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## An inventory and condition survey of the Roebourne Plains and surrounds, Western Australia

A L. Payne

Peter J. Tille  
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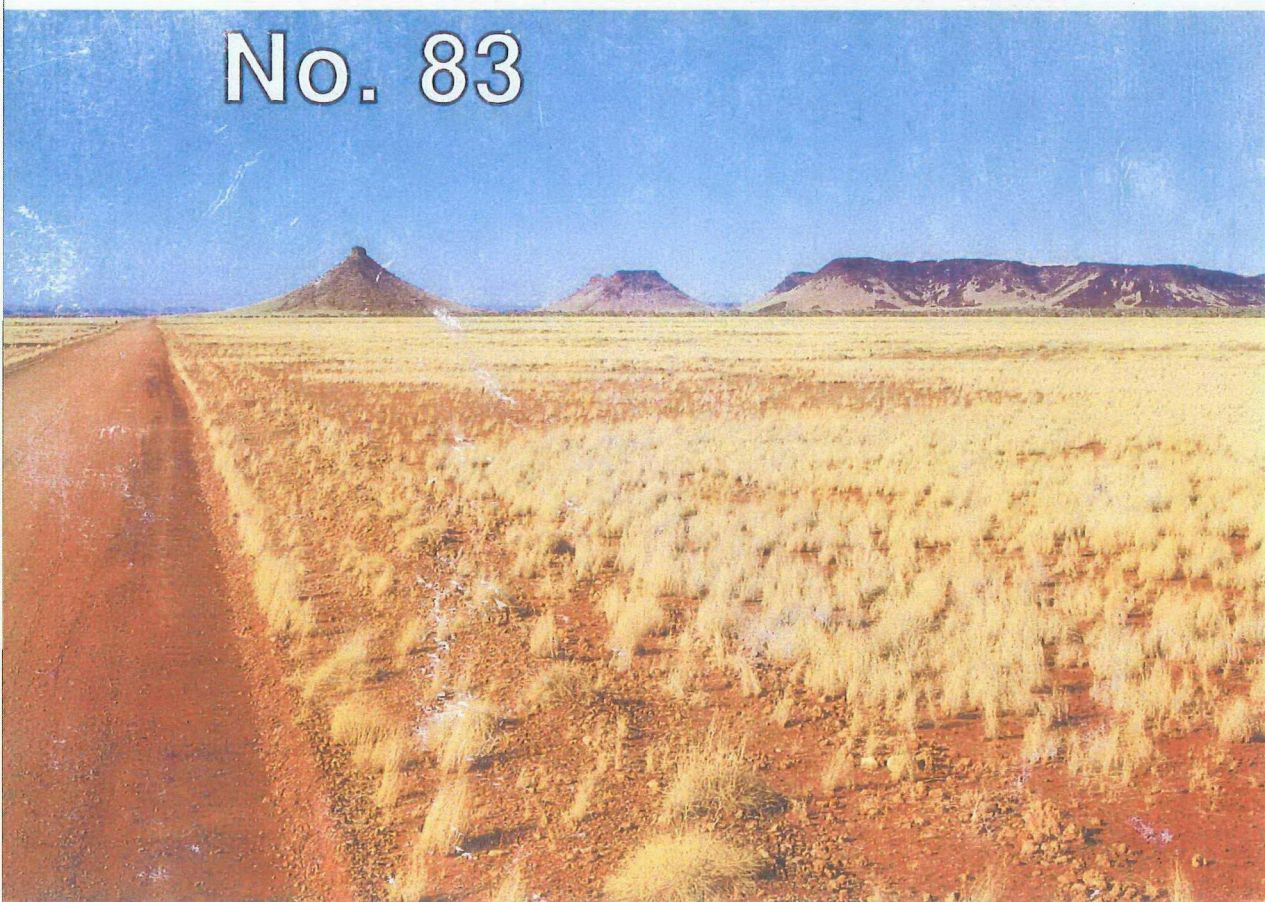
# Technical Bulletin

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**An inventory and condition  
survey of the Roebourne Plains  
and surrounds, Western Australia**

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**No. 83**



A.L. Payne  
P.J. Tille

**Front cover:**

The Roebourne Plains, covered predominantly with a tussock grass pasture of *Eragrostis xerophila*, have a back drop of the rugged, spinifex (*Triodia* spp.) clad hills which typify the Pilbara. This photograph shows Pyramid Hill on Pyramid station.

# **An inventory and condition survey of the Roebourne Plains and surrounds, Western Australia**

By: A.L. Payne and P.J. Tille

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## Appendix 7.

### Map

**Land systems of the Roebourne Plains and surrounds at 1:250,000 scale**  
(One map sheet accompanies this publication.)

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## Abstract and recommendations

1. The survey area is located in the North-West Division of Western Australia. It covers parts of the Dampier-Barrow Island, Pyramid, Roebourne and Yarraloola 1:250,000 scale map sheets and all of the Karratha, Mallina, Pyramid, Sherlock, Mt Welcome and Warambie pastoral leases.
2. The area is described in terms of climate, geomorphology, hydrogeology, vegetation, soils, pasture types, land systems and degradation. Land system and degradation maps are presented at a scale of 1:250,000.
3. Condition statements are presented for each land system, each station, and for the whole survey area.
4. Almost 1,200 assessments of pasture condition and soil condition were made while traversing throughout the survey area.
  - (a) Fifty-one per cent of these traverse records indicated good range condition.
  - (b) Twenty-seven per cent of traverse records indicated fair range condition.
  - (c) Twenty-two per cent of traverse records indicated poor range condition.
5. The area surveyed covers about 10,216 km<sup>2</sup>. About 38% of this area is alluvial plain, commonly referred to as the Roebourne Plains. These plains contain the Cheerawarra, Horseflat, Mallina, Sherlock and River land systems which support most of the district's productive pastures. It is on these plains that practically all of the significant pasture and soil degradation in the district has occurred. The remainder of the area consists of rocky hills, stony plains and sandy plains supporting mainly hard spinifex grasslands of low pastoral value. Very little significant degradation has occurred in these areas.
6. A total of 233 km<sup>2</sup> of degradation have been identified on the Roebourne Plains. This is about 5.9% of the total area of the plains, and comprises about 47 km<sup>2</sup> which are severely degraded and eroded, 151 km<sup>2</sup> which are degraded and 35 km<sup>2</sup> which are gullied.
7. The worst affected land system is the Cheerawarra land system which accounts for about 7% of the Roebourne Plains and occurs along the coastal edge of the plain. About 12% of this system is affected by degradation. A substantial proportion of this is severe wind erosion with extensive bare saline scalds. These scalds are probably the major source of dust in the district.
8. The Horseflat land system accounts for about half of the Roebourne Plains. This system supports Roebourne Plains grass (*Eragrostis xerophila*) native pastures which are one of the principal bases for the pastoral industry in the district. It contains the major portion of the degradation in the district, about 149 km<sup>2</sup>, which is 7.5% of this land system. Most of this degradation consists of pasture deterioration with minor wind erosion. However, there are extensive areas of severe wind erosion and significant areas affected by gully erosion.
9. About 4.5% of the Mallina land system, which supports mainly soft spinifex pastures, is affected by degradation. This is mainly in the form of wind scalds.
10. Neither the Sherlock nor River land systems contain significant areas of severe degradation or erosion. However, considerable parts of the Sherlock land system suffer from pasture deterioration and there is some minor erosion.
11. Thirteen major areas of concern, encompassing the most severe patches of degradation, have been identified. These areas have been arranged according to a suggested order of priority for treatment.
12. Area 6 (Jones River) and Area 8 (Warambie-Sherlock Coast) are considered to have a very high priority for regeneration. Area 8 contains the greatest area of severe wind erosion, about 1800 ha, and is probably the major source of uplifted dust in the district. Area 6 does not contain as large an area of degradation, and is unlikely to generate as much uplifted dust. However, because of its location, it is highly visible to the public and this probably has a large influence on public perception of management practices on the Roebourne Plains.
13. Area 1 (Karratha Coast), Area 7 (Georges River), Area 9 (Sherlock Homestead) and Area 11 (Mallina Homestead) are considered to have a high priority for regeneration. All contain about 2000 ha of degradation and are likely to be major sources of uplifted dust. Areas 7 and 9 probably contribute more to dust storms affecting the townsites than Areas 1 and 11.
14. Area 3 (Nickol River), Area 4 (Roebourne), Area 5 (Harding Rivers), Area 10 (Balla Balla) and Area 13 (Pyramid Homestead) are all considered to have a moderate priority for regeneration. All, apart from Areas 4 and 13, are probably significant sources of uplifted dust. Area 4, while not containing large areas of wind erosion may contribute to Roebourne's dust problem because of its close proximity to the town. Similarly, Area 3, being close to Karratha could be an important source of dust affecting that town. Area 13 contains large areas of degraded pasture.
15. Areas 2 (Karratha Homestead) and 12 (Sherlock River) are considered to have a low priority for regeneration. Neither contains any severely degraded or eroded areas and both consist of relatively small scattered patches of degradation. In Area 2, extensive regeneration works have already been implemented.



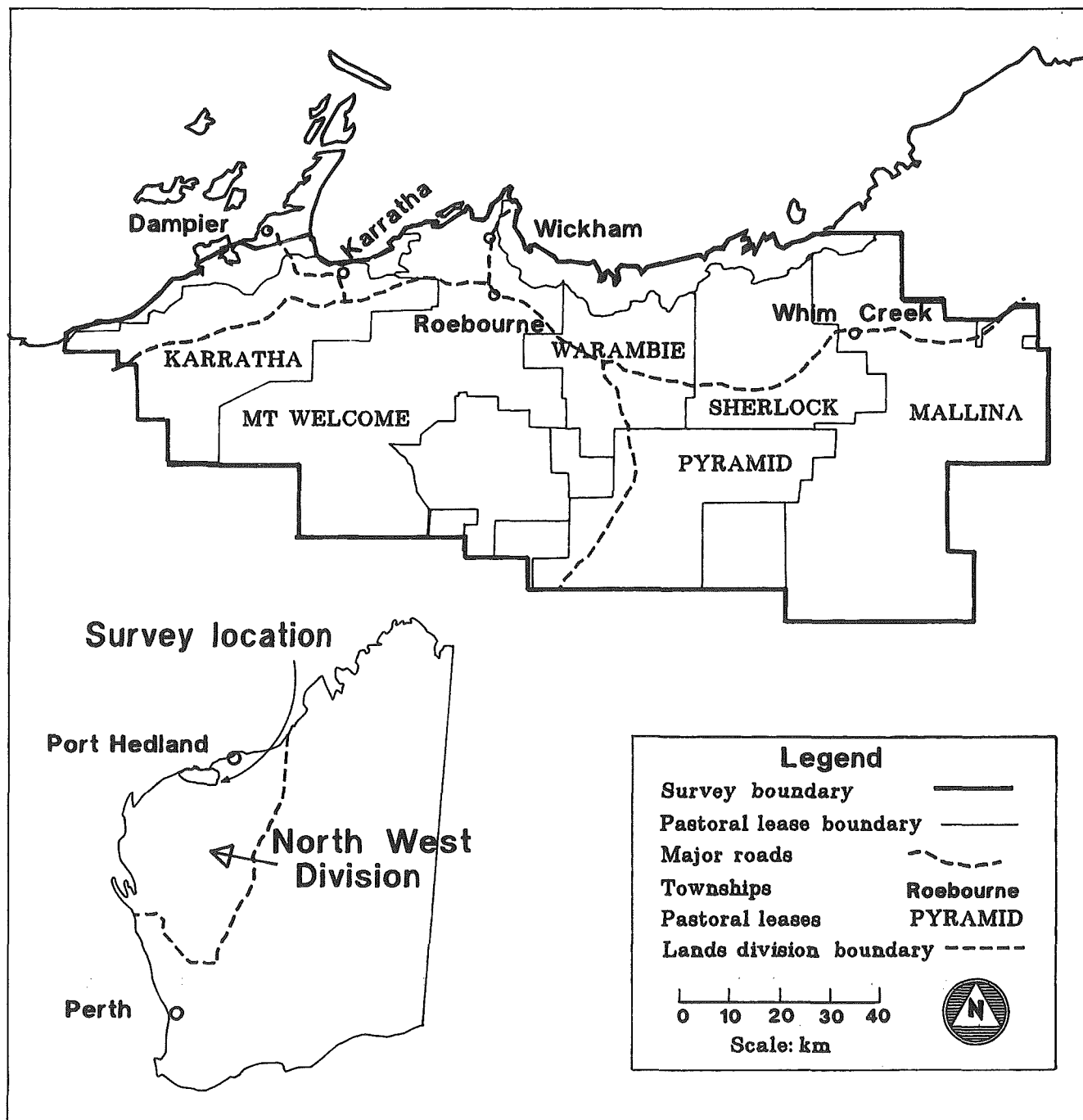
16. While some of the degradation may be because of natural factors, the majority of it can be attributed to the grazing pressure of stock. Much of the damage probably occurred in the first half of this century, when stocking levels were considerably higher than they are now. Many of the most severe patches of degradation coincide with the route of the Stock Reserve No. 9701.
17. Regeneration of much of the degraded country in the survey area can be achieved through careful manipulation of stock grazing pressure. In some of the worst affected areas, total exclusion of stock for a number of seasons is preferable. However, the relatively small size of some of the stations ensures that such management is very difficult.
18. Many areas on the Horseflat and Mallina land systems that have been scalded will probably require cultural treatment, such as ponding and ripping, to encourage regeneration. In some cases however, the soils may be too saline and too sodic for these methods to be effective and difficulties will be experienced in trying to promote the re-establishment of pasture species. Similar problems will be experienced on the Cheerawarra land system where great care must be taken not to initiate further erosion. On this system, it may be possible to devise a method of trapping wind-blown sediment to create hummocks which can be vegetated. In many cases, determining the best methods to rehabilitate areas will be a matter of trial and error, and new techniques may have to be developed.
19. Many of the gullies in the survey area are partly stabilized by vegetation or stony mantles and would respond further to conservative stocking practices. Active gullying is present, but is limited in extent. The intensive efforts which would be required for rehabilitation are probably not warranted except in special circumstances such as where gullies threaten roads, power lines or watering points.
20. The dust storms affecting the towns and the North West Coastal Highway are believed by many to be a major problem in this district. However, to effectively tackle this problem additional information is needed on the nature of the storms and their occurrence. It is important to have data on the wind strength and direction when these storms occur in order to determine the source of the dust. Because of the absence of this data it has only been possible to identify likely sources of the dust in this survey. It would be of value to establish whether the storms are a regular occurrence or are only initiated after an exceptionally poor run of seasons.

# Introduction

This inventory and condition survey of the Roebourne Plains district was undertaken by the Rangeland Management Branch of the Western Australian Department of Agriculture in November and December, 1987. The survey was done in response to reports of degradation in the district and complaints about dust storms. These storms appear to be a result of this degradation, and affected the towns of Karratha, Wickham, Dampier and Roebourne. Also, on a number of occasions in the 1980s, dust storms had severely reduced visibility on the North West Coastal Highway.

The Roebourne Plains are situated on the northern coast of the North-West Division of Western Australia (Figure 1). The survey area covered about 10,200 km<sup>2</sup> on six pastoral leases. These were Karratha, Mallina, Pyramid, Sherlock, Mt Welcome and Warambie stations. The aim of the survey was to describe the pastoral resources of the area and assess the distribution, extent and nature of existing land degradation. This information was collected primarily to assist the Roebourne-Port Hedland Land Conservation District Committee develop policies and strategies to regenerate degraded areas on the Roebourne Plains, thus reducing the dust problem, and to generally improve the range condition throughout the area.

Figure 1. Location map, Roebourne Plains survey



The first pastoral stations were established in the district in the 1860s, with sheep being transported to Nickol Bay by ship. Pastoralism expanded steadily and for a century it remained the dominant land use in the area. The town of Roebourne and the port of Cossack were established in the early days to support the pastoral industry. Sheep numbers continued to grow until the 1930s when a number of factors, including overstocking, drought and a decline in wool prices, halted this growth. By this time however, great damage had been inflicted on the pastures and soils of the district (Pastoral Leases Committee 1963) and the productivity of the land continued to decline. By the 1960s stock numbers were half the level that they were during the 1930s.

The 1960s saw the development of mining as the dominant industry in the Pilbara. The towns of Karratha, Wickham and Dampier were established, causing a dramatic increase in population in the district. Ports were developed and new roads, railways, powerlines and pipelines changed the landscape.

Although pastoralism is now of decreased importance it still occupies the major portion of the land in the district. The six stations surveyed carried about 65,000 sheep and 2750 cattle in 1986.

Information which assisted in the preparation of this report came from a number of sources. The Geological Survey of Western Australia prepared a number of geological maps of the area at scales of 1:50,000 (Geological Survey of Western Australia 1979 a, b, c; 1980 a, b) and 1:250,000 (Kriewaldt 1964, Kriewaldt and Ryan 1967, Ryan 1966 and Williams 1968). Beard (1975) mapped vegetation at a scale of 1:1,000,000 while Bettenay *et al.* (1967) mapped soils at the same scale. Churchwood and MacArthur (1980) described soil patterns in the Georges River catchment while Kok (1983) conducted a rangeland inventory of Karratha Station and Dames and Moore (1982) conducted detailed environmental investigations for the construction of the Harding Dam.

In this survey, station plans have been prepared at a scale of 1:100,000 for each property. These show land system boundaries and the distribution and nature of degraded areas. They show the location of inventory sites described during the survey and soil sampling sites as well as the results of condition assessments made whilst traversing. From these a map of the study area has been prepared at a scale of 1:250,000 showing the distribution of land systems and degraded areas. Thirteen major areas of degradation have been identified, described in detail and possible management techniques prescribed.

## Climate

The Roebourne Plains district has an arid climate (Craig 1983), however, climatic conditions are strongly influenced by tropical cyclones.

Annual rainfall throughout the area is about 300 mm. Although rainfall is highly variable from year to year, there is a pronounced summer peak, often associated with the passage of the 'north-west monsoons'. Tropical cyclones tend to occur on an average of seven years in every decade and bring high velocity winds and heavy rainfalls. They usually occur between January and March and the average annual rainfall can be exceeded in one event. Flooding usually results from these events and long dry periods can occur between cyclones. Little rain usually falls between September and December.

Temperatures are high, especially during the summer months when daily maximums are usually above 30°C and often exceed 40°C. Temperatures on the coast are often moderated in the afternoon by sea breezes. In the coldest months, July and August, daily maximums of about 25°C are experienced. Figure 2 presents climatic data for the town of Roebourne.

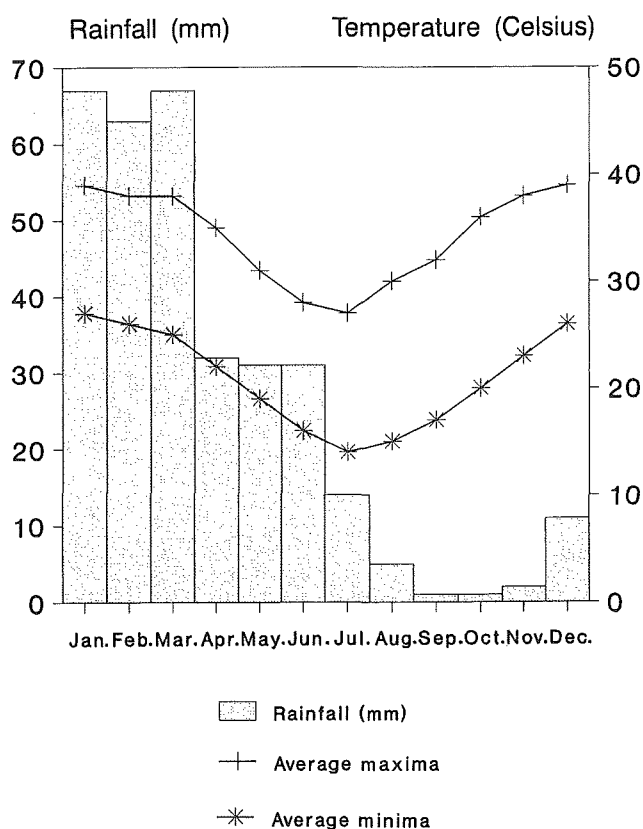


Figure 2. Climatic data for Roebourne

## Geology and geomorphology

Three main geomorphic units can be identified in the Roebourne Plains district (Figure 3). These are the upland plateau, the coastal plain and a transition zone between the two (Williams 1968).

The upland plateau occupies the southern portion of the district and is part of the Chichester Plateau (Beard 1975). It is a tableland formed on Proterozoic rocks of the Fortescue Group (mainly basalt with some siltstone, mudstone, shale, dolorite and jaspilite) which becomes very rugged where it is dissected. It is mainly the dissected margins of the plateau which occur within the study area. Some abrupt escarpments are present on the plateau's northern edge.

The coastal plain and the transition zone have been grouped together as the Abydos Plain by Beard (1975). The coastal plain occupies the northern portion of the survey area and is commonly referred to as the Roebourne Plains. It is a broad, low lying plain that slopes gently seawards and is traversed by a number of north flowing rivers. It has formed on Quaternary alluvium and is fringed on its northern boundary by tidal and salt flats, mangrove communities, sand shoals and sand dunes. Sediments include clay, sand, silt and kunkar (calcrete).

The transition zone lies between the upland plateau and the coastal plain. It has formed on Archaean rocks and consists of low hills and some gently undulating plains. Granitic tors and outcrops are occasionally present. The geology is extremely complex and includes granitic gneiss and migmatite, metamorphosed mafic and ultramafic volcanic rocks as well as metamorphosed sedimentary rocks.

## Hydrogeology

Groundwater is available mainly from unconfined aquifers at shallow depth in the Quaternary sediments. The water is generally of good quality and in fair supply with quality and supplies tending to be better towards the hills than on the coast (Kriewaldt 1964). Water supplies tend to be better in the proximity of drainage channels where subsurface flows persist throughout the year. The depth to the water table on the alluvial plain is commonly between 4 and 10 m. Being surficial, these aquifers are dependent upon rainfall in the area and water levels will fall in response to poor seasons or over pumping.

## Vegetation

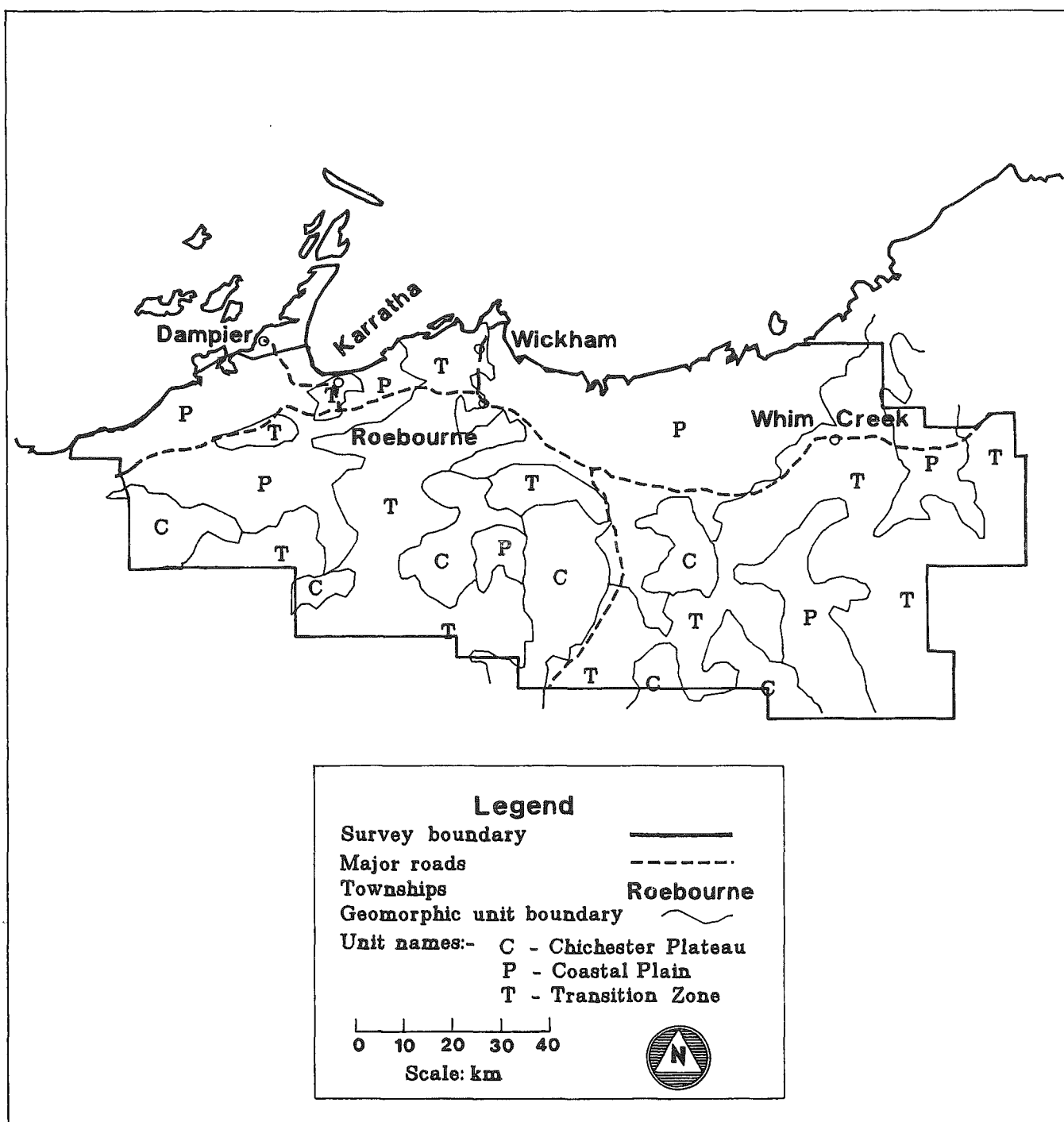
The vegetation of the study area has been described by Beard (1975) and Craig (1983). On the Chichester Plateau it is dominantly an *Acacia pyrifolia*-*Triodia* spp. shrub steppe on the plateau surface, with *Eucalyptus brevifolia* - *Triodia wiseana* tree steppe and *Acacia pyrifolia* - *Triodia pungens* shrub steppe on the dissected margins.

The intermediate zone is also dominated by *Acacia pyrifolia* - *Triodia* shrub steppe with the following spinifex species being present; *T. pungens*, *T. wiseana*, *T. longiceps*, *T. angusta* and *T. secunda*.

On the coastal plains, grasslands of *Eragrostis xerophila* dominate.



Figure 3. Geomorphic units, Roebourne Plains survey



## Survey methods

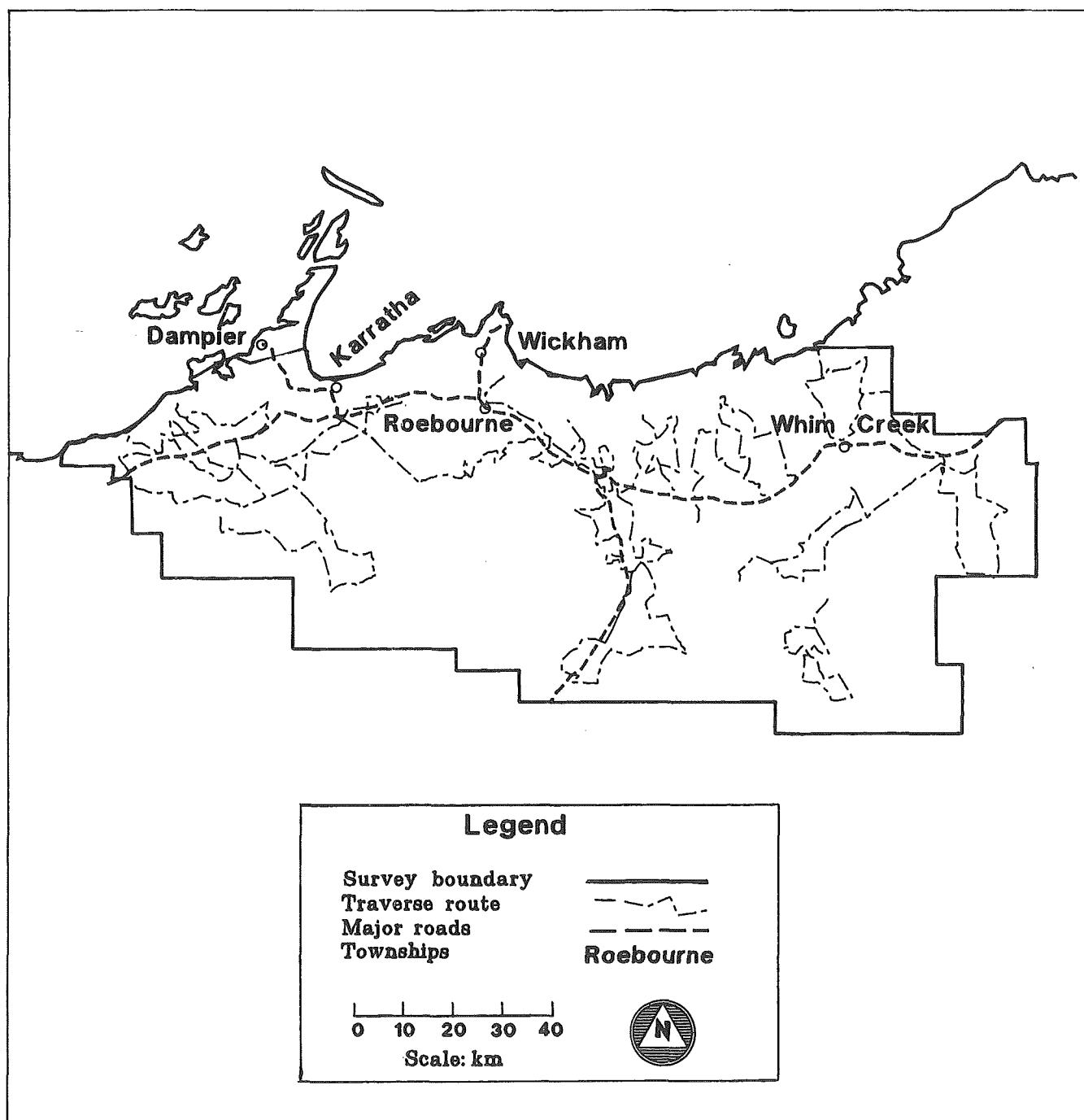
This survey adopted the land system approach to resource description and evaluation, as has been used for land surveys by the CSIRO and for previous regional surveys commissioned by the Pastoral Board of Western Australia (Wilcox and McKinnon, undated, circa 1972; Payne *et al.* 1979, 1982, 1988; Mitchell *et al.* 1979).

Christian and Stewart (1953, 1968) defined a land system as 'an area or group of areas throughout which there is a recurring pattern of topography, soils and vegetation'. Each land system has a characteristic pattern able to be seen on aerial photographs and generally occurs over an area greater than 5 km<sup>2</sup>. Land systems consist of smaller land units or

elements, each of which has a distinctive photographic pattern. The relative proportion of the component units and their arrangement one to another gives the broader photographic pattern that characterizes the particular land system.

As a preliminary to field-work, tentative land systems and areas of degradation and their likely boundaries were identified and marked onto 1:25,000 scale colour aerial photographs taken in 1986. Published information on geology, landforms, soils, vegetation and land system classifications were used to assist in the mapping process. These included the Geological Survey of Western Australia 1:250,000 (Kriewaldt 1964; Kriewaldt and Ryan 1967; Ryan 1966; Williams 1968) and 1:50,000 map sheet series (1979 a, b, c and 1980 a, b), Beard (1975), Churchwood and McArthur (1980), Kok (1983) and Payne *et al.* (1982).

Figure 4. Traverse routes, Roebourne Plains survey



## Fieldwork

Fieldwork was conducted over a three week period, in late November and early December 1987, and consisted of a series of 26 overland traverses totalling about 1200 kilometres. (See Figure 4)

Each traverse consisted of between 10 and 92 km of continuous travel, planned to provide progressive coverage of various landforms and areas of degradation on every station. From these fundamental lines of coverage, visits to each of the 75 inventory sites (Figure 5), 52 soil sampling sites (Figure 6) and numerous other field checks were made as small diversions usually of <2 km from the traverse route.

In addition to the field checking of land system and degradation area boundaries, assessments of erosion status and pasture condition were made every kilometre along the traverse route.

## Degradation assessment

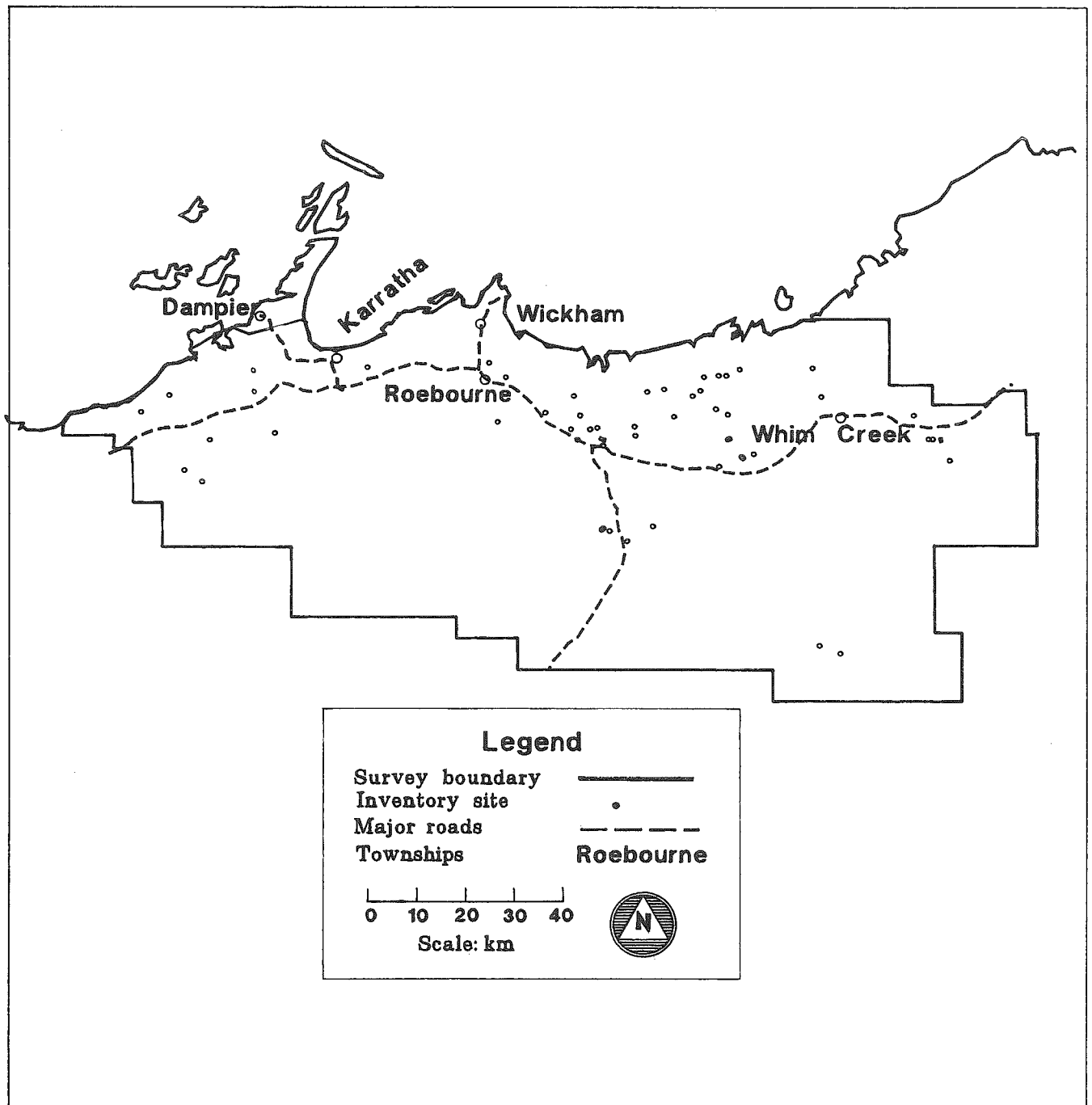
Degraded areas were interpreted and mapped on the aerial photographs with as many areas as possible being visited in the field and verified or amended as necessary.

Three categories of degradation and one category of regeneration were identified and mapped as follows:

### a) Degraded areas

These are areas having little perennial vegetation and often with some minor erosion. Although this category includes some areas which are bare though partly stabilized by a stony mantle, other areas have the potential to become severely degraded and eroded without careful management. If stocking rates are carefully controlled, natural regeneration can be expected on many degraded areas, although some may also benefit from cultural treatment.

Figure 5. Inventory sites, Roebourne Plains survey



**b) Severely degraded and eroded areas**

These are areas with very little or no perennial vegetation that have moderate or severe erosion. This is mostly wind erosion with scalds and hummocks being commonly present. These areas are major contributors to dust storms. In many cases, treatment will be needed to encourage regeneration.

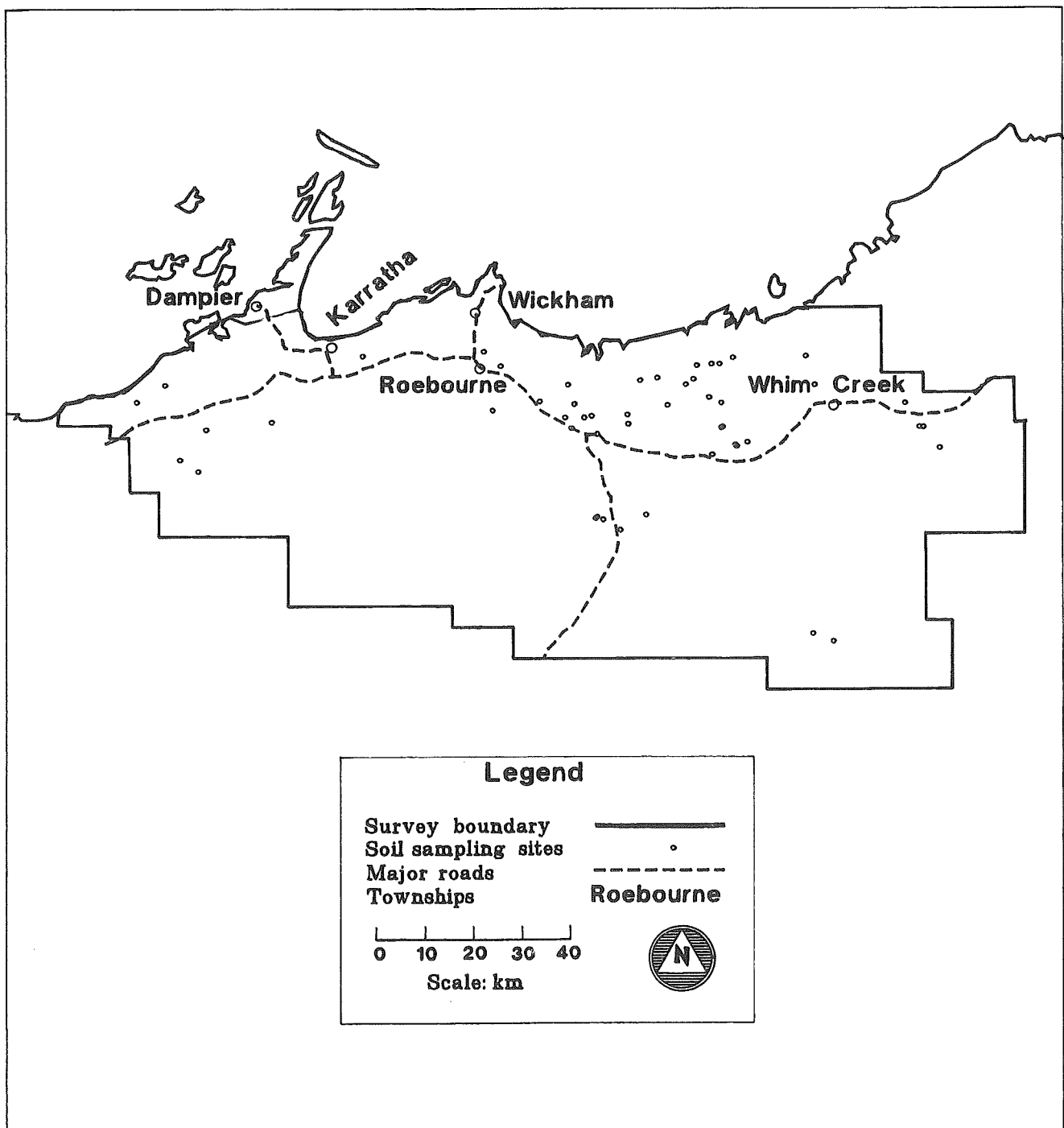
**c) Gullied areas**

These are areas containing concentrations of active or partly stabilized gullies. Often these gullies are not large and do not present a significant problem, although this is not always the case. The gullies are often surrounded by scalded areas, which may exhibit rill erosion.

**d) Regeneration areas**

These are areas where regeneration works such as ponding or ripping have been undertaken during the past 4 or 5 years. As a result regeneration is occurring in some cases, although in others the works are too recent to have had an effect.

Figure 6. Soil sampling sites, Roebourne Plains survey





## Site inventory techniques

### Inventory site selection

Sites were selected for inventory purposes on the aerial photographs. The aim was to obtain a representative sample of sites covering the different land systems and the variation of photographic patterns which occur within each land system. Greatest attention was paid to the land systems of the alluvial plain on which most of the degradation was located.

### Site identification and photographic record

On arriving at a preselected site, its exact location was marked on the relevant aerial photograph and later transferred to the appropriate 1:100,000 topographical sheet.

Oblique photographs, in colour transparency, were taken from the top of the vehicle (a viewpoint about 3.5 m above ground) with a conspicuous identification plate in the foreground.

### Site data recording

At each site, information was collected on basic attributes of surface geology, landform, ground surface, drainage features, any evidence of soil erosion, soil profile and vegetation. The data were recorded on thematic coding sheets modified from those used by Payne *et al.* (1982).

### Landscape features

General information on each site's position and pattern in the landscape was recorded on an *ad hoc* basis as notes and sketches entered directly on the data sheets.

Specific data on the following site attributes were routinely recorded:

Date  
Aerial photograph: year, run and number  
1:250,000 map sheet name  
AMG reference  
Land tenure status  
Landform type  
Land system  
Land unit  
Wind erosion evidence  
Water erosion evidence  
Slope  
Visible relief in metres  
Microrelief type  
Gilgai type (if present)  
Surface geology  
Susceptibility to flooding  
Vegetation dominants  
Vegetation structure

### Soil

Soil profiles were described from holes drilled with a 50 mm diameter auger to a maximum depth of 1 m. Profile characteristics and horizon textures were used to classify

each soil according to Northcote (1979). Data collected at each site included:

Stony mantle cover class  
Size of mantle pieces  
Mantle lithology  
Total depth of soil if < 1 m  
Principal profile form  
Parent material (if struck) and  
Soil horizon details for each horizon:  
Depth  
Colour: hue/chroma value  
Texture  
pH  
Inclusions

### Vegetation

Some attempt was made to identify every perennial plant found on the site. Specimen material was collected from unfamiliar or doubtfully identified perennials and referred to the Western Australian Herbarium for identification. Identifications were made to species level in the majority of cases.

While the importance of annual herbs, forbs and grasses in the diets selected by pastoral stock is well known (Wilson and Harrington 1984), they contribute little to the dry season diet or towards preventing accelerated soil loss in times of drought (Wilcox 1979, Anon. 1978) and are accordingly considered to be of a lesser importance than perennials in the context of the present type of resource survey.

At each site, the structure of the association was noted and an estimate of the projected foliar cover of woody elements or perennial grasses was made by comparing them with reference photographs depicting calibrated sites of various association types (low shrublands, mixed shrublands, tall shrublands and tussock grasslands).

### Soil samples

Soil samples were taken from 52 sites for laboratory analysis. In some cases these sites coincided with inventory sites, but more commonly this was not the case. These samples were taken to give an indication of soil conditions on degraded areas and to assist in determining suitable regeneration techniques. Samples were taken from a representative range of degraded areas with varying degrees of degradation on various land systems. Some samples were taken from undegraded areas to give a comparison of soil conditions on degraded and undegraded sites.

At each site three samples were collected. One of the top 10 cm of soil, one of the soil between 10 and 40 cm and one between 40 and 80 cm. Information was recorded in the field with regards to site location, present land use, range condition, vegetation, nature of degradation, slope gradient, soil surface nature, land system and land unit. For each sample taken the soil texture, colour, structure, pH and whether gypsum or any gravel, rock or stone was present, was recorded.

Each sample was analysed in the laboratory for pH and electrical conductivity of a 1:5 soil:water suspension, chloride percentage, soluble calcium, magnesium and sodium cations, saturation percentage, electrical conductivity of the saturation extract ( $EC_e$ ) and sodium absorption ratio (SAR) (Loveday 1974). The exchangeable sodium percentage (ESP) was calculated from the SAR (Wilcox 1963). Appendix 5 shows the results of the analyses of the soil samples.

## Condition assessment by traverse

While the aim was to assess soil and pasture condition objectively over as wide an area as possible, time constraints upon the survey precluded the application of quantified, plot-based techniques such as those proposed by Lendon and Lamacraft (1976). A traverse method very similar to that described by Payne *et al.* (1982) was used to achieve comprehensive coverage and a large number of assessments on each station by a distance sampling procedure.

The method involved continuous accurate positioning of the traverse vehicle while travelling along a mapped course, usually a station track or minor road, but occasionally across country. At intervals of 1 km from the starting point, the particular land unit and land system being crossed at the time was identified and noted. The soil erosion status and pasture condition was then assessed over an area up to 50 m either side of the kilometre point. Traverse speed was about 40 km/h, or less. At this speed erosion assessments and species identification could usually be made with an acceptable degree of confidence, but it was sometimes necessary to stop the vehicle and inspect the site on foot.

Where traverses ran along fencelines, assessments were made for the paddock adjacent to the track rather than across the fence. Two assessors were present to resolve difficulties in assigning ratings to difficult or unusual sites.

**Table 1. Criteria for erosion ratings**

### *Wind erosion*

Severity	Rating	Comment
Nil	0	No erosion
Minor	1	Litter redistribution and small scalds. Small isolated scalds on which the surface shows some degree of polishing. Redistribution of soil to the margins of the scald, or minor build up of soil material around obstacles.
Moderate	2	Large isolated scalds and hummocks. Stripping of the soil surface and build-up against obstacles associated with large, but generally discontinuous scalds; or, numerous small scalds scattered throughout the site.
Severe	3	Major deflation of soil surface. Active stripping resulting in large continuous scalds with polished and sealed surfaces. Frequent large hummocks against obstacles. In sandy systems major dune drift. Plant cover very sparse to absent.

