Conservation of the Sunshine Coast heathlands

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Captivation and enchantment
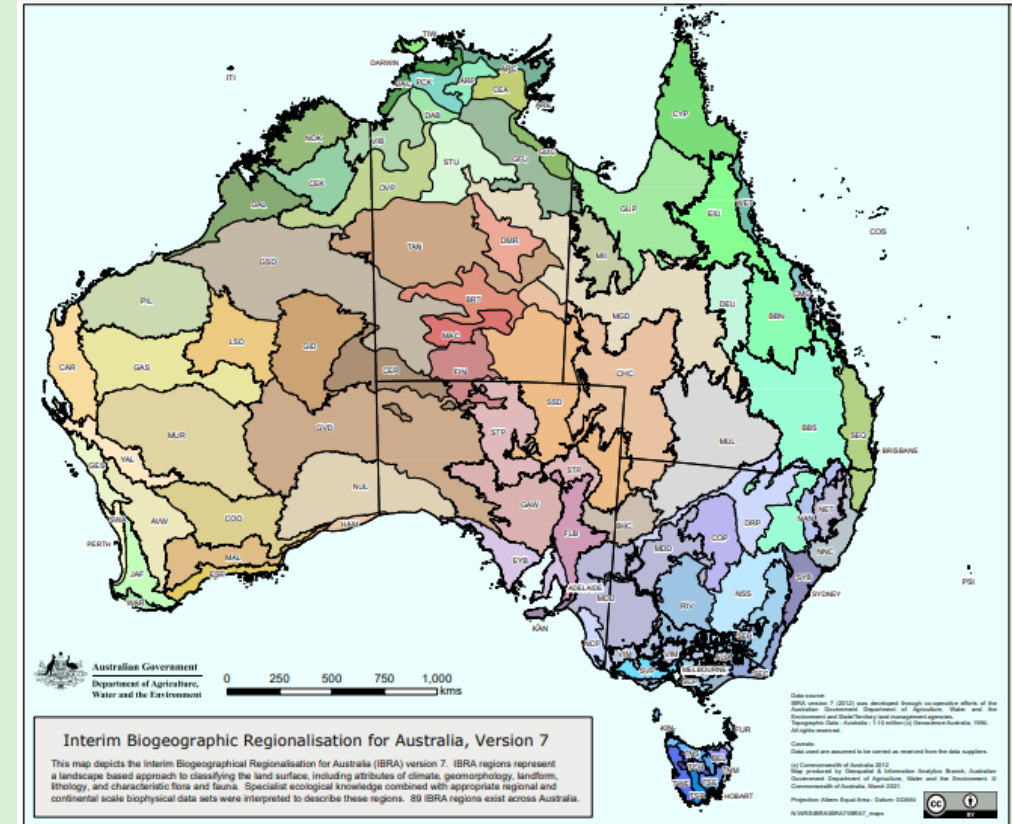
Mt Peregian 1996

Introduction

Convention on Biological Diversity

• 30% of land and sea area conserved by 2030

• Maintain connectivity, integrity, genetic diversity

Australia has goals of ecological representation:

• 89 bioregions

• 1573 Regional Ecosystems in Queensland

Interim Biogeographic Regionalisation for Australia, Version 7

Heath is a highly diverse ecosystem globally

### Fynbos, South Africa

European heathlands

Mediterranean heathlands

Where is heath in Australia?

- mostly coastal

- dense, low height

- shrubs, sclerophyllous leaves, often fire adapted

- low fertility or seasonally waterlogged substrates

- most heath species are endemic to this continent

- heath evolved within a wider rainforest distribution?

Sunshine Coast heaths

Kwongan

Sydney Sandstones
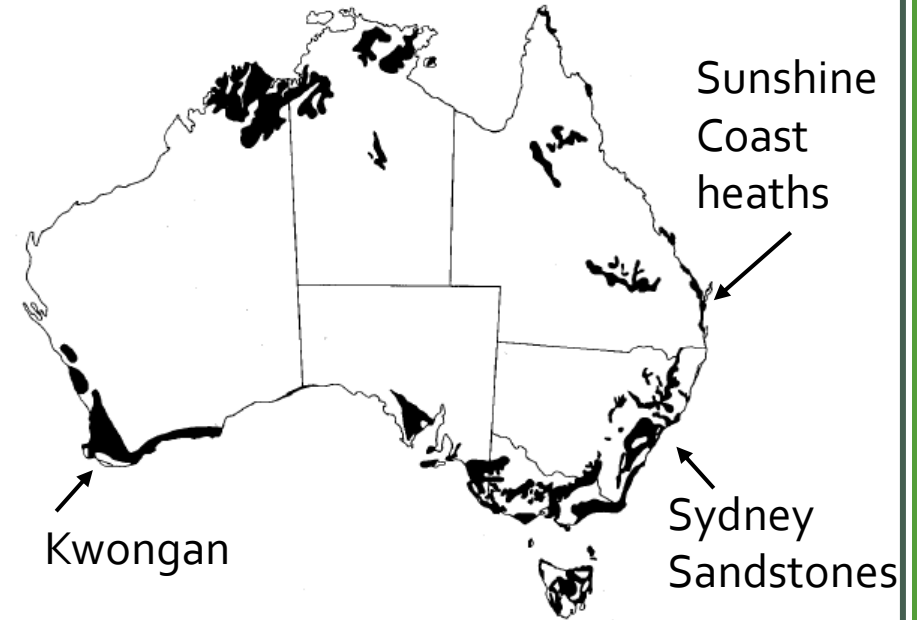
Distribution of Australian heath (Specht 1994)

Our heaths matter! Residents have engaged with the heath for millennia.
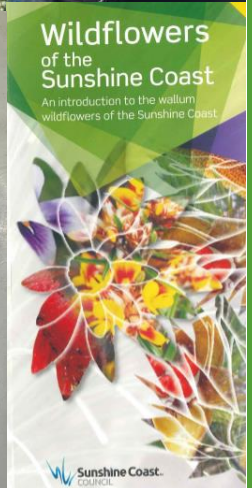

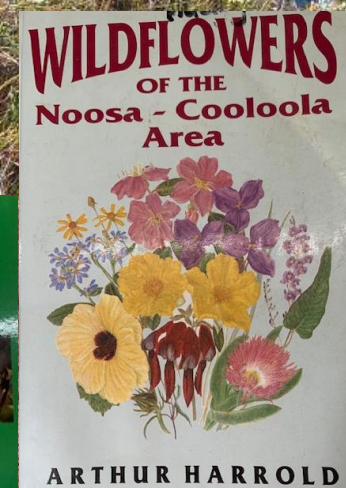(Jones 1990)

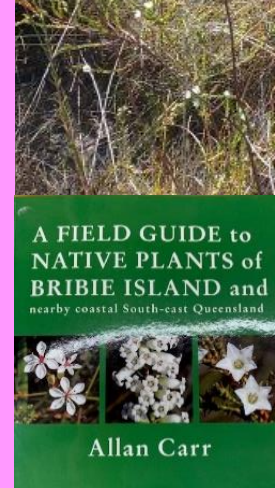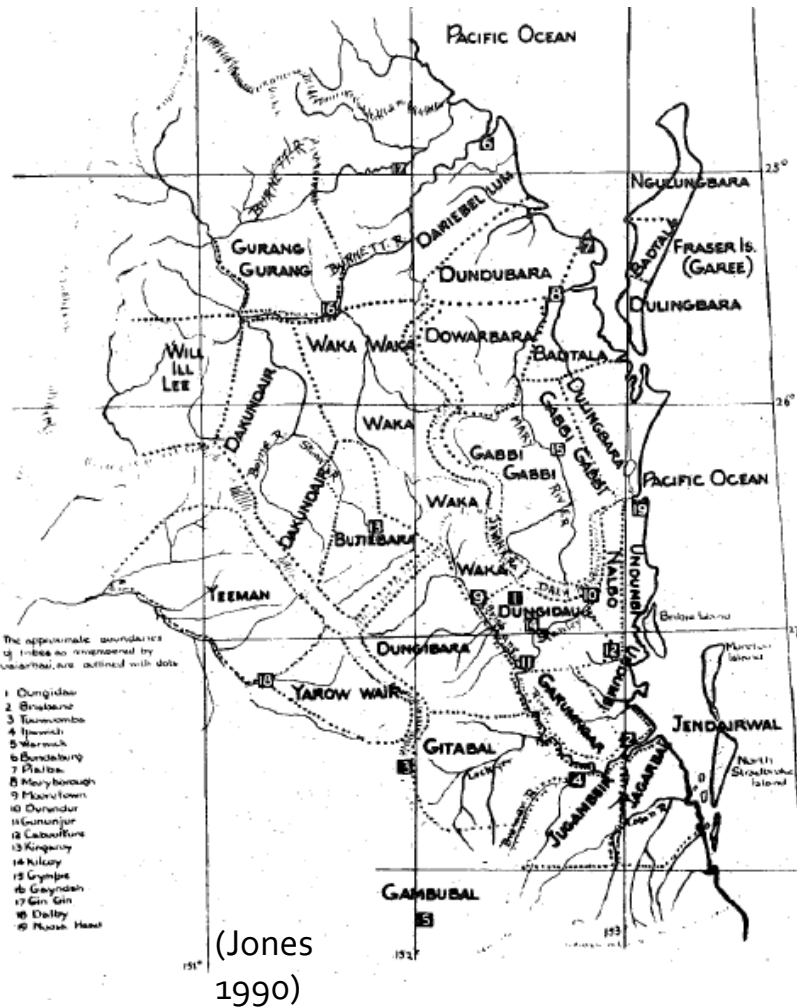Indigenous words are infused in our place & plant names.

