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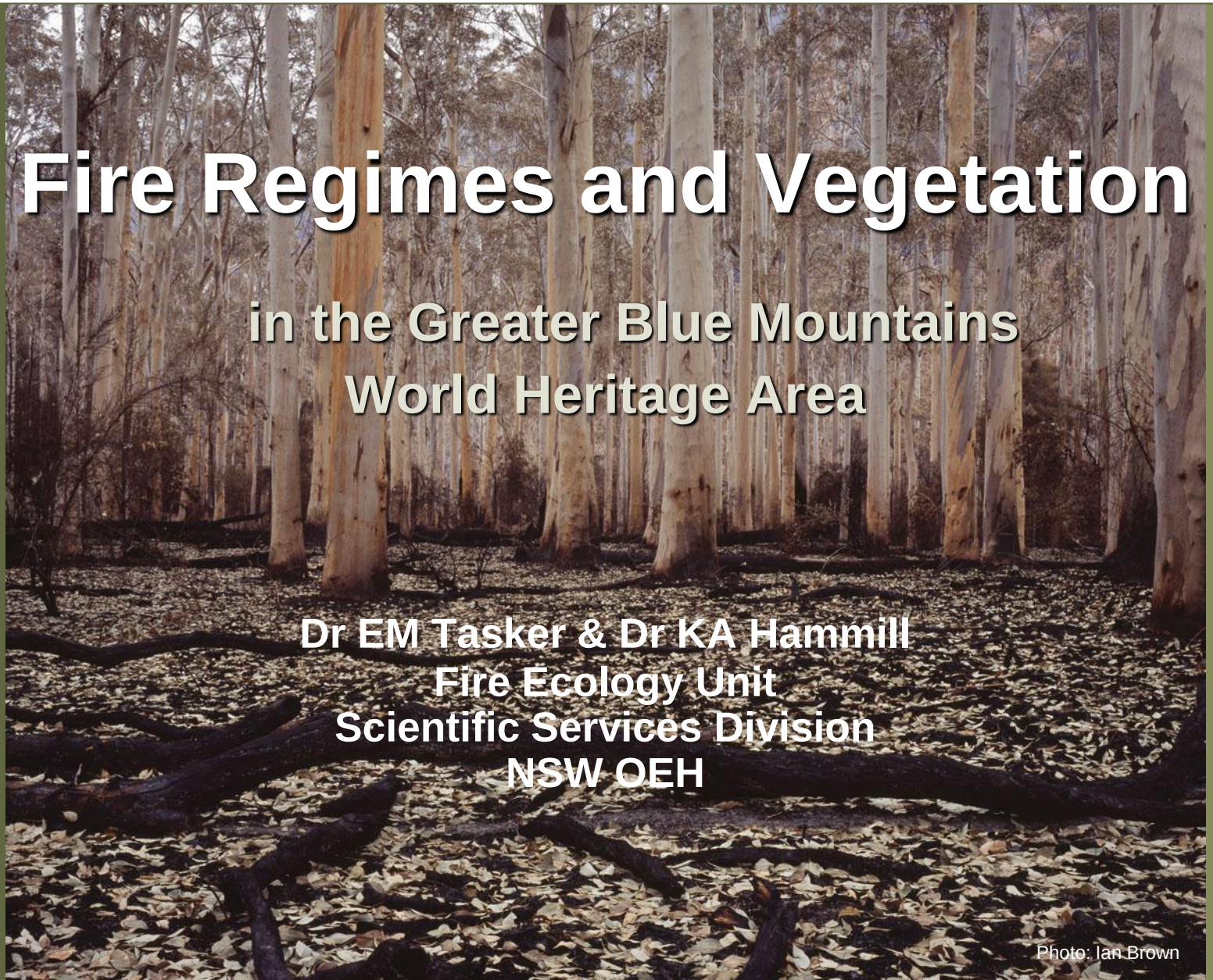


# Fire Regimes and Vegetation

## in the Greater Blue Mountains World Heritage Area

**Dr EM Tasker & Dr KA Hammill**
**Fire Ecology Unit**
**Scientific Services Division**
**NSW OEH**

Photo: Ian Brown

# Greater Blue Mountains World Heritage Area

- 1.03 million hectares
- Eight conservation reserves (Blue Mountains NP, Gardens of Stone NP, Kanangra-Boyd NP, Nattai NP, Thirlmere Lakes NP, Wollemi NP, Yengo NP & Jenolan Karst Conservation Reserve)
- Almost 250 km north-south from the edge of the Hunter Valley to the Southern Highlands near Mittagong

Photo: Neil Stone/NPWS

# Why study fire in the Blue Mountains World Heritage Area?

# Highly fire-prone: frequent and big fires

Since 1970 major bushfire seasons in 1978, 80, 81, 83, 85, 94, 98, 2002, 03, 07

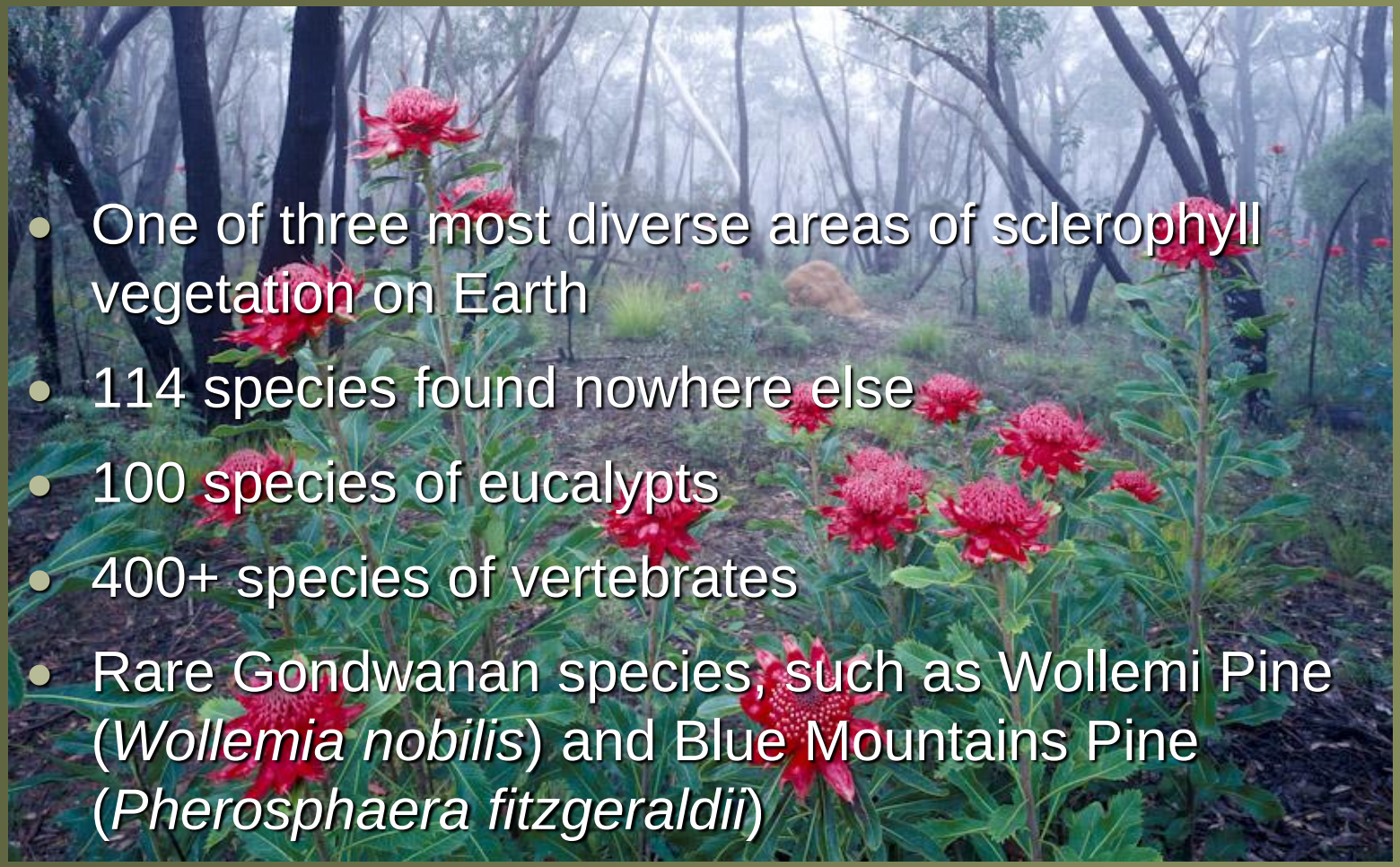
# Fire records kept by the National Parks & Wildlife Service since 1970

Grose Valley, Nov 2006

Photo: Neil Stone/NPWS

# People and assets embedded within a highly flammable landscape

# High conservation value



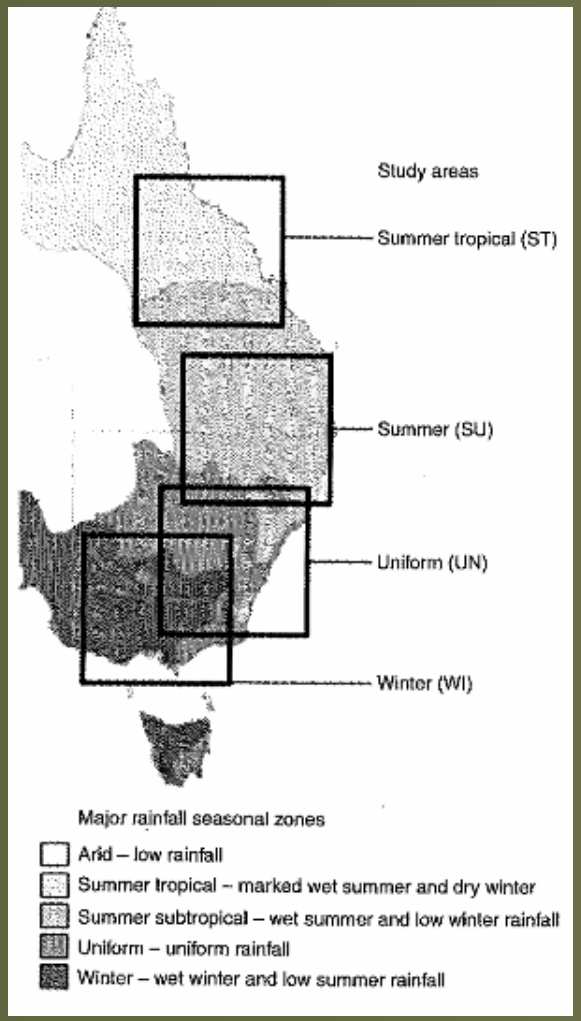
- One of three most diverse areas of sclerophyll vegetation on Earth
- 114 species found nowhere else
- 100 species of eucalypts
- 400+ species of vertebrates
- Rare Gondwanan species, such as Wollemi Pine (*Wollemia nobilis*) and Blue Mountains Pine (*Pherosphaera fitzgeraldii*)

# Climate change

Recent modeling predictions:

- More high-extreme FFDI days
- Earlier start to the fire season
- Potentially more frequent fires of high intensity

