csv,conf 2014 - Berlin.

The COMPADRE and COMADRE population matrix databases

Owen R. Jones

University of Southern Denmark

Max-Planck Odense Center on the Biodemography of Aging

jones@biology.sdu.dk, website: owenjon.es

@jonesor

csv,conf 2014 - Berlin.

The COMPADRE and COMADRE population matrix databases

Owen R. Jones

and Roberto Salguero-Gómez

with Yvonne Buckley, Hal Caswell, Miguel Franco, James Vaupel, Annette Baudisch, and many more…

MAX PLANCK INSTITUTE FOR DEMOGRAPHIC RESEARCH

Outline

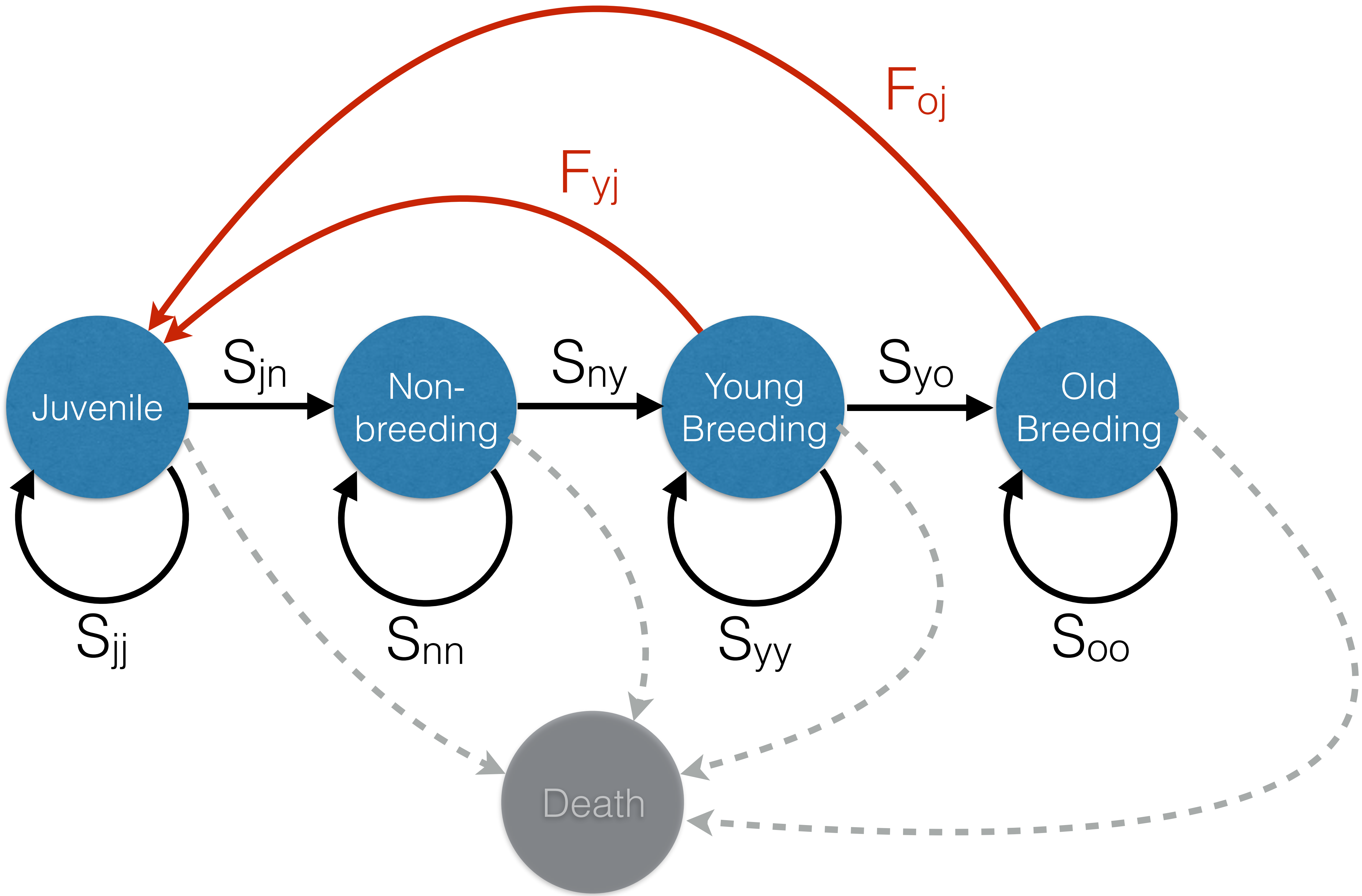
- What are matrix models?
- Why are they useful?
- COMPADRE & COMADRE
- Where do our data come from?
- How do we digitise it?
- How do we distribute it?

What are matrix models?

Mathematical models describing a life cycle of a species in a particular location/population.

- Probabilities of progression from stage-to-stage in a time step (usually a year).
- Probability of death in a time step.
- Number of offspring produced in a time step.

What are matrix models?



What are matrix models?

transition matrix

population vector

$$\mathbf{A} = \begin{bmatrix} S_{jj} & 0 & F_{yj} & F_{oj} \\ S_{jn} & S_{nn} & 0 & 0 \\ 0 & S_{ny} & S_{yy} & 0 \\ 0 & 0 & S_{yo} & S_{oo} \end{bmatrix} \qquad n = \begin{bmatrix} j \\ n \\ y \\ o \end{bmatrix}$$

$$n_{t+1} = \mathbf{A} n_t \qquad n_t = \mathbf{A}^t n_0$$

What are matrix models?

