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Reading the rangeland: a guide to the arid shrublands of Western Australia

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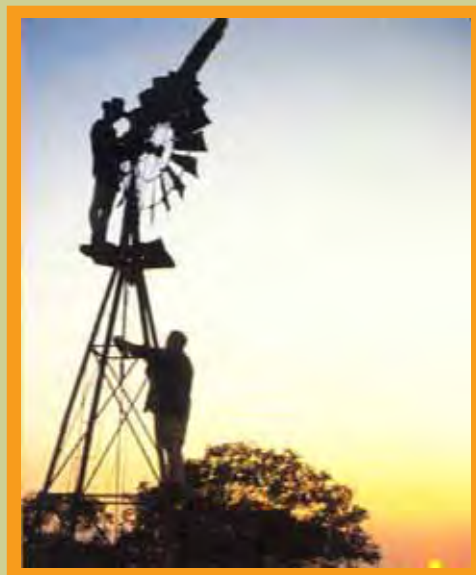
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Reading the RANGELAND

A guide to
the arid shrublands
of Western Australia

by Don Burnside, Alec Holm,
Alan Payne and Georgina Wilson



DEPARTMENT OF AGRICULTURE
WESTERN AUSTRALIA

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Background to authors

Department of Agriculture senior adviser **Don Burnside** has spent most of his working years based at Kalgoorlie and Carnarvon in the WA arid shrubland. In these locations he was involved with rangeland research and extension activities, in particular the establishment of land conservation districts in the pastoral areas. He recently completed post-graduate studies in Agricultural Extension at the University of Queensland.

Alec Holm has been working in the rangeland since 1968 based in the Kimberley and Gascoyne. He has also worked in Nigeria and is currently involved in an FAO project in Iran. Alec holds a Master of Agricultural Science degree from the University of Western Australia and has published many scientific papers on his research work in the rangelands. He is currently the senior adviser managing the soil and vegetation monitoring program in the rangelands.

Alan Payne is the senior adviser leading the Rangeland Survey Group within the Department of Agriculture and has been actively involved in studying and surveying the outback areas of Western Australia for many years. He has an unparalleled experience in Australia in this work and has co-authored several of the detailed surveys of the rangeland which helped provide background material for this book.

Georgina Wilson is a journalist with a healthy curiosity about the rangeland, and a determination not to become confused by technical jargon. Since graduating in Agricultural Science from the University of Western Australia she has worked in WA, interstate and overseas in broadcasting, newspapers and other communications media.

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- **Philip Thomas** for organising maps and other cheerful assistance.
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- **David Tongway** from CSIRO Wildlife and Ecology in Canberra, for his enthusiasm, encouragement and the use of photographs and drawings.
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Foreword

As a farmer, I welcome this publication that can help translate detailed scientific research to the people who will benefit most.

Managing the rangelands is complex. Soils and vegetation can vary considerably over short distances in distinct or subtle ways. Separating climatic from management influences on the condition of the land has always been difficult.

Whether we live on a sheep station, in a country town, in an Aboriginal community, a mining camp, or even if we only visit the Australian outback, it is vital that we understand and appreciate the unique character and management requirements of the rangelands. This book funded by the National Landcare Program will contribute to that understanding.

Much of our vast arid shrubland has only been settled by Europeans for just over a century compared with thousands of years of Aboriginal involvement. Consequently, our understanding of its unique landscape and processes is still evolving. Learning to 'read the rangeland' has been a slow process, involving the knowledge and skills of pastoralists, Aborigines and scientists. In particular, the Resource Inventory and Condition Surveys commissioned by the Government since the late 1960s have given present and future users an excellent body of knowledge to guide management. I acknowledge the efforts made by people in the Departments of Agriculture and Land Administration in mapping and describing the soil and vegetation in the arid shrubland areas.

Reading the rangeland has been prepared by an experienced team involving technical experts in rangeland management and publication. It was also 'road tested' by a diverse group of leading pastoralists and others with love for and interest in the country. I believe the final text melds the ideas from both these groups in a way that both new and old users of the rangeland will find fascinating.

I commend it to you.



Monty House MLA
MINISTER FOR PRIMARY INDUSTRY



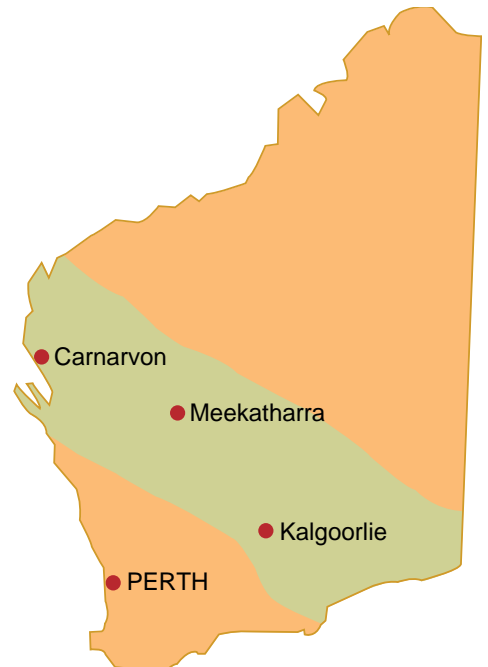
Chapter 1 - Introducing the arid shrublands

When most people think of Australia's outback they often visualise the arid shrublands — endless red-brown plains as far as the eye can see, perhaps broken by an occasional range of low hills, scantily clothed in stunted mulgas casting their shade over grey-green shrubs and dry grasses.

In Western Australia, such lands stretch from the Indian Ocean between Kalbarri and Exmouth in a broad arc through the Goldfields to the Nullarbor and the Southern Ocean. They cover about 850,000 square kilometres bounded by the 23° line of south latitude to the north, the drier desert country in the north-east, and to the south by the agricultural areas where more reliable and more generous rainfall encourages landowners to plant and harvest crops.

These shrublands, often known as 'pastoral country' or 'station country' because pastoral leases occupy 85 per cent of the area, were first opened for European settlement in the 1870s. Towards the end of the nineteenth century gold discoveries stimulated further interest, and by 1910 most of the suitable grazing country had been allocated to pastoralists.

Grazing of sheep for wool expanded steadily as new settlers took advantage of the large tracts of land available, and sheep numbers peaked in the 1930s. During this



time and subsequently, considerable damage was often wreaked unwittingly on some areas of land. Most new settlers, for example, knew little about the rangeland onto which they were releasing their herds of cattle and flocks of sheep. Its grasses and herbs varied from those found in other parts of Australia and were radically different from those known in Europe. Its shrubs were also new but the stock soon found which were more palatable. If stocking rates were excessive, particularly around rivers and other water sources, few pastoralists would have understood the long-term damage before the most

palatable species were eaten out or trampling had led to soil erosion.

Mining also had a major impact on the landscape from an early stage, particularly on the vegetation of the Murchison and Goldfields. Timber was harvested extensively for fuel and building purposes. Meat, dairy and draft animals needed forage and soon made use of the more palatable local shrubs and grasses close to mining settlements.

Population of the rangelands is now very low, mostly pastoralists, Aborigines and miners, but the very emptiness of the country is an attraction to many seeking an escape from the cities, or a wilderness experience.

Some stations now offer accommodation to travellers and tourists, ranging from bedrooms with private facilities within the homestead to self-contained cottages, shearers quarters and caravan parks. Guests may have the opportunity to become temporary station hands, go bush walking, bird watching and sight seeing.

The main tourist season is in the cooler months from May to October and details of accommodation can be obtained from local and city tourist offices, motoring organisations and accommodation guides.

Though rainfall in the WA shrublands is comparable to that experienced in other famous rangelands of the world such as the Texas plains or parts of north Africa, its reliability here is lower. The most reliable rainfall occurs in the winter, the result of

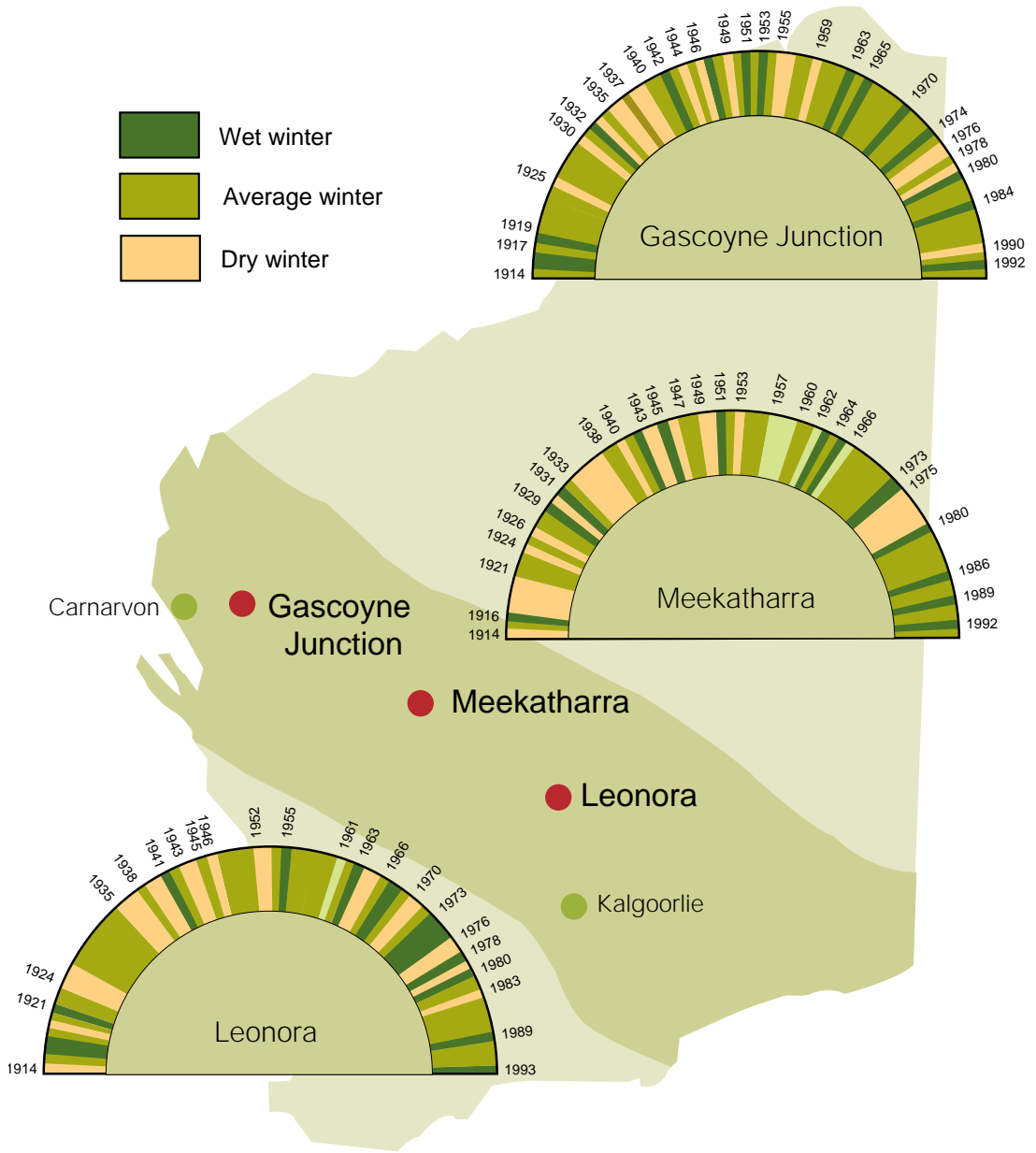
rain-bearing depressions that stray north and eastward from the agricultural areas, but the heaviest rainfall events frequently result from tropical cyclones in summer.

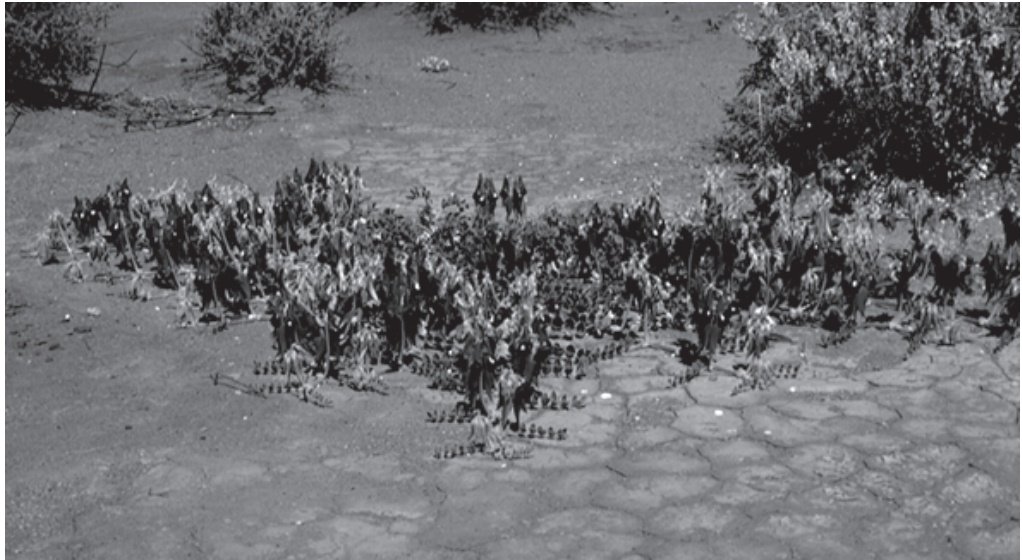
In the Murchison for example less than 20 per cent of rain normally falls in summer, making the winter rain the most important for stock and vegetation. While raw rainfall data are frequently used as a gauge of season, more sophisticated measures now available consider the effects of both rainfall and evaporation rates. For the arid shrublands a dry winter season (May to October) is considered to have less than twenty five consecutive days suitable for plant growth while a wet winter has at least a seventy five consecutive days suitable for growth.

Seasons in selected shrubland centres in 80 years from 1914 to 1993

Centre	No. of dry winters	No. of wet winters
<i>Gascoyne Junction</i>	18	15
<i>Meekatharra</i>	33	14
<i>Leonora</i>	23	16

Considering the records from three rangeland centres, it can be seen that some very dry winters are inevitable, even close to the coast. In the eighty years from 1914 to 1993 Gascoyne Junction for example had eighteen dry winters while further inland there were even more.





Sturt's desert pea is one of the many attractive wildflowers that bloom in the shrublands in good seasons and attract the attention of travellers.

At Meekatharra four winters occurred in which the soil water store was never sufficient for plant growth on even five consecutive days. One of the worst periods was during the 1930s and 1940s, although the late 1970s were also very dry.

All three of these centres experienced extremely dry winters in some years, but at other times they fared differently due to the different paths and intensity of the rainfall patterns.

A wet winter season followed by good summer rain can produce a relatively luxuriant growth of grasses and other plants very quickly, but successive dry seasons, which occur more frequently, result in few new plants and heavy pressure on existing vegetation from both native fauna and introduced stock.

“It’s a wonderful season in the north. The wildflowers look fantastic,” may be a frequent comment from travellers, but the colourful everlasting daisies and other annuals are poor indicators of the true condition of the country. A little winter rain and ephemeral plants such as the everlastings will germinate, mature and set seed within a very short time. But in drier years after their remains have been whirled away by the scorching, summer wind leaving only bare soil surface, it will be the less eye-catching perennial grasses and shrubs which provide food for both stock and native fauna and lasting protection for the soil.

Adaptation of some shrubs to these hot arid environments can be truly amazing. Even in late summer when conditions are most

severe they continue, not only to survive, but produce food material. For example, the optimum temperature for photosynthesis for the berry saltbush is more than 37°C and its heat resistance limit is 59°C. Values for hop mulga are only slightly lower.

With rainfall so irregular, plant communities have become very diverse because no single set of survival strategies will remain successful over long periods. Slow growing, deep-rooted plants are better able to survive long droughts and to make better use of water than fast growing, shallow-rooted annual grasses or herbs but are less competitive as seedlings. Short-lived plants grow faster, invest less energy into producing roots, but are less drought tolerant. This means that without influence from man or other animals the mix and hierarchy of species can change fairly quickly.

Long-lived deep-rooting perennials tend to dominate regions with intermittent rain and low fertility but their regeneration may be irregular. Pearl bluebush plants for example are believed to have a lifespan of up to three hundred years but good establishment may only occur every twenty or thirty years in the right combination of conditions. But the passage of a deep rain-bearing depression can turn drought-stricken country into a garden almost overnight as perennial grasses respond with new green shoots, and annual herbs and grasses germinate very quickly. (Succulents that store water in their stems such as cacti, require regular rain,

which explains their absence from the arid shrublands.)

All arid zone perennial shrubs have a high regeneration rate after defoliation which may result from grazing, fire or drought. (In fact defoliation may be a survival mechanism for some shrubs in prolonged dry periods. If they have no leaves, they need not continue photosynthesis!) But if shrubs face a second defoliation soon after recovery from the first (perhaps due to heavy grazing), they often fail to survive.

Grazing by introduced animals is sometimes considered to be universally harmful to natural vegetation, but this is not necessarily true. Heavy grazing by both native and introduced animals can certainly remove palatable plants and tilt the balance in favour of less palatable species but lower levels of grazing pressure may do no harm or even benefit vegetation. Twenty three years after exclosure of a site at Coodardy near Cue the species diversity was actually lower than on a similar grazed area. However, in other cases exclosure has resulted in increased species richness.

After more than one hundred and twenty years of settlement in some areas of WA's rangeland, understanding of the interactions between plants, animals, soils and climate is still incomplete. This is due to the complexity of the environment and the relatively short period of scientific inquiry.

Rangeland condition can be considered from two viewpoints: **short-term seasonal** condition and **long-term** condition. Seasonal conditions relate to the relative abundance of short-lived plants that thrive in favourable conditions after good rains.

On a year-round or longer basis, animals cannot survive on seasonal growth alone but require long-lived vegetation as well. In general terms, long-term condition is almost independent of season but depends on grazing pressure, major climatic events and sometimes fire.

In good seasons, long-term condition is often not a major influence on animal production. Indeed, some degraded areas with reasonably healthy soil can produce larger amounts of forage than similar country in good condition. But it is during the inevitable dry spells that good long-term condition becomes vital – providing a readily available, if less attractive, source of perennial vegetation to protect the soil and succour its inhabitants.

New species of plants are still being discovered and even major species such as the mulga may be subdivided into new sub-species as distinctly different forms are revealed. Read a scientific description concerning rangeland plant species from ten or twenty years ago and several botanical names are sure to differ from the latest publications.

Official knowledge about the rangeland has accumulated slowly. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) began mapping the WA rangelands in the 1950s but these first surveys were concerned mainly with broad scale description, without assessing range condition.

The Western Australian Department of Lands and Surveys began its own surveys in the 1960s and prepared maps showing broad classification of pasture types. The main use was to define land degradation and estimate paddock and station carrying capacities for the pastoral industry.

More recently, detailed rangeland surveys of certain regions have been completed and reports published by the Department of Agriculture (DAWA) and the Department of Lands and Surveys (now known as Department of Land Administration, DOLA). These began with a report on the condition of the Gascoyne Catchment, commissioned by the Pastoral Board in 1969 after a series of damaging floods affected the Carnarvon townsite. More recent surveys have included parts of the WA Nullarbor Plain (1979), the Ashburton River Catchment (1983), the Carnarvon Basin (1987), the Murchison (1994) and the north-eastern Goldfields (1994).

Overgrazing by feral and domestic animals has been a common cause of land degradation, frequently involving the most productive areas of fragile alluvial country

because it was close to water. Over five survey areas (Murchison, Gascoyne, Nullarbor, Ashburton and Carnarvon) about 40 per cent of land was estimated to be in good condition, a third in fair condition and just over a quarter in poor condition based on its potential for long-term sustainable pastoral production. The proportions varied considerably in different areas, with less than 10 per cent in poor condition in the Ashburton but more than 40 per cent degraded to poor in the Murchison and Nullarbor. However, on the Nullarbor the change was caused by the effects of rabbits and fire rather than domestic stock.

Rangeland monitoring using large scale aerial photography was begun by DAWA in conjunction with CSIRO in 1970. Today, satellite imagery is combined with close range ground data from seventeen hundred permanent sites, helps to provide valuable information for both the government and pastoralists to aid future management. With every year the knowledge bank on this unique area is growing, but much remains unclear. It is important that we conserve the land for long-term sustainable pastoral production and other uses, and learn how to overcome past mistakes.

Modern mining operators are also making far fewer mistakes than the pioneers. By law, companies must rehabilitate land as an integral part of their operations. But mining does bring people, and the control of people can be difficult. Uncontrolled access to land by off-road vehicles – four-wheel drives and

trail bikes – plus the lighting of bushfires can damage land surrounding mining communities very easily.

Tourists too, travelling through country for a few brief days or weeks, may not realise the impact they could have on what seems a very tough environment. For example, a wheel rut cutting through a crusted soil surface can lead to an erosion gully, diverting natural water flow and resulting in water starvation of many hectares of country. No wonder then that tourist accommodation for those wanting to see Ayers Rock (Uluru National Park) in the Northern Territory is now sited well away from the rock itself.

Any land manager is flying blind without an understanding of the processes that are shaping the landscape and its vegetation. Natural processes involving water, wind and occasionally fire occur continually. Very little may happen for a long time, followed by sudden changes in the balance or survival of species caused by very wet or very dry years.

If soil is lost from rangeland through erosion, it is effectively lost forever as natural weathering of rocks and new soil formation are extremely slow. If plant species are lost or the structure and density of the vegetation is permanently altered, the character of a whole area can change. There are seldom second chances when we make mistakes!

Chapter 2 - Soil and vegetation processes

Western Australia's shrublands have many similarities with rangeland elsewhere such as the Russian steppes, the veldt of South Africa and the plains of America, but tend to be more ancient, less fertile and flatter than most. They are distinctive for their red soils, caused by the presence of iron oxide – a valuable resource exploited further north. Average annual rainfall ranges from 150 to 250 millimetres, but can vary enormously between seasons both in distribution and amount. The statistics themselves can also be misleading as a few very high rainfall years can boost the long-term average, while actual falls are much less in most years.

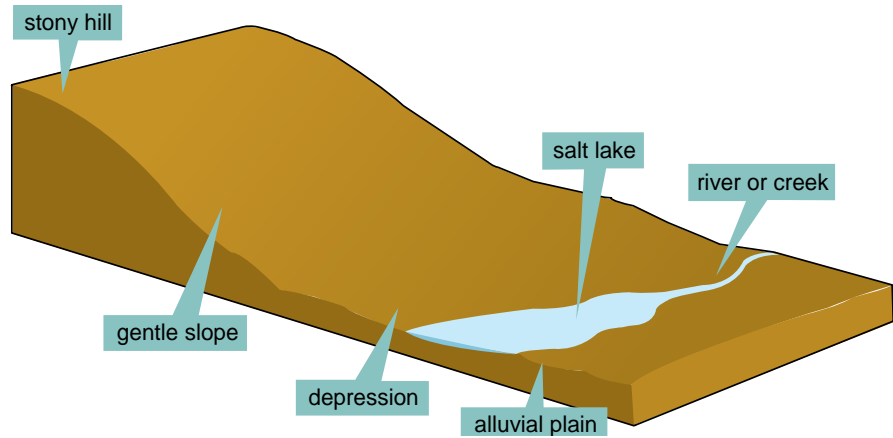
In agricultural areas the **annual pattern** of rainfall is familiar to all and essential to crops and herds alike. In the rangelands, the seasons matter less, and it is the **climatic events** that are vital – events such as a deep rain-bearing depression or tropical cyclone bringing heavy rain in a very short time. Such events can result in a huge pulse of regeneration of both plant and animal communities which declines slowly over years or even decades. Similarly, successive dry years may result in loss of many individual plants and even particular species from certain areas. Depending on the depletion of the seed bank and the soil loss through erosion, return of better

seasons may still result in permanent change in the vegetation as more aggressive colonisers such as annual grasses or unpalatable shrubs gain more advantage from regeneration opportunities.

Soil moisture is normally the limiting factor for plant growth. Soil fertility tends to be secondary, although most WA rangeland soils are inherently infertile. (Phosphorus and nitrogen levels for example are less than half of the average found in arid zones of other continents.) Rangeland soils support comparatively sparse vegetation, which in turn supports low populations of animal life.

And while a general area may receive 200 millimetres over a year, the effective rainfall can be much less or much more for individual patches in different parts of the landscape. A stony hill for example may only absorb half of the rain that falls on it because the other half runs away down the slope. Meanwhile at the foot of that slope, small depressions may receive the equivalent of 600 millimetres – their own basic 200 millimetres plus double this in run-off from surrounding slopes. The result is a dramatic difference in ability to support vegetation and hence animal life.

Structures such as roads, a mine dump or even a stock pad may affect the natural flow of water across the land after rain. Instead of gentle sheet flow with much of



A typical landscape in the arid shrublands.

the water being absorbed as it moves slowly across the plain, a man-made bank may result in ponding on one side and drier conditions on the other.

Water starvation is often apparent when driving through the shrublands, reflected by smaller and more scattered shrubs on the downslope side of the road. Where water once flowed gently across the landscape, road construction, even a simple gravel road, causes some flow to be diverted along the roadway to the detriment of the areas down the slope. Within a couple of years the balance of plant species in both these areas will alter with corresponding changes in the numbers of insects, micro-organisms and small animals.

It's the 'rich get richer and the poor get poorer' syndrome. The better the condition of an area of land, the more effective it can be in trapping and retaining scarce resources and therefore able to retain or even improve on that condition. On a soil in good condition

a fall of 15 mm of rain may be sufficient to start plant growth, but at least 30 mm may be needed on degraded soil where water is poorly absorbed so less is available to plants.

Existing vegetation and its associated litter is also able to conserve precious moisture by shading and mulching effects on the soil surface. These help maintain suitable conditions for further plant growth even under the harshest conditions. And the healthier and more diverse the plant community, the greater the protection and stabilisation for the ground below and around it. Shade and shelter from existing vegetation helps create a niche for germination of more plants and so those processes continue.

Temperature of the ground is also affected considerably by the presence of vegetation. Exposed soil surfaces experience much greater extremes of both heat and cold than those protected by vegetation. On hardpan



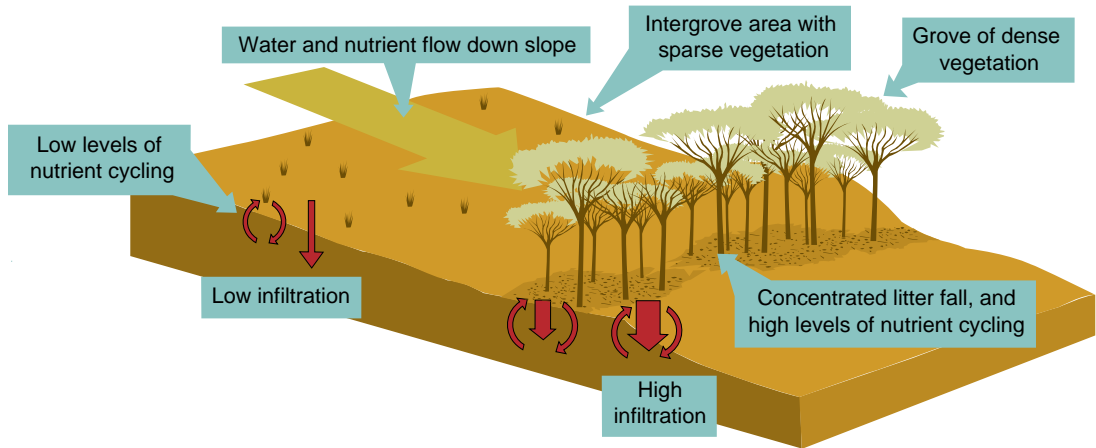
Growth of one vigorous shrub often provides sufficient protection from both animals and the elements for successful establishment of other plants close to its base. Clumps of three or four different species growing together are very common. Very palatable species often survive only where protected by other species that are less attractive to grazing animals.

plains the summer temperature beneath a tree may be 40°C, but could build to 60° or 70°C a few metres away on an exposed stony surface.

Local recycling is also important. Leaves, twigs, pieces of bark, flowers and seeds drop continually from existing plants, and eventually break down to provide nutrients for other plants (or even the same plant if it lives long enough) and soil fauna. And the droppings from the grubs, caterpillars, grasshoppers and other tiny animals which

find food and shelter within the plant community then fertilise the ground and further benefit the plants.

But if land loses its vegetation, the surface becomes more vulnerable to both water and wind, and likely to lose more soil and nutrients which are concentrated in the top 5 to 10 centimetres. Penetration of rain then declines and the whole system can degrade even further. And once a soil surface is worn smooth and sealed by the action of either wind or water or both, its ability to



Water and nutrient movement through groves in the arid shrublands.

trap and incorporate even small amounts of organic matter and water declines even more. It then becomes less fertile and very inhospitable for seedling establishment.

Diversity is extremely important for long-term survival of a community of plants as individual species react differently to opportunities and stresses. A light fall of rain for example might do nothing for a particular grass species except wash the dust from its leaves – certainly not produce new growth. But the same fall might be a useful bonus for lichens growing on the surface and helping to bind the soil.

Similarly, some species of perennial grasses will produce succulent green shoots from light falls of summer rain while other plants make their best and most useful growth during winter. Important palatable shrubs such as currant bush lose their leaves after

periods of moisture stress but resprout after rain, springing to life from apparent death. Maintaining a mixture of species helps ensure that at least some vegetation will survive the extremes of climate and this gives the system **resilience**.

