Forecasting the spatio-temporal uncoupling of bumblebee-flower interaction networks

```
Michael D. Catchen <sup>1,2</sup> Paul CaraDonna <sup>3,4</sup> Jane E. Ogilvie <sup>3</sup> Francis Banville <sup>5,6,2</sup>

Dominique Caron <sup>1,2</sup> Philippe Desjardins-Proulx <sup>5,2</sup> Norma R. Forero-Muñoz <sup>5,2</sup> Andrew Gonzalez <sup>1,2</sup>

Dominique Gravel <sup>6,2</sup> Laura Pollock <sup>1,2</sup> Timothée Poisot <sup>5,2</sup> Tanya Strydom <sup>5,2</sup> Julian Resasco <sup>7</sup>
```

Correspondance to:

Michael D. Catchen — michael.catchen@mail.mcgill.ca

This work is released by its authors under a CC-BY 4.0 license

Last revision: May 5, 2022

 $^{^1}$ McGill University 2 Québec Centre for Biodiversity Sciences 3 Rocky Mountain Biological Laboratory

⁴ Chicago Bontanic Garden ⁵ Université de Montréal ⁶ Université de Sherbrooke ⁷ University of Colorado Boulder

Purpose: This template provides a series of scripts to render a markdown document into an interactive website and a series of PDFs.

Motivation: It makes collaborating on text with GitHub easier, and means that we never need to think about the output.

Internals: GitHub actions and a series of python scritpts. The markdown is handled with pandoc.

1 Abstract

- 2 Using a data set of [DESCRIBE EACH DATASET IN A NICE WAY], we predict a spatiotemporally explicit
- metaweb of interactions between bumblebees (Bombus) and wildflowers (within find clade). We integrate
- 4 this data with crowdsourced occurrence data and climate data to [best paint the picture of the Colorado
- 5 bumblebee-plant metaweb]. Using temporal climate data, we forecast how the spatiotemporal overlap of
- 6 interacting species will change under proposed climate scenarios. We use this to estimate what
- 7 interactions between bees and plants need the most attention to prevent the spatiotemporal decoupling of
- 8 an interactions from threatening ecosystem functioning or the persistence of a species.

9 Introduction

- We estimate the Colorado bumblebee/wild-flower pollination metaweb using network embedding.
 - Then decompose into spatial and temporally explicit network predictions
- Finally suggest a priority of sampling to improve our understanding of this system.

13 Data

10

11

12

14 Methods

15 Concept Fig

16 Metaweb Model

- Phylogeny Construction
- 18 Feature Embedding
- 19 Relative Abundance
- 20 Phylogenetic features
- 21 Environmental niche features
- 22 Temporal niche features
- 23 Metaweb Model Fitting and Validation

24 Figure 2: Model Fit Figure

	ROC-AUC								PR-AUC							
T+P+E+R	0.75	0.72	0.84	0.85	0.86	0.87	0.87	T+P+E+R	0.55	0.47	0.67	0.58	0.70	0.73	0.71	
T+E+R	0.76	0.78	0.84	0.83	0.85	0.87	0.86	T+E+R	0.52	0.53		0.57			0.69	
P+E+R	0.75	0.71	0.85	0.84	0.85	0.88	0.87	P+E+R	0.53	0.46		0.57			0.70	
T+P+E	0.73	0.70	0.82	0.84	0.80	0.86	0.86	T+P+E	0.51	0.44	0.65		0.61		0.68	
T+P+R	0.75	0.71	0.84	0.83	0.86	0.86	0.87	T+P+R	0.53	0.42		0.58			0.70	
E+R	0.75	0.77	0.85	0.82	0.85	0.87	0.86	E+R	0.49	0.53		0.59			0.68	
P+R	0.75	0.71	0.85	0.84	0.86	0.88	0.87	P+R	0.52	0.46		0.61			0.70	
T+R	0.75	0.77	0.84	0.81	0.85	0.85	0.85	T+R	0.49	0.52		0.53			0.68	
T+P	0.70	0.71	0.81	0.83	0.81	0.85	0.85	T+P	0.47	0.46	0.63	0.64	0.59		0.66	
T+E	0.65	0.60	0.82	0.83	0.81	0.84	0.84	T+E	0.41	0.32	0.64	0.64			0.67	
P+E	0.71	0.70	0.82	0.85	0.79	0.87	0.86	P+E	0.50	0.44	0.62	0.68	0.54		0.66	
R	0.77	0.77	0.85	0.80	0.84	0.82	0.84	R	0.52	0.52		0.47		0.64	0.65	
E	0.64	0.52	0.79	0.81	0.80	0.81	0.82	E	0.35	0.23	0.56	0.57	0.56	0.59	0.59	
Р	0.69	0.71	0.80	0.82	0.77	0.84	0.84	Р	0.44	0.44	0.57	0.59	0.52	0.63	0.61	
Т	0.57	0.57	0.80	0.80	0.80	0.82	0.82	Т	0.31	0.31	0.59	0.57	0.61	0.62	0.63 4 of 5	

- ²⁶ # Spatiotemporally Explicit Networks
- 27 Now that we have a metaweb.....
- 28 Figure 3: Maps over time figure and Prob(Connectance) vs. Month figure
- 29 Sampling Prioiritization
- 30 Figure 4: Uncertainty and sampling priority map
- 31 Discussion