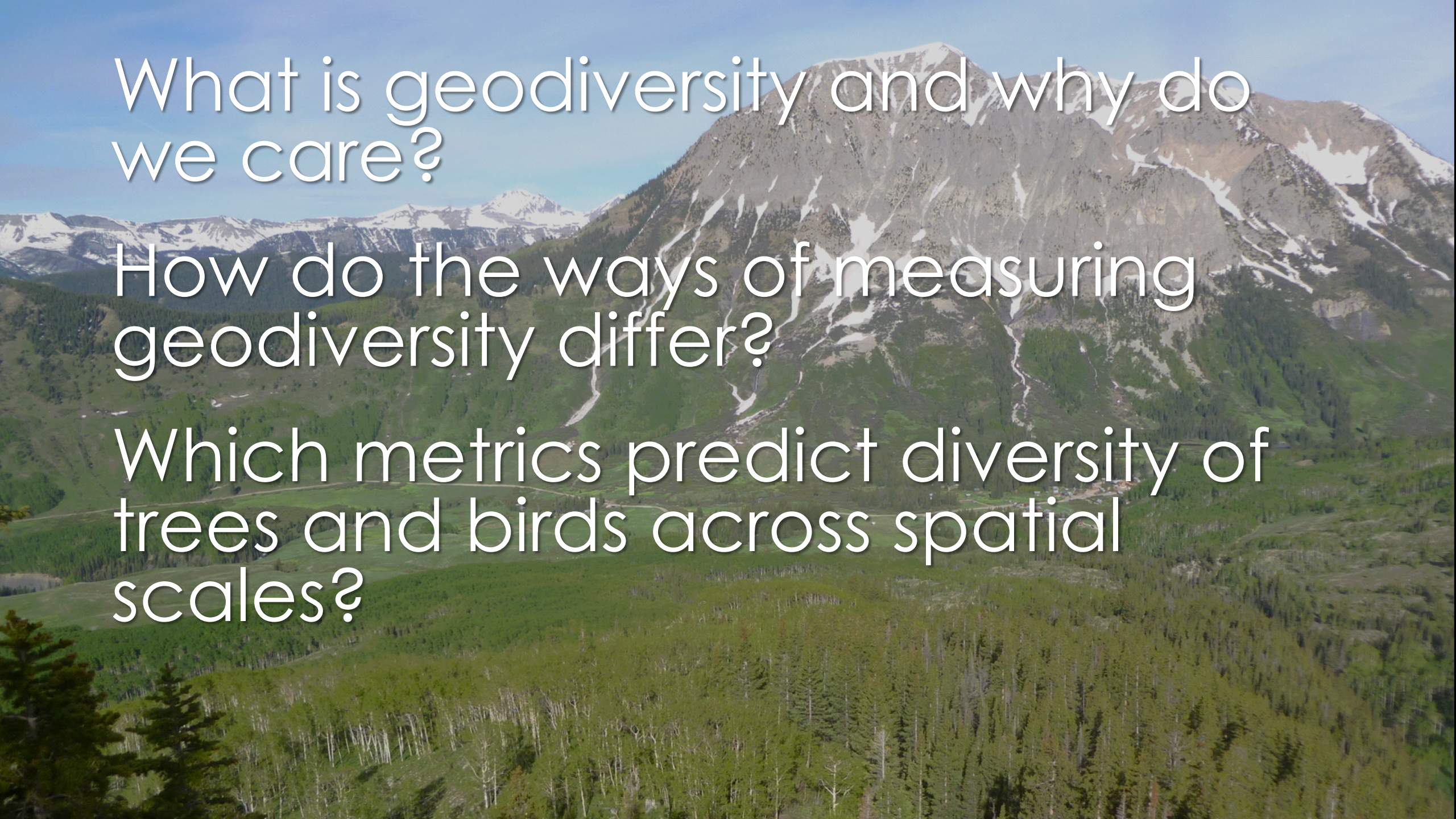
# Connecting Biodiversity, Geodiversity, and Remote Sensing Across Scales

**Sydne Record, Bryn Mawr College**; Phoebe L. Zarnetske, Michigan State University; Kyla Dahlin, Michigan State University; Quentin D. Read, Michigan State University; Sparkle L. Malone, Florida International University; Keith Gaddis, National Aeronautics and Space Administration; John M. Grady, Bryn Mawr College; Jennifer Costanza, North Carolina State University; Martina L. Hobi, Swiss Federal Research Institute; Andrew Latimer, University of California-Davis; Stephanie Pau, Florida State University; Adam M. Wilson, University at Buffalo; Andrew Finley, Michigan State University; Scott Ollinger, University of New Hampshire

# Acknowledgments


Working group
Connecting biodiversity, geodiversity, and remote sensing across scales
PIs
Phoebe Zarnetske
Sydne Record
Kyla Dahlin

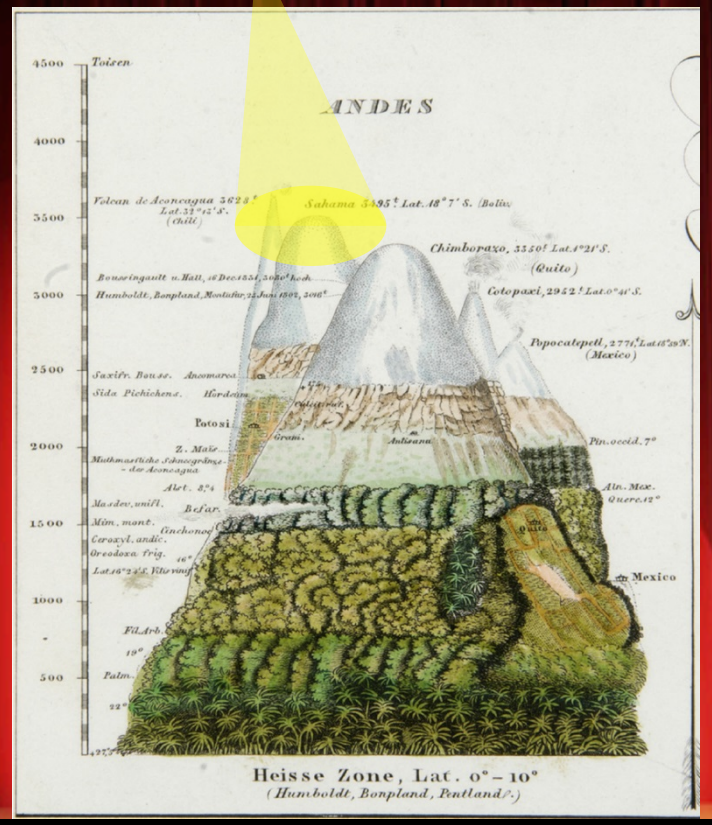



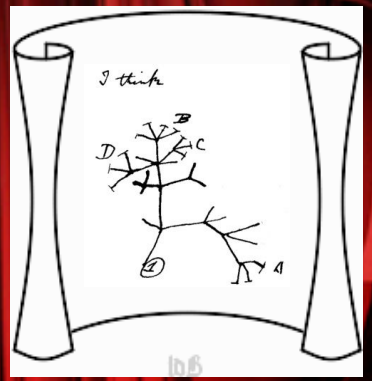
What is geodiversity and why do we care?

How do the ways of measuring geodiversity differ?

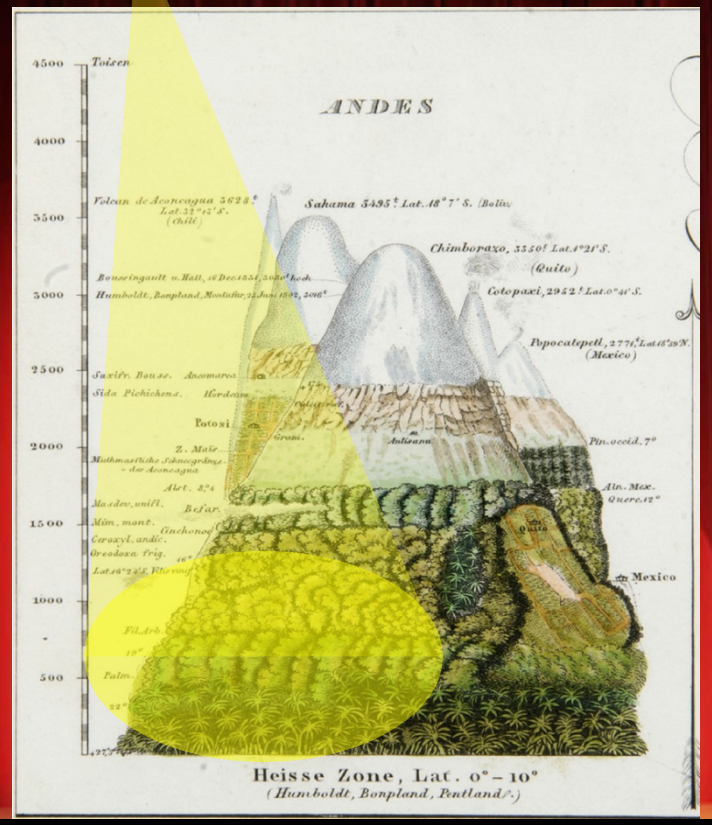
Which metrics predict diversity of trees and birds across spatial scales?

