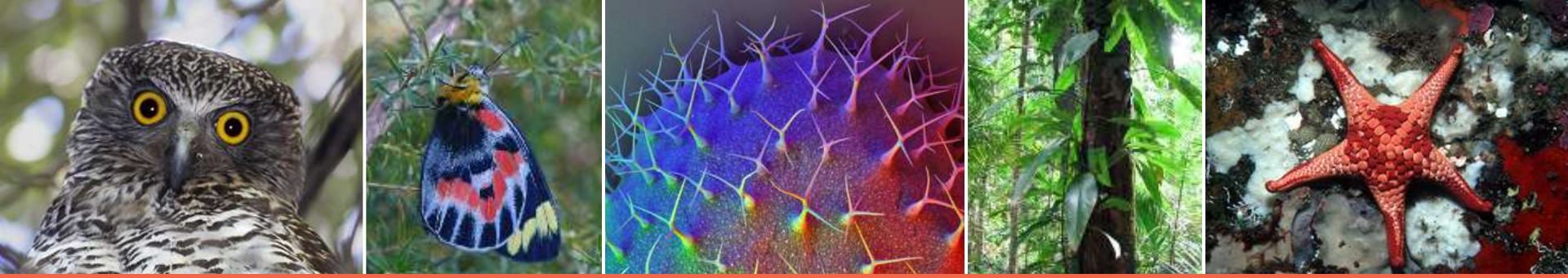


www.ala.org.au

Ecology .101

Lee Belbin

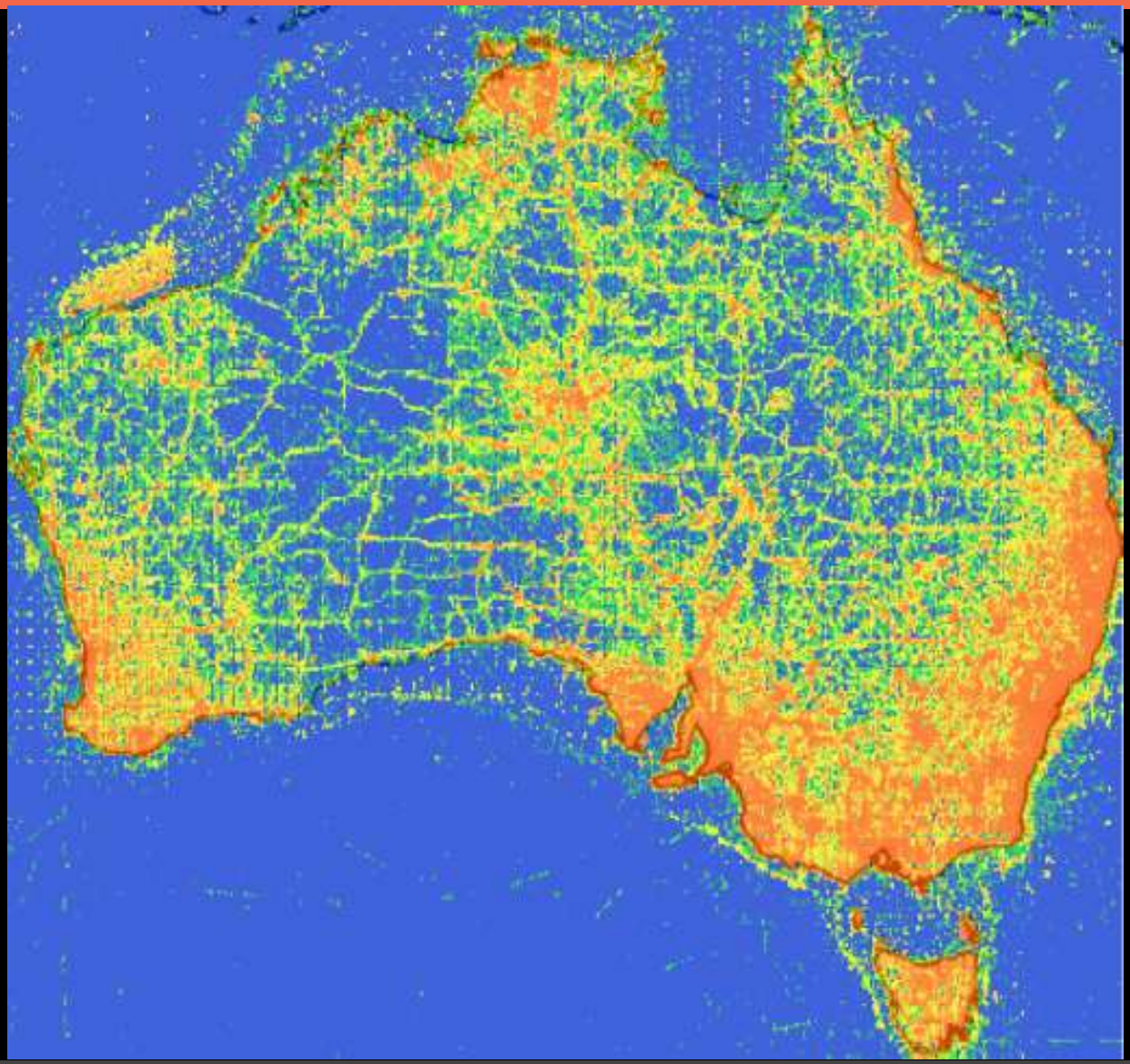
lee@blatantfabrictions.com

ALA, 13th July, 2011

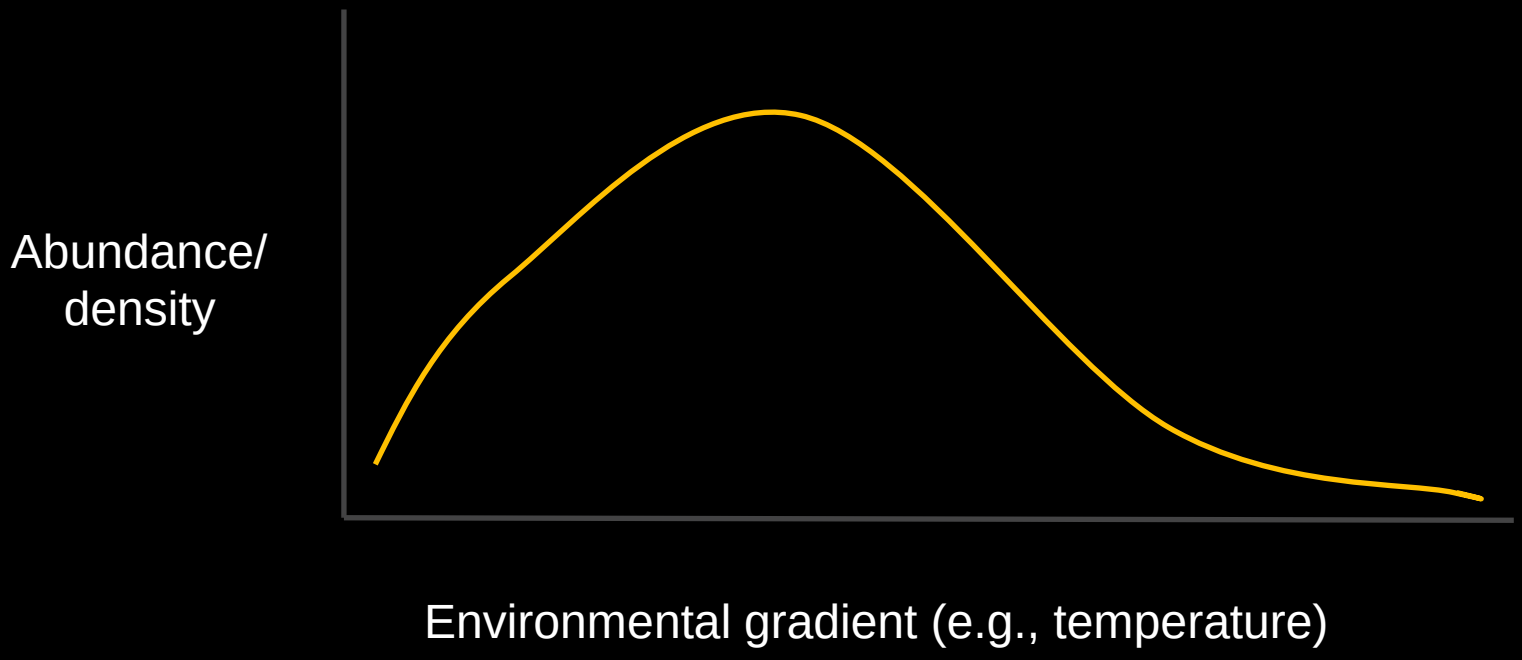
Species and Environment

- Species distributions are controlled by ‘environmental conditions’
  - Species operate at different spatial scales
  - Different conditions apply to different species
  - Competition and herbivery may be significant
