Impact of gamba invasion on fire, fire danger & cost of fire management

Assoc Prof. Samantha Setterfield &
Dr Natalie Rossiter-Rachor,

in collaboration with Bushfires NT, BOM, and NRETAS Weed Management Branch

Based on the journal paper at
http://dx.plos.org/10.1371/journal.pone.0059144

Charles Darwin UNIVERSITY
Innovation in Education

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

Overview

- What is gamba grass?
- Where is it?
- How does it alter fuel and fire characteristics?
- What are the resulting impacts on:
  - Tree cover
  - Grassland Fire Danger Index (GFDI)?
  - Cost of fire management

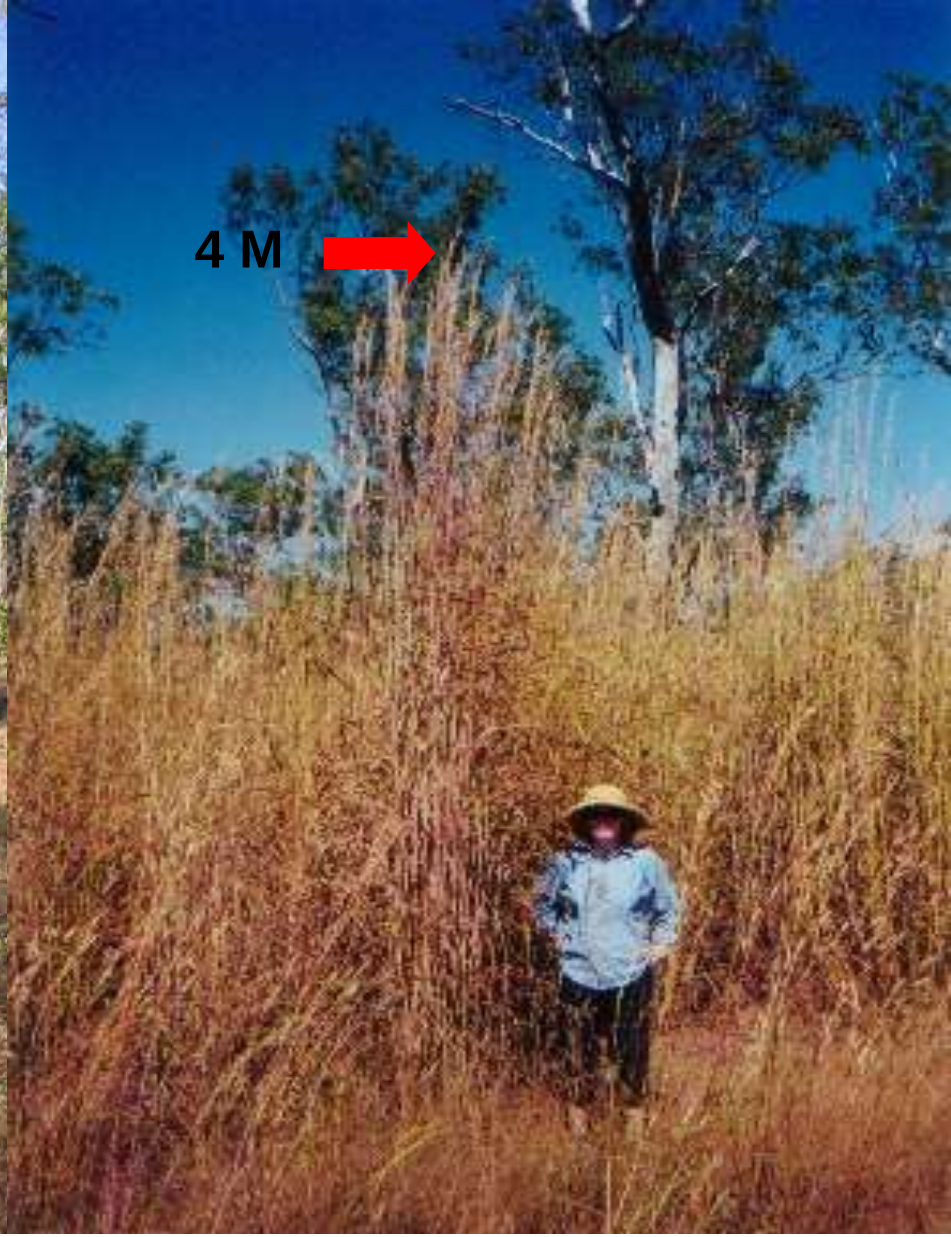
Gamba grass (*Andropogon gayanus*)

- Vigorous perennial tussock grass (grows up to 4 m)
- Introduced from Africa as a pasture species
- Declared noxious weed in all northern states in 2008
- Declared a WONS in 2012
- Now widely distributed in native savannas
  - Mary River National Park
  - Litchfield National Park
  - Coomalie Shire

Gamba is highly invasive

- Produces lots of seed (70,000 seeds m^{-2})
- Establishes in range of habitats
  - Unburnt/burnt savanna
  - Floodplain margins
- Superior competitor for resources
  - Light, water, nutrients
- Spreads rapidly
  - "Natural" (Wind, water, feral animals)
  - Anthropogenic (road & transport corridors, hay)

