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Extract from Rangelands 2008 — Taking the Pulse
6. ACRIS — data into information

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6 ACRIS — data into information

In Chapter 3, a range of datasets are examined for their capacity to report *changes* in, as distinct from the *state* of, the resource condition of the Australian rangelands. Chapter 3 provided an interpretation of what those data indicate about trends within selected bioregions, while Chapter 5 flagged emerging trends in rangelands resource management. This chapter integrates the results of the more targeted assessments in the earlier chapters to show how insights critical to the needs of the key Australian Collaborative Rangeland Information System (ACRIS) users can be drawn from the data at both the national and the regional scales.

The chapter has two major parts.

- *Data integration* — demonstrating the potential of the various datasets available through ACRIS to inform regional and national rangelands issues in an integrated way
- *Refinements to ACRIS* — the current status of ACRIS as an information system and the actions required to develop its functionality.

Data integration

ACRIS seeks to provide information on change in natural resource condition at a scale that is useful to those needing to develop responses to current and emerging issues. Those users include national, state, territory and local governments, regional natural resource management (NRM) organisations, and local community groups. While ACRIS is not currently able to meet the needs of all these users, this report is a significant step towards providing information required to support government legislative and policy initiatives relevant to the management of the rangelands, including:

- the establishment of policy and program priorities and the evaluation of their outcomes
- the evaluation of regional resource management strategies and investment plans developed in the context of initiatives such as the Australian Government's Natural Heritage Trust, and the equivalent approaches of the state and territory governments
- tracking compliance with jurisdictional legislative regimes
- meeting regional, national and international reporting obligations.

The types of issues that the analyses undertaken by the ACRIS seek to address can be grouped into three general categories:

1. *Understanding biophysical functioning of the rangelands*. While much is known at local and regional scales, there is potential value in integrating that knowledge across regions and jurisdictions. Consistent meta-analysis of jurisdictional monitoring data and the systematic interpretation of emergent trends with data quantifying climate variability, fire regimes and components of total grazing pressure should improve our understanding of how the rangelands change and what biophysical processes most influence those changes. More integrated analysis may provide better answers to questions such as the location of areas where agriculture will be profitable and sustainable, and areas of high biodiversity conservation value, the trend in condition of those areas, and their specific management needs.
2. *Identifying trends in resource conditions in the rangelands*. Identified trends could flag the need for responses or interventions at the relevant scale, such as targeted regional investments, changes

to state/territory land tenure arrangements, or coordinated national responses. Information on trends in resource condition is also required to monitor the effectiveness of existing NRM policies or programs in attaining their original objectives.

3. *The capacity of the current arrangements to meet the needs of the ACRIS partners*. At this stage, the main users of ACRIS are the national, state and territory governments. Comprehensive information that they need for the development of effective responses to current or emerging NRM issues might not currently be available from any information source. Improving the relevance of ACRIS to all rangeland users and managers (for example, the regional NRM groups) requires an assessment of the match between the scale of data collection and the scale at which decision-making occurs.

We present three key findings on change:

1. *Landscape function*. The ACRIS data suggest that landscape function recorded on ground-based monitoring sites improved or remained stable, given the seasonal trends experienced in most rangeland bioregions over the 1992–2005 reporting period. It is not possible to link stocking rates at the local scale directly to those changes. However, at a broader scale, regional livestock numbers have remained relatively high during periods of declining *seasonal quality* in some bioregions, suggesting difficulty in maintaining landscape function in those areas.
2. *Conservation of biodiversity*. The data available for ACRIS purposes indicate that there continues to be a decline in biodiversity.
3. *Land values as an economic indicator*. Land values in many parts of the grazed rangelands have increased in recent years.

These findings are then applied to understanding an emerging issue — the growth of the northern beef industry (see Chapter 3) — and possible implications for sustainable land management.

The data focus is on changes from 1992 to 2005 to give a national view, while regional case studies illustrate the diversity of rangelands' responses.

The context for interpreting the key findings

We have interpreted these key findings about environmental change in the light of the most important and defining characteristic of the Australian rangelands: variability. Variability encompasses not only obvious continental-scale climatic variability or the variability in year-to-year weather patterns recorded at a single site, but also includes significant regional variations in land use intensity that may drive or be driven by yet other variables, such as landscape productivity, market access, property size or land values.

In presenting regional and national changes, it is critically important to emphasise the value of interpreting measures of change within a context of *seasonal quality* (see Box 2.1 in Chapter 2 and the Climate Variability theme in Chapter 3 for details). Interpreting the key findings generated by ACRIS involves 'seeing through' seasonal variations when detecting long-term trends. While the importance of seasonal conditions on natural resource condition cannot be overstated, that ACRIS has demonstrated the ability to identify possible management-induced responses is a significant achievement.

The impact of management on long-term trends can most readily be detected when the trends in observed rangeland attributes are at odds with seasonal conditions over the observation period. Between the early 1990s and 2005, *seasonal quality* was generally above average in the monsoonal north and northwest rangelands. *Seasonal quality* in central Australia varied from dry conditions in the mid-1990s to very wet seasons in 2000–2001. Above-average seasonal conditions occurred in most of the Western Australia (WA) and South Australia (SA) shrublands until 2001, and were followed by a lengthy drier-than-average period. In the eastern grasslands and mulga lands, *seasonal quality* was lower throughout the early 1990s to 2000, with drought conditions prevailing after 2000.

The interpretation of management effectiveness based on monitoring data over the 1992–2005 period needs to be made in the context of seasonal conditions during that time (Table 6.1). This interpretation builds

Table 6.1 Interpreting trends in landscape function and stock forage relative to regional *seasonal quality* over the reporting period

Seasonal quality	Trends in landscape function and critical stock forage Most of the region showing **decline**	 Most of the region showing **no change**	 Most of the region showing **increase**
Above average	Management has suppressed the expected response. **Further investigation required.**	Management has not allowed the landscape to respond to favourable seasons. **Further investigation required.**	Management has delivered a response consistent with expectations.
Average	Management has not delivered the expected response. **Further investigation required.**	Management has delivered a response consistent with expectations.	Management has delivered a better than expected response. **Investigate, acknowledge and promote.**
Below average	Management has delivered a response consistent with expectations.	Management has limited the impact of below-average seasons. **Investigate, acknowledge and promote.**	Management has had a significantly beneficial impact on the outcome. **Investigate, acknowledge and promote.**

on the *seasonal quality* matrix for understanding biophysical change presented in Chapter 2 (see Box 2.1), and presents a number of possible outcomes of seasonal condition versus rangeland responses at the regional scale.

