Burn your bush before it bites back!

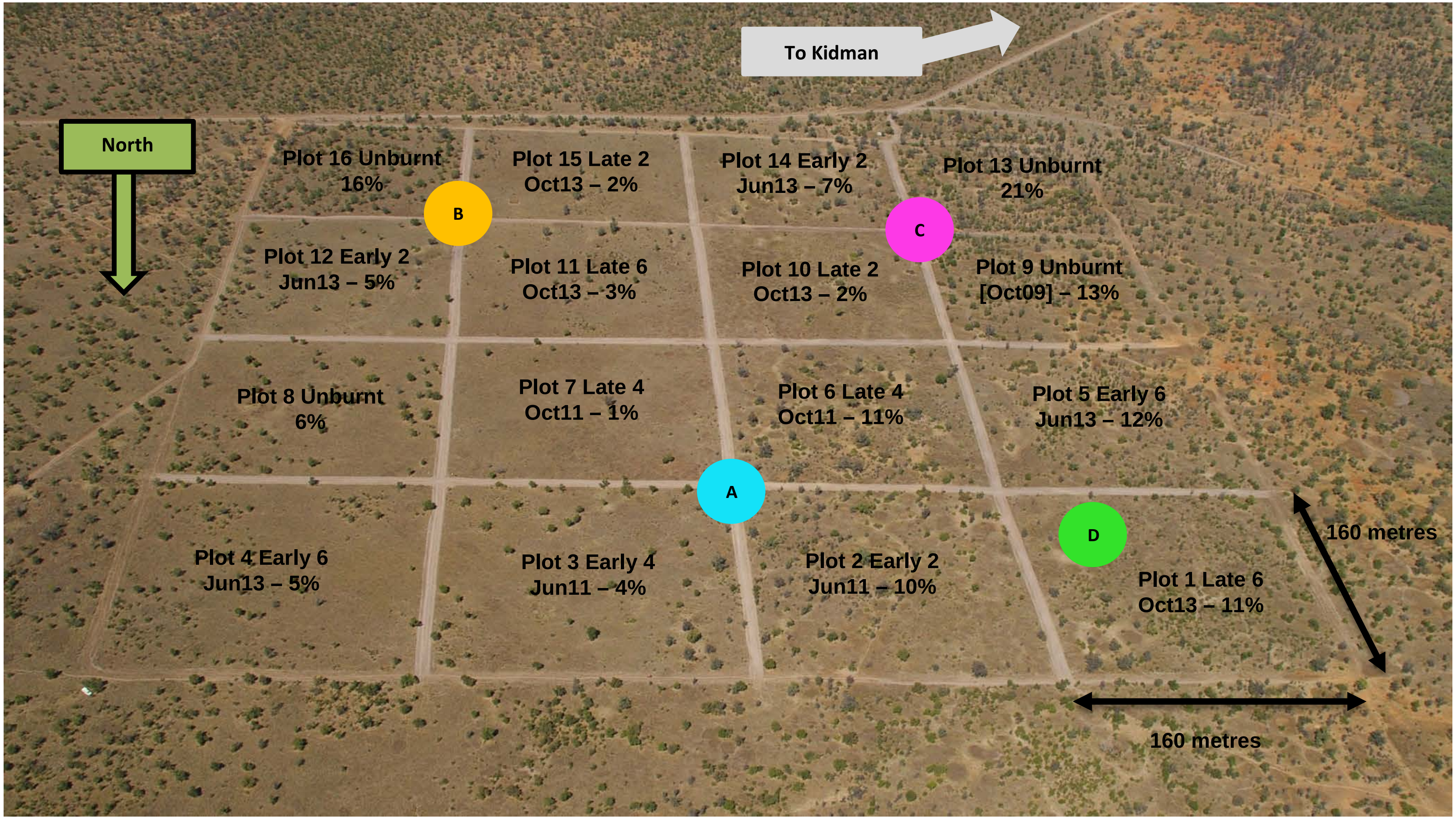
21 years of the Kidman Springs Shruburn experiment

2014 Tour Notes

Dionne Walsh & Robyn Cowley
NT DPIF

Rosewood West Paddock – high productivity cracking black soil

Plot number, fire treatment, when the most recent burn was applied and current woody cover (%):



Rosewood West Paddock – high productivity cracking black soil

A Environmental variation influences the result

- Looking at the aerial photo it is clear there is underlying variation in woody cover unrelated to burning.
- Note that the experimental treatments were allocated randomly.
- Compare the two Late 4 plots (Plots 6 and 7).
- In 1995 Plot 6 had almost double the woody cover of Plot 7 (7.2% versus 3.7%).
- By 2013 the woody cover on Plot 6 had increased 1.5 times, while the woody cover on Plot 7 had decreased to about a quarter of its original figure, even though they had the same fire regime.

