How to present SEMs?

Swiss SEM team

02.11.2021

Department of Evolutionary Biology and Environmental Sciences

University of Zurich

Exercice

We have now analysed the model.

How would you draw the model output to represent the minimum information required in order to reproduce this model?

Draw your idea

What can you expect to see out in nature?

Journal of Experimental Child Psychology 167 (2018) 93–116

Contents lists available at ScienceDirect

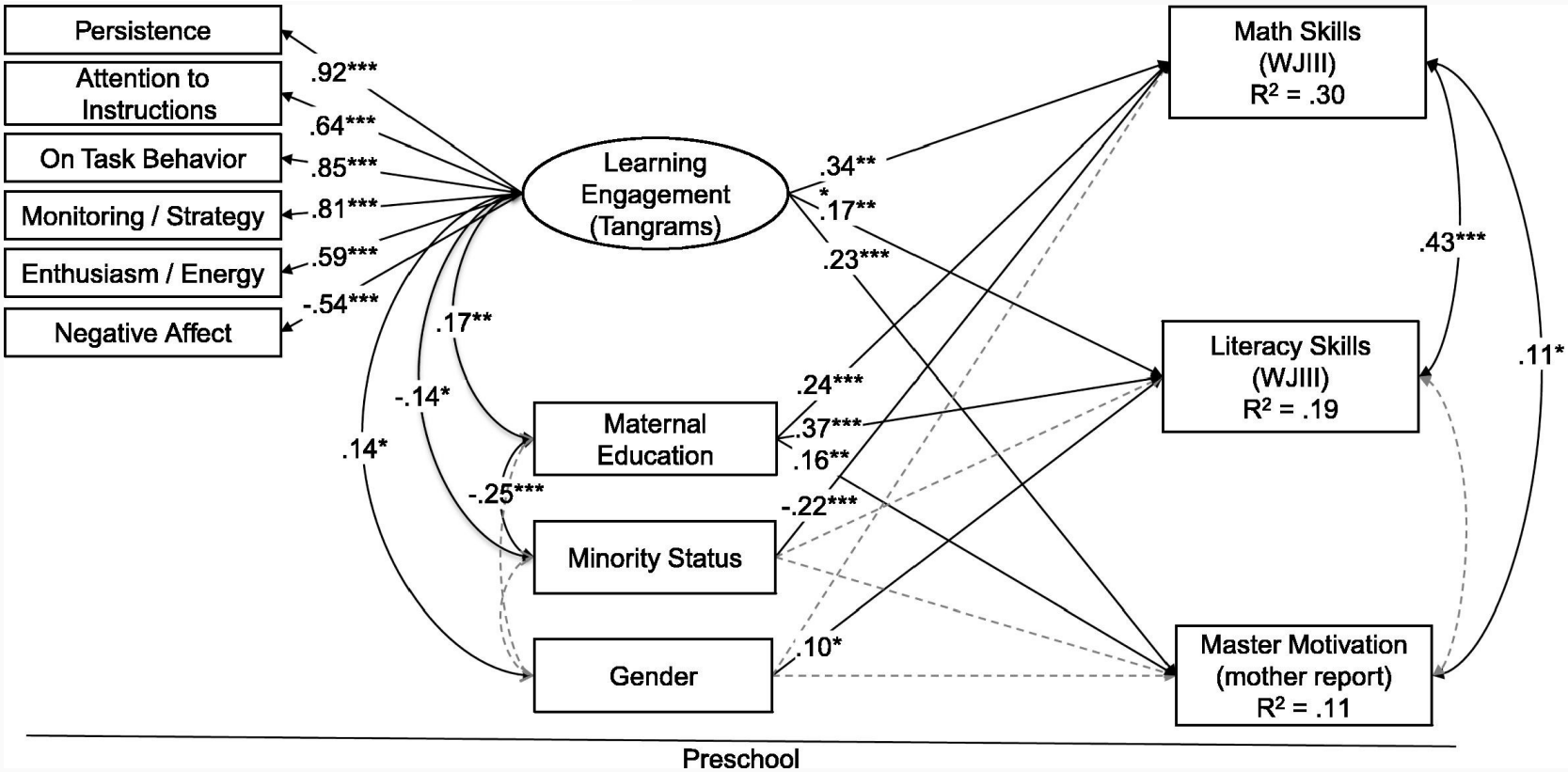
Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Measuring preschool learning engagement in the laboratory

Simone E. Halliday [a,*], Susan D. Calkins [b], Esther M. Leerkes [b]

[a] Department of Psychology, The University of North Carolina at Greensboro, Greensboro, NC 27412, USA
[b] Department of Human Development and Family Studies, The University of North Carolina at Greensboro, Greensboro, NC 27412, USA



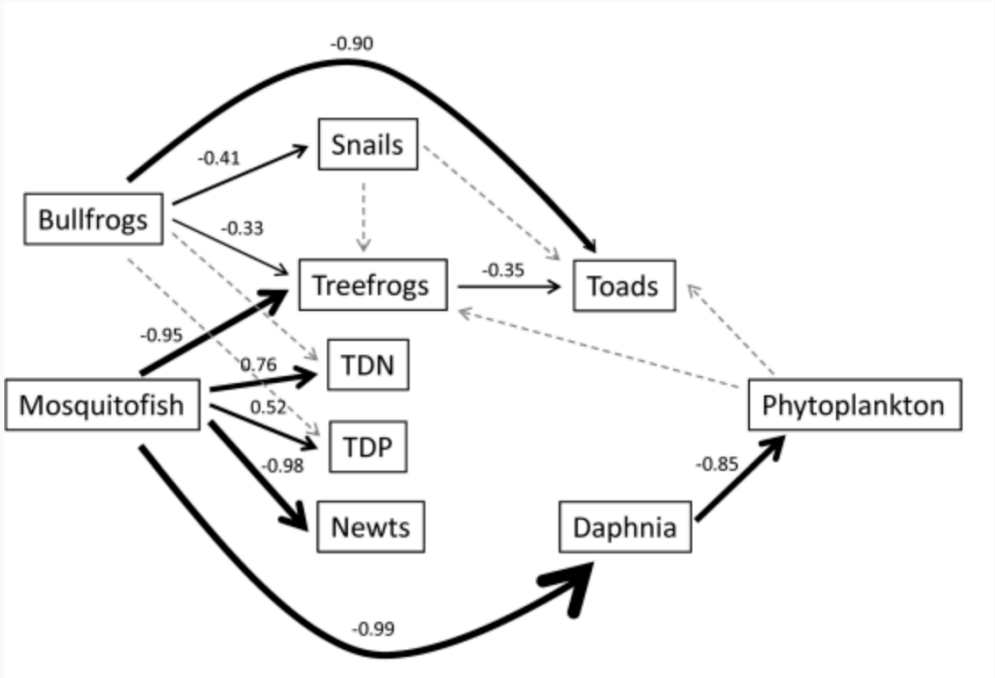
What can you expect to see out in nature?