### *Water erosion*

Severity	Rating	Comment
Nil	0	No erosion
Minor	1	Rilling or isolated thin sheeting. Patchy rilling and small gullies affecting small areas or thin sheeting (1 to 2 cm) and breaking of the surface seal on parts of the site. Some redistribution of soil and litter downslope. Much undisturbed ground between affected areas.
Moderate	2	Gullies and/or sheeting. Gullies on the lower slopes or more susceptible parts of the site, these being capable of extension to less susceptible areas. The gullies may be associated with extensive, but discontinuous disturbance of the soil surface by sheet erosion and redistribution of soil material.
Severe	3	Extensive sheeting, terracing or gullying. Severe sheeting or terracing affecting nearly all of the site. Redistribution of soil and exposure of subsoil or rock material. The sheeting may be associated with or replaced by very extensive gullying over most of the site.

Twenty-six traverses were made during the survey and condition assessments made at 1172 points on 17 land systems.

The definitions and numerical ratings for soil erosion and pasture condition are shown in Table 1 and Table 2 respectively.

**Table 2. Criteria for pasture condition ratings**

### *Pasture condition*

Rating	Condition indicators
1.	Excellent or very good. For the land unit-vegetation type, the site's cover and composition of shrubs, perennial herbs and grasses is near optimal, free of obvious reductions in palatable species or increases in unpalatable species liable to reduce production potential.
2.	Good. Perennials present include all or most of the palatable species expected; some less palatable or unpalatable species may have increased, but total perennial cover is not very different from the optimal.
3.	Fair. Moderate losses of palatable perennials and/or increases in unpalatable shrubs or grasses, but most palatable species and stability desirables still present; foliar cover is less than on comparable sites rated 1 or 2 unless unpalatable species have increased.
4.	Poor. Conspicuous losses of palatable perennials; foliar cover is either decreased through a general loss of perennials or is increased by invasion of unpalatable species.
5.	Very poor. Few palatable perennials remain; cover is either greatly reduced, with much bare ground arising from loss of stability desirables, or has become dominated by a proliferation of unpalatable species.

## Analysis of the field data

Data from the 75 inventory sites were collated by hand and used to prepare detailed land unit, land system, soil type and pasture type descriptions which are presented later.

The condition assessment data obtained whilst traversing were sorted on the Prime computer at the Department of Agriculture. Print-out sheets (for an example see Table 5) showed the number of recordings and percentages in each category of wind erosion (four levels), water erosion (four levels) and pasture condition (five levels) for each land system and its component land units. In addition, expressions for total erosion and range condition were derived from the basic data. Print-out sheets were produced showing condition statements for:

- Each land system and its component land units on each station.
- Each station as a whole.
- Each land system and its component land units within the whole survey area.
- The whole survey area.

## Total erosion

Total erosion was derived by combining the wind and water erosion traverse recordings into rational groupings as shown in Table 3.

Table 3. Derivation of total erosion

Wind erosion + water erosion = total erosion		
Nil	+ Nil	= Nil
Nil	+ Minor	= Minor
Minor	+ Nil	
Minor	+ Minor	
Nil	+ Moderate	= Moderate
Minor	+ Moderate	
Moderate	+ Nil	
Moderate	+ Minor	
Moderate	+ Moderate	
Nil	+ Severe	= Severe
Minor	+ Severe	
Moderate	+ Severe	
Severe	+ Nil	
Severe	+ Minor	
Severe	+ Moderate	
Severe	+ Severe	

## Range condition

Assessments of overall range condition were made in relation to the condition of the two basic range resources - soil and pasture. Three levels of range condition were selected. These levels were termed good, fair and poor and were derived by combining total erosion and pasture condition data obtained on traverse into rational groupings as shown in Table 4.

An example of a full print-out sheet showing wind erosion, water erosion, total erosion, pasture condition and range condition for all land units of a particular land system within the survey area is shown in Table 5.

Complete data for erosion, pasture condition and range condition for all land systems in the survey area are presented in Appendix 4. Because of the different methodology and definitions employed, direct comparisons should not be made between the assessment of range condition by field traverse and the area calculated to be affected by degradation from aerial photograph interpretation (Appendix 3).

Table 4. Derivation of range condition

Good range condition		
Total erosion + pasture condition = range condition		
Nil	+ Excellent	= Good
Nil	+ Good	
Minor	+ Excellent	
Minor	+ Good	
Fair range condition		
Total erosion + pasture condition = range condition		
Nil	+ Fair	= Fair
Minor	+ Fair	
*Moderate	+ Excellent	
*Moderate	+ Good	
* Combinations not encountered in the field. Although theoretically possible they are unlikely to be encountered.		
Poor range condition		
Total erosion + pasture condition = range condition		
Nil	+ Very poor	
Nil	+ Poor	
Minor	+ Very poor	
Minor	+ Poor	
Moderate	+ Very poor	
Moderate	+ Poor	
Moderate	+ Fair	
Severe	+ Very poor	
Severe	+ Poor	
Severe	+ Fair	
*Severe	+ Good	
*Severe	+ Very good	

\* Combinations not encountered in the field

## Map preparation

Once fieldwork was completed, the aerial photographs were re-interpreted and land system and degradation area boundaries finalized. These boundaries were transferred onto 1:50,000 scale plans, which were then reduced to a scale of 1:100,000, and digitized to produce individual station plans.

A regional map, at 1:250,000 scale, showing land systems and degraded areas for the whole survey area was produced. Because of scale limitations the three types of degradation shown on the station plans were amalgamated to a single classification for the 1:250,000 scale regional map.

Table 5. Example of print-out sheet, Cheerawara land system

Land unit	No. of records	Wind erosion (%)				Water erosion (%)				Total erosion (%)				Pasture condition (%)					Range condition (%)		
		Nil	Min.	Mod.	Sev.	Nil	Min.	Mod.	Sev.	Nil	Min.	Mod.	Sev.	Ex.	Good	Fair	Poor	Very poor	Good	Fair	Poor
Calcrete platform	1	100	0	0	0	100	0	0	0	100	0	0	0	0	100	0	0	0	100	0	0
Dissected slope	1	100	0	0	0	0	100	0	0	0	100	0	0	0	0	100	0	0	0	100	0
Dune	3	33	67	0	0	100	0	0	0	33	67	0	0	0	33	67	0	0	33	67	0
Alluvial plain	14	79	7	7	7	93	0	7	0	79	0	14	7	7	58	14	14	7	65	14	21
Gilgai plain	16	44	25	19	13	69	31	0	0	38	31	19	31	0	25	31	19	25	25	31	44
Saline plain	8	25	25	50	0	50	50	0	0	13	37	50	0	0	25	25	38	13	13	38	40
Unspecified plain	13	38	54	8	0	92	8	0	0	38	54	8	0	8	31	45	8	8	38	47	15
System summary	56	50	29	16	5	78	20	2	0	45	32	18	5	4	35	32	16	13	37	34	29

# Land systems

Nineteen land systems were identified and mapped in this survey.

The Chichester Ranges are dominated by the Rocklea land system with lesser occurrences of the Paraburdoo and Boolgeeda land systems. The Boolgeeda system also occurs in the intermediate zone, along with the Boolaloo, Capricorn, Calcrete, Gregory, Macroy, Pyramid, Robe, Ruth, Satirist and Uaroo land systems. All of these systems support predominantly Hard Spinifex pastures of very low pastoral value and have a low susceptibility to erosion and degradation.

The Cheerawarra, Horseflat, Mallina, River and Sherlock land systems occur on the coastal plain. These systems support Soft Spinifex or Tussock Grass pastures of moderate to very high pastoral value. It is on these land systems that most of the degradation and erosion in the study area occurred. The Littoral land system occurs on the northern edge of the coastal plain and is dominated by bare mud flats.

Appendix 1 shows the area of each land system on each of the six stations covered in the survey.

These 19 land systems are described, in alphabetical order, in the following section. Seven of the systems, (those indicated by (A) following the name in the main heading), were originally described further south in the Ashburton River catchment area by Payne *et al.* (1982). In most instances there are minor differences between the original descriptions and those presented here, due mainly to regional differences and natural gradations in vegetation.

In each instance the land system is described by a format which includes the following key features:

1. A statement of total area and its proportion of the survey area.
2. A summary of the key features of the system and its pastoral use.
3. A summary of the range condition assessment by traverse and degradation mapping on the system. This data is presented in more detail in Appendices 2 and 3.
4. A block diagram or plan view of a representative or stylized portion of the system depicting component land units.
5. Tabulated summary descriptions of each land unit. Unit descriptions are headed by a title line, which includes the name of the unit, its average proportion of the system and the intensity of coverage achieved during the survey.

The text describes the landform, soil, vegetation, pasture type and pastoral use limitations of each unit. Projected foliage cover (PFC) is given as a range of per cent cover.

## Boolaloo land system (A) 138 km<sup>2</sup> (1.4% of survey area)

Granitic hills, tors and domes and minor sandy plains, spinifex hummock grasslands with scattered shrubs.

**Geology:** Archaean granites, gneiss and granulitic rocks, minor Quaternary sand.

**Geomorphology:** Granite hills with boulder strewn slopes, shallow valleys and drainage floors, as well as tors and domes surrounded by restricted stony and sandy plains.

**Pastoral use:** Hard (50%) and Soft (50%) Spinifex pastures. The restricted plains may supply some useful grazing if maintained by burning and grazing deferment. Hills and tors are poorly accessible and support very sparse spinifex with large areas of bare rock. Little risk of erosion.

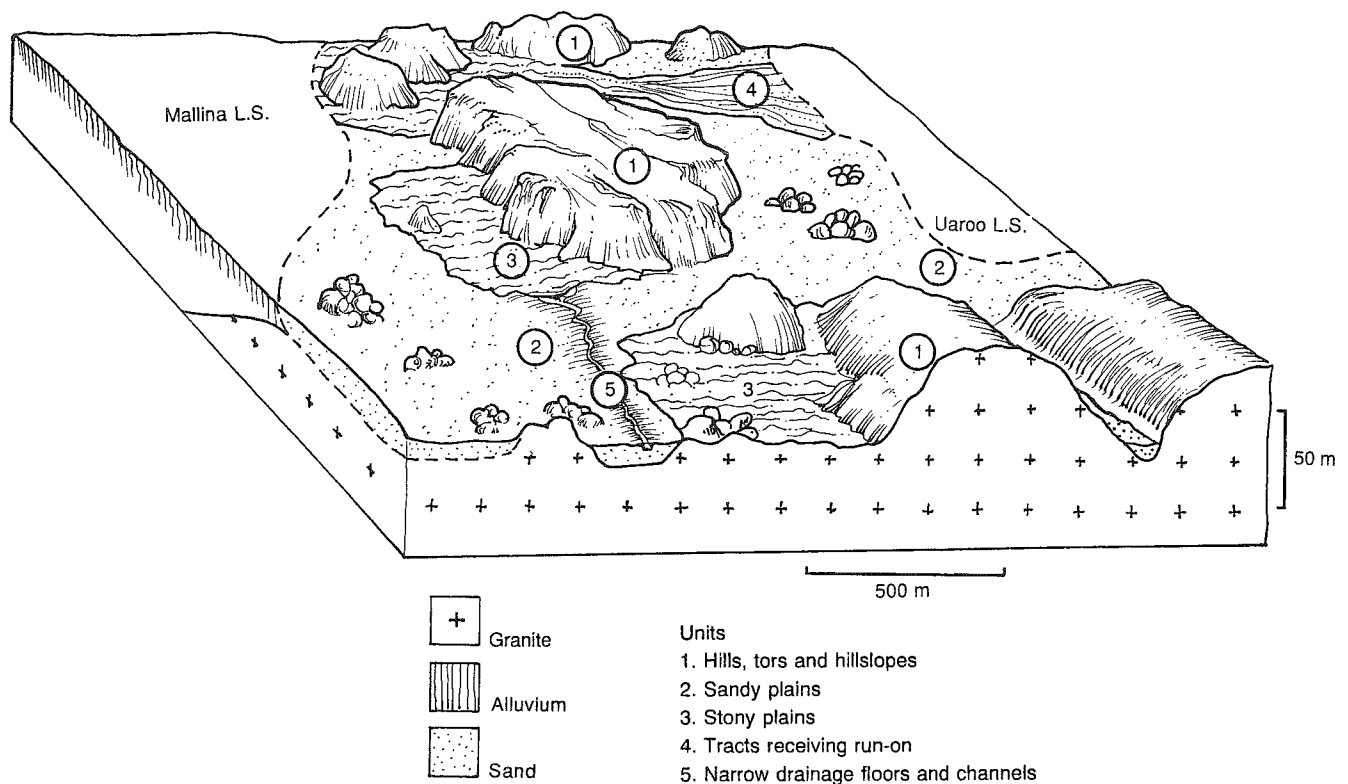
**Estimated carrying capacity:** 20-40 ha/sheep unit (s.u.) depending on burning history and range condition.

**Range condition summary (4 observations):** Good 75%; fair 0%; poor 25%.

Severely degraded and eroded: Nil

Degraded: Nil

Gullied: Nil



# Boolaloo Ls.

Landform and soils	Vegetation : formations and major species		Comments
Rounded crests and boulder strewn slopes convex up to 80%, lower rocky slopes concave up to 10% for fields; relief mainly < 50 m, granite outcrop and occasional pockets of stony skeletal sands.	Unit 1	Hills, tors and hill slopes (55%) 1 site inventory and traversed	Pasture type: <i>Hard Spinifex/Soft Spinifex</i> . Pastoral use limitations: Poor quality pastures, poor accessibility.
	Much bare rock, scattered hummocks of hard spinifex ( <i>Triodia wiseana</i> ?) and soft spinifex ( <i>T. pungens</i> ) and sparse shrubs and herbs.		
Almost flat to gently sloping sandy plains between hills and tors. Soils are red sands or red duplex and gradational soils. i.e. sands and sandy loams over sandy clays.	Unit 2	Sandy plains (25%) Traversed	Pasture type: <i>Soft Spinifex</i> . Pastoral use limitations: Mild susceptibility to wind erosion after fire but system stabilizes rapidly after rain.
	Hummock grasslands of soft spinifex ( <i>Triodia pungens</i> ) and numerous shrubs dominated by <i>Acacia</i> spp.		
Restricted stony plains with slopes up to 2%, sparse to dense quartz colluvial mantle. Soils are probably stony skeletal sands and stony duplex soils over granite.	Unit 3	Stony plains (14%) Traversed	Pasture type: <i>Hard Spinifex</i> . Pastoral use limitations: Very poor quality pastures.
	Hummock grasslands of hard spinifex (probably <i>Triodia wiseana</i> , <i>T. lanigera</i> ) with numerous shrubs dominated by <i>Acacia</i> spp.		
Unchannelled drainage zones usually less than 1 km wide with slopes up to 1%. Soils are probably red duplex and gradational types.	Unit 4	Tracts receiving run on (5%)	Pasture type: <i>Soft Spinifex</i> . Pastoral use limitations: Moderate susceptibility to water erosion.
	As for unit 2		
Floors up to 200 m wide, channels up to 50 m wide and 3 m deep, bedloads of sand, banks and floors reddish sandy soils on granite at variable depth.	Unit 5	Narrow drainage floors and channels (1%)	Pasture type: <i>Soft Spinifex</i> .
	Tall shrublands dominated by <i>Acacia</i> spp. with occasional trees <i>Eucalyptus dichromophloia</i> and prominent ground layer of soft spinifex ( <i>Triodia pungens</i> ) and other perennial grasses.		

## Boolgeeda land system (A) 596 km<sup>2</sup> (5.8% of survey area)

Stony lower slopes and plains found below hill systems;  
hard spinifex hummock grasslands.

**Geology:** Quaternary colluvium.

**Geomorphology:** Very gently inclined stony plains of colluvium with sub parallel and dendritic drainage patterns of moderate density. Relief is up to about 20 m. This land system always occurs at the foot of hill land systems such as Rocklea, Ruth and Capricorn.

**Pastoral use:** Mostly Hard Spinifex pastures (95%), very low carrying capacity and drought durability, all units stable under use. Pastures require periodic burning, followed by deferral of grazing, to maintain some use for grazing.

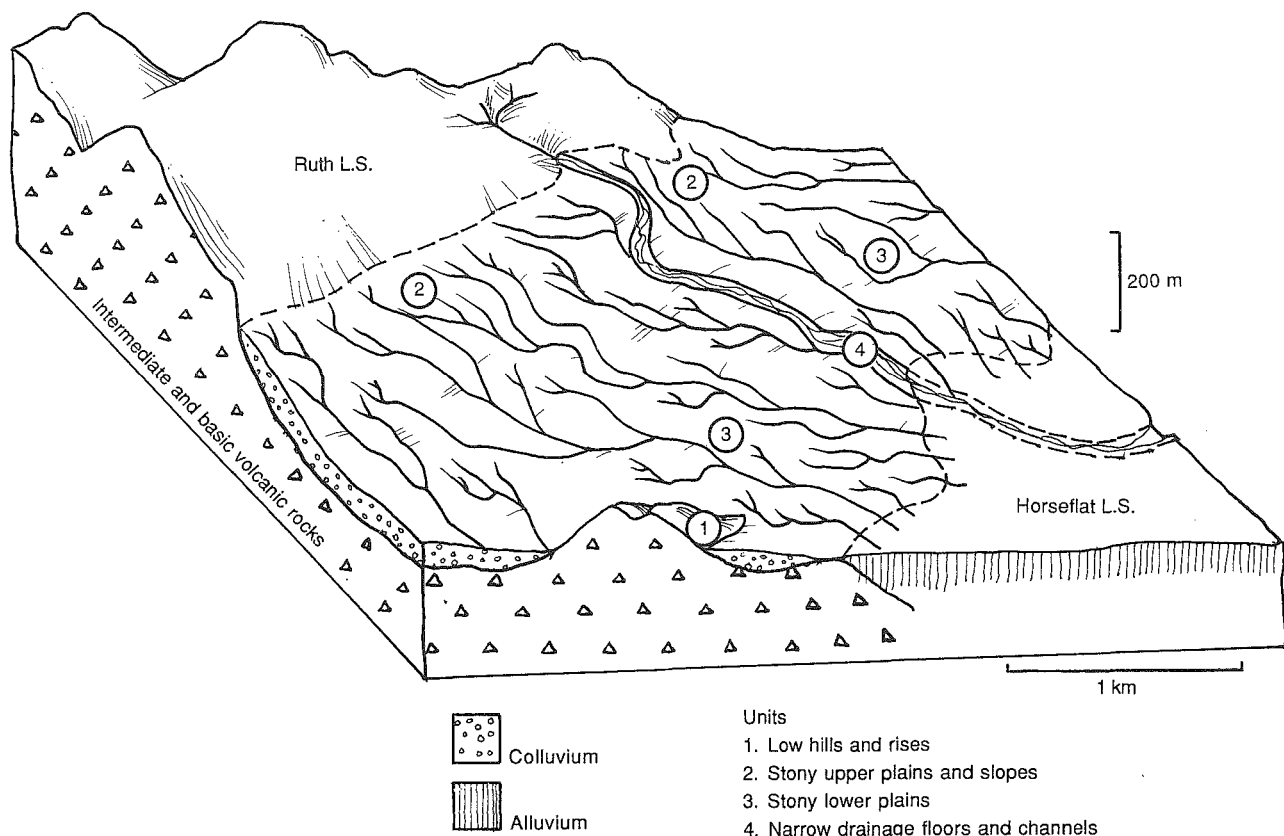
**Estimated carrying capacity:** 20-40 ha/sheep unit depending on burning history and range condition.

**Range condition summary (33 observations):** Good 91%; fair 9%; poor 0%.

Severely degraded and eroded: Nil

Degraded: Nil

Gullied: 0.1 km<sup>2</sup>



# **Boolgeeda l.s.**

Landform and soils	Vegetation : formations and major species	Comments
Isolated hills and outcrop rises above plains, relief up to 20 m, rock outcrop and pockets of stony skeletal sands and clays.	<p><b>Unit 1 Low hills and rises (5%)</b> Sparse hummock grasslands of <i>Triodia wiseana</i> and occasional shrubs <i>Acacia pyrifolia</i>, <i>A. orthocarpa</i>.</p> <p><b>Unit 2 Stony upper plains &amp; slopes (60%) 2 sites inventories and traversed</b> Hummock grasslands of hard spinifex with scattered shrubs. (Shrub PFC* &lt; 2.5-5%). Trees: (occasional) <i>Eucalyptus dichromophloia</i>, Tall shrubs: (&gt; 2 m) <i>Acacia inaequilatera</i>. Low shrubs: (&lt; 2 m) <i>Acacia pyrifolia</i>, <i>A. ancistrocarpa</i>, <i>A. bivenosa</i>, <i>A. inaequilatera</i>, <i>Cassia pruinosa</i>, <i>C. oligophylla</i>, <i>Corchorus walcottii</i>. Perennial grasses: <i>Triodia wiseana</i>.</p>	<p>Pasture type: <i>Hard Spinifex</i>.</p> <p>Pasture type: <i>Hard Spinifex</i>. Pastoral use limitations: Very poor quality pastures but appropriate fire management can improve grazing value.</p>
Plains and very gentle slopes up to 4 or 5 km in extent immediately below adjacent hill land systems, slopes 1-3.5%, dense colluvial mantles, dissected up to 5 m by parallel or sub parallel small creeklines. Soils are shallow reddish brown sandy clays and sandy clay loams, principal profile forms: Uf 6.12, Um 6.24.	<p><b>Unit 3 Stony lower plains (30%) Traversed</b> As for unit 2, trees may include occasional <i>Hakea suberea</i>, tall shrubs include <i>Acacia xiphophylla</i>.</p>	<p>Pasture type: <i>Hard Spinifex</i>. Pastoral use limitations: As for unit 2</p>
Lower plains with slopes mostly < 0.5%, dense stony mantles. Soils are red clays and reddish brown sandy clay loams usually < 1 m deep.	<p><b>Unit 4 Narrow drainage floors &amp; channels (5%) 1 site inventory and traversed</b> Mostly hummock grasslands of hard spinifex with numerous shrubs and occasional trees. (Shrub and tree PFC* 15-20%). Trees: <i>Eucalyptus dichromophloia</i>, <i>Hakea suberea</i>. Tall shrubs: (&gt; 2 m) <i>Acacia xiphophylla</i>, <i>A. coriacea</i>, <i>A. inaequilatera</i>, <i>A. pyrifolia</i>. Low shrubs: (&lt; 2 m) <i>Acacia pyrifolia</i>, <i>A. bivenosa</i>, <i>Indigofera</i> sp, <i>Corchorus</i> spp, <i>Hybanthus enneaspermus</i>. Perennial grasses: <i>Triodia wiseana</i>, <i>T. pungens</i>, <i>Cenchrus ciliaris</i>, <i>Themeda</i> sp.</p>	<p>Pasture type: <i>Hard Spinifex/Soft Spinifex</i>. Pastoral use limitations: As for unit 2.</p>

\*PFC: Projected foliage cover



## Calcrete land system 259 km<sup>2</sup> (2.5% of survey area)

Low calcrete platforms and plains with hard spinifex hummock grasslands.

**Geology:** Quaternary kunkar (calcrete), impure earthy limestone in sheets and encrustations.

**Geomorphology:** Stony plains with a mosaic of calcrete tables and low rises elevated up to 10 m above the surrounding surfaces of narrow inter-table areas, drainage floors and restricted sandy plains.

**Pastoral use:** Mostly very poor quality Hard Spinifex pastures (85%), some Soft Spinifex pasture (15%) of moderate quality; pastures require periodic burning, followed by deferral of grazing, to maintain some use for grazing. Low risk of erosion.

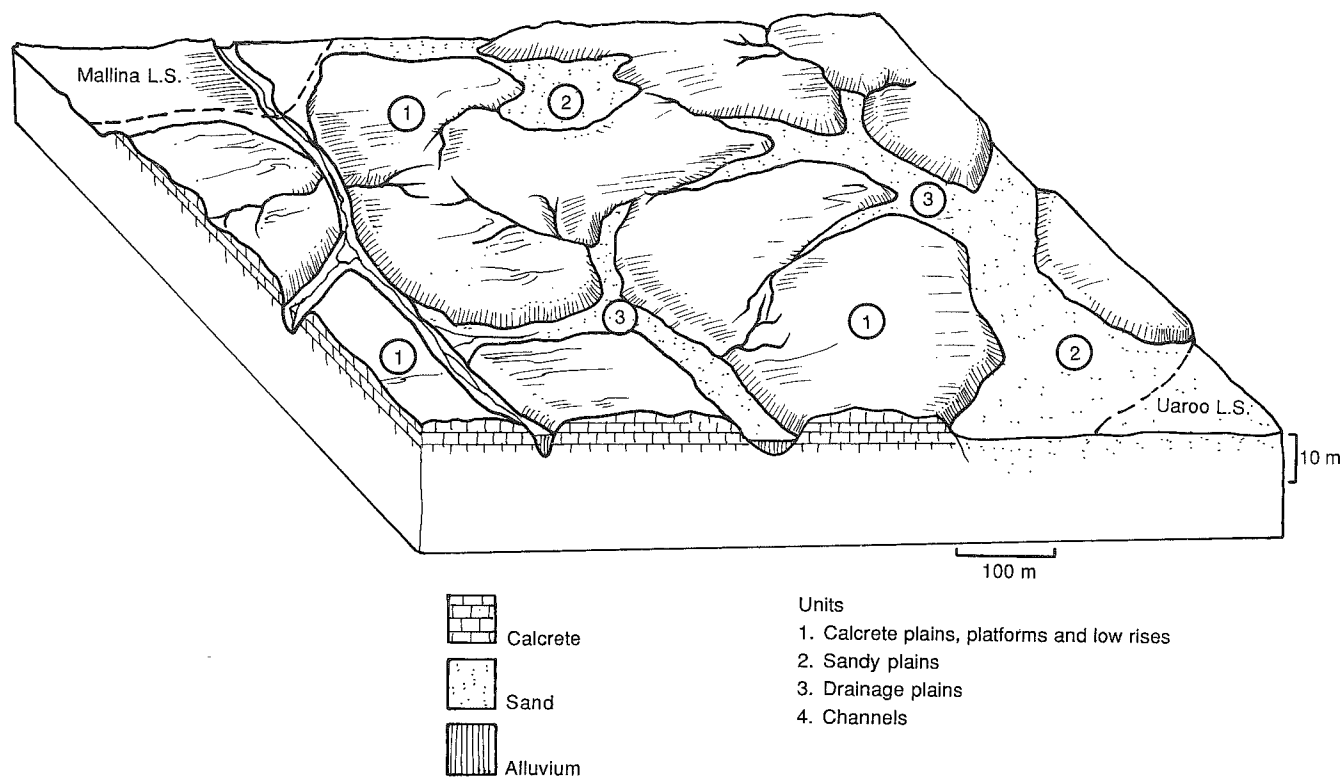
**Estimated carrying capacity:** 20-40 ha/sheep unit depending on burning history and range condition.

**Range condition summary (34 observations):** Good 88%; fair 12%; poor 0%.

Severely degraded and eroded: Nil

Degraded: Nil

Gullied: Nil



## Calcrete l.s.

Landform and soils	Vegetation : formations and major species		Comments
Gently sloping (<1%) plains, slightly raised platforms and low rises with marginal slopes up to 3% with out-cropping calcrete or dense surface mantle of calcrete gravel and rocks, relief up to 10 m. Soils are shallow (15-40 cm) dark brown alkaline loams or fine sandy clays; principal profile forms : Um 1.13, 5.11, Uf 6.12.	<b>Unit 1</b>	<b>Calcrete plains, platforms &amp; low rises (80%)</b> Spinifex hummock grasslands with <i>Triodia wiseana</i> , <i>T. sp.</i> and occasional trees and shrubs. (Shrub and tree PFC < 2.5%). Trees: <i>Eucalyptus dichromophloia</i> . Tall shrubs: (> 2 m) <i>Acacia inaequilatera</i> . Low shrubs: (< 2 m) <i>Acacia inaequilatera</i> , <i>A. pyrifolia</i> , <i>A. ligulata</i> , <i>A. bivenosa</i> , <i>A. translucens</i> , <i>Cassia glutinosa</i> , <i>Corchorus sp.</i> Perennial grasses: <i>Triodia wiseana</i> , <i>T. pungens</i> , <i>T. sp.</i>	<b>3 site inventories and traversed</b> Pasture type: <i>Hard Spinifex</i> . Pastoral use limitations: Generally very poor quality pastures, appropriate fire management can marginally improve grazing value.
Almost flat to gently sloping (< 1%) sandy surfaced plains up to 500 m in extent and marginal to unit 1. Soils are duplex and gradational types i.e. reddish brown sands and sandy loams over sandy clays.	<b>Unit 2</b>	<b>Sandy plains (10%)</b> Traversed Spinifex hummock grasslands with scattered trees and shrubs. Trees: <i>Eucalyptus dichromophloia</i> , <i>E. aspera</i> . Tall shrubs: (> 2 m) <i>Acacia inaequilatera</i> , <i>A. pyrifolia</i> . Low shrubs: (< 2 m) <i>Acacia pyrifolia</i> , <i>A. bivenosa</i> , <i>A. ancistrocarpa</i> , <i>Carissa lanceolata</i> , <i>Cassia notabilis</i> , <i>Psoralea lachnostachys</i> , <i>Corchorus walcottii</i> , Perennial Grasses: <i>Triodia pungens</i> , <i>T. sp</i> (hard), <i>Chrysopogon fallax</i> .	Pasture type: <i>Hard Spinifex/Soft Spinifex</i> . Pastoral use limitations: Mostly poor quality pastures but appropriate fire management can improve grazing value.
Channelled or unchannelled floors, inter-table areas and alluvial plains, slopes mostly < 0.5%. Soils are reddish brown sandy clay loams over sandy clay; principal profile form Gn 2.12	<b>Unit 3</b>	<b>Drainage plains (8%)</b> 1 site inventory and traversed As for unit 2, trees may include <i>Hakea suberea</i> , tall shrubs include <i>Acacia holosericea</i> , <i>A. tumida</i> . (PFC 5-10%).	Pasture type: <i>Soft Spinifex</i> .
Minor creeklines and channels, bedloads of sand, calcrete gravel and rocks.	<b>Unit 4</b>	<b>Channels (2%)</b> Margins support scattered to moderately close communities with <i>Eucalyptus dichromophloia</i> , <i>Acacia holosericea</i> , <i>A. trachycarpa</i> , <i>A. tumida</i> and <i>Triodia</i> spp.	Pasture type: <i>Soft Spinifex</i> .

## Capricorn land system (A) 401 km<sup>2</sup> (3.9% of survey area)

Rugged hills and ridges supporting hard spinifex and sparse shrubs.

**Geology:** Lower Proterozoic acidic tuff, tuffaceous shale, sandstone, greywacke and conglomerate.

**Geomorphology:** Ranges and hills with steep rocky upper slopes, more gently sloping stony lower slopes and restricted stony lower plains and valleys. Angular to rectangular drainage patterns of moderate to high density. Relief is up to 100 m.

**Pastoral use:** Difficult access to stock, predominantly very poor quality Hard Spinifex pastures (90%), some Soft Spinifex pastures (10%). Very low to negligible pastoral value. Little risk of erosion.

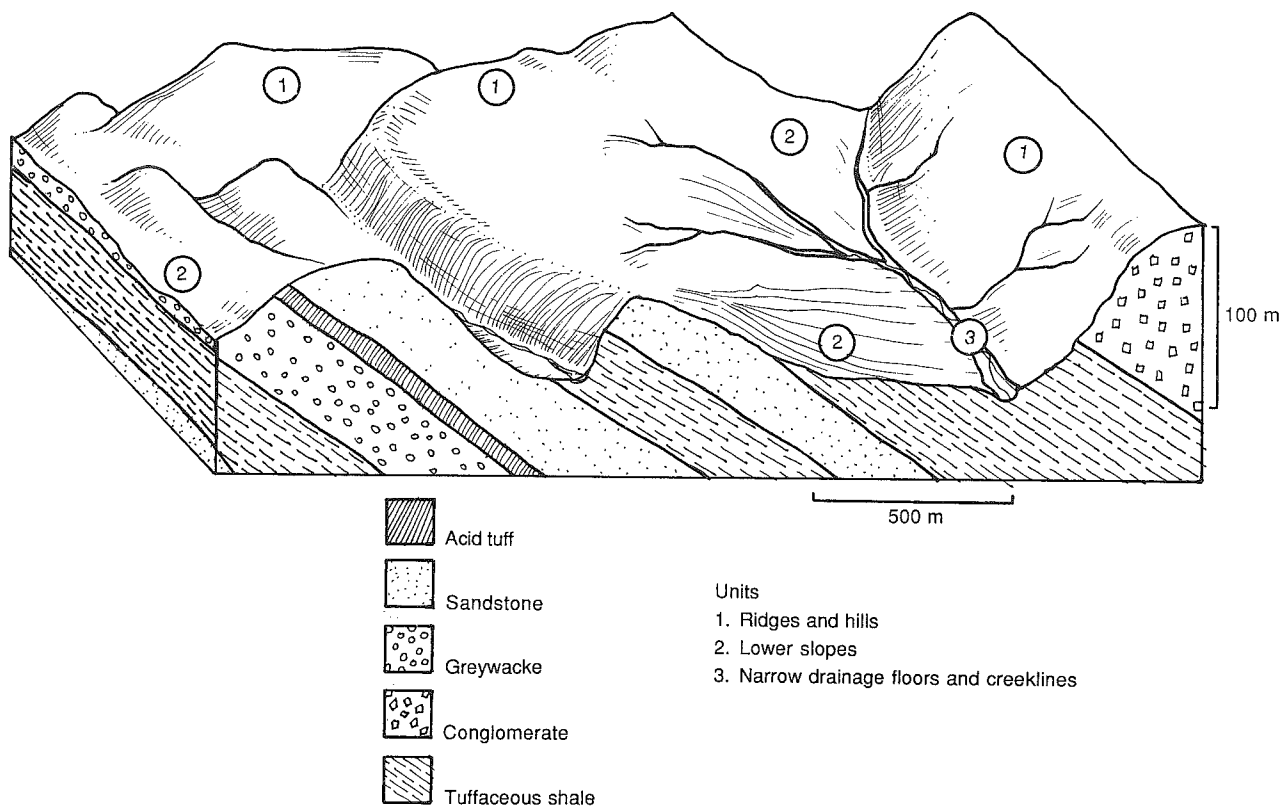
**Estimated carrying capacity:** 40 ha/sheep unit.

**Range condition summary (1 observation):** Good 100%; fair 0%; poor 0%.

Severely degraded and eroded: Nil

Degraded: Nil

Gullied: Nil



# Capricorn I.s.

Landform and soils	Vegetation : formations and major species	Comments
Ridges and hill tracts with rocky summits and upper slopes up to 80%, dense stony mantle or outcropping parent material, relief up to 100 m. Pockets of stony skeletal sands and clays.	<p><b>Unit 1 Ridges and hills (70%)</b> Spinifex hummock grasslands <i>Triodia</i> sp. (hard) or occasionally <i>T. pungens</i> with very sparse shrubs. Trees: (occasional) <i>Eucalyptus dichromophloia</i>. Tall shrubs: (&gt; 2m) <i>Acacia pyrifolia</i>, <i>Grevillea wickhamii</i>. Low shrubs: (&lt; 2 m) <i>Acacia pyrifolia</i>, <i>A. arida</i>, <i>Cassia glutinosa</i>, <i>Indigofera</i> sp., <i>Tribulus playptera</i>. Perennial grasses: <i>Triodia</i> sp. (hard) <i>T. pungens</i>.</p>	Pasture type: Predominantly <i>Hard Spinifex</i> , some <i>Soft Spinifex</i> . Pastoral use limitations: Mostly very poor quality pastures, poor accessibility.
Lower slopes and stony interfluvies extending up to 1 km downslope from hills and upper slopes, slopes up to 5%; variable depth loamy and clayey soils with dense stony mantles.	<p><b>Unit 2 Lower slopes (25%) 1 site inventory</b> As for unit 1.</p>	Pasture type: Predominantly <i>Hard Spinifex</i> , some <i>Soft Spinifex</i> . Pastoral use limitations: Mostly very poor quality pastures.
Floors usually < 200 m wide, single or multiple channels up to 50 m wide incised in bedrock. Shallow stony alluvial soils on banks, channel bedloads range from sand to cobbles.	<p><b>Unit 3 Narrow drainage floors and creeklines (5%) 1 site inventory</b> Spinifex hummock grasslands with numerous shrubs and occasional trees. Trees: <i>Eucalyptus dichromophloia</i>. Tall shrubs: (&gt; 2 m) <i>Acacia pyrifolia</i>, <i>A. bivenosa</i>, <i>A. tumida</i>, <i>Grevillea wickhamii</i>. Low shrubs: (&lt; 2 m) <i>A. pyrifolia</i>, <i>A. bivenosa</i>, <i>Cassia oligophylla</i>, <i>C. luerssenii</i>, <i>Corchorus</i> spp., <i>Trichodesma zeylanicum</i>. Perennial Grasses: <i>Triodia</i> sp. (hard), <i>T. pungens</i>, <i>Themeda</i> sp., <i>Cymbopogon</i> sp.</p>	Pasture type: <i>Hard Spinifex</i> / <i>Soft Spinifex</i> .

## Cheerawarra land system 273 km<sup>2</sup> (2.7% of survey area)

Sandy coastal plains and saline scalds, soft spinifex and buffel grass grasslands.

**Geology:** Quaternary aeolian sand and alluvium.

**Geomorphology:** Slightly undulating, mounded, sandy surfaced coastal plains with clayey saline plains and ill defined drainage tracts. Also bare saline scalds with large wind hummocks, relic foredunes and beach deposits.

**Pastoral use:** Soft Spinifex (40%), Hard Spinifex (30%), Roebourne Plains Grass (10%) and Buffel Tussock Grass (10%) pastures of moderate to high pastoral value; units are highly susceptible to wind erosion if vegetative cover is depleted. Some bare areas and Samphire pastures (10%).

**Estimated carrying capacity:** 7-25 ha/sheep unit depending on range condition.

**Range condition summary (56 observations):** Good 37%; fair 24%; poor 29%.

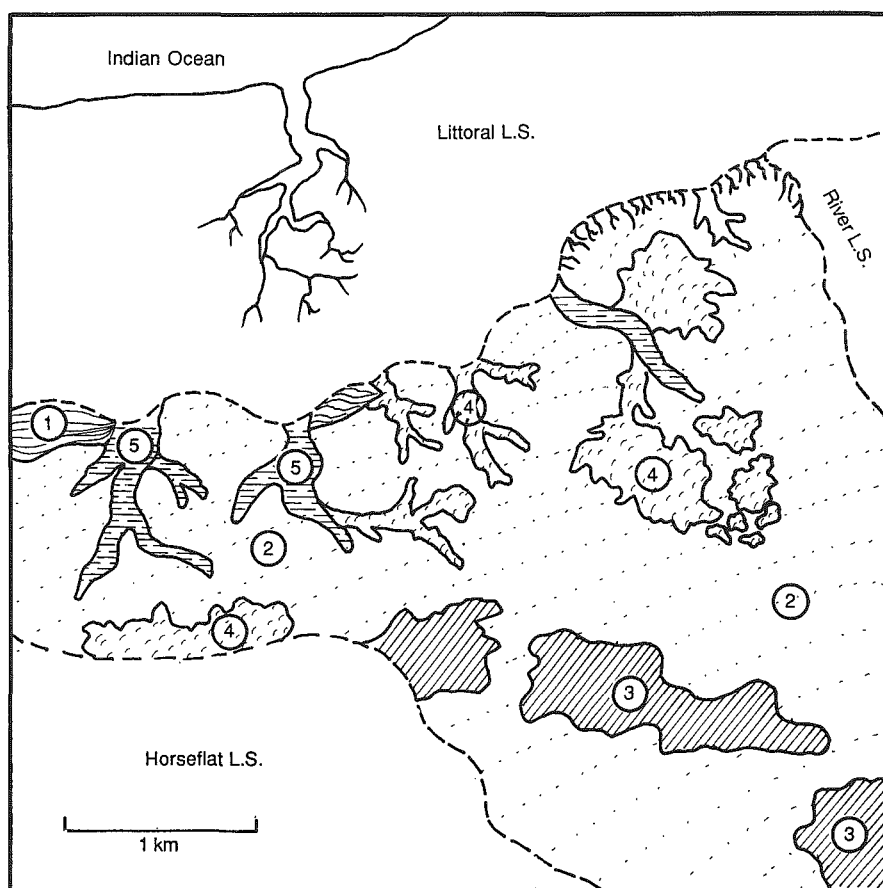
Severely degraded and eroded: 15 km<sup>2</sup>

Degraded: 17 km<sup>2</sup>

Gullied: 1 km<sup>2</sup>

### Units

1. Relic foredunes
2. Sandy surfaced plains
3. Saline clay plains
4. Saline scalds and hummocks
5. Saline drainage tracts



Landform and soils	Vegetation : formations and major species	Comments
Calcreted foredunes up to several km long, slopes 12-15%, relief up to 10 m, calcrete outcrop and surface mantle with little soil development.	<p><b>Unit 1 Relic foredunes (2%) 1 site inventory</b> Hummock grassland of hard spinifex and occasional shrubs. Low shrubs: (&lt; 1 m) <i>Capparis spinosa</i> var. <i>nummularia</i>, <i>Trianthema turgidifolia</i>. Perennial grasses: <i>Triodia</i> sp. (hard), <i>T. pungens</i>.</p>	Pasture type: <i>Hard Spinifex</i> .
<p>65 Almost flat to slightly undulating plains extending up to 4 km with local hummocking and mounding and occasional small saline scalds. Soils are calcareous gradational types i.e. red sandy clay loams merging to sandy clay or light clay, 60 cm - &gt; 1 m deep with alkaline reaction trend; principal profile forms: Gn 2.13, Gc 1.22.</p>	<p><b>Unit 2 Sandy surfaced plains (65%) 3 site inventories and traversed</b> Hummock grasslands of soft and hard spinifex, also buffel grass and very sparse shrubs. (Shrub PFC usually &lt; 2.5%). Tall shrubs: (&gt; 2 m - occasional) <i>Dichrostachys spicata</i>. Low shrubs: (&gt; 2 m) <i>Carissa lanceolata</i>, <i>Acacia translucens</i>, <i>A. ligulata</i>. Perennial grasses: <i>Triodia</i> sp. (hard), <i>T. secunda</i>, <i>T. pungens</i>, <i>Chrysopogon fallax</i>, <i>Cenchrus ciliaris</i>, <i>Eragrostis xerophila</i>.</p>	<p>Pasture type: <i>Soft Spinifex/Hard Spinifex</i> with significant stands of buffel grass in places. Pastoral use limitations: Extreme susceptibility to wind erosion if vegetation is depleted.</p>
Almost flat plains extending up to 1.5 km, slightly lower than unit 2, hummocky surfaces with some through flow, patches with moderate to dense mantle of pebbles and stones. Soils are dark reddish brown, saline clays > 1 m deep with alkaline reaction trend; principal profile form: Uf 6.12.	<p><b>Unit 3 Saline clay plains (15%) 1 site inventory and traversed</b> Patchy low shrublands and grasslands. (Shrub PFC 5-10%). Shrubs: (mostly &lt; 1 m) <i>Sclerolaena hostilis</i>, <i>Atriplex burburyana</i>, <i>Acacia victoriae</i>. Perennial grasses: <i>Triodia pungens</i>, <i>Cenchrus ciliaris</i>, (on mounds) <i>Chrysopogon fallax</i>, <i>Eragrostis xerophila</i>.</p>	<p>Pasture type: <i>Salibush/Tussock Grass</i>. Pastoral use limitations: High susceptibility to wind and water erosion if vegetation is depleted.</p>
Flat, saline scalds as discrete areas up to 300 m in diameter or more diffuse tracts up to 1 km in extent, weakly crusted surfaces puffy underneath, ± sparse to moderate pebble mantle; scalds often ringed by sand hummocks with sharp truncated slopes and relief up to 4 m above scalds. Soils on scalds are dark reddish brown saline clays > 1 m deep, soils on hummocks are red sands > 1 m deep; principal profile form: Uc 5.11.	<p><b>Unit 4 Saline scalds and large sand hummocks (10%) 1 site inventory and traversed</b> Scalds—no vegetation or occasionally very sparse <i>Frankenia</i> sp., <i>Sclerolaena hostilis</i>, <i>Salsola kali</i>. Hummocks support sparse to moderately dense perennial grasses <i>Triodia pungens</i>, <i>Cenchrus ciliaris</i>, also <i>Salsola kali</i>.</p>	<p>Pasture type: <i>Soft Spinifex</i> on hummocks. Pastoral use limitations: High susceptibility to wind erosion, surface crust on scalds gives some protection but is easily disturbed, some hummocks are stabilized or partly stabilized by soft spinifex and buffel grass, elsewhere they are actively eroding.</p>
Diffuse drainage tracts within unit 1 mostly 20-50 m wide but becoming wider near Littoral land system; hummocky margins with flatter, usually unchannelled floors but occasionally guttered or gullies. Soil are red duplex soils (sand over sandy clay) or saline clays > 1 m deep.	<p><b>Unit 5 Saline drainage tracts (8%) 1 site inventory and traversed</b> Grasslands or very scattered halophytic low shrublands or bare surfaces. Tall shrubs: (1-2 m) occasional <i>Acacia coriacea</i>, <i>A. ligulata</i>, <i>A. farnesiana</i>. Low shrubs: <i>Sclerolaena hostilis</i>, <i>Frankenia</i> sp., <i>Halosarcia</i> spp. Perennial grasses: <i>Sporobolus virginicus</i>, <i>Chrysopogon fallax</i>, <i>Triodia pungens</i>, <i>T. sp.</i>, <i>Cenchrus ciliaris</i>.</p>	Pasture type: <i>Tussock Grass</i> or <i>Samphire</i> .

## Gregory land system 27 km<sup>2</sup> (0.3% of survey area)

Linear dunes and restricted sandplains on the eastern boundary of the study area; hard spinifex shrubby grasslands.

**Geology:** Quaternary aeolian sand and alluvium.

**Geomorphology:** Linear red sand dunes up to 12 m high with sandy swales and restricted sand plains. No organized drainage patterns.

