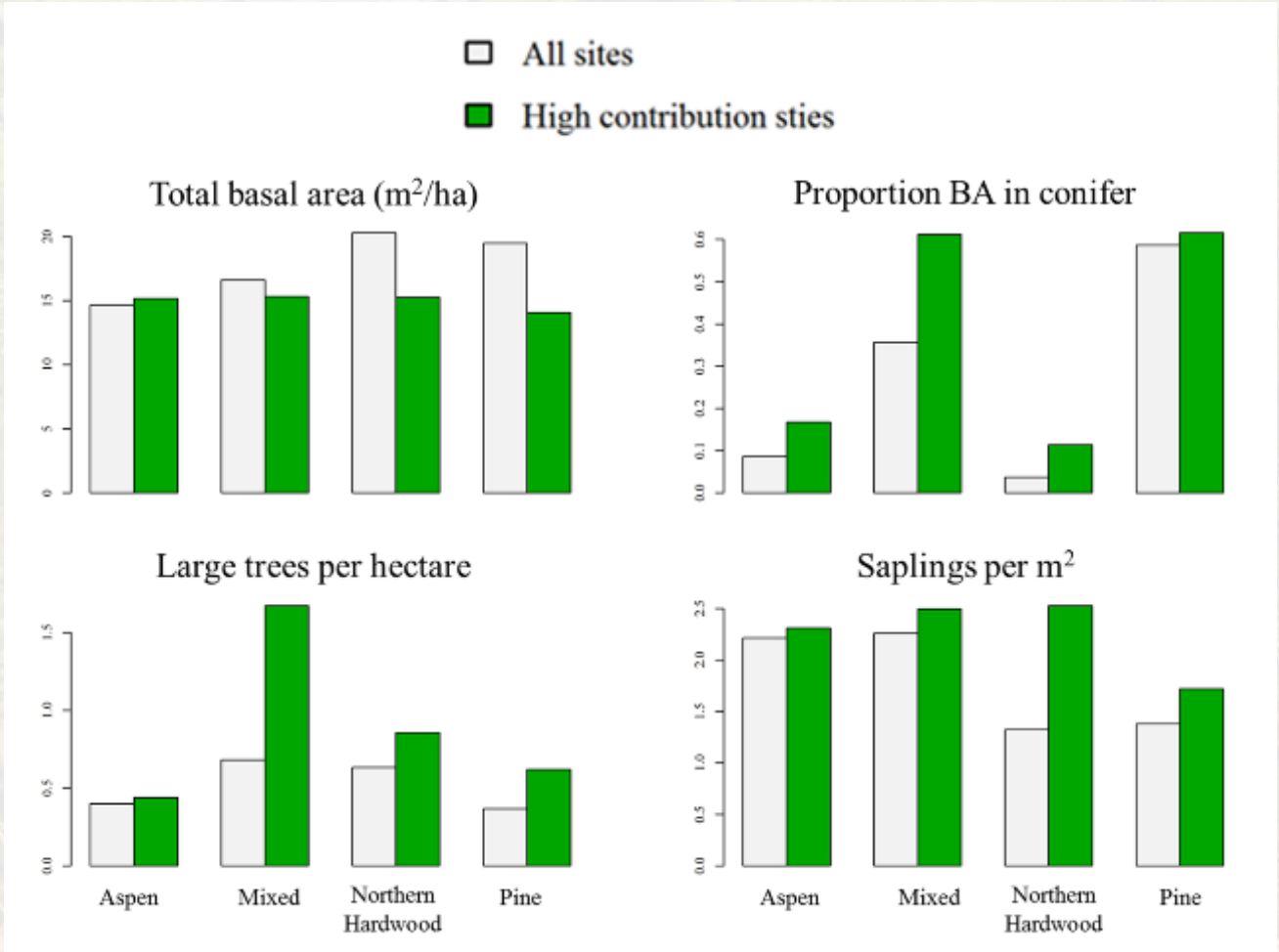
- There is a strong positive link between the uniqueness of a site and its contribution to regional biodiversity