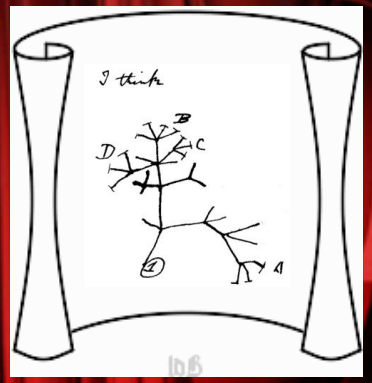
# Conserving nature's stage
# Hutchinson's ecological theatre and evolutionary play



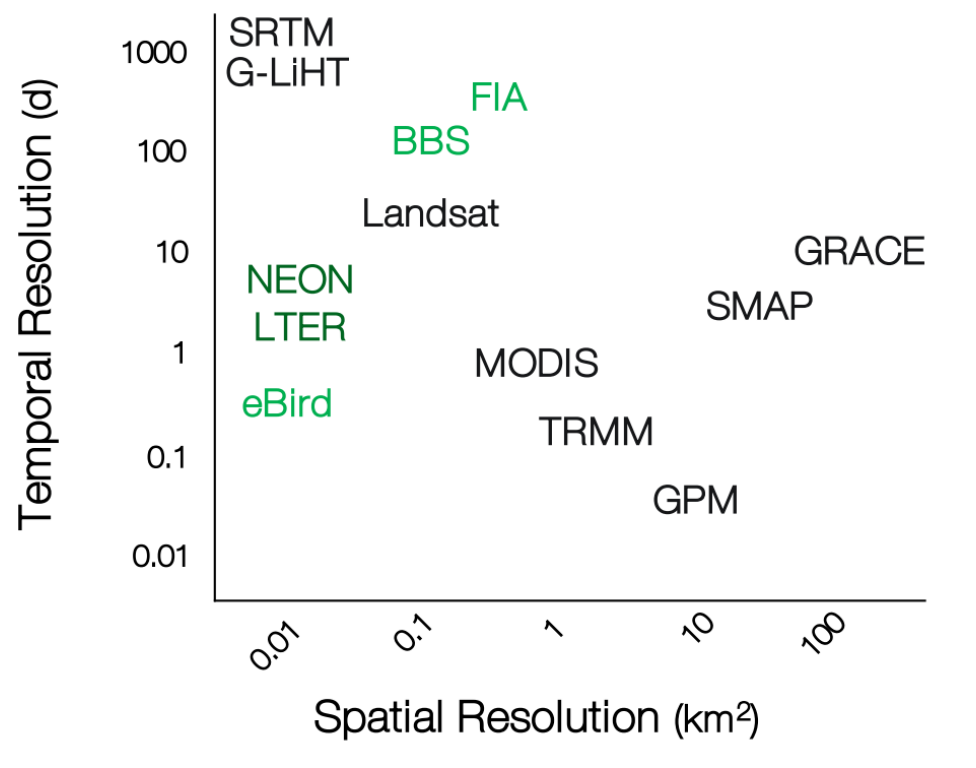
# Conserving nature's stage
# Hutchinson's ecological theatre and evolutionary play



# What is geodiversity and why do we care?

Variety and distribution of nonliving features of the landscape




Zarnetske et al., *Global Ecol Biogeogr* (In review)
Record et al., *Remote Sensing of Plant Biodiversity,* Eds. Cavender-Bares, Gamon, Townsend (In revision)

Geodiversity Data Produc

Secure | https://bioxgeo.github.io/bioXgeo_ProductsTable/

Apps | Inbox - sydne.record | Mail - Sydne Record | https://outlook.com/ | BMC Moodle | Harvard University PI | Oracle PeopleSoft Sig | Online Survey Softwa | Evert, Raven Biology | Ecological Data Wiki | Other boo

Geodiversity | Home

# Geodiversity Data Products

Available geophysical remote sensing products from NASA, with their spatial and temporal scales.

Show 50 entries

Search:

| | Acronym | Product and Mission Name | Minimum Spatial Resolution (m) | Maximum Spatial Resolution (m) | Spatial Extent | Spatial Coverage | Temporal Resolution | Temporal Extent (start) | Temporal Extent (stop) | Geology | Soil | Topography | Atmosphere | Hy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Al | | | | |
| 1 | SRTM | Shuttle Radar Topography Mission | 30 | 90 | 60N to 56S deg lat | near global | None - Single time point | 2000 | | | | Elevation, Slope, Aspect, Energy, Roughness | | |
| 2 | SMAP | Soil Moisture Active/Passive | 9000 | 36000 | global low-veg cover | near global | 8 days | 2015 | 2015 | | Soil Properties | | | Soil |
| 3 | TRMM | Tropical Rainfall Measuring Mission | 250000 | 250000 | 35N to 35S deg lat | tropics | 3 hours - daily | 1998 | 2015 | | | | Precipitation, | |
| 4 | GPM | Global Precipitation Measurement | 10000 | 10000 | Global | global | 30 min | 2014 | | | | | Precipitation, | |

