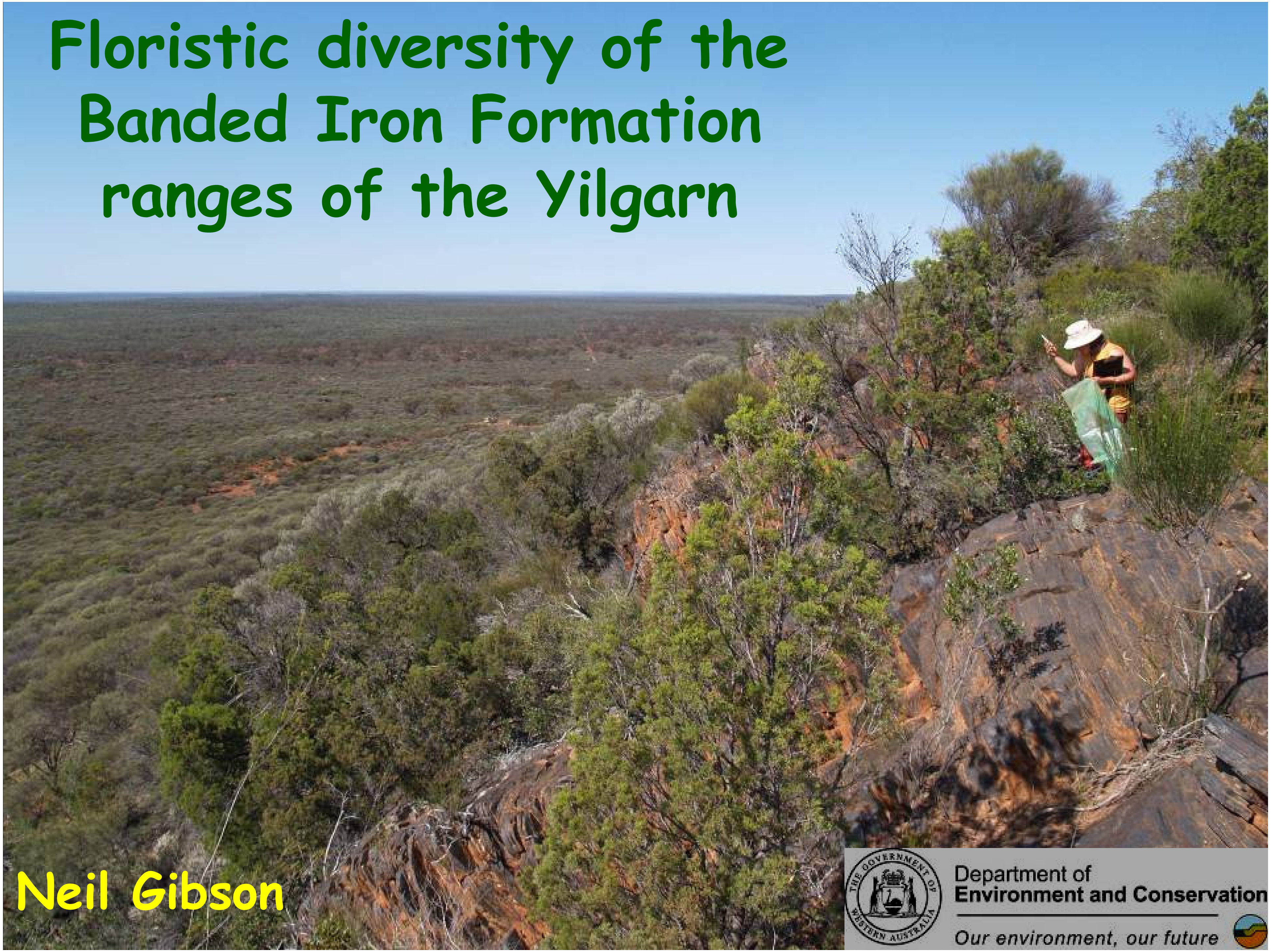
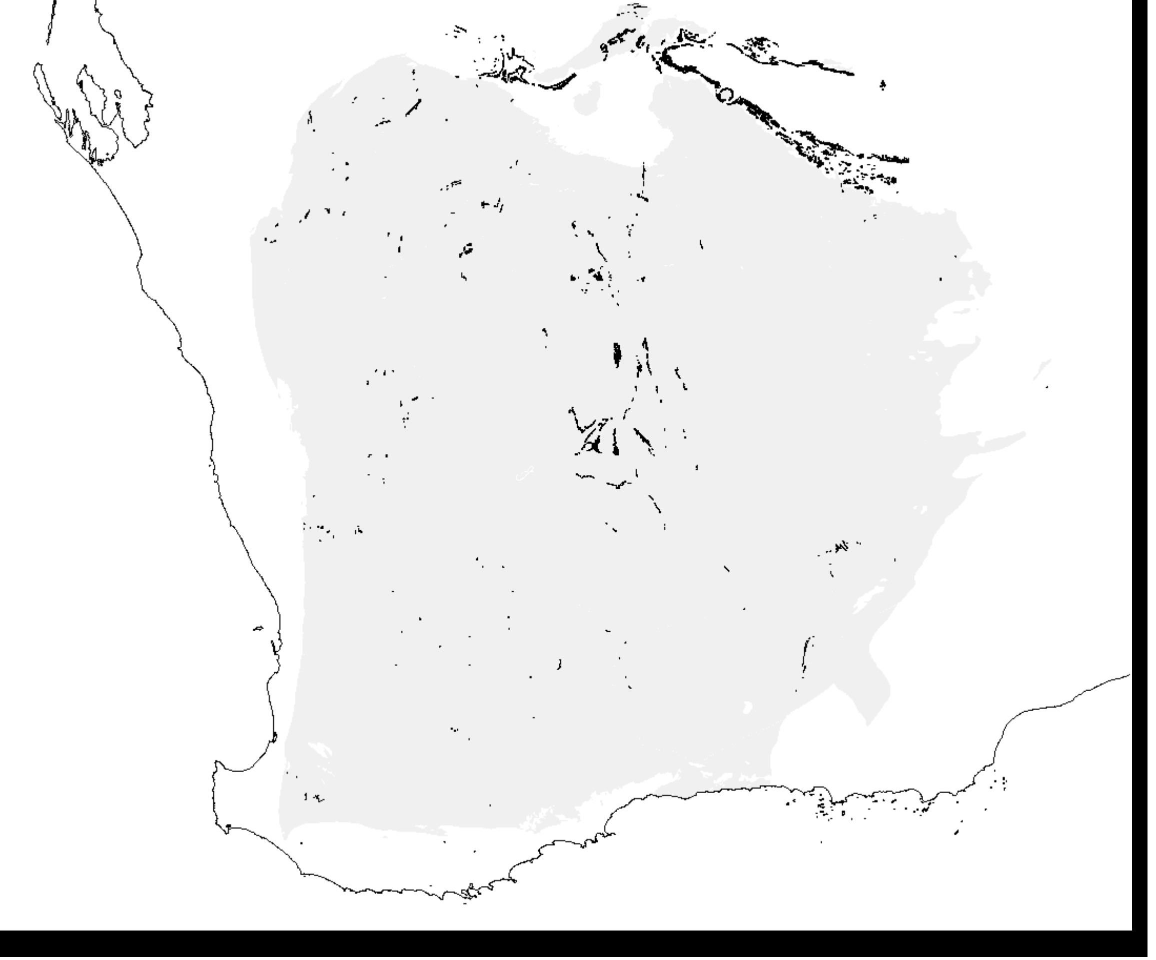
Floristic diversity of the Banded Iron Formation ranges of the Yilgarn