Some country tends to be very resilient and can recover fairly easily after major disturbance such as overgrazing or drought. Other land has little resilience, so that change tends to be more permanent. Examples of resilient country include the bluebush communities on the plains near Kalgoorlie and Carnarvon. This resilience is due to their very flat topography combined with plant species that are both long-lived and resistant to grazing.

In contrast, alluvial plains adjacent to major rivers have much less resilience. If vegetation is removed, erosion is almost

inevitable and the soil fertility and the land's carrying capacity are reduced permanently – at least in human time scales. After a few thousand years there might be significant recovery through new soil formation, but that is pretty irrelevant for most of us.

Landscape processes

When country is healthy, which usually means supporting vegetation close to its potential, the soil, water and nutrients essential for life are conserved and recycled for use within the system. A small amount of wool, meat or other products may be harvested from the range, but the natural processes such as nitrogen fixation by leguminous plants such as acacias and cassias and weathering to provide phosphorus and other minerals, ensures that the system is self-perpetuating.

When rangelands are only in fair condition or worse, they tend to lose material (soil, nutrients, organic matter) through water and wind erosion and cannot recapture replacement. In poor condition, even if grazing pressure is relieved, land recovery can be long and arduous – if it happens at all.

Where land degradation does occur, the extent will depend on the soil type and the position in the landscape. While one particular soil type would be quite stable to disturbance in a hollow or on a flat plain, it might be far less resilient facing the erosive power of water flowing down a slope.

One of the striking aspects of rangeland is the existence of **fertile patches** in otherwise

less fertile surrounding country. These patches may be a relatively small part of the whole landscape but responsible for a large proportion of vegetative growth over time. Each country type has a characteristic pattern of patches and any reduction in their number and size is a sign of deterioration.

In mulga shrublands the fertile patch is a distinctive grove, obvious for its taller and thicker trees and shrubs compared with the areas between groves. As the vegetation between thickets deteriorates, the thickets probably receive additional run-on water, but the areas between are eventually left bare. As the degradation process continues, the thickets themselves lose the capacity to trap run-on water so that water flow through the thicket increases and both water and nutrients pass unhindered and unused through the landscape.

Arid vegetation is well adapted to the climate. The structure of some trees and shrubs allows them to channel rain down the trunks and into the root zone below making the most of any showers. Mulgas for example can capture 40 per cent of the rain that falls on their canopies as stem flow. This contrasts with the 'drip line' below other trees which marks the outside perimeter of the foliage above the ground.

The absorption of moisture into the soil is much greater around and beneath existing plants. In a trial near Carnarvon the infiltration rate beneath bluebush shrubs

was found to be ten times that occurring between the shrubs. Similarly, under perennial grass tussocks such as woolly butt the infiltration rate can be four times greater than in the areas between tussocks. If the tussocks are not present to hold and improve the soil, much of the rain falling on the ground just flows away and evaporates. During relatively light showers of rain grass mounds tend to absorb all the rain, while between the tussocks the water ponds quickly and runs away.

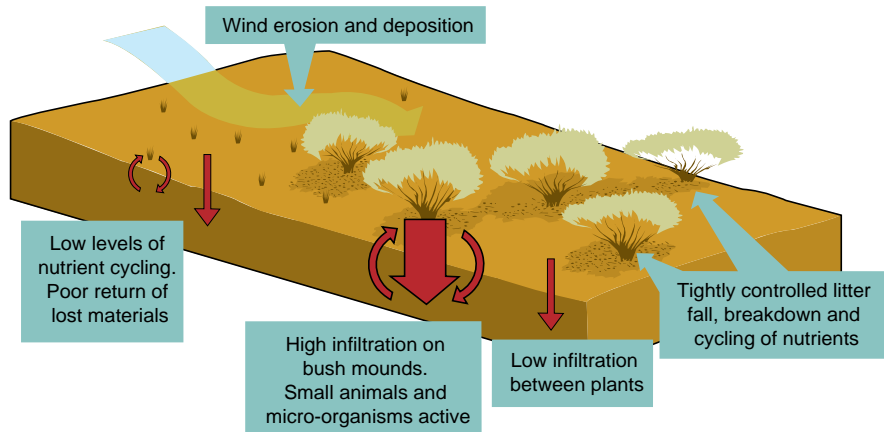
In vegetation dominated by low shrubs or grasses the individual plants tend to form the fertile patches. This is very apparent in

the saltbush and bluebush plains where individual shrubs create bush mounds of accumulated dust, sand and litter beneath and around themselves. The older and more established the plant, the larger and deeper the mound and probably the larger and more varied the associated populations of insects, lizards and other small animals. Their burrowing activity then adds to the network of small channels in the soil, increasing the infiltration of water.

Mounds are topdressed with litter from the shrubs or grasses above which provides shelter and food for small animals and gradually decomposes and is incorporated



Cotton bush is regarded by many as an important indicator species, particularly in mulga country. It is fairly palatable to stock, but its numbers are likely to be highest after loss of other more sensitive indicator plants. Individual plants can live for many years and tend to form mounds around their bases.



The capture of water and nutrients by fertile bush mounds.

into the soil. Concentration of nutrients essential for plant growth such as phosphorus and nitrogen is also much greater in the first centimetre of soil beneath plants in the mounds than outside the mounds.

The mounds are able to capture and hold both soil and water moved from other areas of the landscape. They tend to attract new litter on the upslope side and lose from the downslope side, so these are the aspects to examine to determine whether mounds are extending or diminishing.

Some plant shapes are more effective trappers of litter than others. The least effective would be the icecream cone-shaped shrub which does little better than a telegraph pole. Wind swirls around its base whipping away loose grains of sand plus any leaves, twigs or fruit that fall from above. The most effective trappers are those plants which branch low and spread over

the ground such as some saltbushes and bluebushes, blocking the wind and slowing blow and flow of material by wind or water.

Particularly on deeper soil, a mound may be occupied by one shrub and then attract several others. What at first glance appears to be a single plant may really be multiple plants of the same species or three or four different species taking advantage of the protection from wind and grazing animals, extra shade, moisture and greater fertility. In heavily grazed areas, many palatable plants such as the bluebushes may survive only where protected by larger, less palatable long-lived shrubs such as needlebush.

Scientists often describe the fertile mounds or fertile grove areas as 'sink zones' into which flow resources such as soil particles, water and litter from other 'source zones'.



Litter trails and litter on the move are always a bad sign, indicating that fallen leaves and other material are not being retained, but are being washed or blown away. Fallen branches or other objects on the ground can help to trap small leaves and other organic matter allowing them to be incorporated into the soil rather than lost.

Between the two there is usually a ‘transfer zone’ which is downstream of the source zone. Temporary and intermittent storage of material occurs in this zone and many erosional events such as major storms may be required before sediment crosses the transfer zone. Every source has its associated transfer zone and sink, even though the sink may be a considerable distance away.

Where the fertile patches are individual mounds the distance between mounds can provide a guide to range condition. In a saltbush plain in good condition, mounds may be only 1 to 3 metres apart, but could be separated by 4 to 6 metres of bare ground where condition is poorer. Comparing the number of bush mounds in a certain area gives an indication of landscape health. Individual mounds may have a life of fifty years or more depending on the life spans of their resident plants, but if the shrubs die and the mounds are not recolonised, they are gradually eroded away. The number of remnant bush mounds is another useful indication of range condition. Like empty houses in a neighbourhood, empty mounds are not an encouraging sign.

The amount of litter and its distribution is another pointer to the health of any system. If the litter (leaves, seeds, sticks, feathers, animal droppings) is being actively incorporated into the soil surface then the system is probably healthy. But if litter trains or paths created by either wind or water are obvious, then it is a sure sign that the litter is on the move and less is being retained.

Nature of the soil

Soils vary considerably in their resilience and ability to withstand battering from either the forces of nature or mankind. Sandy soils have the advantage of good water infiltration but may be more

vulnerable to wind erosion than finer clay and loam soils which have well developed surface crusts. After plants are lost from a community, wind erosion increases in the greater spaces between the survivors, and sandy hummocks are deposited around the bases of larger shrubs and trees. Annual plants may grow on these hummocks after rain, but they are too unstable for more permanent growth.

Some soils have a stable surface, which may be protected by stones, natural crusting or plants, but are unstable beneath that surface. Duplex or 'texture contrast' soils are a common example. When the protective surface is cut by an animal hoof or tyre track, the next heavy shower of rain may begin to wash away the soil.

In the higher parts of the landscape some soils are protected by a mantle of grit or stones. These stones deflect the energy of raindrops falling on open ground and prevent erosion, although the soils beneath tend to be shallow and comparatively infertile.

Surface crusts also develop on some soils. They prevent further erosion, but reduce water infiltration. Thin layers of algae, lichens, mosses or other small primitive plants grow over the surface of many soils, and help protect the surface and absorb nitrogen from the air. These plants are known as **cryptogams** and while obvious and colourful during and after rains, at other times they appear merely as dark stains and uneven blotches on the soil surface.

Plant types

Most plants in the arid shrublands are natives, having evolved to suit the particular environment over thousands of years. But a few **exotic plants** have also become established, often through human influence, particularly along roadsides and other areas where the ground has been disturbed. Such immigrants include onion weed and thistles that have spread over many areas.

Many introductions are considered undesirable because they provide little permanent pasture for animals and tend to thrive at the expense of more useful plants. Some, such as the doublegee with sharp spiny seeds, have proved extremely unwelcome to both animals and humans.

Exceptions are buffel grass and Birdwood grass (*Cenchrus* species) which are introduced perennial grasses that are proving a useful forage from the Gascoyne River north. However, they may be displacing some native species, leading to conflict between production and conservation. Wild hops, a distinctive red-flowering winter annual that was introduced by the Afghans, has been useful as an early coloniser of mine dumps.

Annuals, including both grasses and herbaceous plants (or forbs as they are known) are a very important part of the vegetation, particularly in good seasons. While called annuals because they grow and set seed in a single year, they may **not**

appear **every year**, unless the rainfall and seasonal conditions are suitable. In this region most germinate over autumn and winter, providing useful forage over the cooler months and into the spring, but then dry off and lose nutritional value rapidly.

Annuals include many colourful and famous wildflowers such as everlasting daisies and billy buttons, which often thrive on disturbed soil along roadsides where there is less competition from established perennials. Degraded soil from which perennials have been lost can often produce magnificent stands of flowers.

Some plants produce roots, stems and leaves in the first year and flowers and seed in the second before dying. Such short-lived perennials are known as facultative perennials or **biennials**.

But the most important plants in any system are the **perennials**, ranging from large trees down through various sized shrubs to the grasses. Whatever the size, they have a very important role in stabilising the landscape – protecting the soil from the action of both water and wind in all weathers and seasons.

Because the environment is harsh, **trees** are rarely very tall, even when growing along rivers. Among the tallest in the rangelands is the beefwood which may reach 15 metres and is reputed to live for nine hundred years or more. Freshly-cut heartwood supposedly resembles raw beef, hence its common name.

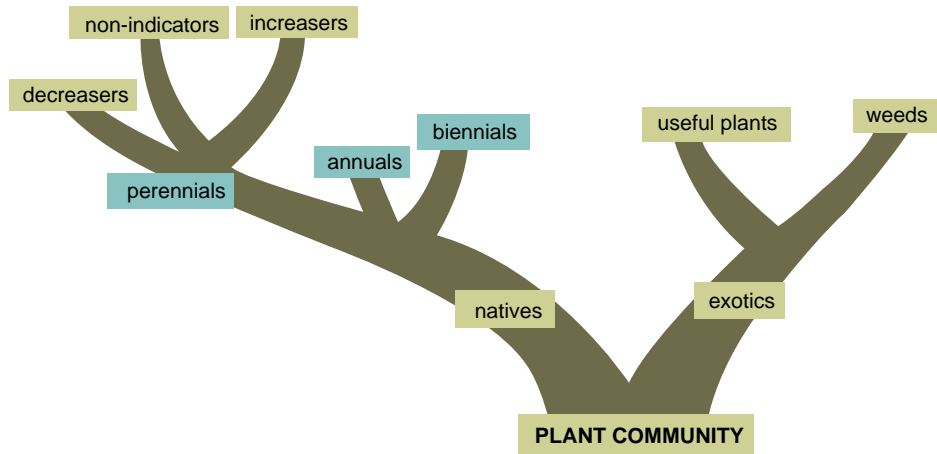
Any plant at least 2 metres high with a **single trunk** to at least 1.5 metres is defined as a **tree**. The most common trees are acacias, such as mulga or snakewood in the northern and western areas, and western myall of the Nullarbor.

Plants more than 2 metres high with **multiple trunks** are described as **tall shrubs**. Many of these are also acacias including bowgada, sugar brother and mulga, which has several different forms, sometimes growing as a tall shrub and at other times as a tree.

Those plants between 1 and 2 metres high are known as **medium shrubs** and those less than one metre high as **low shrubs**. Low and medium shrubs include most of the famous saltbushes and bluebushes, which are both salt and drought tolerant while providing palatable forage. Other useful species include cotton bush, flannel bush and some of the sidas and cassias.

Spinifex is probably the best known of the **perennial grasses**, and several different forms cover thousands of square kilometres. Most spinifexes in the arid shrublands have very little value either to stock or larger native animals such as kangaroos. However, spinifex clumps form important habitats for some birds and small animals. Their seed heads are important food sources for birds and the leaves are useful for termites and other insects.

(To distinguish a perennial from an annual grass species, the simplest method is to



Functional components of the plant community.

check the roots: if it pulls out of the ground easily, it is normally an annual, as perennials need a much stronger root system in order to survive.)

The presence of palatable grasses and shrubs is used frequently as an indicator of the health of the vegetation and landscape. If their number and/or size decline with overgrazing or declining soil health they are described as **decreasers**.

Those plants best able to improve their positions after heavy grazing, erosion or other landscape disturbance are usually known as **increasers**. Frequently these are less palatable plants which tend to be ignored by grazing animals and thus are able to set more seed. They are often woodier and pricklier than the decreasers and eaten only when few alternatives remain in a local area.

Some very palatable shrubs are decreasers in all areas, but others can vary depending on what else is on offer to grazing animals. Plants such as flannel bush and three-winged bluebush could be decreasers in country supporting few alternative browse species, but increasers in more fertile situations where they are ignored.

Overgrazing often results in greater density of woody unpalatable increasers. Apart from providing little forage value for animals, some of these plants are long-lived and can produce thickets which limit stock access to other more palatable plants. The less palatable plants are frequently from the poverty bush (*Eremophila* species) and cassia groups, although a few individual species have some feed value to stock.

Palatability of some other plants varies with the soil. Wilcox bush is a very

palatable low shrub in many locations, though its palatability is often lower on sandy soils. A fairly close relative, turpentine bush, so called for its distinctive tang, is a typical increaser shrub. Turpentine bush is a bright green colour, contrasting with the greyish tones of most shrubs, but is unpalatable to stock. Plants may live for sixty or seventy years and the numbers increase following the grazing of more palatable species.

The cassias (also known as sennas), are distinguished by their yellow five-petalled flowers. They include a few palatable types such as green cassia and creeping cassia, but many others are classic increasers.

In contrast, the **non-indicator plants** include a large group which may or may not be palatable, present in very small numbers, or often out of reach of stock so do not tend to increase to any great extent when others are removed. Numbers remain relatively stable within a plant community and offer little information on the possible changes in condition, except when overgrazing or erosion reaches drastic levels and the number of all plants declines sharply. Many trees, even those with palatable leaves such as mingah bush, are regarded as non-indicators. Others are those plants whose distribution is normally so thin on the ground that their presence or absence provides no clue to condition. Distinctive trees such as the light-green leaved kurrajong are in this category.

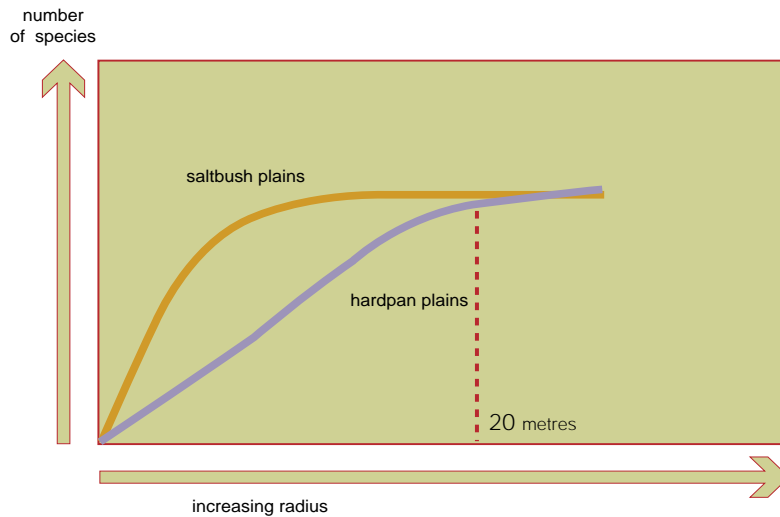
Condition of the range

In this guide, rangeland has been divided into three levels of long-term condition – good, fair and poor – depending on the presence and abundance of **palatable perennial plant species** combined with the **ongoing landscape processes**.

Good condition: When perennial plant species present include all or most of the species expected. Some species may have increased, but the total species composition and number are close to optimal. Soil, water and nutrients are strongly conserved and used within the system. Erosion is non-existent or minor.

Fair condition: Moderate losses of certain perennials and/or increases in other shrubs and grasses have occurred but most original species are still present. Some soil, water and nutrients may have been lost, but most are retained and erosion (if present) is minor. With good seasons and careful management sites can be returned to good condition.

Poor condition: Vegetation is characterised by marked decreases in the number of plants and occasional losses of plant species. This may result in either areas of bare ground or areas dominated by increaser species such as woody shrubs. Because of the loss of individuals and even whole species in rare cases, the soil is more open to water and wind erosion. It tends to lose soil, water and organic matter and is unable to capture replacement materials.



Numbers of species found in a given area can be much greater in some country types than others. In the mulga hardpan areas for example a larger area may reveal more species while in the saltbush plains a few species dominate large areas. A radius of about 20 metres usually provides a reliable guide to the species found in a local area.

Erosion ranges from none to severe and may be continuing.

In some country types **distinct thresholds** have been found. Let the number of plants fall beneath a certain level and there will be a high chance of erosion and a resultant shift from one condition level to another; keep it above this critical point and the system should remain more or less in balance. Flood plains near river frontages provide typical examples of this. Where possible we have tried to indicate these threshold points for common types of vegetation, although they vary considerably in different country types.

In other country the shifts in condition are gradual over a continuum. Lose a few plants and condition of both vegetation and

soil slips only slightly and may be fairly easily reversed by reduced grazing pressure and good seasons.

For each country type we have listed features that should be present for each level of condition, although not all may be found at a single site. For simplicity and ease of reference, most of our measures of plant numbers relate to an area about 10 metres by 10 metres or 100 square metres which we have dubbed a **centihec**. This is one hundredth of a hectare which makes values easily comparable with those used in technical publications such as rangeland survey reports. A centihec is a bit less than half a tennis court. It is three-quarters of the area of a monitoring site (135 square metres) used by pastoralists, allowing

direct comparisons with plant numbers found in these situations.

Numbers of species have been indicated for local areas within a radius of roughly 20 metres. In some country, for example saltbush and bluebush on level plains or river frontages, the vegetation is dominated by just one or two species and a single centihec might give a good indication of the number of species present. But in other country such as mulga hardpan where the individual plant numbers are much lower, a single centihec might contain only four or five different species while a larger area would reveal the much greater diversity of species present.

While the same basic country type can be found in geographically isolated areas, comparing a single factor such as the number of plants can be misleading on its own. For example, the total plants present on good condition mulga hardpan plains in the Murchison will be around 20 plants per centihec but could rise to 35 per centihec in the north-eastern Goldfields, even though the species are similar. And the same broad type of country may support silver saltbush in one area but bladder saltbush a few kilometres away. Bladder saltbush may grow as densely as 250 plants per centihec, but the densest ungrazed stand of silver saltbush may contain only 80 larger and



This small Wilcox bush growing in stony hardpan country near Meekatharra has been grazed heavily, but has the capacity to regenerate given the right seasonal conditions and freedom from overgrazing. The number of Wilcox bushes present is regarded as a key indicator to the health of the rangeland in many areas.

more spreading plants in the same area.

Total amount of plant growth can also be misleading on its own as mass is strongly linked to seasonal conditions and can be boosted enormously by the presence of annuals that may die off and blow away a few months later. Such annual growth can be a very useful addition to the diets of grazing stock in a good year, but may not exist in a drier season.

The size of plants may also not tell the full story. **It is their presence or absence that is more significant.** If an observer views an area that is being grazed by stock after months of dry weather the size of many palatable plants may be fairly small and the total amount of plant material very low. But if good rains fell the next day, seeds would germinate and the existing perennials would respond rapidly with fresh green growth. Within a few weeks, country that appeared to be in only fair or even poor condition to a casual observer could suddenly appear very good again.

Three main elements can affect long-term range condition: seasons, grazing pressure and fire. These can act independently or in combination and result in very long-term or even permanent changes. Where possible we have indicated these effects (as we understand them at present) for different

country types using flow charts. There is no starting point. A particular area of country may be in pristine condition, totally degraded or somewhere in between. The charts indicate how it might have reached its current condition and how this level might be changed.

After a student of the rangeland gets a feel for the plant communities and the likely numbers of certain indicator plants that should be present, both decreaseers and increaseers, he or she should be able to assess the country (read the rangeland) fairly easily regardless of seasonal differences.

Many of the plants described in this guide appear very similar to the untrained eye. This is probably not surprising as they have evolved under the same environmental conditions over thousands of years and are often closely related. In order to gain maximum advantage, we recommend that *Reading the rangeland* should be read in conjunction with *Arid Shrubland Plants of Western Australia* (first and second editions) which contains full colour illustrations and detailed descriptions of most of the plants listed.

Chapter 3 – Main types of country

Over the years, scientists and other observers have sub-divided rangeland into many different categories for varying purposes. Geologists have tended to look mainly at the underlying rocks and have been less interested in what happens above the ground; botanists have concentrated on the exact nature of the vegetation; soil scientists have had a close affinity with the processes that affect the soil, and so on.

In this guide, we have sampled the wisdom of all of these experts seeking common factors rather than differences, and have concentrated on the most extensive types of country. That the tops of hills for example, or narrow fringes a few metres from the main rivers do not fit precisely into any of our groupings will soon become apparent. But such areas are a tiny fraction of the total land and our concern is for the wider

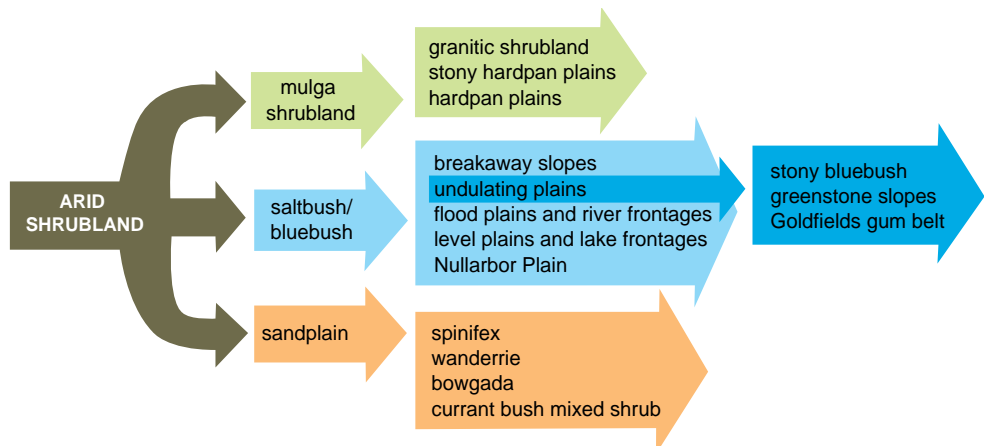
landscape that must be conserved for pastoralism, tourism and for itself.

Three main groups of country are apparent in the arid shrubland:

- Mulga shrubland
- Saltbush and bluebush
- Sandplain.

In some areas these broad country groups may extend for tens of kilometres while in others they combine to form a smaller mosaic across the landscape. Within each main group there are several country types which have different features and different problems for management.

Some of the distinguishing features of the soil and vegetation are listed on page 32 and it should be fairly simple to identify the main groups. Following the key to the next level should help to identify the important country types.



MULGA SHRUBLAND	soil: non-saline, shallow
	main vegetation: open mulga and low shrubs
SALTBUSH/ BLUEBUSH	soil: saline, often eroded
	main vegetation: low bluebush and/or saltbush shrubs
SANDPLAIN	soil: non-saline, deep and sandy
	main vegetation: dense tall shrubs and perennial grasses

Key to country groups.



This area of mulga near Meekatharra is typical of large areas of the rangeland. The mulgas are the largest trees in the landscape which also supports a variety of low shrubs. Standing dead timber is a common feature in these inland areas. Note the distinctive bright green turpentine bush (an increaser species) in the middle ground growing with the grey Wilcox bushes which are useful forage in this country.

Mulga Shrubland

This country is the most common and occupies about 60 per cent of the total shrubland. The shallow soils are relatively infertile and support only scattered vegetation, including the well-known mulga, which is a member of the acacia or wattle family. There are three distinctive types of mulga shrubland:

Granitic Shrubland – see page 42

<i>landscape position</i>	occurring upslope of hardpan plains
<i>topography</i>	hilly or undulating with outcropping granite
<i>soil surface</i>	gritty, coarse sand, cryptogam crusts in parts
<i>water infiltration rate</i>	rapid

Stony Hardpan Plains – see page 47

<i>landscape position</i>	above hardpan plains
<i>topography</i>	gently undulating with distinct drainage lines
<i>soil surface</i>	stony or gravelly
<i>water infiltration rate</i>	slow

Hardpan Plains – see page 52

<i>landscape position</i>	above river flood plains, level plains, lake frontages
<i>topography</i>	level plains, no obvious drainage lines
<i>soil surface</i>	cryptogam crusts common
<i>water infiltration rate</i>	slow

Saltbush and Bluebush

This is some of the most fertile and productive country for grazing animals, although occupying only about 20 per cent of the total rangeland area. The soils are generally 'saline' or salty – a factor which determines which plants grow on them, the best suited including the legendary saltbushes and bluebushes.

In most situations the saltbush and bluebush communities occur on alluvial plains, but are also found on the slopes below breakaways and the undulating plains below these.

Salt crystals lying on the surface of the ground and even on the plants themselves, are an obvious indication of very saline conditions. People familiar with local areas soon learn to recognise the distinctive plants which tolerate salty conditions. Very salty soil is also 'puffy' under a crusted surface.

Low shrubs are the distinctive and dominating form of vegetation, either a single variety of saltbush or bluebush or a mixture of several different types. The soils may be susceptible to wind and water erosion if degraded. We have separated the saltbush and bluebush country into the five most important and commonly occurring groups:



Different forms of low saltbush and bluebush vegetation cover about a fifth of the arid shrubland on saline soils. This area is near the Ashburton River, but similar country carrying slightly different species is very common, particularly on the flood plains of the main rivers and near salt lakes.

Breakaway Slopes – see page 60

<i>landscape position</i>	high, below breakaways
<i>soil surface</i>	sandy
<i>soil colour</i>	greyish-white
<i>soil depth</i>	shallow

Undulating Plains – see page 66

<i>landscape position</i>	mostly lower slopes
<i>soil surface</i>	stony
<i>soil colour</i>	brown or red-brown
<i>soil depth</i>	shallow

Flood Plains and River Frontages – see page 82

<i>landscape position</i>	river plains
<i>soil surface</i>	sandy
<i>soil colour</i>	red-brown to red-grey
<i>soil depth</i>	variable

Level Plains and Lake Frontages – see page 90

<i>landscape position</i>	level plains
<i>soil surface</i>	crusted, cryptogams common
<i>soil colour</i>	red
<i>soil depth</i>	deep

Nullarbor Plain (geographically distinct area) – see page 96

<i>landscape position</i>	gently undulating plains
<i>soil surface</i>	cryptogams common
<i>soil colour</i>	buff (but very dark when cryptogams present)
<i>soil depth</i>	mostly shallow over limestone

Sandplain

Sandplain may be found in small areas interspersed with other country such as mulga shrubland, or cover large areas on its own. There are four basic sandplain types, including the regionally separate currant bush mixed shrub, which occurs on less sandy soils near Carnarvon.



Sandplain areas are often intermingled with other country types. Deep, sandy non-saline soil is usual, supporting a mixture of dense tall shrubs and perennial grasses. This pastoral country in the lower Murchison is dominated by tall bowgada shrubs and wanderrie grasses.