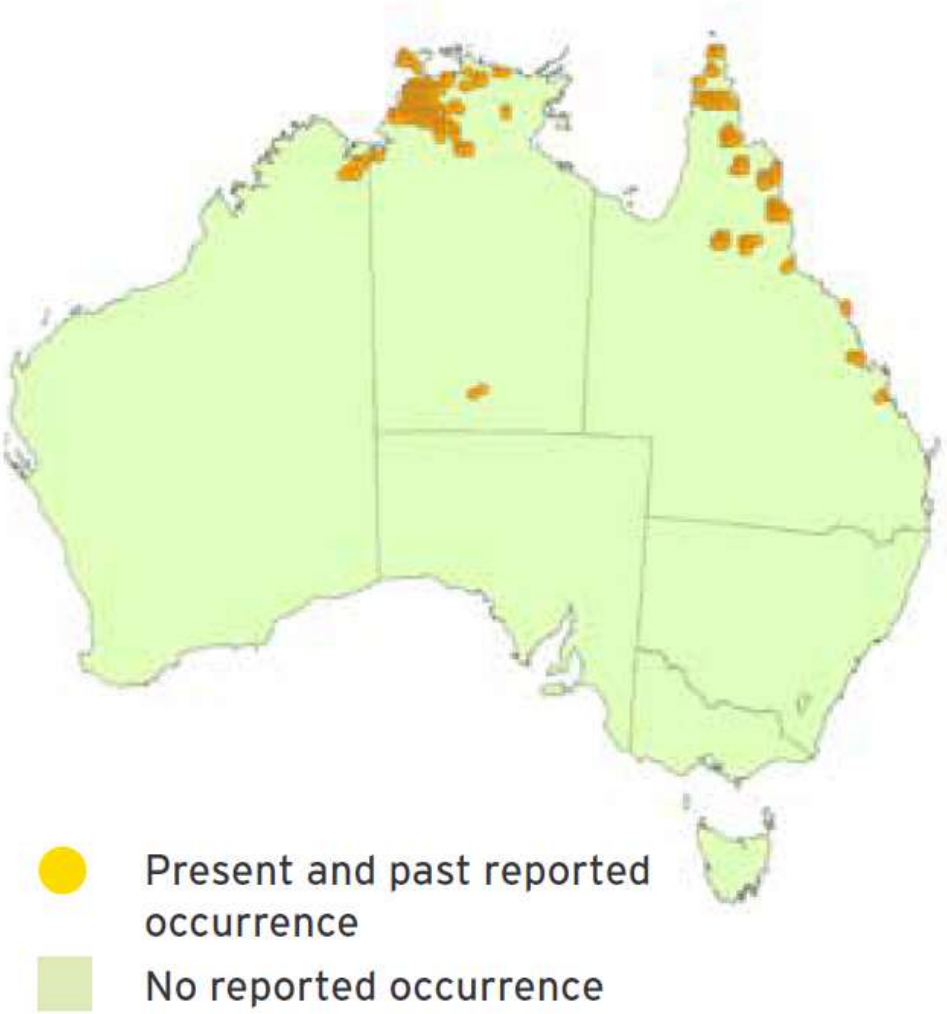
Gamba invasion in Litchfield NP



Native grass

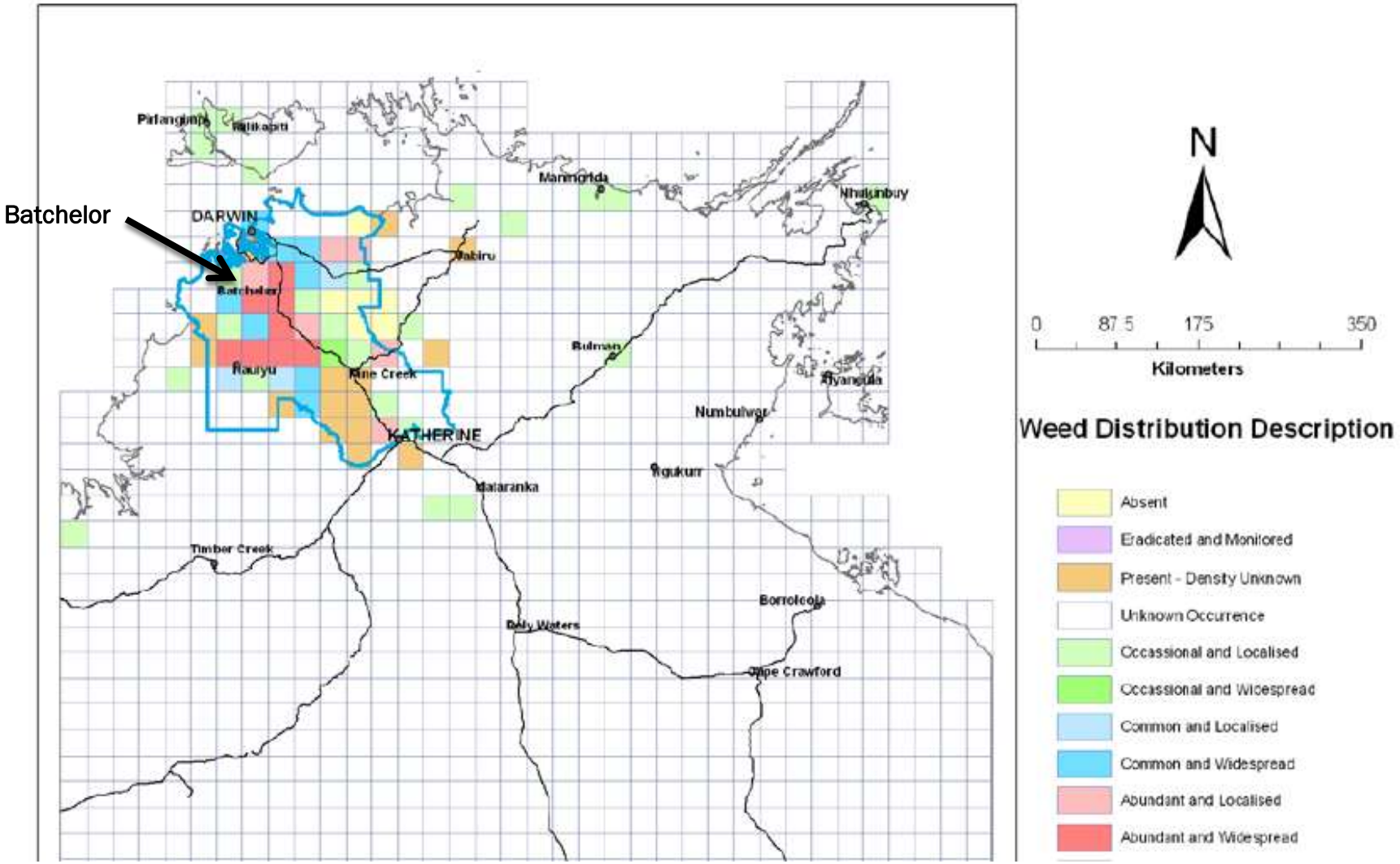
Gamba grass

Current distribution of gamba grass



Source: Weeds Australia 2013

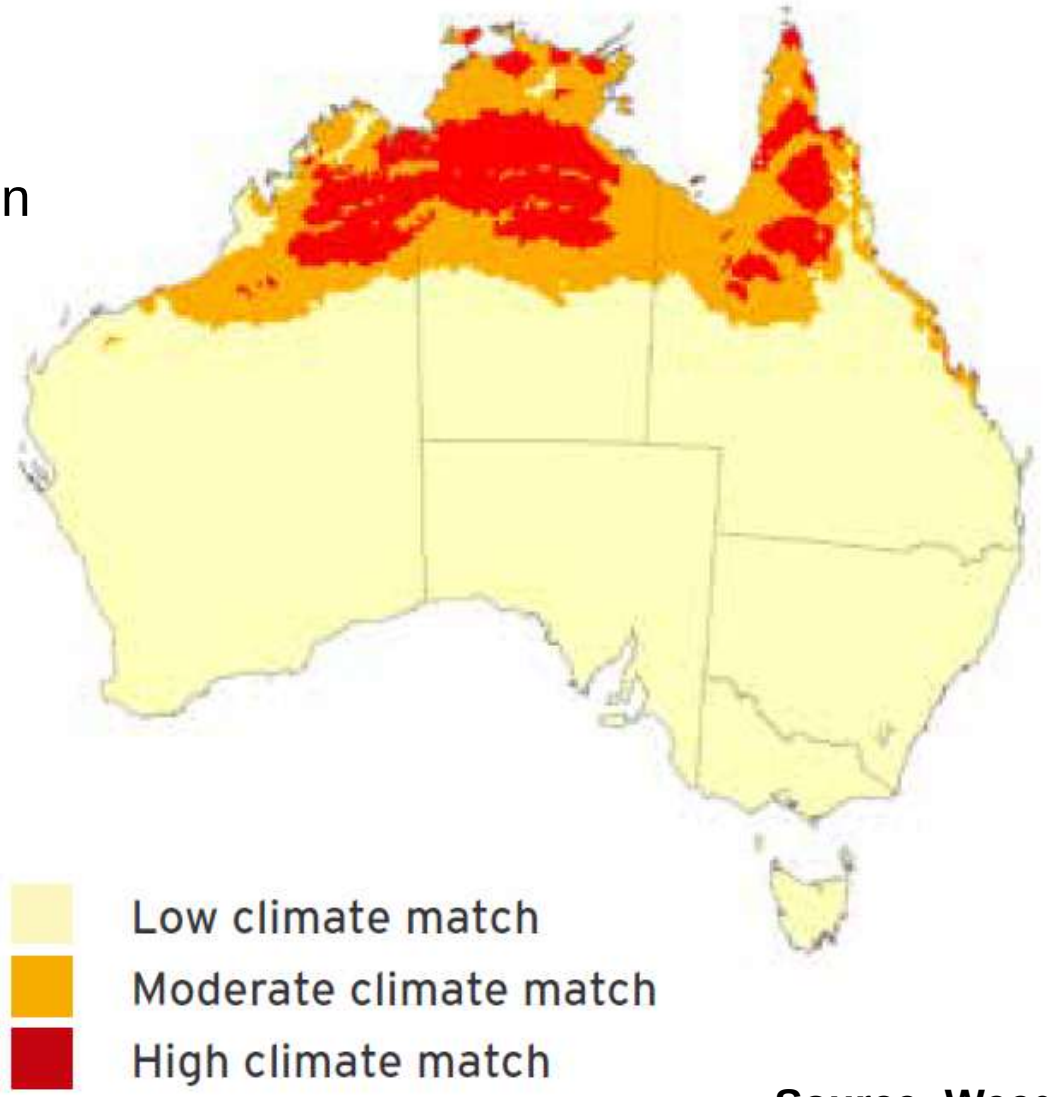
Current distribution of gamba grass in NT



Source NRETAS 2013

Potential distribution of gamba grass

Only in early stages of invasion

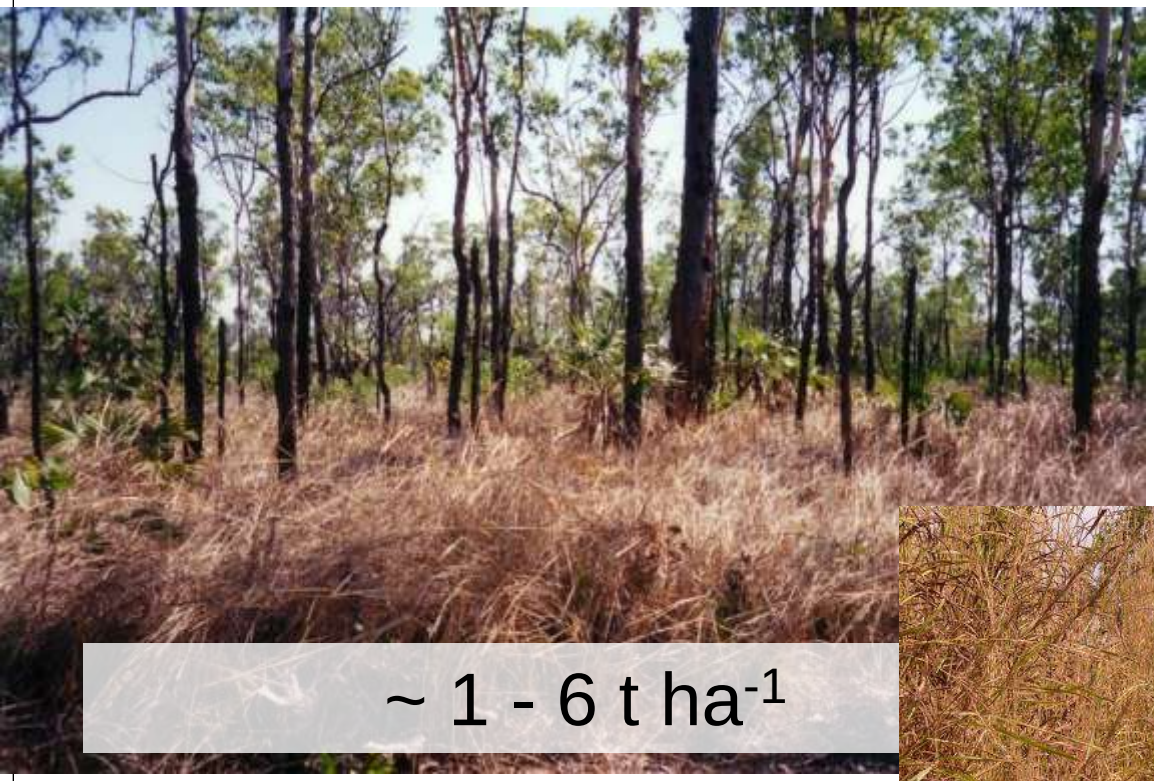


Source: Weeds Australia 2013

Gamba alters fuel & fire characteristics

- Dense, continuous stands
- Higher biomass
- Grows later into dry season
- Taller fuel (remains upright)
- Higher fire intensity

