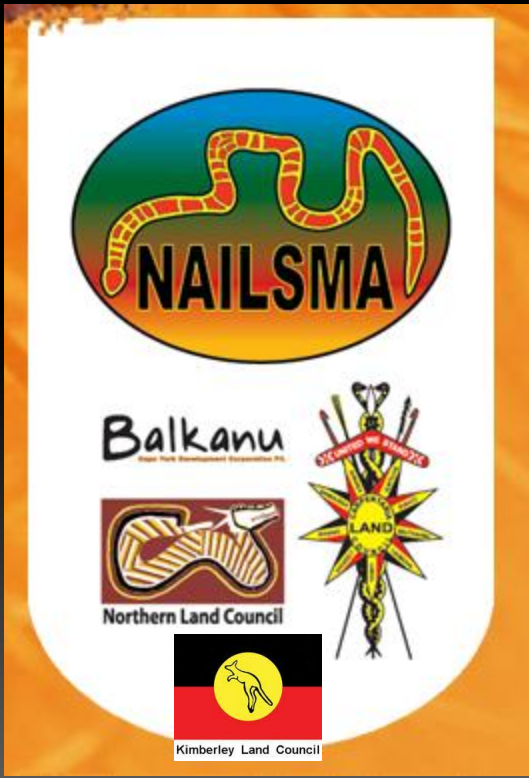


Fire management for conservation, indigenous benefit, and greenhouse gas emissions abatement: west Arnhem Land, NT.



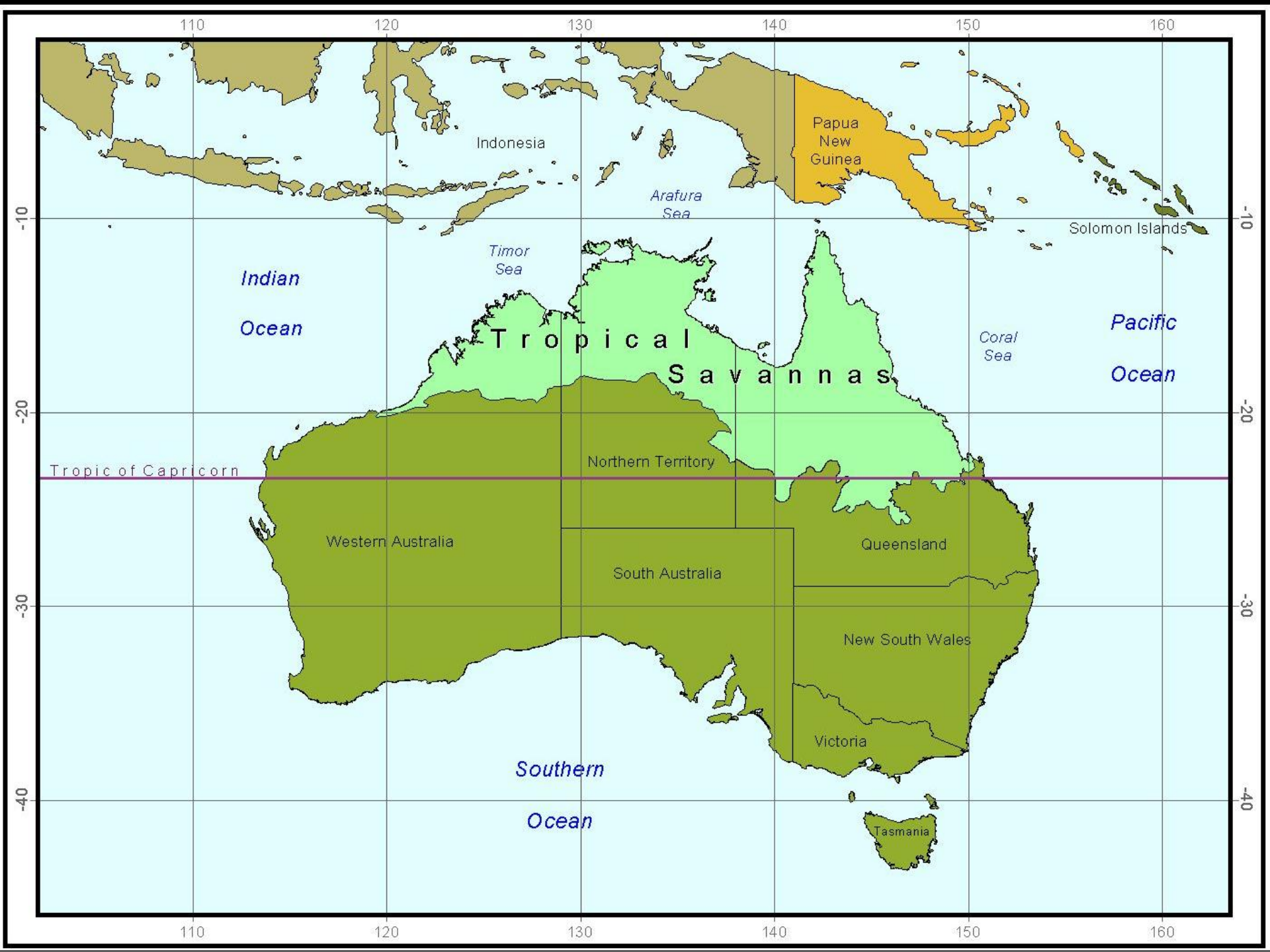
Dr Andrew Edwards

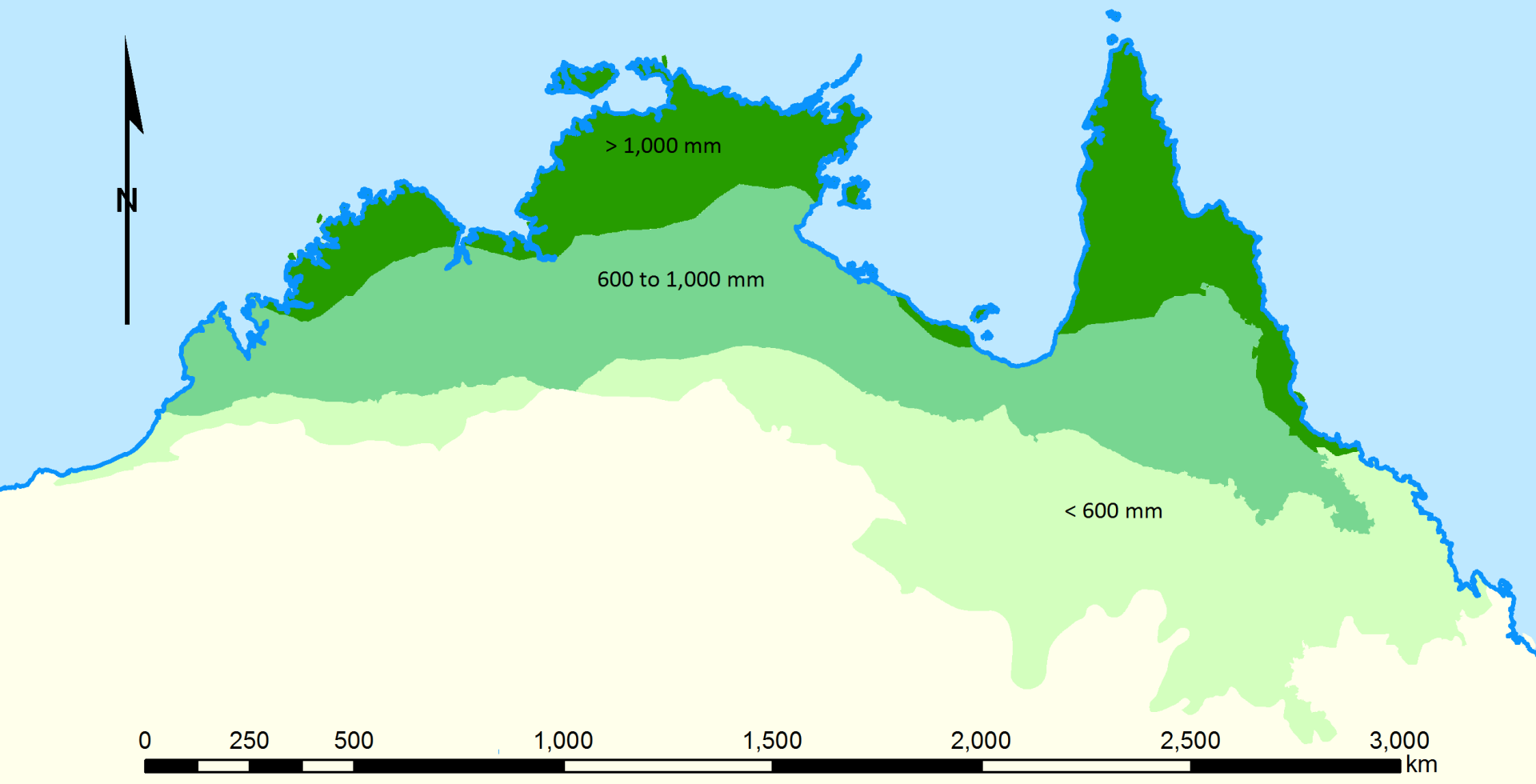
Research Fellow ~ Bushfires



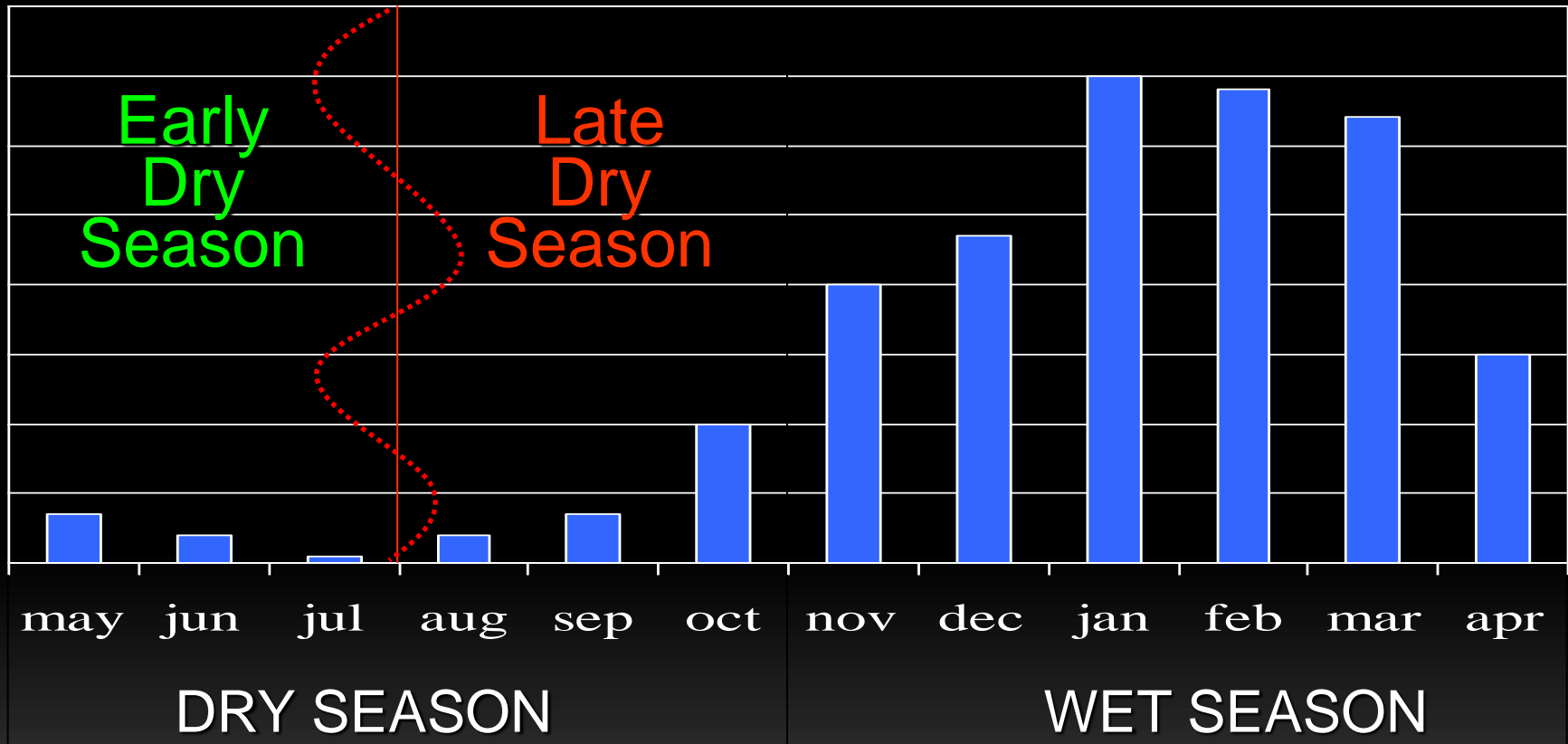
Outline:

- ❖ What's different about where we are?
- ❖ What made us start all this research?
- ❖ How did we do it and what have we found out?
- ❖ What's the link between Indigenous Australians and Carbon?
- ❖ Can this lead to other livelihoods for Indigenous Australians?





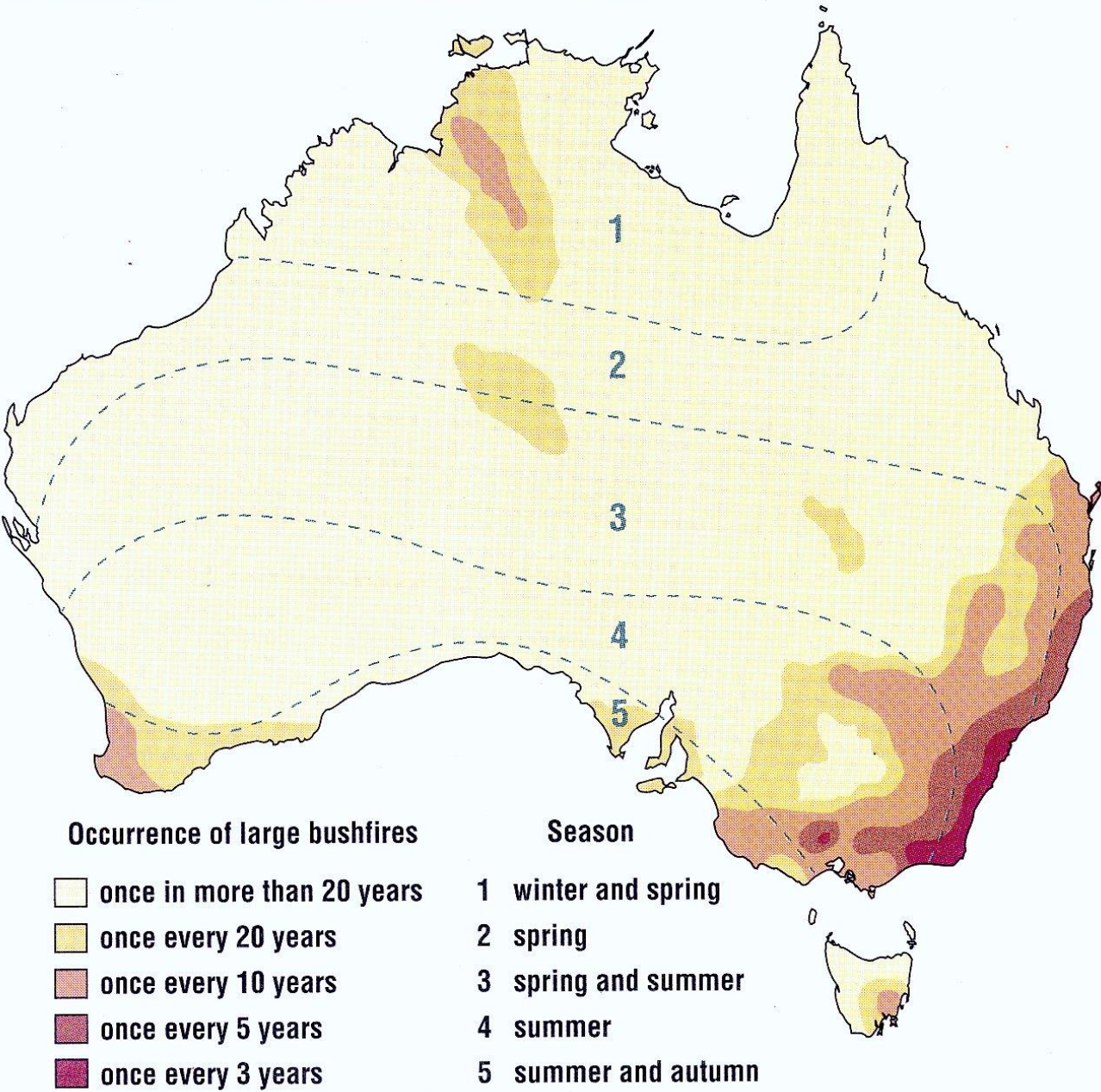
Savannas are characterised by seasonal water availability, with the majority of rainfall being confined to one season of the year.