https://bioxgeo.github.io/bioXgeo_ProductsTable/

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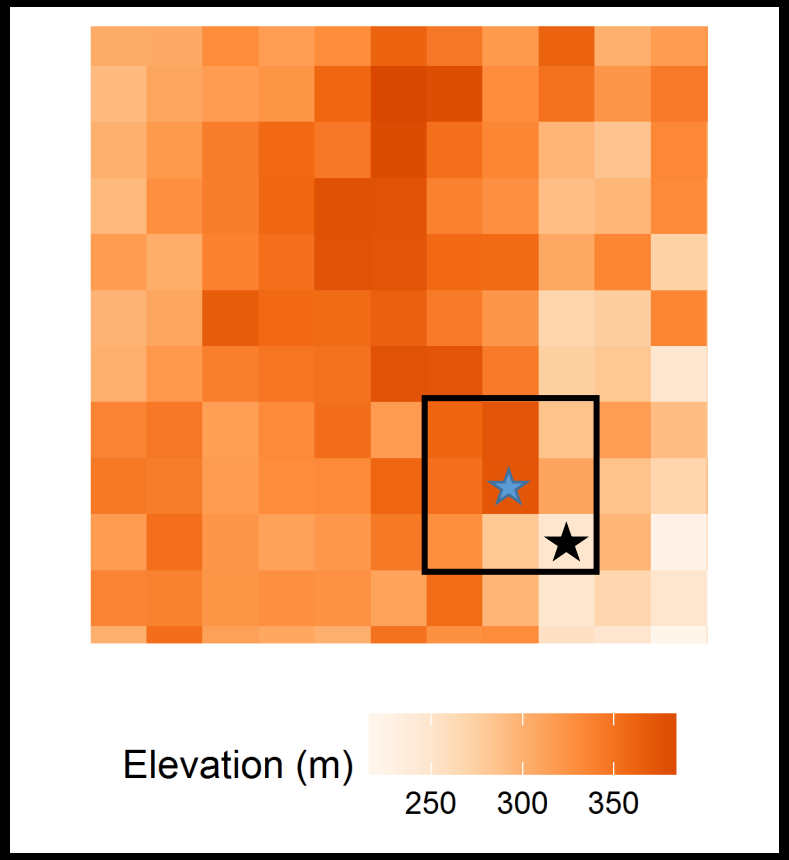
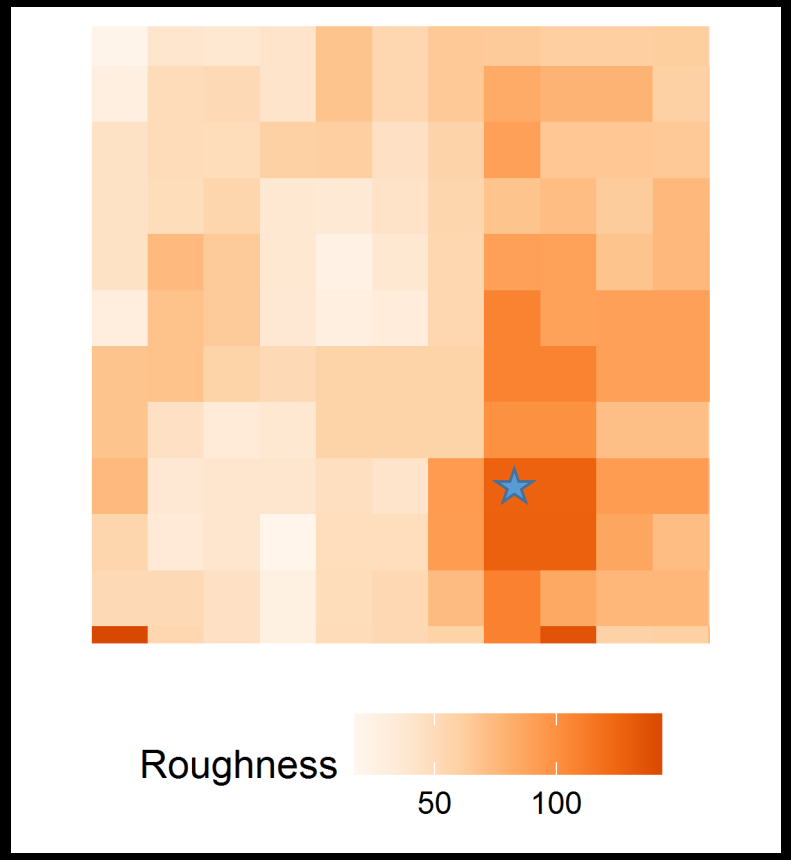
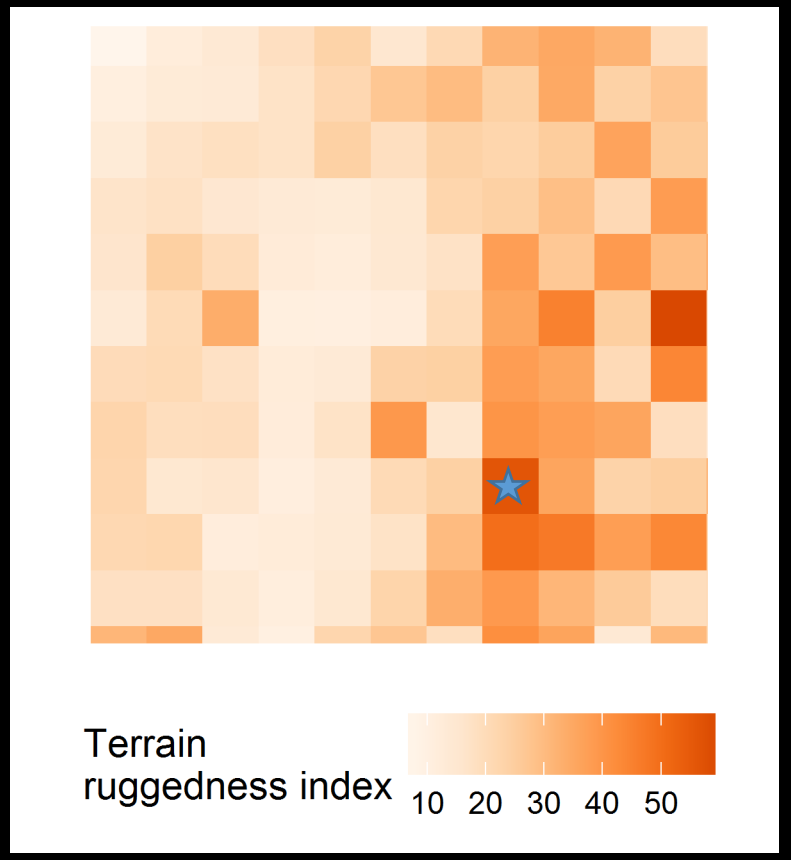
# Some simple landscape metrics…




raw elevation pixel values

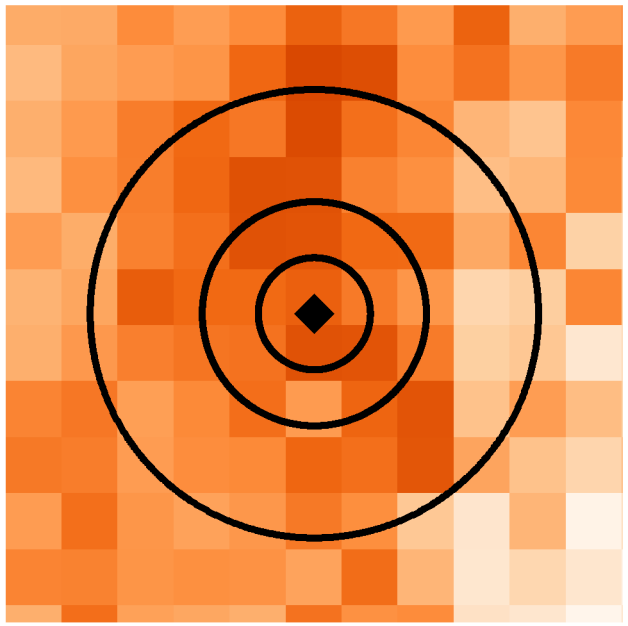



roughness: maximal difference between focal pixel and neighbors

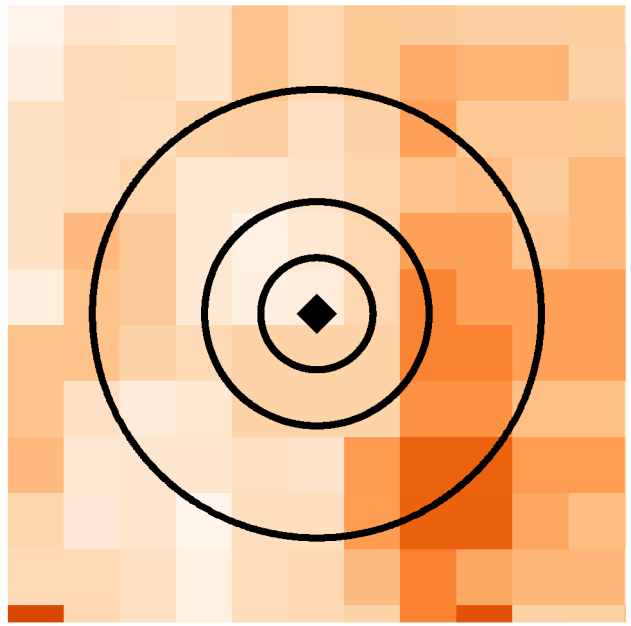



TRI: mean difference between focal pixel and neighbors

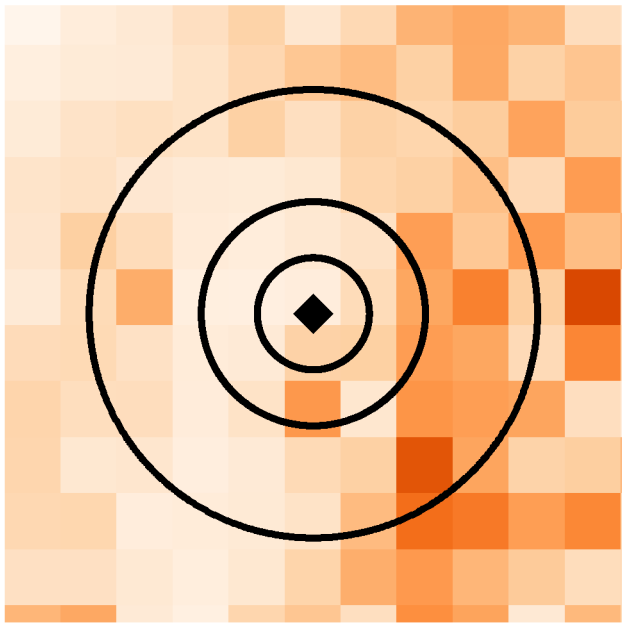
# ...but the spatial grain is what counts!