Where regional declines in landscape function (and/or critical stock forage) have occurred following above-average seasonal conditions, further investigation is required to identify causes, so that more appropriate management responses can be identified and implemented. Similarly, management actions promoting improvements in landscape function despite low *seasonal quality* should be understood, acknowledged and promoted. Individual or grouped monitoring sites with negative trends at odds with a generally positive regional response suggest the need to work at the local or property scale to improve management practices.

Discussion of the key findings

Landscape function and grazing pressure

Landscape function is the capacity of a landscape to capture and retain rainfall and nutrients (Figure 6.1). Fully functional landscapes have a high cover of patches of perennial vegetation that are spatially arranged to efficiently capture runoff and resist wind erosion.

Figure 6.1 A 'leaking' landscape that has reduced landscape function

Low cover and active erosion mean that rainwater and soilborne nutrients (essential resources for plant growth) are lost from the area.

Photo: CSIRO, Alice Springs

Pastoralists, conservation managers and Aboriginal land managers have a key role in managing landscape function by controlling grazing pressure. Landscape function provides a biophysically integrated assessment of landscape condition and resilience.

> **Key finding:** *The ACRIS data suggest that trends in landscape function recorded on ground-based monitoring sites improved or remained stable, given the seasonal trends experienced in most rangeland bioregions over the 1992–2005 reporting period.*
>
> *It is not possible to directly link stocking rates at the local scale to those changes. However, at a broader scale, regional livestock numbers have remained relatively high during periods of declining seasonal quality in some bioregions, suggesting difficulty in maintaining landscape function in those areas.*

ACRIS has been able to report change at monitoring sites for 36 Interim Biogeographic Regionalisation for Australia (IBRA) bioregions in WA, SA, New South Wales (NSW) and the Northern Territory (NT). In 75% of those bioregions, 10% or less of all reassessed sites showed decline in landscape function following above-average *seasonal quality*. Those changes apply to the local areas of monitoring sites, not the whole of each bioregion.

The Queensland monitoring data are not directly comparable with the site-based data from other rangeland jurisdictions, and it is more difficult to separate management-induced responses influencing change from those due to variable *seasonal quality*. Results are illustrated in Figure 3.8 and suggest that, for the most part, pastoral management has not been overriding seasonal influences. However, 27 of 80 sub-IBRA regions (across 13 bioregions) had a small decline in landscape function, and a further 24 subregions were rated as having a larger decline.

Comprehensive data for total grazing pressure (TGP) are not currently available. Based on livestock numbers, at least 12 bioregions, primarily across northern Australia, had higher stock densities towards the end of the reporting period even though *seasonal quality* was variable (ie not consistently above average). However, there was no pattern of northern bioregions showing differential seasonally adjusted change in landscape function at monitoring sites compared with other bioregions.

There are a number of reasons why a direct response of landscape function to livestock density, if and where it exists, was not detected:

- Monitoring sites can only report change for the local area assessed. Pastoral monitoring programs use explicit criteria to position sites, so bias in site selection and lack of replication and controls mean that results from site-based monitoring cannot be extrapolated to a bioregional scale. Different (and adverse) changes attributable to elevated livestock densities relative to seasonal conditions may have occurred elsewhere but not been detected.
- Sheep and cattle are but one component of total herbivore numbers and, at least for some bioregions, their contribution to TGP may have been modest in seasonally adjusted terms. This is demonstrated by changes in kangaroo densities in the southeastern rangelands (Figures 3.33 and 3.34), where both absolute and relative densities changed considerably between 1992 and 2003. More importantly, the data indicate that there were considerable differences among neighbouring bioregions within years. Comprehensive density data for feral herbivore species are lacking, but it is known that goats contribute significantly to TGP in parts of the southern rangelands, donkeys in the more rugged northern regions and camels in the interior.[54]
- This report focuses on change and does not fully account for the baseline status or condition of landscape function. Where landscape function had declined before 1992, thresholds of change may have been exceeded (Friedel 1991) such that further changes in landscape function between 1992 and 2005 were not closely aligned with *seasonal quality* or measurable stocking density.

Palatable perennial forage species critical to sustained livestock production are a subset of the site-based monitoring data used to report change in landscape function. Thus, it is possible to report changes in critical stock forage relative to domestic stocking density in a way that is similar to the reporting of landscape function.

[54] See maps at http://www.anra.gov.au

Figure 6.2 The rangelands contribute much of Australia's biodiversity

Biodiversity has declined in many areas, but ACRIS is not yet able to systematically quantify where and how biodiversity is changing.

Photo: CSIRO, Alice Springs

> **Additional finding:** *Vegetation species used to indicate critical stock forage have remained stable or improved at monitoring sites in 15 rangeland regions despite periods of low seasonal quality and variable stocking density.*

Based on evidence from site-based monitoring, it appears that managers have adjusted stock numbers downwards when faced with difficult seasons. This is illustrated by patterns in the top panel of Figure 3.13. However, there were also declines in stock forage at monitoring sites in these and other bioregions during periods of above-average *seasonal quality* (Figure 3.13 bottom). Thirty-one pastoral bioregions had an adequate density of monitoring sites to allow reporting. For 14 of those bioregions, 10% or more of reassessed sites recorded a decline in critical stock forage following above-average *seasonal quality*.

Similar caveats apply to site-based monitoring of critical stock forage as for landscape function; that is, bias in site selection and lack of replication mean that reported change applies to the local areas of sites and cannot be inferred as having occurred across the whole of each bioregion.

In Queensland, 15 of 80 sub-IBRA regions across three bioregions had high and increasing levels of simulated pasture utilisation (regarded as unsustainable pasture management, Figure 3.14).

As observed for landscape function, some of the decline in northern Australia was associated with high stocking density relative to seasonal conditions (Figure 3.31). However, there was no consistent relationship, as IBRA bioregions elsewhere with stocking densities more closely aligned with *seasonal quality* showed variable changes in seasonally adjusted indicators of stock forage (for the same reasons provided above for landscape function).

The conservation of biodiversity

Rangelands — Tracking Changes (NLWRA 2001a) highlighted the paucity of consistent and relevant data on trends in rangelands biodiversity. While the ACRIS Biodiversity Working Group has sought to identify and develop effective indicators of biodiversity change, the appropriate systems have yet to be developed fully and implemented to monitor that change. Therefore, the assessments in this report document ongoing and increasing pressures on biodiversity, rather than explicitly demonstrating change (Figure 6.2).

> **Key finding:** *The data that are available for ACRIS purposes indicate that there continues to be a decline in biodiversity.*

For example, data collected by the volunteer participants in the national-scale Birds Australia Atlas project demonstrate declines in detection rates for a number of bird species.