Ecology, 93(6), 2012, pp. 1254–1261

Community ecology of invasions: direct and indirect effects of multiple invasive species on aquatic communities

Daniel L. Preston,[1,3] Jeremy S. Henderson,[2] and Pieter T. J. Johnson[1]

[1]*Department of Ecology and Evolutionary Biology, University of Colorado, Ramaley N122, Campus Box 334, Boulder, Colorado 80309 USA*
[2]*Department of Zoology, Oregon State University, 3029 Cordley Hall, Corvallis, Oregon 97331 USA*



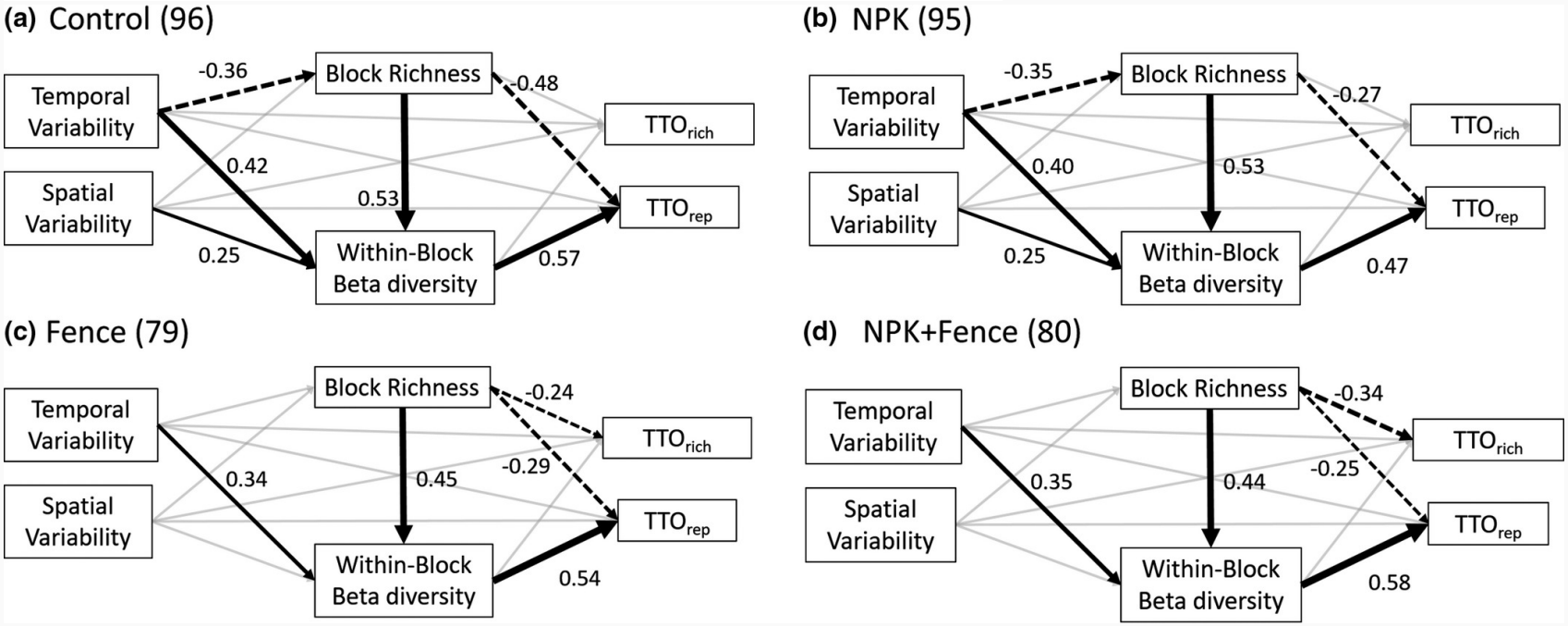
What can you expect to see out in nature?

ECOLOGY LETTERS

Letter | Full Access

Spatial heterogeneity in species composition constrains plant community responses to herbivory and fertilisation

Dorothee Hodapp, Elizabeth T. Borer, W. Stanley Harpole, Eric M. Lind, Eric W. Seabloom, Peter B. Adler, Juan Alberti, Carlos A. Arnillas, Jonathan D. Bakker, Lori Biederman ... See all authors



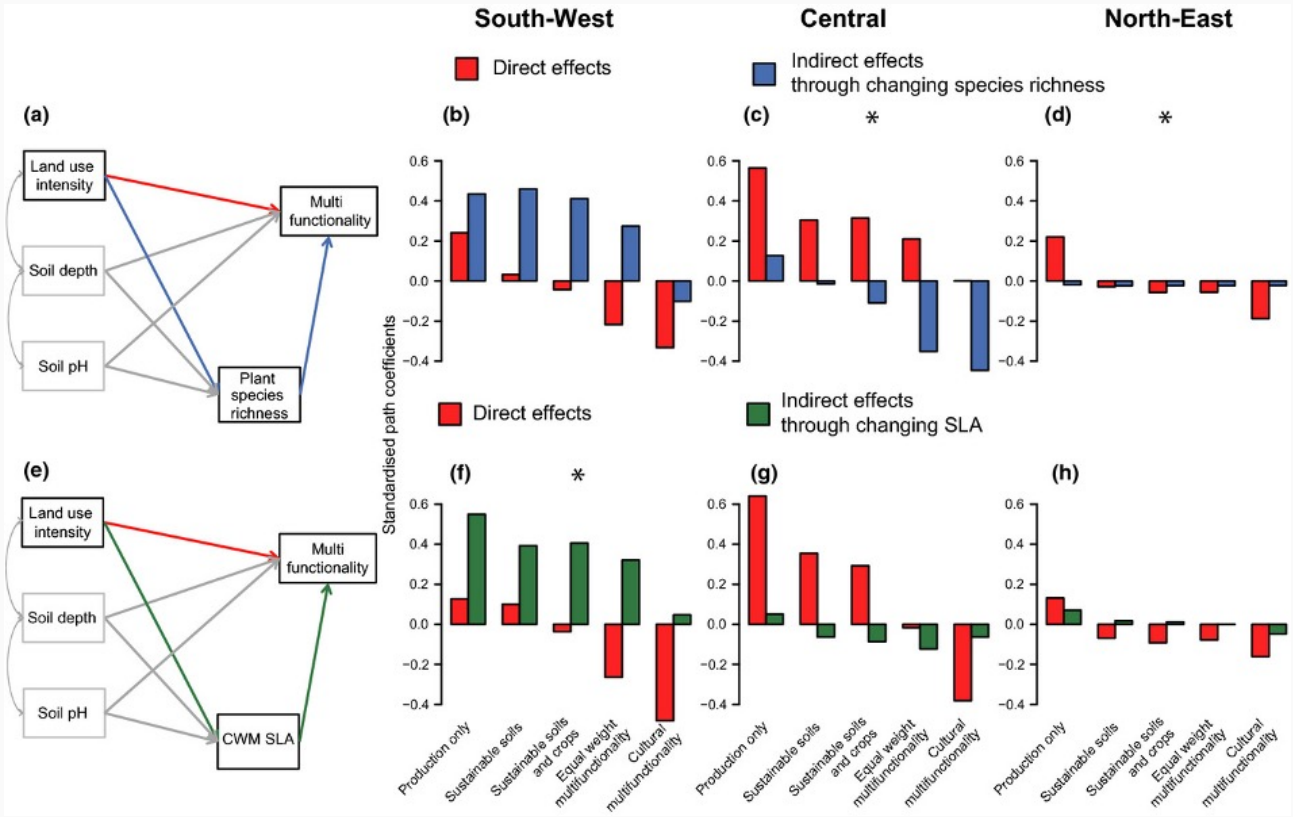
What can you expect to see out in nature?