'Wallum' - *Banksia aemula*

'Kawana' – flowers

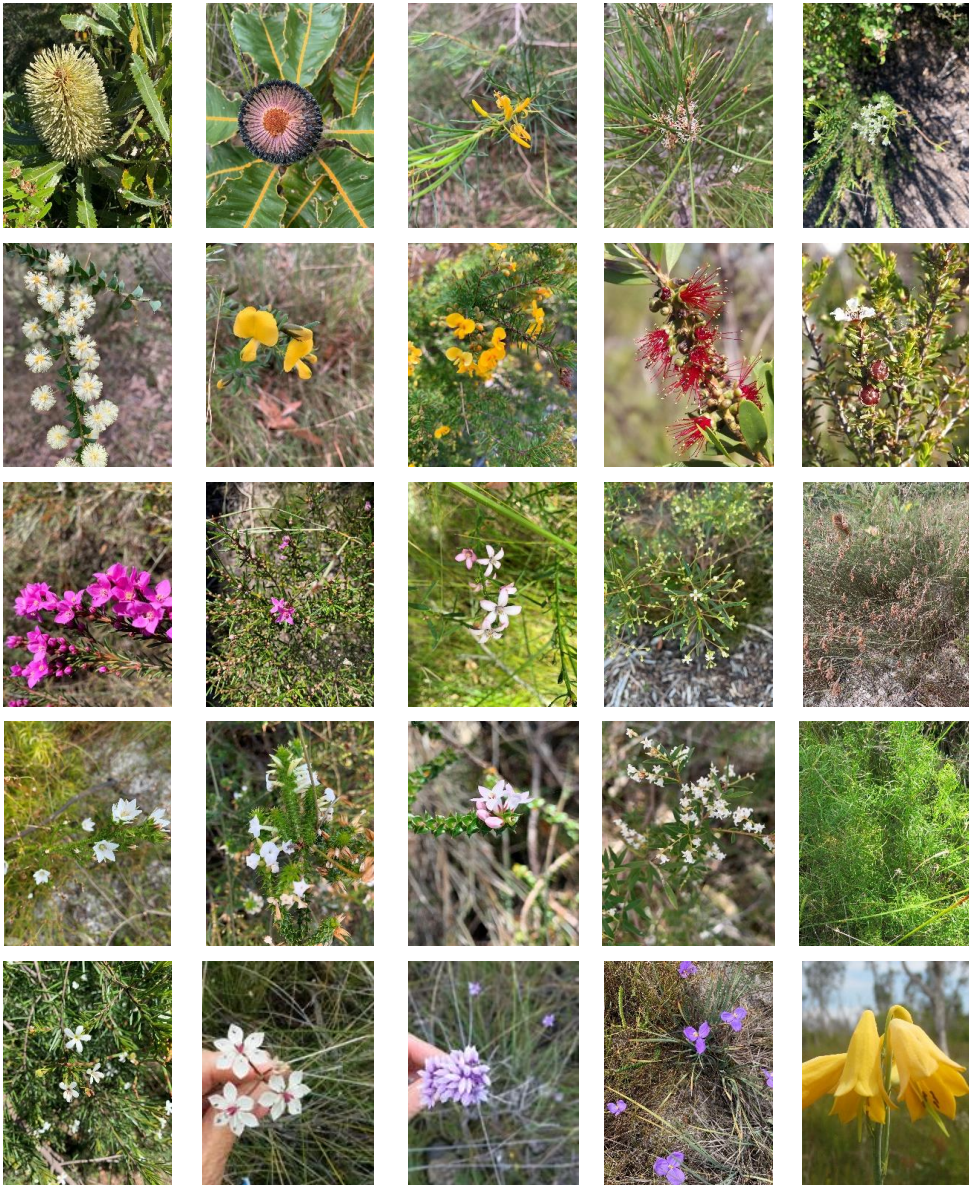'Buderim' - 'honeysuckle' (*Banksia integrifolia*)

'Cooloola'- *Callitris columellaris*

'Midyim' – *Austromyrtus dulcis*

A FIELD GUIDE to NATIVE PLANTS of BRIBIE ISLAND and *nearby coastal South-east Queensland*

Allan Carr

WILDFLOWERS OF THE Noosa - Cooloola Area

ARTHUR HARROLD

Wildflowers of the Sunshine Coast

An introduction to the wallum wildflowers of the Sunshine Coast

Sunshine Coast COUNCIL

Why do we care? The flora is spectacular!

- At least 11 local, and 16 regional endemic species (Young 2015)

- 18 species listed under the NCA, 6 species under the EPBC

- There have been population genetics studies of specific Sunshine Coast flora

- Yet, few community ecology studies of the Sunshine heaths

# There is concern over the loss of heath on the Sunshine Coast

Caloundra, heath preclearing

Caloundra, heath 2017
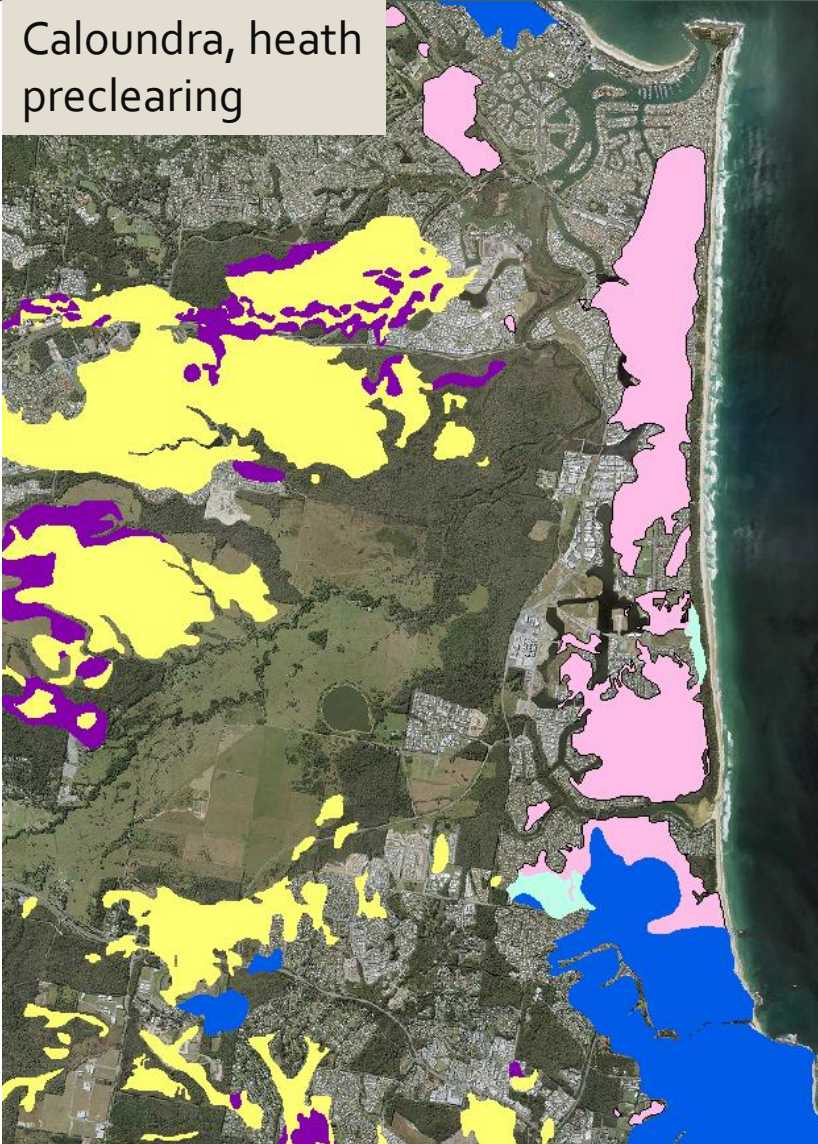
- How much has been lost?

- Is it better to conserve one large patch or several small patches?

- How much connectivity is lost – does it matter?

- Is it worthwhile keeping small remnant patches of heath? Can they maintain their integrity?

- Does changing hydrology from infrastructure matter?