transition matrix

$$\mathbf{A} = \begin{bmatrix} 0.5 & 0 & 2.9 & 1.6 \\ 0.3 & 0.4 & 0 & 0 \\ 0 & 0.6 & 0.5 & 0 \\ 0 & 0 & 0.2 & 0.3 \end{bmatrix}$$

population vector

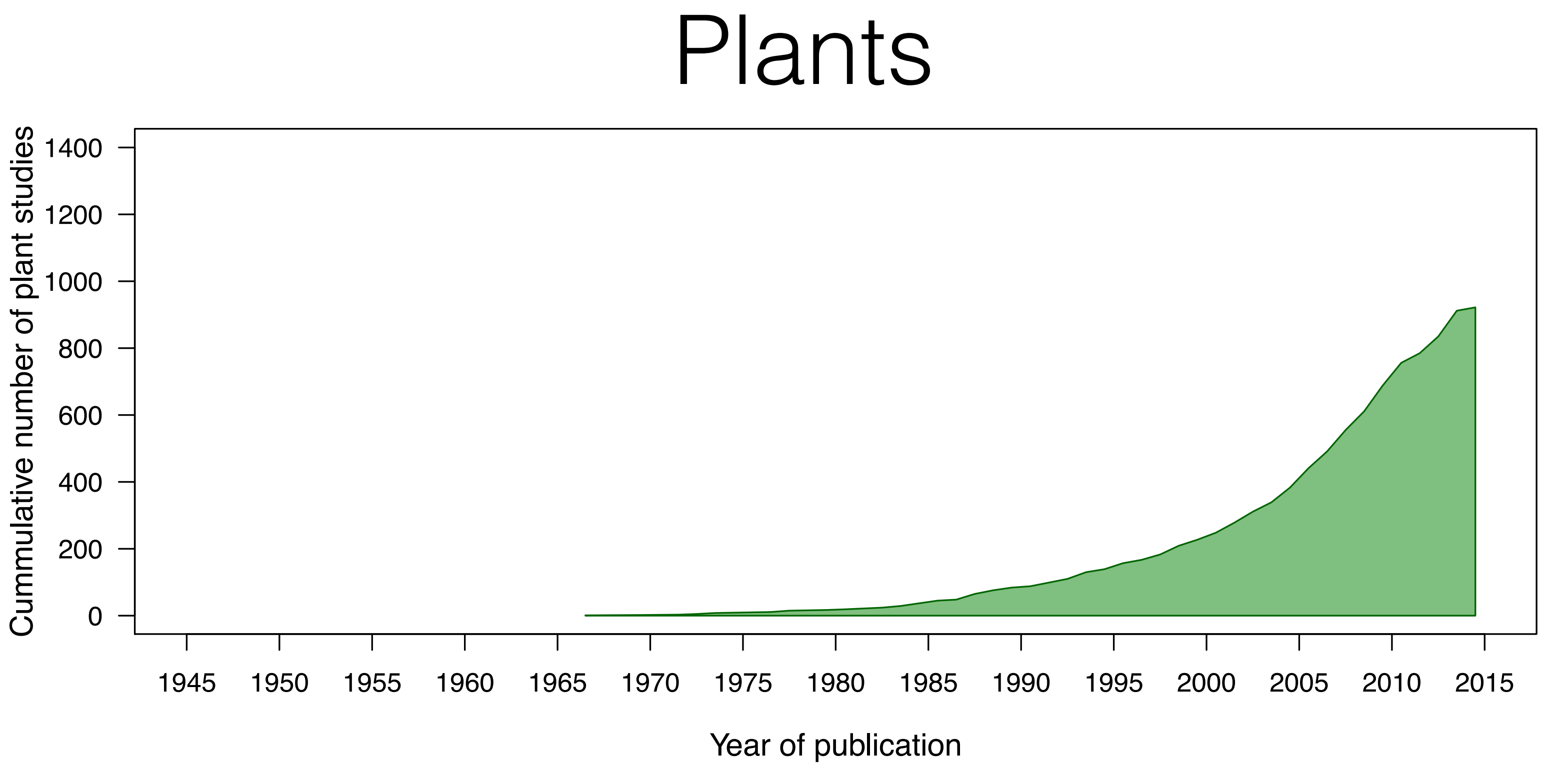
$$n = \begin{bmatrix} j \\ n \\ y \\ o \end{bmatrix}$$

