Day 2: Population growth, species interactions and time series

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Please:

This course is for you!

Please interrupt us as often as needed.

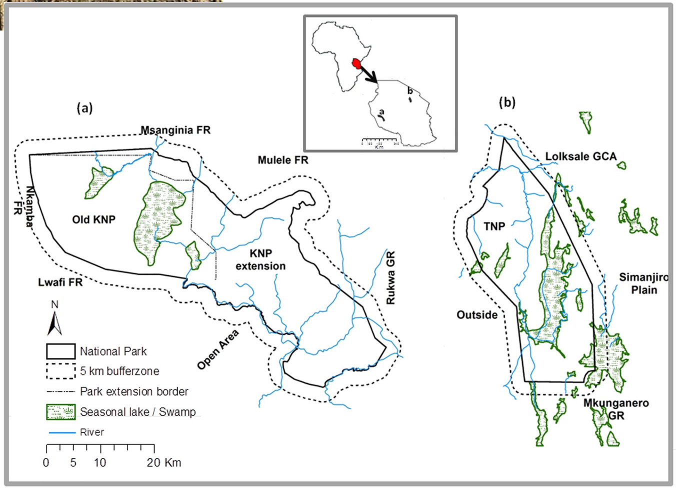
Please give us feedback during and after the course.

Day 2: Population growth, species interactions and time series

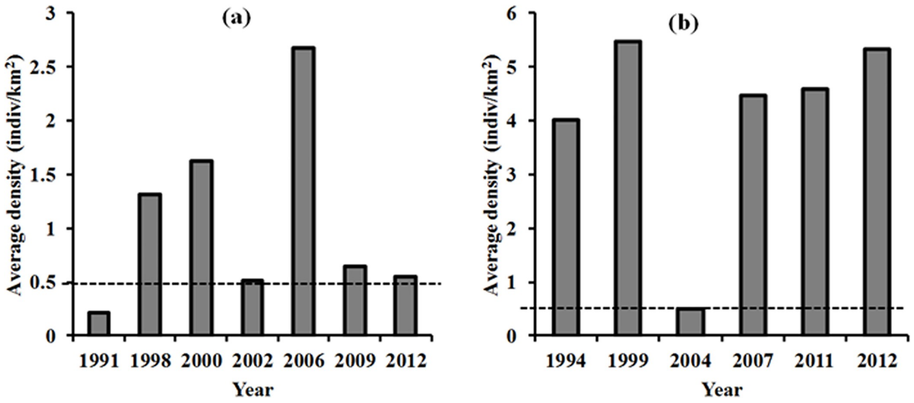
Schedule:

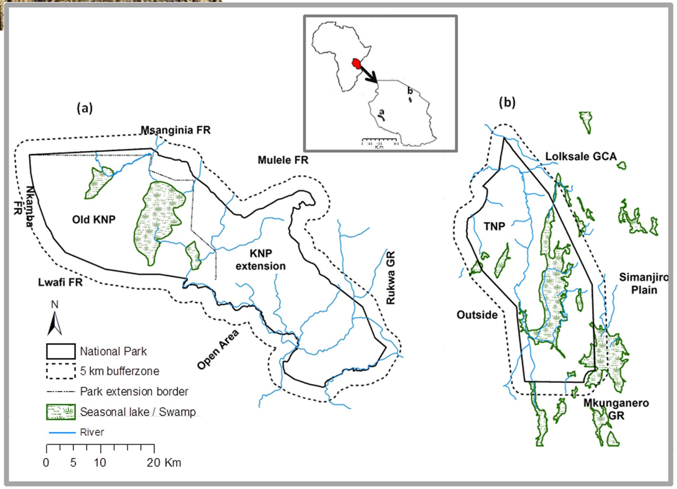
09:30 – 10:15	Introduction (Emanuel Fronhofer)
10:15 – 11:15	Fitting population dynamics in stan/rstan (Peter Kamal)
11:30 – 12:30	Introducing process error and state-space models (Benjamin Rosenbaum)
14:00 – 16:45	It’s your turn!
16:45 – 17:15	Fitting multiple time series at once (Peter Kamal)
17:30 – 18:30	Evening lecture (Benjamin Rosenbaum)

