Australian Government

Management of total grazing pressure

Managing for biodiversity in the rangelands

Alaric Fisher, Leigh Hunt, Craig James, Jill Landsberg,
David Phelps, Anita Smyth, Ian Watson

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Contents

Abstract

Improved management of total grazing pressure will ensure the sustainable capacity of rangelands are not exceeded as well as help maintain the proper functioning of ecosystems and survival of native species.

By total grazing pressure, we mean the combined grazing pressure exerted by all stock – domestic and wild, native and feral – on the vegetation, soil and water resources of rangeland landscapes.

This information has been prepared to provide an overview of guidelines, knowledge gaps and opportunities for managing total grazing pressure across the Australian rangelands. It was collated from the experience and knowledge of an expert panel drawn from the Desert Knowledge and Tropical Savannas Management Cooperative Research Centres. These experts reviewed present and past research projects relating to total grazing pressure and biodiversity conservation in the rangelands that were funded by Natural Heritage Trust, as well as drawing on other published and unpublished information.

We used biophysical characteristics, land uses, land modification and stocking characteristics to create a framework for organising rangelands into ten regions, having similar total grazing pressure and biodiversity characteristics – termed grazing land management zones (GLMZs).

Based on the review of scientific and resource management literature and past research projects, we described the major issues for management of total grazing pressure and biodiversity conservation in these 10 zones. We also identified major knowledge gaps and suggested priorities and opportunities for future investment and management action.

This summary is part of a series of related reports on Managing for Biodiversity in the Rangelands intended to provide government agencies, land managers and others with relevant information on protecting biodiversity in the rangelands.

Managing total grazing pressure for sustainable use of rangelands

Today's pastoral grazing management in rangelands is more in tune with the carrying capacity of the landscape than when rangeland pastoralism began in Australia around 200 years ago. However, total grazing pressures are still high in some areas and in many areas may still be unsustainable.

Management of total grazing pressure is about management of all grazing animals – domestic and wild, native and feral – as only by managing the compound impacts of all these animals will we ensure the sustainability of grazing industries and conservation of biodiversity in rangelands.

Introduction

Pastoral production in Australian rangelands is characterised by the use of large tracts of land with low densities of domestic stock feeding on relatively sparse and variable grasses and shrubs. In many regions pastoral production could be sustainable if domestic stock were the only grazers, but this is rare; most regions with domestic stock also have native and feral grazing animals.

Total grazing pressure in the rangelands has two distinct components – that which is managed and that which is unmanaged. Domestic livestock (mostly sheep, cattle, and in a few areas, goats) make up the component that is generally regarded to be under management control. Wild stock – which may include high populations of native and feral grazing mammals – is essentially unmanaged.

Management of total grazing pressure requires consideration be given to both domestic and non-domestic stock, otherwise excessive grazing occurs, which has both direct and indirect negative impacts.

Direct impacts include soil erosion, fouled water supplies and weed invasion. Indirect impacts are through the loss of potential productivity, biodiversity, and the ecosystem services provided by native flora and fauna. It is a factor in the past and/or current decline of some mammal, bird and plant species as well as the degradation of some ecosystems. For instance, since European settlement 20 species of native mammals have become extinct.

The negative impacts of excessive total grazing pressure affect the value of the rangelands to humans for a range of purposes, including the sustainability of the pastoral industry. These consequences are felt also, not just by rangeland inhabitants, but also by the wider community. For example, rangeland degradation is expected to have consequences for climate change at local and global scales.

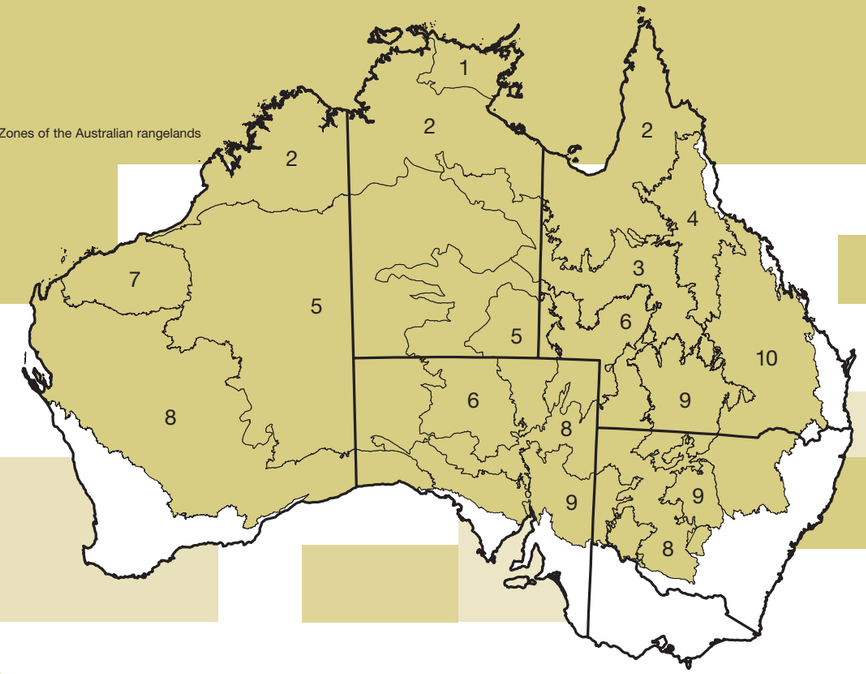


Figure 1: Grazing Land Management Zones of the Australian rangelands

This project

The purpose of this project was to develop guidelines that would assist managing total grazing pressure, particularly in the context of impacts of total grazing pressure on biodiversity issues. It also sought to identify knowledge gaps and priorities for future investment in rangelands.

This project used the experience and knowledge of an expert panel drawn from the Desert Knowledge and Tropical Savannas Management Cooperative Research Centres selected because of their expertise in a particular topic or region. These experts synthesised the available literature relating to total grazing pressure and biodiversity conservation in the Australian rangelands. This also included some present and past research projects that were funded by Natural Heritage Trust.

Our approach was to develop a framework which organised rangelands into regions with similar total grazing pressure and biodiversity characteristics – grazing land management zones (GLMZs).

Key

1. Arnhem Land and Tiwi Islands
2. Tropical Savannas
3. Mitchell Grass Downs
4. Einsleigh and Desert Uplands North Queensland
5. Arid Deserts
6. Central Australia Cattle Grazing
7. Pilbara
8. Southern Australia Sheep and Cattle Grazing
9. Extensive Sheep Grazing
10. Highly Modified Rangelands.

Total Grazing Pressure – management issues and techniques for the rangelands




For each GLMZ we considered: the dominant grazing systems and management of total grazing pressure; major biodiversity issues in relation to total grazing pressure; and knowledge gaps and opportunities to invest. This information was synthesised to identify the major total grazing pressure and biodiversity issues across the rangelands. Then, for each major management issue we described management actions that were most likely to yield positive biodiversity outcomes, and where future investment was most likely to be cost-effective. We also reviewed management of grazing pressure, including grazing management systems for domestic stock and methods for managing wild stock and feral animals.

Note that only a précis of this information is presented in this document and for a full description the full report should be consulted.