A number of measures of land use intensification may provide surrogate measures of biodiversity decline. This report shows that the number and density of artificial waterpoints in the most productive arid and semiarid pastoral regions have considerably reduced the area of land remote from water and subjected it to increased grazing pressure. Such water-remote areas are recognised as providing de facto refuges for species known to decline in response to grazing pressure (James et al 1999, Landsberg et al 2003). Similarly, while the colonising ability and high productivity of exotic pasture species such as buffel grass enhance their value as a pastoral resource, those same characteristics result in impacts on biodiversity, for example through changes in fire regimes and competition with native plant species and habitat.

One nationally available biodiversity indicator is progress towards the achievement of a national system of protected areas that is comprehensive, adequate and representative of the full range of ecosystems or biomes (CAR).

Additional finding: *The number and extent of areas set aside for the long-term protection and management of biodiversity increased across a number of rangeland bioregions over the period from 2000 to 2004 (Figure 3.52).*

For many rangeland bioregions, however, the percentage area reserved or protected for biodiversity conservation remains inadequate according to CAR principles. Considerable investment has been made in increasing the extent of protected areas within some areas of the rangelands (eg the Gascoyne–Murchison area), but there are still gaps in representativeness and adequacy.

One way to complement the long-term protection of areas with important habitats for biodiversity is through management agreements for biodiversity conservation between governments and individual landholders on pastoral leases. Conservation of biodiversity on privately managed land is being achieved through the use of market-based instruments and stewardship programs in some areas. For example, a stewardship program in which landholders are recompensed for managing for specified biodiversity conservation objectives is being tested in western NSW (see 'Information needs of the non-government environment sector' in Chapter 5). This may be particularly important in those areas where there are limited opportunities for the acquisition of properties for the National Reserve System, or for the protection of species where change due to factors such as enhanced climate variability may impact on the ability of the current reserve system to deliver future conservation objectives.

Land values

Key finding: *Land values in many parts of the grazed rangelands have increased in recent years.*

Increases in land values have been in the order of 150% to 300% over the reporting period (Tables 3.21 to 3.24). In NSW, at least, there is evidence that increased land values are linked to the increase in property values in cities and the more closely settled rural land.

For those wishing to purchase rangeland pastoral enterprises, high land values may impose a substantial financial burden, which could add to existing pressures on the land as purchasers seek a real return on their investment. On the other hand, the increased value of the land may lead to it being managed more sustainably in order to retain its value.

Increasing land values also affect organisations with a primary interest in non-pastoral land uses, for example through property acquisition or stewardship programs for biodiversity conservation. It is often those subregions that are the most productive for pastoral or agricultural purposes (and that have usually shown the greatest price rises) that remain under-represented within the conservation estate.

Understanding an emerging issue: the sustainability of the northern beef industry

Meta-analysis of datasets available to ACRIS provides an improved understanding of emerging issues across broad regions of the rangelands. For example, generally good seasons and buoyant cattle prices have boosted the northern beef industry over most of the 15-year reporting period (Figure 6.3). An important issue for the industry is whether it can remain sustainable (economically and environmentally) in the longer term at current levels of grazing intensity. Evidence of the sustainability of the northern beef industry, based on a synthesis of available and relevant ACRIS data, is presented in this section.

The dramatic improvement in the economics of the northern beef industry has seen stock numbers increase, grazing infrastructure increase and land use intensify in some areas. For example, the number of pastoral leases in the Sturt Plateau bioregion increased from nine in the late 1970s to 27 in 2002. The subdivision of leases into smaller portions and associated infrastructure development (additional waterpoints, fences and yards) have provided better herd and land management and greatly assisted fire control programs across the region.

Figure 6.3 Expanding live exports of cattle from northern ports have boosted the profitability of the northern beef industry

Photo: Arthur Mostead

Thirteen bioregions of the NT are located in northern Australia (ie from the Mitchell Grass Downs north). Nine of the bioregions currently have cattle raising as a major land use, and seven of those had increased stocking densities over the reporting period compared with the average for the 1983–91 period. This intensification has mainly occurred in alignment with good seasons. How management responds to a run of less favourable seasons and whether stock numbers are appropriately reduced will test the sustainability of the northern beef industry. An efficient monitoring system that can deliver timely information to pastoralists and land management agencies about trends in landscape function and critical stock forage is critical to guide high-intensity or high environmental risk management systems in this intensifying industry.

The prospect of increased returns from intensified land use and concerns about associated environmental impacts have prompted new investment in research and development work in the area, supported by at least one corporate cattle company, CSIRO and state/NT agencies (Petty et al 2006). Some of the major pastoral companies are implementing environmental management systems aimed at continuous improvement in resource management.

Integration of data for five bioregions

In this section, we examine five IBRA bioregions to illustrate regional diversity, and show how the integration of data across a number of themes can provide insights into regionally important issues, particularly in relation to varying pastoral management practices.

Some of the selected bioregions coincide with the focus bioregions presented in Chapter 4, but others have been chosen to emphasise regional variation in NRM issues and scale of management across the rangelands. The five case study bioregions were chosen for their national spread, their climatic and environmental variability, and their widely varying NRM history, condition and trends.

Desert Uplands (central Queensland)

The Desert Uplands bioregion covers an area of 68 850 km^2 in central Queensland (Figure 2.3). It is dominated by sandstone ranges and sand plains, and is thickly vegetated with acacia and eucalypt woodlands, often with a spinifex understorey. Rain normally falls over summer. Most of the bioregion is under leasehold tenure and is used for cattle grazing, with some sheep grazing in the west.

Over the past 15 years, leaseholders have intensified their land use to take advantage of improved markets for live cattle. Intensification has involved clearing (particularly in the Jericho sub-IBRA region), establishment of buffel grass pastures, herd upgrading and investment in new fences and waterpoints.

This intensification occurred through a period of good seasons in the late 1990s. However, data collected through ACRIS suggest that stocking densities continued to remain high through the drought years after 2000 (Figure 3.31), when

Figure 6.4 Open woodland in the Desert Uplands bioregion

A deep sandy red Kandosol supports a sparse mid-tall woodland of yellow jacket (*Eucalyptus similis*) and gum-topped bloodwood (*Corymbia brachycarpa*) with an understorey of wattles (*Acacia* spp.) and desert heather (*Calytrix microcoma*) — in flower — and a ground layer of gummy spinifex (*Triodia pungens*).