Legend

- 12.2.9
- 12.3.14
- 12.9-10.22
- 12.12.10
- 12.5.9
- 12.3.13
- 12.2.13
- 12.2.12
- 12.8.19
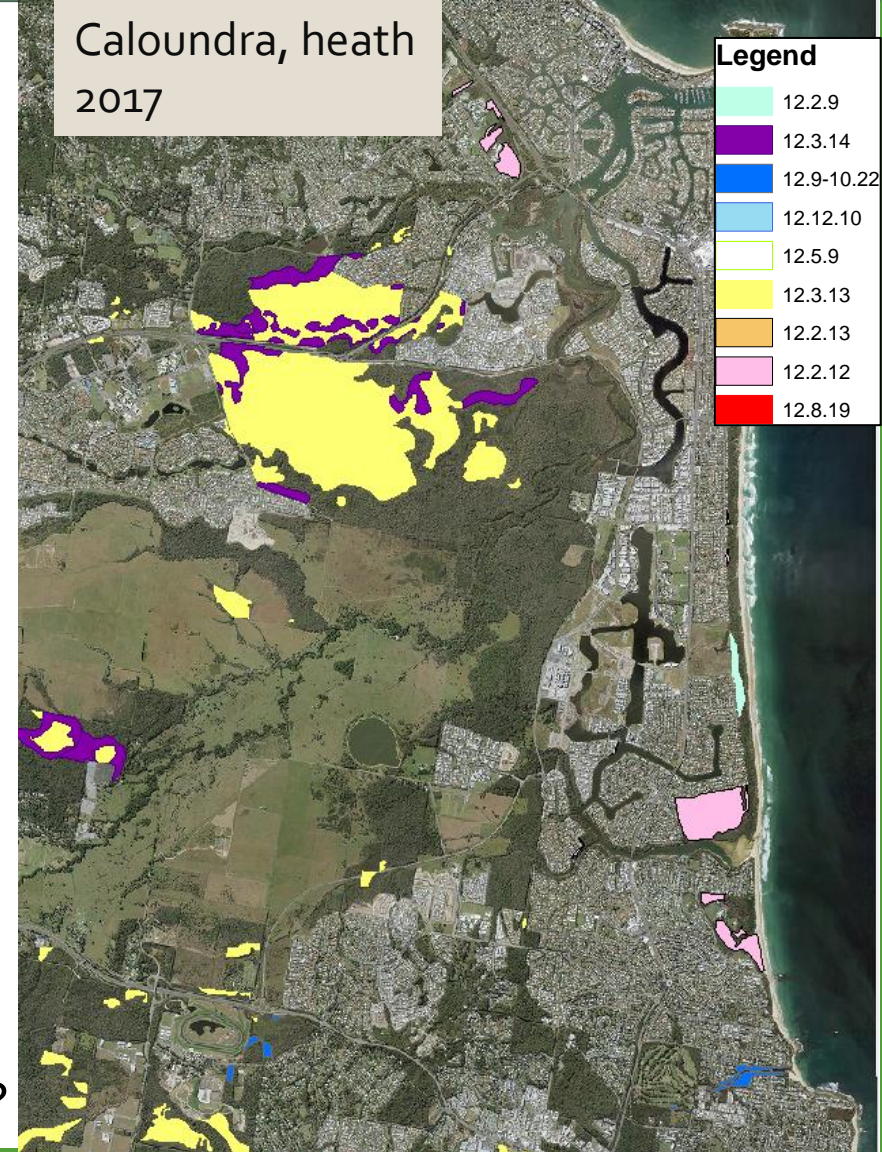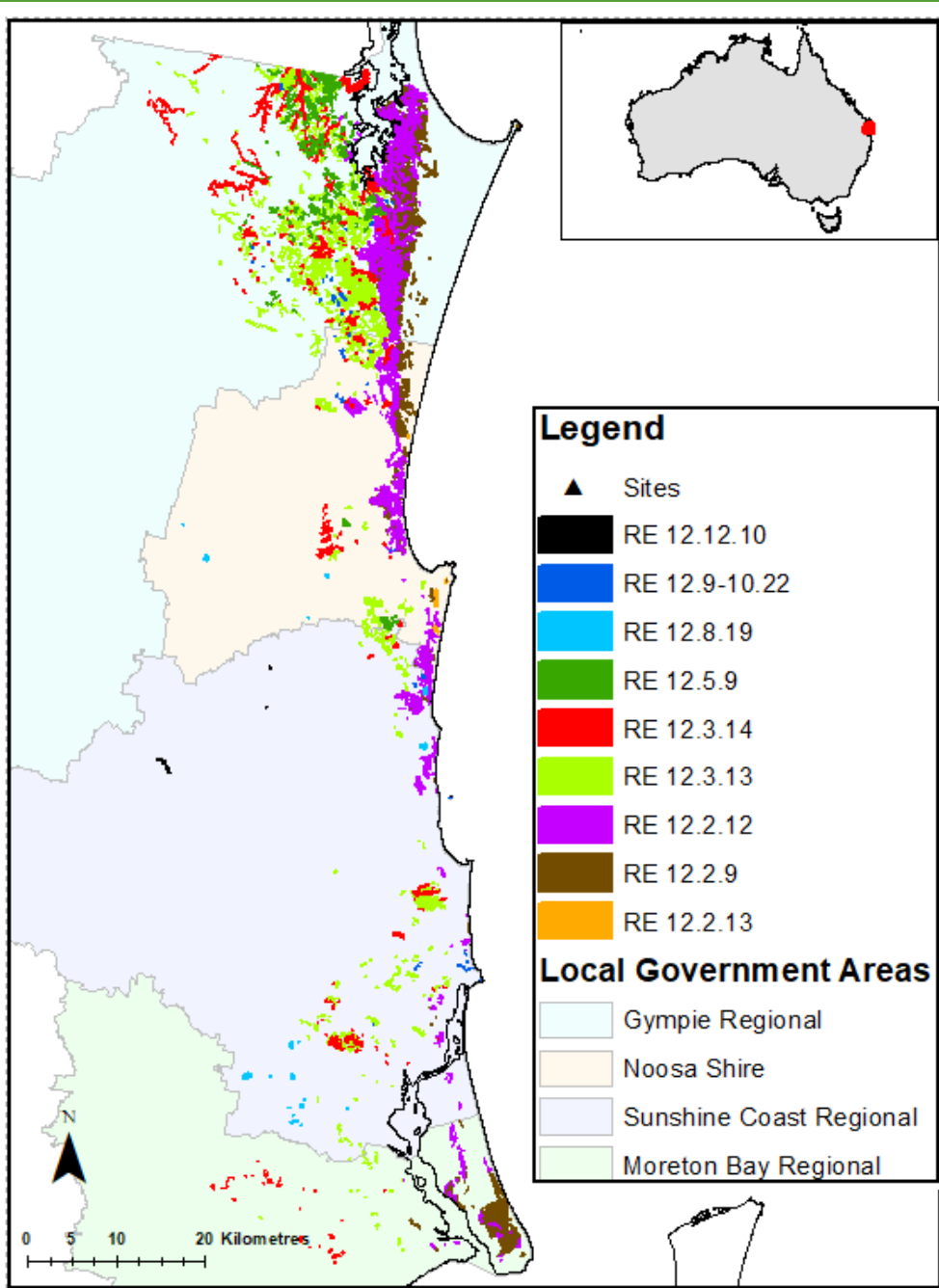
# What are the heath types on the Sunshine Coast?

- Nine heath Regional Ecosystems based on bioregion, land zone (geology & topography), vegetation structure and composition

- Six of them have a biodiversity status "of concern"; One is endangered (12.2.13)

- How much have we lost of each Regional Ecosystem?

- Are some Regional Ecosystems more diverse, more important for conservation than others?

- Is there a centre of diversity? Refugial area?

Legend

△ Sites

- RE 12.12.10
- RE 12.9-10.22
- RE 12.8.19
- RE 12.5.9
- RE 12.3.14
- RE 12.3.13
- RE 12.2.12
- RE 12.2.9
- RE 12.2.13

Local Government Areas

- Gympie Regional
- Noosa Shire
- Sunshine Coast Regional
- Moreton Bay Regional

How significant are the montane heaths of the Glasshouse Mountains, Mt Coolum (RE12.8.19) and Mapleton area (RE 12.12.10)?

Glasshouse Mountains

Eucalyptus kabiana, Mt. Beerwah
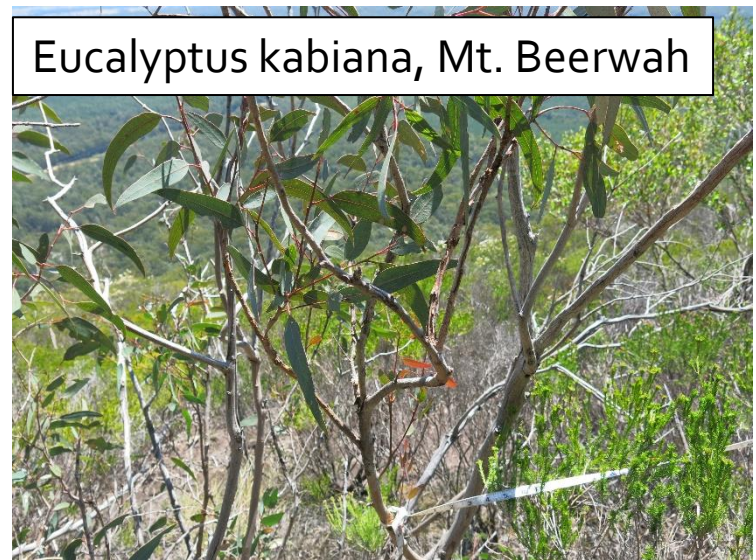
- Glasshouse Mountains: centre of endemism (Beadle 1981, Young 2015).

- Tertiary and Triassic Landscapes

- Are they "old, climatically buffered infertile landscapes" (OCBILs)? (Hopper 2009)

- Will they have higher diversity, be distinctive, and provide evidence of being potentially "refugial" areas?

Mt Coolum RE 12.8.19

Swain's Peak RE 12.12.10

What factors correlate with heath diversity? Would this assist in maintaining their integrity?

Are wet heaths less diverse than dry heaths?

How significant are the mounded and trenched areas and the fens?

How important are substrates for diversity?

Restoration species choice?

Wet heath on sand (RE 12.2.12)

Wet heath, alluvium (RE 12.3.13)

Heath is being lost, and our knowledge of the different types is limited. What do we need to focus on for conserving the area and the integrity of heath?

Aims

1. Is there **variation** in the **species richness, phylogenetic diversity, and composition** of heath across the Sunshine Coast?

2. What **explains** the variation in diversity of heath across the Sunshine Coast?

3. Which are the **priority areas for conservation** of heathlands across the Sunshine Coast?

Beerwah, RE 12.3.14

Methods: sampling heath

Sampled in protected areas, Cooloola to Bribie Island, stratified design, 80 sites.

