1987

An inventory and condition survey of rangelands in the Carnarvon Basin, Western Australia

A L. Payne

G F. Spencer

P J. Curry

Western Australian
Department of Agriculture

ISSN 0083-8675
Agdex 320/10

Technical Bulletin

An inventory and condition survey of rangelands in the Carnarvon Basin, Western Australia

No. 73

A.L. Payne
P.J. Curry
G.F. Spencer

An inventory and condition survey of rangelands in the Carnarvon Basin, Western Australia

By: A.L. Payne, P.J. Curry and G.F. Spencer
Editor: D.A.W. Johnston

Commissioned by the Pastoral Board, Perth, Western Australia, 1980

Technical Bulletin No. 73
December, 1987
Department of Agriculture
Baron-Hay Court
South Perth, 6151
Western Australia
ISSN 0083-8675

56037-1

The authors

A.L. Payne and P.J. Curry, Division of Research Management, Western Australia, Department of Agriculture and G.F. Spencer, Department of Land Administration.

Other contributors

G.J. Eliot, S.J. Fritz and P. Hennig, Division of Resource Management, Western Australian Department of Agriculture; A.D. Allen, Geological Survey, Department of Mines, Western Australia, and P.C. Thomson, Agriculture Protection Board, Western Australia.

Payne, A. L.—
An inventory and condition survey of rangelands in the Carnarvon Basin, Western Australia.

Bibliography.
ISBN 0 7244 9022 1.

1. Pastures—Western Australia—Carnarvon Basin.
2. Rangelands—Western Australia—Carnarvon Basin.
I. Curry, Peter J.
II. Spencer, G. F. (Geoffrey Frank).
III. Western Australia. Dept. of Agriculture.
IV. Western Australia. Pastoral Board.
V. Title. (Series: Technical Bulletin (Western Australia. Dept. of Agriculture); No. 73).

633.2'02'09413

Definition

The Carnarvon Basin may be defined as:

The compound basin of sedimentation containing Proterozoic, Palaeozoic, Mesozoic and Tertiary sediments on a basement of pre-Cambrian gneiss, schist and granite that extends from near Onslow in the north to near Geraldton in the south and from the coast inland as far as 130 miles (208 km) east and seaward for an unknown distance (Condon 1965).

Contents

ERRATA

APPENDIX I—Individual station reports: Gnaraloo. Land systems on this station include approximately 1,100 ha of Chargoo l.s.

NINGALOO-YANREY MAP SHEET—Land system on the coast at Pilgramunna Creek is Coast l.s. (Cs), not Ca as depicted.

QUOBBA MAP SHEET—Land system on Babbage I. (mouth of Gascoyne R.) is Coast l.s. (Cs), not Br as depicted.

Stippled area shown between no. 7 bore and no. 10 bore on Boolathana Station is not severely degraded and eroded.

Abstract and recommendations

1. The area surveyed covers about 74,500 km^2 and includes the catchments of the Lyndon and Minilya rivers and the lower reaches of the Gascoyne and Wooramel Rivers. All of the Minilya, Winning Pool, Quobba, Kennedy Range, Shark Bay, Wooramel, Edel and Yaringa 1:250,000 scale map sheets and parts of the Ningaloo-Yanrey, Edmund, Glenburgh, Byro and Ajana sheets are included.
2. The area is described in terms of climate, geomorphology, hydrogeology, vegetation, soils, pasture types and land systems. Land system maps at 1:250,000 scale are presented.
3. Condition statements are presented for the whole survey area and for each land system, pasture type and station within the survey area.
4. Almost 11,000 assessments of pasture condition and soil condition were made while traversing throughout the survey area.
   (a) Forty-five per cent of these traverse records indicated good range condition.
   (b) Thirty-two per cent of traverse records indicated fair range condition.
   (c) Twenty-three per cent of traverse records indicated poor range condition. Traverse records imply that, as a whole, the proportion of rangeland in poor condition is no less on large stations (> 200,000 ha) than it is on smaller leases.

   Areas in poor range condition have pastures degraded to poor or very poor condition and soil erosion is common, but localized.

   Many of the areas indicated as being in poor or very poor condition are likely to have been so since the 1930s or, in some cases, earlier still. A lack of objective data to draw on before this survey implies that it is generally uncertain whether such areas have further declined, remained more or less unchanged, or recovered to any degree in more recent years.
5. Regeneration programmes are required for areas in poor range condition. These will involve reduced stocking, appropriate seasonal usage, deferment of grazing over some growing seasons and control of total grazing activity by stock, feral goats and kangaroos. Without effective control of kangaroos and goats, it may prove very difficult to reverse degenerative trends and restore the productive capacity of some areas.
6. During the course of the survey it was possible to identify areas showing extreme landscape deterioration, with degraded pastures and moderate or severe erosion. The total area in this category is about 650 km^2 (0.9% of the survey area). These are mainly areas of high grazing potential and are of considerable concern. Special rehabilitation programmes, including initial withdrawal from use and cultural works, are required to restore soils, vegetation and productive use.

   The extent and geographic location of the areas of extreme degradation are shown on the 1:250,000 scale map sheets and in figure 21.
7. Carrying capacity estimations for the pasture types of the area, at three condition levels, are presented. These are guideline figures based on current (1984) knowledge of the pastures. They were used for calculating the recommended carrying capacity for present condition and the capability carrying capacity for optimal condition of each station.
8. The recommended total livestock capacity for 1981-1982 condition of all stations within the survey area is 596,200 sheep units. This assumes that all stations are adequately watered which is not the case. Actual numbers present in 1982 in the survey area were about 484,000 sheep equivalents. Capability carrying capacity for optimal range condition throughout is estimated at 801,000 sheep units.

   At the time of survey only a few stations were clearly overstocked. Any increases in stock numbers in the future will generally require additional watering points to bring unused or little used country into production to accommodate the additional stock. At least 35 of the 54 stations in the survey area have considerable areas that are little used because of insufficient stock watering points.
9. Reports are presented for each station, describing land systems, pasture types, range condition, areas with severe degradation problems (if any), rehabilitation requirements, recommended carrying capacities for present condition and capability carrying capacities for optimal condition.
10. Soil Conservation Districts have been formed or are proposed for large parts of the survey area. The formation of such Districts and their local committees should be actively encouraged as they are the means by which appropriate management practices and rehabilitation programmes for seriously degraded areas can be developed.
11. Rehabilitation programmes will need to be co-operative ventures between station lessees, local government and the Department of Agriculture under the general direction of Soil Conservation District local committees.

12. Government assistance in the form of physical and technical resources will be required to implement rehabilitation programmes as these will generally require inputs beyond the resources of individual lessees. Some such assistance is already being supplied by the Western Australian Government through the Department of Agriculture and by the Commonwealth Government through the National Soil Conservation Programme.

13. Regular monitoring of the rangelands is required throughout the area. Monitoring enables pastoralists to use objective assessments of indicators and trends in pasture condition when planning grazing management practices. Monitoring also enables Government to be aware of changes in the condition of the land and to be able to assess the appropriateness of particular management practices and to advise lessees accordingly.

    This survey provides the inventory and mapping of pasture resources required to implement and maintain range monitoring systems on individual stations.

14. Insufficient stock watering points or poor quality (saline) supplies are problems common to many stations within the survey area. Additional technological development and information on costs and benefits of improved water supplies are required to encourage pastoralists to undertake water supply improvement programmes.

15. Many artesian water supplies used by the industry are reaching the end of their useful life and will need refurbishing or re-drilling in the near future. This will be beyond the means of individual station operators and Government assistance in some form (possibly low interest rate loans) will be required.

16. At least three land systems now alienated could not be economically developed for pastoral use as the pastures they support are of extremely low carrying capacity. Alternate forms of land use may be more appropriate. The systems are Nanga and Zuytdorp in the south-west of the survey area and Inscription on Dirk Hartog Island.

17. Considerable areas of Cape Range (the Range land system) in the north-west of the survey area are currently alienated, but are too rugged and support pastures too poor to be developed for pastoral use. Alternative forms of land use are more appropriate.

18. One land system, Coast, is highly susceptible to wind erosion once vegetative cover is depleted by any means and almost 8% of the system consists of massive blowouts and mobile dunes. Because of its high sensitivity to disturbance and the need to maintain dense vegetative cover, most of the system is unsuitable for development for pastoral purposes. Other forms of land use, with the option of limited pastoral use in some instances, may be more appropriate.

The Carnarvon Basin

Introduction

The findings presented in this report are those of a regional survey of pastoral lands in the Carnarvon Basin. Commissioned by the Pastoral Board of Western Australia in 1980, the survey was undertaken by a joint team from the Department of Agriculture and the Department of Lands and Surveys during 1980-1982. As part of a continuing programme of pastoral land classification, mapping and resource evaluation, it is the fifth survey of its type, others having been undertaken in the Gascoyne River Catchment (Wilcox and McKinnon 1972), the West Kimberley (Payne *et al.* 1979), part of the Nullarbor Plain (Mitchell *et al.* 1979) and the Ashburton River Catchment (Payne *et al.* 1982).

The survey covered about 74,500 km^2 of pastoral land in the Carnarvon Basin and Shark Bay - Byro Plains physiographic regions (Gentilli and Fairbridge 1951). The area covered by the survey extends from Exmouth Gulf in the north to Nerren Nerren station south of Shark Bay and inland to Carey Downs station in the east (figure 1). The survey area includes much of the catchments and all of the lower courses of the Lyndon and Minilya Rivers, as well as the mature reaches and flood plains of the Gascoyne and Wooramel Rivers. In the north and east the boundaries of the survey were fixed at the limits of coverage achieved by surveys of the Ashburton and Gascoyne River catchments; in the west coverage extended to the legal boundary of coastal leases, which is 40 m inland from the mean high water mark. Two major islands, Dirk Hartog and Faure, are included in accordance with their status as pastoral leases. The area dealt with broadly corresponds to the Carnarvon Basin as defined by Condon (1965).

The purpose of this survey is to provide a comprehensive description and mapping of the pastoral resources of the region, together with an evaluation of pastoral potential and the condition of the soils and vegetation throughout. This report, with its accompanying map series at 1:250,000 (figure 2) is primarily intended as a reference for pastoral managers, rangeland advisers and land administrators. the people most involved in planning and implementing pastoral management practices and land usage consistent with the condition, stability and potential of the natural resources.

Accounts of the pastures of the individual stations, together with their corresponding maps, provide an essential framework of resource information required for planning appropriate management for each area of a property.

The impact of grazing and management practices (whether traditional or innovative) needs to be monitored regularly to ensure the preservation or improvement of the productive condition of the land. This report provides a descriptive and comparative basis from which methods to monitor the future trends within each type of rangeland can be rationalized and developed.

As a result of this survey the special needs of severely degraded areas identified within the Carnarvon Basin can be considered from a regional perspective.

The complementary land system maps and summary accounts of landforms, soils and vegetation will also provide researchers and the public with a basic reference on the features and geography of the Carnarvon Basin.

Figure 1. Location map, Carnarvon Basin survey area

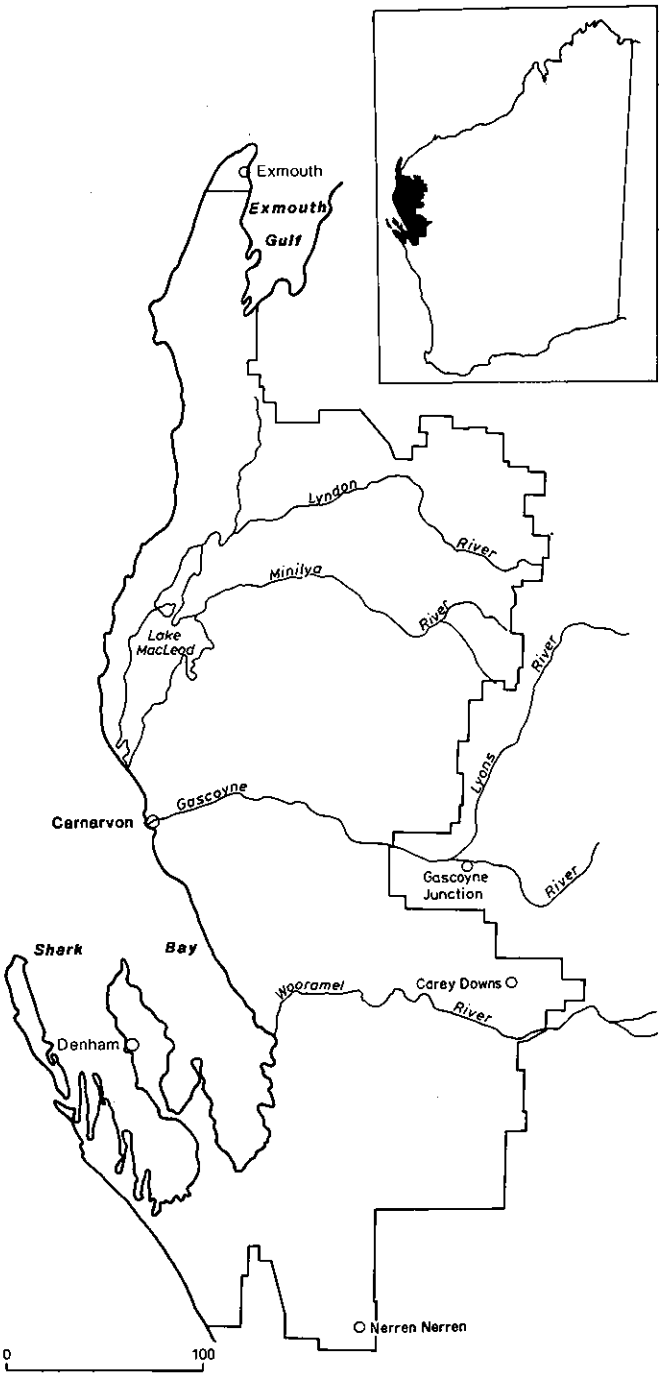
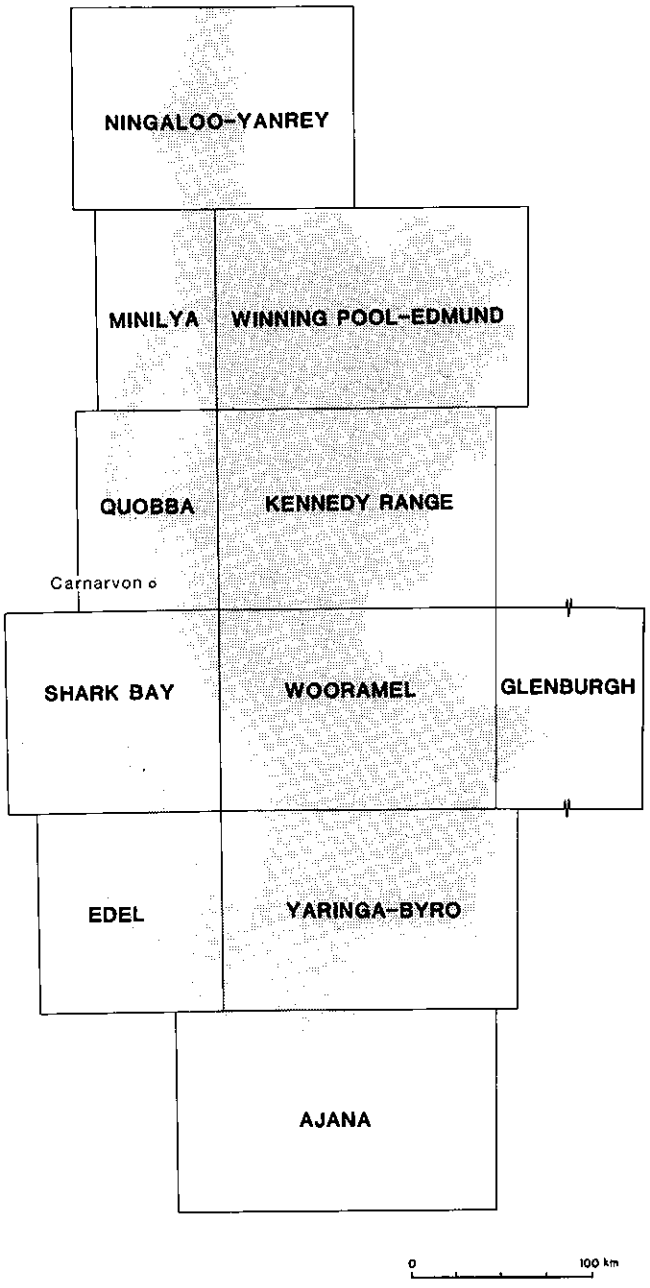


Figure 2. Carnarvon Basin survey area, showing relevant 1:250,000 map sheets



Brief pastoral history

Of the few early attempts of settlement in the Gascoyne and Murchison areas, none appear recorded as being successful until 1872 when Yuin station was established by W. Burgess which opened up the Lower Murchison area (Battye, 1915). In 1873, Maitland Brown leased 50,000 acres* around Boat Haven Loop (now Carrarang station), F.L. Von Bibra leased 20,000 acres on Dirk Hartog Island and C. Broadhurst was granted a lease on Faure Island (Carmody, unpublished). In 1875, Murgoo station was established in the Murchison area with the Gascoyne area being opened in 1876 by the Mungarra Squatting Company (A. Brown and J.H. Monger), on land which is now Brickhouse station. C.Brockman established Boolathana station in the same year bringing 3,600 sheep overland from the Murchison area (Burvill 1979). Wandagee station was established soon after Doorawarrah station in 1879 and a 110,000 acre lease was granted for A. Von Bibra around Useless Loop in October of the same year. Boologooro and Mia Mia stations, established in 1880, were followed by Minilya station and part of Peron Peninsula in 1881, Middalya station in 1882 and Towera station in 1883.

By the late 1880s squatting leases were granted for a 21 year period in blocks not less than 20,000 acres, costing 10 shillings† per 1,000 acres for each of the first seven years, 12 shillings 6 pence†† per 1,000 acres for the second seven years and 15 shillings per 1,000 acres for the third seven year period.

The number of pastoral properties and the amount of wool exported continued to rise, and by the turn of the century the sheep population for Western Australia was about 2,434,000 with about 20% being in the Carnarvon Basin area**. From this time sheep numbers in the Carnarvon Basin area rose from about 530,000 to reach a peak in 1923/24 of about 1,065,000. Then followed a dramatic fall to an all time low reached after the 1930s drought and the Great Depression. Because of overstocking, lack of vermin control, unpredictable seasons and few improvements on many of the properties, large tracts of land had become degraded and no longer supported the pristine pastures present at the time of settlement. The very high stock numbers carried in the 1920s were never regained (figure 3).

Recovery from the Depression was slow. It was not until the 1950s that a boost came for the pastoral industry in the form of higher wool prices.

During the 1950s, stock numbers in the Carnarvon Basin area averaged about 560,000 and gradually rose to about 650,000 in the 1960s until wool prices fell dramatically in 1970/71. This led to a slight decrease in sheep numbers in the early to mid 1970s. It also forced some pastoralists to change their traditional practices and turn away from wool towards the production of beef cattle.

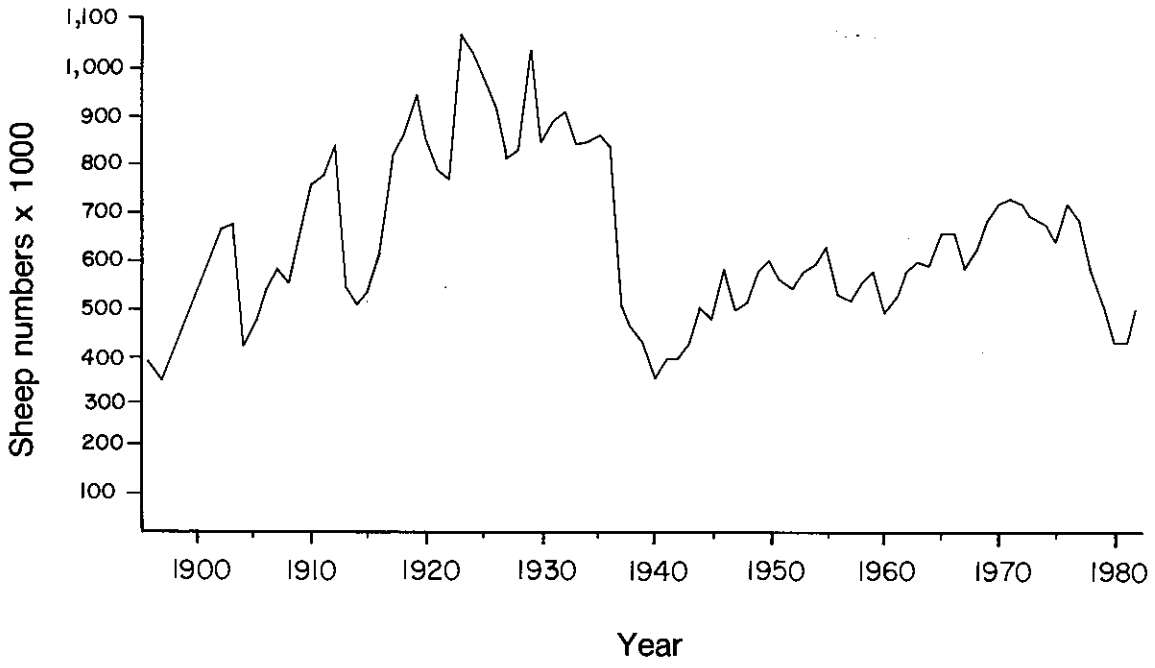
This change was made mainly to offset poor wool prices, while beef cattle were experiencing good returns at that time.

In 1976 came the start of yet another four year drought in which the number of sheep in the Carnarvon Basin area fell from nearly 730,000 in 1976 to about 435,000 in 1980. Cattle numbers in the area also fell dramatically, from about 11,500 to about 3,000.

By 1984 there were 50 pastoral stations in the Exmouth, Carnarvon and Shark Bay Shires, carrying about 515,600 sheep and 3,800 cattle.

* One acre = 0.405 of a hectare
** Statistical boundaries and Districts have changed since 1829 and refer to a somewhat larger area than that covered by this survey.
† One shilling = 10 cents
†† Twelve pence = 1 shilling

Figure 3. Sheep numbers in the Carnarvon Basin survey area, 1896-1982



Climate

Introduction

Climatic classifications of the drier parts of Australia have been based on many criteria and tailored to suit different descriptive purposes (Gentilli 1971), though most tend to emphasize rainfall as the key criterion. We have followed Beard's (1975, 1976) climatic subdivisions of the area which he classified according to the methods of Bagnouls and Gaussen (1957). These define the climate as 'desert' in the inland north-east and south-east, and 'semi-desert' for all other areas excepting the western parts of Shark Bay, which receive sufficient rain in winter to be considered as being within the 'Mediterranean' zone of the State's south-west (figure 4). One common definition of arid land or aridity is that insufficient rain falls for cropping at any season, mean annual rainfall is below 250 mm and that zero rainfall can be recorded in any month. Accordingly, the area can be described as arid everywhere except in the far south-west from Dirk Hartog Island to Tamala station.

Sources of climatic data

To illustrate the main features of the area's climate, we have selected data from the Bureau of Meterology for representative stations at coastal and inland locations.

We have analysed the rainfall records from three coastal stations (figure 5), Cardabia, Brickhouse and Hamelin, and two inland stations, Lyndon and Carey Downs (with additions from nearby Towrana over 1915-1928 and 1951-1958, when no records were kept at Carey Downs). Each of the five stations has between 63 and 74 years of records to 1981.

Measurements of temperature and relative humidity were available from three coastal centres, Learmonth, Carnarvon and Hamelin Pool. Also, we have had to refer to Bureau of Meteorology records from two inland weather stations slightly beyond the survey area, Nyang in the north-east and Gascoyne Junction in the east.

Figure 4. Climatic subdivisions of the survey area (after Bagnouls and Gaussen 1957).

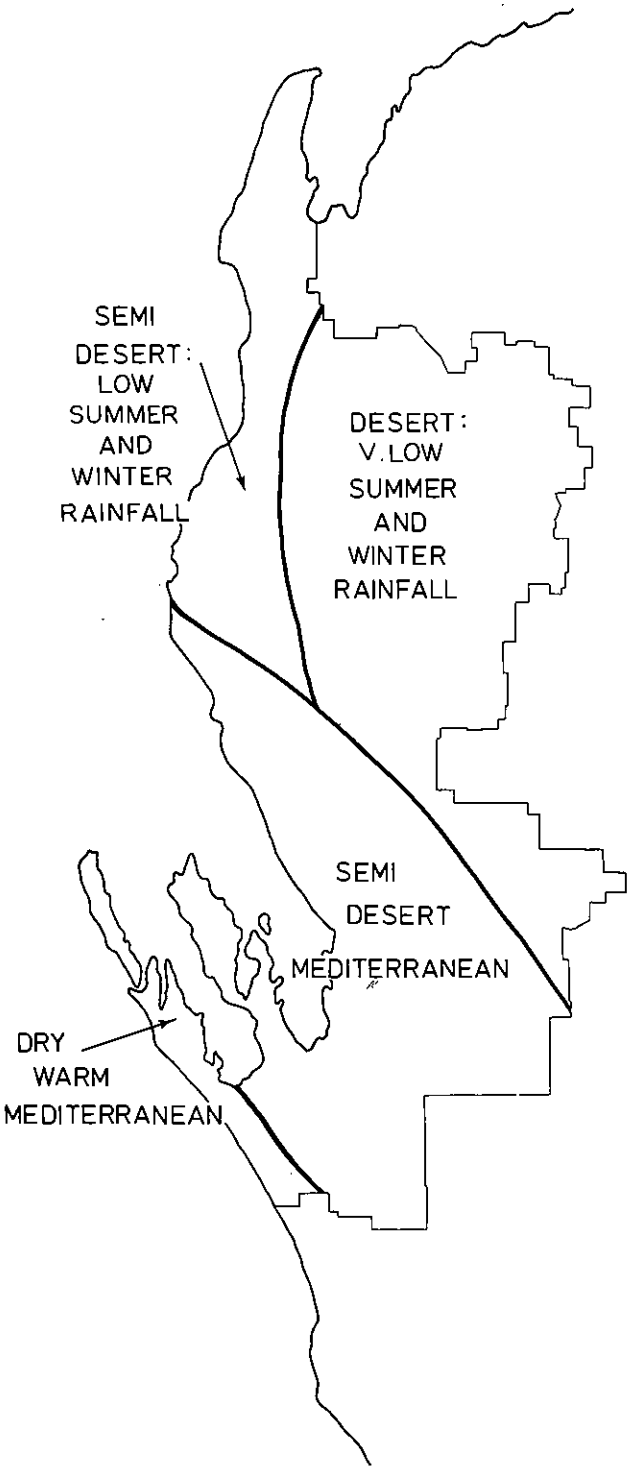


Figure 5. Mean annual rainfall at stations selected for analysis of rainfall records or other meteorological data

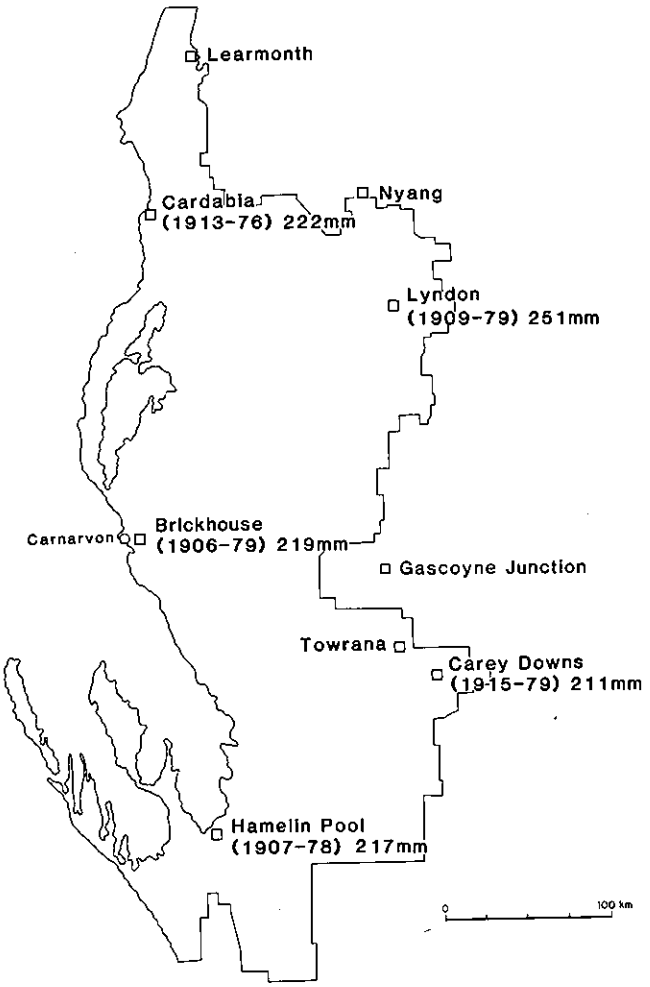
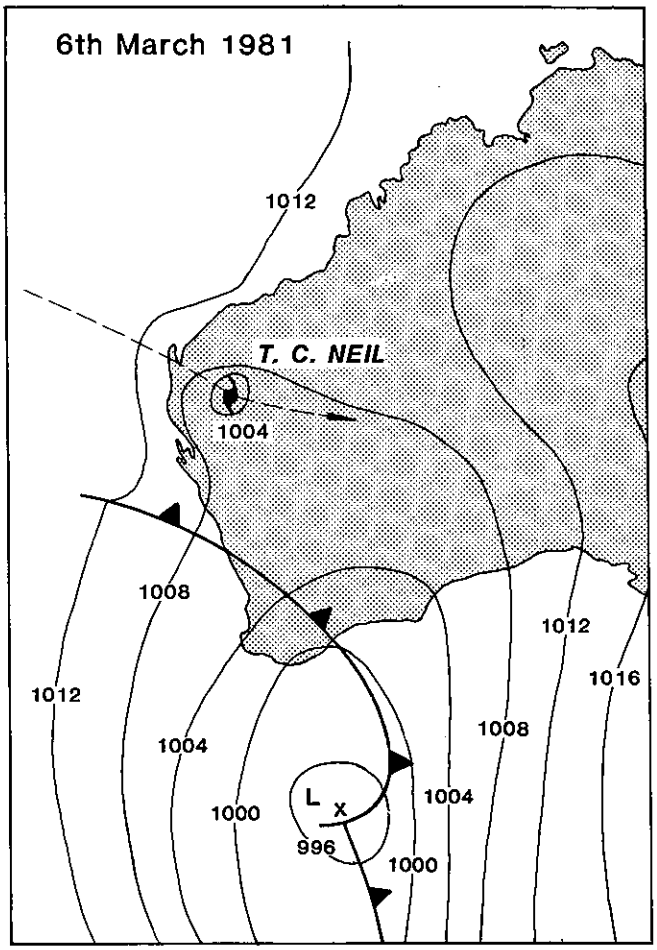


Figure 6. Surface chart depicting the location and direction of passage of a tropical cyclone across the north of the survey area, March 6, 1981



Major climatic patterns

Summer pattern (November to April)

In northern parts of the area, summers are influenced by tropical air masses to a greater extent than the southern and coastal areas, which mainly receive anticyclonic circulations. The early summer period is nearly always dominated by anticyclones and no significant rainfall occurs anywhere. Only in midsummer and autumn are the high temperatures of northern areas broken by thunderstorms, or the south-eastward passage of tropical cyclones (figure 6). Even so, rains that result are more often local than general. Summers in the southern and coastal areas are very dry, but less hot under the ameliorating influences of diurnal sea-breezes.

Winter pattern (May to October)

Generally, winters consist of periods of calm, fine, anticyclonic weather, with mild days and cool nights. These are broken only by the eastward passage of rain-bearing frontal systems. During May, the paths of depressions and their associated fronts from the Indian Ocean shift progressively northward and rain falls further north and penetrates further inland. Useful winter rains most often occur between late May and early July (figure 7), when some of the stronger and more northerly fronts interact with middle-level tropical disturbances which approach from the north-west.

In late winter, depressions travel further south and rain-bearing fronts are usually weak at their northern ends, bringing little rain to this area. In spring, stable anticyclonic conditions re-establish over the area to produce warm and very dry weather during September to early November.

Figure 7. Surface chart depicting the approach of rain-bearing cold front in early winter, May 6, 1984.

