



Australian Government
National Land & Water Resources Audit

Extract from Rangelands 2008 — Taking the Pulse
4. Focus Bioregions

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Assistant Secretary
Biodiversity Conservation Branch
Department of the Environment, Water, Heritage
and the Arts
GPO Box 787
Canberra ACT 2601
Australia

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ISBN 978 0 642 37146 1

ISBN 978 0 642 37147 8 (CD-ROM of the report)

ISBN 978 0 642 37148 5 (PDF)

Product number: PN21387

Suggested citation

Bastin G and the ACRIS Management Committee, Rangelands 2008 — Taking the Pulse, published on behalf of the ACRIS Management Committee by the National Land & Water Resources Audit, Canberra.

Acknowledgments

Rangelands 2008 — Taking the Pulse is the work of many people who have provided data and information that has been incorporated into this report. It has been possible due to significant in-kind contributions from the State and Territory governments and funding from the Australian Government through the Natural Heritage Trust. Particular thanks are due to staff of the Desert Knowledge Cooperative Research Centre, including Melissa Schliebs, Ange Vincent and Craig James.

Cover photograph

West MacDonnell Ranges (photo Department of the Environment, Water, Heritage and the Arts)

Principal author: Gary Bastin, CSIRO and Desert Knowledge CRC

Technical editor: Dr John Ludwig

Editors: Biotext Pty Ltd

Design: Design ONE

Printed in Australia by Lamb Print

Printed with vegetable-based inks on stock that comprises 80% recycled fibre from postconsumer waste and 20% totally chlorine-free pulp, sourced from sustainable forests.

August 2008

4 Focus bioregions

To illustrate how data and information can be compiled for regional rather than national purposes, five focus bioregions (one in each rangeland state and the Northern Territory, NT) were nominated for presentation by each state/NT member of the Australian Collaborative Rangeland Information System Management Committee (ACRIS-MC):

- New South Wales (NSW) — Darling Riverine Plains
- South Australia (SA) — Gawler
- Queensland — Mitchell Grass Downs
- Western Australia (WA) — Murchison
- NT — Sturt Plateau.

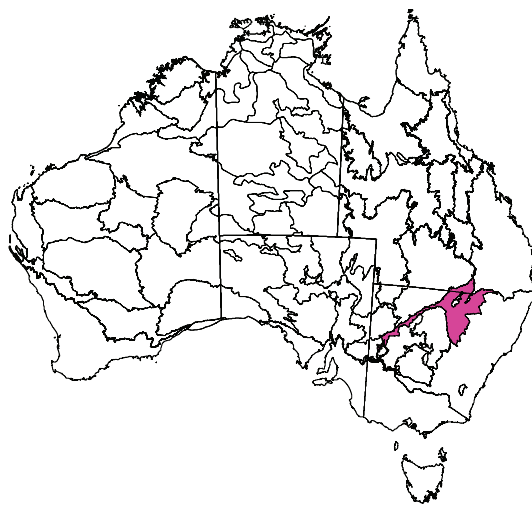
Shortened versions of the information presented in this chapter are available for all 52 rangeland bioregions on the CD accompanying this report.

Darling Riverine Plains bioregion (NSW and Queensland)

The Darling Riverine Plains bioregion includes the Darling River and its tributaries in NSW and Queensland (Figure 4.1). Ninety per cent of the area of this rangeland bioregion (93 316 km²) is in NSW; the remaining 10 013 km² is in Queensland. Most results reported here relate specifically to NSW, but some also include the Queensland portion.

This bioregion includes the extensive alluvial plains of the network of rivers and creeks that flow into the Darling River; together with its floodplains (Figure 4.2). Vegetation includes river red gum, blackbox and coolibah woodlands with inliers of poplar box, belah, redbox and ironbark woodlands on higher parts of the landscape. Major tenure is leasehold in the Western Division and freehold in the Central Division of NSW. Sheep and cattle grazing is the main land use;

Figure 4.1 Darling Riverine Plains bioregion in the NSW and Queensland rangelands



Note: Area = 103 329 km²

other land uses include dryland cropping, irrigated cotton, horticulture and, at Lightning Ridge, black opal mining. Major population centres are Wilcannia, Bourke, Brewarrina and Nyngan.

Regional issues

- Upstream diversion of river flows for irrigation is reducing the size, frequency and effectiveness of downstream flooding. This has reduced pastoral productivity and altered the floodplain ecosystem, particularly that of riparian corridors and wetlands.
- The merino wool industry has been in decline for most of the reporting period. That decline initiated a trend into cereal cropping in the eastern margins of the rangelands, peaking in the late 1990s before the implementation of native vegetation legislation. Cropping has focused on certain soil types, especially those of grasslands. Properties with the capacity to crop have greater options to maintain financial viability.

Figure 4.2 Characteristic landscapes of the NSW Darling Riverine Plains bioregion



Woodland of eucalypts and acacias

Photo: NSW Department of Environment and Climate Change



Coolibah

Photo: NSW Department of Environment and Climate Change



Myall

Photo: NSW Department of Environment and Climate Change



Darling River near Louth

Photo: Arthur Mostead

- A large loss of social infrastructure (eg families, Landcare network, social groups) was evident during the late 1990s and early 2000s, particularly in areas without cropping. Very few young people are now returning to properties.
- Thickening of black box (*Eucalyptus largiflorens*) and coolibah (*E. coolabah*) affects pastoral management in areas where flooding has initiated dense regeneration.
- Perennial grasses appear to have declined across the bioregion in the longer term. The main species, curly Mitchell grass (*Astrebla lappacea*), appears to have remained stable over the 1992–2005 reporting period.

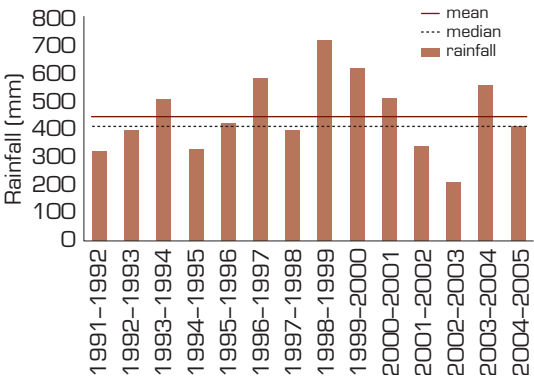
- The bioregion generally has low numbers of feral goats, but feral pigs are associated with the watercourse areas. Rabbits generally have a low impact.

Further information relevant to recent change in the bioregion is available in Grant (2006).

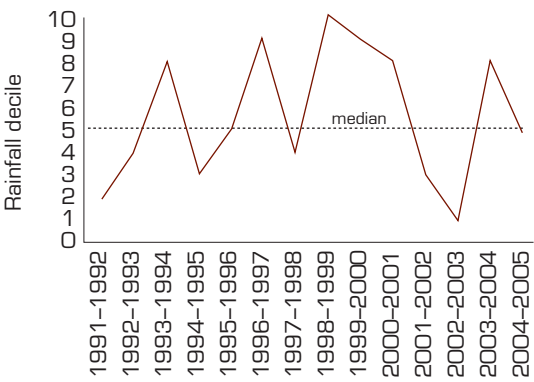
Seasonal quality — 1992–2005

Rainfall was quite variable through the 1992–2005 period and fluctuated both above and below the long-term (1890–2005) median (Figure 4.3, top left and centre). However, the 1992–2005 period as a whole was among the wetter 14-year periods since

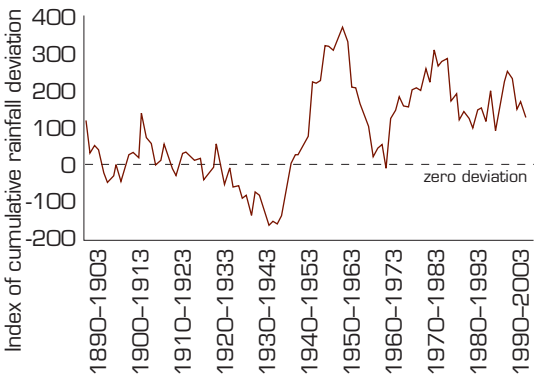
Figure 4.3 Indicators of *seasonal quality* for the entire Darling Riverine Plains bioregion



Annual rainfall, long-term (1890–2005) mean and median



Annual rainfall as deciles of the long-term (1890–2005) rainfall record

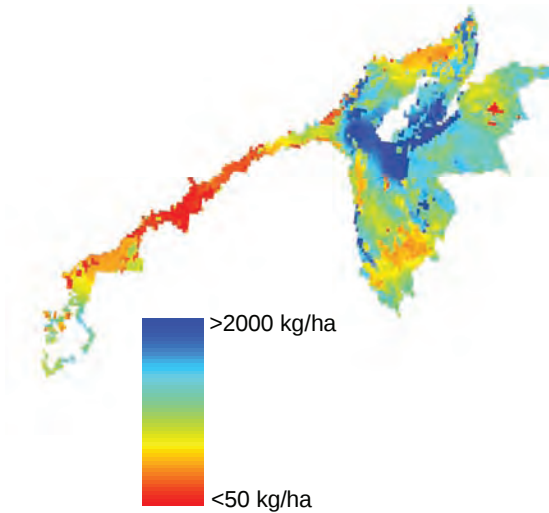


Cumulative percentage deviations of annual rainfall from the long-term (1890–2005) median for all 14-year periods between 1890–1903 and 1992–2005

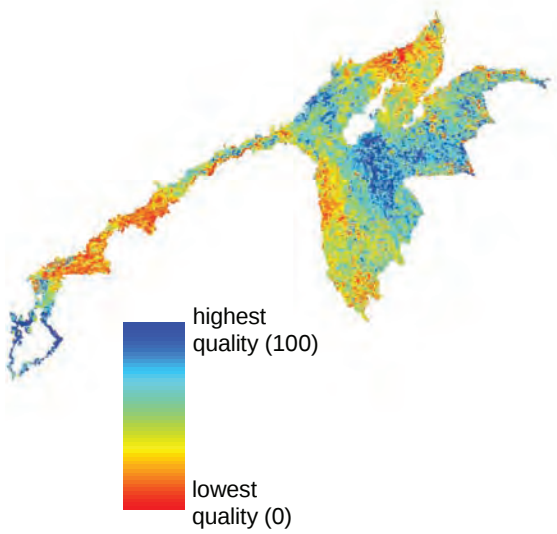
Left: Rainfall

Right: Simulated pasture biomass and vegetation greenness (NDVI)

Note: Indicators are based on spatially averaged annual rainfall (April–March) between 1991–92 and 2004–05. For cumulative percentage deviations, periods below the dashed zero line indicate 14-year sequences with generally less rainfall (poorer *seasonal quality*) and periods above the line indicate sequences of increased rainfall (better *seasonal quality*). All data are for the combined NSW and Queensland components of the bioregion.

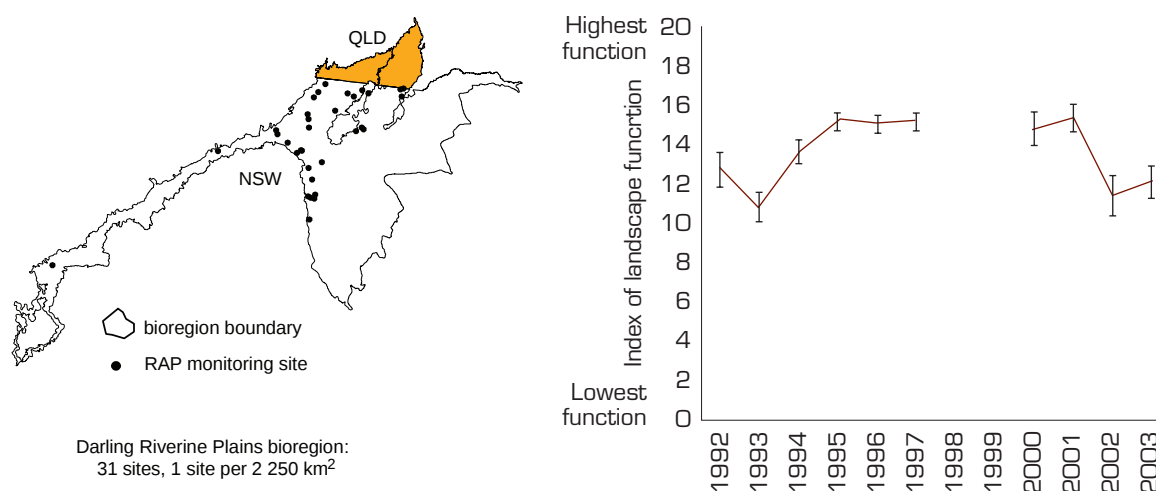


Aussie-GRASS simulated total standing dry matter — 1995



NDVI-based image of 'season quality' for 1995. Each pixel has a relative value according to the greenness of vegetation (ie photosynthetic activity)

Figure 4.4 RAP monitoring sites, Darling Riverine Plains bioregion, and reported changes in an index of landscape function



Locations of RAP monitoring sites

Change in an index of landscape function based on the frequency and cover of perennial grasses. Bars show the standard error of the mean for each year. Data not available for 1998 and 1999.

1890. Figure 4.3 (bottom left) demonstrates apparent longer-term change in the pattern of annual rainfall. The first 30 years of available records show that rainfall fluctuated about the line of 'zero percentage cumulative deviation'. The 1920s to 1940s was a much drier period, and in terms of cumulative rainfall deficiency over successive 14-year periods, was much drier than conditions experienced recently. The past 50 years have been generally above average, and exceptional in the 1950s and 1970s. For the 1992–2005 reporting period, there was marked year-to-year variation, indicating highly variable *seasonal quality*. 2002–03 was a very dry year, while the period 1998–99 to 2000–01 was a wetter period. As in most bioregions, *seasonal quality* varied spatially across the Darling Riverine Plains in some years (shown in Figure 4.3, right, for 1995). This assessment of variability is based on simulated pasture biomass produced by AussieGRASS and 'season quality' derived from the Normalised Difference Vegetation Index (NDVI³⁶).

Change in landscape function

Change in landscape function is reported from 31 Range Assessment Program (RAP) sites in the NSW part

of the Darling Riverine Plains bioregion (Figure 4.4). Each site was assessed at least eight times between 1992 and 2003. An index of landscape function was calculated from the frequency and cover of perennial grasses at each site. Most of the change was probably seasonal, with index values responding to the presence of summer-growing perennial grasses, particularly curly Mitchell grass.

Across all seasonal conditions, 89% of site-time assessments had stable or increased landscape function. Taking account of seasonal conditions prior to each site reassessment, 2% of site-time assessments showed a decline in landscape function (beyond a change threshold) when *seasonal quality* was above average, and 23% of site-time assessments showed an increase when *seasonal quality* was below average (Table 4.1).