Spinifex – see page 104

<i>landscape position</i>	plains, or banks on hardpan plains
<i>main vegetation</i>	many perennial hummock grasses, some shrubs
<i>soil surface</i>	sandy
<i>water infiltration rate</i>	rapid

Wanderrie – see page 106

<i>landscape position</i>	plains, or banks on hardpan plains
<i>main vegetation</i>	many perennial tussock grasses, some shrubs
<i>soil surface</i>	sandy
<i>water infiltration rate</i>	rapid

Bowgada – see page 112

<i>landscape position</i>	gently undulating plains
<i>main vegetation</i>	low trees/tall shrubs, fewer perennial grasses than wanderrie
<i>soil surface</i>	sandy
<i>water infiltration rate</i>	rapid

Currant Bush Mixed Shrub – see page 117

<i>landscape position</i>	plains
<i>main vegetation</i>	medium to tall shrubs, including currant bush
<i>soil surface</i>	thin crust
<i>water infiltration rate</i>	moderate

Chapter 4 – Mulga Shrubland

Mulga shrubland occupies about 500,000 square kilometres of the arid shrublands, stretching over vast areas of the Murchison, Gascoyne and Goldfields above the river flood plains.



The mulga itself is probably not one of the world's most beautiful trees in many eyes but is regarded fondly by those who appreciate its important role in these dry environments.

It grows in several different forms from the southern Pilbara to the Nullarbor, and is frequently the biggest tree or tall shrub in the landscape, reaching 8 metres in some

favoured locations. Some forms have a definite tree shape (single trunk) while others are multi-stemmed shrubs. Leaf shapes range from broad to narrow to very fine. It is less common on very sandy and very clayey soils.

The mulga is very well adapted to low rainfall environments and low fertility. Its branches and leaves slope upwards allowing rain water to be channelled down the stem, increasing the soil moisture close to the trunk. Deep roots help overcome lengthy dry periods by tapping underground soil moisture, while extensive roots just below the soil surface enable it to benefit from light rainfall while simultaneously stabilising the soil.

In inland areas around Meekatharra and Wiluna, dead mulga and other species are a frequent feature of the landscape. Their presence does not mean a recent pestilence (although hail has been known to kill mulga), but can reflect a gradual loss of individuals over many years. Instead of falling to the ground and rotting away quickly under the influence of moisture and animal activity as happens closer to the coast, the dead timber may remain standing for fifty years or more in the dry environment. Mulga fence posts have been known to survive for eighty years in such areas.



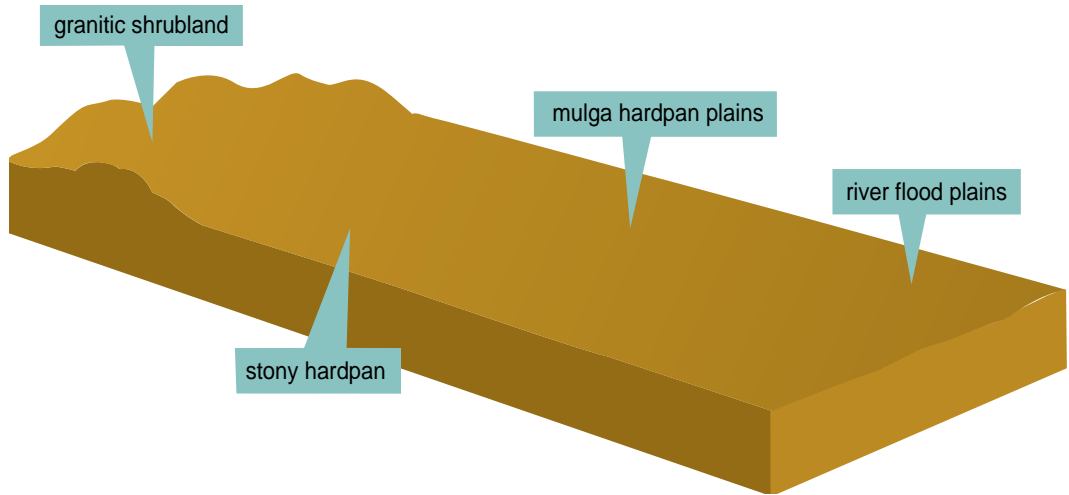
Mulga groving patterns are clearly visible in aerial or satellite photographs (as above). The groves about 50 to 100 metres long, tend to stretch along the contours of the land, even though the country may appear almost flat.

Soils in the mulga shrubland are generally non-saline, shallow and of uniform consistency, that is if they are sandy in the first few centimetres, they remain sandy throughout. They tend to be stable to erosion from water or wind, but may be susceptible to track erosion on tracks and in ‘washes’ that carry concentrated flow. Basic fertility is low.

Good quality underground water is frequently available through bores or wells less than 10 metres deep and this has made the country easy to develop for pastoralism. Mulga country was often the first land to be developed, because of the availability of water. Most mulga shrublands have been

grazed by sheep and cattle, sometimes heavily, for a century or more. Many trees have been removed for fence posts over this time so numbers may now be less than before white settlement.

Groving is a common feature on the hardpan plains, occurring across the direction of the slope. Groves are dense patches of mulga and other shrubs which may range from only 10 metres long to more than a kilometre. At the lower extreme, a mulga grove may consist of only three or four trees, but can still provide protection and a favourable location for smaller shrubs and other plants. Clumping of understory shrubs within fertile patches



Typical arrangement of country types in the mulga.

around the base of trees is common.

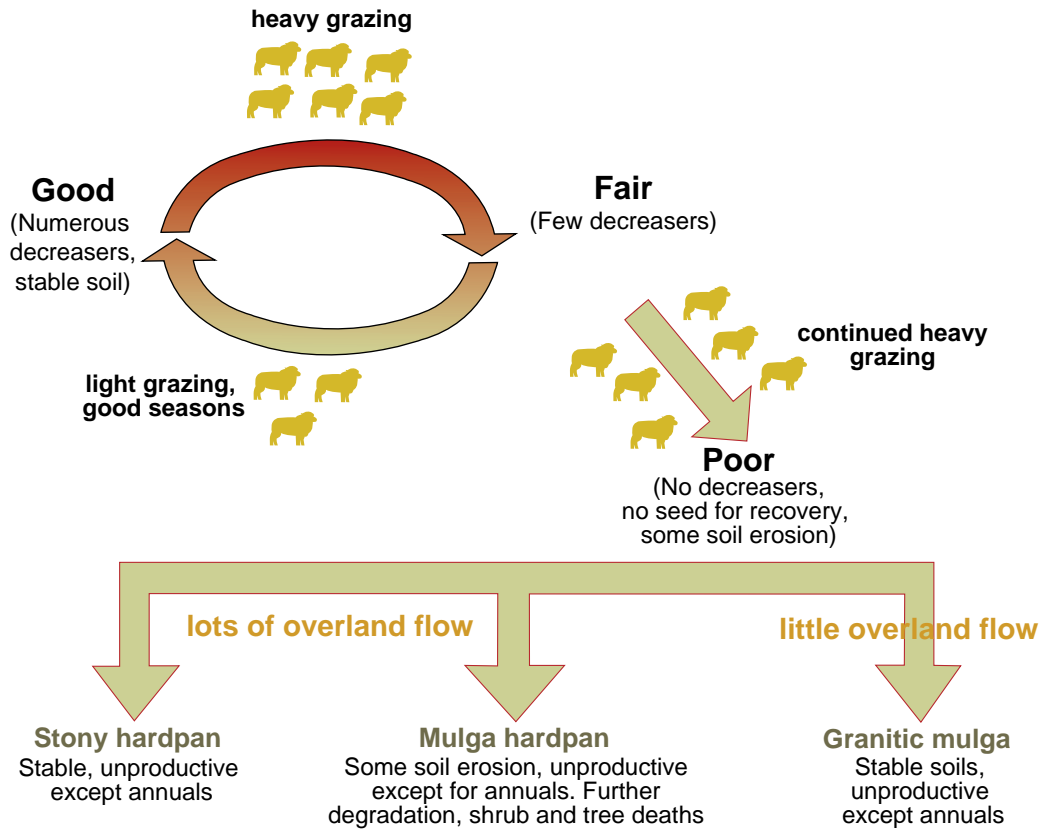
In these types of vegetation, grazing impact is not marked by dramatic change in species related to distance from water, but tends to be reflected in changes across whole paddocks. Some of the most widespread **decreaser** species include cotton bush, horse mulla mulla, mulga bluebush and warty-leaf eremophila, with the most sensitive being horse mulla mulla in the areas where it occurs. Turpentine bush is the most widespread **increaser** following heavy grazing.

Palatable shrubs comprise both long-lived species such as Wilcox bush, compact poverty bush and warty-leaf eremophila plus short-lived species such as cotton bush and mulga bluebush. Germination of the short-lived species can be prolific in favourable years but the long-lived species show steady and less dramatic recruitment. Soils remain

largely intact following overgrazing, so although the soil becomes less suitable for recruitment and water trapping is less effective, rehabilitation can be achieved in the medium term – fifteen to twenty five years.

Regeneration of shrubs is encouraged by building up plant litter and slowing the movement of water and nutrients through the system. Opportunities for re-establishment probably involve a sequence of reasonable to good seasons coupled with low stocking rates to increase both seed and surface litter.

While a casual observer might see a wide variety of vegetation types within the mulga shrubland, it can be divided into three broad types moving down the slope from the tops of any low hills or ridges: **Granitic Shrubland, Stony Hardpan Plains and Hardpan Plains.**



In good condition, mulga shrubland carries a moderate number of decreaseer low shrubs beneath the mulgas and other acacias. Soils are stable under conservative grazing pressure when decreaseer shrub numbers are maintained and there is no soil erosion. If some decreaseers are lost (fair) they can be regained after good seasons and light grazing. However, long-term heavy grazing will result in the country reaching poor condition where no palatable shrubs remain and there is no seed. It is then almost impossible for recovery even if the range is spelled for many years. Reseeding might help recovery but success is uncertain and costs are very high.

Granitic Shrubland

This country type is often found adjacent to and outcropping slightly above the hardpan plains. The soils are generally shallow sandy loams which have been formed by the very slow weathering of granite. Individual areas may be fairly small – perhaps only a few hundred metres across – or much larger. Low granite outcrops are frequent. A typical example is the grit-surfaced plains of the Challenge land system in the Murchison.

Soil surfaces are covered with coarse sandy grit plus some larger stones and pebbles of quartz and granite. The soils tend to be a paler red than the hardpan plains below. Severely eroded sites are rare, and unlike the hardpan plains, roads and tracks rarely cause erosion here.

This country type grades into stony hardpan in some northern areas. Both landscapes are similar plains, but the soil surfaces are sandier in the granitic shrubland. The underlying granite rocks are rich in quartz but relatively poor in other minerals, especially those required for plant growth. Even in good condition, vegetation will not support high stocking rates although the country is attractive to grazing animals. Granitic areas appear to be less drought resistant than the mulga hardpan plains. Water infiltration is rapid but the soils are shallow and grades are steeper allowing run-off after fairly light showers of rain. Growth of annual species is often rapid after rain.

Differences in species with location are considerable, so that some species found in a typical granitic shrubland in the Goldfields for example, may vary from those found in the Murchison. Generally though, the dominant plants will always be acacias, eremophilas, cassias or *Ptilotus* species (cotton bush and mulla mullas).

Groving effects are not common. Trees and tall shrubs are mostly sparse – usually only one or two per centihec (an area 10 metres by 10 metres or 100 square metres) – but include the granite wattle (also known as witchetty bush), mulga, curara and miniritchie. Miniritchie is distinctive for its red bark which separates into small curls along the trunk.

Tall saltbush (often called rhagodia or climbing saltbush) can also be a feature.

The characteristic grasses are short annuals such as wind grass and Murchison red grass. Perennial grasses are few although lemon-scented grass is widely distributed through the Murchison, Gascoyne and northern Goldfields. This grass is rarely if ever eaten by stock, though pastoralists have reported it grazed by euros. Occasional broad-leaved wanderrie and creeping wanderrie may also be present.

Kite-leaf poison occurs around the granite domes in some areas and has caused heavy losses of sheep, cattle, goats and horses. It contains a toxin similar to the widely used

rabbit poison 1080 (monosodium fluoro acetate), to which the native marsupials are immune, having evolved in the same place and time. The leaves are usually eaten when fresh green shoots are present but no other attractive forage is available.

Decreasers include felty fuchsia bush, flat-leaved bluebush, horse mulla mulla, lax bluebush, warty-leaf eremophila, silky bluebush, cotton bush and Wilcox bush. Tall sida and tall saltbush are very resilient to overgrazing and may be the last remaining decreaseers.

Some students of the rangeland put high value on the presence of individual species such as cotton bush, but concentrating on one species only can be misleading. It appears that certain sites may be unusually productive for cotton bush, and that soil fertility varies over short distances irrespective of range condition.

On degraded sites **increasers** occasionally include turpentine bush, crinkled cassia, straight-leaved cassia and banana-leaf cassia.

A good indicator of range condition is the number of species present and the numbers of the palatable plants or decreaseers.

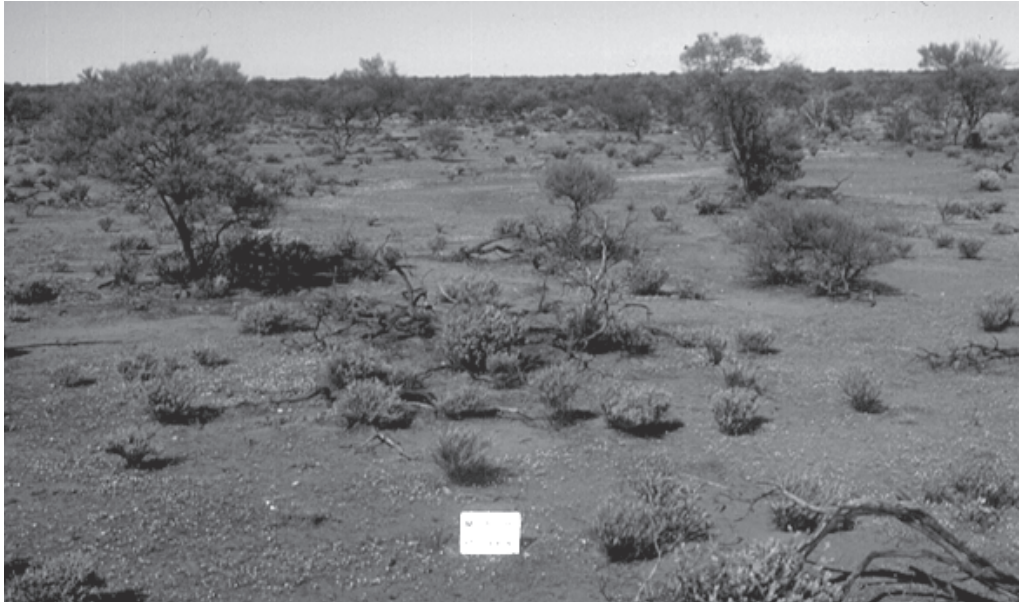
Good news signs

- Many different species present
- Mixed aged plants
- Lots of cotton bush, Wilcox bush, flat-leaved bluebush, felty fuchsia bush, warty-leaf eremophila
- Plentiful cryptogamic crust

Bad news signs

- Few species present and areas of bare ground
- Absence of cotton bush, Wilcox bush, tall saltbush, curara, mulga
- Young crinkled cassia, banana-leaf cassia
- Well chewed bushes
- Broken soil surfaces and absence of crusting

Indicator	Good	Fair	Poor
Number of decreaseer species in local area	4-9	4-6	<4
Average number of decreaseers per centihec	>10	5-10	<3



This site near Cue carrying sparse mulga with a good understorey of low shrubs including many decreaser species is in good condition. There are numerous cotton bush (12 per centihec) and compact poverty bush plants (10 per centihec) visible in the foreground plus a few horse mulla mulla, tall saltbushes and silky bluebushes.

Good condition

- Dominant plants are acacias, poverty bushes, cotton bush and cassias. There could be a scattering of dead or moribund plants, but the stand is not dominated by dead individuals.
- Different aged plants (different sizes) may be evident within most species.
- The number of decreaseers is at least 10 plants per centihec.
- Not all decreaser species grow at any one site but 4 to 9 palatable species are present. These include cotton bush, Wilcox bush, felty fuchsia bush, tall saltbush, horse mulla mulla, warty-leaf eremophila, sidas and small bluebushes.
- A few increaser species such as unpalatable cassias may be present but are not dominant in any of the vegetation layers.
- There is no accelerated soil erosion. Soil surface crusts of lichen and algae are well developed.



This area of granitic shrubland north-east of Leonora is in fair condition. The low shrub layer is dominated by cotton bush (about 10 per centihec) with a few other small decreaser shrubs which are not readily visible in the photograph. There is no soil erosion.

Fair condition

- The number of decreaser low shrubs falls to between 5 and 10 plants per centihec and the number of species is about 4 to 6 at any one site.
- Key decreaser species may become confined to protected areas under taller shrubs where grazing is restricted.
- Some increaser species are present but not usually dominant.
- There is no accelerated soil erosion and soil surface crusts are still obvious and largely intact.



Both the absence of decreaser (usually palatable) low shrubs and minor soil erosion indicate that this site west of Cue, photographed in January 1994, is in poor condition. It supports a few granite wattles and mulga plus some dry annual grasses and herbs.

Poor condition

- The number of different decreaseers at a local site is now less than 4 species and the total number of decreaser plants is less than 3 per centihec.
- Increaser species such as turpentine bush, grey turpentine bush, spoon-leaved eremophila and crinkled cassia are more frequent and dominate the low and/or medium shrub layers.
- There may be slight or minor soil erosion in the form of small scalds up to 5 metres in diameter with redistribution of soil surface material and litter. Soil surface crusts are still present but patchy.

Stony Hardpan Plains

These gently sloping or undulating plains are one of the least productive country types covered in this guide. They are clearly recognised by their stony surfaces, including a 'quartz strew' around Meekatharra and quartz strew or fine ironstone grit mantles in the north-eastern Goldfields. They normally occur slightly higher in the landscape than the more extensive mulga hardpan plains and shed water onto the lower plains via narrow drainage lines or as broad sheet flow.

Soils beneath the stony mantle are infertile and very shallow, frequently less than 30 centimetres deep. Water infiltration is generally slow, much of it running off down the slope. As a result, vegetation is normally scattered and stunted although it may occur as fairly dense small groves between much larger open spaces.

This type of rangeland often merges with several other types including granitic shrubland and mulga hardpan plains.

Vegetation resembles that of the hardpan plains but is much sparser. Medium shrubs are less prominent than the low shrubs, tall shrubs or trees which are found mainly on the creeklines. Mulga is very common and gidgee grows in some areas.

Regeneration of mulga from seedlings has been poorer here than in most other vegetation types. Growing effects are infrequent and groves are usually less than

30 metres wide and 100 metres long. Soils within groves are usually deeper and less stony.

Trees are fewer and species of acacias and poverty bushes differ slightly from those found on the hardpan plains. Notable examples present may include spoon-leaved eremophila, grey turpentine bush, rock fuchsia bush and Murchison willow. Small perennial shrubs such as cotton bush, horse mulla mulla and royal mulla mulla are often conspicuous, as is cannon balls which is a biennial.

The soil supports abundant annuals after effective rains including wind grass and has a reputation for growing good wool albeit at low stocking rates. Perennial grasses are rare.

Watching the health and numbers of key decreaser species provides a good guide to changes in condition. Excess grazing may result in a loss of palatable acacias but encourage more unpalatable eremophilas (poverty bushes) and cassias which help maintain the total plant numbers while reducing useful feed. This effect is seen often near homesteads and shearing sheds where stock are held in small paddocks.

Palatable perennials often grow in clumps of tall shrubs and around decaying mulga log mounds which provide some protection and a more fertile niche.

Typical **decreasers** include mulga bluebush, cotton bush, warty-leaf eremophila, tall saltbush, horse mulla mulla, royal mulla mulla, George's bluebush, flat-leaved bluebush and pussy bluebush. Sidas and ruby saltbush are decreasers in the Carnarvon area but less important elsewhere.

Common **increasers** include turpentine bush, grey turpentine bush and spoon-leaved eremophila. Variable cassia and crinkled cassia grow in the north-eastern Goldfields; wait-a-while is common in the Carnarvon Basin and the Gascoyne.

Good examples of this type of country can be found on the Windarra land system of the north-eastern Goldfields or the Koonmarra land system in the Meekatharra and Murchison districts where the individual stony plains are up to 2 kilometres wide and 3 kilometres long.

Good news signs

- Horse mulla mulla, mulga bluebush, cotton bush, George's bluebush, Wilcox bush, warty-leaf eremophila, young mulgas present
- Mixed age plants present

Bad news signs

- Poverty bushes and nothing else
- Acacias and nothing else except poverty bushes

Indicator	Good	Fair	Poor
Number of different decreaser species present	>7	4-6	<3
Number of decreaser plants per centihec	>5	1-3	<1
Total low shrub numbers per centihec	15-30	10	<7



This stony hardpan plain near Leonora, photographed in the spring of 1993, is in good condition. Sparse mulga is growing on the slopes, with a dense stand of mulga on the creekline in the background. Low shrubs are abundant, with cotton bush (in bloom), mulga bluebush and Wilcox bush obvious in the photograph. This country type is one of the least productive in the rangeland and vegetation is never very dense.

Good condition

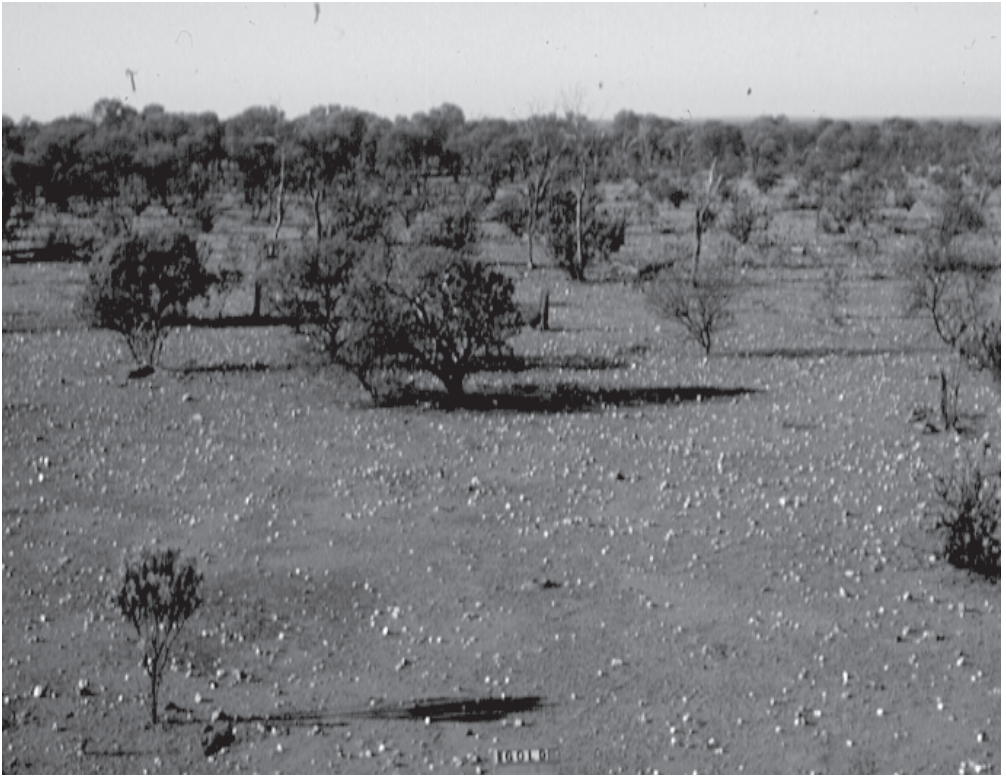
- Total low shrub numbers are usually between 15 and 30 plants per centihec.
- At least 5 decreaser low shrubs per centihec and 7 different decreaser species at a local site including horse mulla mulla, cotton bush, warty-leaf eremophila, bluebushes and Wilcox bush.
- Less palatable shrubs are always present including straight-leaved cassia, crinkled cassia, various eremophilas and flannel bush.
- There is no erosion.



This site in the north-eastern Goldfields is in fair to good condition. Decreaser shrubs are mainly cotton bush and tall sida. The ground is protected by a thin layer of stones and there is no soil erosion.

Fair condition

- The number of decreasers falls to as low as 1 plant per centihec with few young decreaser species. Some of the more sensitive indicators such as horse mulla mulla, warty-leaf eremophila, flat-leaved bluebush and ruby saltbush may exist only as occasional overbrowsed individuals.
- Unpalatable species may increase in number marginally, but in general remain roughly constant while the more palatable plants decline.
- Decreaser species decline to about 4 to 6 in a local area.
- Total low shrub numbers are around 10 per centihec.
- There is no erosion.



This country north of Leonora is in poor condition. Mulgas are the most prominent trees or tall shrubs while the lower storey is dominated by turpentine bush (10 per centihec) which is an increaser species, unpalatable to grazing animals. There are virtually no decreaser shrubs present and none that are readily apparent in the photograph.

Poor condition

- Few (less than 3) decreaser species are present and the effect of overgrazing becomes obvious. No decreaser plants may be present per centihec. Understoreys are sparse, sometimes containing only unpalatable species such as turpentine bush.
- Total low shrub numbers fall to less than 7 per centihec.
- Even normally unpalatable shrubs may be grazed and decline in number.
- Erosion remains very uncommon because of protection from the stony mantles.

Hardpan Plains

Hardpan plains, sometimes called wash plains, occupy extensive areas of the Gascoyne, Murchison and north-eastern Goldfields between the low hills and the river flood plains or salt lakes. They are the most widespread country type in the rangelands of Western Australia and in some areas extend over 60 kilometres without change. The landscape often appears almost flat, but there is usually a very gentle slope (one in three hundred) allowing water to flow slowly across the contour after rain. Some micro-terracing (1 to 2 millimetres deep) can be seen.

The red-brown soil is normally fairly shallow – perhaps only 15 to 80 centimetres thick – and overlies a red-brown ‘hardpan’ known locally as coffee rock or Murchison cement. This is sometimes visible when exposed by erosion and can provide a frustrating barrier to both human activity and plant roots. Once a mulga or other well adapted plant penetrates this barrier, it is able to gain advantage from good quality groundwater at comparatively shallow depth (commonly 6 to 16 metres in the Meekatharra-Wiluna area) but growth of smaller species can be severely limited. The shrubs that grow do fairly well, but there are comparatively few of them.

The soil has been formed by slow weathering and deposition and is normally stable and non-saline. Its surface may be

covered with a few stones and pebbles in some areas, but more commonly is stone-free. Tiny lichens, algae and fungi (collectively called cryptogams) are widespread and help protect the soil surface while fixing nitrogen from the atmosphere. Tiny annual plants are also common which dry off to hard remnants at the end of winter. These also help to protect the soil surface from erosion.

Vegetation on these soils is fairly scattered and is sometimes concentrated into denser groves which are roughly aligned on the contour. These groves intercept run-off water and material carried with it from higher up the slope. Soils are deeper in the groves and such areas are favoured by many forms of animal life. Vegetation within the groves is at least twice as dense as between the groves.

Other areas, known as water course country, are dominated by ‘washes’ which carry more concentrated water flow. Soil surfaces are frequently sealed, making plant germination difficult. Some washes support dense mulga and hop mulga with almost no understorey shrubs.

Groving is more developed in areas that receive concentrated sheet flow, where individual groves may be 500 metres long and up to 100 metres wide. In some flatter areas groving is indistinct on the ground but visible from the air.

Hardpan plains often adjoin stony hardpan plains or granitic shrubland on the higher side of the gentle slope, and sandier wanderrie country on the low side.

Tall shrubs or low trees, most commonly mulga and sometimes hop mulga, are the dominant upper storey and curara, gidgee, bowgada and other acacias may also be present. Of the perennial grasses, woolly butt is found occasionally. In good seasons many annual grasses appear, but this reflects seasonal condition only.

The best indicator of range condition is the number of all perennial shrubs and decreaser low shrubs. However individual shrub numbers tend to be much higher in the Goldfields than the Murchison for this type of country.

Some of the most widely occurring **decreaser** species include mulga bluebush, cotton bush, Wilcox bush, tall sida, warty-leaf eremophila, tall saltbush and flat-leaved bluebush. Other decreaseers include felty fuchsia bush, ruby saltbush, green cassia, red grevillea and mulga broombush.

Good examples of this country can be found in the Yanganoo land system near the Murchison and Roderick Rivers and Rainbow and Jundee land systems in the north-eastern Goldfields.

Good news signs

- Plentiful low shrubs
- Mulga bluebush, cotton bush, Wilcox bush and tall sida of different ages
- Intact groves, lots of cryptogamic crusts

Bad news signs

- Very heavily grazed old Wilcox bush, tall saltbush
- Palatable shrubs such as mulga bluebush hard to find
- Reduced numbers of all plants, death of mulgas and other tall shrubs and trees in groves
- Breakdown of groves, guttering through groves
- Obvious terraces in drainage lines
- Some signs of surface sealing

Indicator	Good	Fair	Poor
Number of plant species present	>10	>7	<5
Number of plants per centihec	20-35	12-18	<10
Number of decreaser shrub species present	5-10	6-8	<4
Number of decreaseers per centihec	10-25	2-5	<2



This mulga hardpan site in the mid-Murchison area is in good condition. There is a good range of decreaser species present including mulga bluebush, cotton bush, horse mulla mulla, Wilcox bush and silky bluebush. There is no erosion.