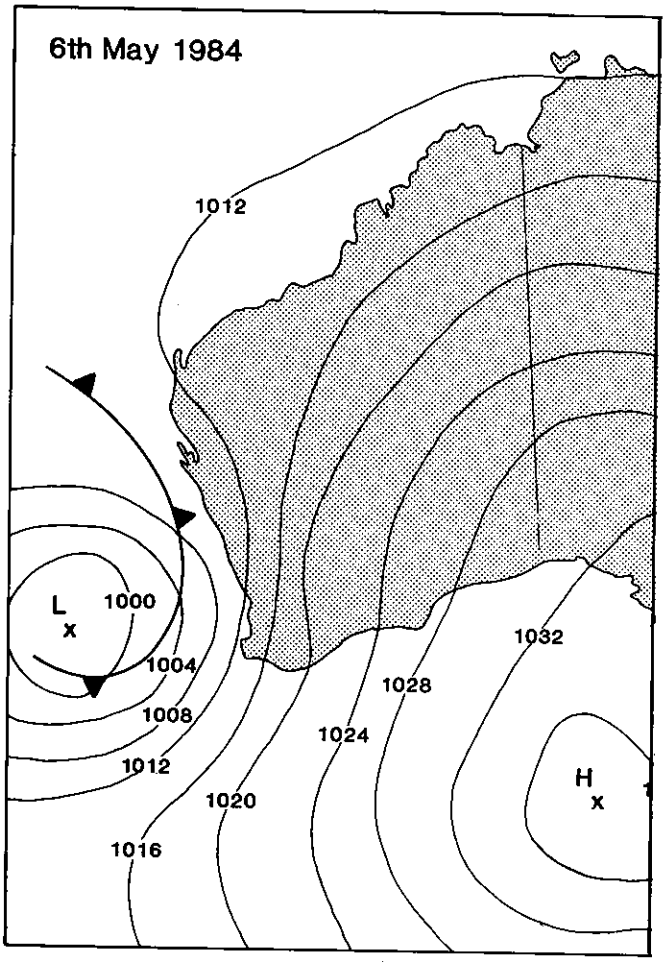


Table 1. Percentage incidence of strong winds at Carnarvon

Season	Time (WST)	Wind velocity km/h 11-30	>30
Summer (January)	0900	40	30 (S)
	1500	43	27 (S.W, S)
Winter (July)	0900	40	5 (S.E, E)
	1500	60	10 (S)

Temperatures

Mean monthly maximum and minimum temperatures for five centres are given in figures 10 and 11. Maximum temperatures are highest in January and February and the inland stations are hotter than those on the coast. There is notable variation in summer maxima at the coastal centres. For example, the January mean maximum is 30.8°C at Carnarvon and 37.2°C at Hamelin Pool. This is because the summer southerlies travel over the ocean before reaching Carnarvon and over land before reaching Hamelin Pool. Extremes of temperature experienced exceed 50°C inland and 45°C on the coast. Winter maxima are consistent throughout, except for the far north, where they are from 3° to 7°C higher at Learmonth than elsewhere. The lowest mean maxima occur in July at all centres.

Inland areas have lower winter minima than coastal areas. The lowest winter minima occur in July, except in the north-east at Nyang (August). Summer minima are slightly lower at coastal centres than inland.

The annual range of mean monthly maxima is much less along the coast than it is inland. For example, at Gascoyne Junction the range is from 22.4°C (July) to 40.5°C (January), compared with 21.9°C (July) to 32.0°C (February) at Carnarvon. The range of mean minima is again slightly less in coastal areas, for example from 9.5°C in July and August to 21.8°C in February at Hamelin Pool and from 11.5°C in August to 25.3°C in March at Nyang.

Climatic factors

Humidity and winds

As shown in figures 8 and 9, the inland parts of the area receive less humid airflows than coastal areas. The north is influenced by moist tropical air masses in summer, which account for the higher humidities observed at Learmonth. The south is much more evenly humid under the influence of onshore winds throughout the year.

In summer, the prevailing winds are southerly and moderately strong in coastal districts. Inland, breezes are lighter and more variable, often easterly under the influence of the Pilbara stationary heat low (Gentilli 1971).

During winter, winds are lighter but more humid throughout. In July, breezes at Carnarvon are mainly from the south-east in the morning and the south-western quarter in the afternoon. The eastward passage of frontal systems temporarily upsets this pattern with periods of moist westerly airstreams and rainfall.

Table 1 indicates the percentage incidence and direction of strong winds in summer and winter at Carnarvon.

Figure 8. Mean monthly relative humidity at 0900 hours, western standard time

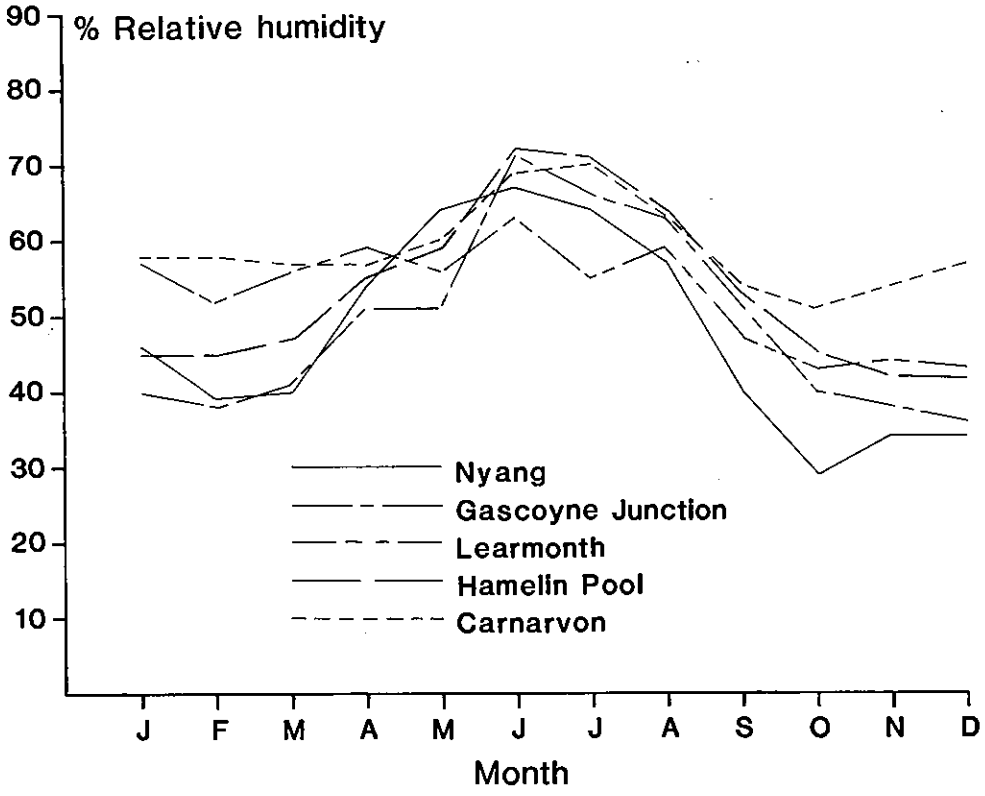
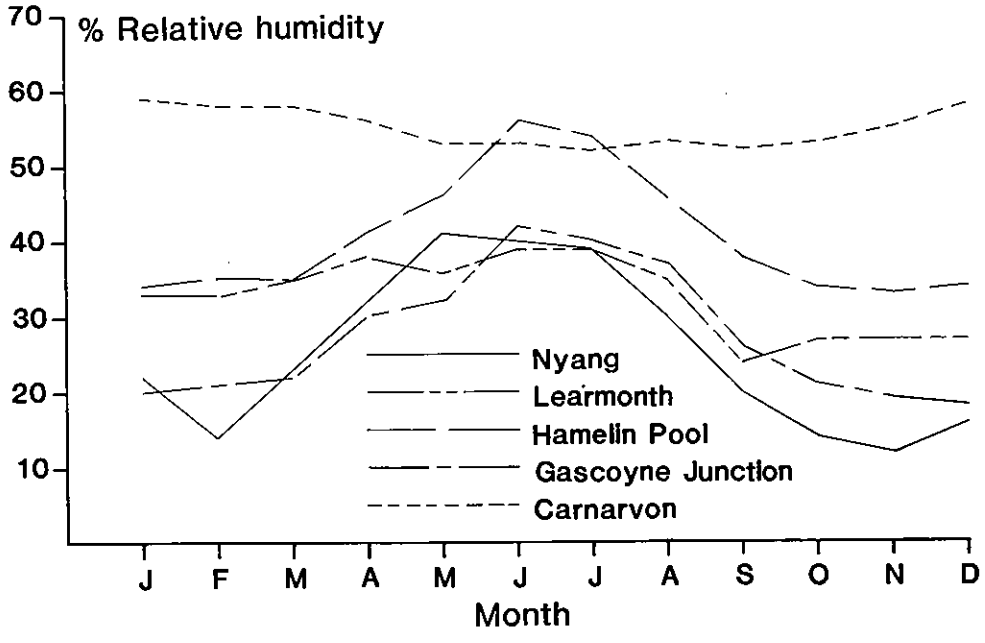


Figure 9. Mean monthly relative humidity at 1500 hours, western standard time



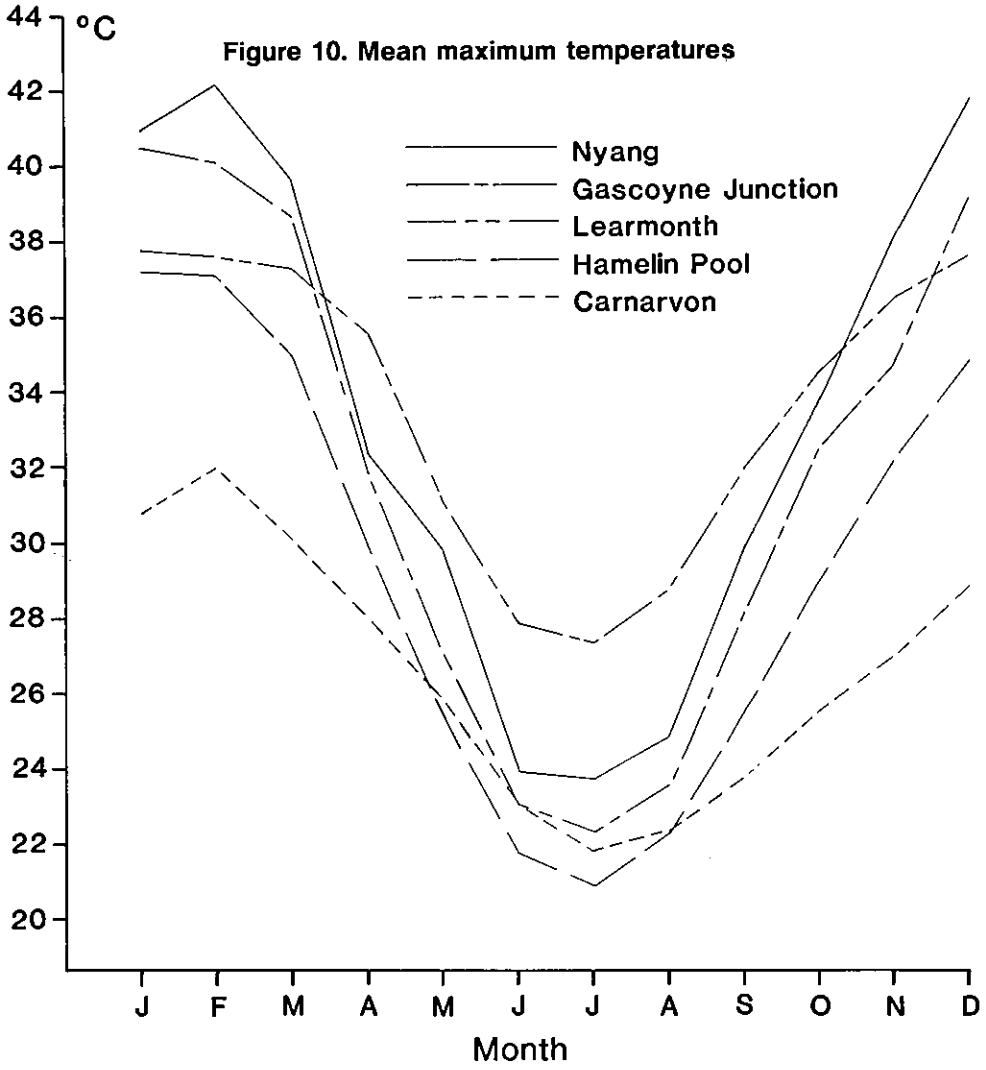


Figure 10. Mean maximum temperatures

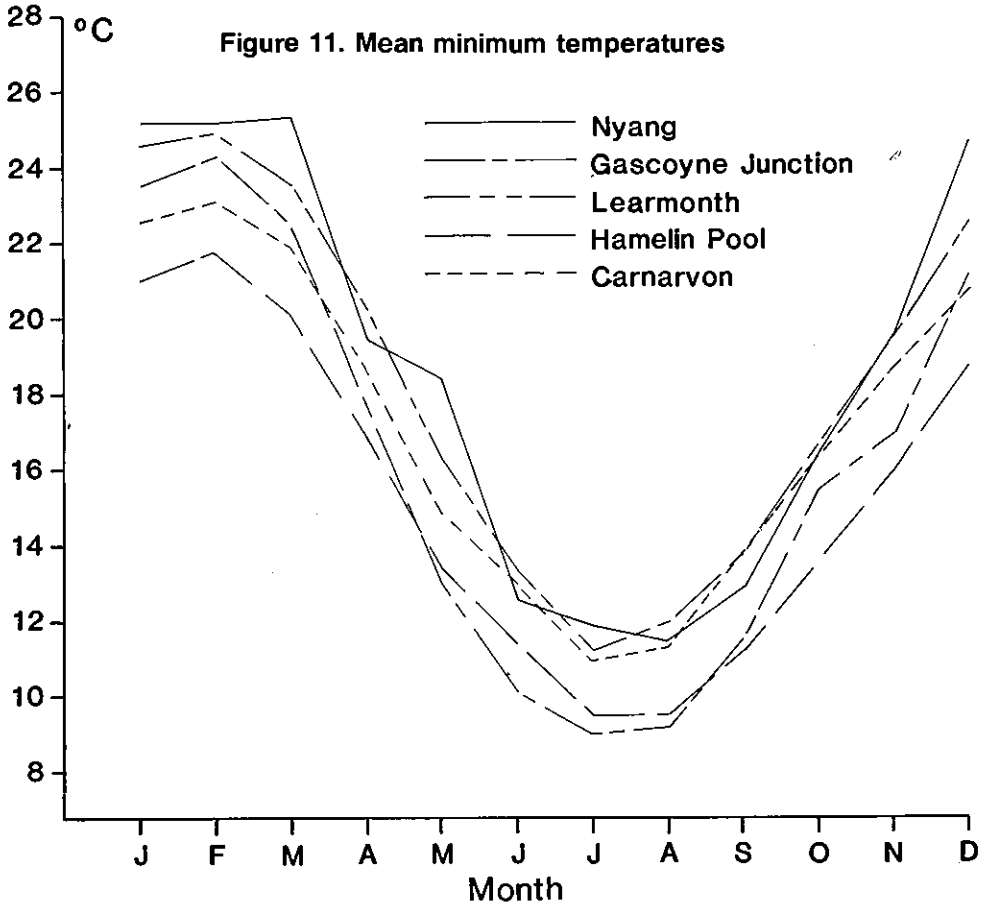


Figure 11. Mean minimum temperatures

Rainfall

In an arid land, rainfall is the limiting factor in the growth of plants and a primary controller of biological processes generally. Variations in the distribution and timing of rainfall have 'exaggerated importance in arid ecosystems however low the overall turn-over of biomass' (Graetz 1981).

Assessed by long-term averages, the mean annual rainfall across most of the area appears to be remarkably consistent at about 220mm which falls predominantly in winter (figure 12). Only in the north-east, at Lyndon, is the influence of occasional heavy summer rainfall sufficiently great to inflate the mean annual figure to 251mm, about 15% above the others (figure 5). At Lyndon, the months of January, April and May average the wettest, while at the other stations May and June are wettest (or June and July at Hamelin Pool) (figure 13). On the other side of the area, the far western part of Shark Bay is significantly wetter in winter (over 300 mm mean annual rainfall).

The variability of monthly rainfall provides an insight into the reliability, if not the effectiveness, of rainfall at different seasons. Coefficients of variation are lowest in early winter (May to July) at all five stations (figure 14), which implies that the early winter period has both the highest and the most reliable rainfall.

Rainfall in any one summer month is frequently zero, but occasional storms at the coastal stations inflate the year to year variation in the early summer months to 300-500% of the monthly means. Variation in the monthly rainfall inland during summer is rather less as a result of more frequent falls, even if these are mainly local and light.

Figure 12. Proportions of average winter (shaded) to average summer rainfall

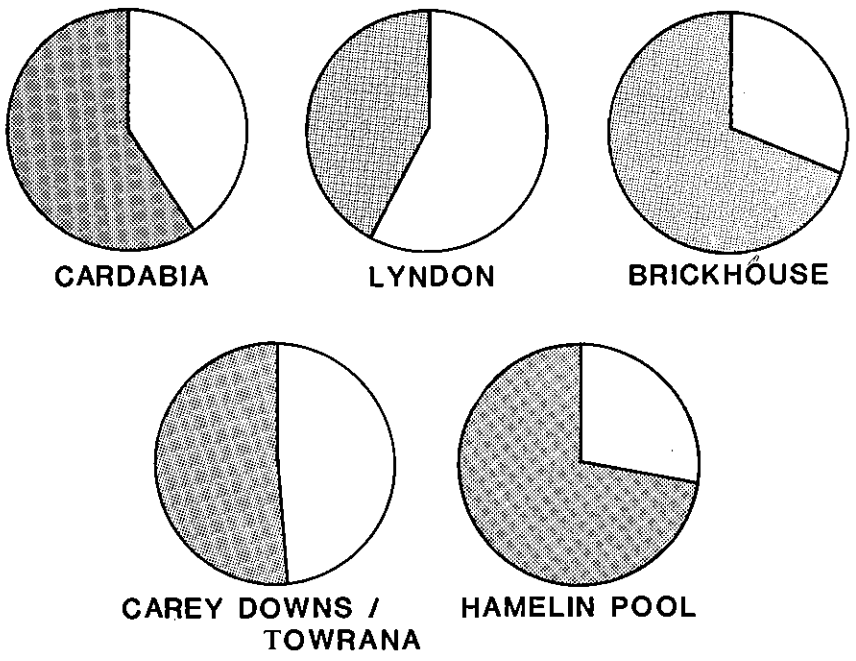
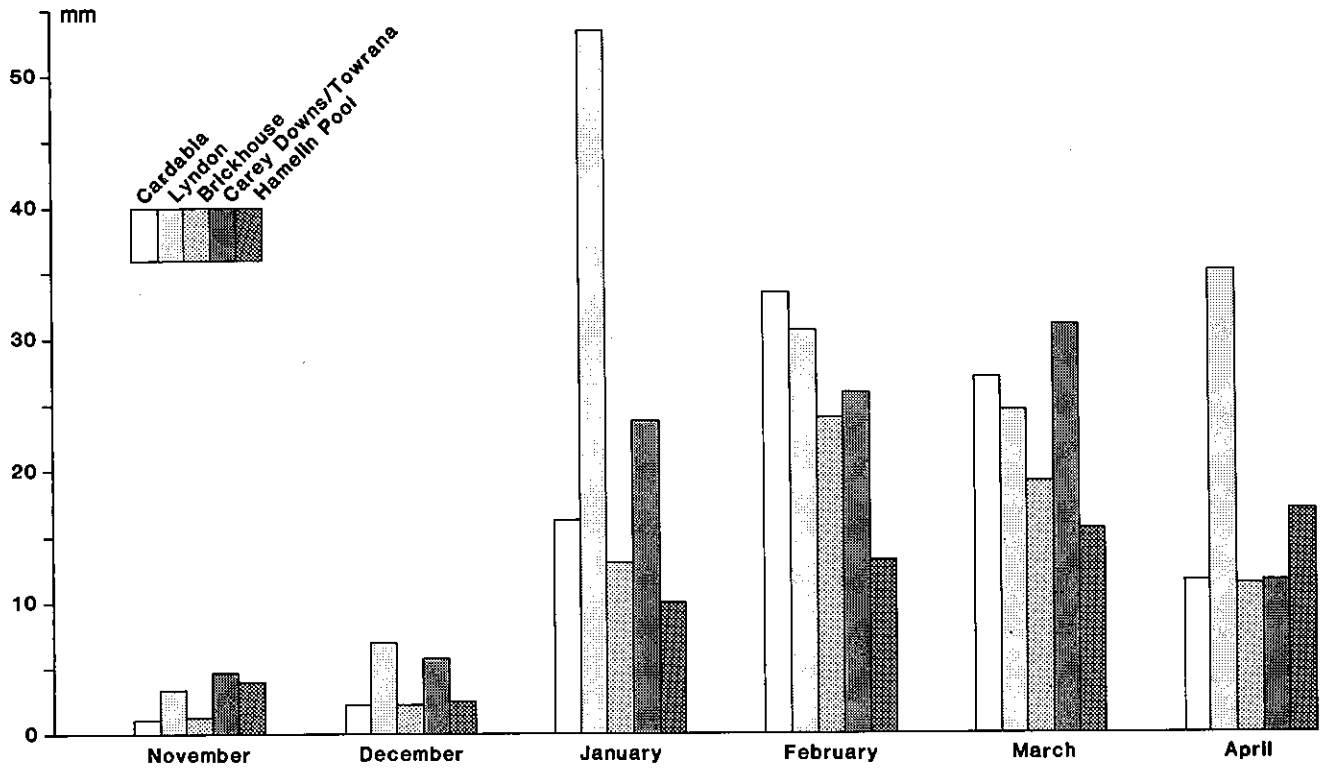


Figure 13. Mean monthly rainfall at five centres; summer months above, winter months below.



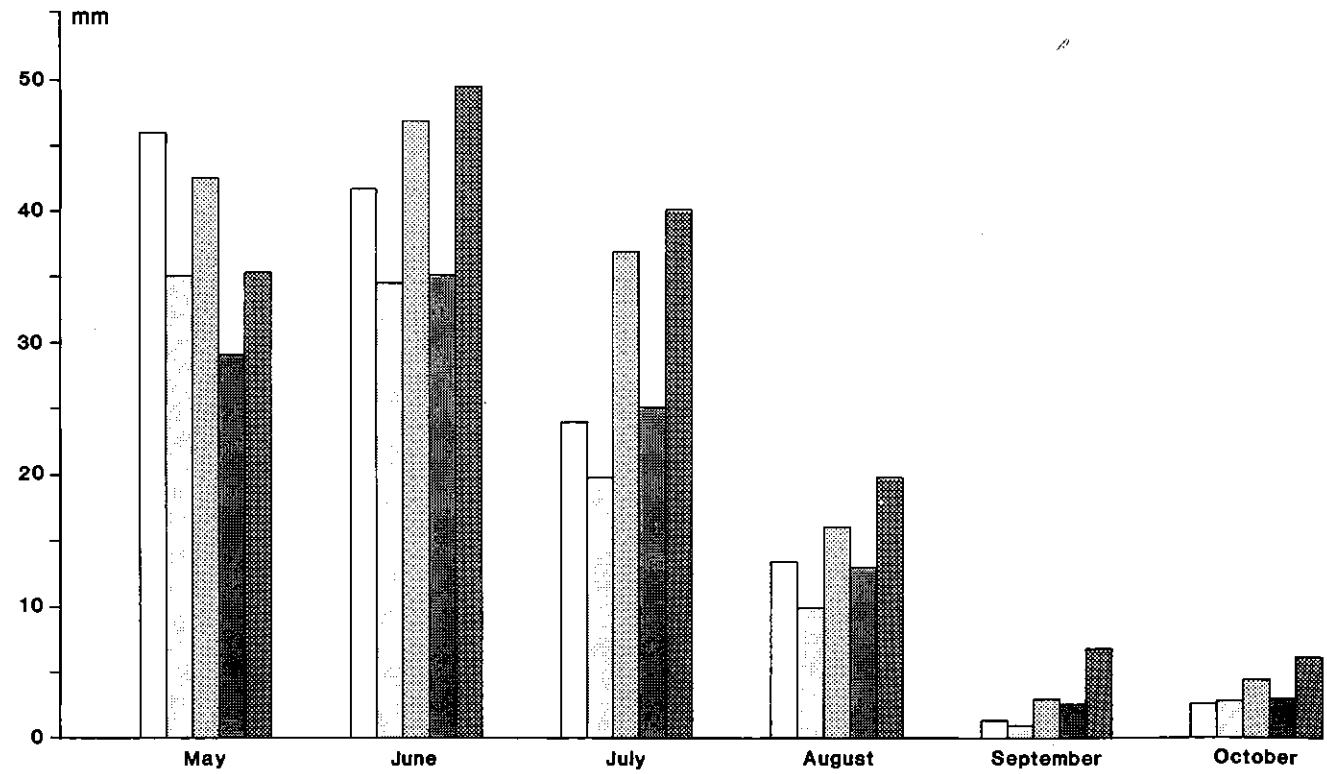
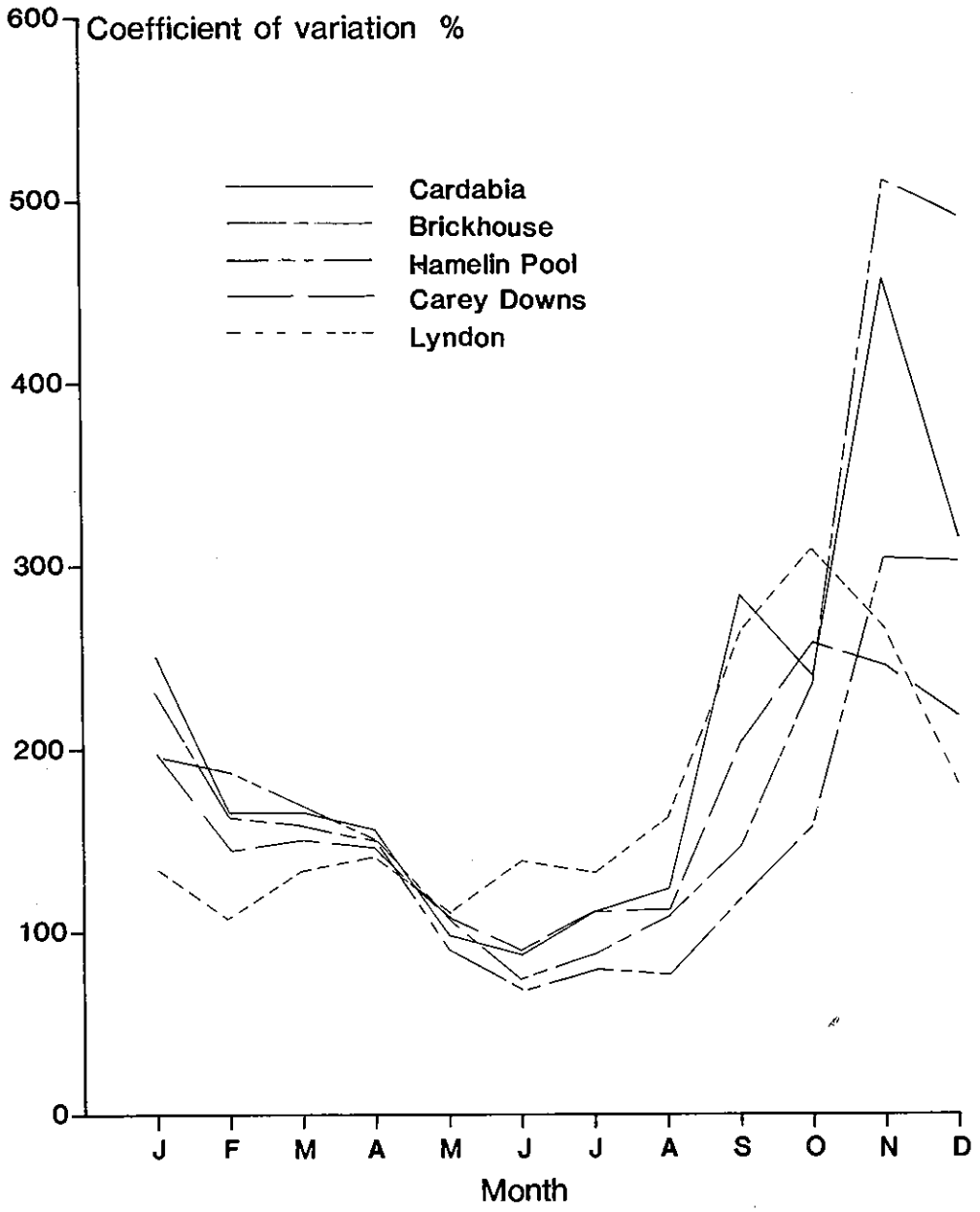


Figure 14. Annual variation in mean monthly rainfall, expressed as percentage coefficient of variation (c.v.).



Rainfall effectiveness and estimated periods of plant growth

Plant growth in the arid zone is limited primarily by a lack of soil moisture. Even in the wettest years (table 2), actual rainfall never approaches the area's evaporation potential (2600-3200 mm). Growth is confined to limited periods of available soil moisture that follow rainfall events. Because potential evaporation is much higher in summer (over 300mm in January) than in winter (65mm in the south and 90mm in the north-east in July), it is usually the winter rains that give the longer-lasting recharges of soil moisture sufficient to promote significant periods of plant growth. Summer falls are mainly too light to result in much growth, except locally on sites receiving run-on. Heavier summer falls that result from the passage of cyclonic depressions occur very infrequently. These irregular rains are nonetheless vital because they trigger shrub germination and many other biological events that cannot take place in winter.

Table 2. Wettest and driest years

Station	Driest year	Total mm	Wettest year	Total mm
Cardabia	1919	50	1918	611
Lyndon	1936	26	1909	647
Brickhouse	1938	47	1923	481
Carey Downs/Towrana	1919	54	1963	511
Hamelin	1911	61	1971	409

Table 3. Frequency and duration of significant periods of available soil moisture from documented rainfall events at five stations, as estimated by the ARWATBAL model.

Station	Significant winter growth periods (May-Sept 30+days) frequency as per cent of years	mean duration days± S.D.	Significant summer growth periods (Oct-Apr 20+days) frequency as per cent of years	mean duration days ± S.D.
Cardabia (68 years)	84	78±31	25	26±7
Lyndon (72 years)	65	75±27	36	28±10
Brickhouse (77 years)	94	92±27	17	26±5
Carey Downs/ Towrana (64 years)	83	67±22	14	27±9
Hamelin (76 years)	93	96±31	14	26±7

We have estimated rainfall effectiveness in terms of the duration of sufficient soil moisture to induce significant plant growth. The standards adopted are a minimum of 30 days of continuously favourable soil water potentials in winter and 20 days in summer, as defined by Fitzpatrick, Slatyer and Krishnan (1967). These seasonal critera tend towards being liberal estimates of the frequency of summer growth, when higher temperatures prevail to speed rates of growth; conversely, they do not take into account cold spells, when low temperatures can inhibit winter growth.

The incidence and duration of such growth periods has been estimated using the ARWATBAL model (Fitzpatrick *et al., op.cit.*). This programme requires inputs of environmental variables (rainfall and potential transpiration) expressed as values for each 5-day period during the year. It estimates moisture storage in a generalized way for typical central Australian conditions and cannot take account of local changes in soils or hydrology.

The results of this growth period analysis are summarized in table 3. Significant growth periods occurred during the winter months in more than 80% of recorded years, at all stations except Lyndon. Disregarding periods of favourable soil moisture that fell short of the 30 day standard, winter growth periods are impressively long and mostly between two and three months of continuously available moisture (table 3). The coastal localities of Brickhouse and Hamelin Pool can be seen to have fared best, in the near-annual frequency and the long average duration of significant winter growth periods.

In the summer months, evaporation deficits are so large that only the heaviest recharges of soil moisture persist long enough to register as significant growth periods. These are calculated to have occurred less often than one year in three everywhere other than at Lyndon, where they were recorded in 36% of years. The duration of significant periods of summer growth averaged 27 days over the five stations.

This pattern of predominantly winter pasture growth extends north and east of the area as far as the northern part of the Ashburton catchment (Payne, Mitchell and Holman 1982). In summary, significant winter rainfall can be expected in most years everywhere in the survey region. If these falls have not eventuated by the end of July, no useful rains can be expected until the following winter. Effective summer rains are an unusual event everywhere, rather than something on which to rely. This has vital implications in management planning.

Available data do not suggest any particular correlation between the incidence of effective summer rainfall and the winter rainfall that precedes or follows it. Actual winter rainfall cannot be used to predict rains in the following summer and vice-versa.

The lack of success which meteorologists have had in long-term weather forecasting for this area and elsewhere was emphasized by Nicholls (1983), to quote '...no method for accurate long-range prediction of rainfall *in the west of the continent*, ... is presently available' (our italics).

Geology and geomorphic districts

The survey area (figure 1) extends over about 74,500 km^2 and falls almost entirely within the North-west (Artesian) Basin as described by Maitland (1919). The area is bounded by the geographicals 22°01'S to 27°17'S and 112°55'E to 115°48'E extending in a north-south direction for some 600 km, and in an east-west direction for 300 km. The western boundary is the coastline and included the islands of Dirk Hartog and Faure. The eastern boundary is coincident with the catchment boundary of the Ashburton and Gascoyne Survey areas to the north, and the proposed Murchison Survey area to the south.

The geology of the area is well-documented and has been mapped at a scale of 1:250,000. Numerous works have been published on the Phanerozoic deposits of the Carnarvon Basin (Maitland's N.W. Basin) among which that of Condon (1965-1968) is outstanding. While most of the survey area fits within the tectonic province of the Carnarvon Basin, the older crystalline rocks in the north-east fall within the tectonic boundary of the Gascoyne Province.