YEKKE DRY	WURRKENG LATE DRY	KURRUNG BUILD UP	KUNUMELENG FIRST STORMS	KUDJEWK WET	BANGKERRENG LATE WET
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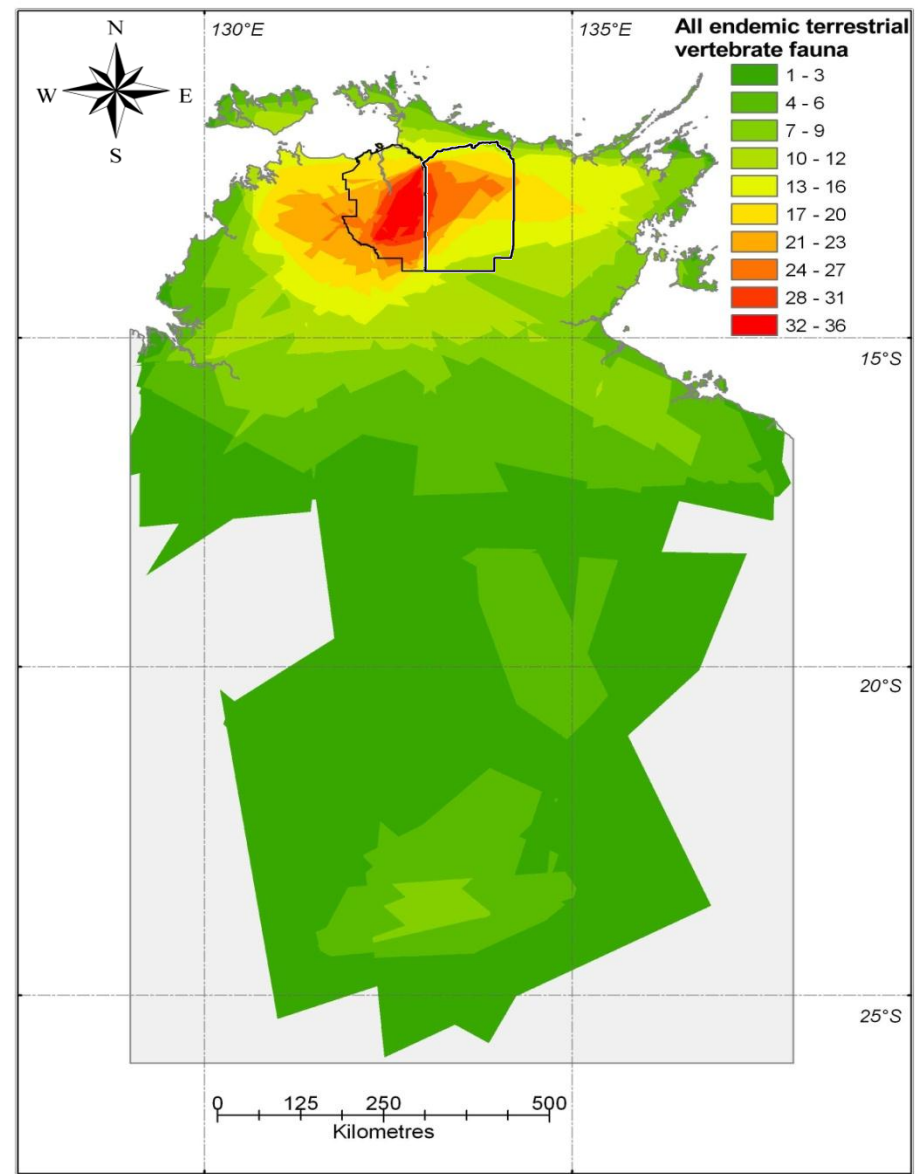
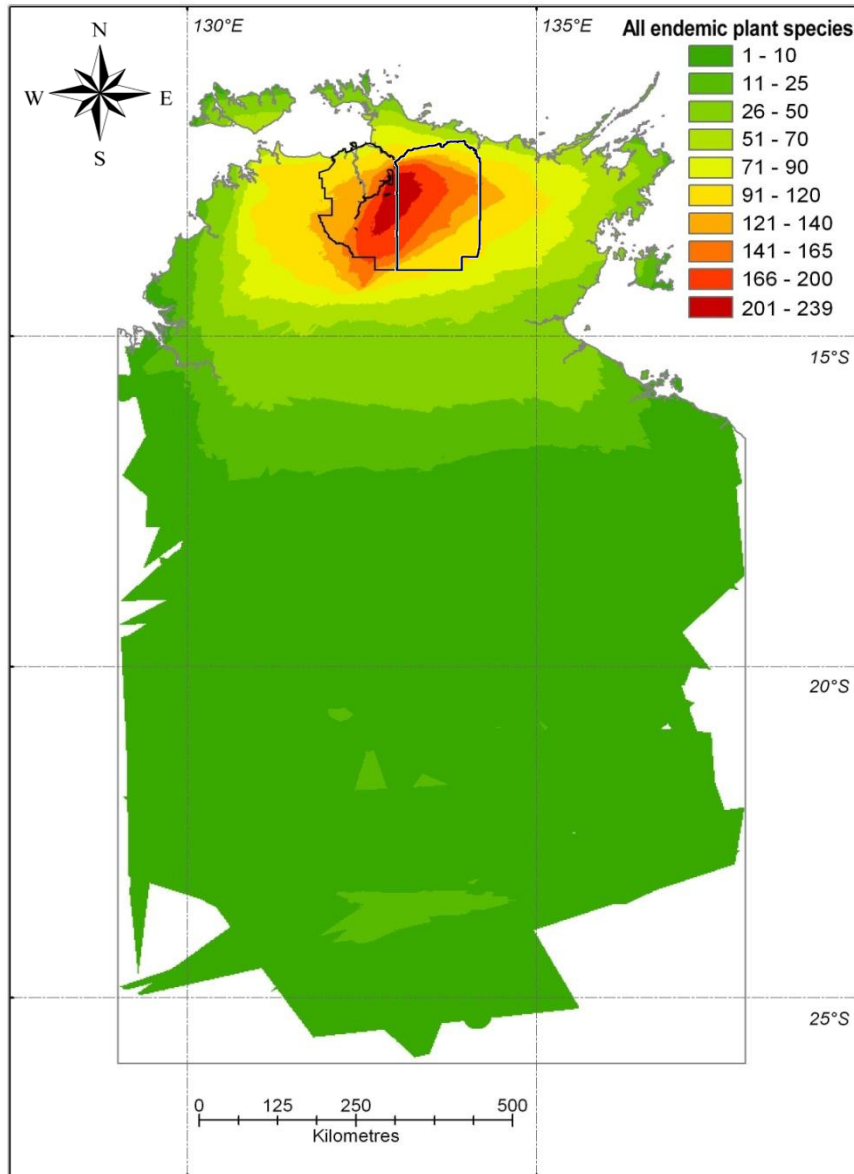
Fig 2.7 Frequency of bushfires

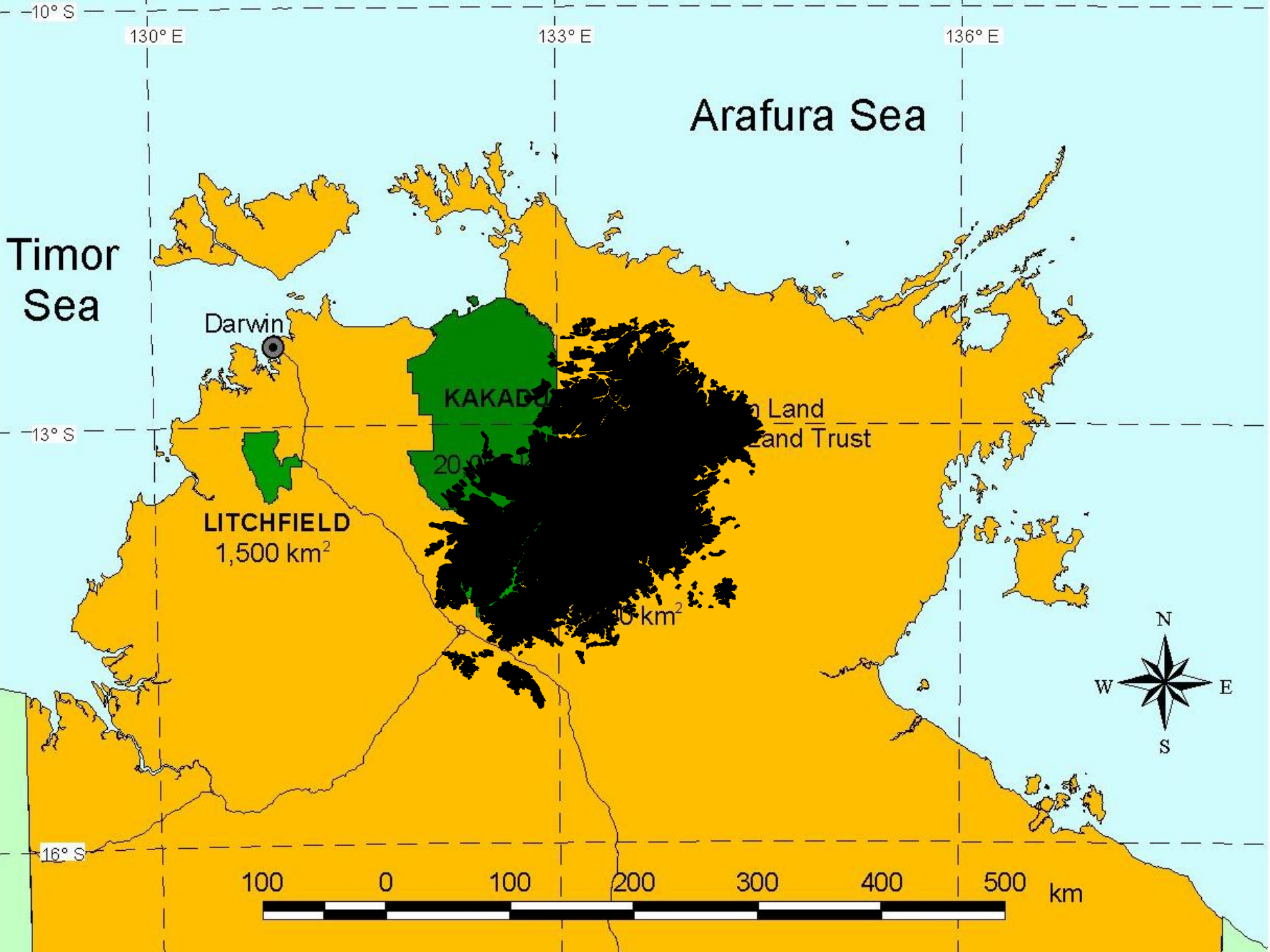
Fire the Enigma

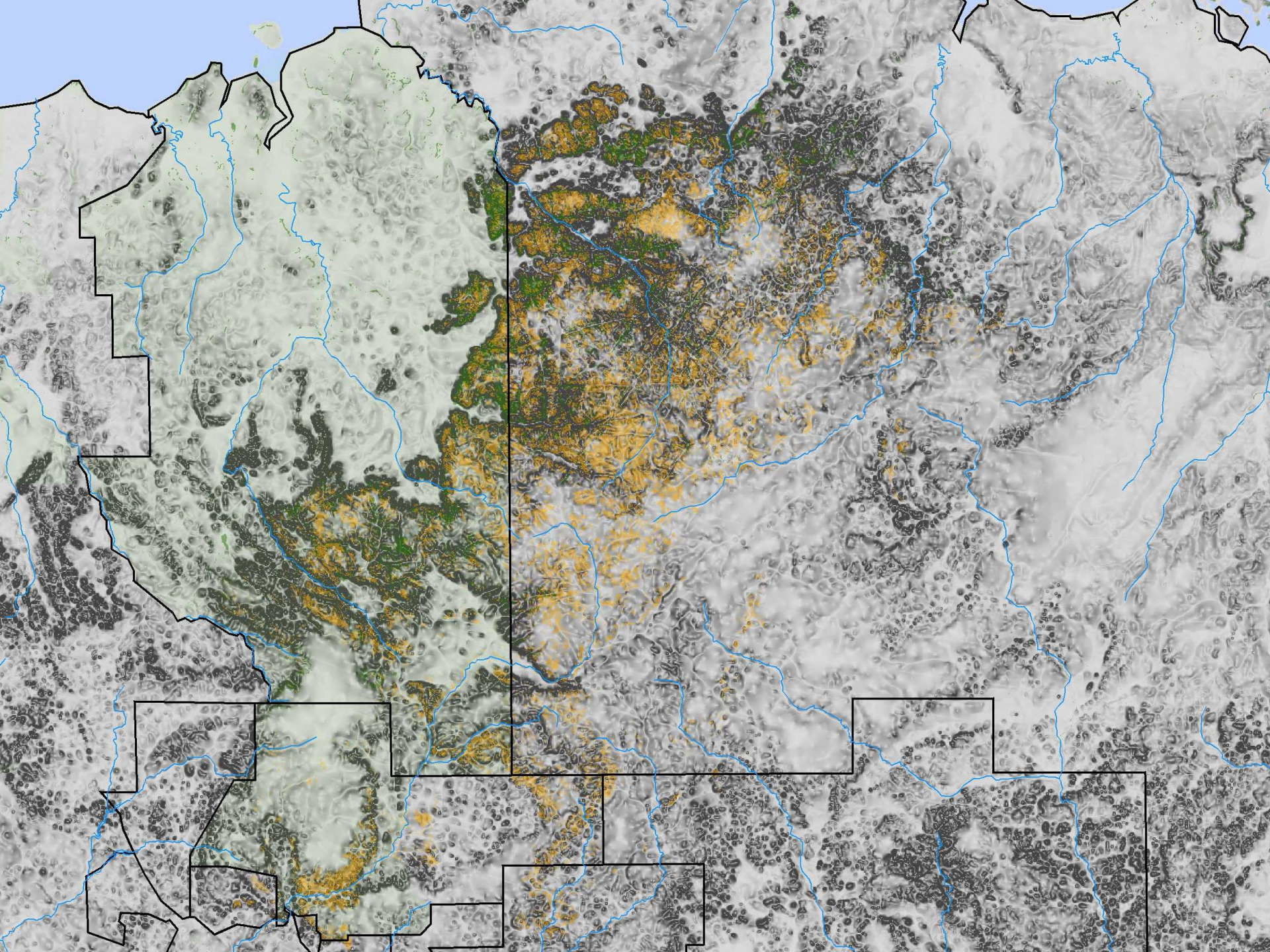


Source :
State of Environment 1996

Hot Spot of Endemicism







The Plateau, Escarpment & Lowlands



Different types of fire:

~ **prescribed burning**

the result is a low intensity, low severity fire that reduces the fuel and does not affect the overstorey





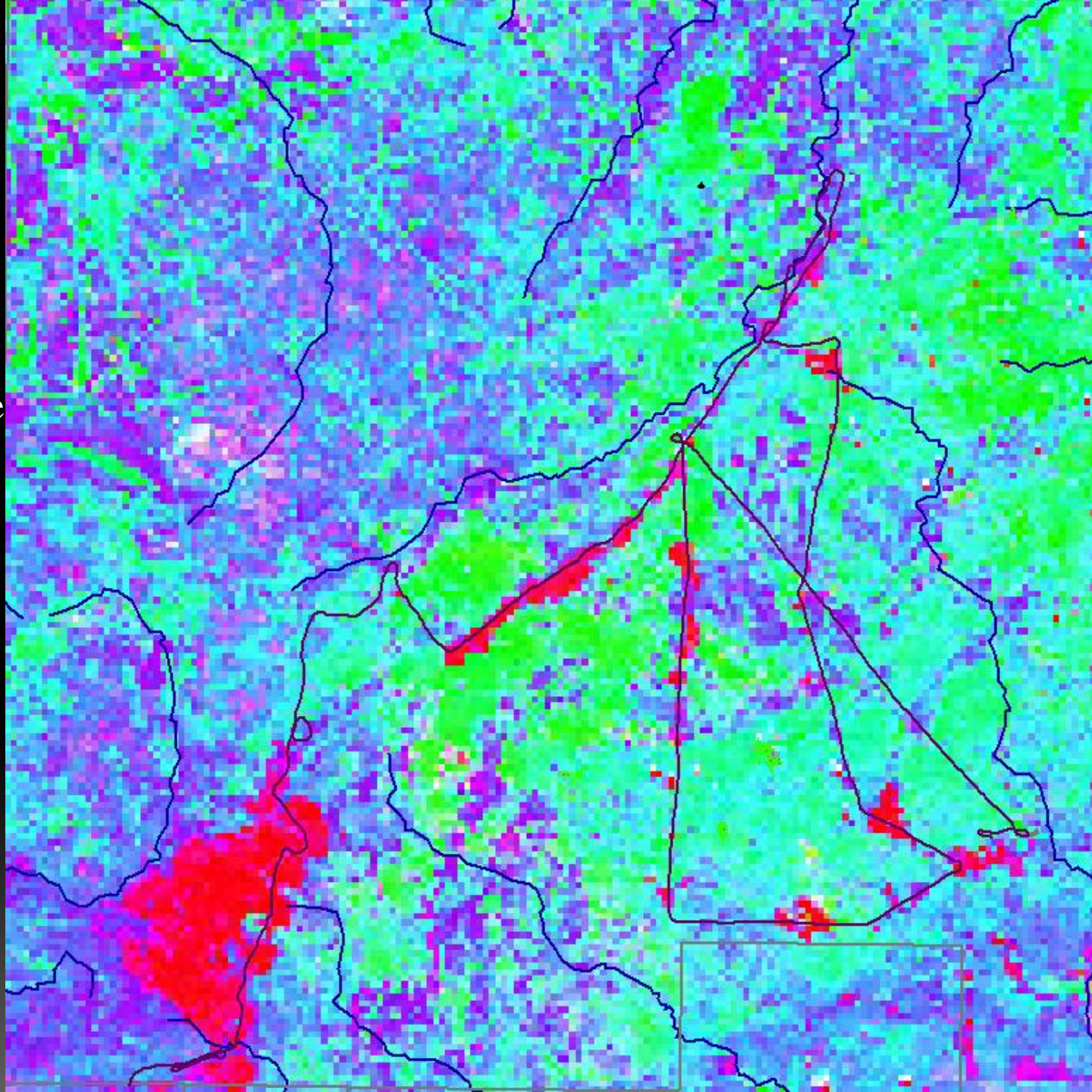
INITIAL RUN

Aerial Prescribed
Burning

9th May

MODIS satellite image

12th May



A person wearing a helmet and dark clothing is riding a red and black ATV through a field of tall, dry grass. The person is moving away from the camera, leaving a path of flattened grass. In the background, there are several trees and a line of fire burning across the horizon. The sky is clear and blue.