  - There may be barriers to dispersion
  - Limits to growth, survival and reproduction
  - Environmental diversity = ecological diversity
  - Biodiversity = ‘biological diversity’

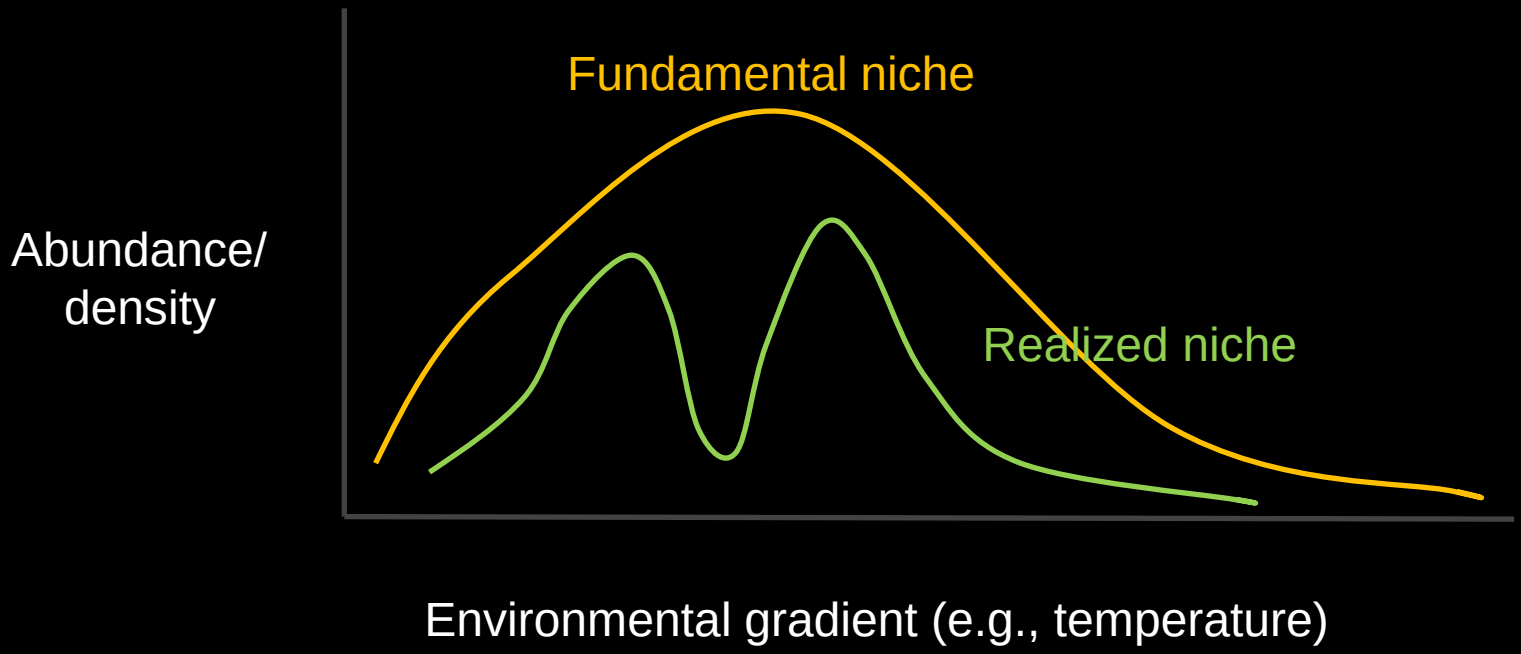
Species Diversity



Species ‘Responses’



Niche

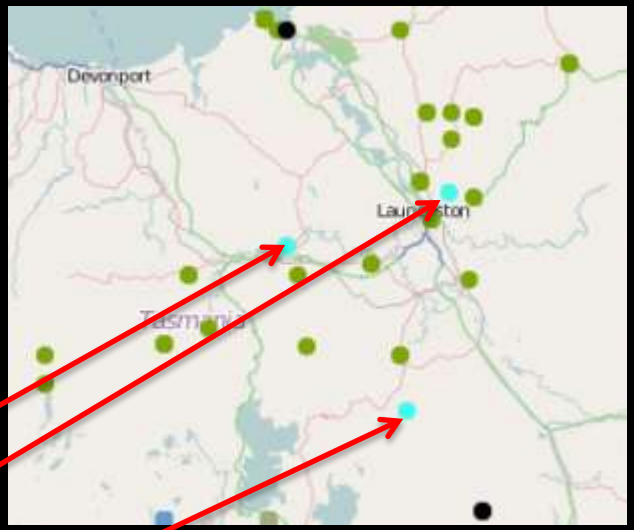

Fundamental niche
Realized niche
Abundance/
density
Environmental gradient (e.g., temperature)