Basin development and regional geology

The geological history of the basin has been dominated by intermittent regression and transgression of the sea (Condon 1965) and a rather complex tectonic setting from the Silurian to the Tertiary (Thomas and Smith 1976). Sedimentation was initiated during the Silurian with activity along the Darling Fault. The relative uplifting of the Pre-Cambrian hinterland provided a huge source of fluviatile sediments which covered the basin. Fluvial sedimentation slowed during the Devonian with marine conditions becoming established over most of the basin (Thomas and Smith 1974).

The eastern margin was uplifted during the Permian; again providing a source of sediment. At this time, the southern part of the basin was characterized by a long period of non-deposition. Marine conditions steadily diminished in the northern part of the basin with the regression continuing into the Jurassic, allowing widespread fluvial sedimentation. Jurassic down-warping and rapid sedimentation was initiated in the north while the southern Carnarvon Basin was uplifted, block faulted and eroded (Thomas and Smith 1974).

In the early Cretaceous the basin was again flooded by transgressing seas. A wedge of marine sediments was deposited, thinning east and south to little more than a veneer (Johnstone *et al.*, 1976).

The Cape Range, Giralia Range and Rough Range anticlines resulted after a period of Tertiary tectonism which uplifted old Jurassic troughs. In the Hamelin Pool area, numerous small anticlines have been produced by minor reverse movements along older normal faults, causing arching of the Cretaceous and Tertiary veneer (Thomas and Smith 1974).

Except for the outcropping anticlinal coastal structures and the Permian and Cretaceous surface sediments at the eastern margin, Quaternary non-marine superficial deposits now cover most of the Carnarvon Basin. The Pre-Cambrian crystalline schists and granites of the Gascoyne Province not only provide an eastern delineation but also form the floor for the Carnarvon Basin (Condon 1965).

Geomorphology

The surface of the Carnarvon Basin slopes very gently towards the coast and is characterized by low relief, open drainage, and large, gently undulating sand plains. This contrasts strongly with the small area of Pre-Cambrian rocks in the north-east of the survey area which falls within the Gascoyne Province and has moderately high relief, a close dendritic drainage pattern and mature valley topography.

Exposed surface rocks in the basin range in age from the Permian to the Quaternary. The Permian beds appear in the eastern part of the basin and consist of sandstone, greywacke and siltstone. They have been peneplained and uplifted some hundreds of metres and then dissected to form long ridge lines and isolated mesas. The most prominent of these structures is the Kennedy Range. It exposes a Tertiary horizontal capping, but is mostly covered by longitudinal dunes trending N.W.-S.E.

Other structures of note are the low anticlinal range of hills which expose Cretaceous and Tertiary sediments. They extend from Lake McLeod to North-West Cape. The largest of them, the Cape Range, rises to 300 m above sea-level and occupies almost the entire Exmouth peninsula. This range provides spectacular canyons where erosion has penetrated the hard limestone capping and dissected the underlying softer sandstone and calcarenite.

Most of the middle basin north of the Wooramel River contains longitudinal dunes trending from N.W.-S.E. to an E-W direction further inland. South of the Wooramel River the basin is mostly a gently undulating and featureless sandplain which rises from sea level at Hamelin Pool to about 300 m in the south-east.

The coastline has several salient features. The Zuytdorp Cliffs in the south rise to 300 m above the Indian Ocean, but north of Steep Point they give way to an irregular coastline of islands, inlets and narrow tidal mudflats which extend from Shark Bay to Lake McLeod. North of Lake McLeod, the coastline is once again characterized by limestone platforms and, in places, high cliffs.

The Lyndon and Minilya Rivers, both with their headwaters in the Pre-Cambrian rocks to the east, empty into the large playa of Lake MacLeod. Further south, past changes in the course of the Gascoyne River have formed the Brown, Boodalia and present day deltas. The Brown Range and Bejaling Beach Ridges are reworked sediments, resulting from these old deltas (Johnson 1974). The Wooramel River crosses the Carnarvon Basin in the south and empties into Shark Bay through a delta of Pleistocene to Holocene age.

Geomorphic districts

Jutson (1934) defined geomorphology and physiography as, the science which treats of the origin and history of landforms. Landform is a combination of relief and shape and as such, reflects the geomorphic evolution of the landscape. He was the first in 1914 to subdivide the State into six 'physiographic' divisions. The current survey not only fits into his rather expansive North-West Division, but also into the later (1934) sub-unit of Murchisonia.

However, the North-West (Artesian) Basin as delineated by Maitland (1919) was the first State-wide subdivisional unit to bare a resemblance to the present day Carnarvon Basin. Clarke's (1926) Carnarvon Natural Region (based on climate, geology, and geography) coincided with Maitland's North-West Basin, but it was Gentilli and Fairbridge (1951) who first used the term Carnarvon (or North-West) Basin for this large basin of Phanerozoic sediments.

Condon (1965) attempted a six unit physiographic subdivision of the Carnarvon Basin to which the districts adopted by this report show some resemblance. Further work by Loeffler and Ruxton (1969) and particularly Mabbutt (1968, 1973) on a geomorphic classification to the Australian continent have set the criteria for the delineation of the geomorphic districts used here (table 4).

These geomorphic districts adopted for this report (figure 15) correspond, with some minor variations, to Mabbutt's regional approach which classified all landforms as either erosional or depositional. Mabbutt further classified erosional surfaces on relief, and depositional surfaces on their genesis.

Table 4. The geomorphic districts of the survey area.

Surface type	Landform/ genesis	Geomorphic Districts	Area within survey (approx.) Km²	%
Erosional	Plains	Carbla Plateau	3,525	4.7
		Mardathuna Plains	2,955	4.0
		Towera Stony Plains	3,035	4.1
		Wandagee Permian Plains	2,255	3.0
		Winning Plains	4,575	6.1
	Plains and hills	Giralia Range	6,480	8.7
		Lyndon Proterozoic Hills	2,530	3.4
		Tamala Limestone Plains	685	0.9
	Hills	Cape Range	1,830	2.5
		Permian Hills	2,355	3.2
Depositional	Aeolian	Coastal Dunes	5,265	7.1
		Ridge Dunes	11,480	15.4
		Victoria Sand Plain	16,675	22.3
	Fluvial	Alluvial Plains	6,910	9.3
	Lacustrine and marine	Lake MacLeod and Saline Plains	3,935	5.3

Erosional surfaces predominating

Forms of Low Relief: Plains (relative relief <30m)

Carbla Plateau District (3,525 km²)

A partly dissected, calcrete-duricrusted plateau is located adjacent to the coast immediately south of the Wooramel River. It is bounded to the east by the Victoria Plateau where it rises to an elevation of about 90 m from the synclinal structure of Hamelin Pool.

The district is based on Toolonga calcilutite of Cretaceous age, which has been duricrusted to form calcrete at the surface. Special coastal features unique to this area are the growth of stromatolites in hypersaline conditions and the formation of Hamelin coquina. The latter is a beach ridge complex consisting predominantly of small shells swept from the sub-littoral platform onto the shore.

Five land systems, Foscal, Toolonga, Salune, Snakewood and Yaringa are exclusive to the district. The most elevated of these systems, Yaringa and Toolonga, are generally found in the central and eastern areas of the district. The Yaringa system is characterized by residual areas of sand overlying the frequently outcropping calcrete. In contrast, the Toolonga system has very little sand and consists largely of extensive undulating calcrete plains. Closer to the coast, the Toolonga calcilutite has been dissected in part to form low breakaways and isolated mesas which characterize the upper units of the Foscal system. These upper units have erosional surfaces, while the lower units consist of depositional plains of Quaternary colluvium. Low plains with duplex soils characterize the Snakewood system which is located throughout the southern part of the district. It is based on Quaternary alluvium and colluvium, and in most instances is found below the calcrete systems.

Mardathuna Plains District (2,955 km²)

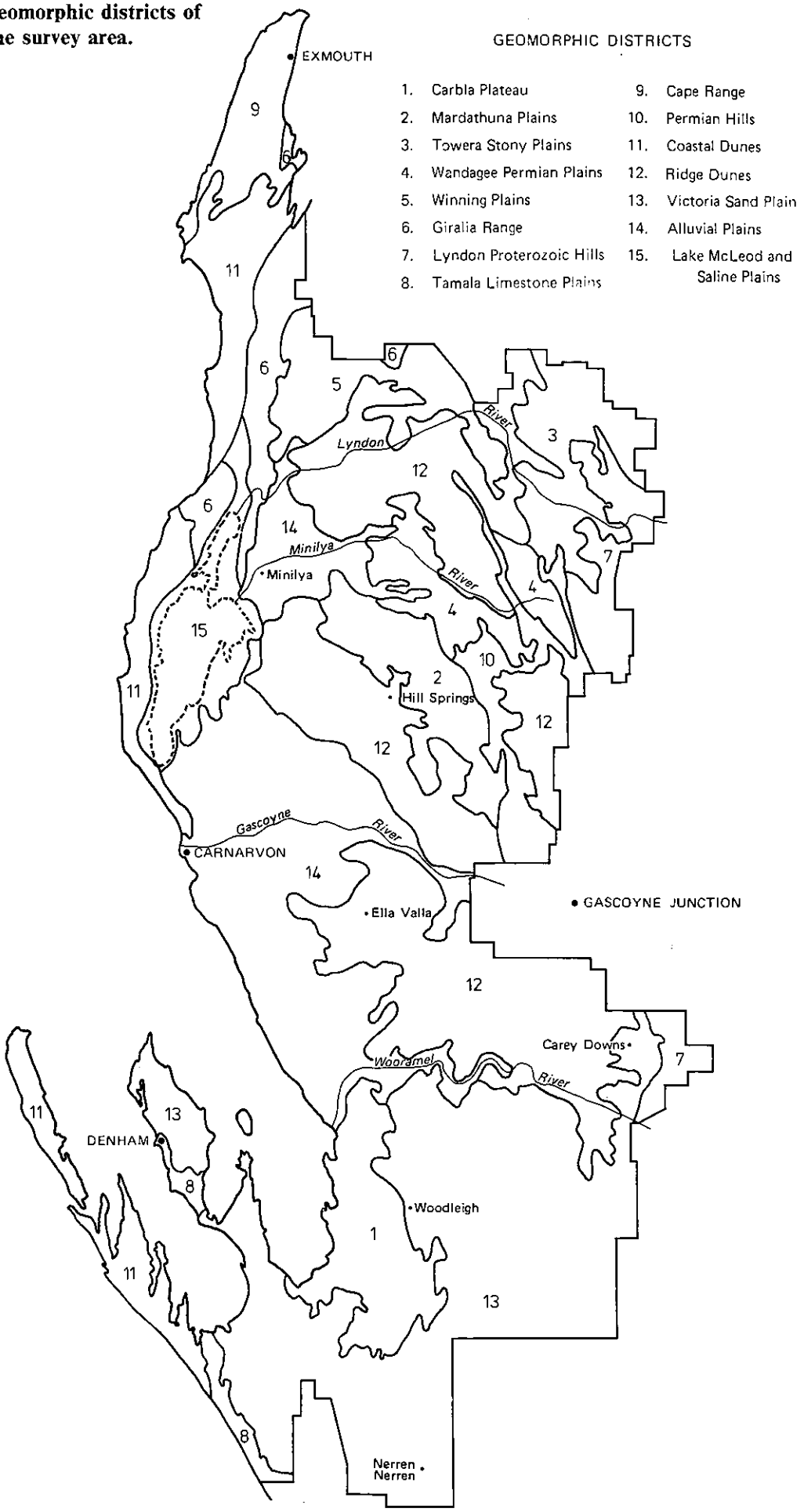
This district lies immediately west of the Kennedy Range. It extends in a north-westerly direction as a narrow strip, about 25 km wide, from the Gascoyne River to the Minilya River. From the foot of the Kennedy Range the district slopes away gently westward and down by 120 m.

The district is based on claystones and siltstones of the early Cretaceous Winning Group, laid down during a period of marine transgression. This sequence is composed of, in ascending order: the Birdrong Formation, Munderong Shale, Windalia Radiolarite, and Gearle Siltstone. Only the latter two outcrop.

These marine sediments have been dissected in the east to produce plains, which in their upper reaches have intense dendritic drainage patterns. All the streams drain westward, where they become intermittent, endoreic and disappear into the adjacent Ridge Dune District.

The discontinuous Billy system, which lies adjacent and parallel to the Kennedy Range, provides this area with its highest relief. The characteristic low mesas and plateaux are capped with duricrusted Tertiary sediments which overlie Windalia Radiolarite. Lower in the profile and further west is the Windalia system. It is based on Windalia Radiolarite, a highly porous siliceous siltstone which is composed primarily of the tests of radiolaria. Typical of the system is the intense dendritic drainage in the higher units above extensive lower gravelly plains. The gently sloping plains of the O'Brien system are found throughout the region below the Windalia system. It is based on Quaternary wash - a thin veneer of alluvial gravel, sand and clay over bedrock. Confined to this district, the Mary system occurs further west. It consists of low, stony calcrete plains overlying Cretaceous Korojon calcarenite. Minor occurrences of the soft-weathering, poorly consolidated Gearle

Figure 15. Geomorphic districts of the survey area.



Siltstone on Hill Springs and Mardathuna stations provide the only locations for the Gearle system in this district. The sandy alluvium of the Cahill system covers the narrow flood plains of the streams which have their headwaters in the higher systems of Billy, Windalia and O'Brien Rivers. The Cahill system is exclusive to this district.

Towera Stony Plains District (3,035 km²)

This district lies below the Proterozoic hills of the Gascoyne Province. It consists mainly of broad, stony plains which encompass the headwaters of the intermittent Yannarie and Lyndon Rivers.

Four land systems, Durlacher, Yinnietharra, Duffy and Wash characterize the district. The first three are exclusive to it. They are all based on Proterozoic granite, granodiorite and metamorphic rocks which outcrop in the upper units and provide a stony mantle for the lower units.

The Durlacher system consists mainly of broad, stony plains extending up to 30km. There is abundant outcrop of gneiss, quartz and schistose rock in the upper units, which are at times marked by sharp quartz ridges and strike residuals. The Yinnietharra system is similar to Durlacher, but the extensive cobble and pebble mantle is lacking and drainage zones are wide and sandy. The erosional surfaces of the low granite hills provide the upper units of the system, while the lower units are predominantly depositional plains of Quaternary colluvium and alluvium. The Duffy system of undulating sandy and stony plains and minor low hills is located exclusively on Towera station. The upper units of the system are based on outcropping muscovite-biotite, granodiorite, and adamellite. The lower units consist of sandy wash and alluvium. The Wash system is located in the west of the district, along the flanks of the Lyndon River and consists mainly of broad, sandy plains and sandy banks. It is based on Quaternary colluvium and alluvium which has originated from the Proterozoic uplands to the east.

Wandagee Permian Plains District (2,255 km²)

This district flanks the Minilya River from the old Moogooree station homestead in the east to Wandagee station homestead in the west. The plains extend up to 25 km in width as they follow the course of the Minilya River between the Gooch and Kennedy Ranges. A minor non-contiguous part of this district occurs further south on Winderie station.

Four endemic land systems, Jimba, Mantle, Wandagee, and Yalkalya characterize the district. They are all based on outcropping Permian sediments in their upper units with Quaternary colluvium and alluvium in the lower units. They develop soft soils which support pastures highly palatable to livestock.

The Jimba system is based on Permian marine sediments of the Byro Group which outcrop throughout the district. These sediments of siltstone, shale and quartz greywacke are essentially free of boulders and pebbles and form broad lower plains with little surface mantle. The absence of a pebble mantle and the soft nature of the soil predisposes areas of this system to severe erosion where the vegetation has become degraded.

The Mantle system is based on Permian glacial and continental to marine sediments of the Lyons Formation. The outcropping quartz greywacke, siltstone, shale and tillites have given rise to soils in the wide lower units which, in general, are covered with a cobble or pebble mantle. The flat and unprotected plains common in the Jimba system are lacking and the topography tends to be more undulating. The Wandagee system is based on Permian marine sediments outcropping predominantly on Mia Mia and Wandagee stations. On Mia Mia station, the system is characterized by minor outcropping of calcareous siltstone of the Callytharra Formation above subsequent broad plains of Quaternary colluvium and alluvium. On Wandagee station, the system is based on the earlier sequence of shale, siltstone and quartz greywacke of the Byro Group.

The Yalkalya system consists predominantly of broad Quaternary colluvial and alluvial plains with calcrete rises and outcropping Permian sediments of the Byro Group. The system is limited to Wandagee and Minilya stations. The Bidgemia system occurs only on Winderie station. It flanks Jacobs Gully from its headwaters in the Permian hills of the Pells Range to its junction with the Gascoyne River. The system is characterized by low sand dunes which are arranged longitudinal to water flowing towards major drainage. The interdunes consist of Quaternary alluvium and colluvium derived from the Pells Range. The Wash system in this district occurs below the Permian hills of the Gooch Range. Based on Quaternary colluvium and alluvium, the system is characterized by broad sandy plains of low relief.

Winning Plains District (4,575 km²)

This district extends 100 km eastward from the Giralia anticline as a narrowing tongue of land. It follows the northern limit of the survey area and terminates in the Pleiades Hills area on Lyndon station.

The district is based on the Lower Cretaceous sediments of the Winning Group which were deposited during the Neocomian to Turonian transgression. The Winning Group consists, in ascending order, of the Birdrong Sandstone, Munderong Shale, Windalia Radiolarite and Gearle Siltstone. The Birdrong Sandstone does not outcrop in this district. It does, however, form the main artesian aquifer of the Carnarvon Basin and is known in bores thoughout the western part of the basin. Windalia Radiolarite outcrops extensively throughout the district and conformably overlies the Munderong Shale. The Gearle Siltstone conformably overlies Windalia Radiolarite and outcrops only in the western part of the district. Five land systems, Carleeda, Lake, Wapet, Winning and Yarcowie are exclusive to the district. Other systems ocurring are Billy, Gearle, O'Brien, Windalia and Donovan.

The high mesas and plateaux of the Pleiades Hills are capped with Tertiary age Merlinleigh Sandstone which has been lateritized at the surface and overlies Windalia Radiolarite to form the Billy land system. Lower in the profile is the Windalia system. It is based on Windalia Radiolarite, a highly porous siliceous siltstone formed under very quiet marine-shelf conditions. The system has been

dissected in its upper units to produce an intense dendritic drainage pattern above broad gently sloping gravelly plains. Both the Billy and Windalia systems in this district are located adjacent to the Pleiades Hills.

The gently sloping plains of the O'Brien system are based on Quaternary wash below outcropping rises of Windalia Radiolarite. Adjacent to the Pleiades Hills it occurs below the Windalia system in a profile characteristic of the Mardathuna Plains District. Further west, the O'Brien system occurs adjacent to the Wapet and Winning land systems. The Winning system occurs on the central and eastern parts of the region and consists of low hills, mesas, ridges and stony rises above broad lower plains. The surface of the upper units is locally duricrusted to form a hard capping over the Windalia Radiolarite. The lower plains of Quaternary wash are often saline. The Carleeda system is located along the boundary between Cardabia and Winning stations. It consists of undulating calcrete plains with a relative relief of less than 20 m, but has moderately steep marginal slopes. On these margins, Late Cretaceous shallow marine sediments of Toolonga Calcilutite and Korojon Calcarenite outcrop and unconformably overlie the Gearle Siltstone. From the plains of the Carleeda system, the calcrete surface dips gently in a south-westerly direction to Chinkia Creek. The subsequent outwash plains of Quaternary wash and the minor stony calcrete plains with alkaline clayey soils characterize the Donovan land system.

Wapet, a minor endemic system, is based on north-south outcropping Windalia Radiolarite which occurs adjacent and parallel to the Giralia Anticline. The system consists of stony plains of low to moderate relief below low stony rises which have a dense mantle of angular Windalia Radiolarite. The Gearle system encompasses the headwaters of Cardabia Creek and flanks almost the entire length of this intermittent watercourse as it drains south to the Lyndon River. Soft bentonitic claystones with barite nodules, which were formed in a quiet marine-shelf environment, comprise the Gearle Siltstone formation. The Yarcowie land system, found only in the far north-west, is based on the Gearle Siltstone formation and is characterized by nearly flat gilgai plains which have developed *in situ* on the weathered siltstone.

Forms of moderate relief: Plains and hills (relative relief 30 m to > 100m)

Giralia Range District (6,480 km²)

This district, of dissected limestone hills, undulating stony uplands and outwash plains, is located in the north-west and includes the non-contiguous anticlinal structures of the Giralia Range, Gnargoo Range and the numerous small folds adjacent to Lake McLeod.

The district was subjected to a period of major block-faulting and deformation in the Jurassic and Early Cretaceous, which signalled the onset of complete continental breakup (Thomas and Smith 1974). Following extensive marine sedimentation, the district was again subjected to tectonic stress in the Late Miocene. This resulted in the formation of a series of huge anticlinal folds on the older normal faults, the largest of which is the Giralia Range. It extends for 120 km and rises to 170 m above sea level, exposing sediments from the Late Cretaceous to the Late Tertiary.

Toolonga Calcilutite and Korojon Calcarenite of Late Cretaceous age, unconformably overlie Gearle Siltstone and are both poorly exposed in this district. Where exposed, they occupy the highest position in the profile. Tertiary sedimentation occurred in three main cycles:

(1) Cardabia Group (Palaeocene to Early Eocene)
(2) Giralia Calcarenite (Middle to Late Eocene)
(3) Cape Range Group : Trealla Limestone (Late Oligocene to Middle Miocene)

Three land systems, Jubilee, Firecracker, and Trealla are exclusive to the district. The most elevated of these systems, Jubilee, is based on the outcropping Late Cretaceous and Early Tertiary sediments and is characterized by limestone hills and cuestas above undulating stony plains. The dissected hill tracts rise to 50 m above the lower units and extend for several kilometres.

Lower in the profile, the Firecracker system is characterized by undulating stony uplands and lower plains. The system is located exclusively in the area adjacent to the axial plane of the Giralia anticline. The Trealla system is based on Trealla Limestone of the Cape Range Group which outcrops extensively in the area adjacent to Lake McLeod. The system consists of gently sloping plains with limestone at variable depth or occasionally outcropping to form a pebbled and cobbled mantle. Marginal to these plains the limestone surface can dip 30-40 m to produce deeply dissected fringing slopes. The Donovan system lies below the Jubilee and Firecracker systems. It consists of gently dissected limestone plains and broad outwash alluvial plains and fans, receiving run-off from the higher systems.

Lyndon Proterozoic Hills District (2,530 km²)

This district is characterized by Pre-Cambrian metamorphic and plutonic crystalline rocks such as schists, granites and granodiorites of Lower Proterozoic age, and lies within the tectonic unit of the Gascoyne Province. Most of the district is in the north-west of the survey area, located between the Phanerozoic sediments of the Carnarvon Basin to the west and the Proterozoic sedimentary rocks of the Bangemall Basin to the east. The district also occurs further south, on Carey Downs and Callytharra Springs stations.

The headwaters of the intermittent and endoreic Yannarie River and the intermittent Lyndon and Minilya Rivers encompass the district. These rivers are probably not very old, although they rise in an area of outcropping Pre-Cambrian rocks (Condon 1965).

All the land systems occurring within the district, Augustus, Collier, Agamemnon, Glenburgh, Thomas, James, Phillips, Capricorn and Kooline, occur as discrete areas and extend into the Gascoyne Catchment (Wilcox and McKinnon, 1972), or the Ashburton Catchment (Payne, Mitchell and Holman 1982) survey areas. The granitic and metamorphic rocks give rise to a number of distinctive land systems which dominate the district.

In the north-east of the district, a relic of the Bangemall Group of Proterozoic sedimentary rocks outcrops, and forms the Collier and Augustus hill systems. Augustus is based on dolomite, shale, siltstone, sandstone and chert and is characterized by mountain ranges and hills with steep escarpments and upper slopes. Based on the same geology as the Augustus system, Collier is located lower in the profile and is less rugged in its landform. It consists of extensive areas of low rocky hills, and undulating stony uplands above stony plains and interfluves.

The Agamemnon, Glenburgh and Thomas systems provide the highest relief of the other systems based on Proterozoic metamorphic or granitic rocks. The Agamemnon system consists of low schist hills, strike ridges, and massive gneissic outcrops which rise to 90 m above rocky undulating plains. Granite outcrops occur throughout the district, but it is the Glenburgh system which is characterized by extensive outcropping of high, granitic hills. Intrusive dykes are common on the Glenburgh system and their scree often covers the more rapidly eroding granitic hills. The Thomas system is located in the south of the district, Carey Downs and Callytharra Springs stations, where it occurs below the Agamemnon system. The characteristic features of the Thomas system are the lateritized breakaways and mesas above lower plains, and rounded rocky hills rising to 30 m.

The undulating plains of the James and Phillips systems slope away below the hills systems. Both James (based on granite) and Phillips (based on metamorphic rocks), have prominent dykes and quartz strike ridges. In the James system, low granite hills, rising to 30 m above undulating plains with tor fields, are common. High peaks and ridges in the Phillips system rise to 80 m above the drainage tracts, but it is the rounded, cobble strewn summits of the lower hills which form the major aspect and characterize the system.

Tamala Limestone District (685 km²)

The Tamala Limestone district, of undulating limestone plains with shallow calcareous sand lies in two distinct areas on Peron Peninsula and Edel Land. On Peron Peninsula, the district extends north from Taillefer Isthmus to the town of Denham. On Edel Land, the district extends north, as a 10 km coastal strip, from the southern extremity of the survey area to Henri Freycinet Harbour.

The district is based on Tamala Limestone (consolidated to unconsolidated quartzose calcarenite). The origin of the limestone is attributed to the erosion and transportation by wind of the wide expanses of unconsolidated marine carbonate sediments during low sea-levels in the Pleistocene. A coastal dune belt was formed and constitutes what is now called Tamala Limestone. The Zuytdorp Cliffs were subsequently formed by an eroding ocean as sea levels rose. Aeolian cross-bedding is common and attests to the aeolian origin of the unit.

Four constituent land systems, Cullawarra, Taillefer, Tamala and Zuytdorp are all restricted to the district. The systems have similar landforms and have been largely differentiated on surface characteristics. The most elevated of the systems, Zuytdorp, is located exclusively in the south of the district, where it rises to an elevation of 290 m at Womerangee Hill and includes the Zuytdorp Cliffs along its western edge. The system consists of undulating limestone plains and low hills with areas of shallow sand. The limestone slopes of the Zuytdorp Cliffs have been deeply dissected and at their base marine erosion has produced platforms and terraces. The Cullawarra system abuts the Zuytdorp system to the north and is characterized by extensive areas of undulating limestone plains with numerous stony outcrops, low hills and minor areas of sandplain. The Tamala system is located south of Henri Freycinet Harbour on Edel Land and is exclusive to Tamala station. It consists of low, rounded limestone rises and stony plains above extensive sandy plains with very recently redeposited soils. The Taillefer system is confined to Peron Station. It has been differentiated from the other systems within the district on its higher proportion of sand plain and different vegetation. Also based on Tamala Limestone, the Taillefer system is characterized by extensive plains of shallow calcareous sand, minor low ridges of limestone and low coastal dunes.

Forms of marked relief: Hills (relative relief >100 m)

Cape Range District (1,830 km²)

The Cape Range district, of deeply dissected limestone ranges and outwash plains, makes up the extreme north-west of the survey area, and includes the Rough and Cape Ranges. The Cape Range is the most elevated part of the district, rising to 300 m above sea level, and trends in a north to north-east direction. The intermittent drainage emanating from the Cape Range is by a series of short parallel flow lines which fan out near the coast and form outwash plains.

The huge anticlinal structures of the Cape and Rough Ranges have resulted from Post-Middle Miocene period reverse movements on older normal faults. In the Cape Range area the folding continued during the Quaternary (van de Graaff, *et al.*, 1980), with the resulting anticlines exposing sediments from the Late Tertiary Cape Range Group and providing the geological and geomorphic basis for the district. The outcropping marine depositional sequence of the Cape Range Group, unconformably overlies the Giralia Calcarenite. Higher in the stratigraphic profile, but lower in the cross-section of the district, Exmouth Sandstone, of Quaternary marine and eolian deposits, unconformably overlies the Cape Range Group. Outcropping Bundera Calcarenite unconformably overlies the Exmouth Sandstone or Cape Range Group.

Two land systems, Range and Learmonth, are confined to the district. Range is based predominantly on limestones of the Cape Range Group, and the Quaternary sediments of Exmouth Sandstone and Bundera Calcarenite. It is characterized by deeply dissected plateaux, narrow valleys and spectacular gorges. East of the axial

plane of the Cape Range Anticline, the system dips rapidly to the coast and Trealla Limestone outcrops extensively. West of the axial plane, dissection has not been as intense due to the gentler dip of the strata.

Below Range is the Learmonth system of gentle stony upper slopes, sandy plains, and outwash alluvial plains receiving run-off from the Cape and Rough Ranges. Adjacent to Rough Range and east of Cape Range, the Learmonth system is based on Trealla Limestone in its upper unit, with lower plains of Quaternary colluvium and alluvium where small alluvial fans of limestone gravel have formed. On the western side of Cape Range, the Learmonth system extends north from Ningaloo homestead for over 80 km, as a 2 km wide tract of land. Here, the Learmonth system is based mainly on calcarenite and calcirudite of shallow marine and aeolian origin.

Permian Hills District (2,355 km²)

The Permian Hills district represents a collection of dissected Permian hills, ridge lines and isolated mesas with steep stony slopes and restricted plains in the east of the survey area. It outcrops as the Gooch Range on Winning, Mia Mia and Middalya stations, and extends south to include the Kennedy Range on Williambury, Mardathuna and Mooka stations and the Kennedy Range National Park. The district is also evident in minor outcroppings on Carey Downs and Callytharra Springs stations. Included in the district is a thin wedge of Devonian sediments which outcrop in the north-east of the area on Williambury and Lyndon stations.

The Gooch and Kennedy Ranges rise to 300 m above sea level, and provide the district with its greatest relief. Intermittent and endoreic drainage west of the Kennedy Range has deeply dissected the Permian beds to produce an intensely dendritic pattern. East of the Kennedy Range the district forms part of the catchment boundary for the Gascoyne River.

The district is based on Permian sediments deposited when the eastern margin of the basin was uplifted. At this time, glaciers emptied into the Carnarvon Basin, and depositied glacial erratics in a marine environment (Thomas and Smith 1974). The resulting marine siltstone and lithic sandstone containing numerous boulder beds formed the basal unit and is known as the Lyons Group. By the Artinskian, tectonic stability had returned and resulted in a widespread sequence of shelf sediments, mainly black shales and fine-grained sandstones, being deposited.

The Callytharra Formation was the first of these and disconformably overlies the Lyons Group. The Wooramel Group of arenaceous sediments disconformably overlies the Callytharra Formation, the Byro Group of siltstones, shales and fine sandstones and the Kennedy Group of fossiliferous sandstone. Tectonic stability was interrupted in the Jurassic by block faulting around the margins of the Pre-Cambrian Shield, related to the break-up of Gondwanaland, the former super-continent of the southern hemisphere (Thomas and Smith 1974, 1976).

Six land systems, Fossil, Moogooloo, Pells, Sandiman, Two Hills and Gneudna characterize the district. The discontinuous Fossil system outcrops in the north of the district as the Gooch Range. It is also located to the south as minor outcroppings on Winderie station. The Gooch Range rises to 330 m above sea level, capped locally with ferruginized calcarenite to give a mesa-like appearance.

The Moogooloo system, of long low ridges and hills above stony slopes with rocky outcrops, is located extensively on the western margin of the Kennedy Range, but also outcrops as a 2 km wide tract of land on the eastern margin of the Kennedy Range. The Moogooloo system is based on westerly dipping Permian sediments of the Kennedy Group. The soft Permian sediments have been deeply dissected.

The Pells system occurs predominantly on Williambury station, but also as minor outcroppings further south on Carey Downs and Callytharra Springs stations. It is based primarily on the Wooramel Group of Permian sediments which have been eroded to produce mesas and low round-topped hills and ridges above dissected stony slopes with rocky outcrops. The landform is similar to the Moogooloo system, differing mainly in its lack of long ridges.

Fragmented areas of the Sandiman system occur on Winderie, Towrana and Carey Downs stations. Based predominantly on the Lyons Group, the system is characterized by low breakaways and low rounded hills above heavily cobble-strewn slopes. These slopes are frequently tillitic, covered with an extensive mantle of glacial erratics, granitic and glacial boulders.

The Two Hills and Gneudna systems are located exclusively on Williambury and Lyndon stations. Derived from Devonian age deposits which separate the Permian sediments from the Pre-Cambrian hinterland, the systems extend as a 3-4 km wide tract of land for some 80 km in a north to north-westerly direction. The Two Hills system, which is based primarily on the Willaraddie Formation of quartz greywacke and siltstone, is characterized by very low hills which slope to the west towards the expansive Permian plains and to the east to the Gneudna system. The Gneudna system is based on an earlier sequence of Devonian sediments. The almost flat plans of the Gneudna system result from parallel bedding of the soft sediments which outcrop.