Fisher, A., Hunt, L., James, C., Landsberg, J., Phelps, D., Smyth, A., Watson, I. 2004. Review of total grazing pressure management issues and priorities for biodiversity conservation in rangelands: A resource to aid NRM planning. Desert Knowledge CRC Project Report No. 3 (August 2004); Desert Knowledge CRC and Tropical Savannas Management CRC, Alice Springs.

Total grazing pressure in the rangelands is the combined grazing pressure exerted by all stock – domestic and wild, native and feral – on the vegetation, soil and water resources of rangeland landscapes. Generally total grazing pressure has two components, domestic stock that is managed, and wild stock that is largely unmanaged.

Although domestic livestock is managed, the degree of control exercised over stock varies between geographical regions and animal species. There is usually less control of stock in more extensive areas – typically where cattle are run in central and northern Australia. Animal numbers are largely managed and monitored. In some states, maximum and sometimes minimum, numbers are imposed through legislation. Typically there is little control over where, and when, animals graze which results in uneven grazing with some parts heavily used and other parts hardly used at all.

Wild stock is essentially unmanaged, although some control of numbers occurs for some species in particular areas. While there are some examples of success in managing total grazing pressure in the rangelands there are also examples where wild stock exert more grazing pressure than domestic stock.

Issues in the management of the natural resource base

The options for managing total grazing pressure in the rangelands are limited compared with the intensive use zone. Contributing to this difference is the scale of enterprises and management units, the variable and unpredictable climate, the magnitude of pest populations, the limited availability of labour and the limited control that can be achieved over animals and their movements. Economic circumstances for grazing enterprises and the low financial returns that are generally achieved per land area in the rangelands also have a strong influence.

A full description of management issues and techniques for the rangelands is given in the main report however these are the important issues for total grazing.




Types of grazing enterprises

Different types of grazing enterprises have different issues for management of total grazing pressure.

Sheep are generally more common in the south and are found on smaller properties where control of availability of water is high, the use of dietary supplements is limited, fire is actively excluded, and set-stocking is a common management practice. Intensity of use is high, with high domestic stocking rates and generally high numbers of rabbits, feral goats and kangaroos. These areas have suffered extinction of some native mammals.

In contrast, cattle are more common in the north, and are run on large properties where both fire and supplements are commonly used management tools. Control over water availability is variable, and a set stocking regime, or set utilisation, is a common grazing management practice. The intensity of use by domestic stock is low but increasing. Wild stock includes horses, donkeys, camels and pigs. Many native mammals are in decline in these areas.

Control over where animals graze in the landscape has improved markedly in cattle-grazing regions since the Brucellosis and Tuberculosis Eradication Campaign of the 1980s–1990s, which involved fencing programs to facilitate disease testing and control of livestock. Where there is more settlement, often sheep dominated areas, paddocks are smaller and more control can be exercised over animals. Here it is more common to find paddocks being spelled and the class of livestock assigned to paddocks varies depending on characteristics of the land and on animal needs.

There is a need to acknowledge all grazers

For many years, land managers and administrators disregarded the grazing pressure exerted by wild stock in the rangelands. Yet, effective management, which benefits animal production and protects biodiversity, must take account of all grazing species.

In recent years, land managers and administrators have acknowledged and accepted the need to take account of non-domestic grazing pressure when setting carrying capacities and stocking rates. Also accepted is the need for occasional resting of paddocks to ensure the persistence of preferred perennial plants. These provide incentive for wild-stock populations to be effectively controlled.

Feral animals – pest or resource?

For some feral species there is an apparent conflict between the need to control feral animals because of increased pressure they exert on the land and the market value of the pest animals when caught and sold. Often managers have allowed feral populations to increase to provide additional income at a later stage, especially in poor seasons. Many managers fail to recognise that feral species in fact compete with domestic livestock, reducing livestock productivity, so total grazing pressure on the land has often been excessive.

It is important for managers to be clear about the true role of feral species in the rangelands, which generally should be seen as a threat rather than as an economic resource. Thus it is vital for the maintenance of biodiversity and the sustainability of pastoral enterprises that populations of feral pest species are minimised at all times.

Management methods for domestic livestock

Across the rangelands, there is a range of specific issues to consider when choosing and implementing grazing management practices to achieve an acceptable balance between animal production, long-term sustainability, and the protection of biodiversity. While management strategies and associated issues for specific pest animals are discussed in the main report, issues to note for management methods include the following.

Stocking rates, utilisation rates, carrying capacity

Some states recommend carrying capacities (number of animals per unit area) for different land systems, based on rangeland assessment surveys and historical carrying capacities. Recommendations are based on what is considered to be a safe level in the long term and are appropriate for most but the driest years, i.e. the number that can be carried without forced destocking in about eight or nine years out of ten. Some states specify maximum allowable stock numbers rather than carrying capacities.

For best management, stocking rates (the actual number of livestock on the land at a particular time) should be based on the capacity of the land to carry stock. While long-term carrying capacities may be provided by state agencies, the manager must make short-term decisions in response to seasonal conditions. Stocking rates should be conservative to provide a buffer against declining seasonal conditions and forage availability – ideally they should be set at a level that avoids forced destocking in all but the worst drought, i.e. a one in ten year drought.

Drought and risk management

Managing drought is a critical part of successful overall grazing management. Substantial long-term damage happens to natural resources during drought because forage is reduced, plants are put under stress, and livestock tend to use parts of the landscape that they usually avoid.

Prompt decision-making during drought is critical for sustainability. Planning for drought increases the chances of the business and the rangelands surviving in reasonable condition. Issues to consider include:

- an early reduction in stock numbers decreases the risk of land degradation and the need for forced selling of stock when prices are poor;
- the use of critical indicators of pasture condition (e.g. minimum stubble height measures) protects perennial plants from overuse;
- having control of wild stock numbers before the drought increases the capacity for successfully managing drought;
- use of tools to assist timely and informed decisions, for example, considering stock numbers or comparison of previous drought events will enables more informed decision-making however, not all regions have well-developed and appropriate tools for use in this context; and
- supplementary feeding of livestock during drought is generally not recommended, except for a breeding nucleus of stock, as artificially maintaining livestock on the land creates the potential for overgrazing of perennial plants during times of high stress;
- vegetation should be allowed to recover for some months following the breaking of a drought before restocking and the same applies to grazing soon after a fire, or early in the wet season following the breaking of dormancy in perennial grasses.

Impact across the landscape

Should animals be spread evenly across the landscape? There has been the widely accepted view that grazing pressure should be spread over the landscape as evenly as possible – although there is now a growing view that more uniform grazing may reduce biodiversity because it leaves little of the landscape unaffected by grazing.

Uneven distribution of grazing within paddocks leads to localised patches of degradation because of animals' preferences for particular forage types. More even distribution is achieved by subdividing the landscape with fencing and by locating watering points strategically. Smaller paddocks and shorter return distances to water for a drink result in more even use of the landscape as a whole and of the area within a paddock. However, the relative benefits and costs of these alternatives, both economically and environmentally, are not clear.

The alternative belief holds that paddocks, which contain a diversity of land types, may offer production benefits for domestic stock. It means that areas that are a less preferred land type or are remote from water or usual grazing areas can provide quality forage during less favourable seasonal periods and thus may buffer declining productivity. However, this may actually increase degradation because such resource reserves can maintain animals on the landscape during resource shortages. This might be less of a problem for resilient land types, but careful management is essential in this situation.