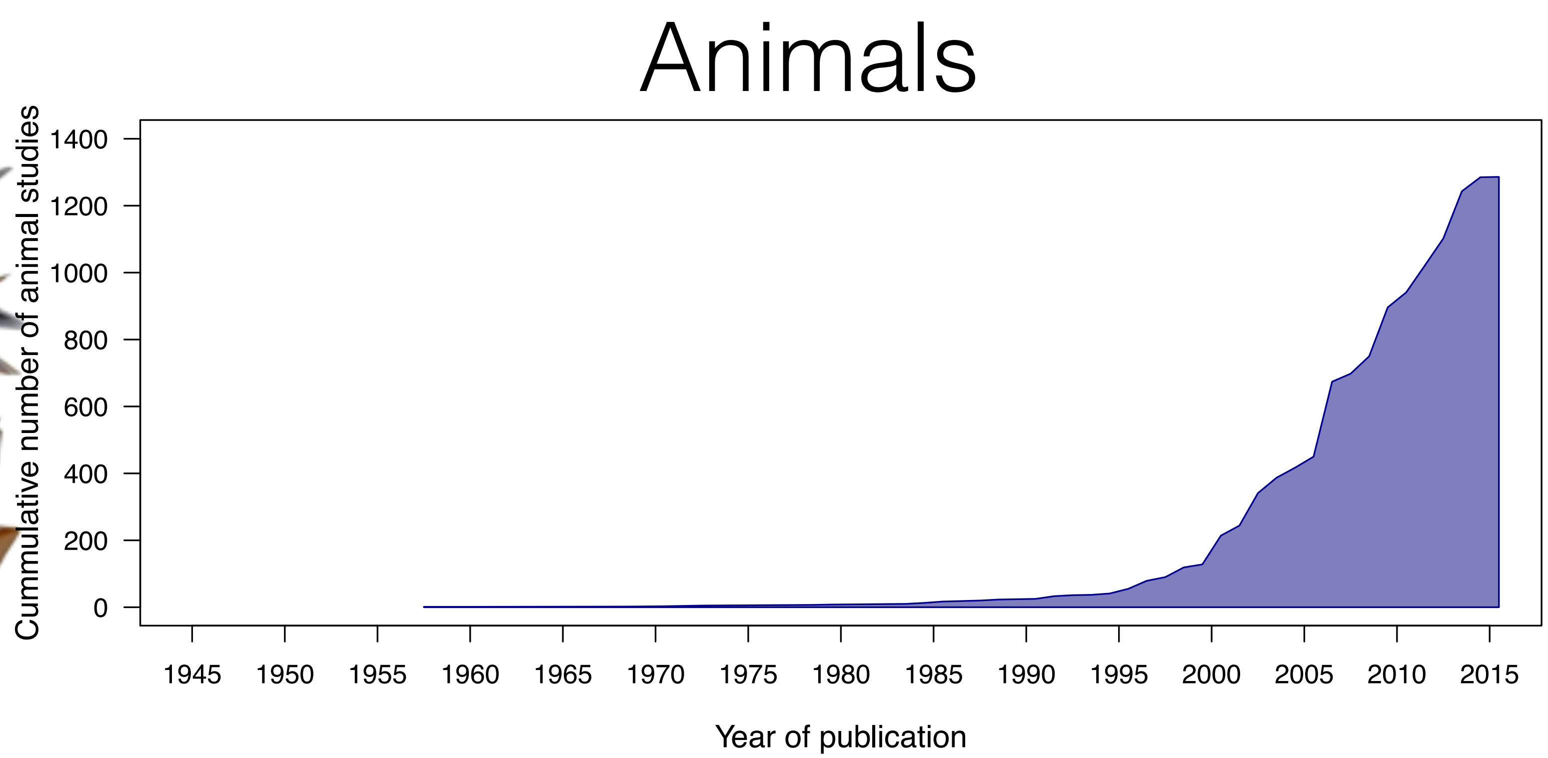
$$n_{t+1} = \mathbf{A} n_t \qquad n_t = \mathbf{A}^t \, n_0$$

What are they used for?

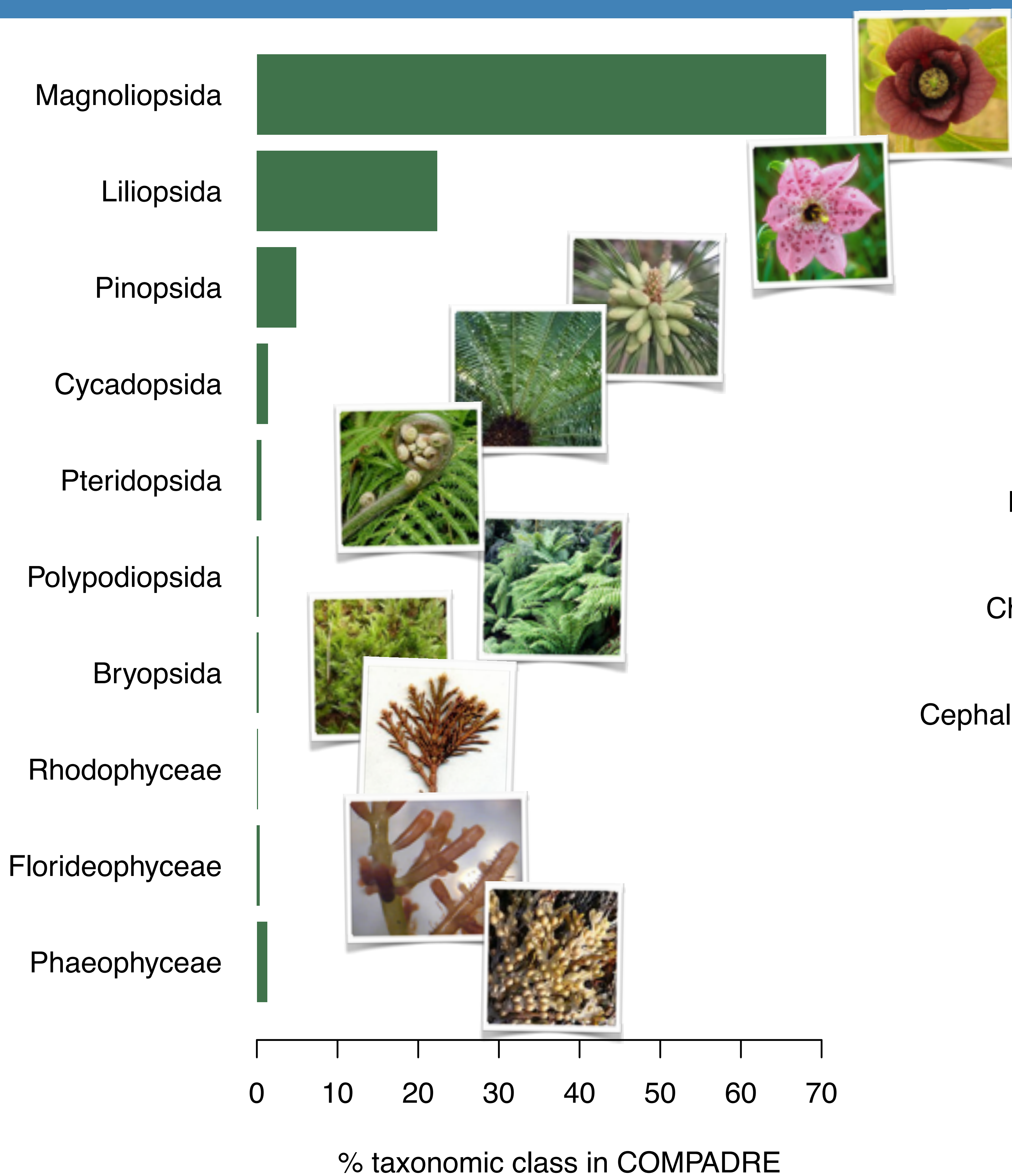
- Population analysis
  - Species management
  - Species conservation
  - e.g. "*What is the future fate of populations in the face of future climate change?*"
  - *"Which stages are most important for conservation purposes?"*
- Evolution of ageing
  - e.g. *"Is senescence inevitable?"*