Mtui et al. 2017 PloS ONE



Mtui et al. 2017 PloS ONE





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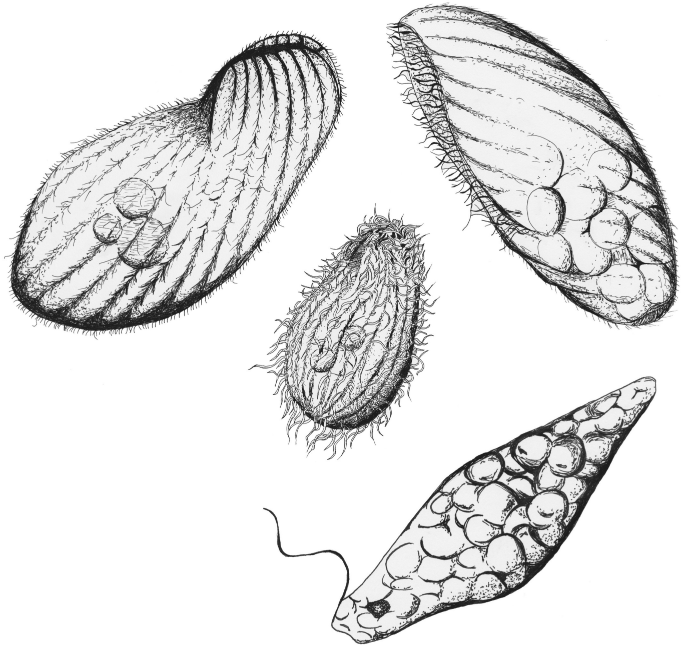
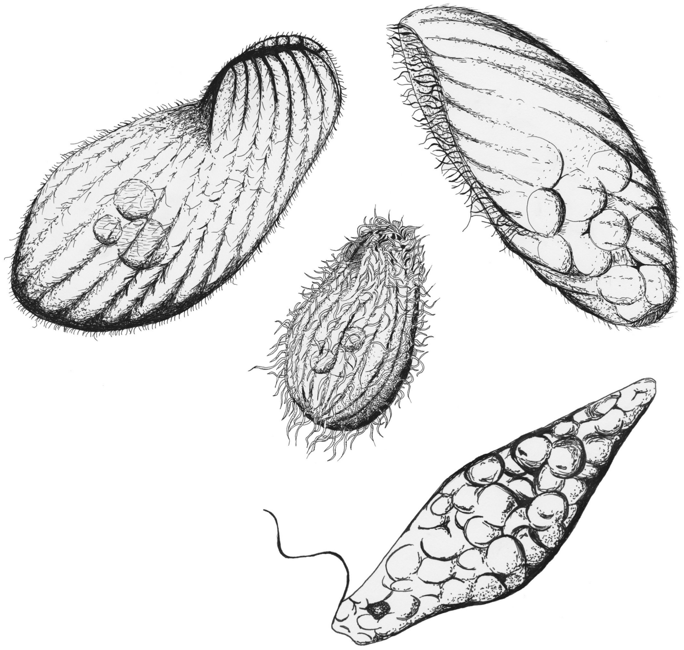
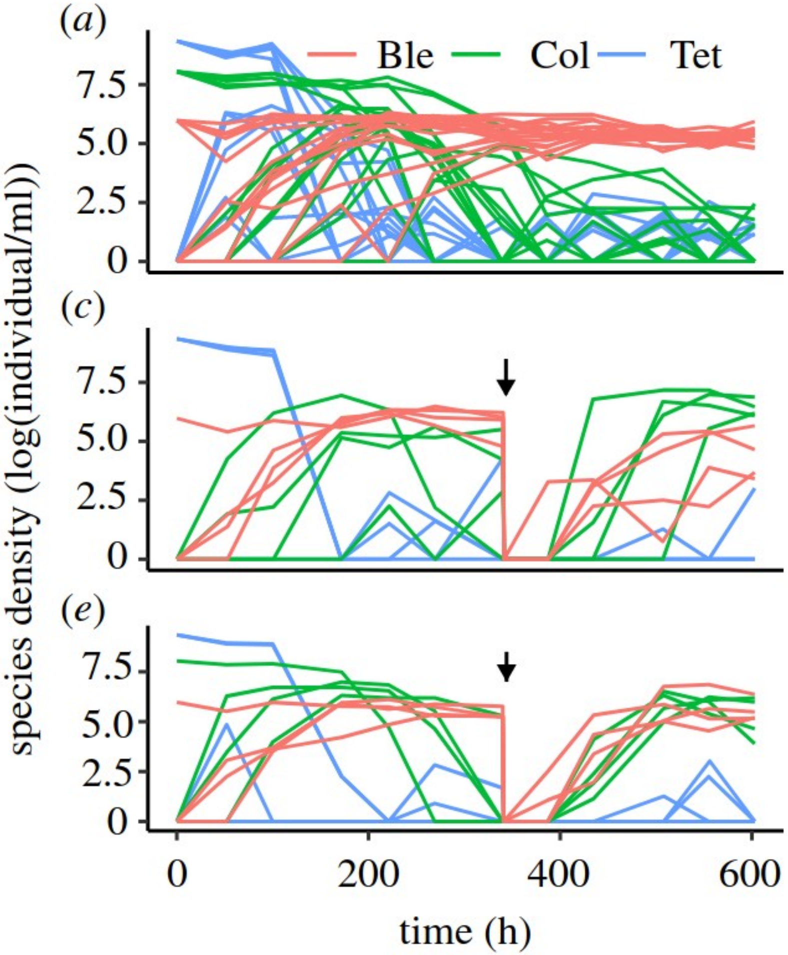


Saade et al. 2022 PRSB





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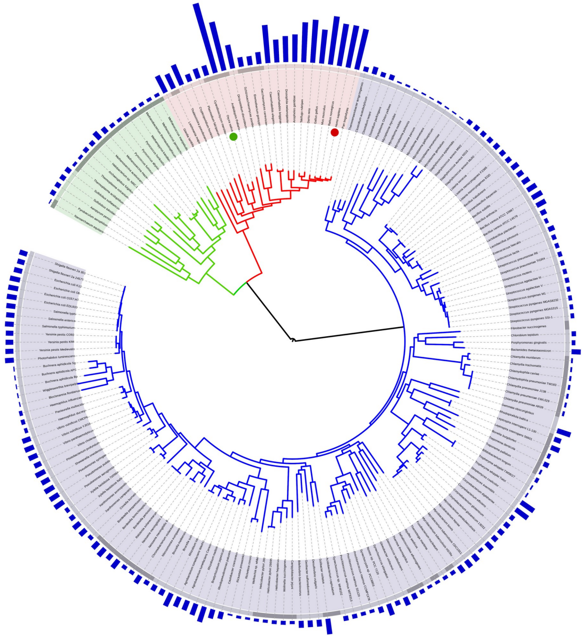

