TALKING FIRE

Burning for pastoral management in the Desert Uplands

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FOREWORD

Friend or foe? A puzzling and contentious question in the Desert Uplands Bioregion!
A friend if it is used correctly and wisely, a foe if it is allowed to run rampant over the countryside. A friend to manage our vegetation and keep our woodland clean, healthy and open range as when the first settlers came to this land. A foe when a lightning strike or a neighbour's burn ignites and devastates the landscape, killing our native pastures. A vexing question – the only answer is gather what we think is the correct information and carefully trial burning techniques for ourselves. Therefore, the Desert Uplands Committee does not endorse the methods delivered in this booklet, however the Committee recommends it to landholders as a valuable reference and educational tool. However, any outcomes, successful or unsuccessful, that landholders have after burning, the Committee and authors of this book would feel privileged to receive and therefore improve best management practice for burning in the Desert Uplands Bioregion.

Lesley Marshall
Chairman
Desert Uplands Committee Inc.

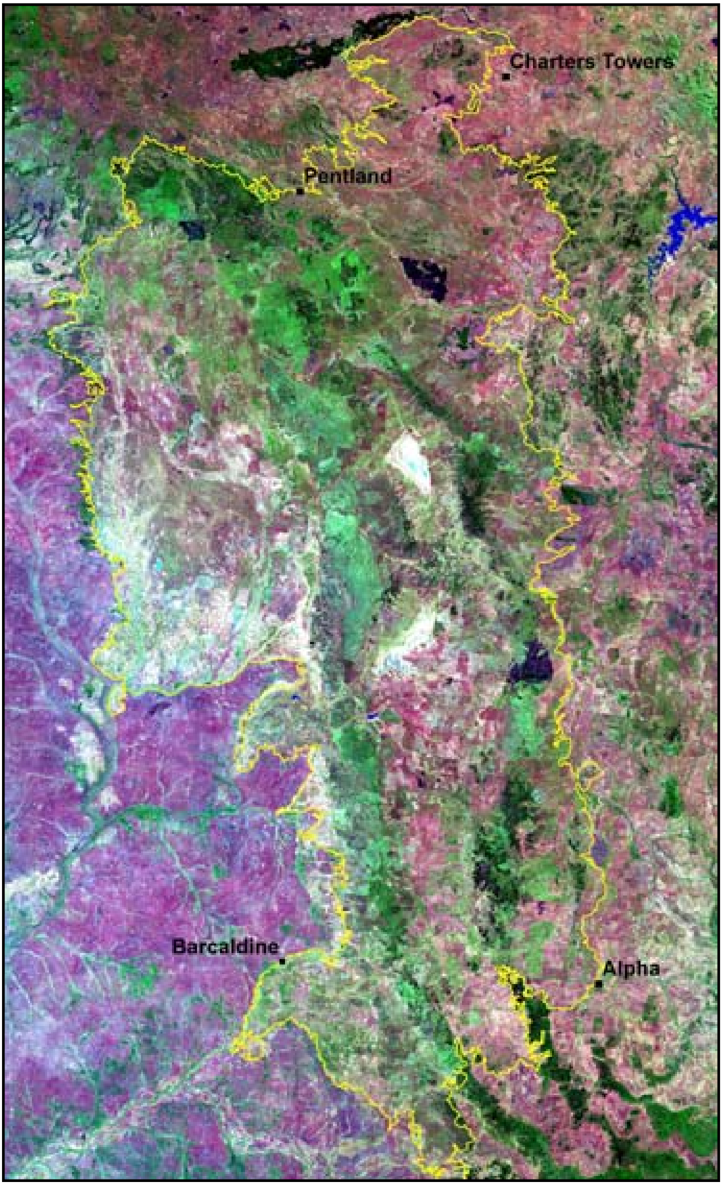
Introduction

"Put a hot fire through, then it rains and you turn into a good manager."

This booklet sought to address the pros and cons of burning for pastoral management in the Desert Uplands region of Queensland. This was not quite as easy as it seemed. As it turned out even experienced bushmen could disagree about the effects of fire. This does not necessarily mean that one is right and the other wrong, as contradictory opinions and observations may well be valid in different landscapes and circumstances. As such, this booklet cannot be taken as a prescription for guaranteed outcomes. Rather, it attempts to assemble existing knowledge in the hope that graziers and other land managers will continue to use fire and develop a better understanding of its merits and consequences. A deeper knowledge of landscape burning can only come with more trial and error, and careful observations applied to furthering our collective wisdom.

The booklet is arranged into different sections addressing some of the major issues for pastoralists interested in understanding fire. A selection of observations and opinions from interviews with long-term graziers from the Desert Uplands is given in italic text at the beginning of each section. We have tried to arrange the quotes in themes, so one quote will invariably be from a different individual to that of the next. The plain text attempts to flesh out these views and observations in the context of relevant published and unpublished data from research studies.

This booklet has not covered technical details of fire behaviour or techniques for lighting or fighting fires. Advice on these aspects of burning can be obtained from the local fire wardens or the offices of the Queensland Rural Fire Service.



The Desert Uplands region as viewed by satellite in 2001. The region is situated almost in the geographic centre of Queensland and occupies an area of about 7 million ha. The western boundary is clearly delineated from the Mitchell Grass Downs (mauve). The boundary on the east is less distinct but mostly follows the Belyando River floodplain. Hard ridges of lancewood (dark green) run north-south. Lake Buchanan and Lake Galilee (white) are evident in the centre of the region. Areas of clearing (pink) show up in the south. The scars of some large fires (dark purple) can be seen in the north and east.

