Richness and Endemism Mapping in Australian Subtropical Rainforest Herpetofauna

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Subtropical Rainforests –
A Refuge For Herpetofauna

- Subtropical Rainforest herpetofauna = high diversity and endemism in uplands, some lowland rainforest.

- Lots of Short-Ranged Endemics (SREs, distribution <10,000km2).

- Threats e.g. Invasive spp, Diseases, Fire, Climate Change.

Weber et al. 2014 - Subtropical Rainforest Flora Richness/Endemism

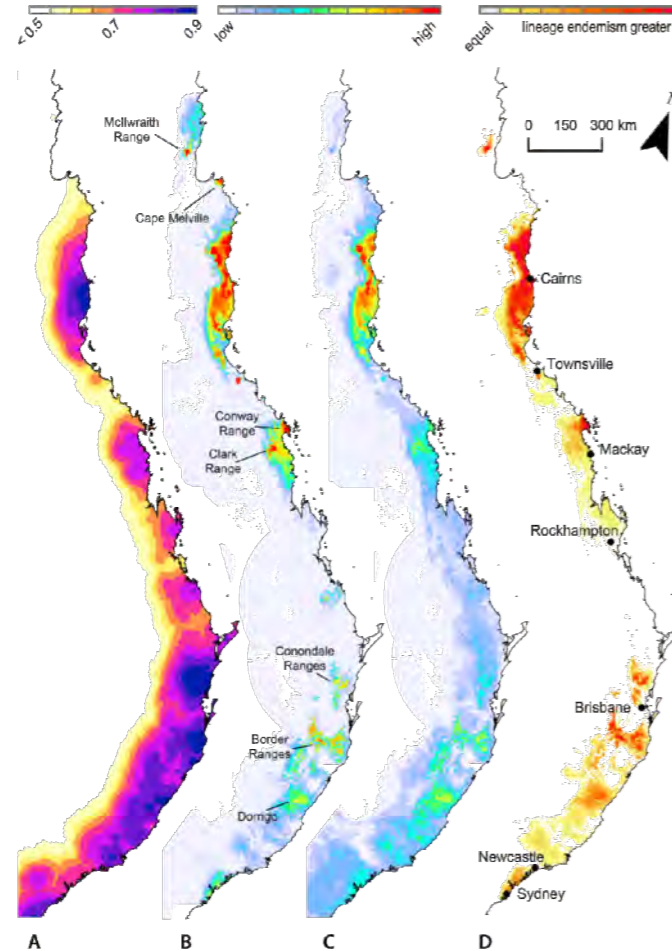P value richness
- 0-0.9 (blue)
- 0.9-1 (red)

P value WE
- 0-0.9 (blue)
- 0.9-1 (red)
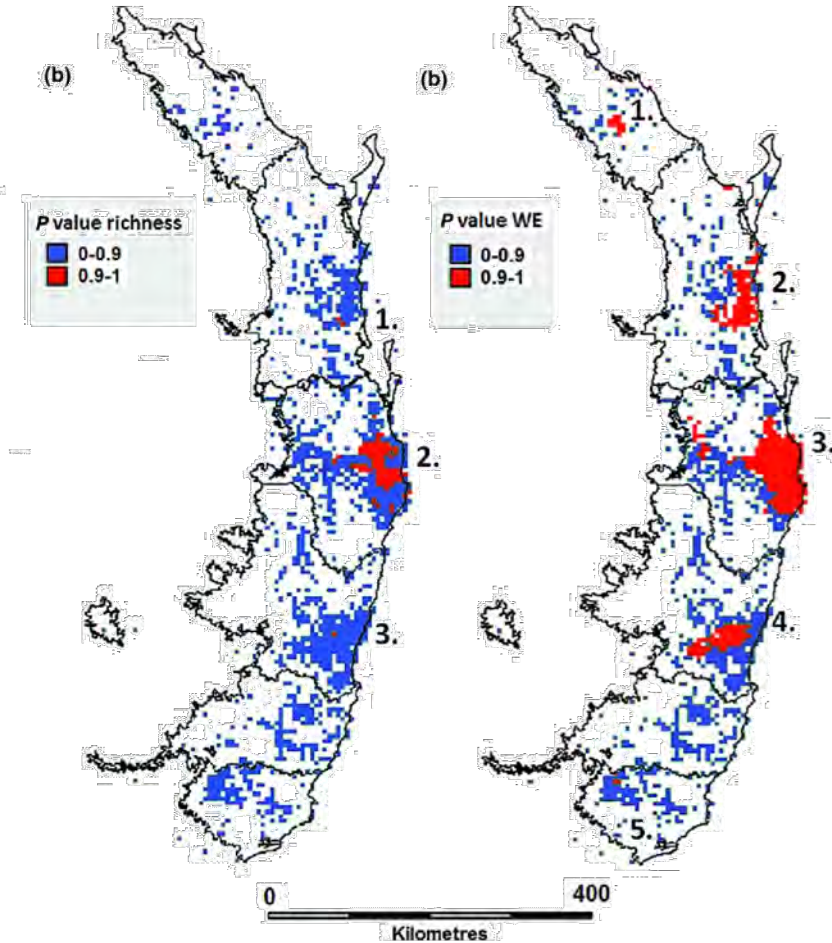
Richness Hotspots
1. Sunshine Coast
2. Border Ranges-Big Scrub
3. Dorrigo