# E.g. Clarke *et al*. (2011) "Regional signatures of future fire weather over eastern Australia…"

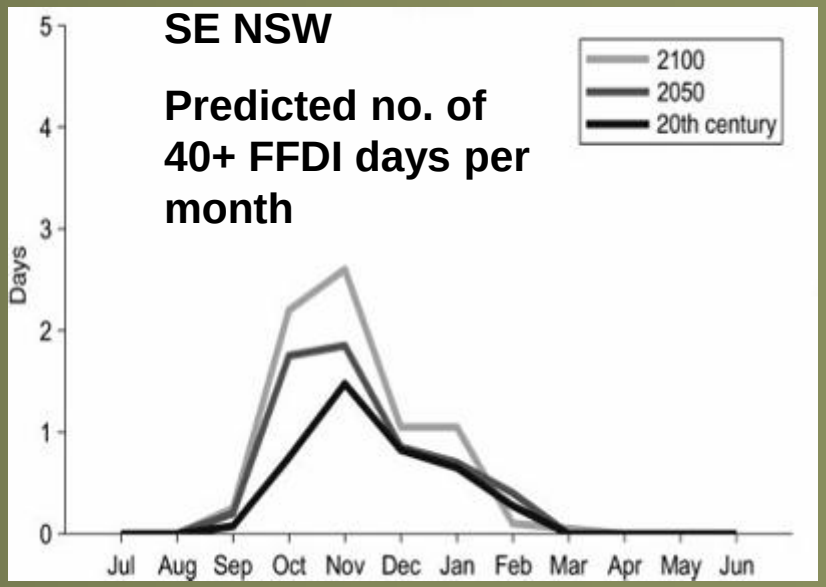



= Little change in fire weather

= Little change

= Strong increase

= Strong increase



# Our Project:
# Fire regime analysis for the GBMWHA

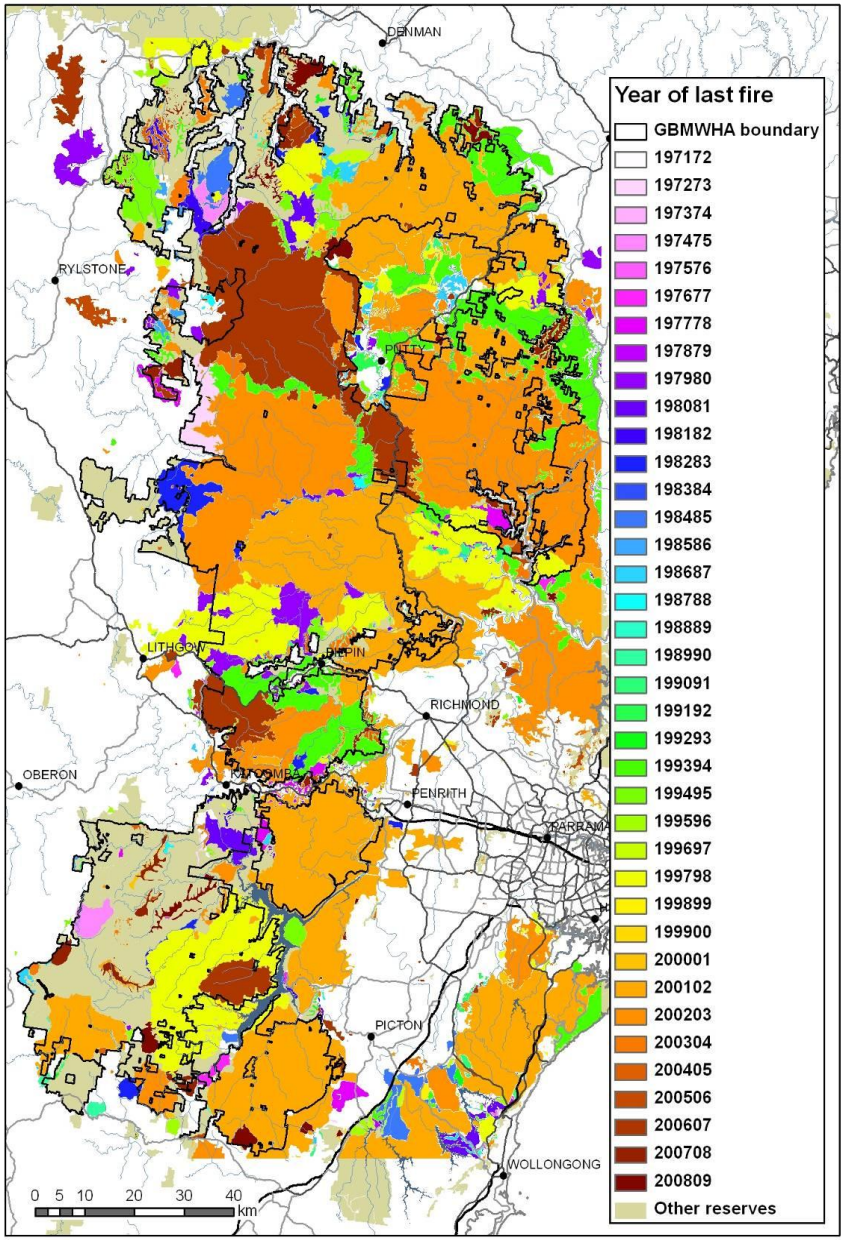
- Combined fire perimeter maps from NPWS records & analysed the patterns
- Compiled a single vegetation map for the WHA
- Combined vegetation and fire frequency maps, compared this with biodiversity fire thresholds
- Prepared fire severity maps for all major bushfires in last 20 years (5 seasons)

# What is a fire history useful for?

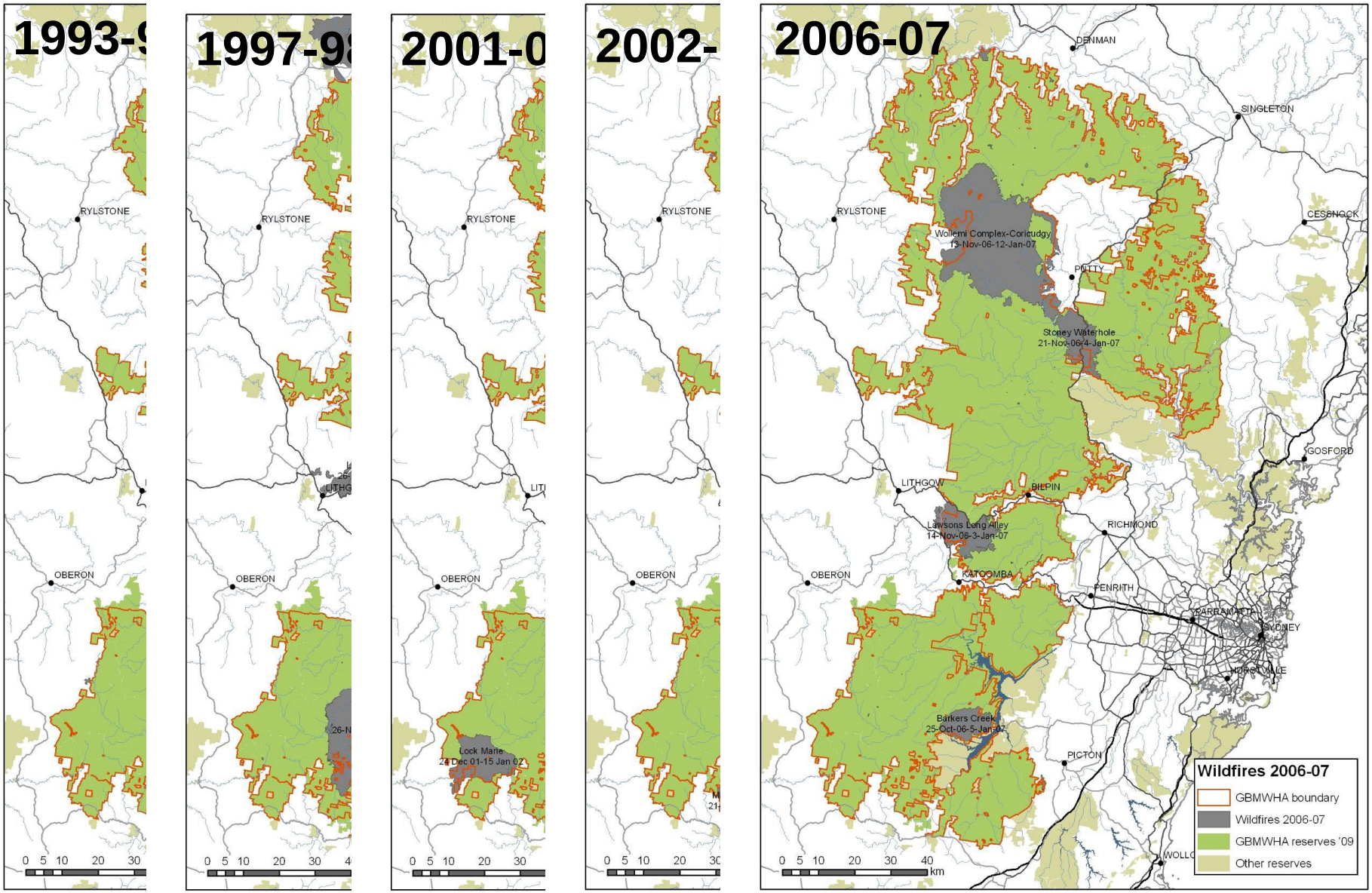
Fire frequency, severity and time since fire affect:

- fuel loads and fuel accumulation rates
- vegetation structure and (above ground) composition, hence longer-term fuel patterns
- fire behaviour of subsequent bushfires
- erosion potential
- soil nutrients and soil carbon
- fauna