Depositional surfaces predominating

Aeolian forms

Coastal Dunes District (5,265 km²)

This district of coastal dunes and undulating plains of shallow calcareous sand over limestone or calcrete is located in two distinct areas.

The first encompasses the Edel Peninsula and Dirk Hartog Island which were formed by a Holocence marine transgression over a terrain of Pleistocene dunes. The first dunal landscape was formed in the Middle Pleistocene with the localized formation of the aeolian-originated Peron Sandstone on Tertiary anticlines. The calcreted surface of the Peron Sandstone preserved the shape of the dunes at a time when strong onshore winds built up new calcareous dunes from material generated on the sea floor. The formation of these dunes was most active during the last glacial periods when extensive areas of the shelf were exposed. This formation of indurated calcarenite, known as Tamala Limestone, is exposed extensively on Dirk Hartog Island and Edel Peninsula, and in this area provides the basis for the district.

The second part of the district is located west of Lake MacLeod and extends north to Exmouth Gulf. Early to Middle Phanerozoic sedimentation within this area was intermittent and occurred predominantly in a marine-shelf environment. However, during the Pleistocene, calcareous aeolianite accumulated and this formation can be equated to the Tamala Limestone found further south.

Five land systems Cardabia, Mallee, Coast, Inscription and Edel are exclusive to the district. All the systems have similar landform and in most instances are differentiated on relief and vegetation type.

In the north of the district the Cardabia system features elevated undulating sandplain with longitudinal and occasionally reticulate dunes over limestone or calcrete at shallow depth. The Mallee system is located to the west of Lake McLeod. It is similar to the Cardabia system, having the same geology and similar landform, but different vegetation. Large arcuate, longitudinal and reticulate coastal dunes with narrow interdunal calcareous swales characterize the Coast system. It is based on the Tamala Limestone sequence in the Shark Bay area and Holocene age unconsolidated coastal quartz sand deposits north of Carnarvon. Cliffs, wave-cut platforms, narrow beaches and mobile unvegetated sand drifts also feature in the dunal landform of the Coast system. The Inscription system is located exclusively on Dirk Hartog Island. Based on unconsolidated calcarenite of Tamala Limestone, the system is characterized by gently undulating sand plain over limestone. The Edel system, on Dirk Hartog Island and Edel Peninsula, is similarly based and consists of extensive undulating sandy plains, minor saline flats and occasional longitudinal dunes and limestone rises.

Ridge Dunes District (11,480 km²)

This large district occupies almost the entire central portion of the survey area, extending from Winning station in the north, to the Wooramel River in the south.

As the name suggests, the district features longitudinal and convergent, or occasionally reticulate sand ridges and flat to undulating interdunal plains of aeolian sand. The medium-grained, red quartz sand which characterizes the district was derived directly from the upper part of a lateritic profile and subsequently moved only a short distance into dunes during arid stages of the Pleistocene glaciation. The ice advances of the northern hemisphere were accompanied by dry conditions elsewhere and this peak dune-building period has been dated in Australia at about 18,000 - 16,000 years before present. The sand ridges and plains are now fixed by spinifex in the north and acacia shrublands in the south.

Eight land systems, Uaroo, Giralia, Spot, Kennedy, Yalbalgo, Yagina, Ella and Divide comprise the district. In the north, large dunes up to 20 m high with broad swales 500 m to 2 km wide characterize the Giralia system. The Uaroo system and parts of the Giralia system are often clayey and at times have only a thin veneer of sand over calcrete. To the west lies the Spot system, where the sand dunes are replaced by low, narrow banks and sandy rises encompassing restricted plains with heavier soils. The Spot system over-laps the Cretaceous sediments found still further west and as a tract of land 2-10 km wide for some 90 km separates the Cretaceous Winning Plains District from the Ridge Dunes District. The Kennedy land system is similar in most respects to the Giralia system, but is distinctive being located exclusively on top of the Kennedy Range, where the soil has been derived from Permian sediments rearranged into a dunal landscape during the Quaternary. South of the Minilya River are sand plains and swales with longitudinal and some reticulate dunes, comprising the Yalbalgo system. The Yalbalgo system is 50 km across in places, extending 250 km south to the Wooramel River. Swales and sandplain cover over duricrusted (ferruginized) Trealla Limestone to form the Yagina system. The resulting lateritic soil (above the ferruginous zone) developed after deep weathering in a humid climate during the upper Tertiary. Rock outcrop is common on the restricted loamy plains between the small linear dunes and diffuse sandy banks. The Ella land system occurs only to the south of the Gascoyne River. Positioned west of the Yalbalgo system it acts as a buffer zone separating the Alluvial Plains District from the Sand Dunes District and displays features of both districts. Ella is characterized by low sand dunes, sand banks, swales and duplex plains with discrete foci.

Victoria Sand Plain District (16,675 km²)

This large district occupies the southern part of the survey area, stretching from the Wooramel River to the southern extremity of the survey area and includes most of Peron Peninsula. The district is characterized by extensive flat to gently undulating sandplain with minor dune fields.

East of Hamelin Pool, thick, Permian glacial marine sediments in the east, and Cretaceous marine sediments in the western half of the district were subjected to lateritic weathering in the Late Tertiary. The trend towards a drier climate in the Pleistocene resulted in the development of calcrete and widespread aeolian reworking of the lateritic soils. On Peron Peninsula, the sands originate from the aeolian reworking of Peron Sandstone.

Ten land systems, Sandplain, Nerren, Garry, Wooramel, York, Tarcumba, Cooloomia, Nanga, Peron and Birrida occur within the district. The Sandplain system, the largest, extends south from the Wooramel River to the survey boundary and east from the Carbla Plateau to the survey extremity. It is characterized by vast plains of deep, slightly coherent sand and occasional sandy banks and broad low dunes.

Further to the west, similar sandplains support scattered clumps of eucalypts to form the Nerren land system. On Talisker station, small outcrops of silcrete (intensely silicified sandstone) provide the basis for the minor land system of Garry. The Wooramel land system lies to the west of and below the Permian and Proterozoic hills on Carey Downs and Callytharra Springs stations. Run-off from the uplands drains through the system and either enters the Wooramel River or is absorbed by the Ridge Dunes systems further west. The joint action of this surface and ground water has resulted in the formation of a hard-pan (duricrust) at shallow depth and produced characteristic plains of shallow soil and weakly groved vegetation.

To the south of the district, the York system follows the tenuous fingers of palaeodrainage lines. Flat plains with gradational calcareous soils characterize the system. Further north, the Tarcumba system also follows, in part, palaeodrainage lines. The Tarcumba system features colluvial plains with deep gradational soils and sand with calcrete at shallow depth.

The characteristic undulating sandplain of the western part of the district is interrupted on Coburn and Nerren Nerren stations by small areas of calcrete outcrop of the Cooloomia system. Immediately west and north lies the extensive Nanga system of undulating sandplain with areas of irregular sand ridges. On Peron Peninsula, unconsolidated calcareous sand has been reworked to form an extensive undulating sandplain, the Peron land system.

Birridas (gypsiferous pans) occur commonly on Peron Peninsula. Their peripheral moats were formed from seepage of fresh groundwater from the surrounding sandplain systems which dissolved the gypsum.

Fluvial forms

Alluvial Plains District (6,910 km²)

This district of predominantly alluvial deposits with areas of red, aeolian sand banks and dunes and occasional claypans, extends as two contiguous areas from north of Lake MacLeod to Hamelin Pool. It is based on the main channels, flood plains and deltas of the Lyndon, Minilya, Gascoyne and Wooramel Rivers. Sandplain and sand dune deposits, particularly in the area adjacent to the Gascoyne River, have been extensively redistributed or modified by floods of the Gascoyne River. The Boodalia and Brown River deltas and older palaeodrainage lines to the south, are all ancestral Gascoyne River courses which have deposited extensive areas of alluvium and predate the Ridge Dune District to the east.

Twelve land systems River, Barrabiddy, Marloo, Delta, Sable, Sandal, Target, Brown, Lyall, Lyons, Salune, and Littoral occur. The River system is common to all the main water courses except the Wooramel River and is characterized by narrow active flood plains flanking the middle course of these major rivers and creeks. Barrabiddy land system is restricted to the flanks of the Barrabiddy Creek which has its headwaters in the Permian plains on Wandagee station. The soft sediments from these plains have been eroded and then transported to produce the fragile loamy clay flood plains with intense shallow parallel channels which characterize the system. At the confluence of Cardabia Creek and the Minilya River, sediments have been deposited to form the extensive flat alluvial plains of the Marloo system. The broad active flood plains of the Delta system flank the lower reaches of the major rivers. The Delta system grades laterally north and south into the Sable land system. While not exhibiting the features of an active flood plain, the Sable system is still characterized by extensive alluvial plains. Further east, Sable and Delta systems are replaced by the sandy alluvial plains systems of Sandal and Target which display greater areas of sand across their surfaces. The Sandal system is very extensive, occurring from the Lyndon River, south to the Wooramel River and is characterized by low sandy banks and interbanks with duplex soils. The Target system is less extensive, with internally drained interbanks and drainage foci. Pleistocene alluvial deposits from the reworking of sediments by the Brown River delta (old Gascoyne River delta), are now evident as deep red sand dunes arranged transverse to the Gascoyne River and comprise the Brown land system. Adjacent to the Brown system on Boolathana station is the Lyall system of aeolian longitudinal and reticulate sand dunes with narrow, saline, interdunal alluvial plains. The Lyons land system is characterized by linear and reticulate dunes with numerous claypans. It is located, in areas adjacent to the Gascoyne River, where the Alluvial Plains District abuts the Ridge Dunes District, and further south where it flanks the middle course of the Wooramel River. The Salune system, of dunes and saline alluvial swales, extends for a short distance south of the Wooramel River in a narrow discontinuous strip east of the Carbla Plateau.

Supratidal flats and tidal mangrove swamps of the Littoral system fringe the coastal areas of the district.

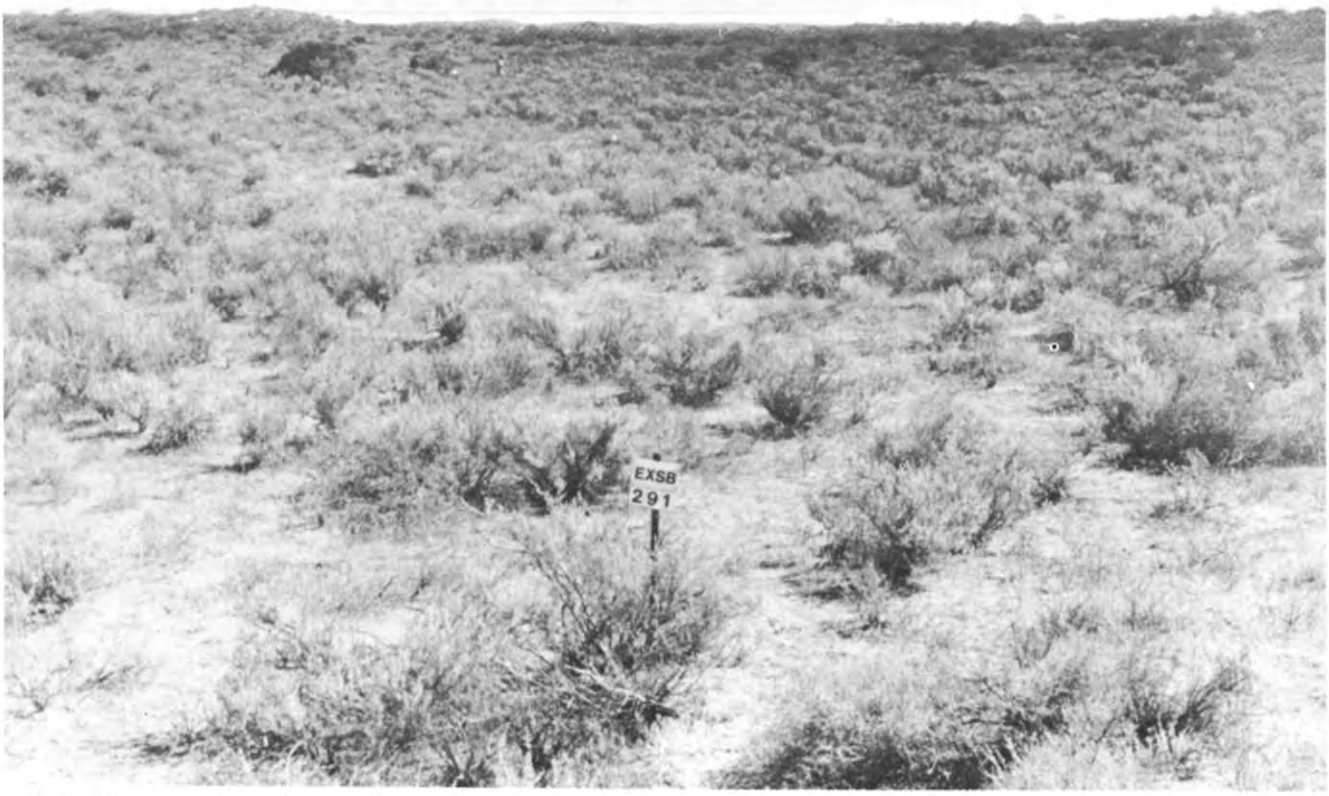
Lacustrine and marine forms

Lake McLeod and Saline Plains District(3,935 km²)

A district of flat saline plains is located on the periphery of Lake McLeod, and is subject to regular inundation. The shape of Lake McLeod was largely determined by the gently dipping Tertiary anticlines which flank it to the east and west. Subsequent marine deposition, erosion and lake and aeolian deposition have formed the basis for three land systems, McLeod, Chargoo and Warroora.

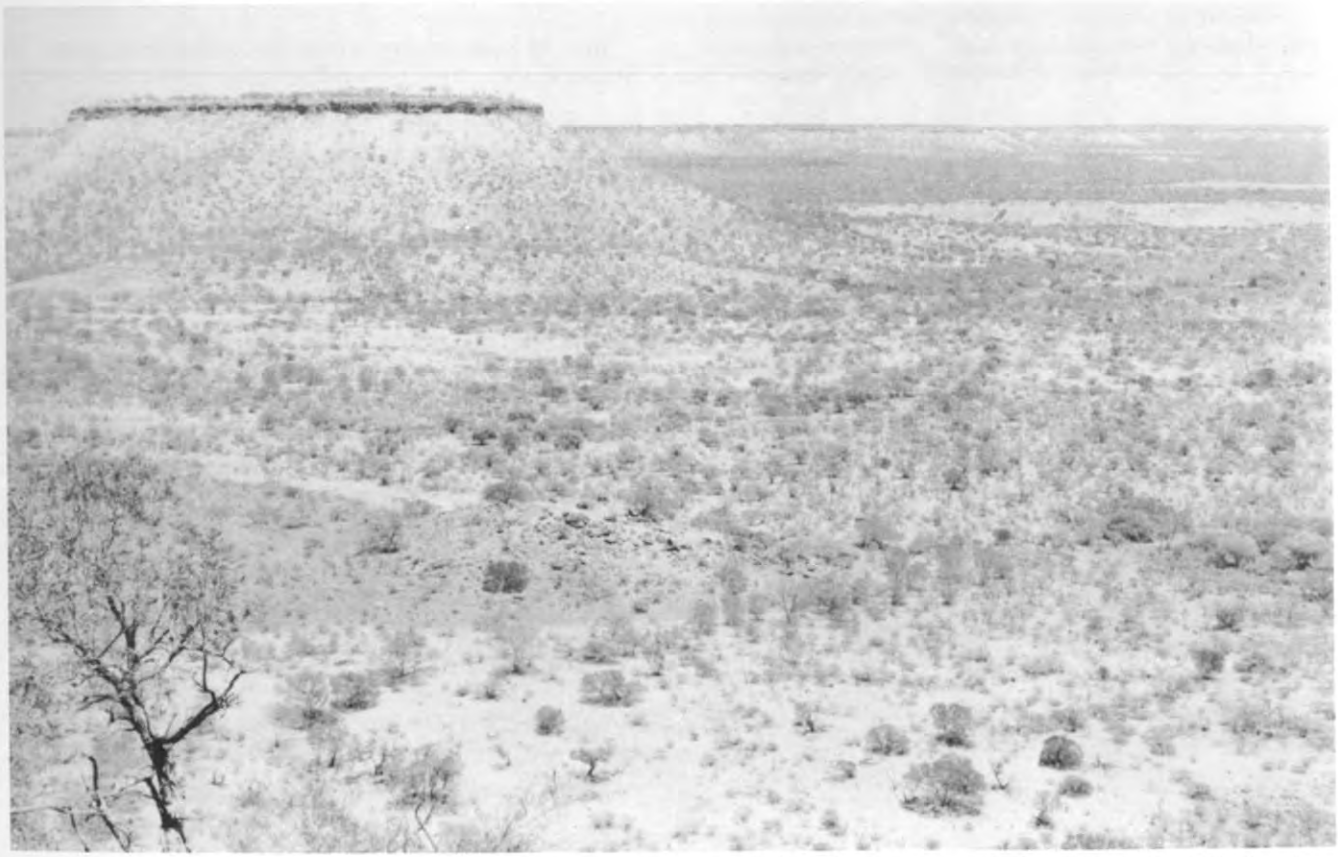
The McLeod system of highly saline plains, tidal mudflats with low sandy banks is based predominantly on lake bed deposits of gypsiferous sand with areas of shallow marine deposits (calcarenite) and aeolian calcareous sand. Broad alluvial plains and lacustrine deposits of bedded gypsum with clay, silt and sand characterize the Chargoo system, located predominantly north of Lake McLeod. Slightly higher in the profile, the Warroora system of flat saline plains with sluggish drainage tracts is located throughout the district. It is based on marine deposition with small areas of sand displaying an aeolian origin.

1. Slopes and flat-topped hills of the Fossil land system rise above spinifex-clad sandy plains, on Mia Mia station. Rugged hills and low ranges mostly occur in the north and east of the survey area and may be partly or largely inaccessible to grazing stock. Rocky uplands invariably have very shallow soils and low pastoral productivity.

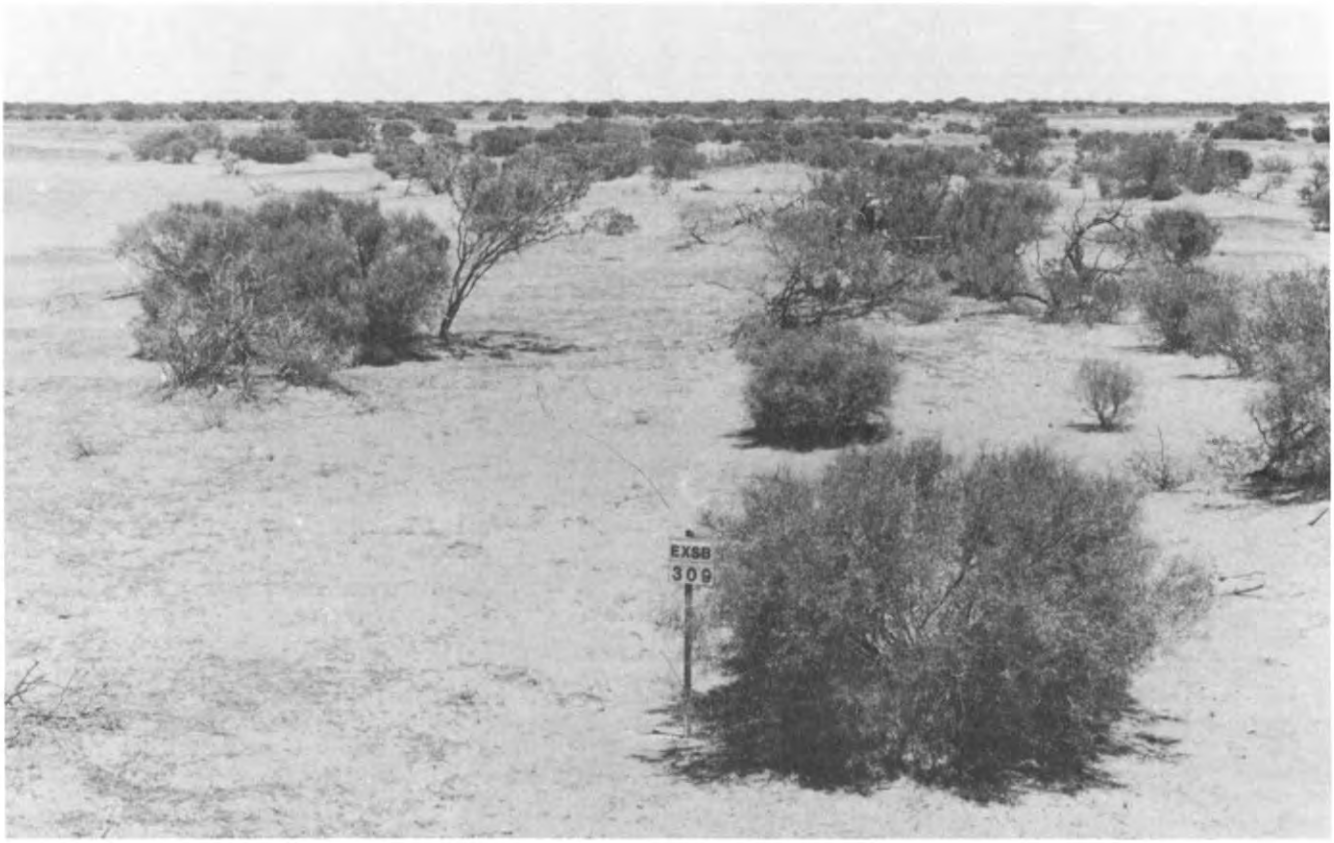


2. Saltbush plain with low, linear dunes, Lyell land system on Boolathana station. Many parts of the extensive alluvial plains surrounding Carnarvon feature sandy banks or relic dunes of aeolian origin. These sandy units support tall shrublands with fewer drought-resistant browse shrubs but produce much annual herbage in good seasons.

3. Mallee and other South-West Botanical Province shrubland regrowth after fire, on a plain of deep sand, Nanga land system (Victoria Sandplain geomorphic district). Such communities have low or very low pastoral potential and are not improved by burning.



4. Flat-topped residuals (buttes and mesas) above interfluvial plains characteristic of the Windalia land system, in the Mardathuna Plains geomorphic district. This system supports scattered acacia shrublands and pastures of the Acacia Short Grass Forb (ASGF) type.



5. Shrub associations on the broad alluvial plains are frequently subject to increases or invasions by undesirable species, when desirable plants are lost. Here, a degraded shrubland consists mostly of needle bush *Hakea preissii*, a thicket-forming species which presents a serious problem for pastoral management. Note the scalded and hummocked soil surfaces.

Hydrogeology

The Carnarvon Basin is generally lacking in permanent surface water, but the presence of groundwater (underground water) has allowed the successful development of a pastoral industry. In the 1860s when the pastoral industry commenced, water for stock was mainly obtained from shallow wells and later (from about the turn of the century) from artesian bores. Since commencement of the pastoral industry about 1,000 shallow bores and wells and about 100 artesian bores have been constructed for pastoral use. Early reports on the artesian water resources of the area include anon (1915, 1921, 1925), MacKay (1963) and Maitland (1913).

Occurrence of groundwater

Groundwater in the area originates from rainfall. The quantity obtainable and salinity are controlled by the geology, climate, topography and vegetation. Groundwater occurs either: as unconfined groundwater, which forms the regional water table and is at atmospheric pressure; or as artesian groundwater, which is under pressure and rises when encountered in a bore and may flow at the surface.

Geologically the area lies within the Carnarvon Basin, except for a small proportion which lies within the adjoining Gascoyne Province (figure 16). The Carnarvon Basin comprises mainly sedimentary rocks whereas the Gascoyne Province consists of crystalline rocks. Both areas are overlain by alluvium of variable thickness and extent.

Sources of groundwater (aquifers) such as sand, gravel, sandstone and limestone form only a small proportion of the rocks, thus limiting the availability of groundwater. Further limitations on groundwater availability are the restriction of recharge to local areas and the low rainfall and high evaporation rates. These factors combine to make direct recharge or recharge from river flows, only local or occasional events.

Groundwater stored in shallow, unconfined aquifers is subject to the concentrating effect of water use by trees and other deep rooted vegetation. This, combined with the small proportion of rainfall available to recharge the aquifers, results in most groundwaters being brackish to saline. An exception to this is in localized high intake areas where rapid movement of water to the aquifer results in relatively fresher supplies.

The water table, or the top of the unconfined groundwater, in general follows the ground surface contours, but with a flatter slope. The slope and level of the potentiometric (pressure) surface of the artesian groundwater supplies however, is controlled by the structure and make-up of the rock layers in which they occur.

Both the unconfined and artesian groundwaters flow toward the sea where they are eventually discharged. The unconfined groundwater discharges directly into the sea, whereas the artesian waters are thought to discharge through faults or via overlying aquifers.

Water quality categories referred to in this account are as follows:

Fresh:	below 500 mg/L total dissolved salts
Marginal:	500 - 1,500
Brackish:	1,500 - 3,000
Saline:	3,000 - 7,000
Very saline:	7,000 - 35,000
Mineralized:	over 35,000

Availability of groundwater

A large number of geological formations are recognized in the area. These formations are listed and their groundwater potential is summarized in table4. Their general relationships are shown in a diagrammatic section (figure 17).

Locating groundwater in some areas depends on precise bore location. (Advice on this matter can be obtained from the Hydrogeology Section of the Geological Survey or can be obtained by reference to the relevent geological maps.)

For convenience in describing availability of groundwater, the region can be subdivided into broad geological areas, namely the western and eastern Carnarvon Basin, and the Gascoyne Province. These are described below.

Western Carnarvon Basin

The western Carnarvon Basin is a coastal lowland rising to about 100 m above sea level, with some local areas of higher relief. It is formed by Quaternary alluvium and Tertiary Limestone, sand and clay, overlying and concealing Cretaceous sediments (figure 17). Unconfined groundwater occurs in the surficial sediments throughout the western Carnarvon Basin and artesian groundwater in the underlying Cretaceous sediments.

Unconfined groundwater

Supplies of unconfined groundwater are generally available at varying depths down to about 30 m. The most readily obtainable supplies are from: river bed sand (especially in the Gascoyne River); minor beds of sand and gravel within the alluvium of the river flood-plains; weathered (lateritized) outcrops of the Cretaceous sediment and from the Tertiary limestone and sand.

Bore yields of 5-100 m^3/day are generally obtainable and larger supplies of 1,000-5,000 m^3/day are locally obtainable from river bed sand, alluvial sand and gravel and from Tertiary limestone.

Fresh groundwater is restricted to the vicinity of the major rivers (figure 18) where it is recharged by river flows, or in elevated areas such as the Cape Range. However, in the latter case fresh or brackish groundwater usually overlies very saline groundwater and care has to be exercised not to draw in saline groundwater while pumping.

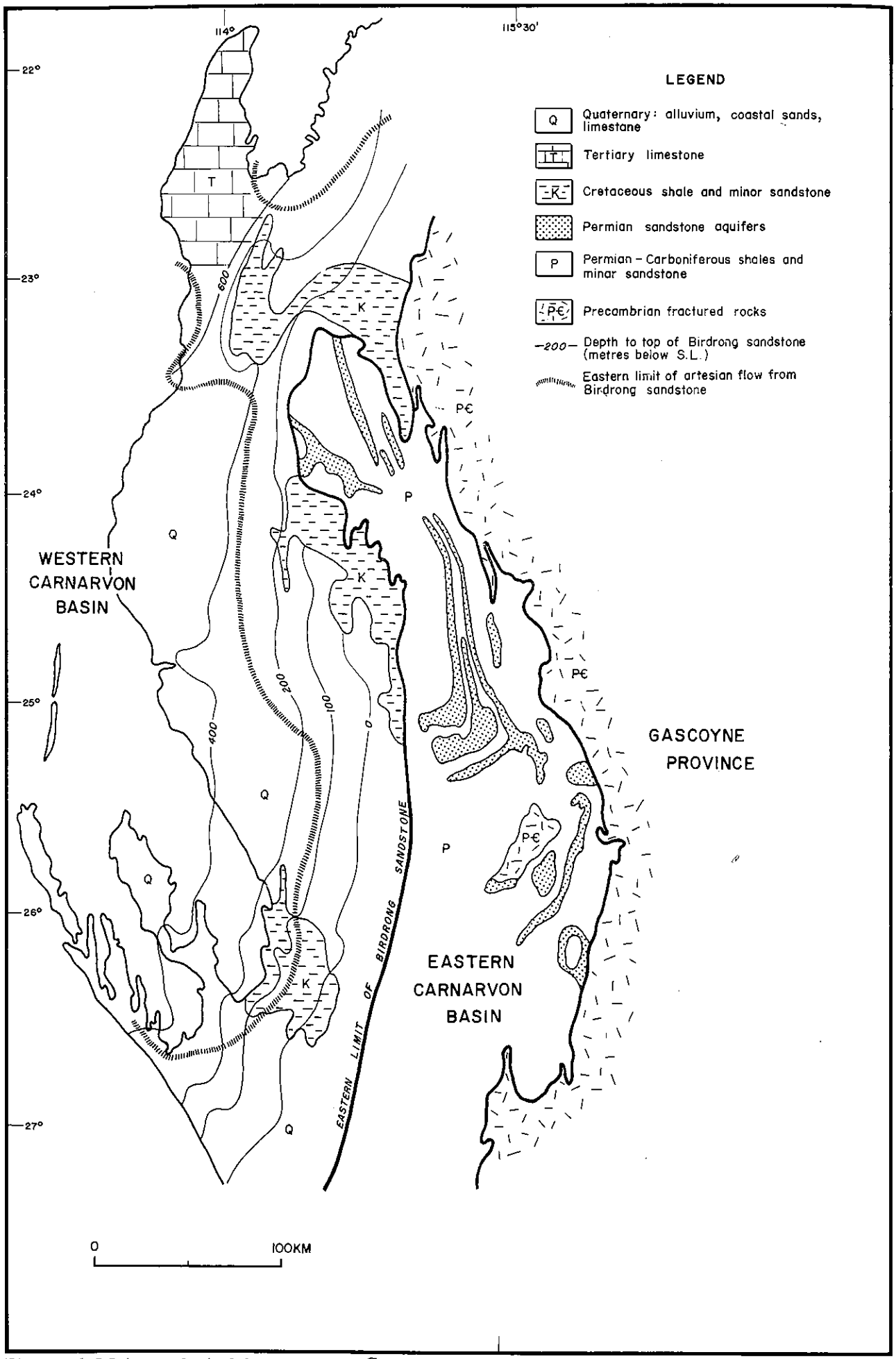
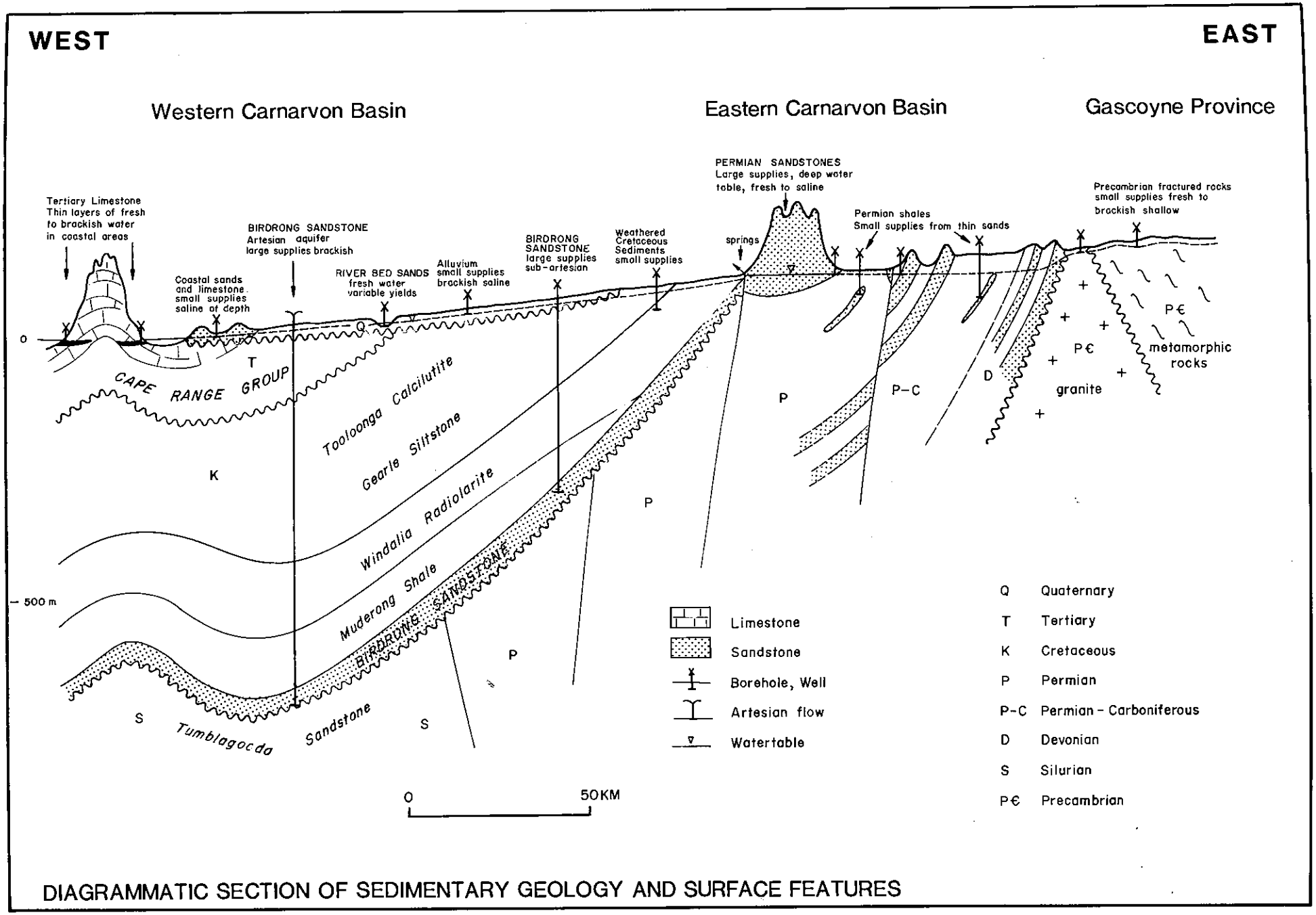


Figure 16. Major geological features of the Carnarvon region



DIAGRAMMATIC SECTION OF SEDIMENTARY GEOLOGY AND SURFACE FEATURES

Figure 17. Diagrammatic section of sedimentary geology and surface features

Artesian groundwater

Artesian groundwater occurs throughout most of the western Carnarvon Basin, principally in the Birdrong Sandstone (table 4). It is mainly used in the Hamelin Pool, Wooramel and Carnarvon coastal areas where the aquifer is not too deep and alternative sources of groundwater are not generally available.