Fire and land-use history of the Desert Uplands

To gain an understanding of the present and the future, a good place to start is the past. This section attempts to summarise historical fire patterns in the region and begins with the local graziers' views on the topic.

"Before the white man you didn't need blackfellas to start a fire, I mean you get thunderstorms that light them every year. And without any livestock you get a thunderstorm light a fire and it would have kept on going. I mean what would have stopped it? If there were no livestock for hundreds of miles, you know, the country just grown up, they would have burnt out a hell of a lot of country. Very fierce these big fires would have been too. And the only thing that'd stop them was where a fire had been the year before - or the year before that, maybe two years. So there would have been massive fires throughout the history of Australia."

"You go back to the aboriginal times and all the native animals would have had to live within natural water points - of which there wasn't a lot. So they were concentrated there. And that country probably towards the end of the dry season would have been bare. And all of the country further out that they couldn't eat would have been massively grassed and would have burnt near every year. And see, people are going on about fire, but Australia probably had more fires before white man came then than it does now. There was no stock to eat the grass and there was no road or breaks or nothing to stop the fires.

"I reckon aboriginals only burnt around watering points because that's where the game was and where they lived. If a fire burnt out 50 miles that wasn't intended."

"My old man was raised with a blackfella. Apparently the Aborigines used to burn whenever the grass would burn – they didn't like walking through spinifex especially with no clothes on and could see to hunt."

"Country was really open before 1950. Not 'cos of droughts; 'cos of previous fire."

"In the 1950s people burnt every year but not now in these dry years. Most fires in the 50s were at the end of the year. People were always either lighting fires or putting fires out. Fires were often lit after the first bit of rain or just because there was lots more grass. But now the combination of dry years and grazing means we're in a 'can't burn'

cycle. Also there's less fires now because there's lots more watering points – there's no more back country."

"Fires are not as intense these days due to more management of fire – with roads and heavy machinery you can keep the fires in smaller areas."

The legendary explorer Ludwig Leichhardt crossed the north-eastern corner of the Desert Uplands in April 1845. A few days before he had noted that 'all the surrounding ironbark bark forest was burnt' and soon after watched 'a native busily occupied in burning the grass, and eagerly watching its progress'[1]. Leichhardt was making the critical observation that fire was an important part of the routine management of the local aboriginal tribes. Just how much fire they used is difficult to say because only a year later Major Thomas Mitchell spent two months (July to September) following the Belyando River and made only one reference to landscape burning. 'We found much of the grass on fire, and heard the natives' voices although we saw none'[2].

The aboriginal population of the *Yagalingu, Miyan* and *Yilba*[3] people in the Desert Uplands was probably fairly sparse given the lack of natural waters, but it seems likely that these hunter-gatherers lit fires whenever they traversed country with sufficient fuel. Records of aboriginal burning compiled from other historical accounts for similar country indicate that burning could occur at any time throughout the year[4]. Lightning during early wet season storms would have been another important source of ignition. Fires could have spread over large areas after good seasons but could have been pulled up by moist air at night, changes in the weather, streams and rocks, or certain vegetation types that do not carry much fuel.

There have been a lot of changes in the Desert Uplands since the time of Leichhardt and Mitchell[5]. In the early years, pastoral settlement was limited by isolation, lack of water and the heart-leaf poison bush (*Gastrolobium grandiflorum*) that killed stock in the days when fences were scarce. For many years much of the Desert Uplands was used as drought refuge blocks run in conjunction with more productive properties on the Mitchell grass downs. However, the region has always been poorly suited to sheep, and there has been a steady transition to cattle. Development of the region progressed with the advent of the railway in the 1880s, the development of bore-fed waters tapping shallow sandstone aquifers, thousands of miles of fencing, and in recent years the development of buffel grass (*Cenchrus ciliaris*) pasture on land cleared of trees. The region is now used for extensive cattle grazing on properties typically in the 10,000 ha to 50,000 ha range.

Despite the fact that grazing has reduced fuels there is still plenty of scope for burning by pastoralists. A questionnaire survey conducted in 1996-1997 established that about 86% of commercial beef producers in central Queensland use fire[6]. The most common motive was to control 'woody weeds', but many graziers also used fire for pasture management and to reduce fire risk. Another study indicated that most eucalypt country in central Queensland is burnt at least once per decade, with nearly all fires occurring in either spring or summer[7]. Landscape fires are definitely more frequent and widespread after good seasons when growth provides abundant fuel, such as in the 1950s and 1970s.

Under typical weather conditions the low fuel environment in the Desert Uplands allow for fires that can be easily managed.

The Desert Uplands landscape

To manage the landscape it is important to understand the features and forces that shape its character. This section provides background on the physical and cultural landscape of the Desert Uplands, with particular emphasis on features that affect fire and its management.

"Oh well most of the desert country back in those days was used as drought relief country. And the blocks were all run in conjunction with a place on the downs. And what they tended to do – that was before my time – but they put a man on there and they used to just run enough stock to probably pay for that man. But the place was always understocked. Then when you got the drought on the downs, all the stock went up to the desert. Just to keep them alive. It was drought feed. Stock will live on the desert through a pretty dry time a lot longer than they will on the downs. They get pretty poor but they survive."

"The desert country was probably regarded - it probably still is regarded as second-rate country compared to the downs. It was cheap country. So they had big areas of it and mostly kept it as drought reserve. Because they didn't have to work it hard it tended to get overgrown. And if you didn't get a drought then you'd probably burn a bit of it."

"Jericho Shire was noted to have the worst cattle in the world."

"Mostly blocks were cut up too small. They were cut up for downs people from Muttaburra and Aramac for drought relief but they were never thought to be viable concerns in their own right."

