trophiCH

a swiss metaweb

Merin Reji Chacko
29th June 2023

Agenda

11:00-11:15	Update MRC
11:15-11:50	Scientific discussion (Ch. 2)
11:50-12:00	Discussion **MRC**+FA+NF Discussion **LP**+FA+NF

The architecture of food webs in the face of global change

Land-use intensity influences European tetrapod food-webs

Christophe Botella, Pierre Gaüzère, Louise O'Connor, Marc Ohlmann, Julien Renaud, Yue Dou, Catherine Graham, Peter Verburg, Luigi Maiorano, Wilfried Thuiller

Blue and green food webs respond differently to elevation and land use

Hsi-Cheng Ho, Jakob Brodersen, Martin M. Gossner, Catherine H. Graham, Silvana Kaeser, Merin Reji Chacko, Ole Seehausen, Niklaus E. Zimmermann, Loïc Pellissier & Florian Altermatt

Nature Communications 13, Article number: 6415 (2022) | Cite this article

Journal of Biogeography

RESEARCH PAPER | Full Access

The structure of plant–herbivore interaction networks varies along elevational gradients in the European Alps

Camille Pitteloud, Jean-Claude Walser, Patrice Descombes, Charles Novaes de Santana, Sergio Rasmann, Loïc Pellissier

Journal of Animal Ecology

Standard Paper | Free Access

Changes in host–parasitoid food web structure with elevation

Sarah C. Maunsell, Roger L. Kitching, Chris J. Burwell, Rebecca J. Morris

Changes in plant-herbivore network structure and robustness along land-use intensity gradients in grasslands and forests

FELIX NEFF, MARTIN BRÄNDLE, DIDEM AMBARLI, CHRISTIAN AMMER, JÜRGEN BAUHUS, STEFFEN BOCH, NORBERT HÖLZEL, VALENTIN H. KLAUS, TILL KLEINEBECKER, [...] AND MARTIN M. GOSSNER +8 authors Authors Info & Affiliations

SCIENCE ADVANCES • 14 May 2021 • Vol 7, Issue 20 • DOI: 10.1126/sciadv.abf3985

Crop and forest pest metawebs shift towards increased linkage and suitability overlap under climate change

Marc Grünig, Dominique Mazzi, Pierluigi Calanca, Dirk Nikolaus Karger & Loïc Pellissier