Landholders should monitor preferred parts of the landscape and areas which concentrate animal activity, such as water points, as these will be the first to exhibit signs of excessive grazing pressure. These indicators will also point to broader scale, long-term consequences that may be occurring in the landscape.

Riparian management

Management of riparian habitats is important because these areas usually have very high biodiversity values, are very sensitive to the impacts of grazing, and can be substantially impacted as livestock tend to congregate in these areas.

Recommended practice to minimise the impact of grazing by domestic stock in riparian zones is to fence them to exclude, or better control, use by domestic stock. This can be costly and anticipated benefits are not always achieved. For example, weeds can increase. Other techniques include installing off-stream water points and placing supplements away from watercourses.

Use of fire

Fire is a useful management tool, particularly in grassy rangeland areas, although all regions should include fire in their normal pasture management. Fire can be used to manage pasture composition, improve pasture vigour and quality, manage woody vegetation structure, and remove heavily grazed patches from the pasture.

Use of fire can enhance biodiversity through patch mosaic burning which can increase the diversity of habitat types or post-fire successional stages in the landscape. It can also limit development of dense woody vegetation, which reduces habitat value for many native species.

While we don't know how the frequency of burning for pasture management compares with burning for the promotion of biodiversity. We do know that for pasture management purposes:

- tropical tall-grass pastures may need to be burnt every two years and other grass pastures every four to six years;
- annual short-grass pastures should not be burnt at all; and
- rangeland types not adapted to fire (e.g. the chenopod shrublands), need contingency planning to minimise the adverse effects of wildfire.

Biodiversity

Native species of flora and fauna may decline, be unaffected or increase in response to grazing. Biodiversity is generally decreased in areas around water points where there is moderate to heavy grazing by native animals. Also, strategies to achieve more even grazing of the landscape, as desired for pastoral activities, are likely to reduce biodiversity at the paddock level.

At present there are no grazing systems regarded as suitable for the maintenance of all species.

One key strategy for maintaining grazing-sensitive species is to protect some land from grazing at property and regional scales. It is recommended that approximately 10 percent of the landscape should remain ungrazed or only lightly grazed. This means ensuring some areas remain distant from water points (more than 4 km from water for sheep or 8 km for cattle) or by fencing off areas. Feral animals and weeds should be controlled in these areas.

The limitations of this strategy are that only a small fraction of the landscape can be protected in this way. Also, the resource-rich areas that are important for biodiversity – such as riparian zones, local sinks for run-off and nutrients, breakaways – are also important for domestic stock production and so pastoralists often are not willing to exclude them from being grazed.

Another strategy is to develop grazing systems that are conducive to the persistence of species that may otherwise be disadvantaged by continuous grazing.

Grazing management systems

Given the diversity of rangeland types across Australia, there is a limited range of grazing management systems in use for domestic livestock in the rangelands. Those in common use have usually developed through practical experience over many years rather than as a result of scientific investigation and assessment – in fact in many regions it is rare for insights from scientific studies into be incorporated to grazing management.

The most commonly used grazing management practices are outlined in Table 1 but some general recommendations can be made for the appropriate grazing system in particular rangeland areas with particular vegetation types.

- Tactical grazing should be used for systems based on perennials where climate is unpredictable. Annual systems should use a feed budgeting approach.
- More reliable tropical savannas can use safe use rates in conjunction with pasture growth models (and local knowledge), or early wet season spelling (acknowledging that use rates can be higher with the latter).
- Continuous grazing is okay for resilient systems if stocking rates are constantly monitored and reviewed.
- Seasonal forecasting should be used in all areas to manage risk, although in some regions this is more accurate and reliable than others.

Table1:

Features and management issues associated with commonly used grazing management practices

Continuous grazing systems	Features	Management Issues
Set stocking	• Stock levels set at conservative rate – i.e. a level where forced destocking is only rarely required (1 in 10 years) • Most common in southern areas – widely used in the chenopod shrublands and mulga woodlands / shrublands of South Australia and Western Australia (GLMZs 8 and 9) – where ephemeral and annual species provide forage when sufficient rain has been received, and the perennial shrubs are relied upon to provide feed at other times.	• Knowing the best time to destock or reduce numbers in worsening seasonal conditions • Common problems include leaving stock on too long when going into drought which causes declines in perennial shrub density. • Can lead to increased, and irreversible impact in practical terms, in areas surrounding water points. • Can be managed using simple plant-based indicators and spatial monitoring.
Seasonal tracking	• Tracking of seasonal conditions occurs and livestock numbers are varied depending on seasonal conditions and forage availability. • Usually some livestock is maintained on properties even in the worst years. • Commonly used in the semi-arid woodland areas of New South Wales and South Australia.	• This can have short- and long-term financial benefits for pastoral enterprises when used to moderate extent, as very conservative stocking rates may not provide satisfactory economic returns in the short term. • This approach is associated with higher economic and ecological risks and good managerial skills are required to implement this approach properly to minimise these risks.
Set utilisation	• Practiced in tropical and subtropical savanna systems where there is a distinct summer growing season and perennial grasses dominate pastures. • Stock numbers are set by forage available at the end of the growing season and the defined safe use levels for this forage. • Once livestock have been allocated to paddocks at the end of the growing season, they usually remain in place until the end of the next growing season.	• Use rates of between 10% and 30% of standing forage at the end of the growing season are recommended, with the actual rate depending on the ecosystem and management context. • Computer-based models of pasture growth based on rainfall received during the growth season are sometimes used to estimate the appropriate livestock number to achieve the specified safe utilisation level. • While this system is a form of continuous grazing, it is ‘set use’ rather than set stocking.
Rotational grazing and spelling	• Rotational grazing and spelling systems take many forms but they usually involve multiple paddock systems. • Many rotational grazing systems use regular spelling (or grazing) on a calendar basis or on the basis of the number of days of grazing or spelling. • Numerous systems are in use in rangelands in the United States but few have been tested in Australian rangelands – some principles might be relevant.	• There is growing interest in this system in recognition that most native pasture species are not well adapted to continuous grazing, and some form of pasture resting/spelling is needed to let plants to recover from grazing and complete their life cycle processes. • However there is little objective information to support or challenge the claimed benefits of rotational grazing, or the pros and cons of alternative rotational grazing schemes, so their value remains unproven. • In systems where rainfall and plant growth are unreliable and unpredictable this approach may not offer any benefits. • These systems (including cell grazing) can operate on recommendations that we consider inappropriate such as the use of very high stock densities, often well above usually accepted limits. Despite a lack of explicit scientific evidence with which to refute them they are contrary to normally accepted practice for protecting the soil surface and limiting plant defoliation.
Opportunistic	• Other less formal spelling or rotational grazing systems can sometimes offer benefits for natural resource condition. These can include opportunistic spelling (often with forced destocking due to drought and/or deferring the build-up of stock numbers following drought-breaking rains), or rotation of stock between water points in a paddock (especially where forced to do this due to seasonal waters drying up). • Resting can also involve taking advantage of exceptionally good seasonal conditions to rest a few paddocks at a time.	• One problem with resting is that it is rarely done for sufficient time. Resting should occur for long enough to allow plant responses to reduced grazing. One difficulty in applying resting is a lack of indicators and rules for resting strategies. • Where there is a variety of range types with differing plant communities and growth habits is available within a single property, then it can be useful to devise rotational systems that take advantage of seasonal differences in growth, forage availability or resistance to defoliation • Currently wet-season spelling is not widely applied on commercial properties but is an appropriate management practice in GLMZs 2 and 4. • Early wet season spelling is currently recommended for tropical and subtropical savanna pastures to maintain palatable, perennial and productive native grasses (i.e. the ‘3P’ grasses). This protects palatable perennial grasses from defoliation during the sensitive period when the plants are just beginning to regrow following the start of the wet season. • Wet-season spelling also allows an increase in utilisation rates and animal production that compensated for having some land ‘out of production’ during the spelling period.
Tactical grazing	• Tactical grazing involves adjusting stock numbers in accordance with changes in seasonal and climatic conditions and plant growth. The key principle underpinning tactical grazing is the need for grazing to be managed in a way that recognises the critical importance of perennial plants. These species must be able to complete all life cycle stages to ensure the persistence of plant populations. • Decisions are made, based on plant condition scores, to alter stock numbers or destock. For example, in the semi-arid woodlands of New South Wales or wherever seasonal conditions are unpredictable, minimum stubble height (grazing residue) for perennial grasses is 10 cm. The mortality of the grasses increases dramatically during drought by grazing beyond this limit.	• For regions where the climate (and rainfall in particular) is erratic and unreliable, tactical grazing is recommended (e.g. GLMZs 6, 8 and 9). • An important part of applying tactical grazing is the identification and definition of objectives and strategies on a paddock-by-paddock basis (Campbell & Hacker 2000) • Tactical grazing acknowledges the potential for plants to be killed by grazing and for recruitment to be limited because grazing can limit growth, flowering, and seed production. • Regions with an erratic and unreliable climate are most likely to benefit from tactical grazing since many plants do not complete life cycle processes on a regular or annual basis.