- Geological substrate

- Age of substrate

- Elevation : <6 metres, < 10 metres (past sea level rises)
- Aspect

- Regional Ecosystem

- Moisture: wet, moist, dry
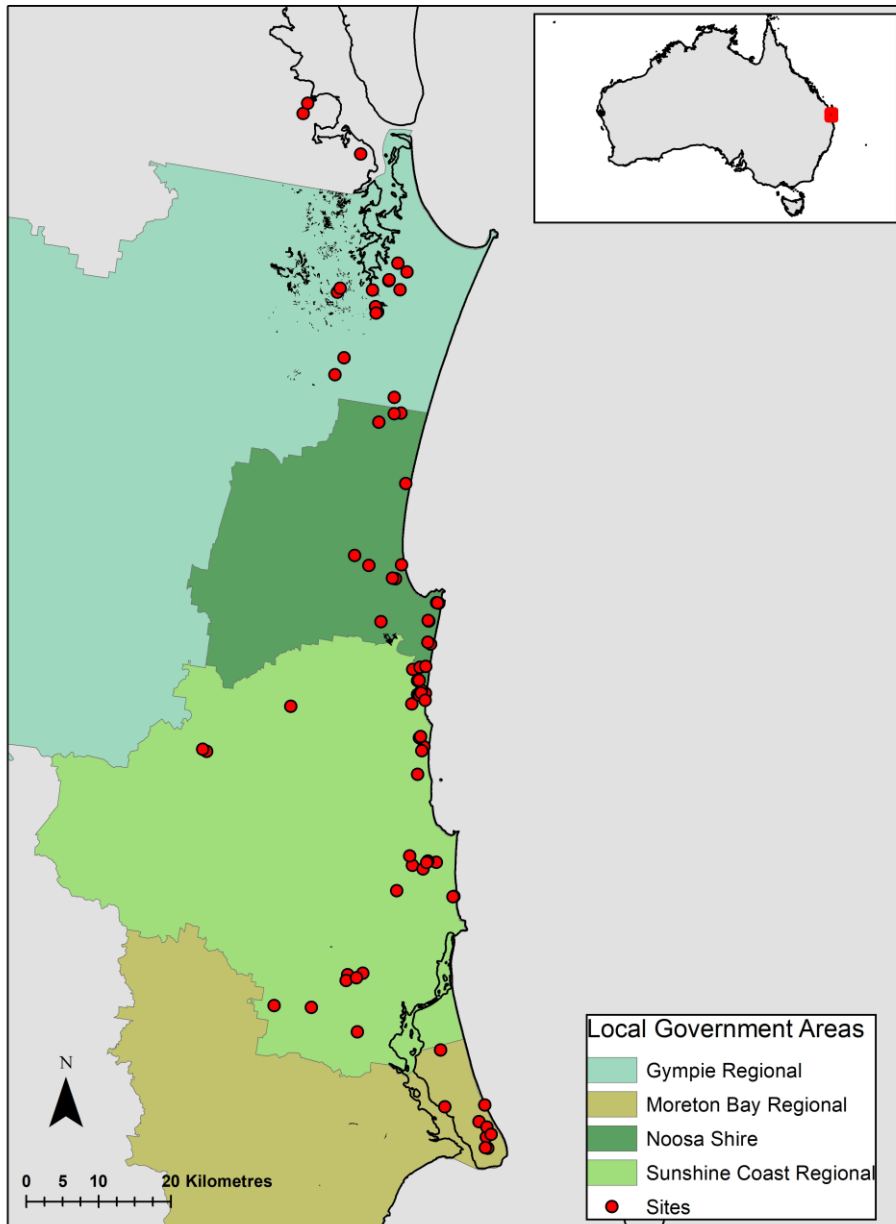
Methods: fieldwork collecting site data

1. Species list - for each site, 50 metres x 20 metres

2. Structural data
- Height of each layer
- Cover (%)
- Number of species in each layer

3. Abiotic data

- Elevation, aspect, GPS location, slope, topography, soil colour & texture, moisture status

In addition across all sites: a vouchered DNA specimen with for each species (366 species)

Methods: Constructing the phylogeny

Methods

How to measure diversity?

Diversity – how much?

Species Richness
Genus Richness
Family Richness
Phylogenetic Diversity
(community genetic diversity)

Site	SR	GR	FR	PD
15248	34	32	19	1866.9
15250	9	9	8	824.5
15621	20	17	9	1061.0*L
16488	28	25	16	1687.7
16491	25	22	13	1433.6

Phylogenetic Dispersion – how phylogenetically related are species within groups?

Closely Related (clustered)

Distantly related ("even")

https://phys.org/news/2014-07-scientists-big-efforts.html
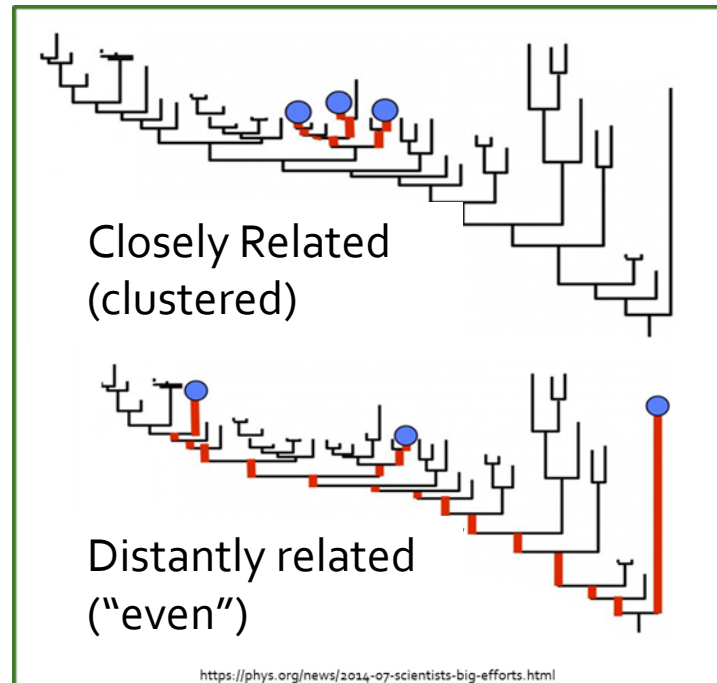
Distinctiveness – how dissimilar are communities?
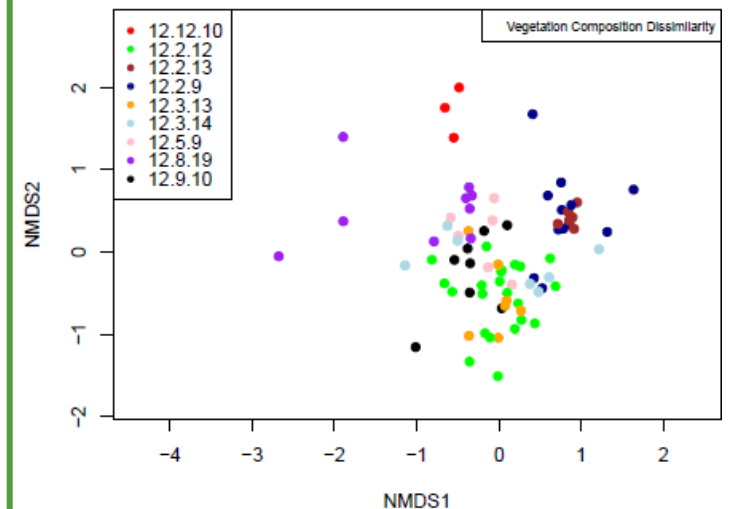
Analysis

1. The phylogenetic tree used to generate the diversity metrics to explore variation

2. Explored conservation status of heath using Qld Herbarium data

- Patches size and number

- Preclearing and remnant extent of heath (2019)

- Correlations between extent, patches and diversity metrics

1. Is there **variation** in the **species richness, phylogenetic diversity, and composition** of heath across the Sunshine Coast?

Dutgee, Cooloola, RE 12.2.12

Sunshine Coast heath taxa

- 366 species excluding ferns and orchids

- 73 families, 201 genera

- Myrtaceae, Cyperaceae, Proteaceae, Xanthorrhoeaceae and Fabaceae were each encountered on over 70 of the 80 sites

Species rich families	Species	Significant genera
Myrtaceae	42	*Leptospermum, Melaleuca*
Cyperaceae	34	*Ptilothrix, Schoenus*
Poaceae	29	*Aristida, Eriachne*
Fabaceae	27	*Pultenaea, Dillwynia*
Ericaceae	22	*Epacris, Leucopogon*
Mimosaceae	19	*Acacia*
Proteaceae	19	*Banksia, Hakea, Persoonia*
Restionaceae	12	*Empodisma, Baloskion*
Rutaceae	12	*Boronia, Philotheca*
Laxmanniaceae	12	*Laxmannia, Lomandra*

Restionaceae, Cyperaceae, Poaceae

Xanthorrhoeaceae
Orchidaceae

Lauraceae
(*Cassytha*)

Proteaceae

Dilleniaceae

Ericaceae

Goodeniaceae

Rutaceae

Myrtaceae

Fabaceae

Legend:
- Gymnosperms (green)
- Basal Angiosperms (yellow)
- Monocots (purple)
- Basal Eudicots (cyan)
- Asterids (dark green)
- Rosids (blue)
- Heath Species (red)

Phylogeny consistent with heath evolving within a wider rainforest distribution

- Most ancient lineage is Lauraceae (*Cassytha* spp.)

- Heath is clustered within the rainforest phylogeny

- Low phylogenetic diversity compared to rainforest

- No unique heath orders

Eight Regional Ecosystems have a significantly low phylogenetic diversity *(p<0.05)*
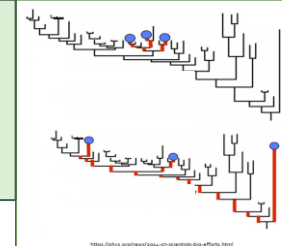
Diversity metrics of the heathland Regional Ecosystems

RE	SR	PD	NRI
12.2.9	121	**3632.7**^{*L}	0.63
12.2.12	151	**4258.2**^{*L}	0.09
12.2.13	61	**2376.7**^{*L}	**2.41**^{*C}
12.3.13	89	**3004.5**^{*L}	-0.76
12.3.14	95	**3153.7**^{*L}	-0.16
12.5.9	114	**3564.0**^{*L}	0.60
12.8.19	106	**3295.2**^{*L}	0.88
12.9-10.22	123	**3849.0**^{*L}	0.41
12.12.10	61	**2743.2**	1.52

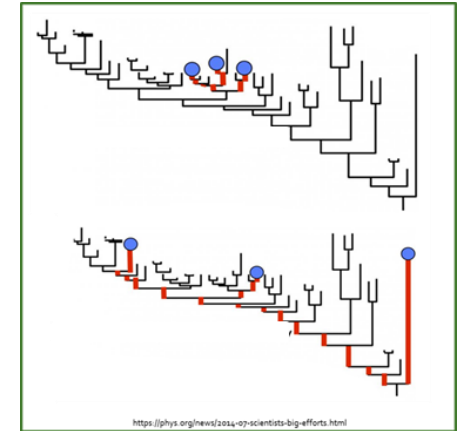## RE 12.2.13 is phylogenetically clustered

12.2.13 Marcus High Dunes

- Some unique species
- Environmental filtering?
- Recently expanded onto the Holocene/Pleistocene dunes?

