BioSpace25 - Biodiversity insight from Space
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A comparative analysis of field-based ecology and remote sensing approaches to plant functional diversity

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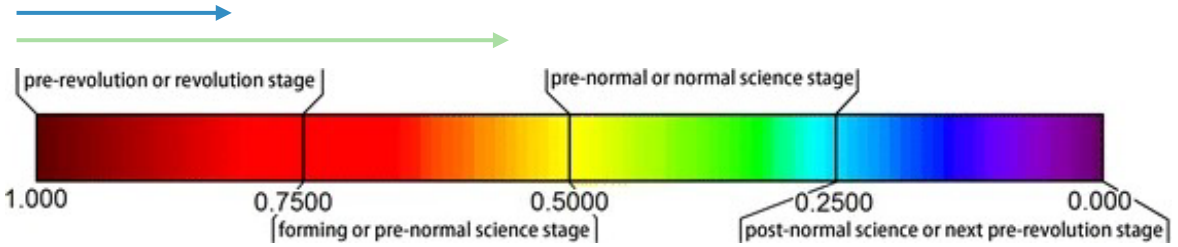
Motivation

- Global initiatives addressed to contribute to the monitoring global biodiversity → *Essential Biodiversity Variables (EBVs)*→ great value due to their **scalability**
- Plant traits & Functional Diversity (FD) → provide mechanistic insights into ecosystem functioning
- Coupling **field-based ecology** and **remote sensing (RS)** approaches is promising to **scale-up** EBVs
- **Gap:** systematic understanding of how their methodological and conceptual differences affect the study of functional diversity.
- **Aim:** to identify the methodological challenges of integrating plant functional diversity research in field-based ecology and remote sensing

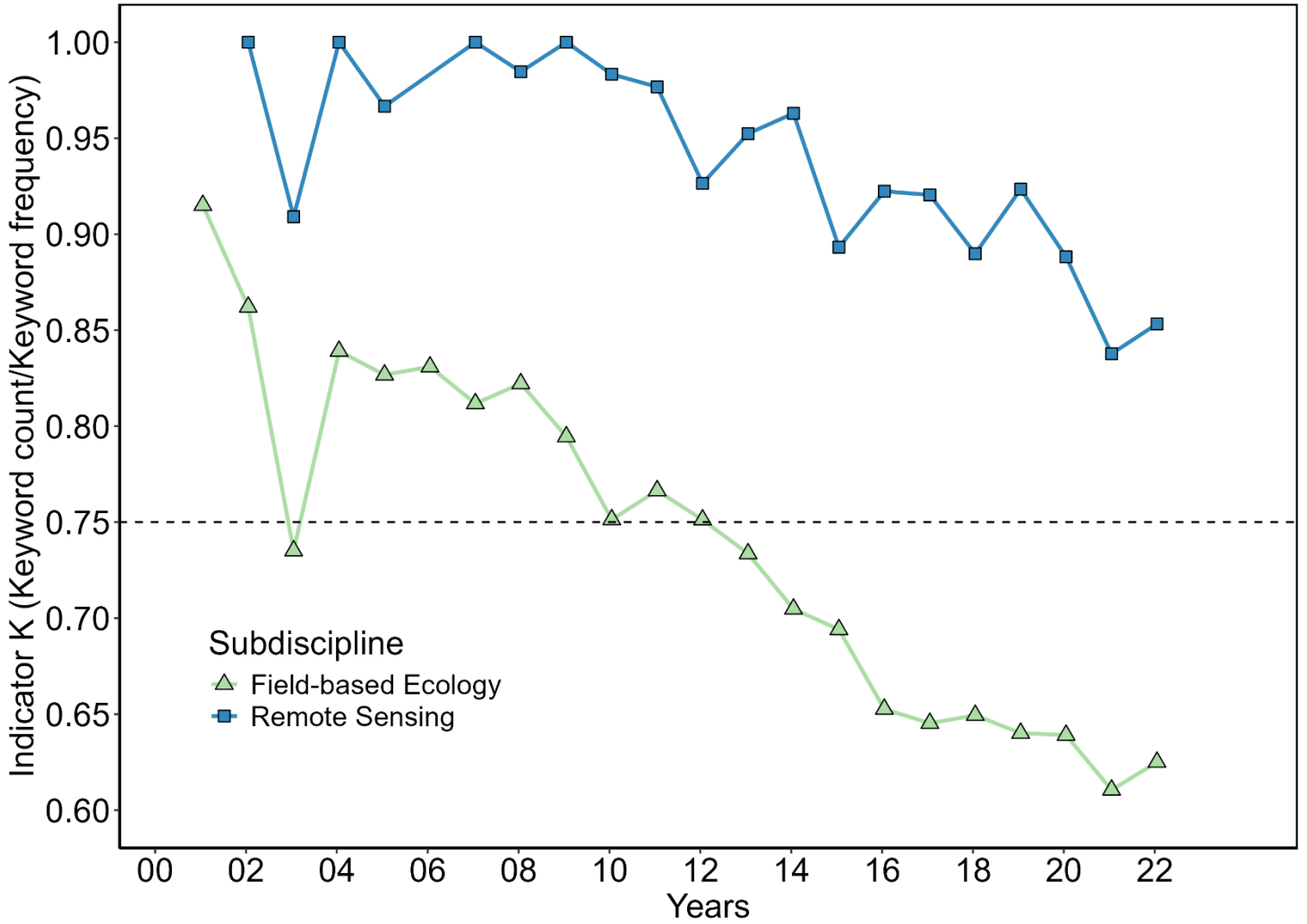
Research Weaving = Bibliometric analysis + Systematic review (i.e., SD, EA, DC, MA, S)