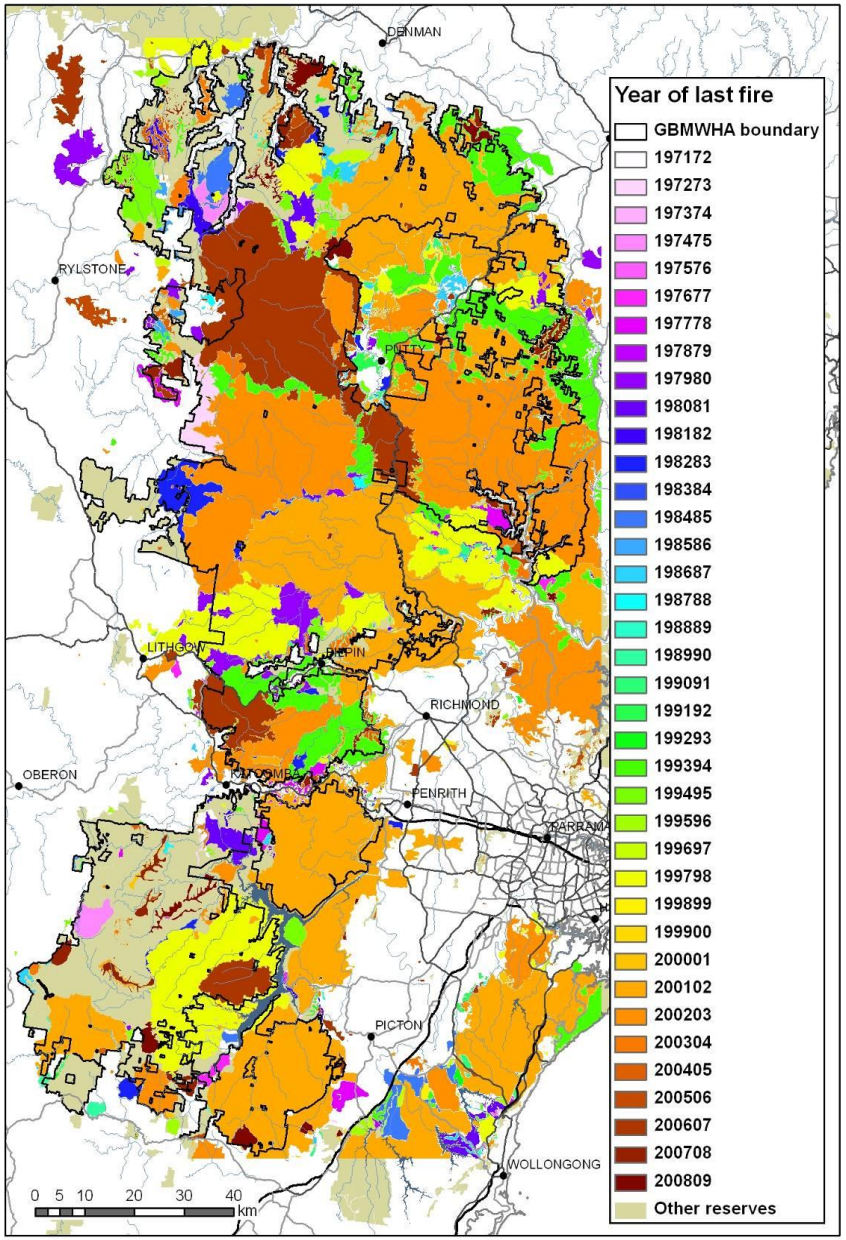
# Time Since Last Fire



# Major bush fire seasons past two decades

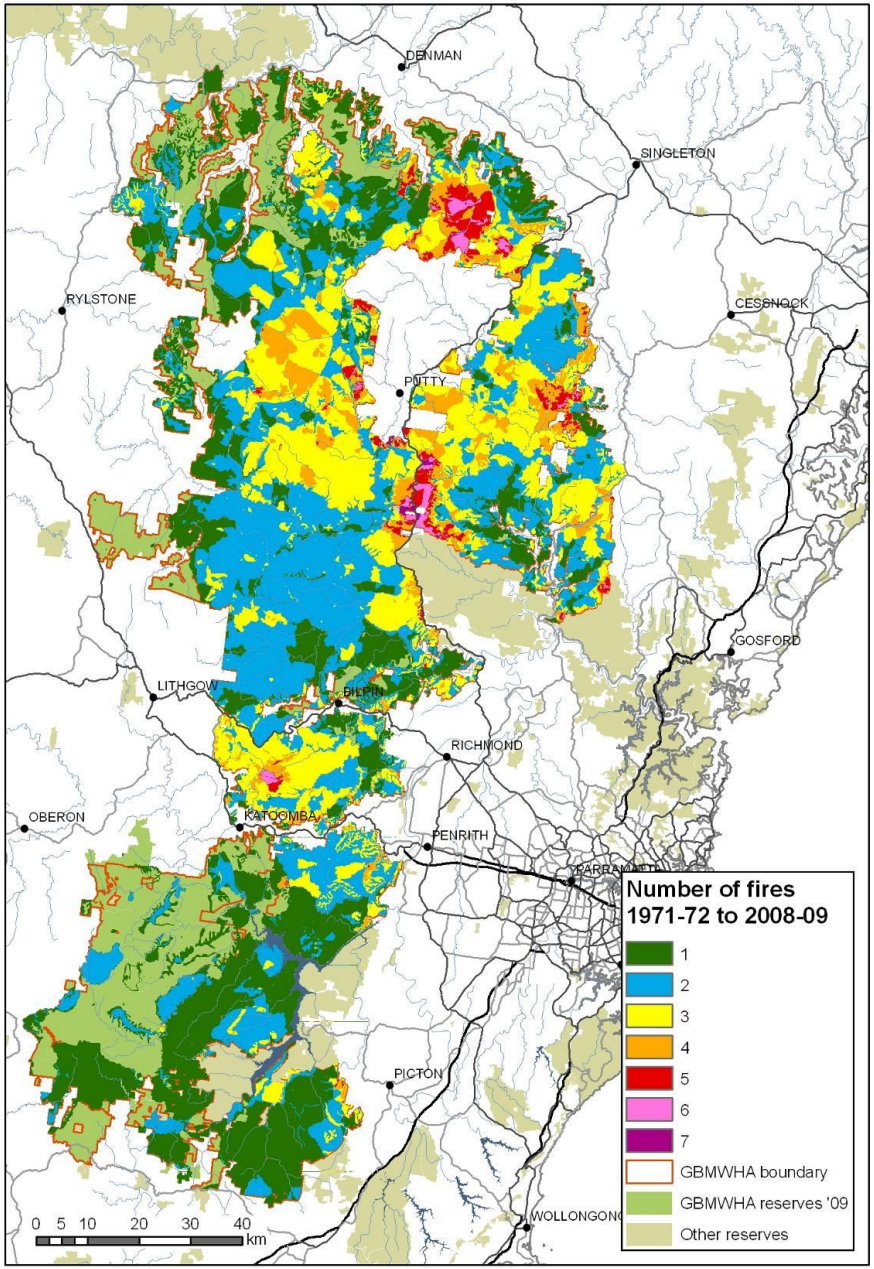


# Time Since Last Fire



# Number of Fires 1971-2009:

| | |
|---|---|
| 0 fires | 18% |
| 1 fire | 26% |
| 2 fires | 29% |
| 3 fires | 20% |
| 4 fires | 5% |
| 5 fires | 1% |
| 6 fires | 1% |
| 7 fires | 1% |

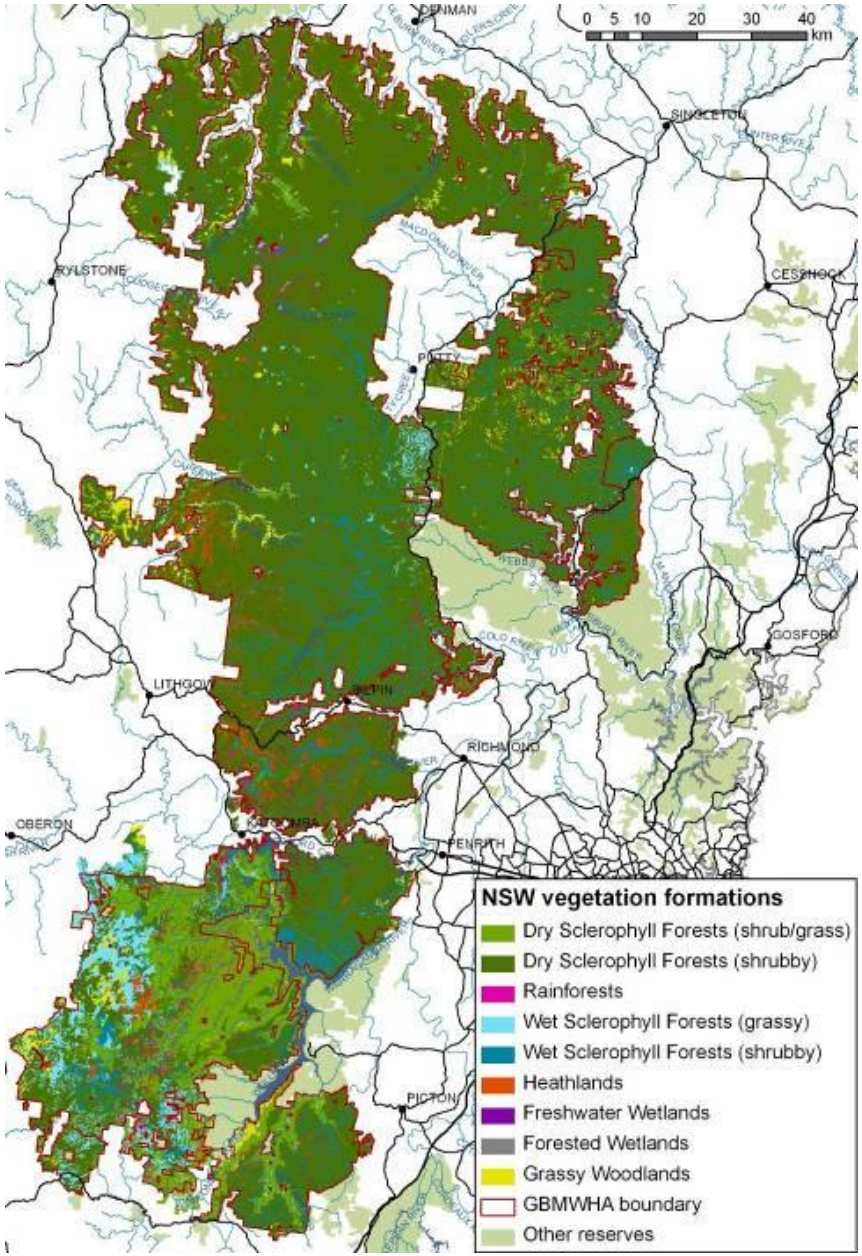


# Vegetation

590 mapped floristic communities

Eight broad vegetation types:

| | |
|---|---|
| DSF | 85% |
| WSF | 9% |
| Grassy Woodlands | 2% |
| Heathlands | 2% |
| Rainforest | 1.5% |
| Wetlands & swamps | <1% |



# Vegetation fire frequency thresholds

| | Recommended fire intervals (years) | |
|---|---|---|
| | MINIMUM | MAXIMUM |
| Wet sclerophyll forests (shrubby) | 25* | 60 |
| Wet sclerophyll forests (grassy) | 10* | 50 |
| Dry sclerophyll forests (shrubby) | 7 | 30 |
| Dry sclerophyll forests (shrub/grass) | 5 | 50 |
| Heathlands | 7 | 30 |
| Freshwater wetlands, swamps | 6 | 35 |
| Forested wetlands | 7 | 35 |
| Grassy woodlands | 5 | 40 |
| Rainforests | Fire should be avoided | |

From Kenny, Sutherland, Tasker & Bradstock (2004)