Endemism Hotspots
1. Bulburin
2. K'gari–Sunshine Coast
3. Border Ranges–Big Scrub
4. Dorrigo–Ebor
5. Barrington Tops

Rosauer et al. 2015 - Rainforest Herp. Lineage Endemism

Herp. Lineage Endemism
A) Paleo habitat stability
B) Model-weighted lineage endemism
C) Model-weighted species richness
D) Lineage endemism minus species endemism.
Red = greater lineage than species endemism.

Plant Richness/Endemism
- Bulburin
- Sunshine Coast/K'gari
- Border Ranges-Big Scrub
- Dorrigo-Ebor
- Barrington Tops

Herp Lineage Endemism
- Aus Wet Tropics
- Eungella Region
- Sunshine Coast
- Border Ranges
- Dorrigo
- Only ~20 subtropical herps with lineage data available.
- No *A. wollumbin, P. knowlesi* etc

Study Goals...

- Build knowledge on distributions of subtropical rainforest taxa. New taxa still being discovered (*P. knowlesi* in 2022), always new records.

- Understand rainforest systems more generally – where are the hotspots?

- Limited rainforest conservation resources – Spatial Conservation Prioritization using modelled hotspot areas.

Questions for biodiversity conservation…

- Do richness and endemism hotspots overlap?

- Are there overlooked areas of SREs/endemism?

- Do bushfire impacts differ in SREs vs non-SREs?

Study Area and SDMs
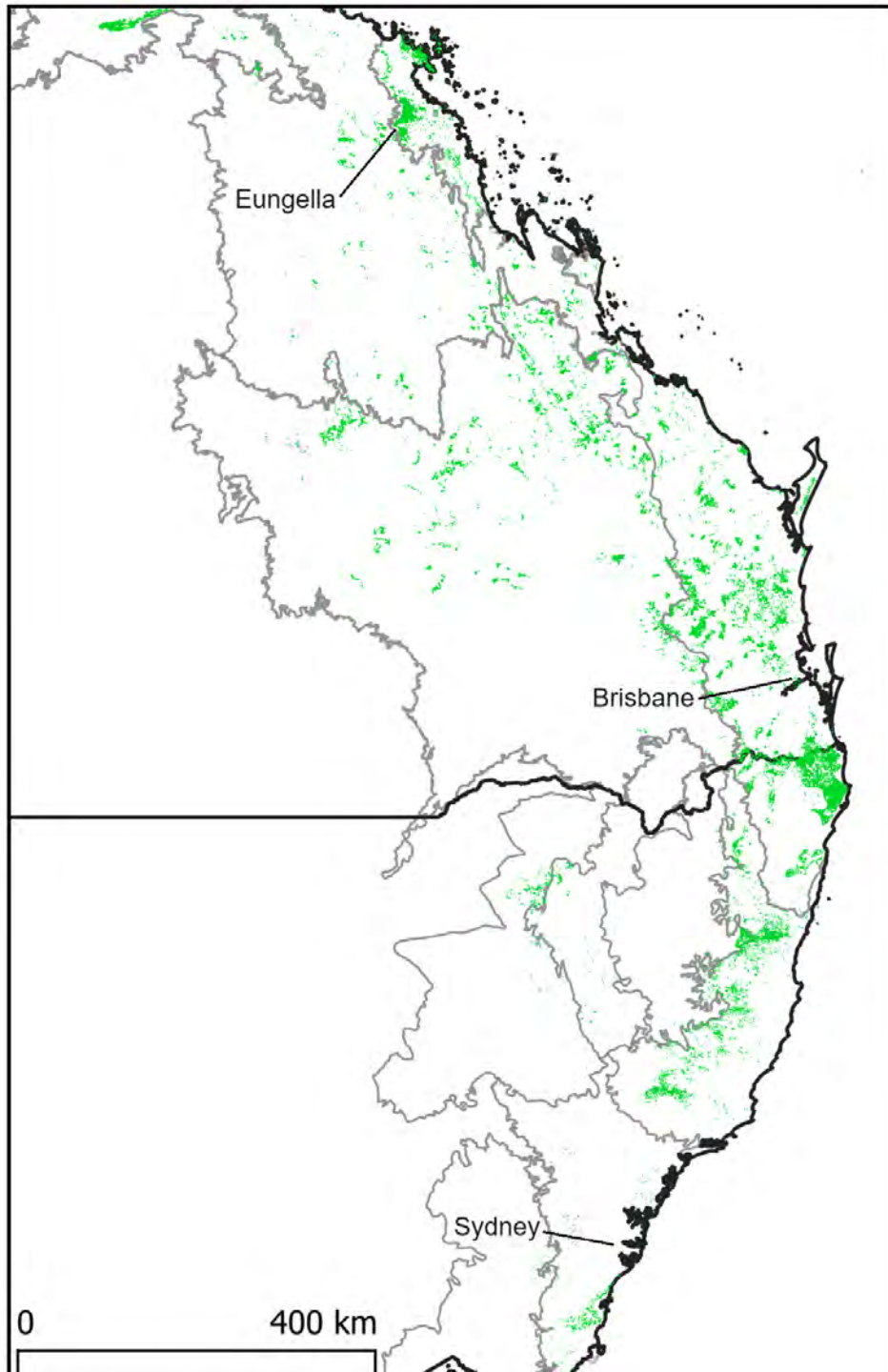
- Subtropical rainforest, latitude ~20-35°sth, Eungella QLD to Illawara NSW.