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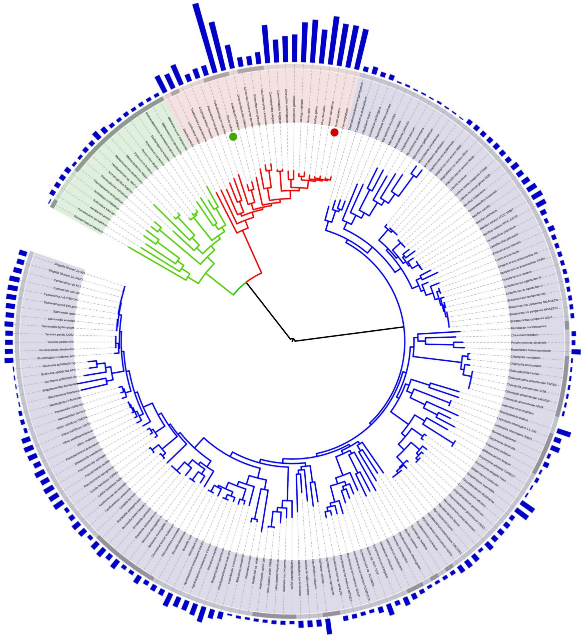
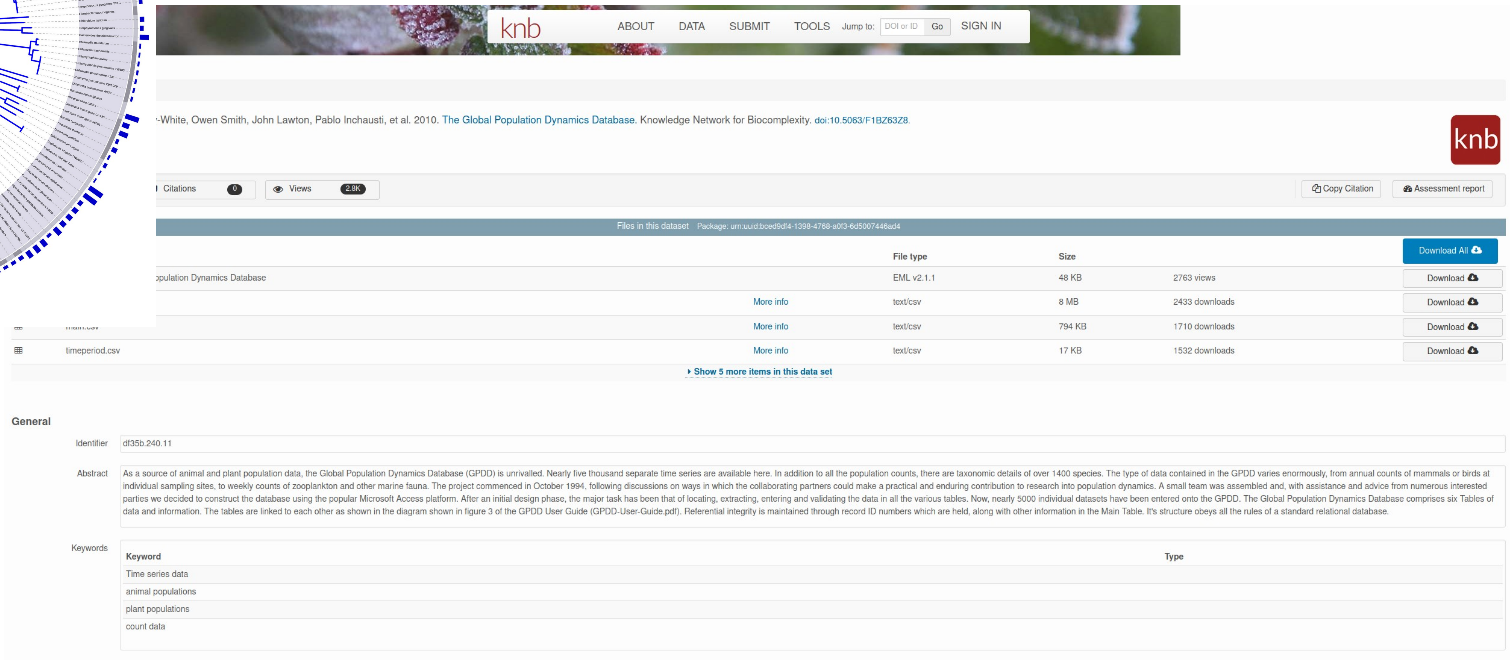


Global Population Dynamics Database



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-White, Owen Smith, John Lawton, Pablo Inchausti, et al. 2010. The Global Population Dynamics Database. Knowledge Network for Biocomplexity. doi:10.5063/F1BZ63Z8.