Good condition

- Total shrub number is at least 20 plants per centihec, possibly up to 35 in some ungrazed areas of the north-eastern Goldfields.
- Up to 10 different species grow in a local area.
- Variable understorey consists of between 5 and 10 different decreaser species including cotton bush, Wilcox bush, mulga bluebush, flat-leaved bluebush and tall sida.
- Number of decreaser plants is more than 10 per centihec, possibly up to 25 in some areas of the north-eastern Goldfields.
- Mulga groves may be apparent, where the density and diversity of vegetation is much greater than between groves, except in the mulga washes where there are very few low shrubs.
- Good cryptogamic crusts are present and there is no erosion.



Tall shrubs including mulga and bowgada are the dominant vegetation on this fair condition mulga hardpan site near Sandstone. There is a scattering of decreaser low shrubs such as Wilcox bush, cotton bush, tall saltbush, mulga broombush and silky bluebush, but their numbers are below the potential. The soil surface is well crusted with small algae and lichens. The pink flowering annual under the trees is pink velleia which is common to the region.

Fair condition

- Most decreaser species are present but in reduced numbers (around 4 to 6 per centihec) and often confined to areas protected from heavy grazing within shelter of larger, unpalatable shrubs.
- About 6 to 8 decreaser species occur in a local area.
- Increaser species including cassias and poverty bushes may approach dominance.
- Mulga groves are likely to be less dense and less able to trap water and nutrients.
- Occasional minor soil erosion may occur, triggered by vehicle or animal tracks, but most areas retain fairly good cryptogamic crusts.



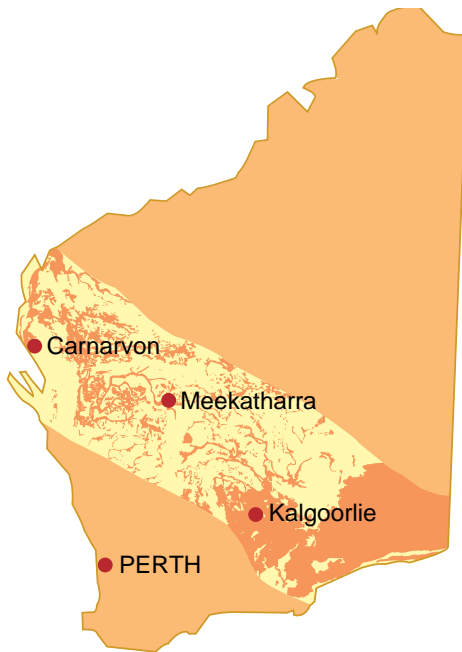
The vegetation on this shallow soil is in poor condition only, as there are no decreaser low shrubs present. The tall shrubs are predominantly mulga and curara. The soil surface is still reasonably stable and capable of supporting annuals in season as shown in this photograph which was taken in July 1993.

Poor condition

- Total shrubs number less than 10 per centihec, mainly tall shrubs.
- Decreaser shrub number is less than 2 per centihec with less than 4 different decreaser species present at a local site.
- Turpentine bush, other unpalatable poverty bushes and cassias may increase in both number and size but woody weed invasion is rare.
- Loss of larger trees and shrubs allows more rapid water flow across the surface after rain. Soil surfaces may become bare and sealed, although many retain a patchy cryptogamic crust.
- Groves are no longer effective in trapping litter, allowing water to flow through causing further plant death and erosion.
- Between the groves the soil remains stable unless disturbed by vehicle or stock tracks when erosion may reveal the underlying hardpan layer. Micro-terraces can amalgamate to form more obvious terraces. Wind erosion increases with greater space between tall shrubs and trees and sandy hummocks are deposited around trunks.

Chapter 5 – Saltbush and Bluebush

Saltbush and bluebush are some of the best known groups of plants able to thrive on salty or saline soil. Such country covers almost 20 per cent or 150,000 square kilometres of the arid rangeland in WA and is very useful for stock, especially if ample supplies of fresh water are available.



Saltbush and bluebush are often known as chenopods (members of the family *Chenopodiaceae* named from the Greek for the goosefoot shape of some leaves). The plants are halophytes (salt-loving) and

drought evading, and also include the samphires, frankenias and bindiis.

The chenopods are a young and vigorously evolving set of species, with forms which often dominate the vegetation in widely varying locations. They tend to flower and fruit after heavy rain regardless of season and their distribution is often clearly patterned, usually through the spacing of **bush mounds** of one or more individual plants.

Seeing a lot of saltbush and bluebush is a sure sign to many people that the soil is saline. In very salty areas crystals of salt are visible on the soil surface or on some plant stems. The soil surface may be puffy under a thin crust. Finding saline sites indicates that saltbushes and bluebushes should be present.

Anyone carrying an electrical conductivity meter to check salinity of bores can also test soil salinity using a level tablespoon (10 g) in half a baby food jar (50 mL) of clean water. A reading greater than 50 milliSiemens per metre (mS/m) or about 280 ppm indicates that the soil is salty. Use of fresh water is essential because saline bore water can make almost any soil appear saline.

Saline soils occur on the uplands just below breakaways, on level plains, river and lake frontages and on the Nullarbor Plain. Many of their features such as depth,

susceptibility to degradation and structure vary widely, but the plant species growing on them are generally similar.

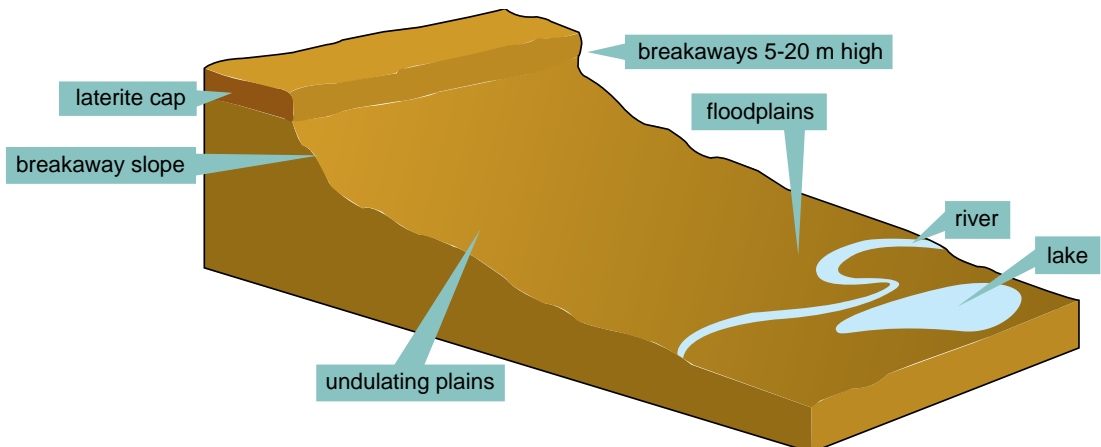
In some areas the silvery-leaved saltbushes (usually *Atriplex* species) are dominant, while in others the bluebushes (now called *Maireana* but previously *Kochia* species) are more common. In general, one or two species will dominate a saltbush site while bluebush sites may involve a mixture of from six to ten different species, ranging from short-lived biennials to long-lived perennials.

Perennial saltbush plants usually live for fifteen to twenty five years, with seedlings establishing in most years, while some bluebushes such as pearl bluebush establish new plants only rarely but may survive for three hundred years. Gascoyne bluebush plants may also live for one hundred and fifty to two hundred years.

Most saltbushes bear separate male and female flowers on different plants, making seed collection a trap for novices. There have been accounts of some people collecting mostly male flowers and then wondering why the germination was so poor! In some species, including the widely occurring bladder saltbush, female plants are more palatable than males.

Many bluebushes are quite small, growing to a maximum of only 30 centimetres tall, while the largest, pearl bluebush and sago bush, can reach 1.5 metres. Most species are less than a metre. When seeds are present the bluebushes are readily identified by their seed cases surrounded by papery wings which grow along the stems.

No single species of bluebush is distributed over the entire rangeland, but in local areas three or four different types may be common. George's bluebush for example is a valuable fodder shrub over large areas of



A typical landscape which often supports saltbushes and bluebushes.

the inland. Sago bush is found in similar areas but is not highly favoured by stock and resists both dry seasons and heavy grazing. Flat-leaved bluebush is widely dispersed over areas north of Kalgoorlie as is three-winged bluebush. Through the Goldfields to the Nullarbor, pearl bluebush is very common while Gascoyne bluebush is restricted to the Gascoyne and Carnarvon areas.

Bluebush communities vary in dominant species, often over short distances. In one area for example, thick growth of Gascoyne

bluebush may cover the ground for many hectares, to be replaced within a short distance by a different bluebush or saltbush species.

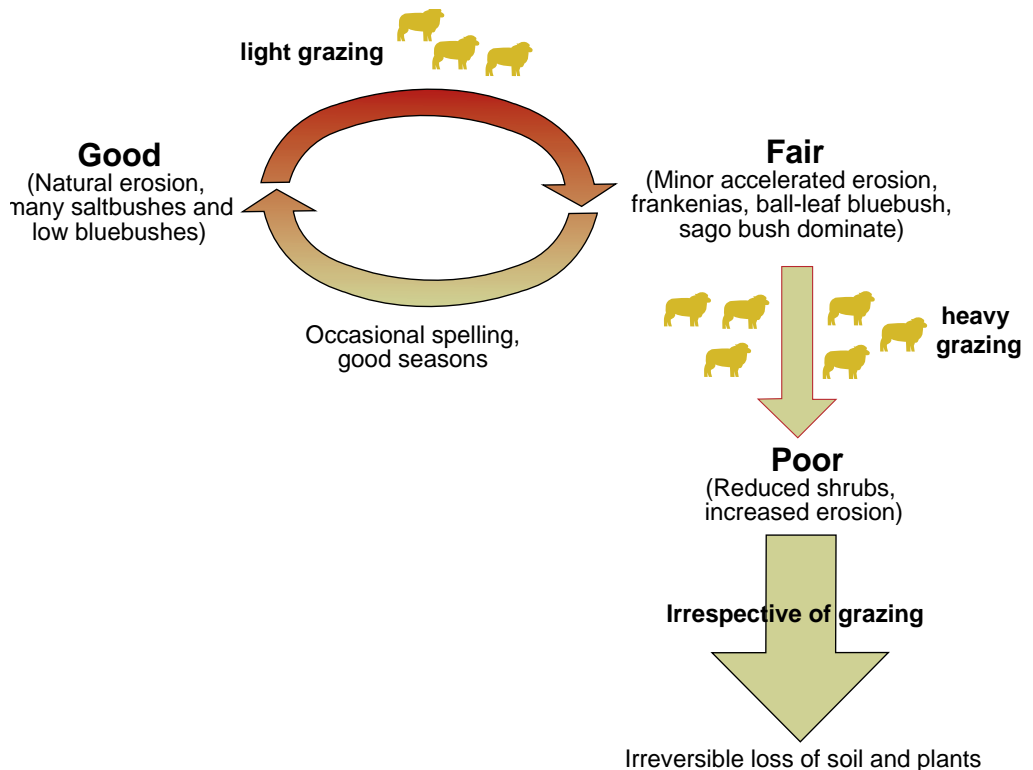
For convenience, we have separated the saltbush and bluebush communities into five types on the basis of their different underlying geology and landscape position, management needs and plant species: **Breakaway Slopes, Undulating Plains, Flood Plains and River Frontages, Level Plains and Lake Frontages**, and the geographically distinct **Nullarbor Plain**.

Breakaway Slopes

Breakaways are one of the more striking features of the shrubland landscape and are formed by erosion of a much earlier land surface. Millions of years ago during a wet climatic period, a gravelly surface crust known as laterite, was formed. The iron and aluminium oxides migrated to the surface to form the distinctive laterite cap. Following uplift of the land, the original plateau was eroded along the drainage lines, and its edge is now marked by breakaways or cliffs. A steep short scarp or laterite face surmounts a

stony footslope followed by a more gentle slope leading down to the lower plains. Some scarps are up to 20 metres high. Granite outcrops and low stony rises may be frequent below the breakaway faces.

Breakaways are widely distributed, with some of the most spectacular in the Sherwood land system near Mount Magnet and the terraces north-east of Leonora. The breakaways themselves are distinctly white in colour caused by the presence of kaolin, a product of weathered granite.



Likely range condition changes in breakaway country.

Breakaway slopes may be up to a kilometre long before grading into other country types, usually undulating plains. Soils are usually shallow, saline sands over clay. They are normally a greyish-white colour, although become more brown further down the slope. Water infiltration is fairly rapid, but because soils are shallow they soon reach capacity and run-off begins. The soil processes remain very active. **Slopes are very susceptible to water erosion, particularly if plant cover is removed by grazing.** But even in ungrazed areas, rilling and terracing erosion patterns can be caused by the ongoing natural erosion.

Typically, erosion creeps slowly upwards, but can quickly accelerate because of the degree of slope. The soils often carry the scars of mismanagement. Because breakaway slopes sometimes cover comparatively small areas in awkward shapes, they are expensive to fence from surrounding country. Maintaining a high level of plant cover is essential to protect the soil. Vegetation cover needed to maintain soil stability varies with the slope of the land, the degree of protection from any stone mantle and the amount of water draining through.

Slight overgrazing leads to loss of saltbushes allowing more persistent species such as ball-leaf bluebush and sago bush to become more prominent. Further grazing will remove these and other perennials but if topsoil is retained the land will still support annual plants.

More seriously degraded areas show patchy scalding, gullying or sheet erosion and support few plants of any sort.

Vegetation often seems to be 'sweeter on the mountain' and many areas have been selectively overgrazed by stock, kangaroos, euros, feral goats and donkeys. Goats and kangaroos in particular favour these areas because there are plenty of caves for shelter as well as delectable plants.

A wide variety of **decreaser** saltbushes and bluebushes grows on ungrazed and lightly grazed breakaway slopes including bladder saltbush, tall saltbush, shy bluebush, George's bluebush, bronze bluebush, felty bluebush, ball-leaf bluebush and three-winged bluebush.

Another distinctive plant group is the frankenias. These plants contain up to 10 per cent salt which is exuded onto the leaves and stems as crystals. They are only eaten if the stock water contains little salt, but the foliage persists more than the saltbushes and bluebushes during dry periods. If only frankenias are present, it indicates a degraded state.

The best indicator of land condition is the number of low shrubs. As condition falls these are sometimes replaced by taller and deeper-rooted acacias, needlebush and cassias. **Increaser** shrubs include mulga, miniritchie, limestone wattle and curara plus banana-leaf, straight-leaved, desert and variable cassias.

Perennial grasses are sparse but Murchison red grass (also called love grass or red grass) is locally abundant. In most years this is only weakly perennial or biennial.

Likely range condition changes

Breakaway country is less resilient than other types that support saltbush and bluebush vegetation. The diagram shows how excessive grazing can push it 'over the edge' forever. Regrettably, many breakaway slopes in the Murchison and north-eastern Goldfields reached that situation many years ago.

With light grazing, there may be a change in relative numbers of different decreaseers present with some selective removal of the more sensitive saltbushes and low bluebushes. This process is reversible, but even without further heavy grazing opportunity exists for woody weeds such as needlebush and poverty bushes to take over the site. Continued heavy grazing leads to the removal of a sufficient number of palatable plants to expose the soil surface to the effects of water erosion. Once the surface begins eroding, particularly down to the clay layer, recovery is not possible.

Good news signs

- Five or six decreaseer species present, particularly saltbushes and bluebushes
- Numerous seedlings or young plants of diverse decreaseer species
- Thick cryptogamic crusts
- Intact soil surface and sheet water flow
- Erosion products trapped and stabilised by vegetation

Bad news signs

- Poor growth of annuals on bare surfaces even after considerable rain
- Reduced numbers of low shrubs with only less palatable or more resilient species remaining
- Incised channels and bare areas
- Obvious terracing, rilling and gullying
- Broken and dispersed cryptogamic crusts



This slope below a breakaway in the Upper Murchison is in fair to good condition. In the foreground, bluebushes and some sago bushes are evident with bladder saltbush in the middle ground. Bladder saltbush is dominant close to the breakaway. The site could support more low shrubs than are evident in the photograph, but the surface of the duplex soil is stable.

Good condition

- One or more key decreaser species such as bladder saltbush, shy bluebush, George's bluebush, frankenia or low mulla mulla is dominant or co-dominant.
- Perennial plant numbers are near to the maximum for the site.
- Minor erosion is common even in ungrazed sites, reflecting inherent instability.



This site near Leonora is rated as being in fair condition because the number of low shrubs is well below the potential, with only the more resistant species such as frankenias, ball-leaf bluebush and samphire remaining. Shrub numbers are inadequate to protect the surface and active erosion is removing soil from the area, producing bare scalded patches.

Fair condition

- Overall numbers of low shrubs are reduced.
- Stands of key decreaser species such as George's bluebush are patchy.
- Very resistant species such as ball-leaf bluebush and sago bush may increase in number.
- Increasers such as silver poverty bush may be more common.
- Reasonable growth of annuals in winter.
- Minor and moderate soil erosion is common in the form of shallow gullies and gutters, sheeting and micro-terracing on the contour.



This breakaway slope east of Cue is in very poor condition. Loss of shrub protection has exposed the soil surface to water erosion which has removed much of the topsoil by sheeting, micro-terracing and rilling. Annual herbs are growing only on the small patches of remaining topsoil. The saline clay sub-soil is exposed in the foreground. Access tracks on this type of country, such as the one on the left of the photograph, invariably become eroded and washed out. The area has suffered an irreversible loss of soil and plants.

Poor condition

- Density of vegetation reduces further.
- Palatable species are scarce or absent, possibly replaced by cassias, needlebush and silver poverty bush, but more commonly by bare ground.
- Reduced growth of annuals due to lower water-holding capacity as water is lost from the system through erosion channels.
- Soil erosion is frequently widespread and severe with more than half of the surface disturbed. This environment becomes very inhospitable for establishment of shrubs.

Undulating Plains

Below the breakaway slopes and adjacent to the major rivers, the country is saline and often stony over different types of underlying rocks. The terrain is undulating, receiving both run-on from upper slopes and contributing some run-off to the lower plains.

Soils are normally fairly shallow dark to dusky red loams or duplexes, up to half of which may be strewn with quartz gravels. These stony mantles help protect the soil surface, but if disturbed, soils become more susceptible to erosion. Removal of vegetation by grazing can trigger accelerated erosion and a plant cover of at least 5 per cent is considered to be the critical level below which soil erosion is very difficult to stop.

The plant species are rich and diverse, often very similar to those growing on the breakaway slopes. Overall grazing capacity is high and the shrubs are very durable in dry conditions, providing a reliable food source for stock and native animals. Water absorption is moderate, and the vegetation responds quickly after rain.

Thickness of vegetation is closely related to position in the landscape as this influences the supply of water. Tall shrubs or trees are sparse, rarely more than two per cent, but include several larger acacias such as mulga, prickly acacia, wait-a-while and snakewood varying slightly with region.

This country is typified by the Durlacher land system of the Carnarvon Basin, Paraburdoo land system in the Ashburton, and Gundockerta in the north-eastern Goldfields.

The country type occurs over a variety of rocks which can affect its stability and the plant species. In some areas, known as **stony bluebush**, the underlying rocks are acidic granite and gneiss. In others the underlying rocks are basic (alkaline) **greenstone** or basalt. Within the greenstone belt, south of Menzies, an area receiving slightly heavier rainfall appears visibly different where a mixture of eucalypts dominates the upper storey species. This is known as the **Goldfields gum belt**.

Stony bluebush

Stony bluebush is the most fragile of the three undulating plain types because of the nature of the underlying granitic rocks. Extensive areas have been heavily stocked and appear to have lost many of their palatable shrub species, particularly close to water.

Decreasers include most of the bluebushes, creeping cassia, frankenias and the more palatable saltbushes such as silver saltbush and tall saltbush (although these are pretty tough). Gascoyne mulla mulla is also often present near Carnarvon. Palatable low shrubs are commonly aggregated around and directly below the tall shrubs.

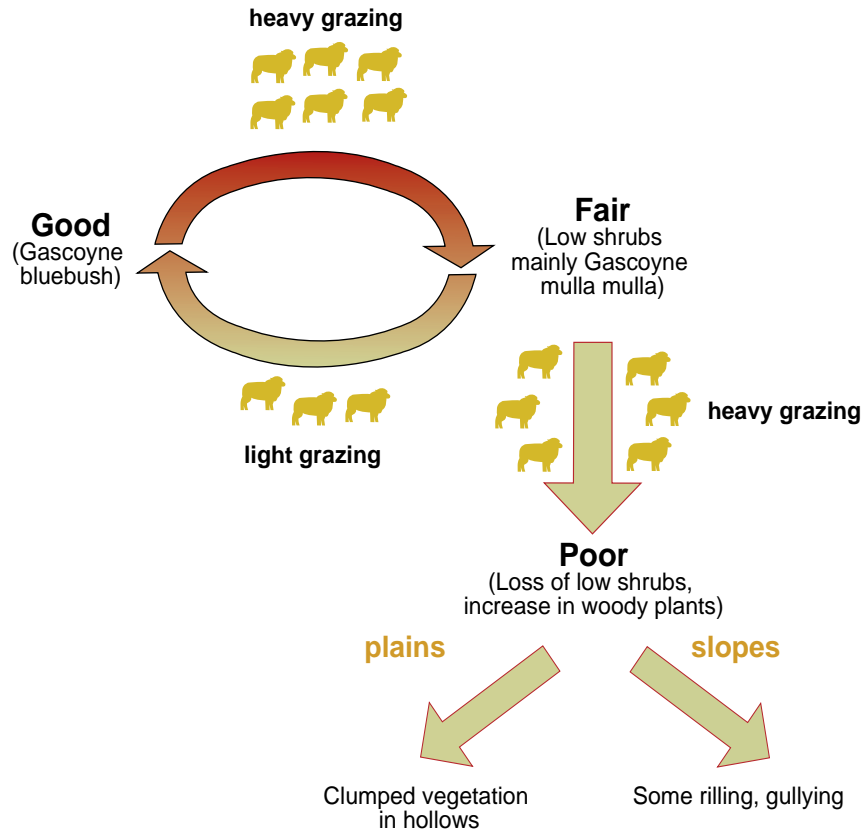
Overuse leads to loss of low shrubs but more tall shrubs and woody weeds (needlebush, wait-a-while, cassias, poverty bushes). Reduced grazing pressure can increase low shrub numbers (particularly perennial mulla mullas) and enhance stability. Shrub recruitment is favoured beneath the tall shrubs and trees.

The only common perennial grass is curly windmill grass but it is very sparse and contributes little to total forage. Local grasses in northern areas include soft

spinifex, Roebourne Plains grass and buffel grass. Wind grass is abundant in very good seasons.

The best indicator of range condition is the number of both decreaseers and increaseers.

Erosion is confined to those areas not protected by a stony mantle. It occurs as rilling and gullyng along fencelines, tracks and animal pads and as sheeting on slopes. Redistribution of soil into hollows and drainage lines causes 'clumpiness' in vegetation. If the topsoil has been stripped



Likely range condition changes in stony bluebush in the Gascoyne.

to expose the infertile, saline soil below, then recovery by grazing management is not possible.

Likely range condition changes

The diagram shows the likely responses to grazing stony bluebush in the Gascoyne (Durlacher land system). This type of country is resilient to heavy grazing, but most commonly there will be a shift from a low shrub population dominated by Gascoyne bluebush to one dominated by the more robust Gascoyne mulla mulla.

Gascoyne bluebush can re-establish under light grazing.

Continued heavy grazing results in a loss of decreaser low shrubs (including Gascoyne mulla mullas) and their replacement by woody weeds such as wait-a-while and straight-tleaved cassia. On the stony plains the vegetation can be quite sparse with some rilling and gullying occurring where the stony mantle does not offer sufficient

Good news signs

- Young George's bluebush, silver saltbush, sago bush, Gascoyne bluebush
- Mixed age plants

Bad news signs

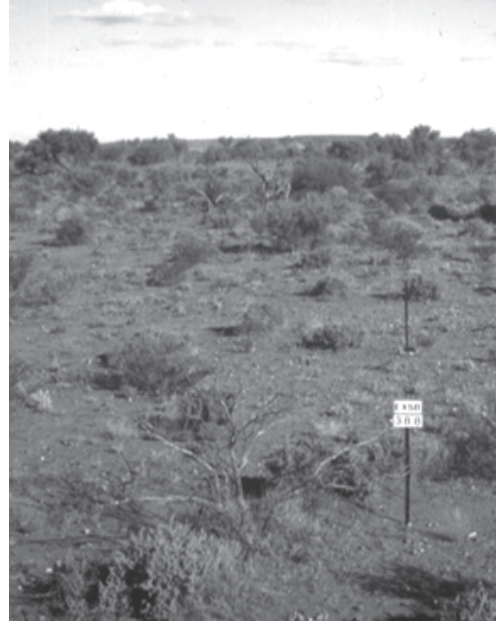
- Seedlings and young plants of prickly acacia, needlebush and wait-a-while
- Heavily grazed old plants of bluebush or sago bush
- Unstable bush mounds, decline in mix of small sensitive palatable shrubs

protection. On the drainage plains and flow zones, low shrubs are absent and the remaining vegetation consists of clumps of woody weeds around drainage hollows and in crab-hole areas. Where these plains carry overland flow, stripping and gullying can be extensive.

This pattern is repeated in other areas with a different set of species.



This stony bluebush community near Sandstone, photographed in April 1994, is in good range condition. Sago bush, a species that is tolerant to grazing, is interspersed with more grazing-sensitive species such as George's bluebush and ball-leaf bluebush. The cover of vegetation indicates a stable and healthy soil surface.



This stony bluebush plain south of Gascoyne Junction is in good condition with a mixture of trees (wait-a-while), tall shrubs (mainly curara) and low shrubs. The low shrubs are dominated by Gascoyne bluebush (3 per centihect), warty-leaf eremophila (10 per centihect) and cassias. The soil surface is stable under a light stone mantle.

Good condition

- Most sensitive decreaser indicators are George's bluebush, ruby saltbush.
- Less sensitive decreasers include silver saltbush, frankenias, tall saltbush and Gascoyne bluebush.
- In some local areas flat-leaved bluebush, shy bluebush, felty bluebush, creeping cassia and sago bush are useful.
- Prickly acacia, needlebush and wait-a-while are present in small numbers.
- Soil surface is intact, supporting abundant cryptogams between stones.



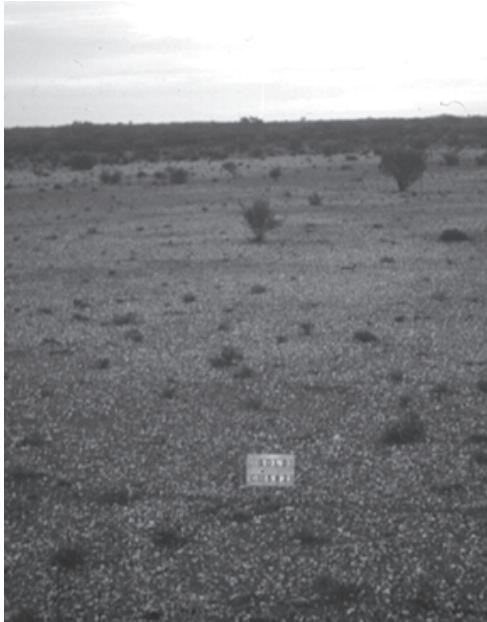
This stony bluebush site east of Leinster is in fair condition. It carries a reasonable number of low shrubs with sago bush, cotton bush and George's bluebush obvious in the foreground. The site could support greater diversity of species, with more individual plants. A patch of sheet erosion is evident in the right middle ground. Water shed from this area is concentrated in a well vegetated hollow immediately down the slope (behind the eroded area).



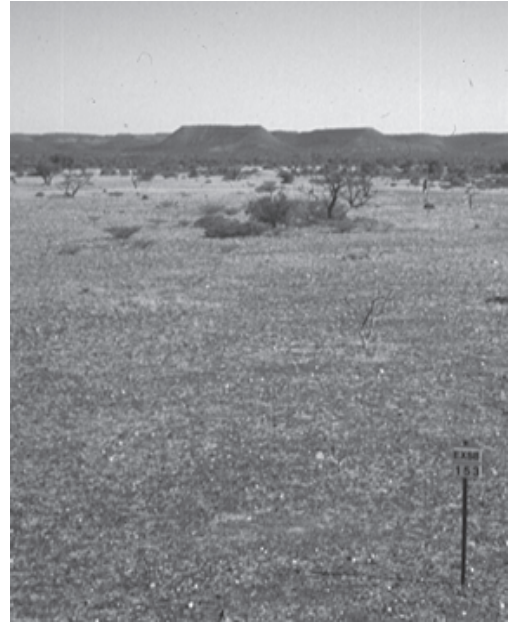
A fine pebble strew litters the soil surface of this stony bluebush country near the Lyndon River in the northern Gascoyne. The site is in fair condition, supporting many different shrub species. Soil surface condition is also fair with some signs of disturbance and surface sealing in the middle ground. Wait-a-while and snakewood grow as trees and tall shrubs. Sago bush (10 per centihec), three-winged bluebush (5 per centihec), cotton bush (3 per centihec), Gascoyne mulla mulla (2 per centihec) and silver saltbush (1 per centihec) dominate the shrubs.

Fair condition

- Fewer species present.
- Sensitive indicators such as the bluebushes and saltbushes may occur only as old, well-chewed individuals or where they are protected by larger shrubs.
- Straight-leaved cassia, prickly acacia and wait-a-while occur more frequently as seedlings and young plants. More bindiis are present.
- Cryptogamic crusts are still fairly obvious and there is generally no soil erosion.



