

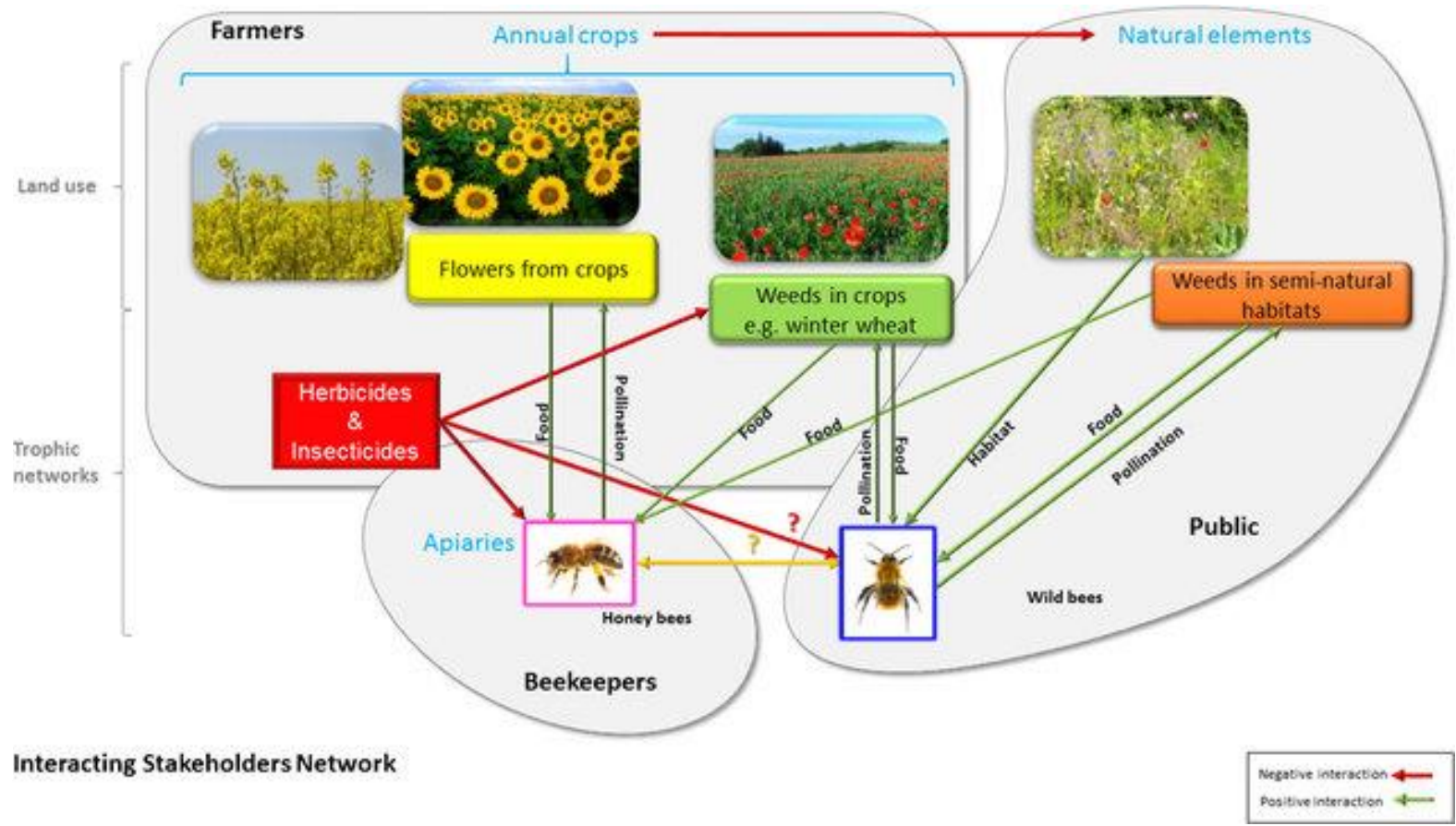
SPECIES ASSOCIATIONS ACROSS SCALES OF ORGANISATION

SLIGHTLY DEVELOPED IDEAS FOR MY FIRST PHD CHAPTER

THE BIRDS AND BEES (AND PLANTS)



If we die,
we're taking
you with us.



https://www.researchgate.net/publication/275956048_Weeds_for_bees_A_review/figures



PLANT-POLLINATOR INTERACTIONS

Research Questions:

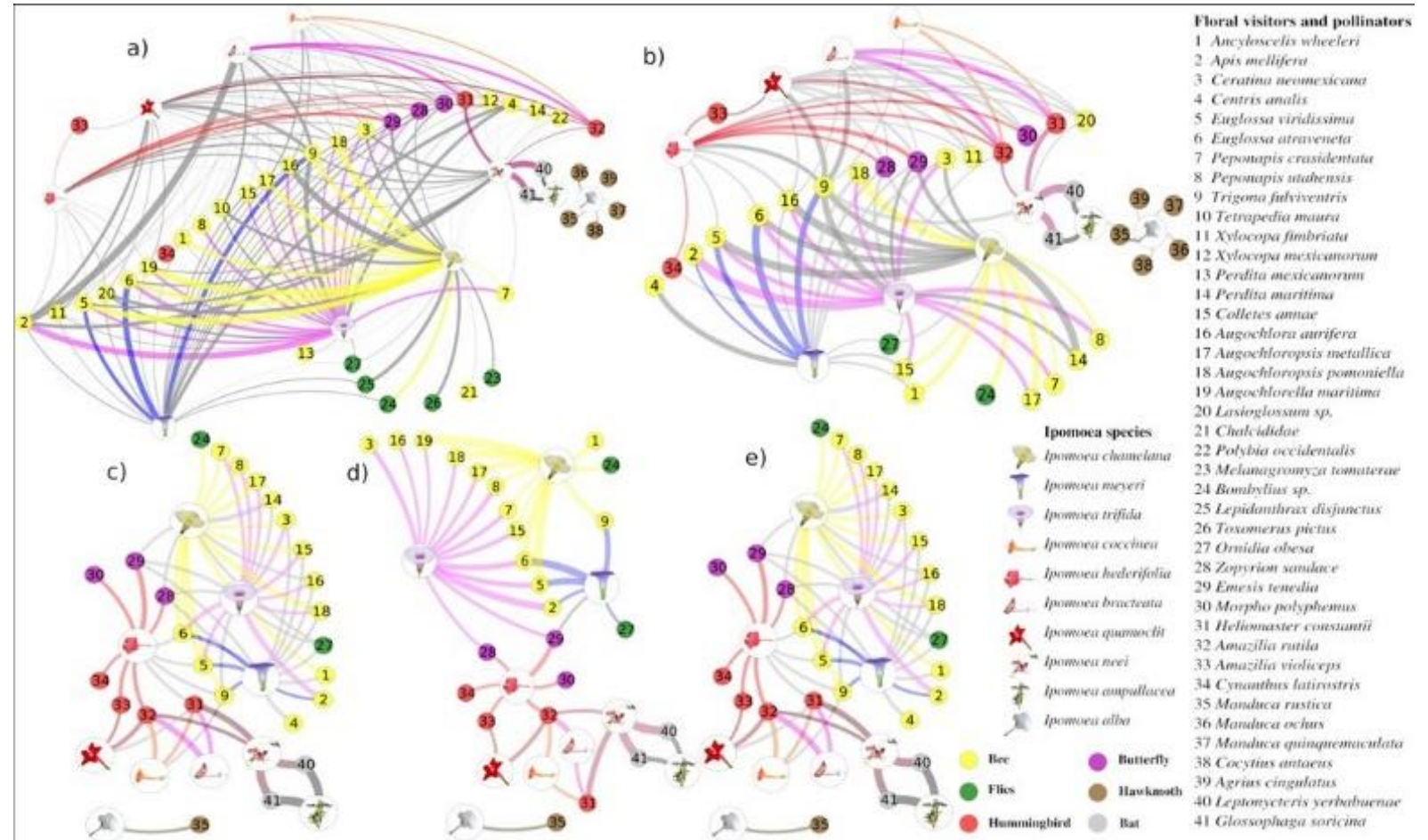
- Which plants are dependant on which pollinator(s)?

Methods:

- Species-Interaction Networks built from observed interaction data

Caveats:

- Immense data and sampling requirements



<https://www.researchgate.net/publication/334036134> The role of pollination effectiveness on the attributes of interaction networks from floral visitation to plant fitness/figures?lo=1

GLOBAL SPECIES-INTERACTIONS

How do global species-interaction networks look like?

What kind of data would we use for this?
Can we use Co-Occurrence data?

What happens to biodiversity projections when considering species-interactions?