Fundamental vs Realized Niche…

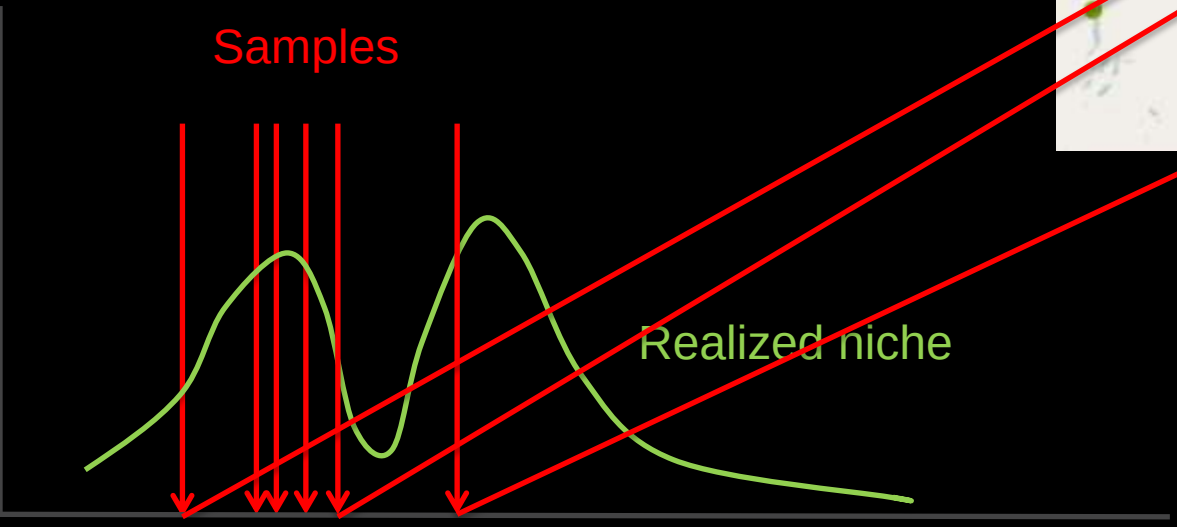
- …are not academic!
- Usually realized niche is smaller in area than its fundamental niche, but…
- Radiata pine was originally from three small localities on a narrow stretch of coast in southern California. Now there are plantations and wild populations over much of the temperate world.
  - Nothing much lives under radiata in Oz!
- Tasmanian blue gum is one of the most common international plantation (& escaped) species
  - Nothing much lives under blue gum anywhere but Oz!
- Competition can lead to a loss or increase in diversity!
  - Eucalypts in Oz vs elsewhere

Species and Location

Geographic/map/spatial



Environmental



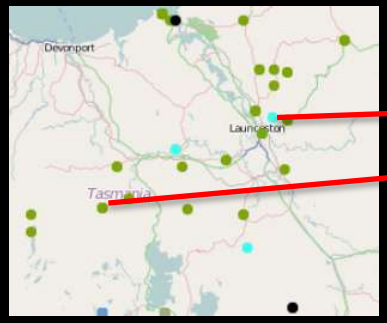
Environmental gradient (e.g., temperature)

Location and Environment

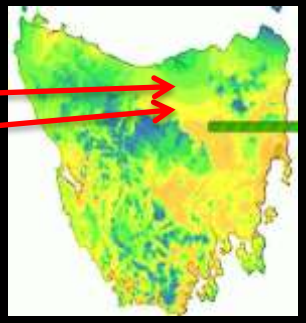
- Location and environment are linked-
  - A small change in location generally means a small change in the environment (spatial autocorrelation)

- Tools that link location and environment are basic to ecology (e.g., ‘sampling’, scatterplot, classification, prediction…)

Geographic



Geographic/
environmental



Proximal & Distal

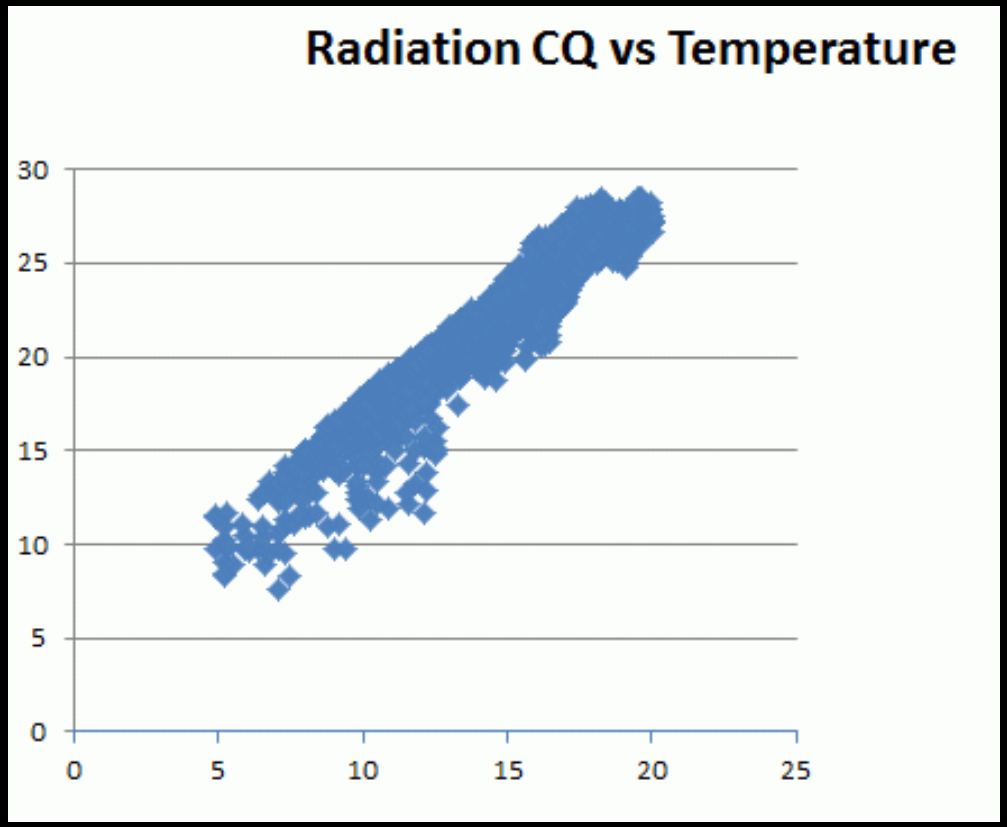
- The distribution of a species may be related to
  - Mean annual temperature (distal)
- But it may be more closely related to
  - Number of frost free days (proximal)

- Henry Nix suggested a suite of more proximal climatic variables – Bioclimatic variables (BIOCLIM: That we have)