Take home message: you can apply a fire regime but you won't always get the same result due to variation in the environment such as starting situation, soil variation, water dynamics, grazing behaviour and fuel loads.

A Burning every four years achieves the best balance between woody cover and pasture condition

- The level of woody cover that this frequency of burning achieves can be observed at A where we have Early 4 (Plot 3) and Late 4 (Plots 6 and 7) side by side.
- Note that the risks of pasture damage are high after early dry season burning due to the sustained grazing that occurs for several months until the next wet season (discussed later on the tour and in these notes).
- The need to spell pastures to prevent pasture damage makes early dry season burning costly in terms of lost cattle production.

Take home message: late dry season fires every four years provide a good balance between woody cover, pasture condition and cattle management.

Rosewood West Paddock – high productivity cracking black soil

B

Early and/or frequent fire is bad for pastures because it increases grazing pressure for longer

- Compare Early 2 (Plot 12) to Late 2 (Plot 15), Late 6 (Plot 11) and unburnt (Plot 16) and the exclosures.
- Before the site was fenced and wet season spelled in 2013/14, perennial grass yields were much higher on the unburnt and Late 6 plots (see tables below).
- After spelling, there were smaller differences in perennial grass yields but the Early 2 plot still had the lowest yield.
- The Early 2 plot has the lowest perennial grass yield and has more annuals and forbs than the other plots.
- The results show that cattle graze feathertop wiregrass heavily after burning.
- [Take notice of the fire impact on the Late 6 plot for comparison later in the tour].

Take home message: to control the impact of grazing after fire you should consider spelling the whole paddock after burning or make sure the burnt area is big enough (and stocking rates are low enough) to prevent large mobs of cattle congregating on burnt patches. Burning later in the year minimises the time between burning and the next wet season.

June 2013 data	**Unburnt (Plot 16)**	**Late 6 (Plot 11)**	**Late 2 (Plot 15)**	**Early 2 (Plot 12)**
Avg perennial grass yield (kg/ha)	2565	1797	862	492
Avg feathertop wiregrass (kg/ha)	1576	1230	435	304
Avg % perennial grass yield	89	81	67	55
Avg % native couch	7	6	16	23
Avg % forbs	3	8	11	19

June 2014 data (after spelling)	**Unburnt (Plot 16)**	**Late 6 (Plot 11)**	**Late 2 (Plot 15)**	**Early 2 (Plot 12)**
Avg perennial grass yield (kg/ha)	1596	1696	1768	1434
Avg feathertop wiregrass (kg/ha)	726	497	565	356
Avg % perennial grass yield	83	75	79	73
Avg % native couch	5	9	8	14
Avg % forbs	10	14	10	13

Rosewood West Paddock – high productivity cracking black soil

C

Frequent fire is bad for pastures because they can't recover quickly enough

- Compare the unburnt controls (Plots 9 and 13) to their neighbours burnt every two years (Plots 10 and 14). Both the burnt plots have lower woody cover than the unburnt plots.
- Late 2 (Plot 10) has lower woody cover (2.4%) than Early 2 (Plot 14) (6.9%).
- Pasture yields on the plots burnt every two years are much lower than on the unburnt plots (see tables below). This is bad for both cattle production and fuel accumulation.
- Note the effect of spelling over the 2013/14 wet season on yields measured in 2014 – still depressed on the burnt plots, but not by as much as when grazing wasn't controlled.

Take home messages: burning every two years reduces total pasture growth, perennial grass growth and the percentage of desirable species in the pasture. Burning too often also results in more short-lived forbs and undesirable species in the pasture.