Wang & Chia, 2018

Results



- Indicator K evolution over the years

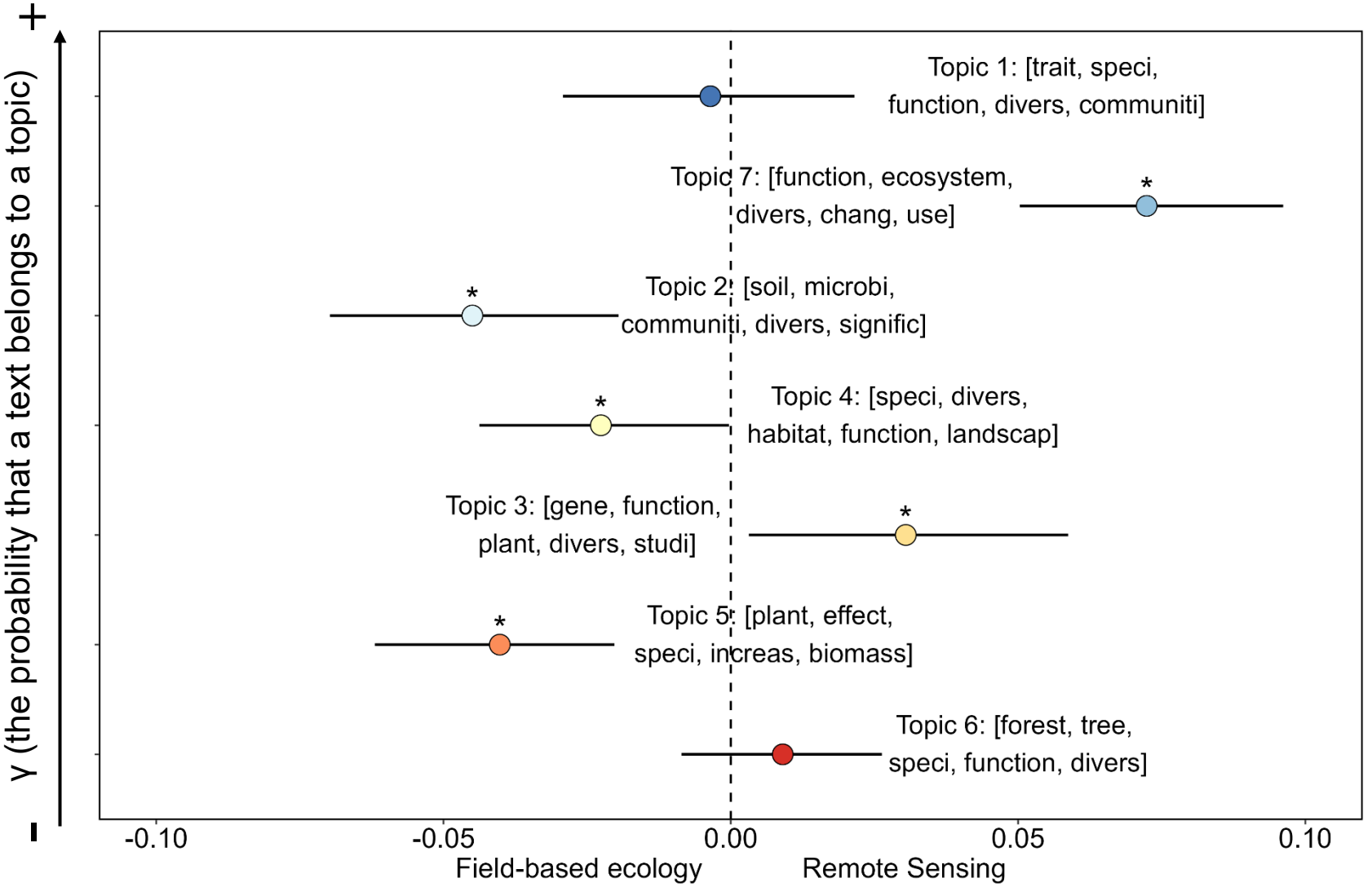


Rate	Field-based	RS
Annual Growth	16.35%	23.76%

- **RS** : pre-evolution or revolution stage
- **Field-based ecology**: pre-normal science stage since 2012