**Pastoral use:** Mostly Hard Spinifex pastures (95%) of very low productivity, but also some useful Soft Spinifex pastures (5%) of moderate productivity and good durability. Summer burning followed by a short deferral from grazing is required every four to five years. This system is generally not susceptible to erosion or significant pasture degradation, however, there is some risk of wind erosion following burning.

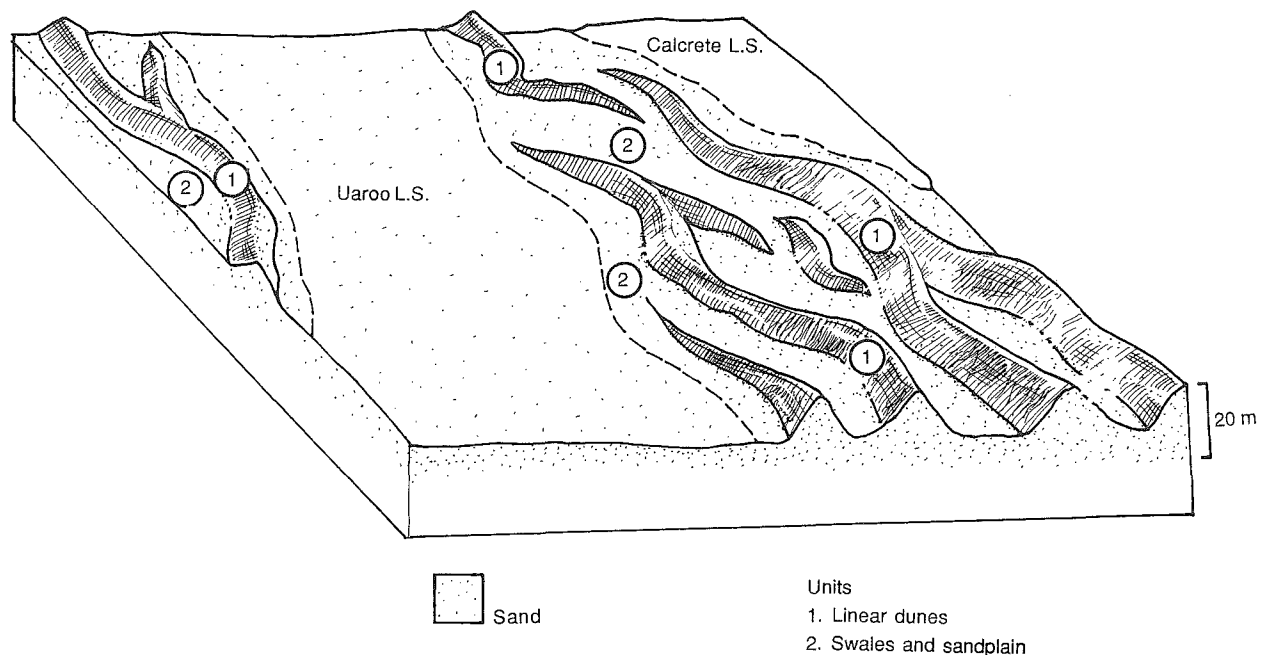
**Estimated carrying capacity:** 20-40 ha/sheep unit depending on burning history and range condition.

**Range condition summary** – not traversed.

Severely degraded and eroded: Nil

Degraded: Nil

Gullied: Nil



Gregory I.s.

Landform and soils	Vegetation : formations and major species	Comments
<p>Linear dunes up to 4 km long and up to 12 m high, side slopes 10-20%, dune crests with mounded, loose surfaces. Soils are red sands &gt; 1 m deep; principal profile form Uc 1.23.</p>	<p><b>Unit 1</b>    <b>Linear dunes (60%)</b>    <b>1 site inventory</b>  Hard spinifex grasslands with numerous shrubs. Tall shrubs: (&gt; 2 m) <i>Acacia</i> spp., <i>A. sp. nova</i>. Low shrubs: (&lt; 2 m) <i>Acacia</i> sp. <i>nova</i>, <i>Corchorus</i> sp., <i>Tricoryne corynothecoides</i>, <i>Indigofera</i> sp., <i>Cassia desolata</i>. Perennial grasses: <i>Triodia basedowii</i>(?), <i>T. pungens</i>, <i>Eriachne helmsii</i>.</p>	<p>Pasture type: <i>Hard Spinifex</i>.  Pastoral use limitations: Poor quality pastures, appropriate fire management can marginally improve grazing value.</p>
<p>Swales and sandplains with concave marginal slopes to 5% near dunes becoming flatter (1% to &lt; 0.3%) elsewhere, up to 2 km in extent. Soils are probably &gt; 1 m deep red sands or red duplex and gradational types.</p>	<p><b>Unit 2</b>    <b>Swales and sandplains (40%)</b>    <b>Traversed</b>  Spinifex grasslands with numerous shrubs and occasional trees. Trees: <i>Eucalyptus dichromophloia</i>, <i>Owenia reticulata</i>. Tall shrubs: (&gt; 2 m) <i>Acacia inaequilatera</i>, <i>A. pyrifolia</i>, <i>A. ancistrocarpa</i>. Low shrubs: (&lt; 2 m) <i>Acacia bivenosa</i>, <i>A. pyrifolia</i>, <i>A. acradenia</i>, <i>A. translucens</i>, <i>Corchorus walcottii</i>, <i>Psoralea lachnostachys</i>, <i>Cassia notabilis</i>. Perennial grasses: <i>Triodia basedowii</i>(?), <i>T. pungens</i>, <i>Chrysopogon fallax</i>, <i>Aristida browniana</i>.</p>	<p>Pasture type: Mostly <i>Hard Spinifex</i>.  Pastoral use limitations: Generally poor quality pastures, appropriate fire management can improve grazing value.</p>



## Horseflat land system 1,998 km<sup>2</sup> (19.6% of survey area)

Extensive, weakly gilgaied clay plains with tussock grasslands.

**Geology:** Quaternary alluvium.

**Geomorphology:** Level, gilgaied and non-gilgaied alluvial clay plains, stony plains, narrow linear drainage depressions and dissected gentle slopes marginal to the River land system.

**Pastoral use:** Roebourne Plains Grass pastures (> 95%) with high pastoral value and moderate drought durability. Some areas are suffering from pasture decline. Parts of the system are prone to erosion, especially gullying on the sloping margins to major watercourses. Some minor occurrences of saltbush are found on this land system and Saltbush pastures may have been more extensive in the past.

**Estimated carrying capacity:** 4-20 ha/sheep unit depending on range condition.

**Range condition summary (539 observations):** Good

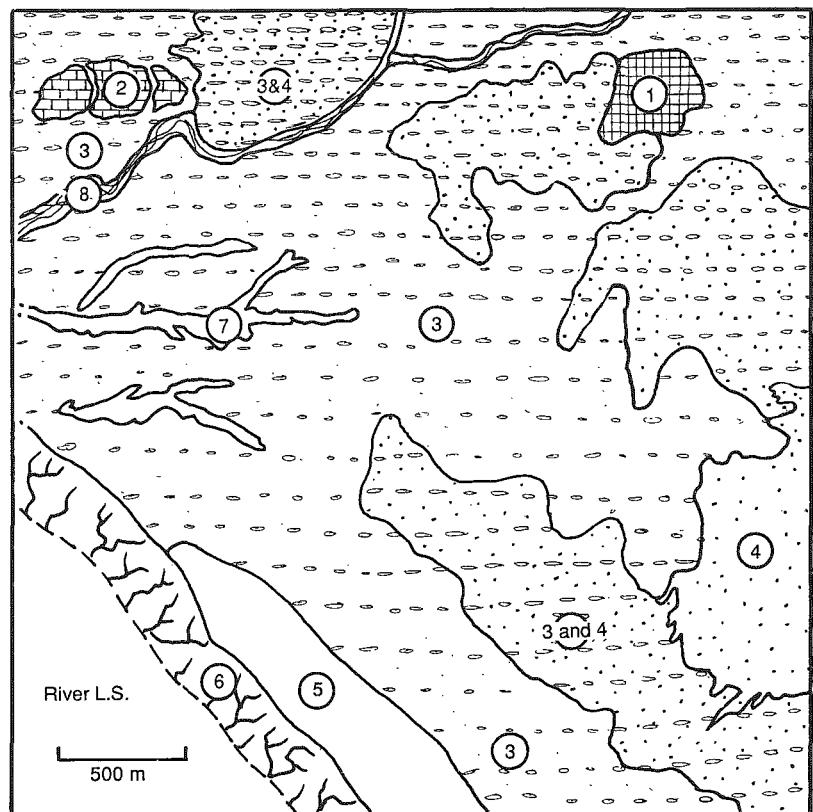
28%; fair 35%; poor 37%.

Severely degraded and eroded: 26 km<sup>2</sup>

Degraded: 94 km<sup>2</sup>

Gullied: 29 km<sup>2</sup>

- Units
1. Stony rises and low hills
  2. Calcrete plains
  3. Gilgaied plains
  4. Non gilgaied, sometimes stony plains
  5. Alluvial plains
  6. Dissected slopes
  7. Linear drainage depressions
  8. Channels and minor river terraces



# Horseflat L.s.

Landform and soils	Vegetation : formations and major species	Comments
Occasional isolated stony rises or low hills extending up to 300 or 400 m, relief up to 20 m, shallow skeletal sands and clays with stony surface mantles and rock outcrop.	<p><b>Unit 1 Stony rises and low hills (&lt; 1%)</b> Sparse hard spinifex grasslands with occasional shrubs.</p> <p><b>Unit 2 Calcrete plains (1%)</b> Traversed Spinifex hummock grasslands with <i>Triodia wiseana</i>, <i>T. sp.</i>, and occasional trees and shrubs. Trees: <i>Eucalyptus dichromophloia</i>. Tall shrubs: (&gt; 2 m) <i>Acacia inaequilatera</i>. Low shrubs: (&lt; 2 m) <i>Acacia inaequilatera</i>, <i>A. pyrifolia</i>, <i>A. bivenosa</i>, <i>A. ligulata</i>, <i>A. translucens</i>, <i>Corchorus</i> spp. Perennial grasses: <i>Triodia wiseana</i>, <i>T. sp.</i>, <i>T. pungens</i>.</p> <p><b>Unit 3 Gilgaied plains (60%)</b> 9 site inventories and traversed Tussock grasslands of variable density dominated by Roebourne Plains grass (<i>Eragrostis xerophila</i>) with occasional patches of other perennial grasses and shrubs. (Shrub PFC usually &lt; 2.5 but occasionally up to 15%). Shrubs: (0.5-2 m) <i>Acacia xiphophylla</i>, <i>Sclerolaena hostilis</i>, <i>Atriplex burburyana</i>, <i>Enchylaena tomentosa</i>. Perennial grasses: <i>Eragrostis xerophila</i>, <i>Eriachne benthamii</i>, <i>Astrebla pectinata</i>, <i>Panicum decompositum</i>, <i>Chrysopogon fallax</i>.</p> <p><b>Unit 4 Non-gilgaied, sometimes stony, plains (25%)</b> 3 site inventories and traversed Annual herbfields or sparse tussock grasslands of Roebourne Plains grass (<i>Eragrostis xerophila</i>), no shrubs. Perennial grasses: <i>Eragrostis xerophila</i>, <i>Triodia</i> sp. (hard). Very stony areas may be bare of perennial cover and act as run-off areas to adjacent gilgaied plains.</p> <p><b>Unit 5 Alluvial plains (5%)</b> 1 site inventory and traversed Sparse tussock grasslands or hummock grasslands and occasional shrubs. Shrubs: (1-2 m) <i>Acacia inaequilatera</i>, <i>A. xiphophylla</i>. Perennial grasses: <i>Eragrostis xerophila</i>, <i>Chrysopogon fallax</i>, <i>Triodia pungens</i>, <i>T. sp</i> (hard).</p>	<p>Pasture type: <i>Hard Spinifex</i>. Pastoral use limitations: Very poor quality pastures.</p> <p>Pasture type: <i>Hard Spinifex</i>. Pastoral use limitations: Very poor quality pastures.</p> <p>Pasture type: <i>Tussock Grass</i>. Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.</p> <p>Pasture type: <i>Sparse Tussock Grass</i> plus annuals. Pastoral use limitations: Mostly ephemeral feed, areas not protected by stony mantle have high susceptibility to erosion.</p> <p>Pasture type: <i>Tussock Grass</i>. Pastoral use limitations: High susceptibility to degradation, much of the unit shows vegetation degradation and is wind eroded.</p>
Almost flat plains restricted to 300 or 400 m in extent, calcrete outcrop or surface mantles of calcrete gravel and fragments. Soils are dark brown, shallow calcareous loams.		
Flat to gently sloping (up to 1%) plains extending for up to 3 km or as a tight mosaic (10-200 m in diameter) with similarly sized non-gilgaied plains (unit 4) or they may be linearly arranged; sparse to moderately dense mantle of pebbles and stones. Soils are red or reddish brown, cracking clays > 1 m deep, principal profile forms: Ug 6.3, also Ug 5.36.		
Almost flat plains extending up to 2 km but more usually as much smaller patches between gilgaied areas (unit 3) marginally higher than unit 3, surface mantle varies from nil to dense gravel, pebbles and rocks. Soils are red clays > 1 m deep; principal profile forms: Uf 5.12, 6.12.		
Almost flat plains 1-2 km in extent often adjacent to dissected slopes (unit 6) or as inclusions in gilgaied plains (unit 3), no surface mantles. Soils are red clays; principal profile form: Uf 6.12.		

## Horseflat l.s. – Continued

Landform and soils	Vegetation : formations and major species		Comments
Short (generally < 400 m wide) slopes (1-2%) flanking River land system and marginal to gilegated plains (unit 3) and alluvial plains (unit 5), mounded surfaces with rills and gullies incised 1-2 m; gullies may be active or stabilized by stony mantle and vegetation. Soils are red clays, reddish brown sandy clays and medium clays; principal profile form: Uf 6.71.	<b>Unit 6</b>	<b>Dissected slopes (6%)</b> 2 site inventories and traversed Scattered shrublands often dominated by snakewood ( <i>Acacia xiphophylla</i> ) with patchy perennial grasses including buffel grass ( <i>Cenchrus ciliaris</i> ) stabilizing some gully floors. (Shrub PFC < 2.5%-15%). Shrubs: (0.5-2 m) <i>Acacia xiphophylla</i> , <i>A. pyrifolia</i> , <i>A. farnesiana</i> , <i>A. sclerosperma</i> . Perennial grasses: <i>Triodia pungens</i> , <i>T. sp.</i> (hard), <i>Cenchrus ciliaris</i> , <i>Eragrostis xerophila</i> .	Pasture type: <i>Tussock Grass</i> . Pastoral use limitations: Parts have moderate to high susceptibility to gully erosion especially where stony mantle is absent.
Generally narrow (20-200 m wide, occasionally much larger) linear drainage zones running through and marginally lower than units 3, 4 & 5; mostly unchanneled. Soils are red clays > 1 m deep, principal profile form: Uf 5.12.	<b>Unit 7</b>	<b>Linear drainage depressions (3%)</b> 2 site inventories and traversed Very dense tussock grasslands with occasional trees and shrubs. (Shrub PFC < 2.5%). Trees: (4-8 m) <i>Eucalyptus coolabah</i> , <i>Hakea suberea</i> . Shrubs: (1-2 m) <i>Acacia farnesiana</i> , <i>A. inaequilatera</i> , <i>A. coriacea</i> . Perennial Grasses: <i>Eriachne benthamii</i> , <i>Eragrostis xerophila</i> , <i>Eulalia fulva</i> , <i>Chrysopogon fallax</i> .	Pasture type: <i>Tussock Grass</i> . Pastoral use limitations: None under controlled stocking.
Channels (up to 50 m wide) banks and narrow river terraces; bedloads of sand, pebbles and cobbles, sandy alluvial soils on banks and terraces.	<b>Unit 8</b>	<b>Channels and minor river terraces (&lt; 1%)</b> Traversed Fringing woodlands of river gum ( <i>Eucalyptus camaldulensis</i> ) with shrubs and often dense grasses. Tall shrubs: (> 2 m) <i>Acacia trachycarpa</i> , <i>A. coriacea</i> , <i>A. pyrifolia</i> . Perennial grasses: <i>Cenchrus ciliaris</i> , <i>Chrysopogon fallax</i> , <i>Triodia pungens</i> .	Pasture type: <i>Tussock Grass</i> (frequently buffel grass) / <i>Soft Spinifex</i> .



Gilgai depressions on the Horseflat land system often support dense stands of Tussock Grass pastures with a number of species, including barley Mitchell grass (*Astrebla pectinata*), swamp wendarrie grass (*Eriachne benthamii*), ribbon grass (*Chrysopogon fallax*) and native panic (*Panicum decompositum*). Site R58.



The giant bindii (*Sclerolaena hostilis*) grows up to a metre tall and colonizes degraded areas on the Horseflat and Cheerawarra land systems when the grazing pressure is reduced. It is palatable to stock when young, has a good tolerance to salinity and could prove to be very effective in stabilizing areas subject to wind erosion. This photograph clearly demonstrates the effect of grazing pressure on the establishment of giant bindii. Near site R68.

## Littoral land system (A) 718 km<sup>2</sup> (7.0% of survey area)

Extensive bare coastal mudflats flanked by mangroves and samphire flats; minor sandy islands, narrow sandy plains, coastal dunes and beaches.

**Geology:** Quaternary coastal mud, silty loams; aeolian sand.

**Geomorphology:** Estuarine and littoral surfaces with extensive bare saline mudflats subject to infrequent tidal inundation. Slightly higher samphire flats, mangrove seaward fringes with dense branching patterns of shallow tidal creeks, minor linear dunes, sandy islands and beaches are also present. Relief is up to 8 m on dunes and sandy islands.

**Pastoral use:** The mudflats and mangrove (80%) produce no pasture and the Samphire pastures (10%) have a low productivity. Small patches of Soft Spinifex pasture (10%) are also present. Very low to negligible pastoral value.

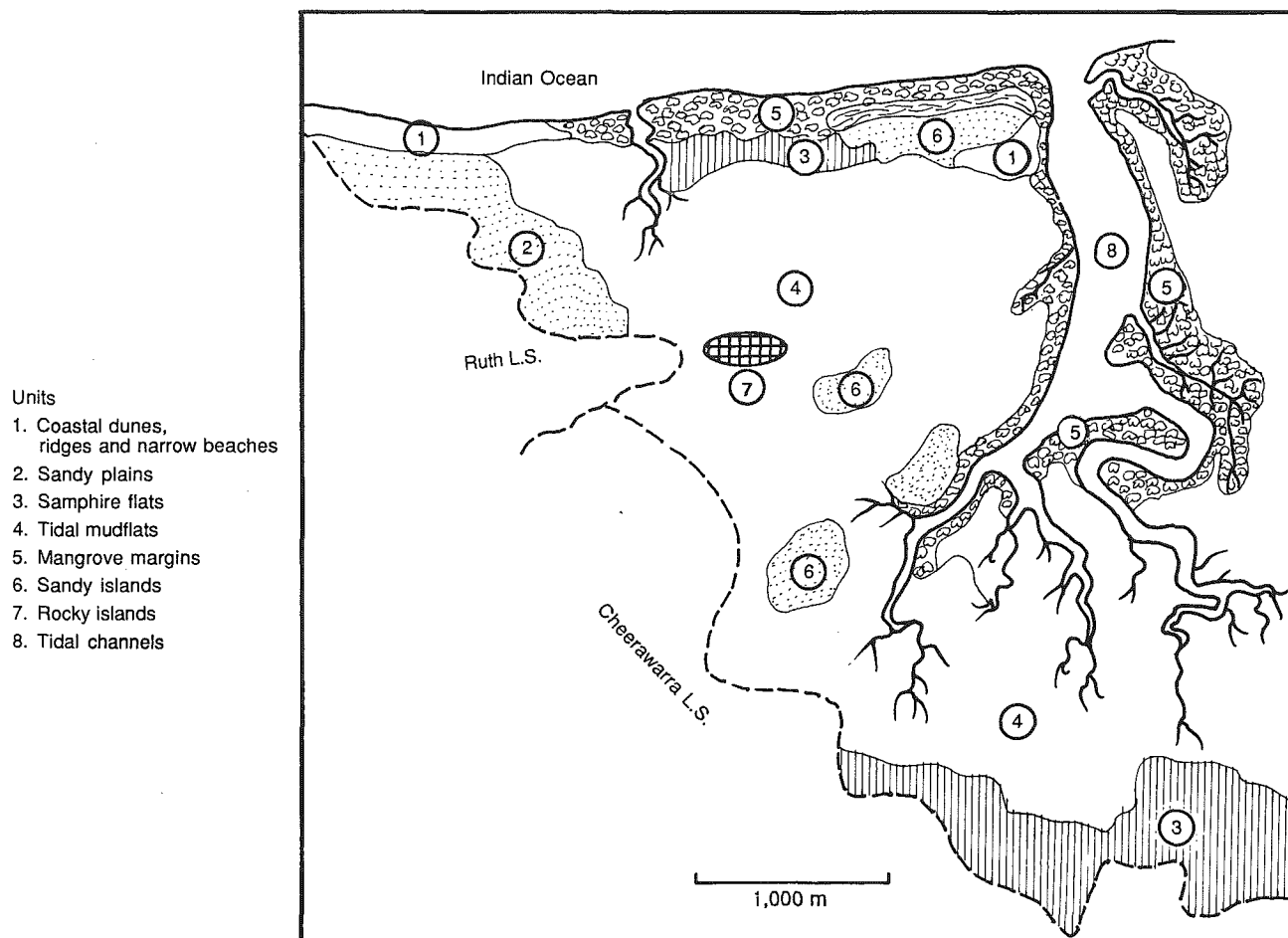
**Estimated carrying capacity:** > 40 ha/sheep unit.

**Range condition summary (4 observations):** Good 100%; fair 0%; poor 0%.

Severely degraded and eroded: Nil

Degraded: 0.1 km<sup>2</sup>

Gullied: 0.2 km<sup>2</sup>



# Littoral Is.

Landform and soils	Vegetation : formations and major species	Comments
Beach fore dunes, hind dunes, storm ridges and beaches, up to 8 m high and sloping up to 20% but usually much less; hummocky microrrelief. Soils are loose light reddish brown shelly sands > 1 m deep; principal profile form, Uc 1.12.	<p><b>Unit 1 Coastal dunes, ridges and narrow beaches (3%)</b> Hummock grasslands of beach spinifex (<i>Spinifex longifolius</i>) or soft spinifex (<i>Triodia pungens</i>) with numerous shrubs. Tall shrubs: (&gt; 2 m) <i>Acacia coriacea</i>. Low shrubs: (&lt; 2 m) <i>Acacia bivenosa</i>, <i>A. ligulata</i>, <i>A. sclerosperma</i>, <i>A. translucens</i>, <i>Rhagodia preissi</i>, <i>Aerva javanica</i>, <i>Threlkeldia diffusa</i>. Perennial grasses: <i>Spinifex longifolius</i>, <i>Triodia pungens</i>, <i>Cenchrus ciliaris</i>, <i>Whiteochloa airoides</i></p> <p><b>Unit 2 Sandy plains (4%) Traversed</b> Hummock grasslands of soft and hard spinifex and very sparse shrubs. Shrubs: <i>Acacia coriacea</i>, <i>A. bivenosa</i>, <i>A. ligulata</i>, <i>A. translucens</i>. Perennial grasses: <i>Triodia secunda</i>, <i>T. pungens</i>, <i>Cenchrus ciliaris</i>, <i>Chrysopogon fallax</i>.</p> <p><b>Unit 3 Samphire flats (10%) Traversed</b> Sparse low shrublands of samphire. Low shrubs: (&lt; 1 m) <i>Halosarcia halocnemoides</i>, <i>H. indica</i>, <i>H. pruinosa</i>, <i>Limonium salicorniaceum</i>, <i>Frankenia</i> spp. Perennial grasses: <i>Sporobolus virginicus</i>.</p> <p><b>Unit 4 Tidal mudflats (70%) Traversed</b> Surfaces often covered with mats and crusts of marine algae, but no permanent vegetation.</p> <p><b>Unit 5 Mangrove margins (5%)</b> Dense mangrove communities with <i>Avicennia marina</i>, <i>Rhizophora stylosa</i>, <i>Cer tops tagal</i> and others.</p> <p><b>Unit 6 Sandy islands (3%)</b> Hummock grasslands of soft and hard spinifex and very sparse shrubs. Shrubs: <i>Acacia coriacea</i>, <i>A. bivenosa</i>, <i>A. ligulata</i>, <i>A. translucens</i>. Perennial grasses: <i>Triodia secunda</i>, <i>T. pungens</i>, <i>Cenchrus ciliaris</i>, <i>Chrysopogon fallax</i>.</p>	<p><b>I site inventory and traversed</b> Pasture type: <i>Soft Spinifex</i>. Pastoral use limitations: High susceptibility to wind erosion if vegetation cover is depleted.</p> <p>Pasture type: <i>Soft Spinifex</i>. Pastoral use limitations: Susceptible to wind erosion if vegetation is depleted.</p> <p>Pasture type: <i>Samphire</i>. Pastoral use limitations: High salinity levels in vegetation.</p> <p>No pastures.</p> <p>No pastures.</p> <p>Pasture type: <i>Soft Spinifex</i>.</p>
Hummocky sandy plains up to 2 km in extent associated with dunes and on landward margins of samphire flats. Soils are probably red duplex and gradational soils i.e. red sandy loams merging to sandy clay loam or sandy clay.		
Flat plains and marshes slightly higher than and intergrading into adjacent bare mudflats (unit 4), periodically inundated by sea during high tides. Soils are saline silty sands, loams and clays often with shell fragments.		
Extensive flat, saline surfaces regularly inundated by tides; soils are saline muds of shelly lime sand, silt and clay.		
Margins and fringes up to 3 km wide but usually much less flanking tidal creeks and in the tidal zone abutting units 1, 3 and 4.		
Oval or circular islands, up to 2 km in extent, usually surrounded by bare mudflats; soils are probably light reddish brown sands or loamy sands.		

**Littoral ls. — Continued**

Landform and soils	Vegetation : formations and major species	Comments
Occasional rocky isolates up to 500 m in extent and 10 m high within units 3 or 4; dense stony mantle and little soil development.	<b>Unit 7</b> <b>Rocky islands (&lt; 1%)</b> Sparse hard spinifex communities.	Pasture type: <i>Hard Spinifex</i> .
Channels 20-200 m wide meandering through other units of the system, bare mud surfaces at low tide.	<b>Unit 8</b> <b>Tidal channels (5%)</b> Narrow fringing communities of mangroves or samphire.	No pastures.



Much of the Littoral land system consists of bare saline mudflats which are inundated by high tides. Other parts of the system support mangrove (*Avicennia marina*, *Ceriops tagal*) and samphire (*Halosarcia* spp.) communities which are of very little use for pastoralism.



## Macroy land system 205 km<sup>2</sup> (2.0% of survey area)

Stony plains with hard and soft spinifex hummock grasslands.

**Geology:** Archaean granitic rocks and Archaean and Proterozoic intermediate and basic rocks.

**Geomorphology:** Gently undulating stony plains and interfluvial with quartz surface mantles. Also present are minor sandy surfaced plains, calcrete plains, drainage floors with dendritic patterns of moderate intensity, minor granite hills and quartz ridges. Relief is up to 20 m, but usually much less.

**Pastoral use:** Mostly Hard Spinifex pastures (55%) of low pastoral value; some areas of Soft Spinifex pastures (45%) of moderate to high value and good drought durability. Regular burning is necessary to maintain pastures in a useful condition for livestock. Negligible risk of erosion.

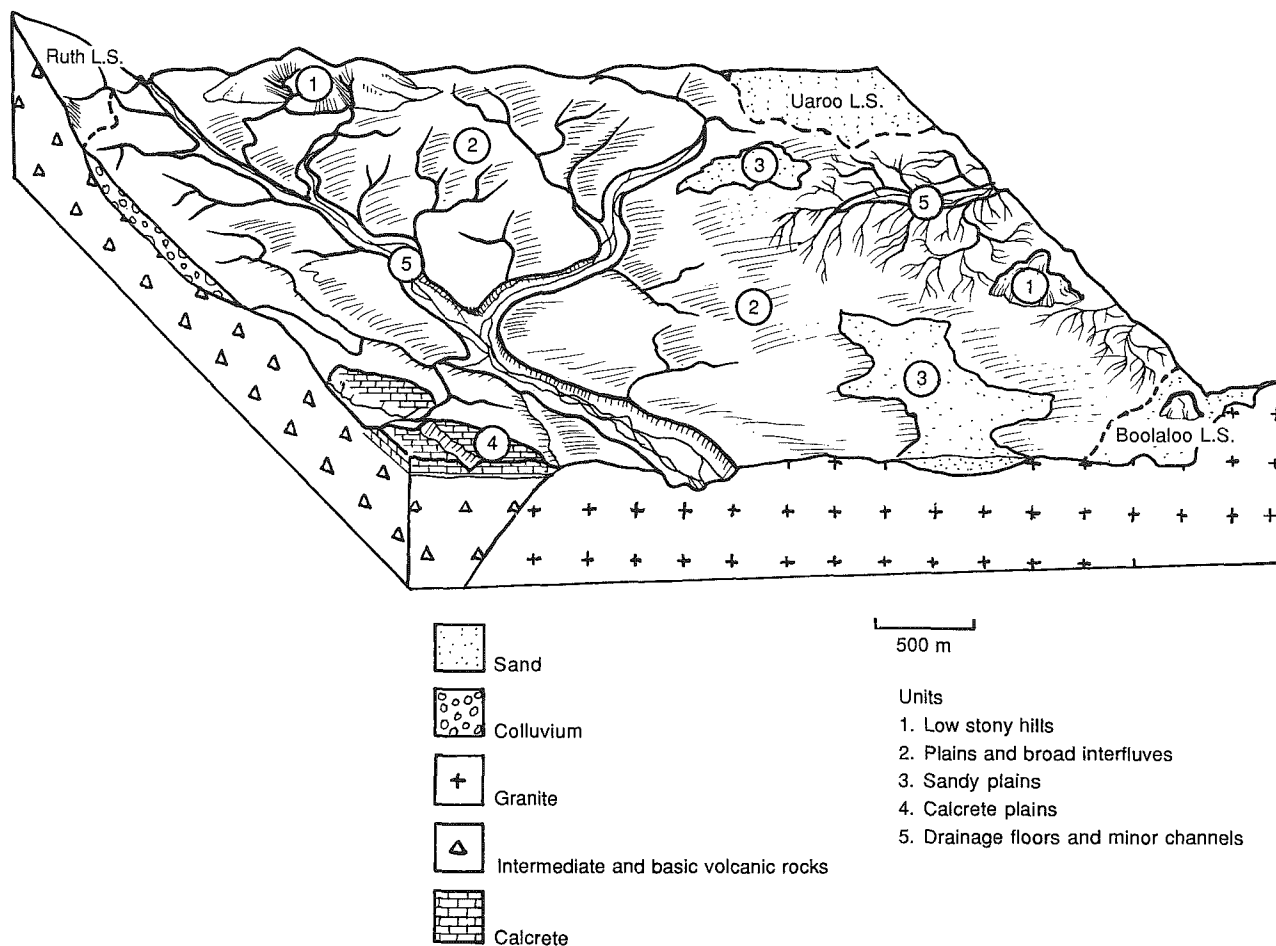
**Estimated carrying capacity:** 15-30 ha/sheep unit depending on burning history and range condition.

**Range condition summary (16 observations):** Good 100%; fair 0%; poor 0%.

Severely degraded and eroded: Nil

Degraded: Nil

Gullied: Nil



Macroy l.s.

Landform and soils	Vegetation : formations and major species		Comments
Isolated granitic hills, tor fields and quartz ridges up to 500 m in extent and 15 m in height, also low rises and crests; dense surface mantles and outcrops of granite rock, pockets of stony skeletal sands and clays.	Unit 1	Low stony hills (8%) Much bare rock, scattered hummocks of hard spinifex ( <i>Triodia wiseana</i> ), also some soft spinifex ( <i>T. pungens</i> ) and sparse shrubs and herbs.	Pasture type: <i>Hard Spinifex</i> . Pastoral use limitations: Poor quality pastures.
Very gently sloping (1%) or gently undulating plains extending up to 4 km between drainage lines, with sparse to dense mantles of quartz pebbles and rocks and occasional granite outcrop. Soils are stony duplex types, i.e. variable depth dark red sandy loams over sandy clay loams or sandy clays; principal profile form Dr 4.13.	Unit 2	Stony plains and broad interfluvies (70%) Hummock grasslands of hard and soft spinifex with very scattered shrubs. (Shrub PFC < 2.5-10%). Trees: (occasional 2-4 m) <i>Acacia inaequilatera</i> , <i>Hakea suberea</i> , <i>Grevillea pyramidalis</i> . Tall shrubs: (> 2 m) <i>Acacia inaequilatera</i> , <i>A. pyrifolia</i> . Low shrubs: (< 2 m) <i>Acacia bivenosa</i> , <i>A. pyrifolia</i> , <i>Cassia notabilis</i> , <i>Corchorus walcottii</i> . Perennial grasses: <i>Triodia</i> sp. (hard), <i>T. pungens</i> .	2 site inventories and traversed Pasture type: <i>Hard Spinifex/Soft Spinifex</i> . Pastoral use limitations: Poor to moderate quality pastures, appropriate fire management necessary for pastures to be useful for stock.
Almost flat to gently sloping sandy surfaced plains as inclusions within unit 2, surface mantle usually absent. Soils are probably red duplex and gradational types i.e. reddish brown loamy sands or sandy loams over sandy clays.	Unit 3	Sandy plains (10%) Spinifex hummock grasslands with scattered trees and shrubs. Trees: <i>Eucalyptus dichromophloia</i> . Tall shrubs: (> 2 m) <i>Acacia inaequilatera</i> , <i>A. pyrifolia</i> , <i>Grevillea pyramidalis</i> . Low shrubs: (< 2 m) <i>Acacia pyrifolia</i> , <i>A. bivenosa</i> , <i>Cassia notabilis</i> , <i>Corchorus walcottii</i> . Perennial grasses: <i>Triodia</i> sp. (hard), <i>T. pungens</i> .	Pasture type: <i>Hard Spinifex/Soft Spinifex</i> . Pastoral use limitations: As for unit 3.

Macrocy 1s. -- Continued

Landform and soils	Vegetation : formations and major species	Comments
Almost flat plains restricted to 300 or 400 m in extent associated with lower parts of unit 2 or unit 5, calcrete outcrop or surface mantles of calcrete gravel and rock fragments. Soils are probably shallow calcareous loams.	<p><b>Unit 4 Calcrete plains (2%) Traversed</b> Hard spinifex (<i>Tridonia wiseana</i>) hummock grasslands with very scattered trees and shrubs.</p> <p><b>Unit 5 Drainage floors and minor channels (10%) 1 site inventory and traversed</b> Soft spinifex hummock grasslands with numerous shrubs and occasional trees. Trees: (4-6 m) <i>Eucalyptus dichromophloia</i>. Tall shrubs: (&gt; 2 m) <i>Acacia pyrifolia</i>, <i>A. inaequilatera</i>, <i>Grevillea pyramidalis</i>. Low shrubs: (&lt; 2 m) <i>Acacia pyrifolia</i>, <i>A. holosericea</i>, <i>A. acradenia</i>, <i>A. bivenosa</i>, <i>Corchorus</i> spp. Perennial grasses: <i>Tridonia pungens</i>, <i>Chrysopogon fallax</i>.</p>	<p>Pasture type: <i>Hard Spinifex</i>. Pastoral use limitations: Very poor quality pastures.</p> <p>Pasture type: <i>Soft Spinifex</i>. Pastoral use limitations: None under controlled use, regular burning is a management requirement.</p>
Linear drainage tracts generally < 400 m wide as slight depressions within unit 3 becoming a little more incised in upper parts adjacent to unit 1, minor channels (up to 10 m wide) may be present. Soils are dark red sandy clay loams of variable depth on parent material; principal profile form Um 1.43.		



Gently sloping plains of the Macroy land system with a dense stony surface mantle and granitic outcrop; sparse hummock grasslands of soft spinifex (*Triodia pungens*).

## Mallina land system 775 km<sup>2</sup> (7.6% of survey area)

Extensive sandy surfaced alluvial plains, sometimes with patchy scalds; soft spinifex hummock grasslands with numerous shrubs.

**Geology:** Quaternary alluvium.

**Geomorphology:** Extensive, level sandy surfaced alluvial plains. Claypans, wind scalds, and wind hummocks are sometimes present, as are minor clay plains with gilgais and minor stony plains.

**Pastoral use:** Soft Spinifex pastures (80%) with moderate productivity and good drought durability. Summer burning followed by a short deferment of grazing is required every 4-5 years. Patches of Hard Spinifex pasture (5%) of low productivity and Roebourne Plains Tussock Grass pastures (10%) with high productivity are also present. Some claypans with no pasture.

This land system is prone to wind erosion resulting in the formation of bare scalds and hummocks. Some areas require spelling or cultural works.

**Estimated carrying capacity:** 7-25 ha/sheep unit depending on burning history and range condition.

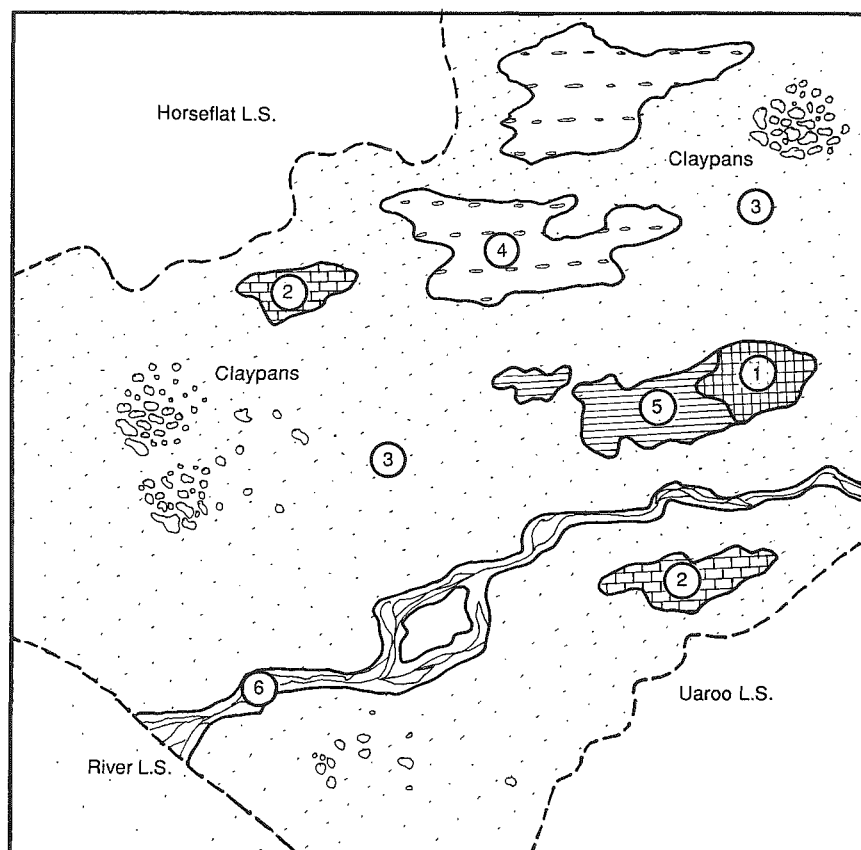
**Range condition summary (170 observations):** Good 57%; fair 31%; poor 12%.

Severely degraded and eroded: 6 km<sup>2</sup>

Degraded: 27 km<sup>2</sup>

Gullied: 2 km<sup>2</sup>

- Units
1. Stony rises and low hills
  2. Calcrete plains
  3. Sandy surfaced alluvial plains (with occasional claypans)
  4. Gilgai plains
  5. Stony plains
  6. Channels and river terraces



# Mallina I.s.

Landform and soils	Vegetation : formations and major species	Comments
Occasional isolated stony rises or low hills up to 400 m in extent, relief up to 20 m, shallow skeletal sands and clays with stony surface mantles and rock outcrop.	<p><b>Unit 1 Stony rises and low hills (2%)</b> Sparse hard spinifex hummock grasslands with occasional shrubs.</p> <p><b>Unit 2 Calcrete plains (3%) Traversed</b> Hard spinifex hummock grasslands with occasional trees and shrubs. Trees: <i>Eucalyptus dichromophloia</i>. Low shrubs: (&gt; 2 m) <i>Acacia inaequilatera</i>. Low shrubs: (&lt; 2 m) <i>Acacia inaequilatera</i>, <i>A. pyrifolia</i>, <i>A. bivenosa</i>, <i>A. ligulata</i>, <i>A. translucens</i>, <i>Corchorus</i> spp. Perennial grasses: <i>Triodia wiseana</i>, <i>T. pungens</i>.</p> <p><b>Unit 3 Sandy surfaced alluvial plains with occasional claypans (75%)</b> Spinifex hummock grasslands dominated by <i>Triodia pungens</i> with scattered shrubs and trees. (Shrub and tree PFC* &lt; 2.5-20%). Trees: (2-8 m) <i>Eucalyptus aspera</i>, <i>E. coolabah</i>, <i>Hakea suberea</i>, <i>Acacia inaequilatera</i>. Tall shrubs: (&gt; 2 m) <i>Acacia inaequilatera</i>, <i>A. pyrifolia</i>, <i>A. sclerosperma</i>. Low shrubs: (&lt; 2 m) <i>Acacia pyrifolia</i>, <i>A. victoriana</i>, <i>A. bivenosa</i>, <i>A. translucens</i>, <i>Carissa lanceolata</i>. Perennial grasses: <i>Triodia pungens</i>, <i>T. secunda</i>, <i>Chrysopogon fallax</i>, <i>Eragrostis xerophila</i>, <i>Cenchrus ciliaris</i>.</p> <p><b>Unit 4 Gilgai plains (10%) 2 site inventories and traversed</b> Sparse to moderately dense tussock grasslands dominated by Roebourne Plains grass (<i>Eragrostis xerophila</i>), very few shrubs. Perennial grasses: <i>Eragrostis xerophila</i>, <i>Eriachne benthamii</i>, <i>Chrysopogon fallax</i>, <i>Triodia pungens</i>.</p>	<p>Pasture type: <i>Hard Spinifex</i>. Pastoral use limitations: Very poor quality pastures; appropriate fire management can marginally improve grazing value.</p> <p>Pasture type: <i>Hard Spinifex</i>. Pastoral use limitations: Moderate to high susceptibility to erosion if vegetative cover is seriously depleted, parts show active wind scalding and hummocking and water scouring and rilling.</p> <p>Pasture type: <i>Tussock Grass</i>. Pastoral use limitations: None under controlled stocking. Generally the unit has low susceptibility to degradation.</p>

\*Projected foliar cover

**Mallina 1.s. — Continued**

Landform and soils	Vegetation : formations and major species		Comments
Restricted, almost flat plains occurring as inclusions within unit 3 may be slightly higher than and shed water onto unit 3, moderate to heavy mantle of subrounded pebbles and stones. Soils are red clays; principal profile form: Uf 6.12.	Unit 5	Stony plains (7%)	Pasture type: Mostly only annuals in season. Pastoral use limitations: No drought durability.
	Traversed Annual herbfields or very sparse tussock grasslands of <i>Eragrostis xerophila</i> and patchy <i>Triodia pungens</i> and <i>T. sp.</i> (hard), no shrubs.		
Narrow river terraces, floodplains, and banks up to 100 m wide flanking channels and creeklines (up to 50 m wide); bedloads of sand, pebbles and cobbles, sandy alluvial soils on banks and terraces.	Unit 6	Channels and river terraces (3%)	Pasture type: <i>Soft Spinifex/Tussock Grass</i> (frequently buffel grass). Pastoral use limitations: Occasionally subject to flooding.
	Traversed Fringing open woodlands of river gum and coolibah ( <i>Eucalyptus camaldulensis</i> , <i>E. coolabah</i> ) with shrubs and often dense grasses. Tall shrubs: (> 2 m) <i>Acacia trachycarpa</i> , <i>A. coriacea</i> , <i>A. pyrifolia</i> . Perennial grasses: <i>Triodia pungens</i> , <i>Chrysopogon fallax</i> , <i>Eragrostis eriopoda</i> , <i>Cenchrus ciliaris</i> .		



Brahman cattle grazing on a mixed soft spinifex (*Triodia pungens*) and ribbon grass (*Chrysopogon fallax*) pasture on the Mallina land system.



## Paraburdoo land system (A) 76 km<sup>2</sup> (0.7% of survey area)

Stony plains derived from basalt with snakewood shrublands and spinifex grasslands.

**Geology:** Quaternary colluvium and alluvium, derived mainly from basalt.

**Geomorphology:** Stony plains with and without gilgais and stony upper interfluvies with moderately dense patterns of sub-parallel tributary drainage which extends downslope into broad drainage zones with channels; isolated low basaltic hills. Relief is mostly < 8 m but isolated hills can be up to 20 m high.

**Pastoral use:** Mixed Hard (55%) and Soft (35%) Spinifex pastures of low to moderate pastoral value and Stony Chenopod pastures (10%) (under snakewood shrub communities) of moderate pastoral value. Many of the chenopod pastures are degraded and, in some snakewood communities, chenopods are now absent. Little erosion is present although there is some risk of erosion on unit 4.

