Toward sustainability for vegetation management—Mitchell grasslands

Richard Thackway, Margie Eddington, James Walcott, Katrina Burton, Ian Frakes and Lucy Randall
The Mitchell grasslands are found in the semi-arid interior of north and northeast Australia. They occur over an area of about 57 million hectares, stretching from northwest New South Wales through west Queensland and to the mid-north of the Northern Territory. There are smaller, scattered patches in the East Kimberley and the northern parts of South Australia.

The Mitchell grasslands support an extensive pastoral industry that generates more than $500 million each year from sheep and cattle products. Pastoralism occupies a large area, is highly dependent on natural resources and has a central role in land management. As such it is a critical component in the sustainable management of the Mitchell grasslands.

The major challenge for land managers is ensuring the landscape is not over grazed. Light to moderate grazing of the Mitchell grasslands can be sustainable under the right conditions, which allow other native species to persist and the ecosystem as a whole to continue.

The introduction of exotic species, especially the woody prickly acacia, if not properly managed, has the potential to threaten the biological values of the grasslands.
Aim of the Vegetation Profiles

This is the first publication in a series of vegetation management booklets to be published by the Bureau of Rural Sciences (BRS). The booklets provide factual, up-to-date information about key vegetation types in the agricultural landscape. Other editions will include temperate and tropical grassy woodlands.

The profiles are aimed at a broad audience, including primary producers, government and local government agencies, regional managers, policy-makers and the general public. They can be used as a handy reference for general interest, or as a basis for decision-making.

This profile complements another BRS publication on Australia’s rangelands Towards Sustainability for Australia’s Rangelands: Analysing the options

Acknowledgments

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The Mitchell grasslands are some of the most important and productive grazing lands in the north and northeast Australian inland. There are four species of Mitchell grasses (all in the genus *Astrebla*). The grasses grow as tussocks (Figure 1), which form the stabilising perennial component of the grassland ecosystems because they tolerate drought, fire and moderate grazing pressure. Other species grow in between the tussocks. Examples are the annual Flinders grass (*Iseilema* spp), the short-lived perennial Queensland bluegrass (*Dichanthium sericeum*), which is less widespread, and various herbs that provide valuable livestock feed after rains. There is a wide diversity of palatable species whose presence is dependent on the timing of rainfall—especially the difference between summer and winter rains. In some areas in the north, and central-west Queensland, feathertop grass (*Aristida latifolia*) is common. Further south white speargrass (*Aristida leptopoda*) occurs.

The grasslands provide several benefits including biodiversity conservation, provision of food, maintenance of soil health and carbon sequestration. They also have heritage value and support a developing tourist industry.
The Mitchell grasses

Mitchell grasses are named after the explorer Thomas Mitchell who first noted them in 1835 near Bourke, New South Wales (NSW). Indigenous use of the Mitchell grasslands centred on hunting game that grazed the grasslands, principally kangaroo, wallaby, bustard and emu. Grasses also provided an important part of the human diet, with the large seeds being used to make flour.

There are four types of Mitchell grass: curly Mitchell (Astrebla lappacea), barley Mitchell (A. pectinata), bull Mitchell (A. squarrosa) and hoop Mitchell (A. elymoides). They each grow as tussocks up to 1.5 m tall when mature, with bases from 5 cm to 50 cm in diameter. The two shortest grasses, curly and hoop Mitchell, are considered to have the best feed value, while the tallest, bull Mitchell, has the least feed value.

The Mitchell grasses have strong, deep roots that can tap subsoil stores of moisture. The roots also contain reserves of starch. After light rains, shoots appear. They can flower quickly and set seed. Heavier rains will often lead to new tillers, which grow and flower more slowly. Individual plants may live for up to 30 years.

Widespread germination occurs only rarely and seems to be associated with large volumes of rain coming after a period of drought. Some minor recruitment does occur in other years. The plants grow mainly in the summer when daytime temperatures reach 30–35°C. Growth ceases when overnight temperatures fall below about 15°C.

Where are the Mitchell grasslands?

The Mitchell grasslands cover a broad sweep of the semi-arid interior of north and northeast Australia, beginning in northwest NSW. They achieve their greatest extent in west Queensland, but also occur through the centre of the Northern Territory to the Kimberley region of Western Australia, with a small occurrence in northern South Australia (Figure 2). It is estimated that Mitchell grasslands and their related communities cover about 57 million hectares (ha) in northern Australia, which represents about 15% of Australia’s land area.