- Older & Mature:
  Field-based ecology > RS

• STM - Topic prevalence & effects of subdiscipline



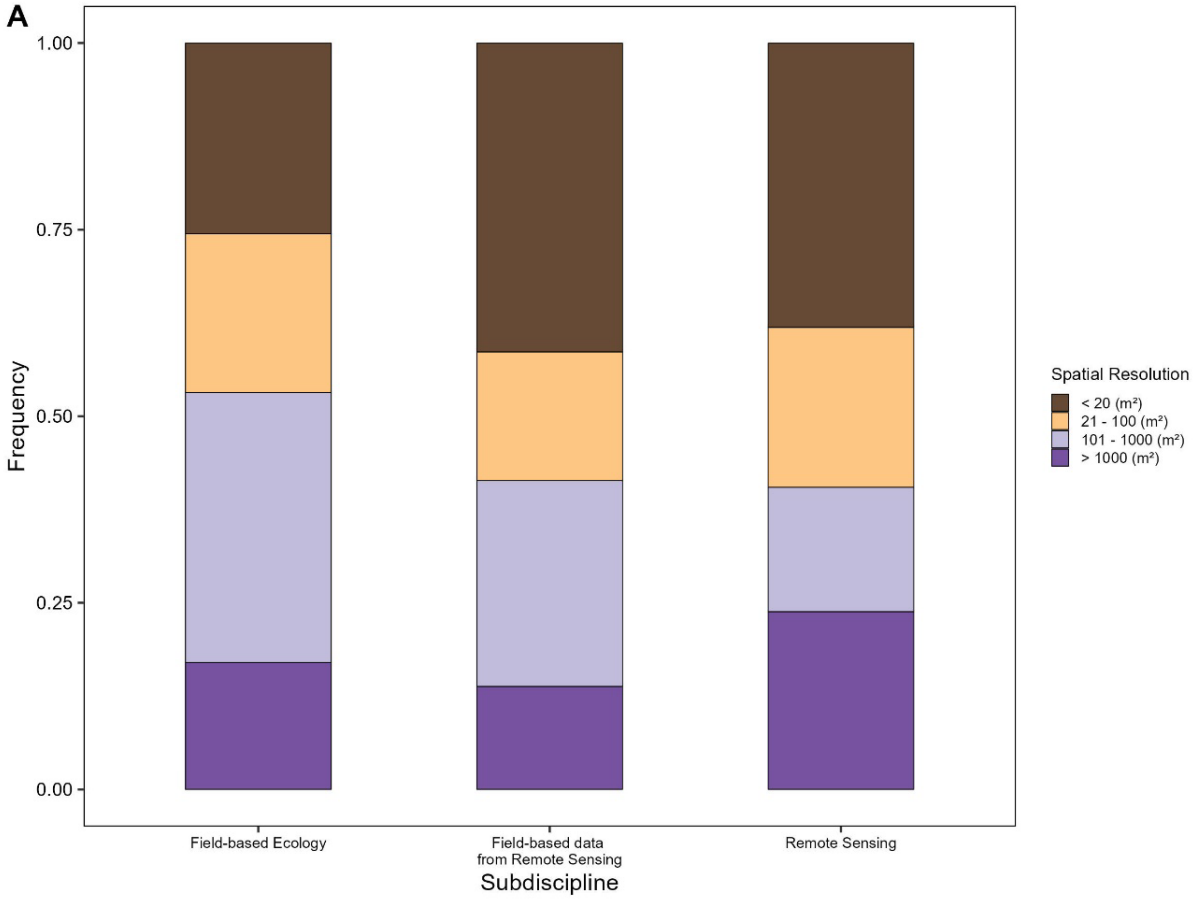
7 topics were the most representative for clustering the abstracts

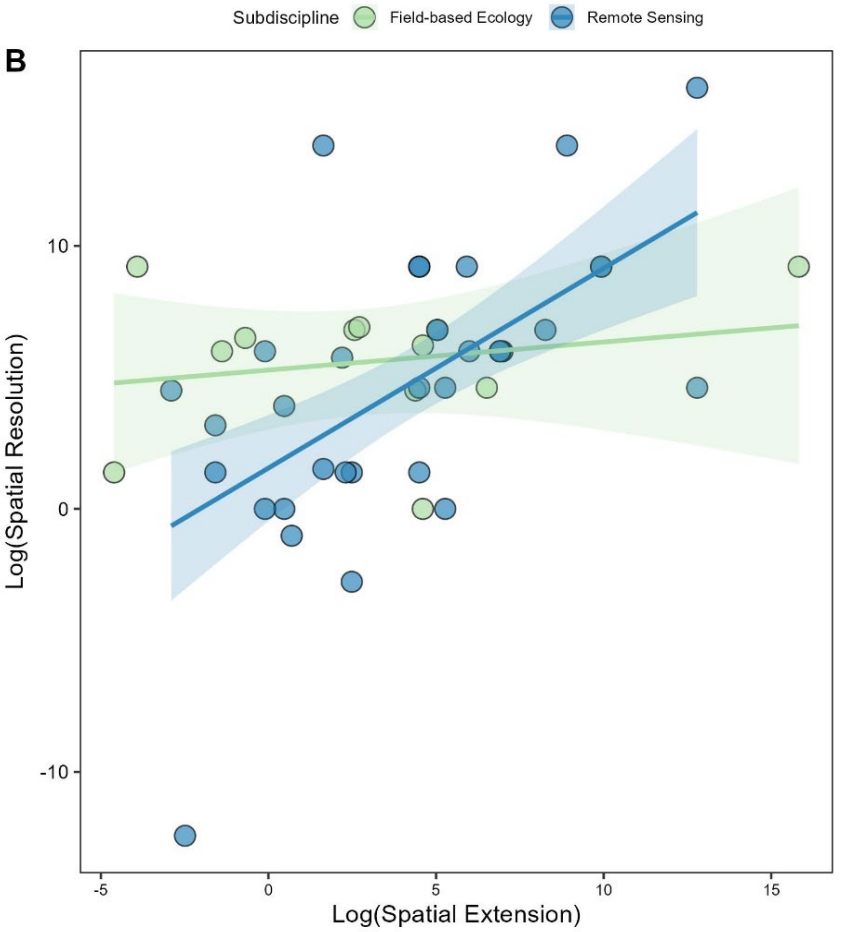
- **Field-based ecology** → about high biological resolution (e.g., soil, microbiology, species) and biomass topics
- **RS** → about ecosystem and land-use change topics