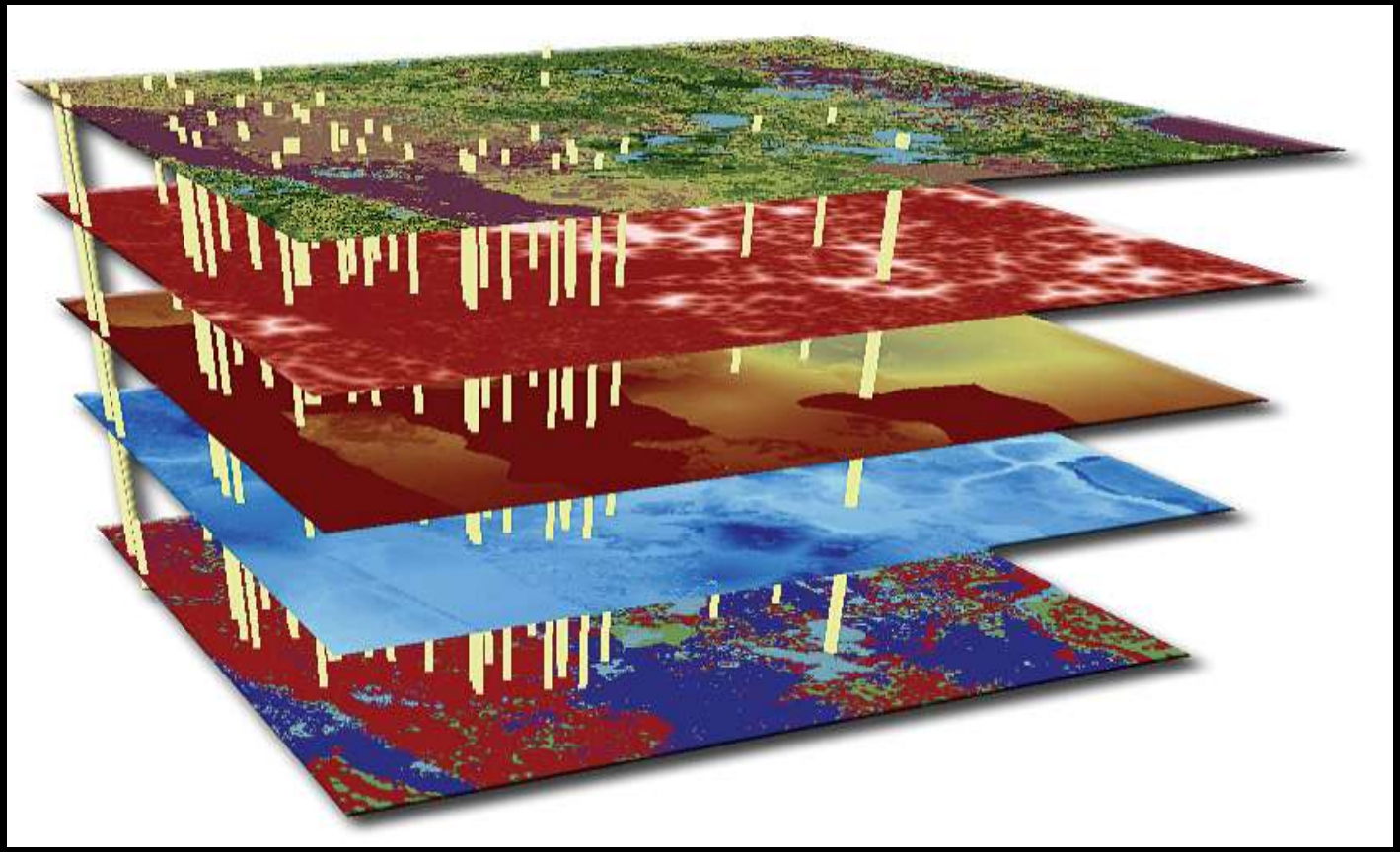
Environments

- Climate
  - Temperature
  - Precipitation
  - Solar radiation
  - Humidity
  - Evaporation
  - Depth
- Substrate & marine
  - Physics
  - Chemistry
- Topography
  - Slope
  - Aspect

