Department of Environment and Resource Management

Managing grazing lands in Queensland

June 2011

Tomorrow's Queensland: strong, green, smart, healthy and fair

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Summary

This publication is a guide to good management practices for grazing lands in Queensland. Its primary purpose is to assist lessees of rural leasehold land to which the Delbessie Agreement applies. The Delbessie Agreement is a framework of legislation, policies and guidelines supporting the environmentally sustainable and productive use of rural leasehold land. This guide will also assist graziers with obligations under the Reef Protection Policy.

There is no set formula for managing the pastures across such a large and diverse area as the grazing lands of Queensland, therefore careful consideration needs to be given to how pastures, trees, soils, grazing animals and climate all interact. This guide contains summarised information from the many sources referred to in this guide. If more specific information is required about a particular topic, it is recommended that these sources be consulted.

Experienced graziers will already be well aware of much of the information provided in this publication. However a number of fundamental issues have been covered for the benefit of other readers who have an interest in the management of the vast area of grazing lands in Queensland.

The major management issue in grazing systems is managing stock numbers to match the current and expected seasonal conditions. Graziers need to make regular decisions about how many animals they should run on a piece of land and the impact of feral and native herbivores. Sustainable management practices have both environmental and economic benefits which help to ensure long-term profit and viability.

There are a number of legislative acts that relate to grazing lands. This guide relates primarily to the *Land Act 1994* and *Great Barrier Reef Amendment Act 2009*. *The Great Barrier Reef Amendment Act 2009* introduced regulations to improve the quality of water entering the Great Barrier Reef lagoon by reducing the levels of farm chemicals, fertiliser and sediment in river outflows.

The *Land Act 1994* states that leaseholders have a duty of care for the land, to take all reasonable steps to:

- maintain pastures dominated by perennial and productive species
- maintain native grassland free of encroachment from woody vegetation
- conserve soil
- avoid causing or contributing to land salinity that reduces productivity or damages any other land
- conserve biodiversity
- conserve water resources
- protect riparian vegetation
- manage any declared pests.

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Introduction

More than 80 per cent of Queensland's total area of 1 727 000 square kilometres is used for grazing on lands, extending from humid tropical areas to arid western rangelands.

Most extensive grazing practices are carried out on native pastures. Although there are significant areas of introduced pastures, they would occupy less than 10 per cent of the total pasture area of Queensland. Inputs to most grazing lands are minimal with virtually no use of fertilisers or irrigation—herbicides are used to overcome exotic weed invasion while pesticides are used to control pests such as locusts.

There are a number of inherent challenges associated with the management of pastures in Queensland's grazing lands, including highly variable weather conditions, variable commodity prices and property sizes that are sometimes too small to make a living from a grazing enterprise. These pressures can lead to excessive stocking rates—the major cause of land degradation in our grazing lands. The challenge for graziers is to be able to match their management actions to the prevailing conditions while still generating an adequate income.

Climate

Rainfall variability is a key feature of the Queensland climate with the rainfall decreasing and becoming more variable from the coast to inland. Annual average rainfall totals vary from 2000 to 4000 millimetres on the wet tropical coast to 150 to 250 millimetres in the south-west arid zone.

In the northern areas of the state, a high proportion of the rain falls in the summer months. South of the Tropic of Capricorn, winter rainfall becomes an important part of the annual total, rising to about 40 per cent along the southern border of the state.

Rainfall averages are misleading, because they seem to imply what is normal and what can be expected. Figure 1 shows rainfall totals for Jericho in Central Queensland from 1890 to 2010. There are more years with below average rainfall than above average rainfall. The median, the middle point with half the recorded values above it and half below it, is more useful as it discounts the extremes. The average is generally higher than the median, because it is often skewed upwards by occasional very high recordings.

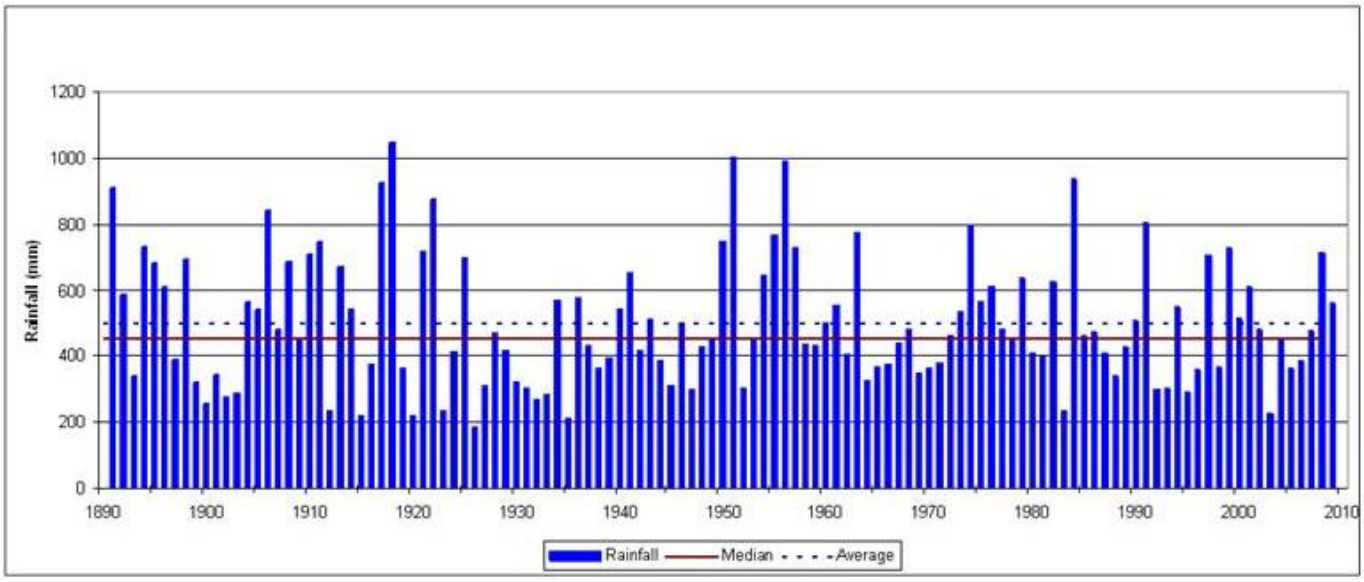

Figure 1 Annual rainfall totals for Jericho, Central Queensland

The total amount of rainfall received in any year or season does not necessarily give an indication of how good that year may or may not have been. This is because a high proportion of the rainfall may have occurred in just a few days, or there may have been many small falls which were lost due to evaporation.

High rainfall over an extended period in a summer season can produce very high pasture growth. Although a great supply of feed is generated, the nutrient value of the feed may be poor, reducing the benefit to livestock. Supplementing may be required to improve the quality of the feed. An outcome of the high pasture yields in these particular seasons is the need to manage land appropriately for fires in the dry season as well as weeds and regrowth.

High temperatures affect pasture growth and stock health. Much of the state experiences daily mean maxima of greater than 32 degrees Celsius in January. The north-west and western parts of the state have the highest temperatures. Heatwaves can be severe, especially in dry years. Frosts are a regular feature of the inland environment in winter in southern areas of the state and cause rapid deterioration of above ground parts of many pasture species.

Future scenarios related to climate change may make the task of managing grazing lands even more complex. Increased temperature variations (both maxima and minima), more intense rainfall events but reduced rainfall overall, and rises in evaporation rates are likely to have a negative impact on grazing animals, pasture production and the health of our grazing landscapes. Results from experiments where plants were subjected to increased atmospheric carbon dioxide levels showed there are likely to be some ecological changes in grazing lands, for example giving advantage to woody vegetation over grasses.

The future impact of climate change on El Niño (i.e. a weather phenomenon that occurs in the eastern and central equatorial Pacific Ocean, where the region's winds weaken and sea temperatures become warmer) is still uncertain. However, the proportion of El Niño compared to La Niña (i.e. a cooling of the equatorial waters in the Pacific Ocean causing chaotic weather changes worldwide) events has increased over recent decades, causing more frequent and prolonged periods of drought. More information on the above topic is available on the Queensland Office of Climate Change website at <www.climatechange.qld.gov.au>.

The following CSIRO publications also provide more information. They can be found by typing the titles into a web search engine:

- Climate change impacts on northern Australian rangeland livestock carrying capacity: a review of challenges
- The climate change risk management matrix for the grazing industry of northern Australia.

Land types in Queensland

The CD_ROM *Land types of Queensland* provides information about more than 230 land types from 16 Grazing land management (GLM) regions in Queensland. Land type descriptions include landform, woody vegetation, expected pasture composition (including suitable sown pastures and introduced weeds), soil characteristics, biodiversity features and the regional ecosystems that they occur in. Limitations of each land type are provided together with land and grazing management recommendations. A copy of the CD-ROM can be obtained from the Department of Employment Economic Development and Innovation (DEEDI) by phoning 13 25 23 or via the website <www.deedi.qld.gov.au>.

The land types represented on the CD-ROM vary from better quality clay soils, fertile loams and friable earths that are representative of about one-third of Queensland, to the less fertile texture contrast soils, massive earths and sands representing two-thirds of the state. These less fertile soils are naturally low in organic matter and some plant nutrients.