standard deviation of elevation within circle



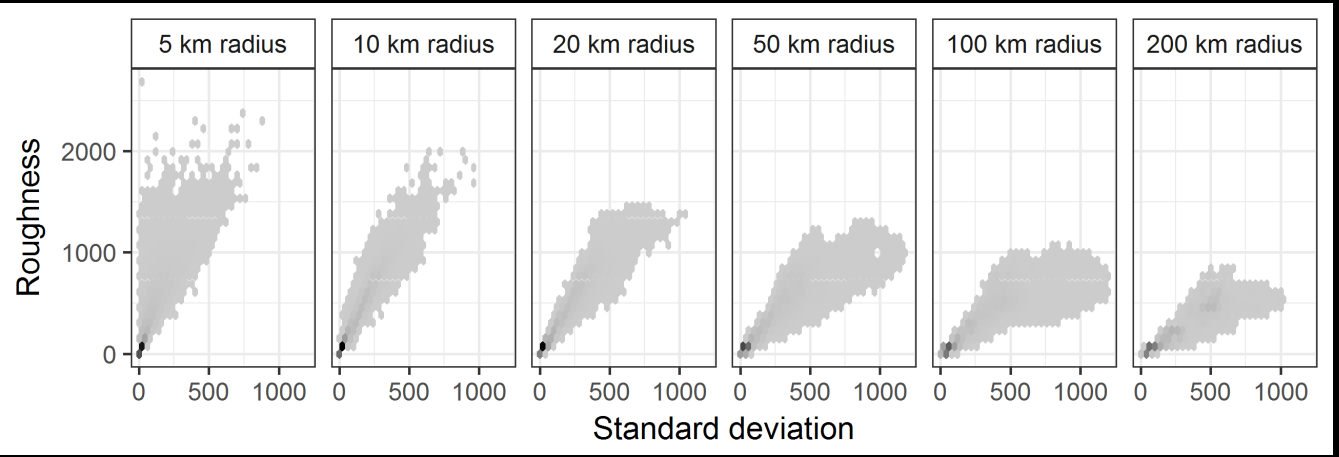

mean roughness within circle



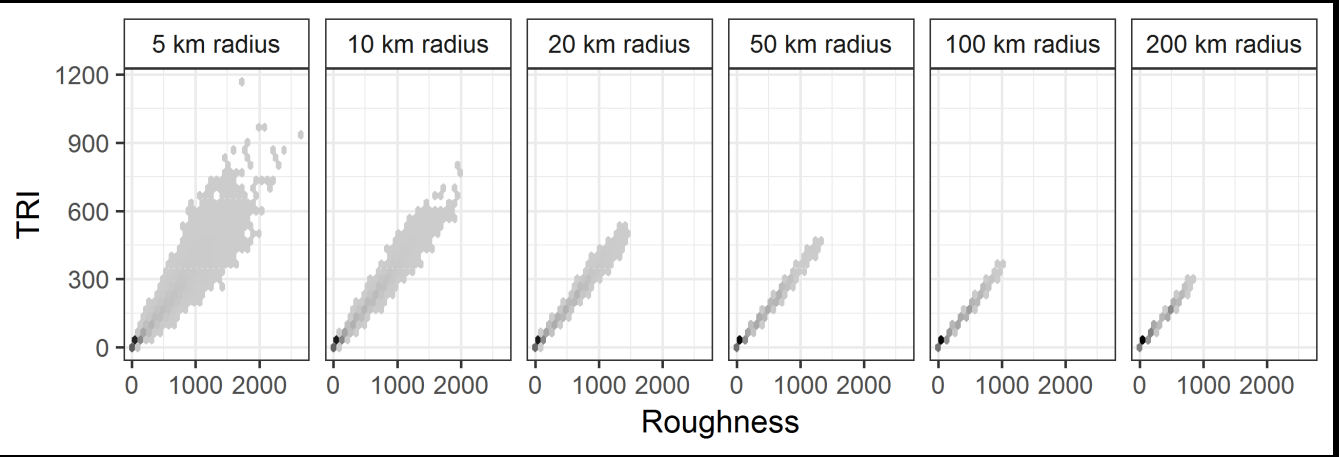

mean TRI within circle

# Metrics capture different, but overlapping, aspects of geodiversity

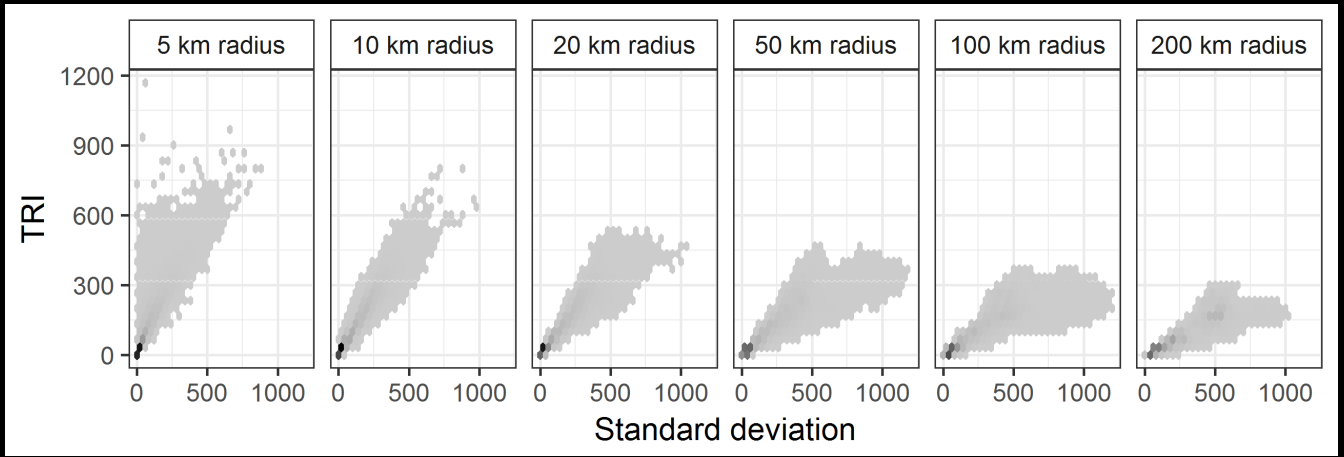
roughness vs. standard deviation

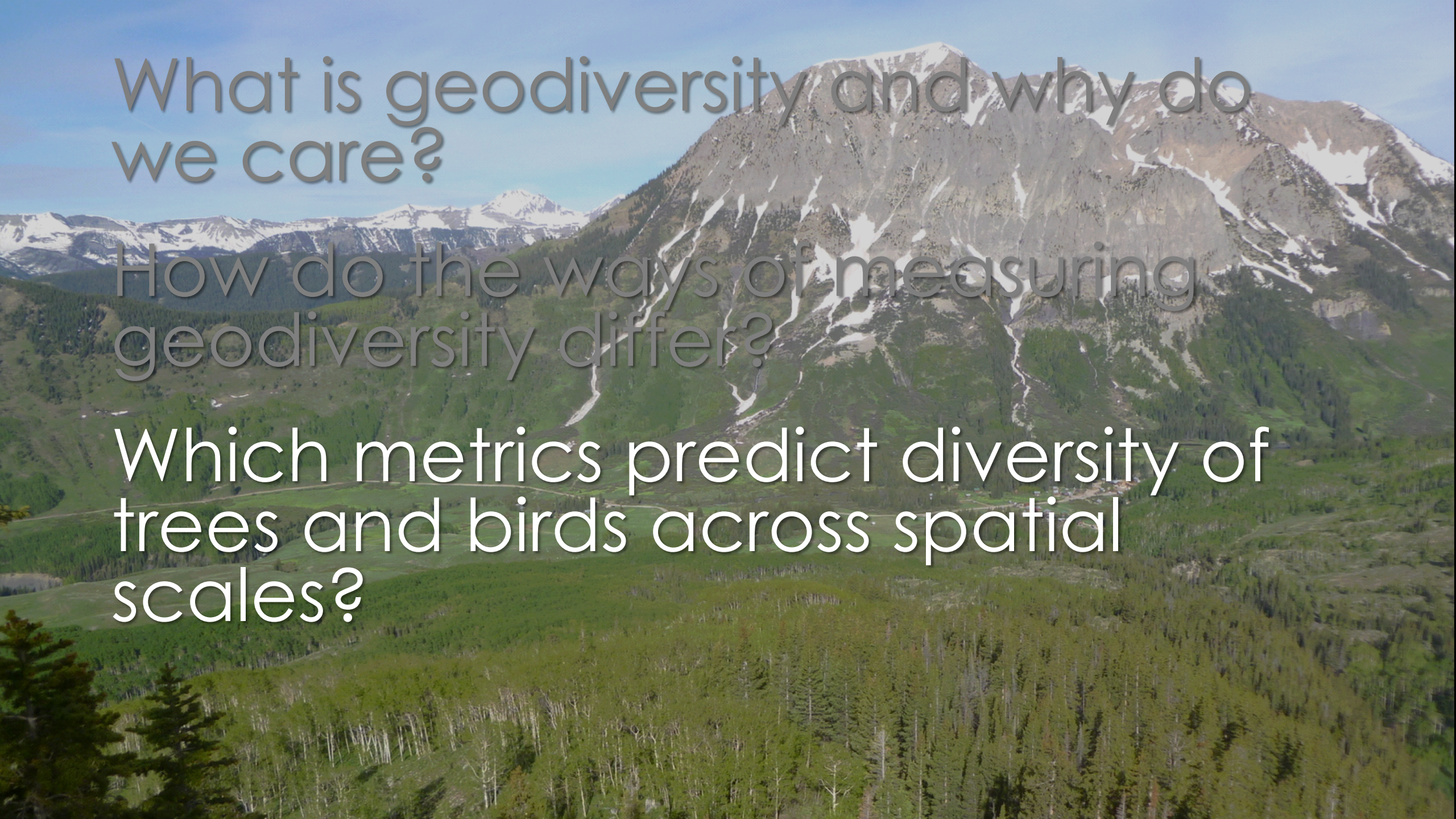



ruggedness vs. roughness




ruggedness vs. standard deviation