- High biodiversity does not necessarily equate with a higher diversity contribution

Forest Type Diversity Contribution



High Contribution Sites



Take-home Messages

- In our region:
  1. Retain overstory conifers and large-diameter trees
  2. Create canopy openings
  3. Maintain some areas with very low canopy cover

Management Implications

- Biodiversity is a scale-dependent measurement, and patterns change as scale changes

- It is critical that managers:
  1. Recognize and conserve unique areas
  2. Understand the importance of maintaining heterogeneity across scales

Management Implications

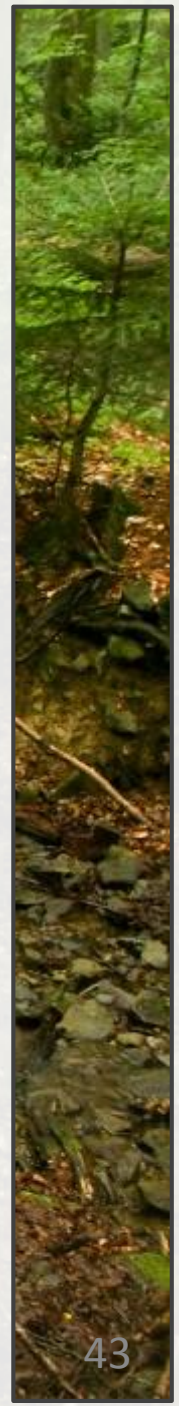
- Larger management scales

1. Greater environmental variability leads to greater biodiversity

2. Seems important to keep some areas variable and some more homogeneous

Acknowledgements

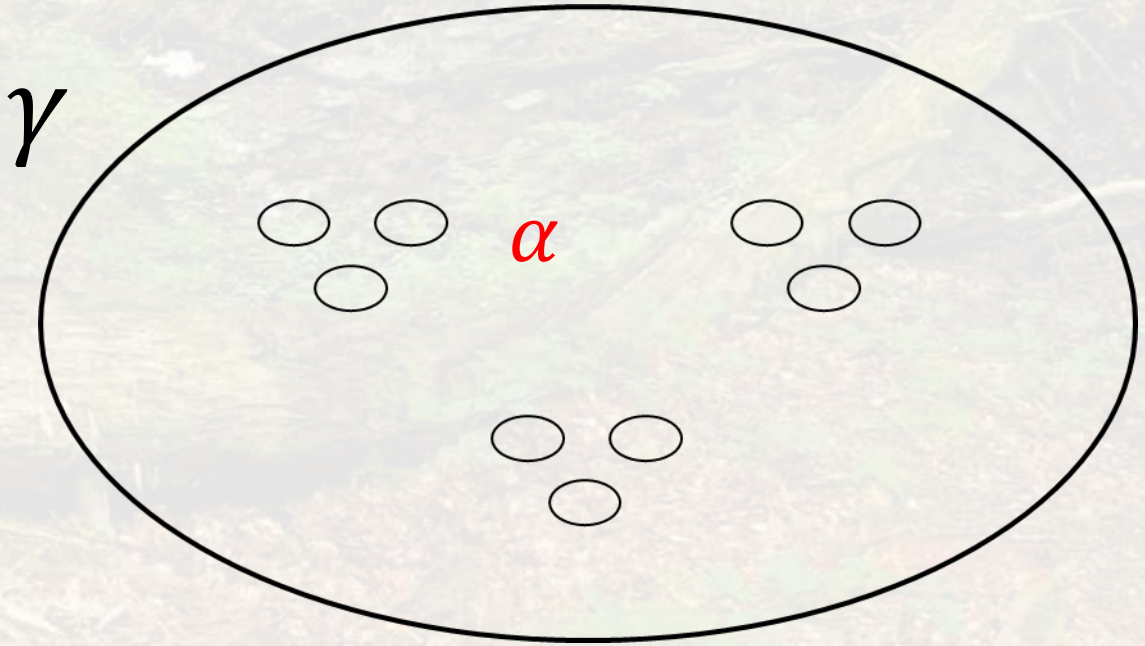
- Boone and Crockett Club
- Quantitative Wildlife Center
- Michigan DNR
- MSU Department of Fisheries and Wildlife
- The Glassen Foundation