"Up until the 1950s a lot of this desert country was only used as drought reserve. Probably the best thing would have been to keep it that way. Of course it's too late for that now."

"I've been here all my life since 1937. When we first came here it was pretty droughty sort of desert, this country was known as desert and it was, just blowing sand with coarse grass sticking up here and there. I think it probably had been overstocked with sheep for a long time."

"I think the country has probably improved a bit since we took the sheep off it."

"There seems to be a bit more guts in our box country than the ironbark country"

"Without development work there'd be no-one living here."

"Really what we need to do in this country is control the ironbark; broad leaf ironbark mainly."

"Well, the problem is you got two idiot fringes – one wants to pull everything down and the other doesn't want to pull anything. And they're both equally stupid."

"If we can't control our regrowth, not our regrowth but native vegetation well you might as well leave it now and that applies to the whole north of Australia actually."

"Spinifex is a great drought feed because it hangs in there where buffel won't necessarily successfully strike."

"There probably was a bit more kangaroo grass before the sheep ate it out."

"As far as I can see the only saviour of this country is buffel grass– it's the only way that anyone can ever make a living. I mean no-one could make a living on this country until we had buffel grass and then gradually everyone had enough buffel grass to wean their weaners onto and gave a little bit of income but before that you had to get your weaners off your cows and get them onto downs country or something like that because you couldn't keep them here or they'd die."

"I know EPA don't like buffel grass but the point is that if buffel grass wasn't there it'd be a dustbowl. I just don't know what conservationists want to conserve. You know, do they want to conserve bare ground and dust storms?"

"Buffel does die in a drought. It needs rain every 200 days so if you get less than say two drops of rain in a year your buffel will die."

"I don't think buffel will take over this country because everything eats it first."

"Some virgin ironbark has all buffel underneath it. The buffel there is healthier than in the pulled country – its greener cos there's more shade."

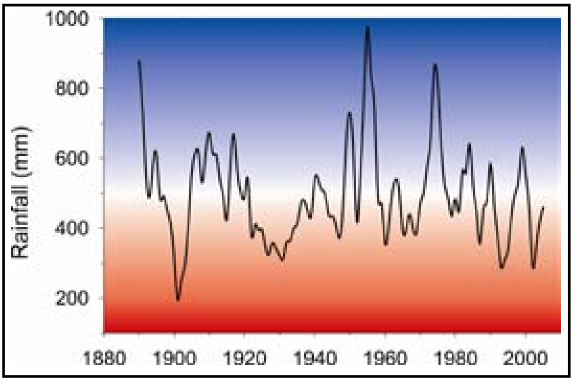
"Depending on soil type cattle don't necessarily go for buffel if they have a choice."

"Buffel stabilises soil."

"Buffel's taking over this desert country."

"Buffel will form a monoculture and take out all the little herbs and legumes. What you gain in bulk you lose in diversity and that's a big price to pay."

The Desert Uplands region[8] in central Queensland is characterised by a hot, semi-arid climate, sandy infertile soils and eucalypt woodland with spinifex in the understorey. These characteristics give the region a 'desert' feel, despite the Desert Uplands having far more rainfall than other 'deserts'. The total rainfall is between about 400 mm and 600 mm per annum with typically 50% falling in one summer month. However, the historical rainfall data shows that years with average rainfall are not normal with the worst drought on record, often referred to as the Big Drought or Federation Drought ending about 1904. That drought had nine consecutive years of below average rainfall. The 18 years prior to 1939 also had below average rainfall but this was less intense than the earlier drought. By contrast the second half of the twentieth century included the wettest times with exceptional periods of rain in the 1950s and 1970s but also two substantial droughts between 1992 and 2002.



Moving average (3-year) rainfall for central Desert Uplands. The average rainfall is 495 mm with drought indicated by increasing intensity of red and the wet times by increasing intensity of blue.

The Desert Uplands is sandstone tableland with its eastern boundary being the Belyando River and western boundary formed by the Mitchell grasslands. Extensive sandsheets have formed infertile and poorly structured soils. The sandsheets mostly support silver-leaved ironbark (*E. melanophloia*, *E. whitei*) woodland with bloodwood (*Corymbia clarksoniana*, *C. dallachiana*) occurring as scattered individuals. Large areas of country also support box (*Eucalyptus populnea*, *E. brownii*) woodland. The box soils tend to have 'sodic' sub-soils (meaning high levels of free sodium), which impedes drainage and limits root penetration. The top soils tend to be loamier and have slightly higher fertility than ironbark woodlands.

Exposed sandstone ridges and ferricrete scarps with skeletal soils support scrubs of lancewood (*Acacia shirleyi*) or bendee (*Acacia catenulata*). The most infertile soils are the red sands dominated by yellow jacket (*Eucalyptus similis*). Heart-leaf poison bush can occur amongst the spinifex tussocks in yellow jacket country and is sufficiently poisonous to stock that it requires careful management.

On floodplains and some other situations, clay or loamy soils occur and these are the most fertile in the region. These fertile soils support gidgee (*Acacia cambagei*) or blackwood (*Acacia argyrodendron*) scrubs which have been extensively cleared for buffel grass pasture. Coolibah (*Eucalyptus coolabah*) occurs on the most active floodplain areas and watercourses may be fringed with blue or red gums (*Eucalyptus tereticornis* or *E. camaldulensis*) or paperbarks (*Melaleuca fluviatilis*).

Within the typical ironbark and box woodlands of the Desert Uplands there are a host of trees and shrubs[9]. Of greatest interest to the pastoralist are the species that have either feed value or threaten pasture production when they proliferate as woody weeds. Important fodder species include ironwood (*Acacia excelsa*), kurrajong (*Brachychiton populnea*), prickly pine (*Bursaria incana*) and supple-jack (*Ventilago viminalis*), but even leaf litter including that of eucalypt trees provide a component of the diet of cattle.