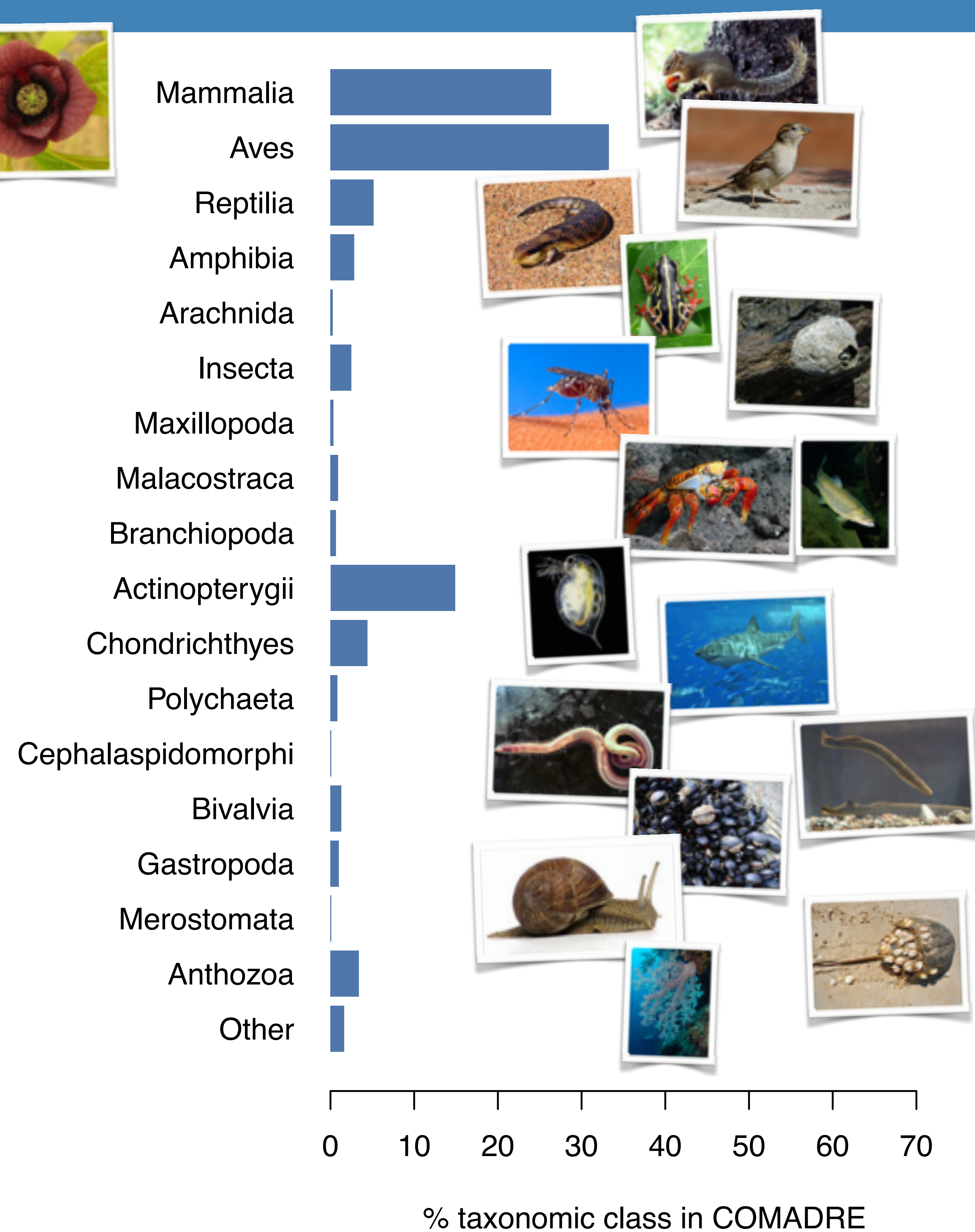
Where do the data come from?





Where do the data come from?





COMPADRE and COMADRE

COMPADRE
Plant Matrix Database

COMADRE
Animal Matrix Database

Some history

1990-2000: Miguel Franco & Jonathan Silvertown

- "mean control matrices" for ~100 plant species

2006-2010: Roberto Salguero-Gómez

- "mean control matrices" for ~400 plant species

2011-now: Roberto Salguero-Gómez & Owen Jones

- Mean and individual matrices for 1000 plant species
- Covariates including location, taxonomy, growth form, etc.

2011-now: Salguero-Gómez and Jones

- Animal matrices, from bears to bugs
- 1300 species in 900 publications

COMPADRE 1.0

COMPADRE 2.0

COMPADRE 3.0

COMADRE 1.0

How do we digitise it?