PITFALLS - ENVIRONMENT

"Species may simply co-occur because they favor the same abiotic conditions"

Treating co-occurrences due to overlapping niches as interactions leads to **false positives**.

Latent-Variable Models

- "Dummy" Variables to capture un-measured responses

Climate-Data Input

- Obtain climate parameters for each occurrence
- Generate species niche models

PITFALLS - MULTIPLE INTERACTIONS

"Interaction of two species can be masked (statistically speaking) by interactions with a third or more species"

Missing species interactions due to multiple interactions leads to **false negatives**.

→ Sampling and resampling to generate robust networks

Bayesian Networks

- Probabilistic
- Directed Networks

Markov Networks

- Stochastic
- Undirected Networks

PITFALLS - INDIRECT INTERACTIONS

Indirect interactions show a weakened co-occurrence signal the longer the chain of interactions.

Not accounting for indirect interactions leads to **false negatives**. Species can **alter their interactions** given the presence of other species.

Graphical Methods

- Track interactions from one species to another and build chains

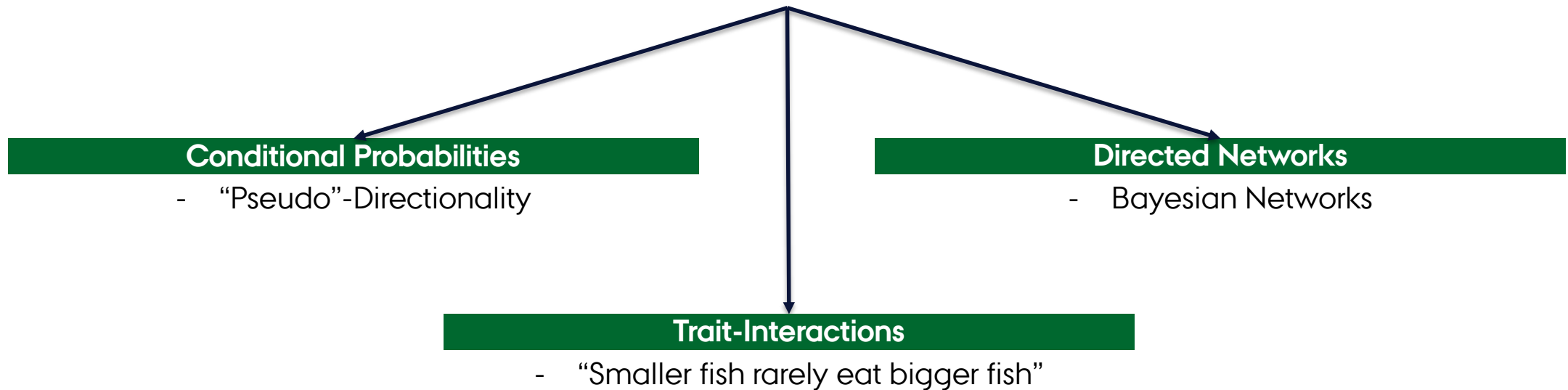
Spatial Compartmentalisation

- Elicit interaction networks for rigidly defined local pools of species assemblages

PITFALLS - ASYMMETRIC INTERACTIONS

Opposing interactions may cancel each other out as far as detection of co-occurrence signals can go.

We need a way to identify **interaction directionality**.



PITFALLS - SAMPLING COVERAGE & SIZE

Negative and positive interactions are misestimated when not using the full range of both species for sampling of presence/absence data.

Not considering the full range for each species when identifying interactions leads to **false positives** and **false negatives**.

Two species interacting (with no other interactions) requires at least 500 samples of presence/absence of both species to reach a 95% confidence of co-occurrence signal.

Obtain large samples for species occurrences.

Point-Location Data

- Plot Frameworks
- Citizen Science

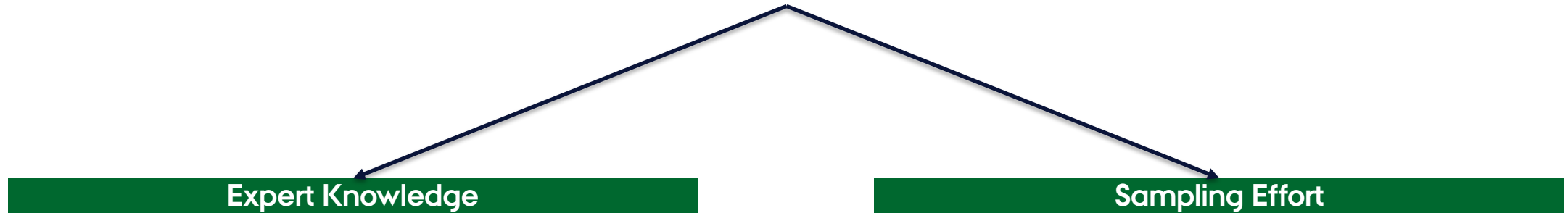
SpeciesRange Estimates

- Obtained from Species Distribution Models
 - Generate inferred knowledge of presence/absence

