

Australian Government

National Land & Water Resources Audit

Extract from Rangelands 2008 — Taking the Pulse Appendix 1 Jurisdictional reporting

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Appendix 1 Jurisdictional reporting

This appendix provides an update on the jurisdictional monitoring activity reported in *Rangelands* — *Tracking Changes* (NLWRA 2001a). Programs provided by Australian Government agencies to support jurisdictional reporting are also described.

Western Australia

Rangelands make up about 87% of WA and include all but the southwest of the state. Livestock grazing on pastoral leasehold land is the dominant commercial land use across about 42% (910 000 km²) of the WA rangelands.There are about 460 pastoral stations.

The Pastoral Lands Board of WA has responsibility for administering pastoral leases under the *Land Administration Act 1997*. The WA Department of Agriculture and Food provides rangeland monitoring, condition assessment and lease inspection services to the board under a memorandum of understanding.

There are three major components to WA rangeland assessment:

- Regional-scale resource inventory and condition surveys are progressively conducted across all the pastoral areas. The inventories map resources by land system and vegetation type.
- Each pastoral lease is inspected by ground traverse on a one to six-year cycle. The inspection reports are used by the Pastoral Lands Board to determine whether remedial actions are needed on individual leases.
- The pastoral areas are subject to regional-scale range monitoring using the Western Australian Rangeland Monitoring System (WARMS). This regional-scale monitoring has provided much of the data for ACRIS reporting.

WARMS consists of about 1622 permanent ground sites at which attributes of perennial vegetation and soil surface condition are assessed (Figure A1).There

are two types of WARMS sites: grassland sites are used in the Kimberley, Pilbara and northern Gascoyne; shrubland sites are used from the southern Pilbara through to the Nullarbor. Grassland sites are assessed on a three-year cycle and shrubland sites on a five-year cycle. The system in its current form began in 1992, although many old monitoring sites were incorporated into the new system and some data and photo records go back to the 1970s. For grassland sites, three complete cycles of assessment (ie four assessment dates) were available for ACRIS reporting (1994–96, 1997–99, 2000–02, 2003–05). For shrubland sites, one complete cycle was available (most sites were established between 1993 and 1999, and reassessed for the first time between 1999 and 2005).

Since Rangelands — Tracking Changes (NLWRA 2001a), WARMS has begun reporting regularly to a range of end users, such as the Pastoral Lands Board, the WA Commissioner for Soil Conservation, state of the environment reporting agencies, the scientific community and ACRIS. All data are housed in a corporate Oracle database with access via a userfriendly 'front end'. Analysis procedures have been improved and many of the basic data summaries are now handled through permanent queries in the database. Vegetation types have been assigned to all sites and improvements have been made to the way soil surface condition data are summarised.

The WA Department of Agriculture and Food remains committed to its rangelands activities. It invests about \$1.6 million of core funds each year directly into pastoral monitoring, lease inspection and resource inventory projects (not including the costs of maintaining staff and offices in remote locations). WARMS will continue to provide useful information. As each complete cycle of assessment is finished, the ability to separate long-term trend from shorterterm natural fluctuation will be improved and better information will be available on the health of our rangelands.

Figure A1 WARMS grassland and shrubland sites, WA



Source: Ian Watson, WA Department of Agriculture and Food

South Australia

Rangelands cover 85% of SA, including all but the southern portion of the state. The main vegetation types are tussock (spinifex) grasslands, low open woodlands of mulga, mallee and myall, and various chenopod shrublands (saltbushes, bluebushes and cottonbushes).

Pastoralism is the dominant land use over about 60% of the SA rangelands, with sheep predominantly to the south of the dingo-proof fence and cattle to the north. Products of mining activities include oil, natural gas, iron, copper, uranium, silver and gold.

The 40% of the SA rangelands that are not under pastoral lease are mainly the Great Victoria and Simpson sandy desert areas dedicated as conservation or regional reserves, and the northwest ranges forming the Pitjantjatjara lands. The SA Pastoral Board administers pastoral leasehold land under the *Pastoral Land Management and Conservation Act 1989*. The board performs that function with support from the Pastoral Land Management Group within the SA Department of Water, Land and Biodiversity Conservation. The department also has responsibility for the *Natural Resources Management Act* (2004) and has the lead responsibility for management and monitoring of the rangelands. The Department for Environment and Heritage has the lead role in the development of biodiversity plans and the management of arid zone parks.