This stony bluebush community near Leinster is in poor condition. A few low decreaser shrubs including George's bluebush and frankenias can be seen. There are many three-winged bluebushes in the foreground and abundant young needlebushes in the background. Needlebush is a potent increaser in this vegetation type. Soil surface condition is fair to good and protected by a mantle of quartz stones.



This stony bluebush site in the Gascoyne is derived from rocks which characteristically weather to clayey soils that support abundant low shrubs. This vegetation is in poor condition with no decreaser low shrubs and only sparse wait-a-while and royal poverty bush (4 per centihec) mainly evident in the background. Soil surface condition is still good, being stable with obvious cryptogam crusts.

Poor condition

- Relatively thick stands of wait-a-while, prickly acacia present.
- Palatable species may be absent or present only as heavily grazed relics.
- Some bush mounds are degraded and run-off is increased.
- Few cryptogamic crusts present.
- Minor or moderate sheet and channel erosion can be present.

Greenstone slopes

Extensive areas of upland country which cover metamorphosed volcanic rock occur through the Murchison and Goldfields. These are known popularly as the greenstones or greenstone belts and contain the major gold and nickel deposits plus a varied assortment of other minerals which are very beneficial for plant growth. The country can be very productive and is usually considerably more fertile than similar granite or stony bluebush country because of the presence of the extra minerals. Some basalt and dolerite is hard and resistant to erosion while other rocks are softer. Land systems which typify this country include Austin in the Murchison, and Gundockerta and Leonora in the north-eastern Goldfields.

Some of the most typical and distinctive examples of greenstone country are found in the Goldfields around Leonora, Laverton and Menzies. In these areas the land has been used extensively for both mining and pastoral activity, mainly wool production. Very little greenstone occurs west of a line from Meekatharra, Cue to Yalgoo.

Trees and perennial grasses are sparse but there is a diverse mixture of scattered low, medium and tall shrubs.

The overstorey of the vegetation often includes black oak or scattered eucalypts (south of Menzies), sparse needlebush and mulga. Understorey shrubs may be bladder and silver saltbush, cotton bush, sago bush, sage, George's bluebush, three-winged

bluebush, false bluebush (well south of Kalgoorlie and on the western Nullarbor) or pearl bluebush (higher up the slope and generally south of Leonora). Samphire may grow on saline slopes and broom bush appears on the less alkaline sites, usually on rising ground. A wide range of other eremophilas may also be present including pixie bush.

The most sensitive **decreasers** are George's bluebush and the saltbushes. Feather spear grass is a common perennial where land is in good condition and neverfail often grows in drainage holes.

Annuals in season may include everlastings, large white paper daisy and purple mulla mulla.

When land is degraded there is an **increase** in species such as desert cassia, tan wattle (south of Menzies), needlebush, three-winged bluebush and hop bush, while other low shrubs decline. Sago bush can occupy sites that previously supported more palatable species such as bladder saltbush, but this may not mean a lower grazing value. If pearl bluebush or sago bush is the only shrub in the understorey it usually reflects previous overgrazing.

When shrubs are lost the annual spear grass and bindii numbers increase.

Likely range condition changes

Greenstone country supports a varied population of tall and low shrubs with the variation between different sites resulting from different environmental and grazing impacts.

Moderate grazing can result in some loss of bladder and silver saltbush and small bluebushes, but very little change in the number of pearl bluebush and perhaps some increase in sago bush. In this condition, the vegetation retains its resilience and protects the soil surface from erosion.

Change from this stable state varies and will depend on management and climate. The country can be comparatively fragile where the stone mantles are not heavy. Conservative use and favourable seasons may lead to the recruitment of decreaser shrubs although this requires a seed source. More commonly, conservative use results in more George's bluebush, sago bush and cotton bush.

Continued heavy grazing results in further reductions in the low shrubs, and depending on climatic events and the presence of seed sources, may encourage a dramatic increase in woody weeds such as needlebush. In some situations, particular climatic events seem to have led to a 'take-over' by three-winged bluebush which may occupy a site for ten to twenty years.

Good news signs

- Young saltbushes, George's bluebushes, sago bushes
- Well branched low and medium shrubs (not hedged)
- Healthy bush mounds
- Well developed soil surface crusting

Bad news signs

- Too much cotton bush
- Well grazed pearl bluebush and sago bush are the only plants present
- Young needlebush, desert cassia and hop bush
- Surface sealing and crust disturbance between shrubs



This greenstone slope on the Leonora common is in good condition. The wide range of low shrubs present includes George's bluebush, cotton bush, sago bush, silver saltbush and felty bluebush. Further up the slope (in the background) pearl bluebush is growing. Shrub numbers and annual vegetation production are highest in small depressions that gain water from surrounding areas (shown in the middle ground). This photograph was taken in September 1993 after two good seasons which resulted in abundant annual growth.

Good condition

- Diversity of low and medium shrubs present such as George's bluebush, sago bush, sage and bladder saltbush.
- A range of mixed age plants present on non-stony surfaces.
- Soil surface crusting should be evident on non-stony areas.
- Almost no young increaser plants present.



Scattered mulga and needlebush grow on this greenstone slope east of Leonora which is in fair to poor condition with a much reduced low shrub population dominated by hardy sago bush and sage. Cotton bush, which can increase in such situations, is also obvious. Annual grass and herb production can be high in good seasons such as when this photograph was taken in 1993.

Fair condition

- Vegetation dominated by long-lived shrubs such as pearl bluebush, sago bush and sage.
- Few young decreaser species present.
- Increase in numbers of three-winged bluebush and cotton bush.
- Reduced soil surface crusting evident.
- Smaller bush mounds and signs of water flow between mounds.



This greenstone country east of Leonora is in poor condition with few low shrubs surviving below old needlebushes. Some saline samphire plants can be seen in the background, but these are generally resistant to grazing. Although the site is in poor condition, the inherently high soil fertility encouraged abundant growth of annual vegetation in the good 1993 season.



Young needlebush have taken over this alluvial plain in greenstone country east of Leinster. Few decreaser shrubs are evident, mainly old, resilient sago bush and sage. The needlebush plants appear to be of similar age, suggesting they became established in a particularly favourable time (perhaps the wet mid-1970s). Their presence will profoundly alter the nature of this site for many years to come.

Poor condition

- Distinct loss of decreaser shrubs, often leaving only sago and pearl bluebush, and not many of them.
- More increaser species such as three-winged bluebush, needlebush, desert cassia, hop bush and some eremophilas. Three-winged bluebush dominates some sites.
- Possible loss of all shrubs with only bindiis and spear grass remaining.
- Reduced soil surface crusting and minor sand piling against fallen trees.
- Further loss of bush mounds through trampling, wind erosion, water erosion.

Goldfields gum belt

Within the Goldfields lies an extensive area covering about 200 kilometres by 150 kilometres and extending from south of Menzies to the north of Lake Moore, east to Zanthus and west to the farming belt where the overstorey vegetation comprises a range of eucalypts instead of the more usual acacias such as mulga, snakewood and wait-a-while. The Graves and Campsite land systems in the north-eastern Goldfields are examples.

Much of the area has never been used for grazing, particularly where the eucalypts form a thick woodland. The areas of saltbush and bluebush between Kambalda and Menzies provide some of the best grazing country in the shrublands but their use is hampered by lack of fresh groundwater. This changed for many pastoralists when large dams were excavated using heavy machinery after World War II, and more recently during the gold mining boom. Pipelines have been run from the dams to open up grazing in new areas.

The main Goldfields eucalypts include salmon gum and gimlet with less extensive areas of York gum, several different blackbutts and many others – reputedly up to a quarter of all Australian species.

In the early days of mining, larger trees were felled extensively for firewood, mining and building timber, railway sleepers and fuel for the pumping stations on the

Goldfields water pipeline. Around 1904 more than half a million tons a year was being harvested in this way. Many trees have now grown back to full size, sometimes in coppice form (multiple trunks from an old base). Recruitment from seed is common.

Trees are now more numerous on many sites than before European settlement.



However, there are fewer salmon gums in the broad valley floors that support dense saltbush and bluebush. These shrubs may be suppressing the regrowth of eucalypts.

Soil depth is variable and the eucalypts favour alkaline loams where the soil is sufficiently deep above the underlying

granite and greenstone. Granite is often visible as outcropping rock. The eucalypts become smaller, more scattered and more drought tolerant as rainfall declines.

Fertile patches or groving effects exist around crabholes or drainage areas where eucalypts are taller and thicker.

The most important shrubs are bladder saltbush and pearl bluebush followed by sago bush, old man saltbush and frankenias. Several shorter-lived bluebushes such as felty bluebush and George's bluebush also grow widely.

Pearl bluebush is a valuable stabiliser of the landscape and feed reserve in this country but is not grazed heavily if more attractive alternatives are available. It is relatively unresponsive to season and new plants appear to germinate if rain falls just after fruiting. In ungrazed areas on Gindalbie Station where plants were monitored for eleven years, numbers of pearl bluebush remained unchanged at around 6 plants per centihec on ungrazed sites. There was neither recruitment of new plants nor major loss of old plants although numbers of other shrubs such as bladder saltbush, broom bush and short-lived bluebush species waxed and waned with season. Scientists believe that a dramatic loss of pearl bluebush should be regarded as a catastrophe and any increase is a bonus that should be cherished.

In contrast, bladder saltbush responds to both season and grazing and new plants may establish even in fairly dry years. On

Gindalbie Station plant numbers doubled after thirteen years of protection from grazing, but high losses were observed even in exclosures during very dry years.

Old man saltbush is more plentiful on overgrazed country and appears to recruit more readily when grazed. Plants can grow very big and may reach the size of a room. They are not very palatable but sheep will eat them when good water is available.

Tan wattle, three-winged bluebush, desert cassia, hop bush and broom bush are **increasers**.

Vegetation can be dense in the gum belt and occasional fires occur after good seasons, for example early 1994 and the mid-1970s. At these times useful shrubs such as bluebush and saltbush are replaced by desert cassia and tan wattle. Pearl bluebush appears to survive fires better than bladder saltbush and has been known to regenerate from the roots after five years.

The presence of particular eucalypts can be a useful indicator of soil type. Goldfields blackbutt commonly grows with pearl bluebush on shallow clay loams on the rises, while gimlet and salmon gums combine with saltbushes on heavier soils in valley floors.



This open plain in the eastern Goldfields is in good condition. The shallow loam soil formed on weathered greenstone supports abundant bladder saltbush which is obvious in the foreground. The taller shrubs in the middle ground include broom bush, desert cassia and old man saltbush. The soil surface is well crusted and supports annual spear grasses. Shrub numbers are lower in the areas underneath the gum trees in the background.

Good news signs

- Young bladder saltbush, pearl bluebush, sago bush present
- Other bluebushes present
- Good soil surface crusting

Bad news signs

- Heavily chewed pearl bluebush and little else present
- Young increasers present such as desert cassia, tan wattle, hop bush
- Sealed soil surface, rilled in places

Good condition

- Plentiful bladder saltbush and pearl bluebush growing beneath eucalypts; some silver saltbush and sago bush.
- Smaller bluebushes present including George's bluebush and felty bluebush.
- Extensive cryptogamic crusting present.



This open woodland west of Menzies is in fair to good condition with low shrubs limited by competition from the gum trees which grow in a groving pattern. Bladder saltbush is obvious in the foreground with some bluebush under the trees in the middle ground. Dry annual spear grass is abundant following good seasons in 1992 and 1993. The soil surface is stable although less productive areas are covered by small ironstone pebbles (foreground).

Fair condition

- Fewer saltbushes present, bluebushes are more dominant.
- Reduced species diversity; longer lived shrubs are smaller and more rounded.
- Some desert cassia and hop bush evident, more cotton bush and old man saltbush.
- Some breakdown of soil surface crust.



This site north of Kalgoorlie has lost nearly all the decreaser low shrubs normally occurring in this country. It is in poor condition with only tall salmon gums remaining. Some gum tree recruitment is occurring in the middle ground. Soil surface condition is fair with some obvious sealing limiting growth of annual plants. This photograph, taken in January 1994 after two good seasons, shows abundant dry annual grass and herbs.

Poor condition

- Few or no pearl bluebush plants are present.
- Old man saltbush showing effects of grazing.
- Tan wattle, desert cassia and hop bush are present in larger numbers.
- Surface sealing and loss of crust.
- Evidence of water erosion in valley floors.

Flood Plains and River Frontages

This type of country includes the flood plains of the major river systems, the Gascoyne, Murchison, Ashburton, Greenough, Minilya and Wooramel, which flow westward to the Indian Ocean. In some cases the flood plains are narrow belts close to the river beds, but may be 20 kilometres wide along parts of the Gascoyne and Murchison Rivers. Typical examples are the Delta land system of the Carnarvon Basin, the Beringarra land system of the Murchison and the Edward land system of the Ashburton. While the north-eastern Goldfields lacks rivers, the Wilson land system around major ephemeral creeks shares similar vegetation and soils.

In an undegraded state the soil is relatively fertile, favoured by overbank flooding of water and sediments plus channelled drainage. Because of the attractive feed, water and shade, river frontages are favoured by both native and feral animals and have been used heavily. Most early shearing sheds were sited close to the rivers so the grazing pressure at shearing was even greater than normal.

Soils are mostly loam over clay, and range in colour from red-brown to red-grey. Depth varies depending on soil condition with some soils more than a metre deep, while others are shallow and eroded.

Overuse causes loss of many palatable shrubs and instability in the topsoil layer. The most susceptible soils are sandy at the surface. The action of water and wind can scald, scour and create hummocks in destabilised soil, and some unfortunate examples of this are common.

This is an all or nothing system!

Maintaining adequate plant cover is essential. If shrubs are removed, soil erosion will follow almost inevitably. Major degradation can occur and regeneration will be extremely difficult. On degraded sites woody weeds may invade and help to restabilise the soil. The critical level of



plant cover appears to be at least 10 per cent. Large areas should be fenced off to allow specific management.

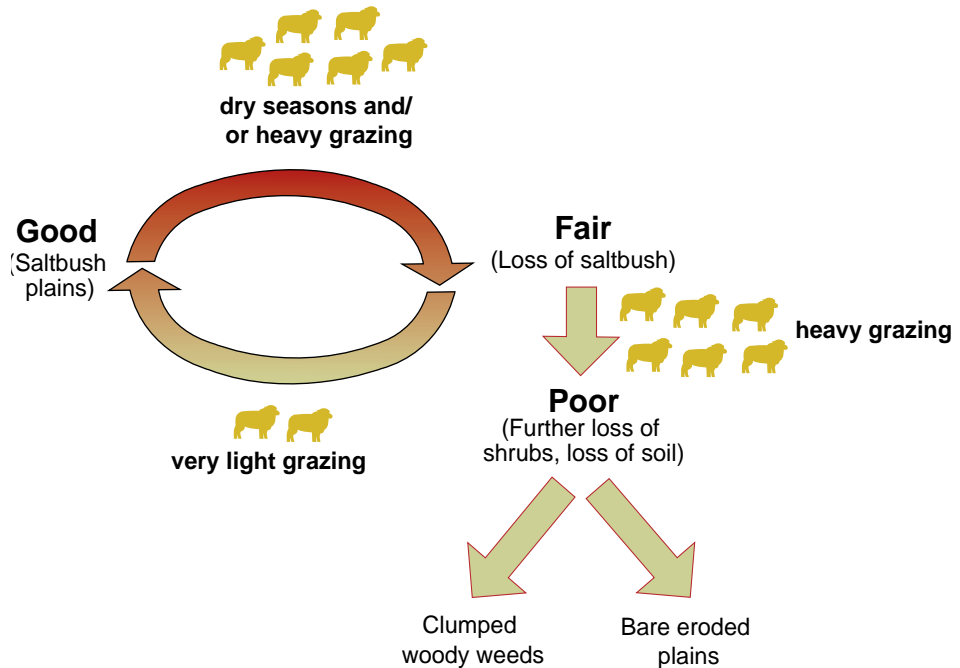
The start of active soil erosion represents the passing of a threshold from which regeneration will not be achieved merely by manipulating grazing pressure. It is therefore very important to monitor changes in vegetation to prevent crossing this threshold.

Likely range condition changes

Floodplains and river frontages are fertile areas supporting a diverse range of decreaser shrubs, which rapidly erode when disturbed. In the natural state these plains,

with their abundant plant cover, tolerate occasional floods and windstorms without significant soil loss. The low shrubs are adapted to grazing. Moderate grazing stimulates growth and confers some ‘drought proofing’ on species such as shy bluebush.

Excessive grazing, especially in dry years, kills the less hardy perennial species such as bladder saltbush, silver saltbush and shy bluebush. Excessive animal activity in dry times cuts the soil surface which is then lost through floods and strong winds, exposing hardpan or clay subsoils. This transition can occur over just a few years. Once this threshold is crossed, the topsoil and its



Likely range condition changes in flood plains.

associated plants cannot be replaced. The erosion process and recovery of non-eroded parts of the landscape gives the characteristic ‘islands of stability’ structure to the partially degraded state. Continued erosion of these islands produces the totally degraded state of bare, scalded flat with sandy accumulations of eroded surface materials.

Woody weeds such as needlebush and prickly acacia colonise these sandy banks. Where useful summer rain falls, such as along the Ashburton River, buffel grass is also an active coloniser.

Nutritious annual species grow prolifically after seasonal rains and animals continue to obtain good grazing from these degraded systems for short periods of the year.

Degradation is seen most clearly as the loss of individual plants followed by destruction of bush mounds. Unless this can be reversed, continued grazing leads to further loss of perennial plants and loss of topsoil – which has happened to extensive areas. To prevent irreversible damage, germination of new saltbush or bluebush is required, followed by plant growth and increase in size of the mounds.

Low saltbush and bluebush shrubland is the main vegetation and has considerable drought durability when in good condition. Perennial shrubs are augmented by biennials such as bindiis, plus annual grasses and herbs in good seasons.

Saltbush communities are more sensitive to grazing than bluebush and will be eaten out

allowing soil erosion if country is not managed properly.

Trees to 4 metres high and tall shrubs to 3 metres are diverse but scattered, and may include wait-a-while, prickly acacia, curara, needlebush and coolabahs.

Leaves of prickly acacia (often known as bardi bush for the bardis or witchetty grubs which inhabit it) appear quite bluish on young plants which are unpalatable, but are yellowish green on more mature plants.

Coolabahs are distinctive white-trunked eucalypts growing along creek beds and close to rivers. River gums, which look very similar, only grow close to permanent water.

Medium shrubs including green cassia (also called tall cassia), crinkled cassia, mingah bush and tall saltbush are common.

Low shrubs are dominant and diverse and may include George’s bluebush, shy bluebush, spiny bluebush, swamp saltbush, bladder saltbush, silver saltbush, flannel bush, samphire, frankenias and river saltbush. Gascoyne bluebush is present in some areas.

These plains support high quality annual plants in good seasons. In winter these include everlastings, billy buttons and small salt-tolerant plants such as the bindiis and annual mulla mullas. Summer rain causes germination of bindiis and some short-lived grasses such as love grass and wind grass.

Introduced buffel and Birdwood grasses have colonised areas near the northern rivers. Their growth provides an appealing biomass for both stock and native animals, but after a growth flush protein levels fall and animals graze remnant shrubs heavily in an effort to maintain protein intake. Such buffel grass colonisation may also change the habitat for fauna.

Increaser shrubs on the river frontages include prickly acacia, needlebush, silver poverty bush, straight-leaved cassia and crinkled cassia.

The best indicator of range condition is the number of saltbushes and bluebushes present, though precise numbers will depend on the dominant species. For example mature silver saltbush plants are larger than bladder saltbush so numbers per centihec will be lower for country in similar condition.

Good news signs

- Abundant bush mounds supporting decreaser species
- Young saltbushes, bluebushes
- No erosion
- Abundant cryptogamic crusts

Bad news signs

- Many young needlebush, prickly acacia, silver poverty bush, cassias
- Dominant vegetation is increasers – prickly acacias, wait-a-while
- Breakdown of bush mounds
- Onset of soil erosion, bare scalded areas
- Poor cryptogamic crusts, powdering of surface crusts

Indicator	Good	Fair	Poor
Numbers of bladder saltbush plants per centihec	>80	40-50	<20
Numbers of silver saltbush plants per centihec	30-50	20	>10



This river frontage country close to the Gascoyne River is in good range condition with a plentiful cover of the decreaser low shrub, bladder saltbush. Another sign of a healthy community is the mixture of even-aged saltbushes. The soil surface is stable and the areas between the shrubs are supporting annual grasses and herbs in this good 1992 season.

Good condition (bladder saltbush areas)

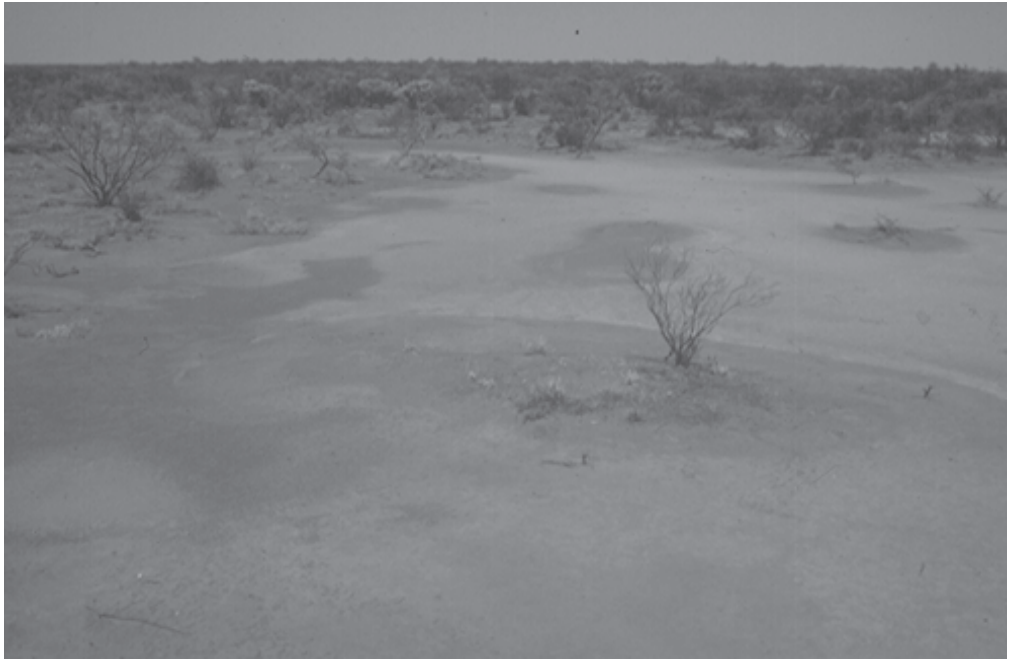
- Bladder saltbush is dominant, and may occur as thickly as 250 plants per centihec, averaging about 80. This is the most useful indicator.
- Other palatable plants such as sage, green cassia, Wilcox bush and various bluebushes are also present.
- Occasional prickly acacia, needlebush, wait-a-while and silver poverty bush may be seen.
- Good cryptogamic crusts are present.
- There is little or no erosion.



This Wooramel River frontage is in fair condition. In the foreground the soil remains intact with reasonable numbers of Gascoyne bluebush and some young needlebush. The system is vulnerable to water and wind erosion. In the background of the photograph surface soil has been lost due to the action of water and wind. This mosaic pattern of stable and eroded soil surfaces is typical of river frontages.

Fair condition (bladder saltbush areas)

- The number of bladder saltbush plants falls to 40 to 50 per centihec.
- Bush mounds are slightly reduced in size and elevation due to both the removal of surrounding soils through water and wind erosion and their local redeposition.
- Cryptogamic crusts are still present but some breakdown has occurred.
- Occasional minor to moderate soil erosion may be present.



This Murchison River frontage country is in poor condition with vegetation reduced to scattered needlebush and prickly acacia and a few remnant low shrubs on residual soil surfaces. More than half of the area has lost soil to water erosion, leaving a hard sealed surface that is almost impermeable. This is a very difficult environment for plant establishment and the country was probably overstocked in the early days of pastoral development.

Poor condition (bladder saltbush areas)

- If the bladder saltbush numbers fall below about 20 per cent, the total vegetation declines sharply also.
- Other palatable species are rarely present and the range of perennial species is usually narrow.
- Some invasion of increaser shrubs such as needlebush.
- Cryptogamic crusts are generally absent.
- Moderate to severe erosion in the form of scalding, hummocking, gullying and sheeting is often apparent.

Good condition (silver saltbush areas)

- Silver saltbush may occur from 30 to 80 plants per centihec.
- The low shrubs ruby saltbush, felty bluebush, ragged-leaf fan flower, Gascoyne bluebush and flat-leaved bluebush may be present, but distribution is patchy and absences do not necessarily imply poor condition.
- Cotton bush, tall saltbush and flannel bush are commonly present at about 5 to 10 plants per centihec.
- Increasers such as wait-a-while, tomato bush, prickly acacia and needlebush may be present but in very low numbers.

Fair condition (silver saltbush areas)

- Overgrazing causes silver saltbush to decline and numbers fall to 10 to 20 plants per centihec with some plants grazed back to unpalatable woody material.
- Other decreaseers may still be present but in smaller numbers.
- Cotton bush may increase in number as other shrubs disappear.
- Increaser shrubs rise slightly in number.
- Fair cryptogamic crusts, but partial breakdown of crusts in some places.
- Occasional minor wind and water erosion may occur.

Poor condition (silver saltbush areas)

- If silver saltbush numbers fall below about 10 per centihec, the total vegetation declines sharply also.
- Degraded sites may be invaded by unpalatable larger shrubs such as needlebush, prickly acacia, crinkled cassia and silver poverty bush.
- Bush mounds are nearly all remnants, greatly deflated, with no surviving bushes on them.
- Cryptogamic crusts are poor or absent.
- Wind erosion is common in the form of hummocking while water erosion occurs as rilling, gullying and sheeting.

Level Plains and Lake Frontages

Dense saltbush and bluebush shrubs are the dominant plants of the level plains, which cover large areas of very valuable pastoral land north and south of Carnarvon and in the ancient drainage systems through the Murchison and Goldfields. These drainage systems flow eastward into local salt lakes, unlike the main rivers which flow west to the sea.

Good examples can be found in the Sable land system of the Carnarvon Basin and the Carnegie land system of the Murchison.

Some of the salt lakes are very large, extending to 70 kilometres long. The lake beds are bare of vegetation and some are used for sporting activities. Soils are very saline close to the lakes but with distance grade to less saline alluvial plains whose pastoral use is limited by supplies of fresh water.

In general, this country type is almost identical to the river frontages and flood plains, but is much less prone to degradation. The plains are almost flat with gradients less than one in three hundred. Soils are fairly deep loams over clay. They are normally internally drained with crytogamic crusts covering more than half the soil surface.

A distinctive pattern of shrub mounds, creating individual fertile patches, is a feature of the landscape. In these mounds

the fertility and water infiltration are much higher than between the mounds. Their density and size are a very good guide to condition.

Decreaser shrubs are very similar to those growing on the river frontages. They include shy bluebush, bronze bluebush, George's bluebush, bladder saltbush, silver saltbush, frankenias, Gascoyne mulla mulla, cotton bush, scrambling saltbush, Gascoyne bluebush, currant bush and sage. Sage is one of the toughest decreaseers.

The variety of these species falls with declining condition and in the north-eastern



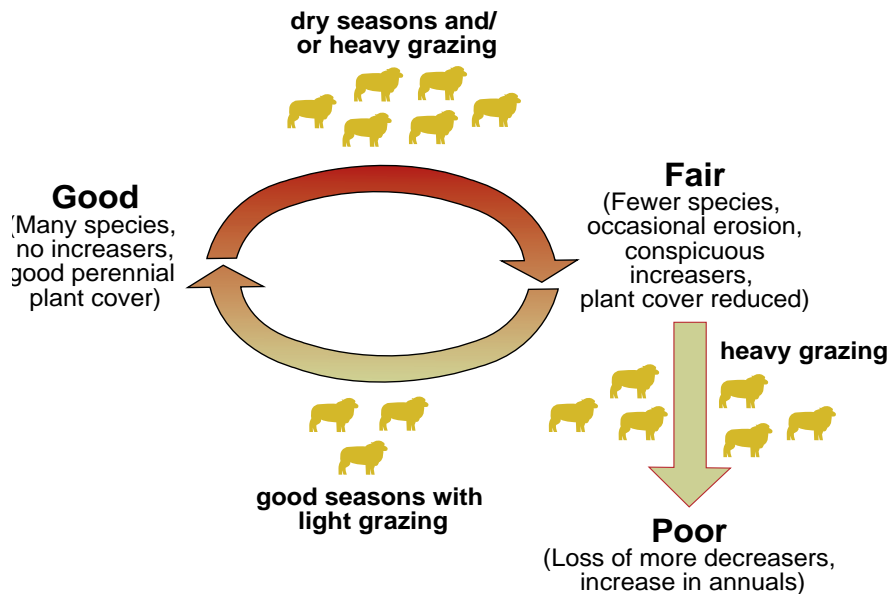
Goldfields ranges from seven to ten species for good condition country, around seven for fair condition and less than seven in poor condition.