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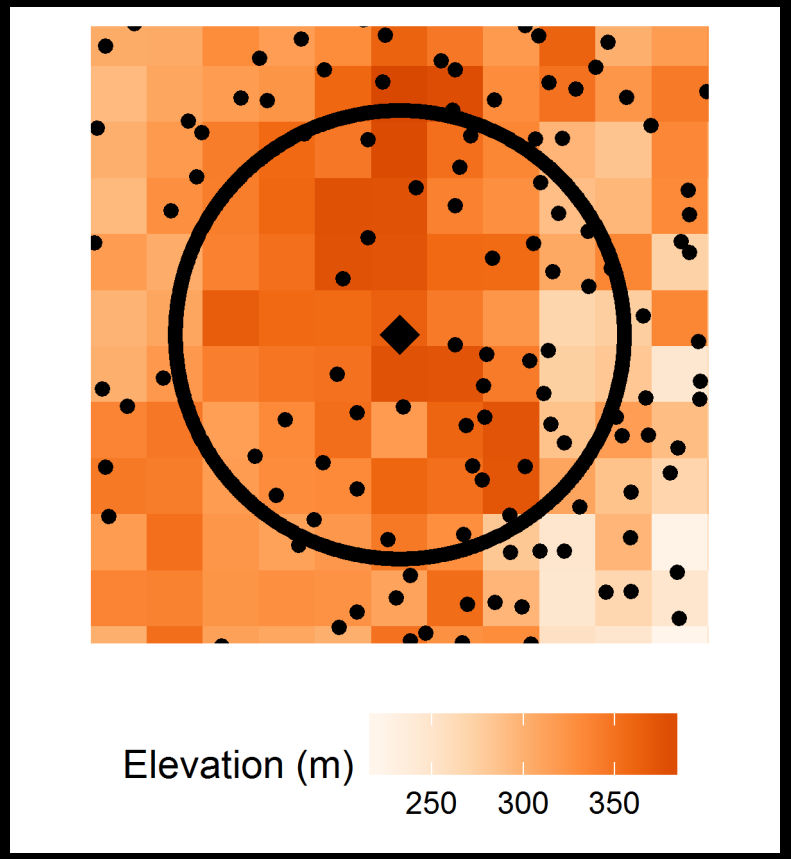
Which metrics predict diversity of trees and birds across spatial scales?

# Scale of biodiversity metrics = scale of geodiversity metrics

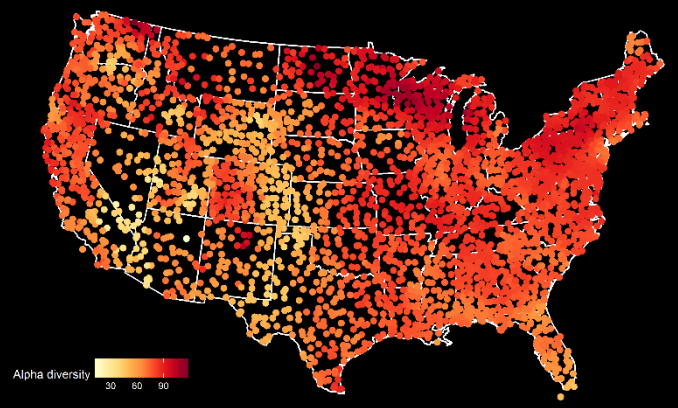



**Alpha:** average richness of all plots in circle

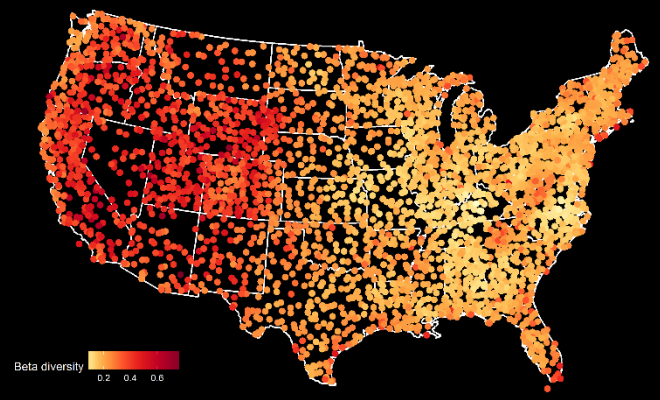
**Beta:** average pairwise difference between plots in circle