Sustainable management

Change in critical stock forage

The frequency of the palatable and perennial (2P) curly Mitchell grass at RAP sites at each assessment is used to report change in critical stock forage. As for landscape function, the same sites were assessed at least eight times between 1992 and 2003 (no data are available for 1998 and 1999) (Table 4.2).

³⁶ See <http://www.environment.gov.au/erin/ndvi.html>.

Table 4.1 Seasonally interpreted change in landscape function at RAP sites in the Darling Riverine Plains

Seasonal quality	Number of site by year combinations	Percentage of reassessed sites showing		
		Decline >4 decrease in index	No change	Increase >4 increase in index
Above average	62	2	90	8
Average	62	5	92	3
Below average	93	20	57	23

Note: The light grey cell indicates a likely adverse effect related to grazing management, in that no change or an increase in the landscape function indicator would be expected following above-average *seasonal quality*. The grey cell represents an encouraging result, as a decrease in landscape function would be expected following poor seasonal conditions.

Table 4.2 Seasonally interpreted change in critical stock forage at RAP sites in the Darling Riverine Plains

Seasonal quality	Number of site by year combinations	Percentage of reassessed sites showing		
		Decline >11 decrease in freq	No change	Increase >12 increase in freq
Above average	69	17	71	12
Average	46	17	65	18
Below average	69	9	82	9

Note: The light grey cell indicates a likely adverse effect related to grazing management, in that no change or an increase in curly Mitchell grass frequency would be expected following above-average *seasonal quality*. The grey cell represents an encouraging result, as a decrease in frequency would be expected following poor seasonal conditions.

Table 4.3 Seasonally interpreted change in native-plant species richness at RAP sites in the Darling Riverine Plains

Seasonal quality	Number of site by year combinations	Percentage of reassessed sites showing		
		Decline >12 decr. in no. spp.	No change	Increase >15 incr. in no. spp.
Above average	102	11	77	12
Average	68	24	75	1
Below average	102	11	66	23

See Table 4.2 for explanation of cell colours.

Note that sites selected for reporting change were restricted to those where curly Mitchell grass was present at the start of the period.

Species richness

Site-time assessments at RAP sites were used to determine seasonally interpreted change in native-plant species richness (Table 4.3). A higher percentage of sites had increased species richness following adverse seasons than declined following better *seasonal quality*.

Change in woody cover

The 'annualised rate' of woody vegetation change between 2004 and 2006 was 1468 ha based on analysis of satellite data using Queensland State-wide Landcover and Tree Study (SLATS) methods. Woody vegetation is defined as 'woody communities with 20% crown cover or more (eg woodlands, open forests and closed forests) and taller than about 2 metres'. The 'annualised rate' of clearing represents the 'annual rate of woody vegetation change, which is largely due to cropping, pasture and thinning' (DNR 2007).

It is not possible to report change for earlier years of the 1992–2005 period using this method.

Distance from stock water

Reporting on distance from stock water is for the whole Darling Riverine Plains bioregion.

Based on the locations of stock waterpoints (bores and dams) sourced from Geoscience Australia's Geodata Topo 250K vector product (Series 3, June 2006), the percentage of sub-IBRA area within 3 km and beyond 8 km of permanent and semipermanent sources of stock water is listed in Table 4.4. This analysis does not include the locations of natural waters (eg rivers), which provide many additional sources of water for stock. For some sub-IBRAs, the percentage area within 3 km of water may be understated and the area beyond 8 km overstated.

Table 4.4 Percentage of sub-IBRA area within 3 km or beyond 8 km of permanent and semipermanent sources of stock water (bores and dams only), Darling Riverine Plains

Sub-IBRA	% of sub-IBRA area	
	<3 km from water	>8 km from water
Culgoa–Bokhara (DRP1)	84.1	0.0
Warrambool–Moonie (DRP2)	100.0	0.0
Castlereagh–Barwon (DRP3)	36.5	20.6
Bogan–Macquarie (DRP4)	35.5	28.3
Louth Plains (DRP5)	56.5	0.4
Wilcannia Plains (DRP6)	48.4	4.0
Menindee (DRP7)	50.8	3.6
Great Darling Anabranch (DRP8)	62.9	1.8
Pooncarie–Darling (DRP9)	55.0	0.0

It is not possible to report change in watered area.

Weeds

Weeds known to occur in the bioregion include African boxthorn (*Lycium ferocissimum*), Athel pine (*Tamarix aphylla*), bitou bush (*Chrysanthemoides*

monilifera subsp. *rotund*; in NSW), blackberry (*Rubus fruticosus*), mesquite (*Prosopis* spp.), mother of millions (*Bryophyllum tubiflorum* and hybrids), parkinsonia (*Parkinsonia aculeata*), broad leaf or tree privet (*Ligustrum lucidum*), silver leaf nightshade (*Solanum elaeagnifolium*), St Johns wort (*Hypericum perforatum*) and water hyacinth (*Eichhornia crassipes*).³⁷

Components of total grazing pressure

Domestic stocking density

Eighty-eight per cent of the area of the Darling Riverine Plains bioregion was under pastoral land use in 1992, reducing to 80% in 2001. Based on Australian Bureau of Statistics (ABS)-sourced data and taking account of this reduced area, stocking density decreased from 11% above the 1983–91 average in 1992 to slightly below the 1983–91 base between 1993 and 2000 when mainly drier seasonal conditions prevailed (Figure 4.5). Stocking density then declined over the next three years to 75% of the base (in 2003). Stocking density increased slightly in 2004 to 77% of the 1983–91 average. Stocking density responded to seasonal quality but it is likely that expanded cropping also contributed to the overall decline in stocking density. Spatial averaging conceals likely variation in stocking density trends across the bioregion.

Kangaroo densities (Figure 4.6) were probably affected by changing seasonal conditions although this is not readily apparent from the graphed decile rainfalls. Contributing species to kangaroo density are reds, western and eastern greys.

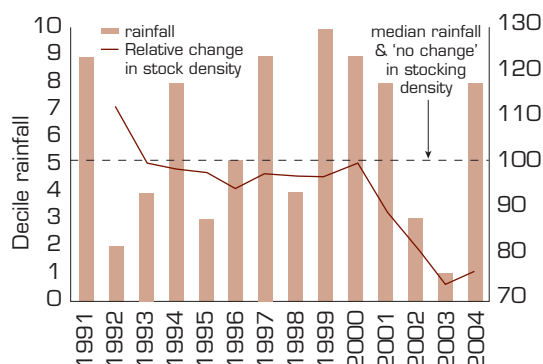
Invasive animals

Invasive animal species known to occur in the bioregion include pig (*Sus scrofa*), goat (*Capra hircus*), fox (*Vulpes vulpes*), rabbit (*Oryctolagus cuniculus*), wild dog (*Canis lupus familiaris*), feral cat (*Felis catus*), starling (*Sturnus vulgaris*) and carp (*Cyprinus carpio*).³⁸

³⁷ See <http://www.anra.gov.au>

³⁸ See <http://www.anra.gov.au>

Figure 4.5 Change in domestic stocking density (sheep and beef cattle) and *seasonal quality* as deciles of rainfall, Darling Riverine Plains bioregion



Fire and dust

Fire

Fire was insignificant between 1997 and 2005 (the period of available data), with a maximum of 1.4% of the bioregion area burned in 2005.

The frequency of fire between 1997 and 2005 was very low compared with all rangeland bioregions (mean frequency ($\log_{10}$ transformed) = 0.07).

Dust

The mean DSI_3 value (1992–2005) was 1.40, a low value among all rangeland bioregions. Dust levels were lowest in the far northeast of the bioregion, near the NSW–Queensland border.

Biodiversity

There are Ramsar-listed wetlands in NSW and case studies of waterbirds (both components of the Biodiversity Working Group's indicator on wetlands).

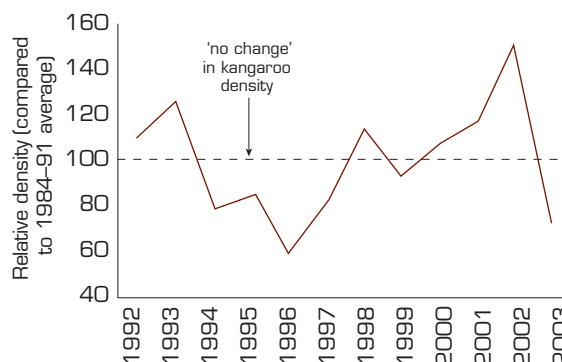
Change in land use and land values

According to available National Land & Water Resources Audit (the Audit) data, 88% of the area of the Darling Riverine Plains bioregion was under pastoral land use in 1992, reducing to 80% in 2001.

Properties in the NSW part of the bioregion are relatively small compared with pastoral holdings in the northern, central and western parts of the

Figure 4.6 Kangaroo density, NSW component of the Darling Riverine Plains bioregion (DSEs)

Kangaroos



rangelands. Based on all land parcels larger than 10 ha, average property size is 812 ha, with the largest holdings being greater than 30 000 ha (300 km²). Most grazing enterprises are larger than 10 000 ha.

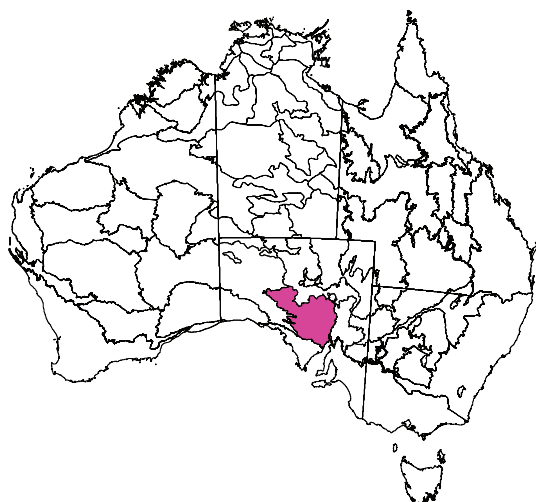
The market value of a typical (ie representative) property in the Brewarrina area increased by ~80% between 1996 and 2005 (values expressed in 2005 dollars).³⁹

Gawler bioregion (SA)

The Gawler bioregion is in the southern central portion of the SA rangelands (Figure 4.7). Characteristic landscapes are rounded rocky hills, plains and salt-encrusted lake beds (Figures 4.8 and 4.9). Vegetation types include spinifex grasslands, open woodlands and chenopod shrubs. Sheep grazing and some cattle grazing are the most extensive industries (83% of bioregion area is pastoral lease), but mining (particularly copper, uranium and gold at Olympic Dam) provides the main source of revenue. Iron ore is also extracted in the Iron Knob area, opals at Andamooka and copper at Mt Gunson. Conservation reserves make up 12.9% of the bioregion and include Lake Torrens, Gawler Ranges and Lake Gairdner national parks, Lake Gilles Conservation Park, Lake Gilles Conservation Reserve and the sections of Yellabinna Regional Reserve that are in the bioregion. Tourism interest is focused on

³⁹ See Table 16, 'Western grazing', at http://www.lands.nsw.gov.au/valuation/nsw_land_values for typical property values at other locations in the NSW Western Division.

Figure 4.7 Gawler bioregion, SA



Note: Area = 123 600 km²

the Gawler Ranges National Park, as well as on Olympic Dam and the Andamooka and Coober Pedy opal fields. Active Australian Defence Force and aerospace facilities are located at Woomera. Major population centres are Whyalla, Port Augusta, Roxby Downs and Woomera.

Figure 4.9 Lake Gairdner, Gawler bioregion



Lake Gairdner is a prominent lake in the Gawler bioregion. This photo is of the southeastern corner, looking west.

Photo: Peter Canty, SA Department for Environment and Heritage

Regional issues

- The Gawler bioregion lacks landscape diversity, being dominated by chenopod shrublands and low woodlands. Sheep are the predominant species of livestock.

Figure 4.8 Rocky hills and shrubby plains of the Gawler bioregion



Photo: Pastoral Land Management Group, SA Department of Water; Land and Biodiversity Conservation

Figure 4.10 Change at a photopoint in the Gawler bioregion, 1955 to 1992



In 1955, the area had a reduced density of bluebush (*Maireana sedifolia*) as a result of high grazing pressure.



By 1992 there had been significant colonisation by valuable saltbushes (*Atriplex stipitata* and *A. vesicaria*).

Photos: Pastoral Land Management Group, SA Department of Water, Land and Biodiversity Conservation

- Some increases in woody cover are evident, possibly due to the effects of continual grazing pressure.
- There have been historically high levels of stocking.
- Available water supplies are fully exploited. Groundwater is limited in extent and is generally of poor to marginal quality.
- Rabbit numbers are recovering following the spread of rabbit haemorrhagic disease (calicivirus) in the 1990s.
- Feral goats persist in the more inaccessible areas.
- This region has the most extensive rangeland monitoring program in SA (Figure 4.10). The second round of condition assessments on pastoral leases is under way.

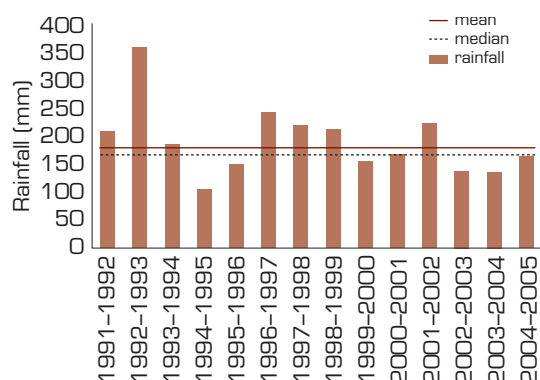
Further information relevant to recent changes within the Gawler bioregion is available in Della Torre (2005).