Land and pasture degradation

Land degradation has had an enormous impact on the productivity and biodiversity of some of the state's grazing lands. Forms of degradation include:

- soil erosion by both water and wind
- invasion by exotic weeds including succulents, vines and woody species
- thickening of native species
- reduction in pasture quality through selective grazing or overgrazing
- salinity.

The introduction of cattle with a greater ability to forage under adverse conditions, combined with the use of drought supplements, has had a negative affect on land condition. That is, when a drought breaks increased numbers of stock feed on the growing grasses.

Erosion by water begins when raindrops fall on bare soil. Raindrop splash and the dislodgement of soil particles cause the surface to seal, and runoff begins. Lighter textured, bare soil surfaces are also susceptible to wind erosion as winds move much faster over a soil surface without vegetative cover. If all of the topsoil is removed, the land is referred to as being 'scalded', with the term 'clay pan' also used to describe such land.

Erosion reduces productivity by dislodging topsoils that are often very shallow and contain the majority of available nutrients and organic matter in the soil profile. In arid, low nutrient landscapes, many of the available nutrients can be lost when dust particles are lifted by a dust storm. Eroded soils are subject to more extreme temperature ranges and have lower porosity and microbial activity.

A downward spiral of degradation begins when high runoff rates result in reduced entry of water into the soil causing less plant growth. Land degradation can have a significant affect on natural biodiversity by reducing habitat quality for most living things—whether above or below ground level, or in water.

Nutrients are made available to pastures via the process of mineralisation and the breakdown of organic matter. Fertility decline, including a decline in soil carbon levels in pasture lands is a common occurrence especially where land is subject to continued heavy grazing pressure and erosion.

Virtually no fertilisers have ever been used in the rangelands of Queensland because their use is not considered to be economic. In many areas a positive response to fertilisers would be likely in good seasons when soil moisture is not limiting plant growth. However, the high cost of purchasing and distributing fertiliser in areas with an unpredictable climate generally rules out any opportunity for its use.

Once land condition deteriorates, its ability to grow useful pasture declines and it becomes more susceptible to extreme weather events. In GLM workshops graziers are provided with information to help them classify land into four different conditions that vary from condition A to condition D. Condition A has a good coverage of desirable pastures species, few weeds, good soil condition and no problems from woodland thickening. Condition D land can have problems such as a general lack of desirable pastures, severe erosion resulting in a hostile environment for plant growth and thickets of woody plants over most of the area

Table 1 provides an example for the *Poplar box with sandalwood understorey* land type in the Maranoa Balonne GLM Region. For the same land type, land in very good condition (GLM Condition A) produces more pasture and has a higher safe carrying capacity than land that has been subjected to significant degradation (GLM Condition C).

Table 1 How land condition affects safe carrying capacity

Data applicable to the *Poplar box with sandalwood understorey* land type in the Maranoa Balonne GLM Region	GLM condition A	GLM condition C
Average dry matter production kg/ha/year (as calculated by the *GRASP** Model)	3000	1350
Average amount of pasture available assuming a 20% utilisation rate (kg)	600	270
Pasture consumed by a 450 kg steer in one year (kg)	3650	3650
Number of hectares required for one 450 kg steer	6.1	13.5
Safe carrying capacity for a 500 ha paddock (450 kg steers)	82	37

**GRASP* is a pasture growth model for tropical and sub-tropical grasses which can be calibrated for a broad range of pasture communities, soil types and climatic conditions.

Sustainable stocking rates and favourable seasons may, over time, allow land to improve its condition and to store increased levels of soil carbon. However, land in condition D will, in most cases, have lost all of its topsoil and preferred grass species. It may be incapable of being brought back to a better land condition.

Gully erosion occurs in drainage lines or other areas where runoff has concentrated. It may occur as an isolated event or over large areas, especially where there are soils with highly erodible subsoil.

Stream bank erosion is a common problem in most Queensland river systems. River frontages are particularly subject to erosion in areas where stock congregate.

The movement of sediment, nutrients and organic matter may adversely affect water quality in streams and the coastal environment. Soils with highly erodible, dispersible sub-soils contribute significantly to turbid runoff. Dispersible soils are structurally unstable and when exposed to water readily break down into their constituent particles of sand, silt and clay. Individual clay particles are very fine and remain suspended in water rather than settling out. This leads to a turbid or muddy appearance in dams and watercourses.

Pasture management

The Department of Environment and Resource Management's (DERM) publication, Guidelines for Determining Lease Land Condition, describes how pastures are evaluated as part of the lease land condition assessment for the Delbessie Agreement. The indicators assessed include the relative proportion and density of preferred, intermediate and non-preferred species as well as their health.

Land type information sheets list the species that occur under the categories 'preferred', 'intermediate' and 'non-preferred'. The best pasture species are classified as 'preferred' because they generally have three critical characteristics:

- perennial (long lived and generally have extensive root systems, which can extract more nutrients and water from the soil to produce more growth than annuals)
- palatable (livestock will eat them)
- productive (provides sufficient growth and nutrition for good livestock production).

Some annual species also have a 'preferred' status in land types that are naturally dominated by annual species.

'Preferred' pasture species such as kangaroo grass or Queensland blue grass will gradually be replaced by 'non-preferred' grasses when they are subjected to heavy grazing pressure. Non preferred grasses such as wire grass species are generally unpalatable and unproductive and some species can be poisonous to stock.

The following management options should be considered for keeping land in good condition with a high proportion and density (and thus good ground cover) of preferred species:

- manage total grazing pressure
- use appropriate utilisation rates
- implement appropriately timed spelling and herd management strategies
- monitor pasture composition
- use of hay, supplements, fodder trees and shrubs in a strategic manner
- manage the tree/grass balance to avoid woodland thickening
- implement forage budgeting strategies
- use climate and seasonal forecasting resources
- maintain native grassland free of encroachment from woody vegetation
- use appropriate fire management practices
- fence according to land types
- manage the distance stock have to travel to water.

Managing total grazing pressure

Managing total grazing pressure is the key to maintaining pastures dominated by palatable, perennial and productive species. Native animals such as kangaroos and feral pests such as rabbits, can greatly increase grazing pressure and compete with livestock for feed. In many areas, kangaroo numbers have increased as more permanent watering points have been established for livestock. Rabbits have traditionally thrived in land types which have softer soil types, such as soft mulga. As well as adding to grazing pressure, rabbits compete with many native animals, like the burrowing bettong and bilby.

Pastures that have been destocked for regeneration (e.g. after a fire) can be a prime target for kangaroos and feral pests. Closing down watering points in these paddocks may help to reduce their numbers, however, some evidence shows that moisture in plants alone may sustain kangaroos for a reasonable period. In stocked paddocks, fencing off reticulated water with swing or trap gates may encourage kangaroos to graze elsewhere.

Kangaroo numbers can also be managed by licensed harvesting or culling. This can be especially useful at the end of the summer growing season when stock numbers need to be managed going into winter. Some graziers are attempting to fence their properties to exclude kangaroos.

Using appropriate pasture utilisation rates

The amount of annual pasture growth (from July to June) that is consumed by grazing animals is referred to as the utilisation rate. The safe utilisation rate for land types can vary from around five per cent to 30 per cent depending on land type and climate. In very arid environments or degraded land, safe utilisation rates may be less than five per cent.

High rates of utilisation may seem more profitable in the short term but will cause degradation of pasture bases if continued for a period of time. Heavy grazing can have the following impacts:

- tussock size is reduced—fewer tillers are produced, the root system contracts, less seed is set and the plant may die—these effects are most severe on the pasture species that stock prefer
- if ground cover is poor, drought breaking rainfall may be lost as run-off which could erode the soil and delay the recovery from drought
- less preferred species and weeds (i.e. herbaceous and woody) invade.

Low utilisation rates may appear to 'waste' feed but they allow the pasture to:

- recover following periods of stress
- remain vigorous
- seed
- add ground cover
- help maintain soil health.

Over time, the condition of land can improve with low utilisation rates.

Implement appropriately-timed spelling and herd management strategies

Most damage from grazing occurs when grass is shooting from its reserves after a dormant period—in spring or after a drought or fire. Grazing during flowering and seed set will reduce seed reserves. Overgrazing at this time allows non-preferred species to gain a foothold in the pasture.

The length of time to destock depends on:

- the condition and amount of pasture
- rainfall during the growing season
- the reason for spelling.

Complete rest for as little as three to six weeks during the early to mid growing season can have long term benefits for pastures. It gives highly desirable but slow to establish native species, such as kangaroo grass and forest bluegrass, a chance to rejuvenate their crowns, restore root energy reserves and set seed. It also enables recruitment and establishment of these species, ensuring their survival.

Spelling for one to two months during the peak growing season will allow the palatable grasses to set seed; spelling for four to eight months allows fuel to accumulate and persist for a spring fire to control woody weeds.

Partial destocking of a paddock may not be effective if the remaining stock continue to concentrate on their preferred species.

It is most practical to spell in a wet year when there is abundant pasture. Prior warning of possible wet conditions can be obtained by checking the Southern Oscillation Index (SOI) and outputs from the *AussieGRASS* model (refer to the section titled 'Utilising climate and seasonal forecasting resources').

Types of grazing systems

There are many different types of grazing management systems. Matching stocking rates to carrying capacity is critical to the success of any of these systems. Examples of the systems include:

Continuous stocking—under continuous stocking, pastures rarely, if ever, receive a spell from grazing. It is a low input system commonly used in extensive grazing lands and provides acceptable results where stocking rates are sustainable. Stock can be very selective and preferred species can come under pressure using this system, especially under high stocking rates.