Environmental Correlation

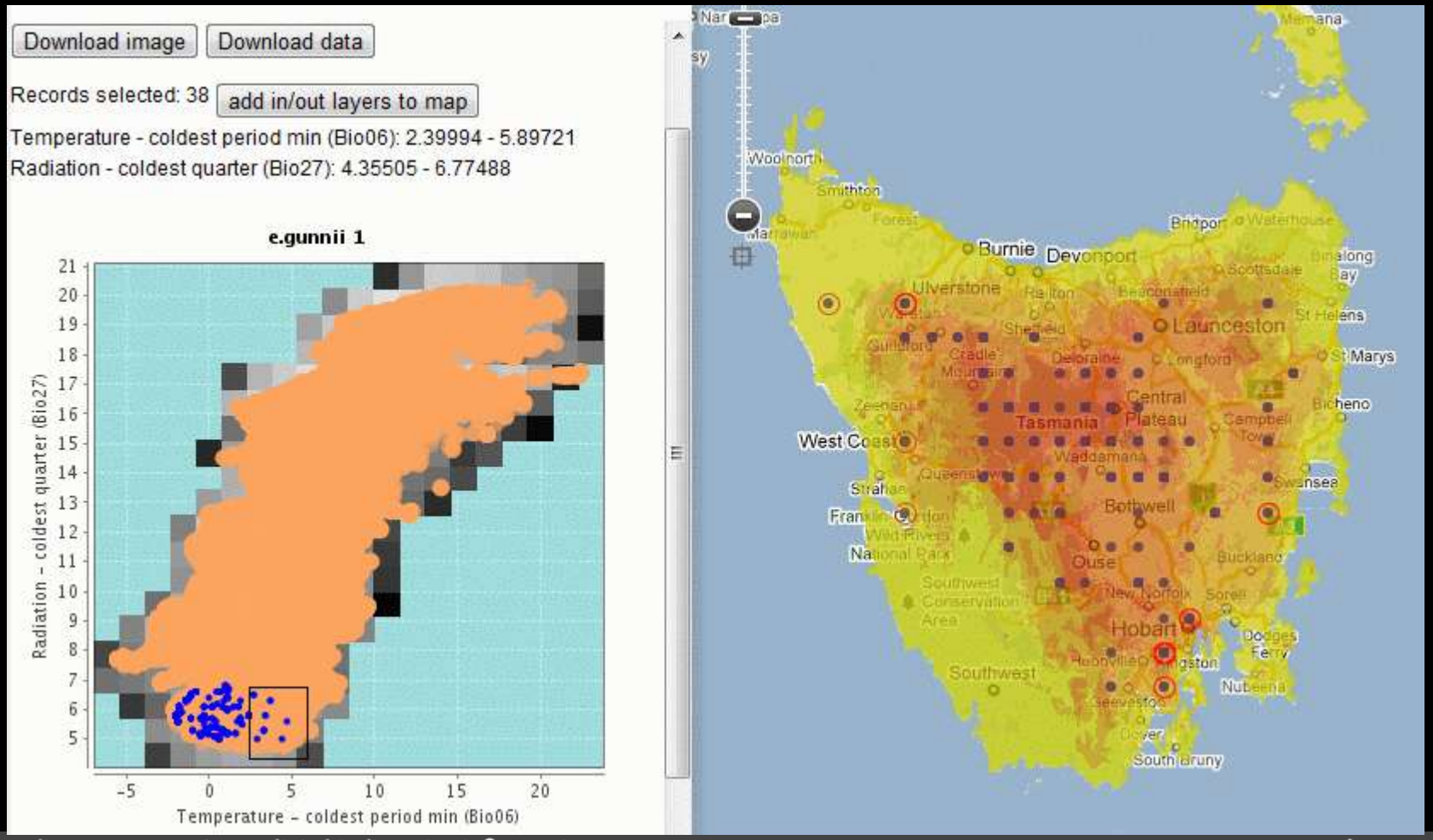


Sampling



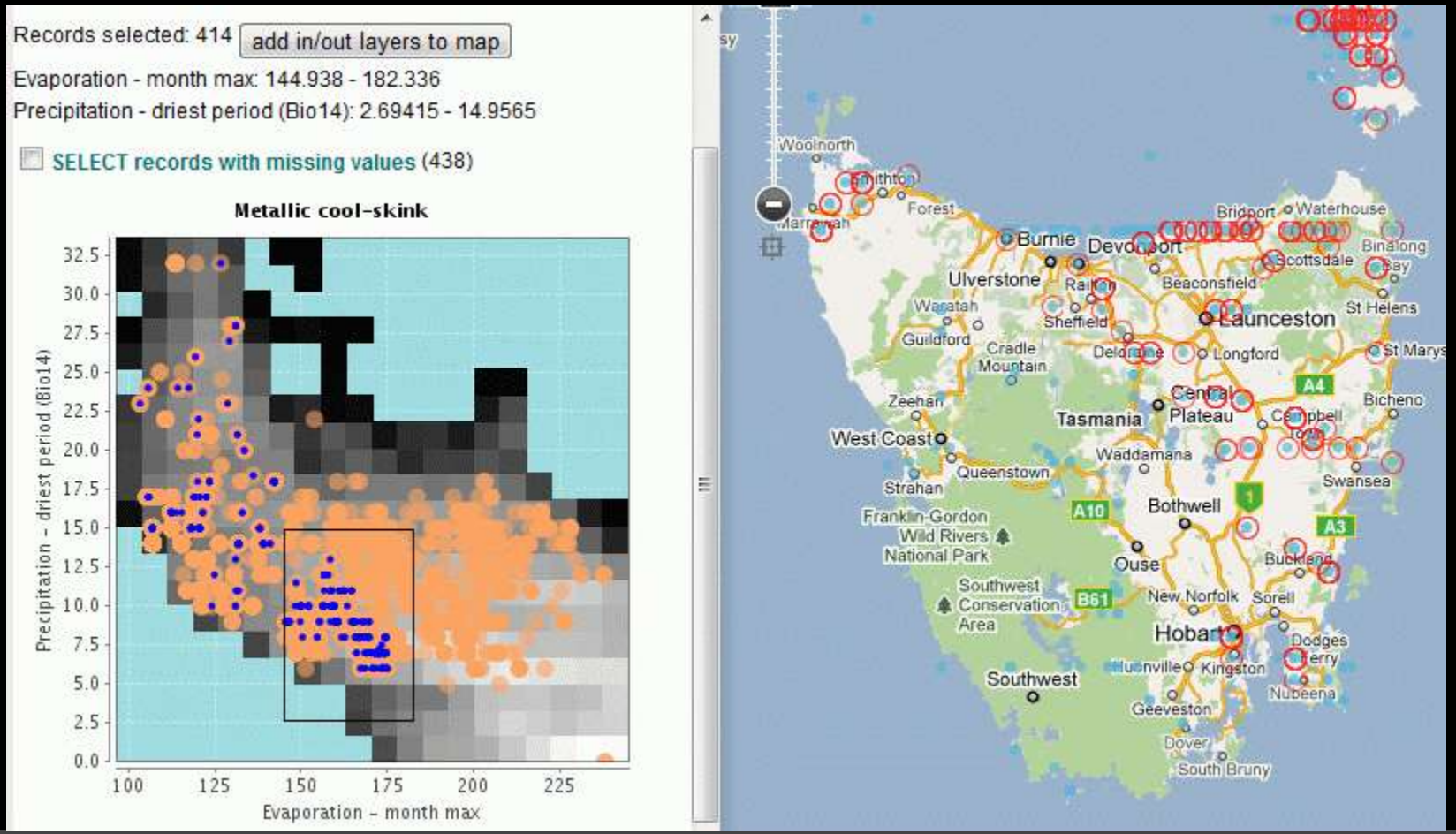
Scatterplots - 1

- Result of searching for detection of environmental outliers
- Simple but a lot of ecology



Scatterplots - 2

- Always raise ecological questions
- …and good for detecting problems!