Regional Ecosystems do not differ in diversity, (species, family, genera, phylogenetic diversity) but some differences in phylogenetic dispersion (NRI)

Summary of mean diversity values of the heath sites grouped by Regional Ecosystem

RE	SR	PD	NRI
12.12.10	30.3	1616.9	0.61 ab
12.2.12	34.5	1754.6	-0.45 ab
12.2.13	36.3	1771.3	**0.87 a**
12.2.9	30.1	1570.0	**0.92 a**
12.3.13	31.0	1652.2	**-1.08 b**
12.3.14	28.7	1464.3	0.09 ab
12.5.9	43.3	1923.3	0.41 ab
12.8.19	31.2	1564.9	-0.09 ab
12.9-10.22	42.5	1991.1	-0.12 ab

12.2.13 on dry sands

12.2.9 on dry sands

12.3.13 on alluvium

https://phys.org/news/2014-07-scientists-big-efforts.html

- Potential OCBILs (RE 12.8.19, 12.12.10) do not have a higher diversity.

- First hint of wider dispersion in the wetter heaths, an aspect of their diversity unknown
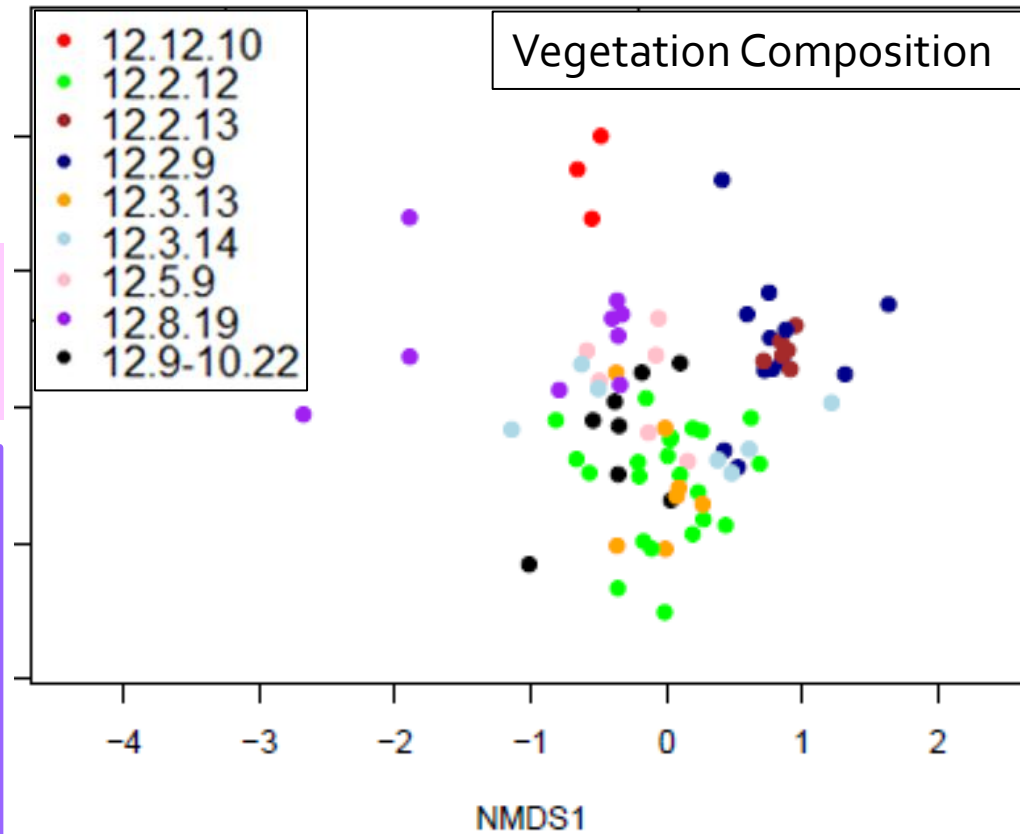
12.12.10 Mapleton

Some Regional Ecosystems have distinctive vegetation composition

12.2.9 Cooloola

Potential OCBILs are distinctive

12.8.19 Mt Coolum

Vegetation Composition

- 12.12.10
- 12.2.12
- 12.2.13
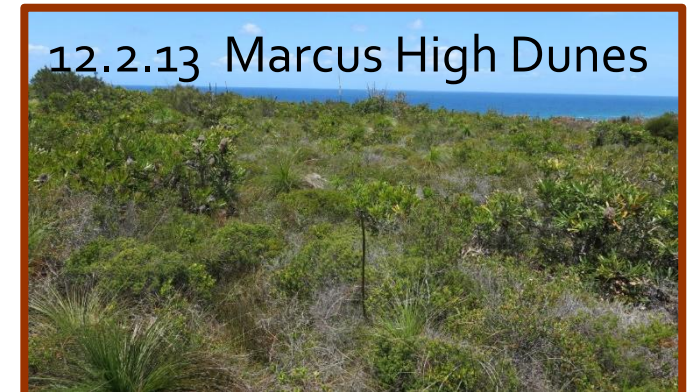- 12.2.9
- 12.3.13
- 12.3.14
- 12.5.9
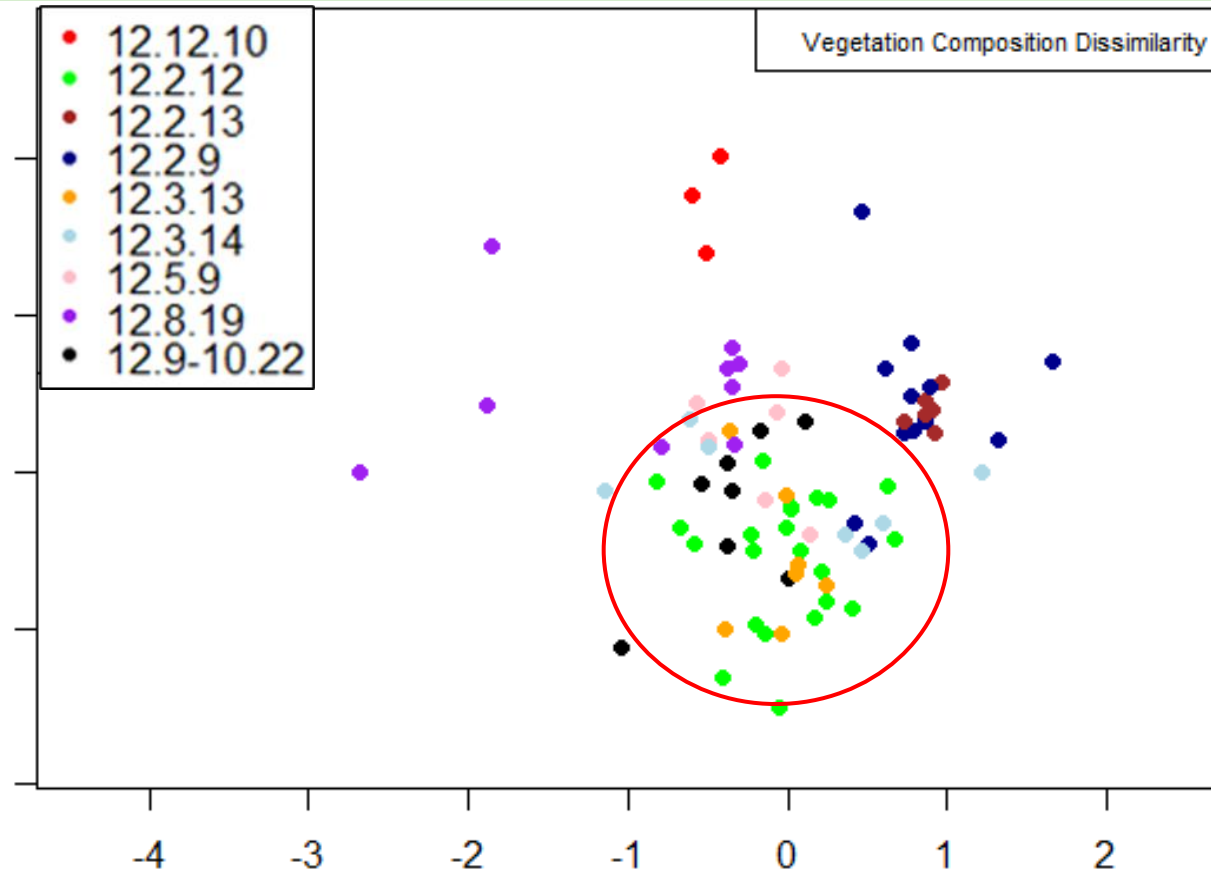- 12.8.19
- 12.9-10.22

NMDS1

Heaths of the dry sands are distinctive as a group.
Environmental filtering?

12.2.13 Marcus High Dunes

Most heath not distinctive. Five Regional Ecosystems overlap in composition.

Legend:
- 12.12.10
- 12.2.12
- 12.2.13
- 12.2.9
- 12.3.13
- 12.3.14
- 12.5.9
- 12.8.19
- 12.9-10.22

Vegetation Composition Dissimilarity

A large variable group:

- Coastal lowlands

- Areas subject to deposition, sediments, rivers and flooding, wet and moist

- Community assembly - a "dynamic system" due to stochastic events of sea level rises, floods, cyclones, fires, drought?