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Files in this dataset Package: urn:uuid:bced9df4-1398-4768-a0f3-6d5007446ad4

		File type	Size		Download All
opulation Dynamics Database		EML v2.1.1	48 KB	2763 views	Download
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main.csv	More info	text/csv	794 KB	1710 downloads	Download
timeperiod.csv	More info	text/csv	17 KB	1532 downloads	Download

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General

Identifier df35b.240.11

Abstract As a source of animal and plant population data, the Global Population Dynamics Database (GPDD) is unrivalled. Nearly five thousand separate time series are available here. In addition to all the population counts, there are taxonomic details of over 1400 species. The type of data contained in the GPDD varies enormously, from annual counts of mammals or birds at individual sampling sites, to weekly counts of zooplankton and other marine fauna. The project commenced in October 1994, following discussions on ways in which the collaborating partners could make a practical and enduring contribution to research into population dynamics. A small team was assembled and, with assistance and advice from numerous interested parties we decided to construct the database using the popular Microsoft Access platform. After an initial design phase, the major task has been that of locating, extracting, entering and validating the data in all the various tables. Now, nearly 5000 individual datasets have been entered onto the GPDD. The Global Population Dynamics Database comprises six Tables of data and information. The tables are linked to each other as shown in the diagram shown in figure 3 of the GPDD User Guide (GPDD-User-Guide.pdf). Referential integrity is maintained through record ID numbers which are held, along with other information in the Main Table. It's structure obeys all the rules of a standard relational database.

Keywords

Keyword	Type
Time series data	
animal populations	
plant populations	
count data	

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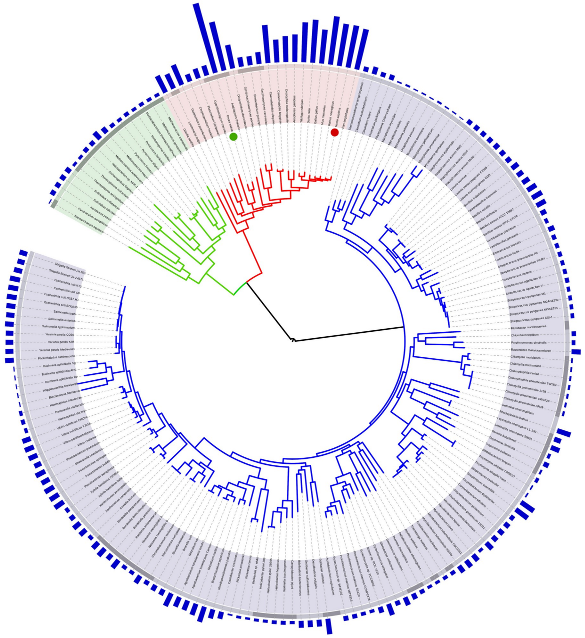

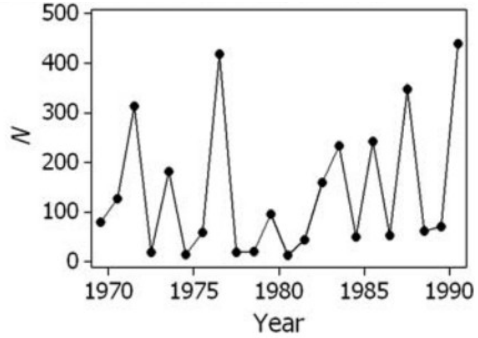

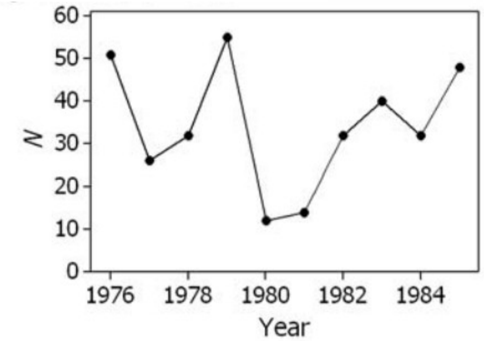

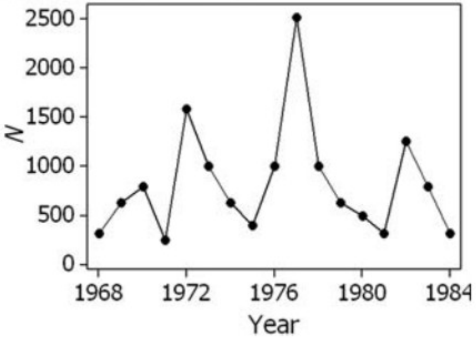

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How should we analyse such data?

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ANOVA

GAM

LM

?