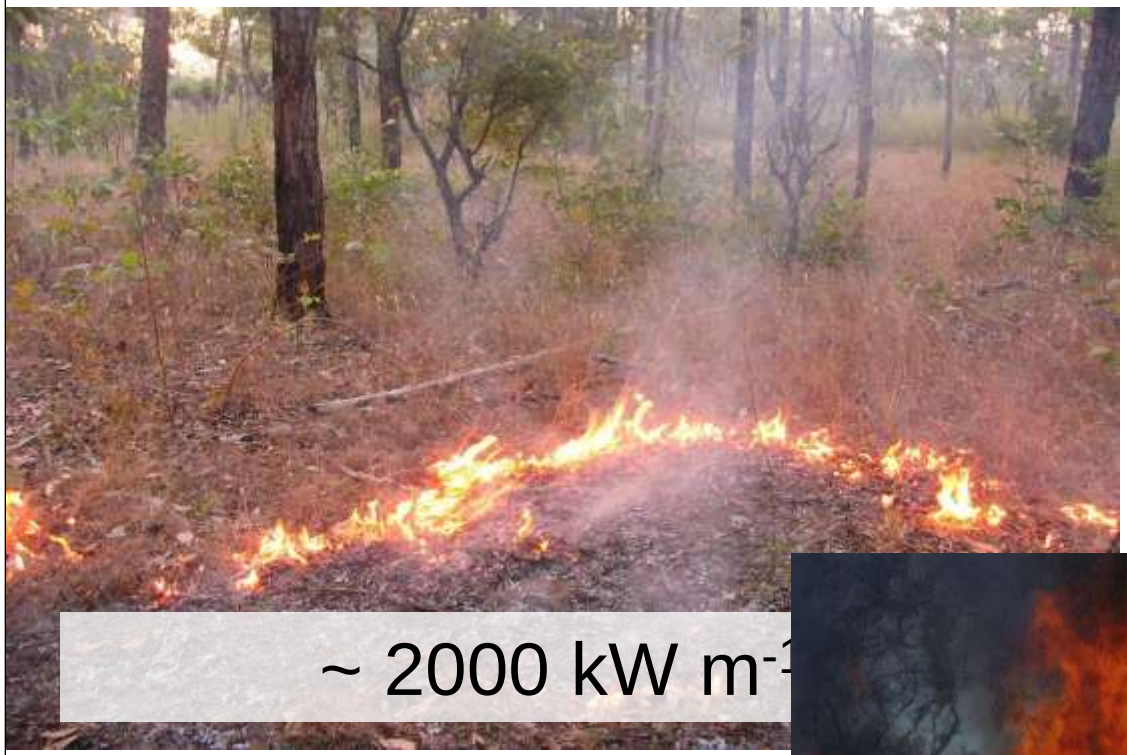
Gamba increases fuel loads



~ 1 - 6 t ha^{-1}

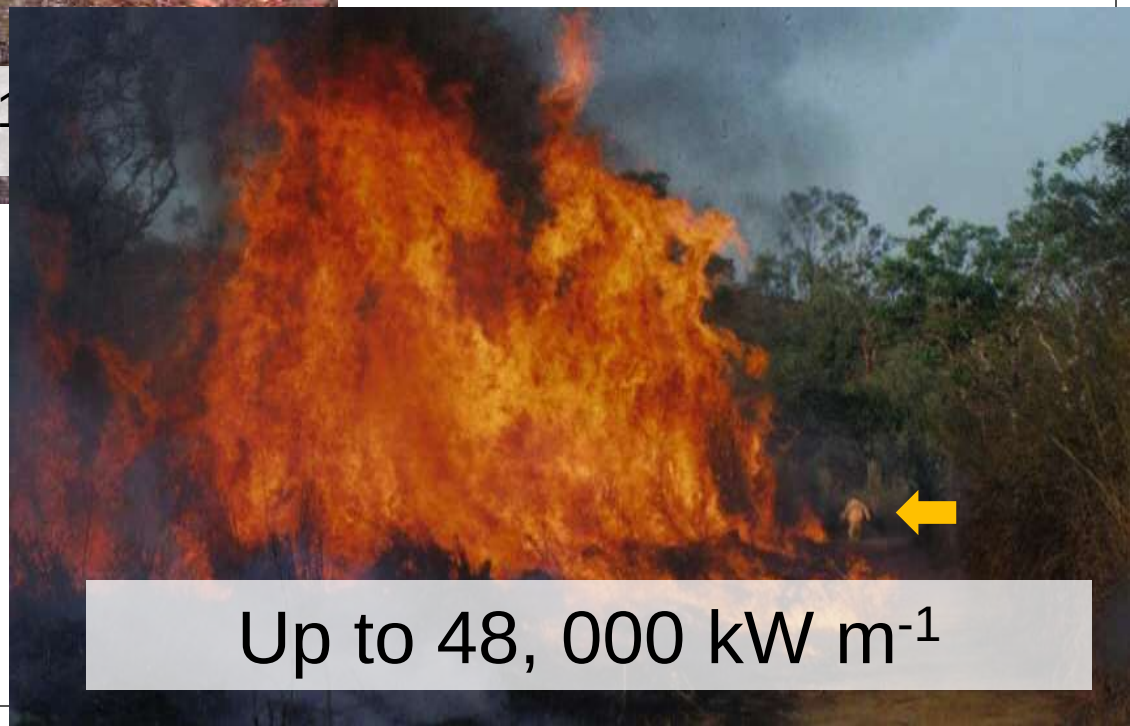
Up to 30 t ha^{-1}

Gamba increases fire intensity



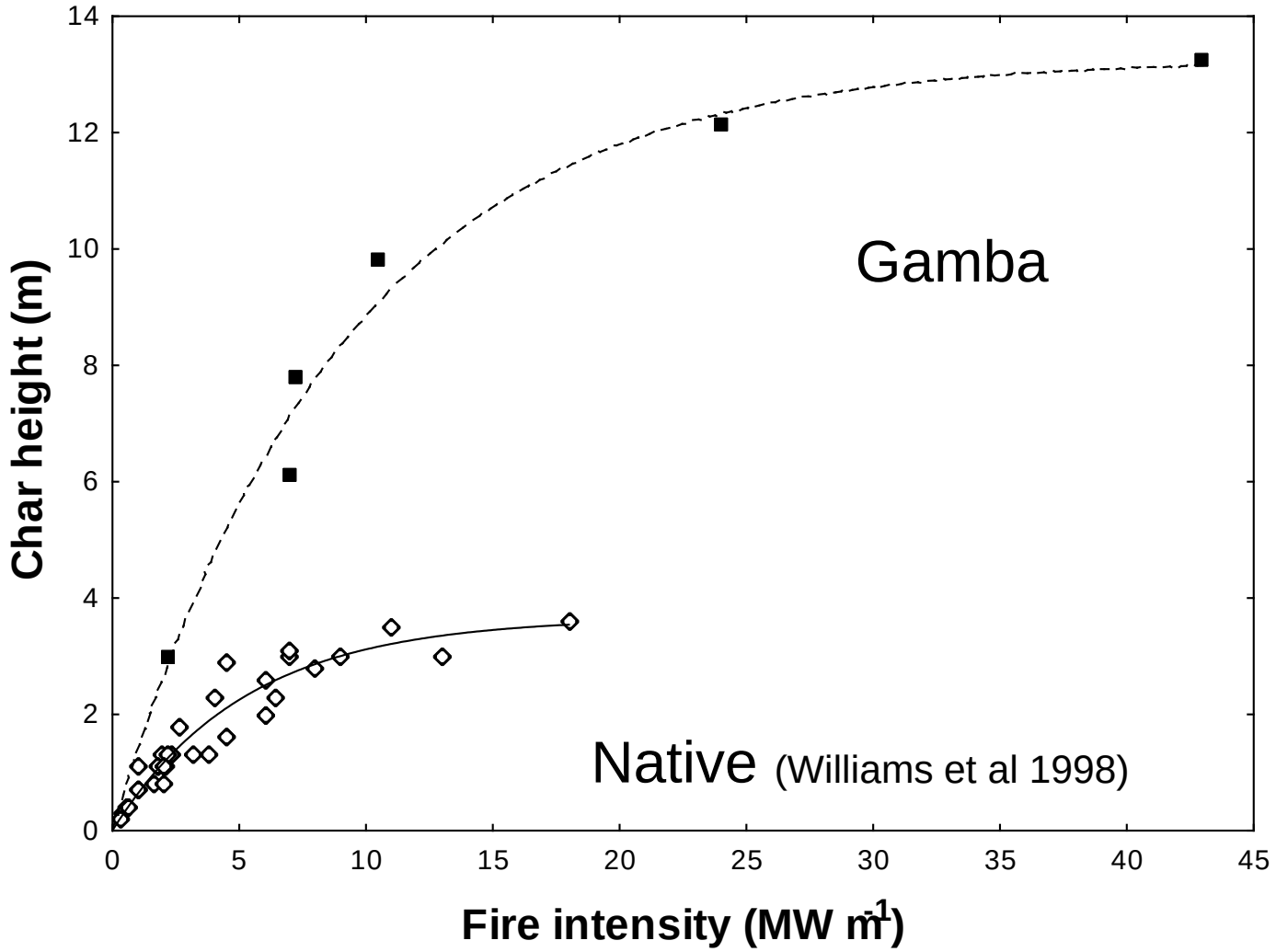
~ 2000 kW m^{-1}

Photo Credit: Bushfires NT



Up to 48, 000 kW m^{-1}

Dramatic increase in char height



Setterfield *et al.* (2010) Div & Dist

Higher fire intensity in Early Dry (June)