Lessons from the intensive use zones

Some principles and practices from the intensive use zone in southeastern Australia are relevant for the more extensively used and managed rangelands. However, the transfer of these techniques is affected by several factors including: differences in enterprise types; level of productivity and extensiveness of properties; and wild stock problems (with some species absent or in fewer numbers in the south). These factors affect the practicality and cost of implementing grazing management practices or of control methods for pest animals.

One such series of management principles for domestic stock management for biodiversity protection has been developed for the grassy eucalypt woodlands of southeast Queensland. These areas are grazed predominantly by cattle. Based on a landscape planning approach, the principles are:

- property planning and management should include a long-term vision that considers the whole of the property and its place in the catchment;
- soils should be managed to prevent erosion and to maintain productive capacity and water quality;
- pastures should be managed for production and to maintain the variety of plants and animals;
- local native trees should be maintained for the long-term ecological health of the property and catchment;
- all properties require an environmental reserve for species that are sensitive to agricultural land uses; and
- watercourses are particularly important to the ecosystem and grazing enterprise, and require special management.

One practical measure also developed for the grassy eucalypt woodlands but with potential for wider applicability is the use of indicators for monitoring results and improving management. These indicators are based on land use and the proportion of a property in particular land use classes. The principle is that certain proportions of each property should be allocated to land uses that are favourable to biodiversity conservation (although the achievement of these ideals is limited by the degree of landscape modification already having occurred). The precise thresholds depend on landscape types with different vegetation communities, however three key recommendations hold in all ecosystems:

- only 30 percent of the land should be used for high intensity land use;
- the remaining 70 percent should include uses that have a range of intensities of use with varying levels of impact on biodiversity; and
- within this 70 percent, about 10 percent should be allocated as environmental reserve.

Thresholds recommended for semi-arid rangelands (which are considered to be essentially intact landscapes with few areas of intensive use, at least in comparison with more temperate areas) reflect the role of water sources in controlling the distribution and activity of livestock in rangelands. The recommended areas of land in different distance-from-water classes are:

- no more than 10 percent close to water points and therefore heavily grazed;
- 40 percent grazed at intermediate distance from water;
- 40 percent grazed but at greater distance from water; and
- 10 percent far from water, beyond the reach of livestock and very infrequently grazed.

For more extensive discussion on indicators for specific ecosystems (e.g. grassy eucalypt woodlands) see the full report.

Management methods for wild stock

Managing grazing pressure from wild stock (including native herbivores such as kangaroos) is more challenging than for domestic stock. While management strategies and associated issues for specific pest animals are discussed in the main report, issues to note for management methods are listed below.

- There are legislative requirements for control methods and approaches to control of wild stock such as management policies and requirements for different species, access of poisons, options for native species.
- Management of wild stock generally involves removal or destruction of the animals – moving wild stock to another part of the landscape is not an option, fencing is not usually feasible for extensive control.
- Regional coordination of management activities is important for some species of wild stock, particularly those that are highly mobile or have large home ranges.
- Timing control operations to take advantage of natural declines in abundance due to poor seasonal conditions or disease outbreaks
- It is vital that part of wild stock control is ongoing with follow-up control of pest species to maximise the long-term effectiveness of management activities.
- Monitoring of populations of wild stock and their impact is also essential, as it is for domestic stock.
- Effectiveness of control should be measured in terms of impact (such as reduction in damage to the environment or production) not numbers of animals killed or removed.
- Ecological benefits should be measured through monitoring the resource base.
- Spatial issues where some species are constrained to particular areas, such as landscapes types or near water, means that control programs may not need to be overly widespread and can be targeted effectively.

Grazing land management zones

Major issues across grazing land management zones

Total grazing pressure issues and solutions vary from region to region, depending on the pastoral infrastructure in place, the type and number of grazing species present, and environmental conditions. The following sections summarise the major issues, knowledge gaps, and priorities arising from a synthesis across the GLMZs.

Biodiversity issues relating to total grazing pressure

Across all zones

- **Habitats of high biodiversity value** (e.g. restricted, sensitive) are often subjected to a concentration of grazing pressure. This is most notably the case in wetland, riparian and run-on habitats, but also some other habitats in particular regions (e.g. breakaways, monsoon rainforests, restricted vegetation communities in arid ranges). Both stock and feral grazers contribute to this pressure, the relative importance of these pressures varying between zones.
- Predation by cats and/or foxes is a serious issue

In most zones

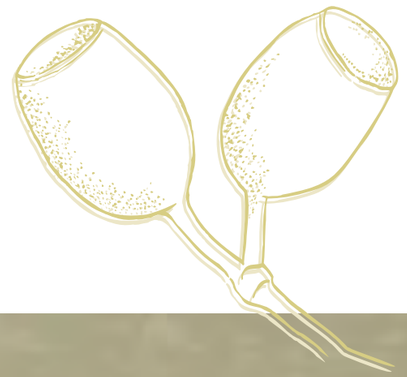
- **Low level of reservation**, or a high bias in reservation.
- **Ubiquity of grazing pressure** across broad landscapes due to the proliferation of water points is a significant issue in many zones. Studies have demonstrated that this results in a significant reduction in biota in a range of rangeland ecosystems.
- **Changes in vegetation structure** are a significant issue in most of the more intensively used zones. This includes clearing, loss of perennial pasture species (grasses and shrubs) or shifts in perennial composition, and vegetation thickening (woody weeds), which creates complex relationships with grazing and fire management.
- **Noxious weeds** have at least the potential for major biodiversity impact. In many cases, weed management is inextricably linked with grazing management, and the removal of grazing does not necessarily produce an improvement in the weed problem.
- **Exotic pasture grasses** have spread to become environmental weeds particularly in the central and northern GLMZs.
- **Changed fire regimes.** The precise nature of the impact on biodiversity of changed fire regimes is usually unclear. Outside the tropical savannas, this is generally related to suppression of fire by pastoral managers, often combined with occasional hot and extensive fires. Again, fire management is usually inextricably linked with grazing management.