Seasonal quality — 1992–2005

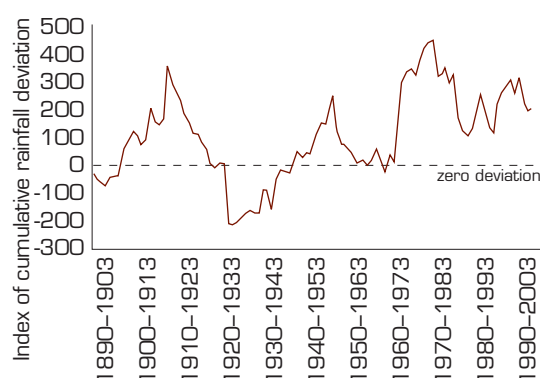
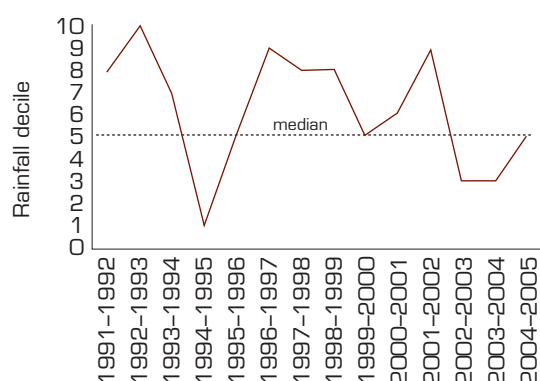
Rainfall was above the long-term (1890–2005) median for 8 of the 14 years between 1992 and 2005, and the period as a whole was better than many other 14-year periods since 1890 (Figure 4.11, left). The past 45 years have been generally wetter, apart from a return to more average *seasonal quality* in some years in the 1980s (Figure 4.11, left). For the 1992–2005 period, several years had better than the median rainfall, while 1994–95 was very dry. As in most bioregions, *seasonal quality* varied spatially across the Gawler bioregion in some years. This assessment of variability is based on simulated pasture biomass produced by AussieGRASS and 'season quality' derived from the NDVI⁴⁰ (Figure 4.11, right panels). Note that much of the south to north decrease in total standing dry matter is due to changing vegetation structure and composition with increasing aridity.

⁴⁰ See <http://www.environment.gov.au/erin/ndvi.html>.

Figure 4.11 Indicators of *seasonal quality* for the Gawler bioregion



Annual rainfall. Long-term (1890–2005) mean and median

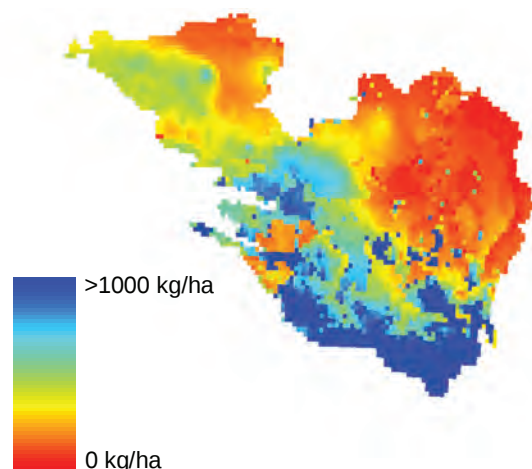


Cumulative percentage deviations of annual (April–March) rainfall from the long-term (1890–2005) median for all 14-year periods between 1890–1903 and 1992–2005

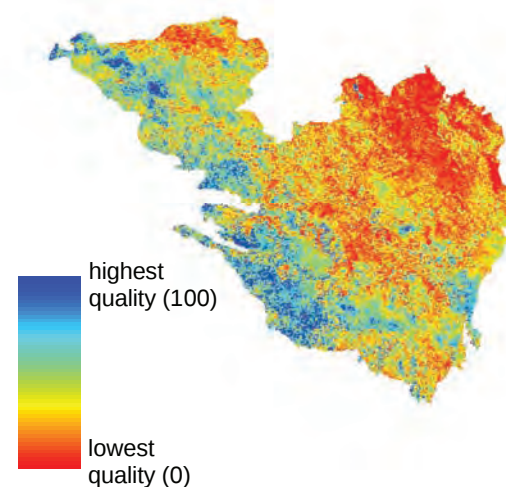
Left: Rainfall

Right: Simulated pasture biomass and vegetation greenness (NDVI)

Note: Indicators are based on spatially averaged annual rainfall (April–March) between 1991–92 and 2004–05. For cumulative percentage deviations, periods below the dashed zero line indicate 14-year sequences with generally less rainfall (poorer *seasonal quality*). Periods above the dashed zero line indicate sequences of increased rainfall (better *seasonal quality*).



Aussie-GRASS simulated total standing dry matter — 1998



NDVI-based image of 'season quality' for 1998. Each pixel has a relative value according to the greenness of vegetation (ie photosynthetic activity)

Figure 4.12 Pastoral monitoring sites and changes in landscape function, Gawler bioregion

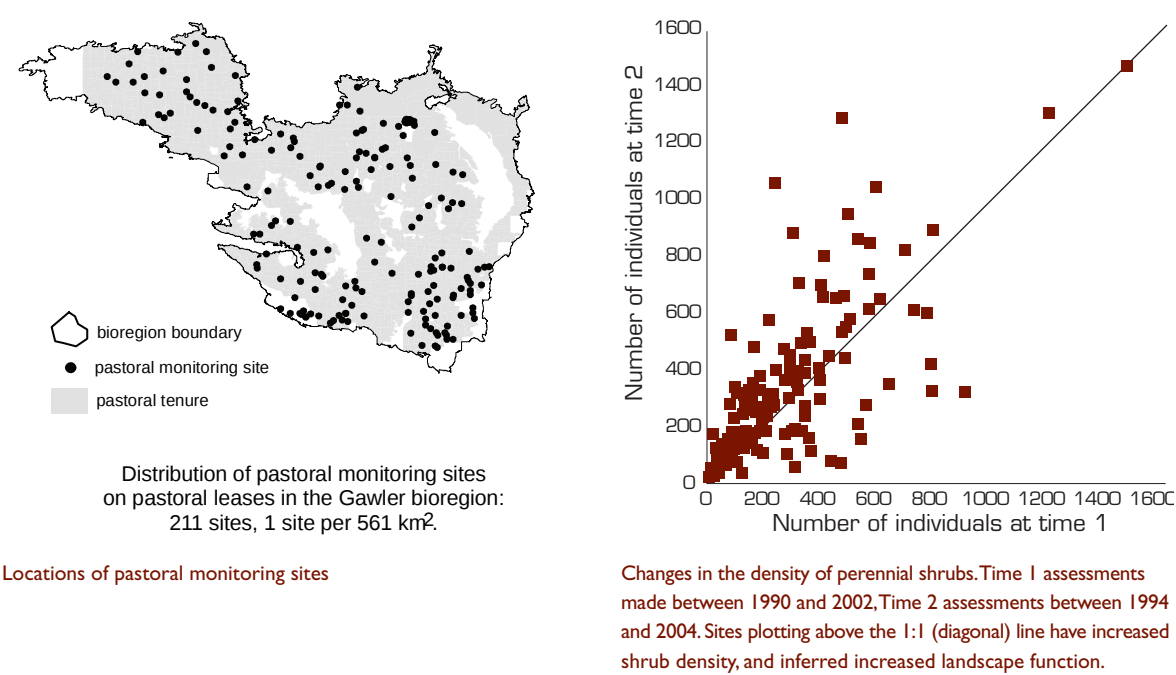


Table 4.5 Percentage of pastoral monitoring sites assessed following variable *seasonal quality* where there was a change in the density of decreaser perennial shrubs

Seasonal quality	Number of sites	Decline. Density <90%	No change. Density between 90% and 110%	Increase. Density ≥110%
Above average	107	16%	25%	59%
Average	56	21%	25%	54%
Below average	2	n.a.	n.a.	n.a.

n.a. = not applicable
Note: The light grey cell indicates a likely adverse effect related to grazing management.

Change in landscape function

Based on the density of longer-lived shrubs measured in fixed (Jessup) transects, ~60% of sites showed an increase in plant density (Figure 4.12), which is assumed to be an increase in landscape function. Taking account of seasonal conditions, 18% of 123 sites assessed following above-average rainfall showed reduced landscape function (ie improved landscape function would have been expected). Insufficient sites were assessed following below-average *seasonal quality* to report change.

There is a high degree of confidence in reporting change in landscape function for the Gawler bioregion:

there is a good density of sites that are well distributed (Figure 4.12, left panel), shrub density reliably indicates landscape function in this environment, and quantitative recording methods ensure good repeatability among observers measuring sites.

Sustainable management

Change in critical stock forage

The density of perennial decreaser shrubs declined at 16% of sites following above-average *seasonal quality* (Table 4.5). Insufficient sites were assessed following below-average *seasonal quality* to report change at this time.

Table 4.6 Percentage of the pastoral lease area of each sub-IBRA within 3 km or beyond 8 km of stock water, Gawler bioregion

Sub IBRA	% sub IBRA area included	% area ≤3 km from stock water	% area >8 km from stock water
Myall Plains (GAW1)	77.7	69.4	2.4
Gawler Volcanics (GAW2)	87.3	52.5	8.2
Gawler Lakes (GAW3)	55.1	44.6	12.6
Arcoona Plateau (GAW4)	90.6	45.6	6.5
Kingoonya (GAW5)	89.3	30.2	15.2

Change in woody cover

Based on the Australian Greenhouse Office definition and mapping of forest extent⁴¹, there is a very small area of forest in the Gawler bioregion and there was very little change in that area between 1991 and 2004. Forest cover increased from 1.90% of the bioregion area in 1991 to 2.09% in 2004, an increase of 0.19%. Reporting is based on analysis of Landsat data; there is high reliability in reporting results because complete coverage of satellite imagery was available.

Distance from stock water

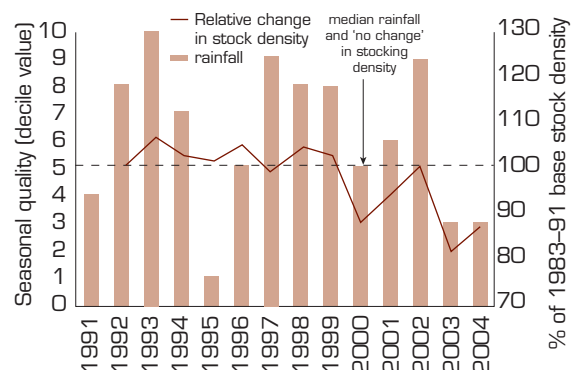
Eighty-three per cent of the Gawler bioregion is occupied as pastoral lease, and most of that area is within grazing distance of stock water (Table 4.6). The non-pastoral area in the Gawler bioregion consists mostly of salt lakes.

It is not possible to report change in distance from stock water for the 1992–2005 period.

Weeds

Weeds known to occur in the bioregion include African boxthorn (*Lycium ferocissimum*), African love grass (*Eragrostis curvula*), Athel pine (*Tamarix aphylla*), Bathurst burr (*Xanthium spinosum*), bridal creeper (*Asparagus asparagoides*), kochia (*Bassia scoparia*), mesquite (*Prosopis* spp.), Noogoora burr (*Xanthium occidentale*), pampas grass (*Cortaderia* spp.), parkinsonia (*Parkinsonia aculeata*), Patersons curse (*Echium plantagineum*), silver leaf nightshade (*Solanum elaeagnifolium*) and wild mignonette (*Reseda luteola*).⁴²

Figure 4.13 Change in domestic stocking density (sheep and beef cattle), Gawler bioregion, 1991 to 2004



Note: Seasonal quality as deciles of rainfall is also shown.

Components of total grazing pressure

Change in domestic stocking density

Fluctuations in stocking density, based on ABS-sourced data, are shown in Figure 4.13. The decline in the latter half of the reporting period was probably largely driven by declining *seasonal quality* (indicated here by rainfall deciles). It is probable that spatial variation in stocking density across the bioregion is concealed by the spatially averaged data presented here.

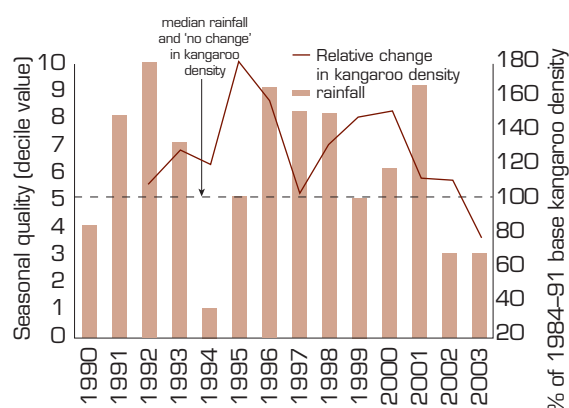
Change in kangaroo density

The combined density of red and western grey kangaroos (expressed as DSEs) fluctuated considerably throughout the 1992–2003 period (Figure 4.14). The initial increase and later decrease were related to *seasonal quality* and broadly correspond with the changes in domestic stocking density reported above.

⁴¹ See <http://www.greenhouse.gov.au/ncas/reports/tech09.html>.

⁴² See <http://www.anra.gov.au>

Figure 4.14 Change in kangaroo density, Gawler bioregion, 1990 to 2003



Invasive animals

Invasive animal species known to occur in the bioregion include goat (*Capra hircus*), fox (*Vulpes vulpes*), rabbit (*Oryctolagus cuniculus*), wild dog (*Canis lupus familiaris*), feral cat (*Felis catus*), starling (*Sturnus vulgaris*) and camel (*Camelus dromedarius*).⁴³

Fire and dust

Fire

No fires were recorded in the bioregion for any year during the 1997–2005 period.

Dust

Atmospheric dust levels based on the Dust Storm Index (DSI) were low to moderate compared with all rangeland bioregions (mean DSI₃ of 1.75 for 1992–2005, where the maximum value among all bioregions was 8.44). Dust levels were higher in the northeast part of the bioregion and negligible in the vicinity of Kingoonya.

Change in biodiversity

By 2005, there were over 200 bird records (Biodiversity Working Group indicator: Fauna surveys), over 200 flora survey sites and more than 200 flora records (Biodiversity Working Group Indicator: flora surveys) for the bioregion.

The bioregion has 8 plant, 3 mammal and 7 bird species and 1 species of reptile, amphibian or fish listed as threatened (Biodiversity Working Group indicator: Threatened species).

Change in land use and land values

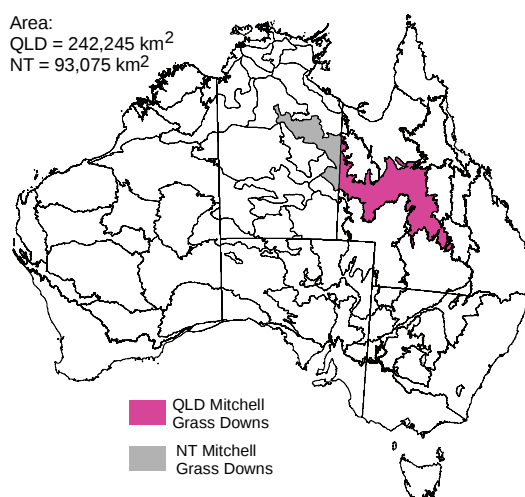
According to available NLWRA data, there was no change between 1992 and 2005 in the percentage area of the bioregion under pastoral land use (83%).

The unimproved value of pastoral land has increased, on average, by ~65% between 1998 and 2004 (values expressed in 2005 dollars).