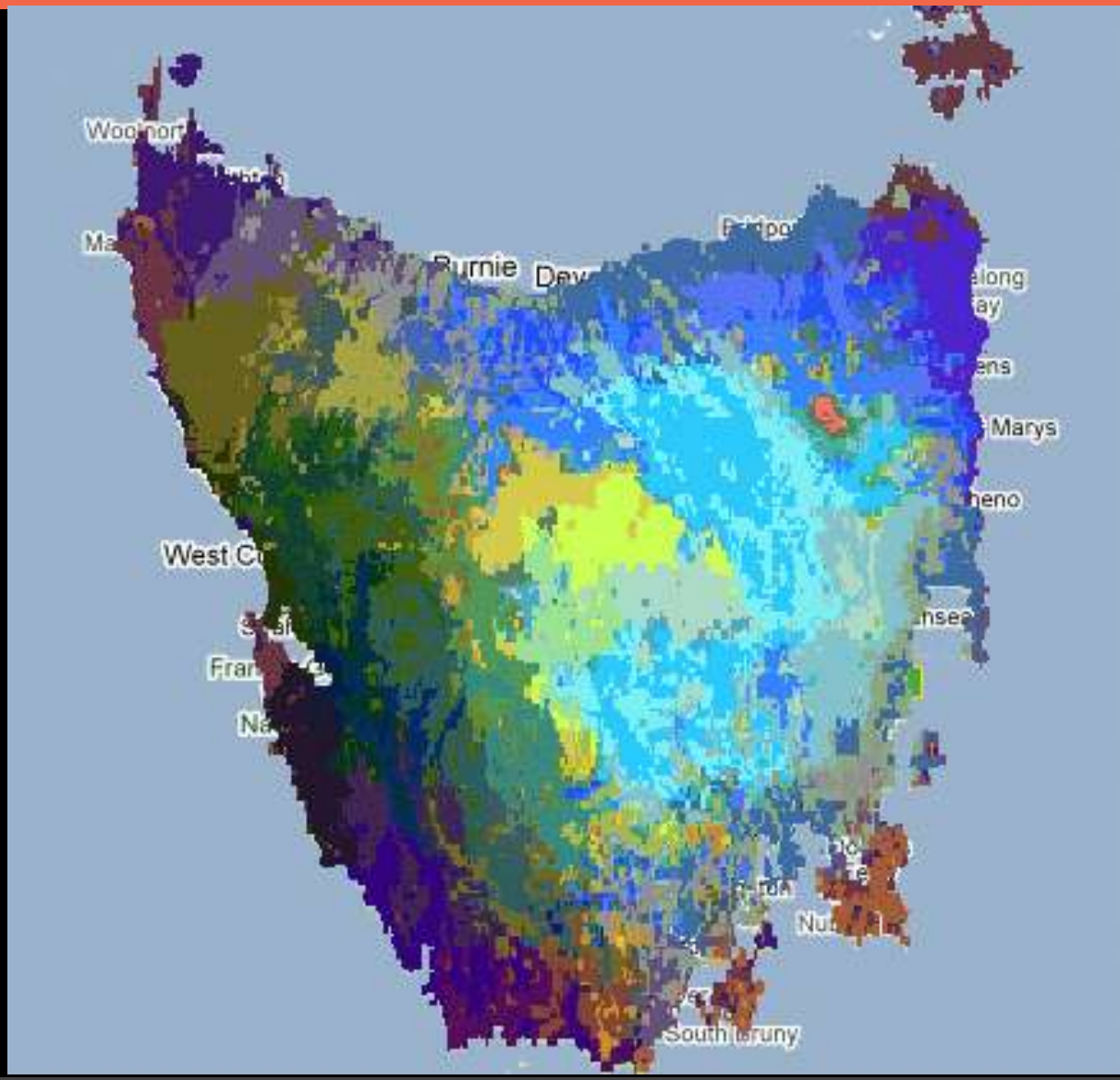


Classification

- The idea:
  - Consistent systematic bio-surveys of all species is a long way off
  - The use of environment as a surrogate for biodiversity
- The Strategy
  - Classifying multiple environmental layers in an area into one new layer with minimal information loss
  - Each grid cell is allocated to a group that is closest in environmental space
- The algorithm (PATN)
  - Select number of groups desired
  - Start with a random grid cell and estimate the environmental distance from the next cell. If close – allocate, if not – form a group
  - Repeat for all cells until number of groups (seed cells) generated
  - Allocate all cells to closest seed and then calculate centroids
  - Remove cell from group, calculate closest centroid, allocate
  - Repeat until no moves between groups

Classification - 2

- 50 groups
- Layers
  - Evap - variability
  - C4 growth index
  - Hum - month max
  - Precip - min diff
  - Precip - driest ¼
  - Temp - max mean
  - Temp - diur range
  - Temp - seasonality
  - Lithology - fertility
- Group means



Classification - 3

group number	red	green	blue	Evaporation - variability	Growth index C4 megatherm plants - annual mean	Humidity - month max relative	Precipitation - min difference between successive months	Precipitation - driest quarter (Bio17)	Temperature - annual max mean	Temperature - diurnal range mean (Bio02)	Temperature - seasonality (Bio04)	Lithology - fertility
1	106	52	68	5.50	0.02	92.02	-0.96	199.32	15.16	7.25	0.86	5.89
2	110	104	45	5.51	0.00	94.93	-1.12	325.25	11.63	7.63	1.01	5.44
3	19	65	48	6.98	0.02	96.95	-1.09	364.30	14.93	8.92	0.98	3.83
4	145	145	145	4.85	0.01	93.19	-1.04	198.78	14.12	8.73	1.05	9.83
5	78	169	199	5.00	0.00	94.26	-0.71	179.84	12.69	10.07	1.22	3.86
6	121	237	242	5.54	0.01	93.23	-0.53	122.63	15.83	11.40	1.27	10.00
7	255	108	105	5.89	0.00	99.70	-0.78	271.51	7.23	6.32	1.16	8.10
8	62	26	114	5.10	0.02	92.71	-0.86	160.77	15.63	7.56	0.88	2.33
9	101	96	25	6.98	0.01	94.65	-1.13	256.07	13.91	7.77	0.94	6.05
10	162	92	63	4.96	0.01	90.42	-0.85	203.94	14.54	7.19	0.86	9.67
11	76	38	205	4.77	0.03	94.40	-0.69	173.60	16.77	8.53	1.02	4.56
12	151	131	49	6.55	0.01	95.71	-1.16	283.16	13.56	8.08	0.99	10.39
13	104	58	67	7.21	0.03	92.28	-0.53	143.92	16.43	7.19	0.97	2.87
14	35	88	20	6.90	0.01	97.08	-1.24	396.08	13.58	8.58	1.02	3.91
15	64	91	94	5.80	0.01	95.09	-1.14	265.88	13.49	8.45	1.03	3.80
16	37	20	42	5.06	0.02	92.67	-1.08	352.89	14.85	7.62	0.86	3.77
17	100	83	127	5.45	0.02	93.26	-0.80	179.94	15.28	8.36	0.96	6.13

Prediction -1

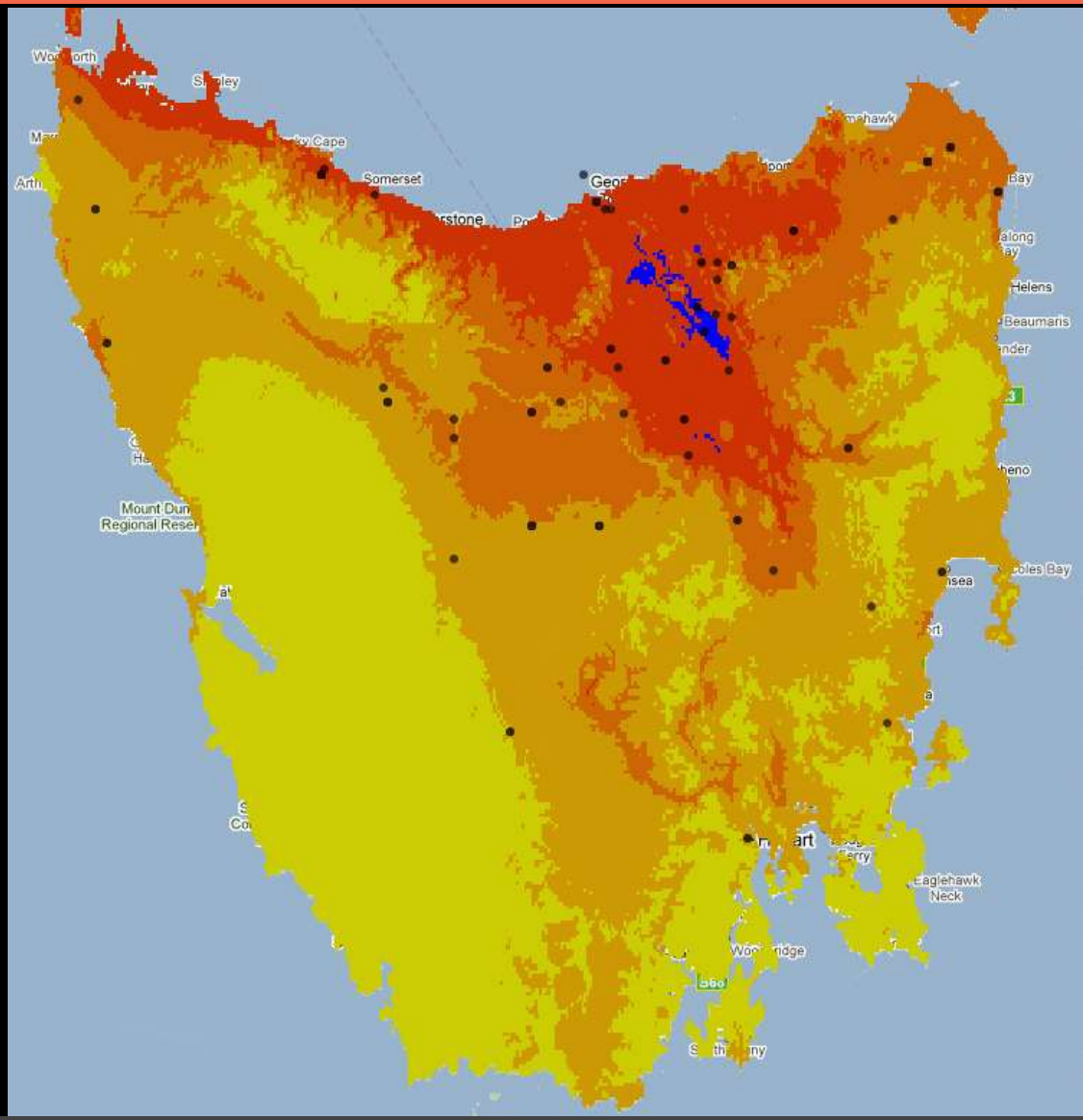
- The Issue
  - Very few (if any) species have been systematically sampled
  - Can we infer from observations where similar conditions occur?
  - We add value to data: From points to area probabilities
- A solution
  - Niche modelling/species modelling /SDMs
    - Identify the environments where they occur and where they don't **appear** to occur
- Caveats
  - GIGO (e.g., sampling bias)
  - Observations and environment are in sync?