Communications Biology 3, Article number: 233 (2020) | Cite this article

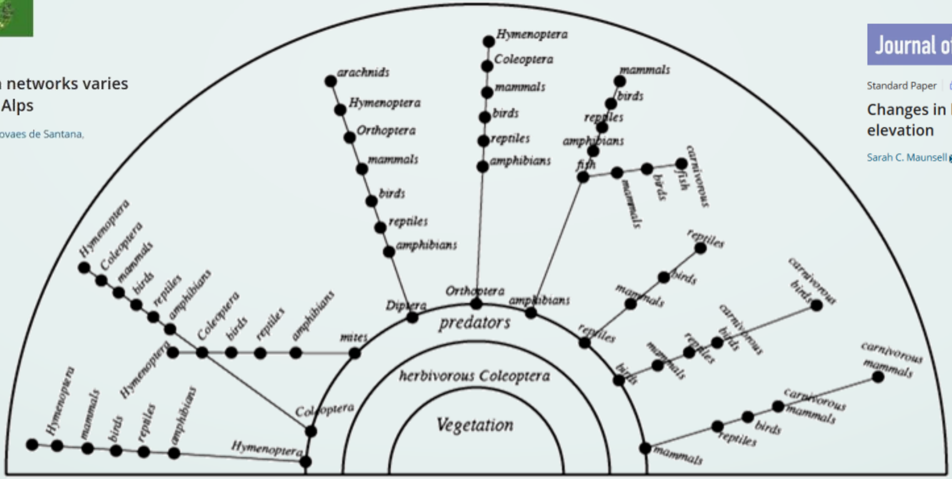
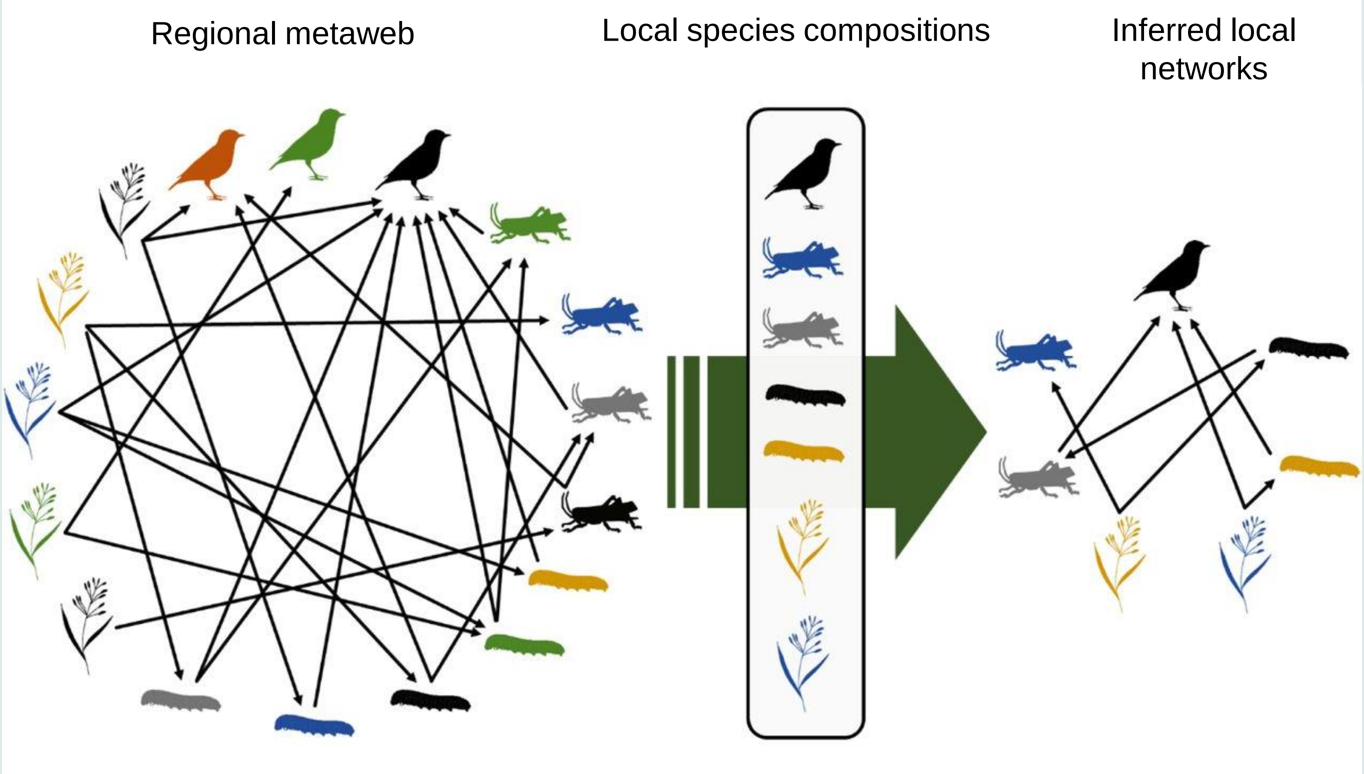


Figure 1. Simplified reproduction of the first food web reported in the literature (Camerano, 1880).