(G)LMM

NLM

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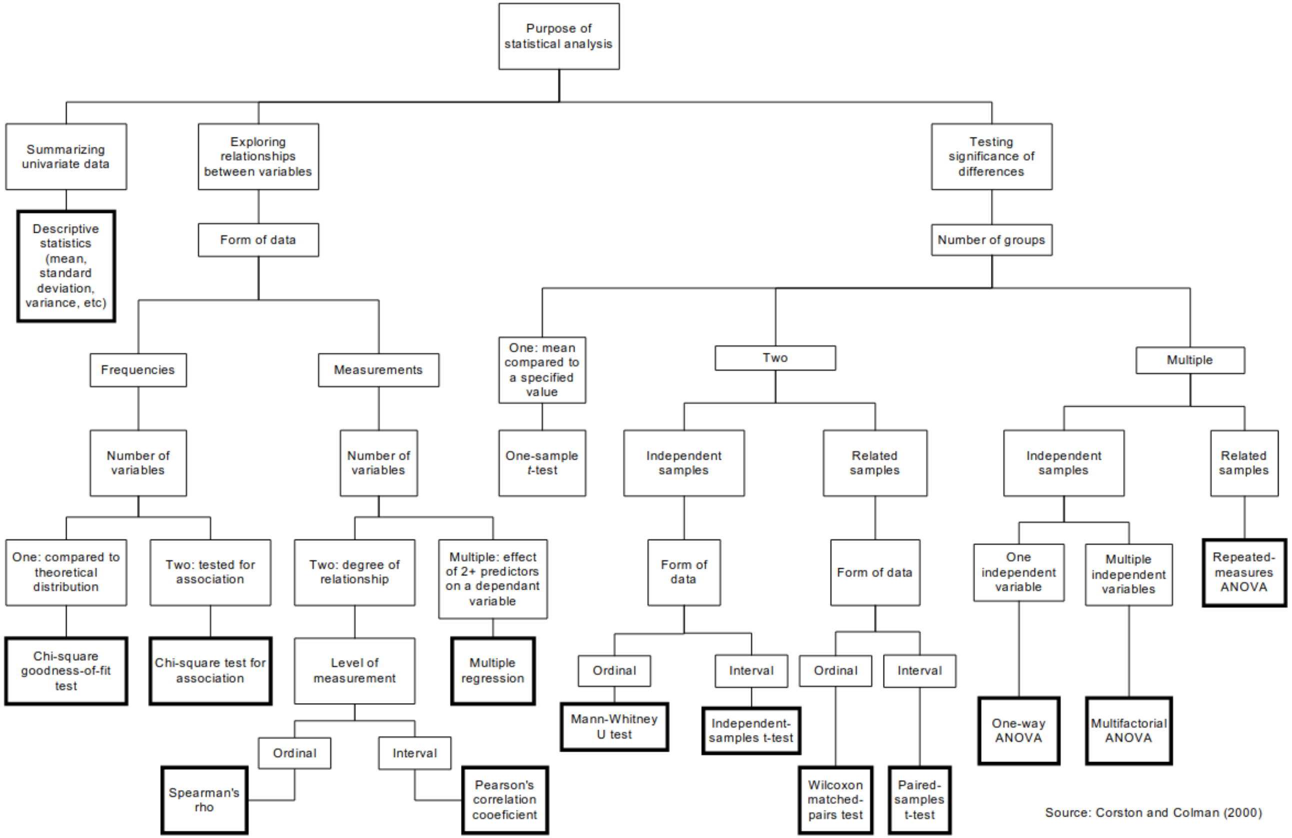
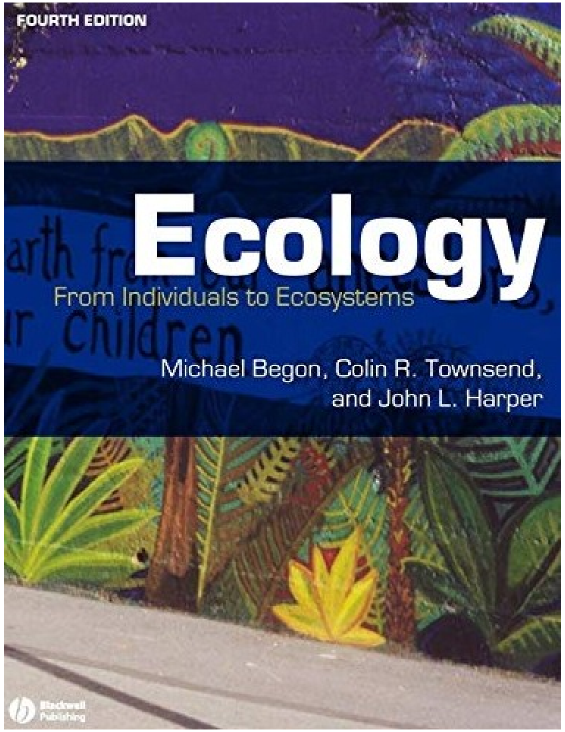


Source: Corston and Colman (2000)

How should we analyse such data?



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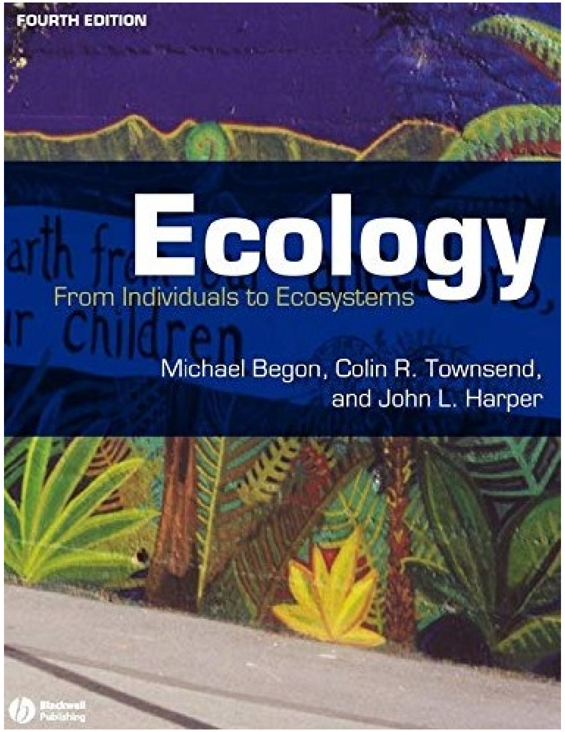
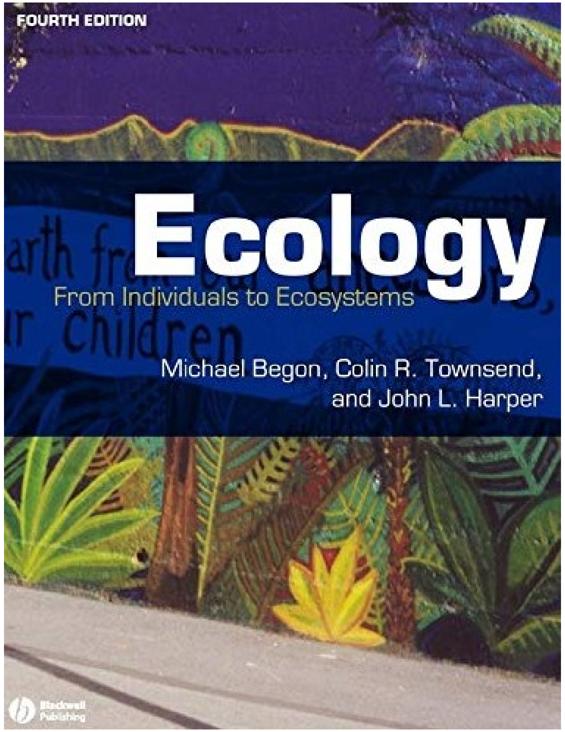