**Estimated carrying capacity:** 15-30 ha/sheep unit depending on range condition.

**Range condition summary (8 observations):** Good 75%; fair 25; poor 0%.

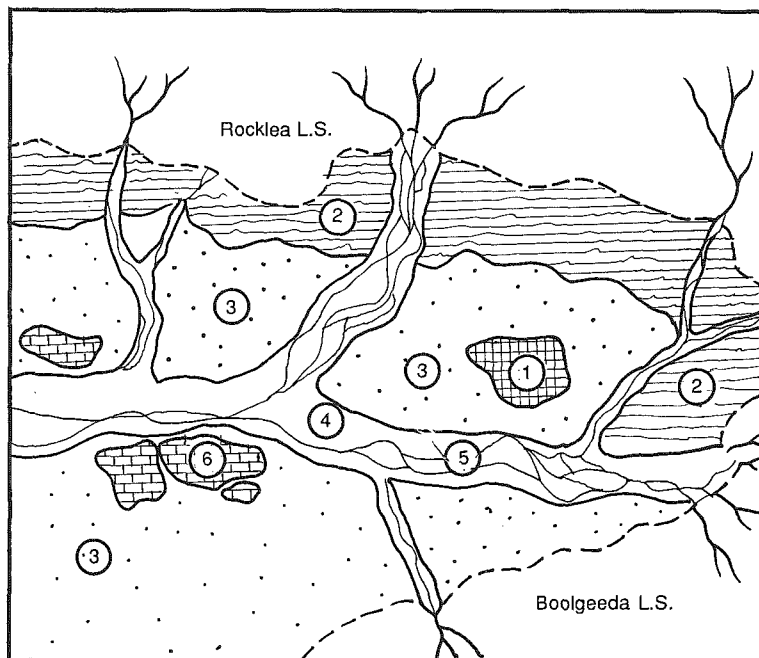
Severely degraded and eroded: Nil

Degraded: Nil

Gullied: Nil

### Units

1. Low basalt hills and ridges
2. Upper interfluvies and slopes
3. Stony plains
4. Drainage floors
5. Braided creeklines and channels
6. Calcrete platforms



Landform and soils	Vegetation : formations and major species	Comments
Occasional isolated hills and ridges extending up to 500 m, relief up to 70 m, stony skeletal clays and sands with dense stony mantle and much rock outcrop.	<p><b>Unit 1 Low basalt hills and ridges (5%)</b> Sparse hard spinifex grasslands with occasional shrubs and small trees. Trees: (2-4 m) <i>Terminalia canescens</i>. Shrubs: (&lt; 2 m) <i>Acacia pyrifolia</i>, <i>Cassia glutinosa</i>, <i>Tribulus platyptera</i>, <i>Gossypium australe</i>. Perennial grasses: <i>Triodia wiseana</i>, <i>T. pungens</i>, <i>Cymbopogon</i> sp.</p> <p><b>Unit 2 Upper interfluvies and slopes (20%)</b> Hummock grasslands of hard spinifex with scattered shrubs. Trees: (occasional) <i>Eucalyptus dichromophloia</i>. Tall shrubs: (&gt; 2 m) <i>Acacia inaequilatera</i>. Low shrubs: (&lt; 2 m) <i>Acacia pyrifolia</i>, <i>A. ancistrocarpa</i>, <i>A. bivenosa</i>, <i>Cassia pruinosa</i>, <i>Corchorus walcottii</i>. Perennial grasses: <i>Triodia wiseana</i>.</p> <p><b>Unit 3 Stony plains (40%) 1 site inventory and traversed</b> Scattered snakewood (<i>Acacia xiphophylla</i>) shrublands with under-shrubs and grasses. Tall shrubs: (&gt; 2 m) <i>Acacia xiphophylla</i>, <i>A. victoriae</i>. Low shrubs: (&lt; 2 m) <i>Acacia xiphophylla</i>, <i>A. victoriae</i>, <i>A. pyrifolia</i>, <i>A. bivenosa</i>, <i>Cassia oligophylla</i>, <i>C. hamersleyensis</i>, <i>Enchylaena tomentosa</i>. Perennial grasses: (scattered) <i>Triodia pungens</i>, <i>T. sp. (hard)</i>, <i>Eragrostis xerophila</i>, <i>Cenchrus ciliaris</i>, <i>Enteropogon acicularis</i>.</p> <p><b>Unit 4 Drainage floors (18%)</b> Traversed Probably scattered mixed <i>Acacia</i> spp. shrublands similar to unit 3 and with occasional trees such as <i>Eucalyptus dichromophloia</i>, <i>Hakea suberea</i>, <i>Grevillea pyramidalis</i>.</p> <p><b>Unit 5 Braided creeklines and channels (7%)</b> Traversed Probably as for units 2 and 3 but more dense.</p> <p><b>Unit 6 Calcrete platforms (10%)</b> Hard spinifex hummock grasslands with occasional trees and shrubs. Trees: <i>Eucalyptus dichromophloia</i>. Tall shrubs: (&gt; 2 m) <i>Acacia inaequilatera</i>. Low shrubs: (&lt; 2 m) <i>Acacia inaequilatera</i>, <i>A. pyrifolia</i>, <i>A. bivenosa</i>, <i>Corchorus</i> spp. Perennial grasses: <i>Triodia wiseana</i>, <i>T. sp.</i></p>	<p>Pasture type: <i>Hard Spinifex</i>.</p> <p>Pasture type: <i>Hard Spinifex</i>. Pastoral use limitations: Very poor quality pastures but appropriate fire management can improve grazing value.</p> <p>Pasture type: <i>Stony Chenopod/Soft Spinifex/Hard Spinifex</i>. Pastoral use limitations: <i>Stony Chenopod</i> pastures readily degrade if management is inappropriate.</p> <p>Pasture type: <i>Soft Spinifex/Hard Spinifex</i>. Pastoral use limitations: Moderate susceptibility to degradation and erosion.</p> <p>Pasture type: <i>Soft Spinifex</i>.</p> <p>Pasture type: <i>Hard Spinifex</i>.</p>
Surfaces immediately below adjacent hill land systems, dissected to 3 m by parallel drainage lines to form interfluvies 100-200 m wide extending up to 2 km downslope, slopes up to 3%, dense colluvial mantles. Soils are probably shallow, reddish brown sandy clays and sandy clay loams.		
Gently sloping (generally <1%) stony plains extending up to 3 km, with or without gilgai microrelief; soils are dark reddish brown light and medium clays of variable depth, principal profile forms: Uf 6.12, Ug 5.36.		
Drainage tracts up to 1 km wide and several kilometres long, slopes < 1%, sometimes unchannelled but central parts often with braided channels or major channels of trunk drainage. Soils are probably dark reddish brown clays and loams.		
Minor channels and runnels up to 10 m wide and 1.5 m deep, separated by narrow uneven surfaced flood banks, major channels up to 50 m wide and 5 m deep; variable sandy and loamy alluvial soils, channel bedloads of sand and gravel.		
Almost flat surfaces associated with unit 4, mostly < 500 m in extent, raised up to 0.5 m above surrounding surfaces; soils are shallow calcareous loams with dense surface mantles of calcrete gravel and rocks.		

## Pyramid land system 335 km<sup>2</sup> (3.3% of survey area)

Stony gilgai plains supporting hard spinifex hummock grasslands and minor tussock grasslands.

**Geology:** Quaternary alluvium and eluvium.

**Geomorphology:** Extensive, slightly elevated stony plains with a mosaic of gilgai and non-gilgai surfaces. Low stony rises and occasional hills, calcreted plains and minor drainage floors and channels are also present.

**Pastoral use:** Although predominantly Hard Spinifex pastures (75%) of very low pastoral value there are significant areas of more productive and useful Roebourne Plains Tussock Grass (20%) and Soft Spinifex (5%) pastures. The system has a low erosion risk, however some areas of plains grass are suffering from pasture decline.

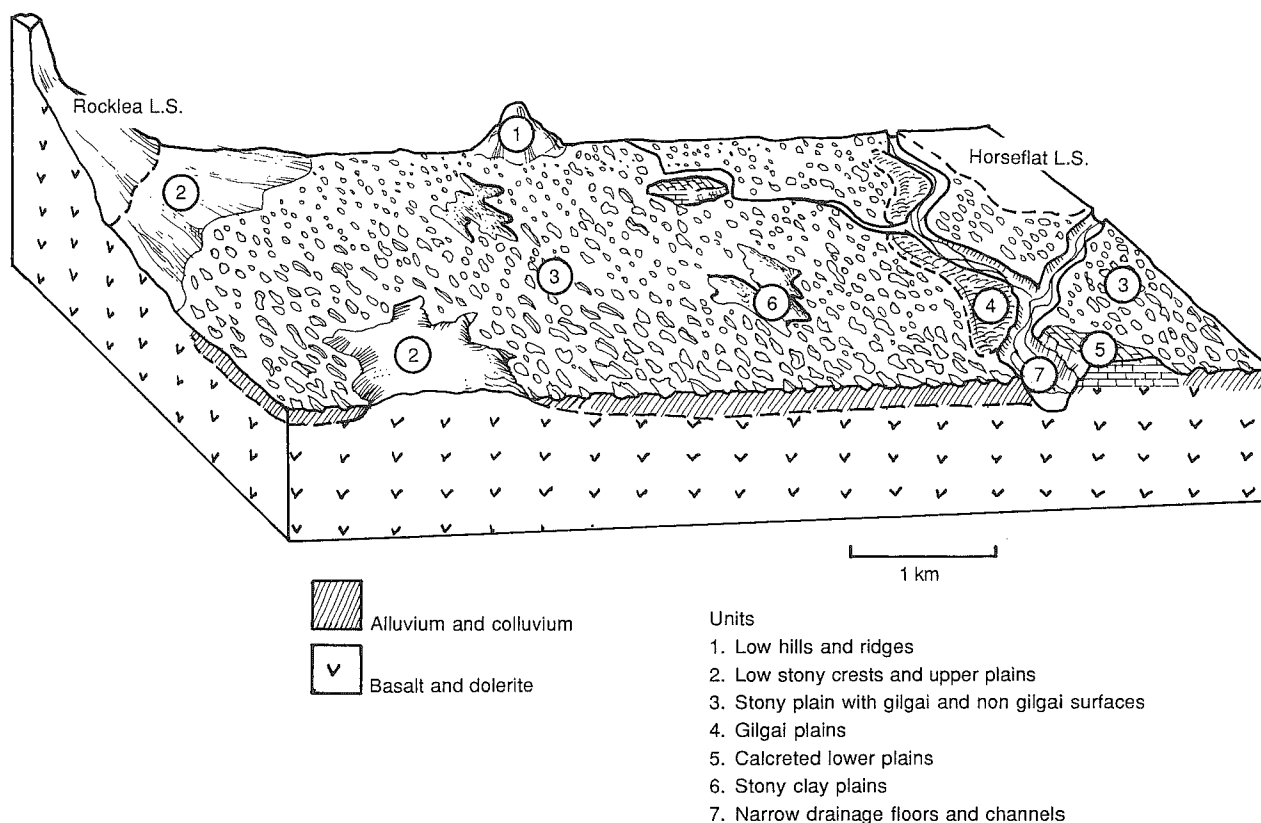
**Estimated carrying capacity:** 15-30 ha/sheep unit depending on range condition.

**Range condition summary (40 observations):** Good 72%; fair 23%; poor 5%.

Severely degraded and eroded: Nil

Degraded: 0.5 km<sup>2</sup>

Gullied: 1 km<sup>2</sup>

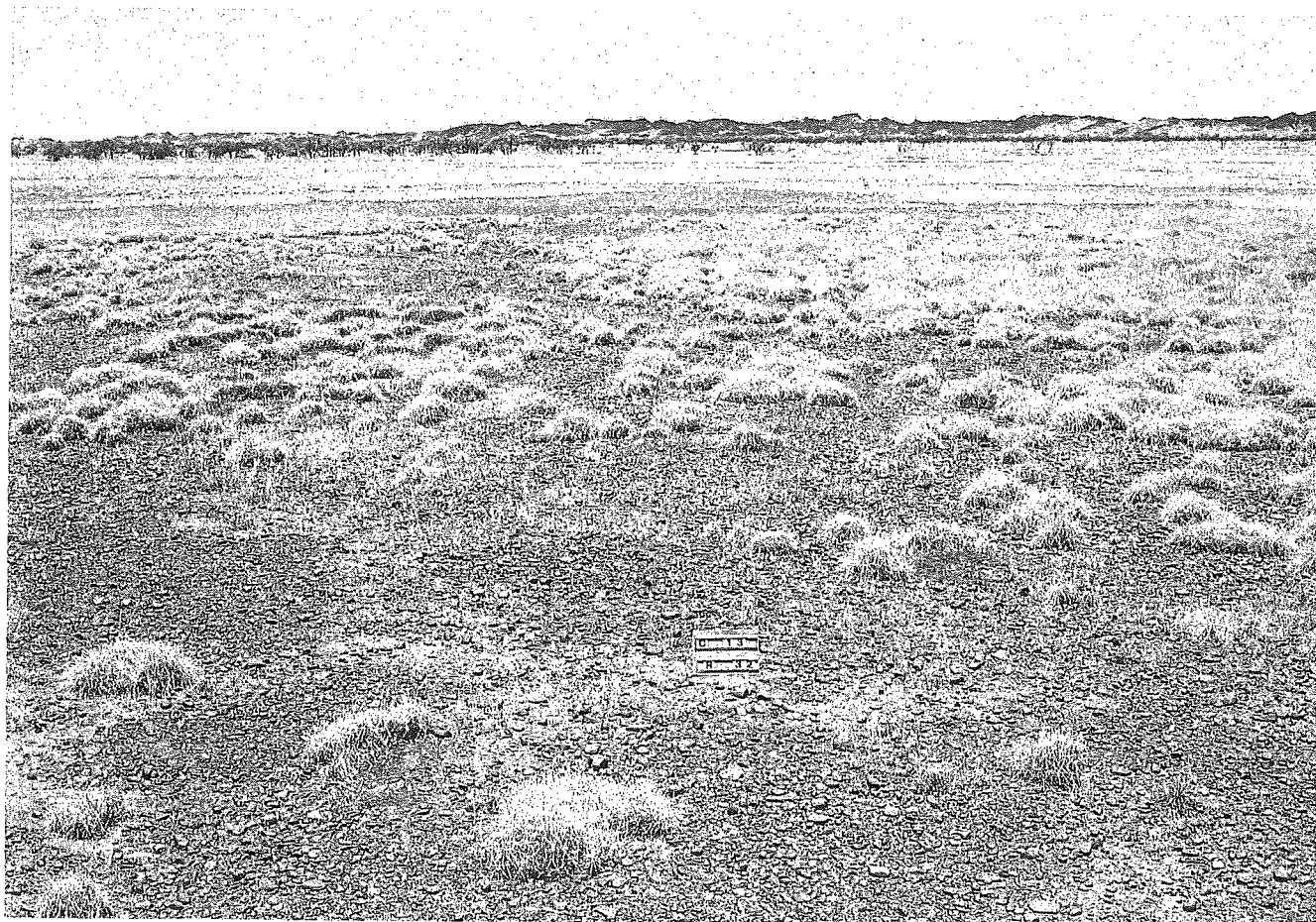


# Pyramid ls.

Landform and soils	Vegetation : formations and major species	Comments
Occasional isolated basalt hills and ridges up to 500 m in extent, relief up to 20 m. Pockets of stony skeletal clays with much outcrop and mantle of rocks and boulders.	<p><b>Unit 1 Low hills and ridges (2%)</b>            Sparse hummock grasslands of hard spinifex with occasional shrubs and trees. Trees: (2-4 m) <i>Terminalia canescens</i>, <i>Acacia pyrifolia</i>, <i>Cassia glutinosa</i>, <i>Tribulus platypterus</i>, <i>Gossypium australe</i>. Perennial grasses: <i>Triodia wiseana</i>, <i>Cymbopogon</i> aff. <i>bombycinus</i>.</p>	Pasture type: <i>Hard Spinifex</i> .
Gently rounded stony crests and upper plains with gentle slopes; elevated up to 5 m above unit 3, moderate to heavy mantle of basalt stones and boulders. Soils are probably shallow, alkaline clays or clay loams over clay.	<p><b>Unit 2 Low stony crests and upper plains (5%)</b>            Patchy hummock grasslands of hard spinifex (<i>Triodia wiseana</i>?) with occasional <i>Eragrostis xerophila</i>, very few shrubs.</p> <p><b>Traversed</b></p>	Pasture type: <i>Hard Spinifex</i> . Pastoral use limitations: Very poor quality pastures, appropriate fire management may marginally improve grazing value.
Almost flat, very stony plains extending up to 5 km between drainage lines, unit is a mosaic of stony pavements 10 m to 200 m in extent and slightly lower gilgated areas of similar dimensions, both parts have a heavy mantle of basalt pebbles and stones. Soils are red, clays and cracking clays usually > 1 m deep; principal profile forms: Uf 6.12, Ug 6.3.	<p><b>Unit 3 Stony plains with gilgai and non gilgai surfaces (80%)</b>            Hummock grassland dominated by <i>Triodia wiseana</i> with patches of tussock grasses and very occasional shrubs. (Shrub PFC usually &lt; 2.5%). Shrubs: (generally &lt;1.5 m) <i>Acacia xiphophylla</i>, <i>Cassia oligophylla</i>, <i>Sida</i> sp, <i>Scleroleana bicornis</i>. Perennial grasses: <i>Triodia wiseana</i>, <i>Eragrostis xerophila</i></p> <p><b>2 site inventories and traversed</b></p>	Pasture type: Predominantly <i>Hard Spinifex</i> , some <i>Tussock Grass</i> . Pastoral use limitations: Poor quality pastures augmented somewhat by Roebourne Plains grass <i>Eragrostis xerophila</i> and numerous annual grasses and forbs in season.

# Pyramid I.s. – Continued

Landform and soils	Vegetation : formations and major species			Comments
<p>Flat plains 200 m-1 km in extent with little surface mantle and cracking, friable surfaces. Soils are cracking clays.</p> <p>Almost flat lower plains associated with drainage lines, up to 500 m in extent, moderate to heavy surface mantle of calcrete gravel and rocks. Soils are shallow calcareous loams.</p>	<b>Unit 4</b>	<b>Non stony gilgai plains (2%)</b>	<b>Traversed</b> Tussock grasslands and herbfields with numerous annual grasses and forbs in season, <i>Eragrostis xerophila</i> or hummocks of <i>Triodia wiseana</i> .	Pasture type: <i>Tussock Grass</i> .
	<b>Unit 5</b>	<b>Calcreted lower plains (5%)</b>	<b>I site inventory and traversed</b> Spinifex hummock grasslands or snakewood ( <i>Acacia xiphophylla</i> ) shrublands with sparse spinifex understorey. Trees: (occasional 4-6 m) <i>Eucalyptus dichromophloia</i> . Tall shrubs: (> 2 m) <i>Acacia xiphophylla</i> . Low shrubs: (1-2 m) <i>Acacia xiphophylla</i> , <i>A. pyrifolia</i> , <i>A. bivenosa</i> . Perennial grasses: <i>Triodia wiseana</i> , <i>Eragrostis xerophila</i> .	Pasture type: <i>Hard Spinifex</i> . Pastoral use limitations: Poor quality pastures.
<p>Flat plains fringing drainage floors, up to 500 m in extent, stony mantle on surface. Soils are red clays.</p> <p>Drainage floors, minor river terraces and banks up to 100 m wide flanking channels and creeklines (up to 50 m wide); stony alluvial soils on terraces and banks, channel bedloads of cobbles and pebbles.</p>	<b>Unit 6</b>	<b>Stony clay plains (3%)</b>	<b>Traversed</b> Herbfields with numerous annual grasses and forbs in season, snakewood ( <i>Acacia xiphophylla</i> ) communities and hummocks of <i>Triodia wiseana</i> .	Pasture type: <i>Ephemeral</i> . Pastoral use limitations: Poor drought durability.
	<b>Unit 7</b>	<b>Narrow drainage floors and channels (3%)</b>	<b>Traversed</b> Open woodlands of coolibah ( <i>Eucalyptus coolabah</i> ) and fringing woodlands of river red gum ( <i>E. camaldulensis</i> ) with shrubs and grasses. Tall shrubs: (> 2 m) <i>Acacia trachycarpa</i> , <i>A. coriacea</i> , <i>A. pyrifolia</i> . Perennial grasses: <i>Triodia pungens</i> , <i>Chrysopogon fallax</i> .	Pasture type: <i>Soft Spinifex</i> .



Stony clay plains of the Pyramid land system with sparse hard spinifex vegetation and occasional tussock grasses; generally low pastoral value.

## River land system 694 km<sup>2</sup> (6.8% of survey area)

Active floodplains and terraces flanking major rivers and creeks with riverine woodlands and tussock and hummock grasslands.

**Geology:** Quaternary alluvium.

**Geomorphology:** Floodplains and river terraces with minor channels and major watercourses which are often braided. Sandy banks and poorly defined levees are often present. Banks and slightly higher upper terraces receive less regular flooding than lower terraces and flood plains.

**Pastoral use:** Highly productive Buffel Tussock Grass pastures (45%) and Soft Spinifex pastures (40%) with good drought durability. Some Hard Spinifex pasture (5%) and river beds without pasture (10%) also present. This land system is stabilized by buffel grass and spinifex and very little erosion is evident. However, if vegetative cover is removed severe water and wind erosion is likely to occur.

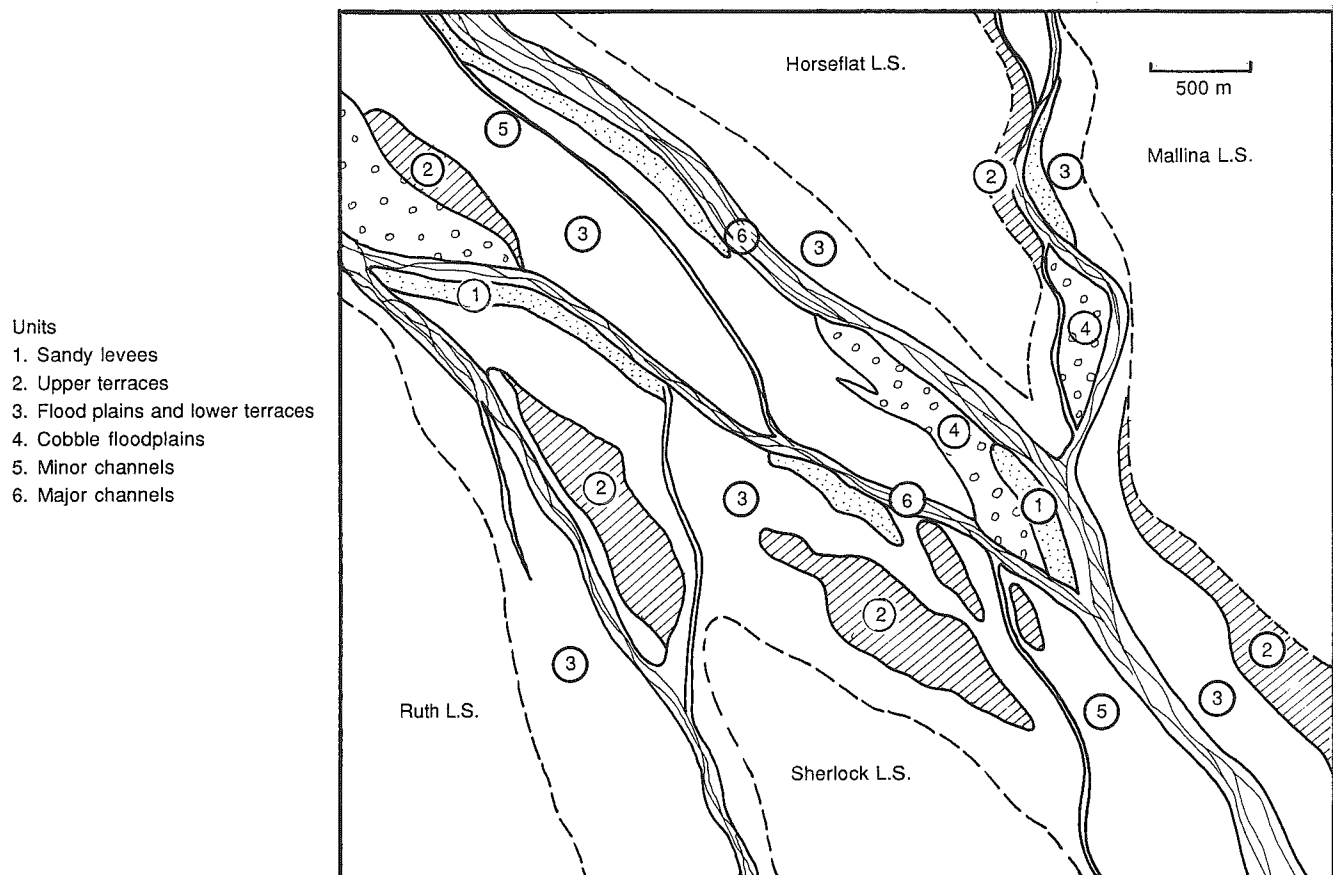
**Estimated carrying capacity:** 4-20 ha/sheep unit depending on range condition.

**Range condition summary (78 observations):** Good 81%; fair 18%; poor 1%.

Severely degraded and eroded: 0.5 km<sup>2</sup>

Degraded: 3.4 km<sup>2</sup>

Gullied: 2.0 km<sup>2</sup>



## River l.s.

Landform and soils	Vegetation : formations and major species				Comments
Narrow (generally < 200 m wide), ill defined sandy levees flanking units 2 and 3 and raised 1-2 m, moundy surfaces. Soils are red sands, principal profile form: Uc 1.23.	<b>Unit 1</b> Dense buffel grass and soft spinifex grasslands with prominent trees and shrubs, or open grassy woodlands. Trees: (4-10 m) <i>Eucalyptus camaldulensis</i> , <i>E. coolabah</i> , <i>Hakea suberea</i> . Tall shrubs: (> 2 m) <i>Acacia pyrifolia</i> . Low shrubs: (< 2 m) <i>Acacia pyrifolia</i> , <i>A. translucens</i> , <i>Dichrostachys spicata</i> . Perennial grasses: <i>Triodia pungens</i> , <i>Cenchrus ciliaris</i> .	<b>Sandy levees (10%)</b>	<b>1 site inventory and traversed</b>	Pasture type: <i>Soft Spinifex/Tussock Grass</i> (buffel grass). Pastoral use limitations: None under controlled stocking.	
Flat, upper terraces marginally higher (1-2 m) than unit 3, up to 500 m wide, mantle absent or sparse to moderate water worn pebbles and cobbles; soils are reddish brown or red loams or loams over sandy clays; principal profile form: Gn 2.13.	<b>Unit 2</b> Sparse hummock grasslands frequently with no shrubs, occasionally with very scattered trees and shrubs. (Tree and shrub PFC 0-5%). Trees: (2-6 m) <i>Hakea suberea</i> , <i>Acacia inaequilatera</i> . Tall shrubs: (< 2 m) <i>Acacia pyrifolia</i> . Low shrubs: (< 2 m) <i>Acacia inaequilatera</i> , <i>A. pyrifolia</i> , <i>A. bivenosa</i> , <i>Ipomoea costata</i> , <i>Grevillea pyramidalis</i> . Perennial grasses: <i>Triodia</i> sp. (hard), <i>T. pungens</i> , <i>Chrysopogon fallax</i> , <i>Themeda australis</i> , <i>Eragrostis xerophila</i> , <i>Cenchrus ciliaris</i> .	<b>Upper terraces (15%)</b>	<b>2 site inventories and traversed</b>	Pasture type: <i>Hard Spinifex/Soft Spinifex</i> . Pastoral use limitations: Subject to occasional flooding.	
Almost flat floodplains and terraces flanking single and multiple channels of the major rivers, commonly 300-800 m wide but up to 2 km in lower reaches, microrrelief often moundy. Soils are red or dark red sands or loams 50 cm to > 1 m deep with alkaline reaction trend; principal profile forms: Uc 1.43, 5.11, Gn 2.13, Gc 1.2.	<b>Unit 3</b> Dense soft spinifex ( <i>Triodia pungens</i> ) hummock grasslands or buffel grass ( <i>Cenchrus ciliaris</i> ) tussock grasslands often with numerous trees and shrubs. (Tree and shrub PFC 10-15%). Trees: (4-6 m) <i>Hakea suberea</i> , <i>Eucalyptus coolabah</i> . Tall shrubs: (> 2 m) <i>Acacia pyrifolia</i> . Low shrubs: (< 2 m) <i>Acacia pyrifolia</i> , <i>A. farnesiana</i> , <i>A. trachycarpa</i> , <i>Solanum lasiophyllum</i> . Perennial grasses: <i>Triodia pungens</i> , <i>Cenchrus ciliaris</i> , <i>Chrysopogon fallax</i> , <i>Aristida browniana</i> , <i>Eragrostis eriopoda</i> , <i>Eulalia fulva</i> .	<b>Flood plains and lower terraces (50%)</b>	<b>4 site inventories and traversed</b>	Pasture type: <i>Soft Spinifex/Tussock Grass</i> (buffel grass). Pastoral use limitations: Generally stable but susceptible to erosion if vegetative cover is removed, subject to episodic flooding.	



Landform and soils	Vegetation : formations and major species	Comments
Active flood areas (up to 500 m wide) over old cobble beds between minor and major channels, uneven surfaces with heavy deposits of waterworn pebbles, cobbles and rocks. Soils are shallow dark red sands over cobbles; principal profile form Uc 1.13.	<p><b>Unit 4 Cobble floodplains (10%) 1 site inventory and traversed</b></p> <p>River gum (<i>Eucalyptus camaldulensis</i>) woodlands with scattered shrubs and perennial grasses. Trees: (6-10 m) <i>Eucalyptus camaldulensis</i>. Tall shrubs: (&gt; 2 m) <i>Acacia trachycarpa</i>, <i>A. pyrifolia</i>. Low shrubs: (&lt; 2 m) <i>Acacia trachycarpa</i>, <i>A. pyrifolia</i>, <i>Grevillea pyramidalis</i>, <i>Corchorus</i> aff. <i>walcottii</i>, <i>Aerva javanica</i>. Perennial grasses: <i>Eriachne obtusa</i>, <i>Triodia pungens</i>, <i>T. sp</i> (hard), <i>Cenchrus ciliaris</i>, <i>Eragrostis eriopoda</i>, <i>Chrysopogon fallax</i>.</p>	Pasture type: <i>Tussock Grass</i> . Pastoral use limitations: Subject to regular flooding.
Channels 30-300 m wide between sandy banks 1-5 m above channel beds, bedloads of sand, gravel, pebbles, cobbles and rocks, soils on banks are sands and sandy loams.	<p><b>Units 5 &amp; 6 Minor and major channels (15%) Traversed</b></p> <p>Channels — no vegetation. Banks — dense fringing woodlands of river gum (<i>Eucalyptus camaldulensis</i>) or cadjeput (<i>Melaleuca leucadendron</i>) with sparse understorey of shrubs and grasses. Trees: (6-15 m) <i>Eucalyptus camaldulensis</i>, <i>Melaleuca leucadendron</i>, <i>Sesbania formosa</i>, <i>Acacia corticea</i>. Tall shrubs: (2-4 m) <i>Melaleuca glomerata</i>. Perennial grasses and sedges: <i>Cenchrus ciliaris</i>, <i>Triodia pungens</i>, <i>T. sp</i> (hard) <i>Cyperus vaginatus</i>, <i>Schoenoplectus littoralis</i>.</p>	Pasture type: <i>Tussock Grass</i> on banks. Pastoral use limitations: Subject to regular flooding.



River channel with bed load of cobbles and pebbles; the eroded streambank in the middle distance is partly stabilized by buffel grass.

## Robe land system (A) 1 km<sup>2</sup> (.01% of survey area)

Small mesas, buttes and restricted stony plains of limonite with hard spinifex grasslands. Very minor occurrences.

**Geology:** Tertiary pisolitic limonite and laterite.

**Geomorphology:** Small remnants of old Tertiary surfaces consisting of mesas and buttes, restricted gravelly lower slopes and plains. Relief is up to 40 m.

**Pastoral use:** Hard Spinifex pastures (95%) with very low carrying capacity and drought durability. All units are stable under use.

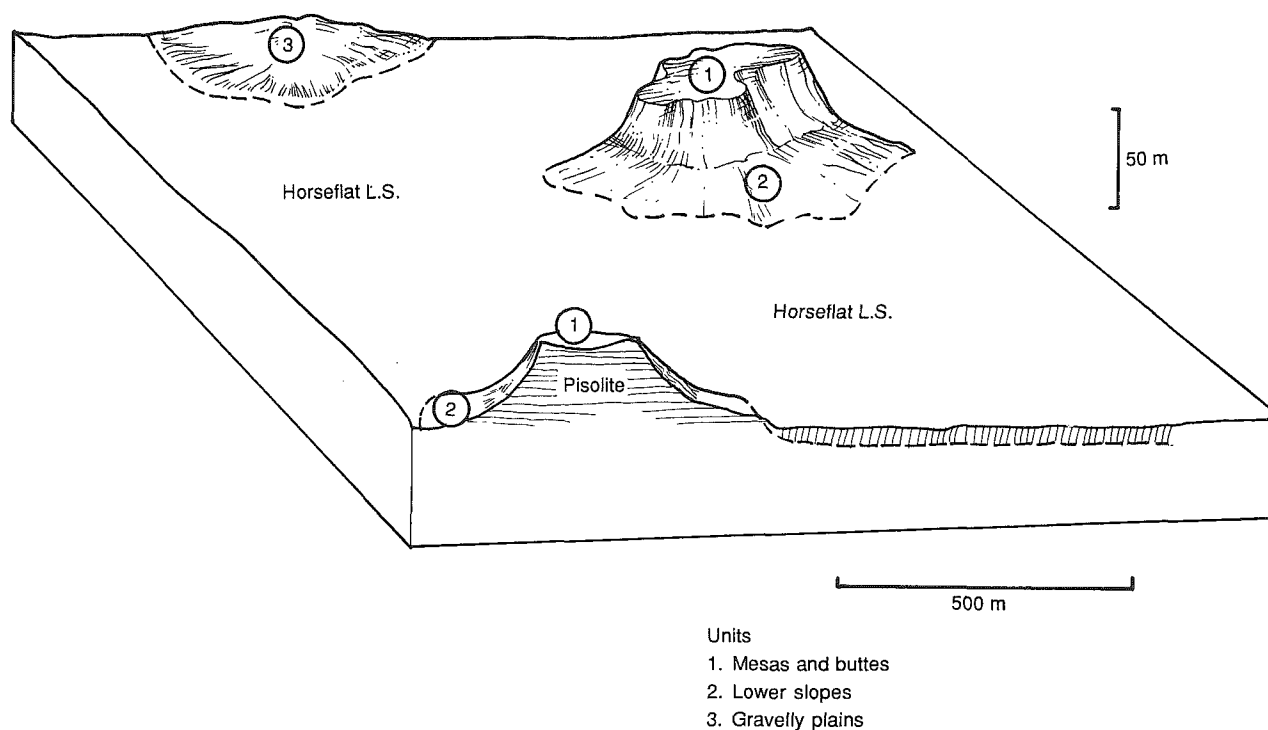
**Estimated carrying capacity:** 20-40 ha/sheep unit depending on range condition.

**Range condition summary** – Not traversed.

Severely degraded and eroded: Nil

Degraded: Nil

Gullied: Nil



Landform and soils	Vegetation : formations and major species	Comments
Small mesas, buttes and upper slopes up to 1 km in extent and up to 40 m high, near vertical breakaway faces up to 10 m, outcrops of limonite and short gravel strewn slopes up to 45%; little soil development.	<b>Unit 1 Mesas and buttes (80%)</b> Probably sparse hard spinifex ( <i>Triodia wiseana?</i> ) grasslands with very scattered shrubs.	Pasture type: <i>Hard Spinifex</i> .
Slopes up to 3% and rarely extending more than 200 m below upper slopes, dense laterite and pisolite mantles; soils are probably variable depth red brown loams over clays.	<b>Unit 2 Lower slopes (10%)</b> Hard spinifex grasslands with occasional shrubs.	Pasture type: <i>Hard Spinifex</i> .
Very gently sloping or rounded plains up to 1 km in extent, may occur as isolates without units 1 and 2, dense gravelly lateritic mantles; soils are probably variable depth red brown loams over clays.	<b>Unit 3 Gravelly plains (10%)</b> Hard spinifex grasslands with occasional shrubs.	Pasture type: <i>Hard Spinifex</i> .

## Rocklea land system (A) 1351 km<sup>2</sup> (13.2% of survey area)

Rugged basalt hills and plateau remnants with hard spinifex grasslands.

**Geology:** Lower Proterozoic age basalt and dolerite, minor Archaean basic rocks.

**Geomorphology:** Extensive basalt hills, ridges and plateau remnants with steep stony slopes, restricted lower slopes and stony interfluvies. Narrow valleys and minor gilgai plains and narrow drainage floors with moderately dense to dense rectangular patterns of incised drainage are often present. Relief is up to 100 m.

**Pastoral use:** Poorly accessible Hard Spinifex pasture (95%) of very low to negligible pastoral value. Some patches of moderate quality Soft Spinifex pasture (5%). Little erosion hazard.

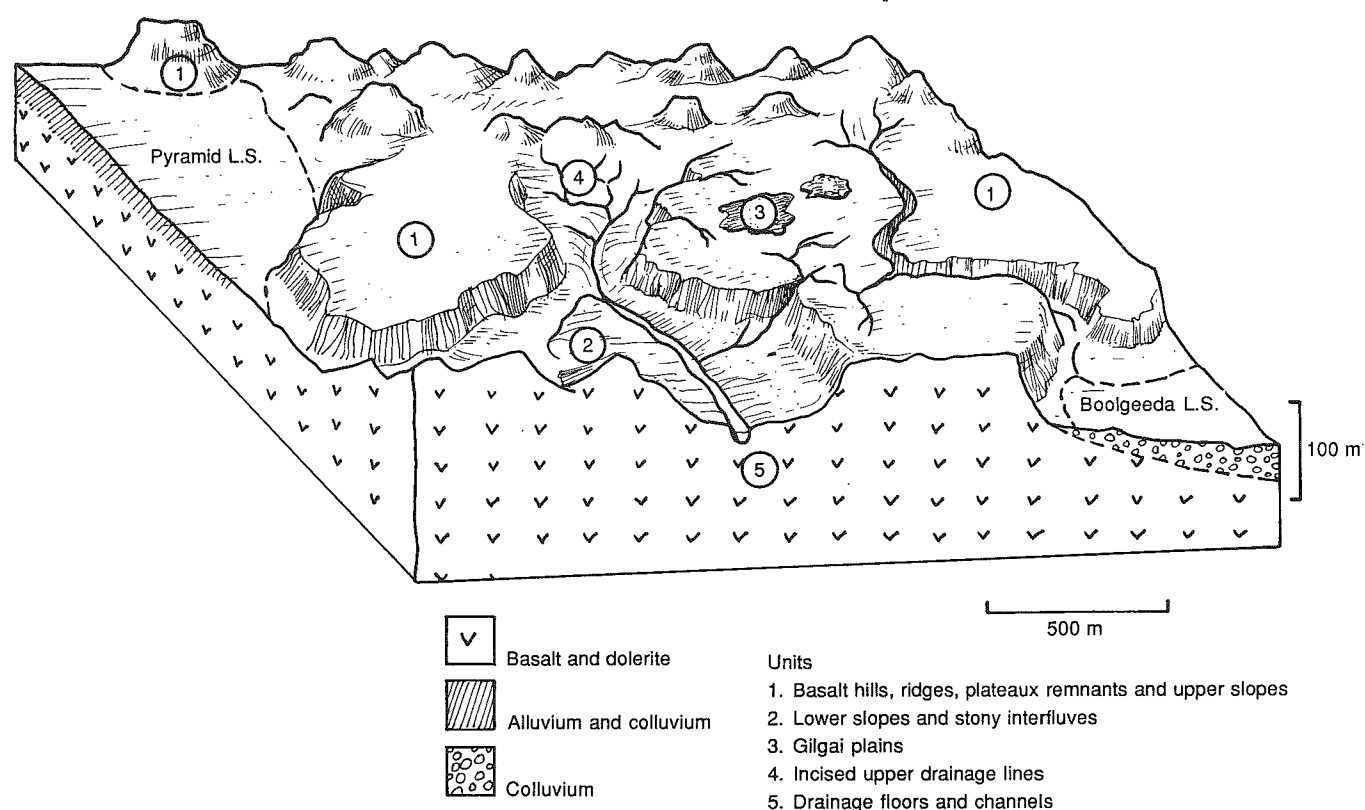
**Estimated carrying capacity:** 40 ha/sheep unit.

**Range condition summary (9 observations):** Good 78%; fair 22%; poor 0%.

Severely degraded and eroded: Nil

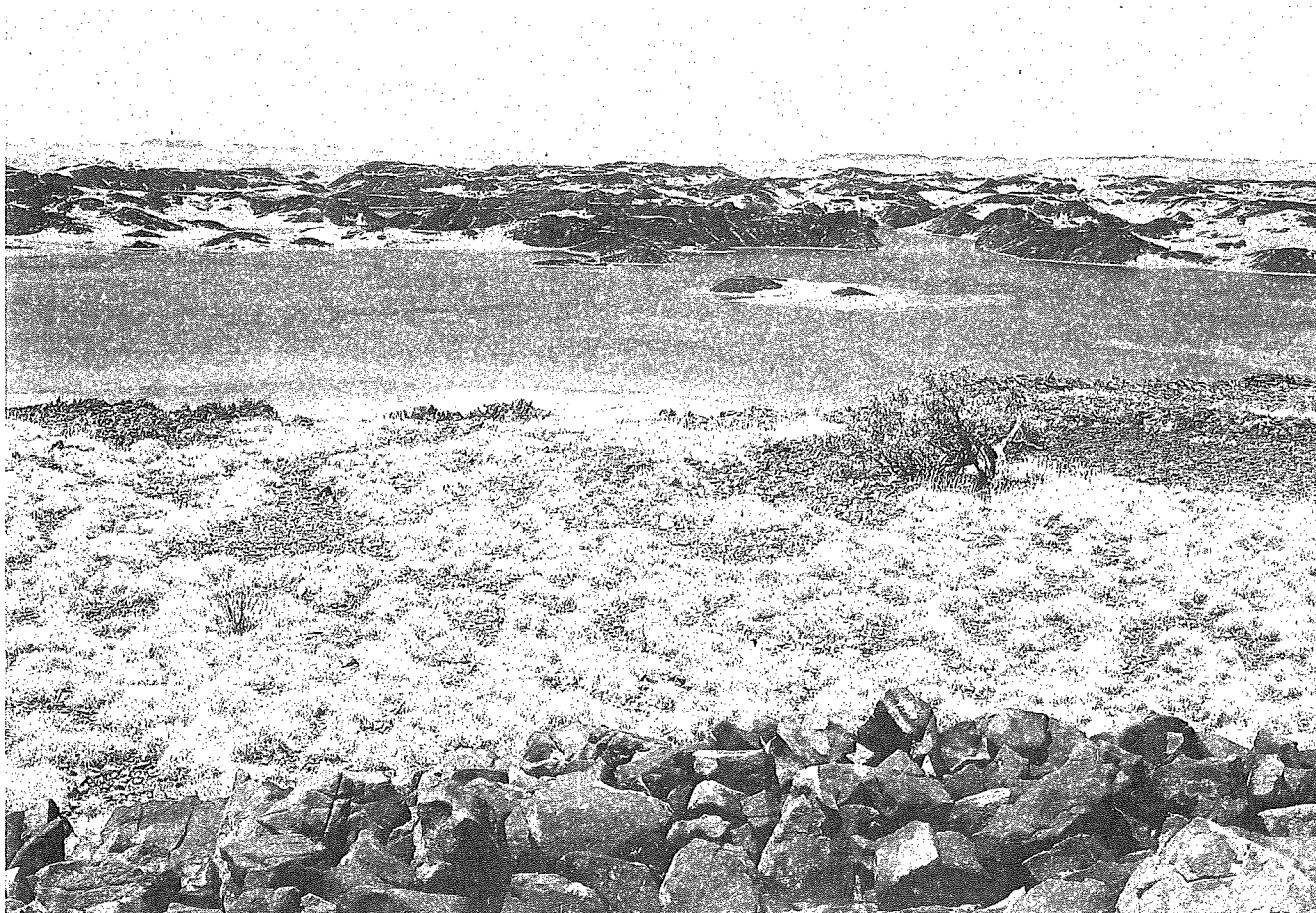
Degraded: 0.2 km<sup>2</sup>

Gullied: 0.1 km<sup>2</sup>



# Rocklea I.s.

Landform and soils	Vegetation : formations and major species	Comments
Extensive hill tracts and highly dissected plateaux remnants up to 100 m high, rounded and flat crests, convex and benched upper slopes up to 70%, dense mantles and outcrops of basalt boulders and stones. Pockets of stony skeletal clays; principal profile forms Uf 1.23, 6.12.	<p><b>Unit 1 Basalt hills, ridges, plateaux remnants and upper slopes (75%)</b> Hard spinifex grasslands with very scattered shrubs and occasional trees (PFC &lt; 2.5-10%). Trees: (2-6 m) <i>Terminalia canescens</i>, <i>Brachychiton</i> sp. Shrubs: (0.5-2 m) <i>Acacia pyrifolia</i>, A. sp., <i>Cassia glutinosa</i>, <i>Tribulus platypterus</i>, <i>Gossypium australe</i>. Perennial grasses: <i>Triodia wiseana</i>, <i>T. pungens</i>, <i>Cymbopogon</i> sp.</p>	<b>2 site inventories and traversed</b> Pasture type: Predominantly <i>Hard Spinifex</i> but occasionally <i>Soft Spinifex</i> . Pastoral use limitations: Very poor quality pastures and poor accessibility.
Concave slopes up to 8% extending up to 1 km downslope from unit 1 to form interflaves up to 5 m high and 400 m wide, dense colluvial mantles of basalt pebbles and rocks. Soils are probably shallow red loams and clays.	<p><b>Unit 2 Lower slopes and stony interflaves (15%)</b> <b>Traversed</b> Hard spinifex grasslands with very scattered shrubs similar to unit 1 but without <i>Terminalia</i> or <i>Brachychiton</i> sp.</p>	Pasture type: <i>Hard Spinifex</i> . Pastoral use limitations: Very poor quality pastures.
Almost flat to gently sloping stony gilgai plains up to 500 m in extent associated with unit 4 or elevated on crests of plateaux remnants. Soils are probably cracking clays, principal profile form: Ug 6.3.	<p><b>Unit 3 Gilgai plains (2%)</b> Probably patchy hard spinifex (<i>Triodia wiseana</i>) grasslands with scattered tussock grasses <i>Eragrostis xerophila</i> and numerous forbs and annual grasses in season.</p>	Pasture type: <i>Hard Spinifex/Tussock Grass</i> .
Narrow headwater valleys with branching channels up to 15 m wide incised up to 5 m, stony marginal slopes up to 10% adjacent to channels. Soils are probably shallow, red stony loams and clays; channels incised in parent material with bedloads of gravel, pebbles and cobbles.	<p><b>Unit 4 Incised upper drainage lines (3%)</b> Hard spinifex (<i>Triodia wiseana</i>) hummock grasslands with scattered shrubs, various <i>Acacia</i> spp. and occasional trees of <i>Eucalyptus dichromophloia</i>.</p>	Pasture type: <i>Hard Spinifex</i> .
Floors rarely more than 400 m wide, slopes 0.5% or less, central tracts with braided channels or single channels up to 50 m wide. Soils are probably red or reddish brown loams and clays of variable depth, channels with mixed bedloads.	<p><b>Unit 5 Drainage floors and channels (5%)</b> Hard spinifex with <i>Acacia</i> spp. shrubs and occasional trees of <i>Eucalyptus dichromophloia</i> shrubs becoming denser along creeklines.</p>	Pasture type: <i>Hard Spinifex</i> .