However, some trees and shrubs are perceived as 'woody weeds' because they can dominate and reduce pasture growth. Increases through time in the abundance or size of woody species is known as 'vegetation thickening'. The trees and shrubs of greatest concern are the dominant ironbark and box eucalypts, mid-storey shrubs such as false sandalwood (*Eremophila mitchellii*), wattles (most commonly *Acacia cowleana, A. elacantha, A. laccata, A. leptostachya, A. melliadora* and *A. tenuissima*) and currant bush (*Carissa ovata, C. lanceolata*) which forms a characteristic low spreading thicket. A particularly common shrub that seems to have limited browse value and is not usually recognised as a woody weed is the desert oak (*Acacia coriacea*).

The most common and useful native pasture grasses include soft spinifex (*Triodia pungens*), blue grasses (*Bothriochloa* spp., *Dichanthium* spp.), golden beard grass

Yellow jacket (*Eucalyptus similis*) woodland occur on very infertile soils. Heart-leaf poison bush (*Gastrolobium grandiflorum*) naturally occurs in this land type and can be poisonous to stock.

(*Chrysopogon fallax*), kangaroo grass (*Themeda triandra*) and black spear grass (*Heteropogon contortus*). Wire grass (*Aristida* spp.) and wanderrie (*Eriachne obtusa*) are also common but of little pastoral value. The spinifex forms a 'hummock', while the other grasses form 'tussocks'. Wherever the soils become loamy the spinifex seems to drop out. However, throughout the Desert Uplands there are areas of sandy country dominated by spinifex hummock grasses, or tussock grasses only, or mixtures of the two types. These patterns do not seem to have much to do with soil type and as we shall see later in the booklet may partly result from fire history.

African buffel grass seems slow to establish on the infertile soils typical of the Desert Uplands. Addressing vegetation thickening and establishing buffel grass have been major motivations for land clearing. In undeveloped eucalypt woodland the establishment of buffel grass is patchy and most obvious where there is some enrichment of nutrient such as under trees. There is no doubt that once established, buffel grass is an asset for pastoralism because of its bulkiness, relatively high protein levels, resilience to grazing and capacity to respond rapidly to small rainfall events. Despite this it does diminish the diversity of forage[10], which is probably important for soil and animal health.

The acacia scrubs do not grow much grass and can act as natural fire breaks. Fire occurs most commonly in the eucalypt country where perennial tussock grasses provide the fuel. Soft spinifex burns particularly well because it retains its bulk from one year to the next, forms 'hummocks' with an open structure and has a highly flammable resin. The extra bulk of buffel grass also enhances burning compared to native tussock grasses.

Fuels can be dramatically reduced in low rainfall years and particularly with

This paddock at 'Glen Innes' in the southern Desert Uplands has been rested for almost three years with close to average rainfall. Fuel loads are about 1.5 tonne per hectare of grass and 1 tonne per hectare of leaf litter, and could only carry a fire during hot windy conditions.

grazing. Grass fuel loads can be very slow to recover because of the infertility of the soils. Paddocks have been rested for three years within a grazing trial in south-east of the Desert Uplands. Despite close to average rainfall during those years, grass fuels are not much more than a tonne per hectare and are insufficient to carry a fire. Where neither spinifex nor buffel grass are abundant, effective burning may only be possible after wet years.

Burning at the 'Wambiana' grazing trial in the northern Desert Uplands (Photo: Peter O'Reagain)

Vegetation thickening and dieback

Many landholders are concerned about increases in trees and shrubs in their grazing lands. Before we discuss the effects of fire on woody plants in the next section, here we summarise information on the rates of both growth and death of woodland trees and the effect of climate on woodland structure.

"Taking sheep out of the country is the reason that it has thickened. Sheep eat out everything, including young ironbarks. Sheep drowned in the 1950-51 flood and people started to give up on them after that. Sheep would never be any good in this country 'cos of the dingoes and black spear grass too. After the sheep left that's when the country thickened up."

"The country has definitely thickened up according to all the photographs I've got. Yes, and the old land surveyors on their original maps had 'open forest country' marked for big areas on the paddock we've got and as you've seen a lot of that country is so bloody thick you can't get through it. And most of that has come since about 1950 with the big rainfall years we had. Before that the country was pretty open. We had that massive rainfall about three years running and most of those suckers sort of started then and they've grown up and they've died back periodically in a dry period and then they've shot again from the roots and every time they do it they get thicker and they've never actually had a complete disaster where they've completely died. Even now we thought they were dead before Christmas and they've practically come back to life again. So I mean next time we get a wet season they're going to be just so thick like hairs on a dog's back. But they are so thick they'll never grow into big trees - just completely stunted. They're woody weeds. And that's what really gives me a pain in the arse - this bloody stupid Government banning all development - because I mean if we can't control those ironbarks you know as thick as they're coming up you might as well walk off. We can hardly run a beast in that country."

"The country's thickened up because we don't get big hot fires these days for whatever reason – no grass, roads acting as firebreaks, you name it."

"I've never seen ironbark seedlings. I reckon they must come up during the really wet times like the 1970s."

"The drought will kill more ironbarks than a fire."

"Ironbark thickened with the first round of drought say back in 2001. Then they came back, died back again the next year, came back a bit, died back again the next year and this year might knock them back for good."

"Trees many hundreds of years old died recently so we haven't had a drought as bad as this one for hundreds of years."