A trophic metaweb (Dunne 2005)



Modified from Ho *et al* 2022

Main questions

01 Data paper

02 How robust is the Swiss metaweb to global perturbances?

03 How does local catchment-level food web structure change across large-scale environmental gradients?

04 How will future changes in land use and climate affect local food webs?

05 How can we monitor the catchment biodiversity in real-time?

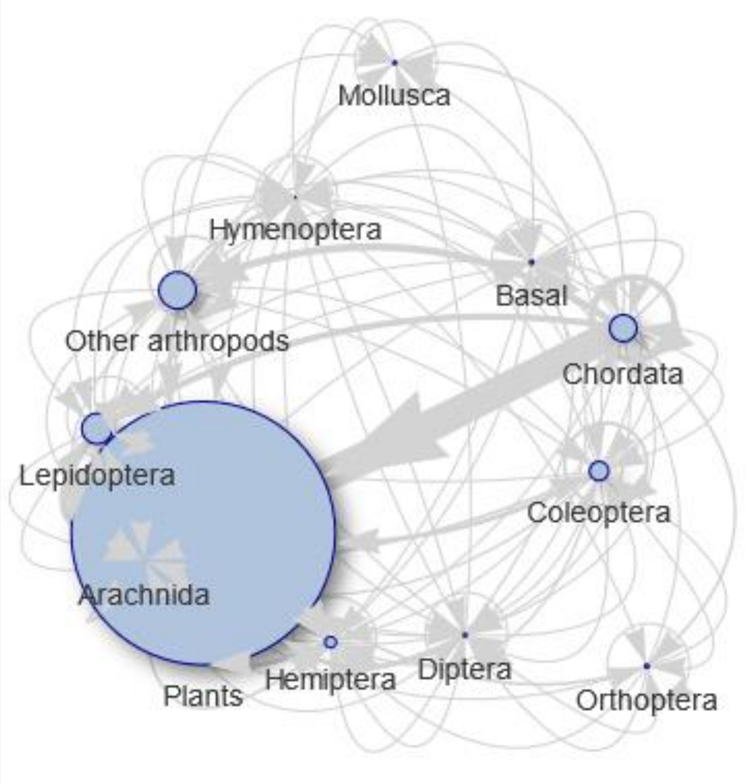
trophiCH: building a metaweb for Switzerland

Group	Documented	Spatial data available	My Checklist
Vertebrates	670	429	616
Arthropods	~33 000	4881	19 379
Mollusca	285	267	288
Tracheophyta	3775	3364	3775
Bryophyta	1093	1046	Basal group
Charophyta	25	23	Basal group
Total	~39 000	10 010	**24 058**

Raw metaweb

- 214 data sources based on existing datasets, natural history texts, online sources and expert knowledge
- 350k interactions
- Wilson Score Interval for sampling error: (0.0408%, 0.35209%)
- [is a disconnected graph]

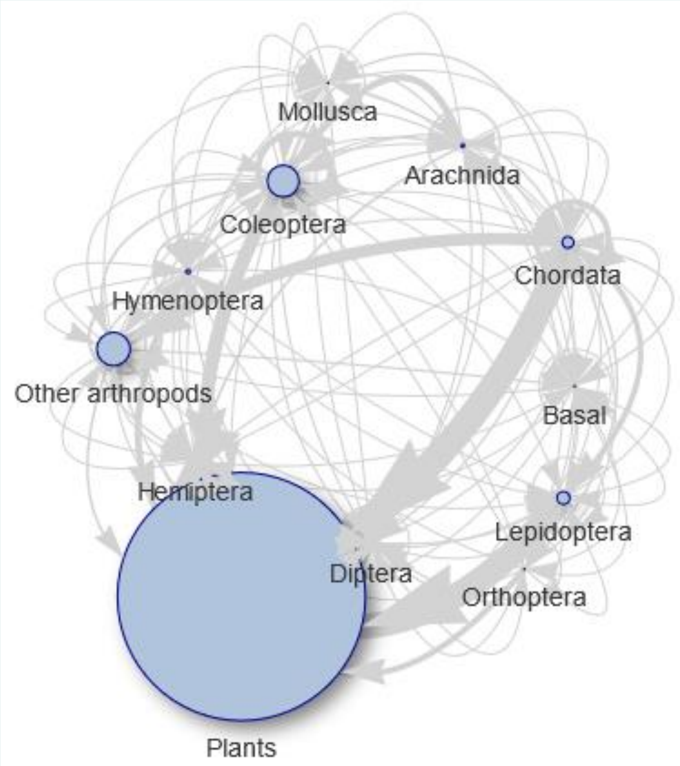
Number of species	14 916
Number of interactions	280 296
Connectance	0.0012