*Crown fire should be avoided in the lower end of the interval range

http://deccnet/faim/resources/NSWFRRDV1.3a.xls - Windows Internet Explorer

http://deccnet/faim/resources/NSWFRRDV1.3a.xls

File Edit View Insert Format Tools Data Go To Favorites Help

N27

| | A | D | F | H | I | J | K | L | M | N | O | P | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Species details** | **Regeneration** | | | **Fire Response References** | | **Vital Attributes** | | | **Life History** | | | |
| 2 | Species | Fire response | Seed storage | Germination cue | NFRR data | Additional fire response data | VA group | Sensitivity: frequent | Sensitivity: infrequent | Primary juvenile period | Secondary juvenile period | Recommended minimimum interval | Lifesp seedl |
| 3 | Abutilon otocarpum | S | | a-heat | 8CN | | SI | 2 | 1 | | | | |
| 4 | Abutilon oxycarpum | S | persistent soil | a-heat | 8BD | II-95b | SI | 2 | 1 | | | | 40 |
| 5 | Acacia acanthoclada | S | persistent soil | a-heat | 8C | | SI | 2 | 1 | | | | |
| 6 | Acacia acinacea | S | persistent soil | heat | 8W 8WA | II-38d | SI | 2 | 1 | 3 | | | |
| 7 | Acacia aculeatissima | S | transient | heat | | III-38d; III-67 | CI | 1 | 1 | 4 | | | |
| 8 | Acacia acuminata subsp. burkittii | R | persistent soil | heat | 9CH | | VSI | 2 | 1 | | | | |
| 9 | Acacia aneura | S r | persistent soil | heat | 8HG 8FO 8FO(1) 9FO(1) 8PL | | SI | 2 | 1 | | | | |
| 10 | Acacia aulacocarpa | R | persistent soil | heat | 9B 9HO 9RS | | VSI | 2 | 1 | | | | |
| 11 | Acacia ausfeldii | S | persistent soil | a-heat | 8CE | | SI | 2 | 1 | | | | |
| 12 | Acacia baileyana | S | persistent soil | heat | 8BF | II-38d | ST | 3 | 3 | 3 | | | 60 |
| 13 | Acacia baueri subsp. baueri | S | persistent soil | a-heat | 2BW 8B | VIII-39 | SI | 2 | 1 | 2 | | 5 | |
| 14 | Acacia betchei | S | persistent soil | a-heat | | II-100 | SI | 2 | 1 | | | | |
| 15 | Acacia binervata | S | persistent soil | heat | 2BF | VIII-35; II-105 | SI | 2 | 1 | 5 | | 10 | >50 |
| 16 | Acacia binervia | S | persistent soil | heat | 2BF | VIII-39; VIII-76; VIII-1( | SI | 2 | 1 | 2 | | | 130 |
| 17 | Acacia blakei subsp. diphylla | S | persistent soil | a-heat | | VIII-74 | SI | 2 | 1 | | | | |
| 18 | Acacia blayana | S | persistent soil | heat | | II-R35 | SI | 2 | 1 | | | | |
| 19 | Acacia brownii | R s | persistent soil | heat | 9BN | VIII&IX-39 | VSI | 2 | 1 | | | | |
| 20 | Acacia bulgaensis | S | persistent soil | a-heat | | II-66 | SI | 2 | 1 | 3-5 | | 8-10 | 70 |
| 21 | Acacia burbidgeae | S | persistent soil | heat | | II-69; II-100 | SI | 2 | 1 | | | 5 | 50 |
| 22 | Acacia buxifolia | R s | persistent soil | heat | 9P 5PU 4PU | II-69 | VSI | 2 | 1 | | 2 | | |
| 23 | Acacia buxifolia subsp. pubiflora | R | persistent soil | a-heat | | IX-100 | VSI | 2 | 1 | | | | |
| 24 | Acacia calamifolia | S | persistent soil | heat | 8CH | | SI | 2 | 1 | | | | |
| 25 | Acacia calcicola | S | persistent soil | a-heat | 8PL | | SI | 2 | 1 | | | | |
| 26 | Acacia capitata | S | persistent soil | a-heat | | II-66 | E | 5 | 5 | | | | |
| 27 | Acacia cheelii | S | persistent soil | a-heat | | II-66 | SI | 2 | 1 | | | | |
| 28 | Acacia chrysotricha | S | persistent soil | heat | | II-R36 | SI | 2 | 1 | | | | |
| 29 | Acacia cognata | R | persistent soil | a-heat | | V-38a | VSI | 2 | 1 | | | | |
| 30 | Acacia colletioides | S | persistent soil | heat | 8C | | SI | 2 | 1 | | | | |
| 31 | Acacia constablei | S | persistent soil | a-heat | | II-R15; II-R35 | SI | 2 | 1 | | | 15 | 35 |
| 32 | Acacia costiniana | S | persistent soil | heat | | II-R35 | SI | 2 | 1 | | | | |
| 33 | Acacia courtii | S | persistent soil | a-heat | | II-R36 | SI | 2 | 1 | | | | |
| 34 | Acacia cowleana | S | persistent soil | heat | 8WI ~~8FO(1)~~ 8PL | | SI | 2 | 1 | | | | |
| 35 | Acacia curranii | R | persistent soil | | | IV-72 | VSI | 2 | 1 | | | | |

ReadMe / SpeciesData / References / Notes / VA Groups

Unknown Zone

start | Inbox - Microsoft Out... | Tasker_FMOconferen... | CorinnaFRDB_briefin... | 2010_BlueMtnsComm... | http://deccnet/faim/r... | 8:12 PM

# How are MIN and MAX fire intervals set?

- MINIMUM interval determined by the slowest-maturing species that are killed by fire and depend on seed to regenerate

  **= maximum time to maturity of species sensitive to frequent fire**

- MAXIMUM interval is determined by the shortest-lived of the species that need fire to germinate, flower or release seed

  **= minimum time to extinction for species sensitive to infrequent fire**

- This is determined for each broad vegetation formation (i.e. rainforest, WSF, DSF…) using knowledge about the species that occur in each

# How do we apply the thresholds?

- GIS calculation of actual fire frequency from mapped fires for all parks
- Overlay with a vegetation map
- GIS comparison of fire frequency against minimum and maximum thresholds per vegetation type
- Generates a map of “too frequently burnt”, within threshold” and “long unburnt” areas

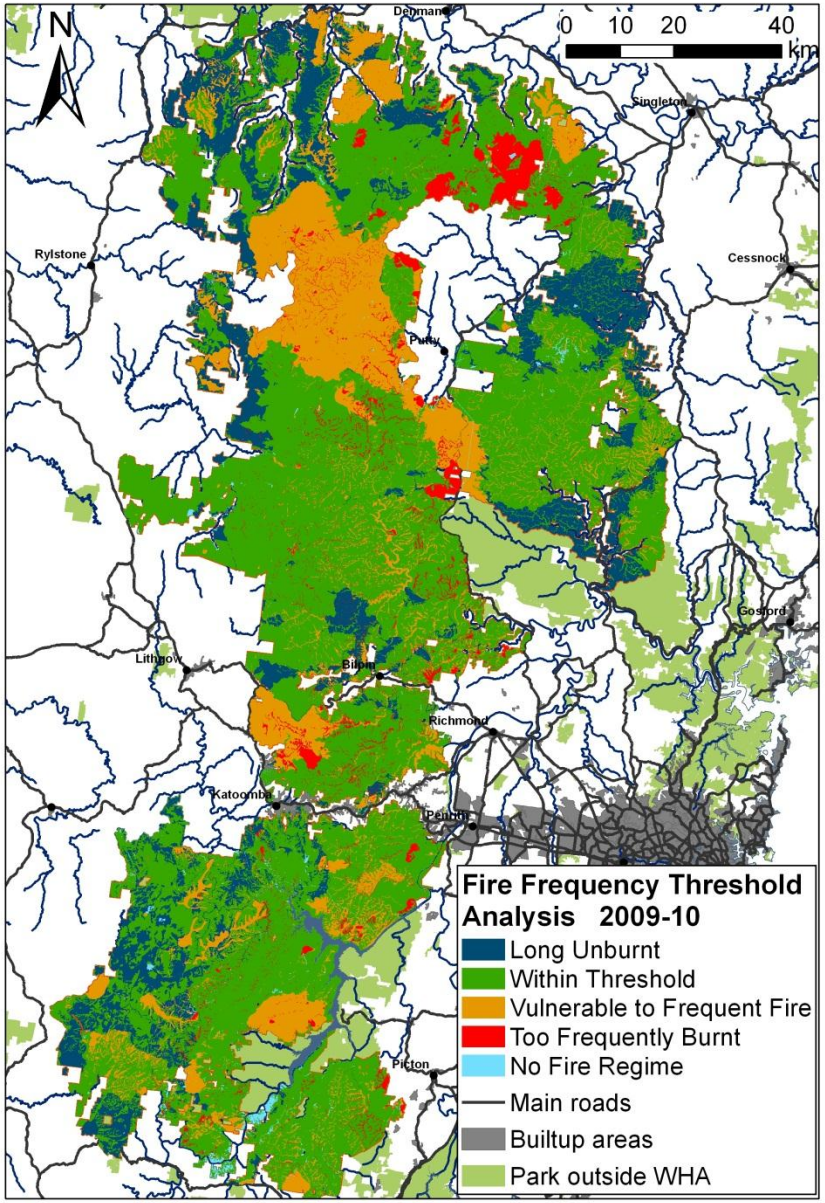
# Fire frequency thresholds

| CATEGORY | % of GBMWHA |
|---|---|
| "Long Unburnt" | 20% |
| "Within Threshold" | 56% |
| "Within Threshold but Vulnerable" | 20% |
| "Too Frequently Burnt" | 4% |

**Long Unburnt**
One or more fire intervals longer than longest suggested interval

**Within Threshold but Vulnerable**
One recent fire interval shorter than suggested shortest interval

**Too Frequently Burnt** Fire intervals repeatedly shorter than suggested shortest interval



# Fire Severity

Govetts Creek from Banks Walls, 2006

# Fire intensity

- Amount of heat energy released by a fire

# Fire severity

- The loss of (or change in) organic matter above- and below-ground resulting from the fire
- Can be used post-fire to estimate intensity

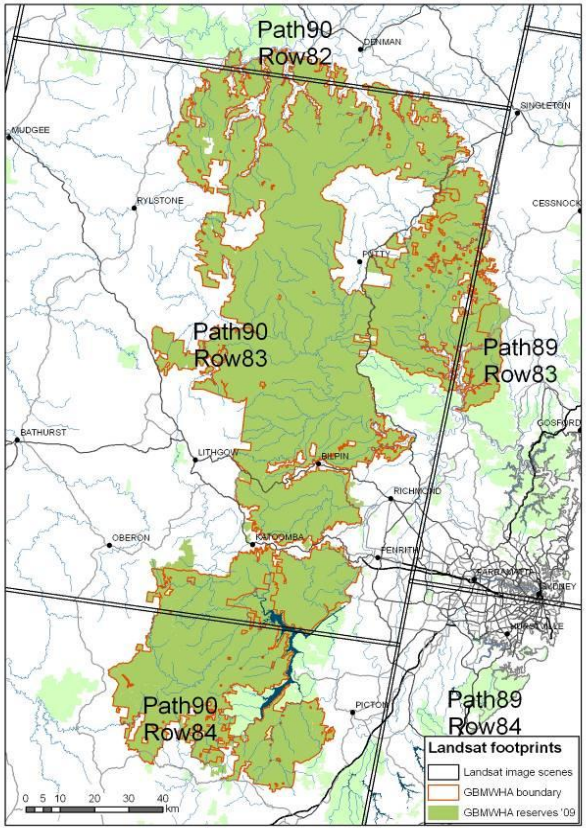
# High intensity fire

- ↑ loss of biomass
- ↑ immediate mortality of plants, animals
- ↓ recovery for some species ↑ for others
- ↑ germination rates of soil seedbanks
- ↑ or ↓ nutrient levels
- ↑ tree fall
- ↑ production of tree hollows
- ↓ fuel accumulation
- ↑ erosion potential