Photo: Mal Lorimer, Queensland Environmental Protection Agency

seasonal quality markedly declined and modelled levels of pasture utilisation were high (Figure 3.14). Interpreting the reasons for those responses is difficult, but the apparent slow response by rangeland managers to reduce stock densities in line with low *seasonal quality* after 2000 suggests that parts of the Desert Uplands bioregion were under considerable grazing pressure at that time, as evidenced by low levels of stock forage from 2002 to 2004 (right panel, Figure 3.31). Alternatively, it may have been that *seasonal quality* was better than that indicated by rainfall and simulated pasture biomass, or managers were supplementary feeding their stock at increasingly higher rates.

The bioregion is ecologically diverse, with 77 regional ecosystems described. More than 1400 plant species have been recorded, 8 of which are listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Figure 3.55), and 33 of which are listed under Queensland's *Nature Conservation Act 1994* as endangered, vulnerable or rare. Thirteen vertebrate species are listed as threatened under the EPBC Act (Figure 3.56), but 33 are listed as threatened under Queensland legislation. Although 28 of the 77 listed regional ecosystems are currently represented in the reserve system, 45% of all regional ecosystems remain outside of protected areas. There has been no increase to the protected area system in the Desert Uplands since 2000 (Figure 3.52). Since the late 1980s, a high rate of tree clearing in the Desert Uplands has led to a 15% reduction in the area of woody habitat through much of the bioregion. Most clearing has been concentrated in the south of the bioregion (Jericho sub-IBRA, Figure 3.64) and in alluvial land systems.

Nevertheless, one of the significant ecosystems for biodiversity in the Desert Uplands — the open woodland of Queensland yellow jacket (*Eucalyptus similis*) and other bloodwoods on deep red earths — is still relatively intact in the bioregion (Figure 6.4). This ecosystem has historically been lightly grazed and is important for declining woodland bird species, as habitat for two rare endemic skinks (*Ctenotus rosarius* and *C. capricorni*), and for a rare species of acacia, White Mountains wattle (*Acacia ramiflora*).

Pilbara (northwest WA)

The Pilbara bioregion in the northwest of Australia (Figure 2.3) is a large and varied region (Figure 6.5) with spectacular mountain ranges, large river catchments and extensive coastal plains. The climate is arid to tropical, with most of the average annual rainfall of about 300 mm associated with cyclones between November and March. Because of the cyclonic nature of the rainfall, annual climate variability is very high. The vegetation consists of tussock and hummock grasslands, with spinifex (*Triodia* spp.) dominating. Buffel grass has extensively colonised the river frontage floodplains in the western area (the most valuable grazing lands) and is encroaching on other riverine systems and transport corridors in the eastern parts.

Based on land use data provided by the Bureau of Rural Sciences (reviewed in Chapter 3), about two-thirds of the bioregion is pastoral leasehold land, with 15% of the leases held by Indigenous communities and a similar proportion held by mining companies. Cattle replaced sheep in the 1970s and 1980s as the terms of trade for wool production in the area deteriorated sharply.

The region has experienced above-average *seasonal quality* for nearly all of the 1992–2005 period, with the exceptions being dry conditions in coastal areas in 2003 and throughout the region in 2004–2005. The reporting period coincided with growth of the live-export market for cattle and improvements

Figure 6.5 Long red dusty outback road in the Karinji National Park in the Pilbara region

Photo: Newspix / Nathan Richter

in cattle husbandry such as more effective weaning, increased fencing and herd upgrading with Brahman-type (*Bos indicus*) genetics.

In response to these favourable conditions, stock numbers rose to be about 40% higher in 2005 than the average for the eight-year period before 1992 (Figure 3.30). This dramatic increase in stock numbers has been encouraged by good seasons, improved markets and intensification. Given that several of the leases held by Indigenous communities are running relatively few cattle, grazing intensity is likely to be even higher on the remainder of the leases.

The data for trends in landscape function and indicators of critical stock forage based on the frequency of perennial grasses suggested that those areas represented by ground-based monitoring sites had either remained stable or improved over the past 15 years (Figures 3.7 and 3.12). However, seasonal conditions were very good throughout much of the mid-to-late 1990s. Since then, conditions have been much drier; however, stock numbers appear not to have decreased in response (Figure 3.30).

Large declines in perennial grass frequency have already been observed on Western Australian Rangeland Monitoring System (WARMS) monitoring sites in the coastal Pilbara. Continued monitoring will show whether those grasses recover when wetter conditions return or the combination of low rainfall and high grazing pressure has resulted in longer-term decline. While the mismatch between grazing pressure and rainfall in the remainder of the Pilbara has not shown up in the monitoring results presented here (to the end of 2005), WARMS monitoring is ongoing. If conditions remain dry and stock numbers remain high, it is likely that perennial grass frequency will decline, with the consequent risk of further rangeland degradation.

Sturt Plateau (NT tropical savannas)

The Sturt Plateau bioregion covers 98 500 km^2 towards the drier margins of the tropical woodlands and savanna lands of northern Australia (Figure 2.3). The landscape is flat to gently undulating plains with little local relief. The vegetation is mainly eucalypt forests and woodlands dominated by bloodwoods over perennial grasses (Figure 4.32).

The main land use is cattle grazing, with pastoral leases covering about 70% of the bioregion. Many of the enterprises have been established over the past 30 years as groundwater investigations, increased drilling activity and water reticulation have provided additional reliable sources of stock water. Most of the enterprises are smaller than elsewhere in the NT (about 1100 km^2), and most are family owned and operated. The improved economics of the cattle industry in the NT over the past decade is encouraging ongoing infrastructure development of waterpoints and improved fire control technologies. Those infrastructure developments have influenced property values, with the unimproved land value of pastoral leases increasing by 45% (Table 3.22) on average between 1991 and 2003 (adjusted to the 2005 dollar value).

In line with much of northern Australia, most of the Sturt Plateau experienced above average *seasonal quality* over the period from 1992–2005 (Figure 4.34). This run of favourable seasons and increased waterpoint distribution has encouraged landholders to increase stock numbers across the region (Figures 3.29 and 4.36), with the domestic stocking density in 1994 being higher than the average for the 1983–91 period. High stock density was maintained until 2000, when the wet years led to a further increase in 2001 and 2002, and then declined slightly through 2003 and 2004.

Based on vegetation data collected at monitoring sites, a small proportion (6%) of sites assessed following above-average *seasonal quality* showed decline in landscape function (Figure 3.8, bottom map). Some of the decline was attributed to extensive wildfire following the extended period of above-average rainfall in the early part of this decade. The decline was temporary, with landscape function found to be restored at most sites when they were reassessed in 2004. There was a similar result for critical stock forage species: 8% of sites had a decline in the composition of palatable perennial grasses following above-average seasonal conditions (Figure 3.13, bottom map).