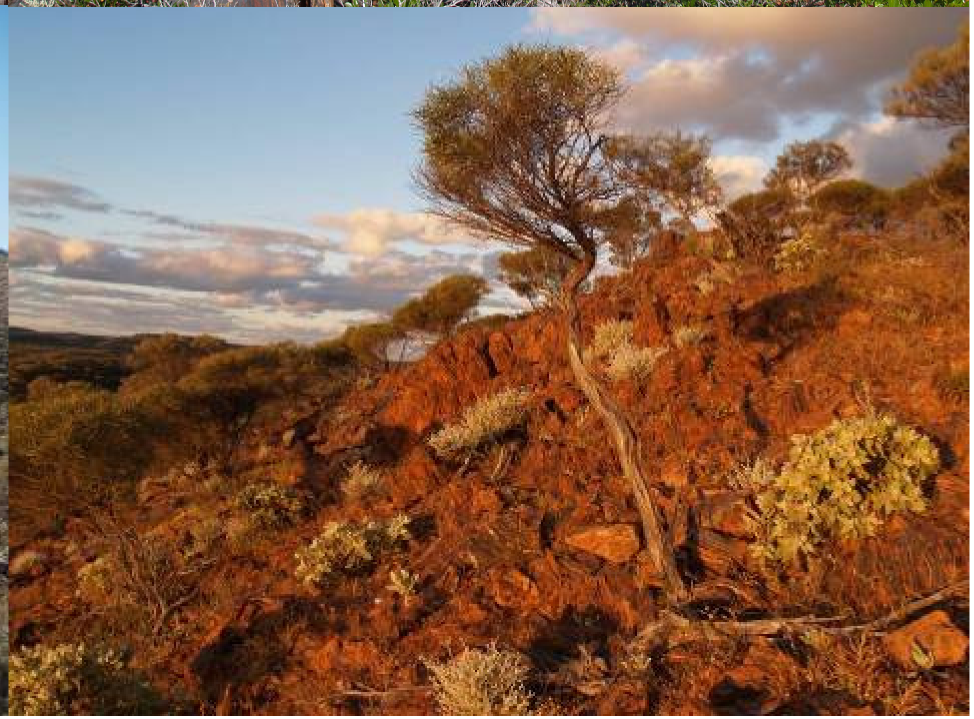
Neil Gibson

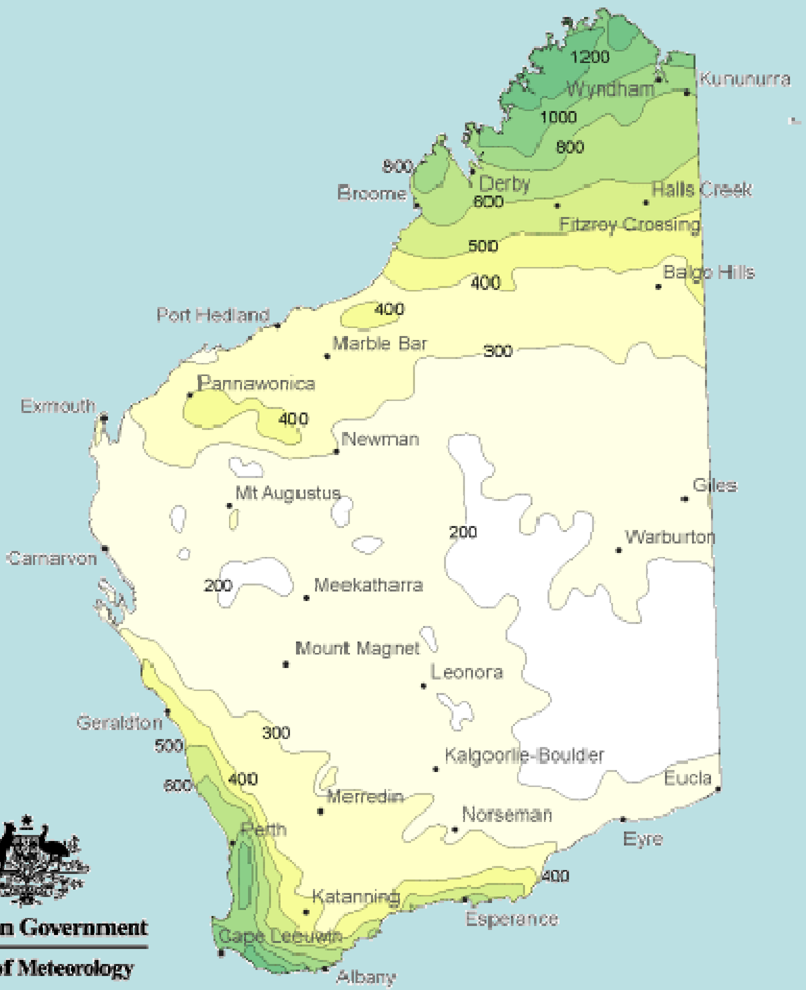
Department of Environment and Conservation
Our environment, our future

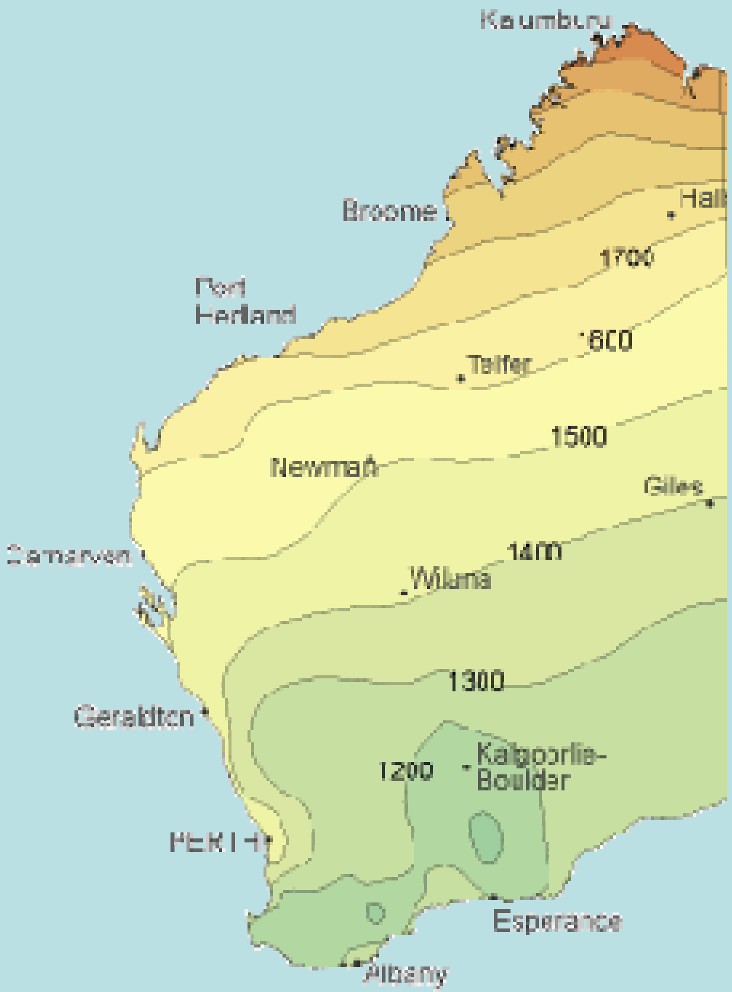
Ancient metamorphosed sedimentary sequences associated with greenstone belts in the granites of the Yilgarn Craton