Rangeland monitoring program

The Pastoral Land Management Group has a comprehensive, integrated program of:

- resource inventory
- resource condition and lease assessment
- lease inspection
- rangeland monitoring.

In the past 15 years, SA has established a baseline set of data (associated with an assessment of lease condition) over all pastoral leases in the state (Figure A2). Each of the 219 pastoral properties on 328 pastoral leases covering 409 000 km² in total now has:

- resource and lease inventory information
- resource condition assessments
- baseline monitoring sites established
- priority paddocks identified for management action and repeat inspections.

Having completed the first round of assessments in December 2000, the SA Pastoral Board has begun the second round, in which the emphasis has shifted to identifying and reporting changes in land condition and, where possible, identifying trends. The program of work to systematically revisit leases and report to the board is scheduled for completion in 2014.

In the second round of assessments, staff will revisit the approximately 5500 photopoint monitoring sites established in the baseline assessment. Twenty thousand randomly generated Land Condition Index sample points will also be assessed as part of the assessment of land condition. About 4500 individual



Figure A2 Pastoral monitoring sites, SA

Source: Mike Fleming, SA Department of Water, Land and Biodiversity Conservation

paddocks will be reassessed, and the previous priority rating for land management action will be reconsidered by the Pastoral Land Management Group and reported to the SA Pastoral Board for its consideration. This work continues to be driven by the requirements and policies of the board in meeting the requirements of the Pastoral Land Management and Conservation Act 1989 (SA).

The two techniques used for assessing resource condition are grazing gradient assessment (for land under cattle grazing) and the Land Condition Index (for land under sheep grazing). The techniques are used in conjunction with site measurements and paddock observations.

Grazing gradient assessment

The grazing gradient assessment method (Pickup et al 1994) was used on a proportion of the northern cattle leases. It allows grazing effects on vegetation to be separated from those due to rainfall and local landscape variability by examining patterns of cover change with increasing distance from water and the nature of vegetation response to high rainfall.

It will be some time before leases are revisited under the current schedule of work. The SA Pastoral Board and Pastoral Land Management Group will review the grazing gradient methodology before beginning the work, with a view to refining the methodology or adopting other best-practice monitoring techniques.

Whichever methodology is adopted, it is imperative that change in land condition can be reported. Any changes in methodology will need to account for the previous dataset and reconcile any differences that might result from changing the way in which data are gathered and interpreted.

Land Condition Index

On most of the leases in the sheep production areas south of the dingo-proof fence, the Land Condition Index (Lange et al 1994) is used as the primary assessment of land condition.

The Land Condition Index is based on the condition rating of 80–100 sample sites within each lease. Assessments are made into one of three classes: high, moderate or low disturbance. The three classes are precisely specified for each component of each pasture type within a district. Under the Pastoral Land Management and Conservation Act, the optimal condition for the land is one that maintains the native plant and animal life. This is important, since it suggests that the Land Condition Index is more closely related to the maintenance of biodiversity than to pastoral production or landscape function. In practice, the maintenance of native species, pastoral production values and landscape function are closely related for many pasture types.

The disturbance classes are mostly based on the presence/absence or abundance of perennial plant species, the level of grazing and browsing of palatable species, and some consideration of soil surface condition. The Land Condition Index provides an inherent assessment of the likelihood of the return of the vegetation community to something like undisturbed condition.

Land condition is reported using a combination of site-specific information at the paddock level and management activities at both the paddock and station levels. The Land Condition Index is one part of the overall methodology used in determining change in land condition at the property level.

Reporting activity

Since Rangelands — Tracking Changes (NLWRA 2001a), the Department of Water, Land and Biodiversity Conservation has been using the Pastoral Management Information System to report to a range of end users, such as:

- the SA Pastoral Board
- the South Australian Arid Lands Natural Resources Management (NRM) Board
- the Alinytjara Wilurara NRM Board
- national and SA state of the environment reporting agencies
- ACRIS.