ECOLOGY LETTERS

Letter | Open Access

Land use intensification alters ecosystem multifunctionality via loss of biodiversity and changes to functional composition

Eric Allan, Pete Manning, Fabian Alt, Julia Binkenstein, Stefan Blaser, Nico Blüthgen, Stefan Böhm, Fabrice Grassein, Norbert Hölzel, Valentin H. Klaus, Till Kleinebecker ... See all authors



What can you expect to see out in nature?

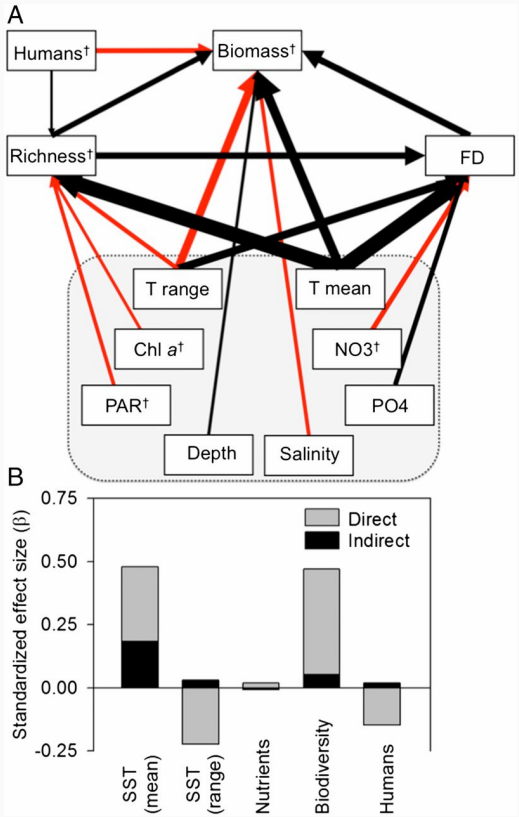
PNAS

Biodiversity enhances reef fish biomass and resistance to climate change

J. Emmett Duffy[a,1], Jonathan S. Lefcheck[b], Rick D. Stuart-Smith[c], Sergio A. Navarrete[d], and Graham J. Edgar[c]

[a]Tennenbaum Marine Observatories Network, Smithsonian Institution, Washington, DC 20013-7012; [b]Department of Biological Sciences, Virginia Institute of Marine Science, The College of William & Mary, Gloucester Point, VA 23062; [c]Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, TAS 7001 Australia; and [d]Estación Costera de Investigaciones Marinas and Center for Marine Conservation, LINC-Global, Pontificia Universidad Católica de Chile, Casilla 114-D, Santiago, Chile

Edited by James A. Estes, University of California, Santa Cruz, CA, and approved April 13, 2016 (received for review December 11, 2015)



What can you expect to see out in nature?

nature COMMUNICATIONS

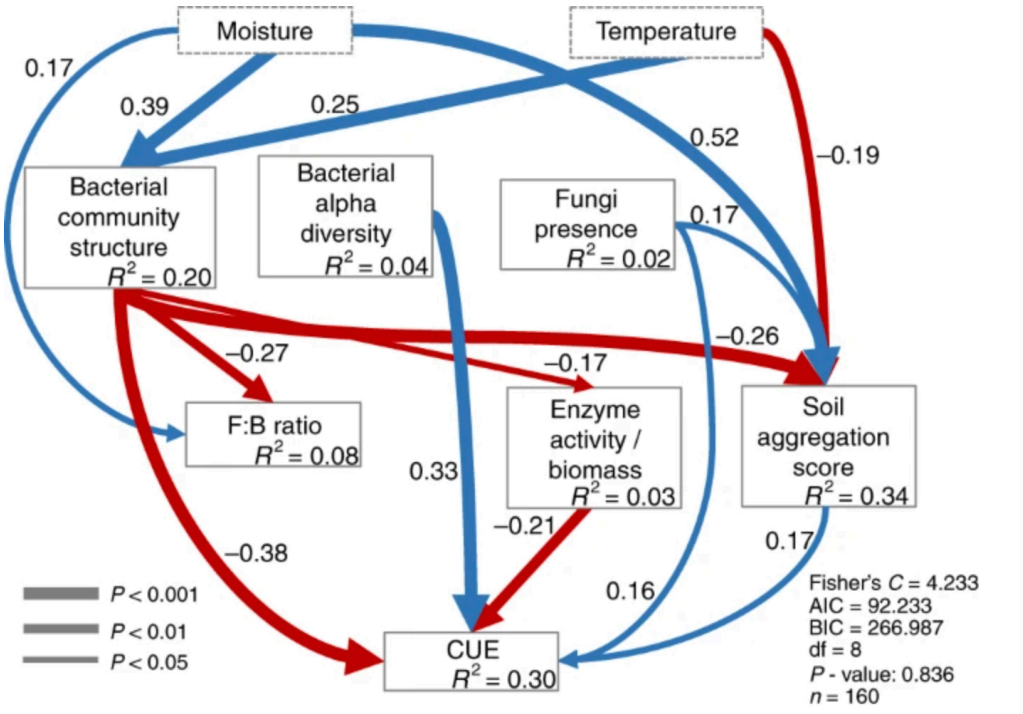
ARTICLE

https://doi.org/10.1038/s41467-020-17502-z OPEN

Microbial diversity drives carbon use efficiency in a model soil

Luiz A. Domeignoz-Horta[1✉], Grace Pold[2], Xiao-Jun Allen Liu[1], Serita D. Frey[3], Jerry M. Melillo[4] & Kristen M. DeAngelis[1✉]

Fig. 4: Structural equation model showing the relative influence of soil abiotic and biotic factors on CUE.