Harding River dam with black basaltic low hills of the Rocklea land system and hard spinifex hummock grasses, mostly unsuitable for pastoral use.

## Ruth land system 1350 km<sup>2</sup> (13.2% of survey area)

Rocky hills and ridges with hard spinifex (occasionally soft spinifex) grasslands.

**Geology:** Archaean and Proterozoic intermediate and basic volcanic rocks, also quartz; minor chert, jaspilite, shale and siltstone.

**Geomorphology:** Rounded hills and ridges with restricted lower slopes and stony interfluves. Drainage patterns are dendritic with narrow drainage floors and channels. Relief is 20-80 m.

**Pastoral use:** Predominantly Hard Spinifex pastures (85%) of very low pastoral value. Some patches of Soft Spinifex pasture (15%) of moderate value. Very low erosion hazard.

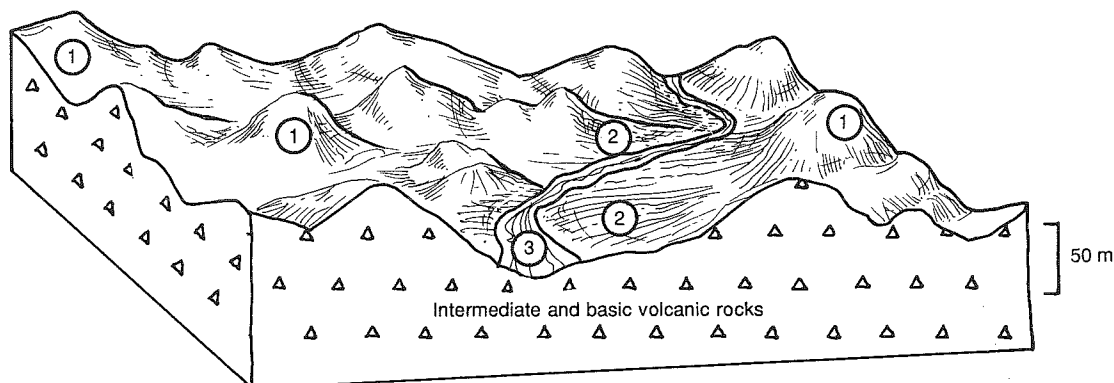
**Estimated carrying capacity:** 20-40 ha/sheep unit depending on range condition.

**Range condition summary (56 observations):** Good 89%; fair 11%; poor 0%.

Severely degraded and eroded: Nil

Degraded: 0.1 km<sup>2</sup>

Gullied: Nil



### Units

1. Hills, ridges and upper slopes
2. Lower slopes
3. Narrow drainage floors, creeklines and channels



Ruth I.s.

Landform and soils	Vegetation : formations and major species	Comments
<p>Extensive hills and ridges with 20-80 m relief, rounded crests and summits, convex and concave slopes up to 50%, dense stony mantles and rock outcrops; pockets of stony skeletal clays, principal profile form: Uf 6.12.</p>	<p><b>Unit 1 Hills, ridges and upper slopes (80%) 1 site inventory and traversed</b>  Hard spinifex hummock grasslands (occasionally soft spinifex) with very scattered shrubs. Tall shrubs: (&gt; 2 m) <i>Acacia pyrifolia</i>, <i>A. orthocarpa</i>. Low shrubs: (&lt; 2 m) <i>Acacia pyrifolia</i>, <i>Cassia glutinosa</i>, <i>Indigofera</i> sp. <i>Tribulus platypterus</i>. Perennial grasses: <i>Triodia wiseana</i>(?), <i>T. pungens</i>.</p>	<p>Pasture type: <i>Hard Spinifex</i>.  Pastoral use limitations: Very poor quality pastures.</p>
<p>Slopes (1-5%) and restricted stony plains extending up to 500 m below unit 1, dense surface mantles of pebbles and stones. Soils are probably shallow reddish brown sandy clays and sandy clay loams.</p>	<p><b>Unit 2 Lower slopes (15%) Traversed</b>  Hard spinifex hummock grasslands (occasionally soft spinifex) with very scattered shrubs. Tall shrubs: (&gt; 2 m) <i>Acacia pyrifolia</i>, <i>A. orthocarpa</i>. Low shrubs: (&lt; 2 m) <i>Acacia pyrifolia</i>, <i>Cassia glutinosa</i>, <i>Indigofera</i> sp. <i>Tribulus platypterus</i>. Perennial grasses: <i>Triodia wiseana</i>(?), <i>T. pungens</i>.</p>	<p>Pasture type: <i>Hard Spinifex</i>.  Pastoral use limitations: Very poor quality pastures.</p>
<p>Very small drainage floors, (generally &lt; 100 m wide) creeklines and channels in valleys between hills and footslopes; shallow clayey soils with dense stony mantles, principal profile form: Uf 1.23; channels incised in bedrock with bedloads of gravel, pebbles and cobbles.</p>	<p><b>Unit 3 Narrow drainage floors, creeklines and channels (5%) 1 site inventory and traversed</b>  Hummock grasslands of hard and soft spinifex with numerous shrubs and occasional trees. Trees: (4-6 m) <i>Eucalyptus dichromophloia</i>. Tall shrubs: (&gt; 2 m) <i>Acacia pyrifolia</i>, <i>A. bivenosa</i>, <i>A. tumida</i>. Low shrubs: (&lt; 2 m) <i>Acacia pyrifolia</i>, <i>A. bivenosa</i>, <i>Corchorus walcottii</i>, <i>C. sp.</i>, <i>Cassia</i> sp., <i>Indigofera</i> sp., <i>Trichodesma zeylanicum</i>, <i>Rhynchosia</i> sp. Perennial grasses: <i>Triodia wiseana</i>(?), <i>T. pungens</i>, <i>Themeda</i> sp., <i>Cymbopogon</i> sp., <i>Cenchrus ciliaris</i>.</p>	<p>Pasture type: <i>Hard Spinifex/Soft Spinifex</i>.</p>

## Satirist land system 49 km<sup>2</sup> (0.5% of survey area)

Stony plains and low rises with hard spinifex shrubby grasslands and gilgai plains with soft spinifex and tussock grasslands.

**Geology:** Quaternary alluvium and colluvium, clay, gravel and pebble deposits.

**Geomorphology:** Level to very gently inclined stony plains with gilgai plains, low rises and drainage flats. Relief is up to 8 m.

**Pastoral use:** Predominantly Hard Spinifex pastures (65%) of very low pastoral value but some inclusions of better quality Tussock Grass (10%) and Soft Spinifex (25%) pastures with moderate to good drought durability. Low erosion risk.

**Estimated carrying capacity:** 15-30 ha/sheep unit depending on burning history and range condition.

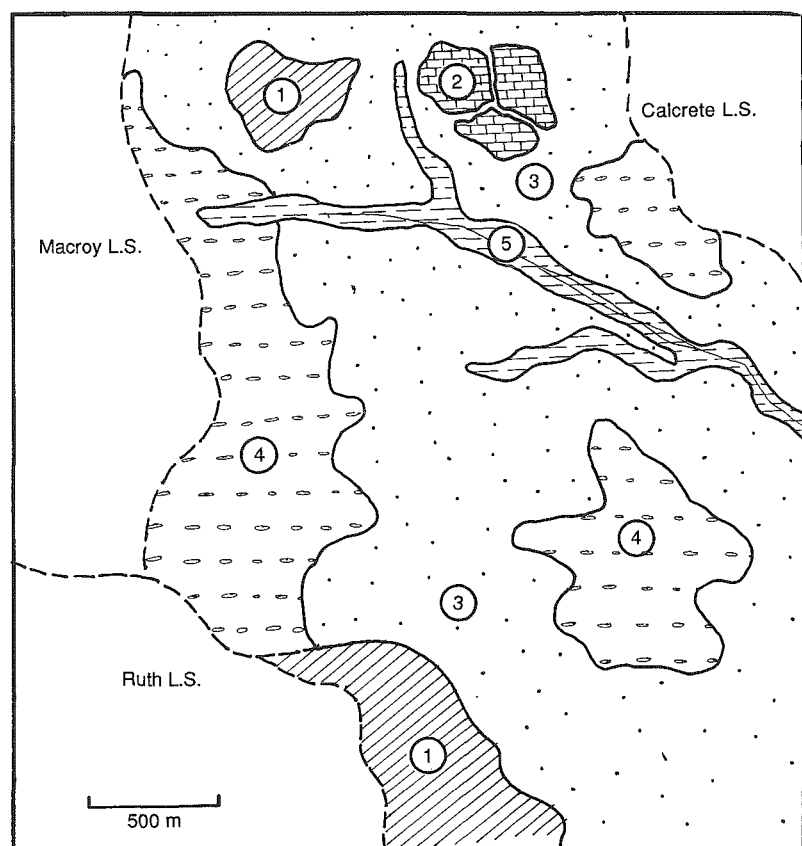
**Range condition summary (13 observations):** Good 92%; fair 8%; poor 0%.

Severely degraded and eroded: Nil

Degraded: Nil

Gullied: 0.2 km<sup>2</sup>

- Units
1. Low rises and upper plains
  2. Calcrete plains
  3. Stony plains
  4. Gilgai plains
  5. Drainage tracts and minor channels



Satirist I.s.

Landform and soils	Vegetation : formations and major species		Comments
Gently sloping rises (up to 3%) and rounded upper plains and interfluvies extending up to 1 km and elevated up to 8 m above other units, dense surface mantles of mixed gravels, pebbles and rocks. Soils are dark yellowish brown alkaline sandy clay loams over clay loams of variable depth, principal profile form: Um 6.	<b>Unit 1</b>	<b>Low rises and upper plains (15%)</b> Hard spinifex hummock grasslands with occasional shrubs. Tall shrubs: (> 2 m) <i>Acacia pyrifolia</i> . Low shrubs: (< 2 m) <i>Acacia pyrifolia</i> , <i>A. bivenosa</i> . Perennial grasses: <i>Triodia</i> sp. (hard).	Pasture type: <i>Hard Spinifex</i> . Pastoral use limitations: Very low pastoral value.
Plains 200-300 m in extent raised up to 3 m above units 3 and 4, gently rounded margins, calcrete outcrop or dense surface mantles of calcrete gravel. Soils are probably shallow calcareous loams.	<b>Unit 2</b>	<b>Calcrete plains (5%)</b> Hard spinifex ( <i>Triodia wiseana</i> ) hummock grasslands with very scattered trees and shrubs.	Pasture type: <i>Hard Spinifex</i> . Pastoral use limitations: Very poor quality pastures.
Almost flat to gently sloping (up to 1%) stony plains extending for up to 2 km, patches of stony gilgais up to 200 m in extent between non-gilgaied surfaces, dense surface mantles of pebbles and cobbles. Soils are probably red clays.	<b>Unit 3</b>	<b>Stony plains (50%) Traversed</b> Mixed hard and soft spinifex hummock grasslands with very scattered shrubs and some tussock grasses in gilgais. Shrubs: <i>Acacia pyrifolia</i> , <i>A. inaequilatera</i> . Perennial grasses: <i>Triodia</i> sp. (hard), <i>T. pungens</i> , <i>Eragrostis xerophila</i> .	Pasture type: <i>Hard Spinifex/Soft Spinifex</i> . Pastoral use limitations: Regular burning required to maintain pasture in attractive condition for livestock.
Almost flat, weakly gilgaied plains up to 500 m in extent, sparse surface mantles; soils are cracking clays; principal profile form: Ug 6.3.	<b>Unit 4</b>	<b>Gilgai plains (25%)</b> <b>1 site inventory and traversed</b> Tussock grasslands with very scattered shrubs. Shrubs: (< 2 m) <i>Acacia farnesiana</i> , <i>A. victoriae</i> , <i>Cassia oligophylla</i> . Perennial grasses: <i>Cenchrus setigerus</i> , <i>C. ciliaris</i> , <i>Triodia pungens</i> .	Pasture type: <i>Tussock Grass and Soft Spinifex</i> . Pastoral use limitations: None under controlled stocking.
Narrow (up to 200 m wide) linear drainage tracts through units 1, 2 & 3 with very little incision except in upper parts, occasional minor channels. Soils are probably red sandy clay loams; channel bedloads of sand and pebbles.	<b>Unit 5</b>	<b>Drainage tracts and minor channels (5%)</b> <b>Traversed</b> Soft spinifex ( <i>Triodia pungens</i> ) hummock grasslands with scattered shrubs such as <i>Acacia pyrifolia</i> , <i>A. bivenosa</i> , <i>A. ancistrocarpa</i> , <i>A. acradenia</i> , <i>A. tumida</i> , <i>Hakea pyramidalis</i> and occasional trees <i>Eucalyptus dichromophloia</i> . Larger channels may have fringes with <i>Eucalyptus coolabah</i>	Pasture type: <i>Soft Spinifex</i> . Pastoral use limitations: None under controlled stocking, regular burning required to maintain pasture in attractive condition for livestock.

## Sherlock land system 185 km<sup>2</sup> (1.8% of survey area)

Stony alluvial plains with snakewood shrublands, spinifex and tussock grasslands.

**Geology:** Quaternary alluvium.

**Geomorphology:** Almost level stony alluvial plains with some gilgai development; through going trunk drainage.

**Pastoral use:** Snakewood communities contain Stony Chenopod pastures (20%) which are extensively degraded and includes death of snakewood. Hard Spinifex pastures (40%) of low pastoral value, Soft Spinifex pastures (25%) of moderate pastoral value and Roebourne Plains Tussock Grass pastures (15%) of high pastoral value with moderate drought durability are also present. Some pasture decline is evident in the plains grass communities. Some gully and sheet erosion is present.

**Estimated carrying capacity:** 10-25 ha/sheep unit depending on range condition.

**Range condition summary (46 observations):** Good 22%; fair 37%; poor 41%.

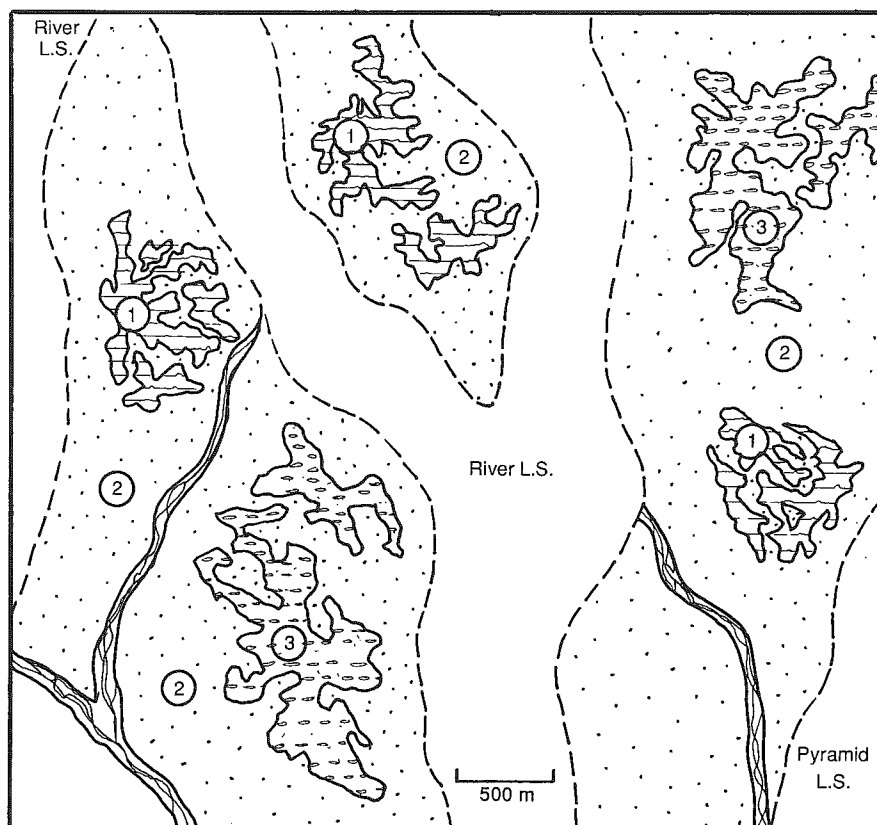
Severely degraded and eroded: Nil

Degraded: 9 km<sup>2</sup>

Gullied: 1 km<sup>2</sup>

### Units

1. Stony plains with spinifex
2. Stony plains with snakewood
3. Gilgai plains
4. Drainage lines



Sherlock I.s.

Landform and soils	Vegetation : formations and major species		Comments
Very gently sloping stony plains slightly above unit 2, dense stony mantles with gilgai patches 10-100 m in extent between non-gilgai surfaces; soils are red clays and cracking clays, principal profile forms: Uf 6.12, Ug 6.3.	<b>Unit 1</b>	<b>Stony plains with spinifex (12%)</b> Non-gilgai areas—hummock grasslands of hard spinifex ( <i>Triodia wiseana?</i> ), no shrubs. Gilgai areas—annual grasslands and herb fields with very scattered tussocks of <i>Eragrostis xerophila</i> , no shrubs.	Pasture type: <i>Hard Spinifex</i> .
Almost flat stony plains with gilgai patches 5-50 m in extent between non-gilgai surfaces, dense stony mantles; soils are red clays or cracking clays principal profile forms: Uf 5.12, 6.12, Ug 6.3.	<b>Unit 2</b>	<b>Stony plains with snakewood (70%)</b> Pachy tall shrublands of snakewood ( <i>Acacia xiphophylla</i> ) with under-shrubs, patchy spinifex and sparse tussock grasses. (P.F.C. < 2.5-20%). Tall shrubs: (> 2 m) <i>Acacia xiphophylla</i> . Low shrubs: (> 2 m) <i>Acacia xiphophylla</i> , <i>A. pyrifolia</i> , <i>Enchylaena tomentosa</i> , <i>Cassia hamersleyensis</i> , <i>C. luerksenii</i> , <i>Sclerolaena hostilis</i> , <i>Pluchea</i> sp. Perennial grasses: <i>Eragrostis xerophila</i> , <i>Triodia pungens</i> , <i>Enteropogon actularis</i> , <i>Cenchrus ciliaris</i> .	Pasture type: <i>Stony Chenopod/Soft Spinifex/Hard Spinifex</i> . Pastoral use limitations: Stony Chenopod pastures easily degraded, controlled stocking is essential.
Almost flat plains 100-400 m in extent, slightly lower than unit 2, gilgai micro-relief with moderate to dense surface mantles of pebbles and stones; soils are probably red cracking clays > 1 m deep, principal profile form: Ug 6.3.	<b>Unit 3</b>	<b>Gilgai plains (15%) Traversed</b> Tussock grasslands of variable density of Roebourne Plains grass ( <i>Eragrostis xerophila</i> ) with occasional patches of other perennial grasses such as <i>Eriachne benthamii</i> and <i>Panicum decompositum</i> .	Pasture type: <i>Tussock Grass</i> . Pastoral use limitations: None under controlled stocking.
Occasional, narrow (up to 100 m wide) linear drainage zones a few metres lower than, and running through, units 2 & 3, with or without channels.	<b>Unit 4</b>	<b>Drainage lines (3%) Traversed</b> Soft spinifex ( <i>Triodia pungens</i> ) grasslands with scattered trees and shrubs such as <i>Eucalyptus coolabah</i> , <i>Hakea suberea</i> , <i>Acacia pyrifolia</i> , <i>A. trachycarpa</i> .	Pasture type: <i>Soft Spinifex</i> .

## Uaroo land system (A) 785 km<sup>2</sup> (7.7% of survey area)

Broad sandy surfaced plains with hard and soft spinifex grasslands.

**Geology:** Quaternary alluvium.

**Geomorphology:** Level or very gently inclined sandy surfaced plains up to 10 km in extent with little organized through drainage. Pebbly surfaced plains, plains with calcrete at very shallow depth, broad mostly unchannelled tracts receiving more concentrated sheet flow, minor low stony hills and rises are also present. Relief is mostly < 5 m, but isolated hills up to 30 m high occur.

**Pastoral use:** Mostly Hard Spinifex pastures (65%) of very low productivity. Some useful Soft Spinifex pastures (35%) of moderate productivity and good durability are also present. Summer burning followed by a short deferment from grazing is required every four or five years. This system is generally not susceptible to erosion or significant pasture degradation, however, there is some risk of wind erosion following burning.

**Estimated carrying capacity:** 15-30 ha/sheep unit depending on burning history and range condition.

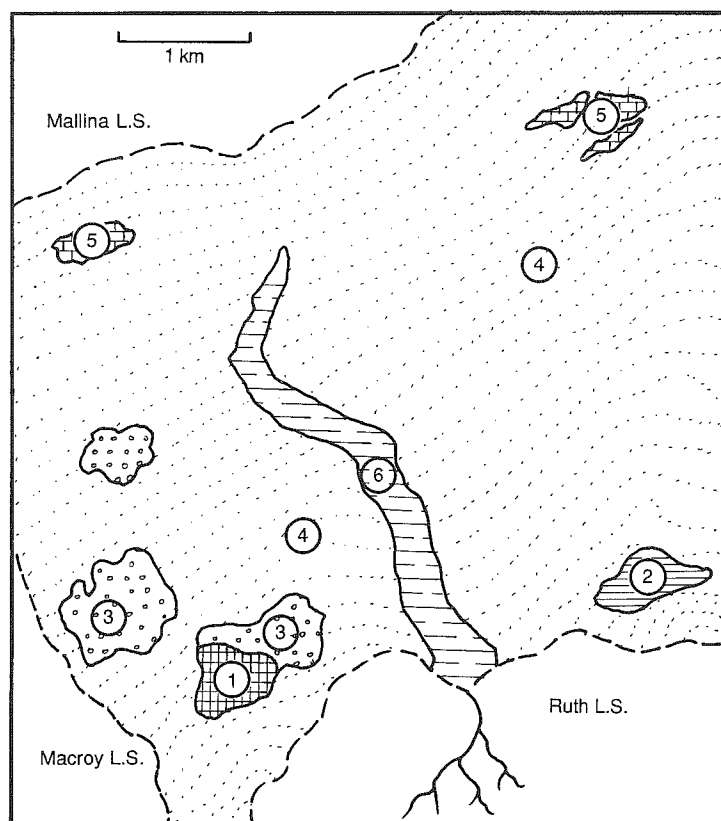
**Range condition summary (65 observations):** Good 100%; fair 0%; poor 0%.

Severely degraded and eroded: Nil

Degraded: Nil

Gullied: Nil

- Units
1. Low hills
  2. Low stony rises
  3. Pebbly plains
  4. Sandy plains
  5. Calcrete plains
  6. Tracts receiving sheet flow



# Uaroo ls.

Landform and soils	Vegetation : formations and major species		Comments
Isolated hills and ridges up to 1 km long and up to 30 m above surrounding plains, steep footslopes with dense stony mantles and rock outcrop, little soil development.	<b>Unit 1</b>	<b>Low hills (&lt; 1%)</b> Hard spinifex grasslands with scattered <i>Acacia</i> spp. shrubs.	Pasture type: <i>Hard Spinifex</i> .
	<b>Unit 2</b>	<b>Low stony rises (2%)</b> <b>Traversed</b> Hard or soft spinifex grasslands with scattered <i>Acacia</i> spp. shrubs.	Pasture type: <i>Hard Spinifex/Soft Spinifex</i> .
Raised surfaces up to 2 km in extent, sloping up to 2%, dense stony mantles and frequent rock outcrop, relief up to 15 m; soils are probably reddish brown sands and loams on parent material at variable depth.	<b>Unit 3</b>	<b>Pebbly plains (10%)</b> <b>Traversed</b> Hummock grasslands of hard and soft spinifex with scattered shrubs. Tall shrubs: (> 2 m) <i>Acacia pyrifolia</i> , <i>A. ancistrocarpa</i> , <i>Grevillea pyramidalis</i> . Low shrubs: (< 2 m) <i>A. pyrifolia</i> , <i>A. translucens</i> , <i>A. bivenosa</i> , <i>Corchorus walcottii</i> . Perennial grasses: <i>Triodia</i> sp. (hard), <i>T. pungens</i> .	Pasture type: <i>Hard Spinifex/Soft Spinifex</i> . Pastoral use limitations: Mostly poor quality pastures, appropriate burning management can improve value for grazing.
Plains up to 3 km in extent, marginal to or as patches within unit 4, slopes up to 1%, dense mantles of gravel and pebbles; soils are probably stony duplex types e.g. dark reddish brown sand and sandy loam surface horizons merging to sandy clay.	<b>Unit 4</b>	<b>Sandy plains (70%)</b> <b>3 site inventories and traversed</b> Hummock grasslands of soft and hard spinifex with very scattered to scattered shrubs and trees (PFC < 2.5-20%). Trees: (2-6 m) <i>Eucalyptus dichromophloia</i> , <i>E. af. aspera</i> , <i>E. setosa</i> , <i>Hakea suberea</i> , <i>Grevillea pyramidalis</i> . Tall shrubs: (> 2 m) <i>Acacia inaequilatera</i> , <i>A. pyrifolia</i> , <i>A. ancistrocarpa</i> . Low shrubs: (< 2 m) <i>Acacia pyrifolia</i> , <i>A. bivenosa</i> , <i>A. ancistrocarpa</i> , <i>A. holosericea</i> , <i>A. translucens</i> , <i>A. acradentia</i> , <i>Carissa lanceolata</i> , <i>Cassia notabilis</i> , <i>Corchorus walcottii</i> , <i>Psoralea lachnostachys</i> . Perennial grasses: <i>Triodia pungens</i> , <i>T. spp.</i> (hard), <i>Chrysopogon fallax</i> , <i>Aristida</i> sp.	Pasture type: <i>Soft Spinifex/Hard Spinifex</i> . Pastoral use limitations: None under controlled stocking; regular burning required to maintain pastures in attractive condition for livestock.
Almost flat sandy surfaced plains often extending several kilometres, micro-relief sometimes mounded, no surface mantles; soils are red duplex and gradational types e.g. red sands/sandy loams over sandy clay loams or sandy clays 60 cm to > 1 m deep, principal profile forms: Dr 2.12, 4.12, 4.52.			

Uaroo I.s. — Continued

Landform and soils	Vegetation : formations and major species	Comments
Restricted plains associated with and raised slightly above unit 4 and other units, slopes up to 1%, dense mantles of calcrete gravels and rock fragments; soils are probably shallow calcareous loams.	<p><b>Unit 5</b>    <b>Calcrete plains (5%)</b>    <b>Traversed</b></p> <p>Hard spinifex (<i>Triodia wisecana</i>) grasslands with very scattered shrubs.</p>	Pasture type: <i>Hard Spinifex</i> .
Tracts up to 3 km wide extending downslope through unit 4, slopes up to 1%, unchannelled or rarely with narrow braided creeklines, no surface mantles; soils are probably red duplex and gradational types.	<p><b>Unit 6</b>    <b>Tracts receiving sheet flow (12%)</b>    <b>Traversed</b></p> <p>Soft spinifex (<i>Triodia pungens</i>) grasslands with numerous shrubs and occasional trees as for unit 4. Also other perennial grasses such as <i>Chrysopogon fallax</i> and <i>Triodia</i> spp.</p>	<p>Pasture type: <i>Soft Spinifex</i>. Pastoral use limitations: Moderate susceptibility to water erosion.</p>



# Soils

The only existing soils map covering the whole of the survey area is sheet 6 of the Atlas of Australian soils (Bettenay *et al.* 1967) at a scale of 1:2,000,000. Maps published by Churchwood and McArthur (1982) and Dames and Moore (1980) cover parts of the survey area in greater detail.

Although no soil maps are presented in this report the land unit descriptions detail the distribution of the various soil types within the land systems mapped. The results of soil sample analyses are presented in Appendix 6.

Eleven major soil types were identified during the survey;

## **Stony skeletal clays (Uf1.23, Uf6.12)**

These soils are widely distributed throughout the study area and are the dominant soil type of the hill land systems. They are commonly red (2.5YR 4/6) clays, often < 50 cm deep, with stones comprising between 20 and 80% of the soil. The pH usually ranges between 6.5 and 7.5.

These soils support Hard and Soft Spinifex pastures and are not susceptible to erosion.

## **Stony skeletal sands (Uc1.23)**

These soils are found on the hill and stony plains land system. They are dark reddish brown or red (2.5YR 3/4, 2.5YR 4/6) sands and sandy loams < 50 cm deep. Stones comprise between 20 and 80% of the soil mass and the soils are slightly acidic (pH 6.0-6.5).

These soils support Hard and Soft Spinifex pastures and are not susceptible to erosion.

## **Shallow calcareous loams (Um1.13, Um5.11, Gn2.12).**

These soils are found on the calcrete platforms which dominate the Calcrete land system and occur as minor inclusions in a number of other land systems. They are commonly < 50 cm deep and calcrete fragments comprise between 20 and 80% of the soil. The soils are usually loams or sandy clay loams, sometimes grading into a sandy clay at depth. Weak polyhedral pedality is often present.

Soil colour ranges from dark red (2.5YR 3/6) to dark brown (7.5YR 3/4) and the soil is alkaline with pH ranging from 7.5 to 9.0.

These soils support Hard Spinifex pastures and are not highly susceptible to erosion under grazing.

## **Stony duplex soils (Dr4.13)**

These soils occur on stony plains and low rises, being most common on the Macroy and Satirist land systems. They can be found on isolated low stony rises on the plains land systems and on gentle slopes in the hill land systems.

They usually consist of 15-30 cm of sandy loam or sandy clay loam overlying a sandy clay. Stones and rock fragments (usually quartz, granitic or metasediments) are present throughout the profile and there is often a weak polyhedral pedality.

Soil colour is dark red (2.5YR 3/6) or reddish brown (5YR 5/4) and the pH ranges from 6.5 to 8.5, often increasing with depth.

These soils support Hard Spinifex pastures and are not highly susceptible to erosion under grazing.

## **Red duplex and gradational soils (Dr2.53, Dr4.13, Gn1.12, Gn2.12, Gn2.13, Gn4.12)**

These soils occur on alluvial plains and are most common on the Mallina and Uaroo land systems, with minor occurrences on the Horseflat and Cheerawarra land systems.

These soils are > 1 m deep and the texture usually ranges from a light sandy clay loam to a sandy clay and increases with depth. In some places there is a surface horizon of sand or sandy loam which is 5-30 cm deep.

Small stones (< 5 mm) are commonly present, but these usually comprise < 2% of the total soil volume.

The soil colour is dark reddish brown (2.5YR 3/4) or red (2.5YR 4/6) and the soil is slightly acidic to neutral on the surface (pH 6.5-7.0) becoming alkaline with depth (pH 7.5-8.0). Where the topsoil is loamy it usually has an earthy fabric.

The top 10 cm of these soils are usually salt free (< 400 mS/m EC<sub>e</sub>) and non sodic with an exchangeable sodium percentage (ESP) < 6. Although they usually remain so to a depth of 40 cm, salinity (up to 800 mS/m EC<sub>e</sub>) and sodicity (ESP up to 15) can increase down the profile. Sodicity and salinity in the subsoil vary greatly between profiles.

These soils usually support Soft Spinifex pastures. They are highly susceptible to wind erosion when the ground cover is disturbed with the topsoil being stripped and often deposited in hummocks while a scalded surface forms on the remaining subsoil.

## **Red sands (Uc1.23, Uc5.11)**

These soils occur on the Gregory and Uaroo land systems. They are also found on hummocks in areas affected by wind erosion.

They are apedal sands > 1 m deep. They are free of stones, red (2.5YR 4/6) and usually slightly acidic (pH 6.0-7.0)

They commonly support Hard and Soft Spinifex pastures and are moderately susceptible to wind erosion when the ground cover is removed.

## **Red clays (Uf6.12, 5.12)**

These soils are widely spread throughout alluvial plains of the Sherlock, Horseflat and Mallina land systems. They are also common on the Boolgeeda land system.

They are uniform clays > 1 m deep with textures including sandy clays, light clays and medium clays, with a slight increase in texture occurring down the profile. The topsoil usually has rough faced polyhedral peds. A stony mantle is often present on the soil surface and the top 10-20 cm can contain up to 50% of stones which range in size from 2-60 mm. Below this depth there is usually < 10% of stones which are commonly < 10 mm in size. In other soils there are very few stones throughout the profile. Soil colour is a dark reddish brown (2.5YR 3/4) or red (2.5YR 4/6). These soils are usually alkaline with the pH ranging from 7.5 to 8.5 in the topsoil and increasing up to 9.0 with depth.

The top 10 cm of these clays are usually salt free (< 400 mS/m EC<sub>e</sub>) and non sodic (ESP < 6). They commonly remain so to a depth of 40 cm, although they can

become slightly saline (400-600 mS/m EC<sub>e</sub>) and sodic (ESP 6-15). The subsoil below 40 cm is often highly saline (> 1200 mS/m EC<sub>e</sub>) and sodic to strongly sodic (ESP 6 - > 15).

These soils support Hard and Soft Spinifex pastures as well as Roebourne Plains Tussock Grass and Stony Chenopod pastures. They are not highly susceptible to erosion although water erosion is evident in some locations.

### **Cracking clays (Ug5.36, Ug6.3)**

These soils are widely spread throughout the gilgaied alluvial plains of the survey area. They are the dominant soil type of the Horseflat land system and they also occur on the Mallina, Pyramid, Sherlock, Satirist and Paraburdoo land systems.

They are uniform clays > 1 m deep, which display seasonal cracking. The texture ranges from a light to medium clay with polyhedral or granular peds in the topsoil. Usually only a few (< 5%) small (< 5 cm) stones are found in the profile, however, in some locations, stones may be found on the surface. The colour ranges from dark reddish brown (2.5YR 3/4) to red (2.5YR 4/6). The soils are alkaline with the pH ranging from 8.0 to 9.0.

The top 10 cm of these clays are usually salt free (< 400 mS/m EC<sub>e</sub>) and non sodic (ESP < 6). They commonly remain so to a depth of 40 cm, although they can become slightly saline (400-600 mS/m EC<sub>e</sub>) and sodic (ESP 6-10). The subsoil below 40 cm is often highly saline (> 1200 mS/m EC<sub>e</sub>) and sodic to strongly sodic (ESP 6 - > 15).

These soils usually support Roebourne Plains Tussock Grass pastures. They are generally not highly susceptible to erosion, but in parts show surface stripping, sealing and gullyng.

### **Calcareous gradational soils (Gc1.22, Gn2.13)**

These soils occur mainly along the coast on the Cheerawarra land system.

They are > 1 m deep and free calcium carbonate is present in the subsoil, and often present in the topsoil.

The topsoil texture is usually a light sandy clay loam or sandy clay loam which grades into a sandy clay at a depth between 40 and 60 cm. The topsoil usually has an earthy fabric. Weak rough faced peds are sometimes present. Stones are mostly absent. Soil colour ranges from dark reddish brown (2.5YR 3/4) to red (2.5YR 4/6). These soils are alkaline with pH ranging from 7.5 to 9.0 and often increasing with depth.

The top 40 cm of the soils are usually salt free (< 400 mS/m EC<sub>e</sub>) and non sodic (ESP < 6). The subsoil may be highly saline (> 1200 mS/m EC<sub>e</sub>) and sodic or strongly sodic (ESP 6 - > 15).

These soils support Soft and Hard Spinifex pastures as well as Tussock Grass pasture. They are highly susceptible to wind erosion when the vegetative cover is removed or the topsoil disturbed.

### **Saline clays (Uf6.12)**

These clays occur on saline flats and depressions in the Cheerawarra land system. Similar profiles are also found on saline scalds on other land systems where the topsoil has been stripped by erosion.

They are medium clays > 1 m deep. There is usually a surface crust present although the topsoil exhibits moderately to well developed rough faced polyhedral peds or is loose and powdery. A thin sandy mantle may be present on the surface. The soil colour is reddish brown (2.5YR 3/4) to red (2.5YR 4/6) and pH ranges from 7.5 to 9.0, often increasing with depth. These soils are usually highly to extremely saline (800-8000 mS/m EC<sub>e</sub>) and strongly sodic (ESP 15-40).

These soils often support no pasture and are susceptible to erosion.

### **Alluvial soils (Uc1.13, Uc5.11, Gn2.13)**

These soils occur in the River land system and along drainage lines in the other land systems. They can be quite variable, most commonly being deep loose sand or gradational soils with sandy topsoil grading into sandy clay loams at depth.

These soils usually support Buffel Tussock Grass and Soft Spinifex pastures. They are highly susceptible to wind and water erosion if the ground cover is removed.

# Pasture types

Within the 19 land systems described for the area, there are six vegetation alliances that can be recognized as broad native pasture types. One exotic pasture type (buffel grass) is also described. The 'pasture type' is not strictly a botanical classification, because, in determining such a class of pastoral lands the perennial plant species that contribute to stock production have an overriding importance. Even so, each 'pasture type' represents a broad working group of similar vegetation associations. Pasture types and the edaphic factors influencing their distribution are listed below:

## A. Hill systems

1. On stony skeletal clays and sands  
Hard Spinifex pastures  
Soft Spinifex pastures (minor)

## B. Plain systems

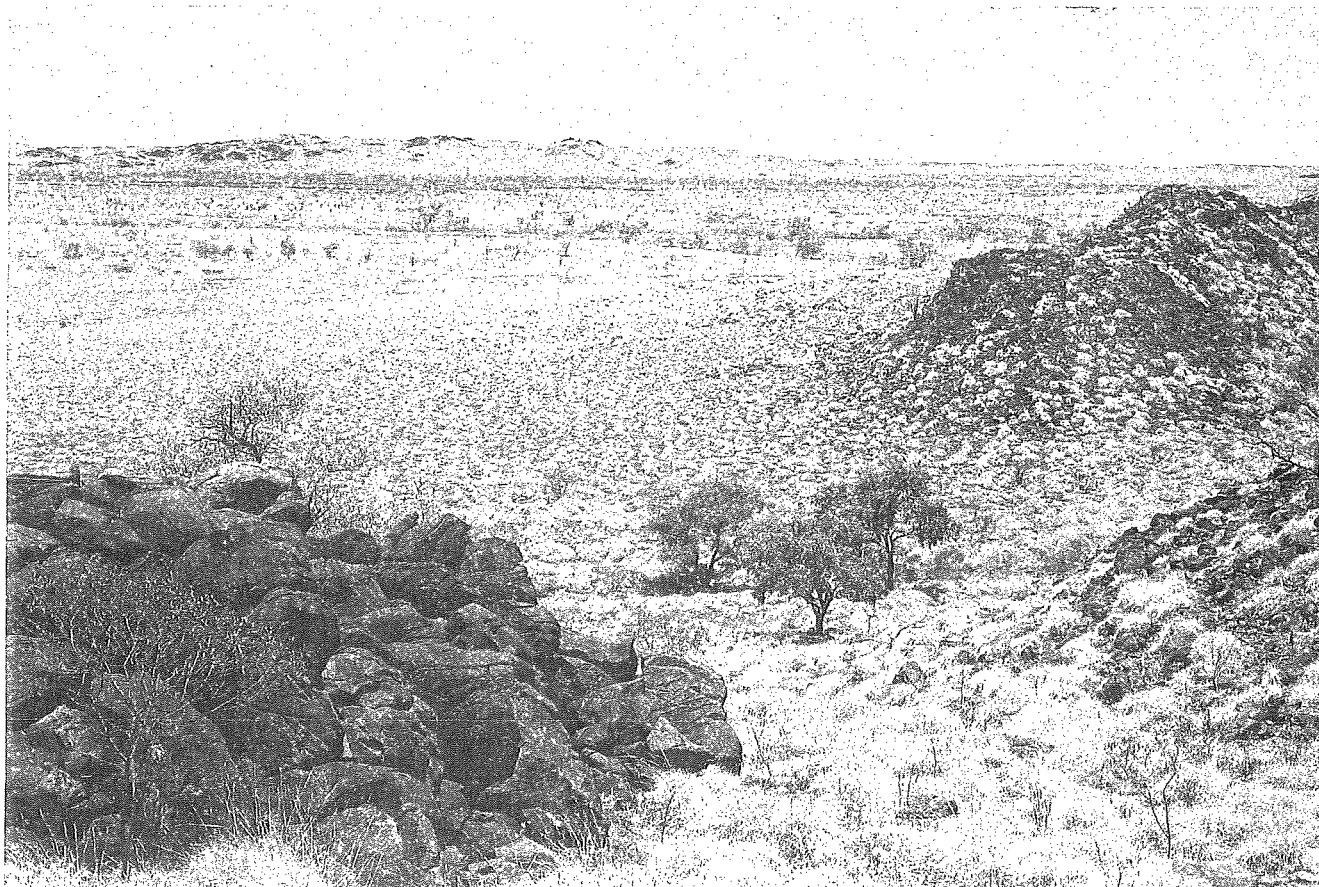
1. On shallow calcareous loams and stony duplex soils  
Hard Spinifex pastures
2. On red sands and red duplex and gradational soils  
Hard Spinifex pastures  
Soft Spinifex pastures
3. On red clays  
Hard Spinifex pastures  
Soft Spinifex pastures  
Roebourne Plains Tussock Grass pastures  
Stony Chenopod pastures (minor)

4. On cracking clays  
Roebourne Plains Tussock Grass pastures  
Saltbush pastures (rare)
5. On calcareous gradational soils and alluvial soils  
Soft Spinifex pastures  
Buffel Tussock Grass pastures

Table 6 summarizes the pasture types in terms of extent, pasture characteristics and present condition. More detailed descriptions of each pasture type (except Samphire pastures), compiled from observations and measurements made at inventory sites throughout the survey area, are presented in order of decreasing area. Suggested levels of use are presented as stocking rates (per annum) as ha/sheep unit (s.u.).

It is stressed that these stocking rates are only a guide to productive potential and are not intended to be rigidly applied by managers or used as a basis for legislative controls. Their value lies in their relativities rather than their absolutes.

The actual grazing value and appropriate stocking of a particular pasture at any time varies enormously with seasonal conditions, perennial pasture condition and the degree of recent use. Browse and herbage accruing from periods of growth will, in practice, be taken by stock, and by many other herbivores including feral donkeys, kangaroos, small mammals and termites and other insects. Such factors dictate that an inflexible adherence to suggested stocking rates is not to be recommended, rather, the aim is to match stocking with the variations in pasture production as closely as possible. Fixed year-round stocking rates result in either under-use or over-use at most times and are largely inappropriate for arid zone pastures.



The Hard Spinifex pasture type is the most widely distributed pasture within the survey area. It is the dominant pasture of the hill systems. Pastoral value is very low as the hard spinifex (*Triodia* spp.) is unattractive to livestock and there is a paucity of other palatable perennials. Poor access in hilly areas further reduces the pastoral value of these pastures. Near site R75.

**Table 6. Summary of pasture types of the survey area**

Pasture type	Area km <sup>2</sup>	Per cent	Landforms, soil and vegetation	Condition
<b>Hard Spinifex</b>	4,850	47.5%	Extensive hill tracts and rugged plateaux, stony plains and some sandy surfaced plains; stony skeletal clays and sands, calcareous loams, stony duplex soils, red sands and red clays; hummock grasslands with sparse shrubs; pastoral value low or very low, some areas unsuitable for pastoralism.	Pasture condition good; not normally susceptible to erosion, sandy systems susceptible to wind erosion after burning, but stabilize rapidly after rain; periodic burning required.
<b>Roebourne Plains Tussock Grass</b>	2,200	21.5%	Extensive, weakly gilgaied alluvial plains; alkaline cracking clay and red clay soils often becoming saline with depth; tussock grass-lands; pastoral value moderate or high.	Moderately resistant to degradation, but some extensive areas of pasture decline, other areas are severely wind scalded and hummocked, some gully erosion on margins to rivers.
<b>Soft Spinifex</b>	2,000	19.6%	Broad alluvial plains, narrow drainage floors and sandy surfaced plains; calcareous gradational soils, red duplex and gradational soils, alluvial soils and red sands; hummock grasslands with numerous shrubs; pastoral value moderate.	Sandy surfaced soils susceptible to wind erosion immediately after fire, but stabilize rapidly after rain; pasture condition mostly good except some severe degradation and wind scalding near the coast; periodic burning required except on Cheerawarra system which is highly susceptible to wind erosion.
<b>Buffel Tussock Grass</b>	340	3.3%	Sandy alluvial plains, river terraces, levees, channel banks and drainage floors; sandy alluvial soils and calcareous gradational soils; tussock grasslands with very scattered shrubs and trees; high pastoral value.	Pasture condition predominantly good, buffel grass has ability to colonize and eventually stabilize many degraded sites; recently colonized sites with poor total cover are still seriously degraded.
<b>Samphire</b>	100	1.0%	Flat plains and marshes, saline silty sands, loams and clays with shell fragments, low shrublands of samphire; low to very low pastoral value.	Mostly good condition, generally low susceptibility to erosion except sites with lighter textured soils which are moderately to highly susceptible if shrubs are depleted.
<b>Stony Chenopod</b>	45	0.4%	Stony plains with gilgai and non-gilgai surfaces; alkaline, red clays, cracking clays and red duplex soils; scattered tall shrublands of snakewood; moderate pastoral value.	Pasture condition mostly poor, but little erosion, pasture type is subject to preferential use especially where it occurs as small inclusions in other pasture types.
<b>Unvegetated</b>	680	6.7%	Saline mud flats, bare claypans, also unvegetated river beds.	
<b>Total</b>	10,215	100.0%		

The following terminology is used to describe the extent of perennial shrub vegetation cover, as a percentage of ground cover (Curry, Payne and Wilcox 1983).

Term	Projected foliar cover (%)
Very scattered	0-10
Scattered	10-20
Moderately close	20-30
Close	30-50
Closed	> 50

## Hard Spinifex pasture type

Area 4,850 km<sup>2</sup> (47.5%)

### Distribution and soil types

The Hard Spinifex pasture type is the largest and most widely distributed pasture within the survey area. It is also the poorest in terms of pastoral value. In the south it is the dominant pasture on extensive, rugged plateaux, hills and ridges of the Rocklea and Capricorn land systems. It is dominant on the low hills and ridges of the Boolaloo, Robe and Ruth land systems. Soils are stony skeletal clays and sands.

Other extensive areas occur on the plain land systems such as Boolgeeda, Calcrete, Gregory, Macroy, Paraburdoo, Pyramid, Satirist, Sherlock and Uaroo where it is frequently associated with lesser areas of Soft Spinifex pastures. Soils may be very shallow to full depth (> 1 m) and are often stony. Hard Spinifex pastures dominate on shallow calcareous loams and stony duplex soils and also occur widely on red sands, red duplex and gradational soils and red clays.