The Birdrong Sandstone averages about 30 m in thickness. It locally outcrops or occurs at shallow depth along the eastern margin of the western Carnarvon Basin. The aquifer is overlain mainly by shale and gets progressively deeper toward the west (figure 19), where it is about 400 m below sea level.

Natural flows and pumped yields from artesian bores range between 500-4,500m^3/day. Most of the artesian bores have been allowed to flow continuously. Consequently there has been a decline in pressure and flow rates from most bores.

Apart from small areas of fresh groundwater near intake areas on the Gascoyne and Wooramel Rivers, all groundwater in the Birdrong Sandstone is brackish to very saline (figure 17). The groundwater in the aquifer varies in temperature from 35° to 60°C and is corrosive.

Eastern Carnarvon Basin

The eastern Carnarvon Basin is a dissected upland rising to 300 m above sea level. It is characterized by undulating terrain interspersed with ridges of sandstone and flat plains underlain by shale. It is composed of folded and faulted Devonian to Permian sedimentary rock (figures 16 and 17). Pastoral development is mainly concentrated on the plains which are the least prospective areas for groundwater resources.

Unconfined groundwater, ranging from near surface along some rivers to depths exceeding 100 m in elevated areas, occurs throughout the eastern Carnarvon Basin. Artesian groundwater occurs in some sandstones which are confined by beds of shale. Springs located on faults and in other geological situations are a feature of the area.

The principle aquifers are the Moogooloo, Mallens and Cundlego sandstones. However, groundwater is obtainable locally from many other formations (table 4). Supplies of 5-100 m^3/day can generally be obtained and larger supplies of up to 2000 m^3/day are occasionally obtained.

Fresh groundwater is usually restricted to areas of outcrop or along the major rivers. Elsewhere, the groundwater is generally brackish to saline (figures 17 and 18).

Gascoyne Province

The Gascoyne Province has an irregular relief about 300 m above sea level. It is underlain by Pre-Cambrian granitic and metamorphic rocks. The province is situated in the eastern part of the area and includes some small inliers in the eastern Carnarvon Basin (figure 16).

Unconfined groundwater at depths down to 20 m occurs throughout the province. Groundwater occurs in fractures within the rocks and consequently supplies are small, generally in the range of 5-100 m^3/day. Larger supplies of groundwater may be obtained in local areas of alluvium. Groundwater salinity ranges from marginal to brackish.

Groundwaters of individual stations

A summary of the groundwater resources known from each station in the area is given in table 5.

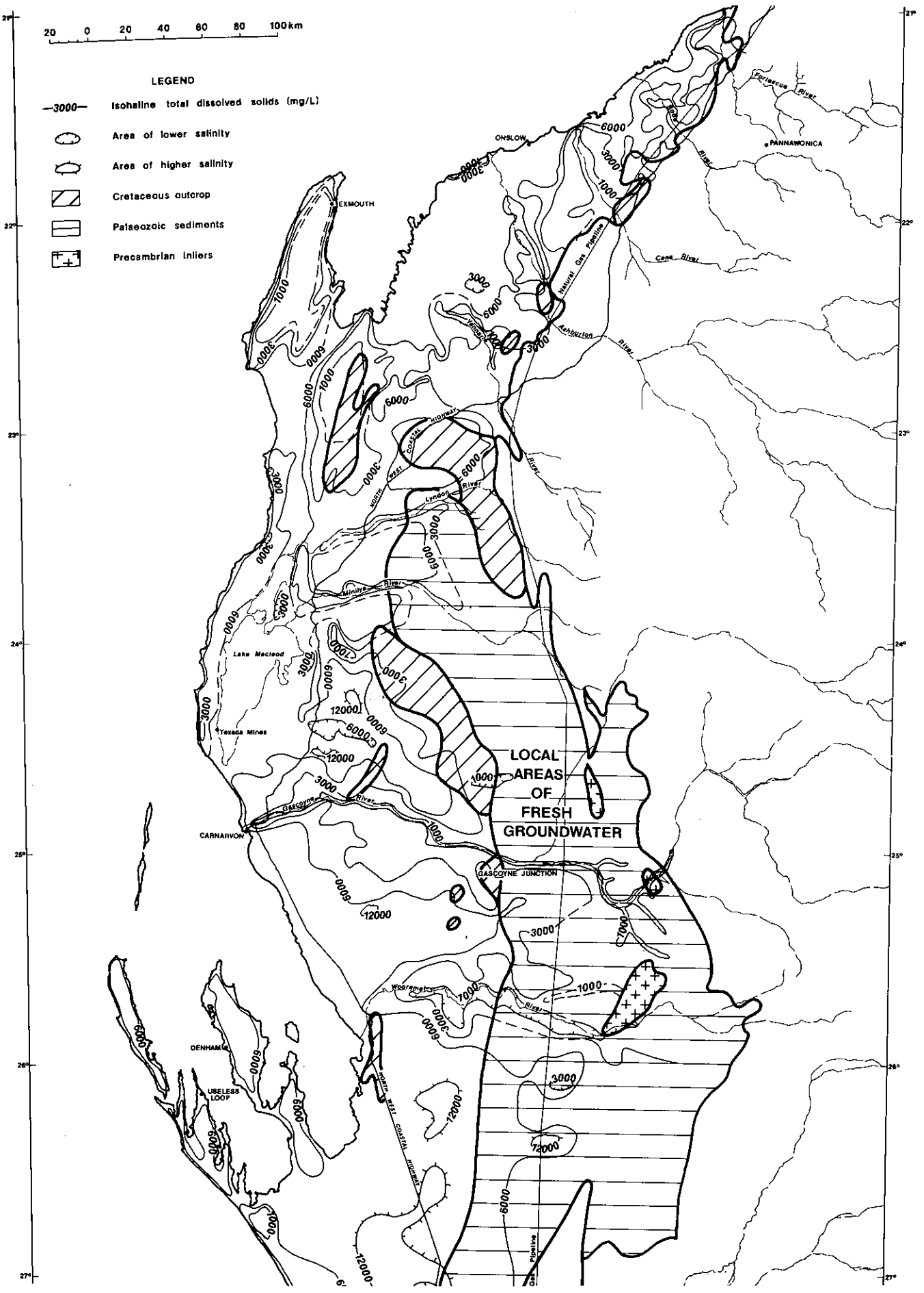


Figure 18. Isohaline map for unconfined groundwater

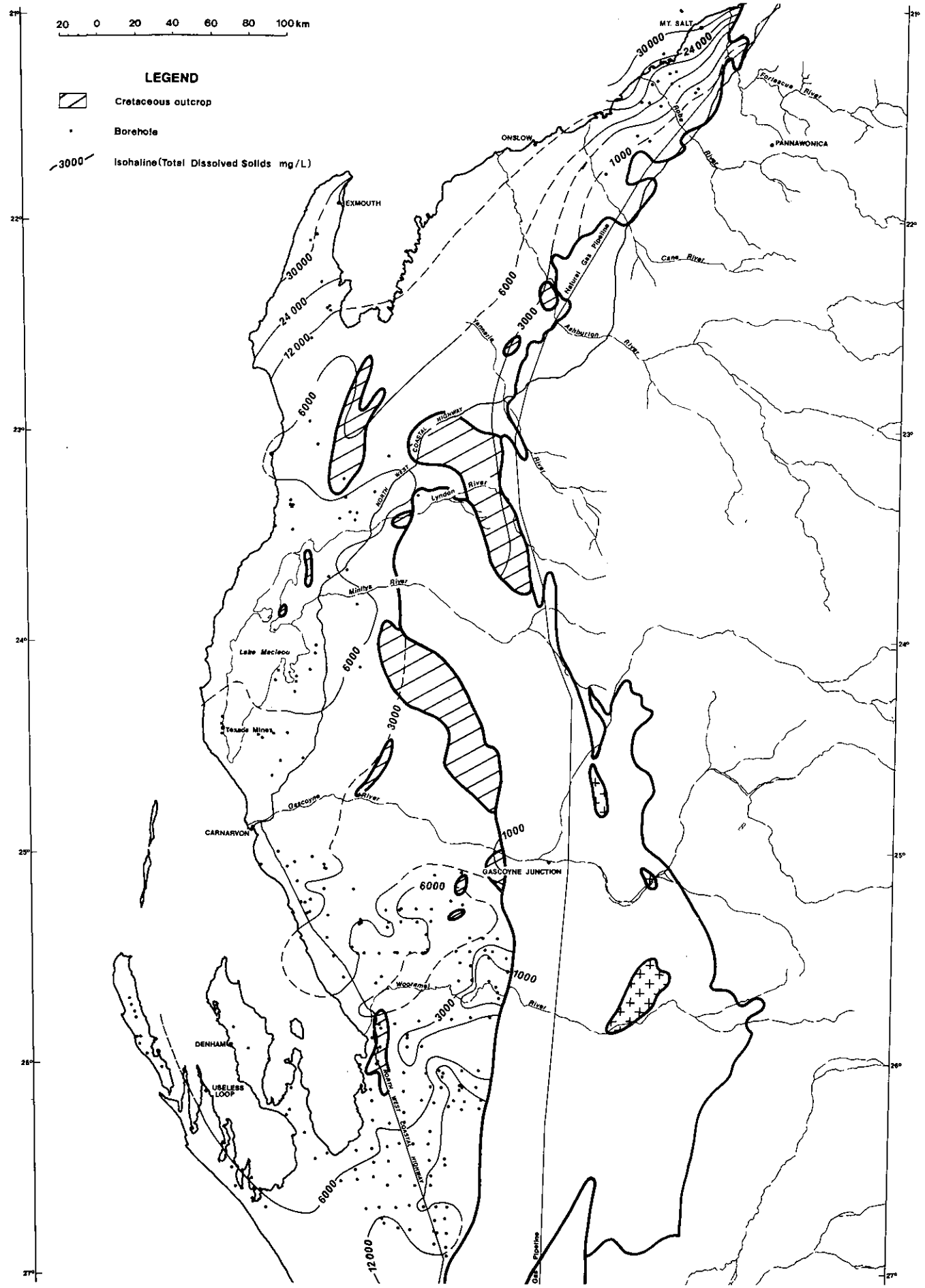


Figure 19. Isohaline map for groundwater in the Birdrong Sandstone

Table 4. Abbreviated stratigraphic table with notes on groundwater potential

Age	Group/formation	Maximum thickness m	Comments
Quaternary: Holocene	Coastal dunes Hamlin Coquina	10 10	Minor aquifer, small supplies of fresh to brackish water overlying saline water.
	River bed sands	10	Major aquifer in Gascoyne River, generally fresh, but temporary aquifers dependent on river flow.
	Alluvium	45	Important aquifer, small to large supplies of generally brackish water except near rivers.
	Bundera Calcarenite	25	Minor aquifer, large supplies of fresh to brackish water.
Quaternary: Pleistocene	Tamala Limestone Exmouth Sandstone	300+ 100+	Small supplies of fresh to brackish water.
Tertiary	Cape Range Group (limestones)	720	Small to large supplies, generally brackish to saline.
Cretaceous	Korojon Calcarenite	45	Unknown
	Toolonga Calcilutite Gearle Siltstone	275 345	Aquiclude, possibly small supplies in weathered part
	Windalia Radiolarite	125	Small supplies in weathered part, occasionally artesian brackish to brine.
	Muderong Shale Birdrong Sandstone	75 35	Aquiclude. Major aquifer, moderate to large supplies, small areas of fresh water, mostly brackish to saline, artesian in low lying areas.
Permian	Kennedy Group	910	Forms Kennedy Range, water table very deep, discharge via springs along the western margin.
	Byro Group	1400	Small supplies from sandstones, very poor prospects in shales; brackish to saline.
	Cundlego Sandstone Mallens Sandstone	410 +80	Major aquifers, large supplies (up to 2000 m^3/d); fresh to saline.
	Wooramel Group Moogooloo Sandstone	225 130	Small to moderate supplies; fresh to brackish. Major aquifer, large supplies; fresh to brackish.
	Callytharra Formation	265	Small supplies; fresh to saline.
Permian-Carboniferous	Lyons Group	1735	Variable, small to moderate supplies in sandstones, poor prospects in shales; fresh to saline.
Carboniferous Devonian	Sandstone, shale, limestone	2500	Local aquifers in sandstone units, small supplies; fresh to saline.
Silurian	Tumblagooda Sandstone	3000	Artesian aquifer where it underlies Birdrong Sandstone; saline.
Pre-Cambrian	Igneous, metamorphic and sedimentary rocks		local fractured rock aquifers, small supplies depending on site specific conditions; fresh to brackish.

Table 5. Summary of groundwater conditions on pastoral stations in the Carnarvon Basin (this is intended only as a guide; detailed information is available from the Geological Survey).

Station	Aquifer	Depth range of bores m	Salinity range mg/L	Comments
Boolathana	Alluvium Birdrong Sandstone	<10 400-500	3,000-8,000 5,000	
Boologooro	Alluvium Birdrong Sandstone	<30 400-500	7,000 7,000	
Brickhouse	River bed sand Alluvium Birdrong Sandstone	<5 ~10 300-500	<1,000 3,000-10,000 3,000-4,000	
Bullara	Tertiary limestone Birdrong Sandstone	10-100 600-1,200	500-10,000 6,000-20,000	
Carey Downs	Alluvium/Lyons Formation Pre-Cambrian	5-20 5-10	500-3,000 200-9,000	
Callagiddy	Alluvium Birdrong Sandstone	20-40 300-500	3,000-10,000 3,000	
Carbla	Birdrong Sandstone	100-150	4,000-6,000	Water table in Cretaceous sediments of low permeability.
Cardabia	Coastal sands and limestone Birdrong Sandstone	5-50 100-1,200	1,000-15,000 1,000-8,000	Saline at depth.
Carrarang	Tamala Limestone Birdrong Sandstone	1-10 400-500	1,000-3,000 5,000-9,000	Water table at sea level.
Callytharra Springs	Moogooloo Sandstone Pre-Cambrian	30-100 5-10	1,000-6,000 200-9,000	Lowest salinity close to Wooramel river. In drainage lines.
Coburn	Birdrong Sandstone	100-200	8,000-13,000	Water table in sediments of low permeability.
Cooralya	Alluvium Birdrong Sandstone	10-30 200-400	5,000-12,000 3,000-5,000	
Dirk Hartog	Tamala Limestone Birdrong Sandstone	- 500-700	- 7,000	No bore data available. One bore known.
Doorawarrah	River bed sand Alluvium Birdrong Sandstone	 15-30 200-300	<500-1,000 2,000-4,000 1,000-3,000	
Edaggee	Alluvium Birdrong Sandstone	30-50 200-400	6,000-14,000 2,000-4,000	
Ella Valla	Alluvium Birdrong Sandstone	30-50 200-400	3,000-14,000 2,000-8,000	
Exmouth	Tertiary limestone	5-100	1,000-4,000	Saline at depth.
Faure	Coastal sands Birdrong Sandstone	 300	Saline? 4,000	Water table close to sea level.
Gilroyd	Moogooloo Sandstone	50-100	1,000-6,000	Lowest salinity close to Wooramel River.
Gnaraloo	Coastal sand and limestone Birdrong Sandstone	5-10 500-600	3,000-8,000 3,000-7,000	Saline at depth.
Hamelin	Coastal sands Birdrong Sandstone	Shallow 50-200	Variable 7,000-13,000	Water table in impermeable Cretaceous sediments inland.
Hill Springs	Alluvium/Windalia Radiolarite Birdrong Sandstone	10-30 200-300	500-8,000 2,000-4,000	
Lyndon	Pre-Cambrian Devonian Sandstone	5-15 10-30	1,000-3,000 1,000-6,000	
Manberry	Alluvium Birdrong Sandstone	10-20 200-350	1,000-10,000 4,000-7,000	
Mardathuna	Alluvium/Windalia Radiolarite Birdrong Sandstone Kennedy Group	10-30 50-200 ?	1,000-8,000 1,000-3,000 1,090-8,000	 Discharge from springs
Marron	Alluvium Birdrong Sandstone	30-40 130-400	8,000-14,000 2,000-7,000	

Station	Aquifer	Depth range of bores m	Salinity range mg/L	Comments
Meadow	Birdrong Sandstone	~100	8,000-13,000	Water table in sediments and low permeability.
Meedo	Alluvium/Windalia Radiolarite	5-20	500-4,000	Lowest salinity close to river.
	Birdrong Sandstone	50-200	1,000-5,000	
Meeragoolia	Alluvium	15-30	2,000-6,000	
	Birdrong Sandstone	200	2,000-3,000	
Mia Mia	Birdrong Sandstone	200-400	6,000-9,000	
	Permian (various)	10-40	1,000-12,000	Best prospects in sandstones.
Middalya	Alluvium	5-10	500-1,500	
	Permian (various)	10-50	1,000-10,000	
Minilya	Alluvium	5-20	1,000-6,000	
	Birdrong Sandstone	400-500	6,000-10,000	
Mooka	Alluvium/Windalia Radiolarite	20-40	1,000-7,000	
	Birdrong Sandstone	50-100	1,000-3,000	
	Kennedy Group	?	?	In eastern part.
Nanga	Tamala Limestone		Variable	Water table near sea level saline at depth.
	Birdrong Sandstone/ Windalia Radiolarite	150-400	4,000-7,000	
Nerren Nerren	Birdrong Sandstone	100-150	8,000-13,000	Water table in sediments of low low permeability. Sub artesian.
Ningaloo	Tertiary limestone	5-30	1,000-10,000	Saline at depth.
Peron	Tamala Limestone		Variable	Water table near sea level.
	Birdrong Sandstone	300-500	4,000-5,000	
	Windalia Radiolarite			
Pimbee	Alluvium/Windalia Radiolarite			
	Birdrong Sandstone	?	2,000-8,000	Depth data unavailable.
Quobba	Coastal sands and limestone	5-10	3,000-8,000	Saline water at depth.
	Birdrong Sandstone	400-500	4,000-8,000	
Talisker	Moogooloo Sandstone	50-100	2,500-10,000	
Tamala	Tamala Limestone		500-800	Water table close to sea level.
	Birdrong Sandstone	300-400	8,000	
Towera	Pre-Cambrian	5-20	1,000-4,000	
	Birdrong Sandstone	10-100	1,500-4,000	
Towrana	Moogooloo Sandstone (only near Wooramel River)	30-50	1,000-3,000	
	Lyons Formation	5-80	500-9,000	
Wahroonga	Alluvium/ Windalia Radiolarite	-	-	Data unavailable.
	Birdrong Sandstone	100-400	5,000-7,000	
Wandagee	Permian Sandstone	10-20	3,000-10,000	Large areas underlain by shale.
	Birdrong Sandstone	300-400	5,000-10,000	Western part only.
Warroora	Coastal sand and limestone	5-20	3,000-1,000	Saline at depth.
	Birdrong Sandstone	500-800	4,000-7,000	
Williambury	Permian Sandstone	10-30	2,000-4,000	
	Granite	5-15		
Winderie	Permian (various)		Bore data	
	Windalia Radiolarite			unavailable.
	Birdrong Sandstone		Extreme west only.	
Winning	Alluvium/Windalia Radiolarite	5-20	2,000-8,000	
	Birdrong Sandstone	50-500	2,000-6,000	
	Permian Sandstone	5-20	2,000-12,000	
Woodleigh	Birdrong Sandstone	100-150	10,000-16,000	Water table in sediments and low permeability.
Wooramel	Alluvium	5-20	>1,000	Lowest salinity close to river.
	Birdrong Sandstone	200-400	1,500-6,000	
Yalardy	Moogooloo Sandstone	50-80	2,000-8,000	
Yalbalgo	Windalia Radiolarite			Incomplete data.
	Birdrong Sandstone	150-400	4,000-5,000	
Yaringa	Birdrong Sandstone	150-200	2,000-8,000	Water table in sediments of low permeability.

Vegetation

Main features of the contemporary flora

The present-day vegetation of the Carnarvon Basin area is mainly dominated by arid (Eremaean) perennial shrub associations. Such plants exhibit a wide range of growth forms and features, but are similar in that all are capable of survival (both as adult plants and as seeds) through adverse seasonal conditions. Whenever seasonal conditions are favourable, a complementary flora of drought-avoiding, short-lived herbs and grasses develops. These annual or ephemeral floral associations form the occasional displays of ground vegetation beneath and between the perennials. Dominating the ephemerals are genera such as *Ptilotus, Sclerolaena, Helichrysum, Helipterum, Angianthus, Calandrinia, Atriplex* and *Aristida.*

A small number of botanical families contain a large proportion of the dominant perennials in the area. These are indicated in table 6. Of these, *Acacia, Eremophila* and *Cassia* are pre-eminent in the taller shrub communities, *Atriplex* and *Maireana* in the low chenopod shrublands, *Eucalyptus* in the low woodlands and *Triodia* and *Plectrachne* in the hummock grasslands.

Table 6. Major families and dominant perennial genera in the Carnarvon Basin area

Family	Genera
Poaceae	*Astrebla, Cenchrus, Eragrostis, Monachather, Plectrachne, Triodia*
Proteaceae	*Banksia, Grevillea, Hakea*
Chenopodiacea	*Atriplex, Halosarcia, Maireana, Rhagodia*
Amaranthaceae	*Ptilotus*
Mimosaceae	*Acacia*
Caesalpiniaceae	*Cassia*
Malvaceae	*Abutilon, Alyogyne, Hibiscus, Sida*
Myrtaceae	*Calothamnus, Calytrix, Eucalyptus, Melaleuca, Thryptomene*
Solanaceae	*Solanum*
Myoporaceae	*Eremophila*

Major structural formation types have been described and mapped at 1:1,000,000 by Beard (1975, 1976). Beard's mapping of the dominant perennial vegetation led him to put forward a map of natural regions for the Pilbara/Murchison. All or part of 17 of these regions fall within the present survey boundaries; see Beard's accounts of each of these regions. On a broad scale, a number of trends are apparent across the survey area.

Hummock grasslands with sparse overstoreys of trees or shrubs predominate on dunefields, sandy plains and limestones in the north, but these decline southwards and are virtually absent south of the Gascoyne River. Acacia shrublands, dominated by mulga *A. aneura* and snakewood *A. xiphophylla*, are very widespread on the hills and stony plains in the east of the area. Shrublands and low woodlands dominated by *Acacia* species gradually replace the hummock grasses on the sand sheets and dunefields through the centre and south-east of the area. Plains developed on Permian sediments in the north and south-central parts are characterized by halophytic communities of chenopod shrubs and *Acacia* species, but are frequently degraded.

The flood plains and alluvial delta areas of the lower Gascoyne and Wooramel rivers are characterized by extensive plains of Gascoyne bluebush, *Maireana polypterygia*, and other low halophytic shrublands. In most places, such plains feature low banks, dunes or small sheets of red sand on which the chenopods are largely replaced by acacia shrublands, with variable understoreys of low shrubs and grasses, including the introduced buffel grass *Cenchrus ciliaris.*

The extensive sandy sheets and dunefields of the far south are subject to a westerly rainfall gradient. Along this gradient, *Acacia ramulosa* dominated communities of mainly Eremaean shrubs found in the east are infiltrated by more mesic species from the South-Western Botanical Province. In some areas south of Shark Bay, an abrupt change to South-Western Botanical Province vegetation with *Banksia, Grevillea, Calothamnus* and *Eucalyptus* spp. occurs on fronts which are less than 1 km wide. The replacement of Eremaean Province species is virtually complete over the areas of 'tree heath' found to the south of Hamelin Pool, while a variety of unusually mixed or gradational assemblages occur throughout the peninsulas and islands of Shark Bay (Burbidge and George 1978).

Evolutionary and pre-historic aspects

The vegetation of the area has not always been as it is now. As with other parts of central and southern Australia which currently experience similar climatic conditions, aridity is thought to have first developed some 5-6 million years ago (during the Late Tertiary period) as summer precipitation declined and dry winters developed. The result was a contraction of the previously widespread Tertiary rainforest and expansion of the Myrtaceae, Chenopodiaceae, the genus *Acacia* and various grasses. Winter-dominated patterns of precipitation appear to have dominated for the past 2.5 million years, that is, since the Pliocene. More severe oscillations in the winter rainfall pattern during the last 400,000 years resulted in recurrent arid periods that constrained the botanical zonations towards the scenery that must have met man's arrival, which seems certain to have been more than 40,000 years before present (B.P.) (Hallam 1985). At this time, the southern arid zone (now dominated by mulga shrublands) is inferred to have experienced a climate more like that of the present mallee and wheatbelt areas (Bowler and Jones 1979). Since then, 'man's agency may have produced changes on a scale that complicates or obscures those biogeographical distributions that can be attributed to the forces of nature acting alone' (Bowler 1982).

A period of roughly 5000 years of severe aridity occurred during the late Quaternary after the recession of the last glaciation, some 18,000 years B.P. It was during this period that vegetation evidently declined and stronger winds were able to shape many of the red dunefields and sand sheets as we see them today (Beard 1982). This very arid period was evidently followed by a phase of considerably warmer and wetter climate, which

lasted until roughly 5,000 years B.P. After this, temperatures and rainfall both declined to about present levels, around which they have evidently stayed ever since (Rognon and Williams 1977).

Post-settlement changes

Settlement and pastoral development within the last 100 years has introduced two major forces of change upon the vegetation. The first constraint is associated with the depasturing of sheep, goats and cattle, and the establishment of stock watering points over areas previously grazed only by native invertebrates and low-density, patchy populations of marsupials. The second constraint is less obvious and is best defined simply as the loss of Aboriginal land use practices. That these would have involved the selective and opportunistic burning of various communities seems beyond doubt (Hallam 1985). However, the strategies they used and the effects of fire upon many types of arid and semi-arid vegetation in the Carnarvon Basin (and elsewhere in central Western Australia) are little-researched and remain largely obscure.

Detailed accounts of vegetation types

Details of the structure and composition of particular formations and community types are given in the sections on pasture types and land systems.

Vegetation bibliography

Botanical publications relevant to the survey area include:

Beard, J.S. (1975, 1976). Vegetation survey of Western Australia: Sheets 5 (Pilbara) and 6 (Murchison). University of Western Australia Press.

Chippendale, G.M., Ludek, W. (1981). The natural distribution of *Eucalyptus* in Australia. Australian National Parks and Wildlife, Service, Canberra. Special Publication No. 6: 1-192.

George, A.S. (1971). The plants seen and collected in north-western Australia by William Dampier. *The Western Australian Naturalist 11*(8): 173-178.

George, A.S. (1981). The Genus *Banksia* L.f. (Proteaceae). *Nuytsia 3*(3): 239-473.

Keighery, G.J. (1981). Distribution maps of the Fabaceae of Western Australia. *Kings Park Research Notes* No. 6: 1-123.

Keighery, G.J. *et al.* (1979-1983). Notes on the biology and phytogeography of Western Australian plants. Parts 1, 2, 3, 4, 7, 11, 12, 14, 15, 17, 18, 19, 20, 23, 24, 25, 26, 27, 29, 30, 31, 32, 33, 34. Various titles, part published.

Marchant, N.G. and Keighery, G.J. (1979). Poorly collected and presumably rare vascular plants of Western Australia. *Kings Park Research Notes* No. 5: 1-103.

Maslin, B.R. and Pedley, L. (1982). The distribution of *Acacia* (Leguminosae, Mimosoideae) in Australia, part 1. *Western Australian Herbarium Research Notes* 6: 1-128.

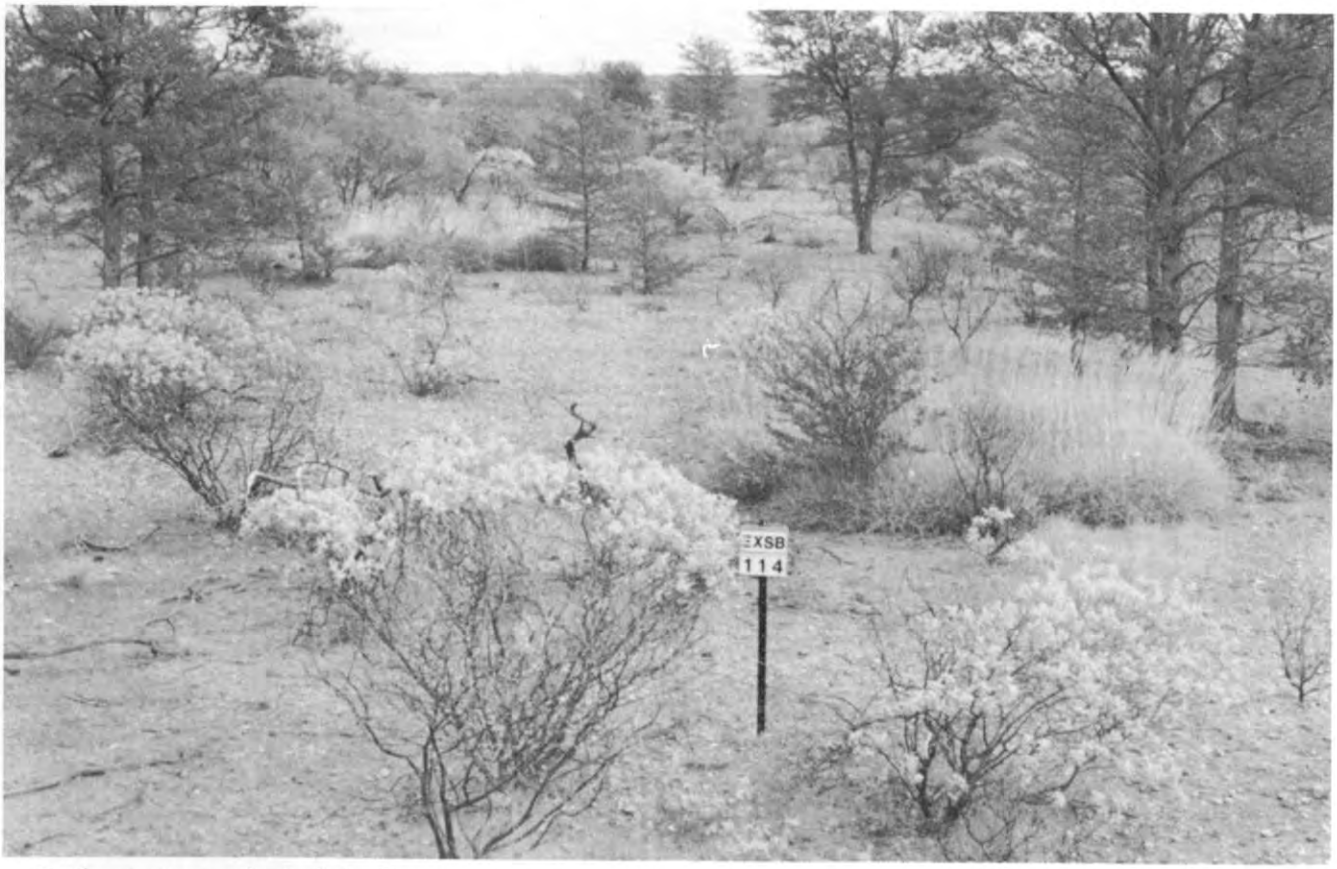
Munir, A.A. (1979). A taxonomic revision of the genus *Pityrodia* (Chloanthaceae). *Journal of the Adelaide Botanic Gardens 2*(1): 1-138.

Scott, J.K. and Kenneally, K.F. (1981). The distribution of Boraginaceae in Western Australia in relation to the biological control of *Echium plantagineum* L. *Western Australian Herbarium Research Notes* 5: 81-109.