Objective 1: Determine scales driving regional diversity

Additive Partitioning at multiple scales

$$\alpha + \beta_1 + \beta_2 = \gamma$$



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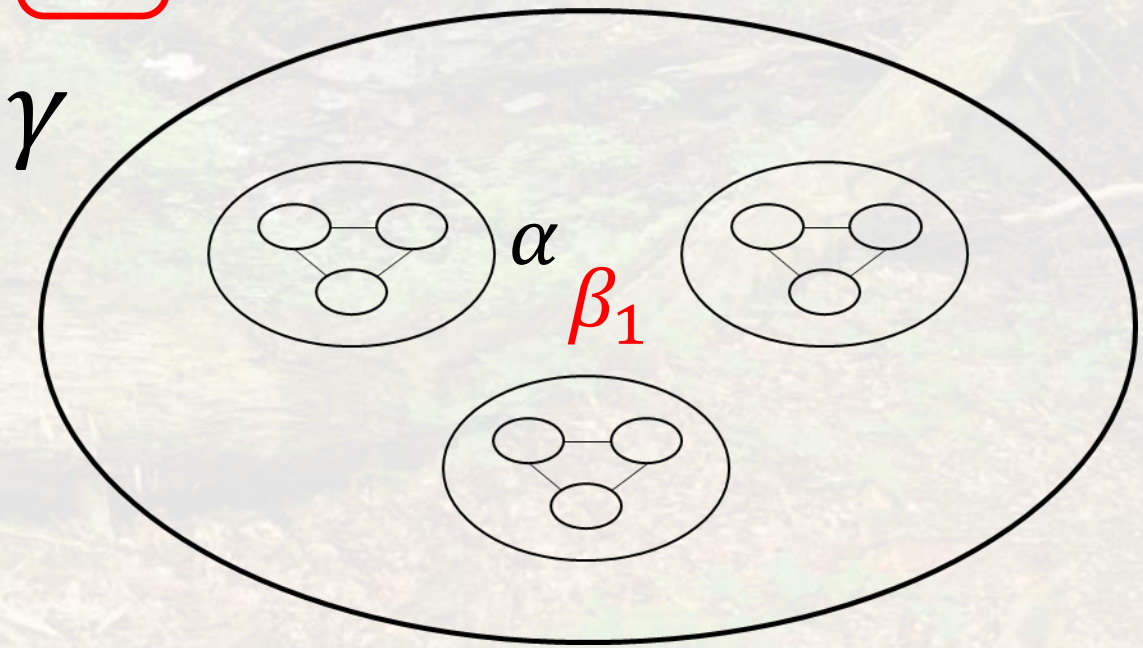