Photo Credit: Dave Muller
25th June 2009

Higher fire intensity in Late Dry (Oct)

Photo Credit: Danny Claris
16th October 2012

Higher fire intensity in Late Dry (Oct)

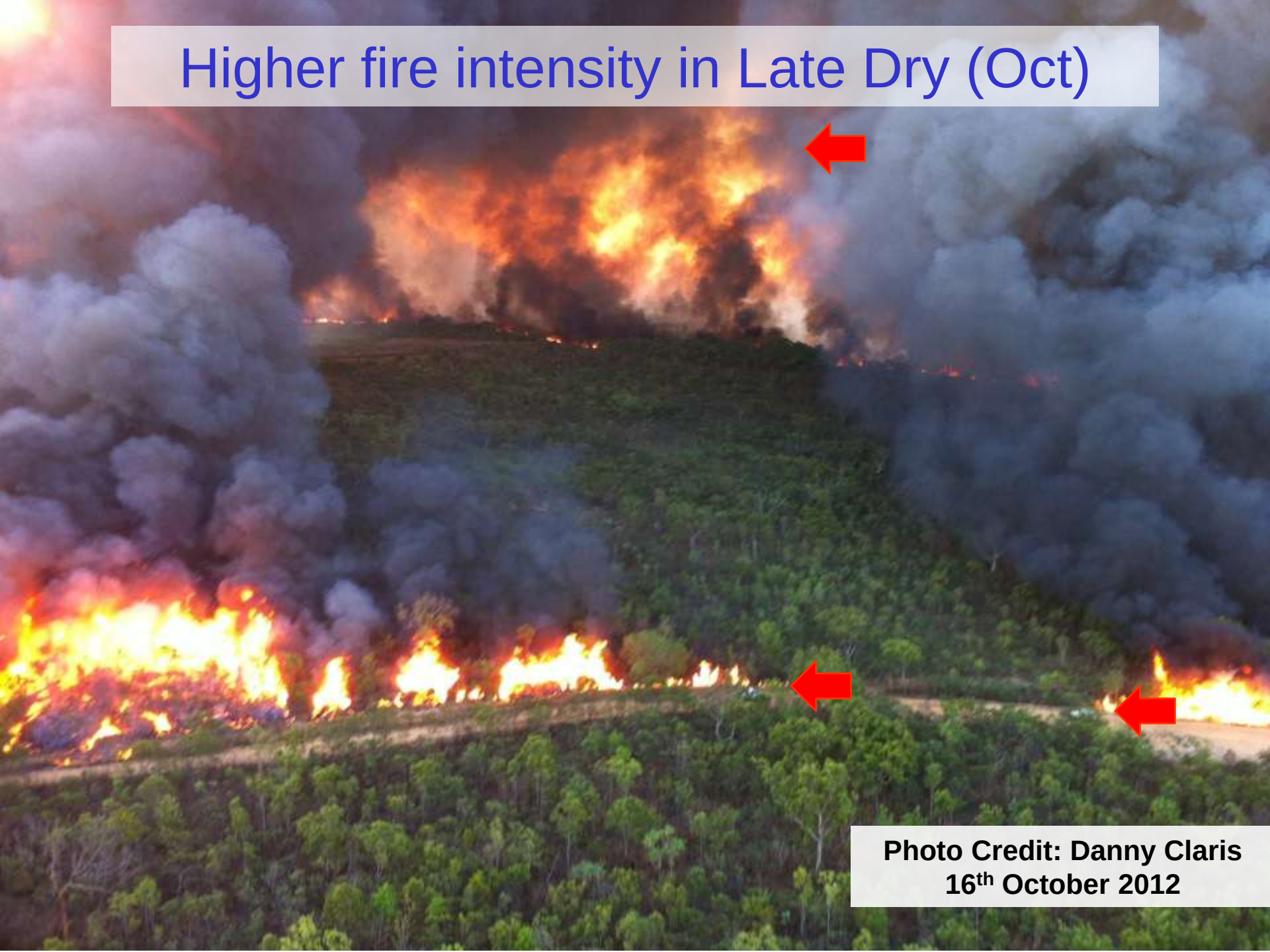


Photo Credit: Danny Claris
16th October 2012

.....what are the impacts of higher intensity fires?

Gamba fires impact on:

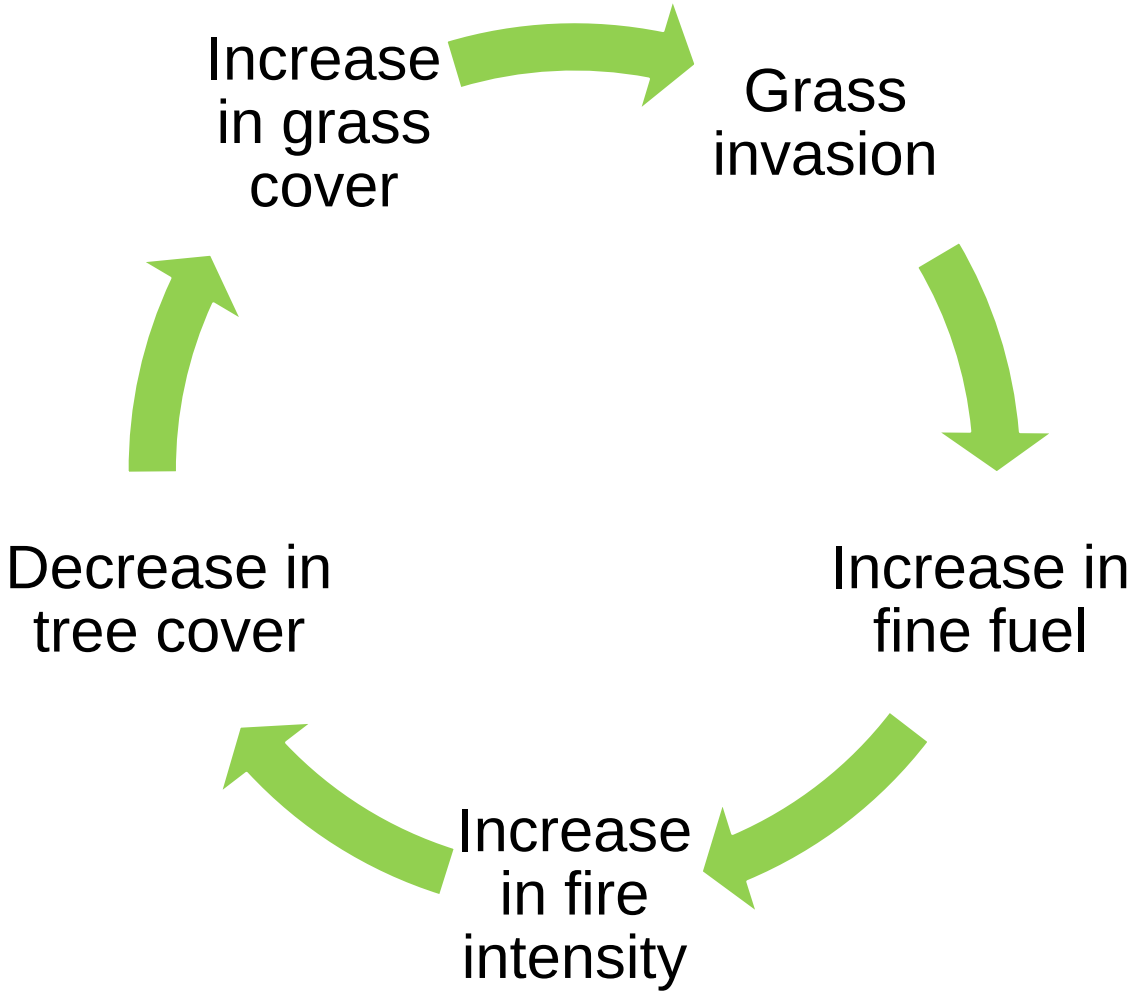
- Plant & animal biodiversity
- Nitrogen cycling
- Tree cover
- The fire risk to emergency services/ community
- The cost of fire management

Gamba fires impact on:

- Plant & animal biodiversity
- Nitrogen cycling
- Tree cover
- The fire risk to emergency services/ community
- The cost of fire management

The alien grass-fire cycle

(*sensu* D'Antonio and Vitousek 1992)



Tree cover

Tree cover

Tree cover under gamba canopy (one plot)

1990

Tree cover under gamba canopy (one plot)