What can you expect to see out in nature?

The ISME Journal (2018) 12:1817–1825
https://doi.org/10.1038/s41396-018-0096-y

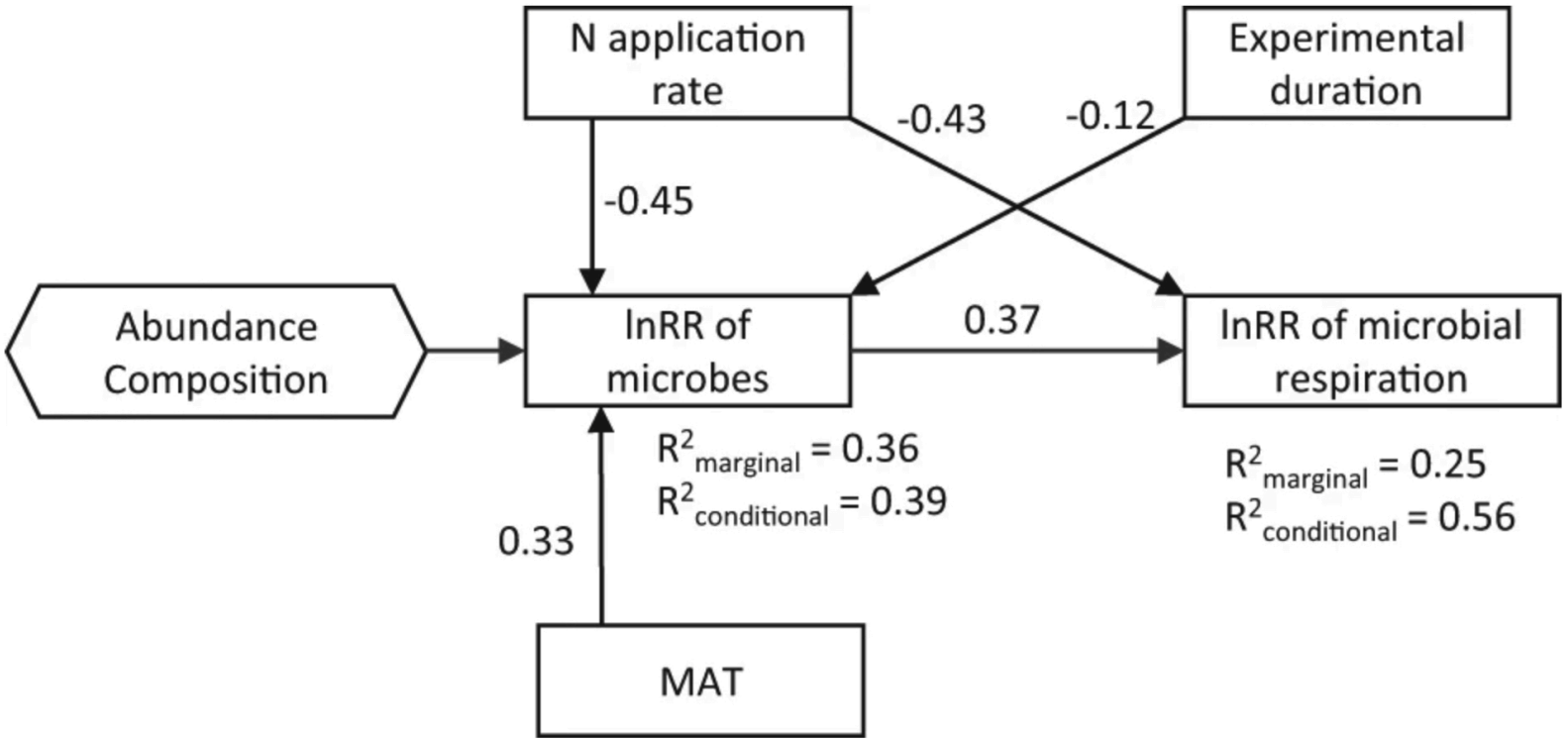
ISME

ARTICLE

Global negative effects of nitrogen deposition on soil microbes

Tian'an Zhang[1] · Han Y. H. Chen[2] · Honghua Ruan[1]

Received: 24 October 2017 / Revised: 13 February 2018 / Accepted: 20 February 2018 / Published online: 27 March 2018



What can you expect to see out in nature?

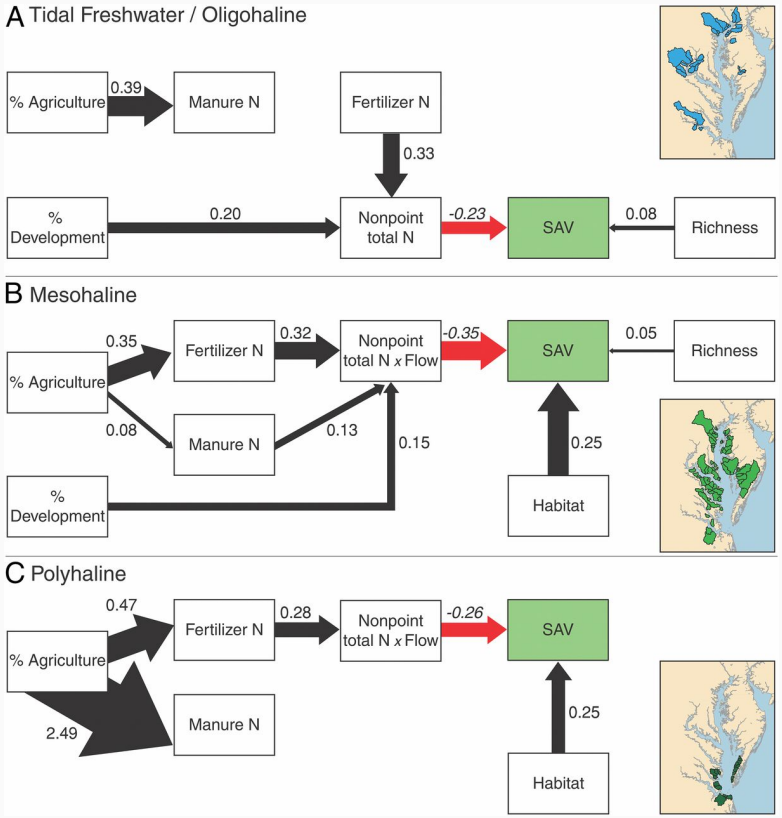
PNAS

Check for updates

Long-term nutrient reductions lead to the unprecedented recovery of a temperate coastal region