Prediction – 2 MaxEnt

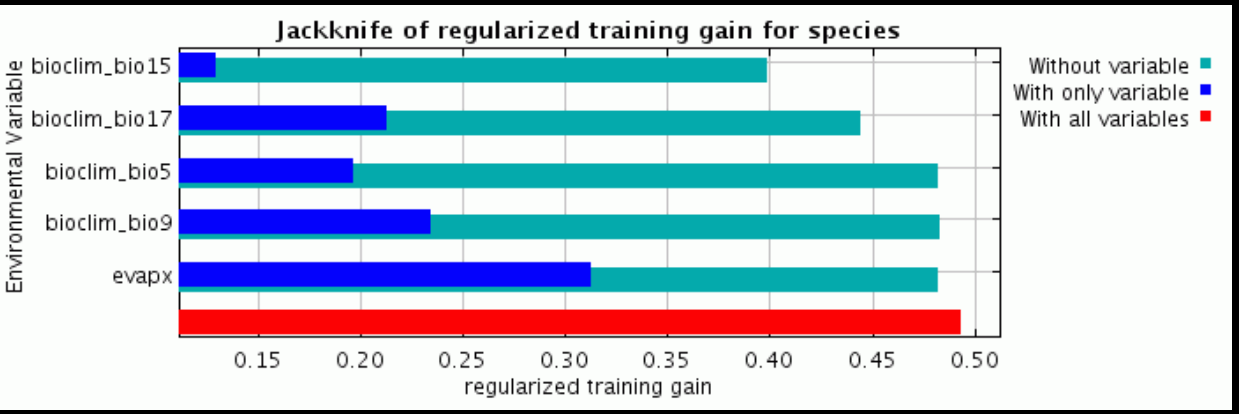
- Plus
  - Requires only presence-only data*
  - Accepts continuous and categorical layers (& interactions)
  - Guaranteed efficient convergence*
  - Continuous probability output
  - Concise mathematical base
  - Active research area
- Minus
  - Not as mature as GLM/GAMs
  - Based on an exponential (unbounded) model
  - Requires specialized software

Prediction - 3

- # 1310445896499
- Tasmanian Devil
- Layers
  - Evap MonMax (evapx)
  - Prec DriQ (Bio17)
  - Prec Seas (Bio15)
  - Tem WarmPmx (Bio05)
  - Tem DriQMean (Bio09)

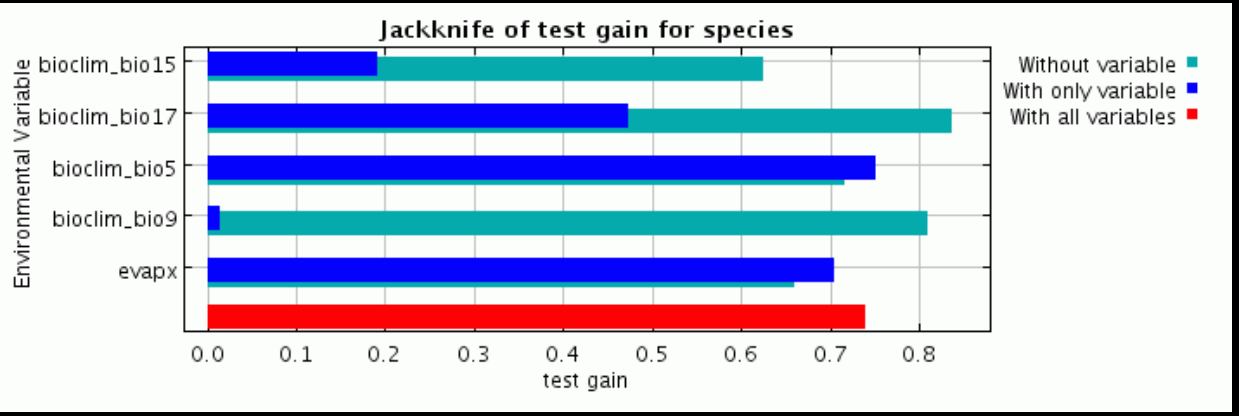


Prediction – 4



Evapx – Highest in isolation

Bio15 – Most unique



Bio05 – Highest in isolation

Bio15 – Most unique

Mike Austin's Ecology Ecology 101

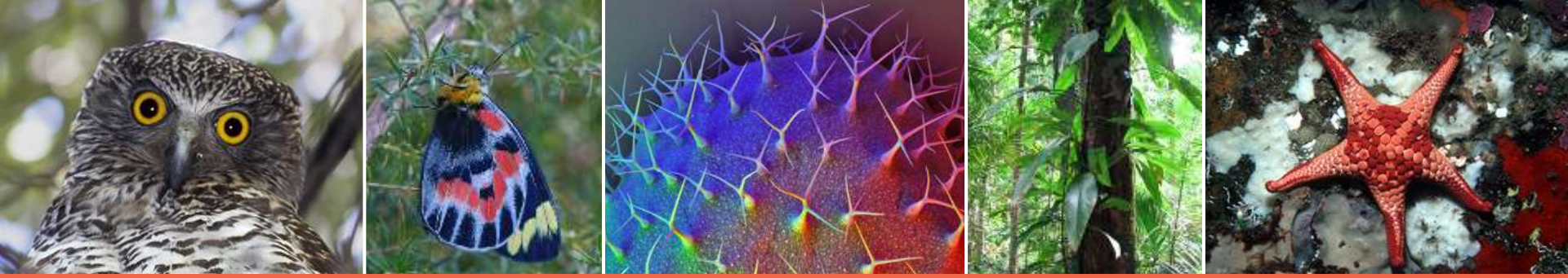
1. The fundamental niche of species is determined by plant's [species] needs for light, water, temperature and nutrients.