While there were relatively small adverse changes in landscape function and critical stock forage during the reporting period, the potential impact of excessive grazing pressure on land and vegetation condition with the return of drier years remains to be seen. As for much of northern Australia, land managers in the Sturt Plateau bioregion may need to destock quickly following a failed wet season to avoid resource degradation. The ability of existing monitoring programs to continue to track change is important, in the light of climate variability.

Mitchell Grass Downs (NT and Queensland)

The Mitchell Grass Downs bioregion is one of the largest in Australia, covering 335 000 km^2 and extending from Elliott in the NT to Tambo in Queensland (Figure 2.3). This distinctive landscape is composed of cracking clay soils supporting mostly treeless Mitchell grasslands, crossed by occasional rivers and floodplains, and interspersed with some minor ridges. The climate is dry monsoonal to subhumid tropical, with an average rainfall of 330 mm occurring over the summer months.

There are two main subregions: the treeless, monsoonal northern lands roughly between Winton and Tennant Creek (Figure 6.6) and the open woodlands between Winton and Tambo (Figure 4.16)

The western half of the northern section of this bioregion in the NT is known as the Barkly Tableland. Land use is cattle grazing throughout, with the industry dominated by very large properties operated by corporate businesses. In many cases, the properties on the Barkly Tableland are run in conjunction with cattle properties, feedlots and processing facilities elsewhere in Australia. This makes the region an important link in a national beef-production chain. Stronger terms of trade for beef cattle operations in northern Australia have encouraged investments in intensification.

Stocking density increased consistently with generally above-average rainfall between 1994 and 1997 and then levelled off with close-to-average *seasonal quality* between 1997 and 1999. Density then increased sharply with above-median rainfall in 2000 and 2001 and remained high following the return to more normal rainfall between 2002 and 2004. Stocking density has been much above the 1983–1991 average since at least 1995.

Based on monitoring data collected by the NT Government, 13% of sites showed a decline in landscape function (Figure 3.8, bottom map) and 10% had reduced palatable perennial grass composition — that is, a decline in critical stock forage (Figure 3.13, bottom map) — when assessed following above-average *seasonal quality*. Significantly, 36% of reassessed sites had increased landscape function and 33% had increased critical stock forage after below-average *seasonal quality* (Figures 3.8 and 3.13, top maps, respectively). These relatively large seasonally adjusted changes, compared to those reported elsewhere, suggest considerable within-region variation that possibly relates to management differences among pastoral leases. The changes emphasise the need for

Figure 6.6 Treeless Mitchell grass downs, Barkly Tableland, NT

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

continued monitoring (particularly where stocking density is high relative to seasonal conditions) and also suggest that there is value in more local investigation to determine why (and where) changes are counter to seasonal expectations.

In the remaining Queensland area, cattle have now largely displaced sheep as the dominant stock, although the proportion of sheep increases as the likelihood of effective winter rainfall and consequent availability of winter herbage increases towards the southern extremity of the bioregion. Holdings are mostly smaller than on the Barkly Tableland, and mostly owned by family businesses. *Seasonal quality* has been variable over the assessment period, but there were three good years between 1999 and 2001 (Figure 4.17). Combined stock numbers increased in response and then fell in recent drier years, but still remained above the average for the 1983–91 period (Figure 4.20). Ground-based monitoring data indicate a significant decline in landscape function for one subregion and some loss of function for a further five subregions (Figure 4.18). Modelled levels of pasture utilisation (indicating sustainability of stock forage) were close to critical thresholds, and therefore of concern, for two subregions (Figures 3.14 and 4.19).

The invasion of grasslands by transformer weed species — prickly acacia (*Acacia nilotica*) in Queensland, and parkinsonia (*Parkinsonia aculeata)* and mesquite (*Prosopis* spp.) across the whole bioregion — is a significant threat to biodiversity and other ecosystem services. In the Queensland area of the bioregion, 54 regional ecosystems have been described and only one small regional ecosystem involving mound springs, is endangered. Since 2000, there has been an increase of less than 2% in the area protected within the reserve system (Figure 3.52), in which two of the five listed regional ecosystems are represented. The number of standardised flora surveys and, in particular, fauna surveys conducted in the bioregion is extremely small (Figure 3.73). Twelve plant species and 15 vertebrate fauna species found in this bioregion have been listed under the EPBC Act, including the desert rat kangaroo (*Caloprymnus campestris*), believed to be nationally extinct, and the western quoll (*Dasyurus geoffroii*), which is now restricted to south-west Western Australia and listed as vulnerable. A distinguishing feature of the Mitchell Grass Downs biota is the soil-crack specialist, which includes rare endemic species such as Collett's snake (*Pseudechis colletti*) and the endangered Julia Creek dunnart (*Sminthopsis douglasi*).

Mulga Lands (Queensland and NSW)

The Mulga Lands bioregion is in southwestern Queensland and northwestern NSW (Figure 2.3), and has an area of 258 000 km^2. The landscape comprises undulating plains and low hills on Cainozoic

Figure 6.7 Mulga shrubland, Mulga Lands bioregion, NSW

Photo: NSW Department of Environment and Climate Change

sediments with red earths and lithosols. The vegetation is dominated by mulga (*Acacia aneura*) shrublands (Figure 6.7) and low eucalypt woodlands. The climate is semiarid, with highly variable summer-dominant rainfall. The spatially averaged median rainfall is 305 mm per year.

The NSW section of this bioregion lies west of the Darling River. Grazing leasehold is the major tenure, and these rangelands have traditionally been used for sheep production on relatively small family-held properties (average lease area of 3725 ha for land parcels larger than 10 ha; most grazing enterprises larger than the average). Declining profitability of wool growing and inadequate property size to enable economic and environmental sustainability are problems throughout the Western Division of NSW. In recent years, diversification from merino sheep to meat-sheep breeds and meat goats has occurred.

In NSW, landscape function and critical stock forage levels have been assessed annually over the reporting period at 19 sites across the bioregion, providing 249 year-to-year recordings. Annual measurements made at sites between 1992 and 2005 show that landscape function improved at 13% of sites, declined at 9%, and showed no change at 78% (Figure 3.7, top panel). These results seem to reflect the variable seasonal conditions throughout this period; they are supported by seasonally interpreted results that show that, across all years, only 3% of assessed sites had a decline in landscape function following above-average *seasonal quality* and 5% of site-by-year assessments had increased landscape function after below-average seasonal conditions (Figure 3.8).