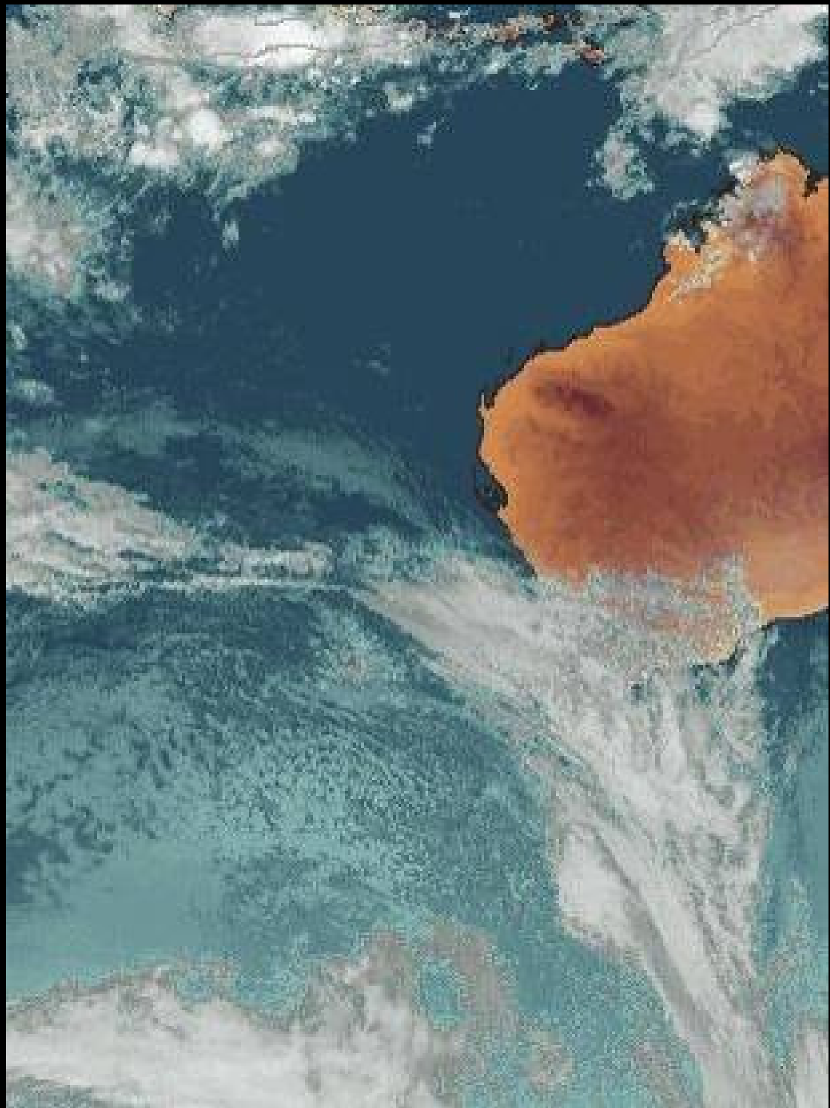



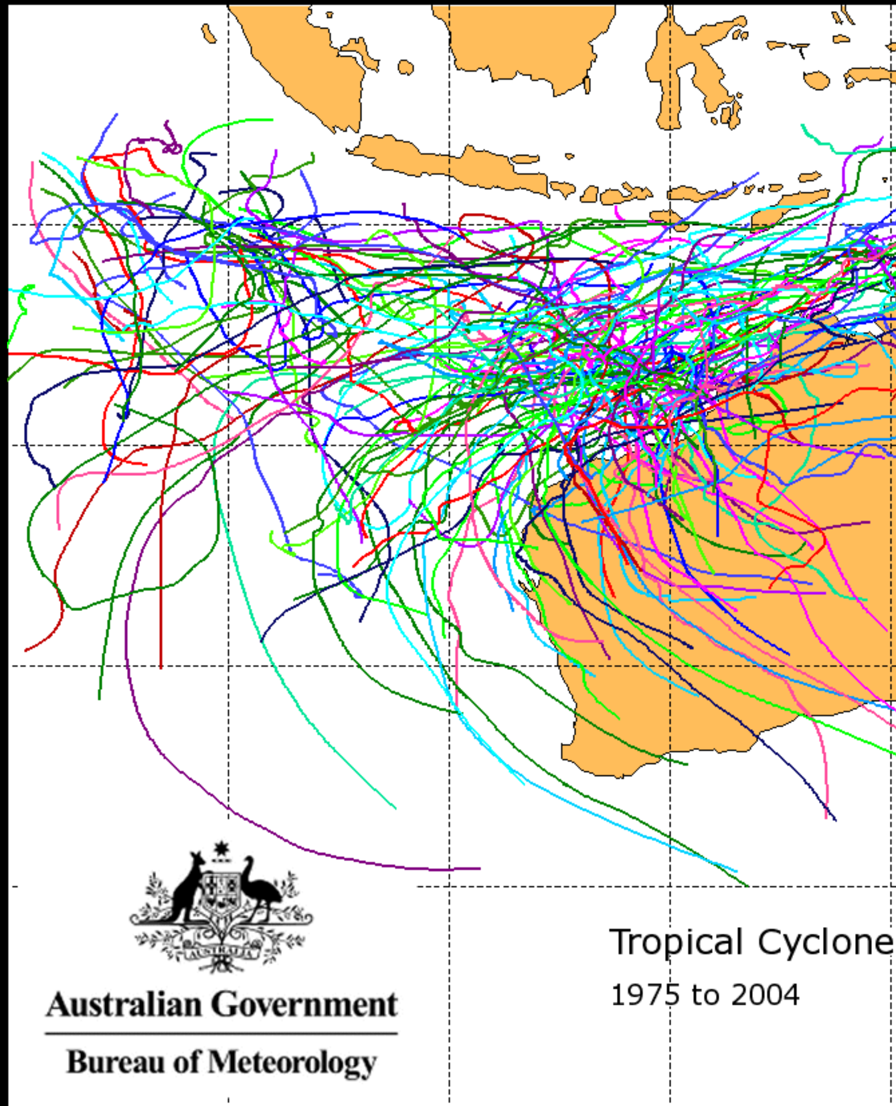




Australian Government

Bureau of Meteorology




Australian Government
Bureau of Meteorology
Tropical Cyclone
1975 to 2004

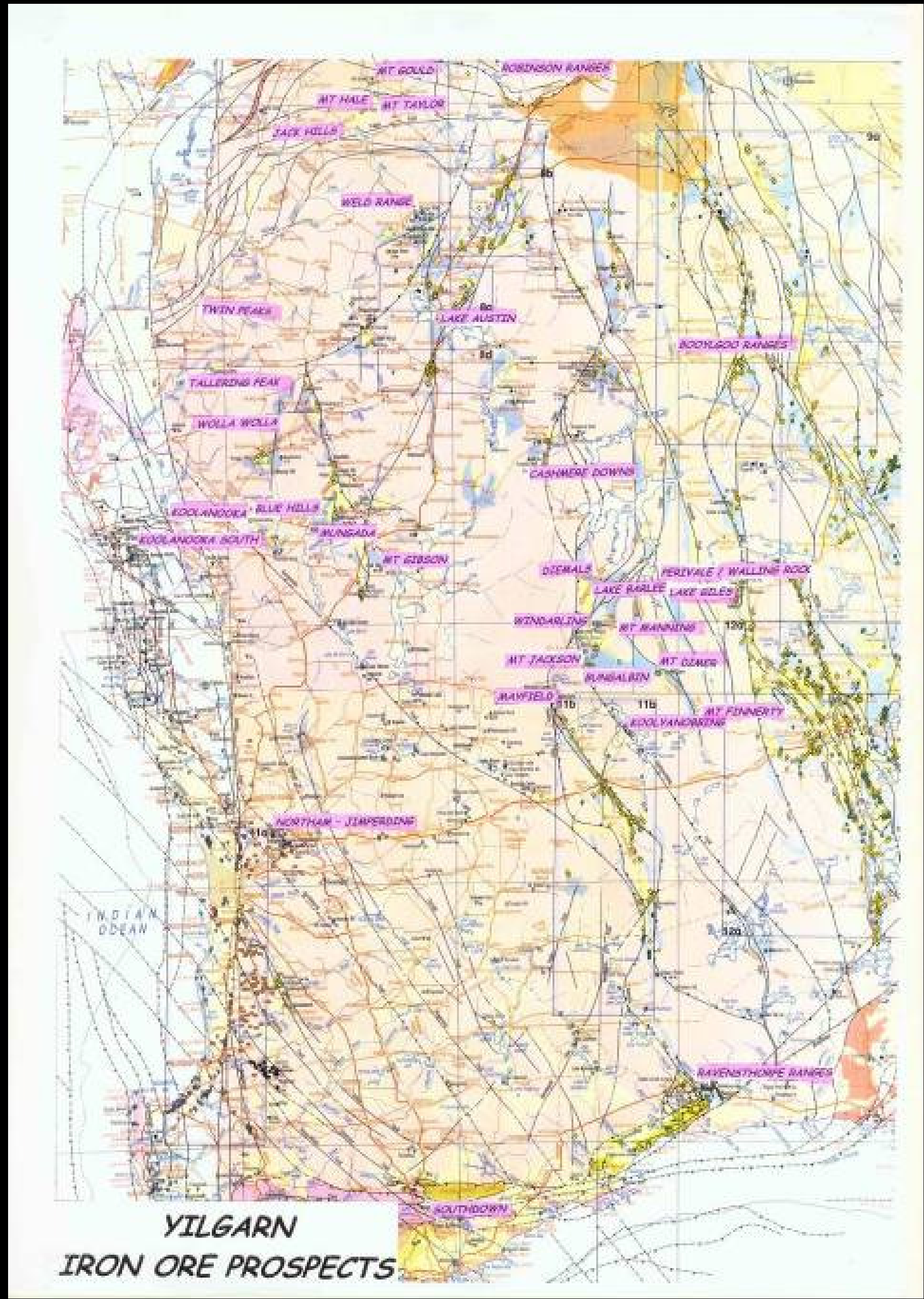
Survey prior to 2004

- Beard mapping 1970s
- DEC & Museum Goldfields surveys 1980s
- Henry-Hall 1990
- DEC Greenstone & BIF Ranges surveys 1994-96