Jonathan S. Lefcheck[a,b,1], Robert J. Orth[b], William C. Dennison[c], David J. Wilcox[b], Rebecca R. Murphy[d], Jennifer Keisman[e], Cassie Gurbisz[f,g], Michael Hannam[h], J. Brooke Landry[i], Kenneth A. Moore[b], Christopher J. Patrick[j], Jeremy Testa[k], Donald E. Weller[h], and Richard A. Batiuk[l]

[a]Center for Ocean Health, Bigelow Laboratory for Ocean Science, East Boothbay, ME 04544; [b]Department of Biological Sciences, Virginia Institute of Marine Science, The College of William & Mary, Gloucester Point, VA 23062; [c]University of Maryland Center for Environmental Science, Cambridge, MD 21613; [d]University of Maryland Center for Environmental Science, Chesapeake Bay Program Office, Annapolis, MD 21403; [e]US Geological Survey, Baltimore, MD 21228; [f]National Socio-Environmental Synthesis Center, Annapolis, MD 21401; [g]Environmental Studies Program, St. Mary's College of Maryland, St. Mary's City, MD 20686; [h]Smithsonian Environmental Research Center, Edgewater, MD 21037; [i]Maryland Department of Natural Resources, Annapolis, MD 21401; [j]Texas A&M University Corpus Christi, Corpus Christi, TX 78412; [k]University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, Solomons, MD 20688; and [l]US Environmental Protection Agency, Annapolis, MD 21403



What can you expect to see out in nature?

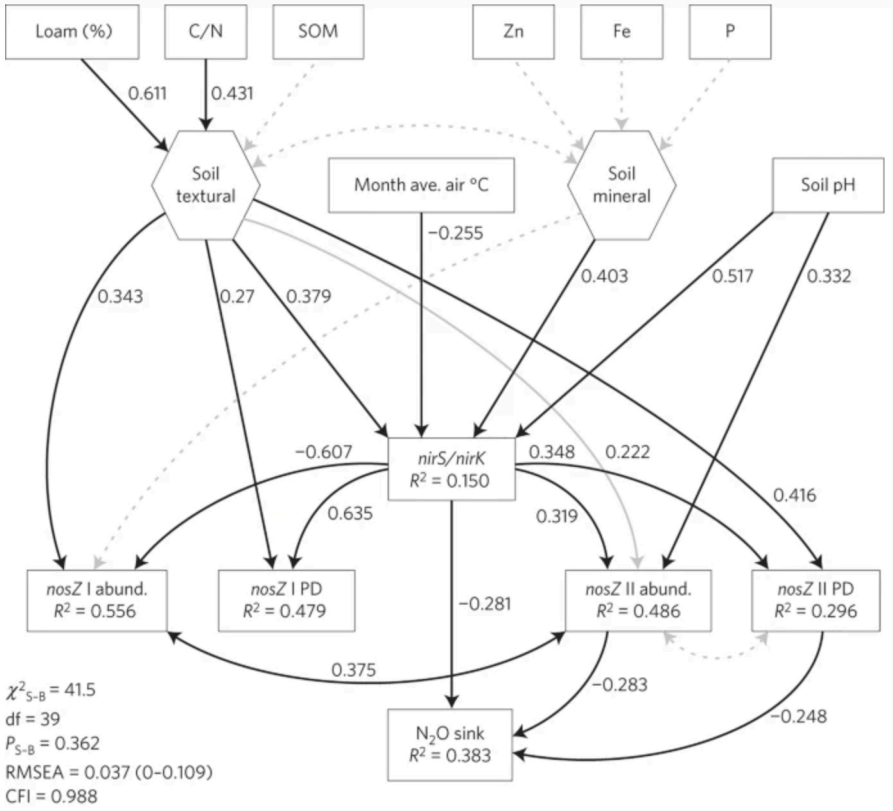
nature climate change

LETTERS

PUBLISHED ONLINE: 13 JULY 2014 | DOI: 10.1038/NCLIMATE2301

Recently identified microbial guild mediates soil N_2O sink capacity

Christopher M. Jones[1,2†], Ayme Spor[1†], Fiona P. Brennan[1,3,4], Marie-Christine Breuil[1], David Bru[1], Philippe Lemanceau[1], Bryan Griffiths[3,5], Sara Hallin[2*] and Laurent Philippot[1]



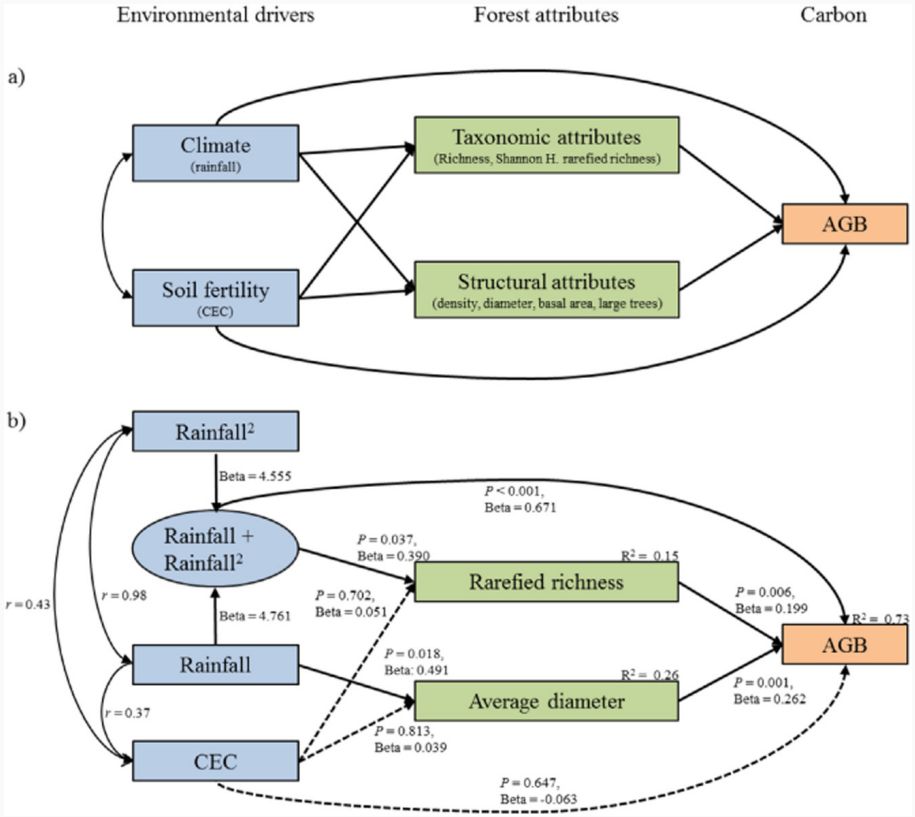
What can you expect to see out in nature?