Notwithstanding the difficulty in interpreting data over time, these examples illustrate how various datasets can be used to highlight regions where further investigation is needed (Table 6.1). Collating better local-scale data to determine whether stock (and kangaroo) densities were actually too high for the seasonal conditions would suggest management actions that might need to be taken.

In the Queensland area of the bioregion, similar industry dynamics apply and a regional strategy attempted to correct some of the most serious concerns. The Queensland area has experienced a protracted period of very dry years during the 1992–2005 reporting period. Low pasture abundance and high woody shrub cover are common. Poor *seasonal quality* over much of the 14-year period accompanied ratings of reduced landscape function and modelled availability of stock forage. However, only two of the 11 Queensland sub-IBRA regions showed an unexpectedly poor change in ratings for landscape function for the prevailing seasons. This is despite the overall assessment that, based on groundcover and predicted forage growth, landscape function and stock forage availability are relatively poor (Figure 3.8).

In the Queensland Mulga Lands, 65 regional ecosystems have been described. Of those, three are considered to be regionally endangered by overclearing or overdevelopment, while five are considered to be of concern because their extent has been reduced to below 30% of their estimated pre-clearing extent. Since 2000 there has been a less than 2% increase in area under protection (Figure 3.52); three of the five Queensland listed regional ecosystems are represented, but at less than 4% of their preclearing extent. Very few standardised biodiversity surveys have been conducted for the bioregion (Figure 3.73). Eight plant species and 14 vertebrate fauna species have been listed under the EPBC Act, including *Sclerolaena walkeri* (a rare chenopod plant) and the greater bilby (*Macrotis lagotis*). Although the rate of clearing in the bioregion was relatively high, particularly in the eastern subregions, in the years 1991–2003 (Figure 3.64), most (80%) of the region remains wooded. Consequently, the bioregion is important for woodland birds, including Hall's babbler (*Pomatostomus halli*), a species with a limited range.

Informing responses to changing pressures on the rangelands

The preceding sections provide examples at national and regional scales of how the various data compiled for this report can be integrated to provide a more complete picture of aspects of environmental, social and economic change in the rangelands. A number of NRM issues, such as invasive animals, weeds and altered fire regimes, continue to threaten both production and biodiversity values in parts of the rangelands. This section discusses those pressures where data compiled in this report (Chapter 3) could help inform the management and policy responses required for control or alleviation.

Fire regimes

High-frequency, high-intensity or large-scale fires can damage rangelands, especially across northern Australia, where up to 30% or 40% of some tropical savanna ecosystems burn each year. The environmental impact of more intense and large-scale fire regimes is uncertain, but there is increasing evidence to suggest that this changed fire regime contributes to the decline in biodiversity at a range of scales (Woinarski et al 2000a). The introduction of fire regimes that reduce large-scale and hot damaging fires, and promote a diversity of burning patterns typically involving small low-intensity burns, offers an opportunity to limit long-term biodiversity decline while achieving adequate tree regeneration control.

A national system for reporting fire extent, intensity and frequency is now in place, and the ACRIS fire information product (Chapter 3) demonstrates emerging information for the rangelands. There is also evidence from the Sturt Plateau bioregion (NT) and elsewhere that regional communities working with government can manage fire in northern Australia for improved production and conservation outcomes.

Climate variability

Chapters 2 and 3 document the importance of rainfall variability as one of the major drivers of change in the rangelands. Managing the land to take account of that variability and longer-term climate change in order to ensure sustained production and biodiversity conservation is a key challenge for the future.

Predicted changes in climate include increased rainfall intensity and cyclone incidence across northern regions, and decreased rainfall amounts and changing seasonal patterns across southern and southeastern regions. It is possible that the above-average *seasonal quality* and consequent increased fires in the northern rangelands over the past 15 years are part of longer-term climate change. If these trends continue, flora and fauna dynamics will undoubtedly change in ways that are not yet clear. This increases the importance of ACRIS providing information on changes as they occur.

Grazing pressure from stock and kangaroos

The long run of good seasons in many regions has encouraged landholders to increase stock numbers and intensify land use, especially in the northern beef industry. This has potential to increase the environmental risk associated with higher grazing pressures. Land management agencies need to be alert to the higher risk, particularly if drier conditions are experienced in the immediate future.

Pastoral development has increased artificial sources of water in the rangelands, contributing to increased kangaroo numbers and the expansion of domestic grazing and feral herbivore populations.

Kangaroos continue to be a significant component of TGP in the southern and eastern rangelands, where they contribute between 20% and 40% of the livestock grazing pressure. This contribution is higher in the more arid, predominantly sheep-grazed, bioregions. There is considerable year-to-year variation in the relative contributions of kangaroos and livestock to TGP. It is important that data from the continuing surveys of kangaroo populations conducted by most rangeland jurisdictions are analysed and reported using agreed standardised methods in order to quantify the seasonally and regionally variable contribution of kangaroo species to TGP.

The other significant contributor to TGP in the rangelands is regionally significant populations of feral herbivores. As yet, density data are inadequate to quantify their contribution to TGP in standardised units (eg dry sheep equivalents). Information is accumulating (Chapter 3), and updates will be largely web based.[55]

Water remoteness

Increased water distribution in many regions (Figure 6.8) has reduced the area of land remote from water — a critical refuge for biodiversity. Given that the level of reservation for biodiversity conservation is inadequate in many regions, water-remote areas can make an important de facto contribution to achieving some regional objectives in biodiversity conservation, provided those areas are managed with an appropriate fire regime and weeds and other pests are controlled.

[55] http://www.anra.gov.au

Figure 6.8 Waterpoints for stock have favoured some species of plants and animals and have been detrimental to others

Water-remote areas that are managed appropriately can assist in conserving biodiversity.

Photo: CSIRO, Alice Springs

Weeds

According to a recent review of weeds (Grice and Martin 2005), the Australian rangelands currently support more than 640 non-native naturalised plant species, including a diverse range of trees, shrubs, grasses, forbs and aquatic plants, all at various stages of invasion. Of those weeds, 92 species were identified as posing a significant threat to rangeland biodiversity.

Weeds tend to be highly habitat dependent and context specific. As a general rule in the subtropics, a perennial tall tussock or rhizomatous grass, with its main growing period in summer, can be guaranteed to reduce the richness of native plant species (Grice and Martin 2005).

The developing capacity to map the current and potential extent of a number of these species has been documented (Chapter 3). As that capacity expands, ACRIS should be better placed to provide more comprehensive information on changes in weed species, and their impact, in the rangelands.