Rotational grazing—where a period of grazing is followed by a period of rest which, depending on pasture growth, may be days, weeks or months. Rotation periods can be based on management objectives for specific paddocks and will depend on seasonal conditions.

Time controlled or cell grazing—a form of rotational grazing where many relatively small paddocks enable a short graze period with heavy stocking rates followed by a long recovery period. It requires significant outlay to provide additional fencing and watering points and requires a higher level of management than other options.

Generally animals make the best weight gains when able to select their diet over a large area under continuous light grazing. Weight gains can be lower when a lack of choice means they eat more mature and less nutritious herbage. This can occur when good feed is in short supply during a dry time and before being moved to the next sub-division in a cell grazing system. However, under both of these scenarios the live weight gain per hectare can be greater when stock numbers are higher.

It can be difficult to make specific comparisons between different grazing systems. For example, some of the benefits accrued to cell grazing, may be due to the overall higher standard of management which cell graziers are likely to apply to all aspects of running a grazing property.

Strategic use of hay, supplements, fodder trees and shrubs

Hay and supplements such as urea, molasses, and cotton seed need to be used with care. They should only be used to maintain or improve the condition of the animals that remain after numbers have been adjusted to the amount of feed available. Incorrect use of supplements can contribute to high grazing pressures, particularly during and straight after drought. This results in damage to pastures and land degradation.

Phosphorus mineral supplement may have to be fed to stock, especially breeders, when the soil has very low phosphorus content. The greatest need is when stock graze on green feed during summer.

Fodder trees and shrubs, particularly mulga, are an important natural resource which supports sheep and cattle production over large areas of south-western Queensland. Under the *Vegetation Management Act 1999*, landholders may apply for a permit to harvest fodder. This permit is valid for five years allowing landholders to plan ahead and apply in advance for their potential fodder needs.

More information on fodder harvesting is available at the Department of Environment and Resource Management (DERM) website <www.derm.qld.gov.au> (search for the term 'fodder harvesting') or by contacting a DERM business centre.

Case study—use of mulga as a feed source

The mulga tree or shrub is a native legume found extensively in south-west Queensland. It has been used as a reserve food source when fodder resources are scarce. However, lopping and pushing mulga can allow property managers to keep too many animals during droughts, resulting in excessive grazing pressure on the limited pasture. Any pasture plants that start to grow after rain will be subject to high grazing pressure and land condition will decline.

A lack of fire and vigorous pasture growth has allowed mulga regrowth and unpalatable shrubs to become so thick that some land now has minimal grazing value, except for browsing purposes. As the density of trees and shrubs increases, grass production declines.

The key to managing mulga and pasture together is to maintain a healthy grassy pasture. In droughts, the area over which mulga is harvested should be limited. At other times, mulga should be used as a supplement to, not a replacement for, perennial pastures.

If there is sufficient fuel for a fire, a burning management system for shrub control in the mulga country is beneficial for livestock production and conservation. Rainfall following burning will lead to overall improvements in the pasture including:

- decreased shrub densities
- increased pasture production
- improved ground cover and reduced runoff
- reduced wind and water erosion
- reduced impact of drought.

Mulga branches harvested for fodder should ideally be placed on the ground at right angles to the slope. They can help pasture to recover by reducing water runoff and soil erosion, trapping mobile surface soil and seeds and by preventing livestock from grazing grasses that re-shoot under the branches.

Any harvesting or burning of fodder trees or shrubs requires an approval under the *Vegetation Management Act 1999*. Contact a DERM business centre for information on the application process.

More information on the use of mulga as a fodder source is available from the DEEDI fact sheet Livestock nutrition – Feeding mulga to sheep in south-west Queensland.

Implementing forage budgeting strategies

Forage budgeting is used to manage the balance between forage demand and forage supply in the short term, taking seasonal conditions into account. The *Stocktake* package (see 'Further information') developed by DEEDI and Meat and Livestock Australia can assist graziers to prepare forage budgets.

When deciding on stocking rates for a paddock, feed budgeting techniques and the time span that stock are intended to be in the paddock need to be considered. The effects of native animals such as kangaroos and pests such as rabbits need to be considered also.

The basic process for forage budgeting is as follows:

- calculate how much edible forage exists in the paddock
- decide how much needs to remain after the animals are taken out in order to maintain pasture condition and ground cover
- nominate the proportion of the pasture that is to be consumed in that time period
- work out how much each animal will eat per day
- decide how long the animals are to stay in the paddock
- calculate how many animals can be safely run for that period.

A good time to assess the amount of feed and to adjust rates is in March-April at the end of the growing season. In more productive pastures, the aim should be to have at least 40 per cent ground cover and 1000 kilograms per hectare of pasture at the beginning of the next summer storm period. In more arid areas, a target of 500 kilograms per hectare may be all that is achievable.

The *Pasture Photo-standards* CD-ROM (available from DEEDI) is useful for developing pasture budgets and dry season business management plans. The CD-ROM contains photo-standards and corresponding pasture yields for many of Queensland’s common pasture communities and is searchable according to region or pasture type.

Utilising climate and seasonal forecasting resources

Because droughts are a recurring natural event in Queensland, it is essential to plan and manage for them. Seasons of below average rainfall are not unusual and should not have disastrous consequences. If properties are managed for drier-than-average years, better seasons become a bonus for both production and the landscape.

Monitoring seasonal forecasts based on the Southern Oscillation Index (SOI) and other measures of the El Niño-Southern Oscillation phenomenon (commonly referred to as ENSO), such as sea-surface temperatures helps to give an outlook for future seasonal conditions.

The SOI measures the differences in air pressure between Tahiti and Darwin. The index scale ranges from about +30 to -30. When the SOI is strongly positive (i.e. greater than +5 and referred to as a La Niña phase) trade winds blow strongly across the Pacific Ocean picking up moisture. In this situation, much of eastern Australia has a chance of receiving greater than average rainfall. With a strongly negative SOI (i.e. less than -5 and referred to as an El Niño phase) trade winds are weakened or reversed and there is a probability of below average rainfall in eastern Australia.

ENSO fluctuates from one year to the next and the SOI is most strongly related to rainfall and climate from winter through to summer. Another phenomenon which influences rainfall and climate over longer time scales is the Inter-decadal Pacific Oscillation (IPO) or Pacific Decadal Oscillation (PDO). When measures of the IPO and ENSO are considered together, improved outlooks for rainfall, with a longer lead time can be obtained. For example, search for 'SPOTA-1' on the Long Paddock website at <www.longpaddock.qld.gov.au>.

As drought conditions develop, it is important to adopt a strategy early while options are available. Stocking rates should be managed according to the pasture available and the condition of that pasture. Stock should be sold or

agisted early in the dry season while they are still in good condition and fit to travel and the pasture is not yet overgrazed.

Valuable climate information about managing climatic risk is available on the Long Paddock website <www.longpaddock.qld.gov.au>. For example, Figure 2 depicts data obtained from the *AussieGRASS* model in February 2010 showing predicted pasture growth for March to May 2010. The estimate is made by considering soil type, pasture type, tree cover and expected rainfall, temperature, humidity and grazing pressure. *AussieGRASS* is a spatial version of the *GRASP* pasture simulation model.

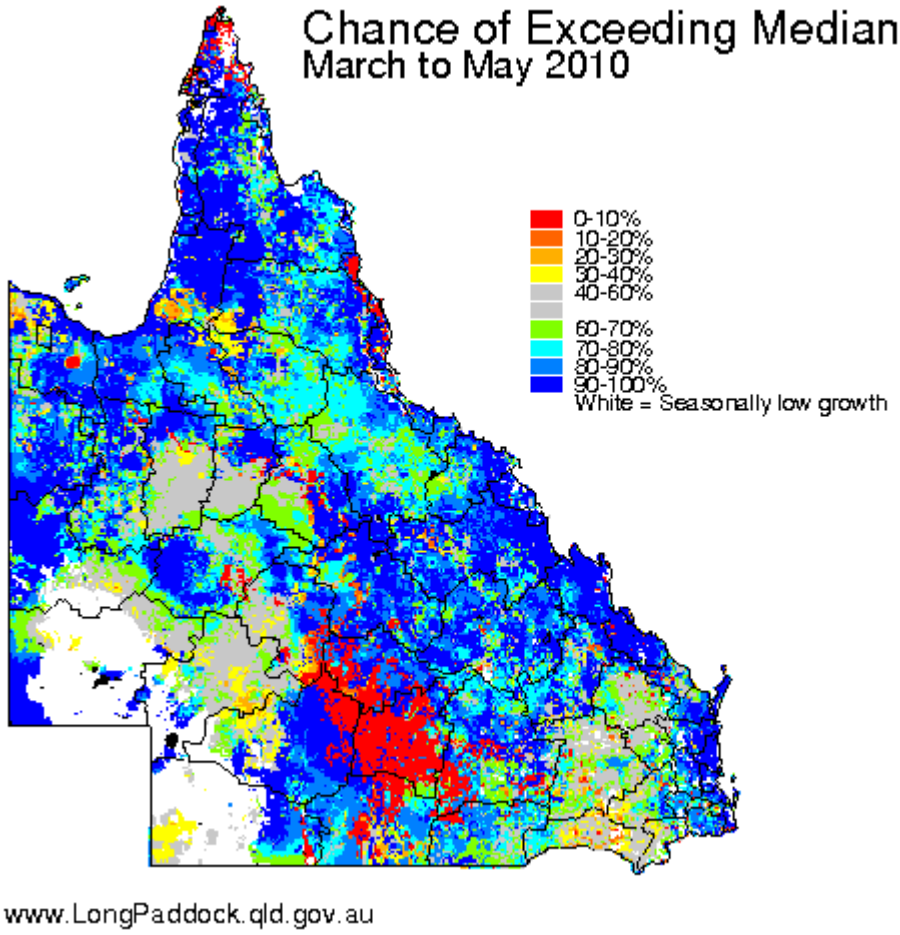

Figure 2 An example of information available from the Long Paddock website

The Long Paddock website also provides information on:

- seasonal climate outlooks—based on the SOI (SOI Phase Scheme) or sea-surface temperatures (SPOTA-1 scheme which stands for Seasonal Pacific Ocean Temperature Analysis version 1)
- historical climate variability
- rainfall maps from 1890 to present
- pasture growth, relative to pasture records from 1957 to present (will be progressively added to the website using the simulation model *AussieGRASS*).