12.2.12 – wet sands

12.3.13 – alluviums

12.3.14 – alluviums

12.5.9 – remnant sediments

12.9-10.22 sedimentary

Seven sites were phylogenetically even

Vegetation Composition

- clustered
- even
- random
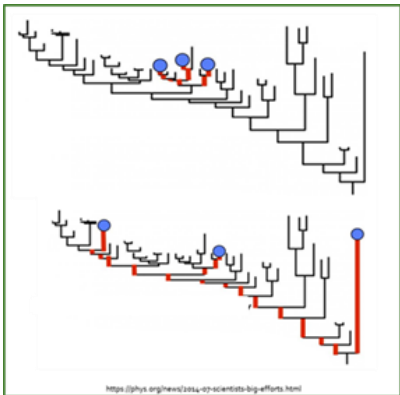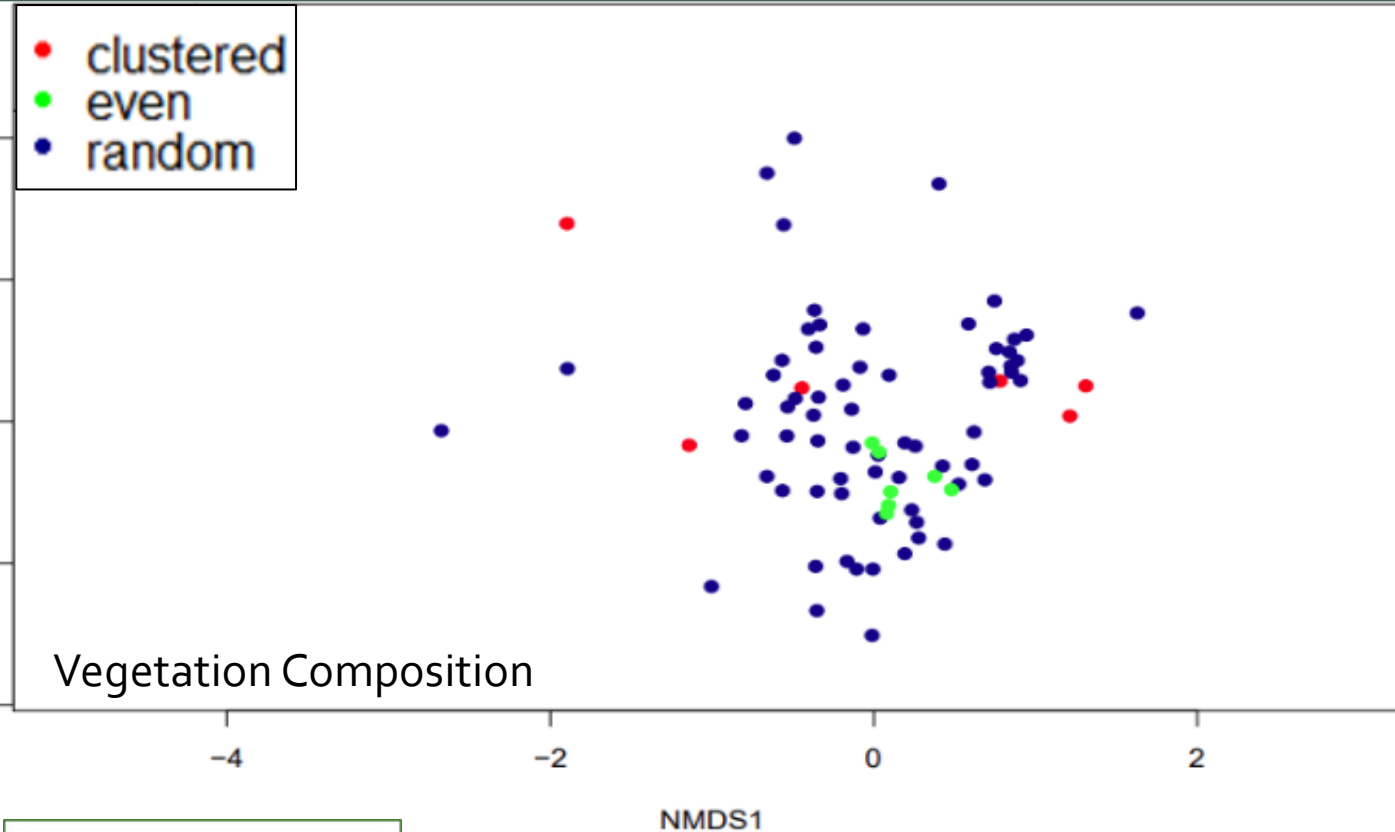
- Phylogenetically even sites found in wet and alluvial areas of the coastal lowlands

- Similar in species composition but scattered across the coast

- Found in RE 12.2.12, 12.3.13 and 12.3.14

- "Refugial environment" (not location)?

- Associated with hummocks $(p < 0.05)$
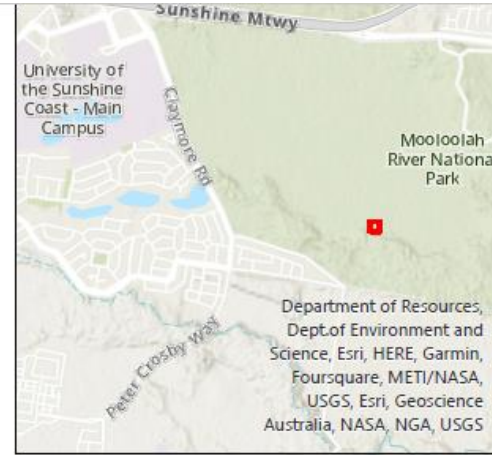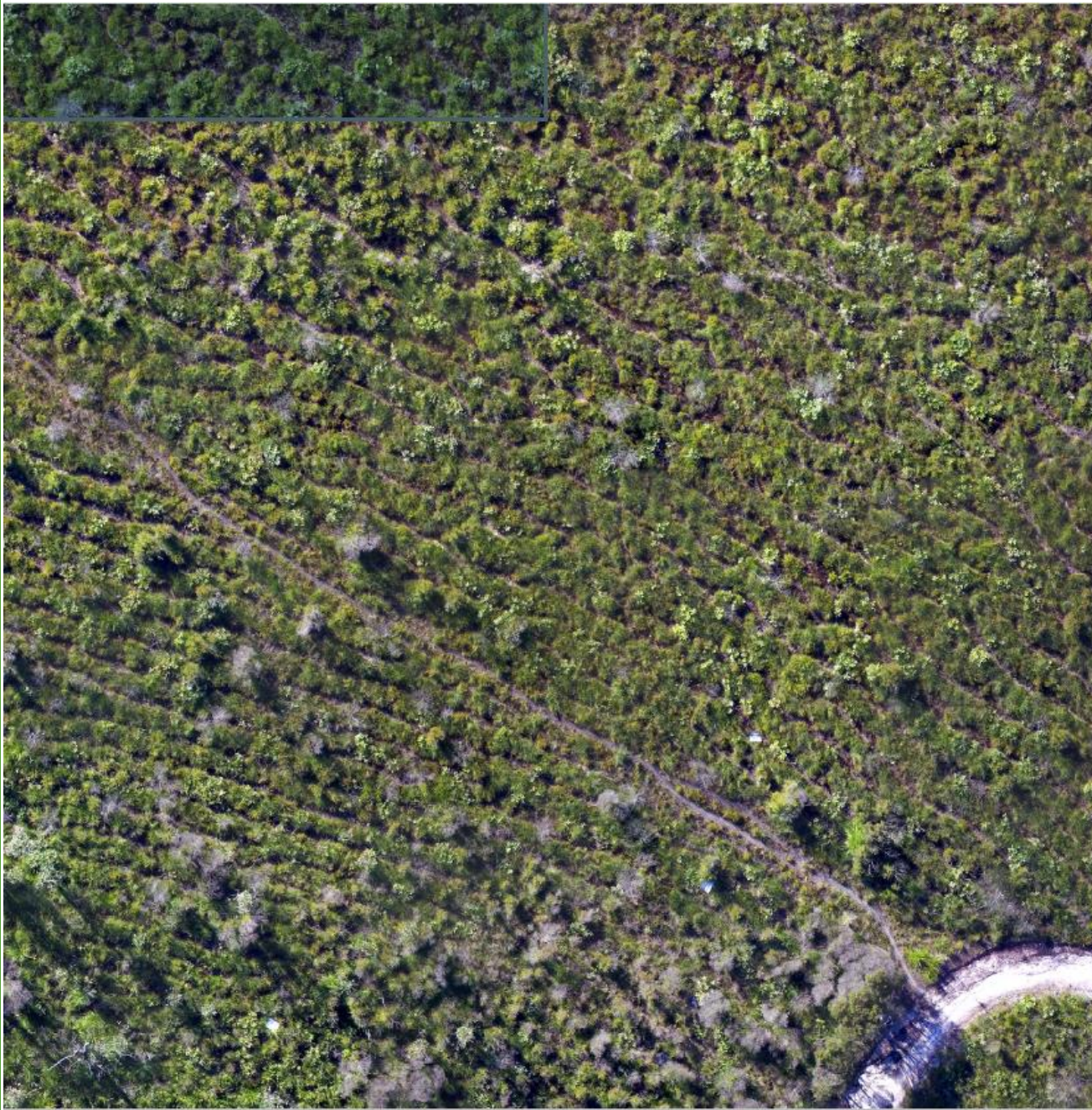
Heath patch in Mooloolah National Park

0 5 10 20
Meters
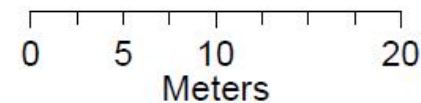
This image shows a section of an orthomosaic made of part of the national park. This was the result of a drone mapping exercise conducted on 25th June 2022, using a Phantom 3 Advanced with standard RGB sensor, and software processing using Metashape and ArcGIS Pro.

N

Map: Judd van der Brenk

- Mounds & trenches associated with phylogenetic dispersion ($p < 0.05$).

- Formed by water flow and differential growth of restiad *Empodisma minus?*

- Refugial areas? Niches in the event of floods, droughts, fire, cyclones?

- "The wetter heaths engineer their own mounds and trenches, and triumph in them!"