Most important **increasers** are needlebush, tomato bush, desert cassia, silver poverty bush and wait-a-while. Kopi poverty bush is common in the north-eastern Goldfields.

In degraded sites sandy accumulations form around annual plants which grow after rain. If these sandy accumulations persist they provide a niche for shrub germination. Some observers believe that successful shrub establishment depends on avoiding disturbance by animals, so conservative stocking and reduction of total grazing pressure are important after significant rainfall.

A major study over ten years was conducted at Boolathana Station near Carnarvon and completed in 1993. Following sustained heavy grazing, the numbers of shy bluebush, Gascoyne bluebush and other perennial shrubs declined sharply but in good years the loss of forage from this 'degraded' range was more than overcome by increased growth of annuals and biennials such as bindiis.

At conservative stocking rates within the long-term capability of the range there were no gains in animal production (wool or lambs) from sheep grazing numerous palatable shrubs compared with those grazing very few shrubs. However at high stocking rates sheep on the degraded range had to be hand-fed in four of ten years to



Likely range condition changes in level plains.

prevent losses, while the non-degraded range supported sheep without extra feeding.

Prominent or dominant low shrubs vary with geographical location and local factors. For example, in more saline areas close to salt lakes, the dominant shrub will be a form of samphire. Two different varieties are common and the green one appears much more palatable than the brown, which has limited appeal to stock except when growth is fresh.

A short distance away as salinity levels change, the dominant species may be silver saltbush or bladder saltbush. This country is very valuable for pastoral use but the loose, coarse textured sandy surface may be lost to water and wind erosion without careful management. Once this occurs, the soil surface can become smooth and niches for regeneration of perennial plants are limited.

The main indicators of condition are very similar to those for the flood plains and river frontages except that the soil is more stable to erosion. Soils are normally most susceptible to water erosion in areas receiving relatively concentrated run-on. Wind erosion can be a problem during prolonged dry periods.

Good news signs

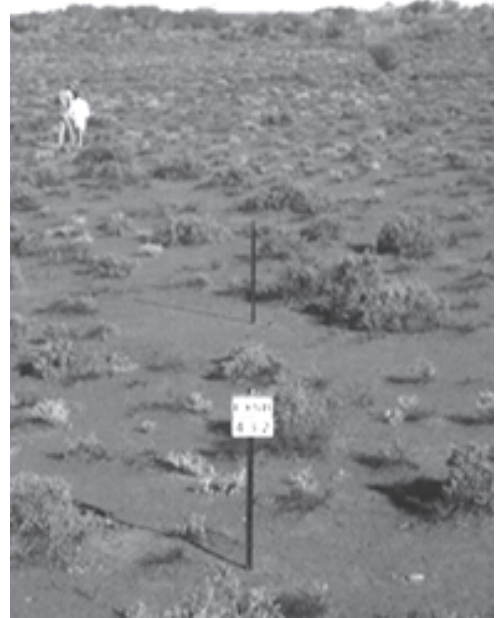
- High diversity of species
- Young and healthy saltbushes, bluebushes present
- Intact bush mounds around the shrubs
- Abundant cryptogamic crusts on soil surface

Bad news signs

- Absence of young low or decreaser shrubs
- Reduced diversity of species
- Many young increaser shrubs present
- Very patchy or no cryptogam crusts
- Signs of wind drift at surface



This lake frontage south-east of Leonora is in good condition with a diverse array of low shrubs including sage, sago bush, grey fan-leaf, three winged bluebush, frankenia, silver saltbush, George's bluebush and sweet samphire evident in the photograph. The shallow duplex soil overlies a hardpan layer. Soil surface condition is good with obvious well developed shrub mounds. The treeless plain is surrounded by low sandy banks supporting large mulgas.



This level plain north of Carnarvon is in very good condition. The Gascoyne bluebushes number about 8 per centihec and the soil is stable and well crusted. The taller shrubs are mainly prickly acacias (2 per centihec). Less obvious shrub species are flannel bush, warty-leaf eremophila, crinkled cassia and berry saltbush. The bush mounds below the Gascoyne bluebushes are important 'sinks' for plant nutrients and organic matter.

Good condition

- Saltbush species such as bladder saltbush, silver saltbush are prominent.
- Other palatable plants such as sage, green cassia, Wilcox bush, bluebushes, cotton bush, tall saltbush, flannel bush and samphire are also present.
- Occasional prickly acacia, needlebush, wait-a-while and silver poverty bush occur.
- Good cryptogamic crusts are present.
- There is little or no erosion.



This small, gritty surfaced alluvial plain east of Leinster is surrounded by more sandy plains with buck wanderrie and spinifex. Shrub numbers are below the site's potential and condition is between fair and good. The dominant shrub species are those most resistant to grazing overuse and include frankenia (foreground), sage (the big plant in the middle of the photograph), tall saltbush and sago bush. Other saltbush plants that could be expected in this country are conspicuous by their absence. Soil condition is fair to good.



This Gascoyne bluebush site just north of Carnarvon is in fair condition. The soil is duplex with a loamy sand layer about 25 cm deep over sandy clay-loam. This is typical of the level plains found along the coast between the Wooramel and Minilya Rivers and has few perennial plant species. Gascoyne bluebush plants dominate the area (8 per centihec) with a few wait-a-while and prickly acacia. More could be present. The photograph was taken in mid-summer 1981 when dry annual growth remained from a very good season.

Fair condition

- Fewer saltbush plants are present.
- Other palatable plants are present but only in low numbers, with some plants grazed back to unpalatable woody material.
- Bush mounds are slightly reduced in size.
- Cryptogamic crusts are still present.
- Occasional minor soil erosion may be present.



Virtually all the decreaser shrubs have disappeared from this alluvial plain near Leonora which is in very poor condition. A few hardy sage and grey fan-leaf plants are surviving but have been grazed heavily. Soil surface condition is fair with evidence of sealing. The low and tall shrubs in the background are growing on a less favoured but more resilient country type.



A degraded level plain north of Carnarvon. The site, which would have once supported Gascoyne bluebush, is now dominated by prickly acacia (4 per centihec) which is an increaser species. Low shrubs are sparse with none evident in this photograph. The soil surface is in fair condition with some crusting and modest growth of annual vegetation.

Poor condition

- Sparse saltbushes are present.
- Other palatable species are rarely present and the range of perennial species is usually narrow.
- Some invasion of increaser shrubs such as needlebush, wait-a-while, tomato bush and prickly acacia.
- Cryptogamic crusts are generally absent.
- Moderate erosion is often apparent.

Nullarbor Plain

The first European explorers including Edward John Eyre and Ernest Giles traversed the Nullarbor Plain as long ago as the 1840s, but development was slow despite favourable first impressions. Pastoral settlement began at Mundrabilla and Balladonia Stations in the 1870s with sheep driven overland from Albany. However, lack of underground water delayed further settlement, and at Balladonia earth tanks had to be dug by hand to collect water for the stock.

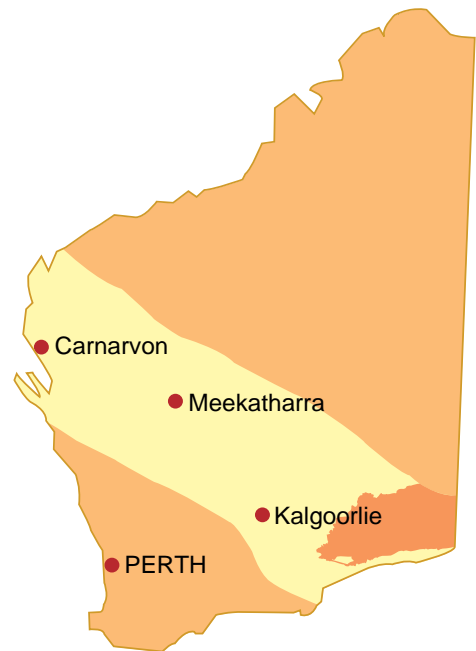
During World War I the transcontinental railway line was built across the Nullarbor, and World War II spurred construction of a main road closer to the coast linking WA and South Australia. But much of the WA area remained vacant Crown Land until 1961 when additional areas were opened for grazing.

The Nullarbor Plain is the most southerly of WA's rangelands and its rainfall is very variable, falling mainly in the winter with the passage of eastward moving depressions. Falls are heavier closer to the coast (about 250 millimetres) but decline to about 150 millimetres or less north of the transcontinental railway line. These more inland areas are colder in winter and hotter in summer.

The Nullarbor region, or Bunda Plateau as it is also known, is one of the largest limestone plains in the world. Soils are paler in colour (more of a buff) than most

of the rangeland and are shallow silty loams which tend to be stable except when disturbed. Rainfall infiltration is low to moderate and run-off drains into large shallow depressions, some known as dongas. Groundwater is generally deep – 75 to 150 metres – and often highly saline. Stony rises occur in some areas and very dark cryptogams are widespread.

The name 'nullarbor' means no trees and was coined from the Latin in 1866 by Delisser, an explorer for the South Australian Government. However his description applies to only part of the total area, the Nullarbor land zone, most of



which is north of the Eyre Highway. Leaving the centre of this treeless area, the vegetation becomes progressively taller, first with medium shrubs and sparse trees, and then into woodland. The distinctive tree species of the region is the western myall, and close to the coast eucalypts and sugarwoods also grow abundantly. North and west of the treeless shrubland the main tree species are mulgas, blackoaks and sugarwoods.

No major rivers or lakes occur on the Nullarbor, but run-off after rain flows into local drainage areas, either claypans or dongas. Dongas are a distinctive local feature occurring away from the centre of the Nullarbor. Their floors contain gilgais which are small mounds and depressions associated with uneven shrinking and swelling of clay soils. Large limestone boulders have been brought to the surface by these forces in some areas. Dongas may be up to a kilometre across and are generally round. They usually occur in chains and are thought to lie above joints in the underlying limestone which is sometimes dissected by deep caves.

Most dongas support sparse trees, mainly desert willow and curara. They are not saline, possibly because of the rapid vertical drainage through the floors. Good quality water is sometimes found beneath them.

Elsewhere, the drainage units are claypans which lack both the tree cover and gilgai

development of the dongas.

Besides its distinctive landform, the modern Nullarbor has been shaped by two specific agents indirectly and directly introduced by European man – rabbits and fire.

Rabbits were introduced to Australia in 1859, spreading gradually overland from Victoria. By 1900 they had found a niche on the Nullarbor where they were able to live underground and eat only the most succulent parts of the plants, from which they obtained enough water to survive. In good seasons their numbers soared, rapidly reaching plague proportions, stripping all available vegetation and contributing to land degradation.

In 1947 it was reported that a team of thirty five trappers near Cocklebidy was catching 20,000 rabbits a week, but the numbers were later reduced by myxomatosis.

Today rabbit populations remain very high and research in 1991 indicated that warren densities were frequently between 100 and 200 per square kilometre. This compared with three to twelve in other arid areas. Rabbits strip bark and leaf from shrubs to grazing height and have killed many shrubs and trees.

Bushfires are believed to be a natural feature of the environment resulting from summer thunderstorms after good seasons. They became more frequent in the era of

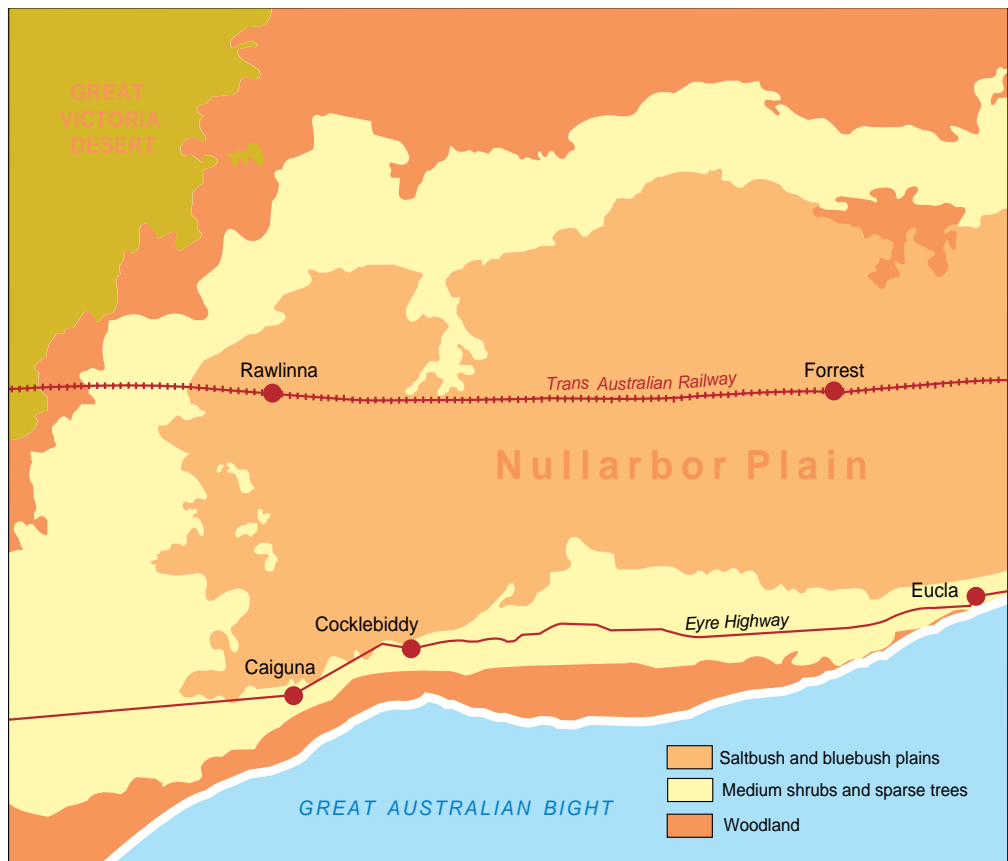
steam trains resulting in loss of shrubs and invasion by annual grasses near the transcontinental railway line. The combination of rabbits and fire has changed the vegetation dramatically. The burnt areas are now dominated by annual grasses and herbs. Such grassy country is often known as the Nullarbor herb field or prairie. Some of the most obvious examples are found close to the railway line and highway.

The time for re-establishment of vegetation after fire is unknown, but in some situations perennial vegetation may never

return. Elimination of shrubs results in colonisation by more annual grasses, which in turn renders the burnt areas more susceptible to further burning and so the cycle perpetuates.

Annual grasses such as spear grass are extremely common, especially in degraded country. Perennial grasses are infrequent, the main species being neverfail and common wallaby grass or white top.

The main shrubs throughout the Nullarbor region are pearl bluebush and bladder saltbush with the bluebush favouring the



risers and saltbush hugging the depressions. Samphire covers some saline areas which tend to grow fewer annual grasses, and are therefore less prone to fire.

Bladder saltbush is a relatively short-lived (maybe twenty five years), shallow-rooted shrub, growing to about 45 centimetres. This is less than in some other areas. It germinates readily over the cooler months, and seedlings and young plants are very common after good rains.

Pearl bluebush, by contrast, has deep roots, grows more slowly, but can live for two hundred years or more. If removed, they are difficult to regenerate except during a run of several exceptional seasons. Plants grow to about 45 centimetres high and about 1 metre apart on well-grazed areas. In ungrazed areas the pearl bluebush is taller, about 1 metre, which makes it easy to distinguish from saltbush.

In a good season pearl bluebush shrubs can almost disappear in a sea of annual grass. This can easily mislead casual observers about the productivity of the area for grazing – especially if they are unaware of the shortage of fresh water which has limited its carrying capacity.

Higher rainfall areas to the south and west support a few medium and taller shrubs including false bluebush, broom bush, nitre bush and bullock bush (known elsewhere as mingah bush). Western myall, sugarwood and some eucalypts (often

mallees) may also be present, especially close to the coast.

Western myall is to the Nullarbor what mulga is to the hardpan plains. It provides shelter and easily cut posts, some of which have endured for nearly a century. But regeneration is limited if rabbits are present. Suckering is never seen and coppicing is rare. Scientists believe that widespread natural germination only follows heavy rain which may only happen a few times a century. Large numbers of seedlings germinate at such times, particularly when protected in natural groves, but the survival rate is very low.

For their first twenty years young myalls are very vulnerable to grazing by both sheep and rabbits. If they survive this early time, the lifespan can be about two hundred and fifty years.

Weeds such as Ward's weed and wild hops have been introduced to some areas through grazing. Ward's weed has good feed value when young and appears to resist fire more than grass.

The main indicator of condition is the density of the saltbushes and bluebushes. If land has been burnt the low saltbush and bluebush shrubs will be replaced by a good cover of diverse herbs in most years. Desert cassias may invade some degraded areas.

Likely range condition changes

Away from frequent fires, rabbits and stock have reduced the shrub numbers leading to more frequent grassy years, encouraging more fires which are started by lightning. The outcome is a stable but more scattered shrubland, with greater pearl bluebush dominance as this resists fire more than bladder saltbush. This state is common over much of the Nullarbor Plain and its fringing woodlands, and is typified by the photograph on page opposite left. This area has not been grazed by domestic stock, but rabbit activity is very obvious.

Where major fires could once be expected only rarely after particularly high rainfall, the more flammable grassy vegetation now results in more frequent fires. Fires were very extensive in 1974-76 and again over the summers in 1992-94.

On large areas close to the railway line and the Eyre Highway, frequent fires caused by human activity have almost removed the shrubs. With moderate or heavy grazing, this has encouraged a 'herbfield' of bindiis, Ward's weed and other short-lived herbs. Spear grass still grows prolifically in wetter years.

In areas that have received little or no grazing such as near the Eyre Highway between Caiguna and Cocklebiddy the vegetation is dominated by spear grass that usually exists as a dense stand of dry grass. This grassy state appears to be suppressing any likelihood of shrub recruitment from remnant populations.

Good news signs

- Young shrubs, plentiful saltbush and bluebush
- Diverse herbs present and good ground cover
- Lots of black cryptogamic crusts
- Plentiful shrubs of mixed ages and sizes

Bad news signs

- No young shrubs, very scattered aged bluebush and saltbush
- Poor cryptogamic crusts, breaks in soil crust
- Predominance of one or two annual species such as limestone bindii or Ward's weed



This country between Rawlinna and Cocklebiddy is typical of the treeless bladder saltbush and pearl bluebush plains on the Nullarbor Plain. There is evidence of past shrub deaths caused by fire, but the site is in good condition. The darker soil surface colour caused by the cryptogams contrasts with the disturbed area on the track.



Vigorous bladder saltbush and pearl bluebush form a stable shrub community beneath scattered western myall and sugarwood trees on the south-western edge of the Nullarbor. The site is in good condition with very dark cryptogam crusting evident on the soil surface.

Good condition

- At least 15 pearl bluebush plants and/or at least 30 bladder saltbush plants per centihec.
- Diverse grasses and herbs are present in season.
- Good cryptogamic crusts are visible.
- No erosion is present.



This site north of Cocklebiddy is in fair condition with an obvious reduction in the population of pearl bluebush and bladder saltbush on the slopes. In the more favoured locations on the drainage floor (darker green area in the background) bladder saltbush is growing in association with samphire. The soil surface is still very stable with good cryptogam crusting in the foreground and middle ground. The patches of white are limestone boulders.

Fair condition

- From 5 to 30 bladder saltbush plants and/or 4 to 15 pearl bluebushes per centihec.
- Land retains fair cryptogamic crusts.
- Diverse grasses and herbs in season.
- No erosion present.



Successive fires have profoundly altered this site on the southern edge of the Nullarbor Plain, changing it from shrubland to annual grassland. Virtually all decreaser shrubs have been removed and it is unlikely that a seed source now exists in the area. Spear grass grows prolifically in good seasons (such as 1992 when this photograph was taken) providing fuel for further fires. It is likely that the vegetation has been permanently altered and is in poor condition compared with its original shrubby state.

Poor condition

- Very sparse saltbush and bluebush shrubs. Dominated by limestone bindii if burnt.
- Abundant spear grass in very good seasons provides significant fire risk.
- Poor annual growth.
- Little or no cryptogamic crust.
- Minor erosion and redistribution of soil by wind may occur occasionally.

Chapter 6 - Sandplain

Very sandy soils are a frequent feature of many areas in the rangelands, often producing some of the most spectacular wildflowers. About a fifth of the arid shrubland is sandplain – fairly flat to undulating plains covered with deep, sandy soils which support a variety of tall shrubs or low trees and perennial grasses. Sandplain areas sometimes extend for many kilometres, but in other places are interspersed with other soil types. Soils are non-saline and mainly red in colour. They absorb rainfall well except in degraded sites where surfaces may become sealed, making it difficult for plant germination. Except in very degraded sites accelerated erosion is usually absent.

Basic fertility of sandplain areas is very low, but their high infiltration rate allows plants to take advantage of relatively light showers of rain. Four main types have been identified: **Spinifex, Wanderrrie, Bowgada and Currant Bush Mixed Shrub.**

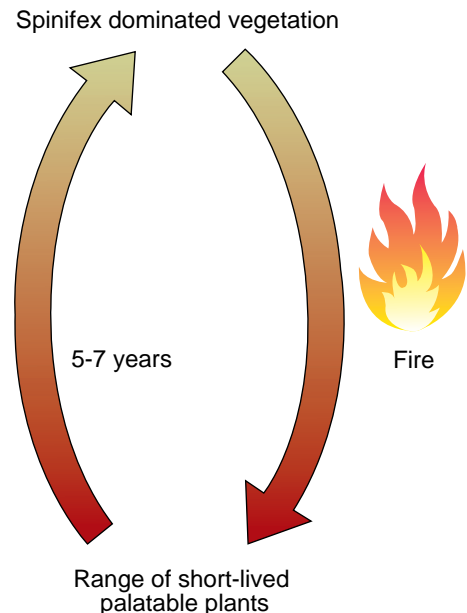
Spinifex

Spinifex is probably Australia's best known native grass, and the name covers several species that dominate large areas of infertile red sand. They are found in arid tracts of the eastern Goldfields, parts of the Gascoyne and Ashburton. Very extensive areas also occur in the Pilbara and other regions north and east of the arid shrubland.

Spinifex grasses are known as hummock grasses because they grow in low rounded hummocks, unlike the taller tussock grasses. They are members of the *Triodia* or *Plectrachne* genera.

Spinifex is usually labelled as either 'hard' or 'soft', and while soft spinifex has some use for grazing, the value of the more extensive hard spinifex country lies between very low and useless – unless recently burnt when germination of more palatable grasses and herbs is stimulated.

Spinifex grasses are well adapted to very arid environments having narrow inrolled leaves and resinous exudates which help



Likely range condition changes.



This deep sandy plain carrying low gum trees and mulgas over old spinifex hummocks is south-east of Wiluna. The blackened trunks and branches in the middle ground are evidence of past fires, although the moribund spinifex hummocks suggest that this site has not been burnt for some years.

minimise water loss. This resin also makes them highly flammable.

Spinifex tends to dominate the vegetation with varying numbers of trees and tall shrubs including mulga, marble gum, gidgee and spreading gidgee.

Spinifex country's greatest value for stock or other animals is about a year after fire and subsequent rain, when diverse short-lived

grasses and woody herbs germinate. These gradually decline in diversity as spinifex regains dominance after about five years. Shrub cover falls below 15 per cent at this stage.

The country is usually very stable, but wind erosion is common on recently burnt areas which have yet to stabilise with seasonal growth.

Wanderrie

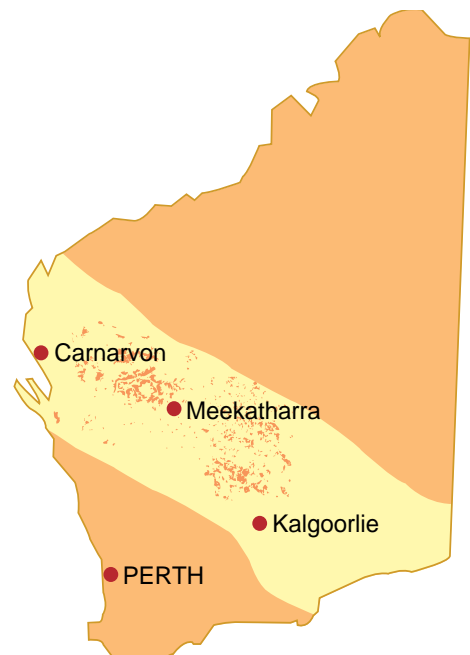
Wanderrie country (pronounced *wand'ry* and sometimes spelt 'wandarrie') is one of the least understood vegetation types in the shrublands, and is scattered over extensive areas of the Murchison River catchment, around Wiluna and through the north-eastern Goldfields.

The name wanderrie comes from a group of perennial tussock grass species, commonly known as 'wanderrie grasses', which are a prominent feature and valuable grazing resource on many sandy soils. Wanderrie country often exists as featureless grassy plains, although around the Murchison and Gascoyne it also appears as 'wanderrie banks' up to a kilometre long and 100 to 200 metres wide which are raised slightly above the general soil surface and escape flooding following heavy rain. This difference in topography may be very slight and almost invisible to the untrained eye, except when indicated by a change in vegetation. Aerial photographs often reveal a mosaic effect, with wanderrie floating in a sea of other vegetation, particularly mulga hardpan plains.

Vegetation varies considerably, but the common features include scattered shrubs and trees and an abundance of perennial grass butts, particularly in good seasons. Local plant composition appears to depend on the rainfall in the past three to five years plus fire and grazing history of the area.

Although known collectively as wanderrie grasses, the individual grass species are not all from the same close botanical grouping. Creeping wanderrie and woolly butt are part of the *Eragrostis* genus while broad-leaved wanderrie, soft wanderrie and buck wanderrie are from three other genera, but have the common link that they thrive in sandy soils.

Woolly butt, also called wire wanderrie, is one of the easiest perennial grasses to recognise because of distinctive dense white woolly fluff at the base of the butts. Individual tussocks have been known to live for twenty years and are palatable to



animals when green but fairly unpalatable and low in nutritive value as they dry off. Despite this, it is still one of the most useful perennial grasses for grazing in the Goldfields and east of Meekatharra.

Buck wanderrie is generally unpalatable and is only grazed if there are few alternatives. When prevalent to the exclusion of more palatable wanderrie grasses it indicates fair to poor range condition.

The most palatable wanderrie grasses are soft wanderrie (sometimes called mulga grass or barbed wire grass for the rough seed capsules) and broad-leaved wanderrie. Creeping wanderrie and woolly butt are rated as slightly less desirable but are the dominant species in some areas. When green these grasses have a crude protein content of up to 15 per cent and are very attractive to stock, but palatability and grazing value decline rapidly as the grass dries off. They respond well to summer rain but may be short-lived if the following seasons are dry.

Even when perennial grasses are rare, in good seasons the wanderrie banks support large numbers of annual herbs such as mulla mullas and everlastings, plus wind grass and false wanderrie grass. Summer rains favour the growth of grasses which are very flammable when dry, making occasional fires possible.

Absorption of rainwater into the banks is much greater than on the sealed and crusted surfaces between the banks, allowing more

efficient use of light rain. Wanderrie soils are usually sand or loamy sand and resist erosion while they retain good perennial plant cover but can degrade under excessive grazing pressure. Invasion of woody weeds such as unpalatable poverty bushes may then be possible.

The presence of broad-leaved wanderrie and soft wanderrie is an indicator of good range condition but their relative abundance can depend heavily on seasons. Broad-leaved wanderrie germinates best after summer rain and may not persist as a perennial if seasons are adverse.

False wanderrie grass is widely distributed in the more northerly areas of the Gascoyne and Murchison and resembles broad-leaved wanderrie grass. Most false wanderrie is annual in habit, low in palatability and removed by trampling. Abundant false wanderrie and wind grass in good seasons usually indicate poor range condition.

Determining range condition is very difficult in this country! In terms of immediate seasonal productive value for stock, wanderrie country is probably at its peak when the number of perennial grass butts is high. But the long-term health of the range may be reflected more accurately by the number of palatable shrubs present. Carrying capacity of country with large numbers of palatable grass butts could fall rapidly after two or three very dry years while similar land supporting fewer grasses but numerous palatable shrubs, would be affected less by the seasons.

The palatable wanderrie grasses are not long-lived and are sensitive to recent rainfall events, particularly summer rainfall. Their absence from a site may only be due to reduced germinating rain in recent years. Another factor is the fire history of a site which may only be evident after close search for burnt stumps. Woolly butt can be killed easily by fire and takes some years to recover.

Neither the shrubs nor the grasses alone can act as reliable indicators of range condition, and it is possible to have abundant wanderrie grasses associated with increaser shrubs and few grasses with many decreaser shrubs. Both vegetation components need to be assessed in the light of recent seasonal events to judge range condition.