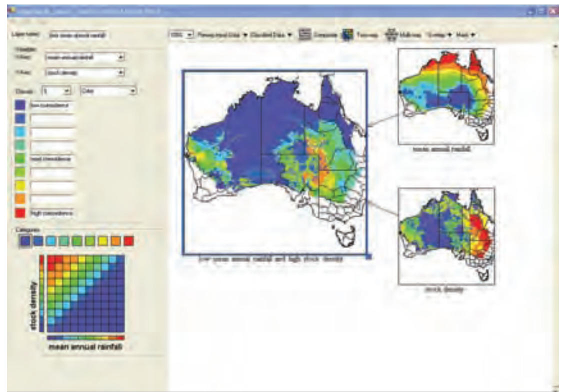
Using ACRIS to inform decision making

By building national capacity to collate rangeland information and monitor and report on conditions on the ground, ACRIS is providing a picture of where changes are occurring in the rangelands. However, charting the course to sustainability requires an understanding of the relationships and processes leading to those changes. Answering such questions as 'What are the constraints and opportunities for further development of grazing and agricultural industries?' or 'Where is there tension between pastoral production and the desire to conserve native flora and fauna?', and then developing an appropriate policy response, involve the integrated analysis of a wide range of social, economic and environmental information. This is a complex exercise for the rangelands because of the diversity of environmental, economic, and social factors affecting outcomes, the limited availability of longer-term pattern and trend information, and the wide range of community views and aspirations.

This complexity points to the need for techniques and tools that can provide a better understanding of the economic, environmental and social factors driving rangelands systems and help in evaluating alternative land use and management options. More tools are needed for examining complex relationships in ways that promote the engagement of stakeholders and allow for alternative views. Multi-criteria analysis (MCA) is one such tool (Figure 6.9).

One area where suitable data and MCA may assist is the complex issue of the extent to which livestock grazing in the rangelands is sustainable. Grazing management can be characterised as sustainable when economic resilience and stability can be achieved in conjunction with regional maintenance of native species and other ecosystem services.

Figure 6.9 Multi-criteria analysis allows complex relationships between economic, environmental and social datasets to be explored



The Multi-Criteria Analysis Shell for Spatial Decision Support (MCAS-S) tool promotes engagement of stakeholders in exploring the alternative views that these data may provide. This example explores the spatial coincidence between relatively low mean annual rainfall and high stock density in the Australian rangelands.

Source: Rob Lesslie, Bureau of Rural Sciences

Sustainability may be under threat where there is potential for pastoral production but ecosystems have limited resilience, creating a threat to the resource base and conservation values. Informed public policy requires an understanding of regional variability and where in the landscape these ecological and economic controls are operating.

Previous work has argued that the trade-off between potential productivity for pastoralism and ecosystem resilience differs by bioregion, and that policy and management responses need to be tailored accordingly (Stafford Smith et al 2000). A spatial multi-criteria modelling approach, using the Multi-Criteria Analysis Shell for Spatial Decision Support (MCAS-S) model (Hill et al 2006, Lesslie et al 2006)[56], was applied to explore regional variability in this relationship. Model outputs may be tested against change data compiled by ACRIS.

Potential productivity for livestock grazing in the rangelands was spatially represented by weighted indices of forage potential, rainfall reliability and

56 http://adl.brs.gov.au/mcass/ (accessed 10 June 2008)

accessibility to services. Ecosystem resilience was similarly mapped using available spatial surrogates. Weighted combinations of mapped values for production potential and ecosystem resilience were then explored for spatial congruency and possible tension.[57]

Policy implications arise from the interplay between potential productivity based on the natural resource base and its sensitivity to risks of damage from livestock grazing. Analysing the relationships between these types of factors can assist in targeting policies more effectively, promoting appropriate development and ensuring that available incentives improve management practices. This could include measures such as specific public investment in regional restructuring and negotiated trade-offs or, at the property scale, application of negotiated stewardship agreements to achieve NRM goals.

ACRIS — refining the information system

The second major part of this integrating chapter summarises the current capacity of ACRIS to transform data into information. It then describes how ACRIS might logically develop to provide a more complete information system for the rangelands.

Producing this report has highlighted the value of long-term, consistent datasets, such as that provided through monitoring the pastoral estate; for example, suitable datasets have enabled reporting on changes in vegetation. Through integration with other datasets, where available (eg domestic stocking density, kangaroo density, fire frequency and wind erosion), analysis can provide more robust interpretations of changes in resource condition and biodiversity assets.

This first attempt to bring rangelands information together in an integrated way does not purport to be a robust product — but it has proved that the task can be achieved. However, the compilation of the report has also highlighted deficiencies, limitations and gaps in existing datasets. The ability to report in a nationally consistent manner on aspects of the rangelands environment has been limited by those deficiencies.

ACRIS in 2008

An 'information system' comprises data, technical infrastructure, institutional arrangements and people. It allows the collection, management, use and dissemination of data and information to report against specific needs and to support decision-making. Currently, the information system element of ACRIS is not a physical, technically integrated system. It is a partnership arrangement that brings together available data and information for manually intensive collation, analysis and reporting, coordinated by the ACRIS-MU (Figure 6.10) on behalf of the ACRIS-MC. ACRIS parallels other information systems for natural resources (Box 6.1); some are well established and others are still developing.

Data contributing to current ACRIS reporting mainly come from two sources:

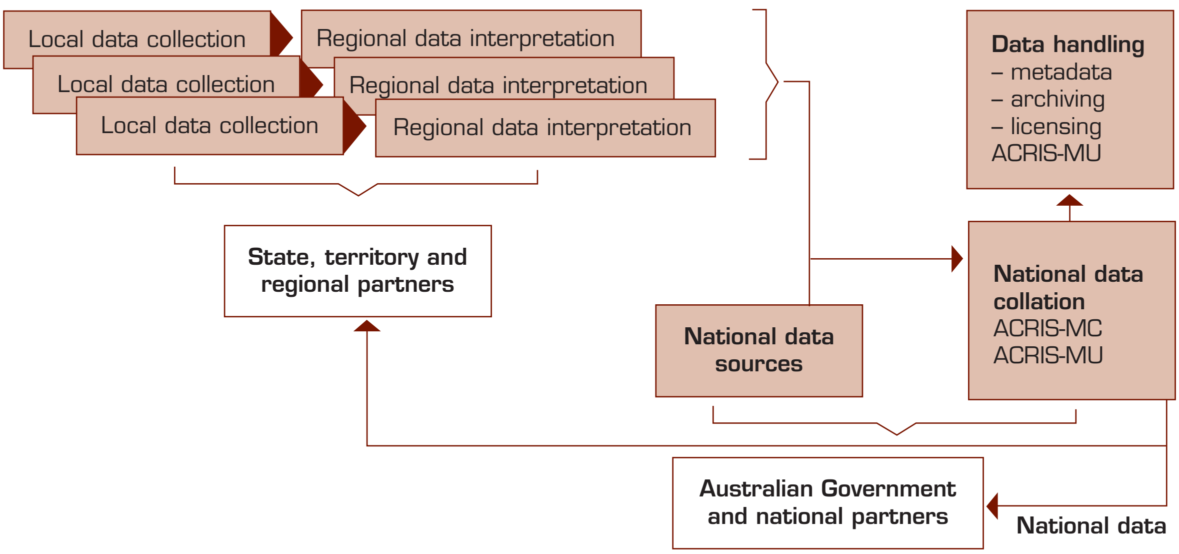
- state and NT data collected by ACRIS partners for their own statutory or advisory monitoring and reporting purposes (eg pastoral monitoring activity undertaken by a state government, see Appendix 1)
- national-level data (eg climate or ABS data), which provide broader context to the state and NT data (nationally collated databases come from Australian Government and in some cases state agencies, depending on the subject matter).