- 63 species >70% rainforest overlap, occurrence data (ALA, museum, & government collections).

- Species Distribution Models, Maxent and RandomForest algorithms (10 runs averaged).

- Some overfitting/overprediction, therefore buffered 15km radius from occurrence points.
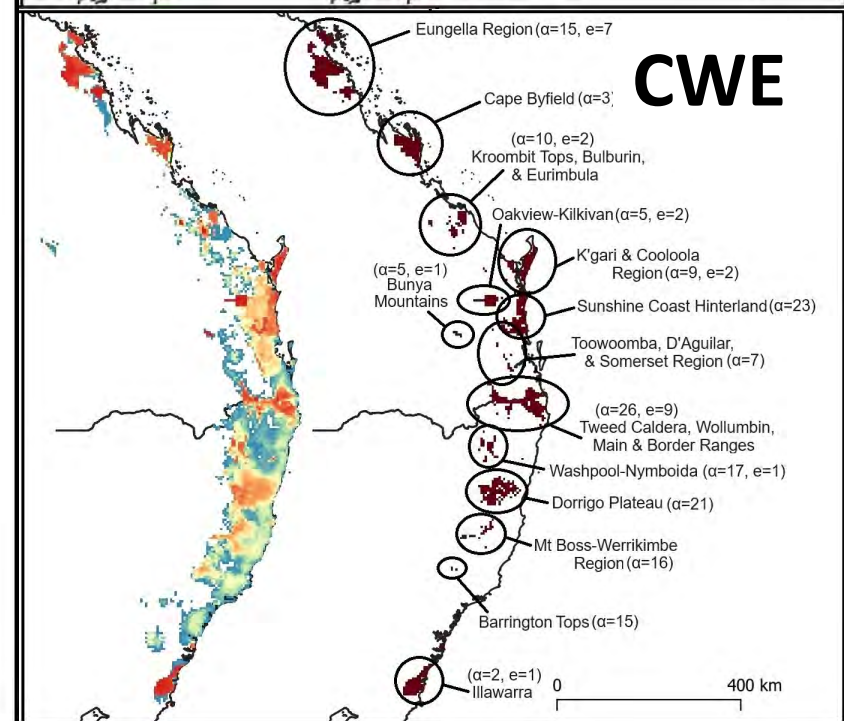
Spatial Analyses

In Biodiverse V 4.3:

- Calculate three biodiversity metrics –

    1. **Species Richness** (α – total number _species per cell_)

    2. **Weighted Endemism** (WE – weight each species by _inverse of range-size_)

    3. **Corrected Weighted Endemism** (CWE- divide WE by α to _control for richness_).

- Hotspot areas = highly significant richness/endemism (p >0.95), 1000 randomizations.

In R:

- Compare overlap of spp. ranges with **2019-2020 megafire extents (GEEBAM)** and the **2018 Qld bushfire extents (SENTINEL)** which impacted Eungella uplands.