In a few zones

- **Widespread land degradation** across entire landscapes due to stock, goats and rabbits.
- **Threatened species management** is primarily an issue in the southern GLMZs, but there are significant declines of at least mammals and birds in the northern GLMZs (and ongoing declines in the southern ones). A range of pressures, including grazing, is implicated in these declines, but the specific causes are unclear.

Knowledge and capacity gaps

- For many of the zones there is a lack of knowledge, understanding and tools required for basic biodiversity management. More basic biodiversity information is required such as knowledge of species distribution, accurate listings of threatened or priority species and ecosystems, as well as an ability to delineate management ‘hotspots’. Effective tools for monitoring biodiversity are also required.
- There is also a lack of understanding of the impact of pastoral use on biodiversity in many zones, particularly the details which may be important for good management, such as the impact:
  - > on riparian / aquatic biodiversity
  - > of environmental weeds, notably pasture grasses
  - > of changed fire regimes
  - > of alternate grazing strategies (e.g. rotational, tactical grazing) and the resulting benefits from biodiversity that ensue from different management strategies



> of meaningful incentives for public-good conservation, notably when conservation values are high, active management is needed, and other sources of income are foregone

– Even where there is a willingness to implement off-reserve conservation actions, there may still be an inadequate understanding of the best ways to approach it (e.g. what is the most appropriate management in ungrazed areas).

– While the impact of feral animals may be recognised, there is often a poor understanding of the location of priority areas for feral control, and/or the most cost-effective means of feral control.

An extension of the above points is that while there may be a 'scientific' understanding of biodiversity values and the impact of total grazing pressure, these issues are generally poorly understood by land managers. There is also a need for recognition of 'other types of knowledge' such as indigenous knowledge of biodiversity and biodiversity management.

To address these information gaps requires information on biodiversity and land management in appropriate and accessible formats appropriate to a diversity of land managers.

Priorities and Investment opportunities

Management for sustainable pastoral production and conservation of biodiversity in the rangelands requires the following top priority investments.

– A set of agreed objectives for biodiversity conservation and management across community and government so that adequate tools (i.e. identification and mapping, grazing management, feral animal control, monitoring etc) can be developed/adapted to meet the needs of those managing for biodiversity.

– The development and effective integration of regional and property NRM plans to provide the framework for TGP management and biodiversity conservation.

One important aspect of developing and integrating regional and property NRM plans is to clarify the expectations placed on individual land managers and to provide realistic, specific (rather than generic) goals.

– The adoption of recommended best management practice (grazing systems) and use of better tools and infrastructure for controlling grazing pressure. This needs to be supported with improved understanding of what is 'best practice' and capacity for landholders to implement it.

– The implementation of off-reserve conservation initiatives, notably:

> protection of 'special areas', particularly through fencing to exclude stock and/or feral animals

> management of water points (or fencing, in some zones) to ensure the retention of significant areas of all major ecosystems that have very low TGP

> the need to provide meaningful incentives for off-reserve conservation initiatives

> improved or continued control of feral grazers – this must be done in a strategic, targeted fashion, and in some zones, be supported by giving land managers better information or access to management technologies

> the need to provide biodiversity and management information to land managers in appropriate, accessible forms is a priority in many regions.

In addition, in most zones there is a need for:

– Further biodiversity inventories particularly for identification of management 'hotspots' – areas of high biodiversity value susceptible to damage by excessive grazing pressure. Priorities need to be determined so that effort is focused where improved management of TGP will have maximum benefit.

– Provision of information and training for land managers to recognise biodiversity hotspots and 'biodiversity-sensitive' management, and incorporate biodiversity conservation into property-level planning, integrated with regional priorities.

– Design and implementation of effective monitoring programs for biodiversity and total grazing pressure to facilitate tracking progress towards conservation and production objectives.

– Experiments on large-scale adaptive management regimes for better grazing management for improved biodiversity outcomes.

In zones with a high percentage of Aboriginal land there is a need for:

- support for local communities in a range of land management actions – one of the most effective ways would be support for Aboriginal ranger groups; and
- resolution to the tension between the control of feral grazers (or uncontrolled stock) and the desire to retain populations for use, either for subsistence or financial return.

Limitations on total grazing pressure management

Options are limited for managing total grazing pressure in the rangelands by a range of factors operating at several levels. The climate is variable and unpredictable; the scale of the enterprise and management unit can be small; feral pest populations can be widespread and hard to control; labour can be limited in availability; and stock and their movements can be difficult to control.

Another strong influence is the economic circumstances for grazing enterprises and the low financial returns that are generally achieved per land unit area in the rangelands. This is worsened by the tendency to view feral species as an economic resource, a 'cash crop' opportunistically harvested – even though these animals can in fact reduce livestock productivity.

In addition to the more general limitations to improvement in the grazing management systems, there are a number of specific barriers to progress. Finding solutions to some of these will result in far better management of rangeland landscapes, and many could be achieved with relatively small budget allocations.

These include factors at the institutional, regional, property and individual level.

Institutional/systemic

- Lack of incentives for land managers to do things that do not add value to the enterprise.
- Lack of formal recognition of landholders who maintain biologically important areas on behalf of society.
- Incorrect use of government processes in dealing with landholders, which signals an attitude of 'control' that engenders a fear of having things 'taken away' rather than co-managed.
- Poor mechanisms for making data on local and regionally significant areas available to land managers.

Regional

- Lack of appreciation of the potential significance of seemingly common habitat types to regional biodiversity maintenance.
- Poor techniques for monitoring the effects of total grazing pressure on elements of biodiversity.
- Inadequate and/or extremely costly techniques for managing total grazing pressure (i.e. controlling animals).

Property and/or Individual

- Misunderstanding of the damaging effect on biodiversity of uncontrolled grazing pressure.
- Misunderstanding of the potentially negative impact of wild stock components of total grazing pressure on economic bottom line of an enterprise.
- Lack of resources and knowledge by land managers to know what to do about managing areas that are obviously biologically special.
- Lack of knowledge of the biodiversity benefits of alternative grazing systems (e.g. rotational grazing), which allows pastoralists to dismiss research results in set-stocked systems.




Grazing land management zones

Zone 1. Arnhem Land and Tiwi Islands

Zone characteristics

Hot climate with seasonal monsoon rainfall; eucalypt open forests and woodlands and other tropical savanna vegetation.

Almost entirely Aboriginal freehold land with very little pastoral activity; grazing pressure mainly from feral herbivores and uncontrolled stock; mostly natural water sources.

Biodiversity Issues

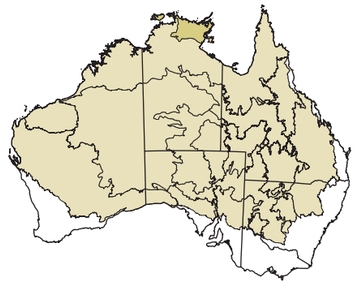
Most ecosystems are represented through Kakadu and Garig Gunak Barlu national parks. There are high levels of richness of both plants and animals. Subregions have significant number of threatened species of birds, reptiles and plants.