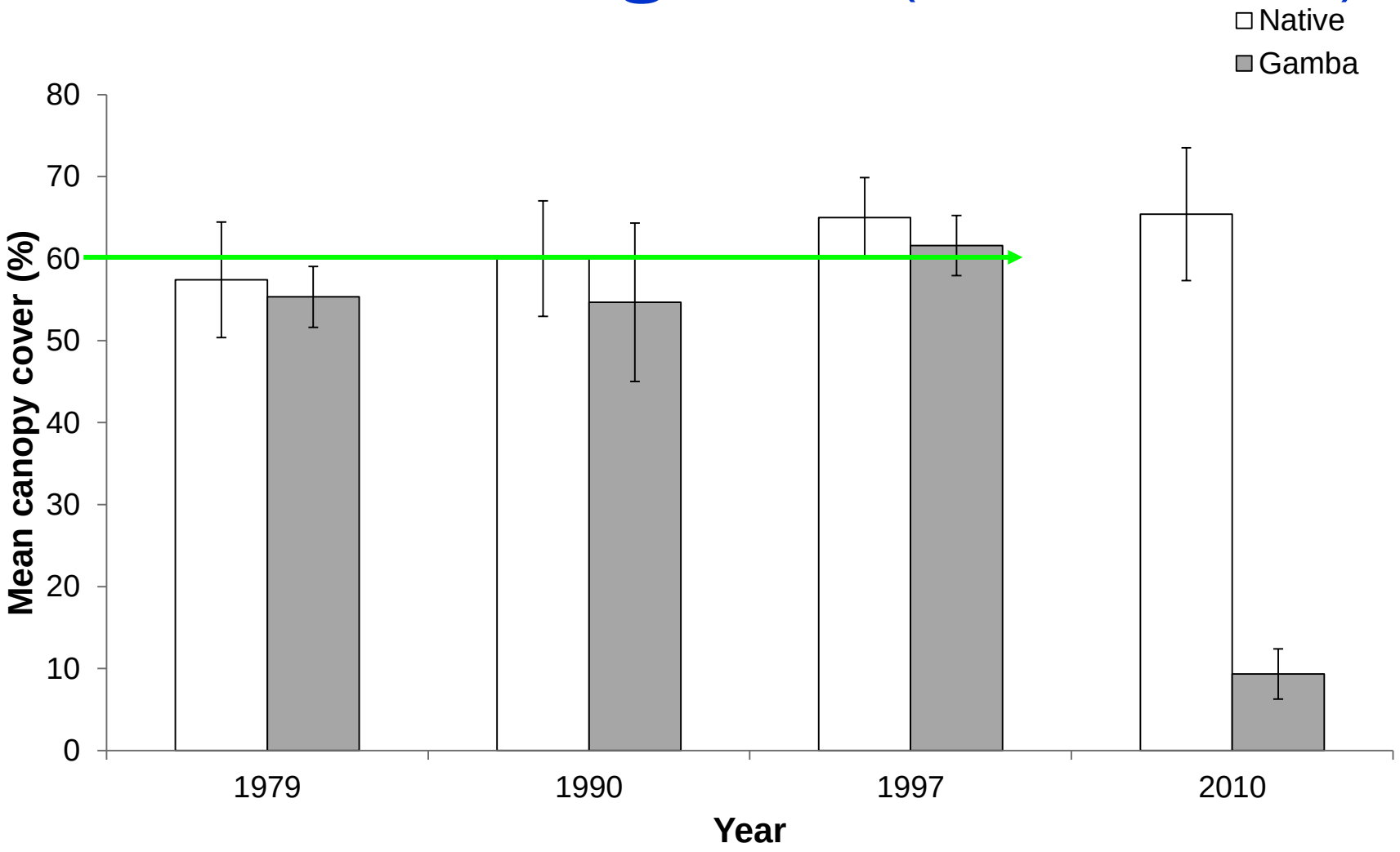
1990

2010

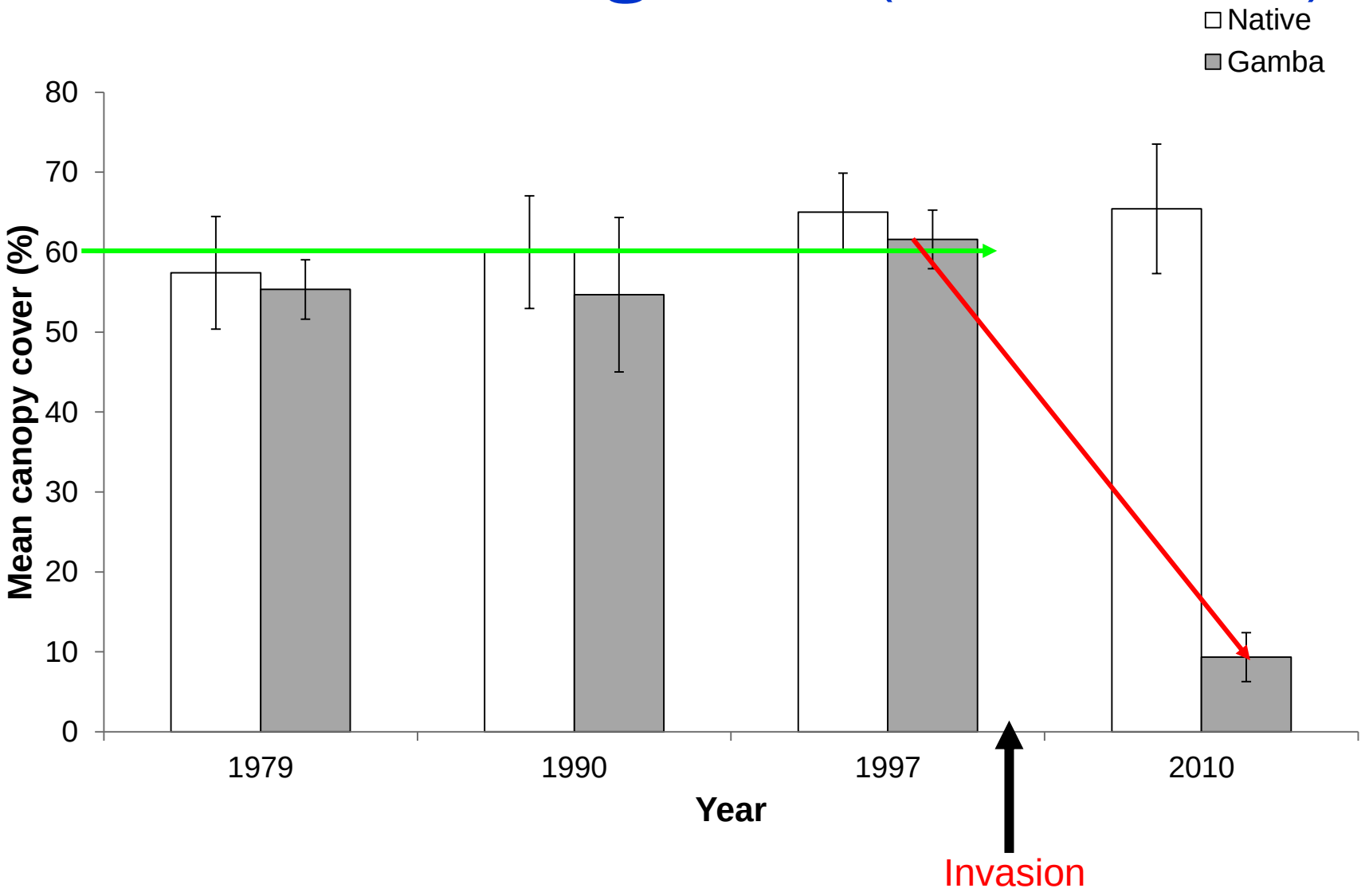
up to 80% reduction in tree cover between 1990 & 2010

(Setterfield et al. in prep)

Tree cover under gamba (1979-2010)



Tree cover under gamba (1979-2010)



Tree decline - Adelaide River…

Tree decline- Litchfield National Park

Tree decline- Litchfield National Park

Documenting changes to fuel loads, fire behaviour & tree cover

How has the increase in fuel loads changed the fire danger index?

The Grassland Fire Danger Index (GFDI)

- McArthur Mark 4 Grassland Fire Danger Index
- Indicator of potential difficulty in controlling a fire, should a fire start on that particular day
- Used for fire weather warnings & fire bans
- Fuel characteristics
  - fuel quantity (t ha^{-1})
  - fuel curing (0-100%) (dryness of vegetation)
- Weather characteristics
  - temperature (^{o}C)
  - wind speed (km hr^{-1})
  - relative humidity (%)

➢Gives a FDI value (0-100+)