"The drought in my father's time killed 15% of trees. This last one killed 85%. The point being that grazing without respite has denuded ground cover to such an extent over so long that the soil surface has changed. We've lost a lot of soil to erosion and much less infiltration with it, so effective rainfall is even less now."

There is a widespread perception throughout the rangelands that timber has thickened during the period of living memory. Rates of vegetation thickening in Queensland's grazing lands have been described from aerial photography[11] and by permanent monitoring field sites[12]. These studies clearly identify that vegetation thickening has occurred, although the averaged rates represented by these studies range from slight to substantial. Average values mask the fact that some sites have undergone thickening, whereas others are stable or have lost tree cover during the second half of the twentieth century. The results raise an important question: Is vegetation thickening a result of management, rainfall patterns or some other factor?

There are large areas of tree dieback after the recent droughts throughout the Desert Uplands.

The pattern of woody vegetation change seems to match the historical pattern of rainfall. A survey in the northern Desert Uplands to Townsville region indicated that over a quarter of the woodland trees (measured as the area of the cross sections of the trunks) were killed during the 1992-1996 drought (see graph on p.11)[13]. Ironbarks were particularly susceptible, bloodwood trees more resilient and some species, like whitewood (*Atalaya hemiglauca*), were barely affected. Such mortality rates are greater than any reported fire-related mortality of eucalypt trees[14].

As the rainfall history on p.11shows, the Big Drought that ended about 1904 was even more severe than those of recent times. The effect on woodland trees must have been dramatic and is described in the memoir of Christison[15] the original lessee of the Desert Uplands property 'Lammermoor':

'The country along Tower Hill Creek and from Torrens Creek to Richmond was nothing but a desert. No storms fell there, bringing relief, but whirlwinds churned and worried the earth, drying up waterholes and silting up tanks. Even the lean, enduring ironbark tree died - stark witnesses to the consuming drought.'

'…now they confronted the record of five years of drought in the dead trees that still stood up from the silvery grass for miles and miles, black trunks grotesquely abbreviated, for winds had whipped away the branches. Mimi was appalled by the sight: "Surely those trees have not been killed by the drought?" she said, but her father did not answer. Some day when people start burning off the dry grass a bush fire will be started which will destroy these skeletons of ironbark forest, and with them the last traces of the Big Drought will disappear.'

The 1950s were spectacularly wet and so extreme that it seems likely that 100 years or more will pass before such sustained high rainfall will re-occur. Given that the droughts of the early pastoral period were severe enough to cause a substantial opening up of the country and that germination and growth of woody plants would likely have exploded during the 1950s it is probably not surprising that woody thickening has occurred since. The thickening period coincides with the memory of older landholders, and explains why it is a dominant image of the changing Desert Uplands landscape.

Another factor affecting both thickening and dieback is how crowded the trees are in the first place. It seems that relatively open areas have a greater likelihood of thickening up and that thickened areas are more susceptible to dieback after drought[16]. Soil structure and depth may also partly explain local patchiness of drought related dieback[17].

Controlling woody plants with fire

A big question for pastoralists is the extent that burning can control woody plants. This section collates people's experiences and some results from trials across northern Australia.

"If I had my time again I'd light up on a stinking hot windy day and just let her rip, aye. That'll clean the country up. Mind you, the neighbours might not like it."

"You can't control those thick trees with fire 'cos no grass will grow once it gets that thick. You can't get thick enough grass to grow unless you shut it up for five or six years, but who wants to do that?"

"I don't think you'd kill even a pole-sized ironbark with fire. Waste me time."

"I've seen no effect of fire on the density of timber."

"If you burn say in August/September when there's no soil moisture you can kill ironbarks, but it will occur at the expense of the grass. To keep your grass you should burn a day or three after an inch or two of rain, but you won't get as good a kill of the trees."

"Hot fires from dry storms can kill trees – from 1 out of 3 trees to even more in patches."

"A hot fire is one way of controlling regrowth."

"To get a really hot fire you have to de-stock it well."

"Once timber gets the upper hand you can't reverse it with fire 'cos you don't have enough fuel. In areas where grass has the upper hand it tends to stay that way too. Moisture doesn't get far down in the soil when there's heaps of grass so therefore it reduces the vigour of the trees in normal years. Usually enough trees survive drought to keep the upper hand. But where drought has really thinned them out, you might then get a winning fire."

"I've never seen ironbark seedlings but they may only occur every 30 years or so."

"Fire may kill ironbark seedlings but only if they are less than 10 inches high; by the time they get as thick as your little finger you're too late and they're away."

"We cleared some timber, pushed it to one side, burnt it, and around the edge of that heaps of ironbark seeds had germinated. Not in the hot centre of the fire which had evidently killed the seeds, but in the cooler fire around the edge we got a nice ring of ironbark seedlings."

"If you see a currant bush 6 foot round and high you know that country needs a burn. Fire won't kill it but it'll peg it back."

"You used to be able to see the range from a mile and a half out and then you couldn't because of the wattles. This was in the 1950s. There was a kanaka living in a hut and he used to burn all the time - the wattles came up thick. Since then someone else has been managing that patch. They put a cool winter burn through the wattles and that's thinned them out and you can see the range again."

"Wattles can be killed by a hot fire, but then the seed germinates like hairs on a dog's back."

"Your best hope with wattles is to germinate the seed with a burn before summer and hope for some scorching weather that will kill the young trees that come up."