Recent initiatives

In partnership with the South Australian Arid Lands and Alinytjara Wilurara NRM regions and the Australian Government, the Pastoral Board and the Department of Water, Land and Biodiversity Conservation are developing the South Australian Arid Lands Information System (ALIS). The ALIS will replace the Pastoral Management Information System with a modern web-based system that will improve the capability of the Pastoral Land Management Group to perform its role as defined in the Pastoral Land Management and Conservation Act. The system will provide a range of functionality that enables the capture, consolidation, storage and reporting of data on SA rangeland assets, including biological, physical, cadastral, tenure, and other related information, pertaining to the South Australian Arid Lands and Alinytjara Wilurara NRM regions.

The users of ALIS will include pastoral landholders, traditional owners, the South Australian Arid Lands and Alinytjara Wilurara NRM boards and groups, the Pastoral Land Management Group, the Pastoral Board and other SA Government agencies and non-government (NGOs).

ALIS is being developed as a web-based system that provides sophisticated spatial and textual data capture, query and reporting functionality based on the particular needs of each user group. It is intended to meet the varying requirements of the mixed audience of government and non-government clients, particularly in the regional areas of SA. Key planned outcomes of ALIS are to:

- provide an accessible and user-friendly data capture tool
- deliver relevant data and information services (both textual and spatial) to all stakeholders within the SA rangelands
- build such services within a standard software development methodology, and on sound, robust, integrated and scalable infrastructure
- provide a single access point to and data repository for information on the rangelands, thereby avoiding data and functional duplication
- integrate textual and spatial data to provide a more complete and holistic view of rangeland information
- improve access to and reporting of information from across the SA Government and NGOs.

By improving the capability for stakeholders to query currently disparate datasets, ALIS will also provide stakeholders with access to information that will increase their potential to:

- manage biodiversity, particularly with regard to:
 - preventing further decline
 - improving understanding of soil degradation
 - developing sustainable use of water resources
- build community capacity by developing effective information dissemination methods.

Pastoral lease inspections continue on a regular schedule across the pastoral leasehold lands.The resource inventory and condition survey has been working in the Kingoonya and Gawler Ranges areas.

The proclamation of the *Natural Resources Management Act 2004* (SA) created eight NRM regions, along with statutory boards responsible for the management of natural resources in those areas. The rangelands of SA predominantly fall within the South Australian Arid Lands and Alinytjara Wilurara regions. The Pastoral Land Management Group played a strong part in the development of management action targets and resource condition targets, and ALIS and other Department of Water, Land and Biodiversity Conservation activities will be a critical component of delivering and reporting against those targets.

Ongoing institutional commitment

The department and the Pastoral Board remain committed to their rangelands activities. Annually, about \$1.3 million of core funds is invested directly in pastoral monitoring, lease inspection and resource inventory projects. In addition, the development of ALIS is an \$840 000 partnership between the state and the Australian Government that will streamline information exchange among a range of stakeholders and continue to provide useful information into the future.

As each complete cycle of assessment is finished, the ability to separate long-term trend from shorterterm natural fluctuation will be improved and better information will be available on the health of our rangelands.

Northern Territory

Rangelands make up about 98% of the NT.The pastoral estate, comprising 219 pastoral leases, covers about 619 000 km² of the territory. Nearly 46% of the NT is under pastoral production.

One of the main responsibilities of the NT Pastoral Land Board, which was developed to implement the *Pastoral Lands Act 1992* (NT), is to monitor and report on the condition of land under pastoral production. Under the Act, the board is also responsible for the instigation of remedial action and plans to restore pastoral land condition.

The Department of Natural Resources, Environment and the Arts (DNRETA), through the Rangelands Management Branch, implements the rangeland monitoring program and provides the Pastoral Land Board with rangeland management, monitoring and assessment information.

Rangeland assessment programs

The rangeland monitoring program within the NT was set up in 1993 as a result of recommendations from the Pastoral Land Board.

The two major roles of the monitoring program implemented by DNRETA are:

• to meet the needs of the Pastoral Land Board — to establish monitoring programs and to monitor

pastoral land use and the effect pastoral management regimes have on the land, and to provide reports on the condition of the pastoral land

• to gain an understanding of landscape processes and the impact the industry has on the land resource.

DNRETA supports the Pastoral Land Board through monitoring the condition of pastoral leases using a two-tiered monitoring system. Combined soil and vegetation data are recorded at a total of 2333 permanent pastoral monitoring sites across the NT (Figure A3).