June 2013 data	**Unburnt (Plot 9)**	**Unburnt (Plot 13)**	**Late 2 (Plot 10)**	**Early 2 (Plot 14)**
Avg pasture yield (kg/ha)	3045	2520	1667	1183
Avg perennial grass yield (kg/ha)	2827	2385	1340	891
Avg % perennial grass yield	92	94	81	72
Avg % curly bluegrass	9	11	3	4
Avg % forbs	3	2	8	20
Avg % Fleming's bush	1	1	7	11

June 2014 data (after spelling)	**Unburnt (Plot 9)**	**Unburnt (Plot 13)**	**Late 2 (Plot 10)**	**Early 2 (Plot 14)**
Avg pasture yield (kg/ha)	3310	2579	2265	2200
Avg perennial grass yield (kg/ha)	3056	2426	1896	1761
Avg % perennial grass yield	92	94	84	80
Avg % curly bluegrass	9	5	4	3
Avg % forbs	2	3	11	8
Avg % Fleming's bush	2	0	8	6

D

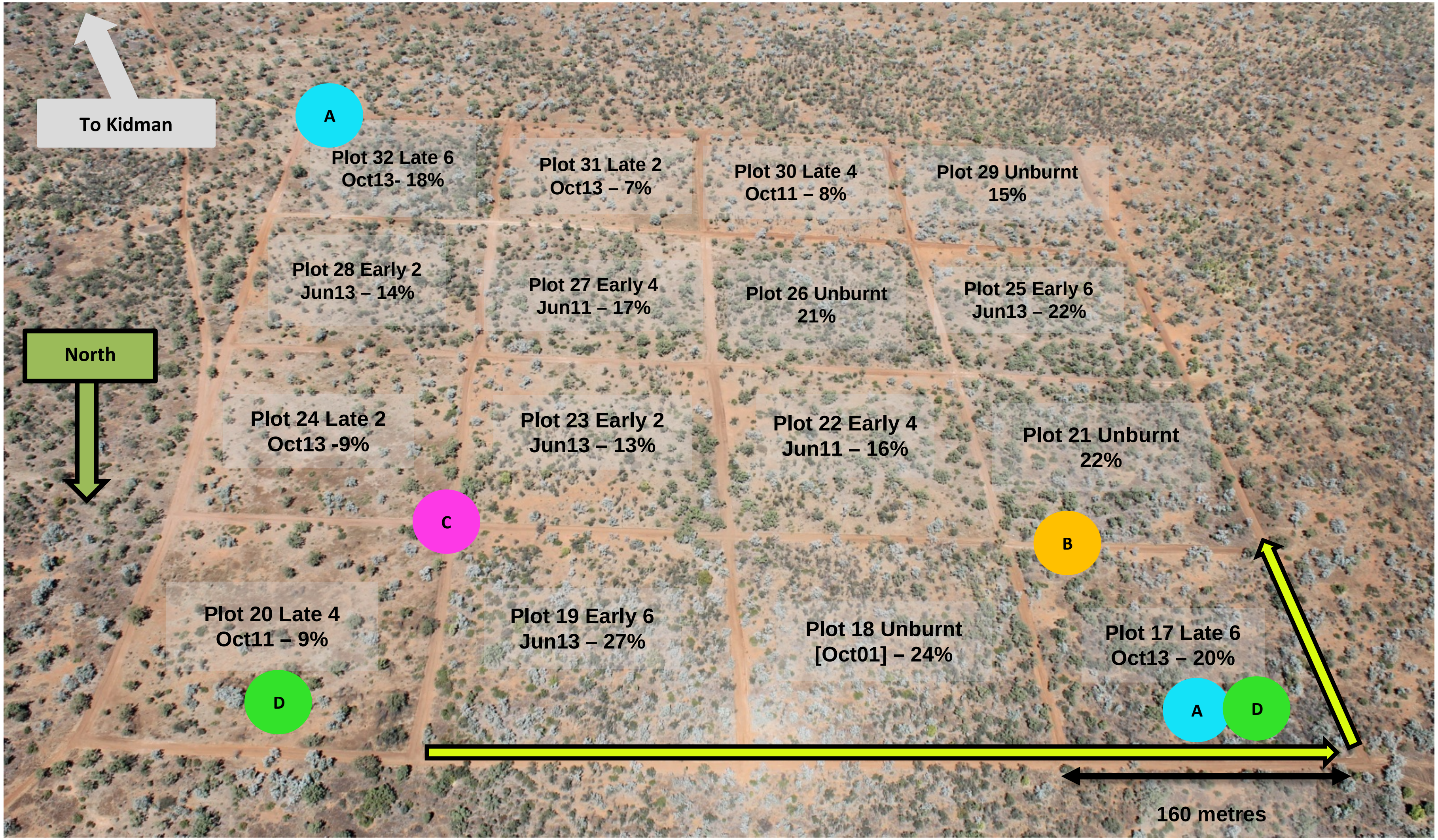
Effect of fuel load and weather conditions for getting good results