Access to the *FORAGE* system, which provides information relating to climate and pasture condition at user-specified locations, is also available from the Long Paddock website. *FORAGE* can be used to assess climate risk and land condition, and to help make management decisions. The system provides a Rainfall and Pasture Report and a Ground Cover Report, as well as products based on satellite imagery of ground cover. It receives requests via the website, which it processes, before generating and emailing the relevant information back to the user. The

Rainfall and Pasture Report from *FORAGE* provides a 30-year time series of interpolated annual rainfall, model-simulated annual pasture growth, pasture biomass (i.e. total standing dry matter) and pasture-litter cover. The Ground Cover Report from *FORAGE* provides a time-series of pasture ground cover derived both from model calculations and satellite imagery. The report is based on around 20 years of data.

An additional software package that provides valuable climate information is *Rainman Streamflow 4.3* (see 'Further information'). This program contains long-term historical rainfall data for some 3800 locations throughout Australia. Using *Rainman Streamflow 4.3*, users can update monthly rainfall data via the Internet each month free of charge. Landholders can also enter and analyse their own rainfall data for answers to questions like:

- 'What chance do I have of getting 120 millimetres of rainfall between October and December (based on different SOI values)?'
- 'How often have we had 75 millimetres of rain in one day?'
- 'How dry were the 12 months up to April 2003 relative to the long-term average?'

The computer program *HowOften?* is also a useful tool for providing climate information. This program will answer queries such as, 'How often does x mm of rain occur between two specified dates at a specified location?'

Managing the tree-grass balance

With the exception of natural grasslands, most pasture species grow in association with woody vegetation such as trees and shrubs. Woody vegetation generally has a more extensive root system and a broader canopy than individual herbaceous plants. Trees compete with pastures for water, nutrients and light. Managed correctly, trees can enhance the grazing value of a pasture landscape. The grass under trees is sometimes of higher quality than grass growing in open areas—particularly in areas with infertile soils. Trees provide:

- shade and shelter for animals, reducing heat and cold stress
- moderate ground temperatures in both summer and winter
- mobilised nutrients from deeper in the soil profile
- lower ground water tables and reduced salinity problems
- reduced wind velocities and improved microclimate for herbage growth
- improved biodiversity.

Persistent, heavy grazing pressure can lead to woodland thickening. A resultant lack of fire and reduced competition from the herbaceous layer allows woody plants to proliferate. This can lead to:

- reduced grazing value
- reduced soil surface cover
- increased risk of erosion
- colonisation by pest plants
- limited access for management purposes (e.g. mustering and weed control).

Under the *Vegetation Management Act 1999*, approval is required to thin remnant vegetation shown on a regional ecosystem map. Clearing of regrowth shown on a regrowth vegetation map must be notified to DERM and conducted in compliance with the Regrowth Vegetation Code. Regional ecosystem maps and regrowth vegetation maps can be requested for individual lot on plan numbers, free of charge, from the DERM website <www.derm.qld.gov.au> (search for 'regional ecosystem map' and/or 'regrowth vegetation map' in the search field on the top right-hand side of the home page).

Maintaining native grassland free of encroachment from woody vegetation

Some grassland ecosystems in Queensland are being invaded by woody species. Encroachment is considered to have occurred when the description of an area is no longer consistent with the description of the regional ecosystem (RE) with which the area was mapped.

Permits under the *Vegetation Management Act 1999* are required before clearing woody vegetation in some grassland ecosystems. More information can be found in the fact sheet titled 'Grassland regional ecosystems and encroachment', which is available on the DERM web site at <www.derm.qld.gov.au>. The fact sheet lists grassland ecosystems where woody vegetation may be cleared without a permit and those where a permit is required before clearing. Natural woody patches in grassland RE's are not considered to be encroachment and cannot be cleared.

Landholders should also check requirements under other Acts, such as the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, which may affect grassland management.

Using appropriate fire management practices

Fire has played an important role in shaping Australian landscapes and the composition of their fauna and flora. Before European settlement, fires would have been a regular occurrence, especially following good seasons. They would have been started by lightning strikes or by Indigenous people to flush game and create fresh pick. Such fires may have covered large areas at a time. The lack of watering points in much of the landscape would have meant that large areas would have been subject to low grazing pressure making it more susceptible to wildfires.

Since the introduction of livestock, the use of fire at the beginning of the growing season became more frequent in many areas to promote fresh plant growth. However the provision of watering points means that much larger areas are grazed regularly providing less fuel for fires. Degraded areas or areas subject to woodland thickening are often incapable of producing sufficient fuel for a fire that may be needed for weed control. In the absence of fire, natural open grasslands can be invaded by woody weeds, such as prickly acacia and mimosa, and native species, like gidgee.

Wild fires today are likely to cover smaller areas when compared to before European settlement. Less fuel makes fires easier to manage assisted by barriers such as fire breaks and roads which create opportunities for backburning.

This section covers a number of issues related to the use of fire. Due to extreme variations in climate, land types and weather conditions, it is not possible to provide strict 'recipes' about fire management in the grazing lands of Queensland.

DERM is preparing guidelines on burning strategies for all regional ecosystems in Queensland. The guidelines are based on an ecological perspective and are designed to enhance biodiversity. Strategies may need to be varied depending on prevailing weather conditions, the local condition of the land, presence of specific weeds and the desire to increase the population of a specific endangered plant or animal. For more information visit the DERM website <www.derm.qld.gov.au> (search for 'regional ecosystems fire management guidelines').

Fire as a friend

If managed appropriately, fire can be a beneficial tool for graziers and land managers as it:

- reduces fire hazard
- controls weeds such as rubbervine, prickly acacia and mimosa
- controls native woody vegetation that is thickening and suppressing pasture growth
- removes rank old grass so stock can reach new growth and obtain a more nutritious pick
- stimulates new growth including seedling regeneration (e.g. fire favours spear grass germination)
- evens up patchy grazing by encouraging stock onto burnt areas.

Fire as a foe

Fires which result from a lightning strike or spread from neighbouring land can devastate a property's landscape and infrastructure. They can create a shortage of feed and create an erosion risk.

The excessive use of fire on a property can have a significant impact on the population of some plants and animals and on surface soil structure.

Managing fire

For many pasture landscapes in Queensland, a fire every three or four years can provide benefits. For this to occur, pasture needs to be managed so that there is sufficient fuel to support the fire. If it is rare that there is sufficient grass to support the fire, a paddock is probably being overgrazed—topsoil may have been lost and/or woody vegetation may be impacting on pasture growth.

Higher rainfall coastal areas are more likely to be able to produce sufficient grass for a fire than arid, inland areas where the use of fire is very limited. In some arid landscapes the use of fire is not recommended because local vegetation is fire sensitive (e.g. saltbushes).

There is a tendency for fire to be over-used in northern regions of the state and under-used in southern areas. One reason for the under utilisation of fire is that the land is not capable of producing sufficient combustible material to provide enough fuel for a suitable fire. This may be due to low rainfall, heavy grazing or a dominance of woody vegetation.

Occasional fires do not damage native pasture species, however, new growth and seedlings that emerge after the fire can be damaged when subjected to heavy grazing pressure. From a grazing perspective, it is better to burn all, or a large part of the paddock. This would avoid the situation where stock might concentrate on and weaken the new growth in a small area that had been burnt. From a biodiversity viewpoint, ‘mosaic’ burning (burning parts of a paddock at different times) has benefits because it allows animals and plants to survive in refuge areas.

When to burn

As a general guide, in North Queensland the best time to burn is after the first rains following the dry season. After burning, the moisture in the soil, as well as subsequent rainfall, aids the recovery of the pasture. A very hot fire that occurs when there is considerable fuel and extreme fire conditions will lead to a slow recovery if there is no rainfall for six months. In Southern Queensland, burning in winter or early spring is preferable to kill mature shrubs and their seedlings without damaging the regenerating grasses.

Burning in the dry season is risky because the wet season rains may fail resulting in a lack of feed for an extended period. If the first rain afterwards is heavy, the lack of cover may result in high rates of runoff and soil erosion.

In order to control woody weeds, a hot fire is generally required. Fire does not kill all woody growth, but will check or control it. The smaller the woody weed is, the more susceptible it is to fire.