PITFALLS - EXCLUSION

Competitive (or otherwise) exclusion will prohibit the detection of a negative species interaction altogether.

Without a full picture of the focal species and their environment, we miss interactions due to exclusion leading to **false negatives**.



PITFALLS - SPECIES-TRAITS

Functional expressions of species can modulate species interactions.

Limit Possible Interactions

- “A herbivore won’t eat a carnivore”

Shape Strength of Interactions

- “A butterfly may interact stronger with an orchid than a bee would”

Identify Asymmetry of Interactions

- “Smaller fish rarely eat bigger fish”

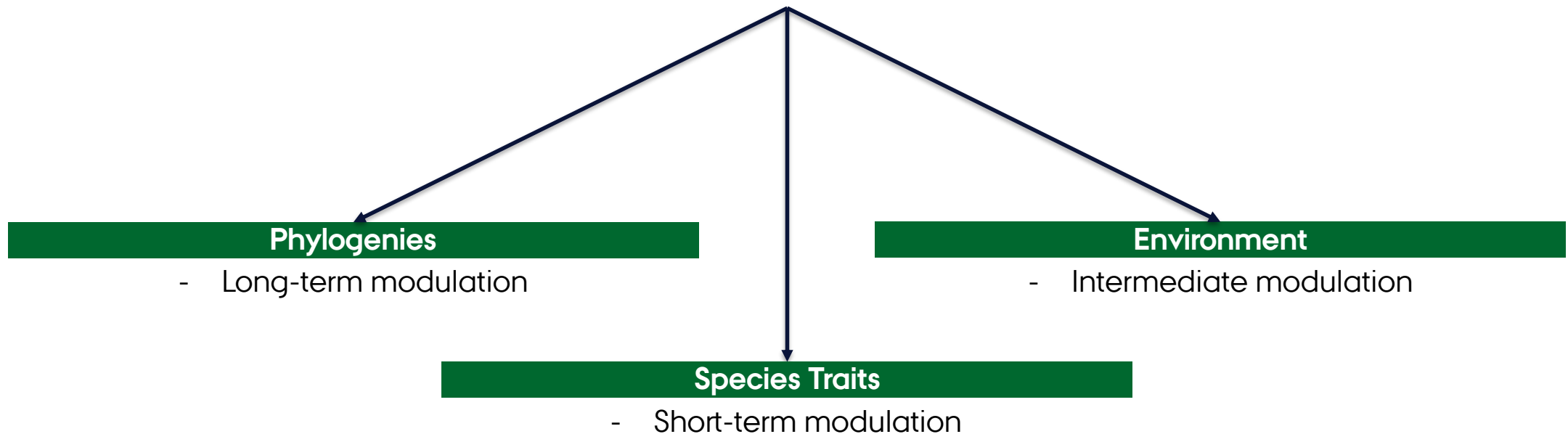
Trait modulations of species-associations are themselves altered by the environment.

“Identifying processes consistent with trait-environment relationships across co-occurring species and functional groups at a given spatio-temporal scale may promote the discovery of generality in community ecology”

PITFALLS - TIME-CONSTRAINTS

Species interactions are shaped through time.

Species-interactions may be modulated over time through different ways.



A WAY BEYOND – THE METHODS

Bayesian Network (Directed Acyclic Graph - DAG)

Interactions

- Environment** → We can use climate data and variability/uncertainty
- Multiple** → It is established via sampling and resampling
- Indirect** → It is a graphical method (tracks interaction chains)

Research Question 1:

Can we identify a best-practise method to address potential pitfalls of inferring interactions from occurrences?

Exclusion → Hard to circumvent with global analyses.

Species-Traits → We can use species-trait values and variabilities.

Time-Constraints → We can use phylogenies.