The largest contiguous Mitchell grass region extends across Queensland and the Northern Territory, and is a prominent feature of the landscape. This region is a landlocked area of 32 million ha supporting a population of 15 000 people. In 2001, this region also supported approximately 2 million cattle and 3.5 million sheep, although these numbers fluctuate during periods of low rainfall. The Mitchell grasses flourish in areas where the annual rainfall is between about 200 and 550 mm per year, and falls mainly in the summer (Figure 2). The amount of rainfall has a major effect on the occurrence and the density of Mitchell grasses, both of which decrease from north to south of the continent and towards the interior.

Distribution of the Mitchell grasses within the overall Mitchell grasslands is also influenced by soil type—hence their occurrence can be patchy. The grasses prefer heavy, cracking, grey, brown and red clays. They typically grow on open, treeless, rolling downs, where the heavy cracking clay soils and a long history of fires (before pastoralism) are thought to have limited the growth of trees. (The trees tend to be confined to less clayey soils and along watercourses.) Mitchell grassland communities are defined as those areas where Mitchell grasses are either dominant or subdominant (Figure 2). A subdominant community includes a forest, woodland or shrubland where Mitchell grass is abundant in the ground layer.

While all four species of Mitchell grass may co-occur, there are clear differences in distribution: curly Mitchell grass generally predominates in central and south Queensland and NSW; barley and hoop Mitchell grass in west Queensland and the Northern Territory. Barley Mitchell grass tends to occur more commonly on red cracking clays, which are found usually in the drier parts of the Mitchell grass regions. Bull Mitchell grass favours wetter habitats, such as flooded areas. It dominates the northern margin and other wetter locations.
Background

What is the condition of Mitchell grasslands?

The Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) has developed a detailed assessment tool for catchment managers, pastoralists and environmentalists. Using this tool, ecologists carried out an evaluation of the Mitchell grasslands. It revealed that the native vegetation cover varied from ‘residual’ (no significant perturbation due to land use) to ‘transformed’ (significant alteration) (Figure 3), as categorised by the VAST (Vegetation Assets, States and Transitions) system (Thackway and Lesslie 2005).

The VAST system can account for changes in land use and can help land managers identify areas for remediation or conservation. Most Mitchell grass pastures belong to the category of modified native (VAST II) (Figure 3), in which vegetation community structure, composition and regenerative capacity are affected to some extent by land use. Some areas, primarily around bore points, have been designated as VAST III because of greater impact from livestock concentration.

The question of grazing is central to the management of the Mitchell grasslands. The complete exclusion of grazing may be as detrimental as heavy grazing (Orr and Phelps 2003, Phelps and Orr 2003). This is a very important point for reserve management strategies.

Monitoring for more than 30 years has indicated that changes in rainfall (in particular, dry spells) can cause major changes in the vegetation types. In fact, the variability in rainfall has far more effect than grazing. Therefore, conclusions made about the dynamics of Mitchell grass pastures from short-term ‘snapshot’ observations can be misleading and inaccurate (Everist and Webb 1975).
Figure 3  Condition of the Mitchell grasslands

Note: The categories are taken from the VAST (Vegetation Assets, States and Transition) framework of Thackway and Lesslie (2005). VAST is used for native vegetation cover. The term ‘residual bare’ means areas where native vegetation does not naturally persist; ‘residual’ means that native vegetation community structure, composition and regenerative capacity is intact, i.e. with no significant perturbation from land management practices; ‘modified’ means intact community structure, but perturbed by land management; and ‘transformed’ means significantly altered by land management.
Values and uses

Pastoralism

The Mitchell grasslands are an important part of the chain of agricultural industry and have a significant role in the sustainability of pastoralism and agri-business throughout Australia. The use of the grasslands as a resource has effects on the movement of stock through both domestic and international markets and the supply of grains for feedlot stock. In Western Australia (WA), Northern Territory (NT) and northern regions of Queensland, the grasslands are used almost exclusively for breeding and/or the fattening of cattle, which are often finished in feedlots. These livestock industries generated more than $500 million from the Mitchell grasslands in 2001.