Species Richness

Eungella

Kroombit Tops

Sunshine Coast Hinterland to D'Aguilar Ranges

Tweed Caldera, Wollumbin, Main & Border Ranges

Washpool-Nymboida

Dorrigo Plateau & Coffs Coast

Mt Boss-Werrikimbe Region

Great Lakes

Barrington Tops

0   400 km

WE

Eungella Region (α=15, e=7)

Kroombit Tops (α=10, e=2) & Bulburin (α=7, e=1)

Oakview-Kilkivan (α=5, e=2)

K'gari (α=9, e=2)

(α=5, e=1) Bunya Mountains

Sunshine Coast Hinterland (α=23) to D'Aguilar Ranges (α=20)

(α=26, e=9) Tweed Caldera, Wollumbin, Main & Border Ranges

Washpool-Nymboida (α=17, e=1)

Dorrigo Plateau & Coffs Coast (α=21)

Mt Boss-Werrikimbe Region (α=16)

Myall River (α=12)

Barrington Tops (α=15)

(α=2, e=1) Illawarra

0   400 km

CWE

Eungella Region (α=15, e=7)

Cape Byfield (α=3)

(α=10, e=2) Kroombit Tops, Bulburin, & Eurimbula

Oakview-Kilkivan (α=5, e=2)

K'gari & Cooloola Region (α=9, e=2)

(α=5, e=1) Bunya Mountains

Sunshine Coast Hinterland (α=23)

Toowoomba, D'Aguilar, & Somerset Region (α=7)

(α=26, e=9) Tweed Caldera, Wollumbin, Main & Border Ranges

Washpool-Nymboida (α=17, e=1)

Dorrigo Plateau (α=21)

Mt Boss-Werrikimbe Region (α=16)

Barrington Tops (α=15)

(α=2, e=1) Illawarra

0   400 km

Novel Areas of High Endemism
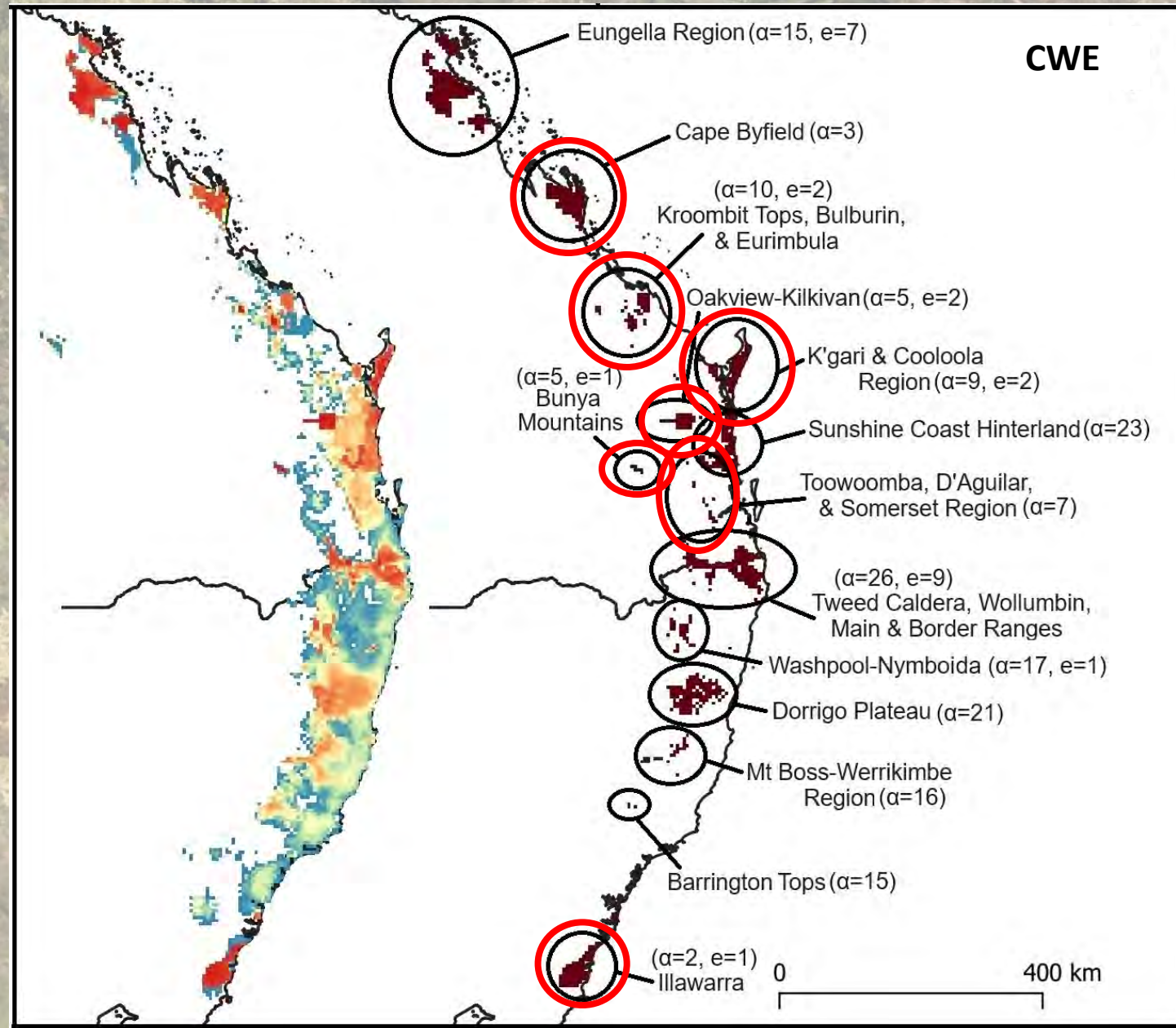
Most Significant Areas for Richness & Endemism