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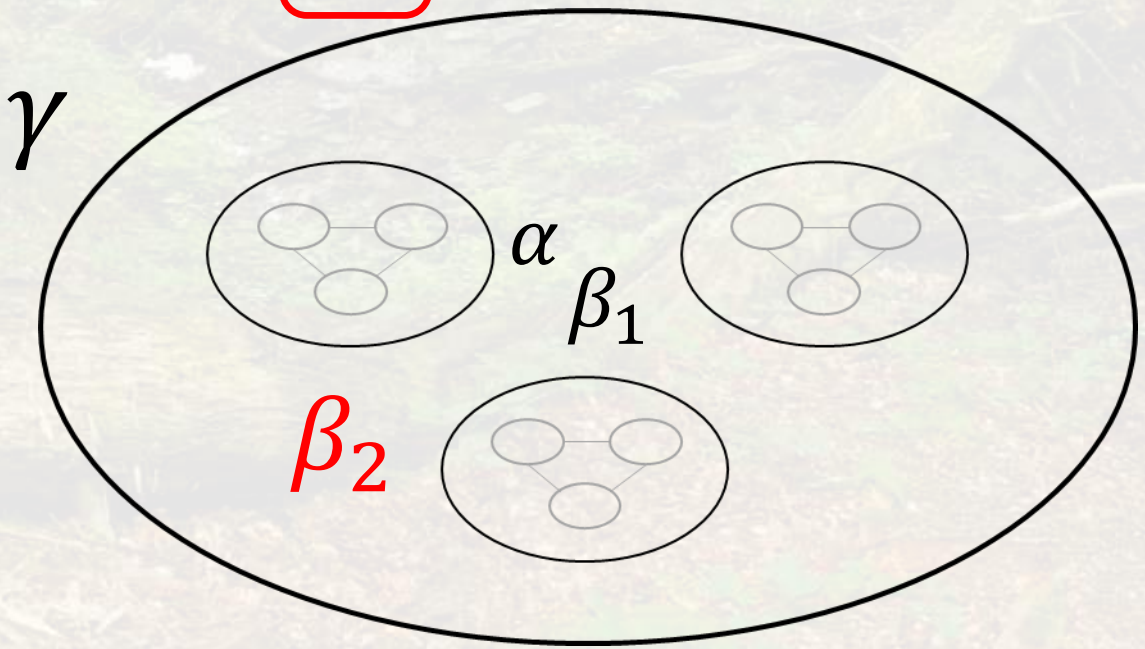

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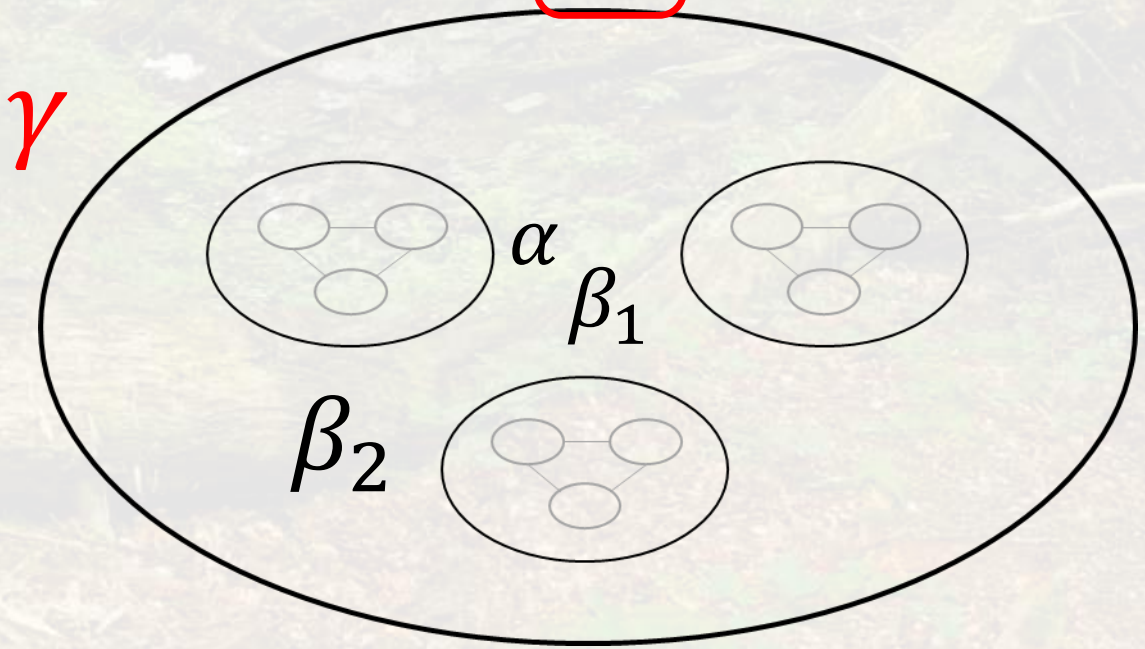

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<u>3 Diversity indices</u>

- Species Richness
- Shannon Diversity
- Simpson Diversity