Unrestrained expansion

- All target taxa at the genus level are expanded to include all species, according to (Maiorano et al 2019)
- [is a disconnected graph]

Number of species	18 656
Number of interactions	624 915
Connectance	0.0017



Restrained expansion

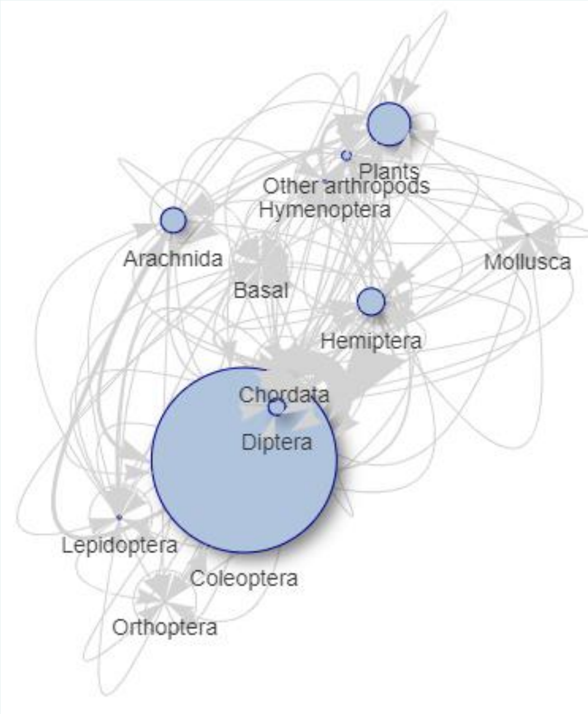
1. Collect habitat and zone information for all species
2. Classify each family in terms of how much expansion is allowed at both source and target levels (Maximum at family level on both sides)
3. Apply generalist information to build first taxonomy-based food web
4. Remove links where the habitat and zone of both species do not match

Source Rank	Target Rank
Species	Family
Genus	Family
Family	Family

Final metaweb

- 376 animal species missing diet information
- 675 species missing all information (dropped)
- [is a connected graph]

Number of species	23 098
Number of interactions	13 182 524
Connectance	0.025



The robustness of the trophiCH metaweb to species loss

Chapter 2

Which species are vulnerable to extinction in Switzerland?

- Habitat loss, fragmentation, and pollution drive species loss in Switzerland now and in the future (Gerecke et al 2019)
- Land-use transitions and wetland degradation contribute to species vulnerability (BAFU 2022)
- Aquatic ecosystems, grasslands, and wetlands, and agroecosystems are most threatened (BAFU 2022)
- IUCN Red List assessments can inform which species and ecosystems at most risk (BAFU 2022)


Life & Aging >

Pesticide sales jump by 17% in Switzerland

© Keystone / Gaetan Bally

Wet weather was responsible for the sale of 2,259 tonnes of plant protection products in Switzerland in 2021.

November 28, 2022

1 minute

Targeted attack simulation – habitat loss

Habitats	Pairwise	Trios	All
Wetland	Wetland - Cropland	Wetland - Cropland - Aquatic	Wetland - Cropland - Aquatic - Grassland
Cropland	Wetland - Aquatic	Wetland - Cropland - Grassland	
Aquatic	Wetland - Grassland	Wetland - Aquatic - Grassland	
Grassland	Cropland - Aquatic	Cropland - Aquatic - Grassland	
	Cropland - Grassland		
	Aquatic - Grassland		

- Extinction likelihood of species calculated according to their degree of association with targeted habitat associations
- All other species also experience ‘background’ extinction likelihood

Target attack simulation – Red List species

- Random species loss + increased extinction likelihood with severity of Red List classification

Analysis pipeline for each scenario

Assign extinction probabilities

- All nodes experience non-zero likelihood of extinction
- Nodes experience higher likelihood of extinction based on relative degree of association to targeted habitat or red list classification

For each iteration:

Null model

- 376 species do not have diet information
- Broad diet information, level of diet specificity and habitat and zone-associations are used to randomly select links
- Generalist: 5% of viable links, specialist: 1-5 links selection from viable links

Drop generalist interactions

- If in-degree > median/mean in-degree, randomly remove 90% of links

Remove nodes

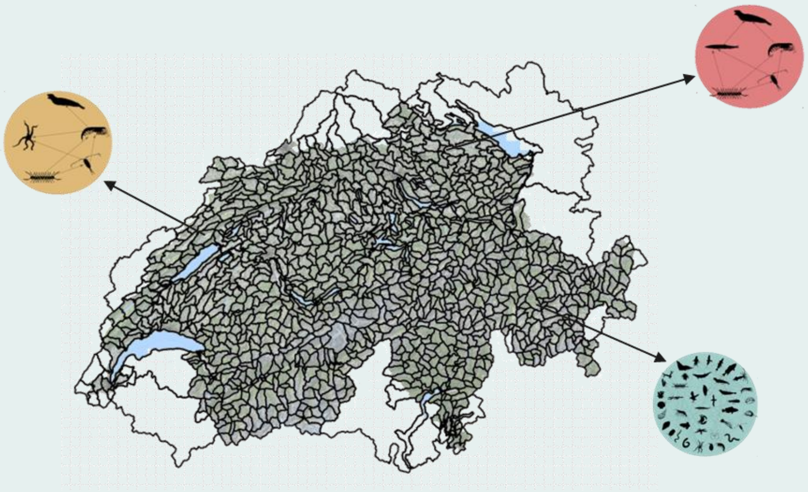
- Sequential removal of species
- Calculate metrics per removal step:
  - R50, connectivity-based metrics, etc.

Build perturbation curves based on iteration means

Chapters 3 and 4

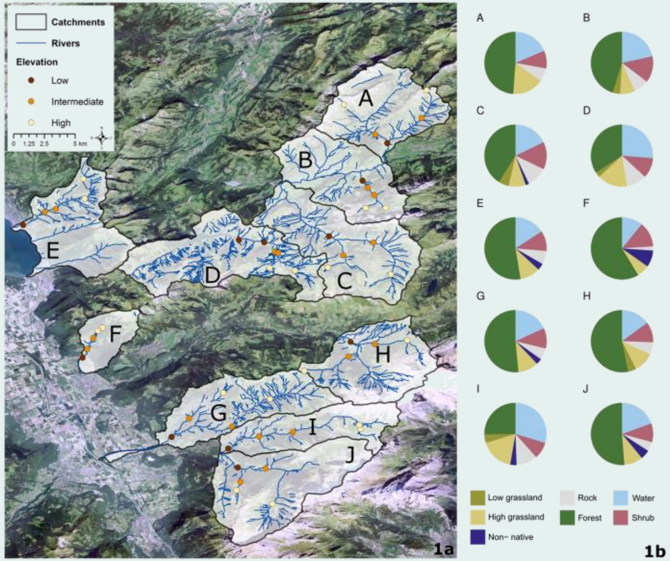
How does local catchment-level food web structure change across large-scale environmental gradients?

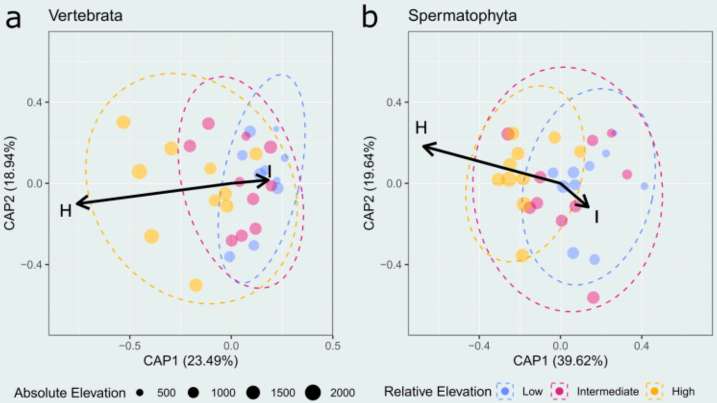
How will future changes in land use and climate affect local food webs?