Typical low intensity grass fires may knock ironbark and other suckering species back to ground level, but it will only kill a relatively small percentage of trees. Data from 'Wambiana', near Charters Towers found that a 'hot' fire (4 tonnes/ha fuel load, strong breeze, 30-35°C air temperature and flame heights between 3 and 5 metres) caused small amounts of death of silver-leaved ironbark trees of any size[18]. A few trees of all size classes did die, but the numbers of very small eucalypts (<0.2 m tall) approximately doubled through resprouting of top-killed individuals. This seems to be a typical pattern for woodland eucalypts. Hot late dry season fires in Kakadu killed 60% of young eucalypt stems but after resprouting about 80% actually survived[19]. Germination also increased numbers of small trees at 'Wambiana', which in the case of silver-leaved ironbark occurred in both ash and non-ash areas.

Eucalypt seedlings are only rarely seen and may be the only lifestage that is vulnerable to burning (Photo: Peter O'Reagain)

Pole-sized ironbark thickets are very difficult to manage with fire. Fuel loads are reduced and the thick bark is a very effective insulator.

It is possible that more than one fire is necessary to thin out the trees. The effect of four fires in six years on tree survival has been monitored north of Charters Towers[20]. For young and old ironbarks and other woodland trees, survivorship seemed to be most strongly related to the intensity of drought and burning had little effect on woody plant density. While each burn killed a small proportion of individuals, their numbers were generally matched by germination or suckering of existing individuals. Perhaps repeated burning does have an effect but only with persistence over longer time frames.

The evidence suggests that burning *per se* is not very effective at killing woodland trees and shrubs. Perhaps fire in combination with drought could result in a more effective kill, but unfortunately there is little fuel during drought. It seems likely that a critical time for burning is when trees and shrubs are very young. In southern Queensland, a high proportion of eucalypts less than 18 months old were killed by a low intensity fire, and their resilience greatly increased with age[21].

Fire can be used to temporarily reduce the cover of currant bush, but it is difficult to kill[22]. Wattles have a distinctive response in relation to fire that was consistently reported and recognised by graziers. The wattles include a number of separate species but they are all short-lived (generally less than 12 years). Wattles have a hard seed that lies dormant in the soil until triggered to germinate by the heat of a fire. It seems likely that wattles can be killed by fire, so it may be possible to manage wattles by repeated burning if the interval between fires is less than the time it takes for young wattles to set seed[23]. This may not always be realistic given insufficient fuel development during the 2-3 years before the wattles set seed, and it is likely that not all wattle seed will germinate with a single burn. Some plants are sensitive to fire, such as rubber vine (*Cryptostegia grandiflora*)[24] that has taken over watercourses in the northern Desert Uplands.

Wattle can germinate in dense stands after burning. The trees in the photo have seeded within 3 years of germinating and will form a dense but short-lived stand.

Fire and pasture

Of all the topics covered in this booklet, the issue of fire and pasture seems to have generated the greatest wealth of commentary and greatest diversity of experience and opinion.

"It's a real mystery you know. In all my years in this desert country I can't say I've ever seen spinifex getting away from seed."

"It's one thing to let your grasses go to seed. But with spinifex you need to look after your tussocks."

"Sheep left in 1974. At that point the shearing paddock was so flogged there were less than a dozen spinifex plants in the 300 acres. 32 years later still without stock the spinny is about halfway there."

"You get a hot fire on a day like today and the clay in the soil will just bake like a clay pot, you know, and nothing will grow in it."

"I'm a big advocate of burning spinifex but reckon you can only burn it once every three or four years because that's how long it takes to grow big enough to get enough fuel to carry a fire. You know, it spreads out and gets all this grey stuff on it. That's the stuff you don't want. You want to keep it in good nick."

"With the burning of rank unpalatable grass, stock will turn to the green-pick and allow for the growth and rejuvenation of the softer grasses in the unburnt areas."

"A hot fire can knock out spinifex. So burn when there's a bit of moisture in the ground – 1 or 2 inches. Basically burn after the first rains in spring and it all should live. The fire might be hot but there's sufficient moisture in the ground for the plants when they start regenerating to grow. And you don't want a fire in that sort of country when there's no moisture in the ground because they'll start to regenerate and won't be able to."

"We don't go out of our way to burn - only if it's been a really good season and there's surplus feed do we bother. When it's rank really, and even then only after a bit of rain."

"If you value your pasture and want it to recover you really, really have to get rain in the few months after the burn. If you don't get rain within 6 months of a hot fire then you're looking at years and years of recovery. But if there's a bit of moisture in the ground the spinifex will come back quick."

"You will get a hot fire in spinifex regardless of whether it's green, and particularly if it's in seed. It won't necessarily die if there's no soil moisture but fire can encourage some of your less palatable grasses like wire grass."

"Doesn't matter if the fuel is sparse as spinifex burns hot and will create its own wind. Hot fires can do something bad to the soil - there are patches where nothing grows afterwards."

"Spinifex is a funny thing; one day you might say it's going to burn well today, and it doesn't, then two days later when conditions are apparently the same it burns like buggery."

"You need to spell spinifex after a burn because it gets kicked over, and runners can't establish with cattle. You also need to burn when there's soil moisture for recovery not death. If you patch burn you need to spell as those burnt areas get eaten out."

"Spinny roots can be 10 feet down in ironbark country with deep red gravelly soil. It can recover quickly in these situations, but in the box country infiltration is less and spinifex has slow growth. Your burning cycle is longer in this country and you need to spell it longer too."

"The little tussocks as big as your thumb at the base can survive a cool fire, but not a hot one. Fist size tussocks can survive a hot fire."

"If you burn it too much … then you run out of feed don't you. You got to have a bit of a guess at that."

If you really hammer spinifex country you'll knock it back and then you get the really undesirables, wire grasses and the like."

"I prefer to save my grass although fire can be used to get rid of rank stuff after exceptionally good seasons perhaps, or maybe two."

"You don't want to burn grass on creek flats … due to subsequent erosion."