- **Border Ranges – 26 spp, 9 locally endemic.**

- Highest values for both richness and endemism, attenuating south into NSW rainforests.

- To north, Brisbane Valley Barrier, then D'Aguilars.

- **Eungella – 15 spp, 7 locally endemic.**

- Higher richness in Sunshine Coast Hinterland (23) and Dorrigo (21) but no taxa locally endemic.

Range Size vs Fire Overlap

Distribution vs % Impacted By Fire

$$y = 0.0149x + 3.0807$$
$$R^2 = 0.1257$$
$$P = 0.004$$
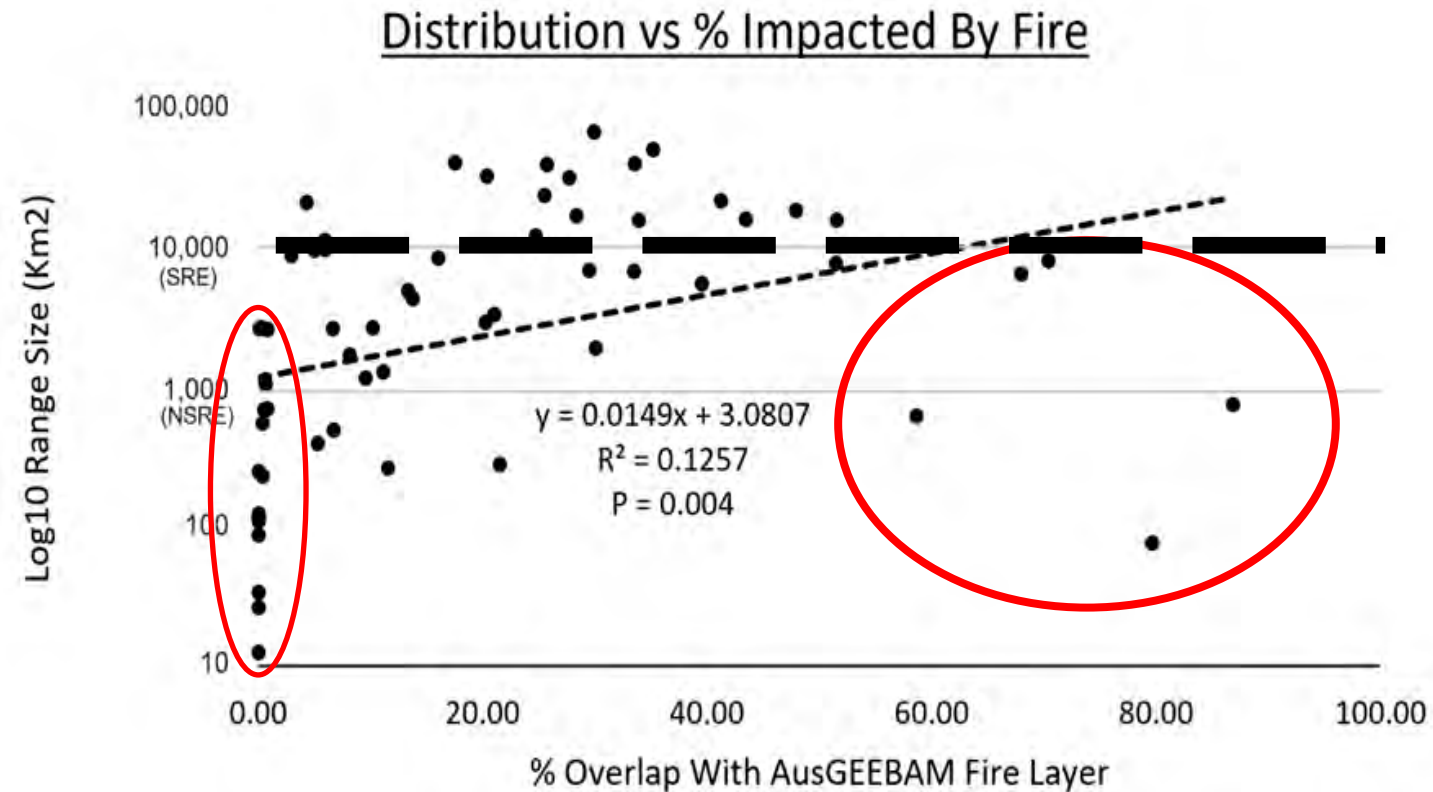
- SREs either in or out!