Weber, J.Z. (1981). A taxonomic revision of *Cassytha* (Lauraceae) in Australia. *Journal of the Adelaide Botanic Gardens 3*(3): 187-269.

Anon. (1980). Cooloomia Nature Reserve. *State Wildlife Authority News Service* (SWANS). Department of Fisheries and Wildlife: Perth 10(3): 7-10.

6. Dune-fields of red sand, arranged in linear or reticulate patterns, occur over large areas in the east and north of the survey area. North of the Gascoyne River they support hummock grasslands of *Triodia* spp with sparse shrubs; further south they are dominated by tall shrublands and low woodlands. Cardabia land system, Exmouth Gulf station.



7. Vegetation typical of the Eremaean Botanical Province: low shrubs of *Cassia helmsii* (foreground) and *Eremophila* spp. (thicket understorey), tall shrubs/low trees *Acacia aneura* (mulga) and hummock grass *Triodia pungens*. Durlacher land system, Towera Station.

8. Tree-heaths and other heath-like communities of the South-West Botanical Province are dominated by the families Myrtaceae and Proteaceae. Such shrub associations are characteristically dense and diverse in composition. They consist of mainly unpalatable species, have been little used for pastoral purposes and are highly susceptible to wildfires. Nanga land system, Coburn Station.

9. Introduced buffel grass *Cenchrus ciliaris* has become widely established on a variety of landforms and soil types in coastal and sub-coastal areas. Exotic plant species found in the area are otherwise mainly various annuals and ephemerals which are mostly encountered on disturbed or degraded country. Donovan land system, Cardabia Station.

Vertebrate Pests

The following summaries relate to certain native and introduced animals in the survey area which are liable to cause adverse effects upon the condition of rangelands, upon livestock management, or which may have other adverse effects on the environment.

Native species

Kangaroos

Distribution

Red kangaroos *Macropus rufus* and euros, *M. robustus*, are found across the survey area, but red kangaroos are more widely distributed and occur in greater numbers. Red kangaroos are most plentiful in areas with a good grass and herb cover and where some trees or shrubs are available for shade.

Impact

It is widely believed that kangaroos compete with sheep for forage, particularly during adverse seasonal conditions, but such competition has not been studied. Kangaroos can adversely affect the regeneration of degraded shrub country (Gardiner 1986), a fact that must be recognized when pasture regeneration is planned. It is also important to recognize that in many arid areas, kangaroo numbers increased after European settlement as new watering points were created and habitats became altered (Ealey 1967, Oliver 1986).

Status and management

Kangaroos are protected animals in Western Australia and their management is regulated under the Kangaroo Management Programme administered by the Department of Conservation and Land Management (McNamara and Prince, 1986). Kangaroos are harvested for pet meat by shooters and harvesting levels are revised in the light of current population trends. The aim is to manage the population so that the species is not endangered while at the same time preventing unacceptable damage to rangelands.

Dingoes

Distribution

The greatest numbers of dingoes, *Canis familiaris dingo*, occur in the north-east of the survey area, in the location of the Lyndon and upper Minilya Rivers. Some dingoes also occur to the south of this area along the Kennedy Range. Dingoes are occasionally found in other areas such as the upper Wooramel River.

Impact

Dingoes have a major impact on the sheep industry. Research has shown that most dingoes in contact with sheep cause losses (Thomson 1984). Sheep are often maimed or, if killed, left uneaten. Sometimes dingoes chase sheep without biting them, leading to adverse consequences such as increased mis-mothering of lambs. Even when not actively harassing sheep, the presence of a dingo in the area can have an adverse influence on sheep distribution and behaviour.

Status and management

Dingoes are declared animals and the aim of control work is to remove dingoes on and near station country in order to prevent harassment and killing of stock.

Emus

Distribution

Emus *Dromaius novaehollandiae* are widely distributed through the survey area. Surveys have shown that emus occur in higher densities in sheep-raising pastoral areas than in either grain-growing or non-pastoral areas (Grice *et al.* 1985). Concentrations of emus occasionally occur in the south, when emus migrating during dry periods strike the State barrier fence north of the Murchison River.

Impact

Emus are not considered to be a major forage competitor with livestock (Davies 1978). They are considered more of a nuisance, damaging fences and sometimes interfering with sheep mustering and trapping operations.

Status and management

Emus are protected native animals. Their populations are controlled primarily by seasonal conditions and to some extent by predators, including dingoes. Locally, they can be controlled by shooting or poisoning when they cause economically unacceptable damage.

There is at least limited commercial potential for emu products, provided that they originate from strictly controlled and licensed facilities. Emu husbandry in the arid zone has proved to be feasible but relies on fairly intensive farming, with tame birds being fed on fodder produced by irrigation or artificial diets. Emu farming, as such, is likely to remain a special form of animal production and is incompatible with conventional pastoral facilities and management practices.

Wedge-tailed Eagles

Distribution

Wedge-tailed eagles *Aquila audax* are found throughout the survey area.

Impact

Wedge-tailed eagles are capable of catching a large number of different species of animal. Studies, near Carnarvon, of the prey taken by eagles to nests showed that young kangaroos made up the largest single component of the diet, with birds, lambs, rabbits, foxes and goats also featuring prominently (Brooker and Ridpath 1980). Eagles do kill some lambs which are potentially viable as well as mismothered offspring. However, it is generally considered that the number of lambs consumed by eagles as live prey represents a small proportion of total lamb losses.

Status and management

Wedge-tailed eagles are currently declared birds throughout the survey area, with the exception of the Shark Bay Shire. This declaration allows for numbers to be reduced and kept restricted, though the Agriculture Protection Board makes no recommendations for, nor does it enforce, the control of wedge-tailed eagles. In practice, pastoralists are able to carry out control work on an *ad hoc* basis if they think it is necessary and some eagles are killed, especially at lambing time.

Introduced species

Goats

Distribution

In the survey area, the main concentrations of goats *Capra hircus* occur along the Gascoyne and Wooramel Rivers and in the country between the two rivers. Goats are otherwise widely distributed in the survey area, usually with higher numbers occurring within about 50 km of the coast.

Impact

Overgrazing by feral goats can seriously alter the balance of species in a plant community as well as drastically reduce the total amount of vegetation present (Hamann 1979). Movements of goats are unchecked by standard sheep fencing, exacerbating the problems of pasture conservation and erosion control. Feral goats are also seen as a problem species because of their potential to act as a reservoir of infection in the event of an exotic disease outbreak.

Status and management

Feral goats are declared animals and the Agriculture Protection Board administers a commercialization policy towards complete eradication.

Goats survive well in many pastoral areas and this highlights their potential for meat and fibre production in these areas. The ability of goats to use coarse, low quality forage efficiently (Coblentz 1977) is seen as one of the reasons why goat husbandry may be a useful adjunct or alternative to present sheep grazing practices in certain rangeland areas. Research may lead to a review of the status of feral goats.

Rabbits

Distribution

Rabbits *Oryctolagus cuniculus* are found along the whole of the coastal strip, generally within 10 km of the coast, although they can extend considerably further inland during good seasons. Pockets of rabbits also occur along the major river systems and the margins of Lake Macleod.

Impact

Rabbits undoubtedly have a significant impact on the native flora. Studies have shown that they can have a major effect on inhibiting regeneration of tree and shrub species. They can alter the vegetation composition by eating all or most of the higher quality forage plants (Lange and Graham 1983). Because of their effects on the vegetation, they can induce or exacerbate soil erosion.

Status and management

Rabbits are declared animals, although eradication is not economically attainable in Western Australia. Effective control can be maintained in some parts of the State. However, in areas such as the present survey area, rabbits are widespread in a range of habitats and persist in the least favourable terrain even after several dry years. As such it is not possible to focus control efforts on restricted areas. The cost of controlling rabbits by any current method is likely to exceed the benefit gained. Rabbits will remain a continuing problem when their numbers build up following good seasons (King 1984).

Foxes

Distribution

Foxes *Vulpes vulpes* are widely distributed over the survey area, possibly in greater numbers closer to the coast.

Impact

Foxes are not considered to be a major threat to the pastoral industry. Studies have shown that, although foxes do kill some lambs, the majority of lambs eaten are either already dead or moribund (Hubach 1981). Foxes pose a threat to native fauna and may have caused the local extinction of some species (Christensen 1980). Foxes would become an important carrier of rabies if the disease ever reached Australia.

Status and management

Foxes are declared animals, although no major co-ordinated control work is carried out. Numbers are reduced by fur hunters, who shoot foxes for commercial gain. Some spot poisoning is carried out and, in dingo areas, foxes are often trapped or poisoned in the course of dingo control operations. An apparently effective baiting campaign to reduce predation by foxes on turtle eggs is carried out in the Cape Range National Park.

Donkeys

Distribution

Donkeys *Equus asinus* are found in several sections of the survey area. Small numbers exist on the lower Wooramel River area, but the main concentrations are found to the north-east of the survey area, from Lyndon station east and south to the Kennedy Range.

Impact

Donkeys can cause considerable damage to perennial grasses, shrubs and herbage, through trampling and heavy grazing. They can reduce the grazing capacity of country and cause erosion. Donkeys also behave aggressively towards domestic stock, sometimes denying them access to water.

Status and management

Feral donkeys are declared animals and the aim of control work is their eradication. No co-ordinated control campaign is carried out in the survey area, although donkeys are often shot in the course of station activities and pet meat shooters occasionally hunt them. Shooting from a helicopter has proved a successful control measure in other areas, and may soon be introduced to eliminate donkeys from the Carnarvon Basin and other areas.

Camels

Distribution

One isolated mob of camels *Camelus dromedarius* exists at the southern end of the Shark Bay Shire. The camels tend to live in the sandhills and mallee shrub areas, avoiding the open plains.

Impact

There is no information available on the effect of camels in this area. Their economic significance is probably restricted to the occasional damage caused to fences and watering points.

Status and management

Feral camels are declared animals, although control work aimed at eradicating them would probably be economically unjustified. No co-ordinated control campaigns exist.

Cats

Distribution

Feral cats *Felis catus* are widely distributed and common throughout the survey area.

Impact

Feral cats pose no economic threat. They may have an adverse effect, however, on populations of native animals (Fitzgerald and Veitch 1985, Wood-Jones 1925).

Status and management

No management policies exist for feral cats, which are established throughout pastoral and unoccupied parts of the arid zone. It seems that they are destined to remain an unfortunate component of the Australian fauna.

The 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, 1972; Payne *et al.*, 1979, 1982; Mitchell *et al.* 1979).

Christian and Stewart (1953, 1968) define 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, generally occurs over an area greater than 5 km^2 and is therefore of a scale suitable for mapping at 1:250,000. 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 their likely boundaries were identified and marked onto the most recently available 1:50,000 or 1:40,000 black and white aerial photographs. Published background information on geology, landforms, soils, vegetation and land system classifications used to assist in this was available from several sources. These included the Geological Survey of Western Australia (1:250,000 and 1:50,000 map sheet series), Bettenay *et al.* (1967), Beard (1975, 1976), Payne *et al.* (1982), Wilcox *et al.* (1972). False colour images generated from Landsat satellite data were also used to provide broad overviews of the area.

Reconnaissance field-work.

Preliminary land system classification was followed by two reconnaissance ground surveys of the area, the objective of which was to familiarize members of the survey team with the major land systems, soil types and vegetation communities throughout. During these reconnaissance exercises (in late 1980 and early 1981) field methods to be used on the main survey were tested and finalized. Substantial progress was also made towards defining land system boundaries along the routes taken and identifying key soil profiles and plant specimens taken at sites selected according to photopattern and their position in the landscape. Broad pasture types were also characterized at this stage and a variety of vegetation states and soil degradation classes were identified and described for future reference.

Main field-work

Between June 1981 and November 1982, the main survey was carried out and completed by 32 weeks of field-work. Field-work periods were each of roughly four weeks duration. The survey proceeded from north to south, normally by travelling each day from one of 15 strategically-positioned base camps established during the programme. On a few occasions, distances or difficult terrain necessitated overnight stops during coverage of a particular area.

The staff complement for the survey normally consisted of two advisers and a technician from the Department of Agriculture and a surveyor, a draftsman-navigator and a senior survey hand from the Department of Lands and Surveys (now Department of Land Administration).

On a day-to-day basis, field-work was carried out during a series of 250 overland traverses. Each traverse consisted of up to 130 km of continuous travel, planned to provide a progressive coverage of the various landforms and management areas of every station. From these fundamental lines of coverage, visits to each of the 669 inventory sites and numerous other field checks were made as small diversions, usually of less than 2 km from the traverse route. In addition assessments of erosion status and pasture condition were made every kilometre along the traverse routes.

The traverses satisfied survey requirements by:

- Providing sufficient ground control to map each area into land systems marked up on aerial photographs.
- Visiting pre-selected inventory sites (query points), chosen according to their photo-pattern, and describing the landform, soils and vegetation of the land unit concerned.
- Characterizing the land systems encountered.
- Attempting to identify grazing-related changes in vegetation or soils and characterizing range condition states within particular land units.
- Assessing the condition of perennial vegetation and soil stability or erosion status at 1 km intervals throughout the traverse, according to criteria applicable to each land unit and vegetation type encountered.
- Identifying and delineating the extent of severely degraded areas.
- Estimating stock carrying capacities appropriate for the conservation of resources within each pasture type and land system.
- Informing pastoralists of the scope and purpose of the survey.

Site inventory techniques

Site selection

Sites were selected for inventory purposes according to:

- Aerial photo-pattern and land unit identification.
- The cumulative coverage of such sites achieved at that time.
- The relative abundance of the type of photo-pattern or land unit within the broader land system.
- The degree to which the site was likely to have been subjected to grazing pressures, so that any range of grazing-related changes such sites might reflect would be identified.

Site identification, marking and photographic record

On arriving at the pre-selected point, the site was marked with a numbered aluminium tag attached to a steel picket driven into the ground. This exact point was located on the aerial photograph, marked up and pin-pricked on the emulsion. The location

was transferred to the appropriate 1:100,000 topographical sheet and the Australian Map Grid (AMG) co-ordinates of the site were then recorded to the nearest 100 m. Oblique photographs, in monochrome and colour transparency, were taken from the top of the vehicle (a viewpoint about 3.5 m above ground) with a conspicuous identification plate suspended on the picket 13.5 m into 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 erosion
Susceptibility to flooding
Susceptibility to shrub invasion
Vegetation dominants
Vegetation structure
Estimated stock carrying capacity

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 (solum depth) if <1 m
Soil horizon details for each horizon:
Depth
Colour: hue/chroma value
Texture
pH
Inclusions
Principal profile form
Parent material (if struck)

Vegetation

Some attempt was made to identify every plant found on the site. Specimen material was collected from unfamiliar or doubtfully identified perennials and referred to the Western Australian Herbarium for identification. Determinations were made to species level in the majority of cases. Where this was not possible genera are stated without specific epithets.

Annuals were identified and listed wherever possible. However the poor winter rainfall which prevailed, particularly in 1982, precluded any meaningful cataloguing of these short-lived plants over the region. 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 order of 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 was made compared with reference photographs depicting calibrated sites of various association types (low shrublands, mixed shrublands, tall shrublands). The basal cover of perennial grasses, where they occurred, was estimated using wheel point apparatus (Tidmarsh and Havenga 1955).

Species composition and density within each major stratum was estimated from belt transect counts confined to the particular land unit being sampled. The area sampled was generally 400 m^2 unless the vegetation was fairly dense, when smaller sampling transects were used. Any evidence of grazing effects was used towards an assessment of indicator value for each species at the particular site. A broad pasture type, for example Saltbush (SALT) or Hard Spinifex (HASP) was assigned to the site. Range condition, in terms of disparity from the optimal soil surface and perennial cover-composition for the site, was assessed in the field on a nominal scale from excellent to very poor, as defined under condition assessment by traverse. Pastoral value, or the inherent productive capability of the land unit and its vegetation, was estimated on a regional scale. Broad summations of these values, obtained from many sites within each major pasture type, are indicated at the end of those summary statements at the head of the key shown on each map sheet.

Condition assessment by traverse

With the aim of assessing 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 100 m either side of the kilometre point. Traverse speed was about 40 km/hour 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.

During the survey, assessments were made at a total of 10,952 traverse points on 86 land systems.

The definitions and numerical ratings for soil erosion and pasture condition are shown in table 7 and table 8 respectively.

Table 7. 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 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	Terracing or extensive gullies. 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.

Table 8. 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

The inventory site data were collated and summarized on a land unit, land system, vegetation and soil basis using a modified INFO package on the Prime computer at the Department of Agriculture. This information was used to draw up detailed land unit, land system, soil type and pasture type descriptions which are presented later in this report.

The condition assessment data obtained whilst traversing were also sorted on the Prime computer. The printout sheets (for an example see table 11) 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 9.

Table 9. Derivation of total erosion

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

Range condition

Assessments of overall range condition were made by taking into account 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 10.

Table 10. Derivation of range condition

Total erosion	+ pasture condition	= range condition
Good range condition		
Nil	+ Excellent	
Nil	+ Good	= Good
Minor	+ Excellent	
Minor	+ Good	
Fair range condition		
Nil	+ Fair	
Minor	+ Fair	= Fair
*Moderate	+ Excellent	
*Moderate	+ Good	
Poor range condition		
Nil	+ Very poor	
Nil	+ Poor	
Minor	+ Very poor	
Minor	+ Poor	
Moderate	+ Very poor	
Moderate	+ Poor	= Poor
Moderate	+ Fair	
Severe	+ Very poor	
Severe	+ Poor	
Severe	+ Fair	
†Severe	+ Good	
†Severe	+ Very good	

* Combinations not encountered in the field. Although theoretically possible they are unlikely to be encountered.

† Combinations not encountered in the field.

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 on one station is shown in table 11.

The traverse data print out sheets were used for preparing condition statements for the individual station reports which are presented in appendix 1. They were also used for preparing general condition statements for each land system which are presented in the section on range condition and regeneration requirements of the survey area.

Map preparation

Monochrome aerial photographs at 1:40,000 and 1:50,000 scale were used during the survey to delineate land system boundaries, locate pastoral improvements, delineate areas of degradation and erosion and to record the position of range evaluation sites. These data were then transferred to 1:50,000 scale Australian Map Grid (AMG) topographical transparent line compilations. Traverse point positions and assessment scores were then plotted on the compilations. Map production proceeded using computer-aided mapping technology, selected primarily because of its relatively low cost for full colour production compared with conventional masking techniques. It also facilitated a requirement for area statements of each land system within each pastoral lease, the projected use of the digital data in a resource management data base, and the ability to plot digital data at any nominal scale, for example the requirement of station plan mapping at a scale of 1:100,000.

The 158 line compilations were captured digitally on an Intergraph work-station with separate design files created for each map sheet (1:250,000 scale), and each major theme placed on a separate level. Linear cadastral boundaries were available in a digital format and thus required no extra treatment. However, non-linear boundaries such as coastlines and lakes were only available in a graphical form on 1:250,000 scale public plans and thus had to be captured digitally. Using a Xynetics flat-bed plotter all digital data for each map-sheet were then precision-plotted at a scale of 1:250,000.

Updated 1:250,000 scale topographical plans of the survey area were biangled to 60% and registered to the Xynetic plots to provide a topographical base on which to overlay the resource information. Using normal cartographic techniques a descriptive key for the land systems and pasture types was added.

Problems with pantone cutting and scanning of the pasture types necessitated the use of a Scitex scanner for colour filling. Plates for each of the process colours (yellow, magenta, cyan and black) were produced and printing initiated for the 1:250,000 scale map-sheets.

Table 11. Example print-out sheet

	No. of records	Wind erosion (%) Nil	Min	Mod	Sev	Water erosion (%) Nil	Min	Mod	Sev	Total erosion (%) Nil	Min	Mod	Sev	Pasture condition (%) Ex	Good	Fair	Poor	Very Poor	Range condition (%) Good	Fair	Poor
Station—Doorawarrah																					
Land system—Sandal																					
Unit—Interbank	25	84	8	8	0	88	12	0	0	84	8	8	0	0	24	60	16	0	24	60	16
Unit—Sandy bank	18	94	6	0	0	94	6	0	0	94	6	0	0	6	61	22	11	0	67	22	11
Unit—Alluvial plain	1	100	0	0	0	100	0	0	0	100	0	0	0	0	0	100	0	0	0	100	0
Unit—Sand sheet	5	100	0	0	0	100	0	0	0	100	0	0	0	0	40	40	20	0	40	40	20
System Summary	49	90	6	4	0	92	8	0	0	90	6	4	0	2	39	45	14	0	41	45	14

10. Collecting information on landform, soils and vegetation at inventory sites ('query points').

11. Each site was photographed as a part of the permanent record.

12. Each site was marked with an aluminium plaque which identifies the agencies, site number and survey code.

Land systems of the survey area

The 89 land systems which were mapped during the course of the survey are described, in alphabetical order, in the following section. Twenty-one of the systems (those indicated by (G) following the name in the main heading) were originally described further east in the Gascoyne catchment (Wilcox and McKinnon 1972) and another nine (as indicated by (A) similarly) were first described in the Ashburton River catchment area (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 landforms or 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 location map, depicting the extent of the system and the map sheets on which it occurs.
3. A summary of the key features of the system and its pastoral use.
4. A block diagram or plan view of a representative or stylised 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 is presented under the following headings.

Landform and soils

Indication of the type of unit (hill, dune, plain), its relief relative to other units and slopes as measured at sites; soil details; colour, texture classes, total depth of profile, particulate inclusions, pH at surface and trend through profile, principal profile form(s) (Northcote 1979).

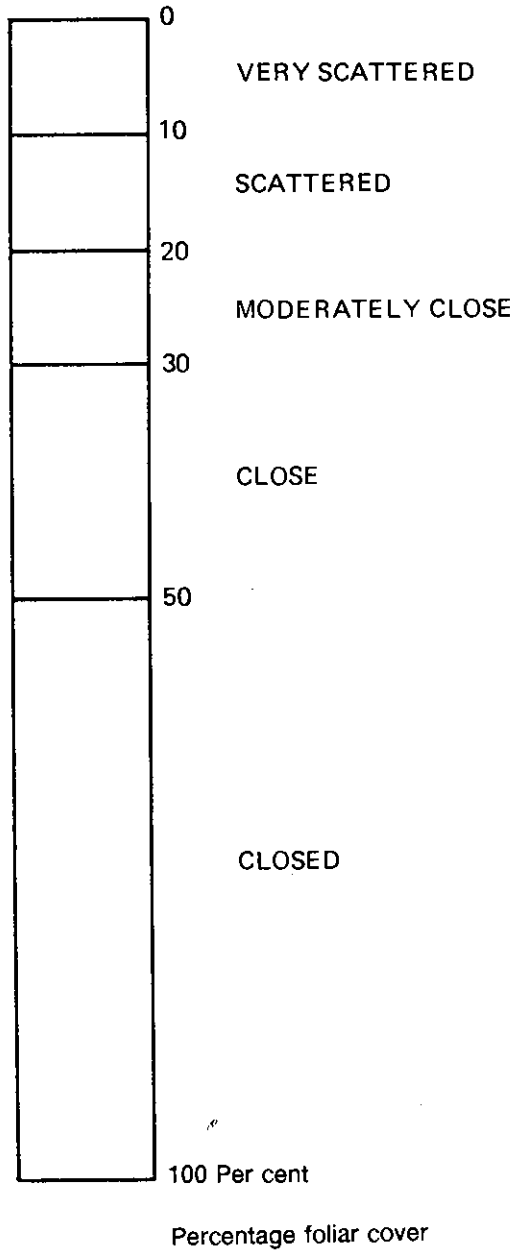
Vegetation: formations and major species

First sentence describes (a) the usual degree of perennial cover (figure 20), (b) the predominating stratum type (low woodland, low shrubland) and (c) the most abundant and widespread species.

In cases where two or more very different types of formations are commonly encountered, each is described separately under (i), (ii) etc.

Projected foliage cover (P.F.C.): range in per cent cover (given where data are sufficient); composition data by stratum, e.g. 'Tall shrubs (560 ± 300/ha; 2-4m)' = tall shrubs (> 2 m high) estimated at a mean density of 560 (± standard deviation if data sufficient) /ha (see unit title line for number of inventory sites sampled); where data less full, figure given represents range of estimates of plant density on < 10 sites; height range as given refers to modal range of shrub heights encountered; species listed (usually six or eight for a well-developed stratum) are those considered the most common and most widespread on the unit.

Figure 20. Scale of projected foliar cover classes and descriptive terms for arid shrublands (after Curry, Payne and Wilcox 1983)



Comments and condition indicators

Pasture type: See section on pasture types for further details.

Desirable perennials: Key species that confer both useful browse and soil/community stability for the unit; (usually) palatable species which management should aim to maintain or increase.

Undesirable perennials: Any species that tend to increase or invade sites on which desirables and/or other perennials have been depleted; these species reduce the herbage response and are normally of little or no value as browse in such situations; increases in undesirables indicates a decline in pasture condition.

Pastoral use limitations: Susceptibility to various forms of degradation, problems of low pastoral value, access to stock, pasture salinity.

Agamemnon Land System (G) 929 km² (1.2% of survey area)

Rocky hills, with peaks and ridges above extensive stony slopes, supporting scattered tall shrublands of mulga and other acacias.

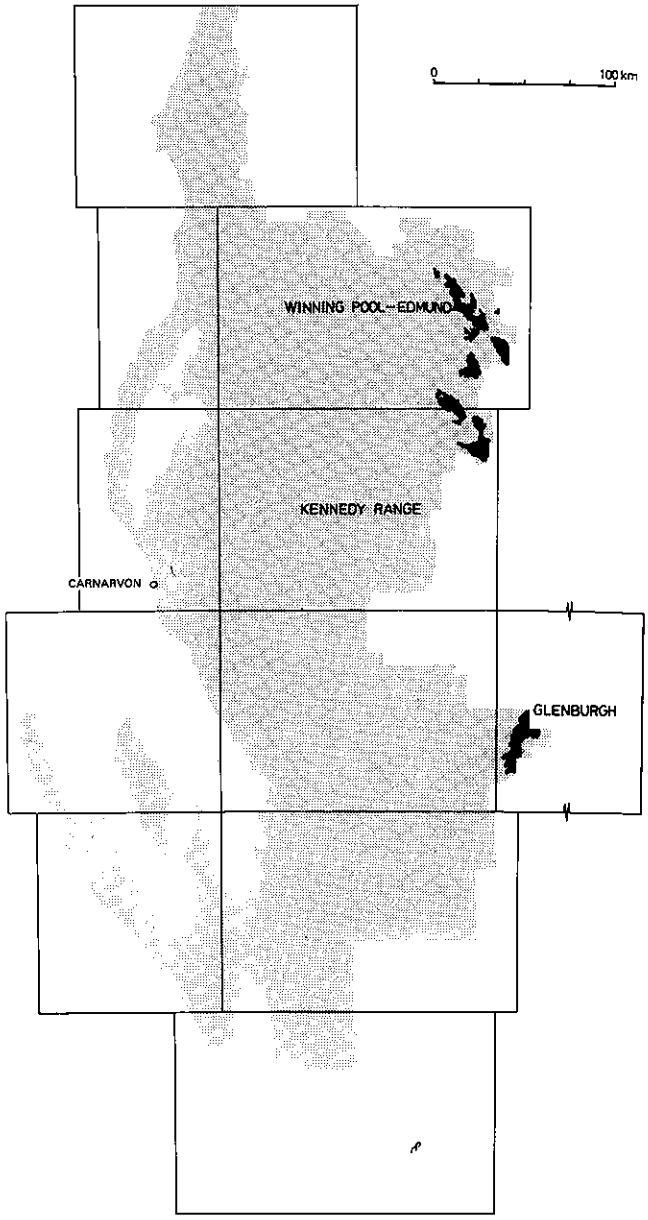
Geology: Early Proterozoic gneiss, schist and quartzite of the Morrissey metamorphic suite.

Geomorphology: Erosional surfaces, mainly low rough hills, with gneissic outcrops, peaks and ridges to 60 m relief, with pebble-strewn footslopes draining across short flats with duplex soils into complex channelled tributaries with sandy bedloads.

Pastoral use: Unproductive hilly pastures with some areas poorly accessible to stock; the lower units 3 and 4 are much more productive and easily reached but are susceptible to overgrazing and subsequent erosion by wind and water.

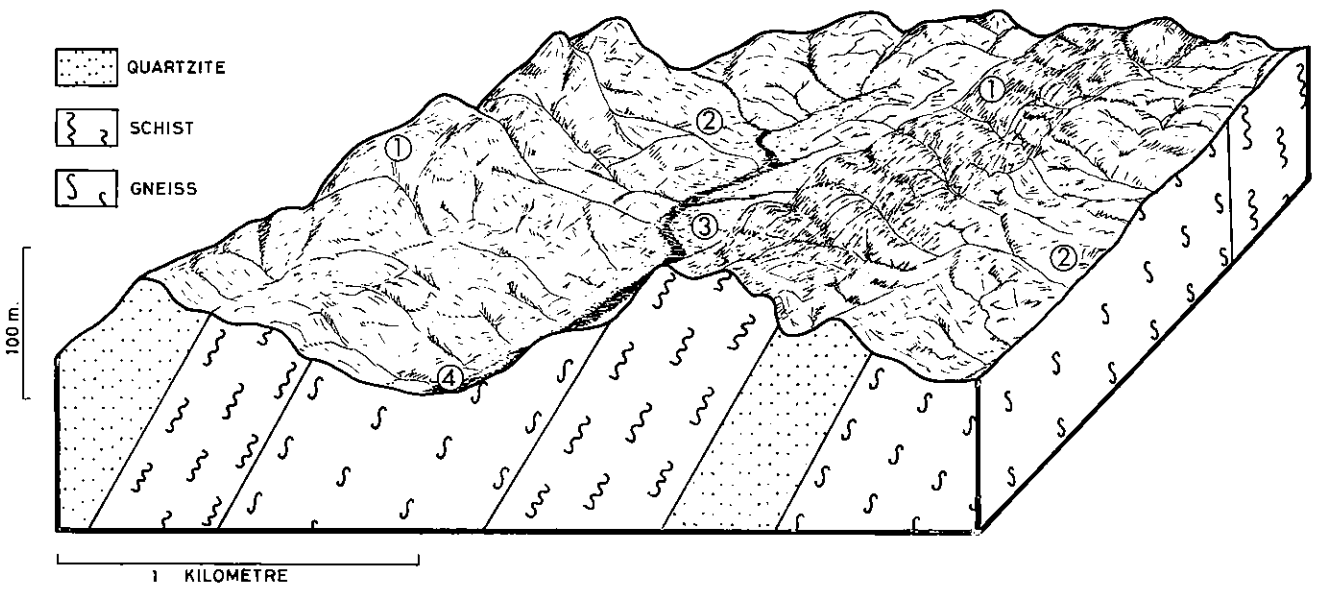
Estimated carrying capacity, good condition: 25 ha/s.u.

Range condition summary: Good 68%; fair 26%; poor 6%.