Spatial dimension

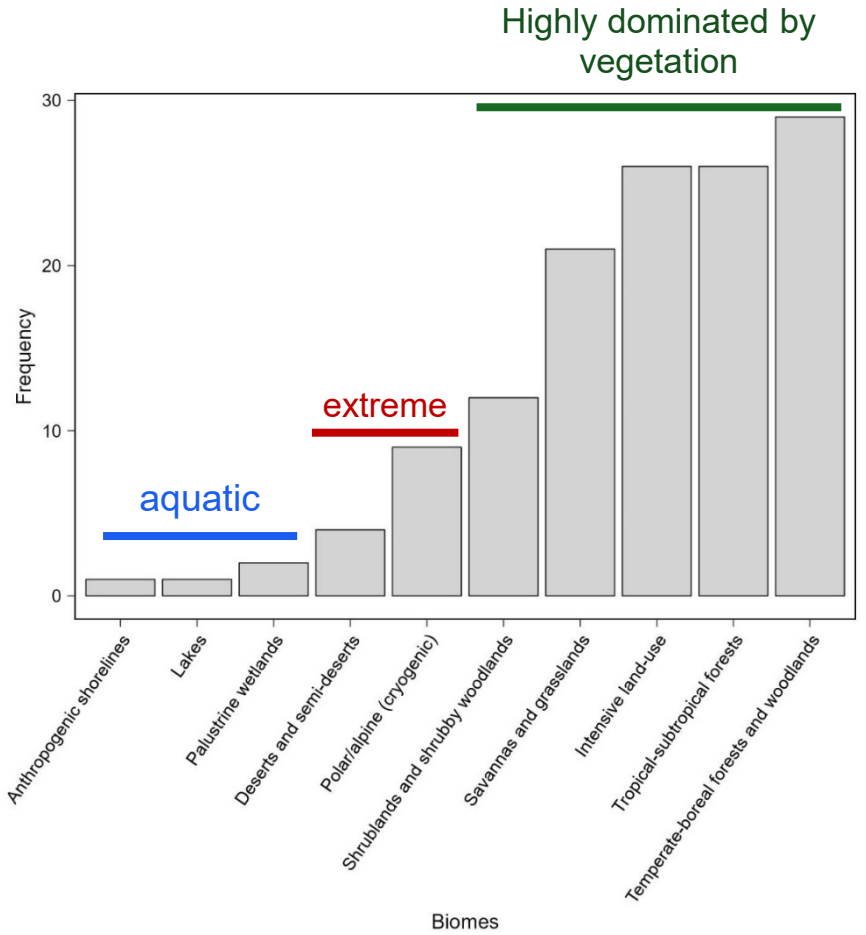
- Very high (< 20 m^2) is more frequent in RS
- Intermediate (101 - 1000 m^2) is more frequent in Field-based
- Coarse (> 1000 m^2) are more represented in RS than field-based

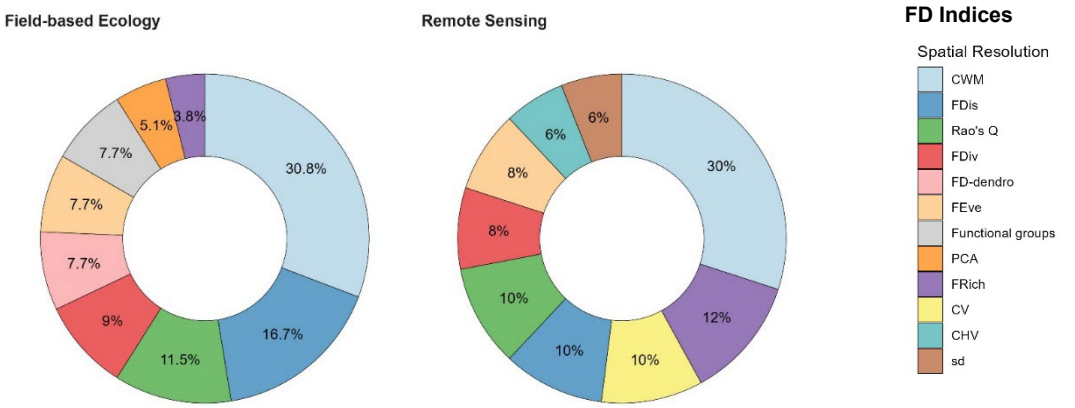
- Spatial ratio is lineal
- **Slope: RS > Field-based ecology**
- RS cover large areas with larger plots/pixels
- Field-based ecology uses intermediate resolution for different extensions