- Portman PER studies 2002

The Issue

Department of Industry & Resources

- BIF prospects in the Yilgarn 30th June 2004



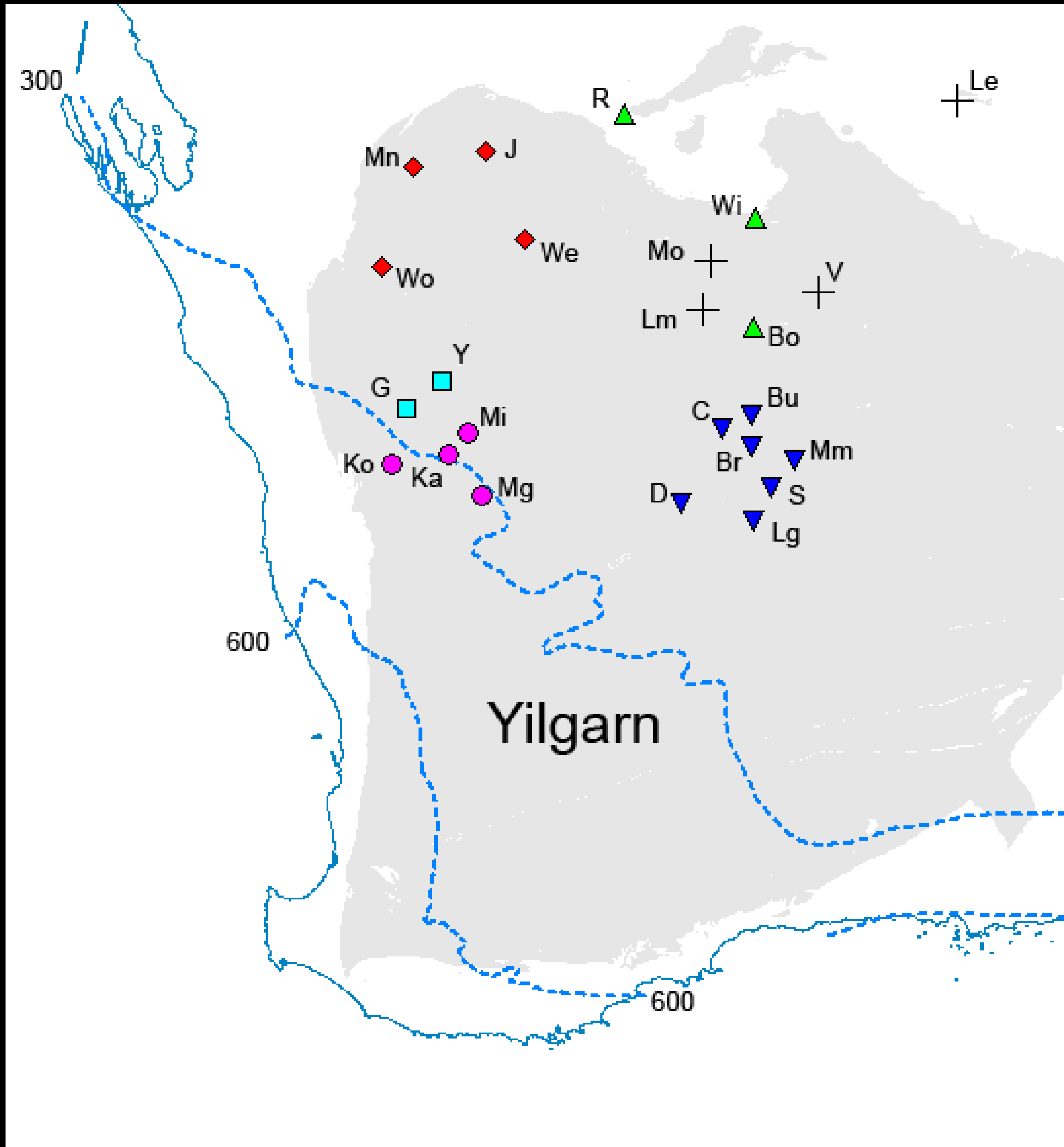
DEC survey team

- Dr Adrienne Markey
- Dr Rachel Meissner
- Dr Wendy Thompson
- Jessica Allen
- Ben Bayliss
- Yvette Caurso
- Steve Dillon
- Gaynor Owen
- Niall Sheehy
- Jessica Wright

Why plot based survey?