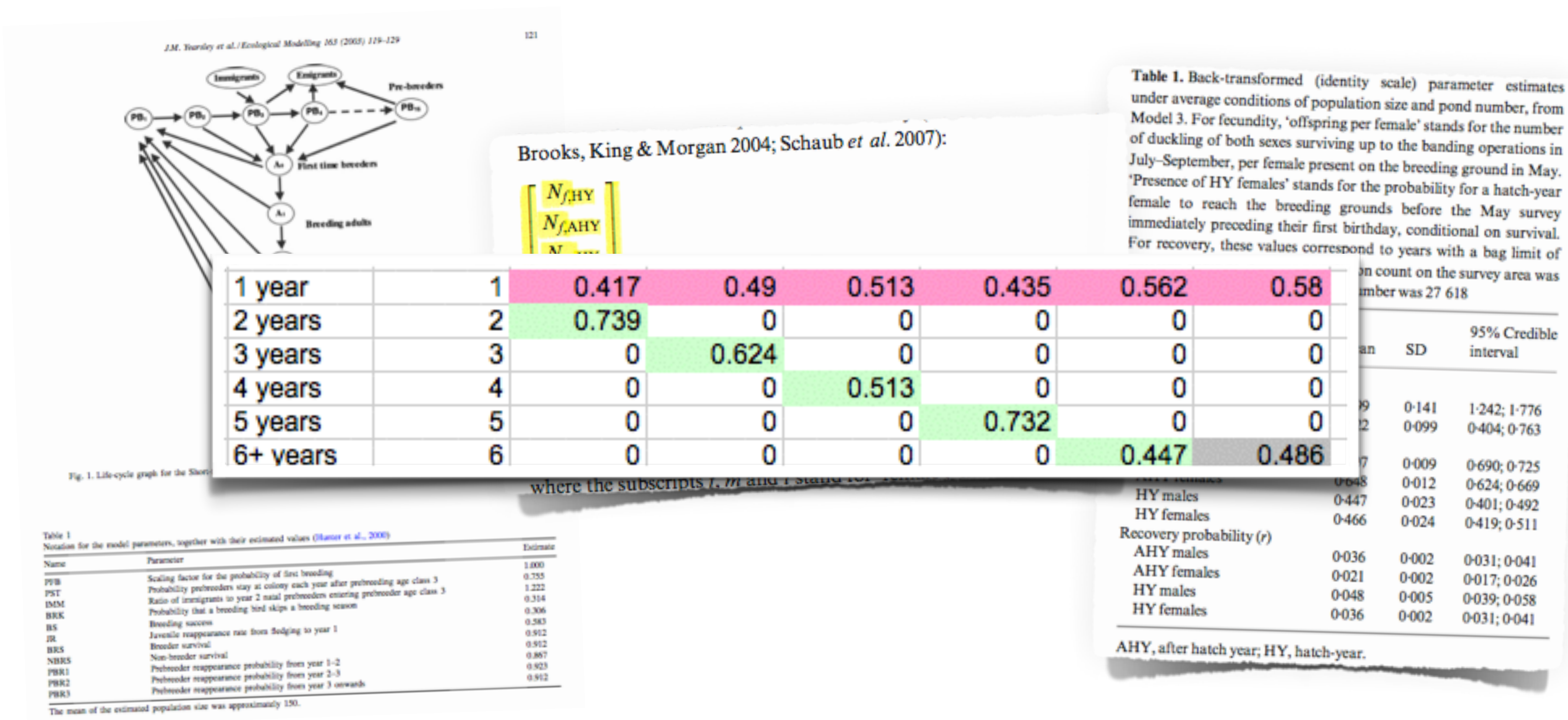
The “Compadrinos”

How do we digitise it?

- Conduct literature searches for PDFs based on citation matches for key literature - Google Scholar, Scopus, Web of Science.
- Read PDFs, extract matrices.
- Check data.
- Resolve problems with authors.

How do we digitise it?

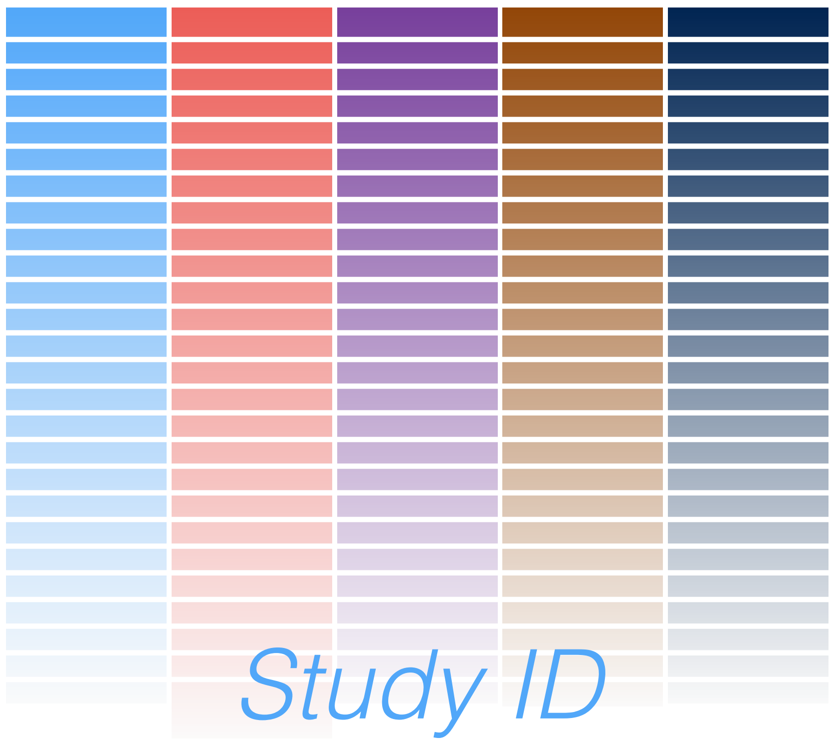
Although matrices are standard mathematical objects…



… their presentation is highly variable.

How do we digitise it?

Study metadata



Study ID

Source info.