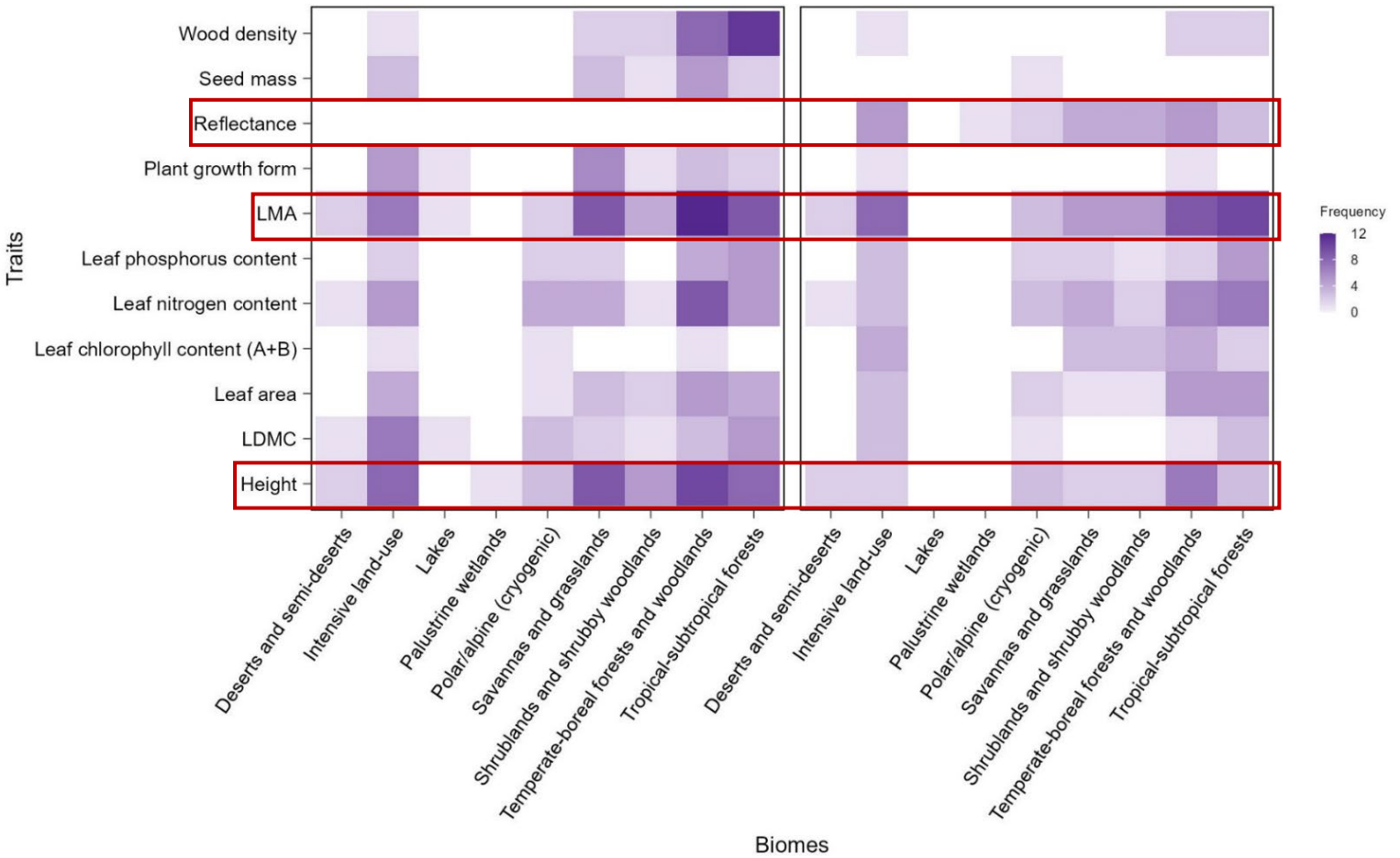


Biomes, Traits & FD Indices





~130 traits



Conclusions

- RS shows higher annual growth rate & it is in a **revolution stage**
- Most studies of RS used detail sample sizes (**Very high**; < 20 m^2)
- Field-based ecology use **Intermediate** resolutions → we measure as much as we can
- Biomes **not dominated by vegetation** are less study
- **LMA** & **Plant Height** are the preferred traits by ecologists & RS specialists, and could be proposed as a *flagship trait (or umbrella trait)*
- We must be carefully with **CWM**, because describe the central tendency, not the distribution

My future work

- Environmental effects on the relationship FD-spectral diversity across spatial scales → from local to national scale

Key recommendations

- Standardization of methods for comparison across scales (e.g., protocols and consistency in trait selection, spatial resolution and diversity indices)
- Interdisciplinary collaboration between “Ecologists-RS specialists-Data scientists” to improve scaling approaches
- Future studies should link FD findings to conservation and policies

Muchas gracias!

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Contact info

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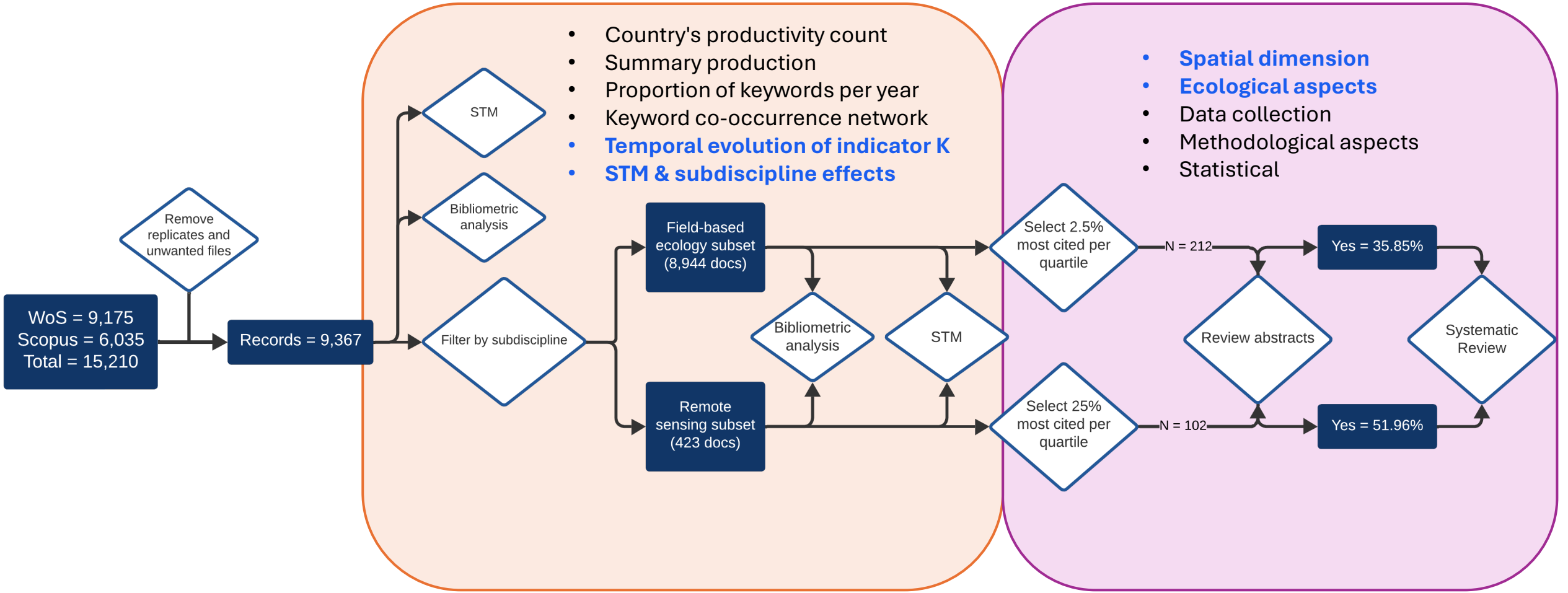