- Most woody plants aren't actually killed by fire. Fire works by making them smaller. Smaller woody plants have less effect on pasture growth and provide better visibility during mustering.
- Compare the two Late 6 plots burnt in October 2013. (We saw one of them at the first stop at Plot 11). Note the difference in scorch height on the rosewoods.
- In October 2013, Plot 1 had a moderate fuel load (average 2,260kg/ha and 52% ground cover) compared to Plot 11 which had a low fuel load (average 1,350kg/ha and 33% ground cover).
- At the time of burning, Plot 1 had more effective weather conditions - the air temperature was higher (40˚C vs 36˚C), the humidity lower (13.5% versus 17.5%) and it was windier (maximum wind gust 12km/hr versus 2.5km/hr). This led to an estimated average fire intensity of 6,082kW/m on Plot 1 compared to 1,626kW/m on Plot 11. Fire intensities >2,000kW/m are needed to have an impact on trees and shrubs.

Take home message: more fuel, higher ground cover and favourable weather conditions result in a better fire for controlling woody plants.

Conkerberry Paddock – moderate productivity red soil

Plot number, fire treatment, when the most recent burn was applied and current woody cover (%):



Conkerberry Paddock – moderate productivity red soil

- As we drive along this firebreak, you can see comparisons of different seasons of burning (Early 6 versus Late 6 versus Unburnt). Note also the high amount of black speargrass inside and outside of the burning experiment. Black speargrass has increased on Kidman (and other stations at similar latitude) due to higher annual rainfall in the past 20-25 years (even on areas that don't get burnt often).

A

Effect of fuel load and weather conditions for getting good results

- Low creeping fires have almost no effect on woody plants.
- High intensity fires (>2,000kW/m) are needed to have an impact.
- The Late 6 fire in October 2013 in Plot 17 had an estimated intensity of >6,000kW/m. Compare this to the equivalent fire treatment applied in Plot 32 which had an estimated intensity of ~700kW/m.
- The fire weather conditions were similar for both plots (>41˚C, 13-16% relative humidity and similar wind speeds). The difference was fuel loads (1,348kg/ha in Plot 17 versus 603kg/ha in Plot 32). Maximum flame height in Plot 17 was 6m compared to only 1m in Plot 32.

Take home message: only burn if you have enough fuel to achieve the result you are looking for.

B

Fire has high impact when trees and shrubs are stressed

- Before burning in October 2013 we noticed that many trees and shrubs across the site had dropped their leaves and were looking stressed as a result of the poor 2012/13 wet season.
- Here we can see that trees and shrubs have died back even on the unburnt plot. The dieback and top kill in the Late 6 plot (Plot 17) has been impressive.

Take home message: late dry season burns in combination with water stress can have a high impact on shrubs and trees.

Conkerberry Paddock – moderate productivity red soil

C

Early and/or frequent fire is bad for pastures because it increases grazing pressure for longer

- Compare Early 2 (Plot 23) to Late 2 (Plot 24), Late 4 (Plot 20) and Early 6 (Plot 19).
- Early fires have little impact on woody cover (Plots 23 and 19). Frequent early fires (Plot 23) also result in less pasture, less perennial grasses, more annuals and more weedy species (see tables below). This is due to the sustained grazing that occurs for several months until the next wet season.
- Late fires have the biggest impact on woody cover (Plots 20 & 24). But if late fires are too frequent (e.g. every two years) they reduce total pasture yield and perennial grass yield and increase the amount of annuals and weedy species.

Take home message: late dry season fires every four years provide a good balance between woody cover, pasture condition, fuel accumulation and cattle management.