Species

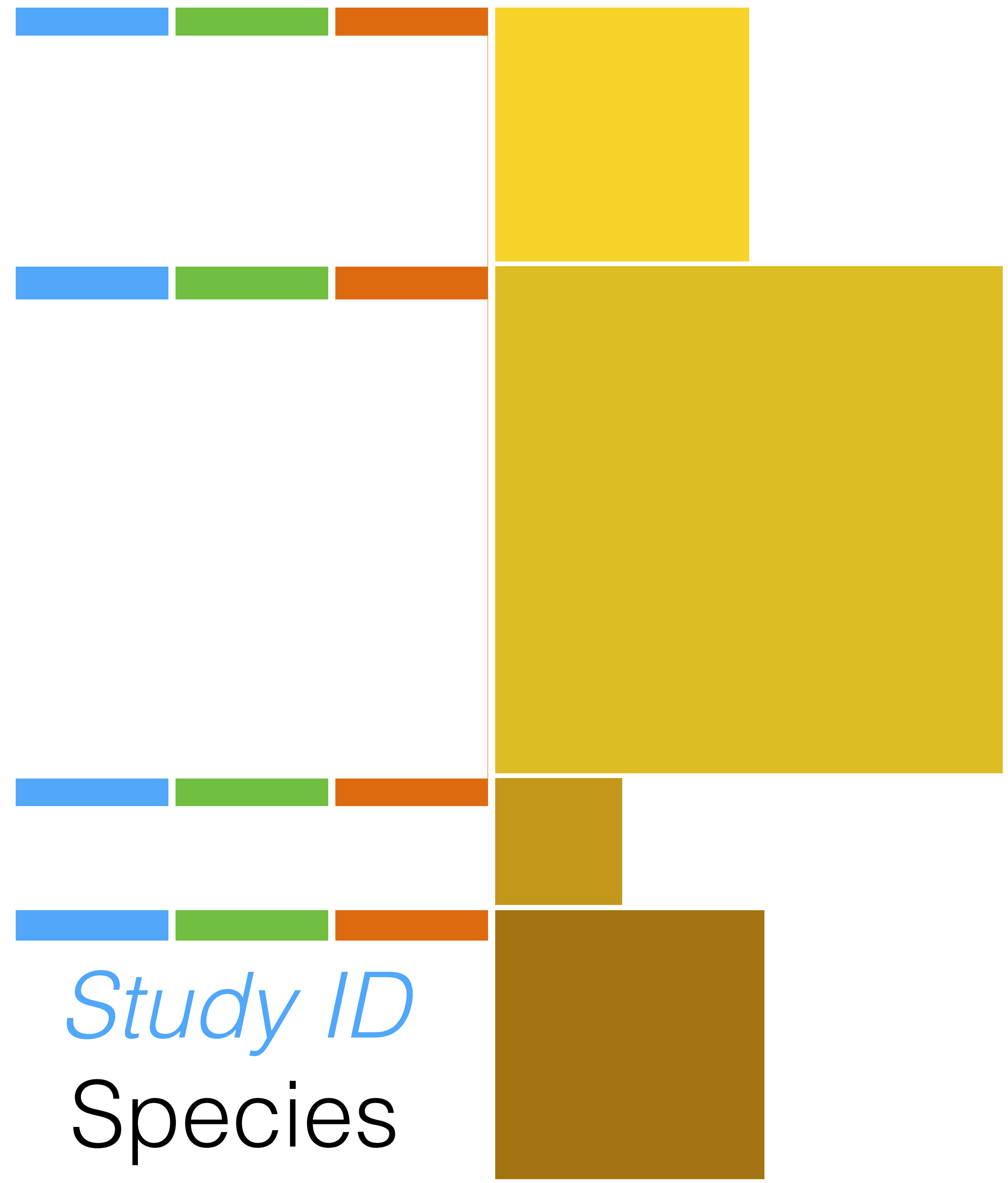
Taxonomy

Growth form

Geo-location

. . .

Matrix metadata & matrices



Study ID

Species

Treatment

Site name

Problems

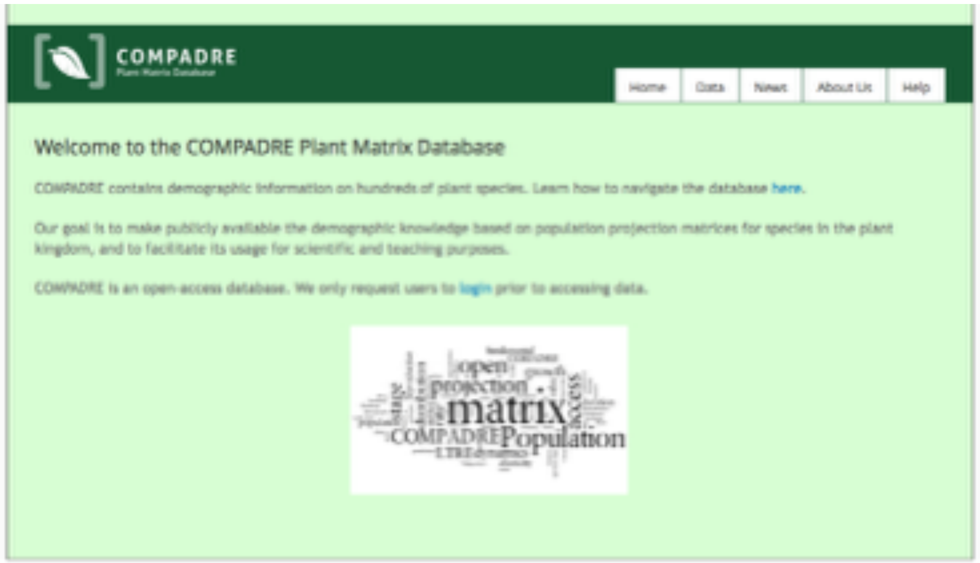
- Envisioned, and spent a year working on a complicated database, but our guru dropped out due to illness.
- Now it is much simpler - just CSV!
- Excel problems!
  - Color coding is a silly idea.
  - Size limit (number of rows).
  - Excel performs poorly with huge shared files.