### Physiognomy and composition

Hard Spinifex pastures are predominantly hummock grasslands. They are invariably dominated by one of several hard spinifex species, sometimes to the virtual exclusion of other ground layer species. The most common hard spinifex in the survey area is limestone spinifex (*Triodia wiseana*). Minor communities of *T. angusta* and *T. secunda* occur. Occasionally, the upper strata may dominate and the pasture type takes the form of a low (<2 m) or tall (>2 m) shrubland.

The upper strata within Hard Spinifex pastures are generally very scattered (PFC < 2.5-10%). Common trees are variable barked bloodwood (*Eucalyptus dichromophloia*, *E. aspera*) and corkwood (*Hakea suberea*) on plain systems and *Terminalia canescens* which is exclusive to basaltic hills and slopes. Shrubs are dominated by *Acacia* spp. particularly the ubiquitous *Acacia inaequilatera* and *A. pyrifolia* and others such as *A. bivenosa*, *A. translucens*, *A. ancistrocarpa*, *A. acradenia* and, on stony hillslopes, *A. orthocarpa*. Widely distributed low shrubs include *Corchorus walcottii*, *Cassia notabilis*, *C. pruinosa*, *C. glutinosa*, native blue bell (*Trichodesma zeylanicum*), *Psoralea lachnostachys*, *Indigofera* spp. and, on hillsides, *Tribulus platypterus*.

Perennial grasses other than hard spinifex occur occasionally, but are never significant in the stand. Buck wandarrie (*Eriachne helmsii*), ribbon grass (*Chrysopogon fallax*), and soft spinifex (*Triodia pungens*) on sandy sites and *Cymbopogon* sp. on stony sites are the most common of these.

Projected foliar cover (PFC) of the whole vegetation stand may range from 0-40% depending mainly on the fire history of the area. Old stands, unburnt for a long time, have a high PFC. Fires often kill senescent stands and, for a short time, totally remove the ground cover.

On recently burnt country, spinifex seedlings establish readily after one reasonable season, but the cover remains low for one or two seasons. In some situations (particularly on plain land systems such as Boolgeeda, Macroy and Uaroo) numerous perennial shrubs emerge as pioneers together with spinifex. As such a stand matures the shrub layer may dominate briefly and the stand would be classified as a shrubland. These fire responsive shrubs include fire wattle (*Acacia pyrifolia*), kanji (*A. inaequilatera*), poverty wattle (*A. translucens*), cockroach bush (*Cassia notabilis*), wooly corchorus (*Corchorus walcottii*) and *Psoralea lachnostachys*. As the stand approaches its climax state (commonly five years after fire) it normally resumes the form of a hummock grassland with the shrub component diminishing through senescence or through competition and crowding by spinifex (Suijdendorp 1967).

### Pastoral value

Hard Spinifex is unattractive to livestock and the pasture type supports only a few palatable perennial species at low density. Pastoral value is generally very low. On hill systems, accessibility to stock is poor and large parts of very rugged land systems such as Rocklea and Capricorn are unsuitable for pastoralism. Elsewhere, accessibility is not a problem, but unless the pasture is associated with large inclusions of better quality pasture types it is of very limited value for livestock production.

Because of the paucity of palatable perennials the pasture type has very little durability in times of drought. However, in good seasons, it does supply small quantities of useful forage from annuals, biennials, and herbs. This is particularly the case in the first few years following burning.

Pastoral value can be marginally improved by strategic burning. Although productivity is very low, recently burnt hard spinifex stands support more useful forage than old senescent stands.

### Common perennial species

#### Trees

*Acacia inaequilatera*  
*Brachychiton* sp.\*  
*Eucalyptus aspera*  
*Eucalyptus dichromophloia*  
*Eucalyptus setosa*  
*Grevillea pyramidalis*  
*Hakea suberea*  
*Owenia reticulata*  
*Terminalia canescens*\*

*Acacia holosericea*  
*Acacia inaequilatera*  
*Acacia pyrifolia*  
*Acacia translucens*  
*Bonamia rosea*  
*Cassia desolata*  
*Cassia glutinosa*  
*Cassia notabilis*  
*Cassia oligophylla*  
*Cassia pruinosa*  
*Carissa lanceolata*  
*Corchorus* sp.  
*Corchorus walcottii*  
*Gossypium australe*  
*Indigofera* sp.  
*Ipomoea costata*  
*Psoralea lachnostachys*  
*Ptilotus obovatus*  
*Tribulus platypterus*  
*Trichodesma zeylanicum*

#### Tall shrubs (> 2 m)

*Acacia ancistrocarpa*  
*Acacia bivenosa*  
*Acacia inaequilatera*  
*Acacia holosericea*  
*Acacia orthocarpa*  
*Acacia pyrifolia*  
*Acacia trachycarpa*  
*Acacia tumida*  
*Acacia xiphophylla*  
*Grevillea pyramidalis*  
*Grevillea wickhamii*

#### Low shrubs (< 2 m)

*Acacia acradenia*  
*Acacia ancistrocarpa*  
*Acacia arida*  
*Acacia bivenosa*

#### Grasses

*Aristida browniana*  
*Chrysopogon fallax*  
*Cymbopogon* sp.  
*Eriachne helmsii*  
*Triodia angusta*  
*Triodia pungens*  
*Triodia secunda*  
*Triodia wiseana*

\* only occurs on basaltic hills

## Condition statement

Condition levels and effects of grazing are difficult to determine on Hard Spinifex pastures. The relatively frequent occurrence of fire strongly influences the situation. The presence or absence of desirable or undesirable species may be more closely linked to particular fire events than to grazing pressure.

Occasionally, shrub invasion can be a problem on some plain areas. After a winter fire, conditions seem to favour the establishment of shrubs. Thick stands of unpalatable species, such as poverty wattle and cockroach bush, often develop at the expense of other species and a stable, non productive shrubby association develops.

On the red sands wind erosion in the form of wind piling and hummocking can occur on burnt areas which have not yet stabilized with seasonal growth. Such areas may appear degraded until after good rain when they are rapidly re-colonized and stabilized by spinifex and other species.

In general, Hard Spinifex pastures within the survey area are stable under grazing, and are in good condition and show no erosion.

## Management

As indicated, Hard Spinifex pastures are generally of limited use to stock. However, controlled fires can be used as an effective management tool to improve carrying capacity. Burning of senescent stands allows the establishment of more nutritious and palatable shrubs, herbs and grass species. A hot summer burn will carry well and spinifex hummocks will be killed outright. It is considered less beneficial to burn in winter as the old spinifex stands may not all be killed and conditions may favour the establishment of unpalatable species and shrub invasion may become a problem.

Following burning, paddocks should be spelled for 6-8 weeks over the growing season to allow palatable seedlings to develop and set seed. If left open to grazing, palatable species will be selectively grazed and unpalatable species, which normally occur at low densities, may increase and reduce the overall productivity (H. Suijendorp, 1967).

Spinifex can be expected to rapidly resume its dominance and become a mature, close community by about five years after a burn. Spinifex paddocks should be burnt on a rotational basis with successive seasonal deferments. Such a practice, once established, will maintain most pastures in the more productive stages for a longer time. As such, they are suitable for use by dry stock on a year long basis.

Where possible, extensive areas of spinifex should be fenced separately from other more productive pastures. This will allow use of spinifex pastures on an opportunistic basis by using the palatable ephemeral growth in good seasons and spelling more valuable pastures at a time when their rejuvenation will be at a maximum.

### Suggested levels of use (per annum):

Young stands with a moderate number of palatable species	20 ha/sheep unit (s.u.)
Older stands with only a low number of palatable species	30 ha/s.u.
Old stands with very few palatable species	40 ha/s.u.

These suggested carrying capacities are for Hard Spinifex pastures on plain land systems. Poorly accessible hill systems such as Ruth, Rocklea and Capricorn should be rated at 30-40 or more ha/s.u.

## Roebourne Plains Tussock Grass pasture type

Area 2,200 km<sup>2</sup> (21.5%)

### Distribution and soil types

Roebourne Plains Tussock Grass pastures occur as extensive grasslands on either side of the North West Coastal Highway across the northern (coastal) half of the survey area. They are the predominant pastures of the Horseflat alluvial plain land system. They also occur as inclusions up to 750 m in extent on other land systems such as Cheerawarra, Mallina, Pyramid and Sherlock.

Soils are predominantly alkaline cracking clays with weakly gilgaied microrelief. Surface mantles are absent or very sparse; soil colour is red or reddish brown and depth > 1 m. Less commonly, soils are stony, non cracking red clays.

### Physiognomy and composition

The pasture type occurs as tussock grasslands on open, treeless plains which may extend for five or six kilometres or more. A feature of the pasture is its occurrence as a natural mosaic of dense and less dense patches of Roebourne Plains grass (*Eragrostis xerophila*) over the plains. Variations in micro topography and soil properties are probably responsible for the patterning.

Roebourne Plains grass occurs with a basal density of up to about 5% and is often associated with patches of swamp wandarrie grass (*Eriachne benthamii*), on the larger gilgai depressions. Other perennial grasses which may occasionally occur as sparse patches or isolated tussocks within the stand are barley Mitchell grass (*Astrebla pectinata*), ribbon grass (*Chrysopogon fallax*) and native panic (*Panicum decompositum*). Shrubs are generally absent although there are sometimes a few patches of snakewood (*Acacia xiphophylla*). Occasionally, on weakly gilgaied saline plains of the Horseflat and Cheerawarra systems Roebourne Plains grass is associated with giant bindii shrubs (*Sclerolaena hostilis*) up to 1 m tall and with PFC up to 15%.

Beard (1975), suggests that parts of the Roebourne Plains may originally have carried silver saltbush (*Atriplex bunburyana*) in addition to perennial grasses. Isolated plants of silver saltbush were seen on the Horseflat land system during the survey. Larger relic patches are present near the Roebourne airport. Here they take the form of low shrublands of saltbush and giant bindii (PFC 5-10%) with prominent patches of Roebourne Plains grass and scattered ribbon grass and buffel grass. Such areas are a Saltbush pasture type rather than Roebourne Plains grass pastures, but because of their very restricted occurrence are not further described here.

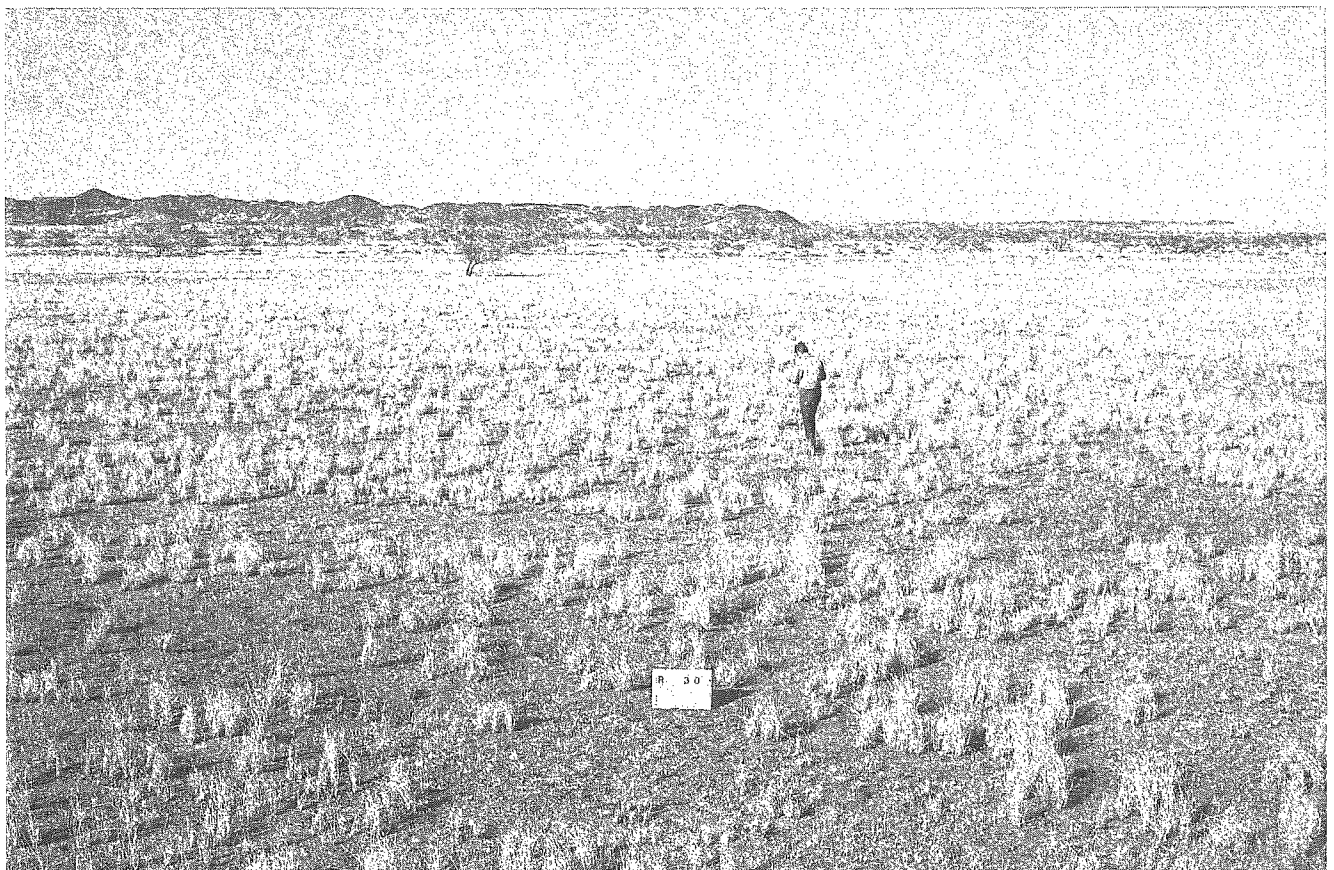
### Pastoral value

Pastoral value is moderate or high with perennial grasses and numerous ephemerals providing nutritious grazing after rain. Roebourne Plains grass provides reasonable quality forage for several months into the dry season, but its palatability and quality deteriorates considerably in prolonged dry periods when pastures provide only a sub-maintenance ration for livestock.



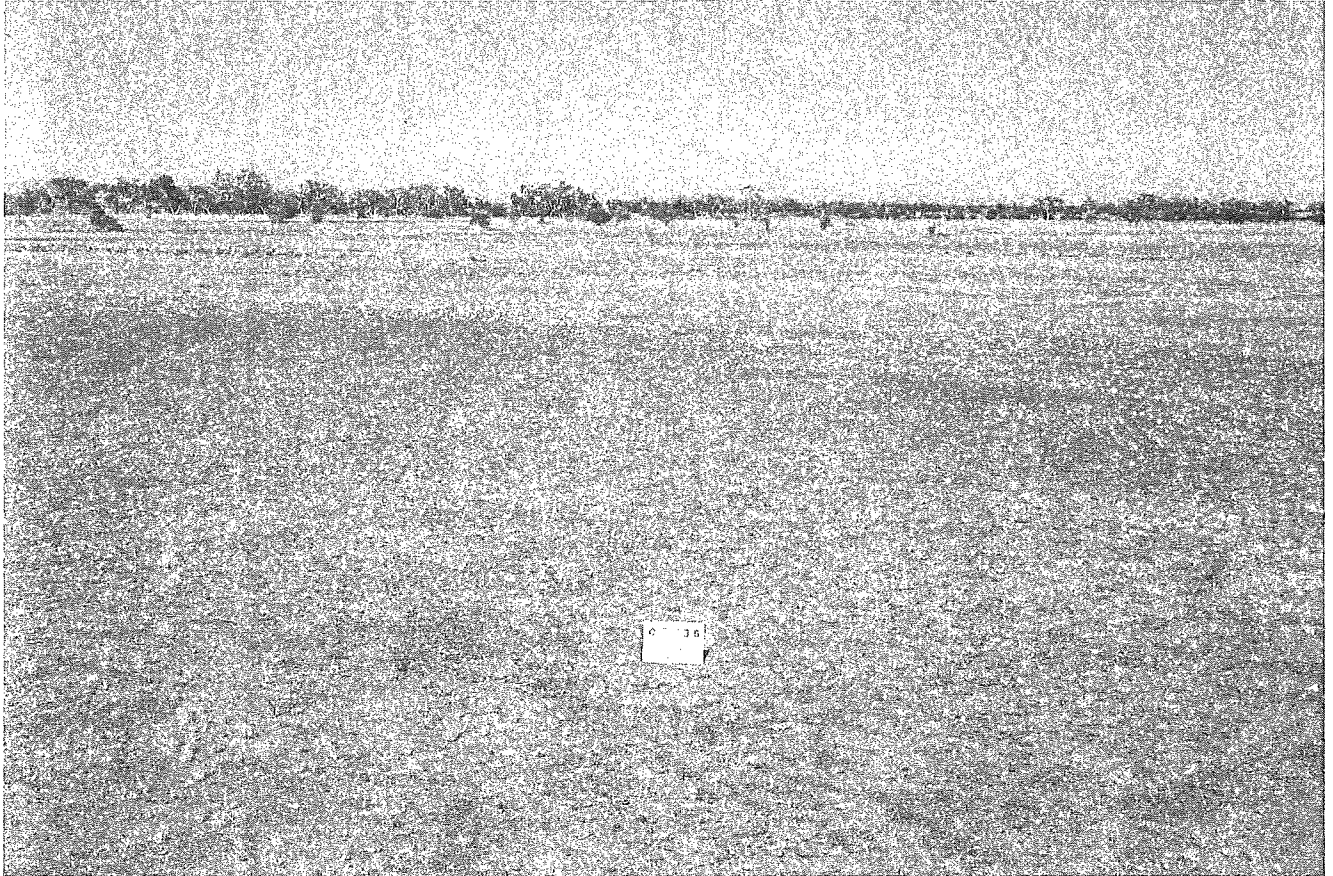


Roebourne Plains grass (*Eragrostis xerophila*) is the dominant species of the tussock grass pastures which cover most of the Horseflat land system. These pastures provide nutritious grazing after rain and reasonable quality forage for several months into the dry season. During long dry seasons they provide only a sub-maintenance ration for livestock. The pasture in this photograph is in good condition. Near site C36.

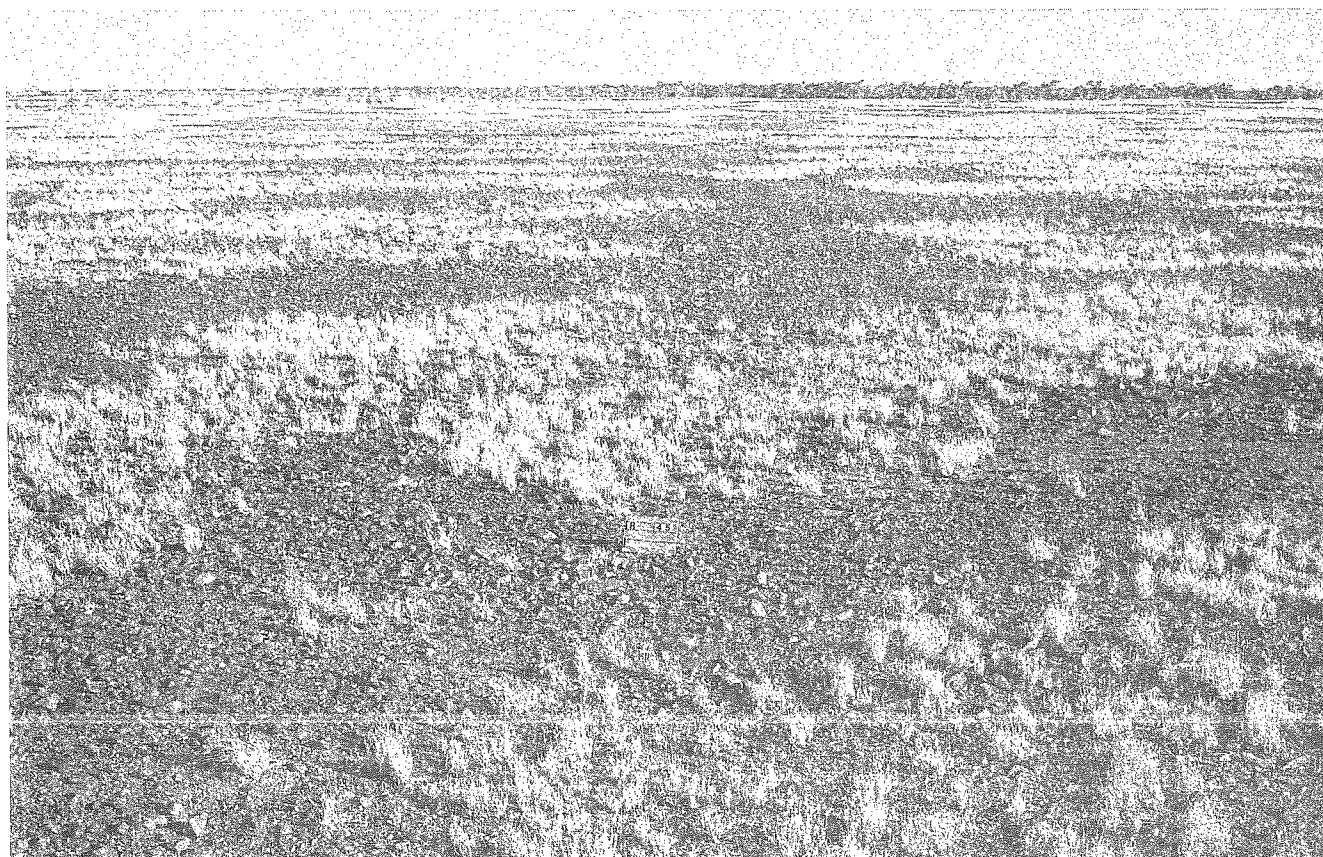


Roebourne Plains grass pastures in fair to good condition. Site R30.





Roebourne Plains grass pastures in poor condition. Site C35.



Tussock grass pastures of Roebourne Plains grass (*Eragrostis xerophila*) often occur naturally in a mosaic pattern with relatively bare stony areas. Such sites (R45) are inherently resistant to erosion.



Silver saltbush (*Atriplex bunburyana*) seen here growing with giant bindii (*Sclerolaena hostilis*) and buffel grass (*Cenchrus ciliaris*) has a very restricted occurrence on the Roebourne Plains. It is possible that this species was originally much more widespread. Near site R52.

## Common perennial species

<b>Tall shrubs (&gt; 2 m)</b>	<i>Sclerolaena bicornis</i> var <i>bicornis</i> <i>Sida</i> sp.
<i>Acacia xiphophylla</i>	<b>Grasses</b>
<b>Low shrubs (&lt; 2 m)</b>	<i>Astrebla pectinata</i> <i>Chrysopogon fallax</i> <i>Eragrostis xerophila</i> <i>Eriachne benthamii</i> <i>Panicum decompositum</i>
<i>Acacia farnesiana</i>	
<i>Acacia xiphophylla</i>	
<i>Atriplex bunburyana</i> *	
<i>Neptunia</i> sp.	
<i>Sclerolaena hostilis</i>	
* occasional isolates or patches	

## Condition statement

The condition of this pasture type is assessed by observing such characteristics as the degree of ground cover (basal cover) afforded by grass tussocks, the vigour of tussocks and the age structure of the stand and the presence or absence of soil erosion.

Because of its flat topography and heavy textured soils the pasture type is relatively resistant to degradation and much of it is in fair or good range condition.

However, heavy grazing pressure on the plains of the Cheerawarra, Horseflat and Mallina land systems have resulted in areas where the perennial grasses have been lost and soil surfaces are eroded. Wind appears to be the main causal agent resulting in scalds and peripheral hummocking, but some areas show water erosion in the form of rilling, scouring and re-distribution of soil material. Gully erosion is fairly common on more sloping surfaces such as margins to the major rivers. Gullies may be active or stabilized depending largely on the degree of stony mantling.

On the Horseflat land system, the natural mosaic of dense plains grass (gilgaied areas) and less dense grass (non-gilgaied areas) can be exacerbated by over use. The less dense areas can become devoid of perennial vegetation resulting in patchy scalds which may be actively wind eroding or protected by a dense stony mantle.

## Management

Roebourne Plain Grass pastures can be used for grazing on a year long basis, but palatability and feed quality when dry and mature is poor. For good animal productivity the best use would appear to be heavy, short term (six month) stocking when feed is green and actively growing. This type of management will necessitate occasional spelling of pasture for a few months after a good season to enable tussocks to recover and hopefully, seedlings to establish.

Numerous stands of seedlings and young plants of Roebourne Plains grass were seen during the survey. However, it is thought that favourable seasonal conditions for establishment do not regularly occur (H. Suijendorp, personal communication) and careful management involving deferred stocking is necessary to take advantage of infrequent seedling recruitments.

Degraded areas will require spelling over a number of consecutive wet seasons and conservative grazing levels at other times. Severely degraded and scalded areas may need special works such as waterponding and reseedling and complete protection from use for a number of years.

Although other perennial grasses such as barley Mitchell grass and native panic are not generally abundant they are palatable and attractive to livestock. Management practices

should aim to maintain these species in the stand. As a general rule, tussock grasses should not be used beyond about 50% by weight, that is, not grazed below about 10-15 cm in height. This will enable the grasses to maintain vigour and provide a reasonable residue of plant material to protect the soil surface.

### Suggested levels of use (per annum):

Good condition	4 ha/sheep unit (s.u.)
Fair condition	8 ha/s.u.
Poor condition	20 ha/s.u.

## Soft Spinifex pasture type

Area 2,000 km<sup>2</sup> (19.6%)

### Distribution and soil types

Soft Spinifex pastures are widely distributed through the survey area. They are major pastures of the Cheerawarra, Mallina and River land systems and important components on many other systems.

Extensive areas occur near the coast on the calcareous gradational soils of the Cheerawarra system and the red duplex and gradational soils of the Mallina system. On the alluvial soils of the River system soft spinifex is dominant or co-dominant with buffel grass.

The pasture type is also common on the sandy surfaced plains, interfluvies and drainage floors of such land systems as Macroy, Uaroo and Satirist. They are common on narrow drainage floors of numerous other systems. Soils are stony duplex soils, red sands or red gradational and duplex soils.

Soft Spinifex pastures, in association with Hard Spinifex, are a minor, but important component on the red clays of stony plains of systems such as Paraburdoo and Sherlock.

Soft Spinifex pastures occur occasionally on stony hills and hillslopes; in particular on granite based systems such as Boolaloo and to a much less extent on systems such as Ruth and Capricorn.

## Physiognomy and composition

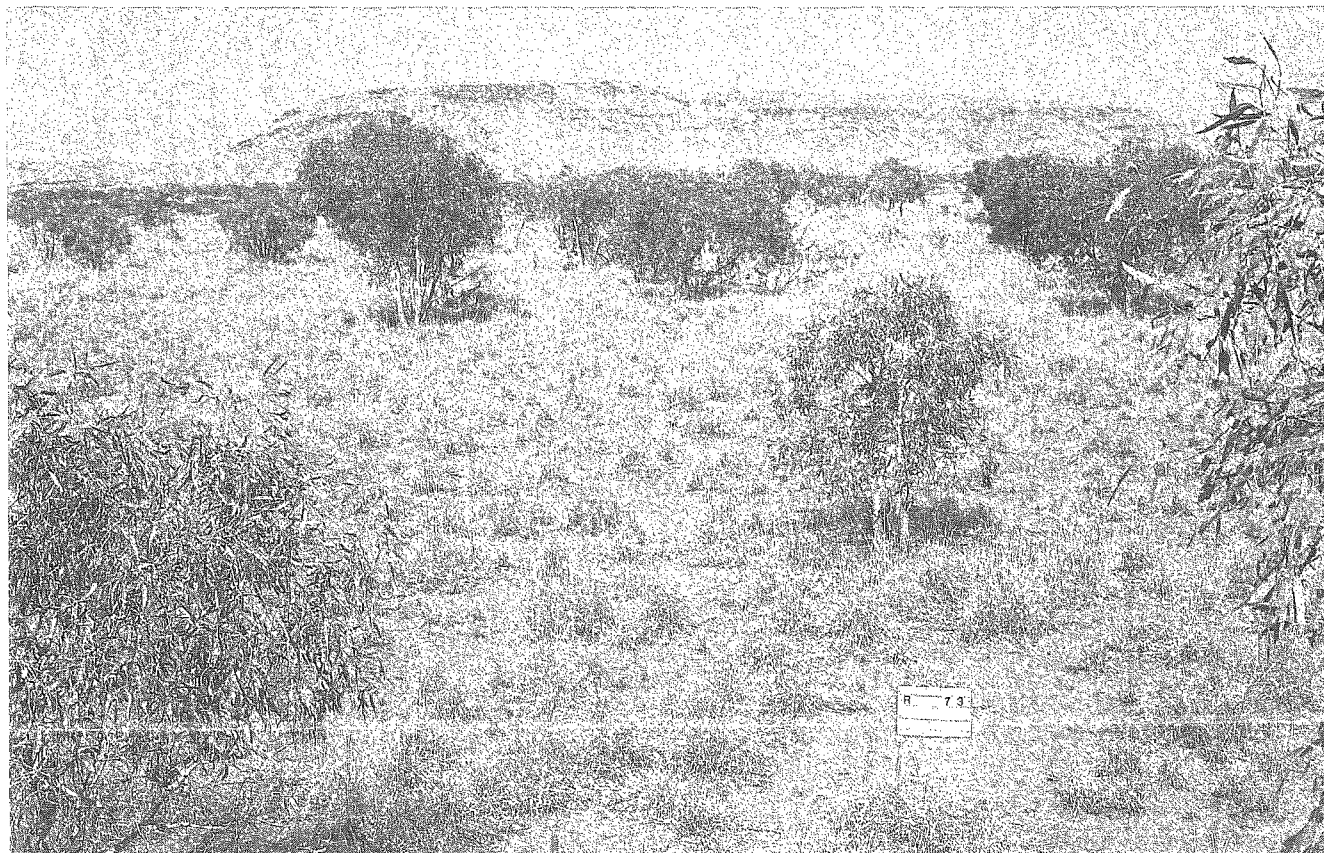
Physiognomy and composition is variable and is a function of the past fire regimes, edaphic factors and prevailing climatic conditions. Pastures may take the form of hummock grasslands, tall or low shrublands and, occasionally, low woodlands. In each case the ground storey is dominated by soft spinifex (*Triodia pungens*).

Shrubs and trees are usually very scattered (PFC < 10%), but may occasionally be scattered (PFC 10-20%). The suites of shrub and tree species found on Soft Spinifex pastures are very similar to those found on Hard Spinifex pastures.

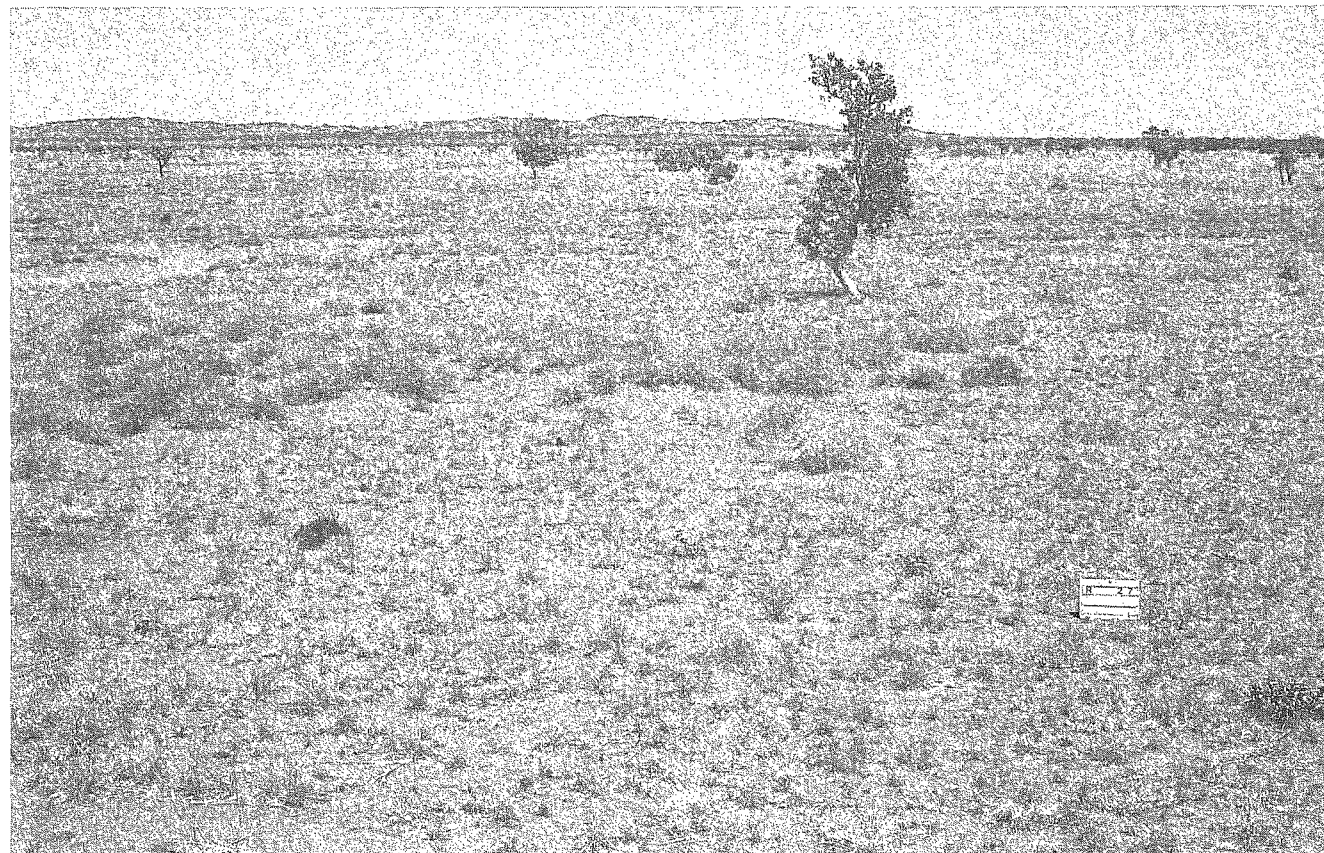
On the Cheerawarra system the pasture type is nearly always a hummock grassland. A few shrubs such as poverty wattle (*Acacia translucens*), umbrella wattle (*A. ligulata*), conkerberry (*Carissa lanceolata*) and *Dichrostachys spicata* may be present, but PFC is generally < 2.5%. Soft spinifex, sometimes associated with patchy hard spinifex (*Triodia secunda*), buffel grass (*Cenchrus ciliaris*) and ribbon grass (*Chrysopogon fallax*) can have a PFC of up to 50%.

Hummock grasslands with high PFC are prone to fire. Evidence of past burns is obvious in many areas where the





Soft Spinifex pastures occur on a wide variety of terrain and soil types. Mature stands of soft spinifex (*Triodia pungens*) such as in this photograph have limited pastoral value. Site R73.



Summer burning on Soft Spinifex pastures promotes the growth of palatable young spinifex and a range of other grasses, herbs and forbs, resulting in pasture of moderate value with good drought durability. Site R27.

vegetation has been completely removed or where sub-climax stages exist. Early seral stages on such systems as Mallina, Macroy and Uaroo often take the form of shrublands, where pioneer perennial shrubs are co-dominant with spinifex seedlings. Prominent shrubs after fire include fire wattle (*Acacia pyrifolia*), kanji (*A. inaequilatera*), poverty wattle (*A. translucens*), *A. ancistrocarpa* and *A. tumida*. Other species include the relatively short lived cockroach bush (*Cassia notabilis*), wooly corchorus (*Corchorus walcottii*), *Psoralea lachnostachys* and *Indigofera* sp. A wide range of small annuals, biennials and herbs also occur after fire. About five years after burning, soft spinifex may regain dominance in the stand as the shrubs either senesce or are crowded out by expanding spinifex hummocks (H. Suijdendorp). Pastures will resume the form of a hummock grassland with scattered or very scattered shrubs. Isolated trees such as variable barked bloodwood (*Eucalyptus dichromophloia*, *E. aspera*) and corkwood (*Hakea suberea*) are occasionally present.

Soft Spinifex pastures are usually more sparse on stony plain systems, such as Paraburdoo and Sherlock, than on more sandy alluvial plains. In these areas, the PFC of spinifex rarely exceeds 20% and the vegetation is in the form of a scattered tall shrubland. The predominant shrub is frequently snakewood (*Acacia xiphophylla*). Other shrubs such as *Acacia bivenosa*, *A. pyrifolia*, *A. victoriae*, *A. ancistrocarpa* and *Cassia* spp. are common. Soft Spinifex pastures on these systems are usually associated with patches of Hard Spinifex and Stony Chenopod pastures.

A few other useful perennial grasses occur as isolated clumps or patches within Soft Spinifex pastures. The most important of these are hop-a-long grass (*Paraneurachne muelleri*), ribbon grass (*Chrysopogon fallax*) and buffel grass (*Cenchrus ciliaris*) on sandy surfaced soils and curly Roebourne Plains grass (*Eragrostis xerophila*) and curly windmill grass (*Enteropogon acicularis*) on more clayey soils.

## Pastoral value

Soft Spinifex pastures are generally of moderate to high pastoral value. Recently burnt areas support a high cover of palatable spinifex seedlings, annuals, herbs and young perennial shrubs and forage value is high. Crude protein levels as high as 9% in *Triodia pungens* seedlings were reported by Suijdendorp (1981). In older stands the larger spinifex hummocks are less palatable to stock and there are fewer other palatable species than in young stands. In these old stands, grazing value is considerably reduced.

The durability and usefulness to stock of young Soft Spinifex pastures in times of drought is high. When maintained in a productive non senescent state, Soft Spinifex pastures are suitable for carrying stock, including breeders, on a year long basis.

## Common perennial species

### Trees

*Acacia inaequilatera*  
*Eucalyptus aspera*  
*Eucalyptus coolabah*  
*Eucalyptus dichromophloia*  
*Eucalyptus setosa*  
*Grevillea pyramidalis*  
*Hakea suberea*

### Tall shrubs (> 2 m)

*Acacia ancistrocarpa*  
*Acacia bivenosa*  
*Acacia coriacea*  
*Acacia inaequilatera*  
*Acacia holosericea*  
*Acacia pyrifolia*  
*Acacia sclerosperma*  
*Acacia trachycarpa*  
*Acacia tumida*  
*Acacia xiphophylla*  
*Dichrostachys spicata*  
*Grevillea pyramidalis*

### Low shrubs (< 2 m)

*Acacia acradenia*  
*Acacia ancistrocarpa*  
*Acacia bivenosa*  
*Acacia holosericea*  
*Acacia inaequilatera*  
*Acacia ligulata*  
*Acacia pyrifolia*  
*Acacia sclerosperma*  
*Acacia translucens*  
*Bonamia rosea*  
*Cassia notabilis*  
*Cassia oligophylla*  
*Cassia pruinosa*  
*Carissa lanceolata*  
*Corchorus walcottii*

*Indigofera* sp.  
*Psoralea lachnostachys*  
*Ptilotus obovatus*  
*Rhynchosia* sp.  
*Solanum* spp.  
*Trichodesma zeylanicum*

### Grasses

*Aristida browniana*  
*Cenchrus ciliaris*  
*Chrysopogon fallax*  
*Enteropogon acicularis*  
*Eragrostis xerophila*  
*Paraneurachne muelleri*  
*Triodia pungens*  
*Triodia wiseana*

## Condition statement

As with Hard Spinifex pastures, condition levels and the effects of grazing are often difficult to assess on Soft Spinifex pastures. The high frequency of fires means that the presence or absence of particular species or suites of species may be more closely linked to season of firing and post-fire stages than to grazing pressure. Although condition can be regarded as being good whenever a high proportion of soft spinifex occurs in the stand, palatability and carrying capacity will vary with the age of the spinifex. Marked shrub increases after fire can be regarded as indicating a decline in condition. Suijdendorp (1981) suggests that 'shrub invasions' do occur after a winter burn. The unpalatable low shrub poverty wattle may thrive and establish in thick stands, at the expense of the spinifex. A stable, less productive disclimax situation is reached. Winter burning appears to promote the vigorous growth of other undesirable and unpalatable perennials such as cockroach bush and wooly corchorus. Some dense, localized patches of shrubs were observed on Soft Spinifex pastures within the survey area, but generally shrub invasion was not considered to be a significant problem.

The condition of Soft Spinifex pastures in the survey area is generally good, but there are some extensive areas that are obviously in poor condition. Soft Spinifex pastures on parts of the Cheerawarra land system near the coast have been depleted and severe wind erosion, resulting in large, saline scalds and sand piling and hummocking, is common. Soft Spinifex pastures on the Mallina system are mostly in good condition, but there are considerable areas of degradation. Such areas are characterized by numerous wind scalds 30 - > 300 m in extent with vegetation reduced to patches on remnant surfaces or wind accumulated sandy hummocks on the scald margins. Water erosion in the form of rilling, scouring and redistribution of soil may also be present.

Soft Spinifex pastures on alluvial plains, stony plains and sand plains elsewhere in the survey area are inherently stable under grazing. Wind erosion may occur on burnt areas that have not received rain, but spinifex seedlings, herbs and annuals rapidly recolonize and stabilize such areas after rain.

## Management

Soft Spinifex pastures are of most use to stock when spinifex plants are young and a range of other grasses, herbs and forbs are present. Areas of useful pasture can be maintained by a system involving periodic burning on a paddock or sub-paddock scale (using natural firebreaks and cleared lines wherever possible) and rotational use.

There is evidence that, in the Pilbara environment, time of burning influences the resulting species composition of the pasture (H. Suijdendorp, 1967). Summer burning, to encourage grass species rather than shrubs, herbs and forbs, is recommended. Burning should be accompanied by deferment of grazing for 6-8 weeks following effective rainfall to ensure that spinifex seedlings and other species have time to establish and develop.

Soft Spinifex plants will usually regain dominance in a stand within about five years. By that time its palatability will be relatively low and there are few other useful species left in the stand. Rotational burning of these pastures will ensure that, at any given time, some areas are in the most acceptable stages of growth with a wide range of plant species available for grazing.

Exceptions to the general recommendation of regular burning need to be made. On the Cheerawarra land system, burning is not recommended as the system is inherently highly susceptible to wind erosion. Grazing pressure needs to be carefully manipulated to ensure that ground cover of desirable perennials such as soft spinifex and buffel grass is sufficient to maintain soil stability.

#### Suggested levels of use (per annum):

Young stands with high numbers of palatable species	6-8 ha/sheep unit (s.u.)
Older stands with only a low to moderate number of palatable species	12 ha/s.u.
Old stands or stands with few palatable species	25 ha/s.u.

## Buffel Tussock Grass pasture type

Area 340 km<sup>2</sup> (3.3%)

### Distribution and soil types

The introduced buffel grass (*Cenchrus ciliaris*) is established throughout the survey area. It occurs as small inclusions on sandy drainage floors along rivers and creeklines on numerous land systems as well as on some much larger areas. Buffel Grass pastures are common on the sandy alluvial plains, river terraces, levees and channel banks of the River land system. They are an important pasture component of sandy surfaced hummocky plains of the Cheerawarra system near the coast.

Generally, the soils favoured by buffel grass are sandy alluvial soils and calcareous gradational soils. Buffel grass is a vigorous competitor and often acts as a pioneer stabilizing disturbed or eroded areas.

### Physiognomy and composition

Within the survey area, Buffel Tussock Grass pastures usually take the form of dense tussock grasslands, grassy tall shrublands or grassy woodlands. On the open plains of the Cheerawarra system it occurs as almost mono specific grasslands with a basal cover up to 8%, or is co-dominant with other grasses such as soft spinifex (*Triodia pungens*) and ribbon grass (*Chrysopogon fallax*). Trees are absent and shrubs such as giant bindii (*Scleroleana hostilis*), if present, have PFC usually < 2.5%.



The introduced buffel grass (*Cenchrus ciliaris*) has formed tussock grass pastures on the sandy soils of the River and Cheerawarra land systems. These pastures have a high or very high pastoral value, are relatively resistant to grazing and are very effective at stabilizing areas prone to erosion. Site R24.

On levees and banks of the River land system buffel grass forms dense stands (sometimes co-dominant with soft spinifex) beneath scattered trees of coolibah (*Eucalyptus coolabah*) and river red gum (*E. camaldulensis*). Elsewhere on river terraces and narrow drainage floors buffel pastures occur as shrubby grasslands with fire wattle (*Acacia pyrifolia*), (*A. trachycarpa*), kapok bush (*Aerva javanica*) and occasional low corkwood trees (*Hakea suberea*). Shrub PFC is generally < 10%.

## Pastoral value

The pastoral value of buffel grass is high or very high. Pastures respond rapidly to small falls of rain, provide good quality feed when green and, compared with native pastures, can be stocked heavily without deteriorating. However, as with other grass pastures, feed value falls markedly with maturity. When very dry the pastures are not as useful as shrub based pasture types or young soft spinifex pastures.

## Common perennial species

### Trees:

*Eucalyptus camaldulensis*  
*Eucalyptus coolabah*  
*Hakea suberea*

### Low shrubs (< 2 m)

*Acacia farnesiana*  
*Acacia pyrifolia*  
*Acacia translucens*  
*Aerva javanica*  
*Psoralea* sp.

### Tall shrubs (> 2 m)

*Acacia coriacea*  
*Acacia pyrifolia*  
*Acacia trachycarpa*

### Grasses:

*Cenchrus ciliaris*  
*Cenchrus setigerus*  
*Chrysopogon fallax*  
*Eragrostis eriopoda*  
*Eragrostis xerophila*  
*Eulalia fulva*  
*Triodia pungens*

## Condition statement

Buffel Grass pastures often provide dense ground cover and are usually in good condition. However, where buffel is acting as a primary colonizer, such as on degraded hummocky plains of the Cheerawarra land system or on sandy hummocks around wind scalds on the Mallina system, the overall condition may be fair or poor.

There are generally no sensitive shrub indicator species in Buffel Grass pastures, but other desirable perennial grasses may be present. Their absence though does not necessarily indicate poorer condition, but rather the aggressive competitiveness of buffel grass. The condition of buffel pastures is best assessed by observing such characteristics as the degree of ground cover (basal cover) afforded by tussocks, the vigour of tussocks and the age structure of the stand.

## Management

Buffel Grass pastures in good condition are stable and very resistant to grazing. They should be stocked fairly heavily to maintain the stand in a short condition as this will encourage and prolong the production of green shoot and leaf. Green feed is available for at least six months of the year, given a reasonable season. Animal productivity over

this time will be good. However, when pastures are completely dry or if they become tall and rank they are less palatable to stock and animal performance will be poor.