Mitchell Grass Downs bioregion (Queensland and the NT)

The Mitchell Grass Downs bioregion extends across central Queensland into the NT (Figure 4.15). Reporting here is confined to the Queensland portion except where otherwise stated. The bioregion encompasses rolling, largely treeless, plains with cracking clay ('black') soils. The predominant vegetation is Mitchell grass tussock grassland with some low-tree overstorey of gidgee (*Acacia cambagei*) and other species (Figure 4.16). Most of the bioregion is under either leasehold or freehold tenure and is grazed by cattle and sheep. There has been a gradual movement out of woolgrowing in recent years. Major population centres are Longreach, Blackall and Hughenden.

Figure 4.15 Mitchell Grass Downs bioregion



⁴³ See <http://www.anra.gov.au>

Figure 4.16 Landscapes of the Mitchell Grass Downs bioregion, Queensland.



Central western Queensland Mitchell Grass Downs in a good season. The shrub is mimosa bush (*Acacia farnesiana*), which provides winter protein and shade.



And when it rains!

Photos: Queensland Department of Primary Industries and Fisheries

Regional issues

Regional issues in the Mitchell Grass Downs bioregion include:

- high levels of pasture utilisation (in two sub-IBRAs and in individual years), which have implications for persistence and recovery of palatable and productive perennial grasses
- Mitchell grass death, with areas of non-recovery to date
- pasture composition changes to more *Aristida* species
- increasing woody Weeds of National Significance (WoNS), particularly prickly acacia (*Acacia nilotica*)
- increasing cover of trees and shrubs in former grassland areas (eg mimosa and gundabluely).

Seasonal quality — 1992–2005

Annual rainfall, as an indicator of *seasonal quality*, was quite variable throughout the reporting period (Figure 4.17, left). The period from April 1998 to March 2001 was wetter (deciles 9 and 10 in terms of the 1890–2005 record). Rainfall was quite variable at other times. Several years in the 1990s and at the end of the reporting period had below-median rainfall. Despite these drier years, the 1992–2005

reporting period as a whole had a significantly positive cumulative rainfall deviation from the long-term median, and *seasonal quality* for the whole period was considerably better than for some other blocks of 14-year periods in the past (ie 1918 to 1940 and 1955 to 1973 were much drier periods than in the recent past).

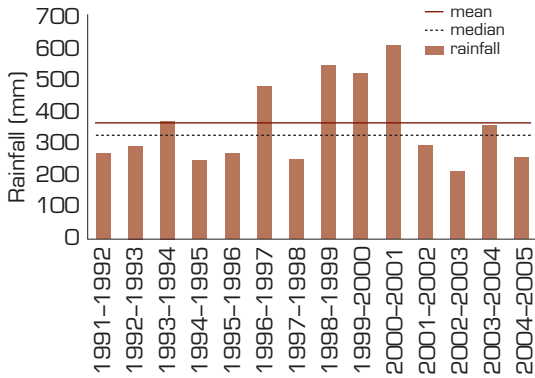
Spatial averaging of rainfall conceals spatial variation in *seasonal quality* for the Queensland portion of the bioregion. The variability shown for 1997 (as an example) was based on simulated pasture biomass produced by AussieGRASS and 'season quality' derived from the NDVI⁴⁴ (Figure 4.17, right panels).

Change in landscape function

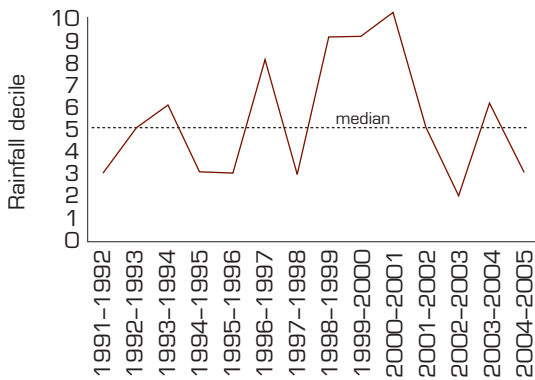
Landscape function declined across most of the bioregion between 1994 and 2005 (Figure 4.18), and significantly so in the Georgina Limestone sub-IBRA. The underlying data to support this assessment were extracted from the Rapid Mobile Data Collection database (Hassett et al 2006). These data were collected along repeat road traverses.

⁴⁴ See <http://www.environment.gov.au/erin/ndvi.html>.

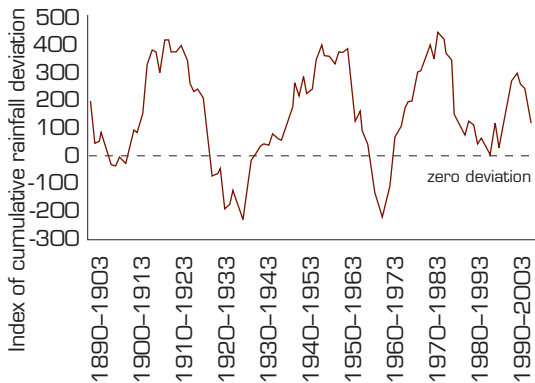
Figure 4.17 Indicators of *seasonal quality*, Mitchell Grass Downs bioregion



Annual rainfall. Long-term (1890–2005) mean and median



Annual rainfall as deciles of the long-term (1890–2005) rainfall

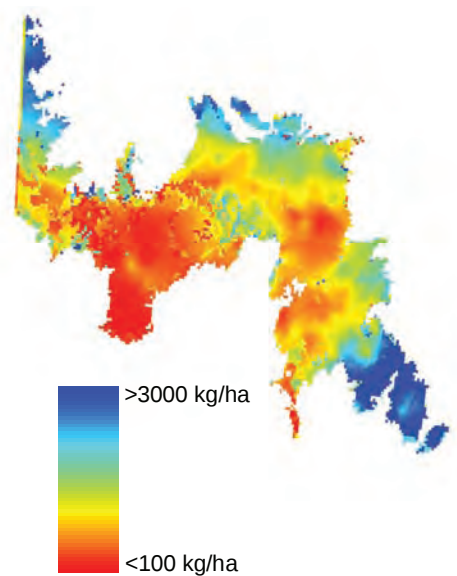


Cumulative percentage deviations of annual (April–March) rainfall from the long-term (1890–2005) median for all 14-year periods between 1890–1903 and 1992–2005

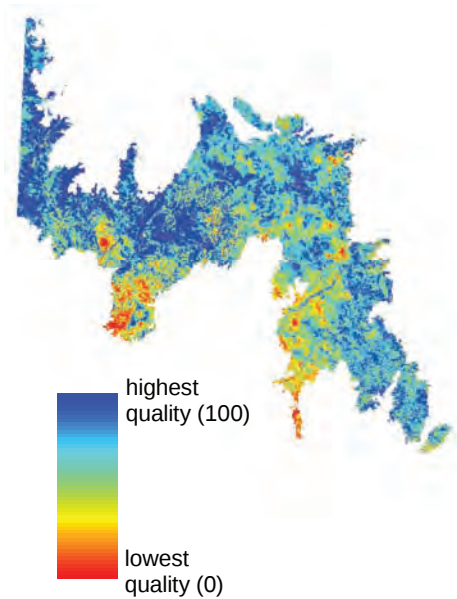
Left: Rainfall

Right: Simulated pasture biomass and vegetation greenness (NDVI)

Note: Indicators are based on spatially averaged annual rainfall (April–March) between 1991–92 and 2004–05. For cumulative percentage deviations, periods below the dashed zero line indicate 14-year sequences with generally less rainfall (poorer *seasonal quality*) and periods above the line indicate sequences of increased rainfall (better *seasonal quality*). All data are for the Queensland part of the bioregion.

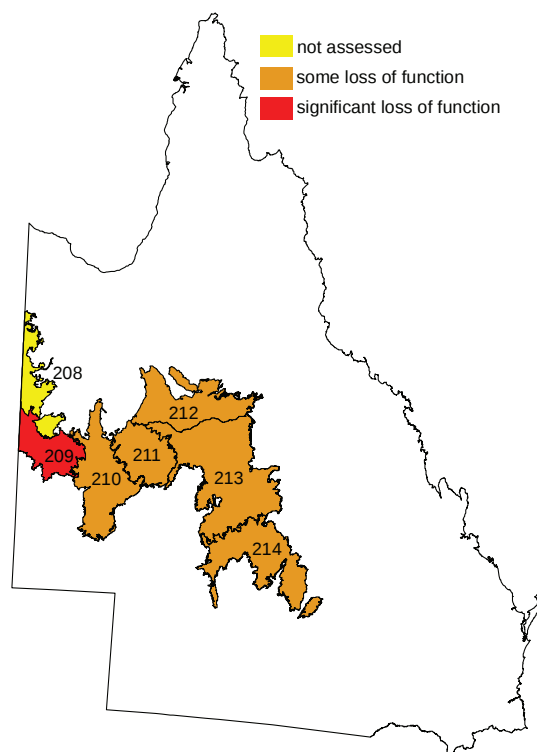


Aussie-GRASS simulated total standing dry matter - 1997



NDVI-based image of 'season quality' for 1997. Each pixel has a relative value according to the greenness of vegetation (ie photosynthetic activity)

Figure 4.18 Change in landscape function, Queensland sub-IBRAs of the Mitchell Grass Downs bioregion



Sub IBRA #	Name
208	Barkly Tableland
209	Georgina Limestone
210	Southwestern Downs
211	Kynuna Plateau
212	Northern Downs
213	Central Downs
214	Southern Wooded Downs

Note: Based on rapid mobile data collection

Source: Queensland Department of Natural Resources and Water.

This summarised reporting of change in landscape function is moderately reliable. Sub-IBRAs where change is reported were surveyed moderately intensively at various times between 1994 and 2005 by the same highly competent observer. Reliability is constrained because assessments were confined to paddock edges fringing roads, and because the index compiled from the available data has not yet been thoroughly tested for its robustness in indicating actual change in landscape function.

Sustainable management

Change in critical stock forage

Three sub-IBRAs (Georgina Limestone, Northern Downs and Barkly Tableland; Figure 4.19a, brightest green) had levels of AussieGRASS simulated annual pasture utilisation between 1991 and 2005 that were less than the specified safe threshold. The utilisation level for the Barkly Tableland sub-IBRA was considerably less than the threshold, implying relatively conservative (and sustainable) grazing management. The Kynuna Plateau and Southern Wooded Downs sub-IBRAs had the highest utilisation levels during the same period (27% and 26%, respectively, darkest green, Figure 4.19a). Those utilisations are at a level that causes loss of palatable perennial grasses and are of considerable concern. Average utilisation elsewhere (Southwestern Downs and Central Downs) was close to the safe threshold.

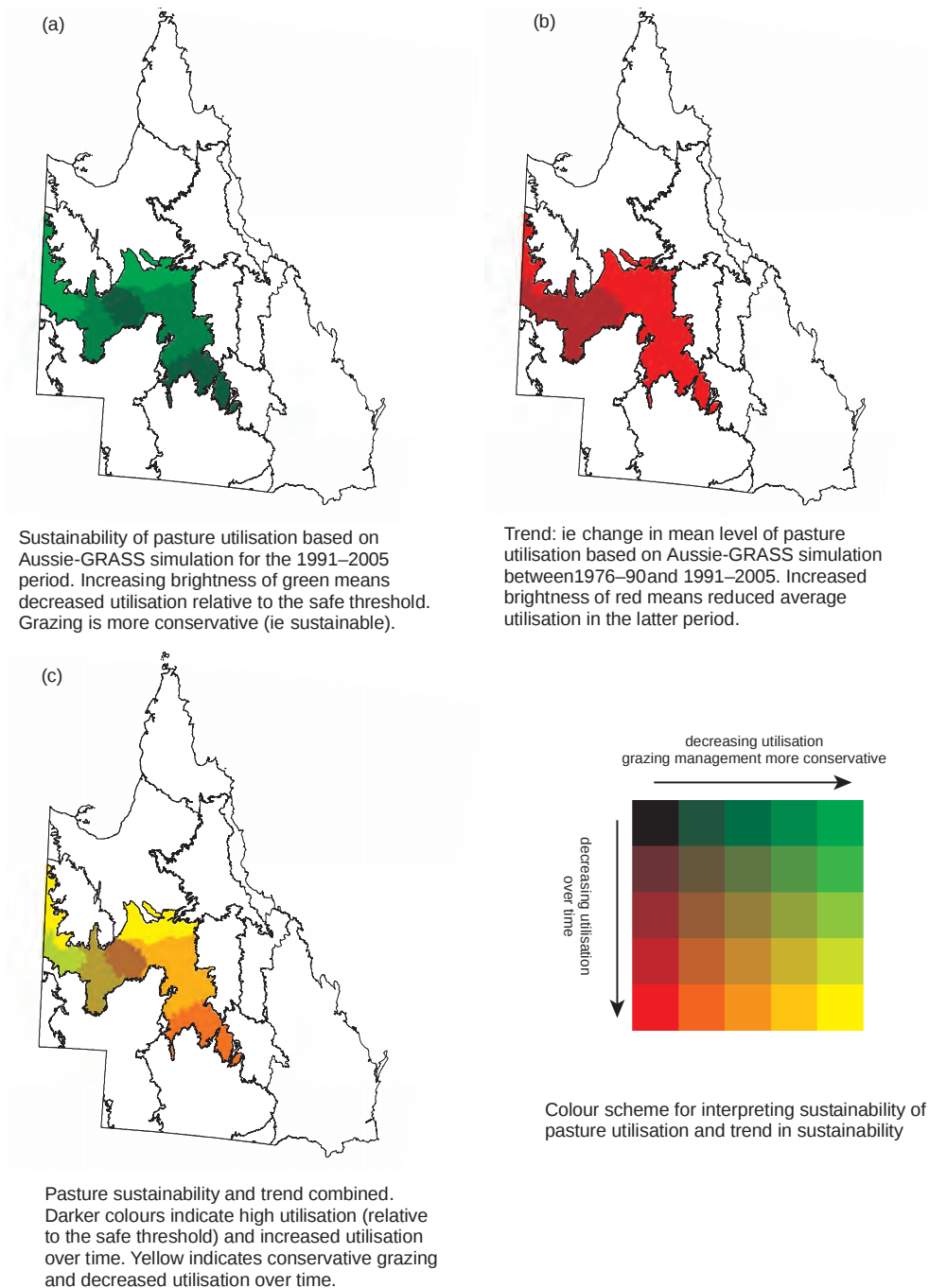
Time-averaged utilisation levels declined between 1976–90 and 1991–2005 in the Barkly Tableland, Northern Downs, Central Downs and Southern Wooded Downs sub-IBRAs (bright red in Figure 4.19b). The Georgina Limestone, Southwestern Downs and Kynuna Plateau sub-IBRAs had lesser decreases in average utilisation between the two periods and were assigned a neutral trend.