On~Ground Follow~up

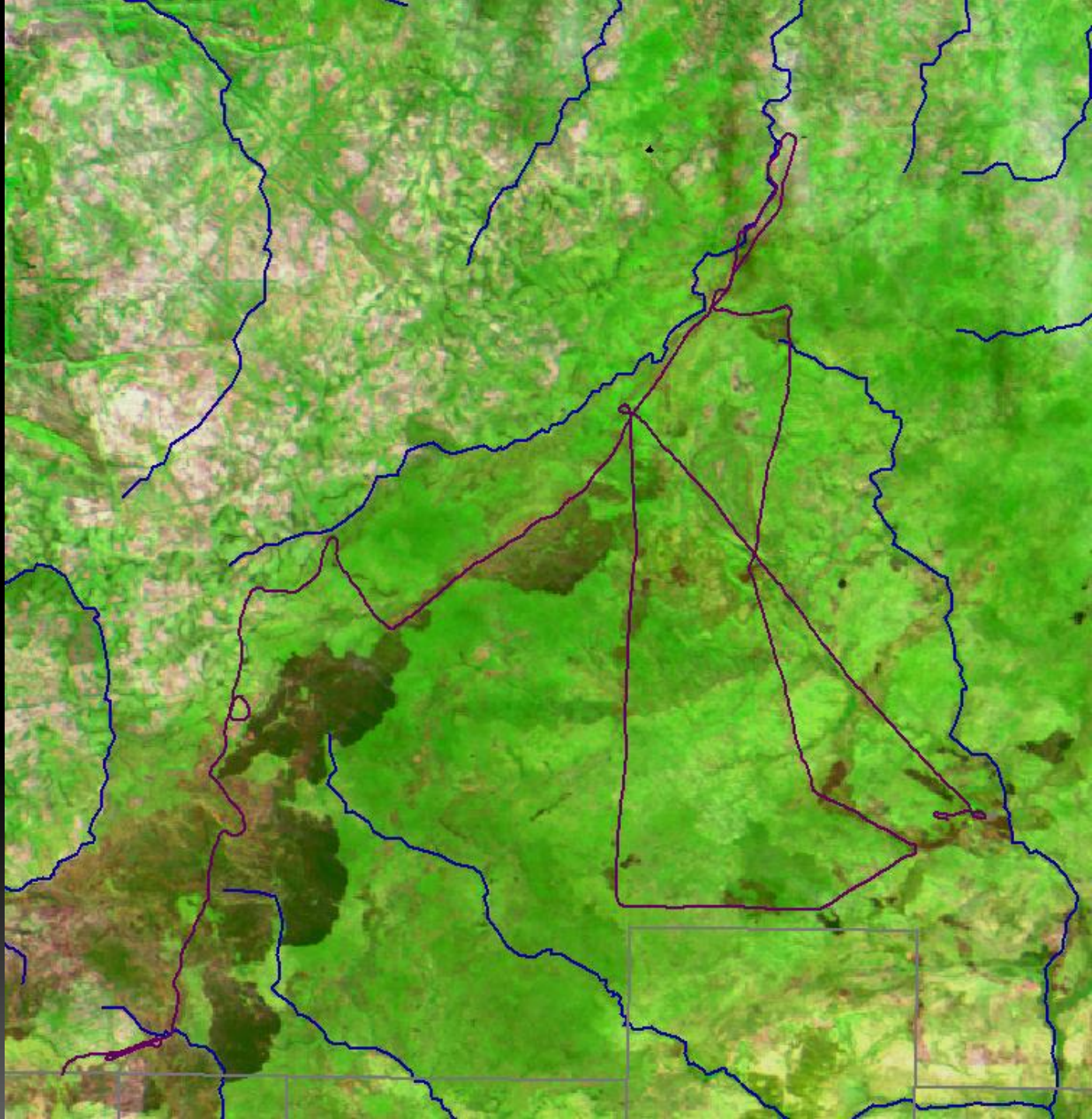
FOLLOW UP

**Aerial Prescribed
Burning**

30th May

**MODIS satellite
image**

2nd June





Different types of fire:

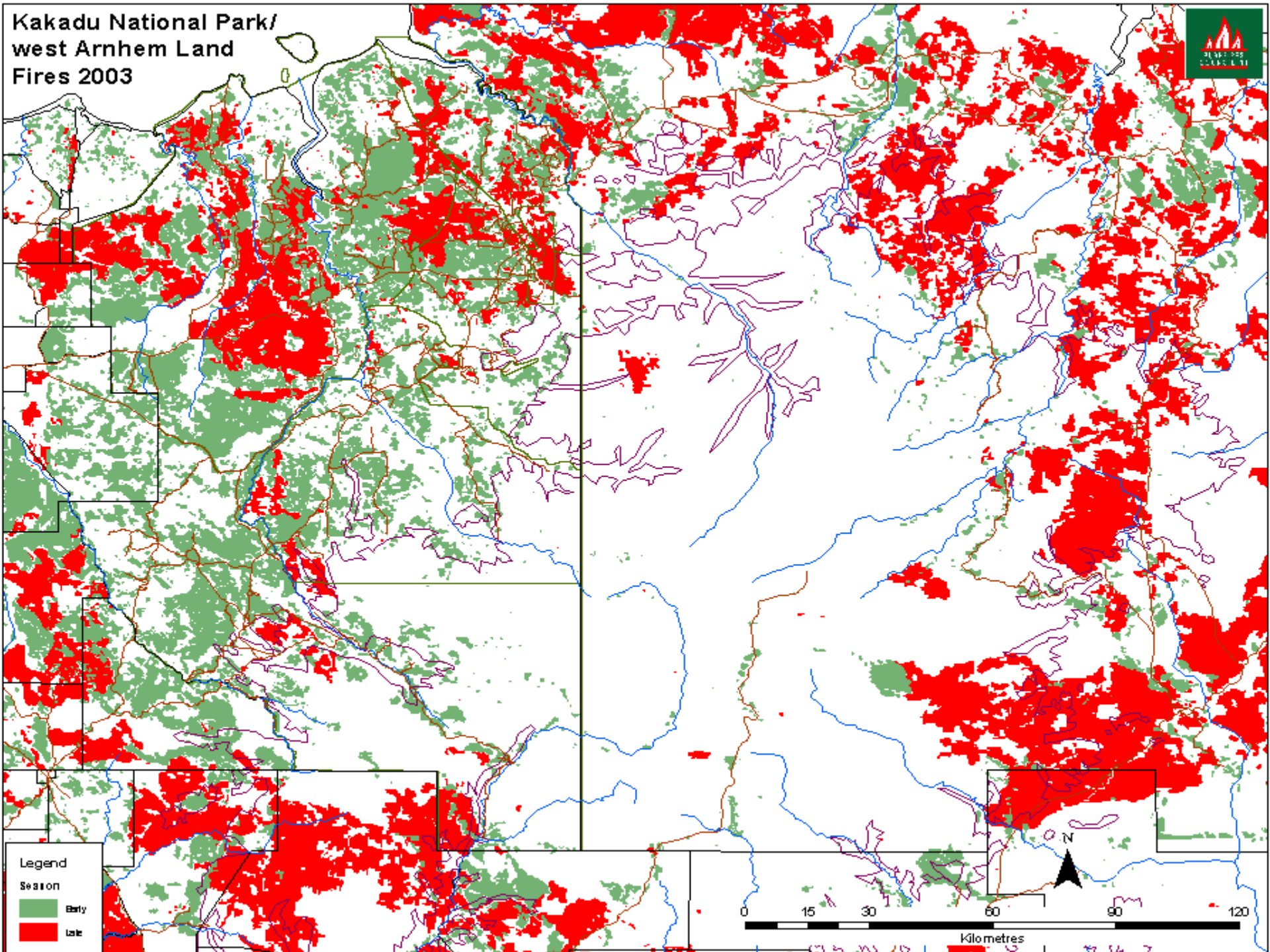
~ Wildfires

**the result is total canopy consumption
local extinction of obligate seeders and
species with small home ranges**





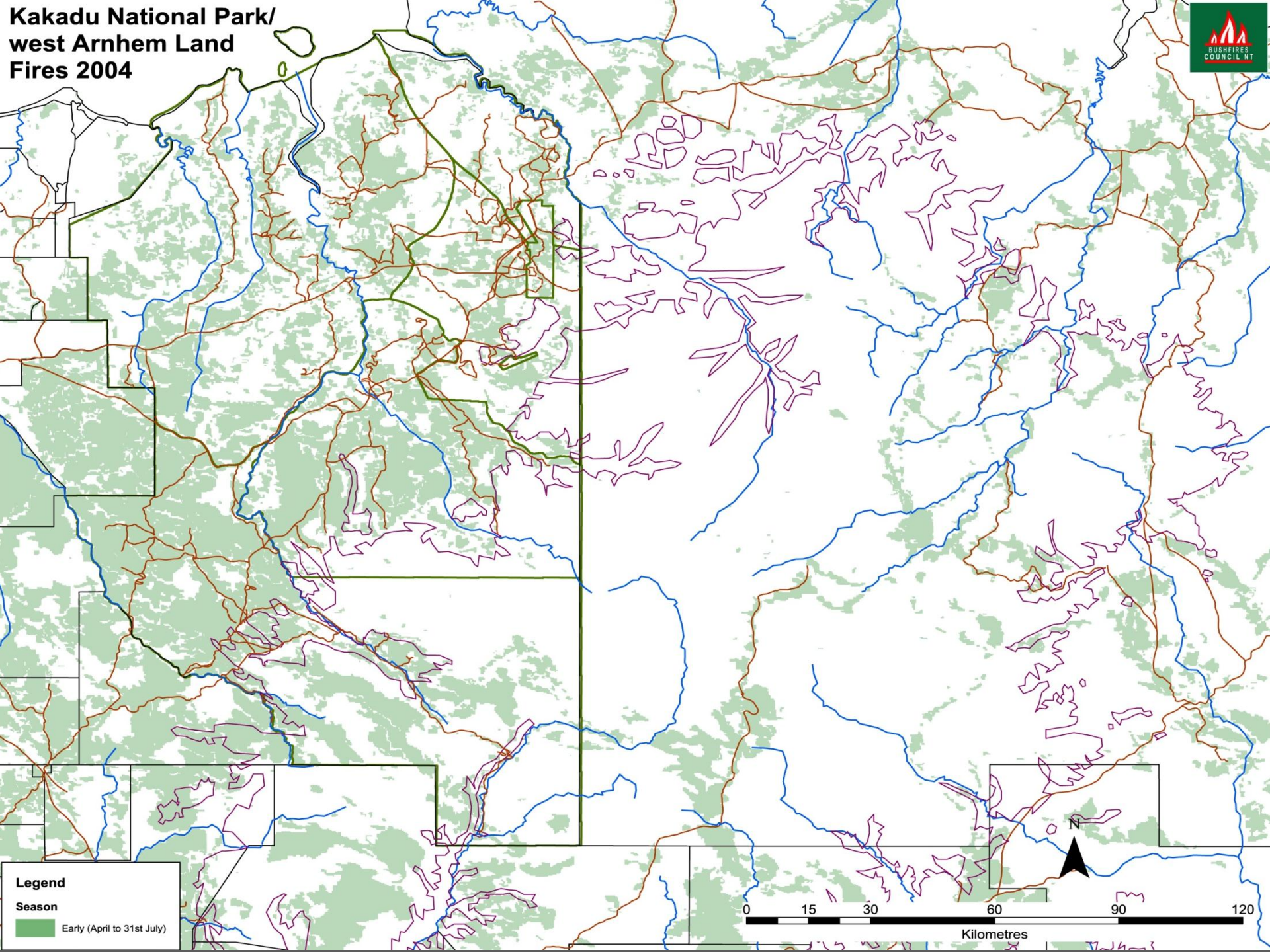
Kakadu National Park/ west Arnhem Land Fires 2003



Legend
Season
■ Early
■ Late


0 15 30 60 90 120
Kilometres

Kakadu National Park/ west Arnhem Land Fires 2004




Legend

Season

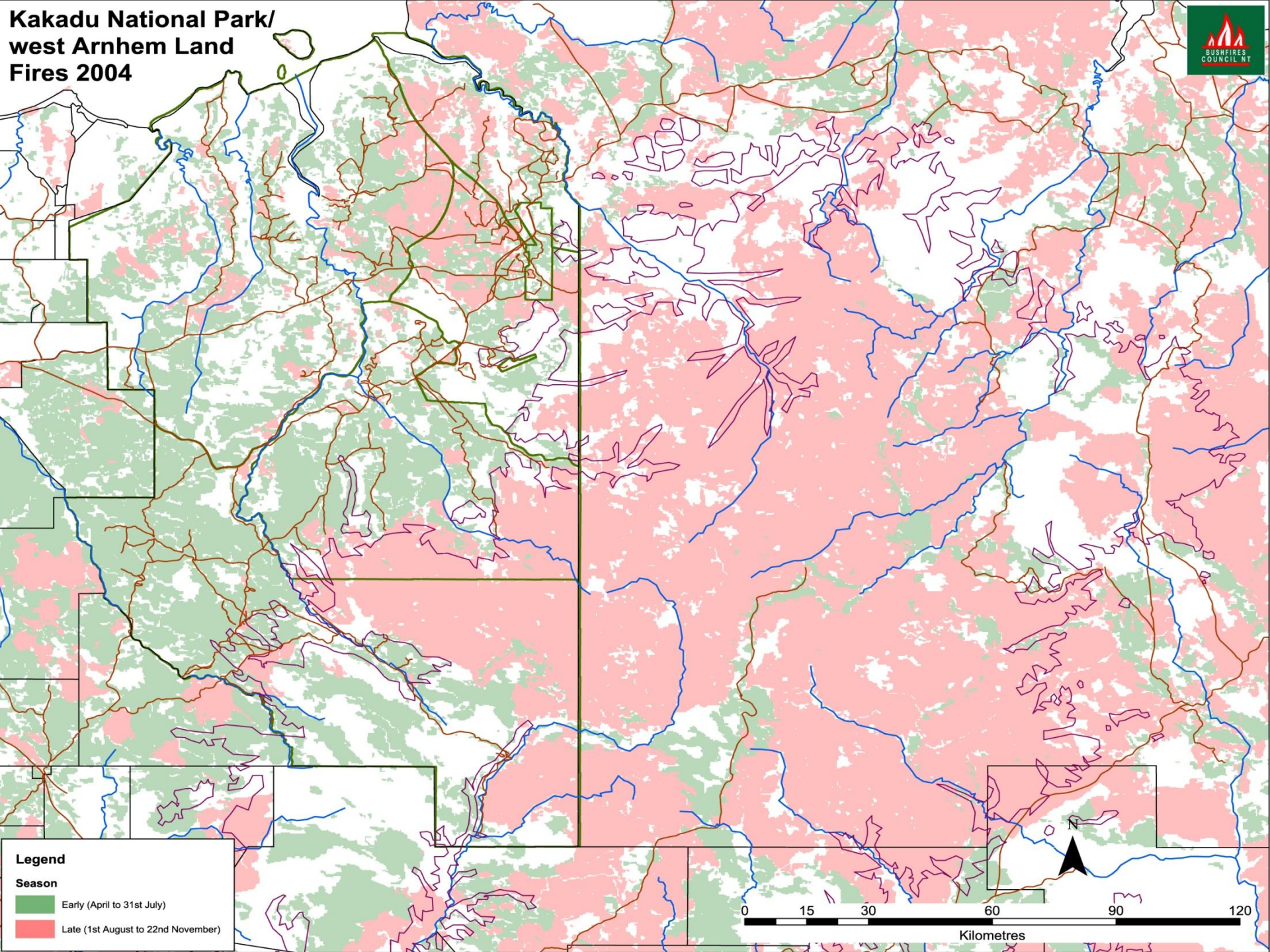
 Early (April to 31st July)