Buffel grass is capable of setting some seed even with heavy grazing, however, occasional spelling for 4-8 weeks over a growing season will ensure that the stand sets plentiful seed and remains vigorous. It is not necessary or desirable to spell for longer than eight weeks as the pastures will quickly become rank if left ungrazed.

## Suggested levels of use (per annum):

Good condition, dense stands	2 ha/sheep unit (s.u.)
Fair condition	5 ha/s.u.
Poor condition	20 ha/s.u.

## Stony Chenopod Pasture type

Area 45 km<sup>2</sup> (0.4%)

## Distribution and soil types

This pasture type is only significant on parts of the Paraburdoo and Sherlock land systems although it also occurs as small patches on other systems such as Horseflat. On the Paraburdoo and Sherlock systems it occurs on stony plains which are frequently a mosaic of gilgai and non gilgai surfaces each 10 or 20 m in extent. Soils are alkaline, non cracking red clays and red duplex types. Dense stony mantles are usually present.

## Physiognomy and composition

The structure of the pasture type is invariably a snakewood (*Acacia xiphophylla*) shrubland usually 2-3 m high, but occasionally 1-1.5 m. Low shrubs which characterize the pasture are clumped beneath or scattered between the snakewoods. The most important are ruby saltbush (*Enchylaena tomentosa*), silver saltbush (*Atriplex bunburyana*), tall saltbush (*Rhagodia eremaea*), giant bindii (*Sclerolaena hostilis*) and creeping cassia (*Cassia hamersleyensis*). Total PFC of the shrubs is commonly 10-20%.

The ground layer consists of very scattered or patchy perennial grasses such as curly windmill grass (*Enteropogon acicularis*), Roebourne Plains grass (*Eragrostis xerophila*), soft spinifex (*Triodia pungens*) and occasionally buffel grass (*Cenchrus ciliaris*).

## Pastoral value

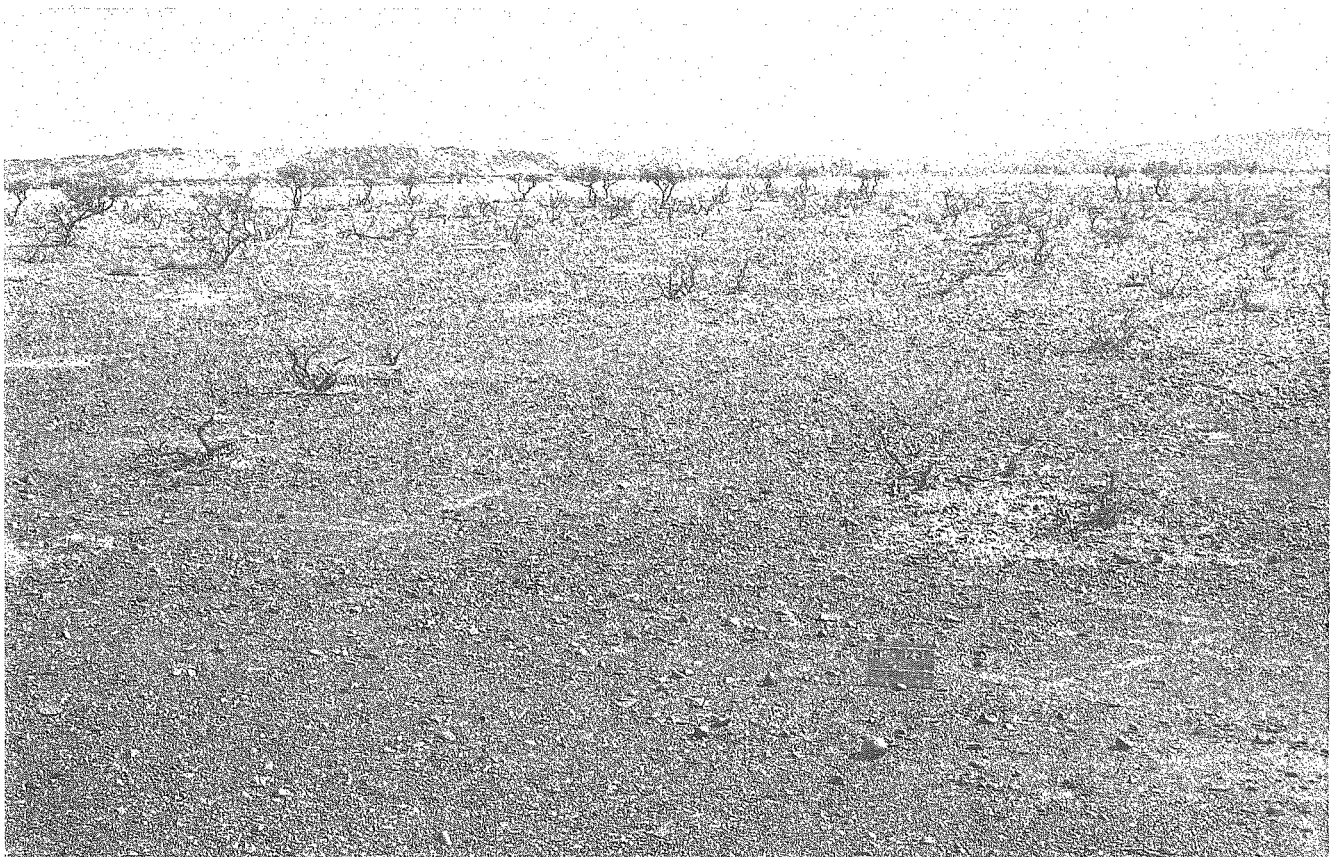
Pastoral value is moderate or high. The low shrubs include a number of palatable types which provide high quality feed in dry seasons. These are augmented by scattered perennial grasses and a range of forbs and herbs in season.

The pasture type may be selectively grazed by livestock in preference to other pastures such as Hard and Soft Spinifex.





The Stony Chenopod pasture type consists mainly of ruby saltbush (*Enchylaena tomentosa*) and climbing saltbush (*Rhagodia eremaea*) growing under snakewood (*Acacia xiphophylla*) communities. This site (near R64) is in good condition.



Over much of the study area overgrazing on Stony Chenopod pastures has resulted in the removal of palatable species and, in some cases, the death of snakewood. This site (R23) is in very poor condition.



## Common perennial species

### Tall shrubs (> 2 m)

*Acacia sclerosperma*  
*Acacia victoriae*  
*Acacia xiphophylla*

### Low shrubs (< 2 m)

*Acacia victoriae*  
*Acacia xiphophylla*  
*Atriplex bunburyana*\*  
*Cassia desolata*  
*Cassia leurossenii*  
*Cassia hamersleyensis*\*  
*Cassia oligophylla*  
*Corchorus* sp.  
*Enchylaena tomentosa*\*  
*Rhagodia eremaea*\*  
*Sclerolaena hostilis*\*  
*Sida* sp.  
*Solanum* sp.

\* desirable indicator species

## Condition statement

There are a number of key shrubs in this pasture type which indicate condition status. When in good condition, silver saltbush and ruby saltbush should dominate in the low shrub layer and other desirable species such as creeping cassia, tall saltbush and perennial grasses are common. Fair condition may be indicated by a marked decline in silver saltbush which is sensitive to high grazing pressure. Other desirables should still be present. As condition deteriorates, silver saltbush disappears completely and other desirables,

such as ruby saltbush, exist only as occasional plants beneath the snakewood. In some cases much of the snakewood may be dead or moribund.

Because of the generally stony nature of the sites, soil erosion is not usually a problem even when pastures are in very poor condition. Occasional rilling and gullyng occurs on the more sloping sites or those not protected by a stony mantle.

Condition of Stony Chenopod pastures, seen in the survey area, varies from fair to very poor. Silver saltbush was not identified in any of these pastures during the survey. There is considerable pasture deterioration on parts of the Sherlock land system but little erosion. Where the pasture type exists as small inclusions within other broad pasture types it may be preferentially overused and frequently degraded with loss of ruby saltbush. There were many instances of dead and moribund snakewood with the low shrub layer completely absent.

## Management

Management should be aimed at maintaining the productivity and vigour of the desirable low shrubs. It is important that Stony Chenopod pastures are often small productive inclusions within other less attractive pastures and that they may be preferentially grazed. In these circumstances it is impossible to fence the Stony Chenopod pastures as separate entities. The effects of grazing on the preferred pasture needs to be carefully monitored.

### Suggested levels of use (per annum):

Good condition	12 ha/sheep unit (s.u.)
Fair condition	20 ha/s.u.
Poor condition	30 ha/s.u.

## Major areas of degradation

It was possible to group most of the occurrences of degradation into 13 major areas which are shown on Figure 7. Within each area there is usually a degree of consistency with regard to the nature and degree of degradation. Each individual major area can be viewed as a potential management unit for which specific rehabilitation programmes could be developed.

For each of the major areas of degradation the location and land systems involved are described, the type of degradation and its current status are discussed, as are the likely offsite effects (with an emphasis on dust storms). Possible management techniques are discussed in this section. A more detailed discussion of possible management techniques for the different types of degradation on the different land systems is presented in the section on regeneration techniques. Appendix 5 details the type and extent of degradation on each of these major areas, as well as the land systems involved.

### Area 1 – Karratha Coast

#### Location

This area is to the west of the Dampier saltworks on Karratha station situated between the coast and the North West Coastal Highway. Much of the degradation is concentrated on the margins of the Yanyare and Maitland Rivers, on the Horseflat and Cheerawarra land systems. The Lower Yanrey and Cheerawarra paddocks contain most of the degradation.

#### Type of degradation

There are about 2000 ha of degraded land in this area, of which 550 ha are severely degraded and eroded, 1280 ha are degraded and 170 ha are gullied.

Severe wind erosion has resulted in the formation of saline scalds with hummocks on the Cheerawarra land system close to the coast. Large saline scalds are also present on the Horseflat land system along the rivers margins; these are probably the result of wind erosion. In some areas there are dead remnants of snakewood communities. There are also patches in these areas where pasture deterioration and minor erosion have occurred. Along the margins of the Maitland and Yanyare Rivers water erosion and minor gullying is common.

#### Current status

In several localities active wind erosion is evident, especially on the puffy saline soils of the Cheerawarra land system. Although the scalds on the Horseflat land system tend to have compacted surfaces, they continue to wind erode when loose material is generated by stock trampling.

Other areas are fairly stable, either because of the presence of a stony mantle or the natural establishment of dense stands of giant bindii (*Sclerolaena hostilis*). Treatment by pitting has been attempted on the large scald near the mouth of the Yanyare River, however this has been ineffective.

#### Off site effects

Dust emanating from this area because of strong, hot easterly winds is likely to be blown directly out to sea where



Remnant snakewood stumps (*Acacia xiphophylla*) show the extent of soil loss on this severely degraded and eroded area on the Horseflat land system. Degradation area 1 – Karratha Coast.

it would not constitute a major problem. However, dust storms may also be generated by strong sea breezes and this area could be a source of dust affecting Karratha and other towns to the north-east.

Suggested management

In much of the area, natural regeneration is likely to occur if stock are removed for a few growing seasons. This process of regeneration has already commenced in places where the grazing pressure is relatively low. However, some of the worst scalds along the rivers will require cultural treatment such as ponding and ripping.

On the highly saline, puffy soils near the coast, large scale cultivation works should not be attempted at this stage as

there is a danger that disturbance could lead to accelerated erosion. In these areas, the authors consider that the best policy is to try to trap wind-blown material and stabilize it. Techniques to achieve this will need to be developed.

Area 2 – Karratha Homestead

Location

This area consists of a number of relatively small and sparsely scattered patches of degradation, occurring both to the east and west of the homestead on Karratha station. The degradation in this area occurs on Horseflat and Mallina land systems.

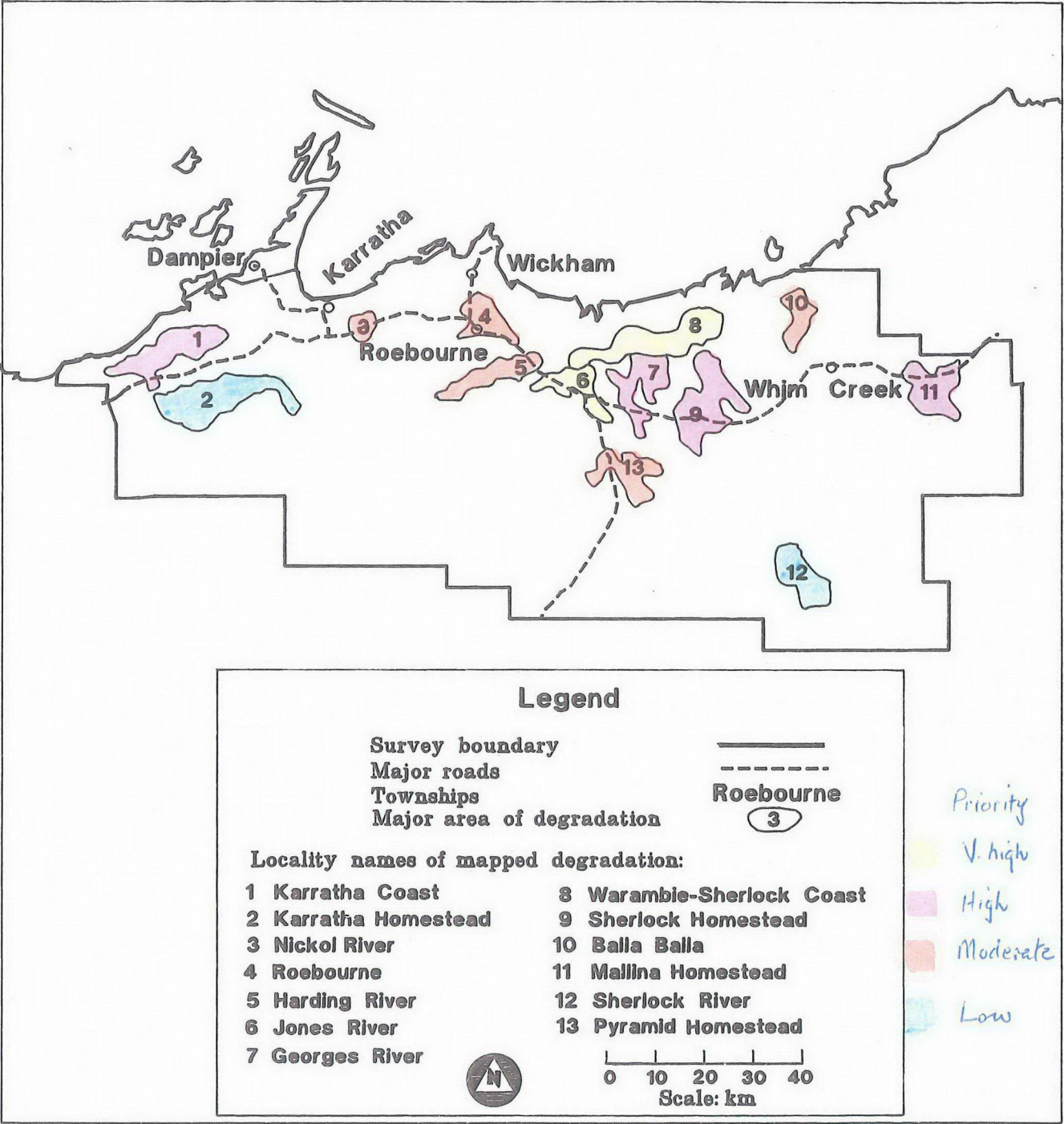


Figure 7. Major areas of degradation, Roebourne Plains survey

## **Type of degradation**

There are about 840 ha of degradation in this area, of which 750 ha are degraded and 90 ha are gullied. On a further 550 ha regeneration works have been undertaken.

Patches of pasture deterioration with minor wind erosion are found on the Horseflat land system. Moderate wind erosion with scalds and hummocks occurs on the Mallina system. There are some areas of snakewood near the homestead suffering from severe decline. Two patches of moderate gully erosion are located in this area, the larger one being near Whyjabby Well in Corringer paddock.

## **Current status**

Most of the worst affected areas have been treated with ponding banks or cultivation. On most of these, good germination of annuals has occurred, however, perennial cover has not yet established. Many other degraded areas appear to be regenerating because of conservative stocking. The gullies near Whyjabby Well are actively eroding.

## **Off site effects**

This area is unlikely to be a major source of dust because of the relatively small areas involved and the fact that some ground cover is often present.

## **Suggested management**

Most of the areas requiring cultural treatment have already been treated. Some of the ponding banks which are falling into disrepair should be regraded and protected from stock to ensure continued regeneration. Additional cultivation, such as chisel ploughing or ripping, within the ponded areas is likely to enhance the regeneration process.

## **Area 3 – Nickol River**

### **Location**

This area straddles the North West Coastal Highway in the vicinity of the Nickol River on the eastern edge of Karratha station. It extends over a fairly small area, however, a large proportion of this area is degraded. Most of the degradation occurs on the Horseflat land system, although it also extends onto the Cheerawarra system.

### **Type of degradation**

There are about 840 ha of degradation in this area, of which 150 ha are severely degraded and eroded, and 690 ha are degraded.

There is severe wind erosion with saline scalds and hummocks evident north of the North West Coastal Highway in Quartz Hill paddock. Patches of pasture decline with minor wind erosion occur north and south of the highway in Nickol paddock. Small areas of minor rilling and gullying are evident along the margins of the river.

### **Current status**

Some wind scalds are actively eroding, while others are partly stabilized by the presence of a stony mantle. Some

areas in the Quartz Hill paddock are being colonized and stabilized by giant bindii because of the absence of stock. The majority of hummocks are vegetated and stable.

## **Off site effects**

The larger active wind scalds are situated a few kilometres east-south-east of Karratha townsite and are likely to contribute to dust storms affecting the town.

## **Suggested management**

The Quartz Hill paddock has been destocked and is unlikely to be grazed in the future. Natural regeneration is occurring on much of this area. Ponding and ripping may be suitable for some scalds, however, it is unlikely to work on saline puffy scalds close to the coast. On these areas trapping drifting sand to create hummocks and allowing them to revegetate naturally may be feasible.

In the north end of the Nickol paddock much of the degradation will probably regenerate if stock are excluded, though some areas may benefit from ponding and ripping.

## **Area 4 – Roebourne**

### **Location**

This area is located around the Roebourne townsite, mostly to its north and east, on Mt Welcome station and various reserves. The degradation has occurred on the Horseflat, Cheerawarra and Littoral land systems.

### **Type of degradation**

There are about 946 ha of degradation in this area, of which 83 ha are severely degraded and eroded, 823 ha are degraded and 40 ha are gullied.

Wind erosion with saline scalds and partly stabilized hummocks is evident. One site of severe wind erosion is located at the mouth of the Harding River. Three stretches of gullying are found to the west of the Harding River. Some extensive stretches of silt deposits and puffy saline soils occur near the mouth of the Harding River. These areas are bare, soft and highly susceptible to wind erosion.

### **Current status**

Most of this area has not been stocked for a considerable time and apart from the worst scalds, appears to be regenerating. Soft spinifex, buffel grass, silver saltbush and giant bindii are all present on hummocks and some of the scalds. However, some areas of active erosion remain and the fine silt deposits at the mouth of the Harding River cannot support vegetation.

### **Off site effects**

Although much of this area appears to be stabilizing, the remaining bare areas, because of their close proximity to Roebourne and Wickham townsites, are likely to make a significant contribution to dust problems in the towns.



## **Suggested management**

This area should continue to remain unstocked. Some regeneration works may be of benefit, especially on the patches adjacent to Roebourne townsite.

## **Area 5 – Harding Rivers**

### **Location**

This area occurs as a narrow band along the Harding and East Harding Rivers, stretching from Woodbrook homestead east to the North West Coastal Highway. It is located mainly on Mt Welcome station with a few cases on Warambie station. Most of the degradation is on the Horseflat land system although some patches occur on the Mallina system.

### **Type of degradation**

There are about 1350 ha of degradation in this area, of which 220 ha are severely degraded and eroded, 1010 ha are degraded and 120 ha are gullied.

Most of the degradation is pasture decline with some wind erosion. A number of cases of severe wind erosion are present in addition to stretches of minor gullying.

### **Current status**

There are some areas of active wind erosion, however, much of the area mapped as being degraded is partly stabilized by a stony mantle. The gullies are partly stabilized.

### **Off site effects**

Some of the actively eroding areas may contribute to dust storms, they are however, relatively small in area and are separated from the towns by hills. As a result this area is not likely to be one of major concern or priority.

### **Suggested management**

Most of these areas would benefit greatly from destocking. The worst affected areas may need cultural treatment such as ponding and ripping.

## **Area 6 – Jones River**

### **Location**

This area is located in the vicinity of the Jones River, mainly to the north of the North West Coastal Highway on Warambie station. It covers a large area of which a substantial proportion suffers degradation. The worst affected areas are in the Jones Coast paddock and almost all the degradation is situated on the Horseflat land system. There are a number of sites on the Cheerawarra land system and one smaller one on the River land system.

## **Type of degradation**

There are about 2020 ha of degradation in this area, of which 420 ha are severely degraded and eroded, 790 ha are degraded and 810 ha are gullied. There are extensive patches of severe wind erosion with scalding and hummocking, as well as areas of pasture decline with minor wind erosion. Along the margins of the Jones River, and some of its tributaries, minor to moderate gullying and rill erosion are found. These gullies are short and run at right angles to the river channel. There is some moderate gullying along the highway which appears to have been initiated as a result of road and powerline construction.

On the northern extreme of this area there are some cases of wind erosion with puffy saline scalds.

### **Current status**

The areas of severe wind erosion in Jones Coast paddock remain active. Other areas where pastures are degraded will remain susceptible to wind erosion unless the perennial grass cover can be improved. Some patches near the highway are partly stabilized by the presence of a moderately dense stony mantle. There are extensive areas along the highway which support no perennial grasses, but which are stable because of the presence of a very dense surface mantle of stone. These areas have not been mapped as being degraded because they are not eroding and it is suspected that they are not capable of supporting perennial grass pastures.

Some of the gullies along the river are partly stabilized while others remain actively eroding. The gullies associated with the highway and powerline are actively eroding.

### **Off site effects**

This area has previously been singled out as the likely major source of dust storms which affect the towns. This is partly because the area of degradation is visible to the public. There have been complaints from travellers about over stocking. The large stony plains create a bad impression, even if they are not the result of mismanagement.

Although this is undoubtedly a major dust generating area which directly affects the highway, and probably affects the towns of Roebourne and Wickham, it would appear that a larger volume of dust comes from the areas nearer to the coast.

The stony plains, which the public perceives to be degraded, probably contribute little if any dust to the atmosphere.

### **Suggested management**

Areas with dense stony mantle are best left untreated at this stage. Although cultivation may improve pasture growth any disturbance of the topsoil and stony mantle could result in wind or water erosion being initiated.

If possible, stock should be totally excluded from the Jones Coast paddock. Failing this, stocking rates should be kept to a bare minimum. Ponding and ripping will be necessary to regenerate the large scalds.

Any treatment of the fringing gullies along the river would be excessively expensive, and most of these gullies do not pose a major problem. Earth works may prove effective on some of the gullies in the vicinity of the North

West Coastal Highway and the powerlines. More detailed investigation is needed to establish the relationship between the altered drainage because of roadworks and the formation of gullies in this area. Where degradation can be shown to have been caused as a result of the actions of the Government instrumentalities, it should be their responsibility to undertake regeneration work.

## Area 7 – Georges River

### Location

This area consists of a number of stretches of degradation occurring along the margins of rivers and creeks in the north-east corner of Warambie station. These stretches are located along the Georges and Little Sherlock Rivers and their distributaries. They occur exclusively on the Horseflat land system.

### Type of degradation

There are about 2220 ha of degradation in this area, of which 580 ha are severely degraded and eroded, 1120 ha are degraded and 520 ha are gullied.

Fringing gullies occur along the margins of the Georges and Little Sherlock Rivers. These are mostly very short and usually about a metre deep. Above the gullies, wind scalds are often present. There are some areas of severe wind erosion with extensive bare scalds and wind hummocks. Away from the main rivers there are also a number of areas suffering from pasture decline and minor wind erosion. Even in areas not mapped as degraded in this general vicinity, pasture condition is often poor.

### Current status

Many of the fringing gullies have active headwalls although the floors are often stabilized with buffel grass. Although some wind scalds are partly stabilized by the presence of a stony mantle, on many erosion remains active. Generally pasture condition continues to decline, however, there are some areas where pasture regeneration appears to be occurring. Four spiral ponds have been constructed on a degraded area, but it is too early to judge their effectiveness.

### Off site effects

The wind scalds probably contribute to dust storms to a similar extent as the scalds of the Jones River area. If degradation continues in this area it has the potential to become a major source of dust.

### Suggested management

The major works which would be required to fully rehabilitate the gullies are probably not justified economically and, in most cases, the gullies do not constitute a major problem. By stabilizing and revegetating the wind scalds adjacent to the gullies, run-off may be reduced and the rate of gully expansion decreased. Some attempt at regenerating these scalds should be made in any case. Many of the scalds should prove suitable for ponding.

Serious consideration should be given to destocking the Georges Coast paddock. This paddock contains some of the worst degradation in the area, including extensive wind

scalds in the adjoining Area 8 (Warambie-Sherlock Coast). It has large areas which could become severely degraded with further grazing pressure.

## Area 8 – Warambie-Sherlock Coast

### Location

This area covers a coastal strip, some 2-7 km wide on Warambie and Sherlock stations. It extends from the mouth of the Jones River eastwards to the mouth of the Sherlock River. Most of the worst degradation can be found in George Coast paddock on Warambie station and the Coast paddock on Sherlock station. The degradation has occurred mainly on the Cheerawarra land system, although in places it extends onto the Horseflat land system.

### Type of degradation

There are about 3450 ha of degradation in this area, of which 1800 ha are severely degraded and eroded, 1510 ha are degraded and 140 ha are gullied.

There is extensive severe wind erosion, with large bare scalds on puffy saline soils and large, partly stabilized, wind hummocks. Large areas are almost totally devoid of vegetation or have a very sparse cover of spinifex or Roebourne plains grass. There are also areas of less severe wind erosion and a number of moderate gullies, the latter being mainly in Coast paddock.

### Current status

Although erosion in this area may be a natural process it is likely that the rate of erosion has been accelerated by grazing pressure in the past. There are large areas where wind erosion actively occurs at the present and dust is being generated even by moderate strength winds. Much of the stable land in this area has the potential to become unstable. A number of the gullies are actively eroding.

### Off site effects

This area is probably the single greatest source of dust for the dust storms which are affecting local towns. It lies directly east of Roebourne, Wickham and Karratha and any dust uplifted by strong easterly winds is likely to be blown over these towns. There are large areas subject to erosion and the soils are highly erodible.

### Suggested management

Great difficulties will be experienced in attempting to rehabilitate this area because conditions are so unsuitable for plant growth. Large scale cultivation works should not be attempted at this stage as there is a danger that disturbance could lead to accelerated erosion.

Hummocks can be stabilized with buffel grass and spinifex and, by trapping wind-blown sand, further hummocks could be created on the scalds. To achieve this, new techniques will have to be developed.

Consideration should be given to destocking George Coast and Coast paddocks to prevent further degradation and encourage natural regeneration to occur. Giant bindii (*Scleroleana hostilis*) is a species that may be useful in attempting regeneration.



The Cheerawarra land system contains large areas of bare saline scalds. These scalds have fine puffy soils which are highly susceptible to wind erosion. They are likely to be a major source of the dust storms which occasionally affect the area. Site R51. Degradation area 8 – Warramie-Sherlock Coast.



Areas along the North West Coastal Highway west of Jones River support very little perennial pasture. However, the presence of a stony mantle over much of this area means that the risk of wind erosion is slight.



Active gully erosion on the edges of the Horseflat land system near the Little Sherlock River.



Many areas of gully erosion are relatively stable because of the presence of a stony mantle on the surface and the establishment of buffel grass (*Cenchrus ciliaris*) on the gully floor. Site R46.



## **Area 9 – Sherlock Homestead**

### **Location**

This area is located on the eastern portion of Sherlock station with the main concentrations of degradation being along the Sherlock River and Bookingarra Creek. The degradation has occurred on the Horseflat and Mallina land systems.

### **Type of degradation**

There are about 2460 ha of degradation in this area, of which 390 ha are severely degraded and eroded, 1460 ha are degraded and 610 ha are gullied.

Two large patches of wind erosion occur in this area, one along the boundary fence between Niana and Bottom Niana paddocks, and one adjacent to the North West Coastal Highway in Home paddock. These both display large scalds and hummocks. There are some cases of smaller scattered wind scalds on Mallina land system in the south of the area. On the Horseflat land system there are a number of areas suffering pasture decline and some minor wind erosion. A number of areas have been affected by rill erosion and minor to moderate gullying.

### **Current status**

Although some areas of wind erosion are partly stabilized by a stony mantle, many continue to be active. Of the areas now suffering from pasture decline, many have the potential to become severely wind eroded. Many of the gullies are partly stabilized with good grass cover on their floors.

### **Off site effects**

The areas affected by wind erosion may contribute to the dust storms affecting the towns, but to a lesser degree than the Warambie-Sherlock Coast area. The patch in Home paddock may also be a source of dust affecting the North West Coastal Highway. The degradation here is also visible from the Highway.

### **Suggested management**

Many of the degraded areas will regenerate naturally if grazing pressure is reduced. Severe scalds may require cultural treatment such as ripping and ponding. Gully control measures are probably not warranted.

## **Area 10 – Balla Balla**

### **Location**

This area is located on the north-west corner of Mallina station. It consists of one large patch of degradation, situated mainly in Quartz Hill paddock, and a few smaller scattered patches surrounding it. The degradation has occurred within the Horseflat land system.

### **Type of degradation**

There are about 960 ha of degradation in this area, of which 20 ha are severely degraded and eroded, 900 ha are degraded and 40 ha are gullied.

Extensive pasture deterioration and minor wind erosion has occurred on a 750 ha patch between Quartz Hill bore and Tin Hat well. Within this patch there are sites of severe wind erosion with scalds and hummocks, in addition to minor water erosion. A smaller though similar patch is located near O.T. well. Some gullying associated with roads and tracks is present.

### **Current status**

The severe wind scalds remain active, while many of the hummocks are partly stabilized by soft spinifex. Some of the degraded flats are partly stabilized by the presence of a stony mantle or remnant Roebourne Plains grass. The gully erosion associated with roads and tracks is active.

### **Off-site effects**

This area is a substantial distance east of the townsites with limited areas suffering severe wind erosion. As a result, it is probably not a major source of dust. However, it is highly visible to travellers heading to Balla Balla harbour.

### **Suggested management**

Most of this area should be capable of natural regeneration provided it is subjected to minimal grazing pressure. The areas with severe wind scalds may require cultural treatment such as ponding and ripping.

## **Area 11 – Mallina Homestead**

### **Location**

This area consists of a number of parcels of degradation situated around Mallina homestead on Mallina station. Most are located south of the North West Coastal Highway between Peawah River and Poverty Creek. All the degradation has occurred on the Mallina land system.

### **Type of degradation**

There are about 2130 ha of degradation in this area, of which 530 ha are severely degraded and eroded and 1600 ha are degraded.

Cases of extensive severe wind erosion with scalding and hummocking occur predominantly to the west of the homestead and just north of Three Mile well. Some of these areas experience minor water erosion. There are extensive areas of small scalds in a mosaic pattern with well vegetated hummocks. These have been mapped as being degraded.

### **Current status**

Active wind erosion occurs on the large scalds, however, in some areas these are partially stabilized by a stony mantle. The smaller scalds probably only experience minor wind erosion. Most of the hummocks are stabilized by a good cover of soft spinifex.

### **Off site effects**

A relatively large amount of dust may be generated off the large scalds. This may contribute to the dust storms affecting the townsites, but probably not as much as those



A severely degraded and eroded area on the Horseflat land system. This photograph shows the hard scalded surfaces and hummocks of loose material formed as a result of wind erosion. Degradation area 10—Balla Balla.

areas which are closer to the townsites. Dust from this area may also affect the highway. The smaller scalds probably are not a major dust source as the surrounding hummocks would decrease the erosive power of the winds.

### **Suggested management**

Cultural treatment such as ponding and ripping may be required on the larger scalds. As much of the worst degradation occurs in holding paddocks around the homestead it will be difficult to devise a suitable stocking management policy. As far as is practical, minimal use should be made of these paddocks.

The areas mapped as degraded should be subjected to minimal grazing pressure. In many cases cultural works on the small scalds are not recommended as they are likely to disturb the stabilized hummocks and lead to accelerated erosion.

## **Area 12—Sherlock River**

### **Location**

This area consists of a number of relatively small sites around the Sherlock River, south of the Old Croydon homestead, on Mallina station. Most of the degradation is on Sherlock land system although some occurs on River land system.

### **Type of degradation**

There are about 1020 ha of degradation in this area, of which 920 ha are degraded and 100 ha are gullied.

Pasture deterioration has occurred in the snakewood shrubland, and in some localities the snakewood communities have died out completely. Pasture deterioration has also occurred in the Roebourne Plains Grass pastures. Wind erosion is evident in some areas. Sheet erosion, rilling and gullying are sometimes present.

### **Current status**

Wind erosion is not extensive because a protective stony mantle is often present. Some of the water erosion remains active although many areas on the River land system which previously experienced wind or water erosion have now stabilized with a good cover of buffel grass.

### **Off site effects**

Very little dust would be uplifted from this area which is in an isolated location.

### **Suggested management**

Much of the area is unsuited to cultural treatment as it is subjected to flooding and channelized flow.

Ponding or ripping may prove effective in some places, but careful management of stocking rates is probably more appropriate for most of this area.

Care should be taken to maintain the good stand of buffel grass pastures on the River land system, which is highly susceptible to erosion if the ground cover is depleted.

## Area 13 – Pyramid Homestead

### Location

This area consists of a number of sites around Pyramid homestead. It is located mainly on Pyramid station, but extends north into Warambie station. The vast majority of the degradation has occurred on the Horseflat land system.

### Type of degradation

There are about 1740 ha of degradation in this area, of which 240 ha are severely degraded and eroded, 1380 ha are degraded and 120 ha are gullied.

Extensive areas of pasture deterioration have occurred, including one large parcel of 550 ha adjacent to the

homestead. These areas experience some wind erosion. A few smaller patches of severe wind erosion with scalds and minor hummocking are evident. There is some water erosion associated with the flooding of the Georges River and minor gullying below the footslopes on the edges of the valley.

### Current status

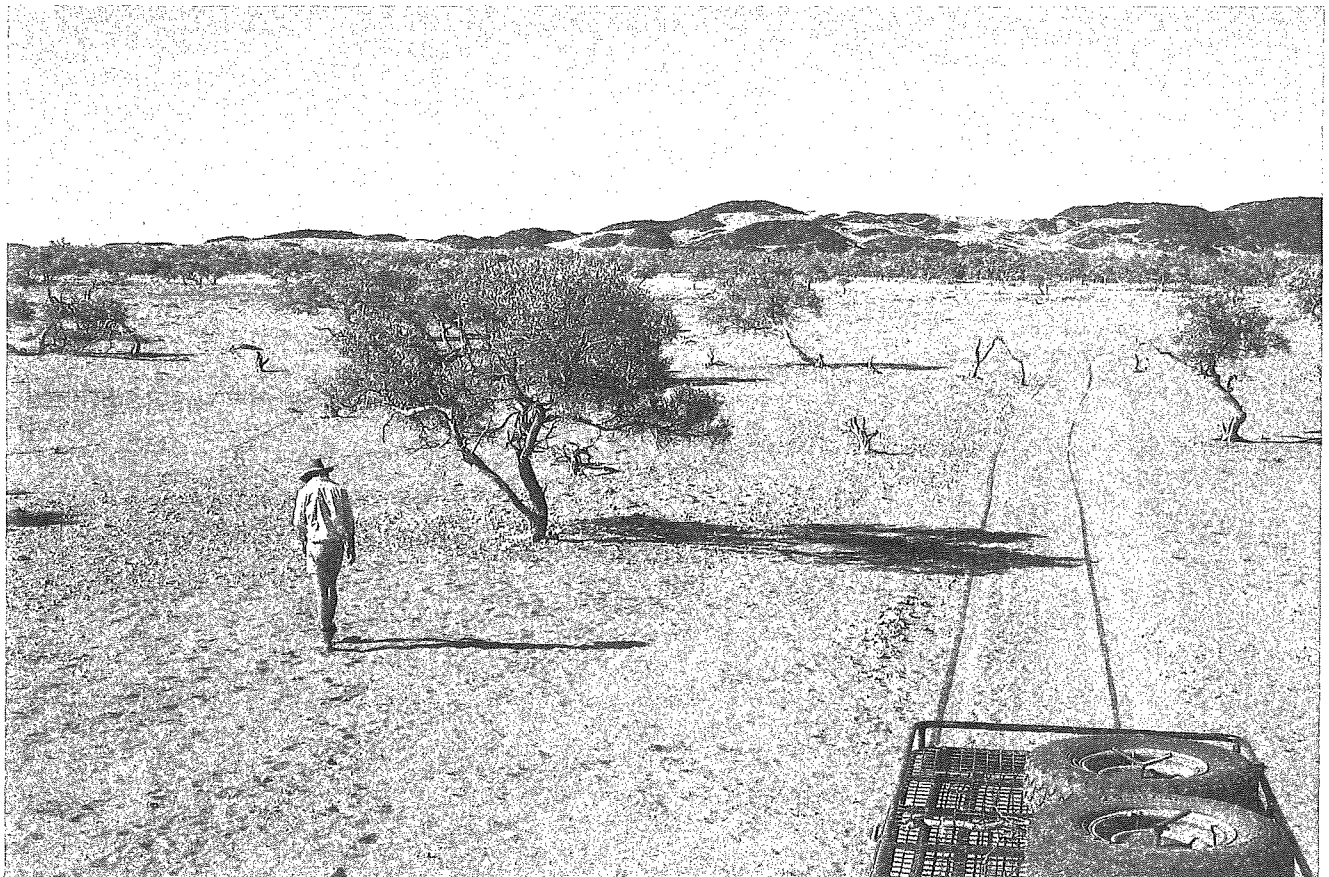
Active wind erosion is confined to a few areas, much of the area being partially stabilized by a stony mantle or remnant Roebourne plains grass. Sediment deposited by flooding is sometimes subject to wind erosion. Much of the water erosion appears to be associated with flooding and will probably continue to occur during inundation.

### Off site effects

This area is unlikely to be a major dust source because of the limited area of active wind erosion. Some uplifted dust may affect the Roebourne-Wittenoom road at times.

### Suggested management

Although some sites may require cultural works such as ponding and ripping, most of this area should regenerate naturally with careful management and control of grazing pressure.



A mantle of loose mobile sand has formed on this paddock as a result of severe wind erosion following the removal of the Roebourne Plains grass pastures. Degradation Area 13 – Pyramid Homestead.

# Regeneration techniques

In most cases, there are several different methods of tackling the problems associated with management and techniques for regenerating degraded areas, and only time and experience will show which is the best. By necessity, much of the early work will be experimental and pioneering in nature.

In any attempt at regenerating degraded areas it is essential to control stock access. Grazing pressure will prevent or seriously retard the growth of seedlings. Trampling by stock is likely to lead to accelerated erosion of fragile soils, and often results in the breaching of ponds and other earth works. Preferably, stock should be totally excluded from areas that are being regenerated. Failing this, stocking rates should be kept to a bare minimum.

Different types of degradation on different land systems are discussed separately.

## Severely degraded areas—Cheerawarra, Horseflat and Mallina land systems.

### Cheerawarra land system

Severe wind erosion has resulted in large, bare saline scalds in depressions, surrounded by large sandy hummocks. The hummocks are often stabilized by soft spinifex (*Triodia pungens*), buffel grass (*Cenchrus ciliaris*) and giant bindii (*Sclerolaena hostilis*). Some are only partly stabilized with annuals, however, regeneration should occur on these areas if stock are excluded. The addition of buffel grass seed may help enhance this process.

The scalds have loose, puffy, saline clay soils, sometimes protected by a thin surface crust. This crust is very fragile and is readily broken by any disturbance such as stock trampling. It appears that dust will be generated from these soils by lower velocity wind than those required to uplift dust on other soil types.

The soils of the scalds are highly to extremely saline and strongly sodic. In the surface soil, salt levels of 1.3% chloride (7000 mS/m EC<sub>e</sub>) have been recorded, along with an exchangeable sodium percentage of 45. This is in contrast with undegraded areas on Cheerawarra land system where the topsoil is usually salt free (< 0.05% chloride) and non-sodic (ESP < 6). High salinity and sodicity levels combined with low soil moisture levels and exposure to wind blast result in conditions which are highly unsuitable for plant growth.

Large scale cultivation works should not be attempted at this stage as there is a danger that disturbance could lead to accelerated erosion. However, a number of small scale experiments with cultivation methods (e.g. contour furrowing) are worth testing.

One of the best strategies could be to trap wind-blown material to create hummocks which provide suitable conditions for plant growth. The soils on existing hummocks do not display the high salinity and sodicity levels experienced on the scalds. While it may not be possible to regenerate the entire scald in this manner, the area prone to wind erosion would be decreased. Techniques for trapping wind-blown material, such as brush fencing, are very labour intensive and expensive. One possible method is to use piles of discarded rubber tyres.

Note: Some of these areas may be the result of natural erosion rather than human activities, however, they nevertheless contribute to the dust problem.

### Horseflat land system

Degradation is in the form of large, bare scalds caused by wind erosion. The scalds are often surrounded by stabilized, or partly stabilized hummocks, which support soft spinifex.

The scald surface is usually hard and crusted in contrast with undegraded Horseflat cracking clays which are friable and self mulching. This reduces infiltration and leaching and, as a result, high salinity levels are often experienced. Salinity levels in the top 10 cm are generally in excess of 0.25% chloride (2000 mS/m EC<sub>e</sub>) and levels as high as 2.0% chloride (8000 mS/m EC<sub>e</sub>) have been recorded. Similar salt levels are usually found throughout the profile. These soils are highly sodic with exchangeable sodium percentages around 40 being common, even on the surface. This is in contrast with soils on undegraded areas of the Horseflat land system where the top 40 cm is usually salt free (< 0.05% chloride) and non sodic (ESP < 6).

The hard surface combined with extreme salinity and sodicity create an inhospitable environment for plant growth. Wind erosion occurs when a powdery surface is created by stock trampling. To regenerate these scalds it is necessary to break up the surface to provide a medium for seed germination and allow for the leaching of salt.

This may be achieved by creating ponds to trap water and ripping the surface inside the ponds. Ripping without ponding and pitting may be effective. However, with extremely saline and sodic soils these methods may not prove to be successful in reducing salinity and sodicity levels sufficiently to allow for the re-establishment of desirable species. Trials will need to be done to assess the suitability of these techniques and to identify suitable species. Giant bindii (*Sclerolaena hostilis*) and silver saltbush (*Atriplex bunburyana*) are two local species which may prove suitable. Introduced species which have been established successfully on the Horseflat system near Karratha (Kok *et al.* 1987) include *Atriplex lentiformis*, *A. cinerea* and *A. nummularia*.

In places where strong overland flows occur, ponding works are likely to be breached and rendered ineffective, and may even cause further water erosion. Areas with rilling or channelized flow should definitely be avoided.

### Mallina land system

Severe degradation occurs as large bare scalds surrounded by hummocks of wind-blown material. Hummocks are usually stabilized, or partly stabilized by soft or hard spinifex. The scald surface is usually hard and crusted and very similar to scald surfaces on the Horseflat land system. The sandy topsoil of red duplex and gradational soils which originally occurred in these areas has been stripped by wind erosion so that the soils on the scald surface now resemble the saline clays. The topsoil is usually saline and is sometimes extremely saline. Sodicity levels are also often high.

The same regeneration techniques applied to scalds on Horseflat land system are appropriate for scalds on Mallina land system i.e. ponding and ripping.

## Degraded areas—Cheerawarra, Horseflat, Mallina and Sherlock land systems.

### Cheerawarra land system

Degraded areas occur as discontinuous scalds and hummocks caused by wind erosion. However, the scalds are not as large or as bare as in the severely degraded areas and hummocks are often well vegetated. Salinity levels in the

soils also tend to be lower. The top 10 cm of soils are often relatively salt free with < 0.05% chloride (400 mS/mEC<sub>e</sub>), although the rest of the profile is highly saline and usually has > 0.1% chloride (800 mS/mEC<sub>e</sub>). Similarly, the top 10 cm are sometimes non sodic (ESP < 6) while the remainder of the profile is sodic or strongly sodic (ESP ranging from 10-30).

Many of these areas will be regenerated naturally if stock are excluded. Giant bindii (*Sclerolaena hostilis*) seems to be particularly effective at colonizing these saline and sodic areas, and provides an excellent ground cover. It appears to be palatable to stock when young, but becomes woody and covered with spiny burrs with age. It may be replaced with other species over time by natural succession. On any of the larger scalds the techniques described previously for the severely degraded areas may be applicable. Other species which may be suitable for regenerating these areas are silver saltbush (*Atriplex bunburyana*) and Roebourne Plains grass (*Eragrostis xerophila*).

### Horseflat land system

Degradation is indicated where perennial pastures have declined and been replaced by annuals such as windgrass, or bare patches. The soil surface often shows structural decline, the cracking clays changing from being friable and self mulching to hard and crusty in places. Some wind or water erosion may be occurring.

Although the top 10 cm of the soil is sometimes saline, or highly saline, it is often non saline with < 0.05% chloride (400 mS/mEC<sub>e</sub>). However, the rest of the profile is usually highly to extremely saline, commonly with > 0.15% chloride (1000 mS/mEC<sub>e</sub>) and sometimes up to 1.0% chloride (5000 mS/mEC<sub>e</sub>). The soils are usually sodic or strongly sodic with exchangeable sodium percentages in the top 10 cm ranging from 6-25, and increasing up to 40 in the subsoil.

Many of these areas will regenerate naturally with destocking, though some areas will benefit from regeneration works similar to those described previously for severely degraded areas of the Horseflat system. Because of the lower salinity and sodicity levels in the topsoil, these techniques are more likely to be successful in these areas. Samples taken inside ponds on Karratha station indicate that salinity and sodicity have decreased to a level suitable for the re-establishment of pasture species.

### Mallina land system

Degraded areas occur as relatively small wind scalds surrounded by extensive areas of stabilized hummocks or undegraded alluvial plain. They occur as small areas of clay plains where the perennial Roebourne Plains Grass pastures have become very sparse and patchy. The soils are usually saline to extremely saline, however, the top 10 cm are often salt free. The soils are usually sodic.