Global Ecology and Biogeography
A Journal of Macroecology

Research Papers | Full Access

Diversity enhances carbon storage in tropical forests

L. Poorter ✉, M. T. van der Sande, J. Thompson, E. J. M. M. Arets, A. Alarcón, J. Álvarez-Sánchez, N. Ascarrunz, P. Balvanera, G. Barajas-Guzmán, A. Boit, F. Bongers, F. A. Carvalho ... See all authors



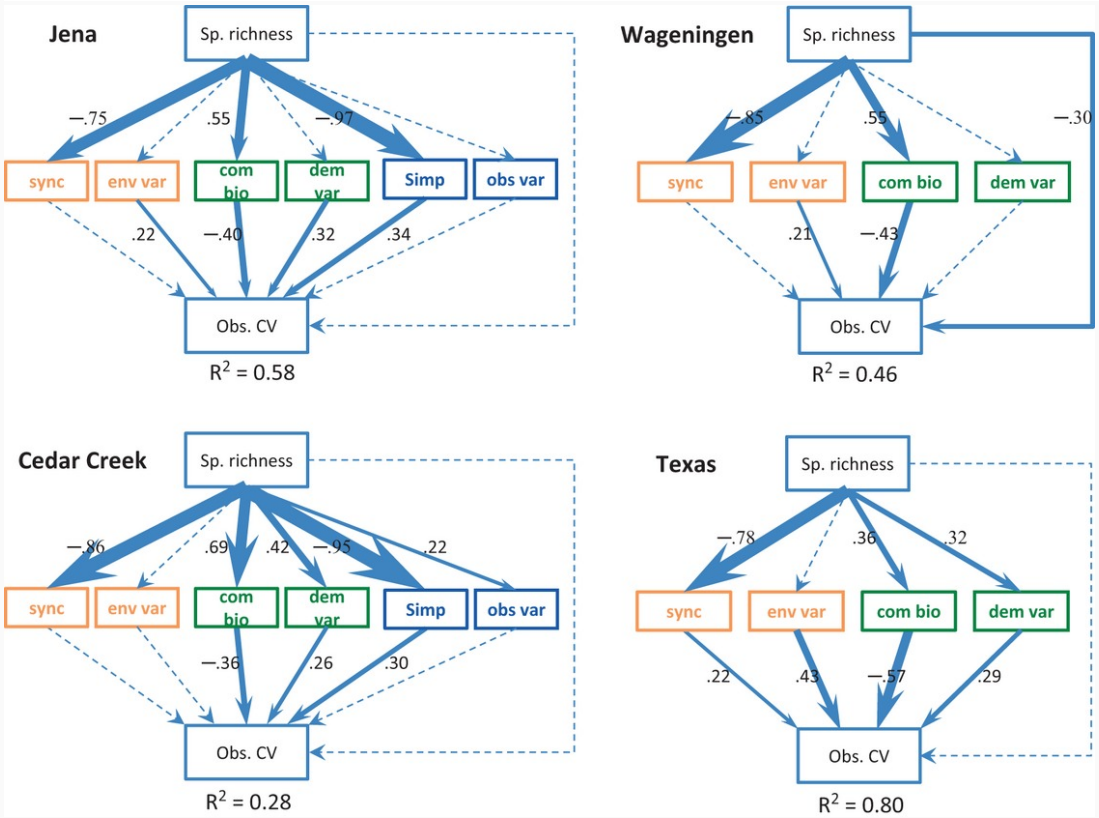
What can you expect to see out in nature?

ECOLOGY LETTERS

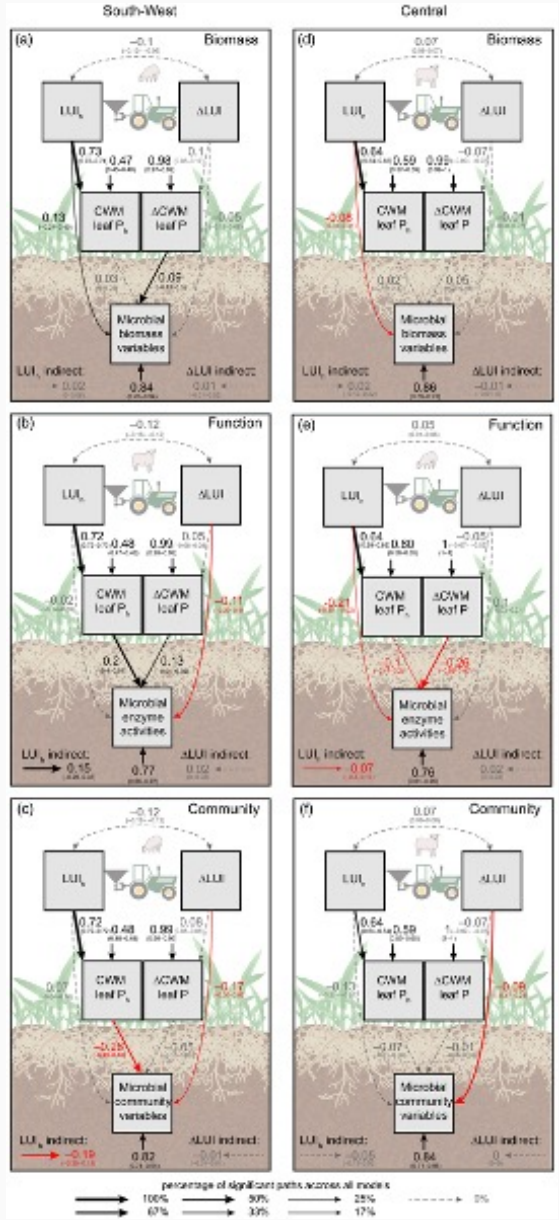
Letter | Full Access

Predicting ecosystem stability from community composition and biodiversity

Claire de Mazancourt, Forest Isbell, Allen Larocque, Frank Berendse, Enrica De Luca, James B. Grace, Bart Haegeman, H. Wayne Polley, Christiane Roscher, Bernhard Schmid ... See all authors



What can you expect to see out in nature?