Tier I monitoring

The Tier I program is a photopoint monitoring program that uses visual estimates to assess land condition. Land managers are encouraged to use the monitoring sites to become more aware of pasture

Figure A3 Tier 1 and Tier 2 monitoring sites, NT



Source: Kate Richardson, DNRETA

species and pasture utilisation by stock on their properties. A total of 2235 Tier I sites are established across 223 properties where pastoral enterprises are undertaken (this includes pastoral and Crown leases and Aboriginal tenures). Sites within the Tier I program are reassessed on a rolling three-year program, with some sites now having had five reassessments. Data collected at Tier I sites include pasture species composition, presence of weeds, erosion, fire and other ancillary information relating to the site and property. Tier I data were used as the basis for ACRIS reporting, as the sites are located across the whole territory.

Tier 2 monitoring

The Tier 2 monitoring program is an integrated monitoring system of remotely sensed images and ground-based data. The satellite images are analysed and correlated with detailed ground-based data collected from permanent sites to provide information on landscape changes. The Tier 2 program uses the field data collection techniques of landscape function analysis. It allows various scales of reporting and assessment to be conducted — from paddock to property and through to region and district. There are currently 98 Tier 2 sites established across the Victoria River District, Sturt Plateau and Alice Springs regions of the NT. The program is currently being extended into the Barkly region.

Recent initiatives

Field data collection enhancements

Modifications to the methods for collecting Tier I data reflect changes within DNRETA to develop and implement an integrated monitoring system across the NT.

Changes to the types of field data collected include more detailed vegetation data representing the various types of cover (bare ground, pasture and woody cover). The additional data collected from the new integrated system will help with the analysis of trends in land condition over longer periods and aid in the use of information products derived from satellite data. The data will also allow for more detailed statistical analysis and presentation of results. The improved methods enable more repeatable data to be collected, thus reducing operator bias when comparing many years of collected data.

Extension of the satellite-based land condition monitoring program

DNRETA was successful in a project bid to the Natural Heritage Trust to secure funding for an 18-month project. The project, NT Satellite Based Land Condition Monitoring, aims to develop a monitoring program that provides annual updates of land condition across the whole of the NT based on MODIS (moderate resolution imaging spectroradiometer) satellite data. Currently, only a small percentage of pastoral lands is monitored and updated annually using Landsat satellite data. The project is tasked with the development, assessment and implementation of indices using MODIS data to monitor land condition changes. MODIS is a new generation satellite with increased spectral and temporal capabilities that has the potential to provide information to further enhance the current monitoring program.

At the completion of the project, DNRETA will take up the program as part of its baseline monitoring program.

External project

The VegMachine project was funded by Meat & Livestock Australia. It has successfully delivered satellite-derived information on long-term changes in cover and management impacts on the land resource to pastoralists across the NT, WA and southern central Queensland. Funding has been secured to continue the delivery of land condition and change information to land managers in the NT.

Ongoing commitment

The monitoring of rangelands is part of DNRETA's core business, and the current program has been recognised as an important provider of baseline vegetation and land condition data across the NT. The program is set to continue and, with enhanced data collection methods, provide data to analyse trends in land condition over longer periods.

New South Wales

NSW rangelands have been monitored annually since the early 1990s at 350 representative sites (Figure A4) as part of the Rangeland Assessment Program (RAP), which is managed by the NSW

Figure A4 RAP monitoring sites, NSW rangelands



Source: Richard Hicks, NSW Department of Environment and Climate Change

Department of Environment and Climate Change. RAP sites were selected to be representative of the numerous rangeland types in NSW and also to have a strong correlation with the Interim Biogeographic Regionalisation for Australia (IBRA) regions reported on in this ACRIS project.

RAP has been highly successful in meeting its initial objectives. The program has provided an opportunity to train many staff in plant recognition and assessment, while providing the participating landholders with important feedback and information on the response of their properties to climate variables and their management regimes.

Information from the program has been used to set targets in local catchment action plans, the NSW Monitoring, Evaluation and Reporting Strategy for natural resources, the standards and targets developed by the NSW Natural Resources Commission for catchment management authorities, and the overarching highlevel NSW State Plan targets specifically dealing with NRM issues.