Combining the two maps shows that the Barkly Tableland and Northern Downs sub-IBRAs had lower (more conservative) levels of pasture utilisation in the 1991–2005 period and a decrease in mean utilisation between the 1976–90 and 1991–2005 periods (yellow in Figure 4.19c). This suggests that those two regions have the most sustainable management in terms of stock forage.

Change in woody cover

The SLATS data show that the Southern Wooded Downs sub-IBRA has relatively high woody cover compared to other regions (Table 4.7). This sub-IBRA also experienced the greatest area of clearing during the 1991–2003 period. By comparison, the Kynuna Plateau and Georgina Limestone sub-IBRAs have moderate levels of woody cover and have undergone little change. Remaining sub-IBRAs have low levels of woody cover that has changed little, apart from some clearing in the Central Downs sub-IBRA.

Figure 4.19 Change in stock forage, sub-IBRAs of the Mitchell Grass Downs bioregion



- a: Sustainability of stock forage based on levels of pasture utilisation for the 1991–2005 period (increasing sustainability shown by increased brightness of green)
- b: Degree of sustainability (ie change in utilisation) between the 1976–90 and 1991–2005 periods (decreasing utilisation shown by increased brightness of blue)
- c: Combined sustainability and trend information. Darker coloured sub-IBRAs represent a low level of sustainability and increased utilisation; green indicates sustainable utilisation but a trend towards reduced sustainability (increased utilisation); red shows low sustainability and improving trend (decreased utilisation); yellow depicts sub-IBRAs with both sustainable and decreasing utilisation (ie improving trend).

Note: Based on AussieGRASS simulation of pasture utilisation. Utilisation levels were space- and time-averaged for the two periods: 1976–1990 and 1991–2005.

Table 4.7 Percentage change in woody cover for Queensland sub-IBRAs of the Mitchell Grass Downs bioregion

Sub-IBRA	SLATS woody cover		Change 1991–2003	Cumulative clearing, 1991–2003
	1991	2003		
Southern Wooded Downs	29.96	26.15	–3.81	4.61
Kynuna Plateau	17.28	17.08	–0.20	0.25
Georgina Limestone	14.89	14.89	0.00	0.00
Central Downs	8.31	7.42	–0.89	1.03
Northern Downs	6.20	5.92	–0.28	0.31
Southwestern Downs	3.85	3.84	–0.01	0.01
Barkly Tableland	3.65	3.64	–0.01	0.00

Source: SLATS data

Table 4.8 Percentage of sub-IBRA area within 3 km and beyond 8 km of permanent and semipermanent sources of stock water, Mitchell Grass Downs bioregion

Sub IBRA	% of sub IBRA area	
	<3 km from water	>8 km from water
Southern Wooded Downs	85.9	0.0
Central Downs	82.5	0.0
Northern Downs	67.0	0.5
Kynuna Plateau	34.5	11.3
Barkly Tableland	31.6	4.6
Southwestern Downs	29.2	14.1
Mitchell Grass Downs P1	25.8	7.2
Georgina Limestone	16.9	30.9

Distance from stock water

Table 4.8 shows the percentage of sub-IBRA area within 3 km and beyond 8 km of permanent and semipermanent sources of stock water. Waterpoint data (bores and dams) were obtained from Geoscience Australia's Geodata Topo 250K vector product (Series 3, June 2006).

Areas more than 8 km from stock water are less likely to be grazed by cattle and are beyond the normal grazing range of sheep. This analysis does not include the locations of natural waters or bore drains, the latter being a very significant source of stock water across much of the bioregion. Thus, the percentage area within 3 km of stock water for some sub-IBRAs is probably significantly understated and the proportion beyond 8 km may be overstated.

It is not possible to report change in watered area. This is a significant issue in parts of Queensland where numerous formerly free-flowing bores (and

their associated bore drains) now have controlled flows and water is now reticulated by polythene pipe, tanks and troughs.

Weeds

Weeds known to occur in the Queensland part of the bioregion include Athel pine (*Tamarix aphylla*), mesquite (*Prosopis* spp.), parkinsonia (*Parkinsonia aculeata*), prickly acacia (*Acacia nilotica*) and rubber vine (*Cryptostegia grandiflora*).⁴⁵

Components of total grazing pressure

Change in domestic stocking density

Based on ABS-sourced data, relative stocking density in the Queensland part of the Mitchell Grass Downs bioregion was initially (until 1997) in line with generally

⁴⁵ See <http://www.anra.gov.au>

deteriorating seasonal quality (Figure 4.20). Stock numbers then increased appreciably between 1999 and 2001 during wetter years and then declined markedly with drier years in 2002 and 2003. Spatial averaging conceals likely variation in stocking density trends across the bioregion.

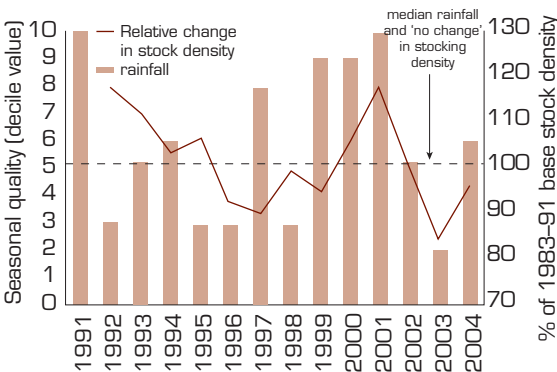
Kangaroo density

Kangaroo density data are available for all or most of the Southern Wooded Downs, Central Downs, Northern Downs and Kynuna Plateau sub-IBRAs. The relative density of red and eastern grey kangaroos (combined and expressed in DSEs) decreased, in a fluctuating manner, between 1993 and 1997 (Figure 4.21). It then increased rapidly and markedly to 2000 (>1.5 times the 1984–91 average) before decreasing in the early years of this decade, particularly due to poorer seasonal quality in 2002 and 2003 (see Figure 4.17).

Invasive animals

Invasive animal species known to occur in the Queensland part of the Mitchell Grass Downs bioregion include pig (*Sus scrofa*), goat (*Capra hircus*), deer (*Cervidae* spp.), fox (*Vulpes vulpes*), rabbit (*Oryctolagus cuniculus*), wild dog (*Canis lupus familiaris*), feral cat (*Felis catus*), starling (*Sturnus vulgaris*) and cane toad (*Bufo marinus*).⁴⁶

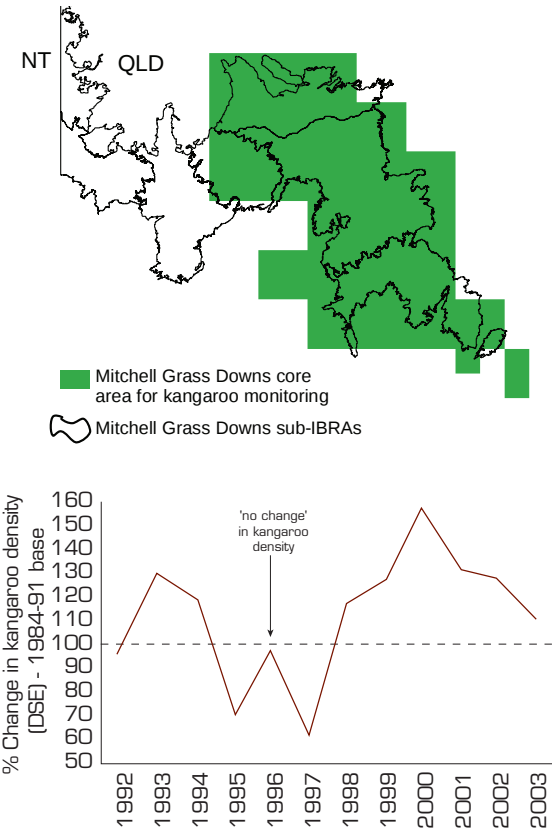
Figure 4.20 Change in domestic stocking density (sheep and beef cattle), Queensland part of the Mitchell Grass Downs bioregion, 1991 to 2004



Note: Seasonal quality as deciles of rainfall is also shown.

⁴⁶ See <http://www.anra.gov.au>

Figure 4.21 Change in kangaroo density, Mitchell Grass Downs bioregion, 1992 to 2003, relative to the average density for 1984–91 (DSE basis)



Note: Density data (bottom) are for the Mitchell Grass Downs core monitoring area (shown in green above).

Fire and dust

Fire

Fire was generally insignificant: less than 1% of the whole bioregion area burned each year between 1998–2000 and 2002–05. Fire was a feature in 2001, when 5.5% of the entire bioregion burned following three wetter years (Figure 4.17). However, extensive wildfires appear to have been confined to sub-IBRAs predominantly in the NT. Apart from 3.1% of the Central Downs sub-IBRA burning in 1997, other Mitchell Grass Downs sub-IBRAs exclusively in Queensland had less than 0.5% of their area burned in any year between 1997 and 2005.

Figure 4.22 Pitfall and funnel trapping — part of a fauna survey in the Mitchell Grass Downs bioregion, Queensland



Photo: Teresa Eyre, Queensland Environmental Protection Agency

Dust

The mean DSI_3 value (1992–2005, entire bioregion) was 1.69, a low to moderate value among all rangeland bioregions (maximum value, 8.44). Dust levels were higher in the central portion of the bioregion (Barkly Tableland sub-IBRA in the vicinity of the NT–Queensland border; Georgina Limestone and Southwestern Downs sub-IBRAs). Dust levels were negligible further into the NT and were low in the far east of the bioregion (Central Downs and Southern Wooded Downs sub-IBRAs).

Change in biodiversity

Fauna and flora surveys have been conducted across much of the bioregion (Figure 4.22). Under the Biodiversity Working Group indicator: Threatened species (for the entire bioregion), there are:

- 12 threatened plant species
- 8 threatened mammal species (which includes two extinct species, the desert rat-kangaroo and the lesser stick-nest rat); also included in the list

is the western quoll, which is listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*, but is extinct in this bioregion

- 9 threatened bird species
- no threatened reptile or amphibian species
- 2 threatened fish species.

Fifty-four regional ecosystems have been described for Queensland sub-IBRAs of the Mitchell Grass Downs bioregion. Under the *Vegetation Management Act 1999* (Qld), four of them are listed as 'of concern' and one is listed as endangered. For two of these regional ecosystems, less than 10% of their pre-clearing distributions are currently represented in reserves (Accad et al 2006) (Biodiversity Working Group indicator: Threatened communities). Descriptions of regional ecosystems are available at the Queensland Environmental Protection Agency website.⁴⁷

⁴⁷ http://www.epa.qld.gov.au/nature_conservation/biodiversity/regional_ecosystems/how_to_download_REDD/

Change in land use and land values

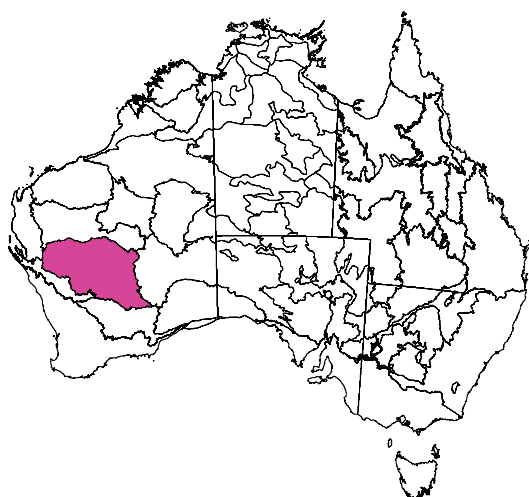
Ninety-six per cent of the entire bioregion area is under pastoral land use. There was no significant change in this area over the 1992–2005 reporting period.

For the Queensland Mitchell Grass Downs, unimproved rangeland values at June 2006 were, on average, \$4792 ± \$261/km² (2005 dollars). There was a large range in average unimproved value across sub-IBRAs (\$333/km² to \$6668/km²). It is not possible to report change in land values.

Murchison bioregion (WA)

The Murchison bioregion encompasses much of the mulga country in the southern rangelands of WA (Figure 4.23) and is 281 200 km² in area. The climate is arid with predominantly winter rainfall. Landscapes comprise low hills and mesas separated by flat colluvium and alluvial plains. Mulga low-woodlands dominate. Other vegetation types include saltbush shrubland on calcareous soils, saline areas with samphire, and hummock grassland on red sandplain. The Murchison is one of the main pastoral (sheep and cattle) areas in WA, but mining (gold, iron and nickel) contributes more to the region's economy. Major population centres are Meekatharra, Leonora, Cue and Mount Magnet.