RESEARCH ARTICLE

Journal of Ecology | BRITISH ECOLOGICAL SOCIETY

Plant functional trait shifts explain concurrent changes in the structure and function of grassland soil microbial communities

Runa S. Boeddinghaus[1] | Sven Marhan[1] | Doreen Berner[1] | Steffen Boch[2,3] | Markus Fischer[3,4] | Norbert Hölzel[5] | Jens Kattge[6,7] | Valentin H. Klaus[5,8] | Till Kleinebecker[5,9] | Yvonne Oelmann[10] | Daniel Prati[3] | Deborah Schäfer[3] | Ingo Schöning[6] | Marion Schrumpf[6] | Elisabeth Sorkau[10,11] | Ellen Kandeler[1] | Peter Manning[4]

What can you expect to see out in nature?

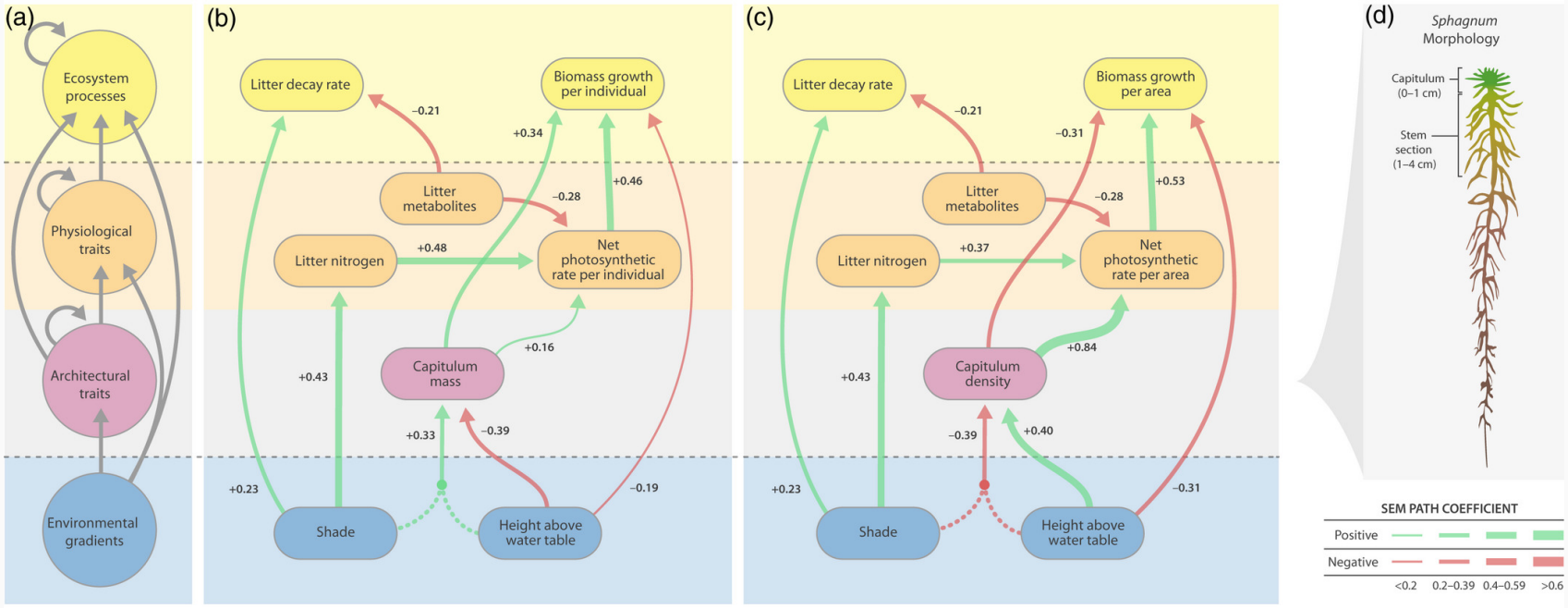
Journal of Ecology

BRITISH ECOLOGICAL SOCIETY

RESEARCH ARTICLE | Open Access

Scaling functional traits to ecosystem processes: Towards a mechanistic understanding in peat mosses

Adriano Mazziotta, Gustaf Granath, Håkan Rydin, Fia Bengtsson, Jon Norberg



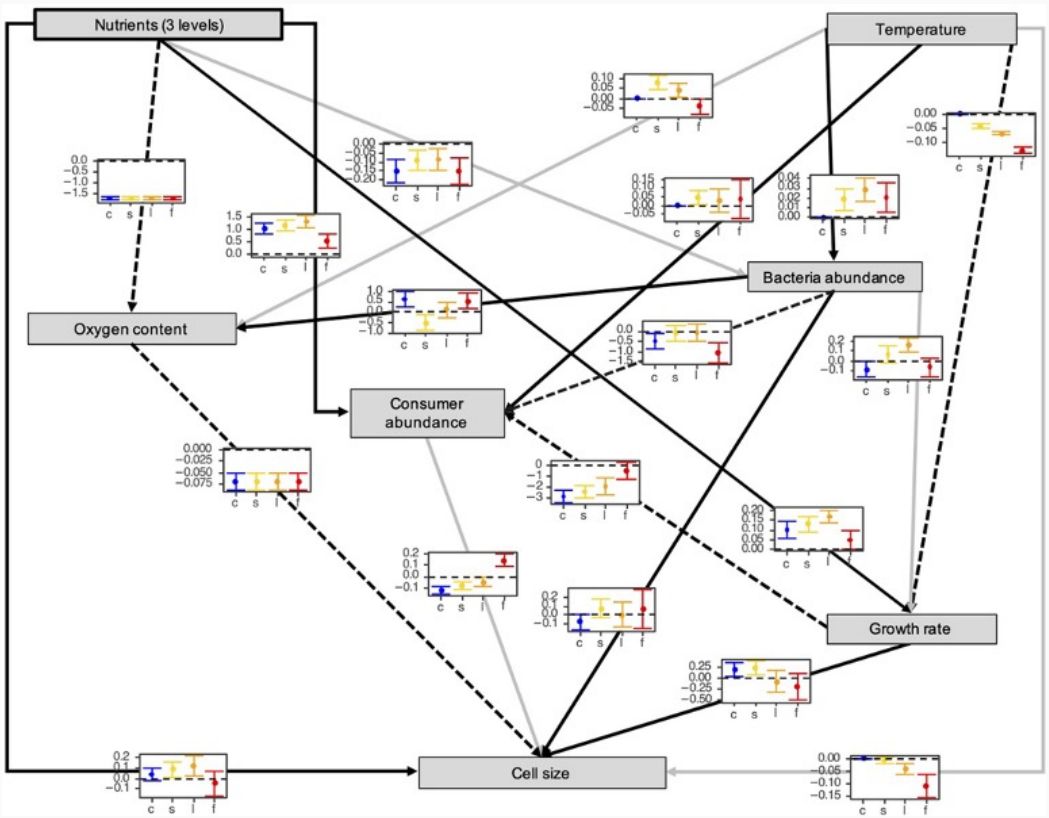
What can you expect to see out in nature?