- Repeatable
- Heterogeneity of units explicit
- Analyzed at a variety of scales
- Classifications can be refined as more information becomes available
- Requires detailed searches resulting in collection & identification of new and / or cryptic taxa

24 BIF ranges surveyed



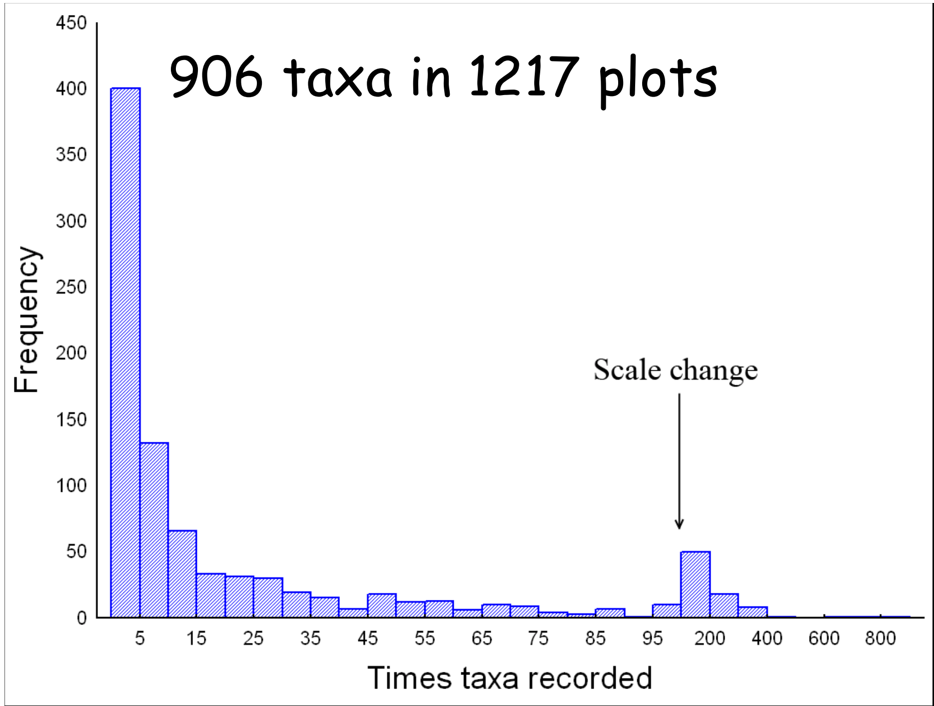
Outcomes 2005 - 2009

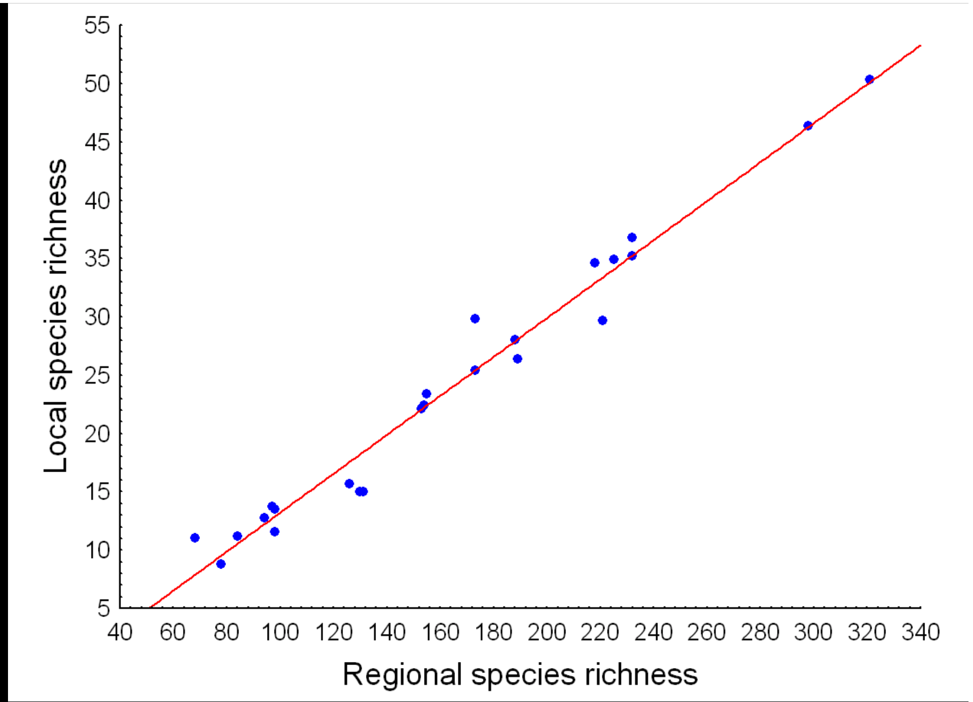
- Established 1217 quadrats across 24 ranges
- Identified > 100 new populations of DRF & Priority taxa
- Identified 21 new taxa
- Documented 11 local endemics and 10 regional endemics
- Documented 69 major range extensions
- Lodged over 6200 vouches specimens

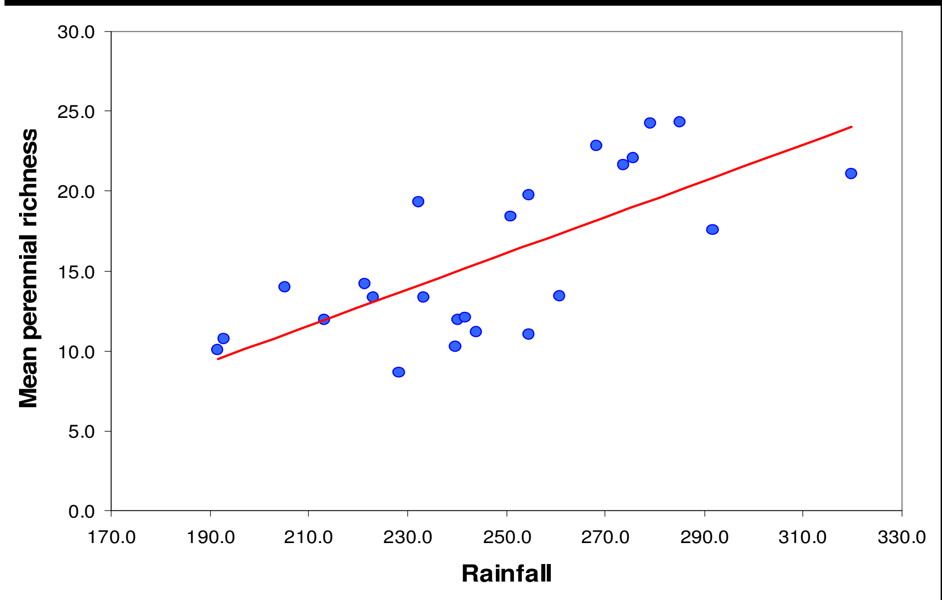
- Found a regular catenary sequence of vegetation types correlated with soil chemistry and landscape position
- Described 134 floristic community types and subtypes
- 17 papers published or in press
- 6 papers in review