A permit from the local Fire Warden of the Queensland Rural Fire Service is essential before commencing burning. Further information to consider prior to burning is available from The Queensland Rural Fire Service website <www.ruralfire.qld.gov.au>. An assessment of the current fire hazard for different parts of the state is shown on the Long Paddock web site (check the Pasture Curing Index and the Potential Grassfire risk indicator). These two products are based on the *AussieGRASS* model.

Care must be taken when establishing and maintaining firebreaks to avoid the spreading of weeds and the concentration of runoff leading to erosion. Further information is contained in the DERM fact sheet L241 Erosion control on fences and firebreaks.

Fencing to land types

Fencing according to land type can help overcome the problem of stock grazing one land type in preference to another in the same paddock. Persistent grazing of one land type can lead to a reduction in palatable productive pasture species and deterioration in soil surface conditions in part of the paddock while the rest of the paddock is under-utilised.

Fencing of riparian corridors or providing off stream water points can be particularly beneficial for the conservation of these valuable assets and is discussed later under 'Protecting riparian vegetation'.

Managing distance to water

There is a strong relationship between grazing pressure and distance to water (Figure 3). In large paddocks with sparsely placed watering points, grazing pressure around watering points is high, whilst other parts of the paddock may not be grazed at all.

While cattle can walk up to 10 kilometres for water, uneven use of forage can be evident even when watering points are spaced four to six kilometres apart.

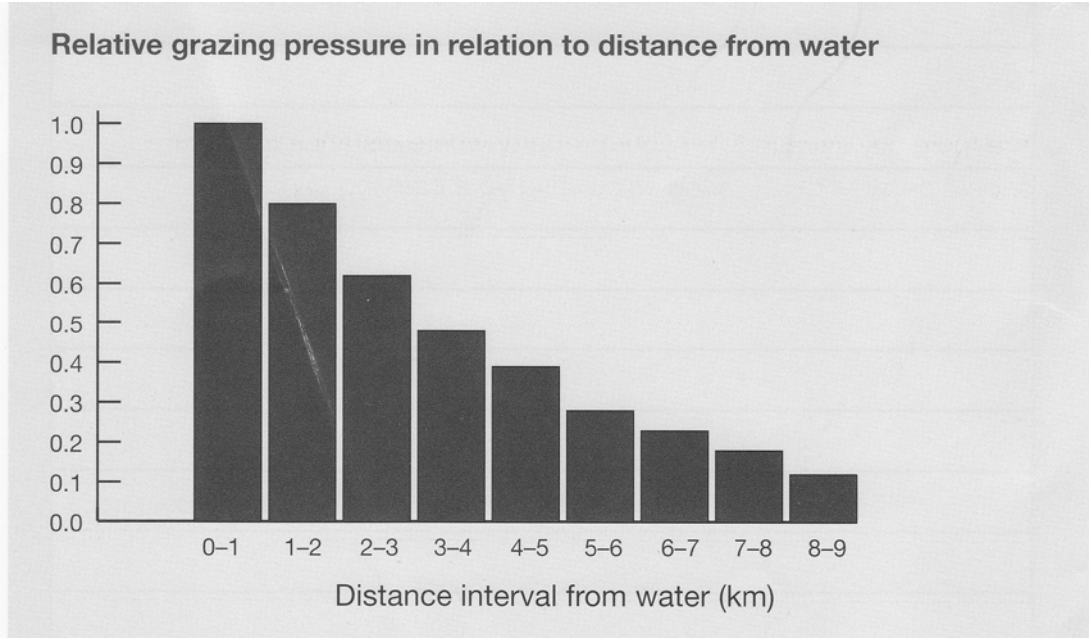

Figure 2 Relative grazing pressure in relation to distance from water. Source *Grazing land management- Maranoa Balonne Version Workshop notes MLA 2005*

Managing watering points and dietary supplements, such as mineral licks, can be an effective way for managing stocking and pasture utilisation rates. They should be located to:

- encourage more even pasture utilisation across a paddock
- minimise erosion risks
- minimise pollution of watercourses (from dung and urine).

It is important to consider that:

- in mid summer, sheep are unlikely to graze beyond three kilometres from water, and cattle five kilometres, and they may return twice daily
- locating a new watering point in a less preferred area of a paddock will help to spread grazing pressure, but may also have a negative impact on biodiversity by giving stock access to a previously ungrazed area
- capping and piping of bores to troughs provides much more control over the location of watering points
- watering points should be placed in areas where the soils are least susceptible to erosion
- watering points should be placed on the opposite side of the paddock from the prevailing winds—stock are more likely to walk towards water into a prevailing wind but then graze away from the watering point with their backs to the prevailing wind.

Monitoring pastures

Gradual changes in rangeland condition and deterioration of native pastures often go undetected unless there is a monitoring system in place. If changes are detected early, grazing management can be modified to stop the decline and improve pasture and land condition.

Monitoring can be as minimal as taking a photo and inspecting selected parts of the paddock to check pasture composition, condition and yield each year. Memories can be short and unreliable; a documented record allows comparison with previous seasons and provides a record to gauge changes in the pasture.

For more information on monitoring pastures, the following publications are recommended:

- Land management self assessment and monitoring kit - Rural Leasehold Land at <www.derm.qld.gov.au>
- The *Stocktake* Package—refer to the section entitled 'Further information'
- *Not just watching the grass grow: graziers who monitor their land*—available by contacting DEEDI on telephone number 13 25 23.

Conserving soil

The DERM publication Guidelines for determining lease land condition describes how soil condition is assessed as part of the lease land condition assessment for the Delbessie Agreement. Indicators assessed include:

- soil surface condition
- total ground cover
- salinity.

Soil surface condition refers to evidence of water or wind erosion including the presence of rills and gullies, exposed subsoils or soil deposits by water or wind.

Reclaiming degraded land, especially in arid and semi-arid environments, can be challenging, costly and take a long time. It is preferable to ensure that degradation is avoided rather than attempting to repair problems later.

The top few centimetres of soil contain most of the available nutrients and organic matter in the soil profile. When this is lost, the soil becomes even less receptive to rainfall, resulting in a near constant drought for the remaining pasture. Seedlings have difficulty establishing on the scalded, often sand-blasted surfaces.

Maintenance of soil cover is the key to controlling erosion in grazing lands. When there is no groundcover, soil is removed by both the action of raindrops, overland flow and wind. Valuable rainfall which should be soaking into the soil is lost as runoff—also carrying away topsoil. Soil may be lost in sheet form, including the formation of scalds (refer to the case study on scald reclamation). When runoff concentrates, either naturally or when influenced by roads, fences, stock pads or firebreaks, both rill and gully erosion may occur.

Total groundcover includes pasture plants and their litter, tree leaf litter, twigs and woody debris, organic crusts, rocks and gravel. All of these components contribute to protecting the soil surface from erosion.

Biological soil crusts occur extensively in Queensland rangelands. They are formed by living organisms that bind together particles of soil into a crust. They can be made up of cyanobacteria (blue-green algae), mosses and lichens. Biological soil crusts also play an important role in fixing nitrogen in the soil, improving soil’s resistance to wind and water erosion, and contributing to plant growth. However, they are vulnerable to damage from livestock and once damaged, can take many years to recover.

The higher the level of ground cover, the greater the benefits provided. However, a minimum level of 30 to 40 per cent is required in order to ensure a reasonable level of protection from erosion and to perform the other ecological functions of ground cover. To achieve this cover level at the beginning of the summer storm season, a surface cover level of around 70 per cent is desirable at the end of the summer growing season.

Depending on tussock size and spacing, some pasture types are more conducive to providing good cover levels than others.

Key issues to address in maintaining cover are:

- stocking rates
- total grazing pressure (domestic stock, feral and native animals)
- thickening of woody vegetation (competes with groundlayer plants and may contribute to bare soils under the vegetation).

Case study—scald reclamation

Scalds or clay pans are bare areas produced by the removal of topsoil by wind and/or water erosion. Raindrops hitting the bare soil surface can 'sort' the soil so that the fine sand, silt and clay particles are re-arranged and packed together. This fills the pore spaces at the surface, causing a surface seal which sets hard like concrete.

Under normal conditions, evaporation effectively pulls water (and any salt that may be present) in the soil to the surface while rainfall effectively pushes the salt back down. When a surface seal forms, very little rainfall moves into the soil—but the salts keep rising and over time, the levels of salt can increase in the surface layers of the soil, further inhibiting plant growth.

Occurrence

While some scalds were reported by early explorers, high grazing pressure has been responsible for large areas of scalding. Scalds are usually found on soils with a lighter textured surface adjacent to watercourses, in depressions or at the base of slopes (footslopes).

Because scalded land has lost its topsoil, it is very difficult to return it to its former productivity. However, there are techniques that help in achieving some form of recovery as well as enhancing biodiversity and sequestering carbon.

Successful reclamation depends on one key factor—improving the soil surface so that water infiltration is improved and plants can establish. Some options to achieve this are described below.

Fencing off affected areas

This option encourages regeneration and revegetation by removing grazing pressure caused by domestic, feral and/or native animals.

Recovery rate is dependent on seasons. In periods of exceptional rainfall, some scalded areas can be covered by pioneering plant species like pigweed. However, under most seasonal conditions this technique will need to be coupled with other management options.