**Gamma:** pooled richness of all plots in circle

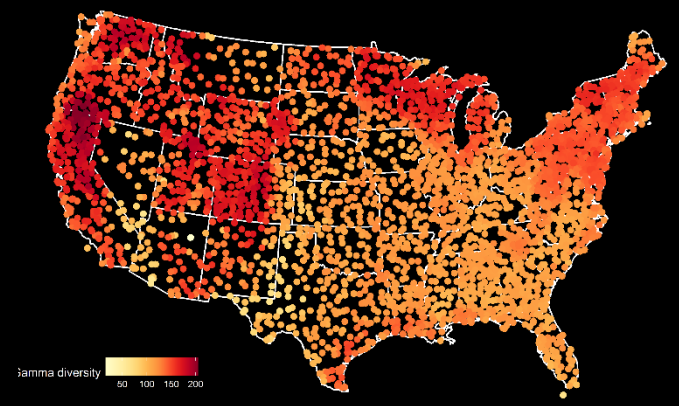
Alpha: local



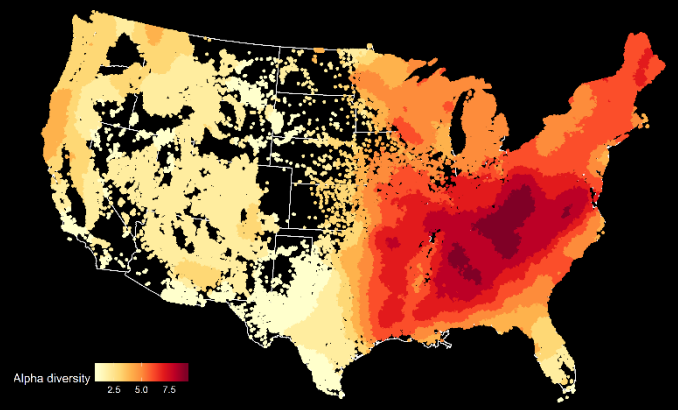

Beta: turnover

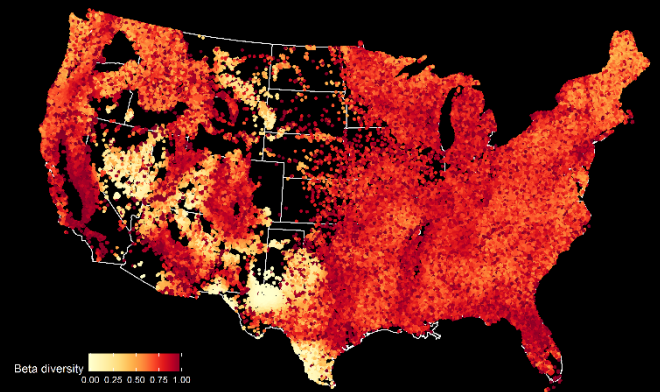


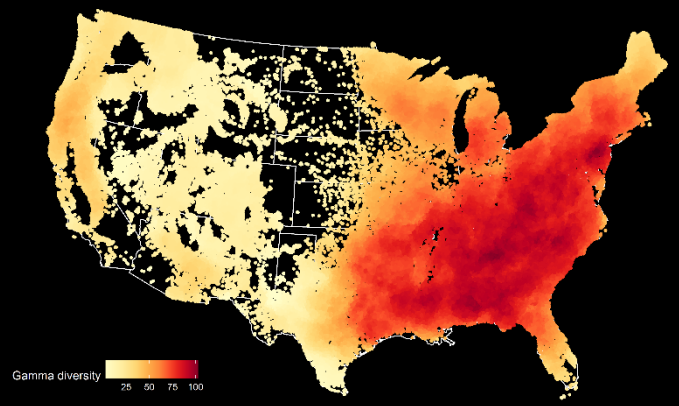

Gamma: regional




**BIRDS** Breeding Bird Survey

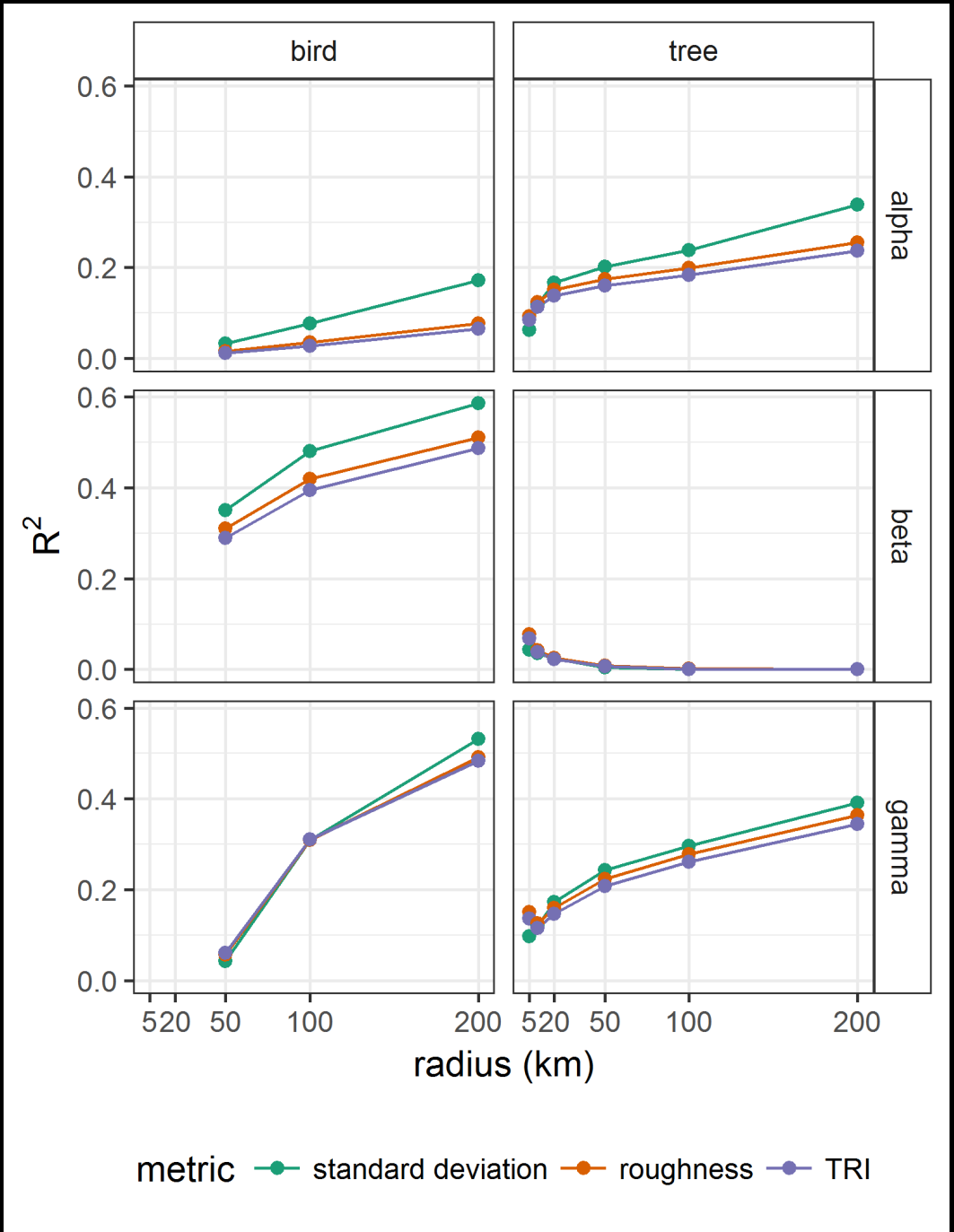


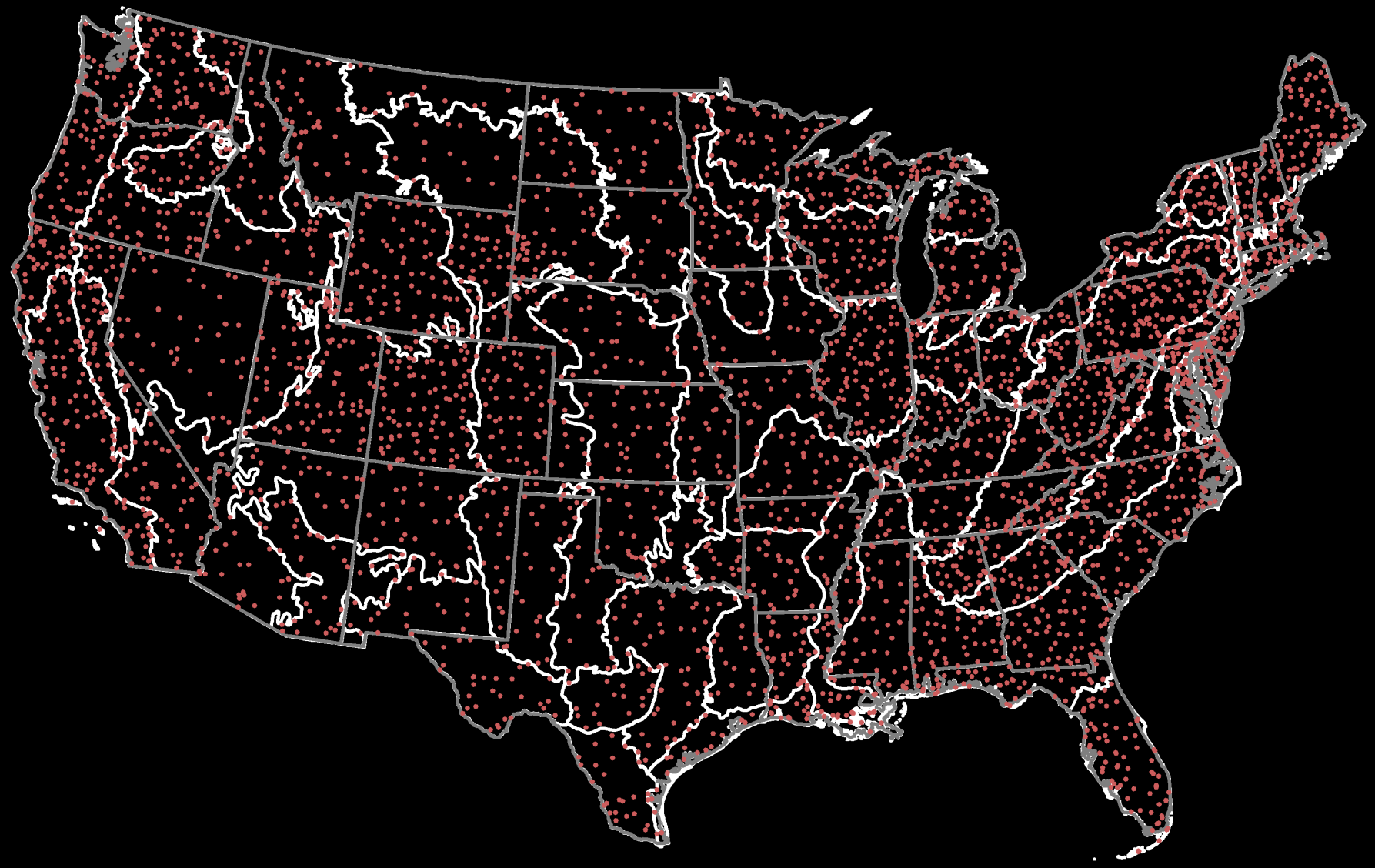




**TREES** Forest Inventory & Analysis

- Predictive power of metrics varies by taxon and scale
- Spatially naïve metric did roughly as well as spatially conscious ones