- 2019-2020 AUS GEEBAM Bushfire layer only.

- Add sequential events e.g. Eungella 2018 and 2021 Bulburin.

Fire Impact Rankings

- Megafires 2019-2020 (% GEEBAM)

- Eungella 2018 (% SENTINEL)

- Top 20 spp mutually exclusive

- Sequential events, lots of SREs.

Species	% GEEBAM	RANK	% SENTINEL	RANK	Fire Impact	SRE
Philoria_pughi	86.83	1	0.00	NA	H	Y
Philoria_knowlesi	79.62	2	2.16	NA	H	Y
Mixophyes_balbus	70.44	3	0.01	NA	H	Y
Philoria_sphagnicola	67.99	4	0.00	NA	H	Y
Philoria_kundagungan	58.63	5	3.94	NA	H	Y
Saproscincus_rosei	51.53	6	0.38	NA	H	N
Litoria_barringtonensis	51.48	7	0.00	NA	H	Y
Lechriodus_fletcheri	47.93	8	0.24	NA	M	N
Saltuarius_moritzi	43.43	9	0.00	NA	M	N
Silvascincus_murrayi	41.23	10	0.27	NA	M	N
Harrisoniascincus_zia	39.51	11	0.81	NA	M	Y
Litoria_chloris	35.20	12	3.46	NA	M	N
Calyptotis_ruficauda	33.93	13	0.04	NA	M	N
Hoplocephalus_stephensii	33.56	14	0.76	NA	M	N
Saproscincus_spectabilis	33.47	15	0.47	NA	M	Y
Mixophyes_fleayi	30.06	16	3.44	NA	M	N
Mixophyes_fasciolatus	29.91	17	2.44	NA	M	N
Assa_darlingtoni	29.48	18	0.45	NA	M	N
Lophosaurus_spinipes	28.33	19	0.67	NA	M	N
Bellatorias_major	27.71	20	0.47	NA	M	N
Phyllurus_caudiannulatus	21.50	NA	88.88	1	H	Y
Tumbunascincus_luteilateralis	0.42	NA	80.38	2	H	Y
Phyllurus_championae	0.56	NA	74.31	3	M	Y
Rheobatrachus_vitellinus	0.00	NA	73.89	4	M	Y
Litoria_kroombitensis	0.00	NA	68.75	5	M	Y
Phyllurus_nepthys	0.62	NA	68.48	6	M	Y
Taudactylus_liemi	0.66	NA	68.15	7	M	Y
Taudactylus_pleione	0.00	NA	51.01	8	M	Y
Taudactylus_eungellensis	0.61	NA	33.63	9	L	Y
Calyptotis_temporalis	13.33	NA	31.60	10	L	Y
Phyllurus_kabikabi	0.00	NA	31.35	11	L	Y
Saproscincus_hannahae	0.83	NA	31.00	12	L	Y
Concinnia_amplus	0.26	NA	30.38	13	L	Y
Lampropholis_adonis	4.30	NA	17.21	14	L	N
Calyptotis_lepidorostrum	5.94	NA	14.50	15	L	N
Phyllurus_ossa	0.09	NA	12.87	16	L	Y
Nangura_spinosa	0.00	NA	8.75	17	L	Y
Ophioscincus_cooloolensis	11.16	NA	7.84	18	L	Y
Lampropholis_couperi	5.03	NA	5.85	19	L	Y
Ophioscincus_ophioscincus	2.92	NA	5.70	20	L	Y