2. What **explains** the variation in diversity of heath across the Sunshine Coast?

Brahminy, Cooloola, dry heath on sand

Moisture: moist sites display a higher diversity and dispersion; dry sites distinctive

- Vegetation composition – dry sites distinctive

- Diversity – moist sites significantly higher diversity

- Phylogenetic dispersion – moist sites significantly phylogenetically dispersed than dry sites
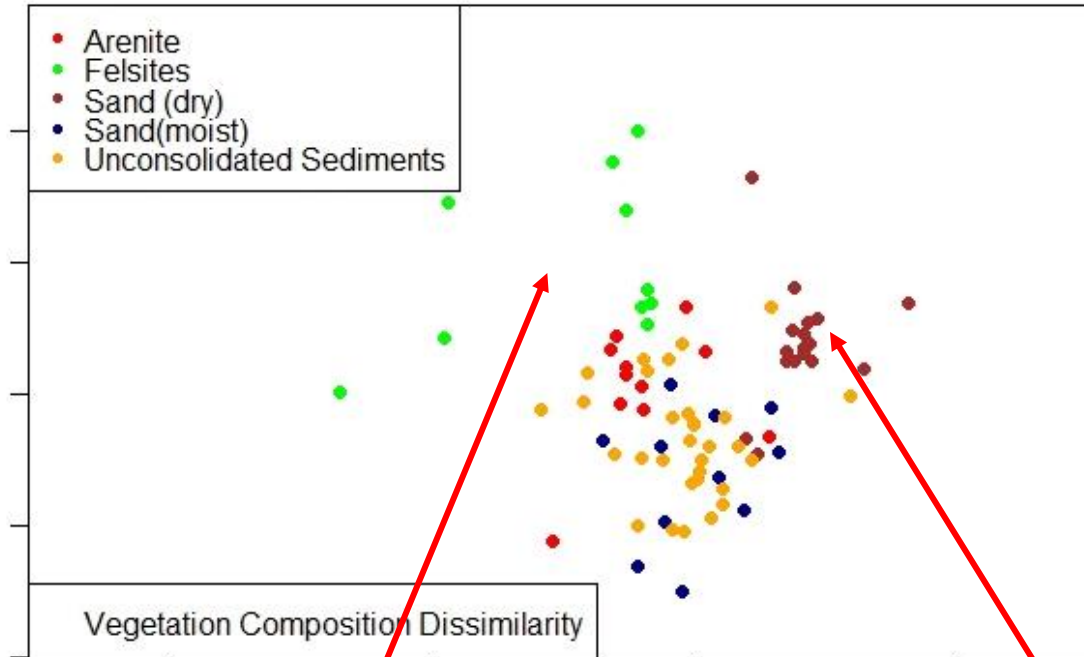

Vegetation Composition Dissimilarity
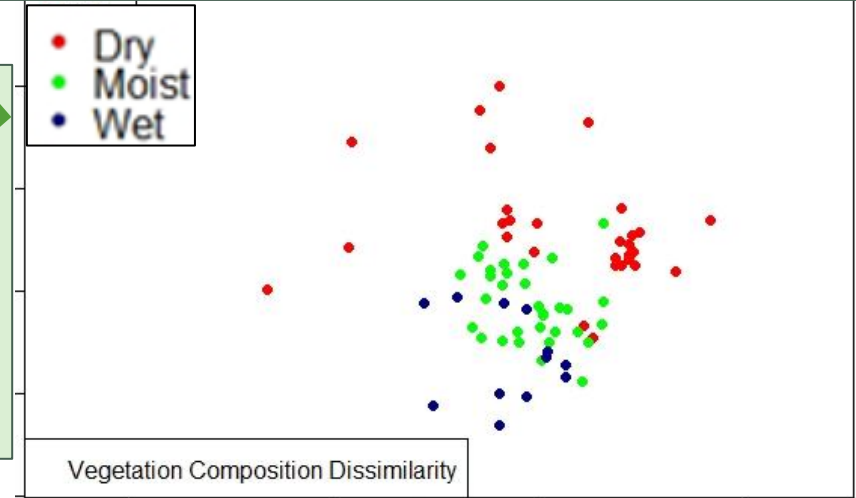
Summary of mean diversity values of the Sunshine Coast heath sites grouped by moisture status

	Variables	SR	GR	FR	PD	NRI
Moisture	Dry	31.5 bc	27.8 bc	16.3) bc	1599.6 bc	0.59 a
	Moist	40.5 a	35.6 a	20.1 a	1918.2) a	-0.42 b
	Wet	29.2 c	26.0) c	15.8 c	1539.6 c	-0.21 ab

https://phys.org/news/2014-07-scientists-big-efforts.html
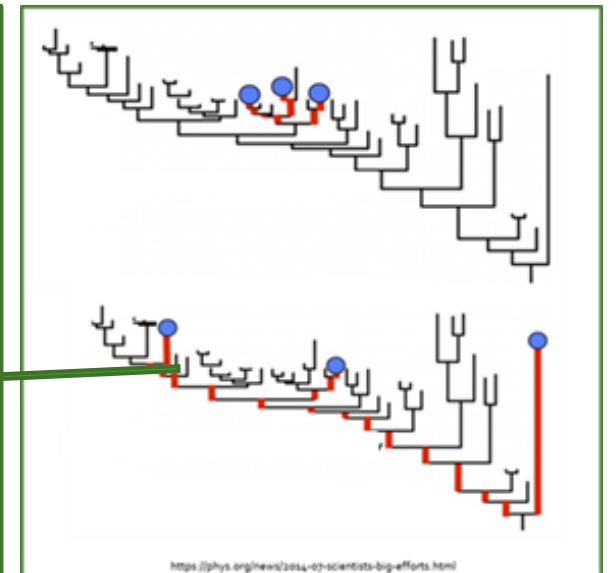
Substrates: no diversity (SR) differences, but volcanics, and dry sand communities, are each distinctive.

Legend:
- Arenite
- Felsites
- Sand (dry)
- Sand(moist)
- Unconsolidated Sediments

Vegetation Composition Dissimilarity

OCBILs?

Environmental filtering?

Summary of mean diversity values of the Sunshine Coast heath sites grouped by substrate (p<0.05)

Substrate	SR	NRI
Arenite	39.2	0.14 ab
Felsites	29.3	0.29 ab
Sand	32.3	**0.46a**
Unconsolidated Sediments	35.5	-0.49 b

Sands are more phylogenetically clustered than unconsolidated sediments.

https://phys.org/news/2014-07-scientists-big-efforts.html
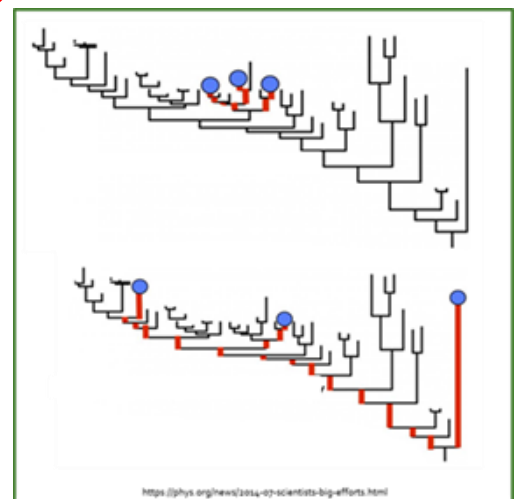
3. Which are the **priority areas for conservation** of heathlands across the Sunshine Coast?

Mt Peregian, RE 12.8.19

Status of Heath
- Remnant Heath in National Parks
- Remnant Heath not in National Parks
- Cleared Heath
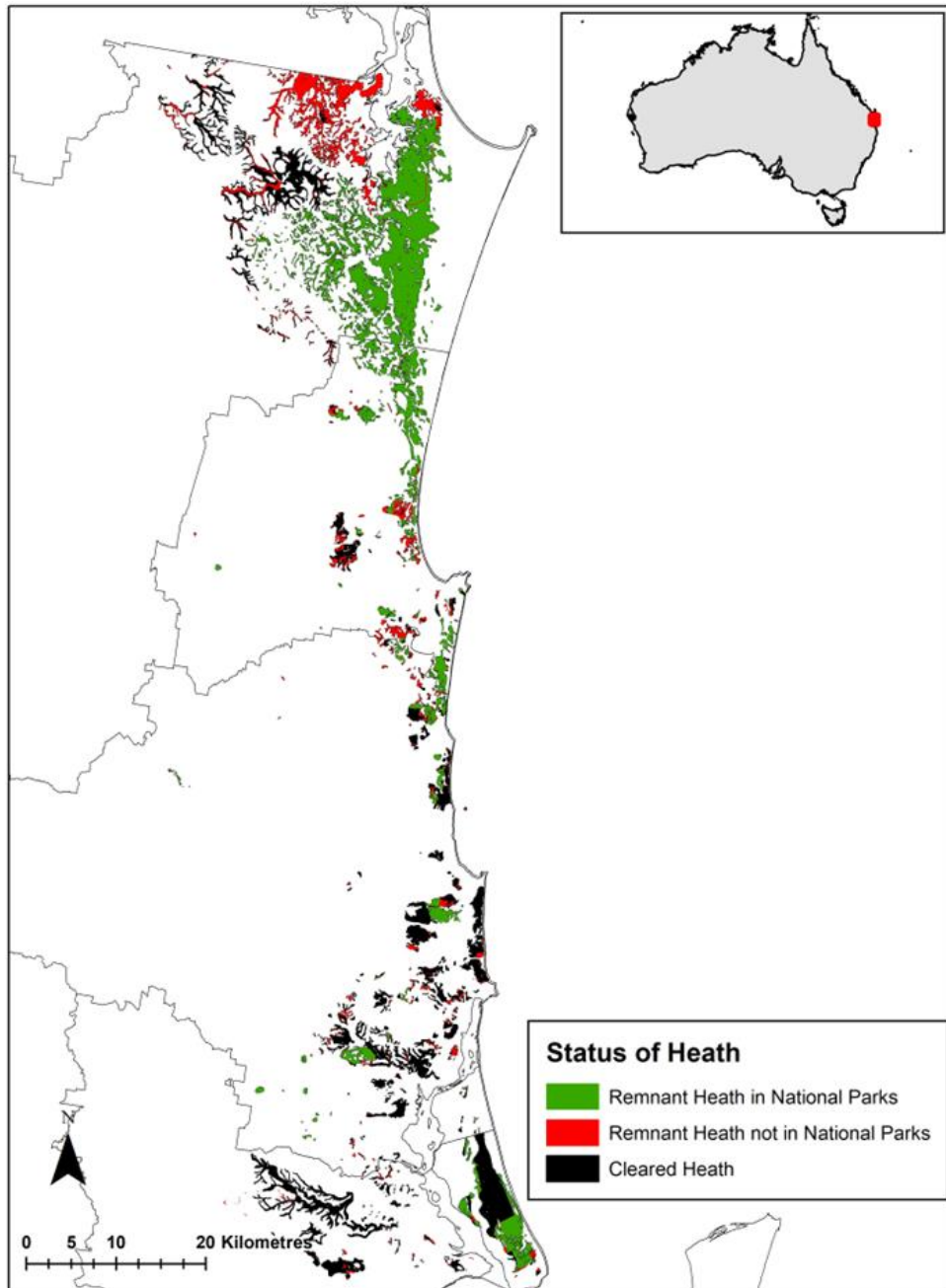
Sunshine Coast heathlands: 62% remains of the pre-clearing extent of 45,356 ha