Threatening processes include: changed fire regimes which impact on some vegetation types; invasion by weeds, especially Mimosa pigra; feral grazing animals; feral animals such as cane toads and cats; and clearing for forestry plantations.

Managing for biodiversity

Knowledge required includes: impact of feral grazers on biodiversity; cost benefit analysis for management of feral grazers; effective management strategies that take account of social, economic and logistic constraints.

Opportunities to invest: developing strategies for effective feral animals management that takes account of ecological, economic, social and logistic issues and constraints; development of meaningful incentives to reduce feral animal populations; continued and expanded support for building capacity of Aboriginal ranger groups and land managers generally.



Zone 2. Tropical Savannas

Zone characteristics

Tropical monsoonal climate; tropical eucalypt, acacia and melaleuca woodlands with grassy understorey.

Low human population densities plus low level of land management capability; grazing of cattle on very large leasehold properties with relatively low densities; significant areas of Aboriginal land and relatively undeveloped pastoral land; variable control of feral animals depending on degree of pastoral development.

Biodiversity Issues

There are: a few threatened ecosystems in Cape York Peninsula, Northern Kimberley, Mt Isa Inlier, and Gulf Plains; few listed threatened species although some threatened bird and/or plant species in some bioregions; evidence of decline in granivorous birds and medium sized mammals; local extinction of mammals in some regions of the Kimberleys; native woody weeds are thickening in some areas and encroaching on others.

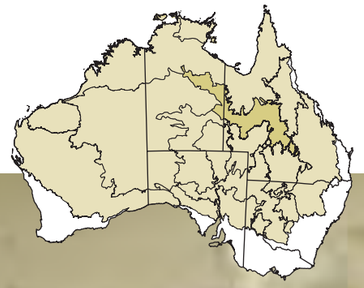
Threats to biodiversity include: changed fire regions; serious environmental weeds (including spread of exotic pasture species to non-pastoral areas); feral animals including grazers; land clearing and habitat fragmentation; proliferation of artificial water sources.

Managing for biodiversity

More than in other zones there is inadequate knowledge of biodiversity leading to difficulty in understanding management requirement or impacts of management regimes. Many land managers have poor knowledge of, and capacity to implement, biodiversity management.

Knowledge required: baseline biodiversity inventory; adequate and consistent listing and prioritisation for management of threatened species; robust data on macropods and feral animals; understanding of the impact of recent and ongoing proliferation of artificial water sources.

Opportunities to invest: control of feral animals and weeds in identified strategic areas; development and implementation of a planning framework and integration of planning at a regional and property scale; resourcing for management including provision of meaningful incentives for conservation.



Zone 3. Mitchell Grass Downs

Zone characteristics

Cracking-clay plains or undulating downs with Mitchell grassland or acacia open woodlands; semi-arid and arid climate with summer rainfall; relatively low habitat diversity; a number of significant wetlands.

Grazing of cattle on very large lease holdings, or grazing of cattle and sheep on medium-sized properties on freehold land (in the east and south-east); relatively high total grazing pressure; high level of infrastructure development and high density of artificial water points; in Queensland zone three large macropod species are commercially harvested.

Biodiversity Issues

A low level of reservation in this zone with some ecosystems listed as threatened with two listed as endangered (mound springs and brigalow / gidgee low woodland); relatively few listed threatened species but ongoing decline noted in a number of taxa, particularly granivorous birds. The long history of research has focused on pasture and grazing rather than biodiversity issues.

Threats to biodiversity: widespread pastoral use with subsequent high occurrence of water points; concentration of grazing pressure on sensitive and restricted ecosystems especially natural water sources; widespread environmental weeds (prickly acacia, mesquite and parkinsonina); feral predators and herbivores; clearing of native vegetation and replacement of native pastures with exotic grasses.

Managing for biodiversity

Knowledge required: broad scale and systematic inventories of the biodiversity (and TGP impact on biodiversity) of the central and southeast regions of the Mitchell grass downs; guidelines for management of wetlands; guidelines on use of fire in pastoral management; guidelines for maintaining biodiversity values through pastoral intensification.

Opportunities to invest: Biodiversity inventories in central and eastern parts of the zone; research on the impact of grazing pressure and of proliferation of water points on biodiversity; regional and property management plans that implement effective off-reserve conservation; incentives to limit proliferation of water points and implement improved off reserve conservation; strategic weed control to prevent further spread of critical species; improved reservation in most of the zone.

Zone 4. Einasleigh and Desert Uplands, North Queensland

Zone characteristics

A diverse mosaic of mainly hilly tropical eucalypt woodlands, with a wide range of altitudes and climate.

Small properties grazing beef and sometimes sheep at moderate to high densities with TGP following clearing and water development; most grazing properties are fenced but this varies across the zone; stock densities are determined by seasons and the individual mix of land types within paddocks; main problem animals are dingoes and pigs.

Biodiversity Issues

A large number of diverse ecosystems, but many are vulnerable because of their small size, and others are threatened by current land use.

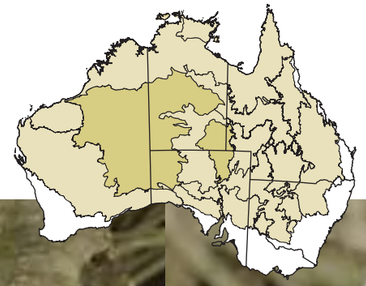
Threats to biodiversity: Widespread land degradation caused by unsustainable grazing pressure particularly for smallholdings; moderate levels of clearing native woody vegetation to replace with non-native pasture e.g. buffel grass.

Infestations of environmental weeds in restricted habitat types; changes in fire regimes (fire suppression to protect pastures coupled with infrequent but extensive wildfires); widespread woody thickening; clearing for horticulture and cropping in more humid parts; impact of mining, particularly clearing for access and contamination by tailings.

Managing for biodiversity

Knowledge required: basic inventory of biodiversity; monitoring of woody thickening and its impact on biodiversity; impact of various land management regimes on biodiversity; accurate lists of threatened species; density of feral or non stock grazers

Opportunities to invest: Several programs underway (Desert Uplands building up program for planned intensification, grant schemes to fence sensitive areas, systematic surveys of Northern Gulf region); needs effective tools for monitoring biodiversity.



Zone 5: Arid deserts

Zone characteristics

Hot, very dry climate; hummock grasslands (Triodia spp.) with a mixture of acacia woodlands and shrublands, chenopod shrublands and eucalypt woodlands.

Low human density; mostly Aboriginal land and Crown; there are some areas of extensive pastoralism and conservation but overall limited areas are used for pastoral purposes; moderate level of reservation although highly variable between subregions; tourism is important in some subregions; main problem animals are camels and rabbits.

Biodiversity Issues

Few ecosystems are protected in reserves, but few are listed as threatened; flora in some regions is highly endemic (e.g. Central Ranges, parts of MacDonnell Ranges, Great Victoria and Gibson deserts); several threatened bird, vascular plant and mammal species; feral animals have caused local mammal extinctions.

Threats to biodiversity: changed fire regimes, feral camels, and, in some land systems, rabbits; in small pastoral areas there is overgrazing by domestic stock; potential tension between reducing feral cattle and camel numbers and retaining useful densities for subsistence and economic use by Aboriginal people; localised declines in some mammal and reptile species due to hunting of some species near settlements.