Why is this more interesting than less informed models?

How should we analyse such data?



Why is this more interesting than less informed models?

→ parameter estimation
→ test of theory predictions
→ maybe wrong inference?

Back to basics: exponential growth, logistic growth and inter-specific competition

Back to basics: exponential growth, logistic growth and inter-specific competition

Journal of the History of Biology
https://doi.org/10.1007/s10739-019-09570-9

ORIGINAL RESEARCH

How the Modern Synthesis Came to Ecology

Philippe Huneman[1]

Abstract

Ecology in principle is tied to evolution, since communities and ecosystems result from evolution and ecological conditions determine fitness values (and ultimately evolution by natural selection). Yet the two disciplines of evolution and ecology

Back to basics: exponential growth, logistic growth and inter-specific competition

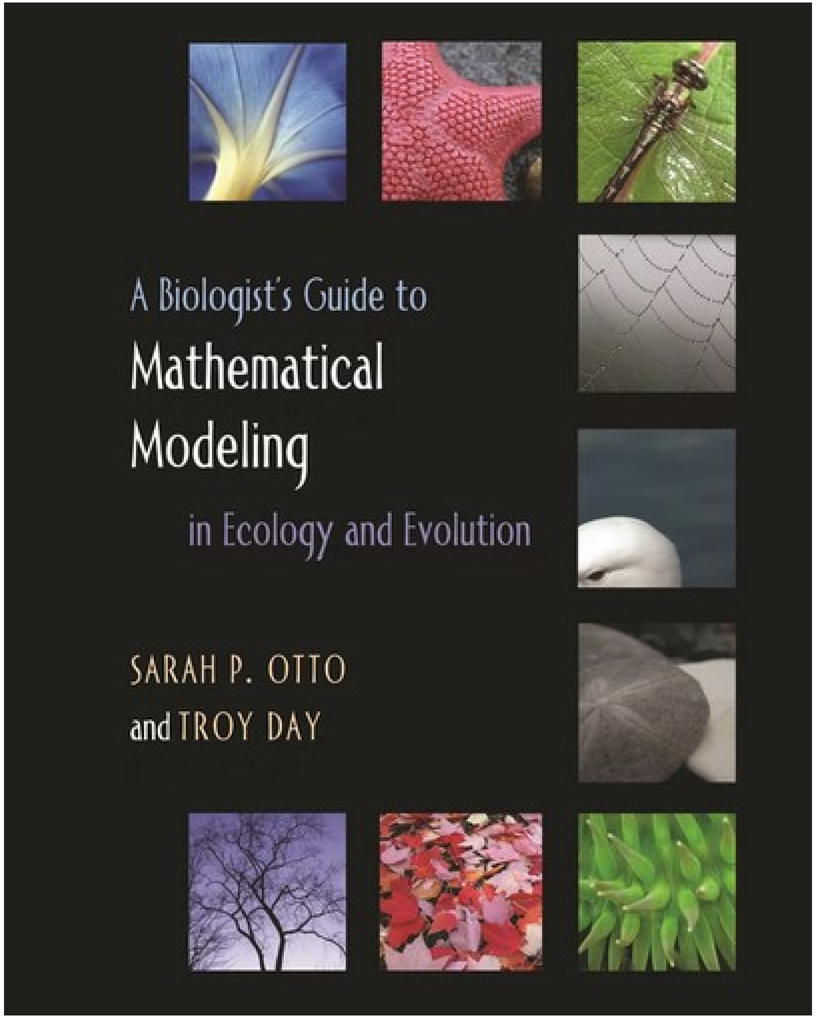
Evolutionary Ecology Research, 2012, **14**: 627–665