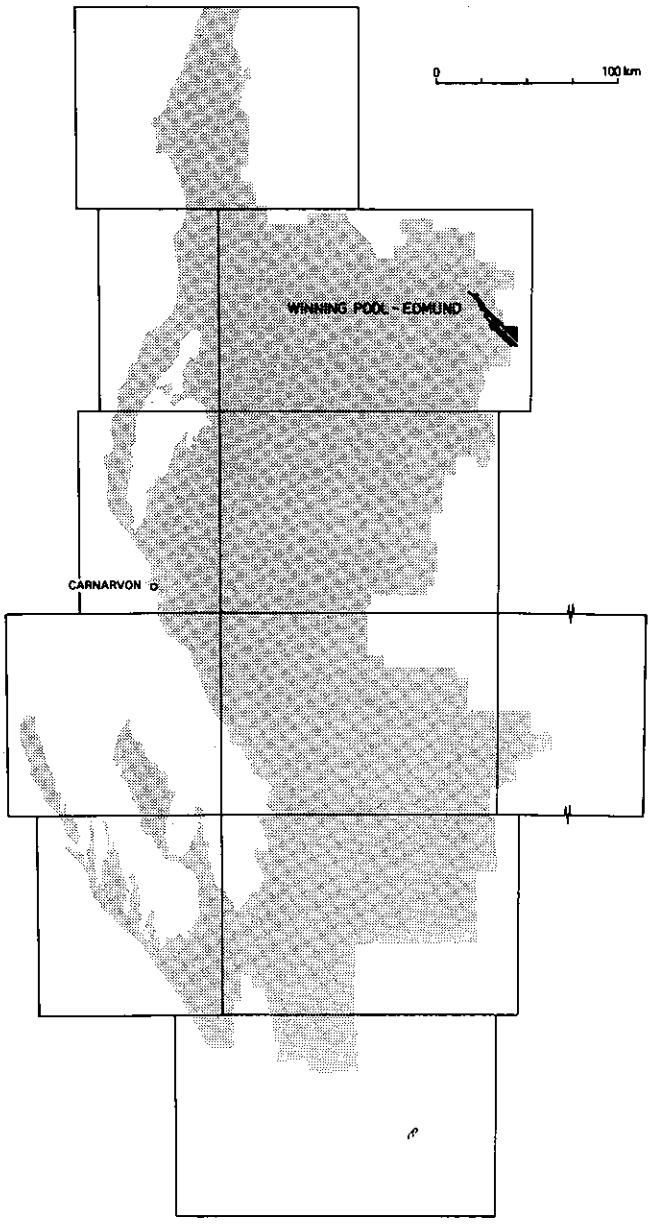
Unit

1. Peaks, outcrops and ridges
2. Rounded summits and stony slopes
3. Drainage flats
4. Narrow drainage floors and channels



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Peaks, outcrops and ridges (35%) Traversed	
Rocky hills with strike ridges of schists and quartzite with occasional gneissic outcrops; locally heavily strewn with boulders. Soils are limited to isolated rocky pockets.	Mostly unvegetated, isolated low shrubs mainly *Eremophila exilifolia* and *E. freelingii.*	Pasture type: *Stony Short Grass Forb.* Pastoral use limitations: Only partially accessible to stock.
	Unit 2 Rounded summits and stony slopes (50%) 2 site inventories and traversed	
Rounded hilltops and slopes, concave or convex, relief up to 40 m, lightly to moderately strewn with quartzite pebbles. Soils are shallow dark red fine sandy loams, pH 6.5 with a neutral trend; principal profile form: Uc 1.43.	Very scattered to scattered shrublands dominated by *Acacia aneura* or *Eremophila* spp. Trees or Tall Shrubs (2-3m): *A. aneura*; Low shrubs (< 1.5 m): *Ptilotus obovatus, Cassia desolata, C. leurssenii, Eremophila freelingii, E. macmillaniana, Acacia tetragonophylla, Solanum lasiophyllum, Rhagodia* spp; Perennial grasses: *Cymbopogon exaltatus.*	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp., *Hybanthus enneaspermus* Pastoral use limitations: Local inaccessibility to stock.
	Unit 3 Drainage flats (5%) Traversed	
Very restricted alluvial fans and drainage plains, slopes up to 4%. Soils are dark red duplex types, loamy sands over sandy loams grading to sandy clay loams and sandy clays, > 1 m deep, pH 6.5-7.5, principal profile form: Dr 4.12.	Scattered shrublands dominated by *Acacia aneura* or *A. victoriae* and *Frankenia* spp on saline sites.	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Frankenia* spp, *Maireana* spp. Pastoral use limitations: Moderate susceptibility to water erosion by surface sheeting, stripping, rilling and guttering.
	Unit 4 Narrow drainage floors and channels (10%) Traversed	
Drainage zones of moderate intensity, radially dendritic around isolated ridges, trellised or rectangular. Otherwise soils are dark red duplex (as unit 3) bordering the channels while the bedloads are of sands, pebbles and cobbles.	Moderately close to close tall shrublands dominated by *Acacia aneura, A. tetragonophylla* and patchy perennial grasses. Trees (2-5 m): *A. aneura, Hakea lorea*; Tall shrubs (2-3 m): *A. tetragonophylla, A. kempeana, A. victoriae, Scaevola spinescens*; Low shrubs (< 2m): *Cassia helmsii Corchorus walcottii, Abutilon* spp, *Ptilotus obovatus, Rhagodia eremaea*; Perennial grasses: *Chrysopogon fallax, Paraneurachne muelleri, Cenchrus ciliaris.*	Pasture type: *Acacia Creek-line.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Chrysopogon fallax.* Pastoral use limitations: slight susceptibility to erosion when degraded.

Augustus Land System (G) 130 km² (0.2% of survey area)



Rugged ranges of hills, ridges and plateaux with skeletal soils supporting tall shrublands of mulga and other acacias.

Geology: Middle Proterozoic sandstone, quartzite, shale and dolomite of the Bangemall group.

Geomorphology: Erosional surfaces: ranges and hills with steep escarpments and upper slopes, restricted lower slopes, valley plains and narrow drainage floors; angular and rectangular drainage patterns of moderate density, relief up to 300 m.

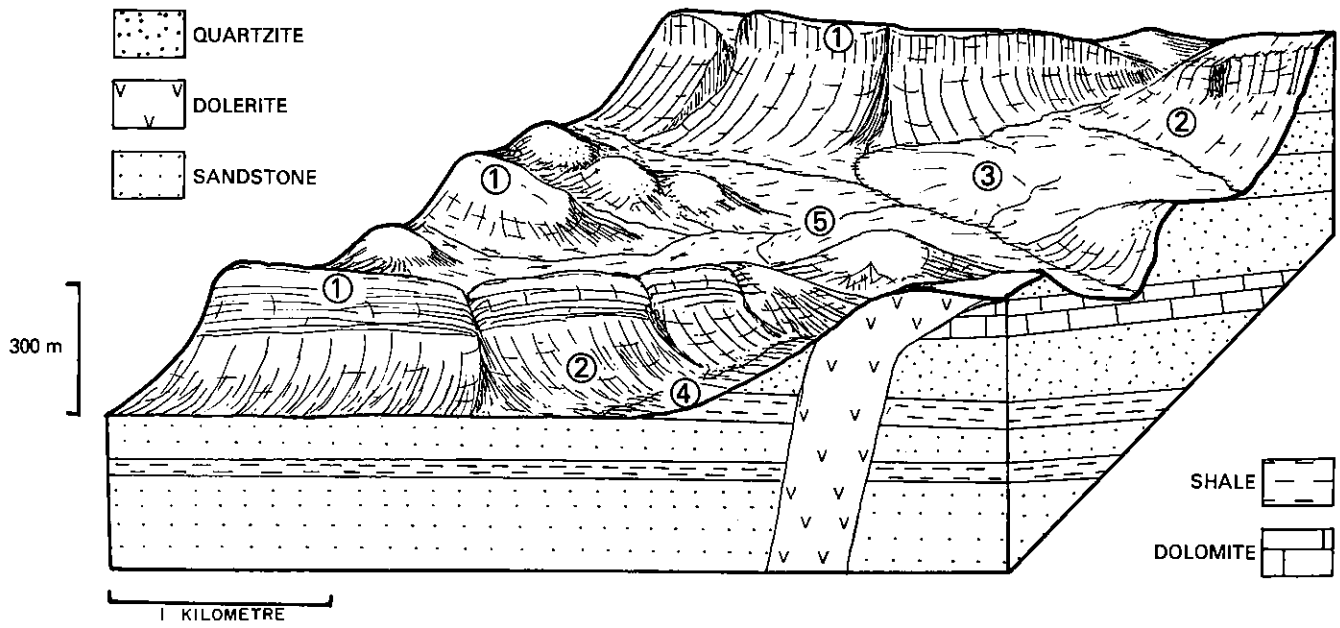
Pastoral use: The uplands of unit 1 are largely inaccessible to stock and are in any case potentially useful only when supporting ephemeral forbs and grasses; the lower units are more accessible, but have very poor drought resistance due to a scarcity of edible shrubs and lack of perennial grasses.

Estimated carrying capacity, good condition: 30 ha/s.u.

Range condition summary: No data, probably mostly good.

Unit

1. Summits, ridges, and rocky uplands
2. Lower footslopes
3. Stony undulations and interfluves
4. Drainage floors
5. Channels and creeks



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Summits, ridges and rocky uplands (65%)	
Rugged sandstone summits and hilltops of up to 300 m relief. Soils are confined to isolated pockets of skeletal sands.	Very scattered to scattered low shrublands dominated by *Acacia aneura*, *A. grasbyi* and *Grevillea nematophylla*. Other low shrubs include *Cassia* spp, *Ptilotus* spp and *Eremophila* spp locally replaced by *Triodia wiseana*.	Pasture type: *Acacia Short Grass Forb.* Sparse perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Very poor accessibility to stock, low productivity and lack of drought durability.
	Unit 2 Lower footslopes (20%)	
Concave slopes up to 5% with boulder outcrops and locally dense mantles of loose rocks. Soils are bouldery and skeletal.	Very scattered tall shrublands dominated by *Acacia aneura*. Low shrubs: *Eremophila freelingii*, *Solanum* spp.	Pasture type: *Acacia Short Grass Forb.* Sparse perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Low productivity and lack of drought durability.
	Unit 3 Stony undulations and interfluves (10%)	
Undulating rocky surfaces, slopes up to 4%, with locally dense mantles of cobbles and pebbles; marginal dissections are mostly narrow. Soils are shallow red loams over parent rock or hardpan; principal profile form: (probably) Um 6.24.	Very scattered tall shrublands dominated by *Acacia* spp, denser in the dissections receiving run-on.	Pasture type: *Acacia Short Grass Forb.* Sparse perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Low productivity and lack of drought durability.
	Unit 4 Drainage floors (2%)	
Angular to rectangular drainage zones, slopes < 0.5%. Soils are alluvial sands or loams, locally saline.	Tall shrublands or low woodlands dominated by *Acacia citrinoviridis*, *A. kempeana* and *A. aneura*. Low shrubs: *Eremophila leucophylla*, *Maireana* spp.	Pasture type: *Acacia Creek-line.* Pastoral use limitations: None under controlled stocking.
	Unit 5 Channels and creeks (3%)	
Irregular incised watercourses, soils are mainly coarse sands to pebbles, more loamy at margins.	Fringing woodlands dominated by *Eucalyptus camaldulensis*, *Acacia coriacea* and *A. citrinoviridis*. Low shrubs: *Eremophila margarethae*, *E. freelingii* and *Solanum* spp.	Pasture type: *Acacia Creek-line.* Pastoral use limitations: None under controlled stocking.

Barrabiddy Land System 152 km² (0.2% of survey area)

Flood plains and broad drainage zones with shallow channelling, supporting tall acacia shrublands with some saltbush and tussock grasses.

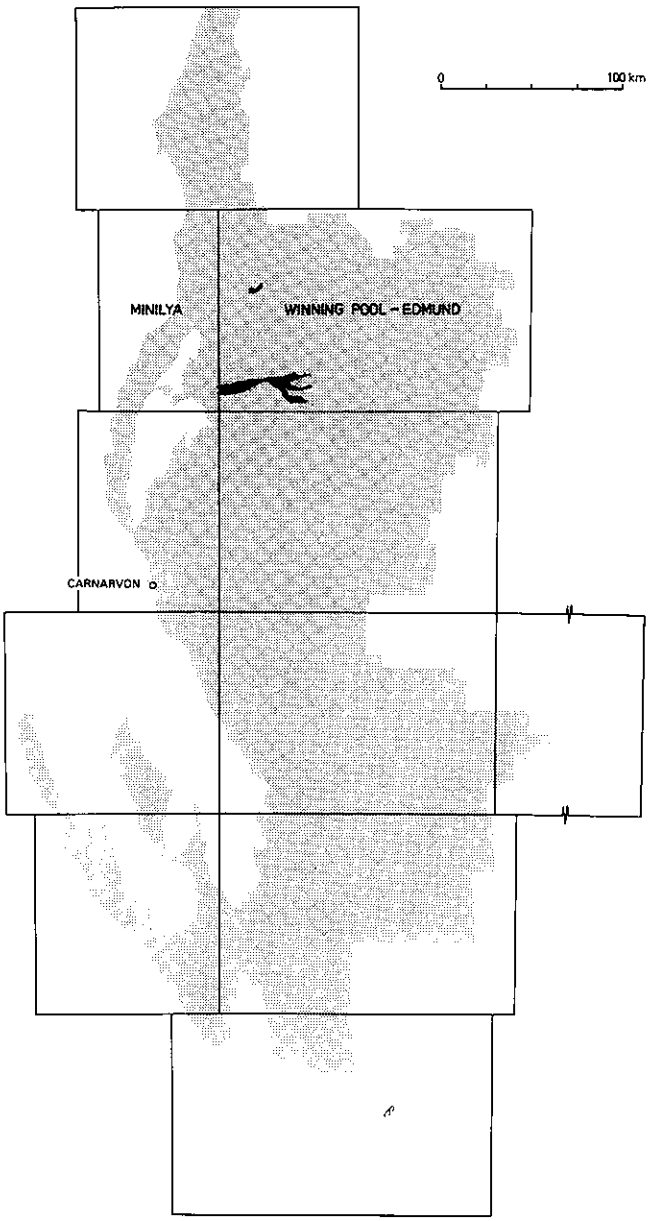
Geology: Quaternary alluvial deposits: sand, silt, gravel and clay.

Geomorphology: The flood plain of Barrabiddy creek: depositional surfaces with very shallow gradients, broad alluvial plains and drainage tracts carrying incised drainage lines of moderate density; relief up to 2 m.

Pastoral use: A highly productive system which is now widely degraded, with the original Saltbush (SALT) and Bluebush (BLUE) pastures eliminated over most parts of the major flood plain unit (3) and widespread accelerated water erosion. Increases in prickly acacia and wait-a-while have probably moderated the rates and extent of topsoil losses, but are useless as replacements for palatable shrubs and perennial grasses.

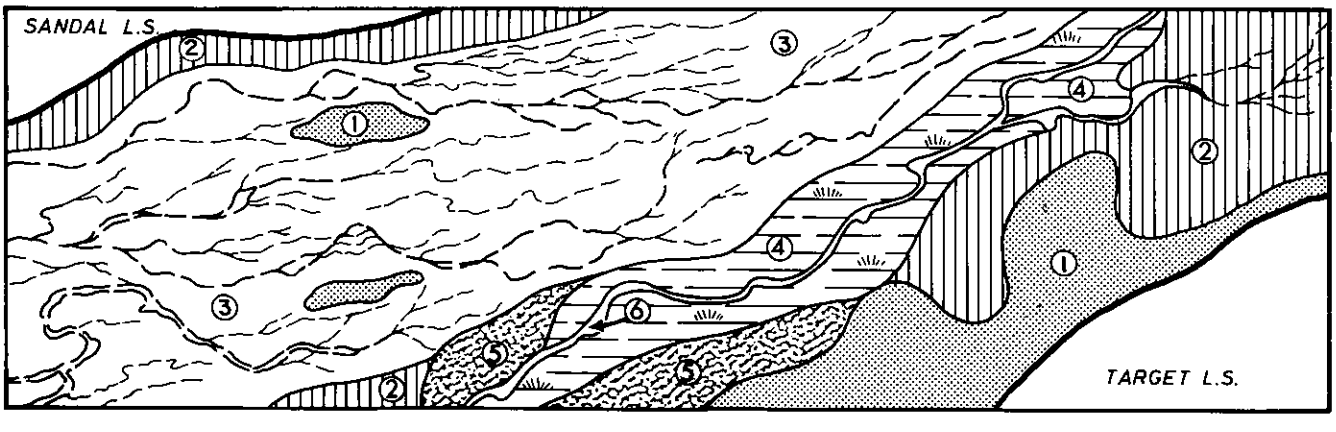
Estimated carrying capacity, good condition: 4 ha/s.u.

Range condition summary: Good 10%; fair 32%; poor 58%.



Unit

1. Sandy banks
2. Alluvial plains
3. Flood plains
4. Low-lying drainage plains
5. Gilgaied plains
6. Major channels and banks



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Sandy banks (10%) 1 site inventory and traversed	
Long sandy banks up to 2 m above unit 6 and rises aligned along the direction of flow down unit 3. Soils are gradational loams, loamy sand grading to sandy clay loams, pH 7.0 with a neutral trend, reddish brown to dark grey and > 1 m deep; principal profile form: Gn 1.12.	Tall shrublands or low woodlands dominated by *Acacia* spp. Trees and tall shrubs: *A. sclerosperma, A. ramulosa, A. subtessarogona, A. citrinoviridis*; Low shrubs: *Cassia* spp, *Maireana planifolia, Scaevola spinescens*; Perennial grasses *Cenchrus ciliaris, Chysopogon fallax.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 2 Alluvial plains (20%) 2 site inventories and traversed	
Plains with flat to mounded surfaces, sloping 0.2 - 0.6%, locally with channelled drainage lines but mainly subject to sheet flooding. Soils are either gradational loams (sandy clay loam to sandy clay, pH 7.0 with a neutral trend) or duplex type (sandy loam over light medium clay, pH 7.0 with an alkaline trend), reddish brown and > 1 m deep, principal profile forms: Gn 4.12, Dr 4.13.	Moderately close tall shrublands dominated by *Acacia* spp and variable chenopod understorey. Trees: *Eucalyptus coolabah*; Tall shrubs (300-450/ha; 2-4 m): *Acacia tetragonophylla, A. xiphophylla, A. sclerosperma*; Low shrubs (1400-2500/ha; 0.5-1.5 m): *Atriplex bunburyana, Rhagodia eremaea, Maireana pyramidata, Ptilotus polakii, Dipteracanthus corynothecus, Ptilotus obovatus, Cassia desolata*; Perennial grasses: *Cenchrus ciliaris, Eragrostis xerophila, Chrysopogon fallax.*	Pasture type: *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Dipteracanthus corynothecus, Ptilotus polakii.* Pastoral use limitations: Locally, moderately susceptible to water erosion when degraded.
	Unit 3 Flood plains (50%) 2 site inventories and traversed	
Plains with uneven surfaces and channelled drainage lines, parallel to braided, of moderate intensity and gently sloping (0.5%). Soils are red or yellowish-red duplex, sand or loamy sand over sandy clay, > 1 m deep; pH 7.0 - 7.5 with a neutral trend; principal profile form: Dr 4.12.	Very scattered to scattered tall shrublands dominated by *Acacia* spp with variable understorey shrubs. Trees and tall shrubs (0-150/ha; 2-4 m): *Acacia cuspidifolia, A. victoriae, A. xiphophylla*; Low shrubs (400-600/ha; < 2 m): *Solanum lasiophyllum, Ptilotus polakii, Maireana planifolia, Lepidium platypetalum, Rhagodia eremaea, Cassia desolata*; Perennial grasses: *Cenchrus ciliaris, Eragrostis xerophila.*	Pasture type: Extensively degraded, probably formerly *Bluebush* or *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Ptilotus polakii.* Undesirable perennials include: *Acacia cuspidifolia, A. victoriae.* Pastoral use limitations: Moderate susceptibility to erosion, mainly by water, when degraded.
	Unit 4 Low-lying drainage plains (10%) Traversed	
Seasonally inundated back plains and ill-defined drainage foci. Soils are probably full depth clays.	Moderately close to close tall shrublands with scattered trees, dominated by *Eucalyptus coolabah* and *Acacia farnesiana.* Trees (6-10 m): *E. coolabah*; Tall shrubs: *A. farnesiana, A. tetragonophylla*; Low shrubs: *Rhagodia eremaea, Ptilotus obovatus*; Perennial grasses: *Chysopogon fallax, Eragrostis setifolia, Eulalia fulva, Cenchrus ciliaris.*	Pasture type: *Tussock Grass.* Desirable perennials include: *Chrysopogon fallax.* Pastoral use limitations: Susceptibility to seasonal inundation, otherwise none under controlled stocking.
	Unit 5 Gilgaied plains (5%) 1 site inventory and traversed	
Gently sloping (< 0.5%) plains with weakly gilgaied surfaces. Soils are reddish-brown heavy clay, > 1m deep, with calcrete inclusions, pH 8.0 with a neutral trend; principal profile form: Uf 6.21.	Scattered tall shrublands dominated by *Acacia victoriae, Maireana aphylla* and *Eragrostis xerophila.* Trees and tall shrubs (2-4 m): *A. victoriae, A. cuspidifolia*; Low shrubs (< 1.5 m): *Maireana aphylla, Ptilotus obovatus, Rhagodia eremaea, Cassia desolata*; Perennial grasses: *Eragrostis xerophila, E. setifolia, Astrebla elymoides.*	Pasture type: *Tussock Grass.* Desirable perennials include: Perennial grasses, *Maireana aphylla.* Undesirable perennials include: *Acacia victoriae, A. cuspidifolia.* Pastoral use limitations: None under controlled stocking.
	Unit 6 Major channels and banks (5%) Traversed	
Watercourses, frequently incised, mostly < 50 m wide with bedloads of sand and gravel, flanked by levees.	Fringing communities dominated by *Eucalyptus* sp. and *Melaleuca* sp. over tussock grasses *Chrysopogon fallax* and *Cenchrus ciliaris.*	Pasture type: *Tussock Grass.* Pastoral use limitations: Susceptible to accelerated water erosion when degraded.

Bidgemia Land System (G) 136 km² (0.2% of survey area)

Tributary drainage plains partly overlain by broad low dunes and sandy banks supporting degraded tall shrublands of various acacias.

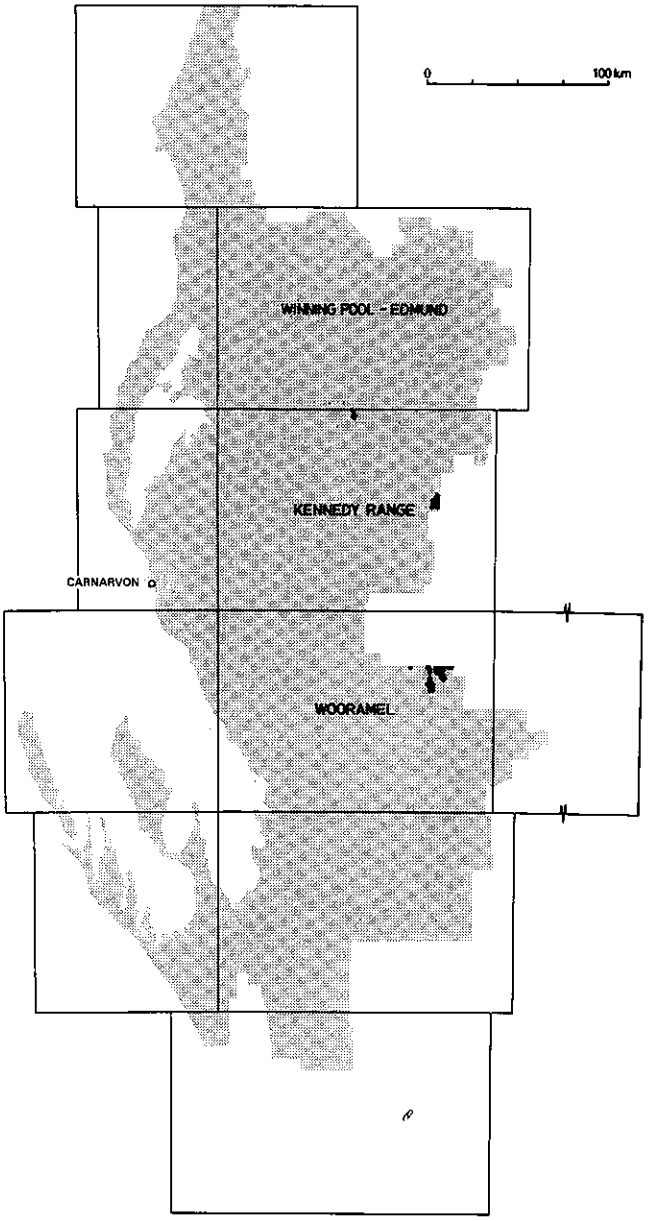
Geology: Pleistocene dune and playa deposits of clay, silt, sand and gravel.

Geomorphology: Depositional plains of low relief situated as tributary drainage areas fringing Permian hills and footslopes; aeolian deposits have developed as longitudinal dunes and sandy banks arranged parallel to the direction of sheet drainage along the interdunal corridors; drainage internal.

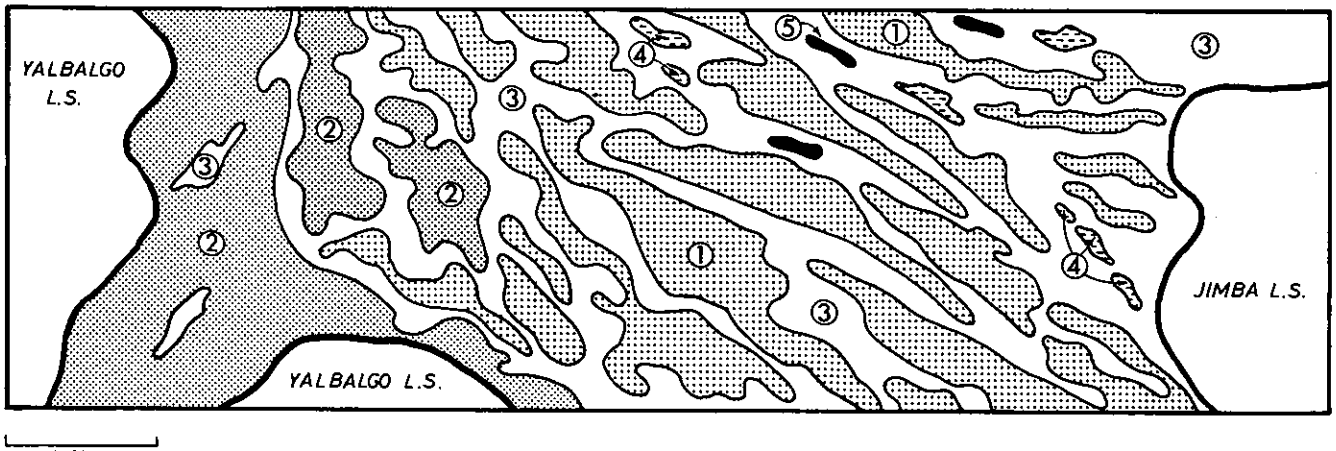
Pastoral use: Productive Acacia Sandplain (ACSA), Currant Bush Mixed Shrub (CBMS) and Saltbush (SALT) pastures, the latter two types now widely degraded by over-use. Unit 3 is highly susceptible to erosion when perennial cover is reduced. Inedible shrub species tend to invade scalded sites.

Estimated carrying capacity, good condition: 8 ha/s.u.

Range condition summary: Good 0%; fair 27%; poor 73%.



Unit
1. Longitudinal dunes
2. Sandy banks
3. Interdunal plains
4. Claypans
5. Drainage foci



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal dunes (35%) 1 site inventory and traversed	
Broad low linear dunes, relief < 5m. Soils are red sands, > 1m deep, pH 6.5 with a neutral trend, principal profile form: Uc 1.23.	Scattered to moderately close tall shrublands dominated by *Acacia sclerosperma, A. ramulosa* and *Eremophila maitlandii*. Tall shrubs (2-4 m): *A. sclerosperma, A. ramulosa A. tetragonophylla, Eremophila maitlandii*; Low shrubs (< 2m): *Olearia axillaris, Mirbelia viminalis, Scaevola tomentosa, Rhagodia eremaea, Solaum lasiophyllum, Corchorus walcottii*; Perennial grasses: *Triodna* spp, *Eriachne helmsii*.	Pasture type: *Acacia Sandplain* with some hard spinifex *Triodia* spp N of Gascoyne R. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Rhagodia eremaea*. Undesirable perennials include: *Olearia axillaris, Eriachne helmsii*. Pastoral use limitations: none under controlled stocking.
	Unit 2 Sandy banks (30%) 1 site inventory and traversed	
Broad banks up to 2 m above unit 3. Soils are dark red loamy sands, > 1 m deep, pH 6.5 with an acid trend; principal profile form: Uc 5.21.	Moderately close tall shrublands dominated by *Acacia sclerosperma* and *A. ramulosa*. Tall shrubs (2-4 m): *A. sclerosperma, A. ramulosa, Eremophila maitlandii, A. tetragonophylla, A. xiphophylla*; Low shrubs (< 2m): *Rhagodia eremaea, Cassia helmsii, Solanum lasiophyllum, Ptilotus obovatus, Acacia victoriae, Eremophila leucophylla*; Perennial grasses: *Eriachne helmsii*.	Pasture type: *Acacia Sandplain*. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila latrobei, Maireana planifolia, Scaevola spinescens*. Undesirable perennials include: *Eremophila maitlandii, Cassia helmsii*. Pastoral use limitations: Slight susceptibility to water erosion.
	Unit 3 Interdunal plains (30%) 1 site inventory and traversed	
Flat interdunal corridors, slopes < 0.5%, subject to broad sheet flow. Soils are lightly to densely strewn with quartz gravels, red duplex types, sands over fine clays (unless subsoil clays have been exposed after loss of A horizon) > 1m deep, pH 6.5 with a neutral trend and siliceous gravel inclusions; principal profile forms: Dr 1.12, Uf 6.12 derived from former by surface stripping.	Very scattered tall shrublands dominated by *Acacia cuspidifolia*. Tall shrubs (2-4m): *A. cuspidifolia, A. victoriae, Scaevola spinescens*; Low shrubs (< 1m): *Ptilotus polakii, Cassia helmsii, Hakea preissii, Eremophila pterocarpa*; Perennial grasses *Cenchrus ciliaris*.	Pasture type: *Currant Bush Mixed Shrub*. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Ptilotus polakii*; in the Gascoyne catchment, sites sandy in good condition support *Maireana polypterygia, M. georgei* and *M. planifolia* (Wilcox *et al.* 1972). Undesirable perennials include: *Acacia victoriae, Eremophila pterocarpa, Hakea preissii*. Pastoral use limitations: Highly susceptible to water erosion (gullying, stripping and scalding) when degraded, no sites remaining in good condition were found in the survey area.
	Unit 4 Claypans (3%) Traversed	
Irregularly shaped flat pans with clay soils.	No permanent vegetation.	
	Unit 5 Drainage foci (2%) Traversed	
Flat-surfaced depressions with loamy or clayey soils.	Tall shrublands with perennial grasses, particularly *Eriachne flaccida*.	Pasture type: *Tussock Grass*.

Billy Land System 328 km² (0.4% of survey area)

Low plateaux, mesas and buttes with stony footslopes and narrow drainage floors, supporting scattered tall shrublands of mulga and other acacias.

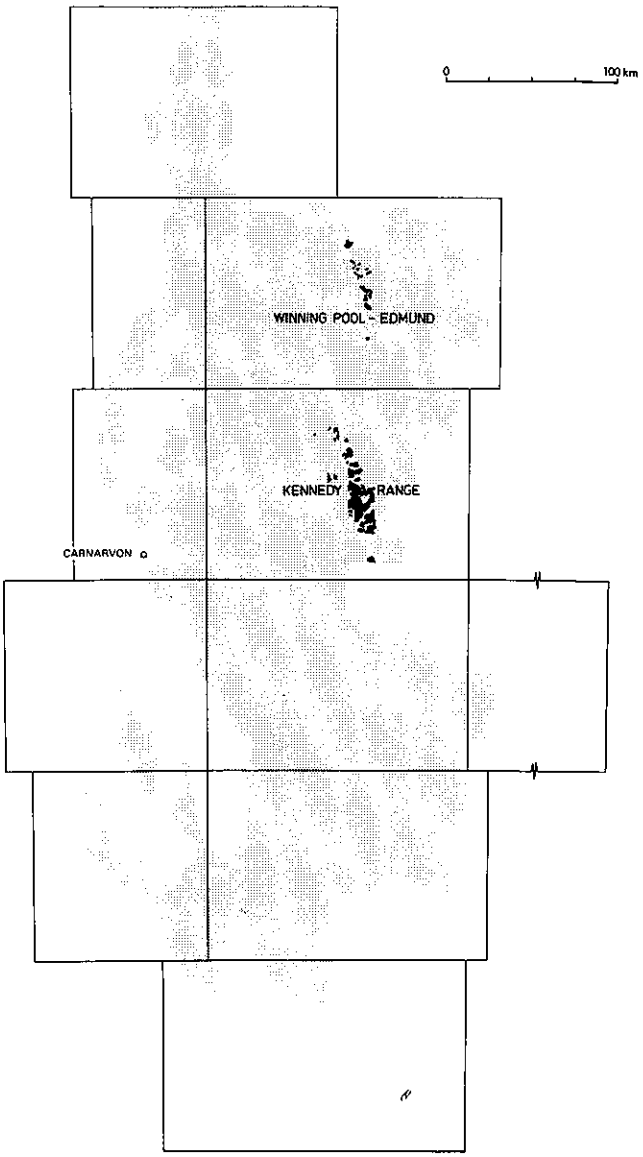
Geology: Residual Tertiary ferruginous and siliceous duricrust over Early Cretaceous Windalia Radiolarite.

Geomorphology: Erosional surfaces: flat-topped residual plateaux, mesas and buttes capped with Tertiary 'billy', flanked by short, steep upper slopes and gentler lower slopes based on Cretaceous sediments; radial to dendritic drainage of low to moderate density flowing through narrow floors of colluvial and alluvial sediments; relief up to 60 m.