Most of the Mitchell grasslands are managed under pastoral leases. Leases vary considerably in size, from about 5000 ha in southeast Queensland and NSW to over 1 000 000 ha in northwest NT. Much of northwest Queensland and the Barkly region of NT are operated by large pastoral companies such as Australian Agricultural (AA Co.) and Northern Australian Pastoral (NAP Co.).

Pastoralism has a long history in most of the Mitchell grasslands. Pastoral enterprises were first established in northern NSW in the late 1850s; in central-west Queensland during the 1860s-80s; and in the Ord, Western Kimberley and Victoria River regions of WA in the late 1880s. The extent of grazing activity was initially limited by the distribution of natural water sources, such as creeks and rivers, some of which were dammed, e.g. in the Barkly region of NT. Grazing spread more widely and evenly with the use of artesian water, e.g. in Queensland. Watering points, facilitated by polythene piping, are now sufficiently well spread throughout the Mitchell grasslands such that the entire landscape is potentially accessible to stock. Artesian bores are being capped to help conserve water sources.

Mitchell grasses are most productive under moderate grazing pressure. In this situation, about 30% of their biomass is consumed over a year, leaving around 15-20 cm of residual tussock. This practice provides a balance between consumption and conservation, and approximates the effects of recent historical fire regimes of around 7-10 years. When the plants are green, livestock generally graze the short-lived annual species (forbs) that grow in between the Mitchell grass tussocks. The Mitchell grasses’ main advantage as livestock fodder is their persistence through prolonged dry seasons.

The Mitchell grasslands can support about one sheep per 1-2 ha or one head of cattle per 10-15 ha, although these numbers are only an average and can vary significantly in different seasons. The stocking rates tend to be higher to the south (Table 1), where a longer growing season provides a more varied diet than in the northern areas.

As noted earlier, Mitchell grasses can be damaged by heavy grazing which contributes to progressive depletion of root reserves. Provided this is not too severe, the plants may recover if there is above-average summer rainfall. On the other hand, there is some evidence that without enough grazing the grasslands may suffer from insufficient nutrient cycling. When this happens, the Mitchell grasses may senesce and annual species or perennial wiregrasses will gradually replace them.
Table 1  Changes over 15 years in livestock features in some representative shires of the Mitchell grasslands

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<tr>
<td></td>
<td>Stocking rate (DSE/ha)</td>
<td>Sheep (% DSE)</td>
<td>Value of livestock ($ million)</td>
<td></td>
</tr>
<tr>
<td>Walgett, NSW</td>
<td>0.83</td>
<td>1.15</td>
<td>0.89</td>
<td>0.78</td>
</tr>
<tr>
<td>Longreach, Qld</td>
<td>0.50</td>
<td>0.66</td>
<td>0.42</td>
<td>0.78</td>
</tr>
<tr>
<td>Boulia, Qld</td>
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<td>0.20</td>
<td>0.22</td>
<td>0.28</td>
</tr>
<tr>
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<td>0.21</td>
<td>0.27</td>
<td>0.31</td>
</tr>
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<td>79.6</td>
<td>73.3</td>
<td>55.4</td>
<td>45.9</td>
</tr>
<tr>
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Note: livestock numbers fluctuate and often follow trends in seasonal rainfall. Total stock density is quoted in dry sheep equivalent (DSE), where 8 sheep are equal to 1 head of cattle. For example, the Walgett Shire shows that in 1986 there was 80% sheep (20% cattle) and by 2001 this had changed to 46% sheep (54% cattle). Source: Australian Bureau of Statistics, AgStats.
Values and uses

Pasture variability

It is possible to estimate the increase in Mitchell grass growth after rainfall by using satellites which measure changes in greenness (plant biomass production) over time. (This is known as remote sensing.) In northern Australia the peak of production occurs in late summer (most commonly in March each year, but any time between January and April is possible). The total amount of biomass produced, as well as the species composition of the vegetation, can vary considerably from year to year.

Biomass production can be correlated with general stock levels. For example, in Table 1, a lower stocking rate was recorded in 1996 than in 2001 for the Longreach and Boulia areas in Queensland, both located within the Mitchell grasslands region. This mirrors the estimates of pasture biomass production. Naturally, stock numbers tend to build up after a series of wet years and reduce in drier years. Remote sensing also shows that biomass production may vary considerably between seasons.

It should be noted, however, that we still need ‘on the ground’ observations to check remotely sensed data. If ancillary information about other factors that affect greenness—such as fire, hail or storm damage, or locust plagues—is used in conjunction with the data from remote sensing, an even more accurate picture of the landscape can be obtained.