Figure 4.23 Murchison bioregion, WA

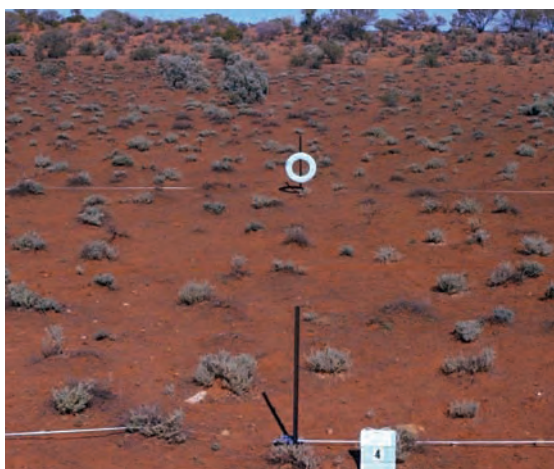


Note: Area = 281 200 km²

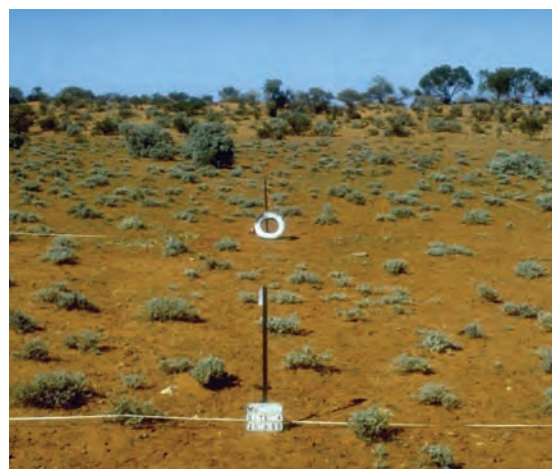
Regional issues

- Over approximately the past decade, the cover and density of shrubs and trees on Western Australian Rangeland Monitoring System (WARMS) sites increased. At other sites, cover and density remained stable (Figure 4.24).
- In general, grazing-sensitive species were not adversely affected on WARMS sites. However, on sites where overall decline was observed, the decline was greatest for grazing-sensitive species.
- Species richness of native shrubs (all species) on WARMS sites increased slightly.
- The apparent positive trends provided by WARMS data apply at a site level. Ecosystem Management Understanding (EMU) Project data, collected at the landscape to patch scale by Pringle et al (2006), generally contradict those findings and conclude that increased erosion, hydrological dysfunction and habitat homogenisation are increasing features of the bioregion.
- About 6% of the pastoral leases are under Indigenous ownership and 22% are under mining company ownership, and are either destocked or running low numbers of livestock.
- There has been a strong trend in enterprise type away from merino sheep to cattle, meat sheep (Figure 4.25) and rangeland goats. This is due to low wool prices, high meat prices, difficulty in finding labour for wool enterprises and wild-dog predation on sheep. Infrastructure on many stations, especially fencing, is not being maintained. This is partly the result of the move away from merino sheep. The region has also seen a large increase in the number of self-mustering yards (Figure 4.26), which enable total grazing pressure (TGP) to be better managed as well as decreasing mustering and labour costs.
- An increasing percentage of pastoralists expect to earn significant off-station income, principally from supporting the mining industry. Many leases are unviable as pastoral enterprises on their own.
- Unmanaged goats contribute a large proportion of the TGP and landscape degradation, but their contribution to station income can be high. A large number of trap yards have been built in the

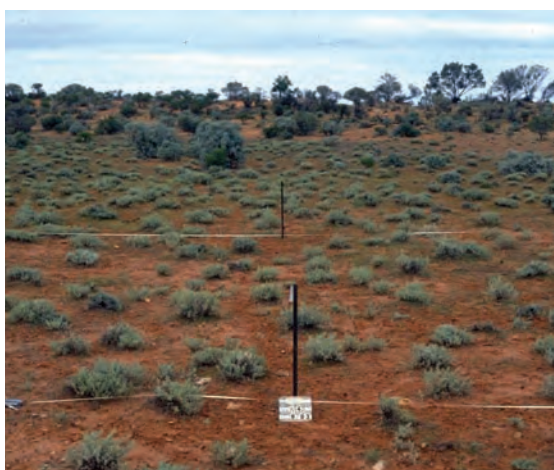
Figure 4.24 WARMS site in the Murchison bioregion, showing little change from 1982 to 2006



1982



1988



1993



2006

Most of the low vegetation is either bladder saltbush (*Atriplex vesicaria*) or low bluebush (*Maireana platycarpa*). Both species are decreaseers and are preferentially grazed by livestock.

Photos: WA Department of Agriculture and Food

past 10 years as a way of lowering the cost of mustering and for better control of TGP (Figure 4.26).

- Wild dog numbers and their impacts have increased markedly in recent years.
- There has been an expansion of mining interest to banded ironstone ranges in recent years. This is significant for conservation, as those systems are highly restricted in area and frequently support endemic biota or assemblages.

- Sandalwood harvesting persists as an industry but will be unsustainable in the longer term if lack of recruitment cannot be addressed.
- About 6.7% of the region is within the conservation estate, but that proportion is inadequate under the principles of CAR (comprehensiveness, adequacy and representativeness).
- More than 40% of the original mammal fauna is now regionally extinct, including almost all medium weight-range species.

Figure 4.25 Dorper and damara meat sheep



Dorpers

Photos: Mark Alchin, WA Department of Agriculture and Food



Damaras

Figure 4.26 Feral goats mustered in a trap yard to help control total grazing pressure



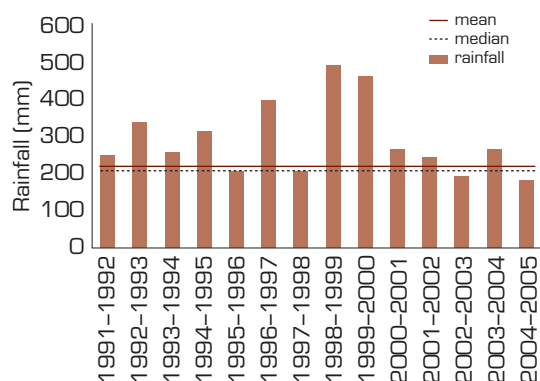
Photo: Mark Alchin, WA Department of Agriculture and Food

- Three mammals, three birds and one reptile are listed as vulnerable, and one reptile is listed as endangered. Three species of plant are listed as declared rare flora and many more have priority status, although most of them have not been studied well enough to determine their current condition and trend.

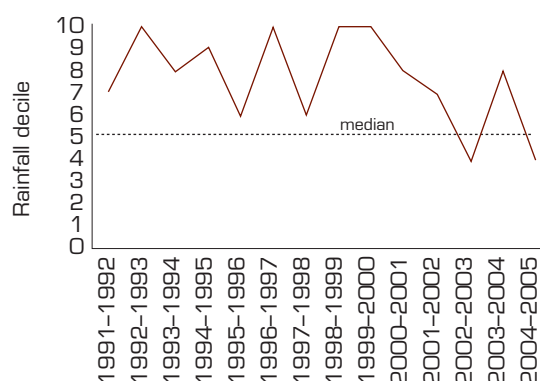
- As long as goats remain unmanaged, they will continue to be one of the more significant threats to biodiversity conservation through broadscale impacts on vegetation associations, cascading influences on landscape function, and grazing of environmentally sensitive sites.
- Although there are no formally listed threatened ecosystems, more than 52 vegetation associations and community types are considered to be at risk from grazing, changed fire regimes and other factors.
- The average 'lease and improvement' value of pastoral land in the Carnarvon–Gascoyne–Murchison region increased by 230% over the period from 1992 to 2005.
- The mid-to-late 1990s was an exceptional sequence of above-average years, particularly in summer rainfall. For part of the bioregion, the period since mid-2001 has been dry.
- The western and southern parts of the region were declared for Exceptional Circumstances drought relief in 2003. Some areas had this declaration extended in 2006.

Further information relevant to recent change in the Gascoyne–Murchison region (which includes the Murchison bioregion) is available in Watson et al (2005b).

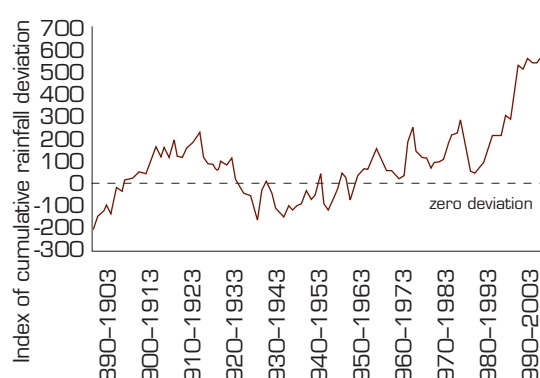
Figure 4.27 Indicators of *seasonal quality*, Murchison bioregion



Annual rainfall. Long-term (1890–2005) mean and median rainfalls are also shown



Annual rainfall as deciles of the long-term (1890–2005) rainfall

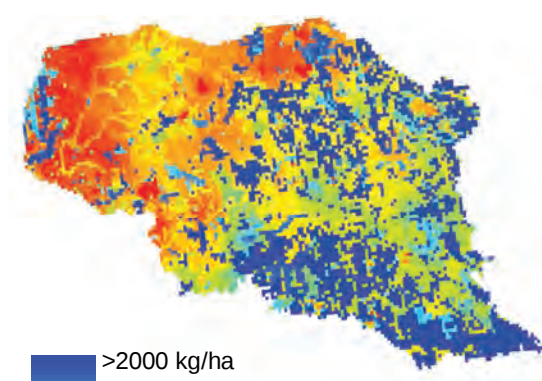


Cumulative percentage deviations of annual (April–March) rainfall from the long-term (1890–2005) median for all 14-year periods between 1890–1903 and 1992–2005

Left: Rainfall

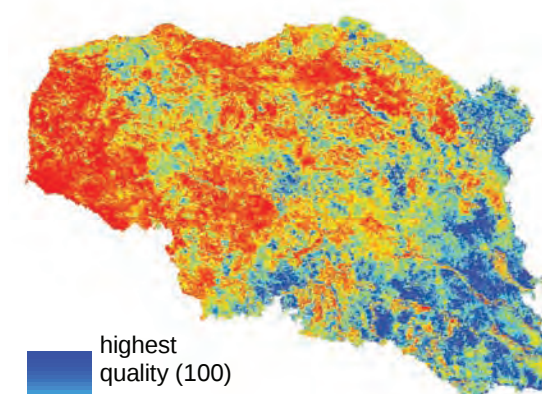
Right: Simulated pasture biomass and vegetation greenness (NDVI)

Note: Indicators are based on spatially averaged annual rainfall (April–March) between 1991–92 and 2004–05. For cumulative percentage deviations, periods below the dashed zero line indicate 14-year sequences with generally less rainfall (poorer *seasonal quality*) and periods above the line indicate sequences of increased rainfall (better *seasonal quality*).



>2000 kg/ha
2000 kg/ha
1000 kg/ha
500 kg/ha
200 kg/ha
<200 kg/ha

Aussie-GRASS simulated total standing dry matter — 2001



highest quality (100)
100
50
0
lowest quality (0)

NDVI-based image of 'season quality' for 2001. Each pixel has a relative value according to the greenness of vegetation (ie photosynthetic activity)

Seasonal quality — 1992–2005

Rainfall was above average for most years, and the 1992–2005 period as a whole was generally wetter than all other 14-year periods since 1890 (Figure 4.27, left panel). Notwithstanding this, the spatial pattern of simulated pasture biomass produced by AussieGRASS and 'season quality' derived from the NDVI show that there was considerable regional variation in some years (Figure 4.27, right panel); that is, some parts of the region were much drier than others (and not all parts can be considered to have had such a good run of seasons).

Change in landscape function

Change in landscape function at the site scale can be reported in a number of ways using WARMS data. Here, we report on the basis of the Resource

Capture Index (RCI) and shrub density (Figure 4.28, the latter for consistency with reporting by other jurisdictions).

WARMS data have high reliability for each site: there are many well-distributed sites in selected parts of the landscape; quantitative data are collected; the focus is on longer-lived plant species, which helps to filter short-term seasonal variability; and both indices (RCI and shrub density) usefully indicate landscape function. WARMS sites report change for the local areas they represent and should not be considered as representing the entire landscape (Pringle et al 2006).

Shrub density

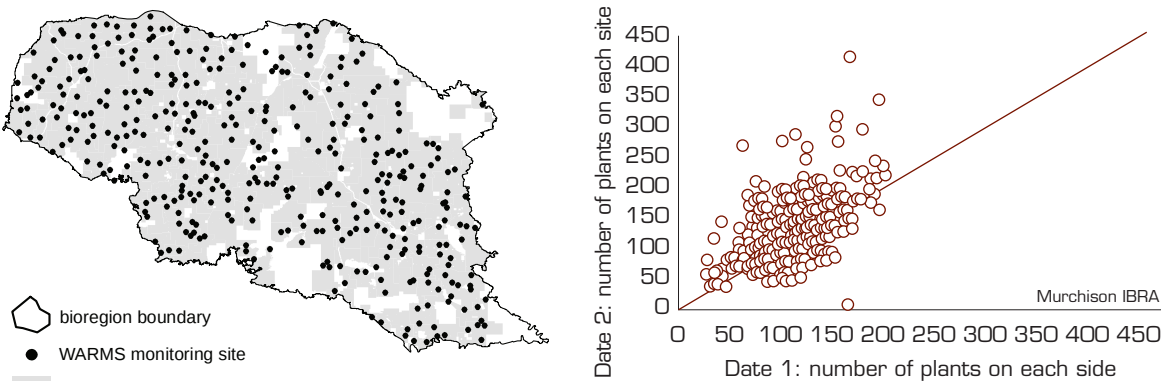
Based on the density of long-lived perennial plants recorded at WARMS monitoring sites, landscape function at those sites generally improved

Table 4.9 Seasonally interpreted change in landscape function at WARMS sites in the Murchison bioregion, based on change in density of longer-lived perennial vegetation

Seasonal quality	Number of sites	Decline. Density <95%	No change. Density between 95% and 105%	Increase. Density >105%
Above average	157	14%	15%	71%
Average	167	30%	23%	47%
Below average	62	60%	19%	21%

Note: The light grey cell indicates a likely adverse effect related to grazing management, in that no change or an increase in the landscape function indicator would be expected following above-average seasonal quality. The grey cell represents an encouraging result, as a decrease in landscape function would be expected following poor seasonal conditions.

Figure 4.28 Changes in landscape function, Murchison bioregion



WARMS sites used to report changes in landscape function

Changes in density of long-lived perennial plants

Table 4.10 Seasonally interpreted change in landscape function at WARMS sites in the Murchison bioregion, based on change in the Resource Capture Index (RCI)

Seasonal quality	Number of sites	Decline. RCI < 0.90	No change. 0.90 ≥ RCI < 1.10	Increase. RCI ≥ 1.10
Above average	94	60%	9%	32%
Average	141	55%	15%	30%
Below average	62	68%	11%	21%

Note: See Table 4.9 for an explanation of cell colours.

Table 4.11 Seasonally interpreted change in critical stock forage at WARMS sites in the Murchison bioregion

Seasonal quality	Species group	Number of sites	Decline. Density < 0.95	No change. 0.95 ≤ density < 1.05	Increase. Density ≥ 1.05
Above average	Decreaser	153	17%	11%	73%
	Intermediate	151	16%	19%	65%
	Increaser	74	7%	36%	57%
Average	Decreaser	165	33%	20%	47%
	Intermediate	166	25%	31%	44%
	Increaser	108	12%	34%	54%
Below average	Decreaser	61	67%	10%	23%
	Intermediate	58	45%	34%	21%
	Increaser	43	28%	33%	40%

Notes: Critical stock forage is based on the frequency of decreaser species. See Table 4.9 for an explanation of cell colours.

(Figure 4.28), in that there was a higher population at the second assessment (1999–2005) at most sites compared with the initial assessment (1993–2001).

Fourteen per cent of sites showed a decline in the density of longer-lived perennial vegetation when *seasonal quality* was above average, and 21% of sites showed improvement when *seasonal quality* was below average (Table 4.9). Interpretation of these seasonally adjusted changes would be enhanced with knowledge of the grazing pressure exerted at each site, but stocking density data at that resolution are not available. Regional livestock numbers decreased between 1998 and 2004, particularly in the west, in response to poorer *seasonal quality* (see Figure 4.29). However, data are lacking on TGP, particularly for feral goats and kangaroos. It is not possible to convert regional livestock trends to an estimate of stocking density at WARMS sites.