Fire Danger Rating Categories

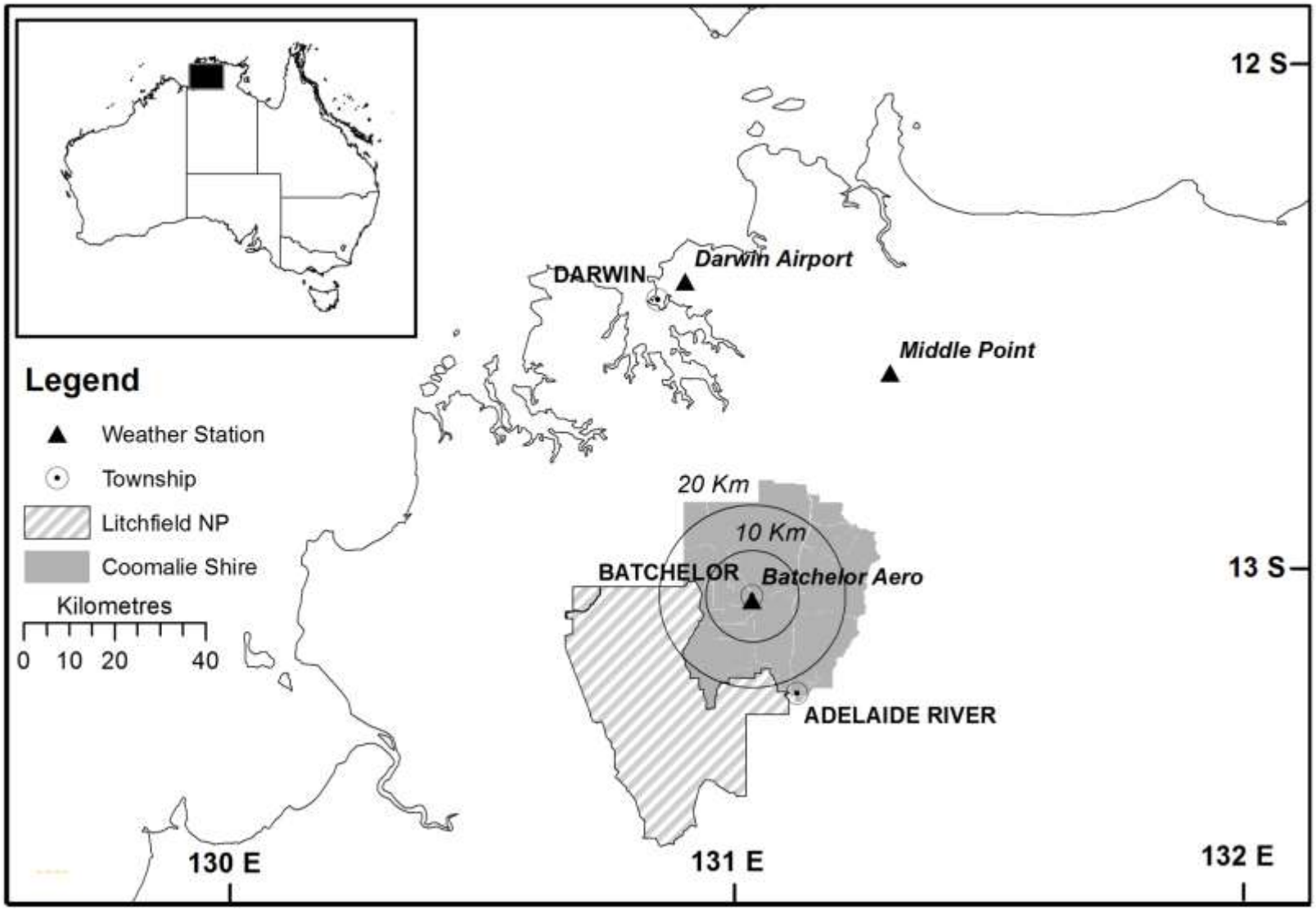
The Grassland Fire Danger Index (GFDI)

- McArthur Mark 4 Grassland Fire Danger Index
- Indicator of potential difficulty in controlling a fire, should a fire start on that particular day
- Used for fire weather warnings & fire bans
- Fuel characteristics
  - fuel quantity (t ha^{-1})
  - fuel curing (0-100%) (dryness of vegetation)
- Weather characteristics
  - temperature (^{o}C)
  - wind speed (km hr^{-1})
  - relative humidity (%)

➢Gives a FDI value (0-100+)

Fire Danger Rating Categories

Study Area: Coomalie Shire

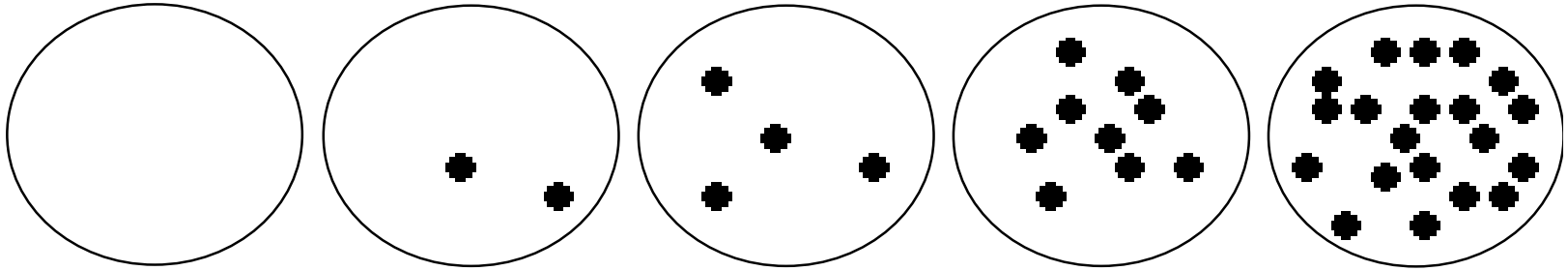


Assessment of Landscape fuel loads

Methods

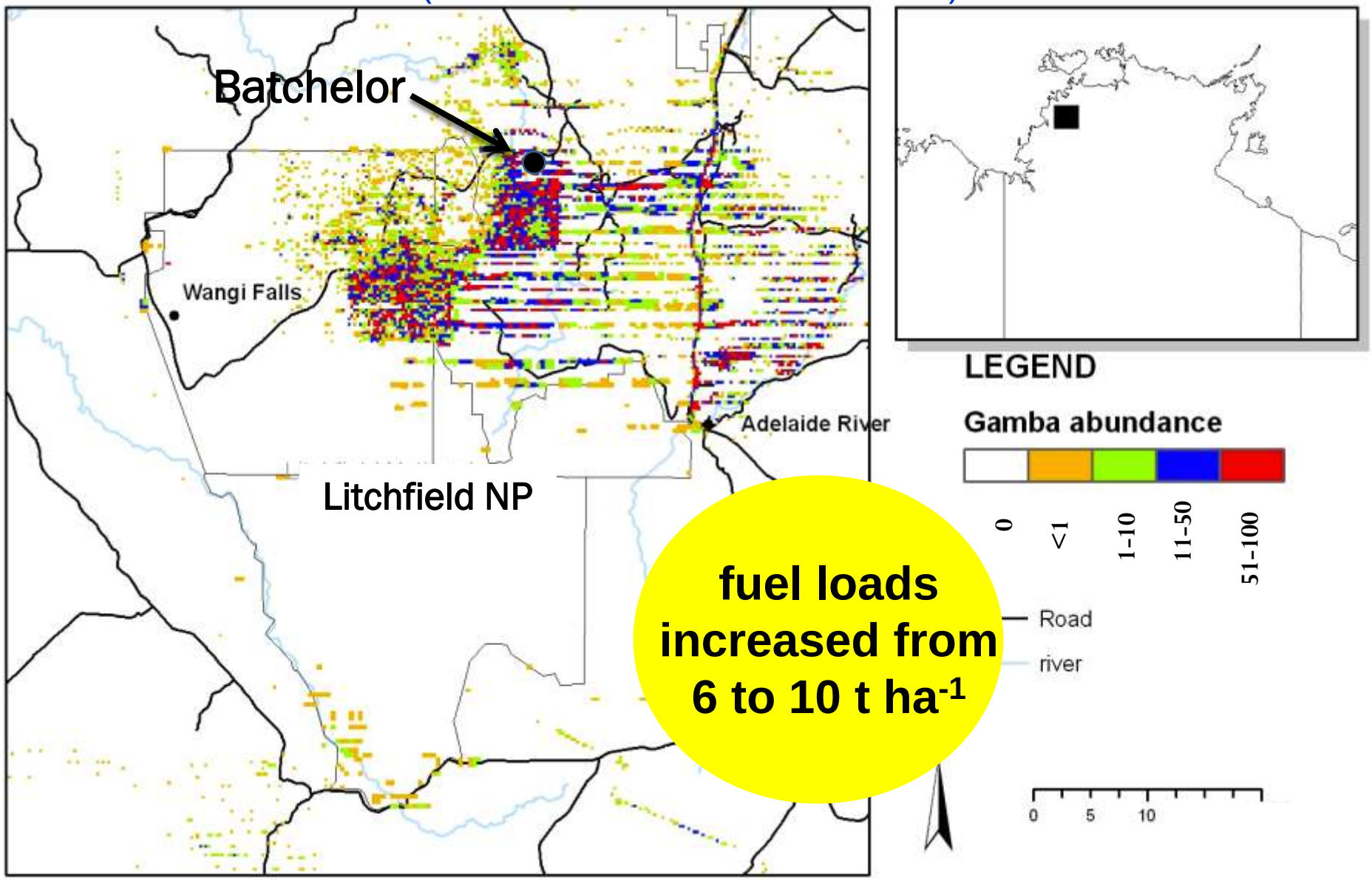
- Aerial survey 2008/2009 (Coomalie/Litchfield)
- Systematic transects, 2 observers in helicopter
- Gamba cover assessed every 200m
- Cover scored using NT Weeds Branch cover classes
- Ground truthing completed
- Destructive fuel load sampling