June 2013 data	**Unburnt (Plot 18)**	**Early 6 (Plot 19)**	**Late 4 (Plot 20)**	**Late 2 (Plot 24)**	**Early 2 (Plot 23)**
Avg pasture yield (kg/ha)	1780	981	1519	1300	776
Avg % perennial grass yield	86	82	67	55	49
Avg % black speargrass	82	67	66	53	33
Avg % annual grasses	5	7	6	17	44
Avg % bachelor's buttons	0	0	0	9	3

June 2014 data (after spelling)	**Unburnt (Plot 18)**	**Early 6 (Plot 19)**	**Late 4 (Plot 20)**	**Late 2 (Plot 24)**	**Early 2 (Plot 23)**
Avg pasture yield (kg/ha)	1560	1792	1803	1187	1443
Avg % perennial grass yield	67	68	56	29	37
Avg % black speargrass	57	50	52	29	19
Avg % annual grasses	21	22	27	31	45
Avg % bachelor's buttons	0	1	0	18	8

D

Follow up fires are needed to manage the mass germination of wattles on red country

- Most of the shrubs and trees in this landscape are very adapted to fire and re-sprout after burning.
- The exception to this is Acacias (wattles) - fires kill the adults but also promote seed germination.
- In Plot 17 we can see all the young wattles that have come up after the fire in October 2013.
- These wattles grow very fast (see Plot 20 for wattles that came up after fire in 2011).

Take home message: apply follow-up fires before young wattles start flowering if you want to reduce the seed bank.

The following pages summarise some of the background to the Shruburn experiment
Please contact NT DPIF on 08 8999 2178 if you have any questions

Background to the Shruburn Experiment

What is the issue?

Woody cover is increasing on productive pastoral land. Left unmanaged, this leads to:

- lower pasture production
- declines in land condition
- reduced carrying capacity
- poorer cattle performance
- lower mustering efficiency
- lower profitability

Why is this happening?

Several causes are implicated:

- lower fire frequency due to:
    - fuel being eaten by cattle leading to fewer and/or less effective fires
    - deliberate exclusion of fire to protect cattle feed
- lower competition between grasses and woody plants due to the removal of grass by cattle
- increased average rainfall since 1974
- increasing atmospheric carbon dioxide which gives woody plants a competitive advantage over grasses

Away from productive pastoral land, woody cover is not increasing as much (and is decreasing in some areas) because there is more fuel and more frequent and/or hotter fires.

I've heard conflicting recommendations about when to burn…

On the most productive pastoral land, fire frequency is typically not high enough to slow the rate of woodland thickening. In contrast, on low productivity pastoral land, national parks, indigenous and defence land, the frequency of late dry season fire is typically higher than recommended for the management of biodiversity and greenhouse gas emissions. This is why you will hear people recommending burning in the early dry season. If you have large areas of rough country that burns a lot in the late dry season, there may be opportunities for you to generate carbon credits.

What to do about woody thickening on productive land?

Fire is the most cost-effective option for producers to manage woody thickening on productive land types…..but...

- Should I burn early or late in the dry season?
- How often should I burn?
- How much of the paddock should I burn?
- What about different land types?
- What about the cattle feed?

An experiment to answer these questions

- Shruburn began in 1993 at Kidman Springs – 21 years of data so far
- Two land types – moderate productivity red soil and high productivity black soil
- Investigating optimum frequency of burning (none, every 2, 4 or 6 years)
- Investigating optimum season of burning ("early dry" – June or "late dry" – October)
- Measuring impacts of burning on woody vegetation as well as the pastures