Bibliometric analysis

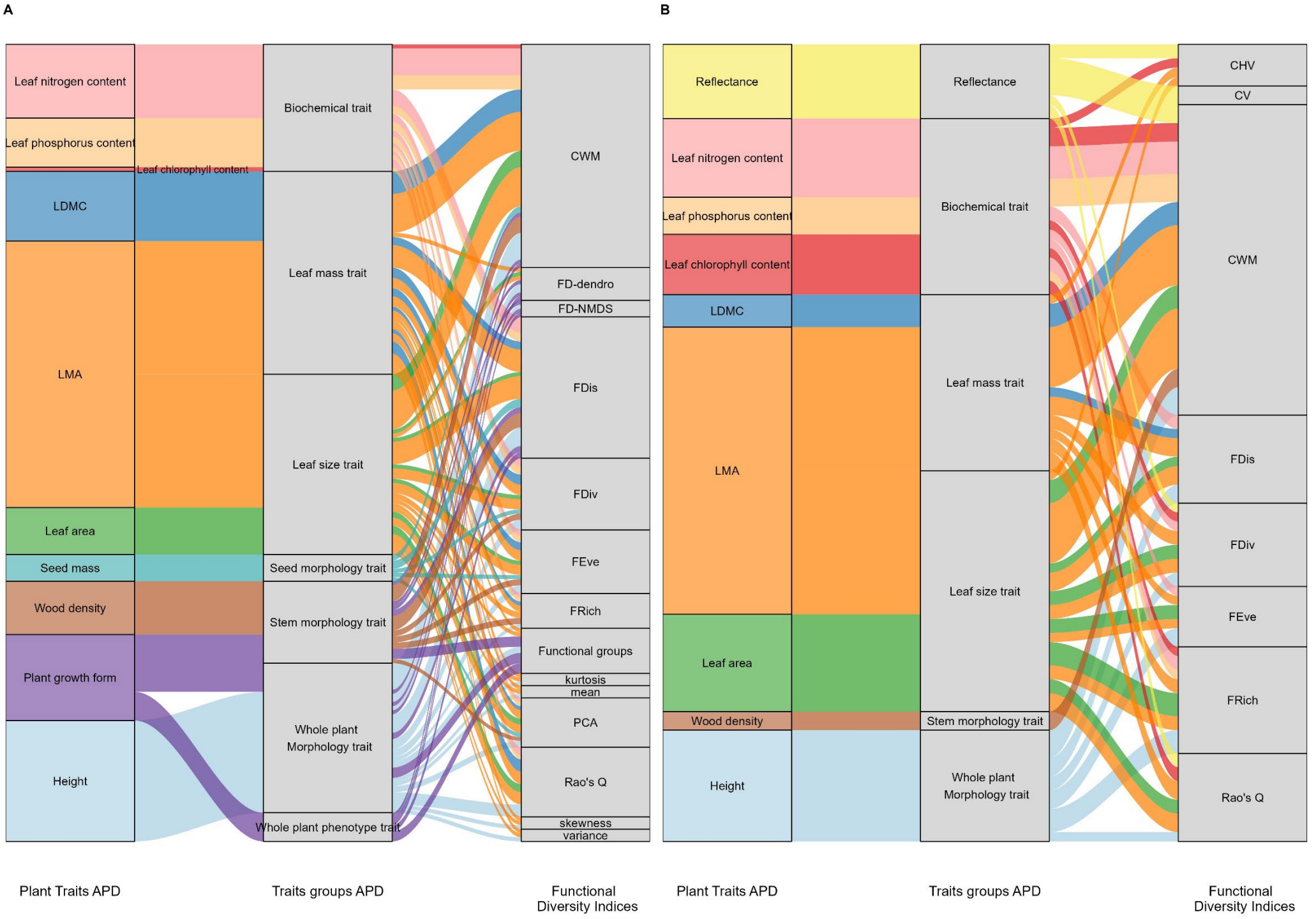
Systematic review

Systematic review parameters

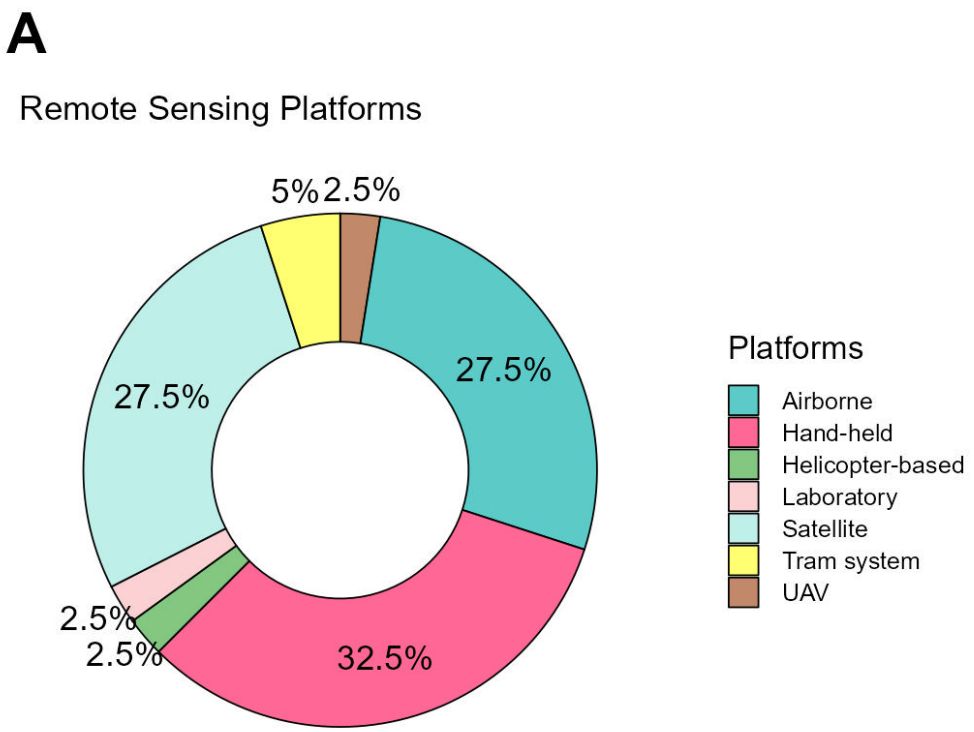
- Spatial dimension
- Ecological aspects
- Data collection
- Methodological aspects
- Statistical

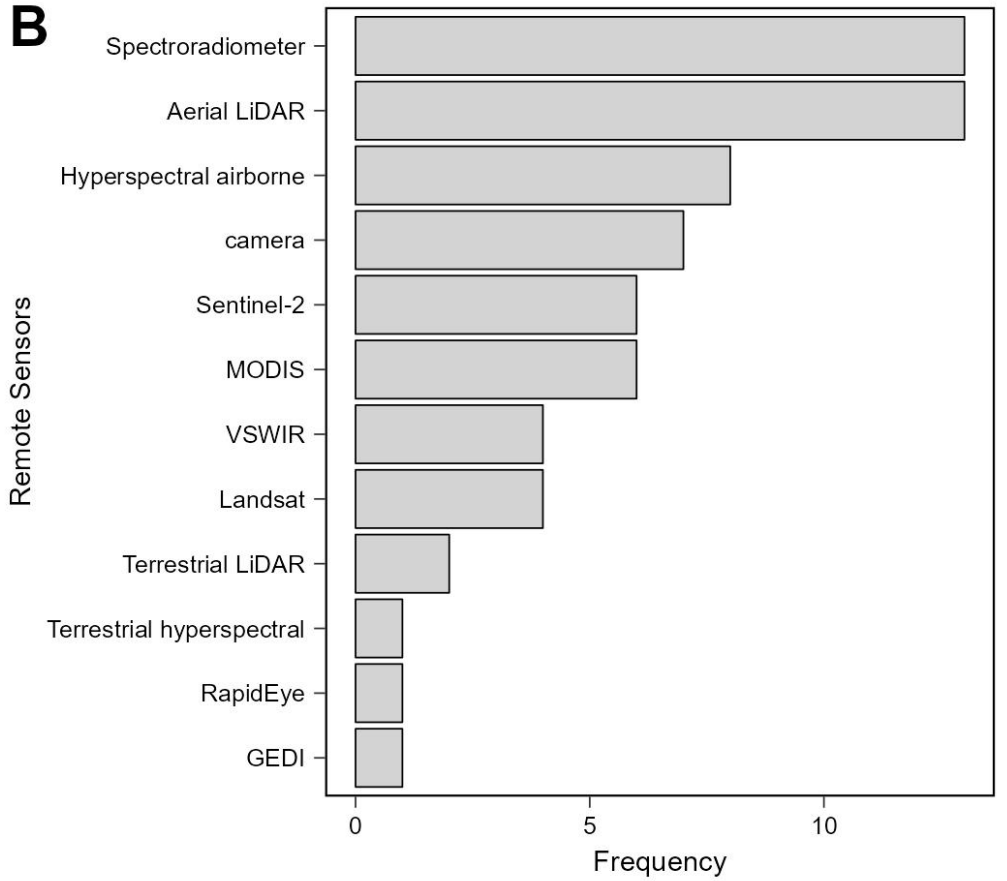
Parameter	Details
spatial extension	Spatial extension (km^2)
spatial resolution	Spatial resolution; pixel size for remote sensors or minimum sampling unit size in field work (m^2)
ecological scale	Biological organization level under study (”population”, ”community”, ”ecosystem”, ”landscape”, ”region”) (multiple categories separated by ”;”)
diversity scale	”alpha”, ”beta”, ”gamma” (multiple categories separated by ”;”)
ecosystem	Ecosystem under study (”forest”, ”shrub”, ”grassland”, etc) according to Keith et al. (2022) (multiple categories separated by ”;”)
link ecosystem function	Which ecosystem function the study is linked to (”nutrients”, ”water”, ”productivity”, ”phenology”, ”pollination”, ”biomass stock”, etc) (multiple categories separated by ”;”)
platform	Platform where the sensor is located (”Hand-held”; ”tower-based”; ”drone-borne”; ”airborne”, ”satellite”)
sensors*	Sensor’s name (i.e., ”OLI”, ”TRL”, etc) (multiple categories separated by ”;”)
sensor data type*	If any sensor is implemented, define data type (”spectroscopy”, ”multispectral”, ”optical multispectral”, ”optical hyperspectral”, ”thermal”, ”sun-induced chlorophyll fluorescence”, ”Radar”, ”Lidar”) (multiple categories separated by ”;”)