These areas probably do not produce much dust, but there is potential for accelerated wind erosion. Conservative stocking should be practiced. Scalds can be repaired using the same techniques described for wind scalds on the Horseflat land system. However, where scalds are small, there is a danger that cultural works may disturb the stabilized hummocks and result in increased erosion.

### Sherlock land system

Degraded areas occur where perennial pastures have deteriorated. In snakewood (*Acacia xiphophylla*) communities this is usually indicated by an absence of chenopods, and in some cases by the death of the snakewood and its associated communities. In the tussock grasslands the deterioration of perennial pastures and their replacement by annuals or bare patches is indicative of degradation.

Some minor wind erosion may occur on gilgai plains which supported tussock grassland. The presence of a stony mantle usually prevents wind erosion in the degraded snakewood communities. Minor water erosion is sometimes present.

Although cultural works may prove effective in some cases on the gilgai plains, destocking is usually all that is required to encourage regeneration. Very little can be done to regenerate degraded snakewood communities apart from removing the grazing pressure.

This land system usually includes bare stony areas which probably never supported anything but very sparse pasture. Machine pitting may encourage pasture growth, but care must be taken with any cultural treatments not to initiate erosion.

### Gullied areas – all land systems

Areas mapped as being gullied usually contain a number of minor to moderate gullies. These gullies are commonly < 1.5 m deep and often partly stabilized. Although some gullies have actively eroding heads and sidewalls, in many cases these are rounded and covered with a dense stony mantle. The gully floors are often broad and flat and sometimes good vegetative cover is present in the accumulated sediment. Buffel grass (*Cenchrus ciliaris*) is a common species on these gully floors.

The gullies usually occupy only part of the area which has been mapped as being gullied. The remainder of the area often consists of scalds which may exhibit some wind or water erosion, or both. In some cases good vegetative cover is present between the gullies, but more commonly the pastures are suffering from water starvation.

Earth works can be constructed to control active gullies, however, these would be very expensive. The gullies may be part of a natural erosion process and, in most cases, are not a major cause for concern except where they threaten roads, fences and other structures. Periodic major flooding of the river systems could be an obstacle to any attempts to control and reclaim gullies.

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# Appendix 1.

## Land system summaries of the stations

### Karratha station (1,003 km<sup>2</sup>)

Land system	Area km <sup>2</sup>	%	Severely degraded & eroded ha	Degraded ha	Gullied ha	Main pasture types	Estimated carrying capacity ha/sheep unit
Boolaloo	1	0.1	—	—	—	Hard Spinifex (50%) Soft Spinifex (50%)	20-40
Boolgeeda	49	4.9	—	—	—	Hard Spinifex (95%)	20-40
Calcrete	5	0.5	—	—	—	Hard Spinifex (85%)	20-40
Capricorn	8	0.8	—	—	—	Soft Spinifex (15%) Hard Spinifex (90%)	40
Cheerawarra	60	6.0	200	503	4	Soft Spinifex (10%) Soft Spinifex (40%) Hard Spinifex (30%) Roebourne Plains Grass (10%) Buffel Grass (10%) Roebourne Plains Grass (95%)	7-25
Horseflat	459	45.7	361	1569	267	Soft Spinifex (10%) Samphire (10%) Hard Spinifex (55%) Soft Spinifex (45%) Soft Spinifex (80%) Roebourne Plains Grass (10%)	6-25 > 40
Littoral	37	3.7	—	—	—	Hard Spinifex (55%) Soft Spinifex (45%) Soft Spinifex (80%) Roebourne Plains Grass (10%)	15-30
Macroy	6	0.6	—	—	—	Hard Spinifex (55%) Soft Spinifex (45%) Soft Spinifex (80%) Roebourne Plains Grass (10%)	7-25
Mallina	96	9.6	—	171	—	Hard Spinifex (55%) Soft Spinifex (35%) Stony Chenopod(10%)	15-30
Paraburdoo	9	0.9	—	—	—	Hard Spinifex (55%) Soft Spinifex (35%) Stony Chenopod(10%)	15-30
River	49	4.9	4	13	19	Buffel Grass (45%) Soft Spinifex (40%) Hard Spinifex (95%)	4-25
Robe	1	0.1	—	—	—	Hard Spinifex (95%)	20-40
Rocklea	169	16.8	—	—	—	Hard Spinifex (95%)	40
Ruth	49	4.9	—	—	—	Hard Spinifex (85%) Soft Spinifex (15%) Hard Spinifex (65%) Soft Spinifex (35%)	20-40
Uaroo	5	0.5	—	—	—	Hard Spinifex (65%) Soft Spinifex (35%)	15-30
Total	1003	100.0	565	2256	290		



# Mallina station (2,837 km<sup>2</sup>—of which 2,216 km<sup>2</sup> was surveyed)

Land system	Area km <sup>2</sup>	%	Severely degraded & eroded ha	Degraded ha	Gullied ha	Main pasture types	Estimated carrying capacity ha/sheep unit
Boolaloo	97	4.4	—	—	—	Hard Spinifex (50%) Soft Spinifex (50%)	20-40
Boolgeeda	116	5.2	—	—	—	Hard Spinifex (95%)	20-40
Calcrete	160	7.2	—	1	—	Hard Spinifex (85%) Soft Spinifex (15%)	20-40
Capricorn	60	2.7	—	—	—	Hard Spinifex (90%) Soft Spinifex (10%)	40
Cheerawarra	3	0.1	—	—	—	Soft Spinifex (40%) Hard Spinifex (30%) Roebourne Plains Grass (10%)	7-25
Gregory	25	1.1	—	—	—	Buffel Grass (10%)	20-40
Horseflat	60	2.7	—	502	12	Hard Spinifex (95%) Roebourne Plains Grass (95%)	6-25
Littoral	< 0.3	—	—	—	—	Soft Spinifex (10%) Samphire (10%)	> 40
Macroy	99	4.5	—	—	—	Hard Spinifex (55%) Soft Spinifex (45%)	15-30
Mallina	277	12.5	228	1480	67	Soft Spinifex (80%) Roebourne Plains Grass (10%)	7-25
Pyramid	25	1.1	—	—	—	Hard Spinifex (75%) Roebourne Plains Grass (20%)	15-30
River	222	10.0	—	41	52	Buffel Grass (45%) Soft Spinifex (40%)	4-25
Rocklea	109	4.9	—	—	—	Hard Spinifex (95%)	40
Ruth	200	9.0	—	—	—	Hard Spinifex (85%) Soft Spinifex (15%)	20-40
Satirist	49	2.2	—	—	20	Hard Spinifex (65%) Soft Spinifex (25%) Roebourne Plains Grass (10%)	15-30
Sherlock	77	3.5	—	914	53	Hard Spinifex (40%) Soft Spinifex (25%) Stony Chenopod(20%) Roebourne Plains Grass (15%)	10-25
Uaroo	637	28.9	—	2	1	Hard Spinifex (65%) Soft Spinifex (35%)	15-30
Total	2216	100.0	228	2940	205		

*Area table is wrong!*  
*a sub-sampled area; hardy, but not*  
*near Batta Batta in side. (see 250,000 map)*

# **Mt Welcome station (1,912 km<sup>2</sup>)**

Land system	Area km <sup>2</sup>	%	Severely degraded & eroded ha	Degraded ha	Gullied ha	Main pasture types	Estimated carrying capacity ha/sheep unit
Boolaloo	28	1.5	—	—	—	Hard Spinifex (50%) Soft Spinifex (50%)	20-40
Boolgeeda	142	7.4	—	—	—	Hard Spinifex (95%)	20-40
Calcrete	24	1.3	—	—	—	Hard Spinifex (85%) Soft Spinifex (15%)	20-40
Capricorn	167	8.7	—	—	—	Hard Spinifex (90%) Soft Spinifex (10%)	40
Cheerawarra	12	0.6	—	61	10	Soft Spinifex (40%) Hard Spinifex (35%) Roebourne Plains Grass (10%)	7-25
Horseflat	324	16.9	149	821	147	Buffel Grass (10%) Roebourne Plains Grass (95%)	6-25
Littoral	8	0.4	—	—	—	Soft Spinifex (10%) Samphire (10%)	> 40
Macroy	40	2.1	—	—	—	Hard Spinifex (55%) Soft Spinifex (45%)	15-30
Mallina	92	4.8	27	115	—	Soft Spinifex (80%) Roebourne Plains Grass (10%)	7-25
Paraburdoo	60	3.1	—	—	—	Hard Spinifex (55%) Soft Spinifex (35%) Stony Chenopod(10%)	15-30
Pyramid	11	0.6	—	—	—	Hard Spinifex (75%) Roebourne Plains Grass (20%)	15-30
River	101	5.3	2	18	18	Buffel Grass (45%) Soft Spinifex (40%)	4-25
Robe	0.6	0.1	—	—	—	Hard Spinifex (95%)	20-40
Rocklea	297	15.5	—	—	—	Hard Spinifex (95%)	40
Ruth	544	28.5	—	3	—	Hard Spinifex (85%) Soft Spinifex (15%)	20-40
Sherlock	35	1.8	—	—	8	Hard Spinifex (40%) Soft Spinifex (25%) Stony Chenopod(20%) Roebourne Plains Grass (15%)	10-25
Uaroo	26	1.4	—	—	—	Hard Spinifex (65%) Soft Spinifex (35%)	15-30
<b>Total</b>	<b>1912</b>	<b>100.0</b>	<b>178</b>	<b>1018</b>	<b>183</b>		

### Pyramid station (1,085 km<sup>2</sup>)

Land system	Area km <sup>2</sup>	%	Severely degraded & eroded ha	Degraded ha	Gullied ha	Main pasture types	Estimated carrying capacity ha/sheep unit
Boolaloo	3	0.3	—	—	—	Hard Spinifex (50%) Soft Spinifex (50%)	20-40
Boolgeeda	103	9.5	—	—	4	Hard Spinifex (95%)	20-40
Calcrete	23	2.1	—	—	—	Hard Spinifex (85%) Soft Spinifex (15%)	20-40
Capricorn	65	6.0	—	—	—	Hard Spinifex (90%) Soft Spinifex (10%)	40
Horseflat	136	12.5	212	1270	58	Roebourne Plains Grass (90%)	6-25
Macroy	7	0.7	—	—	—	Hard Spinifex (55%) Soft Spinifex (45%)	15-30
Mallina	58	5.3	—	7	—	Soft Spinifex (80%) Roebourne Plains Grass (10%)	7-25
Paraburdoo	3	0.3	—	—	—	Hard Spinifex (55%) Soft Spinifex (35%)	15-30
Pyramid	149	13.7	—	52	47	Stony Chenopod(10%) Hard Spinifex (75%) Roebourne Plains Grass (20%)	15-30
River	136	12.5	—	77	4	Buffel Grass (45%) Soft Spinifex (40%)	4-25
Rocklea	231	21.3	—	1	—	Hard Spinifex (95%)	40
Ruth	64	5.9	—	—	—	Hard Spinifex (85%) Soft Spinifex (15%)	20-40
Sherlock	64	5.9	—	—	34	Hard Spinifex (40%) Soft Spinifex (25%) Stony Chenopod(20%) Roebourne Plains Grass (15%)	10-25
Uaroo	43	4.0	—	—	—	Hard Spinifex (65%) Soft Spinifex (35%)	15-30
<b>Total</b>	<b>1085</b>	<b>100.0</b>	<b>212</b>	<b>1407</b>	<b>147</b>		

### Sherlock station (985 km<sup>2</sup>)

Land system	Area km <sup>2</sup>	%	Severely degraded & eroded ha	Degraded ha	Gullied ha	Main pasture types	Estimated carrying capacity ha/sheep unit
Boolaloo	7	0.7	—	—	—	Hard Spinifex (50%) Soft Spinifex (50%)	20-40
Boolgeeda	50	5.1	—	—	2	Hard Spinifex (95%)	20-40
Calcrete	27	2.7	—	—	—	Hard Spinifex (85%) Soft Spinifex (15%)	20-40
Capricorn	5	0.5	—	—	—	Hard Spinifex (90%) Soft Spinifex (10%)	40
Cheerawarra	40	4.1	457	273	30	Soft Spinifex (40%) Hard Spinifex (35%) Roebourne Plains Grass (10%)	7-25
Gregory	3	0.3	—	—	—	Buffel Grass (10%) Hard Spinifex (95%)	20-40
Horseflat	295	29.9	396	1439	515	Roebourne Plains Grass (95%) Soft Spinifex (10%)	6-25
Littoral	0.3	—	—	—	—	Samphire (10%)	> 40
Macroy	46	4.7	—	—	—	Hard Spinifex (55%) Soft Spinifex (45%)	15-30
Mallina	185	18.8	201	271	160	Soft Spinifex (80%) Roebourne Plains Grass (10%)	7-25
Paraburdoo	0.1	—	—	—	—	Hard Spinifex (55%) Soft Spinifex (35%)	15-30
River	47	4.8	11	34	12	Stony Chenopod(10%) Buffel Grass (45%) Soft Spinifex (40%)	4-25
Rocklea	19	1.9	—	—	—	Hard Spinifex (95%)	40
Ruth	188	19.1	—	—	1	Hard Spinifex (85%) Soft Spinifex (15%)	20-40
Uaroo	73	7.4	—	—	—	Hard Spinifex (65%) Soft Spinifex (35%)	15-30
<b>Total</b>	<b>985</b>	<b>100.0</b>	<b>1065</b>	<b>2017</b>	<b>720</b>		

# Warambie station (690 km<sup>2</sup>)

Land system	Area km <sup>2</sup>	%	Severely degraded & eroded ha	Degraded ha	Gullied ha	Main pasture types	Estimated carrying capacity ha/sheep unit
Boolgeeda	28	4.1	—	—	1	Hard Spinifex (95%)	20-40
Calcrete	6	0.9	—	—	—	Hard Spinifex (85%)	20-40
Cheerawarra	78	11.3	700	712	35	Soft Spinifex (15%) Soft Spinifex (40%) Hard Spinifex (35%) Roebourne Plains Grass (10%) Buffel Grass (10%)	7-25
Horseflat	359	52.0	922	1840	1464	Roebourne Plains Grass (95%)	6-25
Littoral	0.3	—	—	—	—	Soft Spinifex (10%) Samphire (10%)	> 40
Macroy	2	0.3	—	—	—	Hard Spinifex (55%)	15-30
Mallina	12	1.7	—	—	—	Soft Spinifex (45%) Soft Spinifex (80%) Roebourne Plains Grass (10%)	7-25
Paraburdoo	3	0.4	—	—	—	Hard Spinifex (55%) Soft Spinifex (35%) Stony Chenopod(10%)	15-30
Pyramid	3	0.4	—	—	—	Hard Spinifex (75%) Roebourne Plains Grass (20%)	15-30
River	70	10.2	7	94	70	Buffel Grass (45%) Soft Spinifex (40%)	4-25
Rocklea	60	8.7	—	—	9	Hard Spinifex (95%)	40
Ruth	67	9.7	—	—	—	Hard Spinifex (85%) Soft Spinifex (15%)	20-40
Sherlock	2	0.3	—	—	—	Hard Spinifex (40%) Soft Spinifex (25%) Stony Chenopod (20%) Roebourne Plains Grass (15%)	10-25
Total	690	100.0	1629	2646	1579		

## Appendix 2.

### Station condition statements

#### Karratha station

Condition statements derived from traverse records (261 recordings on 8 land systems)

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	very poor	good	fair	poor
Boolgeeda	5	100	—	—	—	—	100	—	—	—	100	—	—
Boolaloo	1	100	—	—	—	—	100	—	—	—	100	—	—
Cheerawarra	29	42	38	17	3	3	35	34	14	14	34	38	28
Horseflat	164	82	13	5	—	4	35	40	18	3	38	41	21
Littoral	1	100	—	—	—	—	100	—	—	—	100	—	—
Mallina	32	66	34	—	—	3	47	44	6	—	50	44	6
River	10	100	—	—	—	20	50	30	—	—	70	30	—
Ruth	19	89	11	—	—	26	63	11	—	—	89	11	—
Total — all land systems	261	78	17	5	—	6	41	36	14	3	46	37	17

#### Mallina station (part)

Condition statements derived from traverse records (244 recordings on 14 land systems)

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	very poor	good	fair	poor
Boolgeeda	4	100	—	—	—	75	25	—	—	—	100	—	—
Boolaloo	1	100	—	—	—	100	—	—	—	—	100	—	—
Calcrete	15	100	—	—	—	33	54	13	—	—	87	13	—
Cheerawarra	7	100	—	—	—	—	86	14	—	—	86	14	—
Horseflat	24	50	33	17	—	—	25	25	33	17	25	25	50
Littoral	2	100	—	—	—	—	100	—	—	—	100	—	—
Macroy	13	100	—	—	—	38	62	—	—	—	100	—	—
Mallina	56	53	29	16	2	5	46	29	16	4	52	27	21
Pyramid	1	100	—	—	—	—	100	—	—	—	100	—	—
River	30	66	27	7	—	27	60	13	—	—	80	20	—
Ruth	7	100	—	—	—	57	43	—	—	—	100	—	—
Satirist	13	100	—	—	—	—	92	8	—	—	92	8	—
Sherlock	32	75	16	9	—	—	25	28	22	25	25	28	47
Uaroo	39	97	3	—	—	62	38	—	—	—	100	—	—
Total — all land systems	244	77	16	7	2	22	46	16	10	6	68	16	16

## Mt Welcome station

### Condition statements derived from traverse records (169 recordings on 12 land systems)

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	very poor	good	fair	poor
Boolgeeda	5	100	—	—	—	—	100	—	—	—	100	—	—
Boolaloo	2	100	—	—	—	—	50	—	50	—	50	—	50
Calcrete	4	100	—	—	—	75	—	25	—	—	75	25	—
Cheerawarra	7	29	57	14	—	14	14	58	14	—	29	57	14
Horseflat	82	78	18	4	—	4	24	42	23	7	28	42	30
Littoral	1	100	—	—	—	100	—	—	—	—	100	—	—
Mallina	20	65	20	15	—	5	35	30	25	5	40	30	30
Paraburdoo	8	87	13	—	—	—	75	25	—	—	75	25	—
River	10	90	10	—	—	10	70	20	—	—	80	20	—
Rocklea	3	100	—	—	—	—	67	33	—	—	67	33	—
Ruth	21	100	—	—	—	33	53	14	—	—	86	14	—
Sherlock	6	83	17	—	—	—	—	66	17	17	—	67	33
Total — all land systems	169	81	15	4	—	10	35	34	16	5	45	34	21

## Pyramid station

### Condition statements derived from traverse records (176 recordings on 11 land systems)

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	very poor	good	fair	poor
Boolgeeda	11	100	—	—	—	36	46	18	—	—	82	18	—
Calcrete	7	100	—	—	—	43	43	14	—	—	86	14	—
Horseflat	60	53	35	10	2	2	17	36	32	13	18	37	45
Macroy	1	100	—	—	—	100	—	—	—	—	100	—	—
Mallina	15	87	13	—	—	20	47	33	—	—	67	33	—
Pyramid	39	97	3	—	—	5	67	23	5	—	72	23	5
River	17	82	18	—	—	—	82	12	—	6	82	12	6
Rocklea	5	100	—	—	—	40	40	20	—	—	80	20	—
Ruth	1	100	—	—	—	—	—	100	—	—	—	100	—
Sherlock	8	100	—	—	—	—	25	50	25	—	25	50	25
Uaroo	12	100	—	—	—	75	25	—	—	—	100	—	—
Total — all land systems	176	81	15	3	1	14	41	27	13	5	55	27	18

100% 77 14 3 3 45 37 16  
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## Sherlock station

### Condition statements derived from traverse records (141 recordings on 10 land systems)

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	very poor	good	fair	poor
Boolgeeda	6	100	—	—	—	50	50	—	—	—	100	—	—
Calcrete	3	100	—	—	—	67	33	—	—	—	100	—	—
Cheerawarra	5	20	20	40	20	—	20	—	40	40	20	—	80
Capricorn	1	100	—	—	—	100	—	—	—	—	100	—	—
Horseflat	58	60	19	19	2	3	21	37	22	17	24	33	43
Macroy	2	100	—	—	—	—	100	—	—	—	100	—	—
Mallina	43	93	7	—	—	23	52	23	2	—	75	23	2
River	3	67	33	—	—	33	67	—	—	—	100	—	—
Ruth	6	100	—	—	—	67	33	—	—	—	100	—	—
Uaroo	14	100	—	—	—	86	14	—	—	—	100	—	—
Total — all land systems	141	79	11	9	1	25	33	22	11	9	58	21	21

2004

86 7 3 4  
129 11 5 6

## Warambie station

### Condition statements derived from traverse records (181 recordings on 8 land systems)

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	very poor	good	fair	poor
Boolgeeda	2	100	—	—	—	—	50	50	—	—	50	50	—
Calcrete	5	100	—	—	—	40	60	—	—	—	100	—	—
Cheerawarra	8	37	25	25	13	—	25	37	25	13	25	38	37
Horseflat	151	56	20	20	4	1	23	27	32	17	24	27	49
Mallina	4	25	75	—	—	—	50	50	—	—	50	50	—
River	8	63	37	—	—	50	37	13	—	—	87	13	—
Rocklea	1	100	—	—	—	—	100	—	—	—	100	—	—
Ruth	2	50	50	—	—	—	100	—	—	—	100	—	—
Total — all land systems	181	56	22	18	4	4	27	27	28	14	31	27	42

## Appendix 3.

### Land system degradation status (as mapped on 1:100,000 scale station plans)

Land system	Area	Severely degraded and eroded km <sup>2</sup>	Degraded km <sup>2</sup>	Gullied km <sup>2</sup>	Total degradation km <sup>2</sup>	Total degradation (%)
Boolaloo	138	—	—	—	—	—
Boolgeeda	596	—	—	0.1	0.1	—
Calcrete	259	—	—	—	—	—
Capricorn	401	—	—	—	—	—
Cheerawarra	273	14.6	17.3	1.1	33.0	12.1
Gregory	27	—	—	—	—	—
Horseflat	1,998	25.9	94.3	28.5	148.7	7.4
Littoral	718	—	0.1	0.2	0.3	—
Macroy	205	—	—	—	—	—
Mallina	775	6.1	27.0	2.3	35.4	4.6
Paraburdoo	76	—	—	—	—	—
Pyramid	335	—	0.5	1.0	1.5	0.4
River	694	0.5	3.4	2.0	5.9	0.9
Robe	1	—	—	—	—	—
Rocklea	1,351	—	0.2	0.1	0.3	—
Ruth	1,350	—	0.1	—	0.1	—
Satirist	49	—	—	0.2	0.2	0.4
Sherlock	185	—	9.1	1.0	10.1	5.5
Uaroo	785	—	—	—	—	—
<b>Total</b>	<b>10,216</b>	<b>47.1</b>	<b>152.0</b>	<b>36.5</b>	<b>235.6</b>	<b>2.3</b>



# Appendix 4.

## Land system condition statements

No. of records	Wind erosion (%)				Water erosion (%)				Total erosion (%)				Pasture condition (%)					Range condition (%)		
	nil	min.	mod.	sev.	nil	min.	mod.	sev.	nil	min.	mod.	sev.	exc.	good	fair	poor	very poor	good	fair	poor
<b>Land system—Boolgeeda</b>																				
1	100	—	—	—	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—
1	100	—	—	—	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—
9	100	—	—	—	100	—	—	—	100	—	—	—	11	89	—	—	—	100	—	—
2	100	—	—	—	100	—	—	—	100	—	—	—	—	50	50	—	—	50	50	—
19	100	—	—	—	100	—	—	—	100	—	—	—	37	53	11	—	—	89	11	—
1	100	—	—	—	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—
Total	33	100	—	—	100	—	—	—	100	—	—	—	30	61	9	—	—	91	9	—
<b>Land system—Boolaloo</b>																				
2	100	—	—	—	100	—	—	—	100	—	—	—	50	—	—	50	—	50	—	50
2	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
Total	4	100	—	—	100	—	—	—	100	—	—	—	25	50	—	25	—	75	—	25
<b>Land system—Calcrete</b>																				
20	100	—	—	—	100	—	—	—	100	—	—	—	60	35	5	—	—	95	5	—
1	100	—	—	—	100	—	—	—	100	—	—	—	—	—	100	—	—	—	100	—
1	100	—	—	—	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—
4	100	—	—	—	100	—	—	—	100	—	—	—	—	75	25	—	—	75	25	—
6	100	—	—	—	100	—	—	—	100	—	—	—	33	50	17	—	—	83	17	—
1	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
1	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
Total	34	100	—	—	100	—	—	—	100	—	—	—	44	44	12	—	—	88	12	—
<b>Land system—Cheerawarra</b>																				
1	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
1	100	—	—	—	100	—	—	—	100	—	—	—	—	—	100	—	—	—	100	—
3	33	67	—	—	100	—	—	—	33	67	—	—	—	33	67	—	—	33	67	—
14	79	7	7	7	93	—	7	—	79	—	14	7	7	57	14	14	7	64	14	21
16	44	25	19	13	69	31	—	—	38	31	19	13	—	25	31	19	25	25	31	44
8	25	25	50	—	50	50	—	—	13	38	50	—	—	25	25	38	13	13	38	50
13	38	54	8	—	92	8	—	—	38	54	8	—	8	31	46	8	8	38	46	15
Total	56	50	29	16	5	79	20	2	45	32	18	5	4	36	32	16	13	38	34	29
<b>Land system—Capricorn</b>																				
1	100	—	—	—	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—
Total	1	100	—	—	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—

No. of records	Wind erosion (%)				Water erosion (%)				Total erosion (%)				Pasture condition (%)					Range condition (%)			
	nil	min.	mod.	sev.	nil	min.	mod.	sev.	nil	min.	mod.	sev.	exc.	good	fair	poor	very poor	good	fair	poor	
Land system—Horseflat																					
5	Calcrete platform	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
40	Dissected slope	78	18	5	—	18	58	20	5	15	55	25	5	—	10	30	40	20	8	30	63
10	Narrow drainage floor	90	10	—	—	90	10	—	—	80	20	—	—	10	70	20	—	—	80	20	—
1	Wide drainage floor	—	100	—	—	100	—	—	—	—	100	—	—	—	—	—	100	—	—	—	100
71	Stony gilgai plain	94	4	1	—	94	6	—	—	89	10	1	—	1	32	48	15	3	34	48	18
54	Alluvial plain	52	20	20	7	57	33	9	—	31	31	30	7	2	7	31	31	28	9	30	61
2	Flood plain	50	—	—	50	50	50	—	—	50	—	—	50	—	50	—	—	50	50	—	50
25	Stony plain	92	8	—	—	88	8	4	—	84	12	4	—	—	32	44	24	—	32	44	24
325	Gilgai plain	80	13	7	—	86	12	2	—	74	17	9	—	3	27	35	26	9	30	35	35
5	Saline alluvial plain	—	—	100	—	100	—	—	—	—	—	100	—	—	—	—	40	60	—	—	100
1	Unspecified plain	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
Total	539	79	12	8	1	79	16	4	—	67	20	12	1	3	26	35	25	11	28	35	37
Land system—Littoral																					
2	Dune	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
1	Saline alluvial plain	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
1	Sand sheet	100	—	—	—	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—
Total	4	100	—	—	—	100	—	—	—	100	—	—	—	25	75	—	—	—	100	—	—
Land system—Macroy																					
1	Stony gilgai plain	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
1	Alluvial plain	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
11	Stony plain	100	—	—	—	100	—	—	—	100	—	—	—	36	64	—	—	—	100	—	—
3	Unspecified plain	100	—	—	—	100	—	—	—	100	—	—	—	67	33	—	—	—	100	—	—
Total	16	100	—	—	—	100	—	—	—	100	—	—	—	38	63	—	—	—	100	—	—
Land system—Mallina																					
1	Narrow drainage floor	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
1	Wide drainage floor	100	—	—	—	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—
2	Stony gilgai plain	100	—	—	—	100	—	—	—	100	—	—	—	—	50	50	—	—	50	50	—
130	Alluvial plain	71	22	7	1	88	12	1	—	68	24	8	1	8	50	31	9	2	58	30	12
15	Stony plain	93	7	—	—	80	20	—	—	80	20	—	—	20	27	40	13	—	47	40	13
9	Gilgai plain	56	22	22	—	67	33	—	—	33	44	22	—	—	11	58	33	—	11	56	53
1	Unspecified plain	100	—	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—
1	Low rise	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
10	Sand sheet	100	—	—	—	100	—	—	—	100	—	—	—	40	60	—	—	—	100	—	—
Total	170	75	18	6	1	86	13	1	—	69	23	7	1	11	46	31	10	2	57	31	12

No. of records	Wind erosion (%)				Water erosion (%)				Total erosion (%)				Pasture condition (%)					Range condition (%)		
	nil	min.	mod.	sev.	nil	min.	mod.	sev.	nil	min.	mod.	sev.	exc.	good	fair	poor	very poor	good	fair	poor
<b>Land system—Paraburdoo</b>																				
1	Narrow drainage floor																			
100	—	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
1	Lower footslope																			
100	—	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
5	Stony plain																			
80	20	—	—	—	100	—	—	—	80	20	—	—	—	80	20	—	—	80	20	—
1	Gilgai plain																			
100	—	—	—	—	100	—	—	—	100	—	—	—	—	—	100	—	—	—	100	—
<b>Total</b>																				
8	88	13	—	—	100	—	—	—	88	13	—	—	—	75	25	—	—	75	25	—
<b>Land system—Pyramid</b>																				
2	Narrow drainage floor																			
100	—	—	—	—	50	50	—	—	50	50	—	—	—	50	50	—	—	50	50	—
1	Lower footslope																			
100	—	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
13	Stony gilgai plain																			
100	—	—	—	—	100	—	—	—	100	—	—	—	8	62	31	—	—	69	31	—
16	Stony plain																			
100	—	—	—	—	100	—	—	—	100	—	—	—	6	75	19	—	—	81	19	—
7	Gilgai plain																			
100	—	—	—	—	100	—	—	—	100	—	—	—	—	57	14	29	—	57	14	29
1	Low rise																			
100	—	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
<b>Total</b>																				
40	100	—	—	—	98	—	—	—	98	3	—	—	5	68	23	5	—	73	23	5
<b>Land system—River</b>																				
3	Levee																			
100	—	—	—	—	100	—	—	—	100	—	—	—	33	33	33	—	—	67	33	—
8	Alluvial plain																			
88	13	—	—	—	88	13	—	—	75	25	—	—	38	38	25	—	—	75	25	—
54	Flood plain																			
76	20	4	—	—	93	7	—	—	70	26	4	—	19	67	13	—	2	81	17	2
12	Stony plain																			
100	—	—	—	—	100	—	—	—	100	—	—	—	17	67	17	—	—	83	17	—
1	Low rise																			
100	—	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
<b>Total</b>																				
78	82	15	3	—	94	6	—	—	77	21	3	—	21	63	15	—	1	81	18	1
<b>Land system—Rocklea</b>																				
9	Lower footslope																			
100	—	—	—	—	100	—	—	—	100	—	—	—	22	56	22	—	—	78	22	—
<b>Total</b>																				
9	100	—	—	—	100	—	—	—	100	—	—	—	22	56	22	—	—	78	22	—
<b>Land system—Ruth</b>																				
3	Narrow drainage floor																			
100	—	—	—	—	67	33	—	—	67	33	—	—	33	33	33	—	—	67	33	—
38	Lower footslope																			
100	—	—	—	—	97	3	—	—	97	3	—	—	42	50	8	—	—	92	8	—
2	Upper footslope																			
100	—	—	—	—	100	—	—	—	100	—	—	—	50	50	—	—	—	100	—	—
2	Hill																			
100	—	—	—	—	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—
10	Stony plain																			
100	—	—	—	—	90	10	—	—	90	10	—	—	—	80	20	—	—	80	20	—
1	Low rise																			
100	—	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
<b>Total</b>																				
56	100	—	—	—	95	5	—	—	95	5	—	—	36	54	11	—	—	89	11	—

No. of records	Wind erosion (%)				Water erosion (%)				Total erosion (%)				Pasture condition (%)					Range condition (%)			
	nil	min.	mod.	sev.	nil	min.	mod.	sev.	nil	min.	mod.	sev.	exc.	good	fair	poor	very poor	good	fair	poor	
Land system—Satirist																					
9	Stony plain	100	—	—	—	100	—	—	—	100	—	—	—	—	89	11	—	—	89	11	—
3	Gilgai plain	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
1	Low rise	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
Total	13	100	—	—	—	100	—	—	—	100	—	—	—	—	92	8	—	—	92	8	—
Land system—Sherlock																					
1	Minor channel	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
2	Stony gilgai plain	100	—	—	—	100	—	—	—	100	—	—	—	—	—	100	—	—	—	100	—
3	Alluvial plain	67	33	—	—	67	33	—	—	67	33	—	—	—	67	—	33	—	67	—	33
32	Stony plain	91	6	3	—	84	13	3	—	78	16	6	—	—	19	38	19	25	19	38	44
8	Gilgai plain	100	—	—	—	88	—	13	—	88	—	13	—	—	13	38	38	13	13	38	50
Total	46	91	7	2	—	85	11	4	—	80	13	7	—	—	22	37	22	20	22	37	41
Land system—Uaroo																					
1	Calcrete platform	100	—	—	—	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—
2	Narrow drainage floor	100	—	—	—	50	50	—	—	50	50	—	—	50	50	—	—	—	100	—	—
22	Alluvial plain	100	—	—	—	100	—	—	—	100	—	—	—	73	27	—	—	—	100	—	—
12	Stony plain	100	—	—	—	100	—	—	—	100	—	—	—	50	50	—	—	—	100	—	—
1	Low rise	100	—	—	—	100	—	—	—	100	—	—	—	—	100	—	—	—	100	—	—
27	Sand sheet	100	—	—	—	100	—	—	—	100	—	—	—	78	22	—	—	—	100	—	—
Total	65	100	—	—	—	98	2	—	—	98	2	—	—	69	31	—	—	—	100	—	—
Grand total																					
1,172	83	11	5	1	86	12	2	—	75	16	8	1	13	38	27	15	7	51	27	22	

## Appendix 5.

### Major areas of degradation (approximate)

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#### Area 1—Karratha Coast

Total area of degradation	2,000 ha
Severely degraded and eroded	550 ha—380 ha on Cheerawarra land system —170 ha on Horseflat I.s.
Degraded	1,280 ha—340 ha on Cheerawarra I.s. —940 ha on Horseflat I.s.
Gullied	170 ha—on Horseflat I.s.
Areas with regeneration works	35 ha—on Horseflat I.s.

#### Area 2—Karratha Homestead

Total area of degradation	840 ha
Degraded	750 ha—540 ha on Horseflat land system —210 ha on Mallina I.s.
Gullied	90 ha—on Horseflat I.s.
Areas with regeneration works	550 ha—520 on Horseflat I.s. —30 on Mallina I.s.

#### Area 3—Nickol River

Total area of degradation	840 ha
Severely degraded and eroded	150 ha—10 ha on Cheerawarra land system —140 ha on Horseflat I.s.
Degraded	690 ha—150 ha on Cheerawarra I.s. —540 ha on Horseflat I.s.
Areas with regeneration works	10 ha—on Horseflat I.s.

#### Area 4—Roebourne

Total area of degradation	946 ha
Severely degraded and eroded	83 ha—38 ha on Cheerawarra land system —45 ha on Littoral I.s.
Degraded	823 ha—213 ha on Cheerawarra I.s. —420 ha on Horseflat I.s. —190 ha on Littoral I.s.
Gullied	40 ha—30 ha on Horseflat I.s. —10 ha on Sherlock I.s.

#### Area 5—Harding Rivers

Total area of degradation	1,350 ha
Severely degraded and eroded	220 ha—185 ha on Horseflat land system —35 ha on Mallina I.s.
Degraded	1,010 ha—800 ha on Horseflat I.s. —210 ha on Mallina I.s.
Gullied	120 ha—on Horseflat I.s.

#### Area 6—Jones River

Total area of degradation	2,020 ha
Severely degraded and eroded	420 ha—on Horseflat land system
Degraded	790 ha—770 ha on Horseflat I.s. —20 ha on River I.s.
Gullied	810 ha—on Horseflat I.s.

#### Area 7—Georges River

Total area of degradation	2,220 ha
Severely degraded and eroded	580 ha—on Horseflat land system
Degraded	1,120 ha—on Horseflat I.s.
Gullied	520 ha—on Horseflat I.s.
Areas with regeneration works	10 ha—on Horseflat I.s.

**Area 8—Warambie-Sherlock Coast**

Total area of degradation

3,450 ha—1,800 ha on Warambie station

—1,650 ha on Sherlock station

Severely degraded and eroded

1,800 ha—1,260 ha on Cheerawarra land system

—540 ha on Horseflat I.s.

(50% on Warambie, 50% on Sherlock station)

Degraded

1,510 ha—1,000 ha on Cheerawarra I.s.

—490 ha on Horseflat I.s.

—20 ha on River I.s.

(60% on Warambie, 40% on Sherlock station)

Gullied

140 ha—50 ha on Cheerawarra I.s.

—90 ha on Horseflat I.s.

(80% on Warambie, 20% on Sherlock station)

**Area 9—Sherlock Homestead**

Total area of degradation

2,460 ha

Severely degraded and eroded

390 ha—190 ha on Horseflat land system

—200 ha on Mallina I.s.

Degraded

1,460 ha—1,150 ha on Horseflat I.s.

—310 ha on Mallina I.s.

Gullied

610 ha—460 ha on Horseflat I.s.

—150 ha on Mallina I.s.

**Area 10—Balla Balla**

Total area of degradation

960 ha

Severely degraded and eroded

20 ha on Horseflat land system

Degraded

900 ha on Horseflat I.s.

Gullied

40 ha on Horseflat I.s.

**Area 11—Mallina Homestead**

Total area of degradation

2,130 ha

Severely degraded and eroded

530 ha on Mallina land system

Degraded

1,600 ha on Mallina I.s.

**Area 12—Sherlock River**

Total area of degradation

1,020 ha

Degraded

920 ha—25 ha on River land system

—895 ha on Sherlock I.s.

Gullied

100 ha—50 ha on River I.s.

—50 ha on Sherlock I.s.

**Area 13—Pyramid Homestead**

Total area of degradation

1,740 ha—140 ha on Warambie station

—1,600 ha on Pyramid station

Severely degraded and eroded

240 ha—on Horseflat land system

(100% on Pyramid station)

Degraded

1,380 ha—1,270 ha on Horseflat land system

110 ha on River I.s.

(90% on Pyramid station, 10% on Warambie station)

Gullied

120 ha on Horseflat I.s.

(100% Pyramid station)

## Appendix 6.

### Soil sample analyses

The following table summarizes the results of chemical analyses of 54 soil samples collected within the study area. At each site, three samples were collected, one of the soil in the top 10 cm of the profile, one between 10 and 40 cm and one between 40 and 80 cm. A key has been provided to assist with the interpretation of this table, and is as follows:

		Key	
Soil sample		—Soil sample number	
Degradation area	1	—Karratha Coast (Karratha station)	
	2	—Karratha Homestead (Karratha station)	
	3	—Nickol River (Karratha station)	
	4	—Roebourne (Mt Welcome station)	
	5	—Harding Rivers (Mt Welcome station)	
	6	—Jones River (Warambie station)	
	7	—Georges River (Warambie station)	
	8	—Warambie-Sherlock Coast (Warambie and Sherlock stations)	
	9	—Sherlock Homestead (Sherlock station)	
	10	—Balla Balla (Mallina station)	
	11	—Mallina Homestead (Mallina station)	
	12	—Sherlock River (Mallina station)	
	13	—Pyramid Homestead (Pyramid station)	
Land systems	Che	—Cheerawarra	
	Hof	—Horseflat	
	Mal	—Mallina	
	Rir	—River	
	Srk	—Sherlock	
Range condition		As indicated	
Alkalinity	N	—Non alkaline	pH < 8.0
	A	—Alkaline	pH 8.0-9.5
	S	—Strongly alkaline	pH > 9.5
Salinity	0	—Salt free	< 400 mS/m EC <sub>e</sub>
			< 0.05% Cl <sup>-</sup>
	1	—Saline	400-800 mS/m EC <sub>e</sub>
			or 0.05-0.1% Cl <sup>-</sup>
	2	—Highly saline	800-1,500 mS/m EC <sub>e</sub>
			or 0.1-0.2% Cl <sup>-</sup>
	3	—Extremely saline	> 1,500 mS/m EC <sub>e</sub>
			or > 0.2 Cl <sup>-</sup>
Sodicity	0	—Non sodic	ESP < 6
	1	—Sodic	ESP 6-15
	2	—Strongly sodic	ESP > 15

# Soil sample analyses

Soil sample	Degradation area	Land system	Range condition	Alkalinity			Salinity			Sodicity			Comments
				0-10 cm	10-40 cm	40-80 cm	0-10 cm	10-40 cm	40-80 cm	0-10 cm	10-40 cm	40-80 cm	
1	11	Mal	Poor to very poor	A	A	A	0	1	3	1	1	2	Bare scald
2	11	Mal	Very poor	N	N	A	2	3	3	1	2	2	Bare scald, 300 m from 3
3	11	Mal	Very poor	A	A	A	1	0	2	1	2	2	Bare scald, 300 m from 2
4	11	Mal	Very poor	N	N	N	3	3	3	2	2	2	Bare scald, pitting unsuccessful
5	10	Hof	Good	A	A	A	0	0	0	0	1	1	Undegraded Roebourne Plains grass
6	10	Hof	Very poor to poor	N	A	A	0	0	1	0	1	2	Scald
7	12	Srk	Fair to poor	A	N	A	1	3	3	2	2	2	Degraded snakewood
8	12	Srk	Very poor	A	A	A	0	2	3	0	1	2	Annuals
9	11	Mal	Good	N	A	A	0	1		0	2		Undegraded soft and hard spinifex
10	13	Hof	Poor	A	A	A	3	3	3	2	2	2	Bare scald, stony
11	13	Hof	Very poor	A	A	A	2	3	3	2	2	2	Stony plain, 50 m from C12
12	13	Hof	Good	A	A	N	0	0	2	0	0	2	Roebourne Plains grass depression 50 m from C11
13	13	Py	Fair to good	A	A	A	0	1	2	0	1	2	Hard spinifex and Roebourne Plains grass
14	13	Hof	Poor	S	A	A	0	2	3	2	2	2	Bare scald
15	9	Hof	Fair to good	A	A	A	0	0	2	0	1	2	Undegraded Roebourne Plains grass
16	9	Hof	Poor to very poor	A	A	A	0	3	3	1	2	2	Bare scald, sandy mantle
17	9	Hof	Very poor	A	A	A	1	3	3	1	2	2	Bare scald
18	9	Hof	Very poor	A	A	A	3	3		2	2		Bare scald
19	8	Che	Very poor	A	A	A	3	3	3	2	2	2	Bare scald, powdery
20	8	Hof	Very poor	A	N	A	3	3	3	2	2	2	Bare scald
21	8	Hof	Very poor	A	A	A	3	3	3	2	2	2	Bare scald
22	9	Hof	Very poor to poor	A	A	A	3	3	3	2	2	2	Sheet and rill erosion
23	9	Hof	Poor	A	A	A	0	2	3	1	2	2	Bare stony flat, 20 m from 24
24	9	Hof	Fair to good	A	A	A	0	1	3	0	1	2	Young Roebourne Plains grass, 20 m from 23
25	8	Che	Poor to very poor	A	A	A	0	3	3	1	2	2	Bare scald
26	8	Che	Very good	N	N	A	0	0	0	0	0	0	Soft spinifex
27	8	Che	Good	A	A	A	0	0	1	0	0	2	Undegraded spinifex and buffel grass
28	9	Mal	Very poor	A	A	A	2	3	3	2	2	2	Bare scald
29	6	Hof	Very poor	A	A	A	3	2	3	2	2	2	Annuals
30	5	Hof	Fair	N	A	A	0	0	0	0	0	0	Stable snakewood
31	8	Che	Fair to good	N	N	A	0	2	3	0	1	2	Partially stabilized
32	8	Hof	Poor	A	A	A	0	0	3	0	1	2	Annuals, degrading
33	6	Hof	Very poor	A	A	A	3	3	3	2	2	2	Bare scald
34	6	Hof	Very poor	A	A	N	3	3	3	2	2	2	Bare scald
35	7	Hof	Poor to very poor	A	A	A	0	2	3	1	2	2	Dead Roebourne Plains grass
36	7	Hof	Good	A	A	A	0	0	0	0	0	1	Undegraded Roebourne Plains grass
37	8	Che	Very poor	A	A	A	3	3	3	2	2	2	Bare scald, 15 m from 52
38	8	Che	Poor to fair	S	S	S	1	1	2	2	2	2	Residual hummock partly vegetated
39	7	Hof	Very poor	S	A	A	0	3	3	2	2	2	In recently constructed spiral pond
40	6	Hof	Poor to fair	A	A	A	0	3	3	2	2	2	Stony plain with some Roebourne Plains grass
41	4	Che	Fair to good	N	A	A	3	3	3	2	2	2	Regenerating area with saltbush
42	4	Hof	Fair to good	N	A	A	3	3	3	2	2	2	Previously degraded saltbush pastures
43	5	Hof	Very poor	A	A	A	3	3	3	2	2	2	Bare scald
44	2	Hof	Fair	N	A	A	0	0	1	1	0	1	Inside three year old pond, regenerating
45	1	Hof	Very poor	A	A	A	3	3	3	2	2	2	Bare scald — ripped unsuccessfully
46	2	Mal	Poor to very poor	N	N	A	0	2	2	1	1	2	Bare scald — chisel ploughed without success
47	3	Che	Fair to good	A	A	A	0	2	3	1	2	2	Giant bindii — area regenerating
48	2	Hof	Poor	A	A	A	0	1	3	1	2	2	Inside pond, 15 m from 49
49	2	Hof	Very poor	N	A	A	2	3	3	2	2	2	Bare scald outside pond, 15 m from 48
50	1	Che	Fair	A	A	A	3	3	3	2	2	2	Colonized by giant bindii — regenerating
51	2	Mal	Very poor	A	A	A	0	1	2	1	1	1	Bare scald
52	8	Che	Fair to good	A			0			1			Vegetated non deflated area, 15 m from 37
53	6	Hof	Very poor	A	A		0	0		0	2		Recent wind erosion
54	6	Hof	Poor	A	A		0	1		1	1		Degraded Roebourne Plains grass