Red soil site
Conkerberry Paddock

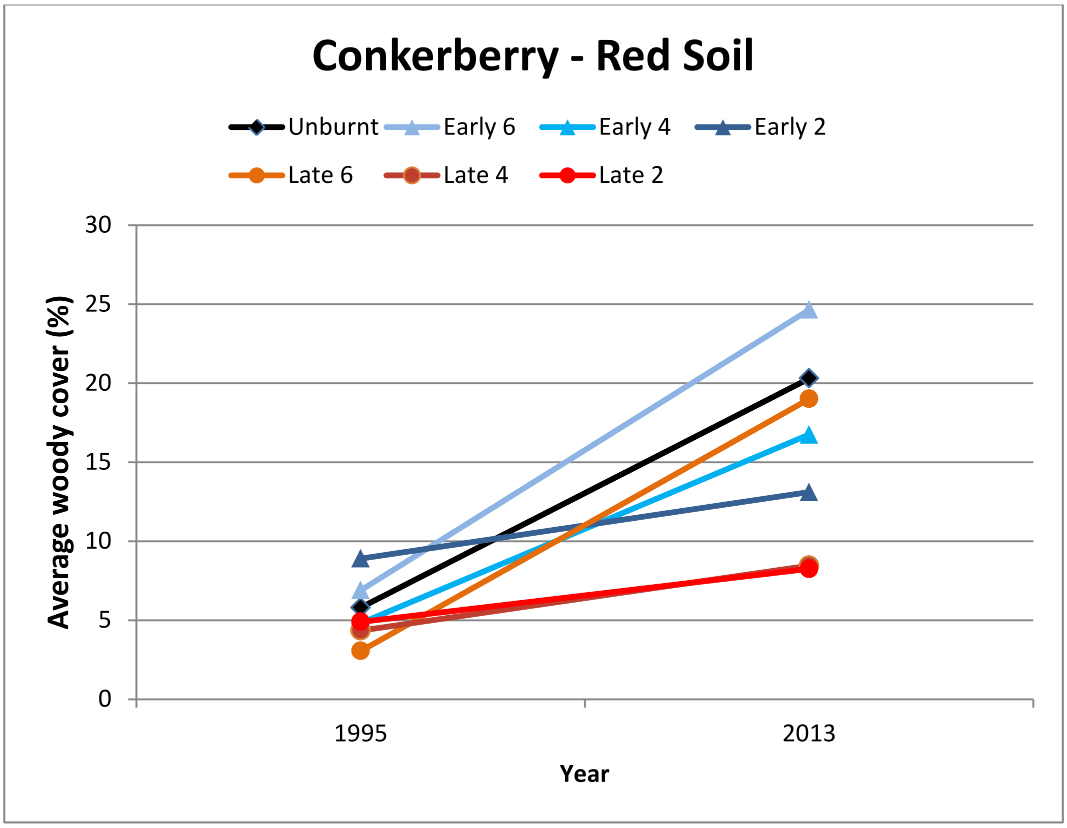
- Open eucalypt woodland
- Dominant species in the pasture layer: black speargrass (*Heteropogon contortus*), bottlewashers (*Enneapogon polyphyllus*) and curly bluegrass (*Dichanthium fecundum*)