"In my capacity as Fire Warden I haven't been busy this year. People want to see grass – they don't want to burn their grass away and not have it come back, or they haven't got the fuel or time to burn."

"No-one desires a hot fire because they can't manage them, although with hindsight I'd let more fires go and not try and put them out."

"I'm not keen on burning, I like wildflowers and a bit of browse for the dry times."

"Fire does more harm than good in this sort of country because many of the scrub species are edible, for example ironwood, acacias, box leaves."

"I'm not particularly pro-fire because I don't see it has any effect on woody vegetation thinning. Currant bush is good for browse and water infiltration, and I want to keep the leaf litter, detritus etc. which a) builds up without fire and b) blows or washes away after fire has exposed it."

"Fire releases nutrients into the atmosphere, reduces mulch and therefore soil health. The soil surface is exposed after fire, dirt and nutrients wash away then moisture retention and infiltration are reduced."

"Fire can't kill buffel."

"It was hot enough that only branches bigger than fist diameter remained on the trees. .... Buffel lived through it and is growing thicker than ever in the new ash nutrient bed ... so we should be burning hotter."

"The buffel seed remains viable for two or three years and can live through fire before germinating. You get a hotter fire through buffel than your native grasses."

"You can't ever have a cool burn in buffel."

The soft spinifex of the Desert Uplands is a characteristic grass of the region and one of the important pasture species. There are far more palatable grasses around, but it is well regarded as a drought feed because it is hardier than other native or exotic grasses. Its large seeds are particularly nutritious and will keep stock in good condition.

Some spinifex species regenerate from seed after fire, but the soft spinifex of the Desert Uplands relies on regeneration from underground buds that are capable of surviving burning. This spinifex can also regenerate from aerial runners. The rarity of spinifex seedlings in the Desert Uplands is a curious fact confirmed by years of observation by many graziers.

Healthy spinifex pasture under ironbark woodland in the northern Desert Uplands. This site was burnt five years previously and has been moderately grazed.

The primary motivation for burning amongst managers in the Desert Uplands is to remove rank old grass and encourage fresh growth. To ensure a response most managers prefer to burn after the first summer rains usually between October and January when there is some soil moisture in the ground. Burning in the dry season is considered risky because the wet season rains may fail resulting in a lack of feed for an extended period. Furthermore it is considered undesirable that bare ground be left for any length of time where it may be exposed to erosion particularly during the intense storms at the start of the wet season.

Stock and other grazing animals are strongly attracted to the green growth of freshly burnt grass suggesting some nutritional benefit. Information from the Desert Uplands is lacking but elsewhere in northern Australia the green-pick of spinifex and other grasses has a higher content of the important nutrients nitrogen and phosphorus than unburnt tussocks[25]. Live-weight loss during the dry season may be minimised if stock have access to previously burnt pasture[26]. However, the results also suggest that the enhanced nutrition of burnt grasses is short-lived and has well and truly subsided within a year. If burnt paddocks are rested for too long, the nutritional benefit of burning will be lost, but heavy grazing without resting a burnt paddock may result in reduced regeneration capacity.

In a paddock that has been patch burnt, the attraction of stock to freshly burnt ground means that the effective stocking rate is much higher than before the burn. Thus in order to maintain the same stocking rate in a paddock after a patchy burn, stock numbers should reflect the area burnt. By the same token, unburnt areas can be effectively rested[27].

Generally it takes around 3-6 years for spinifex to accumulate enough dry matter to burn, with most people burning to reduce this dry matter and promote fresh pick every 4 to 10 years. The frequency is determined largely by rainfall and stocking density. There was a diversity of views regarding the response of spinifex to burning with low soil moisture, with some land managers claiming it could kill spinifex and others attesting to its resilience. There is a general consensus about some aspects of spinifex ecology and management in the Desert Uplands:

- Spinifex grows slower than all other pasture species, responds better to winter rain, can burn when green, and burns hotter than other grasses.
- Spinifex does recover and respond well to cool fires after the first rains of summer. However, there is a widely held view that very hot fires can kill spinifex tussocks less than fist size in diameter. In such cases it has taken at least several decades for the spinifex to regain its former density.
- Spinifex health appears to be influenced more by what happens after a fire than by the fire itself. Several examples were cited of spinifex regenerating extremely slowly in overgrazed areas. Trampling by stock can impede the establishment of runners, and smaller tussocks are susceptible to being uprooted. Given the very low or non-existent recruitment by seed, these factors are extremely important. To this end, some graziers de-stock a burnt spinifex paddock for many months in good seasons, and maybe several growing seasons in a run of dry years.

Monitoring of individual plants of various species before and after a burn in the Desert Uplands indicated that a very high proportion of tussock grasses survive fire[28]. However, fire can damage spinifex and this may partly explain why it is absent in some areas that seem to be suitable. Burning can also cause short-term changes in the composition of herbage[29]. Many palatable and nutritious native legumes for example will germinate with burning and can become abundant immediately after a burn[30].

Some graziers have witnessed curly wire grass (*Aristida jerichoensis*) disappear after a hot fire and some had seen it come back 'stronger than ever'. Studies from the Burnett District suggest that early spring burns decrease the density of wire grass and encourage more palatable species[31]. Positive effects from decreased wire grass were compromised by grazing over the subsequent growing season.