RAP has been essential in providing objective information on the condition of plant species and rangeland types across the western half of NSW, and changes in their condition in response to climate and management variables. The dataset is unique in terms of its long timeframe and the large proportion of NSW that has been monitored. The department hopes to undertake a detailed review of the program in the short term. The review will improve RAP's value to NRM in NSW by identifying ways to improve monitoring and analysis and to provide linkages to additional issues that need consideration.

The reference sites will be used to calibrate various satellite data analysis programs to improve monitoring approaches across NSW.

Queensland

Rangelands make up about 82% of Queensland. Livestock-grazing on freehold and leasehold land is the dominant commercial land use across about 75% (1 212 000 km²) of the Queensland rangelands, on about 4500 rural holdings. The Queensland Department of Natural Resources and Water (QDNRW) has responsibility for administering pastoral leases under the *Land Act 1994* (Qld). The remaining 44% of entities (only 19% of area) is held under freehold tenure.

The QDNRW and the Queensland Department of Primary Industries and Fisheries (DPI&F) provide rangeland monitoring, condition assessment and lease inspection services. QDNRW uses satellite data to track woody vegetation clearing and regeneration. The *Vegetation Management Act 1999* controls timber clearing; under the Act, broadscale clearing of remnant vegetation effectively ceased in December 2006.

Rangeland assessment programs

- SLATS (the State-wide Landcover and Trees Study) uses Landsat TM imagery to monitor woody vegetation clearing, regrowth and cover annually over most of the state. SLATS is run by QDNRW and underpins the Vegetation Management Act.
- A mapping program managed by the Queensland Environmental Protection Agency (EPA) aims to map regional ecosystems at the scale of 1:100 000 for the whole state. 'Regional ecosystems' are remnant vegetation communities consistently associated with a particular combination of

geology, landform and soil (Sattler and Williams 1999). At this stage, mapping is still under way for much of the Queensland rangelands, and about 1350 individual regional ecosystems are currently listed.

- TRAPS (the Transect Recording and Processing System, managed by DPI&F) monitors woody vegetation dynamics at 84 fixed I-ha sites in 33 sub-IBRAs from eight bioregions in timbered Queensland rangelands, except in Cape York (Figure A5).
- QGraze is another protocol set up to monitor pasture condition state-wide, currently at some 445 fixed sites. The data, plus photographs, are archived in a database within DPI&F. The data deal with tree cover, pasture composition, groundcover and soil surface condition. The protocol is used by QDNRW for some of its work, but the data are not in the main DPI&F database.
- Shrub monitoring transects stretch over 60 km through the mulga lands of southwest Queensland and provide a 40-year record of woody plant dynamics under normal property management. They have rarely been recorded in the past two decades but provide visual and hard data from 1965 to today at relocatable locations. DPI&F is the current custodian of these data.
- BAMM (Biodiversity Assessment and Mapping Methodology) identifies three levels of biodiversity significance (state, regional and local) based on a number of data queries that simultaneously integrate an array of current biodiversity information on rarity, diversity, fragmentation, resilience, threats, and ecosystem processes for a bioregion. This activity is managed by the Queensland EPA.
- RMDC (rapid mobile data collection) by QDNRW continues to obtain estimates of pasture biomass, composition, cover and other information. From 30 000 to 100 000 geocoded observations are collected each year. These data are used to calibrate and verify interpretations of satellite remote-sensing imagery.





Data: Madonna Hoffman, Queensland DPI&F. Map:Teresa Eyre, Queensland EPA.

Data from these sources currently feed into Queensland's *State of the Environment* reports. The first report was published in 2003, and the most recent assessment is planned for release in late 2007. The data also link into major national environmental initiatives such as ACRIS, ReefPlan, the Murray-Darling Basin Commission and the Lake Eyre Basin Authority.

Recent initiatives

Proposed new legislation may incorporate more regular and structured monitoring of leasehold lands where lease renewal is occurring. Regular pastoral lease inspections have not been a feature of land administration in Queensland over the past 30 years. QDNRW is enhancing a system to monitor bareground levels using Landsat images and will have 20 years of annual assessments with improved calibration for the next reporting period. Annual assessment should allow better identification of trends than the two-yearly data prototyped in this report. DPI&F is also assessing the value of satellite data for pasture condition assessment. Queensland's monitoring strength is in satellite remote sensing and in primary production modelling based on the GRASP ('grass production') model, backed by significant computer processing power. QDNRW has recently completed a Meat & Livestock Australia research project to assess the use of MODIS satellite data for groundcover and pasture biomass monitoring. Ongoing research will focus on improved correction of problems caused by seasonally varying sun angles, use of 500-m scale MODIS products rather than the I-km product, and automation of output. QDNRW is heavily involved in the MODIS project, which focuses on the usability of that satellite's data for regular monitoring.