Resource Capture Index

Sixty per cent of sites showed a decline in the RCI when *seasonal quality* was above average, and 21% of sites showed an improvement when *seasonal quality* was below average (Table 4.10).

Sustainable management

Change in critical stock forage

The density of long-lived decreaser shrubs declined at 17% of sites following above average *seasonal quality* (Table 4.11). The density of decreaser shrubs increased at 23% of sites following below-average *seasonal quality*.

Native shrub species richness

The richness of native shrub species recorded at WARMS sites provides insight into one aspect of sustainable management: a greater diversity of species provides increased grazing choice for sheep

Table 4.12 Seasonally interpreted change in native-shrub species richness at WARMS sites in the Murchison bioregion

Seasonal quality	Number of sites	Decline. Richness index < 0.80	No change. 0.80 ≤ Richness index < 1.20	Increase. Richness index ≥ 1.20
Above average	157	3%	67%	31%
Average	167	3%	83%	14%
Below average	62	5%	81%	15%

Note: See Table 4.9 for an explanation of cell colours.

Table 4.13 Percentages of pastoral lease area of each sub-IBRA within 3 km and beyond 8 km of permanent or semipermanent sources of stock water, Murchison bioregion

Sub IBRA	% sub IBRA area included	% area ≤3 km from stock water	% area >8 km from stock water
Eastern Murchison (MUR1)	78.3	38.3	11.1
Western Murchison (MUR2)	90.9	48.6	0.3

or cattle and improved ecosystem health. Based on 386 sites, the average ratio of species richness at first assessment (December 1993 to April 2001) to richness at second assessment (September 1999 to November 2005) was 1.08 ± 0.01 (SE). Three per cent of sites had decreased species richness following above average *seasonal quality*, whereas 15% had increased species richness following below-average *seasonal quality* (Table 4.12).

Change in woody cover

Based on WARMS data, cover of woody species increased on average by 28% and remained the same or increased on most sites (68%). On only 3% of sites did cover drop below 50% of the initially recorded value. These results were similar whether large overstorey species were considered or not. Much of the increase in canopy area was driven by *seasonal quality*. Canopy area decreased markedly for those sites that experienced below-average seasonal conditions.

Distance from water

Based on the locations of stock water sources (derived from WA mapping of lease infrastructure), Table 4.13 lists the percentages of pastoral lease areas within each sub-IBRA that are less than 3 km and more than 8 km from waterpoints (water-remote).

The Western Murchison sub-IBRA had almost no areas remote from water.

These analyses do not include the locations of ephemeral natural waters, which can provide additional sources of water for stock, particularly in the early dry season.

It is not possible to report change in watered area for the 1992–2005 period.

Weeds

Weeds known to occur in the bioregion include African boxthorn (*Lycium ferocissimum*), Patersons curse (*Echium plantagineum*), Bathurst burr (*Xanthium spinosum*), mesquite (*Prosopis* spp.) and Mexican poppy (*Argemone ochroleuca*).⁴⁸

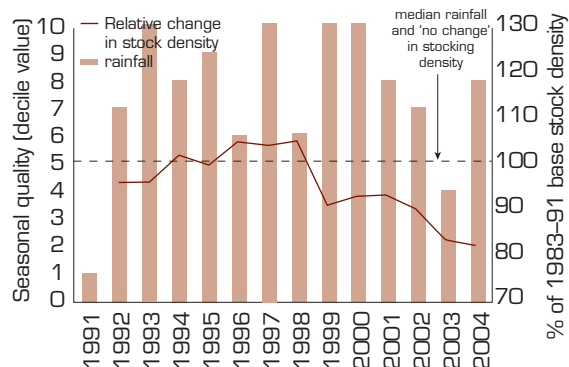
Components of total grazing pressure

Domestic stocking density

Eighty-eight per cent of the Murchison bioregion was pastoral land in the period from 1992 to 2001, reducing to approximately 83% of the bioregion in 2005. Based on ABS-sourced data and taking account of the reduction in grazed area, domestic stocking

⁴⁸ See <http://www.anra.gov.au>

Figure 4.29 Changes in domestic stocking density (sheep and beef cattle), Murchison bioregion, 1991 to 2004



Note: Seasonal quality as deciles of rainfall is also shown.

density was slightly above the 1983–91 average between 1996 and 1998 but decreased sharply in 1999 and then decreased further by 2003 and 2004 (Figure 4.29). The decrease reflects destocking of leases in the western part of the bioregion from 1999–2000 onwards as drought set in. All but the eastern parts of the region were drought declared in 2003. For some areas, this declaration was extended in 2006. Spatial averaging of stocking density across the large extent of this bioregion conceals variation in actual stocking density in parts of the region.

Feral goats contribute significantly to TGP in some parts. There are insufficient reliable data to report goat numbers or their change in density through the 1992–2005 reporting period.

Kangaroos

No suitable data are available to report change in kangaroo density.

Invasive animals

Invasive animal species known to occur in the bioregion include goat (*Capra hircus*), fox (*Vulpes vulpes*), rabbit (*Oryctolagus cuniculus*), wild dog (*Canis lupus familiaris*), feral cat (*Felis catus*), camel (*Camelus dromedarius*), donkey (*Equus asinus*), horse (*Equus caballus*) and feral sheep (*Ovis* spp.).⁴⁹

⁴⁹ See <http://www.anra.gov.au>

Fire and dust

Fire

Fire was insignificant, with a maximum of 1.9% of the bioregion area burned in both 2000 and 2001. Based on the month of burn, fires between 1997 and 2005 were of both hot and cool types; both types occurred each year to varying extents. The frequency of fire between 1997 and 2005 was insignificant; the mean frequency ($\log_{10}$ transformed) was 0.03.

Absence of fire under present-day pastoral management may also be significant, as there may be many plant associations that would have burned under non-pastoral regimes but now rarely burn.

Dust

Atmospheric dust levels based on the DSI were relatively low (mean DSI₃ of 1.43 for the 1992–2005 period, in which the maximum value for all bioregions was 8.44). The spatial distribution map (Chapter 3) shows that the most dust occurs in the eastern area of the bioregion and is probably associated with mining activity in and around Kalgoorlie, which is just south of the bioregion boundary in the Coolgardie bioregion. Dust reporting for the Murchison bioregion has moderate reliability.

Change in biodiversity

The area set aside for conservation purposes increased from about 0.5% of the bioregion in 1998 to 6.7% in 2004, due to the purchase of pastoral leases by the WA Government.

Two plant species are listed as threatened in the Murchison bioregion. There are also 7 mammal species, 2 bird species and 3 species of reptile listed as threatened (Biodiversity Working Group indicator: Threatened species).

Change in land use and land values

Approximately 14 800 km² of pastoral land (5.3% of the bioregion) has been acquired for conservation purposes from 1998 onwards.

It is not possible to describe change in land values for the Murchison region alone, but land values for the Carnarvon–Gascoyne–Murchison region have increased by approximately 230% since 1992.

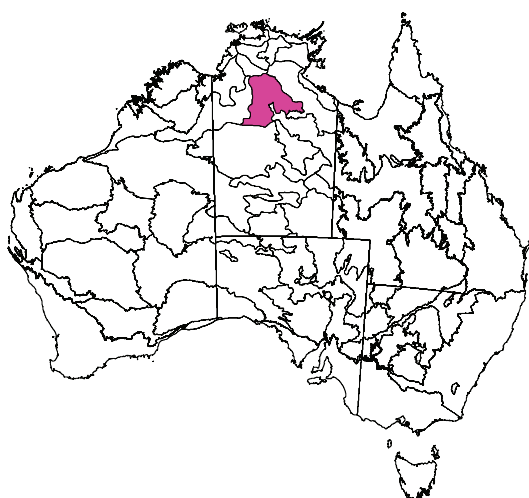
Sturt Plateau bioregion (NT)

The Sturt Plateau bioregion in the northern half of the NT (Figure 4.30) is predominantly eucalypt woodlands or tall shrublands and woodlands of bullwaddy (*Macropteranthea kekwickii*) and lancewood (*Acacia shirleyi*) on flat to gently undulating plains. In more open areas, perennial grasses predominate. Soils are mainly lateritic, but deep sands occur in the south and cracking clays in the southeast. Grazing by cattle is the principal land use (77% of the bioregion area is under pastoral tenure). Aboriginal freehold covers almost 20% of the bioregion, and there is a small area within reserves. Larrimah and Daly Waters are small settlements within the bioregion.

Regional issues

- Historically, pastoral development of the Sturt Plateau bioregion was hindered by water supply problems. There has been considerable development in the past 30 years, mainly through water development and extensive fencing (Figure 4.31).
- Compared with neighbouring productive bioregions, the Sturt Plateau bioregion has a higher proportion of smaller family-owned and operated properties and a lower proportion of larger company-owned stations.
- Increased groundwater information has led to better success rates for drilling bores, and hence to further development.

Figure 4.30 Sturt Plateau bioregion, NT



Note: Area = 98 575 km².

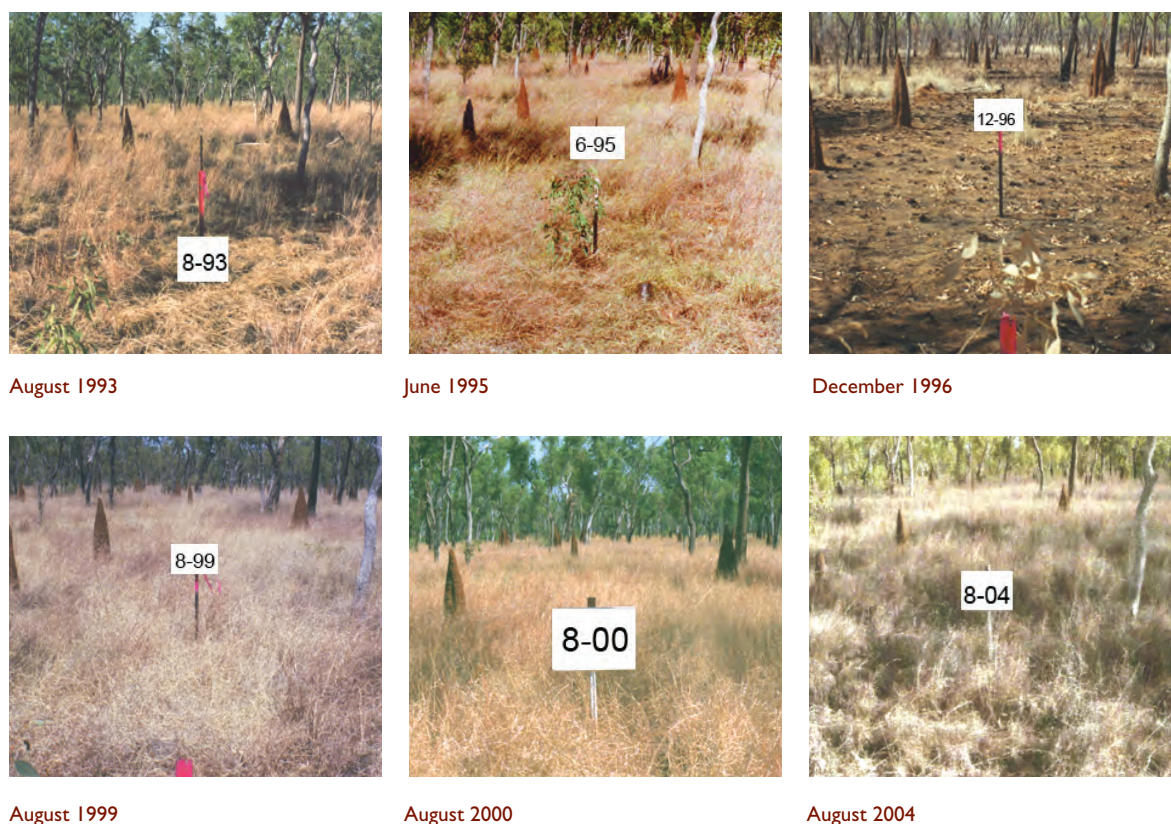
Figure 4.31 New waterpoint infrastructure on the Sturt Plateau



Photo: NT Department of Natural Resources, Environment and the Arts

- Infrastructure development has included the strategic location of waterpoints and the use of polypipe and tanks to better distribute and control grazing.
- Landscape condition (Figure 4.32) and management have improved due to increased infrastructure. This has provided better control of cattle grazing and improved access to control wildfires, which are now less frequent and less intense. There is now less patch grazing by feral animals of new pasture growth after fire and less associated land degradation, as there are now fewer burns.
- The region has a very vocal and proactive 'best practice' group. This has assisted intensification and the further development of properties and the region.
- Stock carrying capacities of the region are being reviewed to take into account infrastructure development and better management of the land (Figure 4.33).
- A major concern is the introduction and spread of weeds along the recently completed Alice Springs–Darwin rail corridor. The region has relatively few weed problems, and properties with infestations are very proactive in management and eradication.
- Some Aboriginal leases are being used for pastoral purposes.

Figure 4.32 Changes at a Tier 1 monitoring site, Sturt Plateau bioregion, 1993 to 2004



The site has been able to recover from fire and increased grazing pressures to record similar cover levels to those present 10 years earlier.

Photos: NT Department of Natural Resources, Environment and the Arts

Figure 4.33 Infrastructure developments in the Sturt Plateau bioregion



Trap yards and other infrastructure developments, including increased water supply, paddocking and increased track access for fire control, have improved land management in the Sturt Plateau bioregion.

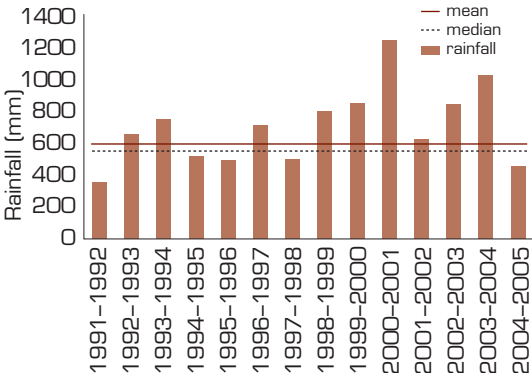
Photo: NT Department of Natural Resources, Environment and the Arts

Seasonal quality — 1992–2005

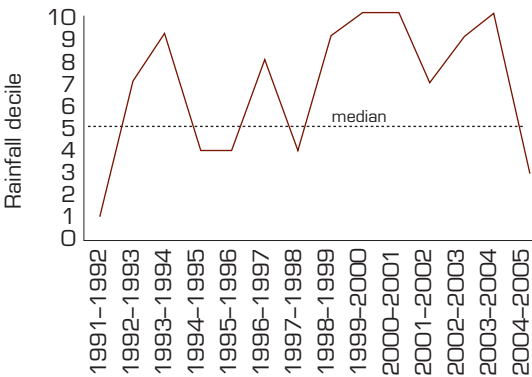
Rainfall was generally above the long-term (1890–2005) median throughout the 1992–2005 period, indicating above-average *seasonal quality*, and the 14-year period as a whole was better than most other 14-year periods since 1890 (Figure 4.34, left). The past 45 years have been generally wetter, apart from a return to more average *seasonal quality* in some years in the 1980s (bottom left panel, Figure 4.34). As in most bioregions, *seasonal quality* has varied spatially across the Sturt Plateau in some years. This assessment of variability is based on simulated pasture biomass produced by AussieGRASS and ‘season quality’ derived from NDVI⁵⁰ (Figure 4.34, right panels).