Managing for biodiversity

Knowledge required: Broad look at feral animal control programs including priority areas, cost benefit analyses involving ecological, economic and social considerations, and effective implementation; optimum fire regimes for biodiversity management; landscape-scale changes to fire regimes.

Opportunities to invest: Best opportunities for investment are through Aboriginal communities and Indigenous Protected Area agreements, specifically by engaging Aboriginal communities in land management and monitoring for biodiversity through ranger groups; resourcing Aboriginal people for land management; adaptive management experiments on landscape-scale fire regimes.

Zone 6: Central cattle grazing

Zone characteristics

Hot, very dry climate; mixture of acacia woodlands, chenopod shrublands, spinifex and tussock grasslands.

Extensive grazing of cattle at relatively low density on very large leasehold properties; proliferation of artificial water sources means that feed, not water, is the limiting resource; horse eradication campaign and rabbits actively controlled.

Biodiversity Issues

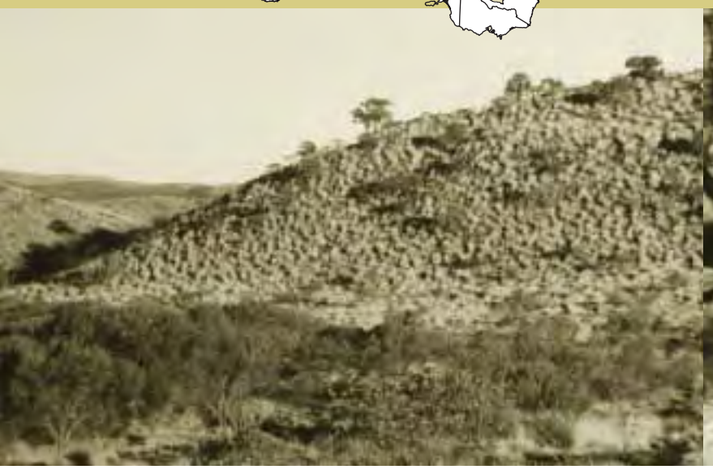
Some threatened ecosystems and some threatened plants and animals especially in Sturt Stony Desert and Diamantina Plains; substantial loss of biodiversity since European settlement, especially extinction of medium sized mammals; overgrazing has led to a decline or regional extinction of birds and general decline in all studied taxa (plants, birds, reptile, ants).

Threats to biodiversity: overgrazing by stock especially in restricted and sensitive habitats; proliferation of water points leading to grazing pressure becoming more extensive across the landscape; grazing and predation by feral animals; changes in fire regime; weed infestation including exotic pasture grasses.

Managing for biodiversity

Knowledge required: the impact of alternate grazing systems (e.g. rotational grazing) on biodiversity leading to alternative land use options for production and conservation; the impact of camels on native biota and diversity of riparian and aquatic areas; impact on native flora and fauna of buffel grass invasions of habitats.

Opportunities to invest: Management of natural waterholes by fencing and piping water to stock troughs. Balancing representation of different ecosystem types by acquiring under-represented habitats in a formal or off-reserve conservation system.



Zone 7. Pilbara: Extensive cattle grazing in tussock and hummock grasslands

Zone characteristics

Hot, arid climate; hummock grasslands on inland ranges and plateaus and acacia woodlands and tussock grasslands on plains.

Extensive grazing of cattle on very large leases; large areas of unallocated Crown land; significant areas under Aboriginal ownership and in conservation reserves; human population is concentrated in large towns serving the mining sector.

Biodiversity Issues

Poor representation of more productive habitat types in reserves; concentration of grazing pressure in some ecosystems; regional extinction of marsupial and rodent species; decline in some medium-sized mammal species; very high mesquite density in localised areas.

Threats to biodiversity: uncontrolled cattle grazing at natural water points; main feral animals are foxes and cats; changed fire regimes; introduced *Cenchrus* species grasses (buffel grass and birdwood grass) now widespread and having substantial impact on alluvial/sandy parts of the region.

Managing for biodiversity

Knowledge required: general understanding of biodiversity including the distributions and abundance of species, identification and mapping of ecosystem types particularly of special places such as restricted ecosystems and hotspots; the institutional, regional and technical capacity for monitoring and measuring biodiversity; off reserve conservation and its potential for biodiversity conservation and also how to foster its uptake; impact of different grazing systems especially those involving ‘resting’; buffel grass and its impact on biodiversity and value for grazing; fire regimes on biodiversity.

Opportunities to invest: Management regimes for identified special areas; improved grazing management systems with extensive spelling of paddocks; better control of watering points including restriction of grazing access; better representation of productive areas in reserves; continued feral animal control.

Zone 8. Southern Australia sheep and cattle grazing in shrublands

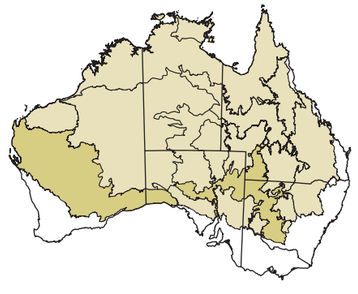
Zone characteristics

This zone occurs in all the rangeland states and is highly variable. It contains arid and semi-arid areas, characterised by a hot, dry climate in northern areas and a more moderate climate in the south. Rainfall is winter-dominated throughout much of the west, but is bimodal or evenly distributed in the south and east of the zone. Problem animals are goats, kangaroos and rabbits. Vegetation is predominantly chenopod and acacia shrublands and woodlands, but there are many vegetation types.

This zone is dominated by pastoral use with many areas settled early in the pastoral history of each state with associated considerable infrastructure development. Some areas have pastoral stations managed by corporations, however generally stations are managed by families or individuals. Pastoral land is managed with continuous or set stocking. Land degradation and resulting loss of biodiversity has been influenced by drought periods. Main problem animals are kangaroos, rabbits and goats.

Biodiversity Issues

This zone is so diverse that almost all of the biodiversity issues found in other zones can be found here. Much of the zone was settled early and degradation was evident by the end of the 19th century. A few areas within this zone came under pastoral land use relatively recently, which means that subsequent pressure on biodiversity has been less intense as large areas remain water remote and Total Grazing Pressures have been kept relatively low. Few identified ecosystems are in the reserve network and there is a high number of threatened bird, mammal and vascular plant species. Natural water sources are few so are important for biodiversity conservation.






Threats to biodiversity: Low capacity of land managers to manage for biodiversity due to lack of financial resources and poor availability of information and management tools; restricted habitats tend to be fragmented and so difficult to manage more broadly; management strategies that include excessive stocking and don't include paddock spelling; widespread degradation through sheet and gully erosion and loss of perennial ground cover; damage to riparian and water zones which lead them to dry up relatively quickly; uncontrolled grazing by feral animals and macropods; spread of exotic pasture species and woody weeds; changed fire regimes; reluctance to spell paddocks because of belief that kangaroos would eat out paddocks anyway; semi-legitimate stock status of feral goats used as 'cash crop'.

Managing for biodiversity

This zone is so diverse that almost all of the knowledge gaps for other zones also exist here. Knowledge required: general information on biodiversity; specific impact of grazing practices on biodiversity; systematic identification and mapping of restricted habitats and special areas as well as those that should go into the reserve system; control of feral animals, especially cats and foxes; relationship between artificial water points and biodiversity.