A WAY BEYOND – THE TERMINOLOGY

Terminology

Interaction	Association
Directed	Undirected
Conveys “certainty” of processes	Acknowledges lack of process-information

Research Question 2:

How do our estimates of species-networks change when considering Interactions vs. Associations?

A WAY BEYOND – THE DATA

Geographic Scale & Scale of Organisation



Data Type	Functional Data	Plot Data	Occurrence Records	Range Records
Presence Indicator	Abundance/Coverage		Presence/Absence	
Data Source	Observed/Measured			Inferred
Biotic	- Fitness Proxies			
Abiotic				ers
Notes	Spatial/Temporal Replica		Citizen Science	Circularity?

Research Question 3:
 At which scale can we create robust species-network estimates given the available biologically relevant information?



Biologically Relevant Information

DATA SOURCES – FUNCTIONAL DATA & RANGE RECORDS

Functional Data

Repository	Taxa	Records	Access
PFTC3	Vascular Plants of the Peruvian Andes	Individual trait expressions at different sites and plots	On request

Range Records

Repository	Taxa	Records	Access
BIEN 4	Mostly plants	Ranges (shapefiles)	R-Package (Bien)
IUCN Red List	Vertebrates excluding birds	Ranges (shapefiles)	R-Package (rredlist)?
Birdlife	Avian	Ranges (shapefiles)	On request

DATA SOURCES – PLOT DATA

Repository	Taxa	Records	Access	Comments
SPlot		Geo-referenced abundance/coverage?	Access via Jens-Christian Svenning	Might run into issues of authorship
Forest Inventory Analysis (FIA)		Biomass/acre by species. Geo-referencing seems to not be a thing due to privacy laws, but we can sort by state	Open access	Trait data available with Alejo's data set
Tundra Trait Team	Tundra plants	Geo-referenced coverage	Acknowledgements need to be given	
BioTIME	Plants and Animals	Geo-referenced abundances	Open access	Aggregation of different studies (species naming)
Global Tundra Change	Tundra plants	Geo-referenced abundances	Open access	

DATA SOURCES - OCCURRENCES

Repository	Taxa	Records	Access	Comments
BIEN 4	Mostly plants	Geo-referenced occurrences	R-Package (Bien)	Only for the US
GBIF	All	Geo-referenced occurrences	R-Package (rgbif)	Obvious data gap in Siberia
Atlas Flora Europeae	Not recording certain taxa yet	Geo-referenced occurrences		I doubt I should use this due to the incompleteness
Tundra Trait Team	Tundra plants	Geo-referenced occurrences + Traits	Open Access	
Tundra Vascular Plants	Tundra vascular plants	Geo-referenced occurrences + Traits	Acknowledgements need to be given according to webpage entry	

FURTHER DATA NEEDS

1. Functional Trait Data

→ TRY, COMPADRE, and BIEN for Plants

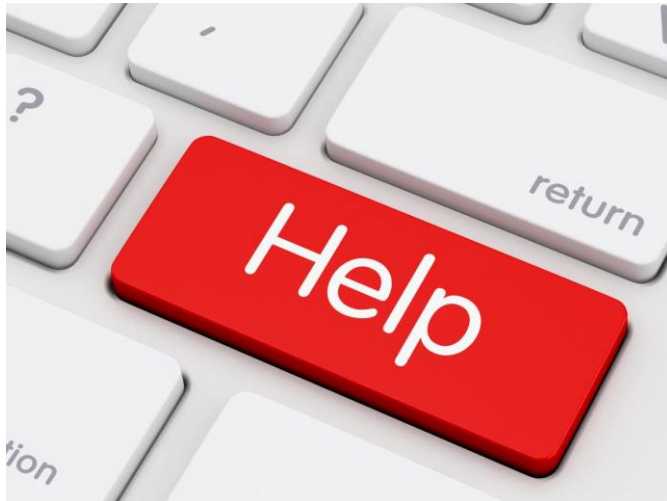
→ COMADRE for Animals... Anything else?

2. Phylogenies

→ Where do I get those from?

→ How do I work with these?

SalGo-Team, what's your emergency?



How do I do phylogenies?!

CURRENT WORK - DATA SIMULATION

Simulate plot-level data with Species Interactions/Associations and effects of:

- Decreasing fitness over time
- Averaged fitness over time
- Big spread in fitness of species
- Plot-level effects

→ Identify appropriate method to circumvent confounding effects above!

Research Question 1:

Can we identify a best-practise method to address potential pitfalls of inferring interactions from occurrences?



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