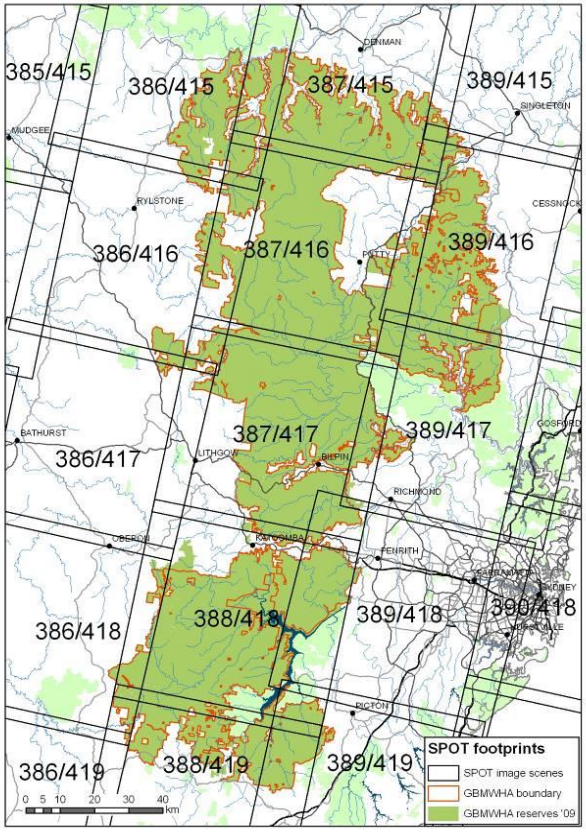
Photo: Ian Brown

Grass-trees

# Obtain satellite images




**Landsat**

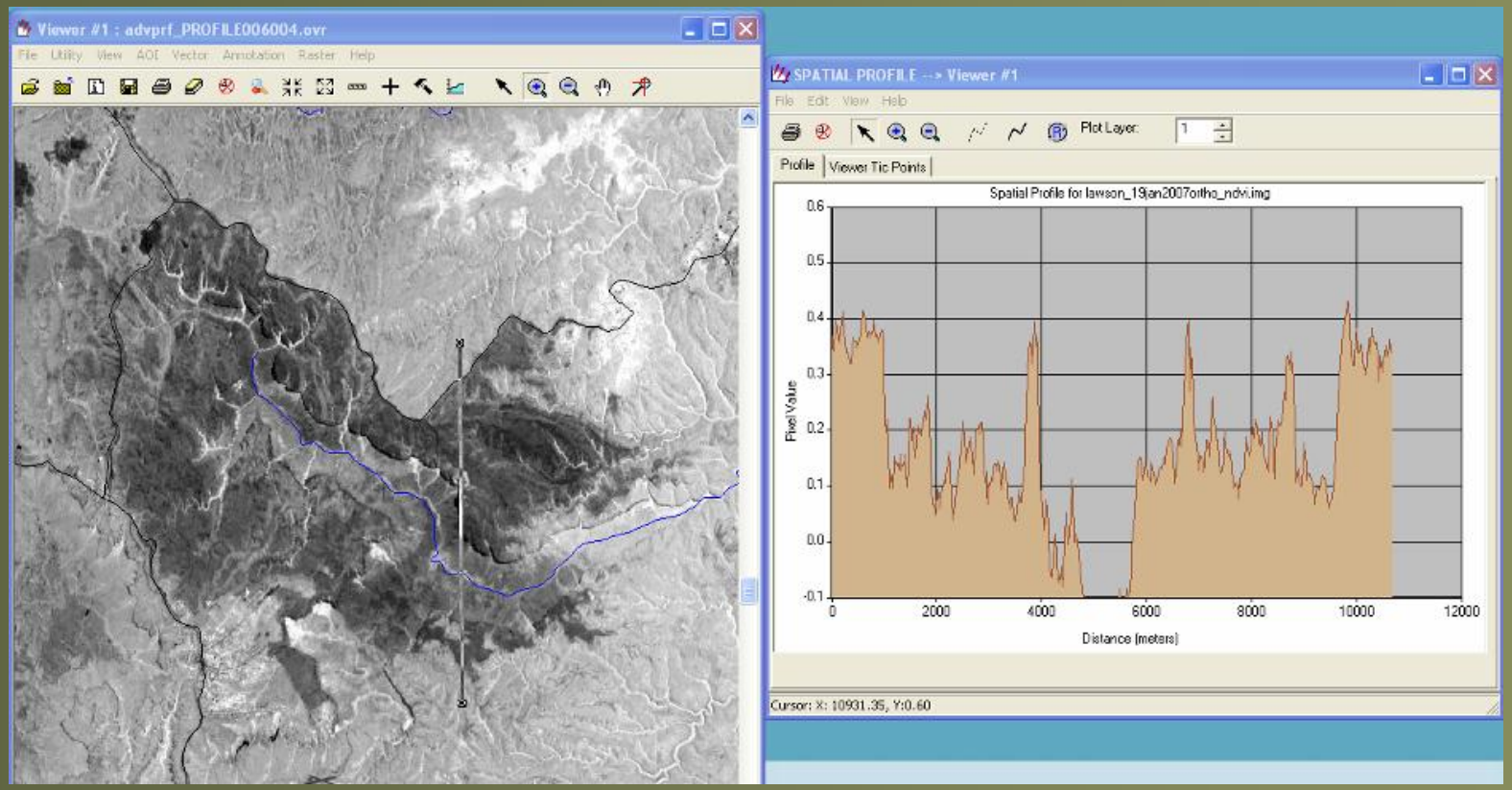



**SPOT**

Pre- and post-fire images preferable, close in time to the fire preferable

## Ratio between wavelengths shows greenness

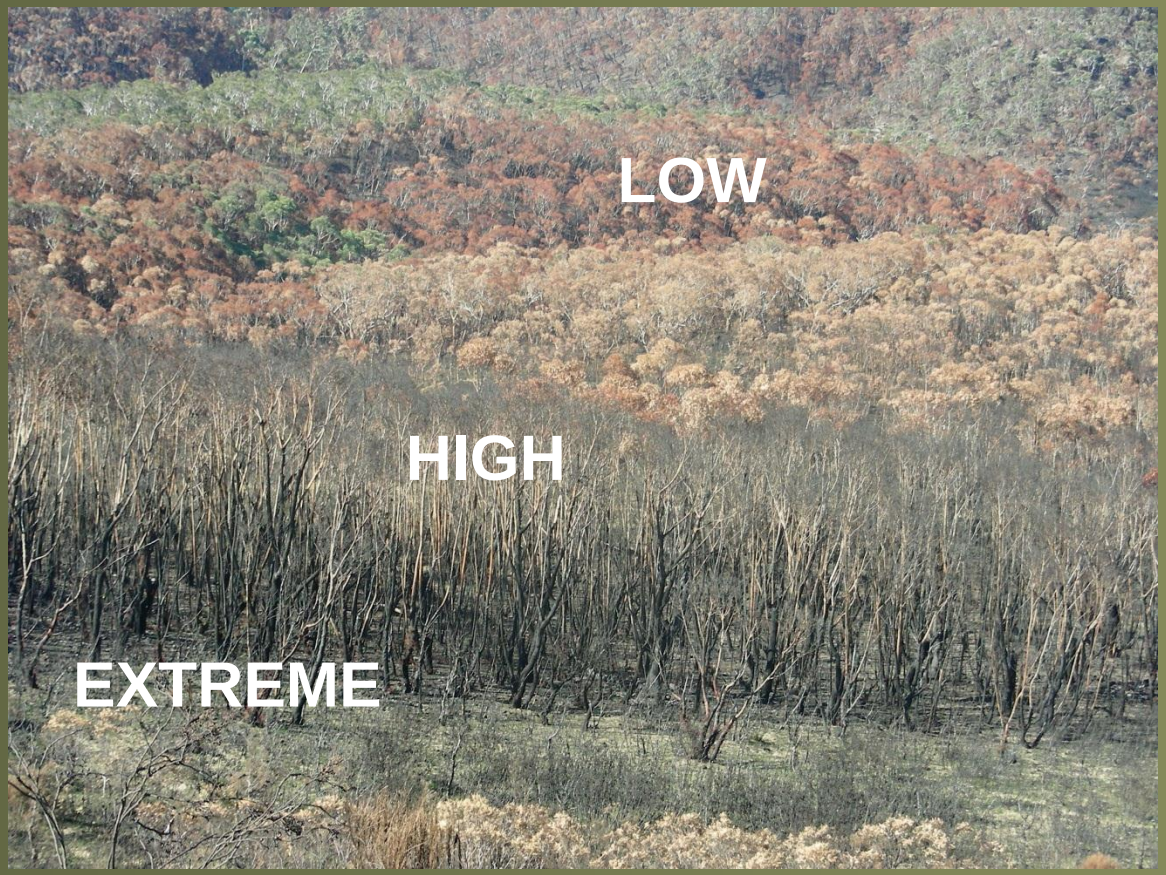
## Change in ratio pre-/post-fire shows change



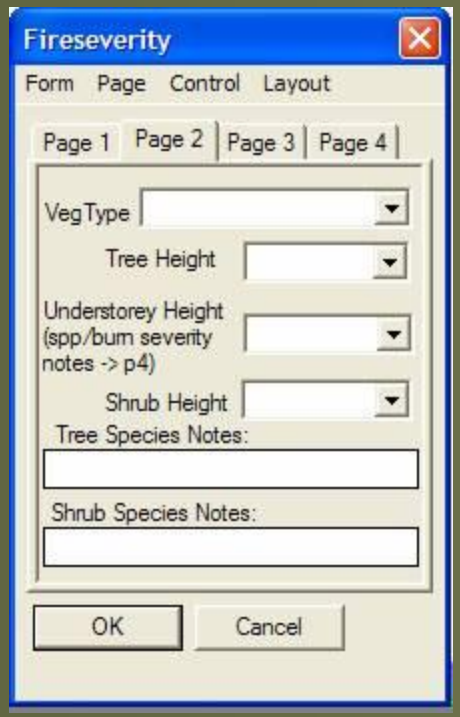

**2007 fire, SPOT NDVI, Lawsons Long Alley Fire, burnt areas dark in image, lower values in histogram**

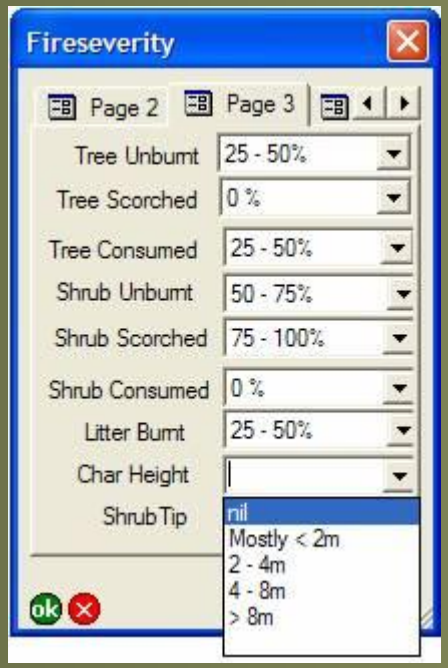
**NDVI** (Normalised Difference Vegetation Index) – visible red & near infra-red bands (Landsat & SPOT)
**NBR** (Normalised Burn Ratio) – near infra-red & far infra-red bands (Landsat only). Can penetrate light smoke/cloud .