AussieGRASS is following a process of continuous improvement with better inputs for stock distribution, better algorithms for groundcover and plant nitrogen dilution with age, and more extensive calibration with increasing amounts of data from the RMDC program.

The Tropical Savannas CRC (ending in 2008) fostered close Queensland links to the NT and WA and delivered significant synergies to work on improved cattle production systems, fire management and biodiversity documentation. There will be a significant gap in savanna science without further investment, as the Desert Knowledge CRC only deals with the driest fringes of the tropical savannas.

Since Rangelands — Tracking Changes (NLWRA 2001a), vegetation and bioregion mapping has continued to be updated, TRAPS woody vegetation assessment has continued but on-ground pasture monitoring (QGraze) has almost ceased. The VegMachine project uses remote sensing data provided by QDNRW to assist landholders to monitor the condition of their property, with Meat & Livestock Australia financial support and links to the NT rangeland monitoring program.

A rapid procedure for the assessment of vegetation condition for biodiversity values is currently being developed and tested by the Queensland EPA in partnership with DPI&F with Meat & Livestock Australia financial support. This project collaborates with a similar project being run by CSIRO with Natural Heritage Trust (NHT2) financial support. The aim of the assessment procedure is to be grazier-friendly, relevant to rangeland ecosystems, and compatible with the four-category ('ABCD') method for rating the condition of grazing lands. The rangelands of Queensland fall wholly or partly under the ambit of nine regional NRM bodies set up under the National Action Plan and Natural Heritage Trust. QDNRW, Queensland EPA and DPI&F have a significant role in assisting those bodies to deliver their monitoring outcomes. The regional NRM bodies are largely dependent on the three Queensland Government agencies for their base data, underlying resource inventory and maps.

Reporting activity

The TRAPS project has continued reporting to a range of end users on woodland dynamics, such as:

- the Australian Greenhouse Office⁵⁸
- the Queensland Government and the SLATS program⁵⁹
- Queensland state of the environment reporting agencies⁶⁰
- ACRIS.

GRASP has been used to develop aspects of the grazing land management training packages prepared for much of rangeland Queensland and the savannas of the NT and WA. It is also used in the Stocktake program for assessing pasture use at the property scale in Queensland rangelands.

Key publications related to monitoring in Queensland include Back et al (1997), Burrows et al (2002), Carter et al (1998), EPA (2006), Goulevitch et al (2007), Littleboy and McKeon (1997) and Stocktake (2006).

Ongoing institutional commitment

The annual investment by Queensland in rangeland monitoring is currently about \$4.7 million. This investment is likely to increase in the future as the new leasehold land strategy is fully implemented. About \$1.6 million is invested in SLATS, but nothing else related to rangeland condition monitoring is currently required by statute. Bare-ground monitoring is likely to continue for the life of the Rural Leasehold Land Strategy, with an investment of \$0.3 million per year above the SLATS funding for research and

⁵⁸ http://www.greenhouse.gov.au

⁵⁹ http://www.nrw.qld.gov.au/slats/

⁶⁰ http://www.epa.qld.gov.au/environmental_management/ state_of_the_environment/

development over the next three years. AussieGRASS has an annual investment of about \$0.6 million, some of which comes from other, non-Queensland agencies.

Expenditure on kangaroo monitoring and management by Queensland EPA is about \$1 million annually.

An estimated \$1 million is spent annually by the state on research and development related to pasture condition, biodiversity and river health. Much of that amount is matched by resources from industry or the Australian Government.

Each completed cycle of assessment improves our ability to separate grazing-induced long-term trends from shorter-term natural fluctuations and climate change. This improved information on the health of our rangelands will be increasingly available if structured monitoring programs are continued.

Australian Government

ACRIS and equivalent systems, such as those required to support the implementation of the National Water Initiative⁶¹, are seeking to establish collaborative mechanisms to enable the identification, collection, storage and use of appropriate datasets. The Australian Government is investing in information systems such as ACRIS and those outlined below to meet environmental and NRM policy needs. ACRIS will draw on these systems as far as possible to inform research on rangelands change. A key ongoing challenge will be ensuring consistency and complementarity between these systems.