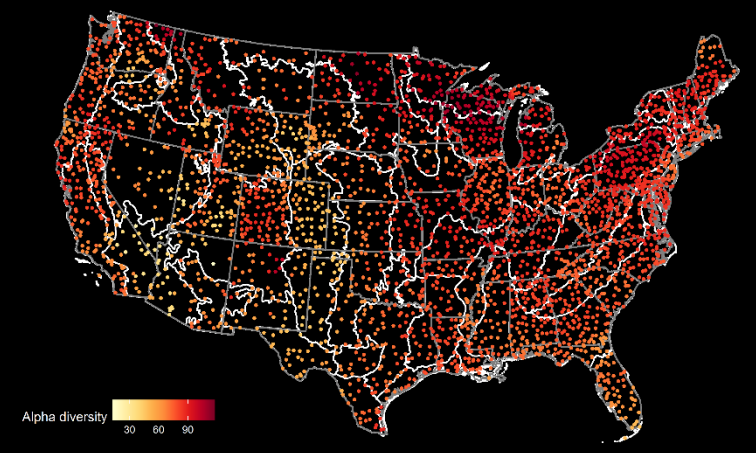


# BBS routes and Bird Conservation Regions

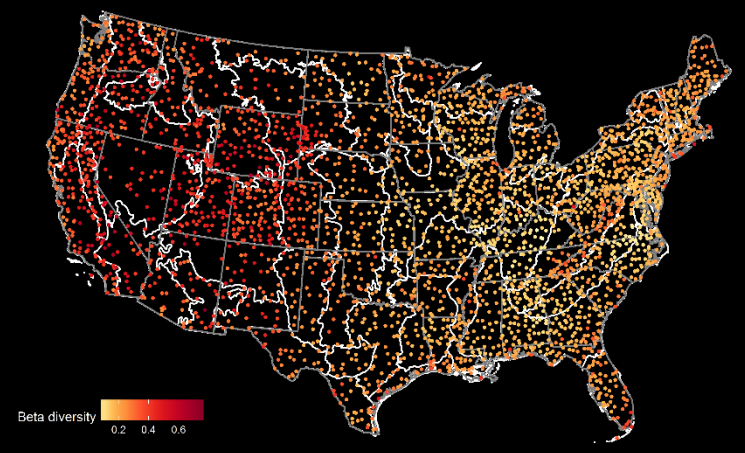


# Biodiversity and geodiversity across BBS routes

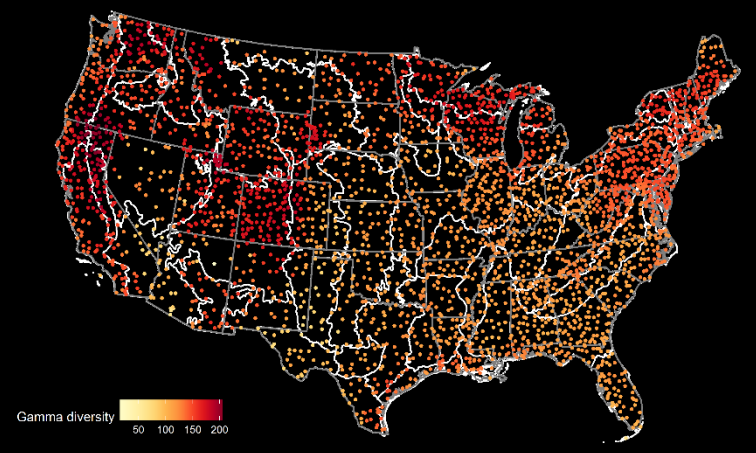
## Alpha: local



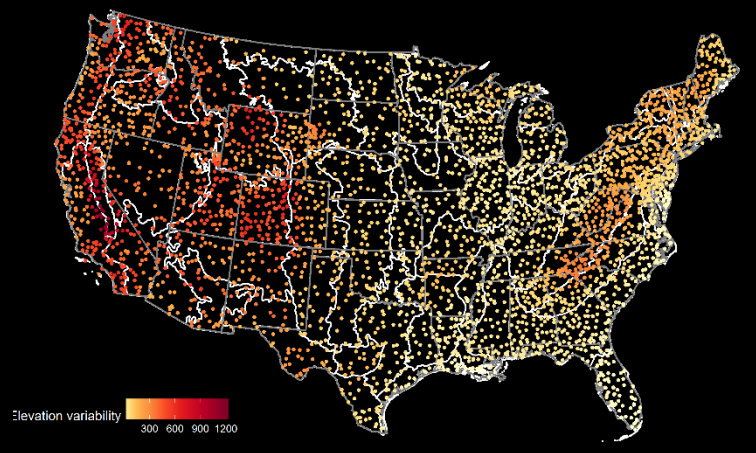

## Beta: turnover



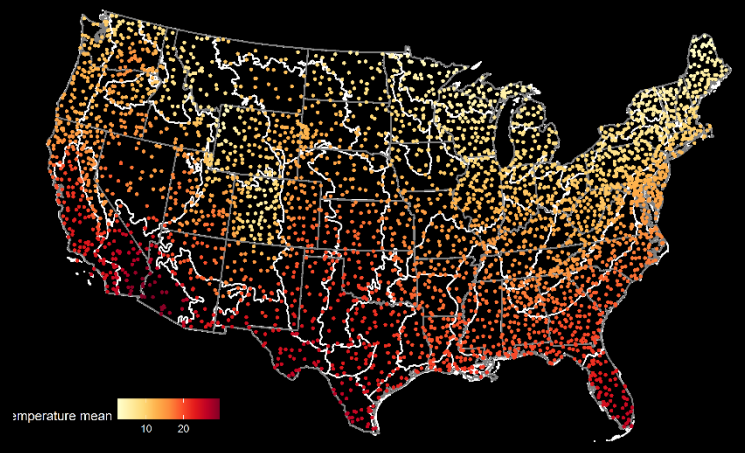

## Gamma: regional



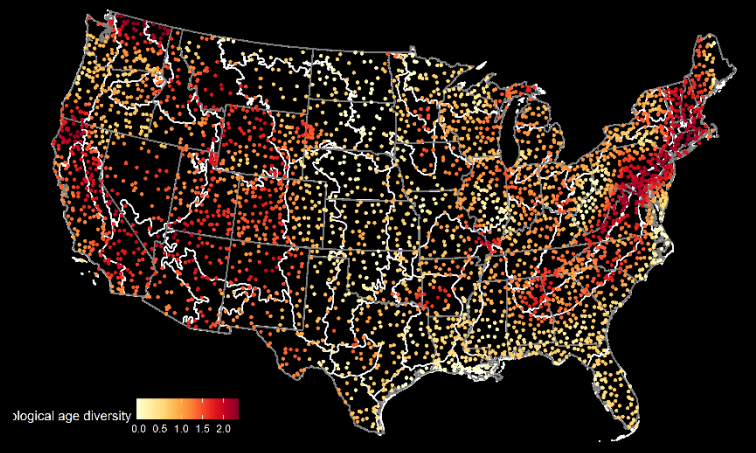

## Elevation variability

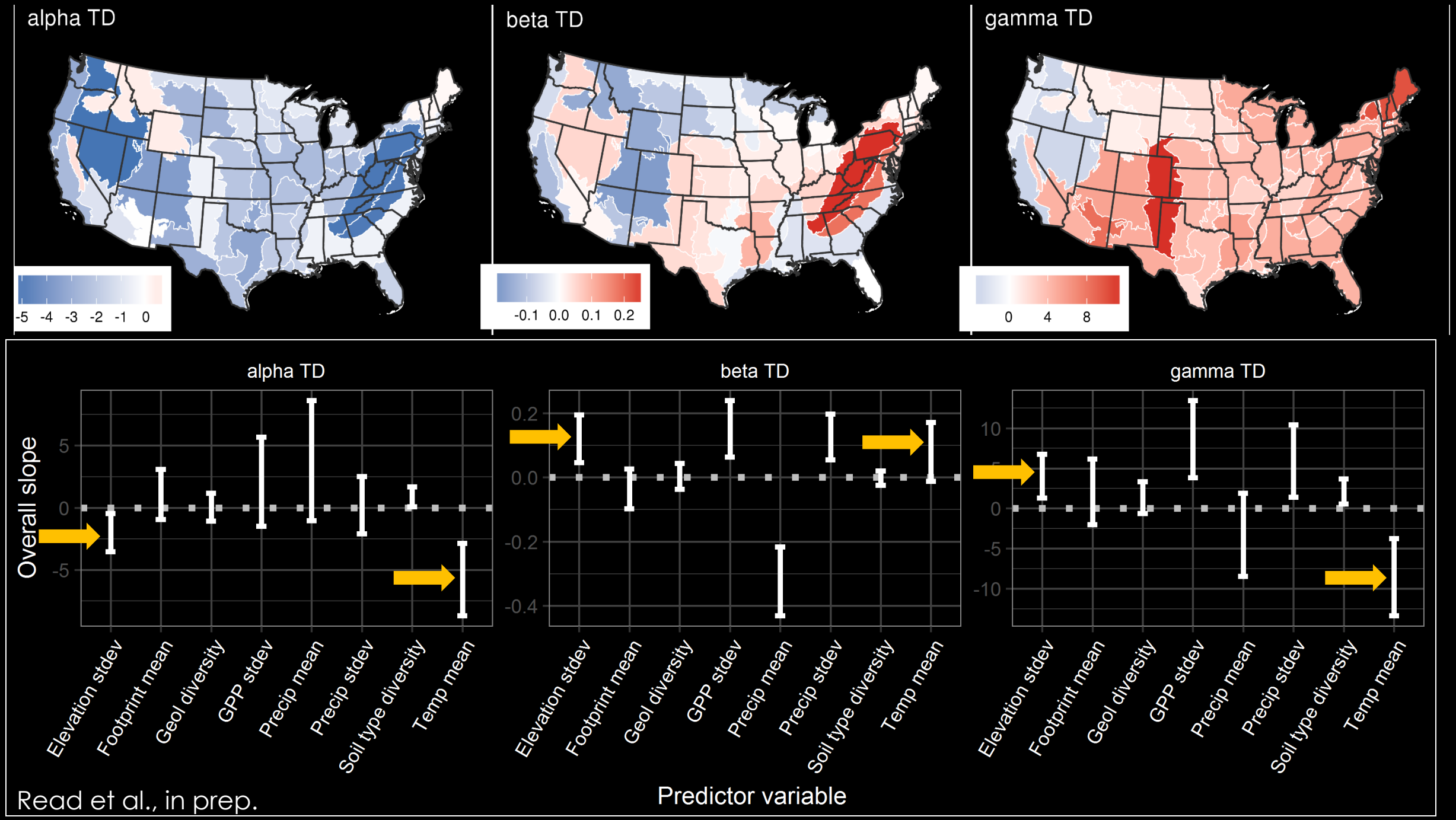



## Temperature mean




## Geological age diversity






Read et al., in prep.

# Take-home messages

- Scale matters