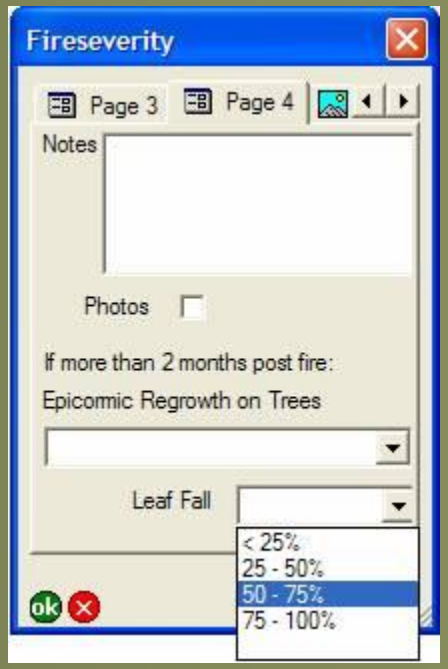
# Field assessment of severity…



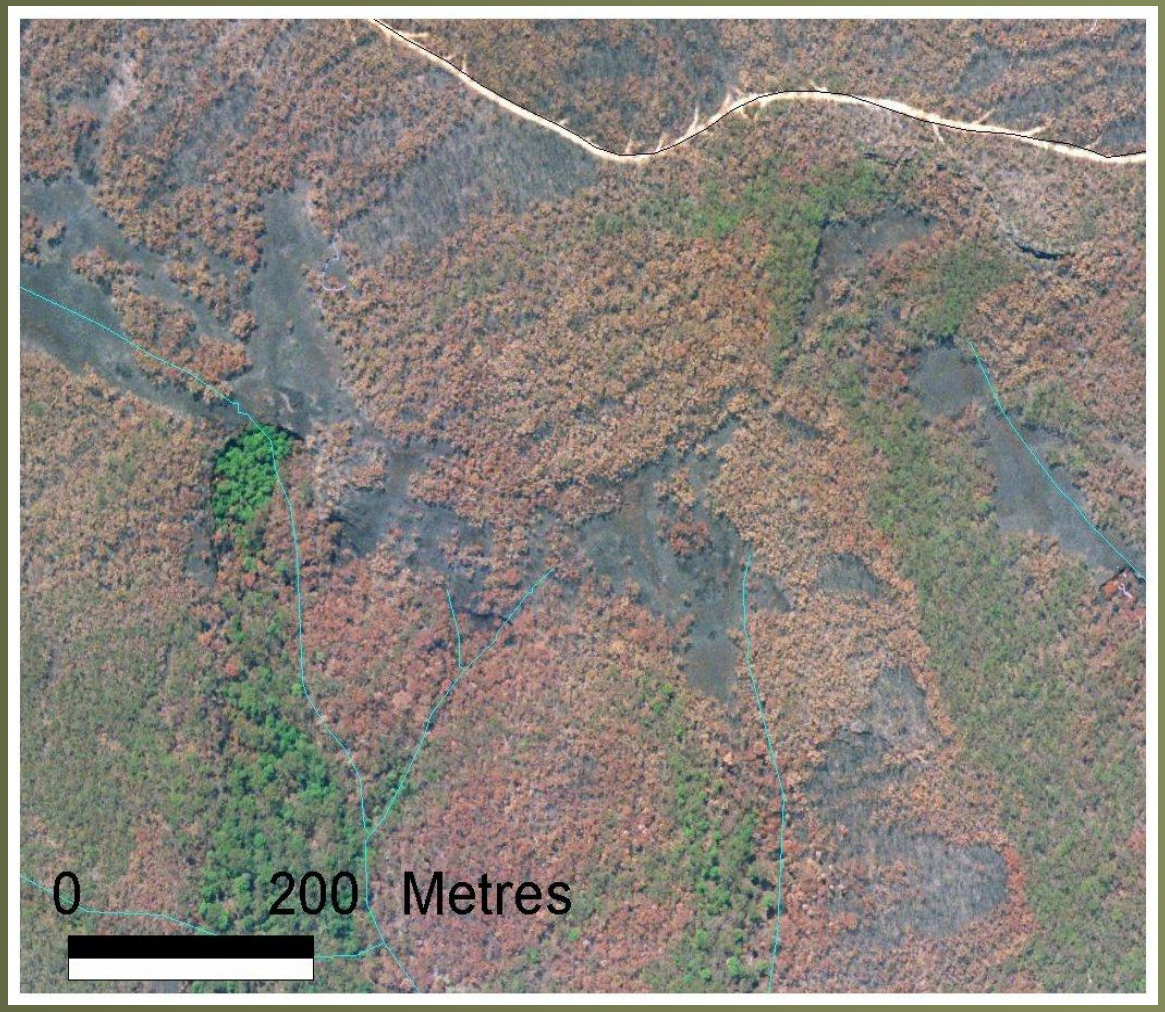

→ GPS the locations of field points with known severities


Fireseverity
Form Page Control Layout
Page 1 Page 2 Page 3 Page 4
VegType
Tree Height
Understorey Height (spp/burn severity notes -> p4)
Shrub Height
Tree Species Notes:
Shrub Species Notes:
OK
Cancel


Fireseverity
Page 2 Page 3
Tree Unburnt 25 - 50%
Tree Scorched 0 %
Tree Consumed 25 - 50%
Shrub Unburnt 50 - 75%
Shrub Scorched 75 - 100%
Shrub Consumed 0 %
Litter Burnt 25 - 50%
Char Height
Shrub Tip
nil
Mostly < 2m
2 - 4m
4 - 8m
> 8m
ok


Fireseverity
Page 3 Page 4
Notes
Photos
If more than 2 months post fire:
Epicormic Regrowth on Trees
Leaf Fall
< 25%
25 - 50%
50 - 75%
75 - 100%
ok

# …or aerial photo assessment for older fires



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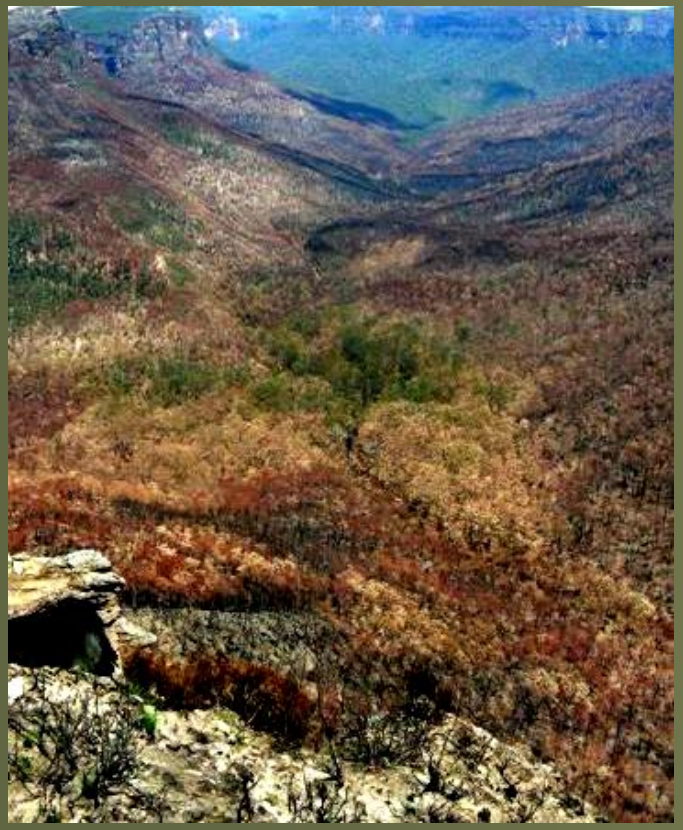
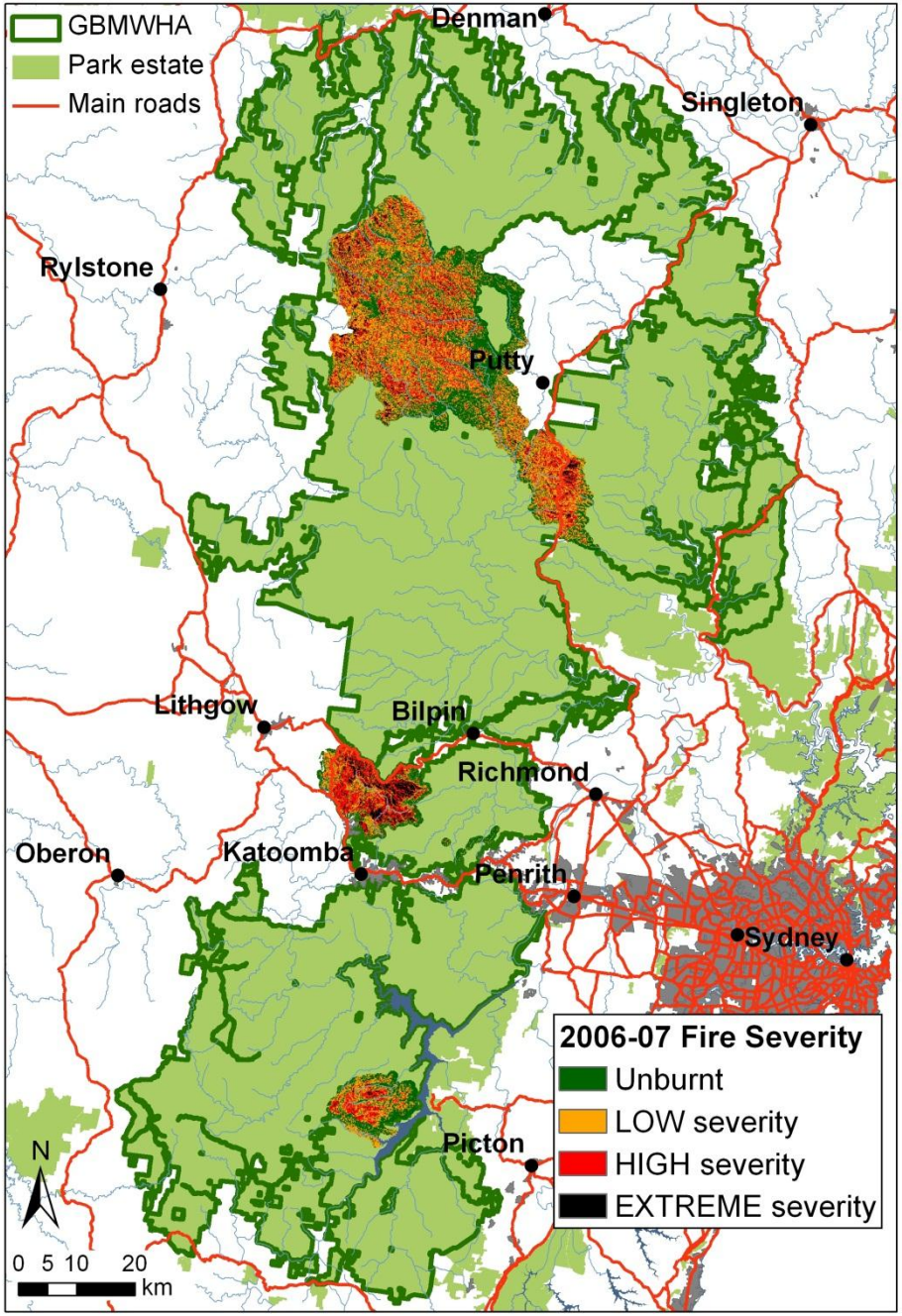
# 2006-07

## Landsat
## single post-fire image



Post-fire in the Grose Valley



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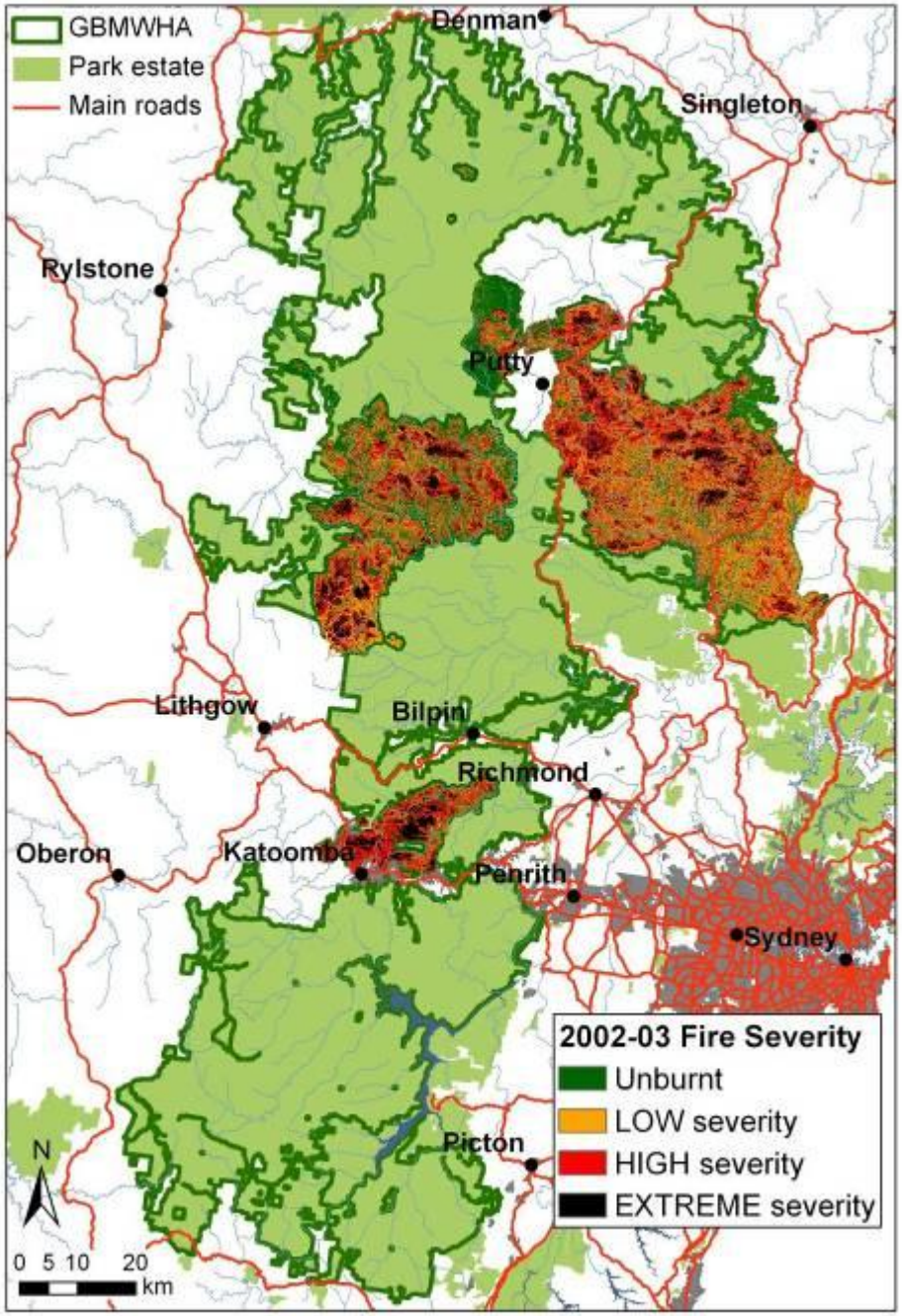
# 2002-03