0 15 30 60 90 120

Kilometres



Kakadu National Park/ west Arnhem Land Fires 2004



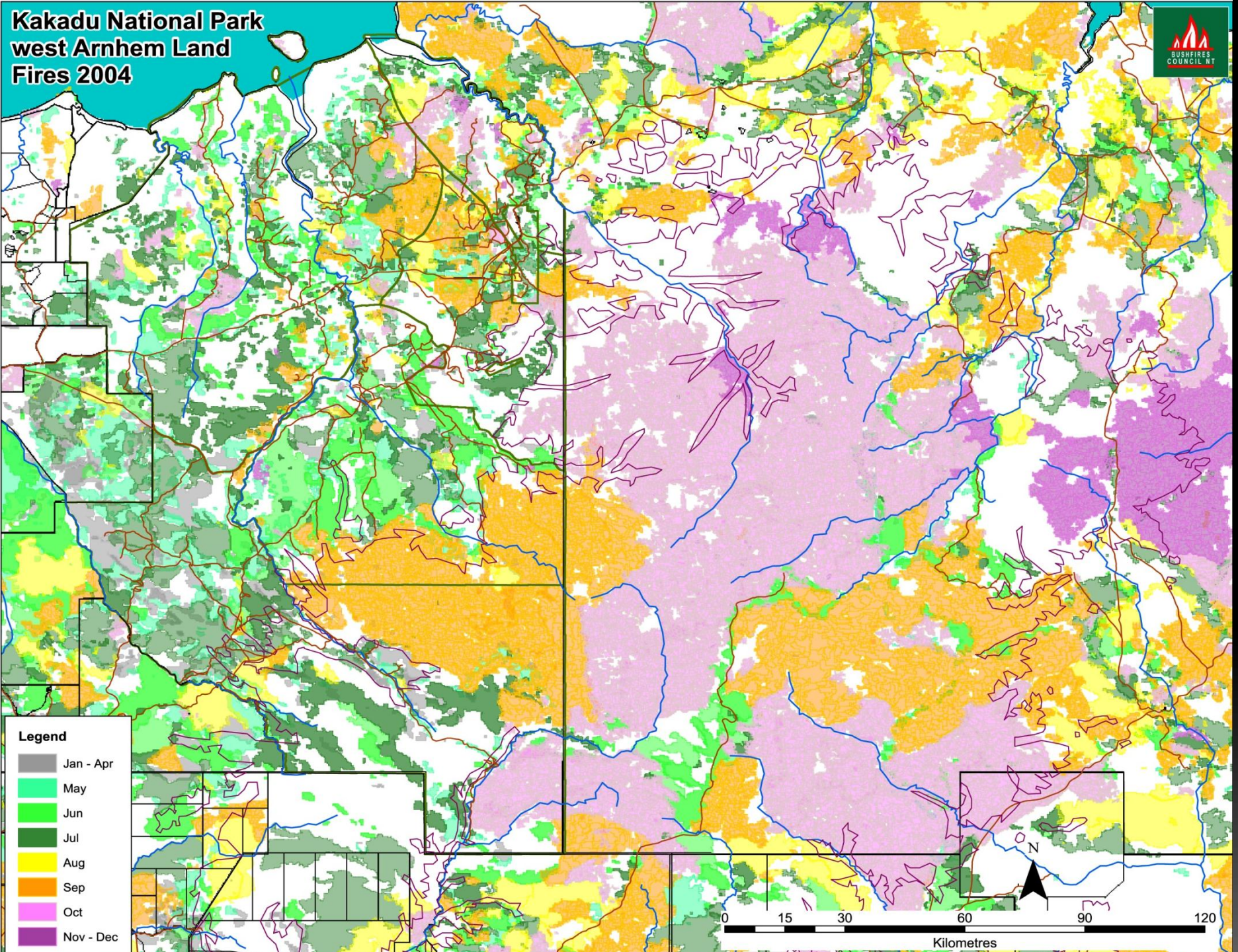
Legend

Season

- Early (April to 31st July)
- Late (1st August to 22nd November)



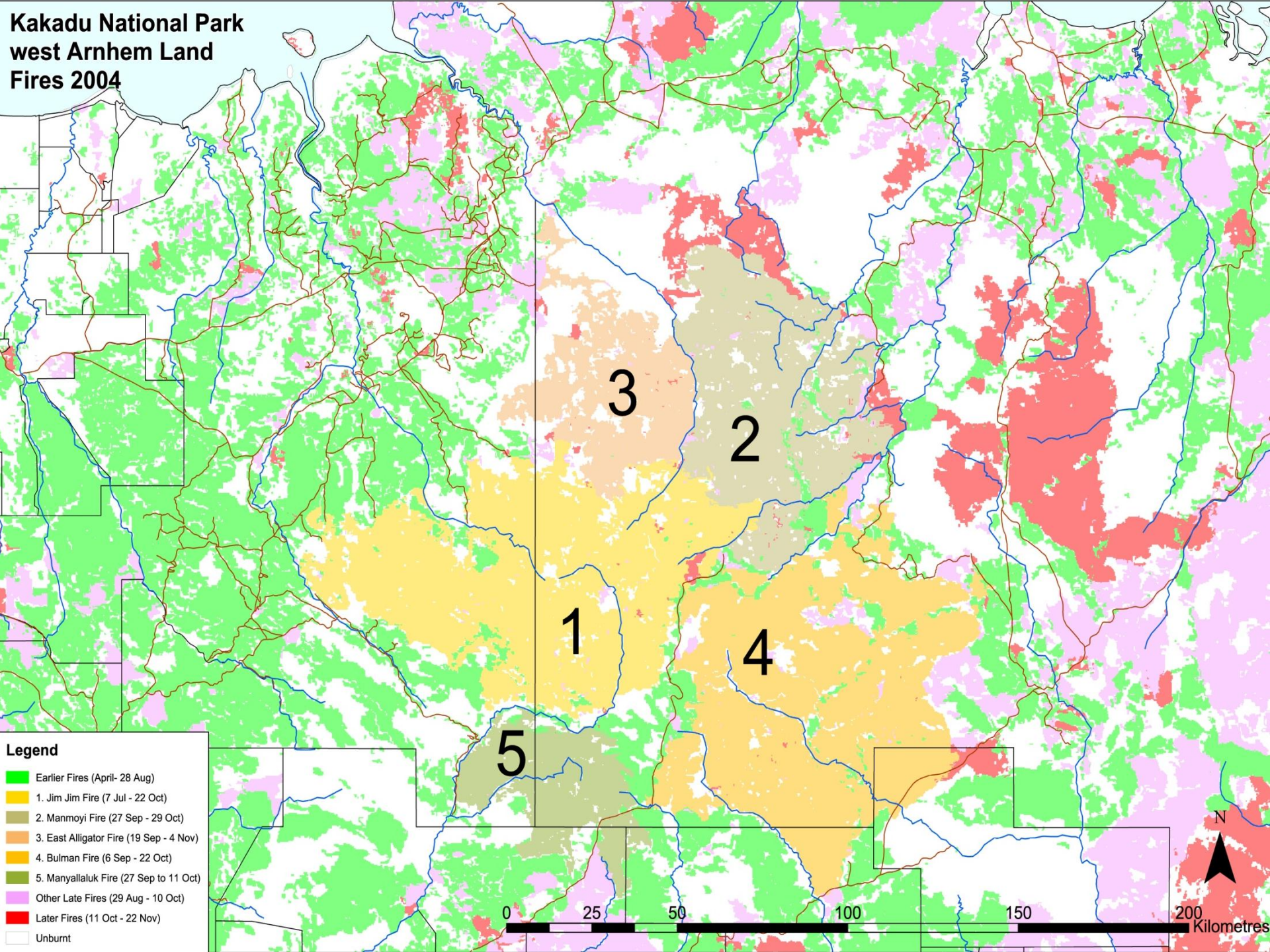
Kakadu National Park west Arnhem Land Fires 2004



- Legend**
- Jan - Apr
 - May
 - Jun
 - Jul
 - Aug
 - Sep
 - Oct
 - Nov - Dec

0 15 30 60 90 120
Kilometres

Kakadu National Park west Arnhem Land Fires 2004

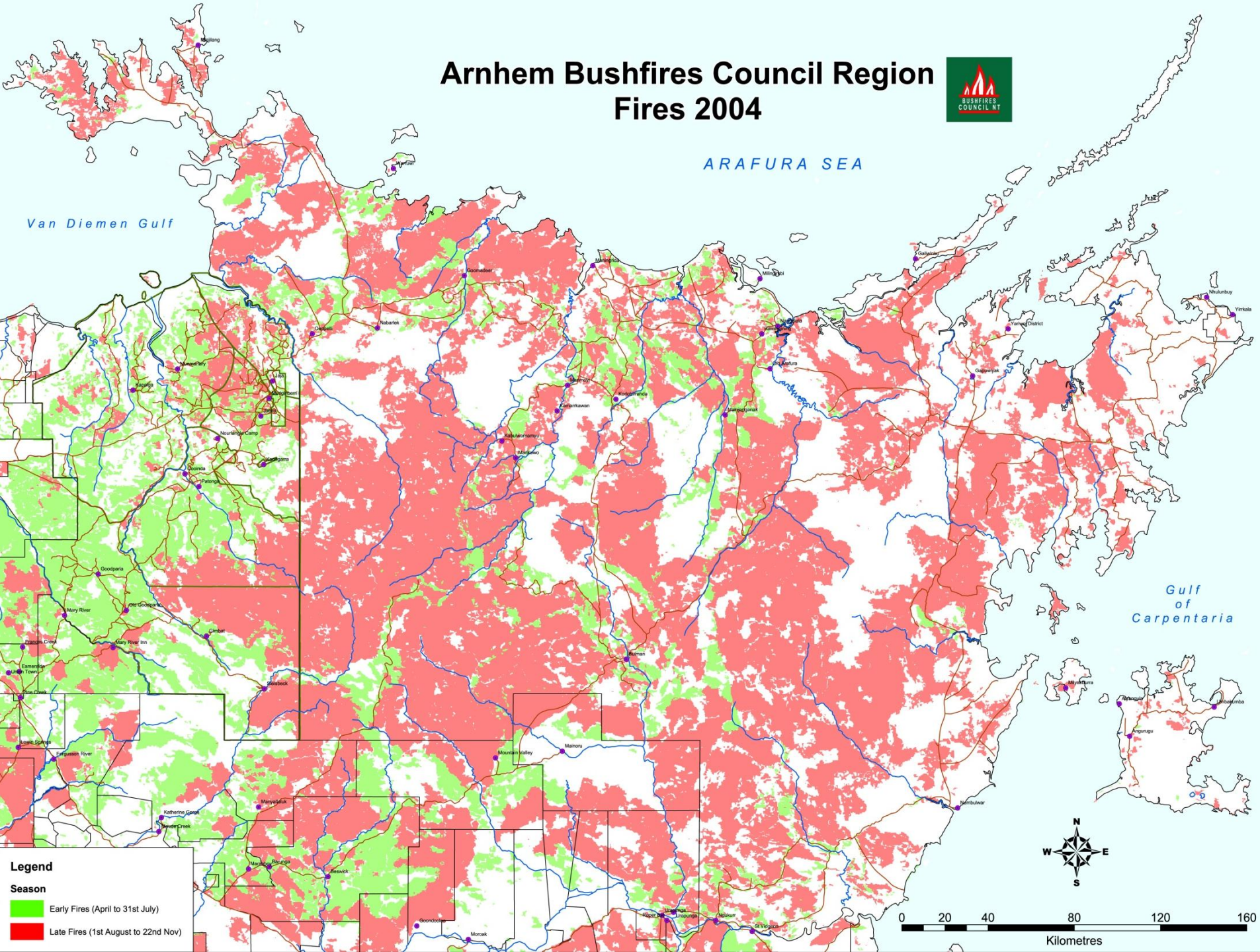


Legend

- Earlier Fires (April- 28 Aug)
- 1. Jim Jim Fire (7 Jul - 22 Oct)
- 2. Manmoyi Fire (27 Sep - 29 Oct)
- 3. East Alligator Fire (19 Sep - 4 Nov)
- 4. Bulman Fire (6 Sep - 22 Oct)
- 5. Manyallaluk Fire (27 Sep to 11 Oct)
- Other Late Fires (29 Aug - 10 Oct)
- Later Fires (11 Oct - 22 Nov)
- Unburnt



Arnhem Bushfires Council Region Fires 2004



Van Diemen Gulf

ARAFURA SEA

Gulf of Carpentaria

Legend

Season

- Early Fires (April to 31st July)
- Late Fires (1st August to 22nd Nov)

0 20 40 80 120 160

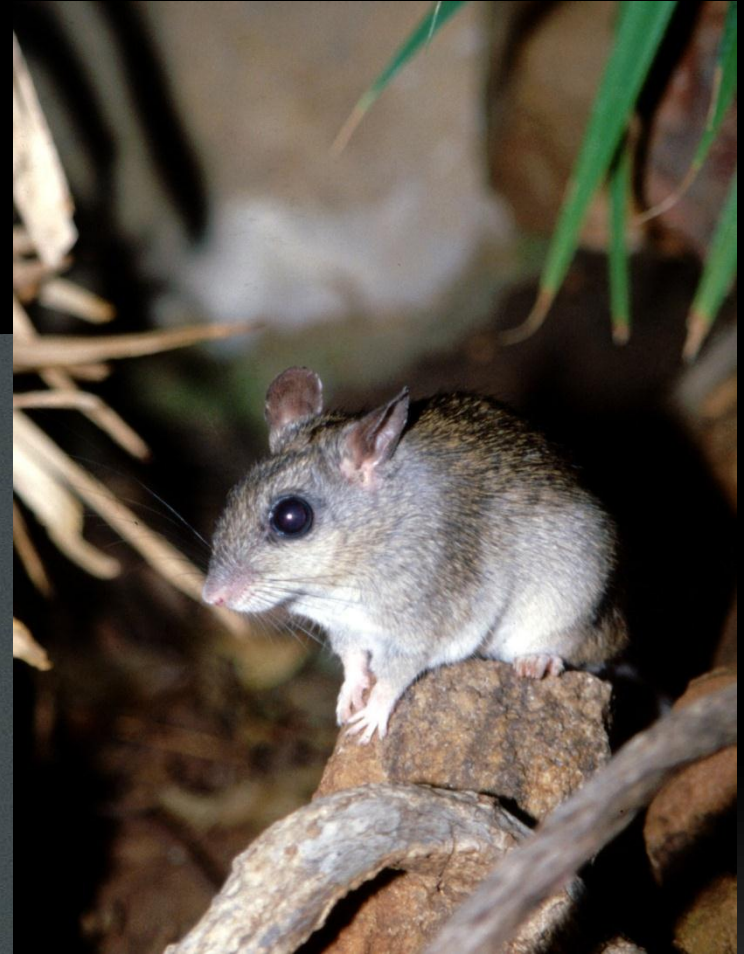
Kilometres



Rabbit Eared Rat

(Conilurus penicillatus)