Kangaroos also contribute to overall grazing pressure and must be accounted for in property management, especially in more southerly reaches.

Fire

Fire is rarely used as part of a management strategy in the Mitchell grasslands, although originally it would have been part of the natural ecosystem (Figure 4). Although fire can remove undesirable pasture species, such as feathertop grass, and improve the quality of pastures when they recover, burning is no longer carried out. This is because the grass is considered too valuable and, where seasons are unreliable, the fires are deemed to be too risky. Firebreaks are commonly established to protect against uncontrolled fires in the dry season.

There is currently some re-assessment of this ‘no fire’ strategy. Exclusion of fire over many years is believed now to have encouraged the expansion of gidyea (Acacia cambagei) which tended to be suppressed under pre-European fire regimes.

Water distribution

Managing the distribution of water is critical in a semi-arid area such as the Mitchell grasslands. During the dry season, cattle graze mainly within a 5 km radius of water. This limitation on the movement of cattle therefore affects grazing intensity in different areas. As the region partly sits on the Great Artesian Basin, many producers have in the past relied on bore drains. However, at present, there is a partly subsidised push for producers to cap these bores and pipe in the water so as to reduce loss by evaporation. Optimum spacing of watering points depends on fence locations and distribution of preferred pasture types. Polythene piping of water after bores have been capped will probably give just as thorough grazing distribution as has occurred in the past with bore drains.
Fauna/habitats

The Mitchell grasslands have a distinctive ground fauna, notable for a very high diversity of large endemic reptile species (such as the very large lizard, Spencer’s monitor, the speckled brown snake and Ingram’s brown snake), very high densities of the several grassland birds (such as the singing bushlark, brown songlark and a number of quail species) and small marsupials (such as the long-tailed planigale and the endangered Julia Creek dunnart). The grasslands themselves are also a major summering ground for some migrant birds, such as the little curlew and oriental pratincole.

Variability in rainfall can cause dramatic changes to the native ecology of the Mitchell grasslands. Populations of the long-haired rat, flock bronzewing and letter-winged kite, as well as locusts and grasshoppers, respond to these events.

Figure 4 Extent of fire affected areas in Australia compared to the distribution of Mitchell grasslands (pink)

The wet season, and the accumulation of water in any depressions in the otherwise typically flat terrain, brings high densities of some burrowing frogs. Filled depressions also become important breeding areas for waterbirds, such as pelicans, ibis, herons, terns and ducks.

At Pigeon Hole, southwest of Katherine, grazing trials are currently under way to monitor cattle and pasture grasses, as well as insects, reptiles and marsupials that share the paddocks. It is hoped that results from this work will help land managers to improve biodiversity conservation when making grazing decisions.
Values and uses

Conservation reserves

A relatively small area of Mitchell grassland (about 4127 km² or 1.31% of the total area) is currently included in the national conservation reserve system. Representative areas of the Mitchell grasslands should be managed to preserve the environmental and biological variation within this region. Australian Government agencies are working with pastoralists and other interested groups to maintain significant areas as open, perennial tussock grassland. This would allow sufficient grazing to maintain the vigour of the Mitchell grasses, while reducing the need for fires to maintain ecological integrity. Total exclusion of livestock may be detrimental, as demonstrated by Orr and Phelps (2003).

Other

Significant marine and land fossils preserved in deposits in the region are attracting increasing interest. The excavation of dinosaur fossils, especially in the areas of Muttaburra and Winton, in Queensland, has expanded our understanding of Australia’s palaeo-history.

The fossils and the outback pastoral experience are a focus for tourism in the area.

The Mitchell grasslands support an extensive pastoral industry
Responding to environmental pressures

Pastoralism is critical to the ecological sustainability of the Mitchell grasslands because of the large area it occupies, its dependence on natural resources and its central role in land management.

Pastoralism of the Mitchell grasslands can be sustainable, if it is not intensive, and economic resilience and stability can be achieved along with regional persistence of native species and the maintenance of other ecosystem services.

Although the grasslands are renowned for their resilience under light to moderate grazing and variable rainfall, overgrazing poses a definite threat. The introduction of exotic species, especially the woody prickly acacia, if not properly managed, has the potential to threaten the biological values of the grasslands.