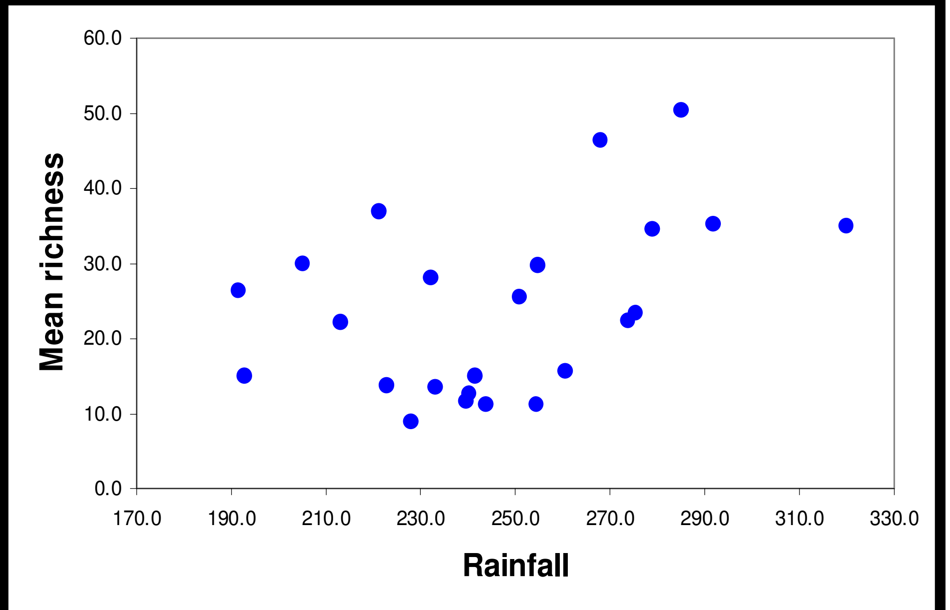
Meta analysis

- Beta diversity
  - How similar are the ranges?
  - What are the major patterns in species richness?
  - To what degree is the compositional variation related to spatial and environmental factors?
  - Can conservation value of the ranges be prioritised?


906 taxa in 1217 plots
Scale change
Frequency
Times taxa recorded
0
50
100
150
200
250
300
350
400
450
5
15
25
35
45
55
65
75
85
95
200
400
600
800


Local species richness
Regional species richness
5
10
15
20
25
30
35
40
45
50
55
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340


Mean perennial richness
Rainfall
0.0
5.0
10.0
15.0
20.0
25.0
30.0
170.0
190.0
210.0
230.0
250.0
270.0
290.0
310.0
330.0


Mean richness
Rainfall
0.0
10.0
20.0
30.0
40.0
50.0
60.0
170.0
190.0
210.0
230.0
250.0
270.0
290.0
310.0
330.0

Beta diversity measures - richness

Additive partitioning of α and β diversity

Regional species richness can be partitioned into its components of average number of species present in a plot (alpha diversity) and average number of species absent from a plot (beta diversity) allowing analysis of hierarchical scale patterning in species diversity.

Regional species richness = alpha (within quadrat)
+ beta (between quadrat)
+ beta (between ranges).

We used this method to examine patterns in alpha and beta diversity where we had 50-54 samples nested in 24 ranges nested in the one region.

Additive partitioning of α and β diversity components of total and perennial species richness in a hierarchical scaled study across 24 BIF ranges.

		Total			Perennial		
Source	No. samples	Observed	Expected	p	Observed	Expected	p
β (between ranges)	24	742.0	564.8	0.001	501.7	381.0	0.001
β (between plots)	50 – 55	140.0	319.3	0.001	91.6	213.6	0.001
α (within plots)	1217	23.9	22.0	0.001	15.7	14.4	0.001
Total		906			609		

Beta diversity measures - composition

- Average Sørensen

  mean of all pairwise dissimilarity measures on individual ranges or region (Jaccard 1900, 1901, 1908; Sørensen 1948, Steinhaus 1947, Odum 1950, Bray & Curtis 1957)

- Multiple site diversity measures (Baselga 2010)

  $\beta_{SØR} = \beta_{SIM} + \beta_{NES}$

TURNOVER

Site 1 xxxx
Site 2 xxxxxx
Site 3 x xxxxxxx

NESTEDNESS

Site 1 xxxxxxxxxxxxxxx
Site 2 xxxxxxxxxxx
Site 3 x xxxxxxx

Comparison of diversity values for 24 BIF ranges.

n = number of plots

S = total species / range

Mean Perennial = mean perennial species per plot

$\beta_{SØR}$ = multiple site Sørensen index

β_{SIM} = multiple site Simpson index

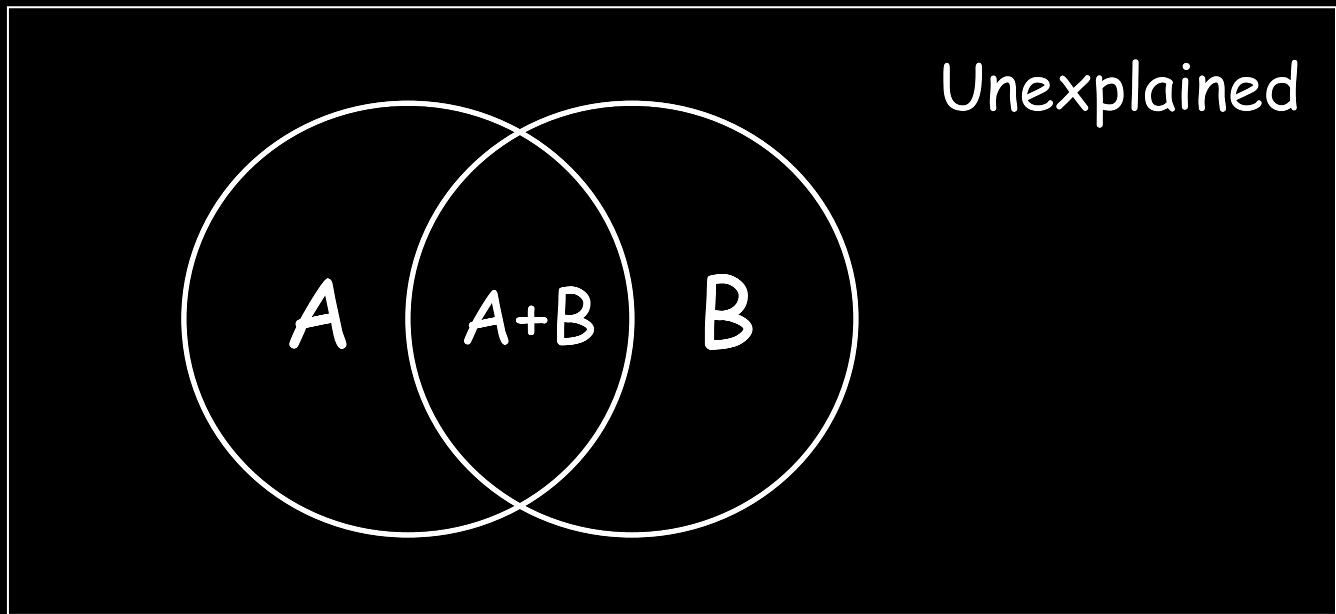
β_{NES} = multiple site nestedness index

Mean Sørensen = mean of all pairwise Sørensen dissimilarity measures.

Range	n	S	Mean Perennial	$\beta_{SØR}$	β_{SIM}	β_{NES}	Mean Sørensen
Bo	51	188	19.3	0.948	0.936	0.013	0.634
Br	50	94	11.9	0.946	0.934	0.012	0.610
Bu	51	98	10.3	0.950	0.934	0.016	0.638
C	51	131	12.1	0.955	0.943	0.012	0.697
D	50	155	22.0	0.949	0.938	0.011	0.665
G	50	218	24.2	0.947	0.935	0.012	0.645
J	50	189	10.1	0.949	0.933	0.015	0.650
Ka	51	321	24.3	0.947	0.937	0.010	0.629
Ko	50	225	21.1	0.949	0.940	0.009	0.665
Le	50	97	13.3	0.945	0.929	0.017	0.608
Lg	51	154	21.6	0.950	0.943	0.007	0.657
Lm	50	98	13.4	0.951	0.935	0.016	0.687
Mg	50	232	17.6	0.949	0.939	0.010	0.663
Mi	52	298	22.8	0.948	0.935	0.013	0.636
Mm	50	68	11.0	0.945	0.929	0.016	0.617
Mn	52	130	10.7	0.956	0.941	0.014	0.708
Mo	50	84	11.2	0.945	0.926	0.020	0.596
R	50	153	11.9	0.944	0.927	0.018	0.592
S	50	126	13.4	0.952	0.939	0.012	0.679
V	50	78	8.6	0.952	0.935	0.018	0.674
We	52	232	14.2	0.946	0.931	0.015	0.600
Wi	50	173	18.4	0.948	0.927	0.021	0.633
Wo	51	173	14.0	0.943	0.924	0.019	0.595
Y	55	221	19.7	0.956	0.938	0.017	0.698
All	1217	906	15.7	0.967	0.950	0.018	0.839

Variance partitioning

Partial redundancy analysis was used to assessed the contribution of each different set of predictors to community composition (Sørensen dissimilarity matrix) following methods of Legendre et al. (2005).