Promoting cover

Cover helps limit evaporation at the soil surface and also reduces the physical action of raindrop impact—reducing erosion and improving infiltration. Cover intercepts runoff carrying seeds and manure and provides a favourable medium in which plants can establish.

There are few options for artificially improving cover in extensive grazing lands. It may be feasible to apply some form of low quality hay to small areas. Applying the hay in strips on the contour would provide benefits to a larger area. Care would need to be taken to ensure that there were no weed seeds in the hay. Graziers in the Burdekin district have used round bales of cane trash laid out in strips on the contour to help rehabilitate small areas of degraded land.

Mechanical disturbance

Mechanical disturbance can be used to break the surface seal. Infiltration should increase, making the surface condition more favourable for the establishment of vegetation. However, the disturbed area may soon seal up again if no cover is established soon after treatment.

It is best to do mechanical disturbance when the soil moisture levels are just right, too dry and it's hard going, too wet and soil compaction can be an issue.

Water ponding

Low earth banks in horse-shoe shapes on the contour can trap the runoff from even small falls of rain on hard surfaces. The runoff is ponded at depths of 10 to 15 centimetres and eventually soaks into the soil. This leaches salts out of the soil profile and improves conditions for plant growth.

On some soil types, subsequent wetting and drying causes cracking to occur which greatly increases infiltration of water. This provides a better environment for plant growth. Once plants are established, they trap wind-blown dust, seed and organic matter which all contribute to the rehabilitation of the site.

An option for providing indentations to retain water on smaller areas of scalding is to allow stock onto the surface for a limited period when conditions are wet.

Post treatment / responses

The first plants to grow back are pioneering species like pigweed and galvanised burr. In time, improvements in organic matter from the pioneer species and reduction in salt levels near the surface allow more permanent, useful grasses to establish.

Reclaimed clay pan areas can be used for strategic grazing. They should be grazed only when groundcover is established and the site is dry to prevent pugging and compaction by livestock.

Gullies

Preventing gullies from occurring, is far better than attempting to control them after they have developed. In many cases there are limited practical options for the control of gullies. Attempting to divert headwaters and to stabilise eroding gully heads can be expensive and technically difficult, especially when the erosion is occurring on many fronts on highly erodible soil types.

Fencing off gullied areas to restrict stock access and to encourage plants to become established may provide some benefits. An alternative to fencing off a gully may be to add dead tree branches below an unstable gully head to restrict stock access and to encourage sedimentation and subsequent grass growth.

Planting vegetation into sediment in the floor of the gully can hasten the healing process. Cereal plants such as oats, wheat, barley, millet or forage sorghum can be used as they provide rapid temporary cover if there is moisture in the soil.

For more information about gullies refer to the DERM fact sheet L81 Gully erosion available from the DERM website <www.derm.qld.gov.au>.

Infrastructure

Runoff concentrations caused by roads, tracks, fence lines, firebreaks, drains or dam bywashes can lead to rill and gully erosion. Erosion can damage these structures leading to inconvenience and increased maintenance or replacement costs.

Careful placement of infrastructure can minimise the erosion risk. Tracks can intercept overland flows and become eroding waterways. Whenever possible, it is best to have tracks on the contour or directly up and down slope (e.g.

on a ridge) to minimise runoff interception. Trafficable banks across roads and tracks (whoa boys) as well as culverts can help to reduce erosion.

Fencing off dams will avoid damage to bywashes and dam walls and prevent the stored water fouling. Water can be pumped to a turkey nest or tank from where it can flow by gravity to troughs.

The following DERM fact sheets contain information about erosion on access tracks, fences and firebreaks:

- Fact sheet: L239 Erosion control on property roads and tracks—cross sections and location
- Fact sheet: L240 Erosion control on property roads and tracks—managing runoff
- Fact sheet: L241 Erosion control on fences and firebreaks.

Conserving biodiversity

The DERM publication Guidelines for determining lease land condition describes how a range of indicators of vegetation structure (recognised as surrogates of biodiversity condition) are considered as part of the lease land condition assessment for the Delbessie Agreement.

As approximately 80 per cent of Queensland is used for grazing purposes, it is essential that biodiversity values are conserved and managed as part of a grazing property. Maintaining healthy biodiversity improves the capacity of ecosystems to resist and recover from climate or management disruptions and provides for sustainability and increased certainty for future generations. The conservation of biodiversity requires planning to limit grazing impacts through the knowledge of how different plant and animal species respond to grazing pressure.

Most wildlife is too secretive to be seen regularly, especially during the hot part of the day. Nevertheless, the creatures in our grazing lands are an important part of the environment and should not be forgotten. Feral pests such as wild dogs, cats, pigs, camels and rabbits can all have an adverse impact on biodiversity.

Some land type information sheets provide advice on flora and fauna species that may be found in each land type as well as advice on management options to maintain biodiversity in these land types.

Maintaining a mosaic at the property level of productive pasture and retained woody or other native vegetation at densities appropriate to each land type is a practical way to achieve good biodiversity outcomes.

Relevant considerations to achieve better biodiversity outcomes include:

- maintaining native pasture composition at densities that conserve and protect ground layer plant and animal species and soil health
- setting specific management goals for biodiversity conservation, e.g. managing fire and grazing to maintain habitat complexity in remnant vegetation
- maintaining important habitat features such as fallen logs, ground cover and large trees with hollows, throughout the landscape
- planning paddock layouts (e.g. fencing to land types or excluding vulnerable areas from regular grazing)
- identifying areas of conservation significance on the property to be managed with decreased grazing—this could be achieved by reducing access to water by stock
- protecting important habitat features, such as riparian areas and other corridors of woodland that provide pathways for movement of native fauna
- introducing special management arrangements such as nature refuges or a voluntary declaration under the *Vegetation Management Act 1999* over an environmentally significant part of the property.

Managing declared pests

The DERM publication Guidelines for determining lease land condition describes how declared pest plants and animals are assessed as part of the lease land condition assessment for the Delbessie Agreement.

Land type information sheets list any declared weeds commonly associated with that land type as well as a range of other weeds that are not declared.

Declared pest plants

There are three classes of declared plants under the *Land Protection (Pest and Stock Route Management) Act 2002*. These plants are targeted for control because they have, or could have, serious economic, environmental or social impacts. The complete list of declared weeds is available on the Biosecurity Queensland section of DEEDI's website <www.biosecurity.qld.gov.au> .

The *Land Protection (Pest and Stock Route Management) Act 2002* places a legal responsibility on all landholders, including state agencies, to control all Class 1 and 2 declared pests. There are also legal obligations associated with the supply, sale, keeping and transport of declared plants. For example, it is illegal to supply a declared plant anywhere in Queensland without a permit issued by Biosecurity Queensland.

Class 1 pest plants

A Class 1 pest is not commonly present in Queensland and if introduced, would cause an adverse economic, environmental or social impact. Class 1 pests established in Queensland are subject to eradication from the state. Landowners must take reasonable steps to keep land free of Class 1 pests.

Class 2 pest plants

Class 2 pests are established in Queensland and have, or could have, an adverse economic, environmental or social impact. The management of these pests requires coordination and they are subject to programs led by local government, community or landowners. Landowners must take reasonable steps to keep land free of Class 2 pests.

Class 3 pest plants

Class 3 pests are established in Queensland and have, or could have, an adverse economic, environmental or social impact. The primary objective of a Class 3 listing is to prevent sale, therefore preventing the spread of these pests into new areas.

Landholders are not required to control Class 3 pests unless they are issued a notice by an issuing entity such as local government. A pest control notice can only be issued for land that is, or is adjacent to, an environmentally significant area.

Other weeds/pest plants

Plants that are not declared under State legislation may have control requirements imposed by local governments if declared under local laws. For example, some local governments have declared leucaena a weed because of its invasiveness around waterways when it escapes from managed areas.

All weeds, including those that are not declared, can affect the productive capacity of grazing land and also have adverse environmental impacts such as disrupting habitats, changing fire regimes and displacing native endemic species. Some weeds can be poisonous at various stages of their growth.

Some plants have become weeds after escaping from gardens while some agricultural crops and pasture species have the potential to become weeds. Buffel grass and rhodes grass are valuable pasture species but they can invade natural ecosystems where they become an environmental weed.

Weed control

The six principles of weed management are as follows: (Source: *Grazing Land Management Workshop Notes – Maranoa-Balonne Version. MLA 2005)*

1. Awareness—be aware of existing and potential weed problems.
2. Detection—be on the look out for new weed infestations before they become too large and difficult to contain.
3. Planning—efforts should be prioritised to plan a strategy for successful control.
4. Prevention—is better than cure, so preventing the introduction of new weeds and containing the spread of existing weeds will have significant benefits.
5. Intervene—and do it early. Controlling weeds now rather than later will prevent the spread of weeds before they become out of control.
6. Control and monitor—as always, monitoring is a critical component of weed management. There is a need to gauge the successes of weed control strategies and to plan future efforts.

It is easier for many weeds to establish in areas subject to heavy grazing or disturbance. Maintenance of pastures dominated by an appropriate proportion and density of perennial and productive species assists protecting soils and maintaining high ground cover. This provides competition for weed seedlings and reduces the likelihood that weeds will establish.

Note that approval is required from DERM if the clearing of native remnant vegetation is considered necessary to control non-native plants or declared pests.