Take Home Messages
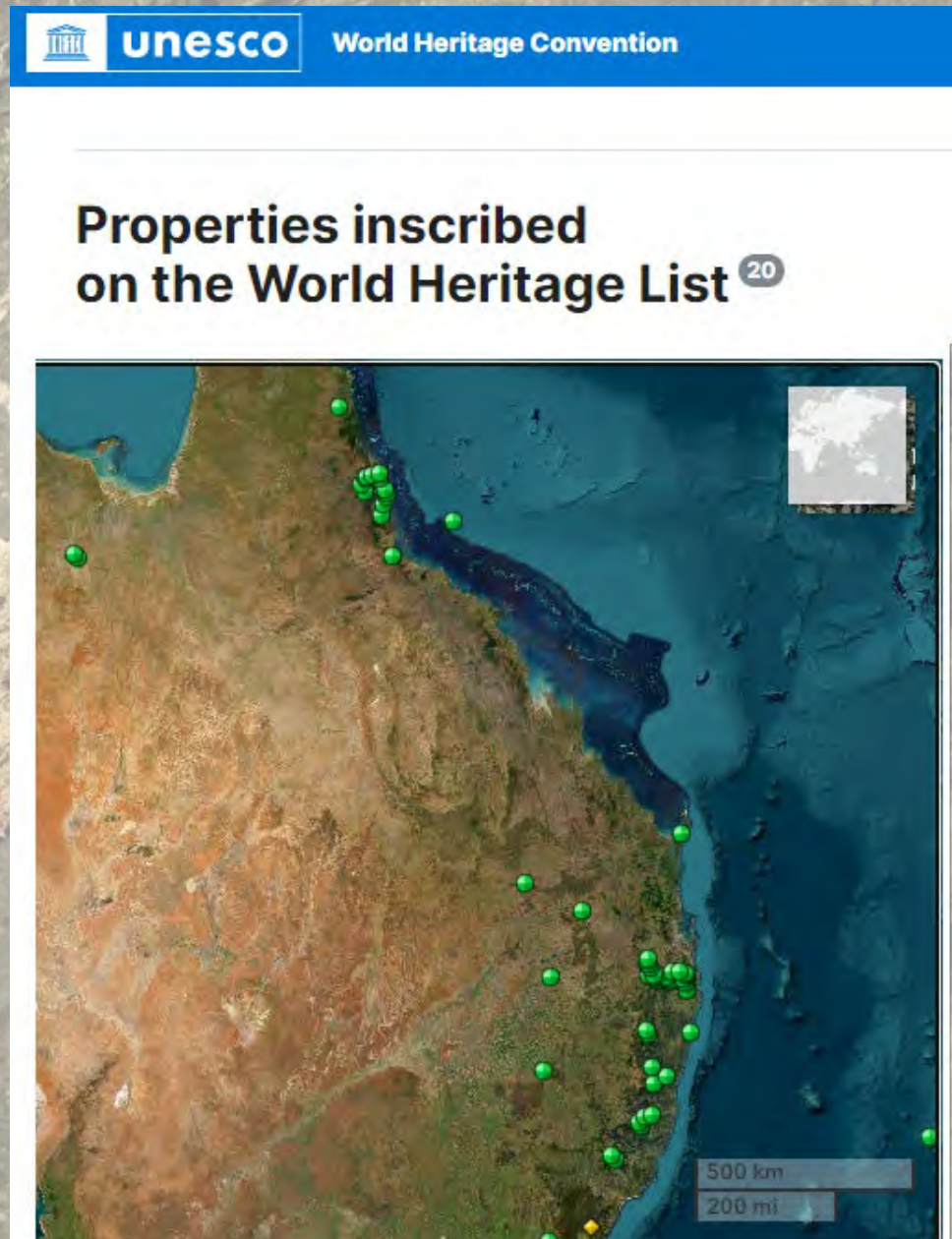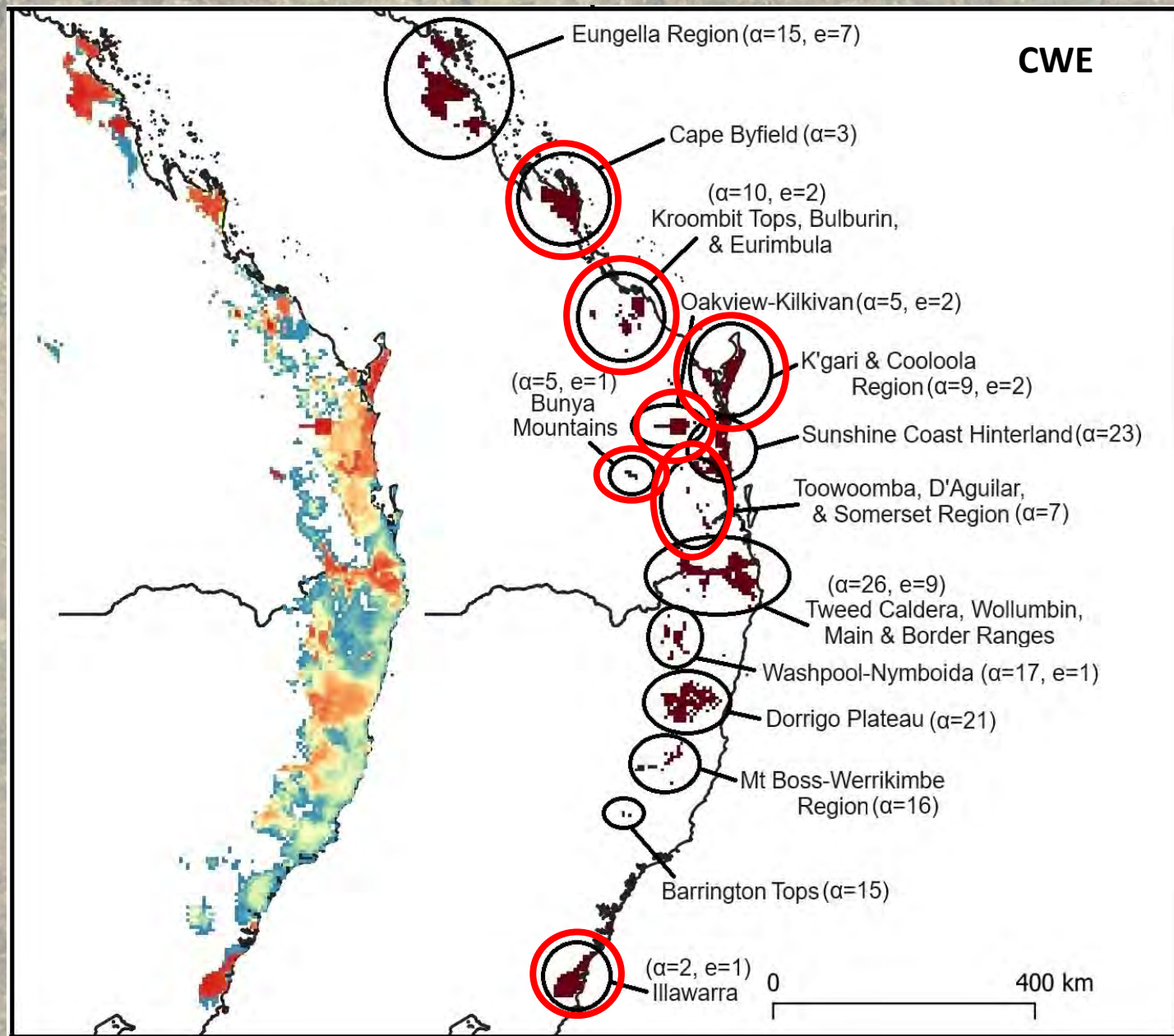
1. Do Richness and Endemism Hotspots Overlap?

■ *Largely yes (SRE dominated), but endemism highlights peripheral areas.*

2. Are there possibly overlooked areas of SREs/endemism?

■ *Endemism highlights Mid-East QLD vine thickets as important areas outside of well-known rainforest regions.*

3. Differing impact of bushfires to SREs vs non-SREs?

■ *Moderate impacts to larger ranged species, bimodal (high/low) impact on SREs, problematic considering sequential fire seasons.*

CWE

Properties inscribed on the World Heritage List [20]

Eungella Region (α=15, e=7)

Cape Byfield (α=3)

(α=10, e=2)
Kroombit Tops, Bulburin, & Eurimbula

Oakview-Kilkivan (α=5, e=2)

K'gari & Cooloola Region (α=9, e=2)

(α=5, e=1)
Bunya Mountains

Sunshine Coast Hinterland (α=23)

Toowoomba, D'Aguilar, & Somerset Region (α=7)

(α=26, e=9)
Tweed Caldera, Wollumbin, Main & Border Ranges

Washpool-Nymboida (α=17, e=1)

Dorrigo Plateau (α=21)

Mt Boss-Werrikimbe Region (α=16)

Barrington Tops (α=15)

0   400 km

(α=2, e=1)
Illawarra

500 km
200 mi