1 year	1	0.417	0.49	0.513	0.435	0.562	0.58
2 years	2	0.739	0	0	0	0	0
3 years	3	0	0.624	0	0	0	0
4 years	4	0	0	0.513	0	0	0
5 years	5	0	0	0	0.732	0	0
6+ years	6	0	0	0	0	0.447	0.486

- Errors in the papers.
- Legal/ethical issues - can we distribute the data?
- Delays at every stage! (original release date Sept. 2013)

How do we distribute it?

- Until now: email/Dropbox distribution on request.
- Online database abandoned for now :(
- Solution: two CSV files
  - (1) metadata; (2) “stacked” matrices.
  - .RData list object with scripts.
  - Updated every few months.
- Open access, but requires registration.



www.comapadre-db.org

Output

Leader	Coauthors	Project title	Status	Description	
Franco	Silvertown	Plant demography: what do we know?	**Published**	Evol Trends Plants 1990	
Silvertown	Franco & McConway	A demographic interpretation of Grime's triangle	**Published**	Funct Ecol 1992	
Silvertown	Franco & McConway	The eternal triangle - an attempt at reconciliation	**Published**	Funct Ecol 1993	
Silvertown	Franco	Plant demography and habitat: a comparative approach	**Published**	Plant Spp Biol 1993	
Silvertown	Franco, Pisanty & Mendoza	Comparative plant demography - relative importance of life-cycle comp	**Published**	J Ecol 1993	
Enright	Franco & Silvertown	Comparing plant life histories using elasticity analysis: the importance o	**Published**	Oeco 1995	
Franco	Silvertown	On trade-offs, elasticities and the comparative method: a reply to Shea,	**Published**	J Ecol 1994	
Franco	Silvertown	Life history variation in plants: an exploration of the fast-slow continuur	**Published**	Phil Trans Biol Sci 1996	
Silvertown	Franco & Menges	Interpretation of elasticity matrices as an aid to management of plant p	**Published**	Cons Biol 1996	
Silvertown	Franco & Perez-Ishiwara	Evolution of senescence in iteroparous perennial plants	**Published**	Evol Ecol Res 2001	
Franco	Silvertown	A comparative demography of plants based upon elasticities of vital rat	**Published**	Ecol 2004	
Salguero-Gomez	Casper	Keeping plant shrinkage in the demographic loop	**Published**	J Ecol 2010	
Salguero-Gomez	de Kroon	Matrix projection models meet variation in the real world	**Published**	J Ecol 2010	
Salguero-Gomez	Plotkin	Matrix dimensions bias demographic inferences: implciations for compa	**Published**	Am Nat 2010	
Salguero-Gomez	Siewert, Casper & Tielborger	A demographic approach to study effects of cliamte change in desert pl	**Published**	Phil Trans Royal Soc B 2012	
Burns	Blomberg, Crone, Ehrlen, Knight, Pichancourt, Ramula,	Empirical tests of life-history evolution theory using phylogenetic analys	**Published**	J Ecol 2010	
Stott	Franco, Carslake, Townley & Hodgson	Boom or burst? A comparative analysis of transient population dynamic	**Published**	J Ecol 2010	
Buckley	Ramula, Blomberg, Burns, Crone, Ehrlen, Knight, Pichai	Causes and consequences of variation in plant population growth rate:	**Published**	Ecol Lett 2010	
Stott	Townsley & Hodgson	A framework for studying transient dynamics of population projection n	**Published**	Ecol Lett 2011	
Crone	Menges, Ellis, Bell, Bierzychudek, Ehrlen, Kaye, Knight,	How do plant ecologists use matrix population models?	**Published**	Ecol Lett 2011	
Baudisch	Salguero-Gomez, Jones, Wrycza, Mbeau-Ache, Franco	The pace and shape of senescence in angiosperms	**Published**	J Ecol 2013	
Caswell	Salguero-Gomez	Age, stage, and senescence in plants	**Published**	J Ecol 2013	
Mbeau-Ache, Univ Plymouth, cyril.mbeauache@	Franco	The time distribution of reproductive value measures the pace of life	**Published**	J Ecol 2013	The pace and d
van de Kerk, Nijmegen	de Kroon, Conde & Jongejans	Carnivora population dynamics are as slow and as fast as that of other r	**Published**	PLOS One 2013	
Jones, MaxO, jones@biology.sdu.dk	Scheuerlein, Salguero-Gomez, Camarda, Schaible, Prin	Varieties of ageing across the tree of life	**Published**	Nature 2014	
Adler, USU, peter.adler@usu.edu	Salguero-Gomez, Compagnoni, Hsu, Mukherjee-Ray, A	Functional traits explain variation in plant history strategies	**Published**	PNAS 2013	
Salguero-Gomez, UQ, r.salguero@uq.edu.au	Jones, Jongejans, Mbeau-Ache, Scheuerlein, Zuidema,	Axes of plant demography: a global perspective	In preparation	Exploration of the general re	
Salguero-Gomez, UQ, r.salguero@uq.edu.au	Jones, Che-Castaldo, Conde, Colchero, Scheuerlein, Bai	COMPADRE III: a database for comparative plant demography	In preparation	Introduction of the database	
Coutts, UQ, s.coutts@uq.edu.au	Salguero-Gomez, Buckley	Are life history similarities predicted more strongly by species or locatio	In preparation	Try and predict dissimilarity	
Che-Castaldo, SESYNC, jchecastaldo@sesync.org	Neel	Predicting extinction risk based on species life history traits	In preparation	Quantifying relationships be	
Conde, USD, dalia@biology.sdu.dk	Jones, Salguero-Gomez, Gaillard, Devillard, Lebreton, S	DSKo: a demogrpahic index of species knowledge for the world vertebra	In preparation	Demographic knowledge acr	
Cohen, Sherbrooke Univ, aacohen1.bus@gmail.c	Salguero-Gomez, Jones, Scheuerlein	Systemic physiological constraints: A new evolutionary theory of aging	In preparation	TBA	
Csergo, UBC, csergo@mail.ubc.ca	Angert & Salguero-Gomez	Plant livelihodd in time across geographic ranges	In preparation	Testing if plant demography	
Salguero-Gomez, UQ, r.salguero@uq.edu.au	Burns & Buckley	Size plasticity allows herbaceous perennials to slow down senescence	In preparation	Testing the role of size plasti	
Salguero-Gomez, UQ, r.salguero@uq.edu.au	Compagnoni, Hsu, Colchero, Wrycza, Jones, Baudisch, I	Testing Finch's hypothesis: the role of plant modularity on the escape o	In stand-by	Phylogenetic correlations of	
Salguero-Gomez, UQ, r.salguero@uq.edu.au	Jones	Evolution of senescence across the tree of life	In stand-by	Phylogenetic analyses on ag	
Jones, MaxO, jones@biology.sdu.dk	Salguero-Gomez	Life and death in the garden: mortality and recruitment trajectories in p	In stand-by	Follow up to axes of senesce	
Violle, CNRS Montpellier, cyrille.violle@cefe.cnrs	Salguero-Gomez, Freville, Lebreton	NA	Brainstorming	Predicting species' distributi	
Salguero-Gomez, UQ, r.salguero@uq.edu.au	Lind, Borer, Seabloom, Buckley, NutNet	Influence of demographic resilience in plant response to eutrophication	Brainstorming	Leveraging population matri	
Petry, UCI, wpetry@uci.edu	NA	Sexual dimorphism in plant life history and it's consequences for popula	Brainstorming	Investigating sex-specific dif	
Salguero-Gomez, UQ, r.salguero@uq.edu.au	Jones, Che-Castaldo, Conde, Colchero, Scheuerlein, Bai	COMADRE: a database for comparative animal demography	Not yet started	Introduction of the database	
Salguero-Gomez, UQ, r.salguero@uq.edu.au	Lebreton	Ro in plant population dynamics	Not yet started	The relationship between Ro	
Hodgson, Univ Exeter, d.j.hodgson@ex.ac.uk	Stott, Townly, Franco & Salguero-Gomez	Grant proposal: Critical reappraisal fo the demogrpahic buffering hypotl	In preparation	Using Compadre and Comad	
Hodgson, Univ Exeter, d.j.hodgson@ex.ac.uk	Stott & McDonald	RAID (Rapid Assessment of Invasive Demography)	PhD project	Seeking demographic correl	
Thomson	Jarrod + others	Natural selection and parent-offspring conflict	In preparation	Using existing data we estim	
Franco, Univ Plymouth, m.franco@plymouth.ac.u	Mbeau-Ache	An empirical evaluationof directionality theory	In preparation	TBA	
Bullock, UK CEH, jmbul@ceh.ac.uk	Hofftman, White & Gilbert	Comparative spread rates of plant species: combining demography and	In preparation	Combining our database of p	
Jones, MaxO, jones@biology.sdu.dk	Salguero-Gomez, Dahlgren et al.	Variation in demographic trajectories	In stand-by	Exploring the issue of spatial	
Burger, MPIDR/Kent burger@demogr.mpg.de	Jones, Scheuerlein	Revisiting Charnov's invariant quantities using projection matrix and life	In stand-by	We use the comparative me	
Baudisch, MPIDR baudisch@demogr.mpg.de	Salguero-Gomez, Jones, Wrycza, ..., Colchero	Two axes of ageing: pace and shape	In preparation	Testing hypothesis of pace a	
Baudisch, MPIDR baudisch@demogr.mpg.de	Salguero-Gomez, Jones, Wrycza, ..., Colchero	Relation between pace and shape depending on life history parameters	Brainstorming	Putting confidence bands ar	
Baudisch, MPIDR baudisch@demogr.mpg.de	Salguero-Gomez, Jones, Wrycza, ..., Colchero	Exploring Determinants of Pace and Shape in the Plant Kingdom	Brainstorming	Would require connection o	
Iles, david.iles@aggiemail.usu.edu	Illes, Koons	Simulation of transients in plants	Brainstorming	TBA	