Chapter 5

How can we monitor catchment biodiversity in real-time?





Merin Reji Chacko, Florian Altermatt, Fabian Fopp, Loïc Pellissier, et al. Catchment-based sampling of river eDNA integrates terrestrial and aquatic biodiversity of alpine landscapes. *Under Revision.*

OTHER PROJECTS

Completed:

1. **Merin Reji Chacko**, Jacqueline Oehri, Elena Plekhanova & Gabriela Schaepman-Strub (2023). Will current protected areas harbour refugia for threatened Arctic vegetation types until 2050? A first assessment, *Arctic, Antarctic, and Alpine Research*, **55**:1, DOI: 10.1080/15230430.2023.2203478
2. Jacqueline Oehri, Gabriela Schaepman-Strub, Jin-Soo Kim, **Merin Reji Chacko** *et al.* (2022) Vegetation type is an important predictor of the arctic summer land surface energy budget. *Nat Commun* **13**, 6379. DOI: 10.1038/s41467-022-34049-3

In progress:

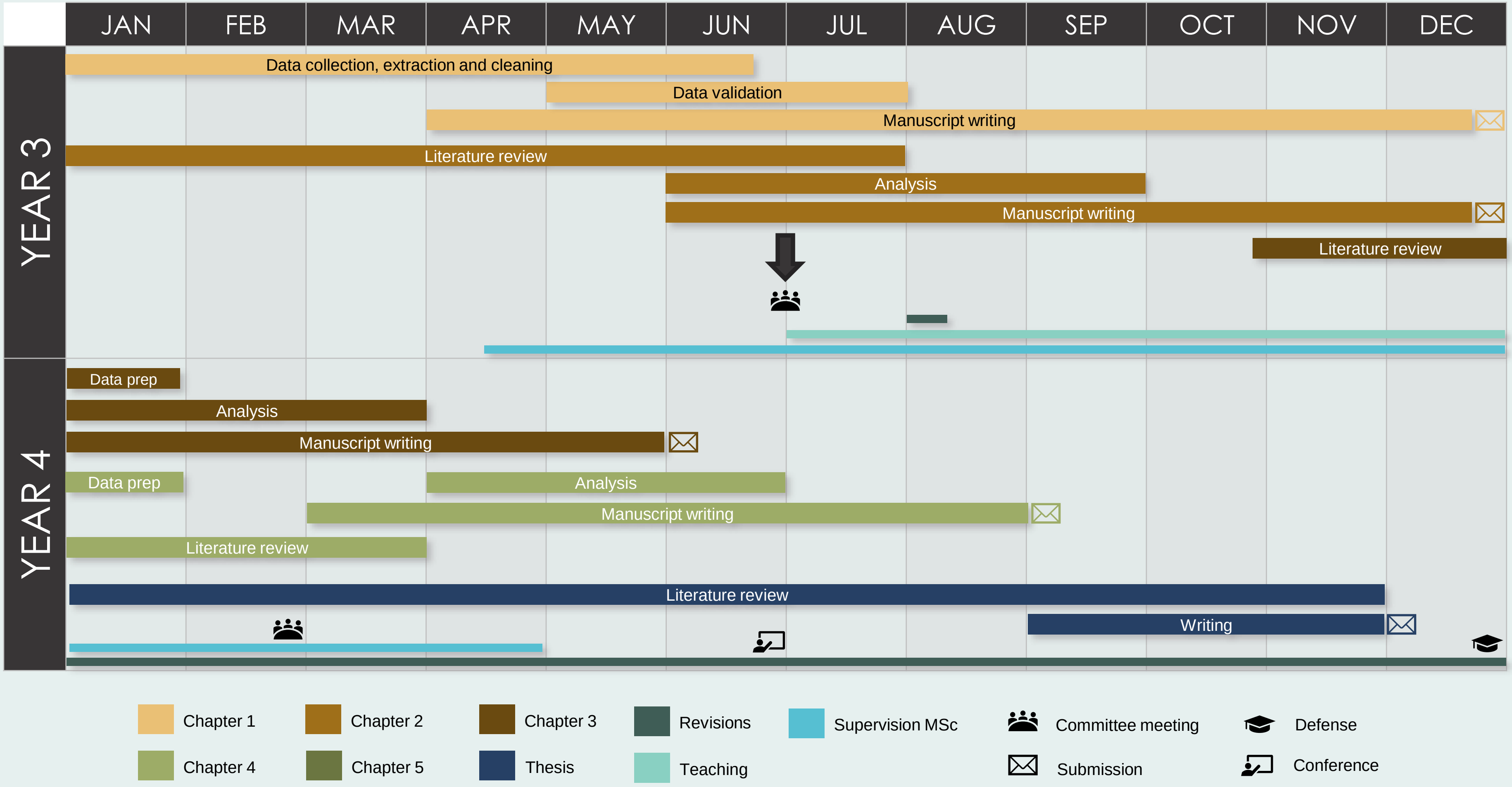
1. Sarah Mayor, Florian Altermatt, Tom Crowther, Iris Hordijk, Jacqueline Oehri, **Merin Reji Chacko**, Michael Schaepman, Bernhard Schmid, and Pascal Niklaus. Landscape diversity promotes landscape functioning in North America. *In prep.*
2. Ramona Julia Heim, Maitane Iturrate-Garcia, **Merin Reji Chacko** and Gabriela Schaepman-Strub. (2023) Deciduous tundra shrubs shift toward more acquisitive light absorption strategy under climate change treatments. *ESS Open Archive* . DOI: 10.22541/essoar.167604135.58009963/v1 *Under Revision*