RESEARCH ARTICLE

Functional Ecology | BRITISH ECOLOGICAL SOCIETY

Testing multiple drivers of the temperature-size rule with nonlinear temperature increase

Andrea Tabi[1,2] | Aurélie Garnier[1,3] | Frank Pennekamp[1]



Discussion

What makes a good data visualization?

Theory

Maybe one slide drawing on theory from people like Edward Tufte

Information/ink ratio

What is a good SEM drawing

Discussion:

- Starting from what you draw and what you just saw, what is the minimum necessary information to include in an SEM?

What is a good SEM drawing

Discussion:

- Starting from what you draw and what you just saw, what is the minimum necessary information to include in an SEM?
- What is missing in your drawing?

Necessary information

There are no rules. Here are our guidelines to help drawing a good/reproducible/interpretable SEM diagram.

1) Represent your variables

Necessary information

There are no rules. Here are our guidelines to help drawing a good/reproducible/interpretable SEM diagram.

1) Represent your variables
2) Represent your coefficients

Necessary information

There are no rules. Here are our guidelines to help drawing a good/reproducible/interpretable SEM diagram.

1) Represent your variables
2) Represent your coefficients
3) Represent all paths

Necessary information

There are no rules. Here are our guidelines to help drawing a good/reproducible/interpretable SEM diagram.

1) Represent your variables
2) Represent your coefficients
3) Represent all paths
4) Report model goodness of fit

Necessary information

There are no rules. Here are our guidelines to help drawing a good/reproducible/interpretable SEM diagram.

1) Represent your variables
2) Represent your coefficients
3) Represent all paths
4) Report model goodness of fit
5) Report explanatory power for endogenous variables

Necessary information

There are no rules. Here are our guidelines to help drawing a good/reproducible/interpretable SEM diagram.

1) Represent your variables
2) Represent your coefficients
3) Represent all paths
4) Report model goodness of fit
5) Report explanatory power for endogenous variables
6) Include important tables

Necessary information: Represent your variables

- Squares are manifest (measured) variables

insert illustration

Necessary information: Represent your variables

- Squares are manifest (measured) variables
- Ellipses are latent variables

insert illustration

Necessary information: Represent your variables

- Squares are manifest (measured) variables
- Ellipses are latent variables
- Hexagons for composite variables

insert illustration

Necessary information: Represent your coefficients

Indicate the magnitude, direction, and significance:

- Color for direction

insert illustration

Necessary information: Represent your coefficients

Indicate the magnitude, direction, and significance:

- Color for direction
- Dashed vs solid for significance

insert illustration

Necessary information: Represent your coefficients

Indicate the magnitude, direction, and significance:

- Color for direction
- Dashed vs solid for significance
- Arrow width for magnitude

insert illustration

Necessary information: Represent your coefficients

Indicate the magnitude, direction, and significance:

- Color for direction
- Dashed vs solid for significance
- Arrow width for magnitude
- Write the numbers

insert illustration

Necessary information: Represent all paths

- Represent all causal paths included in your model regardless of significance.

Necessary information: Represent all paths

- Represent all causal paths included in your model regardless of significance.
- Not necessarily in the same figure.

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- Represent important correlations.

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- Not necessarily in the same figure.
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- Exogenous variables can be included.

Necessary information: Represent all paths

- Represent all causal paths included in your model regardless of significance.
- Not necessarily in the same figure.
- Represent important correlations.
- Exogenous variables can be included.
- Always include correlations among the errors of endogenous variables.

Necessary information: Report model goodness of fit

- Covariance-based approaches:

Necessary information: Report model goodness of fit

- Covariance-based approaches:
  - χ^2

Necessary information: Report model goodness of fit

- Covariance-based approaches:
  - χ^2
  - CFI

Necessary information: Report model goodness of fit

- Covariance-based approaches:
  - χ^2
  - CFI
  - SRMR

Necessary information: Report model goodness of fit

- Covariance-based approaches:
  - χ^2
  - CFI
  - SRMR
  - RMSEA

Necessary information: Explanatory power for endogenous variables

- Residual error or R^2

Necessary information: include important tables

- Table of path coefficients

Room for artistry

This will depend on the audience and support:

- Is this a paper?

Key thing here is that one structure might not work in every case. Not advocating for anything in particular, but note that the same model for a paper might not be the right presentation for an SEM.

Room for artistry

This will depend on the audience and support:

- Is this a paper?
- Is this a presentation?

Key thing here is that one structure might not work in every case. Not advocating for anything in particular, but note that the same model for a paper might not be the right presentation for an SEM.

Room for artistry

This will depend on the audience and support:

- Is this a paper?
- Is this a presentation?
- What is the narrative structure?

Key thing here is that one structure might not work in every case. Not advocating for anything in particular, but note that the same model for a paper might not be the right presentation for an SEM.

Room for artistry

Interactions, multigroup models, composites, etc.

Color, size, etc.

Organizing variables in space in a way that is useful to your reader rather than distracting:

- Top to bottom, or left to right?

Composite variable: do we need to show everything?

Breaking up complicated models into several panels or several figures

Moving information to a supplement

Room for artistry

Interactions, multigroup models, composites, etc.

Color, size, etc.

Organizing variables in space in a way that is useful to your reader rather than distracting:

- Top to bottom, or left to right?
- Mediator relative placement

Composite variable: do we need to show everything?

Breaking up complicated models into several panels or several figures

Moving information to a supplement

Room for artistry

Meta models, apriori models, etc

- Start with something abstract (metamodel concept)

Room for artistry

Meta models, apriori models, etc

- Start with something abstract (metamodel concept)
- shows the core concepts and their relationships, ignoring the data.

Room for artistry

Meta models, apriori models, etc

- Start with something abstract (metamodel concept)
- shows the core concepts and their relationships, ignoring the data.
- The most abstracted vision of the causal process you are trying to capture

Room for artistry

Showing the underlying data

Raw correlations:

- Shows linearity assumption, shows distribution of data, etc

Partial plots

Room for artistry

Showing the underlying data

Raw correlations:

- Shows linearity assumption, shows distribution of data, etc
- Correlation tables

Partial plots

Building the plot

This can be done in R. But it is generally done in external software like powerpoint, illustrator, or Inkscape.

In R, it can be useful to visualise your code and your model output.

Resources for drawing in R:
https://statistics.ohlsen-web.de/sem-path-diagram/