dimensionality fd	Functional diversity dimensionality (unidimensional, multidimensional), i.e. if functional diversity is calculated with one or more traits
diversity index	Metrics applied to traits (e.g., ”Functional dispersion”, ”richness”, ”variance”, ”kurtosis”, ”skewness”) (multiple categories separated by ”;”)
trait identity	Traits involved in the study (”LDMC”, ”SLA”, ”LMA”, ”LAI”, etc) (multiple categories separated by ”;”)
abundance	Is the species abundance considered in the study? (BOOLEAN, yes = 1, no = 0, not specified = empty)
abundance type	How traits are weighted if they are (”individuals”, ”biomass”, ”ground area”, ”plant cover”, ”basal area”, ”leaf area index”) (multiple categories separated by ”;”)
sampling methodology	If ”abundance” is TRUE, how did they sample? (”plots”, ”transect”, etc)
trait data origin	Origin of the data, whether from field work or literature (”field”, ”bib”, ”db”) (multiple categories separated by ”;”)
percentage community	Percentage of how much of the community is covered in the study (0 - 100)
projection direction*	Direction of projection. From field to projection (f-p) or from projection to field (p-f).
statistical method type*	Applied model; empirical model, physical model inversion (empirical model or errors), field-spectral functional diversity relationship (multiple categories separated by ”;”)
statistical method	Specify model used
results validation*	How are RS diveristy estimates validated? (”Using RS-adapted field sampling”, ”Using traditional ecology surveys”, ”Vicarious validation with other RS estimate”, ”Estimates are not validated”)