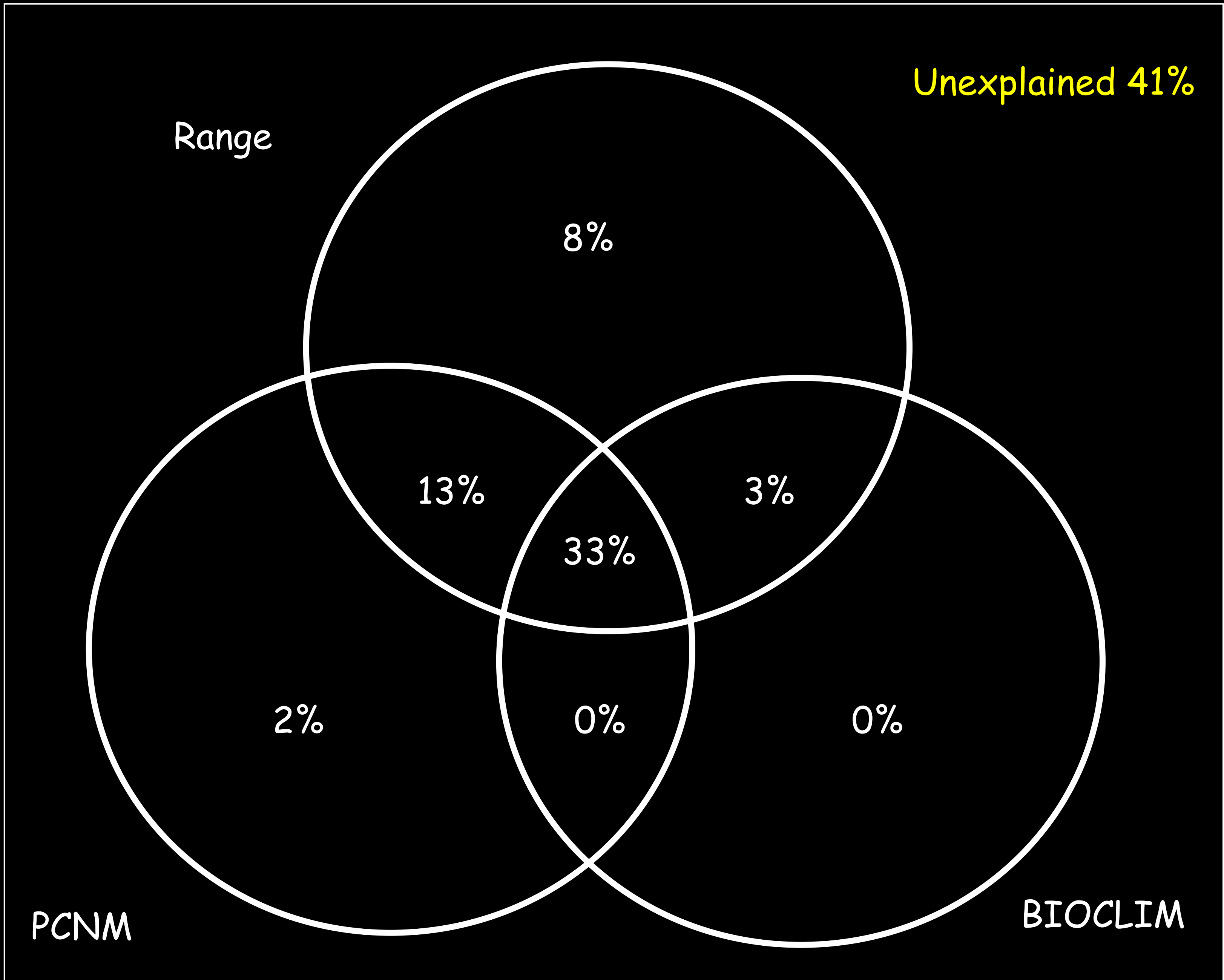
Broad scale spatial pattern

- Simple factor based on individual ranges.

- PCA of 19 BIOCLIM variables (8 precipitation and 11 temperature) for each plot from the 'one km grid' spatial interpolation of Hijmans et al. (2005).
    - Three PC accounted for 92% variance.

- Principal Coordinates of Neighbor Matrices generates a set of explanatory variables that have structure at all scales encompassed by plot locations down to a scale equal to the widest gap (c. 217 km) between neighbouring plots (Borcard & Legendre 2002).
    - 252 eigenfunctions were generated to cover broad scale pattern ranging between 217 & 700 km.
    - 57 vectors were found to be significant and these were used in subsequent analyses.