- Ongoing: add functional traits and phylogenetic diversity, compare to other taxonomic groups, simultaneous explorations across spatial grain and extent

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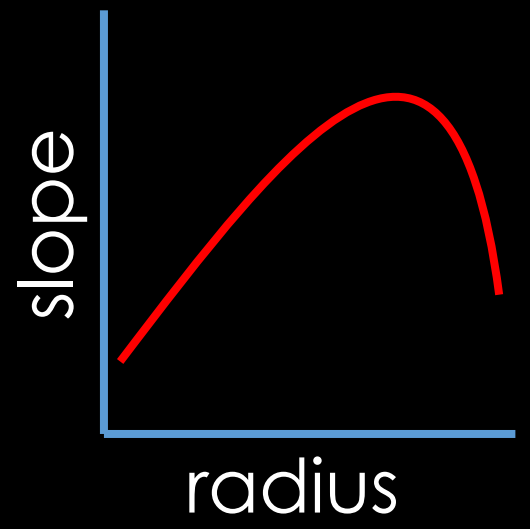
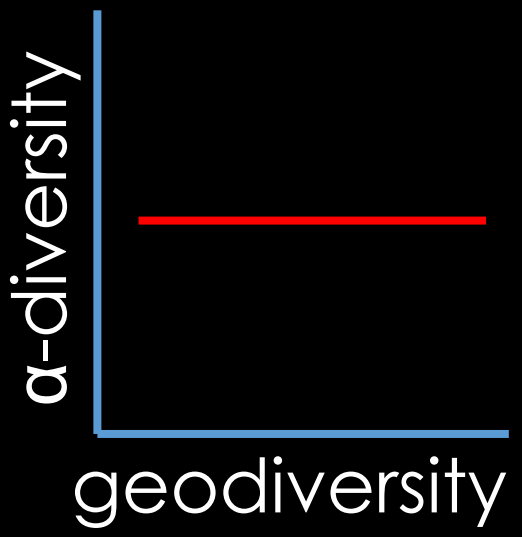
# Predictions

**1** $R^2$ (birds) > $R^2$ (trees)

**2**




**3**

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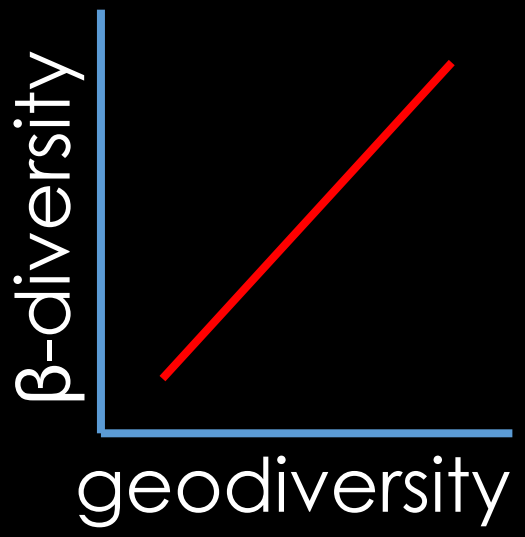
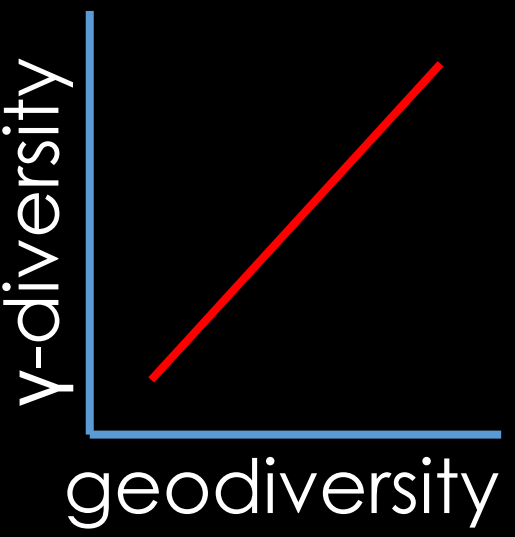



Beta: turnover




Gamma: total

# Slope coefficients

Birds' coefficients may be less scale-dependent than trees'

Birds show a positive signal, trees a negative signal