Home Range < 1 ha



Quoll or Native Cat

(*Dasyurus hallucatus*)

Home Range: $\sim 1\text{km}^2$



Black Footed Tree Rat

(Mesembriomys gouldii)

Home range: 1 ha to 1 km²



Rock Myrtle

(*Petraeomyrtus punicea*)

Shrub, found in rocky heaths

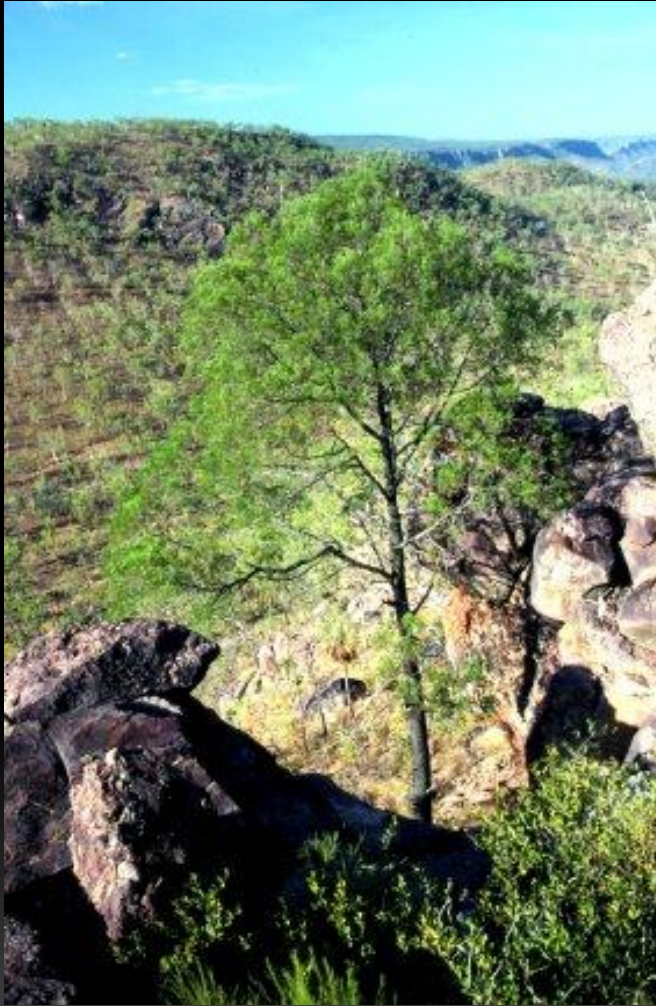
Time to reseed 6 years



Cypress Pine (*Callitris intratropica*)

Tree found in woodlands

Time to reseed >>10 years





The development of economically sustainable bases for regional fire management is critical to long-term conservation of the WALFA region's internationally acclaimed biodiversity values



TROPICAL SAVANNAS CRC

Cooperative Research Centre for the Sustainable Development of Tropical Savannas

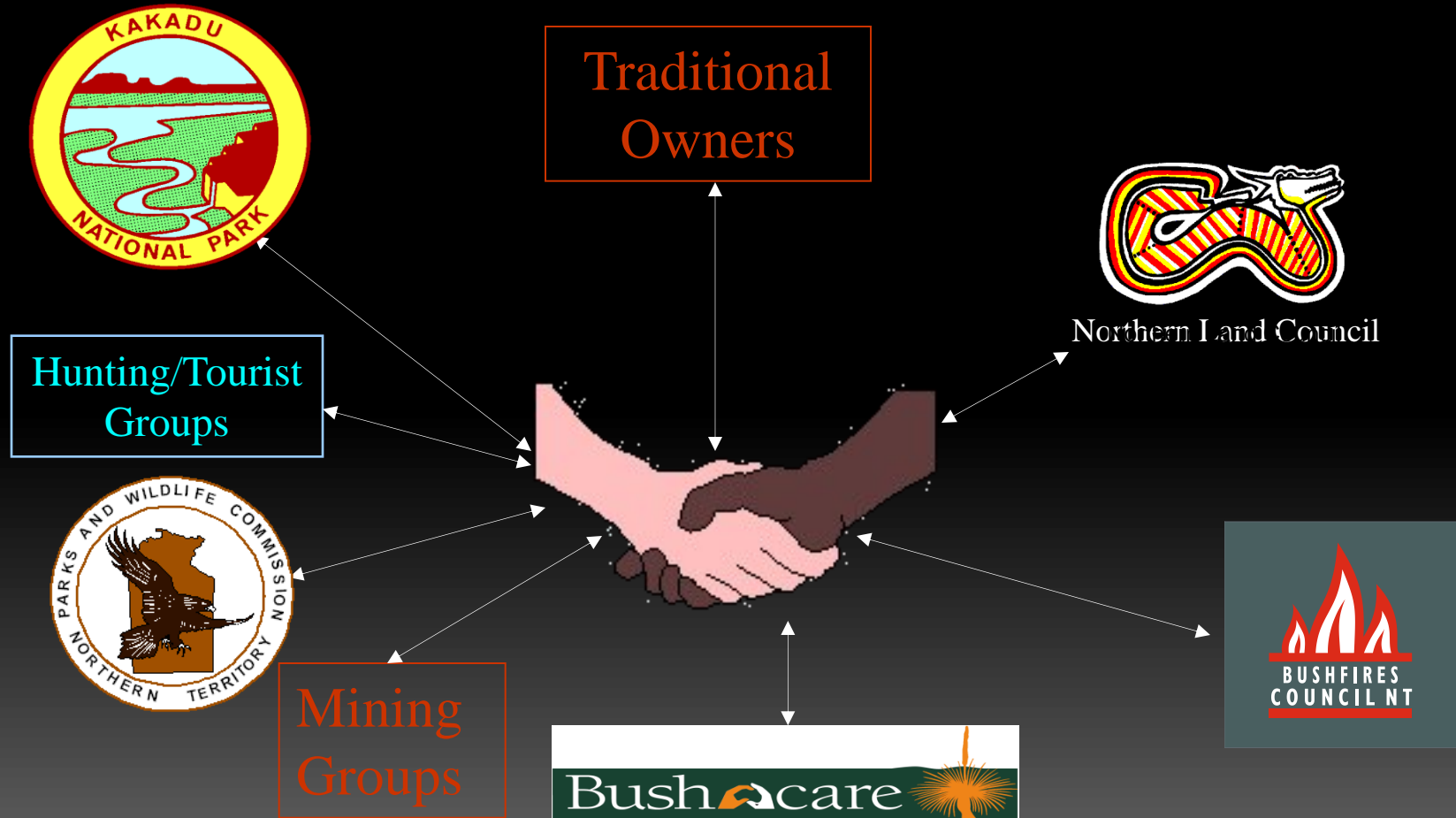


Natural
Heritage
Trust



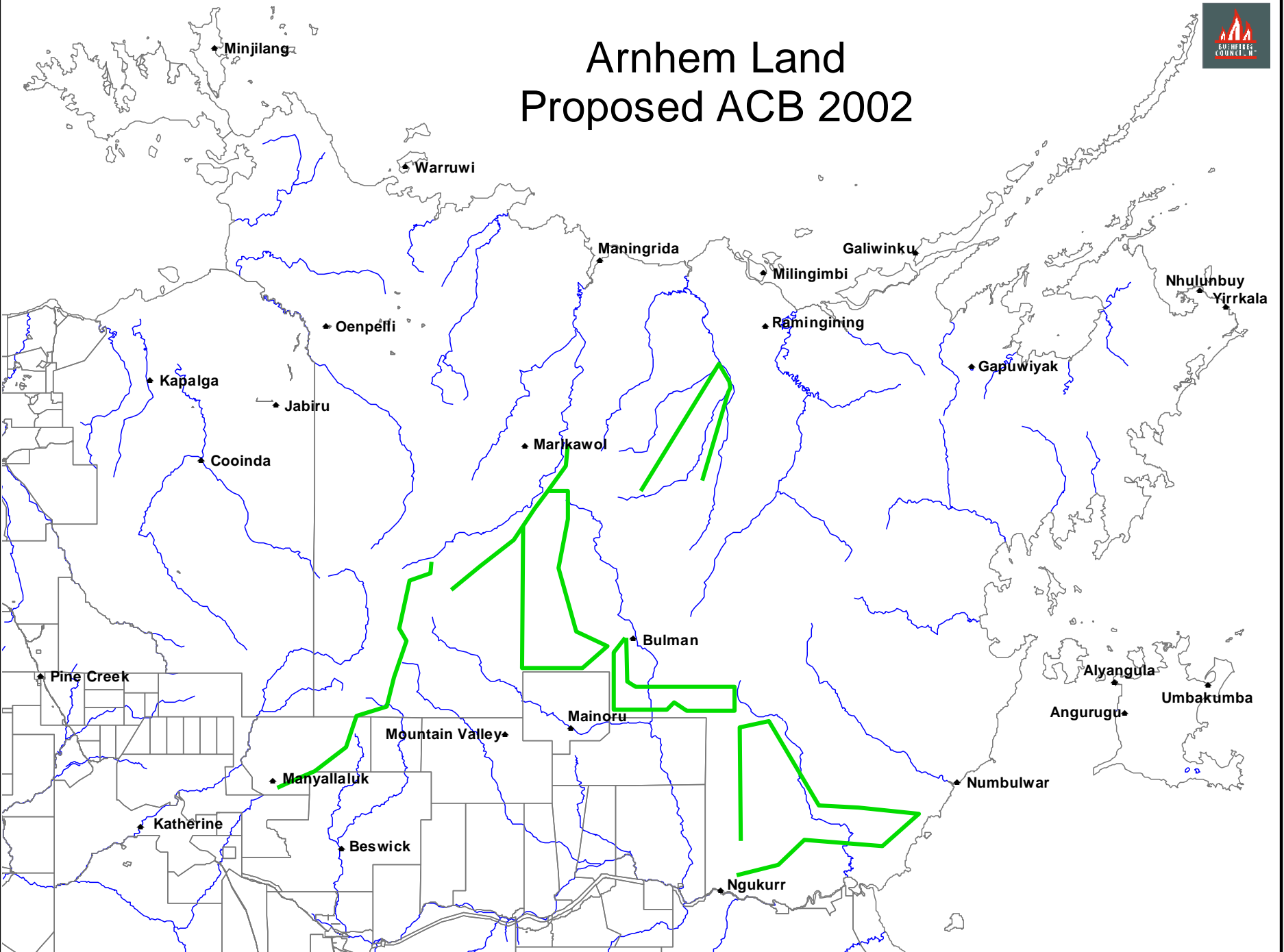
AIMS:

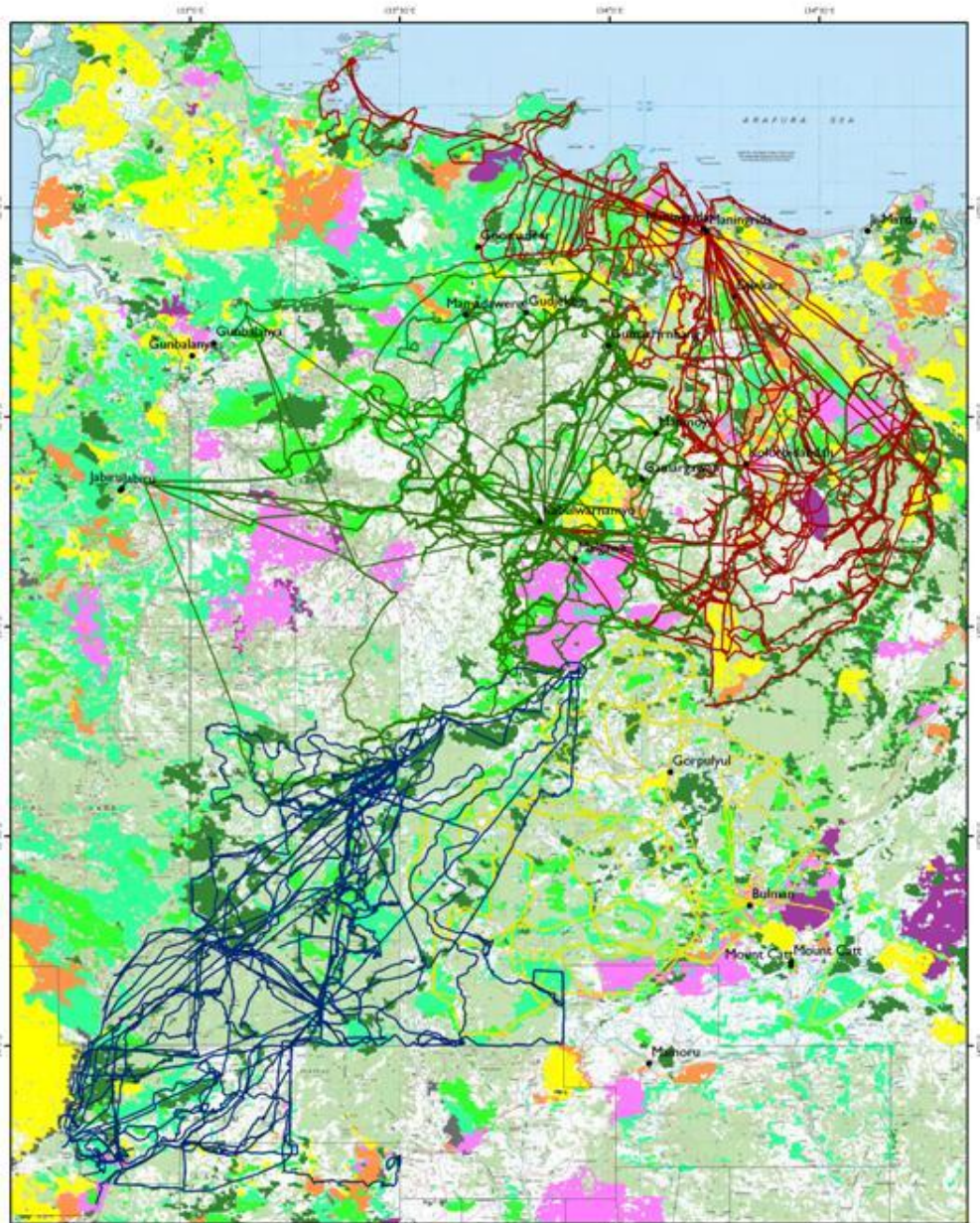
Network of people ~ thorough consultation with aboriginal custodians and organisations, and relevant regional agencies and sectors.