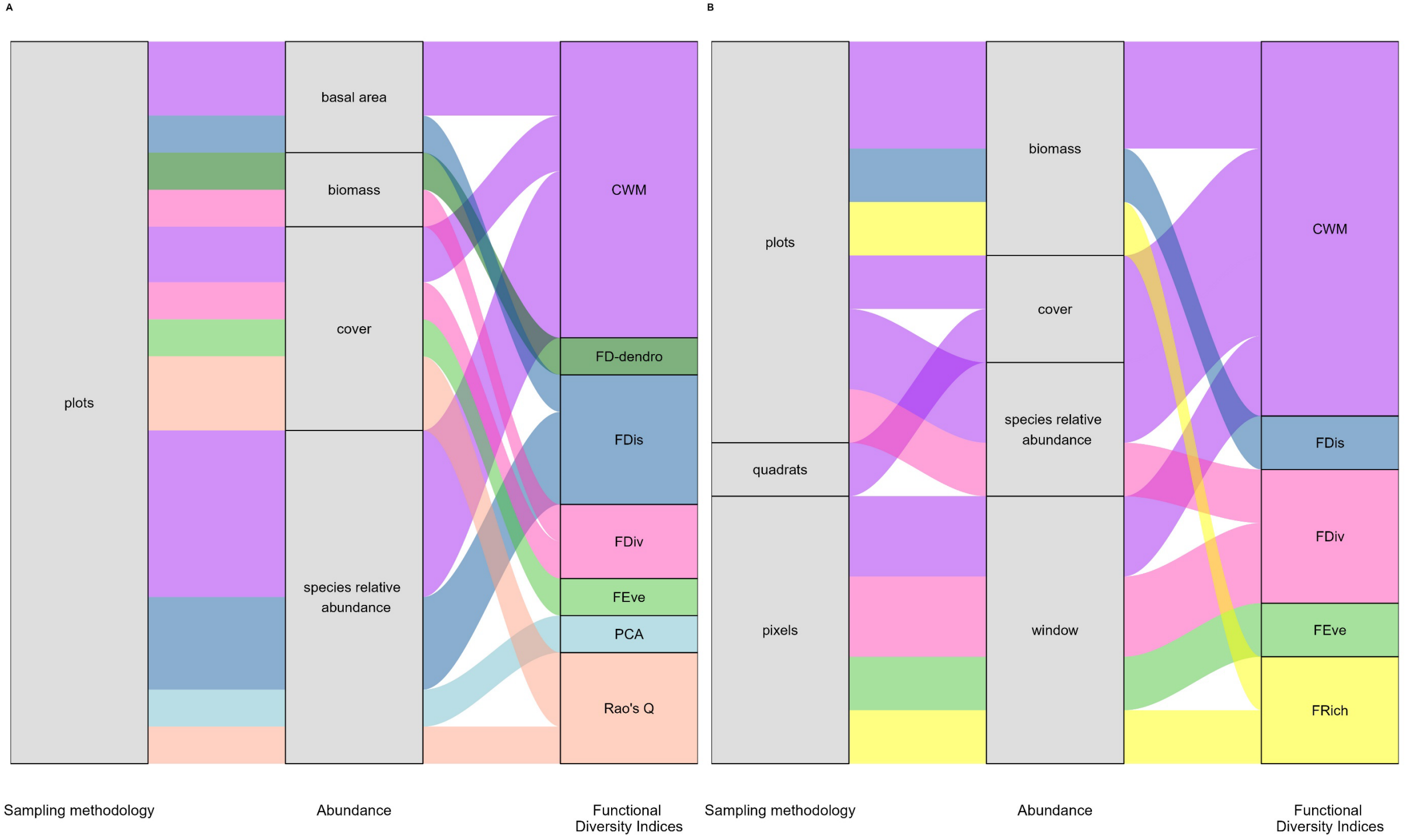
Relation Trait-Group-FD index



Remote sensors






A
plots
basal area
biomass
cover
species relative abundance
CWM
FD-dendro
FDis
FDiv
FEve
PCA
Rao's Q
Sampling methodology
Abundance
Functional Diversity Indices
B
plots
quadrats
pixels
biomass
cover
species relative abundance
window
CWM
FDis
FDiv
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FRich
Sampling methodology
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- Proportion of keywords per year