The gamba grass aerial survey

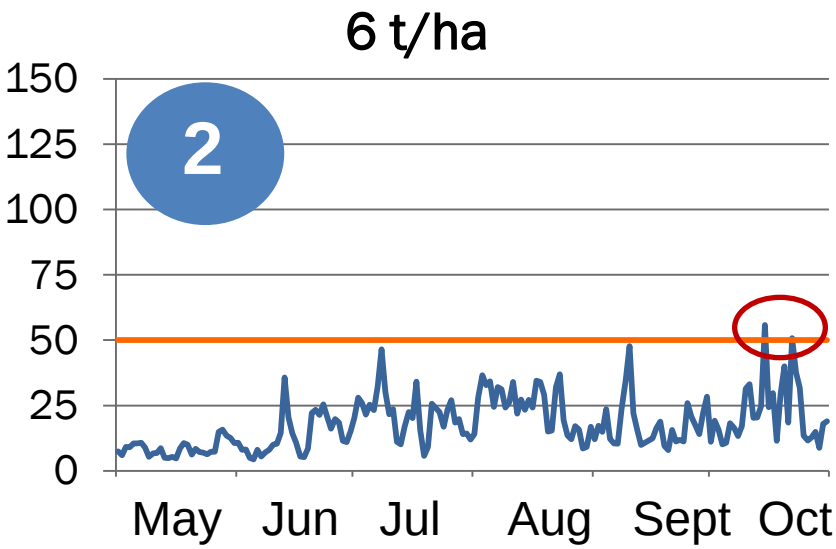


Gamba grass cover-2008/09

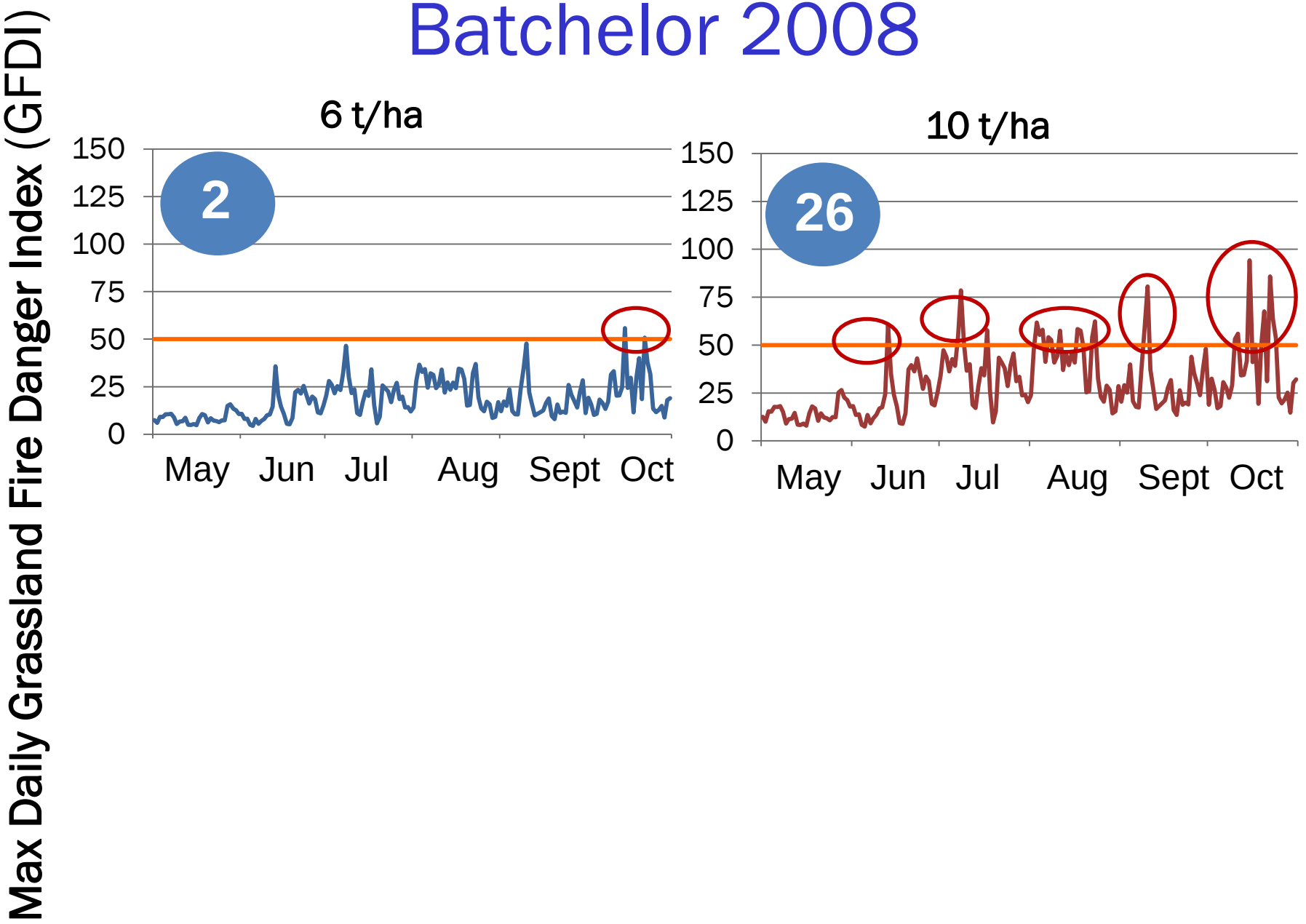
(Setterfield *et al.* 2013)