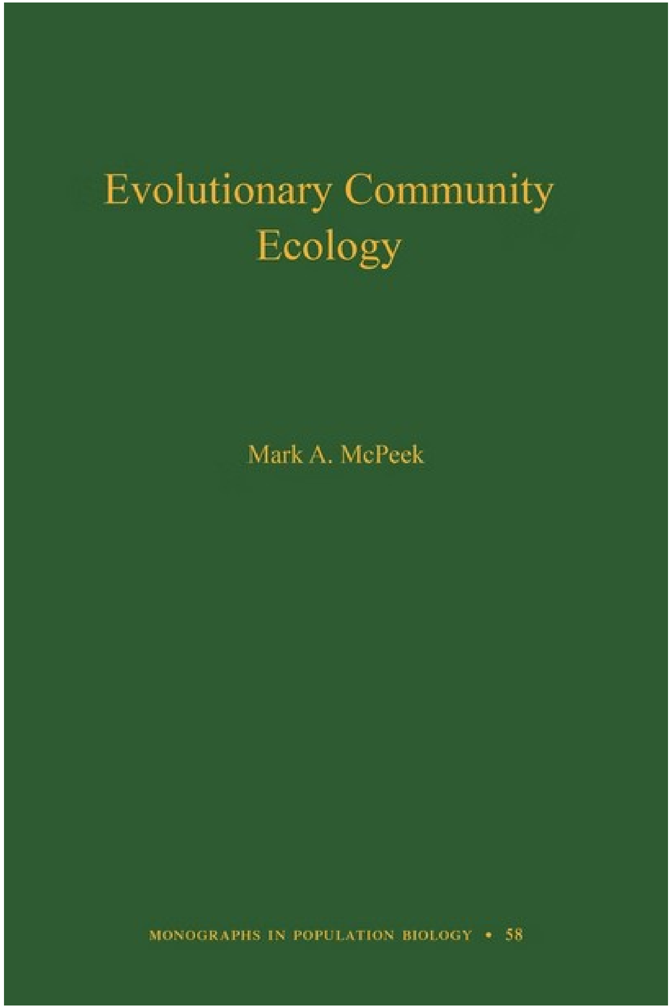
The struggle for existence: how the notion of carrying capacity, *K*, obscures the links between demography, Darwinian evolution, and speciation

James Mallet

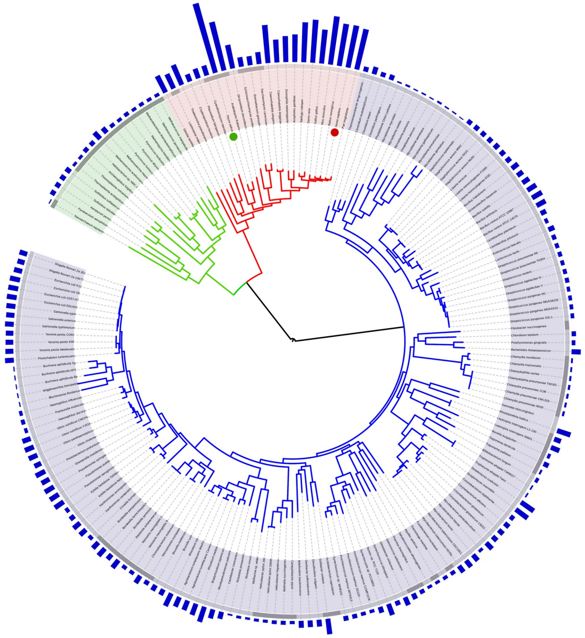
Department of Organismic and Evolutionary Biology, Harvard University, Cambridge, Massachusetts, USA and Department of Genetics, Evolution and Environment, University College London, London, UK

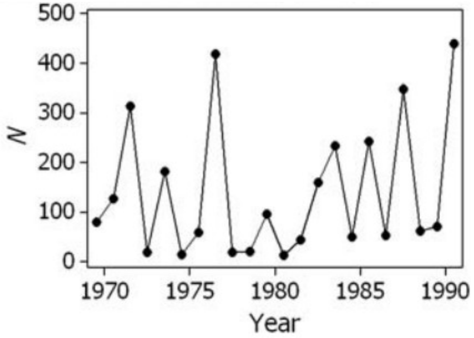
Back to basics: exponential growth, logistic growth and inter-specific competition

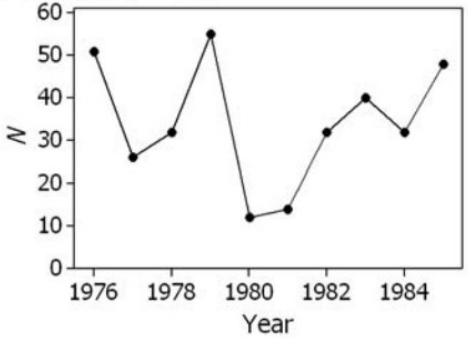


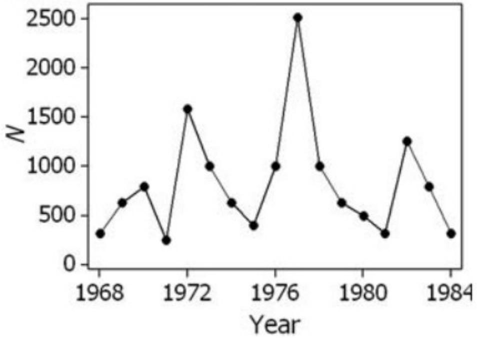


How should we fit such models?