ACRIS is dependent on the ongoing commitment of the states and the NT to maintain (and improve) current monitoring programs and, through participation in the ACRIS-MC, to contribute their data to collaborative and systematic analyses that allow consistent national reporting.

The Australian Government's investment through the Natural Heritage Trust in the collation, integration, synthesis and reporting of the jurisdictional datasets has provided the impetus for establishing a system capable of identifying trends in rangeland condition.

57 The outcome of this analysis, highlighting regions where tensions may exist, can be seen at http://affashop.gov.au/PdfFiles/rangelands.pdf, p 11 (accessed 10 June 2008).

Figure 6.10 ACRIS as a rangelands information system



A future for ACRIS

Data and information reported by the ACRIS are of immediate value to the jurisdictions in meeting their responsibilities for sustainable rangeland management. The relevance of ACRIS to other stakeholders — such as regional NRM groups, industry organisations, Indigenous land managers, the non-government conservation sector and the broader community — is emerging as an important issue. Better understanding of the specific information needs of those users (Chapter 5) and how their needs can be met would further increase the relevance and use of the system, particularly as a repository of interpreted information.

ACRIS could be progressively improved by:

- strengthening the ACRIS partnership, particularly where the current relationship is somewhat peripheral (eg with Indigenous and NRM groups)
- clearly articulating the additional data and information needed for the management of rangelands natural resources
- targeting investment in ongoing and new natural resource monitoring programs
- all partners agreeing to collect data and information independently of any regionalisation (further reporting of change can then undertaken for differing regionalisations depending on the information requirements of the various ACRIS stakeholders).

Conclusions

In producing this report, the ACRIS-MC has used available data to identify the influence of climate variability and better identify trends in natural resources attributable to the actions of land managers.

This first attempt to document these trends at a national scale has shown that, where suitable data are available, it is possible to detect such changes (particularly in relation to pastoral productivity) in a way that can be meaningful to government policy and program managers, regional decision makers and others with an interest in sustainable rangeland management. This is a significant advance on earlier ACRIS products (NLWRA 2001a).

It is important to recognise that these efforts to track natural resource change were undertaken (and to a certain extent achieved) in the context of generally limited reliable data on the base condition of the resource. This is one of the next challenges for ACRIS — to better determine current resource conditions so that future change truly identifies trends.

Both the insights gained through the analysis of currently available data, and the identification of data gaps as documented in this report, provide a sound basis for this rangeland information system to continue to meet emerging information needs in the future.

Box 6.1 Guide to natural resource information systems

Water

Australian Water Resources 2005

Australian Water Resources 2005 provided a baseline assessment of water resources at the beginning of the National Water Initiative. There were two levels of reporting:

- high-level management indicators of water availability and river and wetland health
- water availability, water use, and river and wetland health.

More information is available at the Australian Water Resources website[a].

The Australian Water Availability Project

The Australian Water Availability Project will develop an effective system for estimating soil moisture and other components of the water balance across the continent at 5-km resolution or finer (eg 1 km). Information products (including maps) will provide the water resource information required to increase drought preparedness and improve risk management, and will promote the sustainable use of natural resources. The project will help explain crucial links between water availability and the climate.

More information is available at the project website[b].

Water Resources Observation Network

The Water Resources Observation Network, when developed, will provide information about current water availability, expected future availability, water entitlements (irrigators, industry, urban) and conditions of access. The system is expected to be fully functional by 2010.

More information is available at the network's website[c].

The Great Artesian Basin Sustainability Initiative

The Great Artesian Basin Sustainability Initiative supports artesian bore rehabilitation and bore drain replacement works. The aim is to reduce the amount of Great Artesian Basin groundwater being lost through seepage and evaporation from open bore drains fed from uncontrolled bores.

More information is available at the Queensland Natural Resources and Water website[d] and the SA Department of Water, Land and Biodiversity Conservation website[e].

Land and soil

The Australian Collaborative Land Use Mapping Program

The Bureau of Rural Sciences (BRS), state/territory agency partners and other organisations are working collaboratively to develop a nationally consistent approach for the production of land use information across Australia. National scale land use mapping is available for 1992–93, 1993–94, 1996–97, 1998–99, 2000–01 and 2001–02. Catchment-scale land use data are expected to be completed for Australia by the end of 2007.

More information is available at the BRS website[f].

Australian Soil Resource Information System

The Australian Soil Resource Information System provides online access to the best publicly available information on soil and land resources across Australia in a consistent format. Information is available at seven different scales, from general descriptions of soil types, landforms and regolith across the continent to more detailed information in regions where mapping has been completed.

More information is available at the Australian Soil Resource Information System website[g].

Vegetation

National Vegetation Information System

The National Vegetation Information System (NVIS) is a collaborative initiative between the Australian and state/territory governments to manage national vegetation data to help improve vegetation planning and management. NVIS provides a comprehensive and consistent means of describing and mapping vegetation across jurisdictional boundaries. Further information on NVIS is available at the NVIS website[h].

a http://www.water.gov.au (accessed 10 June 2008)
b http://www.csiro.au/science/ps2by.html (accessed 10 June 2008)
c http://wron.net.au (accessed 10 June 2008)
d http://www.nrw.qld.gov.au/water/gab (accessed 10 June 2008)
e http://www.dwlbc.sa.gov.au/water/projects/gabsi.html (accessed 4 April 2008)
f http://adl.brs.gov.au/mapserv/landuse/ (accessed 10 June 2008)
g http://www.asris.csiro.au/index_ie.html (accessed 10 June 2008)
h http://www.environment.gov.au/erin/nvis/index.html (accessed 10 June 2008)