Case study—chinee apple

Chinee apple, *Ziziphus mauritiana*, (or Indian jujube) is a spiny shrub or small tree growing up to eight metres high. Dense infestations create impenetrable, thorny thickets that seriously hamper stock management, reduce pasture production and accessibility and have a significant impact on biodiversity.

Habitat and distribution

Chinee apple is native to southern Asia and eastern Africa. It is widespread in the dry tropics of North Queensland, the Northern Territory and Western Australia, often spreading from towns formerly associated with mining. Invasion by chinee apple is considered to be in its early stages and many infestations are still of a low density.

Seed spread is assisted by stock, feral pigs, wallabies and birds eating the large quantities of fruit produced by mature trees. Animals consume the fleshy fruits and pass viable seeds that are protected from digestion by a woody casing.

Chinee apple has a tendency to grow densely along watercourses in the Savannah regions of Northern inland Queensland, but can also spread onto dry, exposed hillsides. The pattern of spread has shown no marked preference for any specific soil or vegetation type. The major factor that appears to affect the growth of chinee apple is the density of the associated vegetation. It can form a shrub layer in eucalypt woodlands and areas that have sparse tree cover or where the other tree vegetation has been removed.

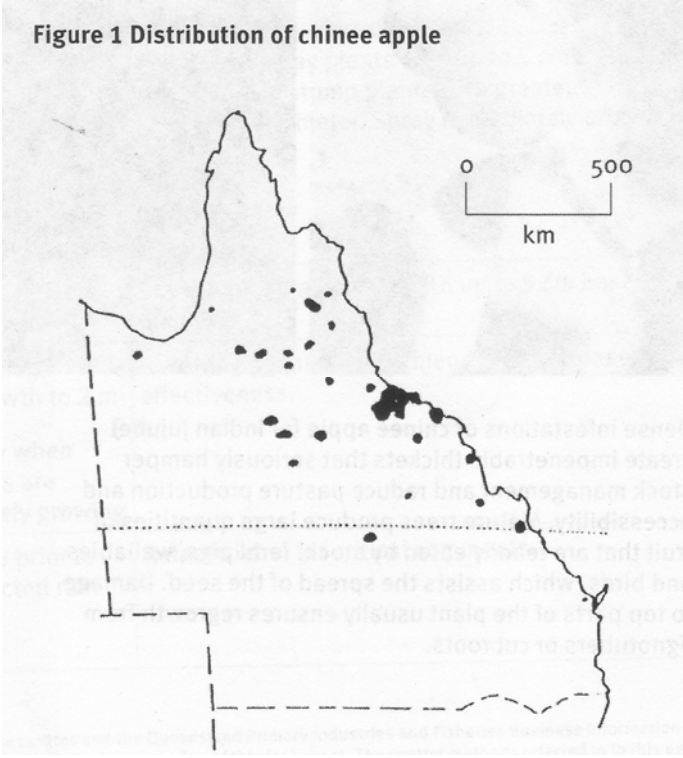

Figure 3 Occurrence of Chinee Apple in Queensland (Source DEEDI fact sheet Chinee Apple, 2009)

Control strategies

Chinee apple is a declared Class 2 plant under the *Land Protection (Pest and Stock Route Management) Act 2002*. This declaration requires landholders to control the plant on the land and waters under their control. A local government may serve a notice upon a landholder requiring control of declared pests.

Areas requiring treatment should be prioritised. Paddocks with only a few chinee apple plants should be treated as the highest priority. If resources are not available to treat all of the plants in a paddock at the one time, effort should be concentrated on the largest plants to more effectively reduce the total seed output of the infestation. Large, healthy chinee apple trees growing in a riparian zone will probably be more significant than those growing in upland areas because of their more prolific seed production, the possibility of downstream transport of seeds and the concentration of stock in the lower parts of the landscape.

An important component of a strategy should be to minimise the risk of cattle spreading the seed. Movement of cattle during the main fruiting period from May to June will encourage the spread of chinee apple. Seed dispersal occurs from July to September.

Control measures

Effective control of chinee apple can be achieved through a combination of mechanical and herbicide treatments, or by herbicide treatment alone. There are currently no biological control agents available.

Dense infestations can initially be cleared by stick raking, ripping or using a cutter bar, if the terrain and soil type permit. Remaining broken and exposed stems should be treated by basal bark spraying as soon as possible following clearing. Improved pasture will assist in the prevention of re-infestation. Follow up monitoring and treatment is essential or the initial treatment efforts will be wasted.

Fire will cause some damage to the plant but regrowth is normally rapid and few plants are killed. Seedlings may be more susceptible to fire but the survival of mature plants will maintain the existing problem.

The methods of chemically treating chinee apple include basal bark spraying, cut stump treatment and soil application. For more information including recommended herbicides, check the fact sheet Chinee apple at <www.biosecurity.qld.gov.au>.

Much of the information in this case study has been sourced from the above fact sheet as well as from the reference Grice, A.C. (2002) *The Biology of Australian Weeds* 39. *Ziziphus mauritiana* Lam. Plant Protection Quarterly 17, 2-11.

Declared animals

Declared pest animals have or could have serious economic, environmental or social impacts. For example, rabbits, deer and feral goats can cause overgrazing, feral cats can have a major impact on biodiversity, and if foot and mouth disease ever entered Australia, feral pigs would be a major carrier.

There are three classes of declared animals and each class requires a form of action. The complete list of declared animals is found on the DEEDI website <www.biosecurity.qld.gov.au> .

Class 1 declared animals

Class 1 animal pests established in Queensland are subject to eradication from the state. Landowners must take reasonable steps to keep land free of Class 1 pests.

Class 2 declared animals

A Class 2 animal pest is one that is established in Queensland and has, or could have, a substantial adverse economic, environmental or social impact.

Management of these pests requires coordination and they are subject to programs led by local government, community or landowners. Landowners must take reasonable steps to keep land free of Class 2 pests.

Class 3 declared animals

Class 3 pests are established in Queensland and have, or could have, an adverse economic, environmental or social impact.

Landholders are not required to control Class 3 pests unless they are issued a notice by an issuing entity such as local government. A pest control notice can only be issued for land that is, or is adjacent to, an environmentally significant area.

It is an offence to introduce, feed, supply or release Class 3 pest animals without a permit.

Pest management plans

A pest management plan for both plant and animal pest species will help to:

- meet pest management statutory obligations in the *Land Protection (Pest and Stock Route Management) Act 2002* and the *Land Act 1994 (Qld)*
- ensure that pest management activities are scheduled and resources are deployed at the optimum time
- monitor how well control methods are working
- set and achieve goals using carefully thought-out action plans
- apply for financial assistance and incentives for pest management (e.g. assistance grants from local government or Natural Resource Management bodies, loan applications from QRAA)
- report progress to funding bodies and local governments.

Avoiding salinity

The DERM publication Guidelines for determining lease land Condition describes how the presence of salinity is assessed as part of the lease land condition assessment for the Delbessie Agreement. Indicators assessed include the presence of plant species that may indicate salinity in conjunction with the scale of bare or eroded areas caused by salinity.

Salinity in soil and water is caused by a range of salts including chlorides, bicarbonates and carbonates of sodium, calcium and magnesium. All soils contain some salts which may have originated from their parent material or from rainfall—all rain contains a small amount of salt, even in inland areas.

High salt levels in soils adversely affect plant growth. In some cases the structure of the soil can also be affected. Salts enter streams via spring flow or when runoff removes salts previously deposited on the surface by evaporation.

Where salinity occurs

Salinity occurs:

- where water accumulates naturally and salts are concentrated by evaporation (e.g. salt lakes, salt pans, salt marshes and salt flats in parts of coastal, south-west and northern Queensland)
- when topsoil is removed by soil erosion exposing naturally saline subsoils (referred to as scalds or claypans)
- where trees are cleared and the water table rises—all groundwater carries some salts and evaporation can cause them to concentrate on the surface
- when groundwater flow is impeded by a natural landscape feature (such as a granite dyke) or man-made obstructions (such as a road)
- where water with a high salt level is used for irrigation (including use of Great Artesian Basin groundwater)
- where land is over-irrigated, resulting in a rise in the water table.

In order to get a rising groundwater table, there needs to be enough rainfall finding its way into the groundwater zone. In dry climates with less than 600 millimetre annual average rainfall, there is less likelihood of this happening because of the high rates of evaporation especially in areas with summer dominant rainfall. Where clay soils predominate, there is even less chance of rainfall moving into groundwater. However the high rates of evaporation that occur in these landscapes will often lead to naturally high levels of salt in these soils.

Salinity may become apparent over a long period of time or may occur as an outbreak after extended periods of rainfall. The following indicators provide evidence of salinity:

- rising groundwater levels in bores
- the ground surface becoming permanently or seasonally damp, waterlogged or remaining damp after extended rain
- intermittent streams flowing for longer periods
- dieback of vegetation in low lying areas, or failure of plants to germinate or grow
- areas of bare soil, often with salt crystals evident
- changing pasture composition and reduced diversity with couch grass and other salt tolerant plants dominating
- buildings affected by rising damp
- deterioration in surface and groundwater quality
- road deterioration and crumbling.

Salinity risk assessments have been completed for the Queensland Murray Darling Basin and Fitzroy catchments. A copy of these publications can be obtained by contacting your local DERM Business Centre or by emailing <productdelivery@derm.qld.gov.au>.