Overgrazing

Increasing stocking rates are a significant threat to these pastures. Mitchell grasslands can become degraded, with an increased risk of desertification if the stocking rate is heavy in relation to available pasture, particularly if there is a series of dry years. Areas around watering points are particularly vulnerable to overgrazing.

Managing kangaroo numbers is also important, particularly in the south of the region where their numbers are far greater than in the north.

Invasive species

The invasion of introduced weeds is a significant threat to production and biodiversity in the Mitchell grasslands. Large areas of grassland are being taken over by weed species such as prickly acacia (Acacia nilotica) and to lesser extents parkinsonia (Parkinsonia aculeata) and mesquite (Prosopis spp).

Prickly acacia is a Weed of National Significance. It currently infests approximately 7 million ha across northern Australia, with the Mitchell grasslands in northeast Queensland most affected. It has taken about 0.5 million ha out of production, and the remaining productive areas suffer from decreasing productivity and increasing maintenance costs (such as loss of grass cover, soil degradation and interference with stock access to water points).

Analysis of the extent of woody vegetation within infested areas of the Mitchell grasslands provides an indication of the spread of prickly acacia over the past decade (Figure 5). The plant may also affect native animals, benefiting some generalist species such as perching birds, nesting finches and some lizards, but at the expense of some grassland specialists. Prickly acacia comes from the Middle East and Africa, and was deliberately introduced in the 1890s as a fodder and shade tree. While it still has these functions, particularly as a feed reserve in droughts, it has spread far in excess of those needs.

Methods of controlling it include bulldozing, especially around watercourses, and controlling cattle access to infested areas to slow its spread. Some producers are experimenting with camels and goats, which graze the plants more successfully than cattle, both in terms of the height that they reach and because of their ability to digest acacia seeds. As in many other areas of Australia, a number of feral animal species have made a home in the Mitchell grasslands, particularly feral pigs and horses. Cats, rabbits, goats and foxes are common in some locations. These species are usually threats to both pastoral activities and to nature conservation because of their habitat destruction or modification, their competition for resources, and their predation.
Responding to environmental pressures

Drought

Every so often, there are reports suggesting that Mitchell grass tussocks are dying. This is usually because of drought and failed wet seasons. Currently, tussocks around Longreach in Queensland are dying and scientists are examining the situation there.

The southern reaches of the Mitchell grasslands are more susceptible to drought over the dry season. To counteract the effect of drought, some pastoralists run both sheep and cattle. This is a market-driven decision, although it does make drought-management decisions easier. This decision can improve market flexibility and facilitate pasture management. Other managers move stock to less drought-affected areas where possible.

Productivity

With the greater number of water points now in existence, it is likely that the use of the grasslands by livestock is close to being as fully effective as possible. The high rainfall variability reduces the predictability of Mitchell grass growth, requiring a conservative approach to grazing that may limit productivity in many parts. A study over many years at the Toorak Research Station in Queensland has indicated that a 30% utilisation of end-of-summer dry matter in the grasslands provides a satisfactory balance between economic productivity and environmental sustainability (D Orr, pers comm, 2006). The infusion of tropical cattle breeds has improved the thriftiness of cattle on Mitchell grasses. Further improvement would come about with appropriate stock management and bore capping. Economic factors, such as the development of live-export markets from Darwin, have helped maintain livestock prices but also have ongoing risks. Management options need to be flexible and must acknowledge risks to the industry.

Figure 5 Extent of woody vegetation within the Mitchell Grass Downs IBRA region between 1991 and 2004

![Figure 5 Extent of woody vegetation within the Mitchell Grass Downs IBRA region between 1991 and 2004](image)
Future management

The Mitchell grasslands are influenced by rainfall, artesian water availability, weeds and economic factors (including livestock price). Management of these grasslands should aim to retain their many values and uses, including their role as important and productive grazing areas. Ongoing maintenance of productivity in this region depends on sustainable management of the grasslands and management of weeds under variable climatic conditions. While there is evidence that the grasslands can be managed sustainably, greater attention will need to be given to:

- using the available land management and monitoring tools to help with decision-making, to set stocking rates and grazing patterns, and to minimise overgrazing;
- strategic burning, woody-weed control, and improving the pasture at the property level; and
- recognising the role of integrated breeding and fattening operations, which span several properties and reduce risks to individual landholders, at the regional level.


Toward sustainability for vegetation management—Mitchell grasslands