Acknowledgements

Digitisation team

Ruth Archer, Hendrik de Burh, Claudia Farack, Fränce Gottschalk, Anne Henning, Gesa Römer, Julia Wille, Stefan Zeh, Alexander Hartmann, Erik Brinks, Gabriela Cosma, Gabriel Hoppe, Christin Endert, Elizabeth McCuaig, Jens Runge, Tara Ruoff, Henry Tai, Bonnie Waring & Angela Zeh

Core committee

Owen Jones, Roberto Salguero-Gómez, Yvonne Buckley, Judy Che-Castaldo, Dalia Conde, Annette Baudisch, Alex Scheuerlein, Hal Caswell, James Vaupel

Science committee

Res Altwegg, Ming Dong, Fernando Colchero, Miguel Franco, David Hodgson, Hans de Kroon, Jean Dominique Lebreton, Jessica Metcalf, Maile Neel, Ingrid Parker, Bernt-Erik Saether, Jonathan Silvertown, Takenori Takada, Juan Silva, Teresa Valverde, Luis Antonio Velez-Espino, Glenda Wardle

Funding

The British Council, Consejo Nacional de Ciencia y Tecnologia (CONACyT) Mexico, Academia Mexicana de Ciencias, The Royal Society of London, The Ferguson Trust, Open University, CONACyT, DGAPA UNAM, Natural Environment Research Council UK, Australian Research Council, Australia–New Zealand Vegetation Function Network, Reese Family Foundation, European Social Fund, EvoDemo Max-Planck Institute for Demographic Research (MPIDR), US Department of Defense, Natural Environmental Research Council UK.

COMPADRE
Plant Matrix Database

COMADRE
Animal Matrix Database

www.compadre-db.org

@compadredb
compadredb.wordpress.com