Prevention and control of salinity

The management of salinity requires a combination of actions, which aim to achieve a balance between the volume of water entering the landscape (recharge) and the volume of water leaving the landscape (discharge).

Increased use of water in the landscape can be achieved by:

- planting, regenerating and maintaining vegetation and good ground cover in recharge, transmission and discharge zones
- maintaining good pasture cover by conservative stocking rates.

For more information refer to the DERM fact sheets relating to salinity. The DERM publication *Salinity Management Handbook* is also recommended.

Protecting riparian vegetation

The DERM publication Guidelines for determining lease land condition describes how riparian vegetation is assessed as part of the lease land condition assessment for the Delbessie Agreement. Indicators considered in the assessment include the structural condition of riparian vegetation, presence of declared pests and animals, the level of riparian area disturbance and bank stability, and soil indicators.

Factors considered in the assessment include:

- attempts to manage the impact of grazing in riparian areas
- the amount of disturbance in riparian areas
- the condition of native pastures, shrubs and trees
- the presence of non-native species.

Frontage country associated with drainage lines, creeks and rivers needs careful management. These areas are often fertile and hold soil moisture for longer. Pastures in such areas are often ‘sweeter’ and are preferentially grazed by stock. Heavy grazing pressure can make these areas subject to severe erosion. Stream bank and gully erosion as well as scalding may be evident.

Fencing riparian zones and providing off stream water points can have a number of benefits associated with restricting stock access to the area, including:

- preventing the disturbance and bogging of the stream bed
- preventing the formation of cattle pads that can cause gullies
- assisting the rehabilitation of gullies
- improving water quality
- reducing the spread of weeds
- making stock mustering easier.

Fencing of riparian areas allows grazing pressure to be more closely controlled. Restricting the grazing of riparian areas to early in the dry season can have the following benefits:

- it directs grazing onto the green leaf of pasture grasses (reducing the amount of browsing on trees and shrubs)
- high levels of ground cover are maintained (pastures have had a chance to be spelled over the wet season)
- it takes advantage of high feed quality compared to surrounding areas.

Strategies for fencing riparian areas include:

- establishing a frontage paddock by fencing out the upland areas adjacent to the floodplain
- fencing out high priority water bodies such as natural springs
- fencing out areas that are especially vulnerable to gully and streambank erosion

- fencing the immediate riparian area. In some landscapes this area is considered to be a width of land equivalent to the height of the stream bank plus five metres.

Fencing is not necessarily intended to completely exclude stock from riparian areas and should create paddocks large enough to be management units. In most cases, it would be impractical to fence both sides of all riparian areas in extensive grazing lands.

Certain types of regrowth vegetation are protected under the vegetation management framework, including regrowth located within 50 metres of a regrowth watercourse in priority reef catchments. For more information, type ‘regrowth regulations’ into the search engine on the DERM website at <www.derm.qld.gov.au>.

Off stream watering points

Off stream watering points (troughs) at permanent water holes, may be used as an alternative to fencing, as they reduce the time cattle spend in creeks and water holes. In many cases, stock prefer to drink from well-placed troughs, particularly if access to the watercourse is difficult, water quality is low, or there is danger (e.g. crocodile habitats).

Conserving water resources

The DERM publication Guidelines for determining lease land condition describes how the conservation of water resources is assessed as part of the lease land condition assessment for the Delbessie Agreement. Indicators considered include ground cover and presence of salinity; the level of riparian area disturbance and bank stability.

Factors considered in the assessment include:

- stability of streambanks
- the condition of riparian vegetation including groundcover
- presence of declared pest plants and animals
- presence of salinity.

Advice provided in the section entitled 'Protecting riparian vegetation' is also applicable to conserving water resources.

Water resources include waterholes, natural springs, permanent lagoons, flowing river and stream reaches, lakes, ponds, off-steam wetlands, groundwater and in some cases artificial dams and weirs.

Management options for maintaining or improving the condition of water resources include:

- adopting the grazing management practices referred to earlier in this publication
- use of artificial off-stream watering points, shade areas and/or feed supplements to attract stock away from water resources
- fencing to better manage stock access to water resources
- planting endemic riparian species and/or aquatic vegetation
- carrying out streambank stabilisation works
- removing aquatic weeds.

A package of information on wetlands produced by Meat and Livestock Australia (MLA) is provided to graziers who attend a GLM workshop.

Of the water discharged from the Great Artesian Basin (GAB) into bore drains, up to 90 per cent can be lost through evaporation and seepage. Due to the uncontrolled discharge of this water since the early 1900s, many bores across the Basin have suffered a decline in pressure and flow rate.

The Great Artesian Basin Sustainability Initiative (GABSI) is a joint Commonwealth/State program to assist landholders to rehabilitate bores and replace bore drains with piped systems. It also addresses associated environmental issues such as erosion, and promotes improved management practices.

Capping and piping a bore has a number benefits for the GAB and for overall property management, including:

- preserving and restoring artesian pressure and using GAB water more efficiently
- improving the distribution of water throughout the property
- providing a cleaner water supply for domestic and stock use
- reducing the number of stock perishing in drains especially in times of drought
- reducing feral animal habitat and invasive weeds.

Further information

AgForward

AgForward provides an industry advisory service for holders of Delbessie Agreement leases; and can deliver information sessions specifically about the lease renewal process under the Delbessie Agreement. For further information, contact AgForward via:

- telephone (07) 3238 6049
- email <agforward@agforward.org.au>
- web site at <www.agforward.org.au>.

Grazing land management workshops

Grazing Land Management (GLM) workshops are customised for each region of Queensland and are designed to help managers improve their profits in a sustainable way. By understanding the relationships between pasture, water, soils, woodlands, biodiversity, fire and weeds, managers can assess pasture management options. Participants are given a comprehensive set of notes that cover the information provided in the workshop.

The workshops can help answer questions such as:

- How can I improve the condition of my land?
- How can I improve carrying capacity?
- I am thinking about buying my neighbour's property—what is it really worth?
- What role does fire play in the management of my property?

For further information contact the DEEDI Business Information Centre on 13 25 23 or email <beef@deedi.qld.gov.au>.

Stocktake package

DEEDI's *Stocktake* package provides a tool for land managers to adjust stock numbers based on seasonal forage supply. It allows managers to quantify the effect that poor land condition can have on their long-term paddock carrying capacity. The package includes a one day workshop, a training manual, a field assessment booklet and a database that can store data and images.

For more information about *Stocktake,* check the DEEDI web site at <www.deedi.qld.gov.au>.

Web sites

DERM's website <www.derm.qld.gov.au> contains a number of publications that relate to this guide. They are best found by using a web search engine or the search box on the home page of the DERM web site.

- *Land Condition Assessment and Monitoring Kit—Rural Leasehold Land*

- Fact sheet: L201 Delbessie Agreement—land condition assessments contains more information about the land condition assessment process
- Delbessie Agreement (State Rural Leasehold Land Strategy) Guidelines for determining lease land condition, sets out the full land condition assessment process.
- State of the Environment Report Queensland for 2007. Check the sections on 'Land, Inland waters and wetlands, Biodiversity, Invasive plants and animals'.

The Queensland Office of Climate Change <www.climatechange.qld.gov.au> website has the following publications:

- Climate change impacts on Queensland's regions—a series of brochures prepared for 13 different regions—. (search for 'Climate change impacts on Queensland's regions')

The Long Paddock website <www.longpaddock.qld.gov.au> includes the following:

- information about SOI values
- current drought declared areas in Queensland
- maps comparing recent rainfall with long term averages
- data from pasture growth models, such as *AussieGRASS*
- seasonal conditions outlook for areas throughout Queensland
- seasonal outlooks based on the SPOTA-1 system
- access to the *FORAGE* products.

The DEEDI web site, <www.dpi.qld.gov.au> has information about many aspects of profitable and sustainable beef production as well as information about *Grazing Land Management* and *Stocktake* workshops

Publications not available online

- Fensham R and Fairfax R 2007. *Talking fire – Burning for pastoral management in the Desert Uplands*, Desert Uplands Build-up and Development Strategy Committee, Barcaldine.
- McIntyre S, McIvor JG, and Heard KM (Editors) 2002. *Managing and Conserving Grassy Woodlands*, CSIRO Publishing.
- McKeon G et al 2004. *Pasture Degradation and Recovery in Australia's Rangelands – Learning from History*. Queensland Department of Natural Resources Mines and Energy.
- Managing for water quality within lands of the Burdekin Catchment – Guidelines for managers, Burdekin Dry Tropics NRM, 2008.

The following publications are available from DEEDI:

- *Managing native pastures: a grazier's guide*
- *Managing grazing in northern Australia: a grazier's guide*
- *Managing grazing in the semi-arid woodlands: a grazier's guide*
- *Managing Mitchell grass: a grazier's guide*
- *Managing Mulga grasslands: a grazier's guide*
- *Graziers' experiences in managing mulga country*
- *Managing northern speargrass: a grazier's guide*
- *Managing southern speargrass: a grazier's guide*
- *Managing the Channel Country sustainably - Producer's experiences.*

Software

- *Land types of Queensland* CD-ROM available from DEEDI

- *Rainman Streamflow 4.3* computer program, available from DEEDI Toowoomba by calling (07) 4688 1200 or online from the Queensland Government Bookshop. <www.bookshop.qld.gov.au>.

Telephone contacts

DERM—13 QGOV (13 74 68)

DEEDI Business Information Centre—13 25 23