Region	Remnant	Pre-clearing Protected
Sunshine Coast heathlands	62%	46%
European heathlands	1-60%	
South African fynbos	67%	
Australia (MVG 18)	90%	52%
Queensland (BVG 29)	93%	
Western Australia	40-50%	

CBD: 30% of land and sea area protected by 2030

Two Regional ecosystems, and the southern Local Government Areas <30%

Regional Ecosystem Extent

RE	Pre-clearing (ha)	Pre-clearing in NP
12.2.9	8493	73%
12.2.12	10683	63%
12.2.13	187 (endangered)	**35%**
12.3.13	12855	**37%**
12.3.14	7534	**18%**
12.5.9	3721	**25%**
12.8.19	242	97%
12.9-10.22	1615	41%
12.12.10	27	94%
All Heath	45356	46%

Local Government Area Extent

LGA	Remnant in NP (%)
Gympie	60
Noosa	65
Sunshine	19
Moreton	24
All Heath	**46**

Community advocacy – more National Parks

Urban development

OCBILs? Distinctive. Limited extent, but well protected

The preclearing matrix of patches of heath remains, but patches are smaller

Summary of Patch data for the Sunshine Coast heathland

	Number of Patches		Smallest Patch (m²)		Largest Patch (ha)		Average Patch Size (ha)	
	Pre	Rem	Pre	Rem	Pre	Rem	Pre	Rem
All	1809	1792	16	15	3094	1304	23.9	15.3***

Violin plot of the preclearing and remnant distribution of heath patches by area
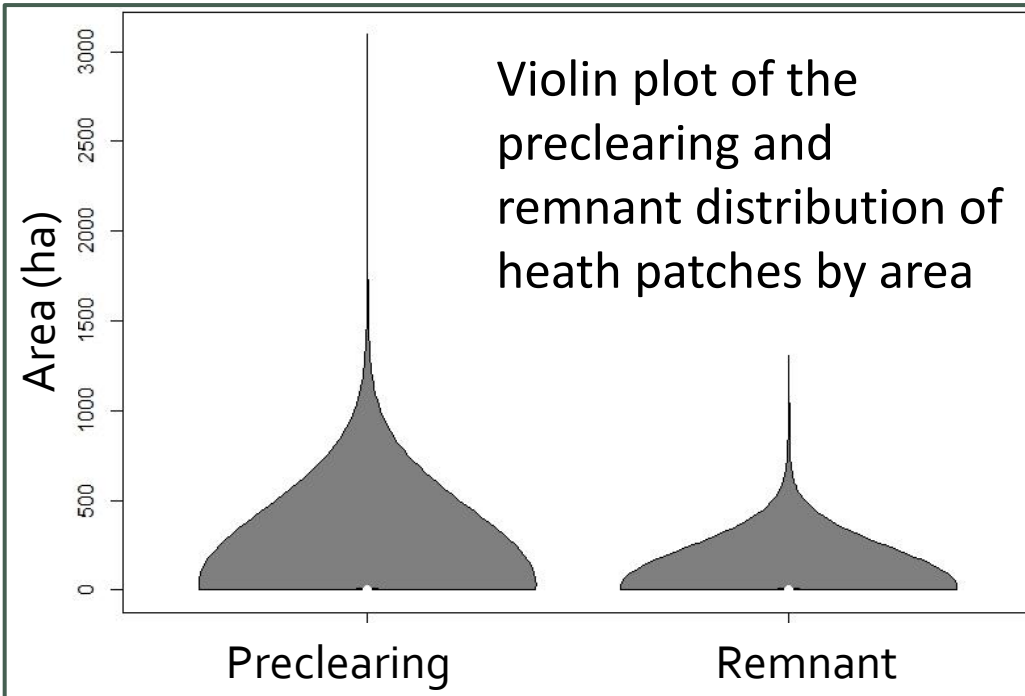
Patches are:
- same distance apart
- same number of patches
- **smaller average size**
- **large patches have been lost**

- Does reduced patch size matter?

- Are small patches valuable for biodiversity?

Increasing phylogenetic dispersion correlates strongly and positively with habitat extent, and number of patches, for the heath Regional Ecosystems
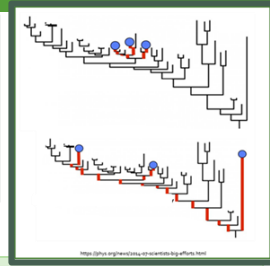
Regional Ecosystem diversity (n = 9), correlations over the study area, with diversity metrics.

	Diversity	SR	PD	MPD	NRI
Extent	Pre-clearing (ha)	0.47	0.46	0.87**	-0.83 **
	Remnant (ha)	0.57	0.57	0.83**	-0.8 *
Number of patches	No. patches pre-clearing	0.36	0.37	0.87**	-0.817 *
	No. Remnant patches	0.36	0.37	0.87**	-0.82 *
Mean patch size (ha)	Size Pre-clearing	0.07	0.0	0.1	-0.03
	Size Remnant	0.44	0.42	0.38	-0.3

For the Regional Ecosystems from this study:

- Increased habitat, increases phylogenetic dispersion

- Increased patch numbers increases phylogenetic dispersion

- No correlation with average patch size and diversity or dispersion

Conclusion

Increasing phylogenetic dispersion

Habitat amount Patch numbers Moist (not wet/dry)
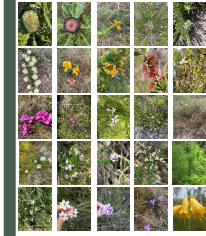
Sunshine Coast heaths 62% left, 46% of preclearing extent protected

Evolutionary history Environmental filtering (clustering)
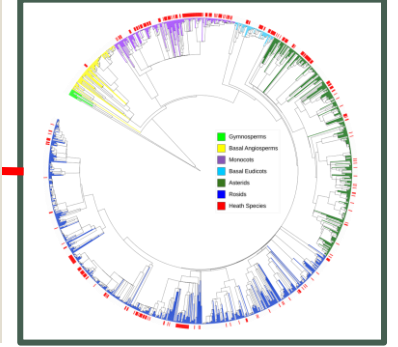
Nine Regional Ecosystems No variation in SR or PD

Moisture

Dryness Felsite substrates

Dryness Sand substrate

Wide variable group of 5 REs (12.2.12, 12.3.13, 12.3.14, 12.5.9, 12.9-10.22) Coastal lowlands

Mounds

Distinctive montane heath (OCBILs?)

RE 12.8.19 & 12.12.10

Distinctive Dry Sands

RE 12.2.9 & 12.2.13

Phylogenetically even sites (with indicator species)

On the Sunshine Coast the matrix of heath remains, providing opportunities to:

Maintain diversity by targeting underrepresented Regional Ecosystems	**Maintain distinctiveness** – OCBILs? (RE 12.8.19, 12.12.10), and the high dunes (RE 12.2.13 &12.2.9)	**Maintain phylogenetic dispersion** – "even sites", the mounded areas, habitat extent and patches
Hydrological infrastructure planning as **moisture** is a major correlate of all areas of diversity	**Restoration targeted:** maintain distinctiveness; but flexibility in other systems; consider connectivity in coastal lowlands	**Research opportunities**: mycorrhizal associations, peat & fen systems, minimum patch sizes
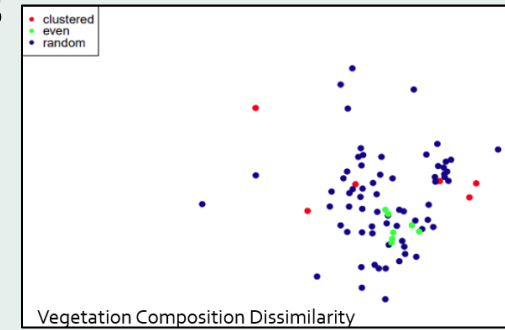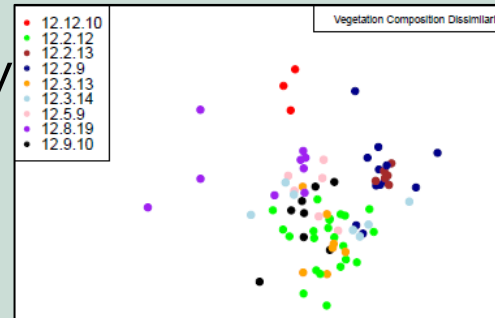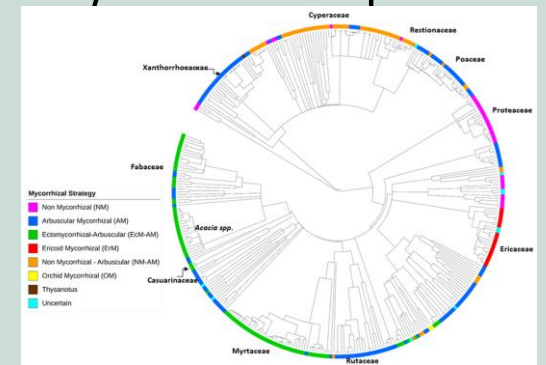
"When the mind opens, the flowers bloom". Kathleen McArthur

"Sculptures in the Sand" in the Pilliga, NSW.

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