Opportunities to invest: regional environmental management strategies that extend across the zone as partnerships between government, rural and indigenous communities; increase the capacity and tools for biodiversity management; acquisition of areas of high conservation value for addition to the reserve system; improved feral animal control; increase markets for kangaroo products; installation of traps at water points; incentives to relocate watering points in less sensitive habitats; alternative land use for areas invaded by woody weed species.

Zone 9. Extensive sheep grazing

Zone characteristics

Warm to hot, semi-arid to arid climate; a mixture of chenopod shrublands, acacia (mainly mulga and myall) woodlands, and eucalypt and mallee woodlands.

Extensive sheep and some cattle pastoralism at low densities on small, mostly leasehold properties. Human population density is low. Grazing occurs on a year round, continuous basis; stock numbers set by lease conditions and modified in poor seasons.

Biodiversity Issues

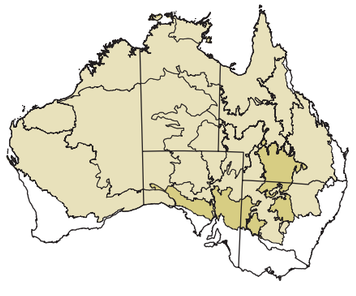
A number of subregions of high biodiversity value; relatively few ecosystems listed as threatened in most parts of the zone; some threatened vascular plant species, 29 threatened bird species and 20 threatened mammal species

Threats to biodiversity: feral animals specifically goats, rabbits and pigs; increased density and spread of woody plants e.g. native shrubs, including species of Eremophila, Dodonaea, Senna and Acacia, especially in New South Wales and Queensland; changed fire regimes; overgrazing by domestic stock, particularly in periods of drought.

Managing for biodiversity

Knowledge required: effect of grazing on biodiversity; density of feral animals; broad and fine-scale tools for managing biodiversity; relationship between artificial water points and biodiversity.

Opportunities for investment: options for grazing management that are more appropriate than set stocking and better for conservation of biodiversity; improved control of feral animals including trap yards for feral goats; fencing of sensitive areas and degraded areas; reducing water points.






Zone 10: Highly modified rangelands

Zone characteristics

High fertility soils, hot to warm seasonal rainfall and large areas of cleared tree, shrub or grassland communities for dryland and irrigated cropping and comparatively intensive grazing systems. It also includes lower fertility soils supporting eucalypt forests and softwood scrub used primarily for extensive grazing.

This zone represents a transition between coastal and cropping areas in the east and the 'true' (less modified) rangelands to the west. A diverse region has been included in the zone because many areas are being converted from rangelands. Management involves a variety of issues that are dominated by land use change rather than TGP.

Most of the zone is under pastoral and agricultural use; low level of conservation across the zone; population density is high with few cities, but several large regional centres; grazing of livestock is on a year round set basis with both feed substitutions and supplementation; wide scale soil loss of vegetation degradation in some areas; problem animals include dingoes.

Biodiversity Issues

Clearing of brigalow and softwood scrub areas has led to loss of habitat and fragmentation of the landscape and also affected ground-dwelling species; several regional ecosystems endangered and many 'of concern', mostly because of the direct impact of clearing and consequent fragmentation; broad-scale declines of many species of plants and animals across the region including some species' distributions contracting to very small and isolated populations.

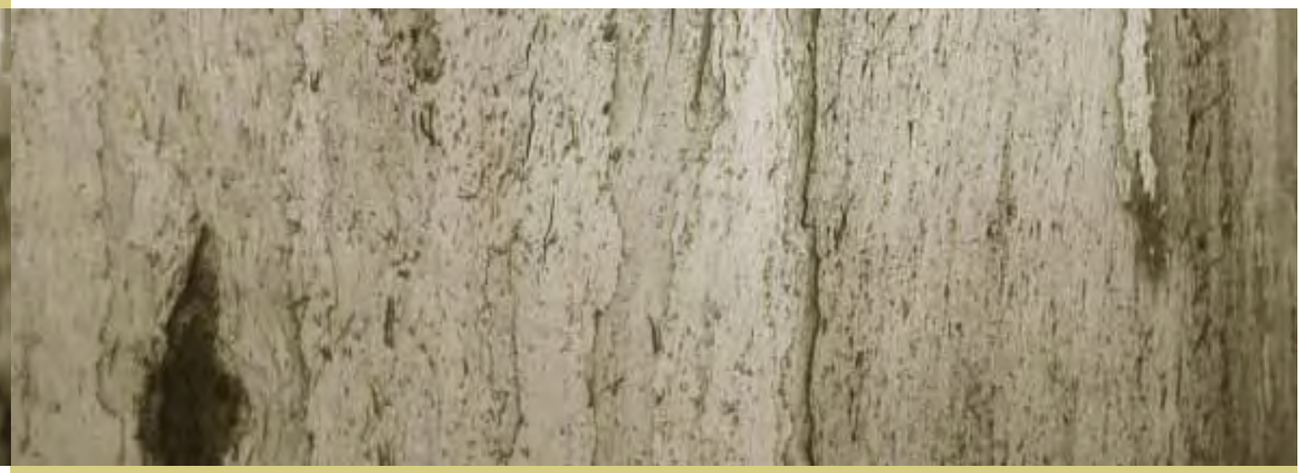
Threats to biodiversity: introduction of exotic species, particularly exotic grasses relate to the loss of native vegetation and the potential loss of key ecosystem processes and biodiversity values; control of grasses is both difficult and controversial in a landscape dominated by high production grazing and cropping systems; changed fire regimes leading to changed vegetation structure; localised grazing threatens remnant vegetation and special mound-like springs in the area.

Managing for biodiversity

Knowledge required: long term impacts of landscape fragmentation and diet switching by native species; review of the current rare and threatened species lists; flexible vegetation management policies (e.g. the introduction of vegetation-clearing trading rights); economically viable thinning within thickened vegetation; potential for current vegetation management policies to protect rare and threatened species and encourage a return to functional ecosystems.

Opportunities to invest: most immediate is the protection of mound springs and small fragmented areas of remnant vegetation; control of weed species, especially those that have impacts at multiple levels (economic, environmental, human health), such as parthenium weed; continued protection of isolated colonies of mammals (e.g. the northern hairy-nosed wombat); re-establishing connectivity across the landscape based on sound science and compensation/incentive packages; incentives for collaboration across state boundaries.

Further information



Reference

See the full report for a comprehensive list of references.

Fisher, A., Hunt, L., James, C., Landsberg, J., Phelps, D., Smyth, A., Watson, I. 2004. Review of total grazing pressure management issues and priorities for biodiversity conservation in rangelands: A resource to aid NRM planning. Desert Knowledge CRC Project Report No. 3 (August 2004); Desert Knowledge CRC and Tropical Savannas Management CRC, Alice Springs.

Useful web links

The Australian Rangeland Society
http://www.austrangesoc.com.au

CSIRO Centre for Arid Zone Research
http://www.cazr.csiro.au

Department of the Environment and Heritage – Managing rangelands
http://www.deh.gov.au/land/management/rangelands/index.html

Natural Heritage Trust
http://www.nht.gov.au

Tropical Savannas CRC
http://savanna.ntu.edu.au

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