Arnhem Land Proposed ACB 2002





N
**Aerial Control Burns
 2008
 Western Arnhem Region**

**Burn lines
 Proponent**
 — Dyelk
 — Jawoyn
 — Manwurrk
 — Mimal

Burnt Area Mapping
 ■ March ■ August
 ■ April ■ September
 ■ May ■ October
 ■ June ■ November
 ■ July ■ December



Two toolboxes:

~ indigenous knowledge

→ how, where, why we burn

~western science:

→ satellite image interpretation

→ ecological analysis

Result:

→ improved conservation management

→ calculation of greenhouse gas emissions

→ **vastly improved resources and employment**







HUMBLE
COYS

Heli-Experts

R44

1159

adidas

Pawpaw
Northern Territory

25 10 2003



26 10 2003



22.09 07:16



Fully trained and equipped, young Indigenous Rangers prepare for fire suppression



Young Indigenous Rangers creating a fire break against the threat of a wildfire in “Catastrophic” fire weather conditions



Young Indigenous Ranger using an innovative technique to create a fire break







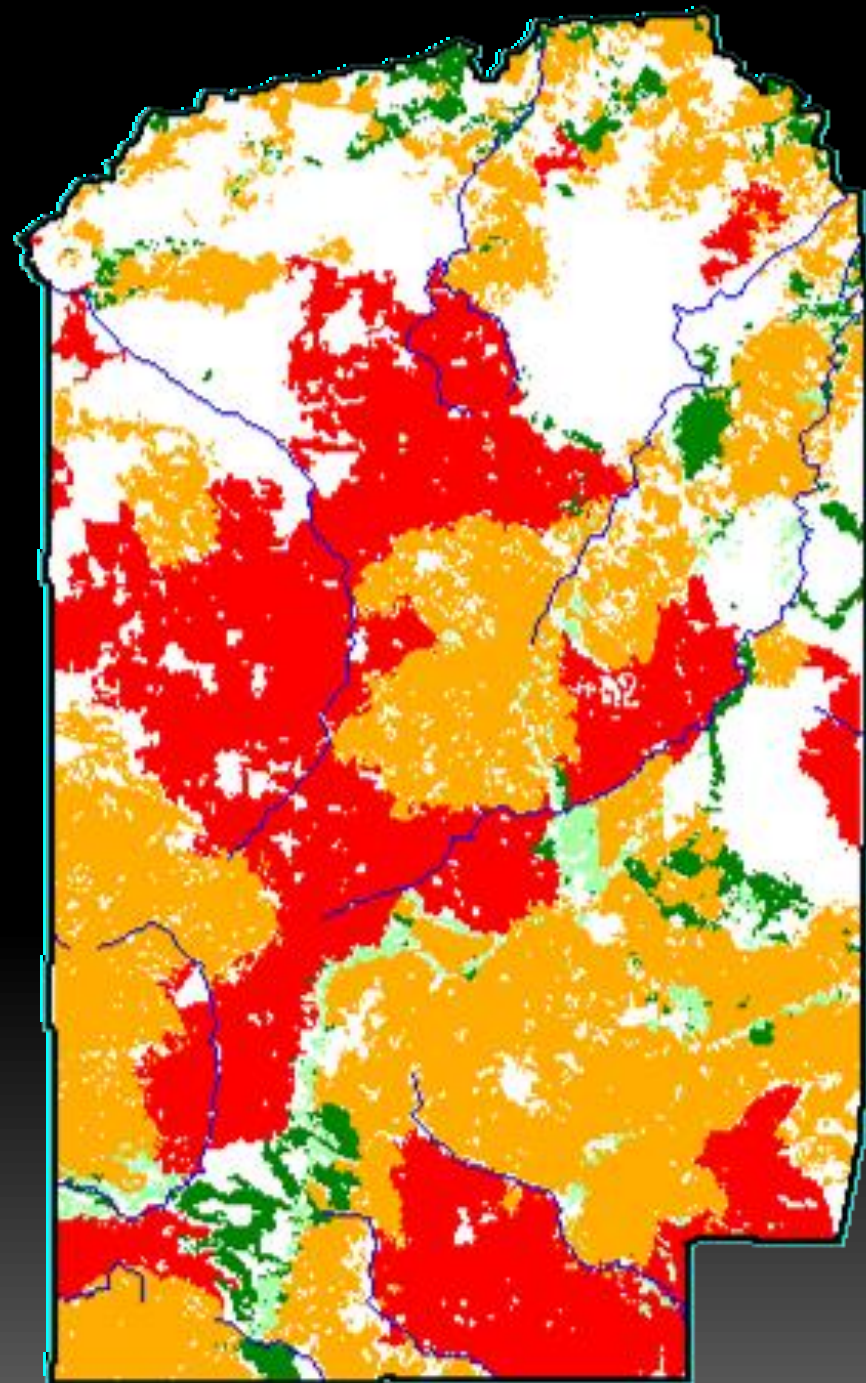
Indigenous Rangers creating a mineral earth fire break to halt an impending wildfire

Spatial Analyses

Fire Affected Areas

2004

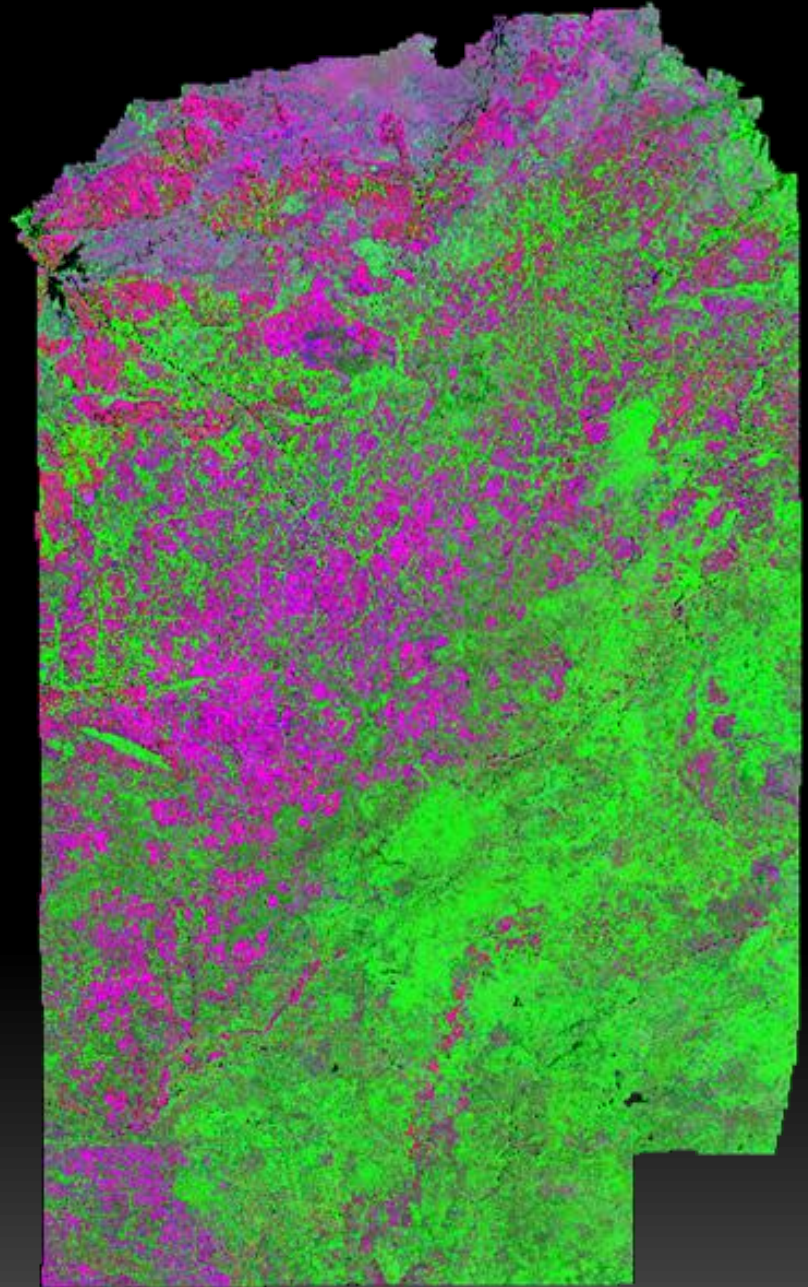
Fires to 15 June	
16 June to 2 Aug.	
3 Aug to 5 Oct.	
6 Oct. to 13 Nov.	



Normalised Difference Vegetation Index

Uses Ratio of Red and
Near Infra Red to
highlight Vegetation

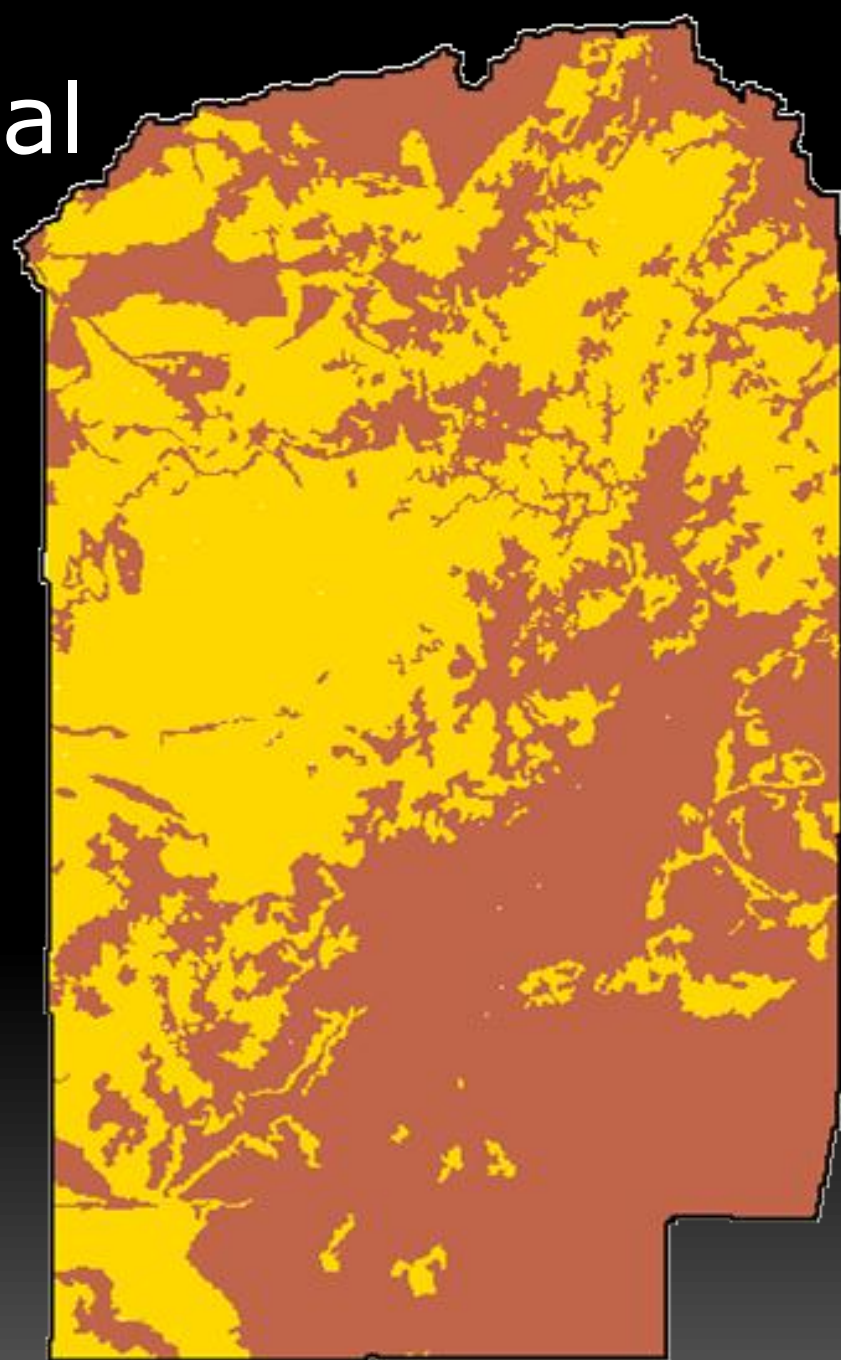
$$\text{NDVI} = \frac{(\text{Red} - \text{NIR})}{(\text{Red} + \text{NIR})}$$



NDVI is directly related to the photosynthetic capacity and hence energy absorption of plant canopies (Sellers 1985 and Myneni et al. 1995)

Geomorphological Mapping¹

Sandstone 
non-Sandstone 

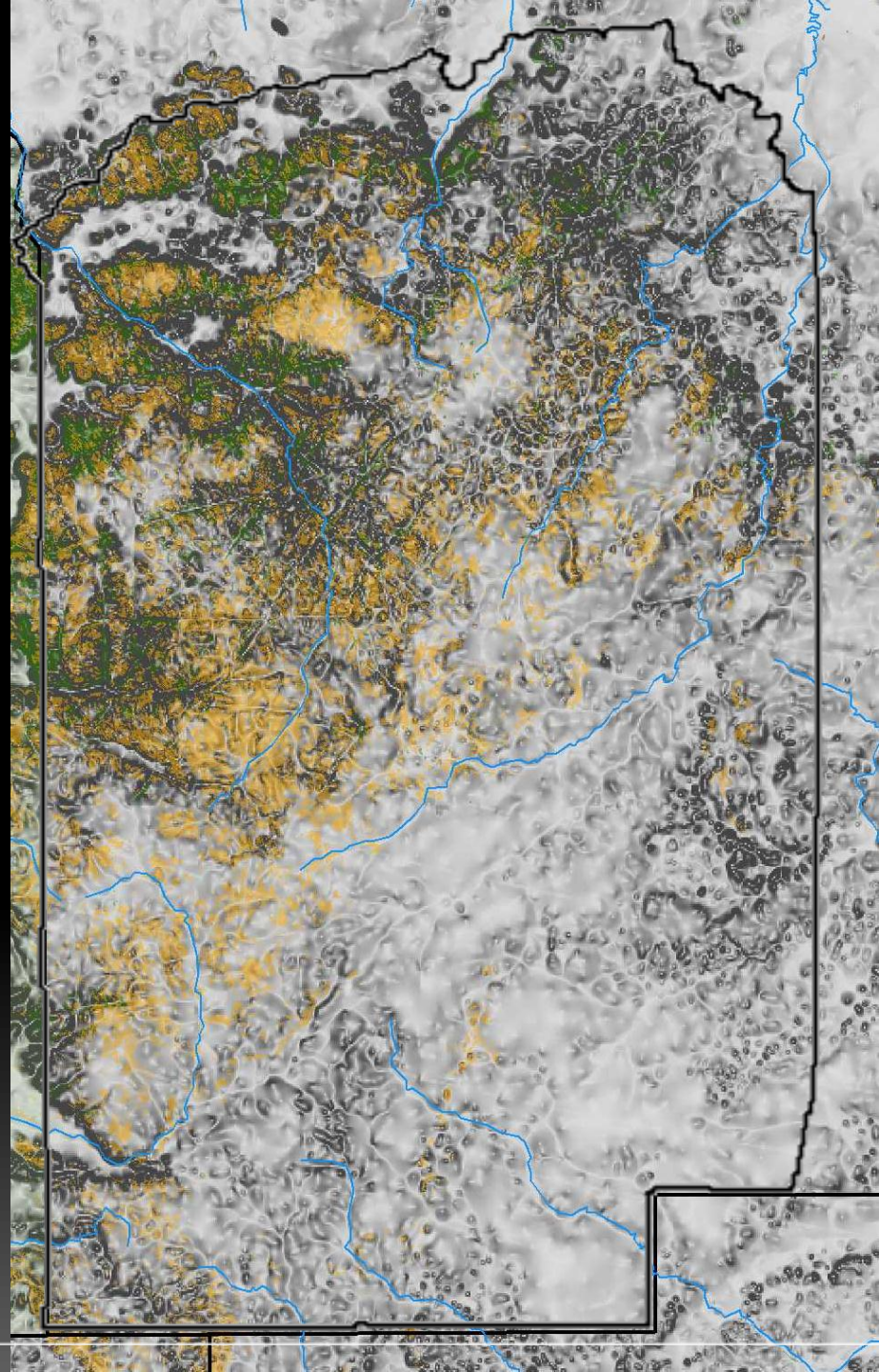


¹ derived from Lynch & Wilson **Land Systems of Arnhem Land** Technical Report No R97/1 Palmerston NT Australia