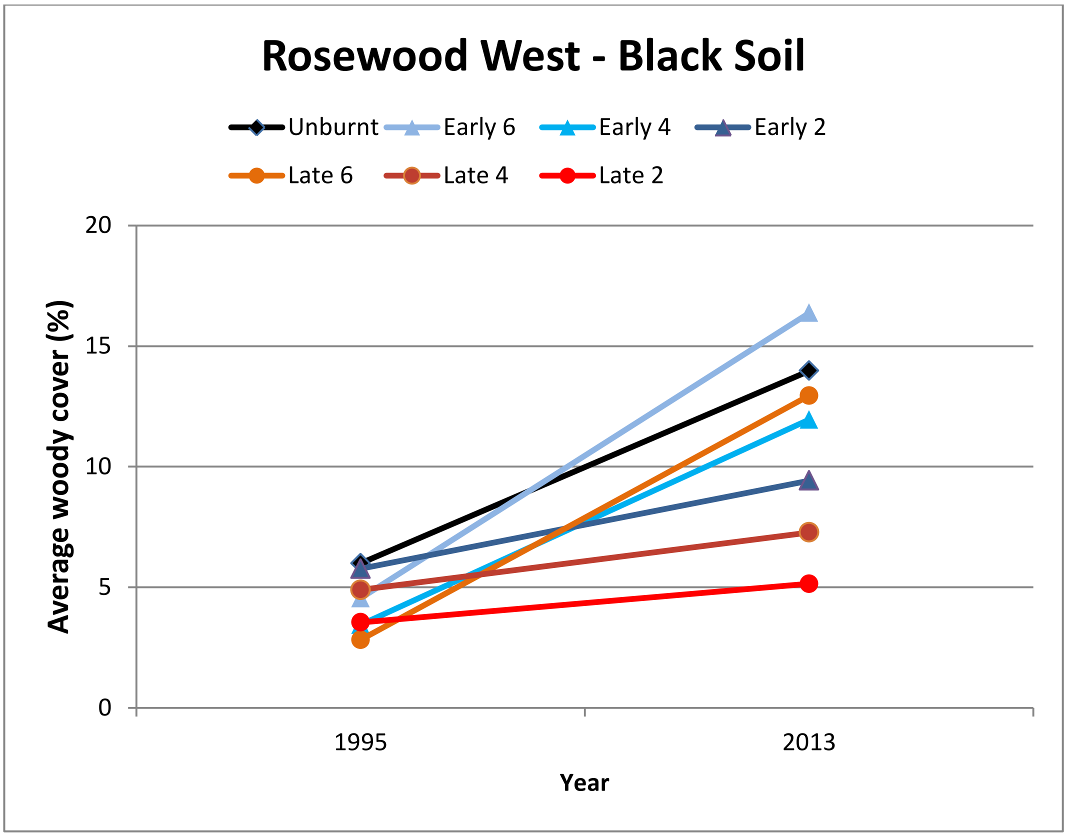
Black soil site
Rosewood West Paddock

- Major tree species are rosewood and bauhinia
- A grassland-shrubland dominated ribbon grass (*Chrysopogon fallax*), curly bluegrass (*Dichanthium fecundum*), silky brown top (*Eulalia aurea*) and wiregrass (*Aristida* spp.)

How has woody cover changed during the experiment?

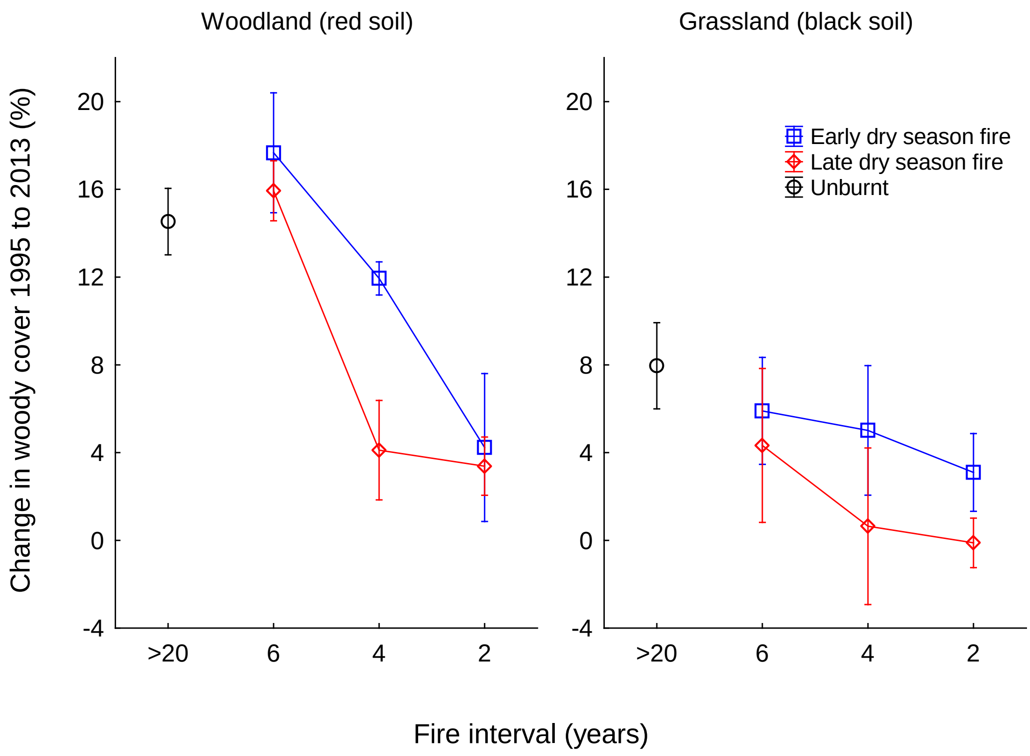
- Woody cover has increased on both soil types for all fire treatments.
- The rate of woody cover increase has been highest on the unburnt, Early 6 and Late 6 plots.
- The rate of woody cover increase has been lowest on the Late 2 and Late 4 plots.