Variance partitioning : Broad Scale



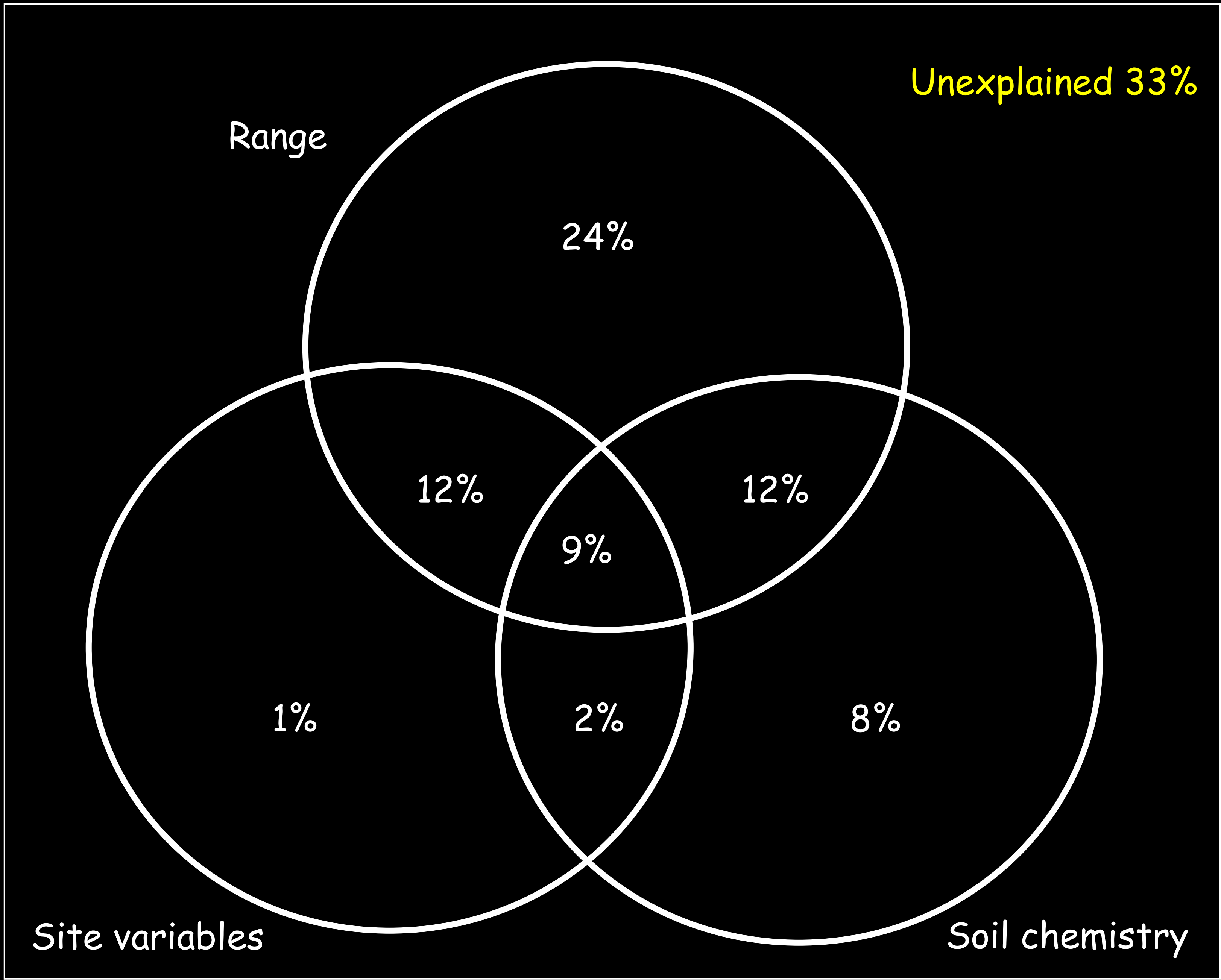
Site variables

Altitude	Range standardized (altitude meters)
North	Cos(aspect radians)
East	Sin(aspect radians)
Slope	Degrees
Topographic position	7 classes
Coarse fragment size	7 classes
Coarse fragment abundance	7 classes
Rock outcrop abundance	6 classes
Litter cover	4 classes
Bare ground cover	4 classes

Soil chemistry

pH	Normalized
Electrical Conductivity	Log(v+1) + Normalized
Organic Carbon	Log(v+1) + Normalized
Nitrogen	Log(v+1) + Normalized
Phosphorus	Log(v+1) + Normalized
Potassium	Log(v+1) + Normalized
Calcium	Log(v+1) + Normalized
SCORE1	PCA1 of 9 metal trace elements
SCORE2	PCA2 of 9 metal trace elements
SCORE3	PCA3 of 9 metal trace elements

Variance partitioning : Broad – Fine Scale



Conclusions

•Demonstrate very high beta diversity in terms of both richness and composition.

•This beta diversity is primarily related to turnover.

• Composition - high beta diversity is only partially correlated with climatic gradients and finer scale environmental patterning.

•Suggesting that compositional patterns may have resulted from the stochastic processes happening over the extraordinarily long evolutionary times these systems have been functioning – neutral theory processes cf. environmental control models.

•In terms of a CAR reserve system each range is 'irreplaceable' *sensus* Pressy.

•Is it possible to identify conservation priorities?

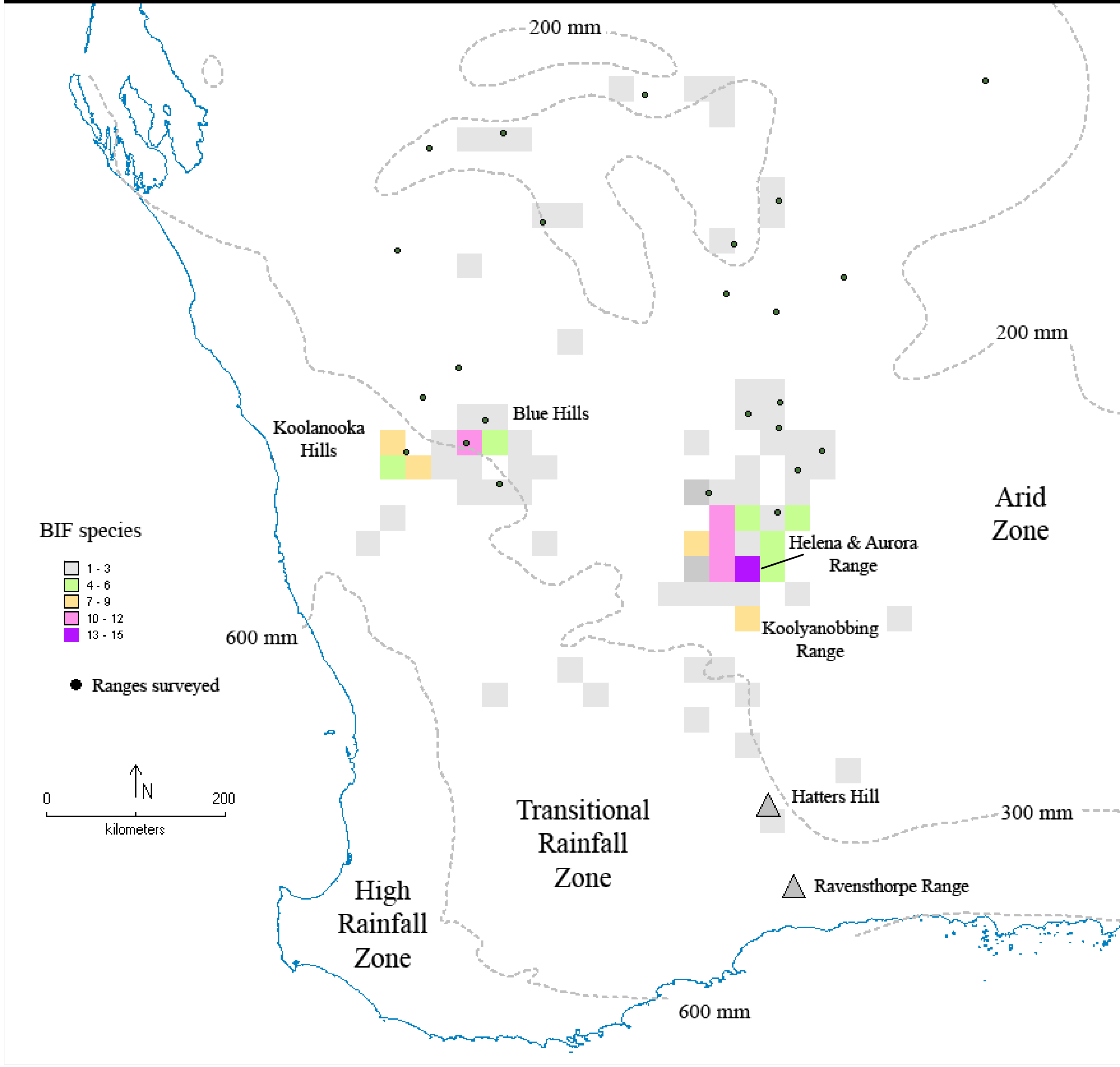
Acacia woodmaniorum

Lepidosperma gibsonii

Prostanthera ferricola

Drummondita rubroviridis

Patterns of specialists BIF taxa



- 24 taxa restricted to individual BIF ranges
- 6 taxa restricted to BIF but occurring across several ranges
- 14 that had their distributions centred on BIF ranges
- two hotspot of specialists BIF taxa
- these areas have highest conservation priority


Team BIF