ADMIN/VARIA

1. Course work – complete!
2. Teaching
   a. Shreyas – MSc project on trait-based models
   b. Teaching two courses online next semester
3. PhD Club at WSL
   a. Course organisation, budget planning, etc
   b. Will resign early spring 2024

Shreyas Agarwal:
April 2023-May 2024

Next steps...


JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
YEAR 3
Data collection, extraction and cleaning
Data validation
Manuscript writing
Literature review
Analysis
Manuscript writing
Literature review
YEAR 4
Data prep
Analysis
Manuscript writing
Data prep
Analysis
Manuscript writing
Literature review
Literature review
Writing
Chapter 1
Chapter 2
Chapter 3
Revisions
Supervision MSc
Committee meeting
Defense
Chapter 4
Chapter 5
Thesis
Teaching
Submission
Conference

Thank You

Open questions

- The metaweb: validation?
- According to the BAFU, Switzerland's biodiversity is under particular pressure from
  - the fragmentation and dissection of habitats by infrastructure and settlements,
  - excessive nitrogen and pesticide inputs
  - the loss and intensive use of soils

Open questions

Assign extinction probabilities

- All nodes experience non-zero likelihood of extinction
- Nodes experience higher likelihood of extinction based on relative degree of association to targeted habitat or red list classification

For each iteration:

Null model

- 376 species do not have diet information
- Broad diet information, level of diet specificity and habitat and zone-associations are used to randomly select links
- Generalist: 5% of viable links, specialist: 1-5 links selection from viable links

Drop generalist interactions

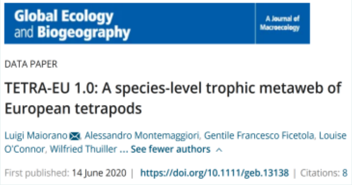
- If in-degree > median/mean in-degree, randomly remove 90% of links (only remove inferred interactions?)
- What if out-degree of the parent node = 1?
  - How to prevent the metaweb from becoming disconnected without skewing removal?

Remove nodes

- Sequential removal of species
- Calculate metrics per removal step:
  - R50, connectivity-based metrics, etc.