Good news signs

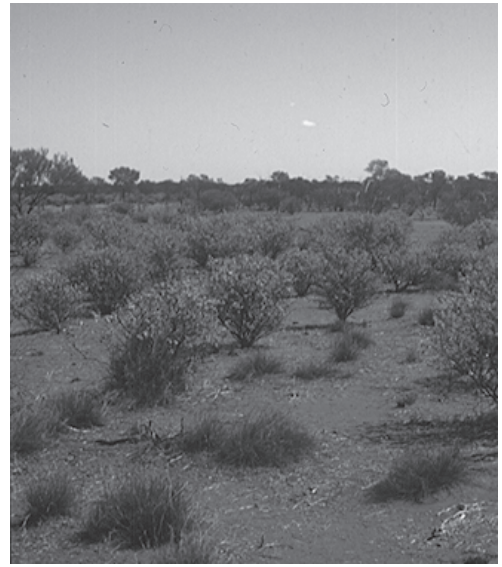
- Large numbers of palatable wanderrie grasses including young plants, particularly if they are present in poor seasons
- Plentiful palatable shrubs such as mulga bluebush, including young plants

Bad news signs

- Lots of false wanderrie and wind grass in good seasons
- Absence of palatable wanderrie grasses after good seasons
- Increase in poverty bushes
- Little or no plant residue from previous season's growth
- Hummocks of sand around plant bases
- Bare and scalded areas



This wanderrie grass site in the lower Murchison has experienced a good winter season (1993) and supports dense broad-leaved wanderrie and a little woolly butt. Virtually the only shrubs present are mulgas. It is possible that decreaser shrubs such as mulga bluebush were removed by past overgrazing and many observers would assess it as poor. Nevertheless, the site is still highly productive for some months after rain.



This area west of Meekatharra supports only very dry buck wanderrie grass and Wilcox bush which tends to be less palatable on such soils. It is not possible to determine whether the absence of broad-leaved wanderrie and woolly butt is due to very dry seasonal conditions, overgrazing or combinations of the two. Assessment of condition is difficult but the site is currently much less productive than its potential, whether people focus on grass or shrubs.

Good long-term range condition

- Usually an abundance of soft wanderrie, broad-leaved wanderrie, creeping wanderrie and woolly butt present or a mixture of some of them in good seasons.
- A range of palatable shrubs such as flat-leaved bluebush, felty bluebush, mulga bluebush, tall saltbush, tall sida and cotton bush, depending on the area. Not all of these species grows at a single site and presence may vary considerably over short distances (less than a kilometre).
- Few if any increaser shrubs such as sandbank poverty bush, turkey bush and little or no false wanderrie or wind grass.
- No evidence of accelerated erosion.



This Goldfields site supports a mixture of wanderrie grasses including patches of woolly butt, broad-leaved wanderrie and buck wanderrie. There is a sprinkling of decreaser low shrubs such as cotton bush and mulga bluebush plus some unpalatable poverty bushes. The soil surface includes small bare sealed patches. The dead trees probably resulted from past droughts.

Fair long-term range condition

- Blend of both palatable perennial grasses such as broad-leaved wanderrie and annual grasses such as false wanderrie present in good seasons.
- The number of decreaser low shrubs balanced or exceeded by the number of increasers and restricted to protected areas.
- Occasional evidence of wind erosion.



This country north of Leonora is producing well below its potential. The perennial woolly butt tussocks are responding to recent rain but have been grazed heavily in the past. No palatable shrubs are evident. The sandbank poverty bushes are not palatable to stock and may be increasing in number. The dead mulgas stand as a reminder of the past droughts and fires.

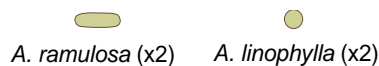
Poor long-term range condition

- Few if any palatable perennial grasses and shrubs are left in good seasons.
- Areas of bare ground or increasing numbers of unpalatable species such as sandbank poverty bush, turkey bush and less commonly some cassias.
- Evidence of wind erosion.

Bowgada

Bowgada (pronounced *bog-a-da*) is the common name for two very similar tall spreading acacias which are the dominant forms of vegetation on extensive areas of sandplain around Carnarvon, parts of the Murchison and the north-eastern Goldfields south of Lake Barlee and Lake Raeside. It often occurs above breakaways on the old plateau surface.

Until the 1980s the two shrubs were considered to be the same species, but botanists have since determined there are actually two separate species, *Acacia linophylla* and *Acacia ramulosa* which differ only in leaf shape. In cross-section, *A. ramulosa* leaves (the most common form) are flat while *A. linophylla* leaves are round. Some intergrades between the two may occur, but anything that is not perfectly cylindrical is considered to be *A. ramulosa*. In other respects however, the two species are very similar.



These shrubs may grow to 4 metres high dominating the vegetation and suppressing smaller shrubs but providing limited grazing for either native fauna, sheep or cattle except from their pods. Sheep will eat the leaves when few alternatives are available and pastoralists have described sheep as wearing bowgada leaf 'collars'. The seed pods contain over 20 per cent



crude protein and are sought eagerly by sheep when the pods drop after good seasons. The shrubs themselves have no indicator value in terms of range condition.

While known as bowgada throughout most of the shrublands the local name is wanyu in the west Gascoyne and Shark Bay areas. Wanyu covers about 25,000 square kilometres or a third of the Carnarvon Basin and as bowgada it occupies extensive undulating plains in other regions. The soils are deep, sandy and non-saline, usually dark red or sometimes yellow. Infiltration of rainfall is very rapid and there is usually very little run-off. Erosion is not a problem. Typical examples of this country would be the Kalli land

system of the Murchison, Sandplain land system in the Carnarvon Basin and Yowie in the north-eastern Goldfields.

While bowgada dominates many areas it is replaced by sugar brother or spinifex wattle on very sandy areas of the lower Murchison. Most other features of the country are similar. Pastoralists often describe it as 'hungry country'.

Trees are scattered but include mulga, native pine and several species of eucalypts in most areas except around Carnarvon. Besides the bowgada, other prominent tall shrubs can include limestone wattle, curara and sandplain wattle (also called fire wattle). Low shrubs are mainly sparse and struggle to grow beneath the tall shrubs.

Common **decreaser** species include cotton bush, horse mulla mulla and silky bluebush.

Wilcox bush, which is quite palatable and a notable decreaser on granite soils is less palatable on bowgada country so should not be used as an indicator.

Increaser low shrubs include poverty bushes such as sandbank poverty bush and turkey bush, but shrub increase is rarely a problem.

The country supports similar perennial grasses to the wanderrie country, normally in much lower numbers, although soft and broad-leaved wanderries may be reasonably plentiful following very wet years, particularly those with summer rains. In the lower Murchison wanderrie and bowgada country are very hard to separate.

Fire history is a major factor in the distribution and size of various plants. Major fires have removed the bowgada/wanyu from some areas and it may take forty years for it to regain dominance. Carrying capacity tends to increase after fire as more palatable low shrubs and grasses re-establish first when their growth is not suppressed by the larger shrubs.

Aerial photographs of the Victoria Sandplain near Shark Bay taken between 1952 and 1981 show that about a quarter had been burnt recently enough to be detected. Most fires were thought to have been started by electrical storms and fuelled by unusually heavy growth of annual grasses.

In 1963 for example, heavy summer rain (162 mm) in January-February followed by heavy winter rains (276 mm) resulted in profuse growth of annuals. Several fires ignited the following November and continued burning for several months. They removed all small shrubs and most wanyu except for a few tall individuals which survived by sprouting from upper branches. Other large perennials such as native poplar and fire bush then germinated followed by cotton bush, flannel bush, flat-leaved bluebush and felty bluebush under the shelter of the native poplar. These first tall colonisers lived only four or five years, soon giving way to scattered limestone wattle, sandplain wattle and in some higher local areas, sandridge gidgee.

Ten to forty years after burning, sites in good condition often show increased cotton bush, flat-leaved bluebush and flannel bush. It's believed that it could take at least forty years for return of the dense wanyu shrublands resulting in improved grazing until this time. Recent burning can be recognised by the presence of blackened stumps, and large numbers of plants of uniform height.

Major droughts have also caused widespread death of bowgada or sugar brother tall shrubs, and large areas of the lower Murchison still exhibited this in the early 1990s following drought in the late 1970s. Older shrubs appeared to succumb more than younger plants and their deaths had a similar effect to fire, resulting in valuable regrowth of numerous perennial grasses and palatable shrubs.

Likely range condition changes

The vegetation component of bowgada in its natural state is strongly influenced by fire. The tall acacia scrub is normally too dense for sufficient grass or herbage to build up for fires. However, occasional extreme droughts will kill mature bowgada, or exceptional rainfall years, particularly summer rainfall years, will permit sufficient material to grow to allow fire to run. Summer thunderstorms with occasional lightning strikes start the fires. Fires may occur only once every thirty to fifty years. The last recorded fires in the Carnarvon region were in 1964.

Good news signs

- Sprinkling of decreaser low shrubs and occasional grasses
- Difficult to crawl through because of thick understorey close to ground
- Can't see through vegetation at ground level

Bad news signs

- Bare surfaces, little litter on ground – swept or vacuumed appearance
- Can see through vegetation below grazing height
- More tomato bush

Fire eliminates the bowgada allowing an abundant recruitment of cottonbush, fire bush, desert poplar and fire wattle. Fire bush, desert poplar and fire wattle die out within ten to twenty years or so and there is a slow recruitment of bowgada and return to the natural bowgada community over thirty years or more.

Grazing has only a limited impact on this community. Excessive grazing of closed bowgada communities may eliminate the few useful perennial shrubs such as warty-leaf eremophila and there may be some increase in unpalatable shrubs such as turkey bush. Excessive grazing of the burnt community has similar effects but has little effect on the long-term processes.



This sandy slope is in fair to good condition with some Wilcox bush growing in association with low bowgada. Decreaser shrubs are sparse in number and there are some broad-leaved wanderrie tussocks evident in the photograph. The soil surface is stable and productive and there is an abundant accumulation of litter beneath the tall shrubs. The soil is inherently infertile.

Good condition in unburnt areas

- A narrow range of species forms a sparse understorey. Decreaser low shrubs such as warty-leaf eremophila, flat-leaved bluebush, mulga bluebush, ruby saltbush, green cassia and tall saltbush are found scattered beneath the taller shrubs. Cotton bush and flannel bush are occasionally present in small numbers.
- Sandbank poverty bush, tall poverty bush, pebble bush and tomato bush are occasionally present.
- Soil surface is usually soft and friable and often covered with plant litter providing niches for germinating seedlings and improved water infiltration.

Fair condition in unburnt areas

- The range of species remains fairly constant but fewer decreaseers are present.
- Density of unpalatables such as sandbank poverty bush, pebble bush and tomato bush may increase marginally.
- Erosion is rare.

Poor condition in unburnt areas

- Very reduced range of species and few if any decreaseers left.
- Surviving decreaseers often show evidence of heavy grazing. Cotton bush and flannel bush are less common while sandbank poverty bush, pebble bush and tomato bush may continue to increase but are not usually a problem.
- Swept or vacuumed appearance to ground.
- Erosion is rare.

Currant Bush Mixed Shrub

Currant bush mixed shrub is unique to the west Gascoyne area where it occupies more than 4,000 square kilometres of the less sandy soils. It often alternates with patches of bowgada/wanyu; the currant bush mixed shrub occupying the lower plains of the landscape on duplex soils and the wanyu on the higher banks, dunes and sandier areas. A thin surface crust may be present. Mosaic patterns showing the differing types of vegetation can be seen clearly from the air. It occurs in Sandal, Spot and Target land systems.

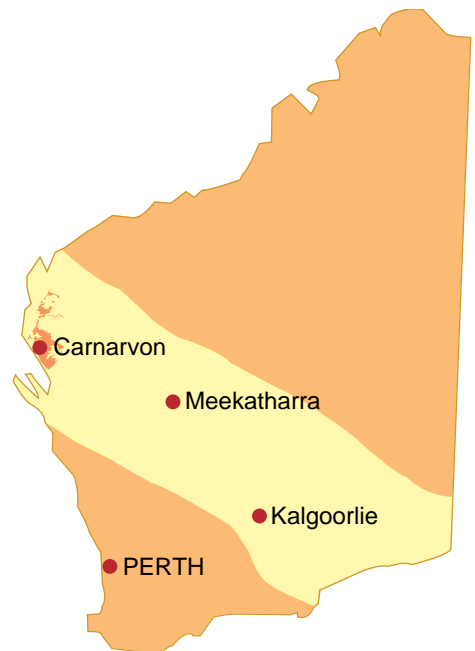
The distinctive plant species is currant bush, so-called for its small black edible berries which grow singly on short stems along the branches. The berries are usually found between May and November in good seasons. The white or cream flowers have a distinctive fan shape and a very sweet smell. Aborigines used the roots to make an infusion for stomach pains and it is sometimes used as a remedy for cancer.

While distributed across most of the arid shrublands, including the Goldfields, the Murchison and the Gascoyne, currant bush normally grows sparsely except on these sandy plains where it may occur in dense patches.

The shrub grows 3 metres high in favourable, non-saline conditions. It is an important forage plant and the leaves, which are dropped in dry seasons, contain up to 13 per cent protein and are relished by stock.

Currant bush may also occur in south-west areas in a prominently spiny form which appears to be highly resistant to grazing and will persist long after palatable species have been removed.

While currant bush is the most distinctive of the palatable species and is locally dominant within stands in good condition, the general vegetation comprises a rich mixture of both low and tall shrub species. Major tall shrubs include curara, prickly acacia (bardi bush), needlebush, mingah bush and pebble bush. Numbers around 3 to 4 per centihec are frequent.



The most common low trees are snakewood, mingah bush and sandalwood. (At one stage sandalwood was Western Australia's most valuable export. The distinctive smell is most apparent in the dry wood including the roots, but the leaves have no smell.)

In good condition country, every snakewood should have a high litter accumulation and smaller shrubs such as ruby saltbush, flat-leaved bluebush, tall saltbush and felty bluebush growing beneath it.

Low shrub densities vary much more widely than tall shrubs and may reach 200 per centihec, although 30 to 40 would be much more common. Up to fifty different low shrub species have been counted in some areas. Because of the wide range and density of palatable shrubs, the country has high pastoral value and resists drought.

Widely distributed **decreaser** low shrubs include scrambling saltbush, ruby saltbush, flat-leaved bluebush, felty bluebush, cotton bush, Gascoyne mulla mulla, tall saltbush and flannel bush.

The most useful indicator plant is currant bush itself. In good seasons and condition, currant bush is a very luminous dark green, but as moisture is lost the leaves darken, then yellow and finally drop off. Bushes may appear to die but will recover after rain.

Ruby saltbush and felty bluebush are also important indicators but can be relatively short-lived and dependent on season. Other

useful indicators could be green cassia, ragged-leaf fan flower, narrow-leaved mulla mulla and warty-leaf eremophila.

Cotton bush is very plentiful on some sites but on its own is a poor indicator of condition. Increasing cotton bush numbers can be expected when long-term grazing pressure falls, but large numbers of plants may die in poor seasons.

The proportion of palatable to unpalatable species is a useful guide to range condition. **Increasesers** include needlebush, tomato bush, prickly acacia, silver poverty bush, waxy-leaf poverty bush and straight-leaved cassia.

The country is very prone to invasion by woody increasers which make it difficult to walk through. Where invasion occurs, often near heavily-used watering points, there is no practical solution other than expensive mechanical removal. Fires are possible but only after a run of exceptional seasons – perhaps only once in thirty to fifty years.

Needlebush invasion is one of the most insidious. Low numbers can germinate almost every year, with higher numbers in some years. Growth rates are very slow and mortality is low.

Burning trials were conducted south-east of Carnarvon in 1985 where fire was found to be useful in killing needlebush, but of little use against other increaser species. Waxy-leaf poverty bush, for example, survived even the most intense fires by

resprouting from the base. Palatable species such as felty bluebush and ruby saltbush were destroyed so that fire gave little advantage except to reduce the needlebush.

Perennial grasses are scarce in this country, but may include buffel grass (in northern areas), curly windmill grass and spinifex. Wind grass is weakly perennial in good seasons and where grazing pressure is not great. Pastoralists have observed that sheep prefer it to mature buffel grass, but if eaten down to the crown it is unlikely to recover. Button grass is plentiful in good seasons.

Likely range condition changes

Currant bush mixed shrub occupies the land systems flanking the erodible river floodplains in the Carnarvon area. The soils are mostly stable.

In the natural state these shrublands support an unusually diverse range of low shrubs, many of which are palatable, with occasional taller shrubs including needlebush and snakewood. Fire is rare.

Grazing has a major impact and excessive grazing, particularly in drier years, eliminates the less hardy species including cotton bush, bluebushes and the younger currant bush and tall saltbush. Seed of species such as cassias remains viable in the soil and these species rapidly colonise the space left after elimination of more

palatable shrubs. Needlebush seed is held in aerial pods and conditions for its release and subsequent successful germination and establishment, occur infrequently.

However with the correct combination of circumstances, needlebush has explosive recruitment potential and seedling storms may occur. There have been at least two major seedling storms within the past forty to fifty years (including one in the mid-60s) leading to a degraded community dominated by needlebush with other unpalatable invaders including cassias and poverty bushes.

This change in species produces needlebush thickets which further reduce the opportunities for growth of annual species and hence fire. There are no known examples of fire-affected needlebush communities however it is known that needlebush is readily killed by fire. Pastoral management has therefore little impact on needlebush-invaded mixed currant bush shrubland. Changes for this community over perhaps a fifty to hundred year time-frame rely on fire, but opportunities are exceedingly rare. Shorter lived species such as cassias may die out but it may take more than a century for needlebush to die and for other species to emerge.

Good news signs

- Plenty of young plants especially palatables such as currant bush
- Wide variety of species present
- Currant bush plants carrying leaf up to grazing height except in very bad years
- Accumulation of plant litter and palatable small shrubs beneath large shrubs
- Snakewood foliage close to ground level
- Curly windmill grass common
- Few young woody weeds

Bad news signs

- Currant bush present only as few, old individuals with no leaves below grazing height
- Increasing numbers of flannel bush and tomato bush, but not of more desirable species
- Numerous young and middle-sized woody weeds such as needlebush, prickly acacia and waxy-leaf poverty bushes
- Palatable species present only as woody individuals
- Little or no curly windmill grass
- Wind erosion removing litter from beneath shrubs
- Bare surface and sealed soils
- Sand piled up around some shrubs



This fair to good site shows a wide range of different aged currant bushes growing on level plains in the Carnarvon district. Other decreaser shrubs including warty-leaf eremophila, tall cassia and cotton bush are present, while numerous annual grasses and herbs grow in season. The scattered taller shrubs include snakewood, needlebush and curara.

Good condition

- Country supports numerous palatable shrub species but distribution is irregular.
- May be high densities (more than 5 per centihec) of currant bush and sometimes snakewood.
- Total shrub densities vary widely but are often from 30 to 50 per centihec.
- Increaser species such as tomato bush are uncommon.
- No erosion is present.



This currant bush mixed shrubland in the Carnarvon area carries about 4 decreaser shrubs per centihec, comprising currant bush, warty-leaf eremophila, scrambling saltbush and cotton bush. The soil surface is mostly stable. There has not been a proliferation of woody shrubs such as prickly acacia, cassias and eramophilas, although they are present in small numbers. Overall condition would be rated as fair.

Fair condition

- Partial but obvious loss of species. The most palatable shrubs such as currant bush, tall cassia and warty-leaf eremophila may be present only as large, old individuals.
- Numbers of flannel bush, waxy-leaf poverty bush, needlebush, pebble bush and wait-a-while may increase.
- Most conspicuous shrubs are 2 to 3 metres tall rather than younger plants.
- Overall shrub numbers are reduced with increasing areas of bare ground.
- There is normally no erosion.



This currant bush mixed shrubland shows a proliferation of unpalatable waxy-leaf poverty bushes. A few decreaser shrubs are still present but overall condition is poor.

Poor condition

- Palatable species are often absent, dead or exist only as occasional heavily browsed relics.
- Species diversity is low and vegetation is dominated by unpalatables such as prickly acacia, needlebush, waxy-leaf poverty bush, straight-leaved cassia or silver poverty bush.
- Erosion is uncommon but may occur as wind-blown soil around shrub bases or more prominent pedestalling and surface soil loss and scalding between shrubs.

Chapter 7 - How the land is managed

Most of the arid shrublands are leased to pastoralists for grazing use, although some of the less accessible and less productive grazing areas remain as vacant Crown Land, and specific areas have been excised as national parks, nature reserves or Aboriginal reserves.

Altogether, about three hundred and thirty separate pastoral leases occupy this country ranging in size from forty four square kilometres on the fringes of the agricultural areas, to nearly five thousand square kilometres on the Nullarbor. Average lease size is 172,000 hectares or 1,720 square kilometres.

Administration of the land is through the Pastoral Board which is part of the Department of Land Administration (DOLA) and responsible to the Minister for Lands. The board consists of five members: two pastoralists, one representative each from DOLA and the Department of Agriculture (DAWA) and an independent chairman.

Current pastoral leases will all expire in 2015 and until then lessees are required to pay annual rent and comply with various statutes and conditions. In general, these conditions have been set to ensure that the land is managed and worked according to accepted standards and that its use is directed towards the conservation and regeneration of vegetation. The Pastoral

Board previously maintained its own field staff of pastoral inspectors but these were transferred to DAWA in 1987.

Pastoral Lease Reports are compiled for every pastoral property on a five-yearly schedule. Range Condition Reports are also prepared when an application for lease sale is received and these are made available to intending purchasers. They contain recommendations on management to address specific land degradation problems. These two reports cover information on stocking history and current stock numbers, seasonal conditions and the effectiveness of fences and waters in management.

Concerns about land degradation through loss of useful species or increased soil erosion are referred to the Commissioner for Soil and Land Conservation for action under the Soil and Land Conservation Act. The Commissioner may issue a notice requesting action such as destocking, fencing and development of a management plan for the lease where it is considered necessary.

Grazing pressure

Rangeland on most pastoral leases or stations supports natural vegetation only, where sheep graze at stocking rates ranging from one sheep to 5 or 6 hectares on good saltbush or bluebush country to one sheep on 30 or 40 hectares on poor condition

stony hardpan plains. Cattle are also run in some areas and some properties have changed from cattle to sheep and back again with fluctuating profitability.

Most paddocks are stocked year-in year-out, but other country is spelled in either summer or winter to assist in recovery of vegetation. Wethers are usually run on poorer country, while more fertile areas such as good lake country are reserved for ewes and lambs which require higher levels of nutrition. Water points - troughs adjacent to windmills or earth dams - are provided about every 4,000 hectares of country and average paddock size is about 7,000 hectares.

Besides the introduced stock, rangelands are also home to a variety of native and feral animals including kangaroos, euros, donkeys, wild horses, goats, foxes, rabbits and wild dogs. Pastoralists are required to contribute to a 'vermin rate' which is used to help finance control and eradication programs for problem plants and animals. Such programs are administered through the Agriculture Protection Board of WA (the APB).

It was estimated in 1990 that a million goats were present in the arid shrublands contributing 12 per cent of the total grazing pressure on the vegetation. Kangaroos were then exerting half of the total grazing pressure, while sheep provided the remaining 38 per cent. During 1991-92 and 1992-93 major feral goat control programs successfully removed more than 900,000

animals, but with rapid natural population increase it was believed that 750,000 goats were still present in June 1993. The goat reduction program allowed the balance to swing back so that sheep exerted 51 per cent of the total grazing pressure, but it is clear that some areas are supporting far more animals than many people believe.

Wild dogs are mainly present in the drier outlying areas and half a million baits have been dropped annually in the last few years, mainly as a preventive measure.

In the Murchison more than 14,000 fresh meat baits were laid on the ground against foxes in 1992-93. But numbers recover quickly, usually through reinvasion from uncontrolled areas and it is expected that lethal baiting will need to be repeated consistently until some form of biological control becomes available.

Emu population numbers build up in good seasons and when food in the pastoral areas is insufficient, the emus tend to migrate south in vast numbers. The State Barrier Fence is maintained to prevent such migrations and stretches from the Zuytdorp Cliffs north of Kalbarri to the Johnston Lakes in the Dundas Shire.

Kangaroo populations are also considerable and while pastoralists may remove sheep to encourage regeneration of vegetation, they often reckon without the kangaroos, which tend to be attracted to unstocked paddocks. In a ten-year trial at Boolathana Station near Carnarvon

weighing of dung in different paddocks showed clearly that the marsupials preferred grazing in the unstocked and lightly stocked paddocks. Removing sheep from an area did not remove all the grazing pressure on its plants.

Numbers of kangaroos multiply following the provision of additional stock waters and when stations are destocked it is essential that the waters too are closed down. The Department of Conservation and Land Management (CALM) has the responsibility for managing kangaroo populations in Western Australia. A management program provides for conservation and the controlled harvesting of particular species.

The main problem weeds in the shrublands are saffron thistle, mesquite and horehound. Where they become a major problem, pastoralists are contracted to help remove them.

Driving through stations

Because stock numbers are low, travellers on the public roads traversing the stations might rarely see any sheep or cattle and might assume none was present. Where fences cross roads, grids usually allow unimpeded travel while preventing stock movement. Gates are sometimes used rather than grids and it is essential that they are left as they are found. A shut gate should be left shut after passing, but if it is open, motorists should not try and be helpful by shutting it behind them. There

might have been a very good reason for leaving it open such as allowing stock access to water.

Main highways are often fenced off from the station country beyond, but other roads are frequently unfenced. Station country should be regarded as private property, with the same laws of trespass that apply in the farming areas. Travellers wishing to enter a lease beyond the immediate road reserve (which can be up to 200 metres wide for main roads), should obtain permission from the occupier.

Absence of fencing means that livestock or wildlife can often be found crossing the roads or lying on them, so always watch for the unexpected, particularly at night. The animal seen on the side of the road may not necessarily be the danger. Beware of its unseen friends and relations who may want to join up from the other side. Collisions between vehicles and kangaroos, emus, donkeys or sheep are never pleasant for either party.

Wet weather can bring additional hazards for those travelling through the shrublands. After a light shower of rain on bitumen, kangaroos often come onto the road to drink surface water. When wet, unsealed roads can suffer considerable damage from vehicles and take months to repair. Always check with the local shire or the occupier before driving on unsealed roads after rain.

Some stations now offer accommodation to travellers and tourists, ranging from

bedrooms with private facilities within the homestead to self-contained cottages, shearers quarters and caravan parks. Guests may be offered the opportunity to become temporary station hands, while bush walking, bird watching, picnics and barbecues are other recommended activities.

The main tourist season is in the cooler months from May to October and details of accommodation can be obtained from local and city tourist offices, motoring organisations and accommodation guides.

Moving off the road verge and camping overnight is also possible, but permission should **always** be sought from the nearest homestead. Many environments are very delicate and vehicle tracks across them may cause damage possibly leading to erosion. Accidental spread of noxious plants from other areas is another concern, particularly around creek beds and other attractive camping sites.

Several basic rules of common courtesy (and law) should be remembered:

- Littering is an offence under law in the station country, just like elsewhere. Plastic containers and tin cans can be fatal to livestock or native animals if chewed or swallowed. A campsite may be many kilometres from the nearest town but should always be left as it was found. All rubbish should be removed, not just buried where it might be uncovered by curious animals.

- Troughs and bores are provided for stock drinking water, not for travellers. Never camp close to watering places as this could prevent stock coming in to drink.
- Fire prevention is essential and visitors should consult the local authority and abide by any fire bans in force. A fire should be covered completely with earth and extinguished before going to sleep or leaving camp.
- Dogs should not be taken onto pastoral properties without permission. Travellers' dogs can also be in danger from poison baits which are sometimes laid to destroy wild dogs and foxes.
- If going near a homestead, proceed with care as small children and family pets may be about.
- If in doubt about directions, consult the pastoralist. (Station boundaries are shown on the Western Australian *Travellers Atlas*.)

Under the Wildlife Conservation Act picking of flora is prohibited except by the owners or occupiers of land, or with their consent. Being leasehold rather than freehold property, pastoral country is regarded as Crown Land but the leaseholders (station owners or managers) have grazing rights to native vegetation which includes the right to pick wildflowers as well as let their stock eat them. (Station owners also have rights to take timber for buildings, stockyards, fences and domestic firewood, but not to harvest timber commercially.)

But the Crown (or State of Western Australia) allows other people only to take flora if they have a licence – either a Commercial Purposes Licence or Licence for Scientific or Other Prescribed Purposes. The second licence, which does not permit commercial sale, is mainly used for botanical, medical or other scientific research.

Licences can be obtained from Conservation and Land Management (CALM) offices in Perth or major centres including Geraldton, Carnarvon, Kalgoorlie and Karratha. Cost is currently \$10 and the licence can extend for up to a year. CALM encourages any traveller with a special

interest in wildflowers who may wish to pick and photograph specimens to obtain such a licence. CALM also has a list of rare and endangered flora which can only be taken with the specific written approval of the Minister.

Mining activity

Although leased to individual pastoralists under certain conditions, the station country remains the property of the Crown and is therefore available for other uses including exploration for minerals. The Mining Act is the principal piece of legislation which regulates this industry and over-rides many other Acts.



Natural water is scarce in much of the rangeland but pastoralists provide troughs for stock such as this one south of Wiluna which is supplied by a windmill. Checking on the windmills is an essential job on the stations, particularly in summer.

Relations between miners and pastoralists are sometimes strained. On one hand, mining operations can severely disrupt normal pastoral activities, but on the other they have frequently become a very important source of secondary income for pastoralists who have been able to supplement their on-station earnings in lean times by offering machinery and labour for road grading, bulldozing and other work.

A code of conduct for mineral exploration on pastoral leases has been established and mineral explorers are required to avoid unnecessary damage to pastoral improvements and natural vegetation. They are not allowed to take water from

pastoralists' bores, dams, troughs or other improvements without agreement. In many places mining companies have purchased the pastoral leases on which valuable minerals have been discovered, and run stock commercially as well as extracting the minerals. In other cases they have been granted permission to destock the properties and have closed off the waters.