⁵⁰ See <http://www.environment.gov.au/erin/ndvi.html>.

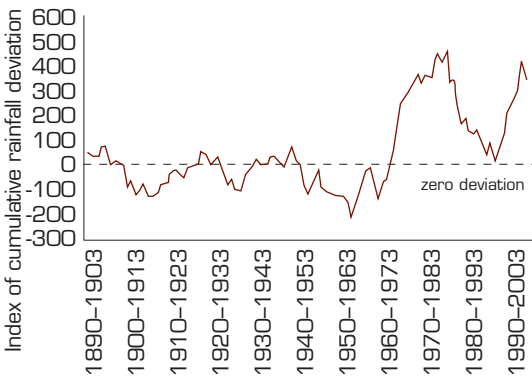
Figure 4.34 Indicators of *seasonal quality*, Sturt Plateau bioregion



Annual rainfall. Long-term (1890–2005) mean and median



Annual rainfall as deciles of the long-term (1890–2005) rainfall

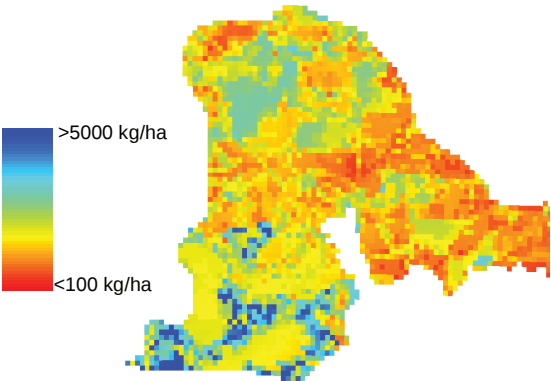


Cumulative percentage deviations of annual (April–March) rainfall from the long-term (1890–2005) median for all 14-year periods between 1890–1903 and 1992–2005

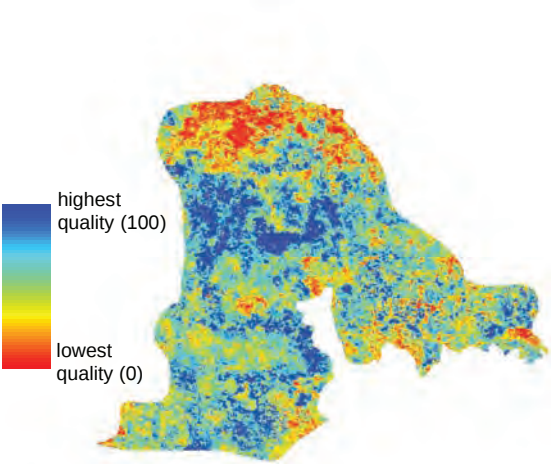
Left: Rainfall

Right: Simulated pasture biomass and vegetation greenness (NDVI)

Note: Indicators are based on spatially averaged annual rainfall (April–March) between 1991–92 and 2004–05. For cumulative percentage deviations, periods below the dashed zero line indicate 14-year sequences with generally less rainfall (poorer *seasonal quality*) and periods above the line indicate sequences of increased rainfall (better *seasonal quality*).



Aussie-GRASS simulated total standing dry matter — 2002



NDVI-based image of 'season quality' for 2002. Each pixel has a relative value according to the greenness of vegetation (ie photosynthetic activity)

Change in landscape function

Using the percentage of groundcover and composition (by biomass) of perennial herbage species (mainly grasses) estimated at Tier 1 monitoring sites as an index, landscape function initially declined (between 1993 and 1996) and then increased to a moderately stable and relatively high value over most of the remainder of the reporting period (Figure 4.35). Taking account of seasonal conditions, 6% of 167 sites assessed following above-average rainfall showed reduced landscape function (ie improved landscape function would have been expected at this time). Decline in landscape function at some sites in the early years of the current decade was due to extensive wildfire following the extended period of above-average rainfall. Perennial grasses were temporarily replaced by annual sorghum on burnt areas. This decline appeared to be temporary — landscape function, on average, was largely restored at those sites assessed in 2004. No sites were assessed following any periods of below-average seasonal quality between 1992 and 2005.

There is a moderate degree of confidence in these data. There is a reasonably high density of Tier 1 sites, but their distribution is clumped to some degree, and the index is based on observer estimates, rather than quantitative measured data. The derived index has not yet been tested to determine its ability to indicate landscape function reliably, compared to the

established method of formal ground-based landscape function analysis used in the WARMS monitoring system.

Sustainable management

Change in critical stock forage

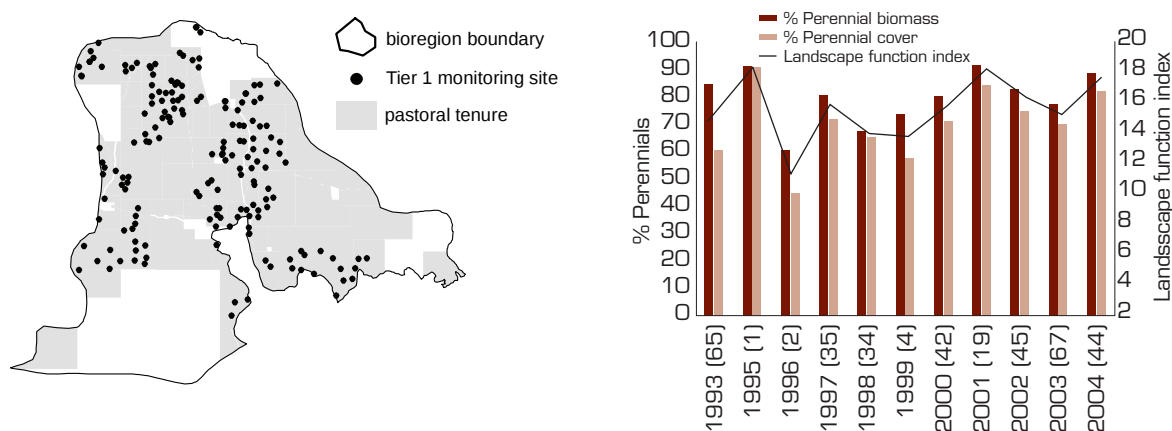
Changes in estimated composition, by biomass, of palatable perennial (2P) grasses were mainly in accord with seasonal expectations (Table 4.14). Across both average and above-average seasonal conditions, 93% of the 183 sites providing suitable data for reporting change showed no change or an improvement in the composition of 2P grasses. Composition is adjusted for utilisation (ie it is adjusted to the composition estimated to be present at the end of the growing season).

Change in woody cover

Based on the Australian Greenhouse Office's definition and mapping, forest extent is negligible in the Sturt Plateau bioregion.⁵¹ Forest covered 0.04% of the bioregion area in 1991, and that proportion remained relatively unchanged at 0.05% in 2004. Reporting is based on analysis of Landsat data and is highly reliable because almost complete coverage of satellite imagery was available (more than 90% of the bioregion area).

⁵¹ <http://www.greenhouse.gov.au/ncas/reports/tech09.html>

Figure 4.35 Changes in an index of landscape function, Sturt Plateau bioregion



Tier 1 monitoring sites used to report changes in landscape function

Change in landscape function is based on the combined estimated percentage cover and composition (by biomass) of perennial herbage species (mainly grasses). Biomass composition is adjusted for grazing to remove any short-term utilisation effects. Figures in parentheses along the horizontal axis show the number of sites assessed each year.

Table 4.14 Percentage of Tier 1 sites assessed following variable *seasonal quality* where there was a change in the estimated composition of palatable perennial (2P) grasses, Sturt Plateau bioregion

Seasonal quality	Number of sites	Percentage of reassessed sites showing		
		Decline >20% decrease in 2P grasses	No change	Improvement >20% increase in 2P grasses
Above average	171	8	67	25
Average	12	0	92	8
Below average	n.a.	n.a.	n.a.	n.a.

n.a. = not applicable
Note: The light grey cell indicates a likely adverse effect related to grazing management, in that no change or an improvement in the composition of 2P grasses would be expected following above-average seasonal conditions.

Table 4.15 Percentages of sub-IBRA area within 3 km and beyond 8 km of permanent and semipermanent sources of stock water, Sturt Plateau bioregion

Sub IBRA	% of sub IBRA area	
	<3 km from water	>8 km from water
Sturt Plateau P1	0.7	96.9
Sturt Plateau P2	7.0	66.7
Sturt Plateau P3	6.4	69.3

Distance from stock water

Based on the locations of stock waterpoints (sourced from Geoscience Australia’s Geodata Topo 250K vector product, Series 3, June 2006), Table 4.15 lists the percentages of sub-IBRA areas within 3 km and further than 8 km of permanent and semipermanent sources of stock water. This analysis does not include the locations of natural waters, which can provide additional sources of water for stock, particularly in the early dry season. Available waterpoint data are probably out of date, as they do not reflect recent infrastructure development in the bioregion.

It is not possible to report change in watered area.

Weeds

Weeds known to occur in the bioregion include bellyache bush (*Jatropha gossypifolia*), Chinee apple (*Zizyphus mauritiana*), grader grass (*Themeda quadrivalvis*), hyptis (*Hyptis suaveolens*), mission grass (*Pennisetum polystachion*), Noogoora burr (*Xanthium occidentale*), parkinsonia (*Parkinsonia aculeata*), prickly acacia (*Acacia nilotica* subsp. *indica*) and sicklepod (*Senna obtusifolia* tora).⁵²

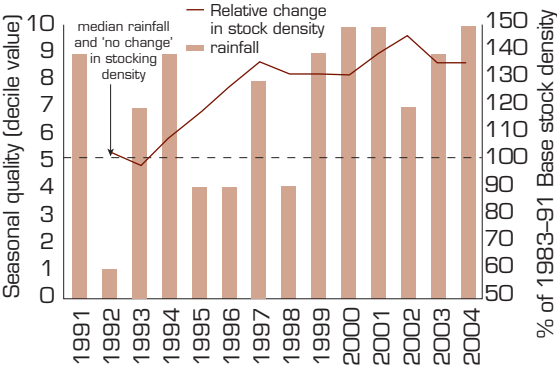
⁵² See <http://www.anra.gov.au>

Components of total grazing pressure

Change in domestic stocking density

Approximately 77% of the Sturt Plateau bioregion is pastoral land. Based on ABS-sourced data, domestic stocking density increased between 1993 and 1997 (Figure 4.36).

Figure 4.36 Change in domestic stocking density (beef cattle), Sturt Plateau bioregion, 1991 to 2004



Note: Seasonal quality as deciles of rainfall is also shown.

Table 4.16 Percentage area of Sturt Plateau bioregion burned, 1997 to 2005

1997	1998	1999	2000	2001	2002	2003	2004	2005
7.9	13.2	41.4	20.2	61.1	27.0	18.2	63.7	2.1

Source: WA Landgate data based on fire-scar mapping from National Oceanic and Atmospheric Administration AVHRR satellite images

This approximate density was maintained until 2000 and then increased to 2002. In both 2003 and 2004, stocking density was 37% above the 1983–91 base. This large increase in stocking density was probably helped by some better seasons but also continued through some seasons of average *seasonal quality*. Apart from the better seasons, the increase was also driven by land use intensification in the region. Spatial averaging conceals likely variation in stocking density trends across the bioregion.

Invasive animals

Invasive animal species known to occur in the Sturt Plateau bioregion include pig (*Sus scrofa*), wild dog (*Canis lupus familiaris*), feral cat (*Felis catus*), cane toad (*Bufo marinus*) and water buffalo (*Bubalus bubalis*).⁵³

Fire and dust

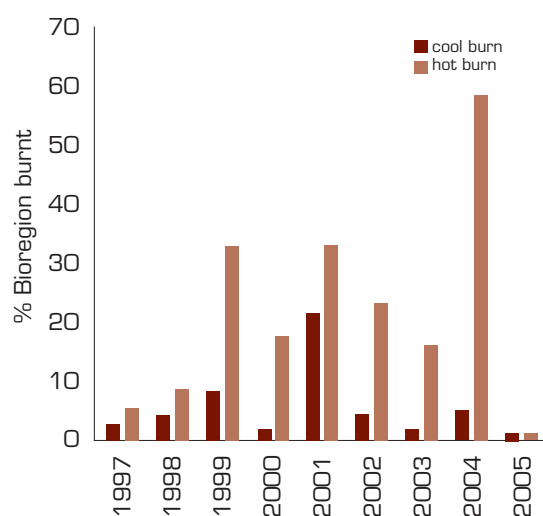
Fire

Large areas of the bioregion were burned in 1999, 2001 and 2004 (Table 4.16). During the most fire-active years (1999 to 2004), hot late dry-season (August–December) fires were predominant (Figure 4.37). Fire frequency was moderate compared with the rangelands as a whole (mean frequency ($\log_{10}$ transformed) = 0.435).

Dust

Atmospheric dust levels based on the DSI were among the lowest levels of all rangeland bioregions (mean DSI₃ of 0.47 for the 1992–2005 period, when the maximum value for all bioregions was 8.44).

Figure 4.37 Area of Sturt Plateau bioregion burned in ‘cool’ (January–July) and ‘hot’ (August–December) fires, 1997 to 2005 (%)



Change in biodiversity

Five mammal species and five bird species are listed as threatened for the Sturt Plateau bioregion (Biodiversity Working Group indicator: Threatened species).

Change in land use and land values

Based on available data, there was no change between 1992 and 2005 in the proportion of the bioregion under pastoral land use (77%). Ninety-five per cent of the area contained in pastoral leases was grazed.

The unimproved value of pastoral land increased by 45% between 1991 and 2003. This was the largest increase of all pastorally significant bioregions in the NT. Increased land values were partly driven by intensification resulting from infrastructure development and increased availability of groundwater.

⁵³ See <http://www.anra.gov.au>