## Landsat
## pre- post-comparison



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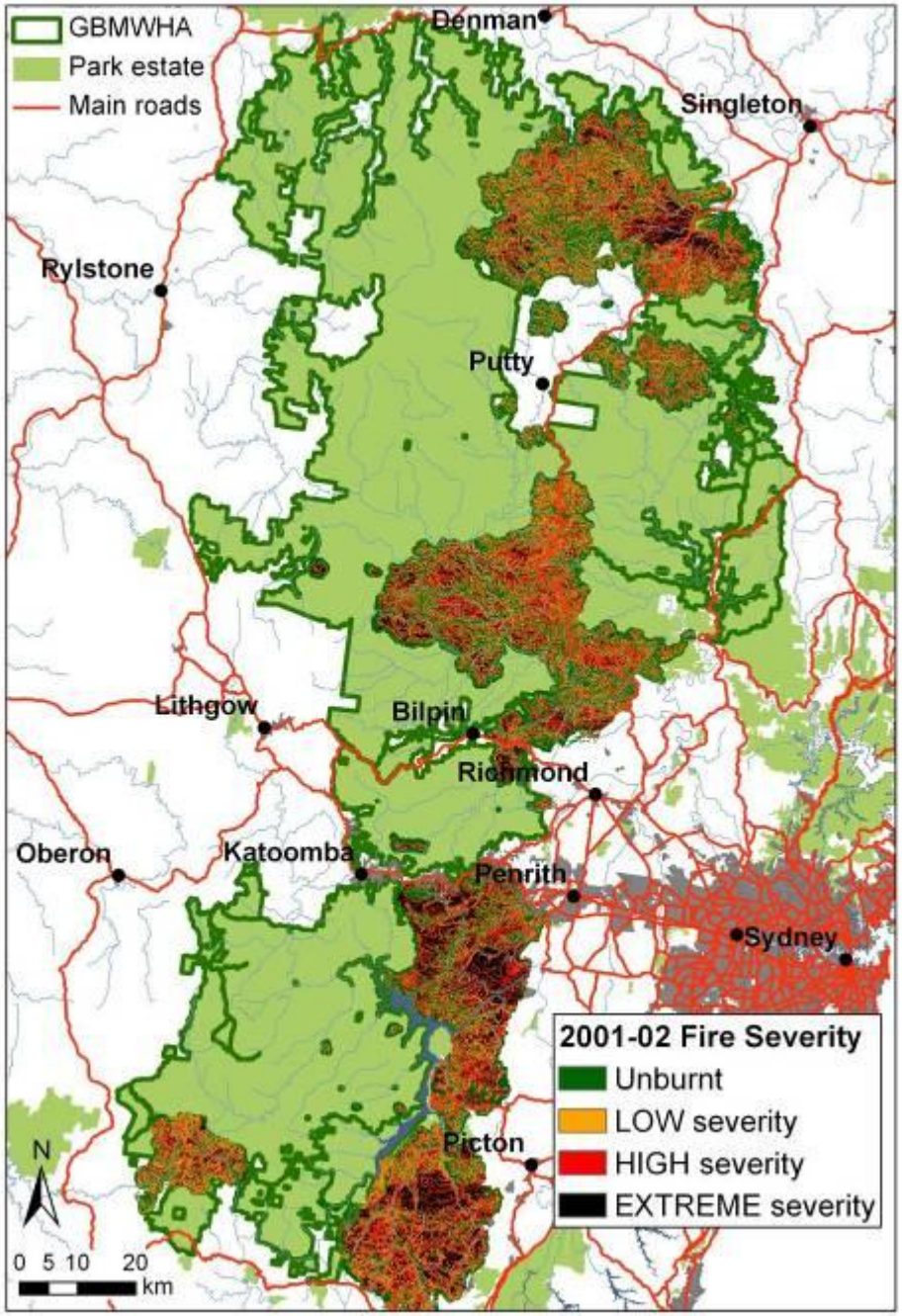
# 2001-02

**Landsat**
**pre- post-comparison**
**(+ single post-fire SPOT)**

**‘Low’**
**canopy unburnt**

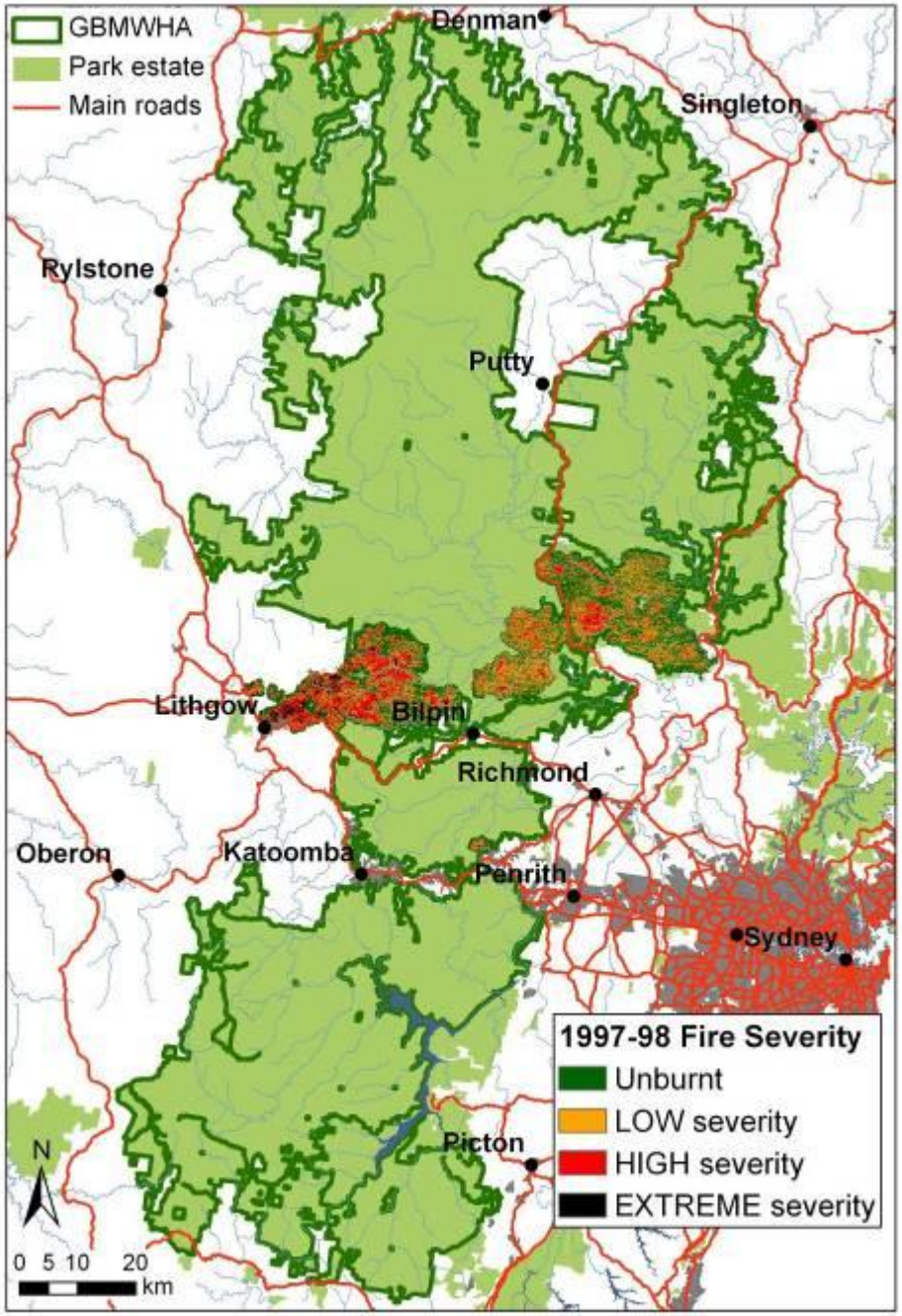
**‘High’**
**complete scorch**



Office of Environment & Heritage

# 1997-98

Landsat
single post-fire image



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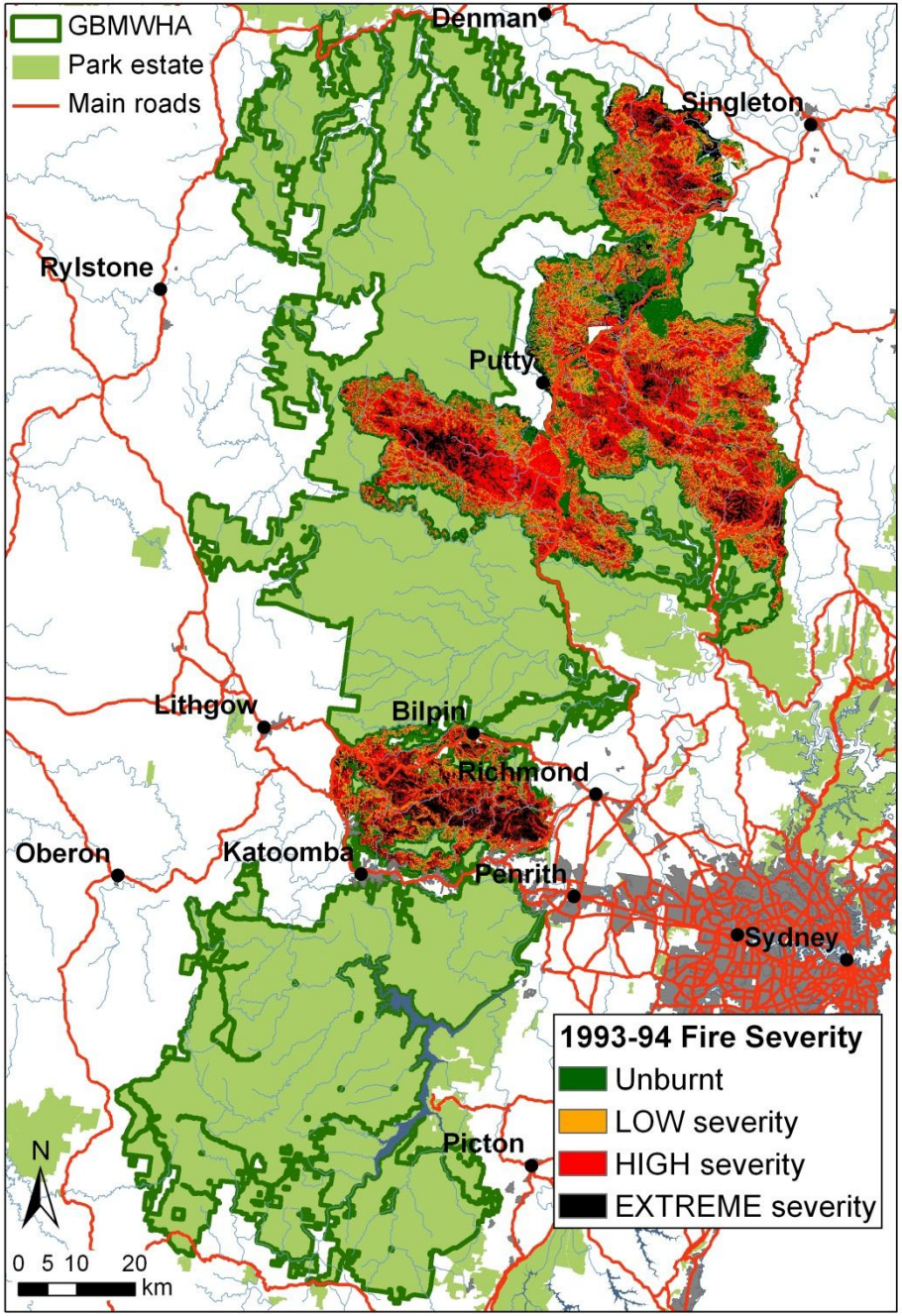
# 1993-94