After exploration or mining is complete, sites have to be rehabilitated to a stable, non-erodible and safe condition.

Compensation or restoration for loss or damage caused by miners is required. The Department of Minerals and Energy can supply full details of these requirements.

Glossary of technical terms

Acacias: Large group of yellow-flowered shrubs and trees, also known as wattles.

Accelerated erosion: The more rapid erosion that follows the destruction or loss of protective cover, often resulting from man's activities on the soil, vegetation and landform. This contrasts with geological erosion which may take thousands of years.

Annual: Plant that completes its life cycle within a single year.

Biennial: Plant that requires more than one season in which to complete its life cycle, but is unlikely to survive more than two or three years, depending on the seasonal conditions.

Bindiis: Prickly biennial or annual low herbs, *Sclerolaena* species.

Breakaway: Short scarp or cliff caused by erosion of ancient land surfaces. Breakaways are scattered throughout the arid shrubland.

Bush mound: Mound of soil built up gradually around a shrub or several shrubs. A mound is able to trap water, nutrients and litter much more readily than the soil between mounds.

Chenopod: Low shrub, member of the *Chenopodiaceae* family such as saltbush, bluebush and samphires, common to vast areas of arid shrubland and often growing in saline soils. Foliage is usually grey-green and palatable to stock although high in salts.

Common: Area of common ground around a town. These may extend for several kilometres in some directions and have often been heavily grazed in the past. Conversely, some are no longer grazed and have recovered to very good range condition.

Copper burrs: Group of annual plants of *Sclerolaena* species. Alternative name for bindiis.

Crusting: Sealing of soil surface to form a protective layer against erosion which may reduce water infiltration rates. These crusts are readily broken by vehicles or stock tracks.

Cryptogams: Small growth of primitive plant life such as lichens, algae and liverworts found on surface of some soils. May not be obvious when ground is dry, but easier to see when wet. Colour ranges through yellow, orange and green to black.

Dongas: Large shallow drainage areas unique to the Nullarbor Plain.

Duplex soil: Also known as texture contrast soil, where a sandy surface layer changes abruptly to a more clayey layer beneath. Such soils are common on the flood plains near rivers, near lake frontages, on saline slopes. They are vulnerable to erosion when the sandy surface is disturbed.

Eucalypts: Large group of trees of *Eucalyptus* species, including gums and mallees. Many are found in the Goldfields, but they tend to be rare in other arid rangelands except near permanent water.

Everlasting daisies: Various species of annual pink, white and yellow daisy common to large areas of WA.

Exclosure: Area fenced to restrict access of grazing animals, used by scientists to assess changes in vegetation and soil condition. Such areas allow separation of climatic and grazing effects.

Floodplain: Area close to river which becomes flooded after heavy rains. Such areas are usually relatively fertile due to the deposition of sediments.

Forbs: Small non-woody annual plants or forage herbs.

Frankenias: Group of fairly tough but palatable, saline, perennial low shrubs of *Frankenia* species.

Greenstone: Distinctive dark coloured rock associated with uplands and mineral deposits in the Goldfields. The term is also used to describe the relatively fertile soils formed from these rocks.

Grove: Dense group of trees or shrubs of varying size which tends to become the fertile patch for a given area. Groves are a distinct feature of some country types.

Gully: A channel more than 30 centimetres deep with short, usually steep walls eroded on a slope by stream flow.

Hardpan: Hard layers cemented by iron and silica just beneath the soil surface which can prevent penetration of plant roots. Local names include 'coffee rock' and 'Murchison cement'. The hardpan layer may be exposed by erosion in some places.

Hummock/Hummocking: Accumulation of sand formed around plants or other objects as a result of wind deposition caused by erosion elsewhere.

Land system: An area or group of areas throughout which there is a recurring pattern of topography, soils and vegetation. This method of land classification is used by the Western Australian Rangeland Survey and some land systems are common to several regions. It is a convenient mapping unit, readily seen on aerial and satellite photographs.

Mallee: Multi-stemmed varieties of *Eucalyptus* species.

Natural erosion: Natural processes involving the movement of land surface material in all natural environments.

Pedestal: Vertical pillar of soil, usually associated with plant or root protection that remains after erosion has removed surrounding soil material.

Perennial: Plant having a life cycle lasting more than two years. Perennials found in the rangeland include small shrubs and grasses which live only a few years to trees and tall shrubs which may survive for hundreds of years.

Poverty bushes: Some members of *Eremophila* genus, mostly unpalatable shrubs. All poverty bushes are eremophilas but not all eremophilas are poverty bushes.

Rill: A small channel up to 30 centimetres deep. The term is often used in relation to erosion.

Saline: High in salt, a term used commonly to describe both water and soil. Saline soils are widespread through the rangeland and support particular types of vegetation such as saltbushes and bluebushes.

Samphires: Group of low growing, salt tolerant shrubs, mostly species of *Halosarcia* or *Gunniopsis*.

Scald: Ground that is bare of vegetation, and from which soil has been eroded by surface wash or wind. Their sealed surfaces are usually impervious to water.

Shrub: Woody plant multistemmed at the base (or within 20 centimetres of ground level) or, if single stemmed, less than 2 metres tall. Shrubs have been separated into low shrubs (less than 1 metre tall), medium shrubs (1 to 2 metres) and tall shrubs (more than 2 metres).

Sidas: Group of plants within the *Sida* genus, mostly palatable perennial shrubs but including some annuals and biennials.

Soil fertility: The ability to supply nutrients for plant growth when other factors are favourable. Most rangeland soils in WA are not fertile except for greenstones and alluvial plains.

Spinifex: Group of perennial hummock grasses, mainly *Triodia* and *Plectrarchne* species.

Strew: Often used to describe small rocks or pebbles 'strewn' over the surface of the ground. Occurs frequently on stony hardpan soils, greenstone and other country high in the landscape.

Terracettes: Shallow erosion faces on slopes resulting either from soil creep or sheet water erosion.

Topography: Description of the relief features or surface configuration of an area such as hills, plains, outcrops of rock.

Tree: Woody plant more than 2 metres tall with a single stem or branches well above the base.

Wanderrie grasses: Common name for group of perennial grasses found widely distributed in sandy soils of the arid shrublands.

Wattle: Common name for members of *Acacia* family, mostly shrubs or trees.

Woody weeds: Common term for unpalatable shrubs which invade degraded land. Examples include needlebush, turpentine bush and some cassias.

Common names of plants in this manual

ball-leaf bluebush	<i>Maireana glomerifolia</i>	buck wanderrie	<i>Eriachne helmsii</i>
banana-leaf cassia	<i>Cassia phyllodinea</i>	buffel grass	<i>Cenchrus ciliaris</i>
bardi bush	<i>Acacia victoriae</i>	bullock bush	<i>Alectryon oleifolius</i>
beefwood	<i>Grevillea striata</i>	button grass	<i>Dactyloctenium radulans</i>
berry saltbush	<i>Rhagodia baccata</i>	cannon balls	<i>Dissocarpus paradoxus</i>
billy buttons	<i>Helipterum craspedioides</i>	cassia, banana-leaf	<i>Cassia phyllodinea</i>
bindii, limestone	<i>Sclerolaena obliquicuspis</i>	cassia, creeping	<i>Cassia hamersleyensis</i>
Birdwood grass	<i>Cenchrus setiger</i>	cassia, crinkled	<i>Cassia helmsii</i>
black oak	<i>Casuarina cristata</i>	cassia, green	<i>Cassia chatelaineana</i>
blackbutt, Goldfields	<i>Eucalyptus lesouefii</i>	cassia, grey	<i>Cassia helmsii</i>
bladder saltbush	<i>Atriplex vesicaria</i>	cassia, straight-leaved	<i>Cassia desolata</i>
bluebush, ball-leaf	<i>Maireana glomerifolia</i>	cassia, tall	<i>Cassia chatelaineana</i>
bluebush, false	<i>Cratystylis conocephala</i>	cassia, variable	<i>Cassia sturtii</i>
bluebush, five pin	<i>Maireana atkinsiana</i>	climbing saltbush	<i>Rhagodia eremea</i>
bluebush, flat-leaved	<i>Maireana planifolia</i>	common wallaby grass	<i>Danthonia caespitosa</i>
bluebush, Gascoyne	<i>Maireana polypterygia</i>	coolabah	<i>Eucalyptus coolabah</i>
bluebush, golden	<i>Maireana georgei</i>	corky-bark kallstroemia	<i>Tribulus platypterus</i>
bluebush, lax	<i>Maireana thesioides</i>	cotton bush	<i>Ptilotus obovatus</i>
bluebush, mulga	<i>Maireana convexa</i>	creeping cassia	<i>Cassia hamersleyensis</i>
bluebush, pearl	<i>Maireana sedifolia</i>	creeping wanderrie	<i>Eragrostis lanipes</i>
bluebush, pussy	<i>Maireana melanocoma</i>	crinkled cassia	<i>Cassia helmsii</i>
bluebush, shy	<i>Maireana platycarpa</i>	curara	<i>Acacia tetragonophylla</i>
bluebush, silky	<i>Maireana villosa</i>	curly windmill grass	<i>Enteropogon acicularis</i>
bluebush, spiny	<i>Maireana aphylla</i>	currant bush	<i>Scaevola spinescens</i>
bluebush, three-winged	<i>Maireana triptera</i>	desert cassia	<i>Cassia nemophila</i>
bowgada	<i>Acacia ramulosa</i> or <i>A. linophylla</i>	desert kurrajong	<i>Brachychiton gregorii</i>
breelya	<i>Gastrolobium laytonii</i>	desert poplar	<i>Codoncarpus cotinifolius</i>
broad-leaved wanderrie	<i>Monachather paradoxa</i>	desert willow	<i>Pitiosporum phylliraeoides</i>
bronze bluebush	<i>Maireana atkinsiana</i>	doublegee	<i>Emex australis</i>
broom bush	<i>Eremophila scoparia</i>	earlobe saltbush	<i>Chenopodium gaudichaudianum</i>
		false wanderrie grass	<i>Eriachne aristidea</i>

feather spear grass	<i>Stipa elegantissima</i>	limestone bindii	<i>Scerolaena patentiscuspis</i>
felty bluebush	<i>Maireana tomentosa</i>	limestone wattle	<i>Acacia sclerosperma</i>
felty fuchsia bush	<i>Eremophila compacta</i>	love grass	<i>Eragrostis dielsii</i>
fire bush	<i>Gyrostemnon ramulosus</i>	low mulla mulla	<i>Ptilotus beardii</i>
fire wattle	<i>Acacia murrayana</i>	marble gum	<i>Eucalyptus gongylocarpa</i>
five pin bluebush	<i>Maireana atkinsiana</i>	mingah bush	<i>Alectryon oleifolius</i>
flannel bush	<i>Solanum lasiophyllum</i>	miniritchie	<i>Acacia grasbyi</i>
flat-leaved bluebush	<i>Maireana planifolia</i>	mulga, hop	<i>Acacia craspedocarpa</i>
Gascoyne bluebush	<i>Maireana polypterygia</i>	mulga	<i>Acacia aneura</i>
Gascoyne mulla mulla	<i>Ptilotus polakii</i>	mulga bluebush	<i>Maireana convexa</i>
George's bluebush	<i>Maireana georgei</i>	mulga broombush	<i>Spartothamnella teucriflora</i>
gidgee	<i>Acacia pruinocarpa</i>	mulla mulla, horse	<i>Ptilotus schwartzii</i>
gimlet	<i>Eucalyptus salubris</i>	mulla mulla, Gascoyne	<i>Ptilotus polakii</i>
golden bluebush	<i>Maireana georgei</i>	mulla mulla, purple	<i>Ptilotus exaltatus</i>
Goldfields blackbutt	<i>Eucalyptus lesouefii</i>	mulla mulla, royal or showy	<i>Ptilotus rotundifolia</i>
granite poverty bush	<i>Eremophila platycalyx</i>	Murchison red grass	<i>Eragrostis dielsii</i>
granite wattle	<i>Acacia kempeana</i>	Murchison willow	<i>Acacia demissa</i> (formerly aff. <i>quadrimarginea</i>)
green cassia	<i>Cassia chatelaineana</i>	myall	<i>Acacia papyrocarpa</i>
grevillea, red	<i>Grevillea deflexa</i>	native pine	<i>Callitris columnellaris</i>
grey cassia	<i>Cassia helmsii</i>	native poplar	<i>Codoncarpus cotinifolius</i>
grey fan-leaf	<i>Lawrencia squamata</i>	needlebush	<i>Hakea preissii</i>
grey turpentine bush	<i>Eremophila macmillaniana</i>	neverfail	<i>Eragrostis setifolia</i>
hop bush	<i>Dodonea lobulata</i>	old man saltbush	<i>Atriplex nummularia</i>
hop mulga	<i>Acacia craspedocarpa</i>	onion weed	<i>Asphodelus fistulosus</i>
horse mulla mulla	<i>Ptilotus schwartzii</i>	pearl bluebush	<i>Maireana sedifolia</i>
kerosene grass	<i>Aristida contorta</i>	pebble bush	<i>Stylobasium spathulatum</i>
kite-leaf poison	<i>Gastrolobium laytonii</i>	pink velleia	<i>Velleia rosea</i>
kopi poverty bush	<i>Eremophila miniata</i>	pixie bush	<i>Eremophila oldfieldii</i>
kurrajong	<i>Brachychiton gregorii</i>	poverty bush, royal	<i>Eremophila cuneifolia</i>
lake fuchsia bush	<i>Eremophila miniata</i>	poverty bush, silver	<i>Eremophila pterocarpa</i>
large white paper daisy	<i>Helipterum floribundum</i>		
lax bluebush	<i>Maireana thesioides</i>		
lemon-scented grass	<i>Cymbopogon ambiguus</i>		

poverty bush, spoon-leaved	<i>Eremophila spathulata</i>	sida, dwarf or prostrate	<i>Sida corrugata</i>
poverty bush, warty-leaf	<i>Eremophila latrobei</i>	silky bluebush	<i>Maireana villosa</i>
poverty bush, waxy-leaf	<i>Eremophila crenulata</i>	silver poverty bush	<i>Eremophila pterocarpa</i>
prickly acacia	<i>Acacia victoriae</i>	silver saltbush	<i>Atriplex bunburyana</i>
purple mulla mulla	<i>Ptilotus exaltatus</i>	silver spear grass	<i>Stipa elegantissima</i>
pussy bluebush	<i>Maireana melanocoma</i>	snakewood	<i>Acacia xiphophylla</i>
ragged-leaf fan flower	<i>Scaevola tomentosa</i>	soft spinifex	<i>Triodia pungens</i>
red grass	<i>Eragrostis dielsii</i>	soft wanderrie grass	<i>Thyridolepis multiculmis</i>
red grevillea	<i>Grevillea deflexa</i>	spear grass	<i>Stipa scabra</i>
rhagodia	<i>Rhagodia eremaea</i>	spinifex wattle	<i>Acacia coolgardiensis</i>
ribbon gum	<i>Eucalyptus gongylocarpa</i>	spiny bluebush	<i>Maireana aphylla</i>
river saltbush	<i>Atriplex amnicola</i>	spoon-leaved eremophila	<i>Eremophila spathulata</i>
Roebourne Plains grass	<i>Eragrostis xerophila</i>	standback	<i>Hakea preissii</i>
royal mulla mulla	<i>Ptilotus rotundifolia</i>	straight-leaved cassia	<i>Cassia desolata</i>
royal poverty bush	<i>Eremophila cuneifolia</i>	sugar brother	<i>Acacia coolgardiensis</i>
ruby saltbush	<i>Enchylaena tomentosa</i>	sugarwood	<i>Myoporum platycarpum</i>
sage	<i>Cratystylis subspinescens</i>	swamp saltbush	<i>Atriplex amnicola</i>
sago bush	<i>Maireana pyramidata</i>	tall cassia	<i>Cassia chatelaineana</i>
salmon gum	<i>Eucalyptus salmonophloia</i>	tall saltbush	<i>Rhagodia eremaea</i>
saltbush, berry	<i>Rhagodia baccata</i>	tall sida	<i>Sida calyxhymenia</i>
saltbush, bladder	<i>Atriplex vesicaria</i>	tan wattle	<i>Acacia hemiteles</i>
saltbush, silver	<i>Atriplex bunburyana</i>	three-winged bluebush	<i>Maireana triptera</i>
saltbush, old man	<i>Atriplex nummularia</i>	tomato bush	<i>Solanum orbiculatum</i>
saltbush, river or swamp	<i>Atriplex amnicola</i>	tree balsam	<i>Euphorbia drummondii</i>
saltbush, tall	<i>Rhagodia eremaea</i>	turkey bush	<i>Eremophila gilesii</i>
sandalwood	<i>Santalum spicatum</i>	turpentine bush	<i>Eremophila fraseri</i>
sandbank poverty bush	<i>Eremophila margarethae</i>	variable cassia	<i>Cassia sturtii</i>
sandplain wattle	<i>Acacia murrayana</i>	wait-a-while	<i>Acacia cuspidifolia</i>
sandridge gidgee	<i>Acacia anastema</i>	wanderrie, soft	<i>Thyridolepis multiculmis</i>
scrambling saltbush	<i>Chenopodium gaudichaudianum</i>	wanderrie, buck	<i>Eriachne helmsii</i>
shy bluebush	<i>Maireana platycarpa</i>	wanderrie, broad-leaved	<i>Monachather paradoxa</i>
sida, tall	<i>Sida calyxhymenia</i>	wanderrie, wire	<i>Eragrostis eriopoda</i>
		wanderrie, creeping	<i>Eragrostis lanipes</i>
		wanderrie, false	<i>Eriachne aristidea</i>

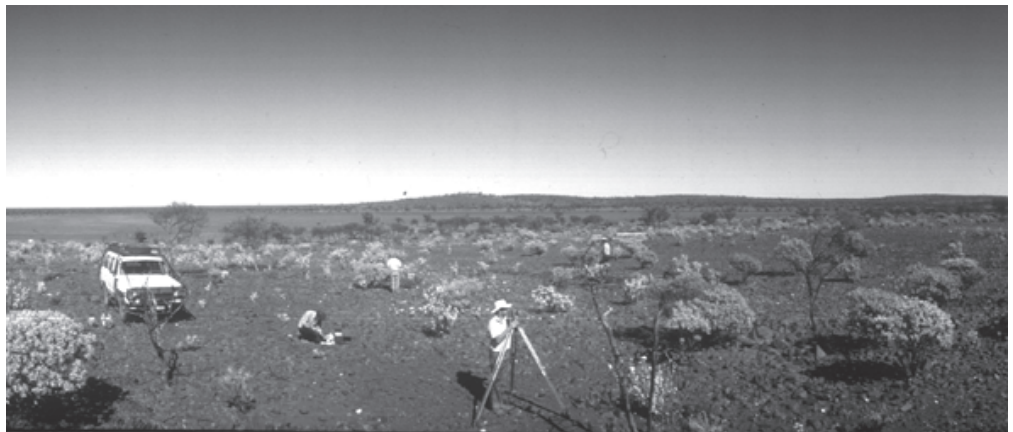
wanyu	<i>Acacia ramulosa</i> or <i>A. linophylla</i>	white sunray	<i>Helipterum floribundum</i>
Ward's weed	<i>Carrichterea annua</i>	white top	<i>Danthonia caespitosa</i>
warty fuchsia bush	<i>Eremophila latrobei</i>	Wilcox bush	<i>Eremophila forrestii</i>
warty-leaf eremophila	<i>Eremophila latrobei</i>	wild hops	<i>Rumex vesicaria</i>
wattle, granite	<i>Acacia kempeana</i>	wild tomato	<i>Solanum orbiculatum</i>
wattle, limestone	<i>Acacia sclerosperma</i>	wind grass	<i>Aristida contorta</i>
wattle, sandplain	<i>Acacia murrayana</i>	wire wanderrie	<i>Eragrostis eriopoda</i>
wattle, tan	<i>Acacia hemiteles</i>	witchetty bush	<i>Acacia kempeana</i>
waxy-leaf poverty bush	<i>Eremophila crenulata</i>	woolly butt	<i>Eragrostis eriopoda</i>
western myall	<i>Acacia papyrocarpa</i>	York gum	<i>Eucalyptus loxophleba</i>

Botanical names of plants in this manual

<i>Acacia anastema</i>	sandridge gidgee	<i>Cassia chatelaineana</i>	green cassia, tall cassia
<i>Acacia aneura</i>	mulga	<i>Cassia desolata</i>	straight-leaved cassia
<i>Acacia coolgardiensis</i>	sugar brother, spinifex wattle	<i>Cassia hamersleyensis</i>	creeping cassia
<i>Acacia craspedocarpa</i>	hop mulga	<i>Cassia helmsii</i>	crinkled cassia
<i>Acacia cuspidifolia</i>	wait-a-while	<i>Cassia nemophila</i>	desert cassia
<i>Acacia demissa</i>	Murchison willow	<i>Cassia phyllodinea</i>	banana-leaf cassia
<i>Acacia grasbyi</i>	miniritchie	<i>Cassia sturtii</i>	variable cassia
<i>Acacia hemiteles</i>	tan wattle	<i>Casuarina cristata</i>	black oak
<i>Acacia kempeana</i>	granite wattle, witchetty bush	<i>Cenchrus ciliaris</i>	buffel grass
<i>Acacia linophylla</i>	bowgada, wanyu	<i>Cenchrus setiger</i>	Birdwood grass
<i>Acacia murrayana</i>	fire wattle, sandplain wattle	<i>Chenopodium gaudichaudianum</i>	earlobe saltbush, scrambling saltbush
<i>Acacia papyrocarpa</i>	myall, western myall	<i>Codoncarpus cotinifolius</i>	native poplar, desert poplar
<i>Acacia pruinocarpa</i>	gidgee	<i>Cratystylis conocephala</i>	false bluebush
<i>Acacia ramulosa</i>	bowgada, wanyu	<i>Cratystylis subspinescens</i>	sage
<i>Acacia sclerosperma</i>	limestone wattle	<i>Cymbopogon ambiguus</i>	lemon-scented grass
<i>Acacia tetragonophylla</i>	curara	<i>Dactyloctenium radulans</i>	button grass
<i>Acacia victoriae</i>	bardi bush, prickly acacia	<i>Danthonia caespitosa</i>	common wallaby grass, white top
<i>Acacia xiphophylla</i>	snakewood	<i>Dissocarpus paradoxus</i>	cannon balls
<i>Alectryon oleifolius</i>	mingah bush, bullock bush	<i>Dodonea lobulata</i>	hop bush
<i>Aristida contorta</i>	wind grass, kerosene grass	<i>Emex australis</i>	doublegee
<i>Asphodelus fistulosus</i>	onion weed	<i>Enchylaena tomentosa</i>	ruby saltbush
<i>Atriplex amnicola</i>	river or swamp saltbush	<i>Eragrostis dielsii</i>	love grass, Murchison red grass
<i>Atriplex bunburyana</i>	silver saltbush	<i>Eragrostis eriopoda</i>	woolly butt, wire wanderrie
<i>Atriplex nummularia</i>	old man saltbush	<i>Eragrostis lanipes</i>	creeping wanderrie
<i>Atriplex vesicaria</i>	bladder saltbush	<i>Eragrostis setifolia</i>	neverfail
<i>Brachychiton gregorii</i>	desert kurrajong	<i>Eragrostis xerophila</i>	Roebourne Plains grass
<i>Callitris columnellaris</i>	native pine	<i>Eremophila compacta</i>	fely fuchsia bush
<i>Carrichterea annua</i>	Ward's weed	<i>Eremophila crenulata</i>	waxy-leaf poverty bush

<i>Eremophila cuneifolia</i>	royal poverty bush	<i>Maireana atkinsiana</i>	bronze bluebush, five pin bluebush
<i>Eremophila forrestii</i>	Wilcox bush	<i>Maireana convexa</i>	mulga bluebush
<i>Eremophila fraseri</i>	turpentine bush	<i>Maireana georgei</i>	George's bluebush, golden bluebush
<i>Eremophila gilesii</i>	turkey bush	<i>Maireana melanocoma</i>	pussy bluebush
<i>Eremophila latrobei</i>	warty fuchsia bush, warty-leaf eremophila	<i>Maireana planifolia</i>	flat-leaved bluebush
<i>Eremophila macmillaniana</i>	grey turpentine bush	<i>Maireana platycarpa</i>	shy bluebush
<i>Eremophila margarethae</i>	sandbank, sandplain poverty bush	<i>Maireana polypterygia</i>	Gascoyne bluebush
<i>Eremophila miniata</i>	kopi poverty bush, lake fuchsia bush	<i>Maireana pyramidata</i>	sago bush
<i>Eremophila oldfieldii</i>	pixie bush	<i>Maireana sedifolia</i>	pearl bluebush
<i>Eremophila platycalyx</i>	granite poverty bush	<i>Maireana thesioides</i>	lax bluebush
<i>Eremophila pterocarpa</i>	silver poverty bush	<i>Maireana tomentosa</i>	felty bluebush
<i>Eremophila scoparia</i>	broom bush	<i>Maireana triptera</i>	three-winged bluebush
<i>Eremophila spathulata</i>	spoon-leaved eremophila	<i>Maireana villosa</i>	silky bluebush
<i>Eriachne aristidea</i>	false wanderrie grass	<i>Monachather paradoxa</i>	broad-leaved wanderrie
<i>Eriachne helmsii</i>	buck wanderrie	<i>Myoporum platycarpum</i>	sugarwood
<i>Eucalyptus coolabah</i>	coolabah	<i>Nitraria schoberi</i>	nitre bush
<i>Eucalyptus lesouefii</i>	Goldfields blackbutt	<i>Pittosporum phylliraeoides</i>	desert willow
<i>Eucalyptus loxophleba</i>	York gum	<i>Ptilotus beardii</i>	low mulla mulla
<i>Eucalyptus salmonophloia</i>	salmon gum	<i>Ptilotus exaltatus</i>	purple mulla mulla
<i>Eucalyptus salubris</i>	gimlet	<i>Ptilotus obovatus</i>	cotton bush
<i>Euphorbia drummondii</i>	tree balsam	<i>Ptilotus polakii</i>	Gascoyne mulla mulla
<i>Gastrolobium laytonii</i>	breelya, kite-leaf poison	<i>Ptilotus rotundifolia</i>	royal or showy mulla mulla
<i>Grevillea deflexa</i>	red grevillea	<i>Ptilotus schwartzii</i>	horse mulla mulla
<i>Grevillea striata</i>	beefwood	<i>Rhagodia baccata</i>	berry saltbush
<i>Gyrostemnon ramulosis</i>	fire bush	<i>Rhagodia eremaea</i>	rhagodia, tall saltbush, climbing saltbush
<i>Hakea preissii</i>	needlebush, standback	<i>Rumex vesicaria</i>	wild hops
<i>Helipterum craspedioides</i>	billy buttons	<i>Santalum spicatum</i>	sandalwood
<i>Helipterum floribundum</i>	large white paper daisy, white sunray	<i>Scaevola spinescens</i>	currant bush
<i>Lawrencia squamata</i>	grey fan-leaf	<i>Scaevola tomentosa</i>	ragged-leaf fan flower
<i>Maireana aphylla</i>	spiny bluebush	<i>Sclerolaena obliquicuspis</i>	limestone bindii

<i>Sida calyxymenia</i>	tall sida	<i>Thyridolepis multiculmis</i>	soft wanderrie grass
<i>Sida corrugata</i>	dwarf or prostrate sida	<i>Tribulus platypterus</i>	skeleton bark, corky-bark kallstroemia
<i>Solanum lasiophyllum</i>	flannel bush	<i>Triodia basedowii</i>	hard spinifex
<i>Solanum orbiculatum</i>	tomato bush, wild tomato	<i>Triodia pungens</i>	soft spinifex
<i>Spartothamnella teucriflora</i>	mulga broombush	<i>Velleia rosea</i>	pink velleia
<i>Stipa elegantissima</i>	feather or silver spear grass		
<i>Stipa scabra</i>	spear grass		
<i>Stylobasium spathulatum</i>	pebble bush		



Departments of Agriculture and Land Administration Rangeland Survey team at work in the Murchison.

Further reading

Rangeland survey reports

- *Lands of the Wiluna-Meekatharra Area, Western Australia, 1958* (1963) by J.A. Mabbutt *et al.* Commonwealth Scientific and Industrial Research Organization, Australia, Land Research Series No. 7.
- *A report on the condition of the Gascoyne Catchment* (circa 1972) by D.G. Wilcox and E.A. McKinnon. Department of Agriculture, Western Australia, Technical Bulletin No. 2.
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The 850,000 square kilometres of Western Australia's arid shrublands stretch from the Indian Ocean north of Carnarvon, eastward and south to the famous Nullarbor Plain and the Southern Ocean.

Across the expanse, larger than many individual nations, are vast sheep and cattle stations, historic settlements dating from the goldrushes and modern mining operations. This fascinating environment has sometimes been treated carelessly since Europeans began cutting its timbers, digging its rich minerals and grazing their stock on the native shrubs and grasses. Damage has been done but experience of both pastoralists and scientists is now offering help in providing a better understanding of the needs of the land.

Reading the rangeland provides a practical insight into its condition, from the mulga shrubland to the spinifex sandplain, granites and the breakaways. It will interest all who love and respect this vast, uniquely Australian environment.

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