New initiatives

Several major new initiatives are expected to deliver significant improvements in the management of information on environmental condition and trends.

Natural Resource Management Spatial Information Strategy

In November 2006, the Natural Heritage Ministerial Board agreed to provide a total of \$4 million over 2006–07 and 2007–08 to develop a spatial information system to better inform Australian Government decisions on NRM program investments. The NRM Spatial Information System will incorporate environmental, social and economic data and will also include information on program priorities, investment principles and requirements under legislation.

Australia's Resources Online

Australia's Resources Online (ARO) is a cooperative project being undertaken by the National Land & Water Resources Audit and the Environmental Resources Information Network (ERIN) in the Department of the Environment, Water, Heritage and the Arts. The objective of ARO is to provide a dynamic, online application that enables access to data on the condition and trend of the land, water and biological resources in Australia.

The ARO application is based on interoperable web technologies that allow the integration of data from different locations and different custodians through a single access point. ARO provides the interface through which the distributed data can be viewed, eliminating the need for centralised national collations. Data custodians will be responsible for providing up-to-date information in the agreed standard web service format. The information is then accessed and viewed through ARO when a user submits a request. Data access agreements are a key to the success of the application tool.

⁶¹ http://www.nwc.gov.au/NWI/index.cfm (accessed 10 July 2007)

Existing information programs

Apart from ACRIS, the Australian Government directly supports a range of collaborative information systems developed to address specific NRM needs. These include the:

- National Vegetation Information System (NVIS)⁶²
- Australian Soil Resource Information System (ASRIS)⁶³
- Australian Collaborative Land Use Mapping Program (ACLUMP).⁶⁴

CSIRO activity to support monitoring

CSIRO has a long history of involvement in and commitment to rangeland inventory and monitoring, although it has no statutory role in monitoring. CSIRO involvement began with land resource surveys in the 1940s and 1950s and continued with the testing and refining of methods for collecting and analysing monitoring data on pastoral lands in the 1980s and 1990s. Throughout, CSIRO staff worked collaboratively with state and NT agency staff to ensure that methods under development were assisting agencies with their monitoring requirements (Foran et al 1985b, Friedel and Shaw 1987, Wilson et al 1987, Bastin et al 1998).

Collaborative development and testing of methods to assist rangeland monitoring continues today.

- The Leakiness Index and calculator (Ludwig et al 2007) for upscaling landscape function assessment (using a digital elevation model and multitemporal cover derived from remote sensing) are being tested in the Burdekin catchment by Queensland DPI&F staff to support their grazing land management program.
- Various projects evaluated the efficacy of indicators and methods for operationally monitoring biodiversity (Smyth et al 2003, Hunt et al 2006).

Other rangelands research in the biodiversity area is exploring how rewards might be used to more explicitly manage pastoral lands for biodiversity, for example through market-based instruments.

CSIRO has recently expanded its research into the social and Indigenous domains, for example:

- understanding regional viability and resilience, and how both are dependent on sustainable livelihoods
- working with partners to achieve stronger livelihoods for Indigenous people (eg bush foods and their sustainable harvest, fire abatement in Arnhem Land and planning for improved management of land and water resources in the NT Daly River catchment), and developing measures to assess success.

Long-term terrestrial monitoring has recently become a national priority⁶⁵; it will require continued developments such as those above and the ACRIS approach for rangelands.

Supporting role of the Desert Knowledge CRC

ACRIS depends on effective collaboration among its partners; many are also partners in the Desert Knowledge CRC, as is CSIRO. The CRC secretariat, as part of the ACRIS Management Unit, has provided an efficient and effective contracting service to ACRIS partners. This partnership will support future improvements to monitoring to incorporate biodiversity, social issues and matters of concern to Indigenous interests.

⁶² http://www.environment.gov.au/erin/nvis/index.html (accessed 10 July 2007)

⁶³ http://www.asris.csiro.au/index_ie.html (accessed 10 July 2007)

⁶⁴ http://adl.brs.gov.au/mapserv/landuse/index.html (accessed 10 July 2007)

⁶⁵ http://www.ncris.dest.gov.au/capabilities/tern.htm (accessed 11 July 2007)