Build perturbation curves based on iteration means

Raw metaweb


Global Ecology and Biogeography

A Journal of Macroecology

DATA PAPER

TETRA-EU 1.0: A species-level trophic metaweb of European tetrapods

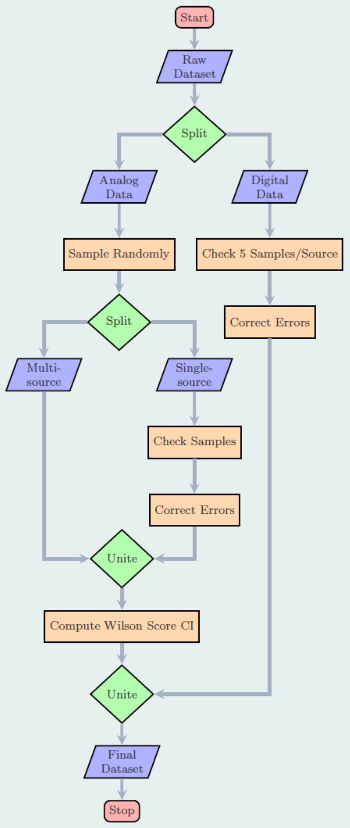
Luigi Maiorano, Alessandro Montemaggiori, Gentile Francesco Ficetola, Louise O'Connor, Wilfried Thuiller ... See fewer authors

First published: 14 June 2020 | https://doi.org/10.1111/geb.13138 | Citations: 8

Collection of taxonomy-based diet information from existing literature and datasets

Subset interactions based on occurrence in Switzerland

Data validation



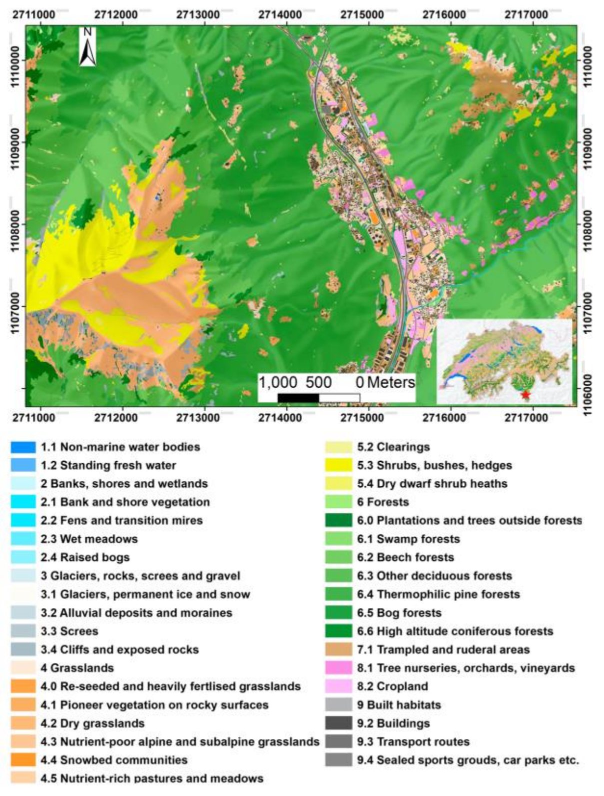
How many errors were made during the data extraction process?

- Sample size based on 95% CI, 1% MOE and 7% estimated error (based on Maiorano et al 2020)

- Wilson Score Interval: (0.0408%, 0.35209%)

Habitat classification

1. Collected empirical information along with interaction datasets
2. Habitat Map of Switzerland intersected with InfoSpecies occurrence data for species with existing spatial coverage
3. Remove uncertain or infrequently associated habitats according to the Habitat Map
4. For species still missing information, infer it from most associated habitats or other species in the same genus
5. If genera not present, then infer using families
6. If species still missing habitat information (~2 200 spp) – manual search (conducted by Zivis at WSL)



Zone classifications

1. Collected along-side interaction datasets
2. For those missing, expansion using closest related species in same genus or same family
3. Those still missing information (~5 000 spp) – manual search by Zivis at WSL by family

Classes are as follows:

On ground; in ground

In vegetation; on vegetation

In air

In water; On water

In dwellings

In host; In host nests

In-degree (restrained expansion)