2. The realised niche of a species is the result of the impact of biotic processes of competition, herbivory and diseases on the fundamental niche.

3. Distribution of species is determined by the realised niche but is conditional on the spatial pattern of suitable lithology [substrate] and terrain, environmental barriers and climatic history.

References

- Austin, M.P. (2002) Spatial prediction of species distribution: an interface between ecological theory and statistical modelling. *Ecological Modelling*, 157, 101–118.
- Austin, M.P. and Van Niel, K.P. (2011) Impact of landscape predictors on climate change modelling of species distributions: a case study with *Eucalyptus fastigata* in southern New South Wales, Australia. *Journal of Biogeography*, 38, 9–19.
- Belbin, L. (1987). The use of non-hierarchical allocation methods for clustering large sets of data. *Australian Computer Journal*, 19, 32-41.
- Elith, J., Phillips, S.J. Hastie, T., Dudı, M., Chee, Y.E. and Yates, C.J., A statistical explanation of MaxEnt for ecologists, *Diversity and Distributions*, 17, 43–57
- Phillips, S.J. MaxEnt tutorial. http://www.cs.princeton.edu/~schapire/maxent/tutorial/tutorial.doc



www.ala.org.au

The Spatial Portal

ATLAS OF LIVING AUSTRALIA
sharing biodiversity knowledge

Lee Belbin

lee@blatantfabrictions.com

ALA, 13th July, 2011

User Needs Analysis

- **Where** does this species occur?
  - Any taxonomic level
- What species occur in this **area**
  - 14 ways to define area
- Donald: Spatial analysis please?
  - Moved from wide range to demos that illustrate the benefit of integrated biological and environmental data…and…
- Lee: Import and Export
  - Import point locations
  - Import assemblages*
  - Import ‘areas’
  - Export checklists
  - Export ‘samples’
  - Export areas

Spatial Portal Data

- Taxa ('species')
  - Any taxonomic level
  - Access via auto-complete
- Layers
  - Environmental (grids with continuous values)
  - Contextual (polygons with class values)
  - Access by auto-complete and classification browse
- Areas
  - Oz gazetteer (points)
  - Additional gazetteers (polygons)
  - Layer classes (some 'non-unique')
  - Access by auto-complete

ALA Bio-Scope

- Plants, animals and microorganisms
- Marine, terrestrial and limnetic
- Native and non-native

- Observations and specimens
- Checklists and expert distributions
- Tracks*

Environmental Scope

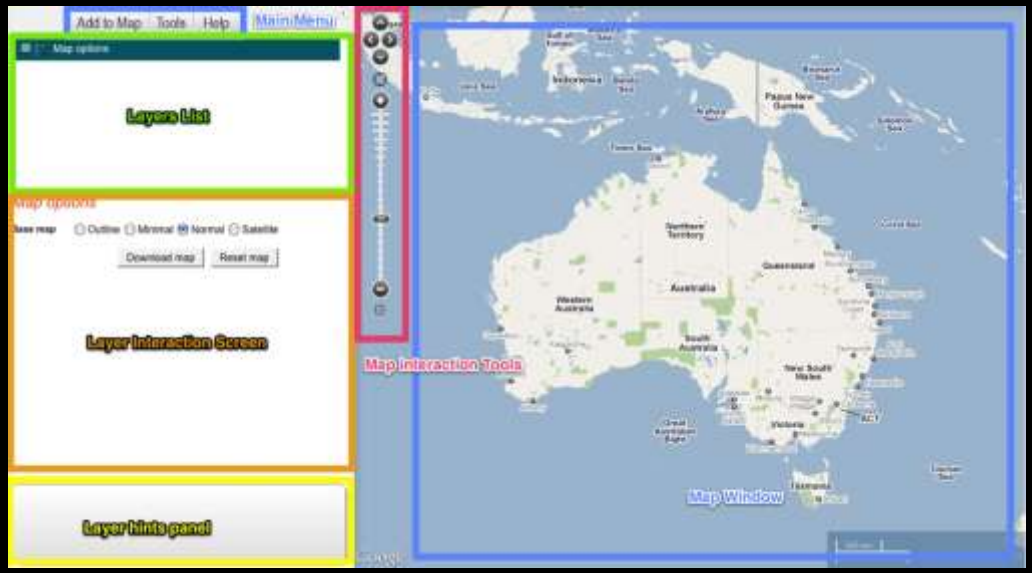
- 215 Environmental layers (6 marine)
  - E.g., Mean annual temperature
- 37 Contextual layers (3 marine)
  - E.g., Land use
- 2-level classification
  - E.g., Biodiversity | Status
- Most 0.01 degree resolution (~1km) but moving to 250m for many

SP Core

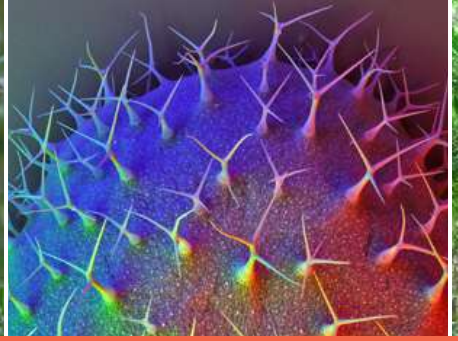
- Integrating biological and ‘environmental’ data
- Data upload and download
- Tools that demonstrate the utility of integrated data

Spatial Portal

- Google look and feel
- Open source software (Geoserver, OpenLayers…)
- Layout
  - Map (Google + hover tool)
  - Tabs
  - Layers (all mapped features)
  - Legend and Scatterplot
  - Hints







The Atlas of Living Australia Participants

www.ala.org.au

CSIRO

Australian museum
nature culture discover

MUSEUMVICTORIA

qm queensland museum

Tasmanian Museum & Art Gallery

Tasmania
Explore the possibilities

MUSEUM AND ART GALLERY NORTHERN TERRITORY

Northern Territory Government

South Australian Museum

WESTERN AUSTRALIAN museum

THE UNIVERSITY of ADELAIDE

Southern Cross UNIVERSITY
A new way to think

ATLAS OF LIVING AUSTRALIA
sharing biodiversity knowledge

CAMD COUNCIL OF AUSTRALASIAN MUSEUM DIRECTORS

CHAH
Council of Heads of Australasian Herbaria

CHAEC
Council of Heads of Australian Entomological Collections

CHAFC

Council of Heads of Australian Collections of Microorganisms

An Australian Government Initiative
National Collaborative Research Infrastructure Strategy

Australian Government
Department of Agriculture, Fisheries and Forestry

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

ABRS

The Atlas is funded by the Australian Government under the National Collaborative Research Infrastructure Strategy and the Education Investment Fund