The graphs below confirm that:

- late dry season fires have the biggest impact on woody cover
- fires every 6 years do not have a big impact on woody cover (particularly on red soil)
- fires every 4 years have a big impact on woody cover and are just as effective as more frequent fires (every 2 years)



Findings from the experiment

- Once woody plants get taller than two metres they become very resistant to fire.
- Burning every six years is not frequent enough to arrest woody thickening.
- Late burns every 4 years achieve a good balance between woody management and looking after the feed supply and land condition.
- Burning more often, or too early in the dry season, damages your pastures unless you control grazing after burning.
- Although late dry season burns are the best, they are riskier in terms of control. You may also have to spell the paddock to ensure you have enough fuel at that time of year.
- Don’t burn unless you have enough fuel to get the result you want – you need continuous fuel loads and maximum flame height to have an impact on woody plants.
- Regular burning of pastures dominated by short-lived (annual) pastures is not recommended due to the risk of land degradation.
- Due to lower and less reliable rainfall, greater care needs to be taken when considering burning in the southern VRD.
- To prevent animals from overgrazing small burnt areas, it is recommended that at least a quarter of the paddock is burnt at a time.
- You may need to spell paddocks for some or all of the wet season after burning to ensure pasture recovery.

The future of the experiment

The long term Kidman Springs fire experiment has been very important for understanding:

- Fire regimes that are optimal for grazed savannas
- The long term cumulative impacts of fire on pastures, woody cover and carbon storage

There's still more that can be learned including:

- Effects of pre and post-fire pasture spelling on pasture condition and woody cover
- Post-fire grazing interactions in the first year after fire on woody plants and pasture composition
- Long term carbon storage dynamics

Acknowledgements

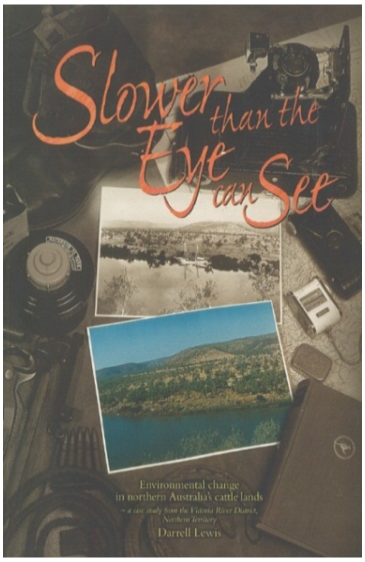
Many people have played major roles in this trial over the past 21 years, including:

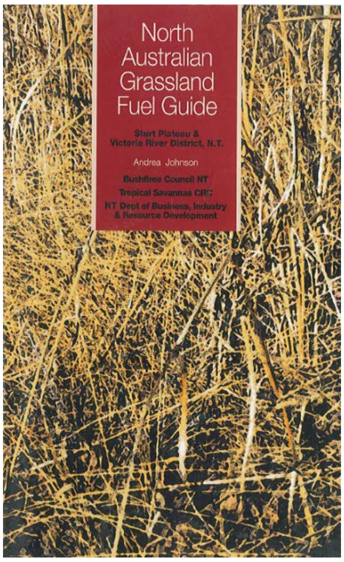
- Rodd Dyer who initiated and managed the trial
- Subsequent project managers Trisha Cowley, Caz Pettit & Robyn Cowley
- Kidman Springs managers and staff
- Field staff who collected the data and conducted the burns
- Mark Hearnden who assisted with data analyses
- The Northern Territory Government for funding this ongoing research and MLA for funding early work at the site

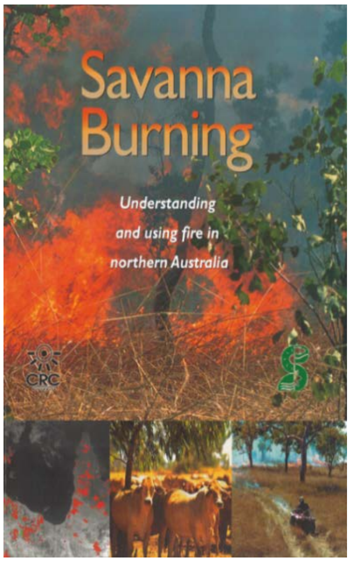
Photo credits: Caroline Pettit, Robyn Cowley and Dionne Walsh

Want to know more?

- Contact NT DPIF – 08 8999 2178, dionne.walsh@nt.gov.au or robyn.cowley@nt.gov.au
- Recommended reading:







"Slower Than the Eye Can See" by Darrell Lewis – interesting history of change in the VRD

http://savanna.cdu.edu.au/publications/landscape_change.html

"North Australian Grassland Fuel Guide" by Andrea Johnson – fuel load and curing guide

http://savanna.cdu.edu.au/publications/grassland_fuel_guide.html

"Savanna Burning" by Rodd Dyer and others – everything you need to know about burning

http://savanna.cdu.edu.au/publications/savanna_burning.htm