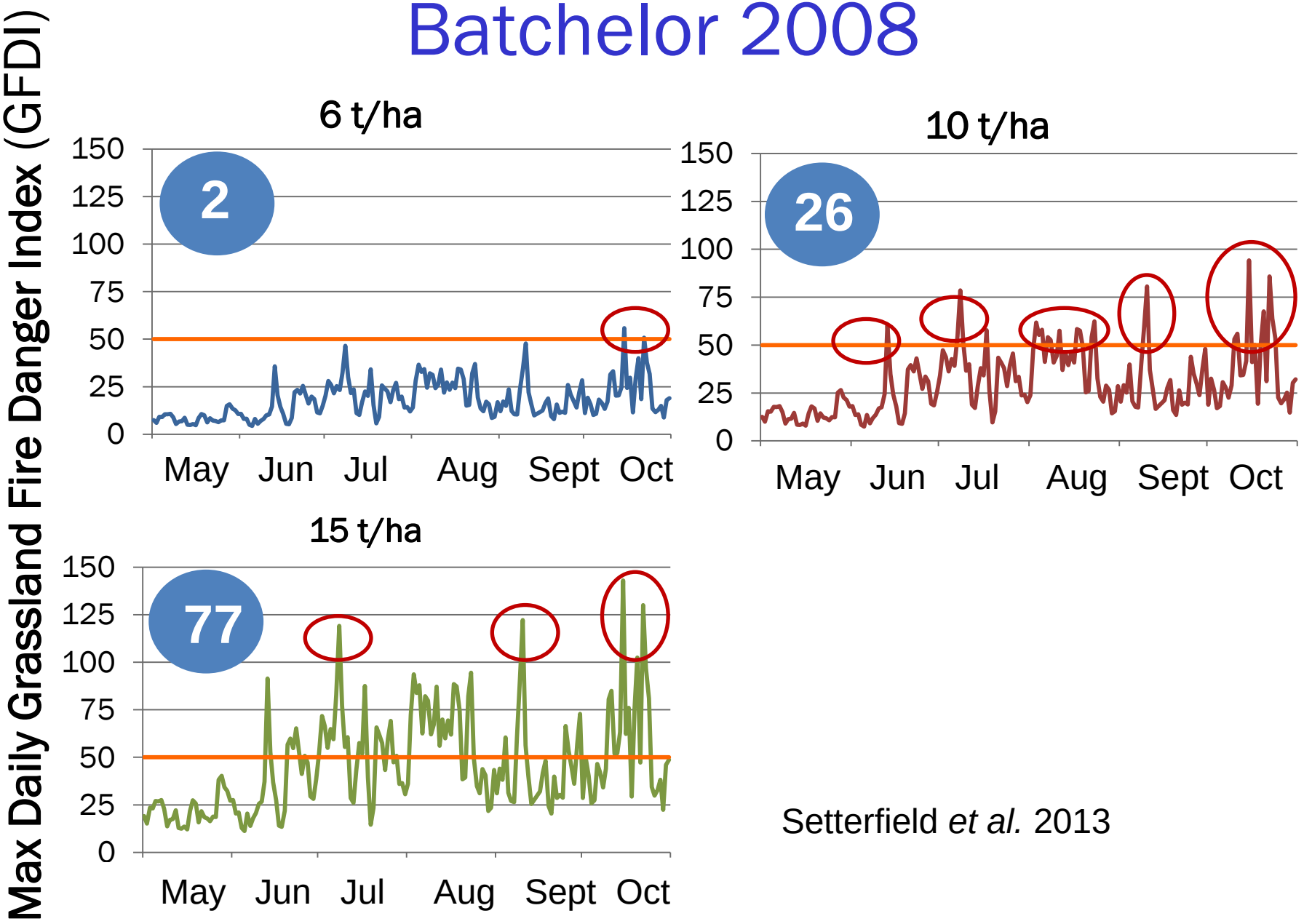
Batchelor 2008



Batchelor 2008

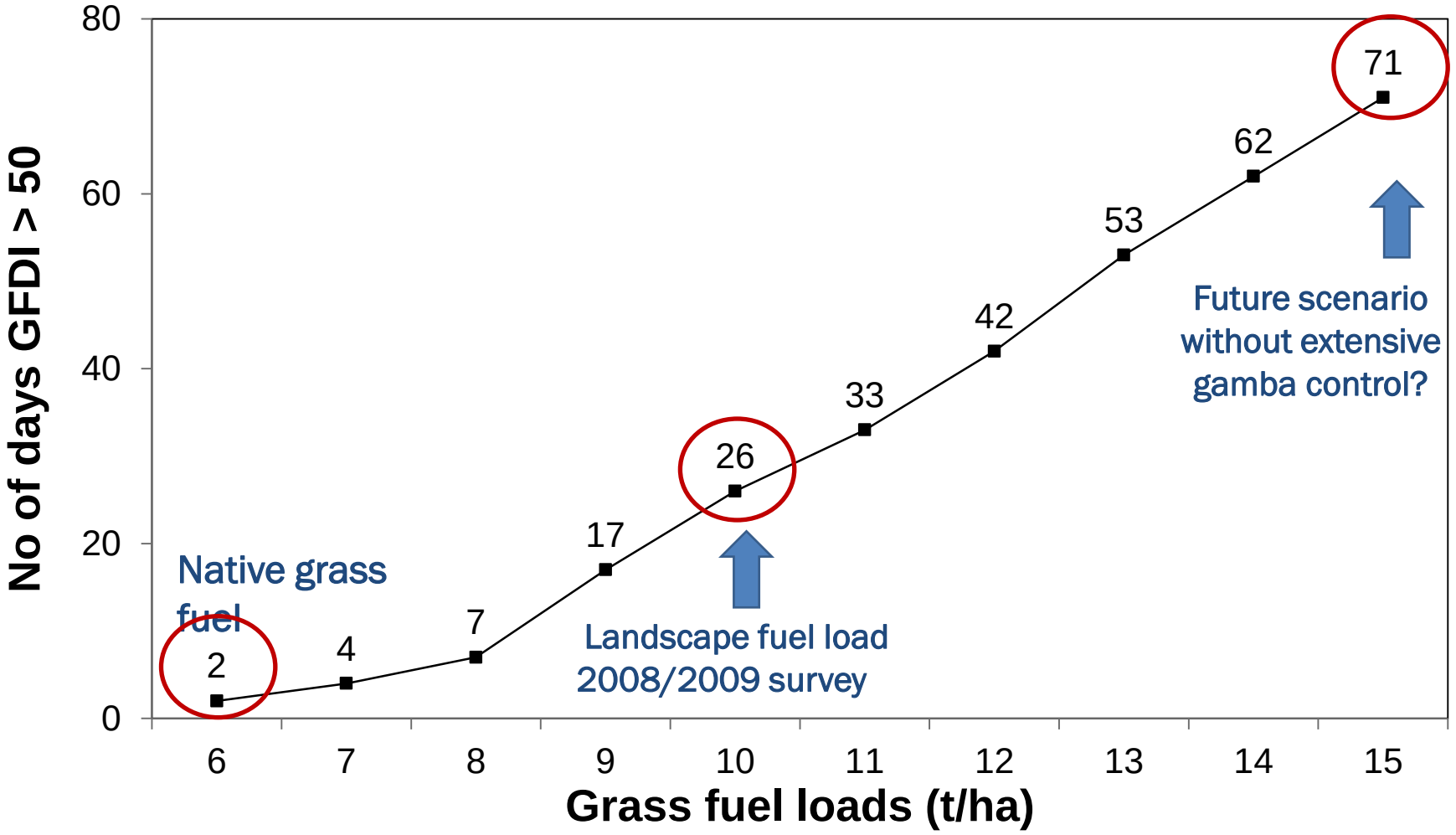


Batchelor 2008

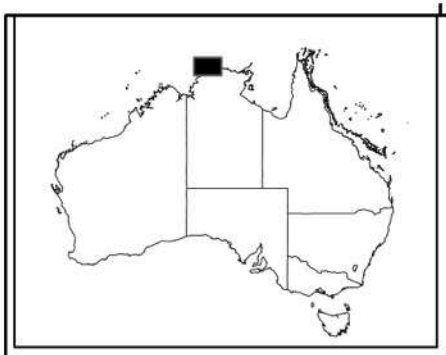


Setterfield *et al.* 2013

GFDI per fuel load- Batchelor 2008



Establishment of separate fire response zones



Darwin

Humpty Doo

Adelaide River

Fire Primary Response Zone

(Litchfield & Coomalie Shires)

N

0 100 200

Kilometers

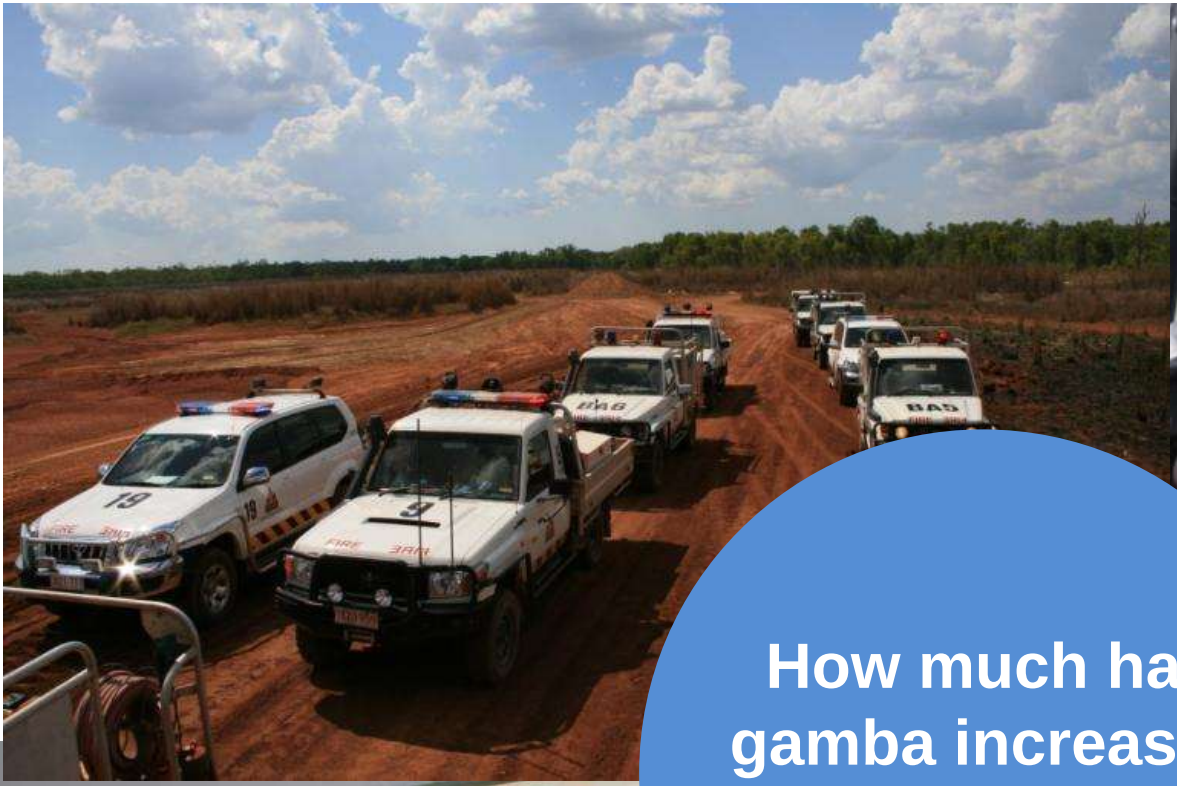
12°S

14°S

130°E

132°E

134°E



How much has gamba increased the cost of fire management?

Large increase in fire management costs (2002 vs 2010)

- Vernon Region
- Stand-by equip. (for fire ban days)
  - ↑ from $375 to $11,000/day

Setterfield *et al.* 2013

Large increase in fire management costs (2002 vs 2010)

- Vernon Region
- Stand-by equip. (for fire ban days)
  - ↑ from $375 to $11,000/day
- Wildfire Management costs
  - ↑ from $225k to $860k/yr

* Data are in 2010 dollars & inc GST

Setterfield *et al.* 2013

Comparison of fire management costs per wildfire event*

	Native	Gamba
Rum jungle	$750	$20,171
Tortilla	$375	$23, 687
Batchelor	$750	$32, 672
Darwin River	$1,500	$27,209

* Cost of staff & equipment

Setterfield *et al*. 2013

Camp Creek Wildfire -2012

- Fire details
  - Date 16th October 2012
  - Burnt 5580 ha
  - Burnt for 9 hours (+ 2 days mop up)
- Staff
  - 6 staff members (34 hours)
  - 6 volunteers (44 hours)
- Equipment
  - 2 helicopters
  - 2 planes
  - 1 water tanker
  - 1 grader
  - 9 grass fire units
  - 12 other vehicles (personal)

➢ **Total equipment cost $15,561**

Photo Credit: Danny Claris

Large increase in fire management costs (Vernon 2002 vs 2010)

- Vernon region

- Total fire management costs
  ↑$275k to $1.3million ***/yr***

* Data are in 2010 dollars & inc GST

Setterfield *et al.* 2013

Implications

- **Need for urgent management**
  - Only in early stages of invasion
  - Must respond quickly to new incursions
  - Need to prevent further spread & increases in density

- **Tree cover**
  - Dramatic ⇓ in tree cover (grass-fire cycle)
  - Savanna woodlands → grasslands
  - Gamba grass is a true 'ecosystem transformer' (*Sensu* Richardson et al 2001)
  - *Serious threat to carbon abatement projects*

Implications

- **Fire Danger Index**
  - ⇑ Fire Danger Risk emergency services
  - ⇑ Fire Danger Risk to community
  - How should Govt. policy respond to this? (Warnings? The community? Tourists?)
  - The Fire Danger risk will continue to ⇑ as gamba density ⇑ and spread continue

- **Cost of fire management**
  - More fire bans each fire season
  - ⇑ cost fire management
  - The cost will continue to ⇑ as gamba density ⇑ and spread continue

➢ *Need benefit:cost of gamba control*

Collaborators

- Charles Darwin University
  - S. Setterfield, M. Douglas, A. Petty
- NRETAS- Weeds Branch
  - K. Ferdinands, P. Barrow, A. Hendry
- Bushfires NT
  - S. Whatley, J. Whatley, C. Platell, S. Davies, A. Turner, S. Sutton
- Bureau of Meteorology
  - I. Shepherd, W. Lynch
- Funding: Australian Weeds Research Centre, CDU, CERF Significant Project, LWA, NHT

Charles Darwin UNIVERSITY
Innovation in Education

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

Video of the 2012 Camp Creek Fire

Photo Credit: Danny Claris
16th October 2012