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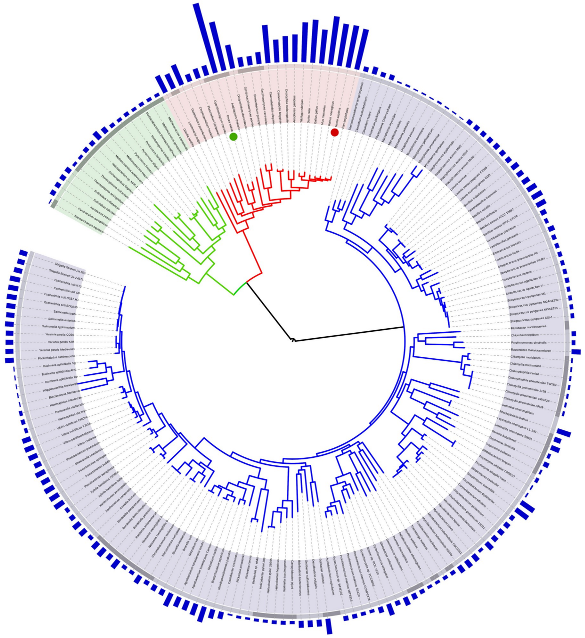
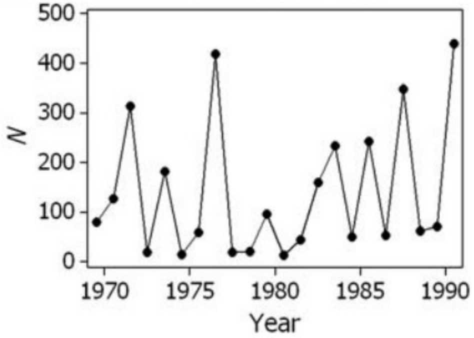
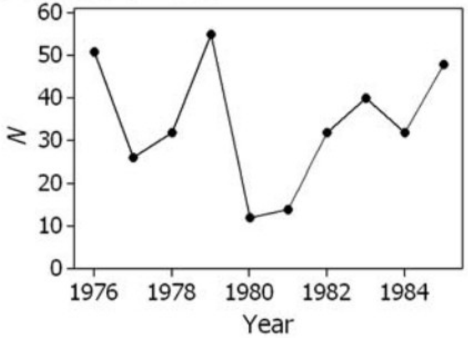
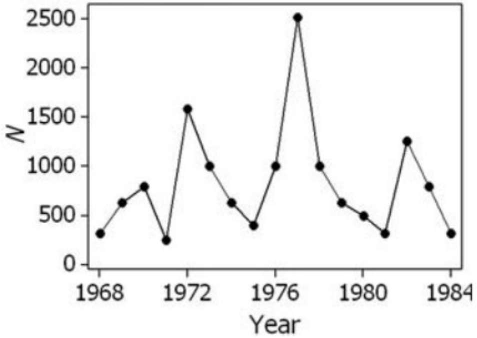






$$\frac{dN}{dt} = r_0 \left[1 - \left(\frac{N}{K} \right)^{\theta} \right] N$$

least-squares



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Methods in Ecology and Evolution

Methods in Ecology and Evolution 2010, **1**, 253–262 doi: 10.1111/j.2041-210X.2010.00029.x

The theta-logistic is unreliable for modelling most census data

Francis Clark[1], Barry W. Brook[1], Steven Delean[1], H. Reşit Akçakaya[2] and Corey J. A. Bradshaw[1,3]*

[1]*The Environment Institute and School of Earth & Environmental Sciences, University of Adelaide, Adelaide, SA 5005, Australia;* [2]*Department of Ecology and Evolution, Stony Brook University, Stony Brook, NY 11794, USA; and* [3]*South Australian Research and Development Institute, P.O. Box 120, Henley Beach, SA 5022, Australia*

Methods in Ecology and Evolution

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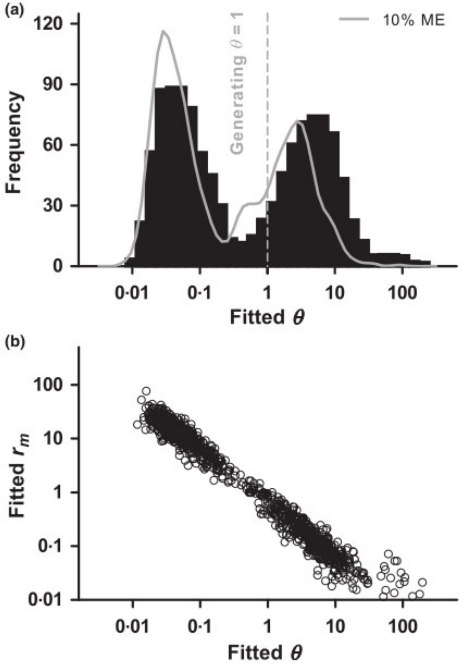

Fig. 2. Bimodality of fitted θ and relationship with r_m. (a) Fitted θ for 1000 simulations of 20 time-steps length, with generating model parameters: $r_m = 0{\cdot}5$, $\theta = 1{\cdot}0$, $\sigma = 0{\cdot}1$ and $K = 100$ (vertical line at generating $\theta = 1{\cdot}0$). Trace shows the effect of 10% measurement error (ME) applied to the abundance values; (b) $\log_{10}$–$\log_{10}$ scatter plot of fitted $[r_m, \theta]$ pairs.

Statistical Rethinking

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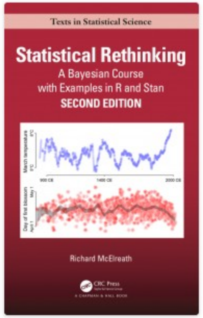
Second Edition

The second edition is now out in print. Publisher information on the CRC Press page. For more detail about what is new, look here.

Materials



2nd Edition

- Book: CRC Press
- Book sample: Chapters 1 and 2 (2MB PDF)
- Lectures and slides:
  * Winter 2022 materials (ongoing)
  * Winter 2019 materials
- Code and examples:
  * R package: rethinking (github repository)
  * R code examples from the book: code.txt
  * Book examples in Stan+tidyverse
  * brms + tidyverse conversion here
  * PyMC3 code examples: PyMC repository
  * NumPyro!
  * More NumPyro
  * TensorFlow Probability notebooks
  * Julia & Turing examples (both 1st and 2nd edition)
  * Another Julia code translation with clean outline in notebook format
  * R-INLA examples

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