## Landsat
## single post-fire image



# Comparison of Methods (1)

**LANDSAT**

- Cheaper (~$1,700)
- Available retrospectively
- 185 x 185 km scenes
- Multiple infra-red bands penetrate smoke (NBR)
- Lower resolution (30m)
- Less frequent (16 days)

**SPOT**

- More expensive ($2,500+)
- Imagery not archived
- 60 x 60 km scenes
- Cannot penetrate smoke
- Better resolution (10m)
- Frequent capture (2-3 days)

NDVI = ratio of visible red and near infra-red bands
NBR = ratio of near infra-red and far infra-red bands

# Comparison of Methods (2)

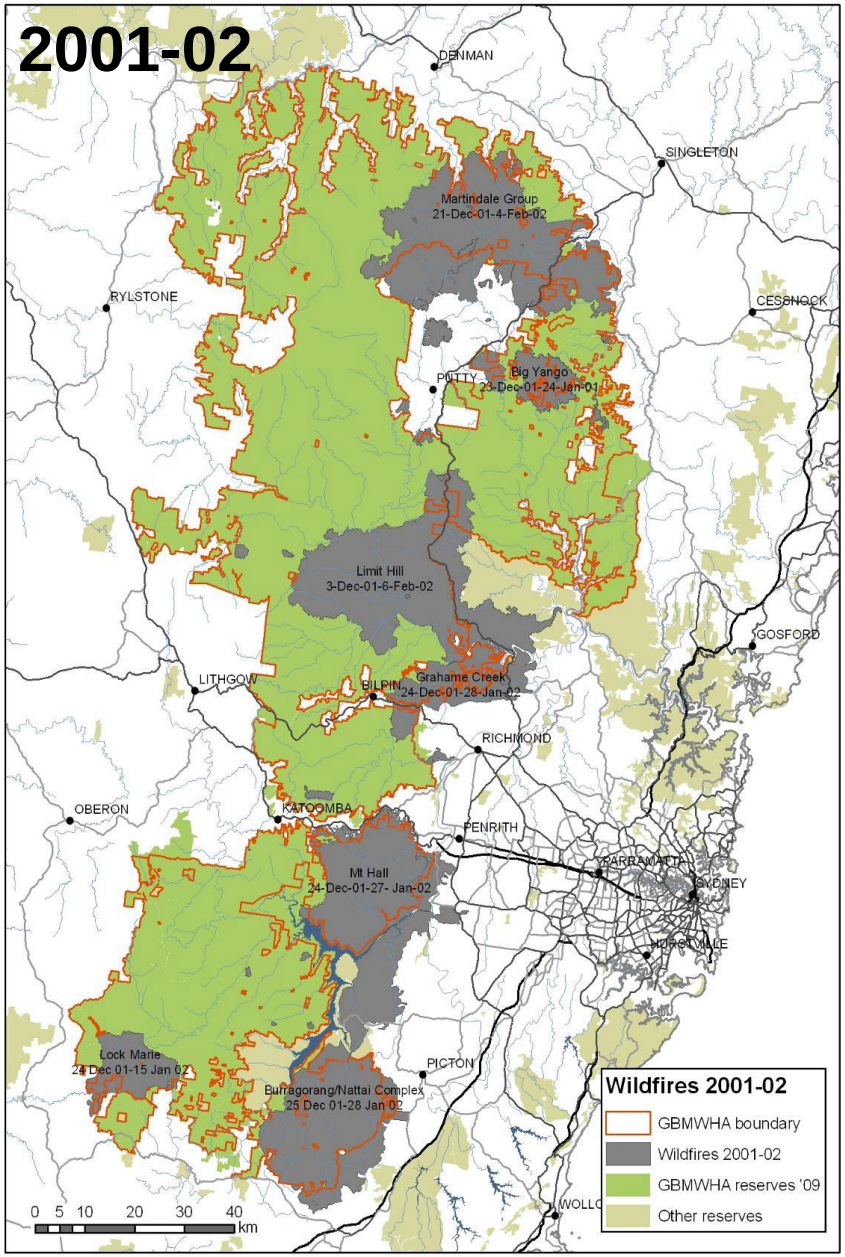
**PRE-/POST-COMPARISON**

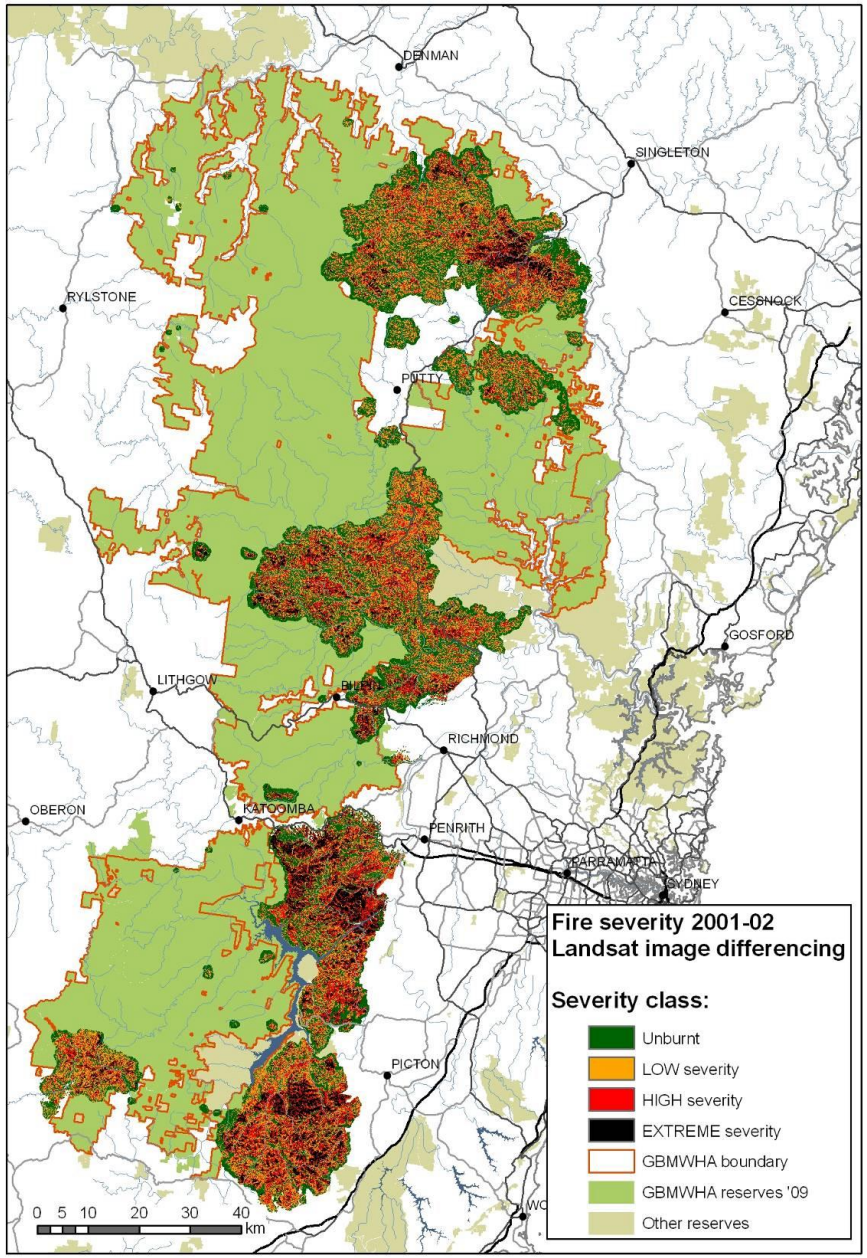
- Less sensitive to vegetation type
- Less sensitive to date of image capture

**SINGLE POST-FIRE IMAGE**

- Confounded by differences in vegetation
- Must be supplemented with a good vegetation map
- More sensitive to date of image capture

# 2001-02


DENMAN
SINGLETON
Martindale Group
21-Dec-01-4-Feb-02
RYLSTONE
CESSNOCK
PUTTY
Big Yango
23-Dec-01-24-Jan-01
Limit Hill
3-Dec-01-6-Feb-02
GOSFORD
LITHGOW
BILPIN
Grahame Creek
24-Dec-01-28-Jan-02
RICHMOND
OBERON
KATOOMBA
PENRITH
PARRAMATTA
SYDNEY
Mt Hall
24-Dec-01-27- Jan-02
HORNSBY
Lock Marie
24 Dec 01-15 Jan 02
PICTON
Bufragorang/Nattai Complex
25 Dec 01-28 Jan 02
Wildfires 2001-02
GBMWHA boundary
Wildfires 2001-02
GBMWHA reserves '09
Other reserves
0 5 10 20 30 40
km


DENMAN
SINGLETON
RYLSTONE
CESSNOCK
PUTTY
GOSFORD
LITHGOW
RICHMOND
OBERON
KATOOMBA
PENRITH
PARRAMATTA
SYDNEY
PICTON
Fire severity 2001-02
Landsat image differencing
Severity class:
Unburnt
LOW severity
HIGH severity
EXTREME severity
GBMWHA boundary
GBMWHA reserves '09
Other reserves
0 5 10 20 30 40
km

# Fire History now being used for:

- Fuel accumulation rate modelling
- Soil carbon modelling
- Testing impacts of repeated high-intensity fires on plant diversity & ‘sensitive’ vegetation types
- Testing impacts of varying fire frequencies on plant diversity

# Summary

- One of the longest comprehensive fire histories available in Australia
- Being used by multiple research projects to test ideas about fuels, repeated fire impacts, climate change and biodiversity
- Being used by fire managers for planning

# Acknowledgments

- NPWS Blue Mountains Region staff, especially Saskia Hayes, Glenn Meade and Jacqueline Reid
- Dept of Environment, Water, Heritage & Arts, Dept of Agriculture, Fisheries & Forestry World Heritage Management Program

Blue Gum forest, Grose Valley soon after Nov 2006 fire