Post-fire pasture recovery is strongly dependent on rainfall and the dry run of recent years has resulted in some bad experiences with burning. As part of a trial at 'Wambiana' in the northern Desert Uplands, a mixed pasture (wire grass, black spear grass, wanderrie) site on yellow earths recovered rapidly after a burn in 1999 that was followed by a short spell of 2 months and decent wet season rain[32]. The same site was extremely slow to recover after a November 2002 burn despite adequate soil moisture at the time and a 6 month wet season spell. The fire was followed by very hot dry December-January weather. The burn may have left the site particularly exposed and resulted in surface soil conditions that killed remaining plants and made recovery from seed very difficult. On more fertile, heavy clay soils in the same paddock, pastures did recover well after the same fire.

Long-term changes in pasture composition seem more likely to result from stocking strategies than fire. It is widely accepted that overgrazing can result in the replacement of palatable perennial grasses with less palatable grasses and annual plants that result in pasture production declines[33]. However, animal production is not necessarily highest on pastures with a bulk of palatable grasses that would normally be identified as in 'good condition'[34]. As for green-pick after fire, pasture cropped by grazing is generally more nutritious than lightly grazed pasture[35]. However, the combination of burning followed by overgrazing results in the long-term exposure of bare ground and increased run-off and soil movement[36]. Simulated overgrazing of burnt patches in eucalypt woodlands on red earth near Katherine created semi-permanent bare scalds[37].

Buffel grass responds rapidly and vigorously to burning. Buffel has spread within the Desert Uplands over recent decades and is still expanding with and without deliberate effort. In the southern parts of the region where development has been more advanced, large areas are almost exclusively dominated by buffel grass. On gidgee soils burning can encourage buffel grass[38], but the influence of burning on buffel grass on the less fertile eucalypt woodlands remains to be seen.

Fire and wildlife

Most pastoralists watch their cattle rather than the other animals that live in the bush. Even with a keen eye, most of the wildlife is too secretive to be seen regularly, especially during the hot part of the day. Nevertheless the creatures of the Desert Uplands are an important part of the environment and should not be forgotten.

"No-one wants a wildfire because you kill so much wildlife and all sorts of things you don't want to kill."

"Roos were in extreme numbers in the early '60s after the very wet '50s, and haven't been seen in such numbers since. They have been knocked about by the recent drought and are not much of a problem."

"11,000 kangaroos and macropods – you get all sorts here - were shot here in 18 months in the early 1960s"

"I've seen kangaroos on fire."

"There seems to be more lizards in this ungrazed paddock."

"If you've got a patch of burnt ground, half the roos in the district will be camping on it."

"The roos don't like rank feed, cattle can eat it, but the kangaroo is pretty fussy about that."

"You do see little rats and things running out of the spinifex as the fire goes through."

You'll always get chicken hawks coming in to hunt around the fire front."

"On freshly burnt areas I have seen rat-kangaroos feeding on the green-pick."

"The budgies and quarian move on to the fresh growth after a fire – they're in there picking up seeds."

Animals respond in their own way to the structure of ironbark woodland whether that has been shaped by drought, clearing, grazing or fire. For example a bunch of small birds prefer a well-developed shrub layer (e.g. bronzewing pigeon, rufous whistler, crested bellbird, grey-fronted honeyeater, grey shrike-thrush, little friarbird, striped honey eater, Australian owlet nightjar, pale-headed rosella, double-barred finch)[39] . Other birds do best in open environments (e.g. budgerigar, cockatiel (quarian), emu, brown falcon, nankeen kestrel, zebra finch) and have probably increased their abundance with clearing. The structure of pasture also influences the distribution and abundance of animals, with some species like the central netted dragon (*Ctenophorus nuchalis)* favouring open areas and a large skink, the leopard ctenotus (*Ctenotus pantherinus*) declining in recently burnt or grazed locations[40].

Two native mice found in the Desert Uplands today illustrate how fire and grazing in combination can affect the abundance of some species. The delicate mouse (*Pseudomys delicatulus*) feeds on the post-fire flush of grasses and seeds. The larger desert mouse (*P. desertor*) requires denser vegetation for protection, and can consume a diet of older spinifex leaves. Thus in long unburnt country the desert mouse is more abundant than the delicate mouse. However, the desert mouse takes longer to recolonise a burnt area if it is also grazed, and delicate mouse numbers can be lower in freshly burnt areas also grazed by stock.

Certainly in the case of the mice and probably most other animals, having a mosaic of habitat with respect to fire frequency will result in the greatest diversity.

The desert mouse (light brown) and delicate mouse take their turns at dominance in a habitat affected by fire.The desert mouse has already been lost from large areas of southern Australia (Photos: Eric Vanderduys and Alex Kutt)

Developing our knowledge

One of the things that became obvious during the compiling this booklet is that there are only few generalisations that can be made about burning country in the Desert Uplands. Very often the observations of graziers appear contradictory and the same can be said of reports from experimental trials. This strongly suggests that fire, soils, and weather can interact to give different results in specific circumstances. To work towards a more complete understanding there is a need for more careful observation. Rangeland scientists can contribute with carefully designed and measured burning trials. Land & Water Australia funding has helped to establish burning trials at 'Glen Innes', near Alpha. The results from these trials are yet to be realised but aim to yield further information on the use fire in the Desert Uplands. The trials have been designed to provide information on the effects of fire on woody plants, as well as the composition and quality of herbage.

The Corella paddock at Glen Innes forms the basis of a fire-grazing trial.

As observers of landscapes, pastoralists have a distinct advantage over the scientists because they have a permanent presence over extended periods of time. They can observe the effects of unusual combinations of weather and fire that scientists are poorly placed to witness. This may be especially important in the Desert Uplands where both the dominant trees and the dominant grass may only successfully establish once or twice a century. The survival of young eucalypt and spinifex seedlings may be critical for determining the structure of a piece of country for the next 100 years or more. Observations of the effects of burning during these rare events may provide us with the 'big picture'.

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