Slope

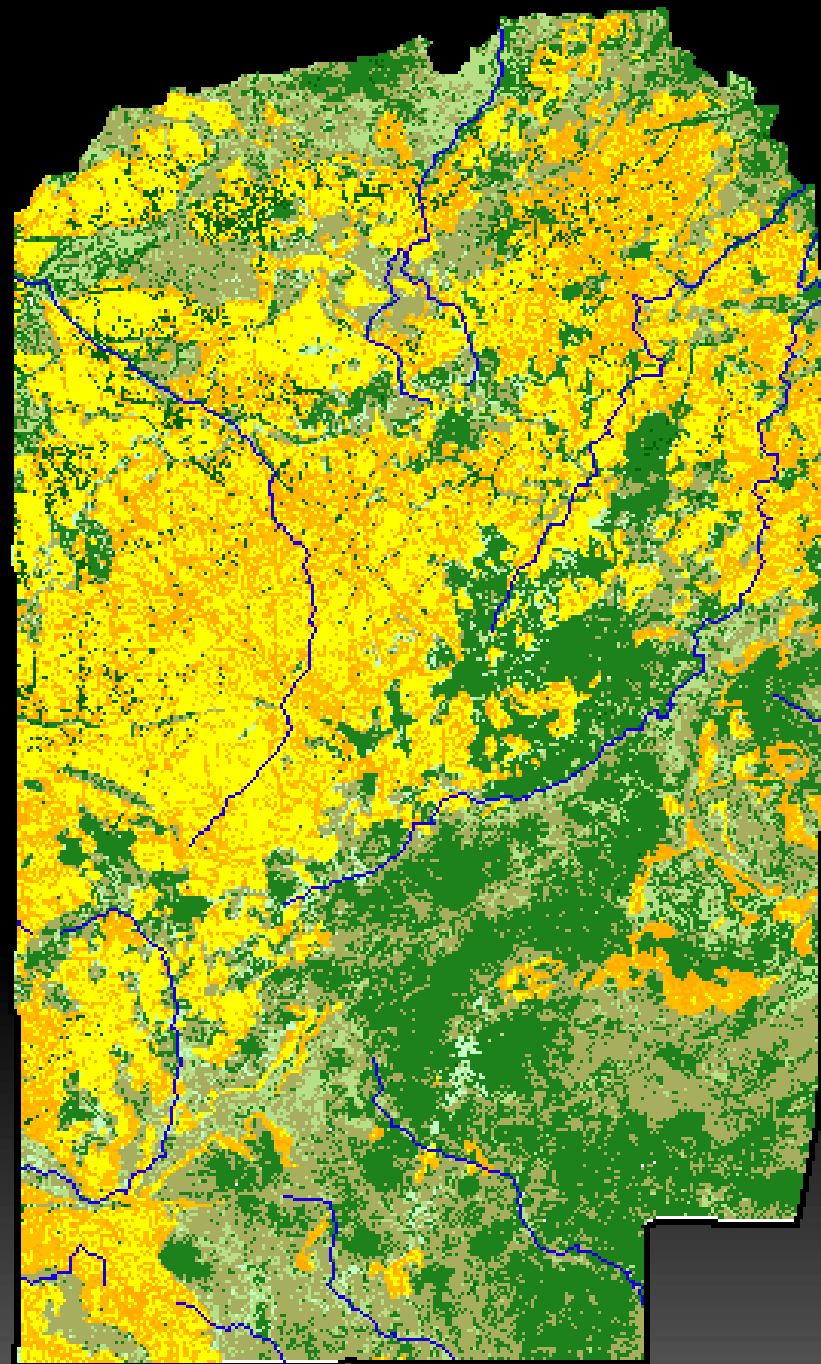
Elevation

Roughness



Habitat Mapping

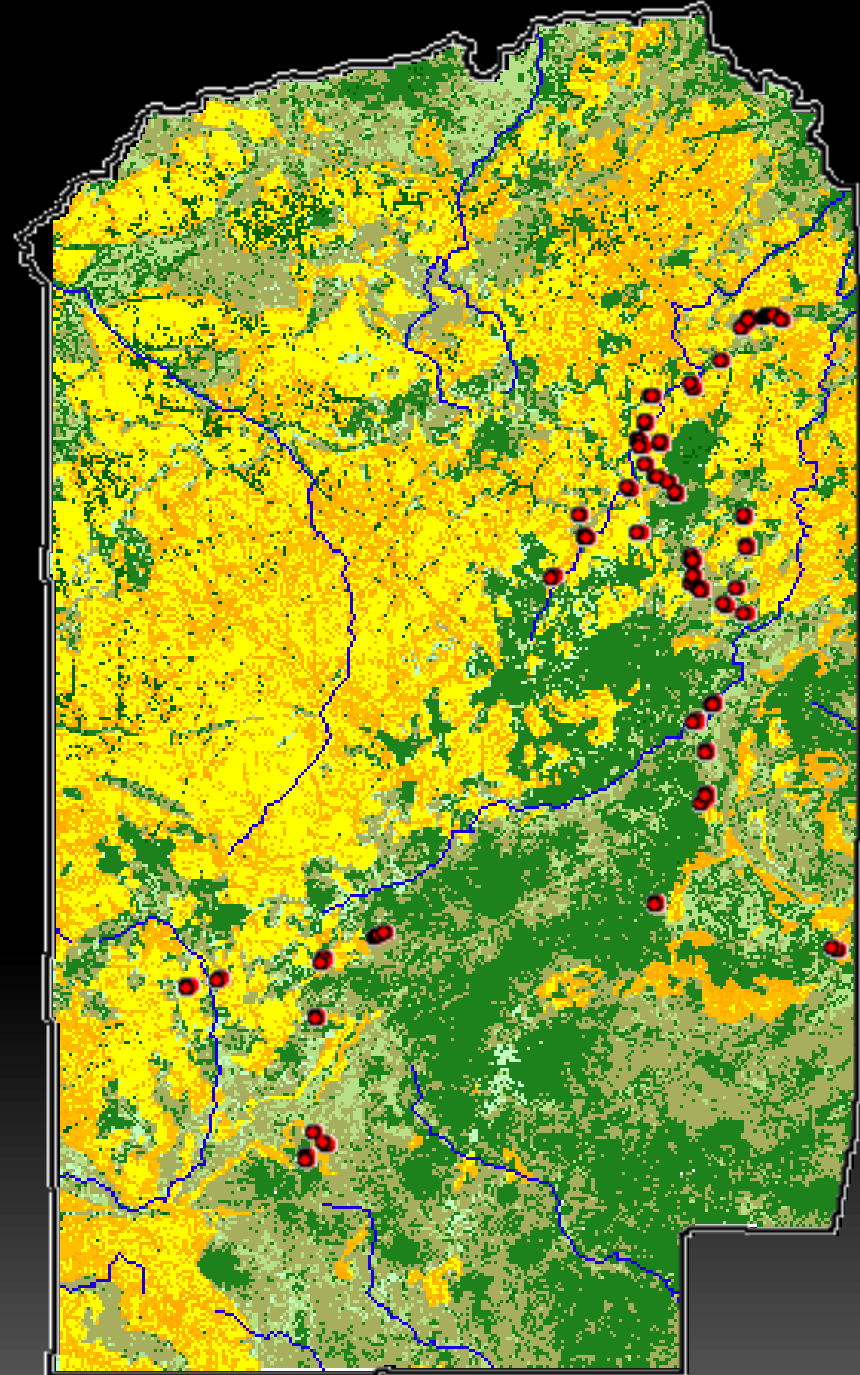
Closed Forest	
Open Forest	
Woodland	
Sandstone Woodland	
Sandstone Heath	



Classification refinement

140 sites

→ 420 x 100m transects





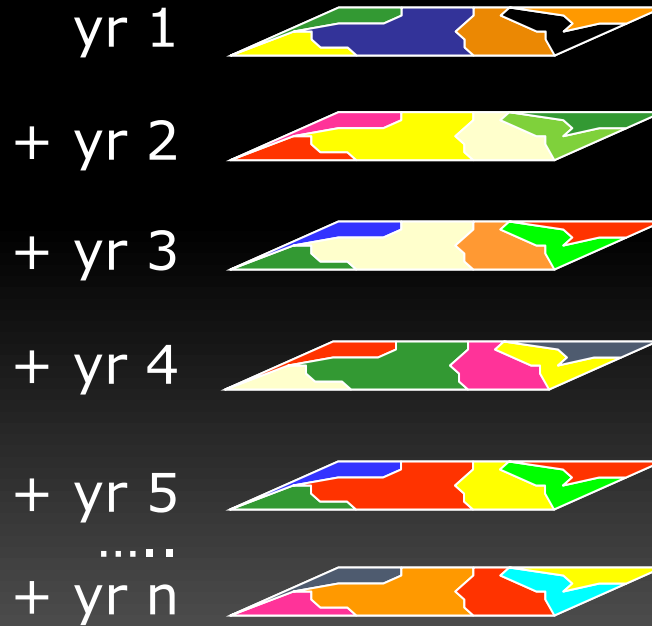
411

Fuel accumulation



Time since last burnt

Fire Histories



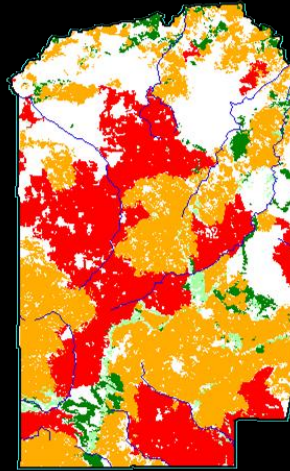
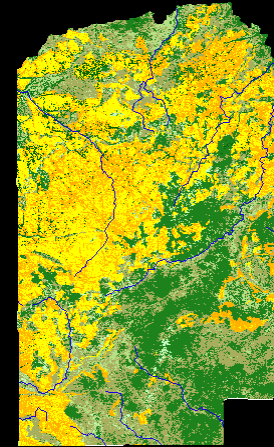
Analysis:

COMBINE

Fuels Mapping

Fire Mapping

Time Since Last Burnt Map



About SavBAT 2.0

Version 2.0 of the Savanna Burning Abatement Tool (SavBAT2) automates GIS processes and mathematical calculations required to estimate greenhouse gas emissions abatement in accordance with the Carbon Credits (Carbon Farming Initiative—Emissions Abatement through Savanna Fire Management) Methodology Determination 2015 (the methodology). SavBAT 2.0 is an enhanced version of SavBAT and includes:

- two mapping options for a project area or a potential project area:
 - A. The user uploads their own raster dataset for vegetation fuel types (see **Mapping Option A** below); or
 - B. The user uploads a vector boundary of their potential project area and the tool uses the government-supplied base map for vegetation fuel types (see **Mapping Option B** below). Note this map is not validated in accordance with the methodology requirements. You should seek your own professional, independent advice about the data on this website and any of your entitlements or obligations in relation to a relevant program administered by the Department of the Environment, and
- estimation of abatement for a hypothetical future year under different scenarios.

SavBAT 2.0 Requirements - Pre-prepared project data for vegetation fuel type:

As described, users either need to prepare and upload a vegetation fuel type map prepared in accordance with the determination (Mapping option A), or instead they can upload a project boundary and use the supplied government vegetation fuel types base map (Mapping option B). Both options use spatial products which need to be created externally from SavBAT 2.0.

- Mapping Option A – requires a GeoTIFF with the format defined in the [SavBAT 2.0 User Manual](#). Projects may span the two rainfall zones, in which case the user's vegetation raster data must contain only the relevant vegetation fuel types for each rainfall zone. SavBAT splits the datasets and calculations for each rainfall zone, before combining the results for the total baseline emissions.
- Mapping Option B - Project Boundary: The user uploads a file delineating the project boundaries. (Eligible file types for upload are shape files, Keyhole Markup Language files (.kml) and zipped .kml (.kmz) files.

It is the user's responsibility to ensure that the dataset falls within the rainfall boundary(ies), that only one start date for the late dry season is selected and the same end year for the baseline period is selected if working with one project spanning both rainfall regions. More information is available in the [SavBAT 2.0 User Manual](#). The raster version of the vegetation fuel types base map can be downloaded [here](#). The metadata for this map can be downloaded [here](#). Accuracy assessment was carried out on each zone and confirmed that the data do not meet the validation requirements of the methodology at project level. You should seek your own professional, independent advice about the dataset and any of your intended use of the dataset.

SavBAT 2.0 Requirements - Pre-prepared project data for fuel use

SavBAT 2.0 does not require that data for project fuel use are entered to undertake calculations or estimates. Users should be aware that this will produce a slightly exaggerated abatement result. When creating an offsets report for submission to the regulator, the methodology requires that the user must account for fuel use. More information is available in the [SavBAT 2.0 User Manual](#).

SavBAT 2.0 Outputs

I agree and next >

Savanna wide Risk Analyses

Key risk attribute models

(a) Greenhouse gas emissions abatement

Applying the nationally accepted Australian model savanna burning emissions (E) are calculated as the product of the mass of fuel pyrolised (FP) and the emission factor (EF) of respective accountable GHG (g) species:

$$E = FP * EF(g)$$

where FP is the product of the area exposed to fire (A) taking into account spatial patchiness, the fuel load (FL) in respective fuel classes, and the burning efficiency (BEF) defined as the mass of fuel exposed to fire that is pyrolised. EF(g) is defined relative to the fuel elemental content where, for carbon species, EF(g) is expressed relative to fuel carbon, and nitrogen species are expressed relative to fuel nitrogen. Fuel carbon mass is determined from fuel mass by the fuel carbon content, while fuel nitrogen is derived from the fuel mass by the product of carbon content and the fuel nitrogen to carbon ratio. Units of emissions (E) are given as Mt CO₂-e, taking into account the enhanced respective warming potential of accountable gases (CH₄, N₂O) relative to CO₂.

File Home Insert Page Layout Formulas Data Review View

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How to use this spreadsheet to calculate your greenhouse gas emissions

This spreadsheet uses the Carbon Farming Initiative - Savanna Burning Methodology

Developed by Bushfires NT, NAILSMA (North Australian Indigenous Land and Sea Management Alliance) and CSIRO.

1. First of all make a copy of this spreadsheet. i.e. Save as... and give it a new appropriate name.
2. Create the table like the data in the 'Data' worksheet.
i.e the veg type, the time since fire, the year of the fire history mapping, the area burnt early and late
To do this you will need to intersect the 3 layers, in Arc GRID the command to use is "combine".
3. Populate the table in the 'Data' worksheet with your data,
make sure you delete all the old west Arnhem data
make sure there are no more than 1000 records, or else you'll have to modify the 'Calcs' worksheet
4. I have password protected the 'LUTs' and 'Calcs' worksheets so you can't accidentally delete or change things
as this would be an almighty disaster, but is very easy to do, I know, I did it, it was a disaster.
the password is: ace
You may need to update certain numbers in the future as more accurate data are always being created.
5. In the 'Results' worksheet you will have to refresh the Pivot tables by right-mouse clicking in the top left hand
corner of the table and selecting refresh. You'll also have to change the area of the region in cell E2 (it's in hectares)
The other tables and things may not work for you.
If not you'll have to do your own pivot tables.
Go back to the 'Calcs' worksheet and select Insert>Pivot table
Follow the prompts, you'll work it out, or if you don't you'll ring me.

Andrew Edwards
Bushfires Research
Bushfires NT
0427 270 835

Key risk attribute models

(b) Savanna burning bio-sequestration

Based on assessment of 10 years of long-term monitoring data for 135 plots, the annual proportional change in tree biomass carbon stocks for both lowland and upland woodland savannas can be given as:

$$\text{New C Biomass (t.ha}^{-1}\text{)} = \text{C biomass} * ((1.45 - 0.11 * \ln(\text{C biomass}) + b)^{(1/6)})$$

Where (1) if fire severity = mild, moderate, severe, then $b = -0.1, -0.15, -0.53$ respectively, and (2) assuming an initial tree carbon biomass of 25.8 t.ha^{-1}

(c) Fire-sensitive obligate seeder plants

(i) Callitris intratropica

Based on assessment of 15 years fire regime observations at 18 long-term monitoring plots, change in stem (≥ 5 cm DBH) density in topographically variable terrain can be given as:

$$\text{Stem density} = 1.33 - 1.15 * \text{frq_sev}$$

where (1) frq_sev = the frequency of moderately severe and severe fires over the assessment period, and (2) assuming an initial stem density of 99.8 stems.km⁻²

(ii) Longer-maturing (LOS) shrub taxa

Based on assessment of 15 years fire regime observations at 34 long-term monitoring plots, change in numbers of longer-maturing (≥ 3 yr) obligate seeder shrub taxa in topographically variable terrain can be given as:

$$\text{Number of LOS taxa} = 0.89 - 0.26 * \text{fire frq}$$

where (1) fire frq = frequency of fires over the assessment period, and (2) assuming an initial complement of 2.27 LOS taxa.0.01 ha⁻¹

Key risk attribute models

(d) Erosion effects

Based on replicated assessment of the effects of Late Dry Season burning on soil movement at two hill-slope sites, the effects of Late Dry Season fires on soil movement in topographically variable terrain can be given as:

$$\text{Soil movement (t.ha}^{-1}\text{)} = (2.0 * \text{frq_nonLDS} + 4.21 * \text{frq_LDS}) * 22.8$$

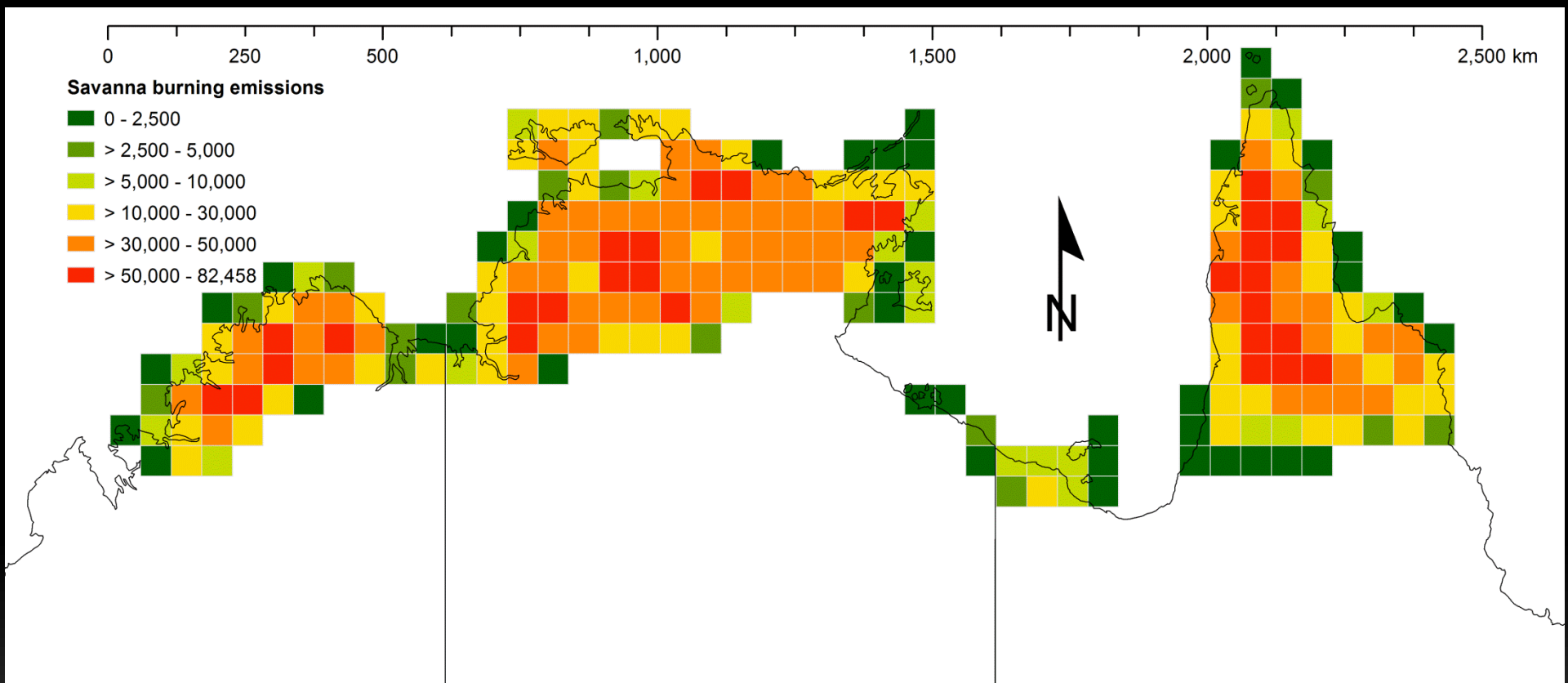
where (1) frq_non-LDS is the mean frequency of Unburnt and Early Dry Season fires combined, frq_LDS is the mean frequency of Late Dry Season fires, and (2) assuming each 1 mm of soil movement results in movement of 22.8 t.ha⁻¹ of fine earth and coarse fragments

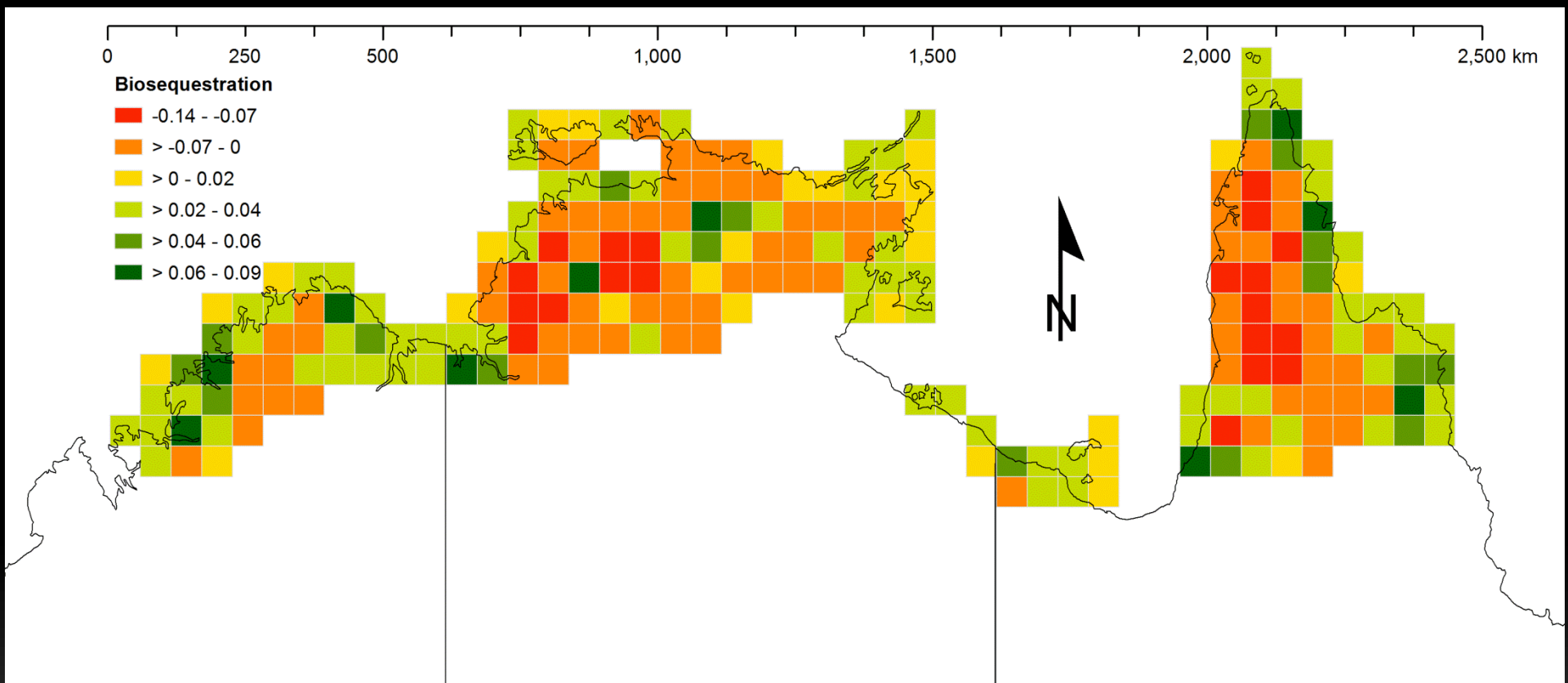
Scenarios: BAU = Business as Usual CCI = Climate Change Impacts IFM = Improved Fire Management

<u>2008-2012</u>	<u>BAU benchmark</u>	<u>BAU+CCI</u>	<u>IFM</u>	<u>IFM+CCI</u>
Fire seasonality	EDS = 0.19; LDS = 0.34	EDS = 0.19; LDS = 0.44	EDS = 0.29; LDS = 0.17	EDS = 0.29; LDS = 0.22
Fire severity	mild = 0.25 moderate = 0.17 severe = 0.11	mild = 0.28 moderate = 0.21 severe = 0.14	mild = 0.28 moderate = 0.12 severe = 0.06	mild = 0.30 moderate = 0.14 severe = 0.07

Effects on key risk attributes

Bio-sequestration (Mt C.y ⁻¹)	-0.641 ± 0.002	-6.86 ± 0.02 (-1078%)	5.51 ± 0.01 (+959%)	2.75 ± 0.006 (+538%)
Obligate seeders - Callitris (Increase in Stems.km ⁻²)	100.25 ± 0.04	99.93 ± 0.05 (-0.32%)	100.44 ± 0.03 (+0.19%)	100.28 ± 0.04 (+0.03%)
Obligate seeders - Longer-maturing shrubs (Species.o.1 ha ⁻¹)	2.75 ± 0.02	2.66 ± 0.02 (-3.3%)	3.08 ± 0.02 (+12%)	2.77 ± 0.02 (+0.7%)
Erosion effects - soil movement (t.ha ⁻¹)*	50	63 (+26%)	28 (-44%)	34 (-32%)

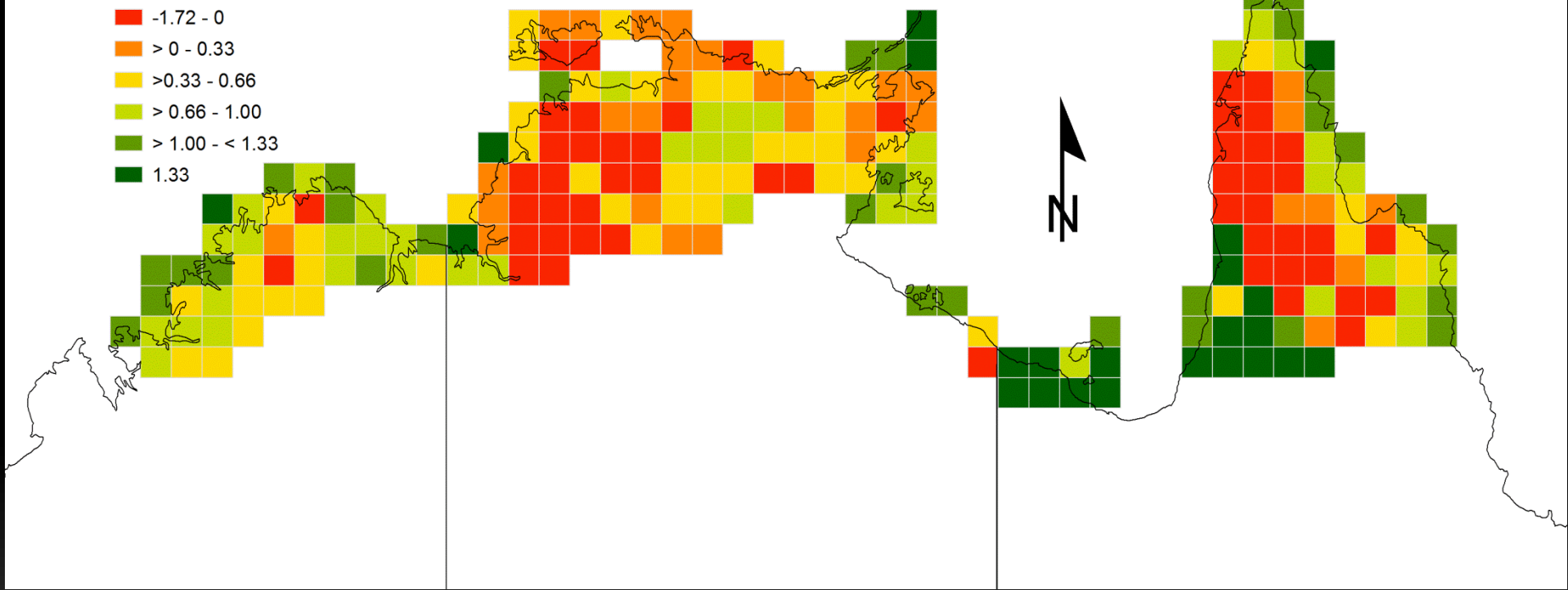




0 250 500 1,000 1,500 2,000 2,500 km

Callitris

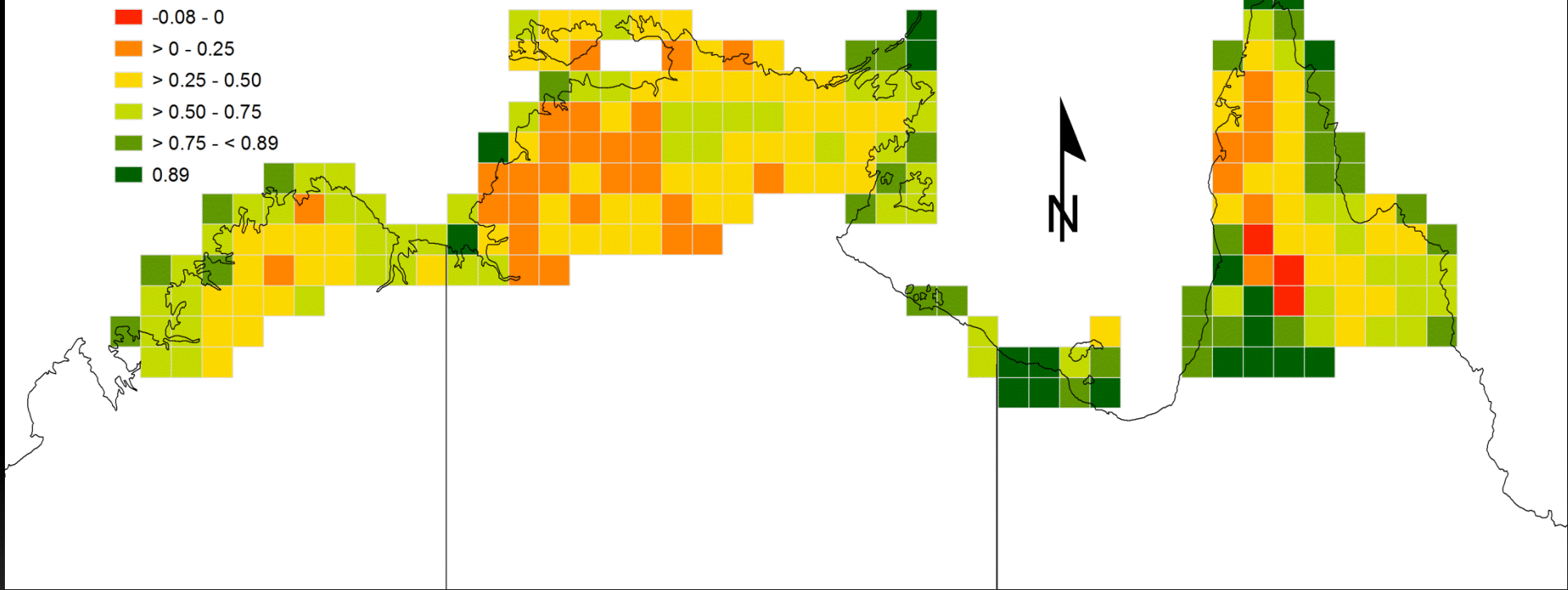
- -1.72 - 0
- > 0 - 0.33
- >0.33 - 0.66
- > 0.66 - 1.00
- > 1.00 - < 1.33
- 1.33



0 250 500 1,000 1,500 2,000 2,500 km

LOS

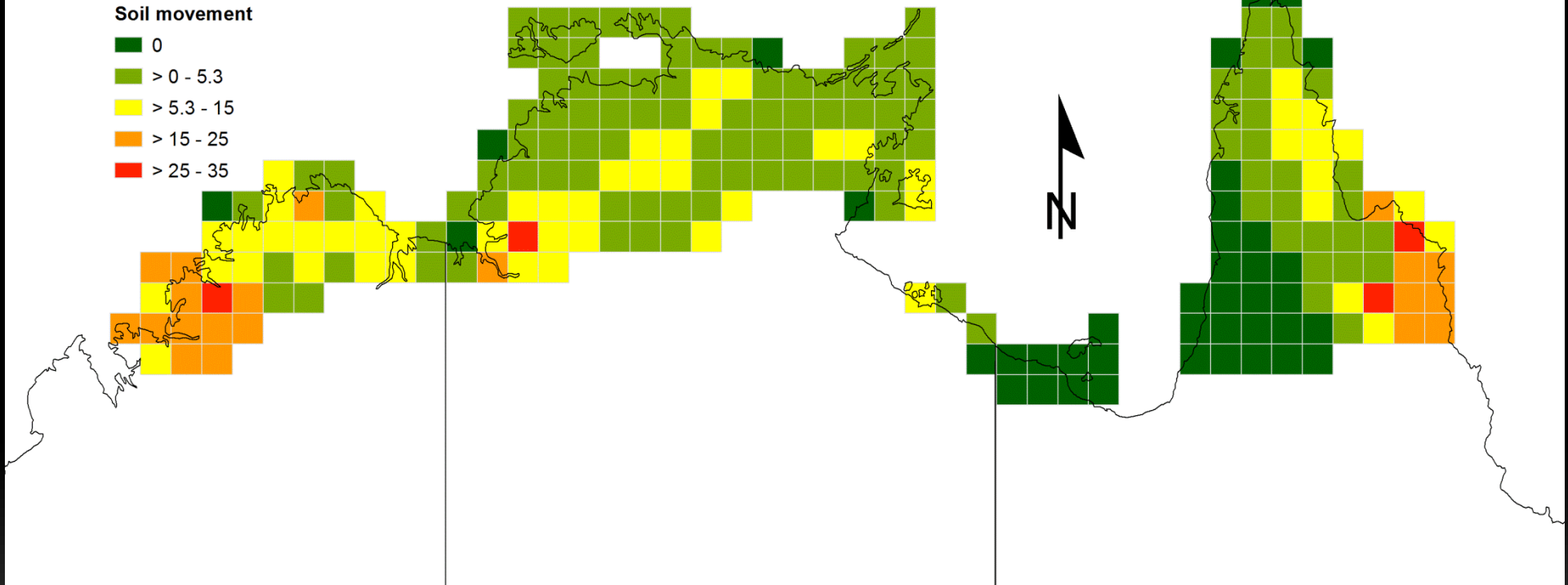
- 0.08 - 0
- > 0 - 0.25
- > 0.25 - 0.50
- > 0.50 - 0.75
- > 0.75 - < 0.89
- 0.89



0 250 500 1,000 1,500 2,000 2,500 km

Soil movement

- 0
- > 0 - 5.3
- > 5.3 - 15
- > 15 - 25
- > 25 - 35



where does this all lead?



Payment for Ecosystem Services (PES)