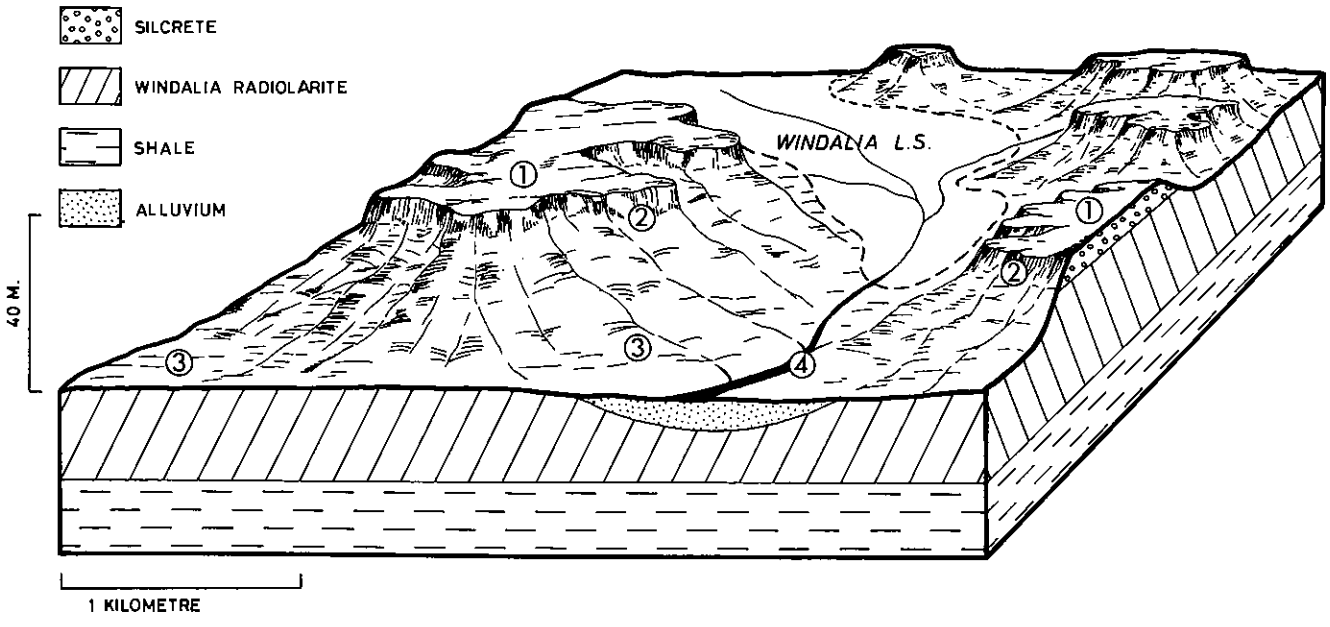
Pastoral use: Stony Short Grass Forb (SSGF) pastures, wholly accessible to stock in most instances. The footslopes support sparse palatable shrubs when in good condition, providing some useful dry season browse, but overall pastoral value is very low. The system is not susceptible to accelerated erosion.

Estimated carrying capacity, good condition: 23 ha/s.u.

Range condition summary: Good 53%; fair 47%; poor 0%.



Unit
1. Plateaux, mesas and buttes
2. Upper footslopes
3. Lower footslopes
4. Drainage floors



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Flat to undulating residual plateaux, mesas and buttes, lightly to heavily strewn with conglomerates, and low hills with slightly rounded tops; relief mainly 30-50m above lower units. Soils are shallow loams (or skeletal loams), fine sandy loam to light sandy clay, < 50 cm deep, pH 6.0 with a neutral trend; principal profile form: Uc 5.21.	**Unit 1 Plateaux, mesas and buttes (50%) 2 site inventories and traversed** Very scattered to scattered low to tall shrublands dominated by *Acacia aneura* or *A. tetragonophylla*. Trees and shrubs (2-4 m): *A. aneura, A. tetragonophylla, A. pruinocarpa*; Low shrubs (< 1m): *Eremophila fraseri, Solanum lasiophyllum, Cassia helmsii, C. luerssenii, Eremophila cuneifolia, E. latrobei, Ptilotus obovatus, Maireana planifolia.*	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Indicators of good condition: *Maireana* spp, *Eremophila latrobei.* Pastoral use limitations: None under controlled stocking.
Steep, rocky upper slopes up to 30 m above shallower, convex lower footslopes (slopes mainly 10-30%), heavily strewn with radiolarite cobbles and pebbles, carrying radial drainage lines of low intensity. Soils are red sandy loam or loamy sand, pH 6.0 with a neutral trend, < 50 cm deep, with radiolarite inclusions throughout, principal profile form: Uc 1.43.	**Unit 2 Upper footslopes (10%)** **Unit 3 Lower footslopes (30%) 2 site inventories and traversed** Very scattered low to tall shrublands dominated by *Acacia* spp. Tall Shrubs (200-750/ha; 2-3 m): *Acacia xiphophylla, A. cuthbertsonii, A. aneura, A. tetragonophylla, A. victoriae, Hakea preissii*; Low shrubs (1800-4000/ha; < 1 m): *Ptilotus polakii, Dipteracanthus corynothecus Cassia desolata, Frankenia* sp., *Rhagodia eremaea, Solanum lasiophyllum.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Phyllanthus* sp. nov. (R.C. 1928), *Ptilotus polakii, Dipteracanthus corynothecus* Pastoral use limitations: None under controlled stocking.
Flat to gently sloping floors, usually strewn with a conglomerate or radiolarite mantle and carrying incised drainage channels and stream beds. Soils are dusky red loamy types, 75 cm deep, sandy loam grading to light sandy clay loam, pH 6.5 with a neutral trend; principal profile form: Uc 5.21.	**Unit 4 Drainage floors (10%) 1 site inventory and traversed** Scattered tall shrublands dominated by *Acacia aneura.* Trees and tall Shrusb (2 - 6 m): *Acacia aneura, Hakea lorea, Grevillea* sp., *Acacia tetragonophylla, A. pruinocarpa*; Low shrubs (< 2m): *Eremophila leucophylla, Solanum lasiophyllum, Eremophila fraseri, E. latrobei, Cassia helmsii, Ptilotus obovatus.*	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.

Birrida Land System 135 km² (0.2% of survey area)

Low-lying evaporite pans of gypsiferous sediments, supporting low shrublands of samphire and saltbush.

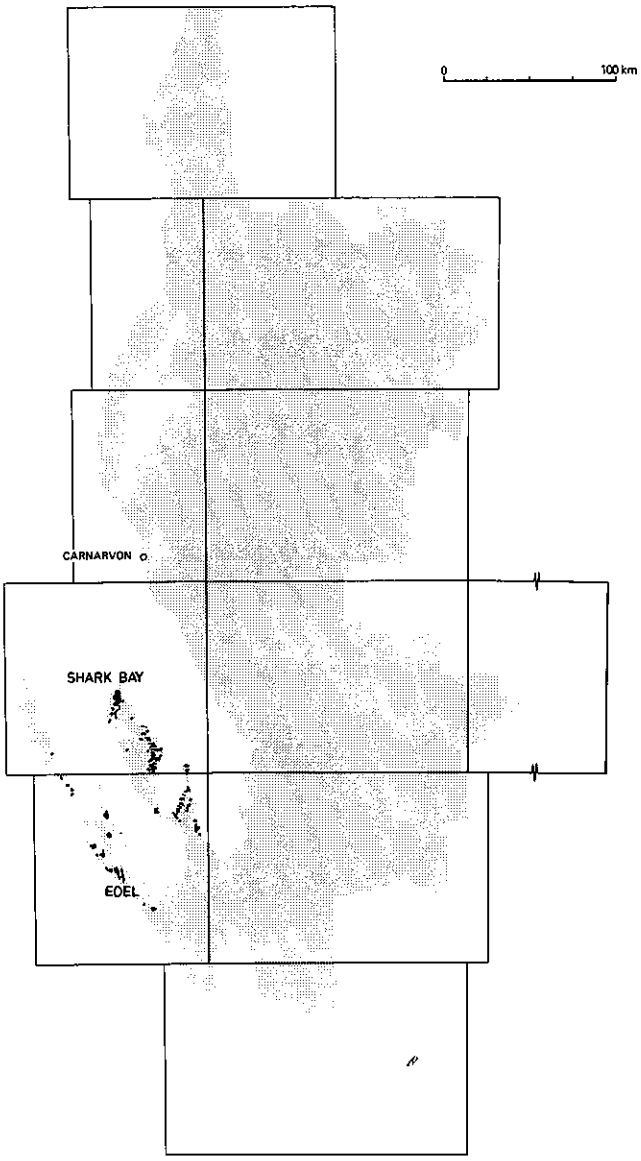
Geology: Pleistocene deposits of gypsum, clay, silt and sand.

Geomorphology: Discrete areas of nearly flat plains with raised centres, often elliptical and occupying wide interdunal depressions ; some receive influxes of seawater along channels connecting with the ocean but most show no surface drainage features beyond peripheral moat-like seepages.

Pastoral use: Samphire (SAMP) and Saltbush (SALT) pastures of little grazing value unless good quality stock water is available nearby. Unit 1 is the most productive. There is no significant erosion risk.

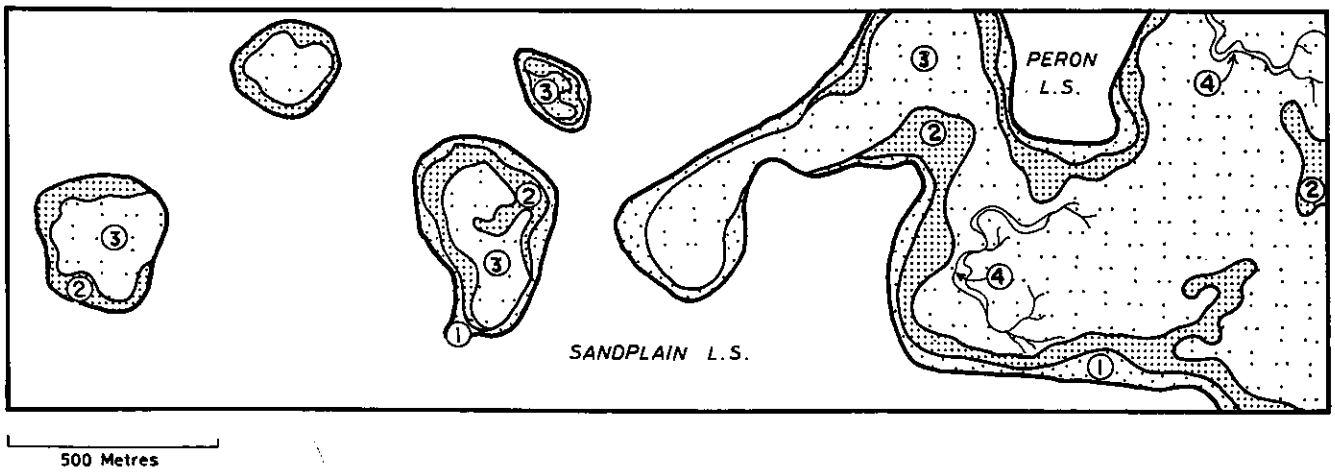
Estimated carrying capacity, good condition: 16 ha/s.u.

Range condition summary: Good 86%; fair 9%; poor 5%.



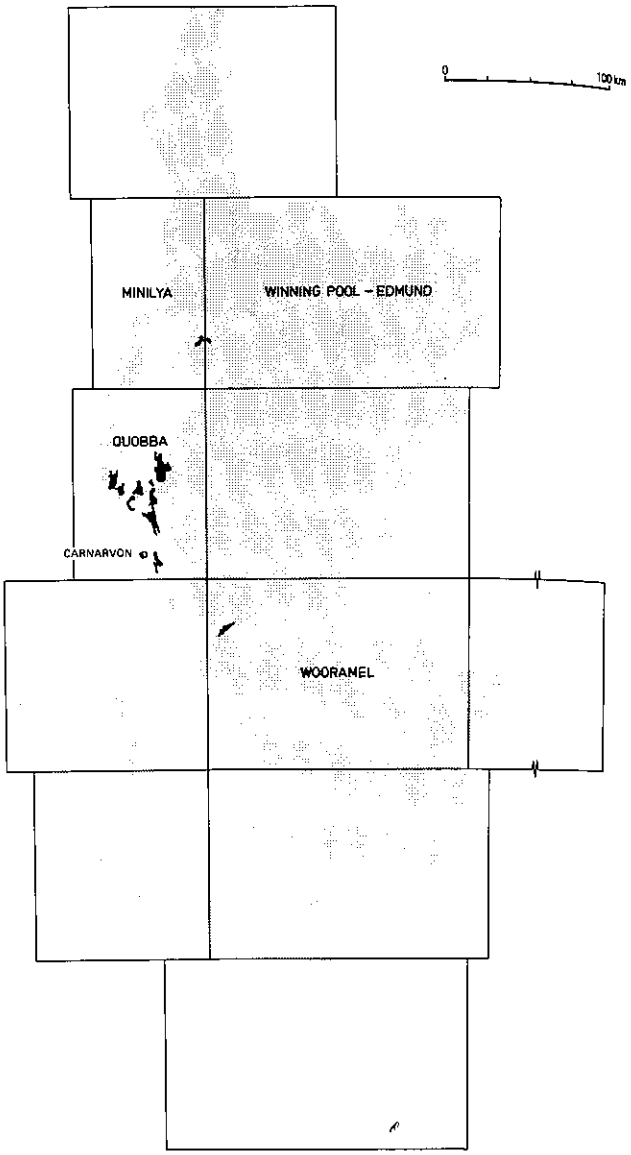
Unit

1. Sandy fringing plains
2. Gypsiferous banks and low dunes
3. Samphire plains
4. Inflow channels and depressions



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Sandy fringing plains (5%) 1 site inventory and traversed	
Gently sloping marginal zones, usually < 200 m wide, with flat to moundy surfaces. Soils are juvenile types, reddish-brown sands over clays and sands, calcareous throughout, mounted by calcrete gravels; pH 8.0-8.5 with alkaline trend.	Scattered or very scattered low shrublands dominated by halophytes. Low shrubs (< 0.5 m): *Frankenia* spp, *Atriplex bunburyana*, *Muellerolimon salicorniaceum*, *Maireana tomentosa*, *Rhagodia latifolia*, *Threlkeldia* spp; Perennial grasses: *Aristida browniana*, *Stipa* sp., *Eragrostis dielsii*, *Cenchrus ciliaris*, *Sporobolus mitchellii*.	Pasture type: *Saltbush*. Desirable perennials include: *Atriplex bunburyana*, *Maireana tomentosa*, perennial grasses. *C. ciliaris* occurs mainly on Faure I.
	Unit 2 Gypsiferous banks and low dunes (10%) 1 site inventory and traversed	
Moundy rises, up to 3 m above major unit (3), occurring as banks or dune-like accretions. Soils are juvenile types, generally thin layers of reddish-brown sand over gypsiferous deposits; pH 9.0 with an alkaline trend.	Scattered low shrublands dominated by *Scaevola crassifolia*. Low shrubs (< 1 m): *S. crassifolia*, *Acacia rostellifera*, *Lawrencia* sp., *Halosarcia* spp, *Carpobrotus* sp.	Pasture type: *Samphire*. Pastoral use limitations: High salinity levels in pasture shrubs.
	Unit 3 Samphire plains (85%) 3 site inventories and traversed	
Virtually flat plains; soils are gypsiferous deposits or juvenile types, sandy clays overlying sands, mostly red or reddish-yellow, > 1 m deep, calcareous throughout, pH 8.0 with an alkaline trend.	Scattered or very scattered low shrublands dominated by very low halophytes. Low shrubs (< 0.5 m): *Halosarcia pruinosa*, *H. pterygosperma*, *Muellerolimon salicorniaceum*, *Frankenia* spp, *Atriplex vesicaria*, *Maireana tomentosa*. Perennial grasses: *Cenchrus ciliaris*.	Pasture type: *Samphire*. Desirable perennials include: *Maireana tomentosa*, *Atriplex vesicaria*. Perennials augmented by *Cenchrus ciliaris* and *Ptilotus obovatus* on Faure I. Pastoral use limitations: High salinity levels in pasture shrubs.
	Unit 4 Inflow channels and depressions (< 1%) Traversed	
Saline channels through gypsiferous deposits.	Very scattered shrublands dominated by *Halosarcia* spp, with or without mangroves *Avicennia marina*.	

Brown Land System 429 km² (0.6% of survey area)



Sandy plains with sparse longitudinal dunes, supporting tall shrublands of acacias.

Geology: Quaternary aeolian quartz sand and beach ridges, locally calcareous; minor Quaternary alluvium.

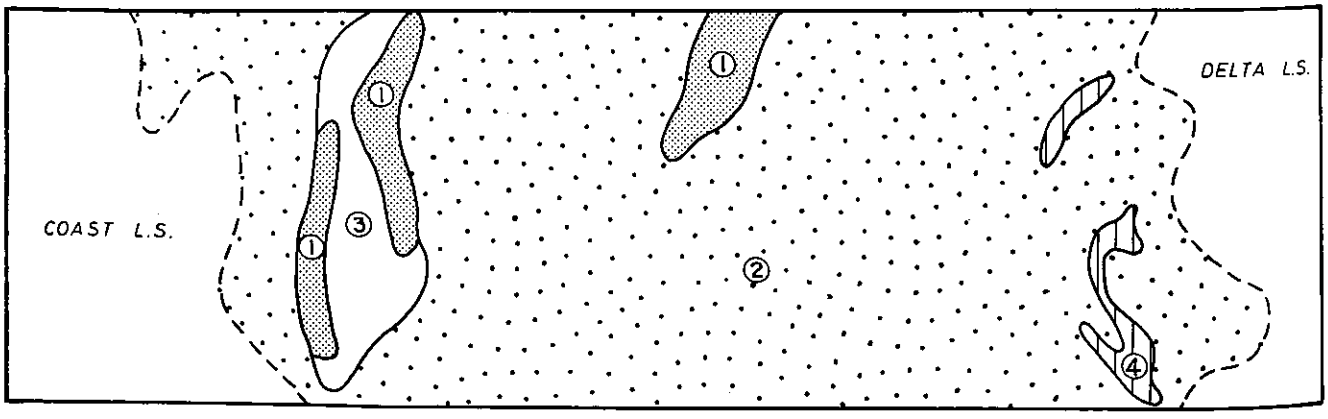
Geomorphology: Depositional surfaces: flat to gently undulating sandplains with longitudinal dunes and swales; minor areas of alluvial plains; no drainage features.

Pastoral use: Acacia Sandplain (ACSA) pastures with a good range of edible browse shrubs (when in good condition) plus minor areas of highly productive Tussock Grass (TUGR), Saltbush (SALT) and Bluebush (BLUE) pastures; system not normally susceptible to erosion except on unit 4.

Estimated carrying capacity, good condition: 10 ha/s.u.

Range condition summary: Good 54%; fair 38%; poor 8%.

Unit
1. Longitudinal dunes
2. Sandy plains
3. Swales
4. Alluvial plains



1 KILOMETRE

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal dunes (5%) Traversed	
Linear dunes, mostly single and orientated N-S, up to 15 m relief. Soils are red sands, principal profile form: probably Uc 1.23.	Scattered to moderately close tall shrublands dominated by *Acacia* spp. Tall shrubs (> 2 m): *A. ramuolosa, A. sclerosperma, A. coriacea*; Low Shrubs (< 2 m): *Rhagodia* spp, *Eremophila maitlandii, E. leucophylla*; Perennial grasses: *Cenchrus ciliaris.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Rhagodia* spp. *C. cilaris* cover tends to replace low shrub cover on degraded sites. Pastoral use limitations: None under controlled stocking.
	Unit 2 Sandy plains (90%) 5 site inventories and traversed	
Sandy plains, often with moundy surfaces, locally lightly strewn with limestone gravel, slopes < 0.5%. Soils are yellowish red to dark red sands with clay content increasing with depth, > 1 m deep, some with inclusions of limestone and shells, pH 6.0-8.5 with an alkaline trend; principal profile forms: Uc 1.12, 1.23, 5.11, Gn 2.12.	Scattered to close tall shrublands (PFC 15 to 40%) dominated by *Acacia tetragonophylla, A. ramulosa* and *A. sclerosperma.* Tall shrubs (150-600/ha; 2-3 m): *A. tetragonophylla, A. ramulosa, A. sclerosperma, Eremophila maitlandii, Stylobasium spathulatum, Heterodendrum oleaefolium*; Low shrubs (1,000-8,000/ha; < 2 m): *Ptilotus obovatus, Solanum lasiophyllum, Atriplex bunburyana, Eremophila leucophylla, Rhagodia eremaea, Scaevola spinescens*; Perennial grasses: *Eragrostis lanipes.*	Pasture type: *Acacia Sandplain* (locally *Saltbush*). Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana tomentosa, Atriplex bunburyana, Scaevola spinescens.* Undesirable perennials include: *Acacia victoriae, Hakea preissii.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Swales (4%) Traversed	
Sandy swales between linear dune.	Tall shrublands similar to those on unit 1 but frequently with a larger component of chenopod shrubs such as *Atriplex bunburyana* and *Maireana polypterygia.*	Pasture type: *Acacia Sandplain/Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 4 Alluvial plains (2%) 1 site inventory and traversed	
Restricted plains with flat surfaces. Soils are reddish-brown duplex, sand over sandy clay sometimes overlain by recent alluvium, > 1 m deep, pH 7.5 with an alkaline trend; principal profile form: Dy 1.12.	Scattered to moderately close tall shrublands dominated by *Acacia tetragonophylla.* Tall shrubs (2-3 m): *A. tetragonophylla, A. sclerosperma, Eremophila youngii*; Low shrubs (< 2 m): *Ptilotus obovatus, Maireana polypterygia, Scaevola spinescens, Acacia victoriae, Rhagodia eremaea, Cassia desolata, Atriplex bunburyana*; Perennial Grasses: *Eragrostis xerophila.*	Pasture type: *Saltbush* or *Bluebush.* Desirable perennials include: *Atriplex bunburyana, Maireana polypterygia, Scaevola spinescens, Eragrostis xerophila.* Undesirable perennials include: *Eremophila youngii, Acacia victoriae.* Pastoral use limitations: Slighlty susceptible to water erosion when degraded.

Cahill Land System 389 km² (0.5% of survey area)

Sandy alluvial plains and channelled flow zones with tall shrublands of various acacias.

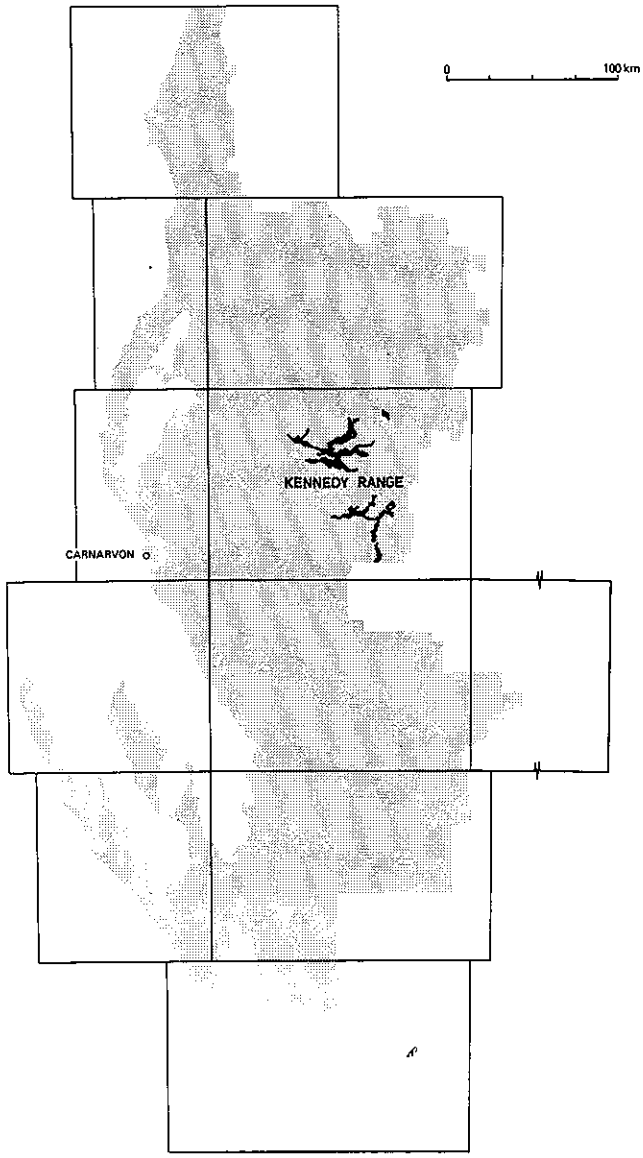
Geology: Quaternary alluvium : clay, silt, sand and gravel.

Geomorphology: Sandy depositional plains of low relief with moundy surfaces and minor low-lying plains with duplex soils flanking broad, sandy channels.

Pastoral use: Predominantly Acacia Sandplain (ACSA) pastures with moderate densities of edible shrubs and some perennial grasses when in good condition ; units 2 and 4 are susceptible to erosion (mainly by water) when degraded.

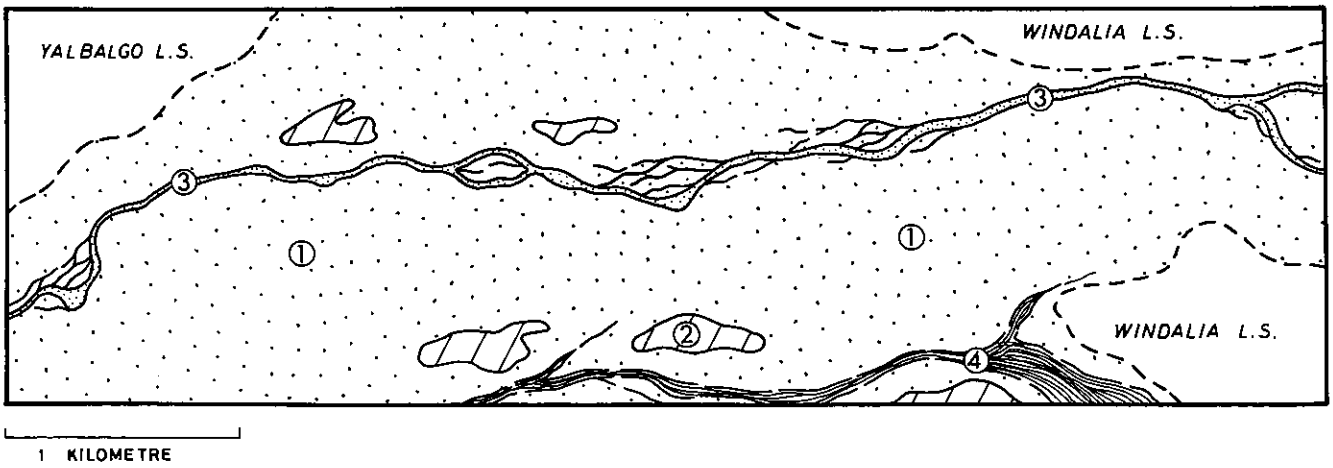
Estimated carrying capacity, good condition: 6 ha/s.u.

Range condition summary: Good 45%; fair 45%; poor 10%.



Unit

1. Broad sandy plains
2. Restricted plains
3. Channelled flow zones
4. Narrow unchannelled drainage zones



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Broad sandy plains (85%) 7 site inventories and traversed	
Plains of low relief (< 3m) with mounded surfaces, often very lightly strewn with radiolarite gravels. Soils are red or dark red sand or loamy sand, > 1m deep, with or without gravel inclusions, pH 6.5-7.5; principal profile form: Uc 5.11 5.21, 1.23.	Very scattered to moderately close tall shrublands dominated by *Acacia* spp, with many understorey shrubs and some perennial grasses. Tress (0.25/ha; 4-8 m): *Eucalyptus coolabah, Acacia pruinocarpa*; Tall shrubs (50-700/ha; 2-4 m): *A. sclerosperma, A. subtessarogona, A. aneura, A. victoriae, Hakea preissii, Stylobasium spathulatum*; Low shrubs (200-2500/ha; < 2m): *Eremophila leucophylla, Solanum lasiophyllum, Rhagodia* spp, *Sida rohlenae, Enchylaena tomentosa, Ptilotus obovatus*; Perennial grasses: *Cenchrus ciliaris, Eriachne eriopoda, Eragrostis* spp, *Monachather paradoxa.*	Pasture type: *Acacia Sandplain* or *Tussock Grass.* Perennials augmented by annual grasses and forbs in favourable seasons. Indicators of good condition: *Eremophila leucophylla, Enchylaena tomentosa,* perennial grasses. Indicators of porr condition: *Hakea preissii, Stylobasium spathulatum.* Pastoral use limitations: none under controlled stocking.
	Unit 2 Restricted plains (5%) Traversed	
Narrow, flat plains, surrounded by unit 1, with red duplex or gradational soils.	Scattered tall shrublands dominated by *Acacia tetragonophylla,* A. *xiphophylla,* A. *aneura,* or *Eremophila pterocarpa.*	Pasture type: *Acacia Short Grass Forb.* The associations observed on this unit have probably replaced degraded *Acacia xiphophylla - Atriplex bunburyana* communities in some instances. Pastoral use limitations: Mild susceptibility to erosion by wind and water.
	Unit 3 Channelled flow zones (5%) 1 site inventory and traversed	
Channels and flow lines with sandy bedloads and surface gravels. Soils are dark red loamy sands > 1m deep, pH 6.0 with an acid trend; principal profile form: Uc 5.11.	Open woodland fringing communities dominated by *Eucalyptus coolabah, Acacia aneura* and A. *citrinoviridis.* Trees (4-10m): *E. coolabah, A. aneura*; Tall shrubs (4-8m): *A. citrinoviridis, A. sclerosperma, A. ramulosa, Cassia chatelainiana*; Low shrubs (< 2m): *Ptilotus obovatus, Cassia helmsii, Rhagodia* spp, *Enchylaena tomentosa, Solanum lasiophyllum, Indigofera* spp.	Pasture type: *Acacia Creek-line.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Cassia chatelainiana, Enchylaena tomentosa.* Pastoral use limitations: None under controlled stocking.
	Unit 4 Narrow unchannelled drainage zones (5%) 1 site inventory and traversed	
Unchannelled zones within unit 1 carrying sluggish local drainage as sheet flow. Soils are shallow red sands over Windalia Radiolarite, pH 6.5 with a neutral trend; principal profile form : Uc 5.13.	Moderately close tall shrublands dominated by *Acacia subtessarogona.* Tall shrubs (2-8 m): *A. subtessarogona, A. sclerosperma, A. victoriae, A. tetragonophylla, A. aneura*; Low shrubs (< 1m): *Sida* spp, *Eremophila leucophylla*; Perennial grasses: *Cenchrus ciliaris.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Slight susceptibility to water erosion.

Capricorn Land System (A) 366 km² (0.5% of survey area)

Rugged sandstone hills, ridges, stony footslopes and interfluves supporting predominantly hard spinifex hummock grasslands with scattered shrubs.

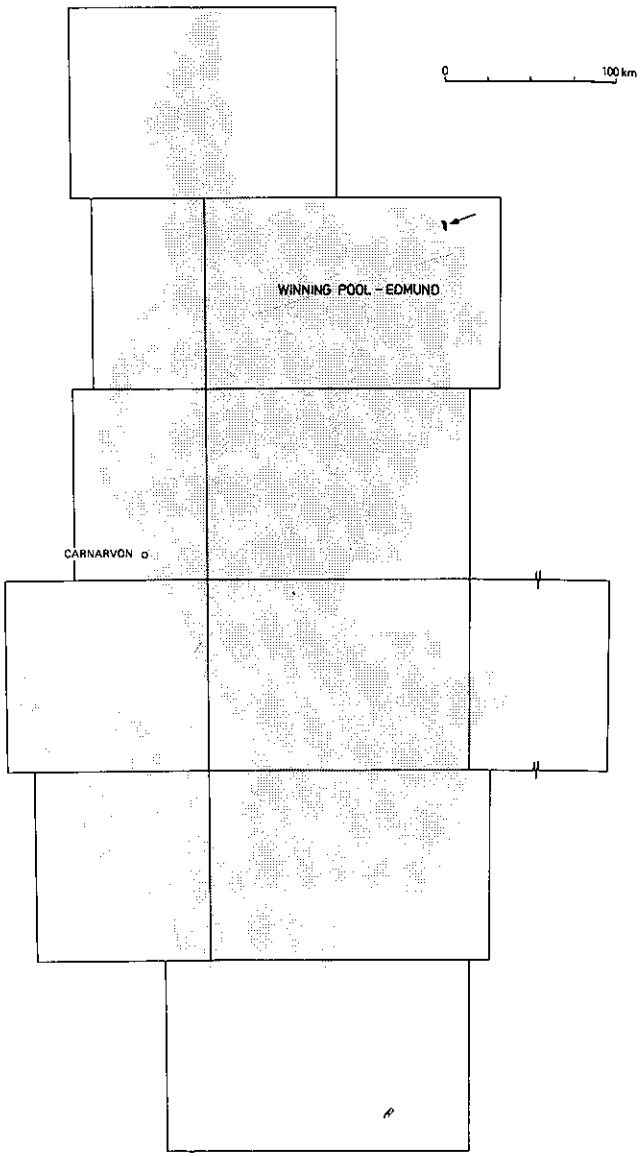
Geology: Lower Proterozoic sandstone, greywacke, dolomite and shale.

Geomorphology: Erosional surfaces: ranges and hills with steep, rocky upper slopes, gently sloping stony footslopes, restricted lower plains and valleys, angular and rectangular drainage patterns of moderate to high density; relief up to 150 m.

Pastoral use: Unproductive Hard Spinifex (HASP) pastures with areas of Stony Short Grass Forb (SSGF) pastures of some value for seasonal use but little drought durability; higher units are frequently inaccessible to stock.

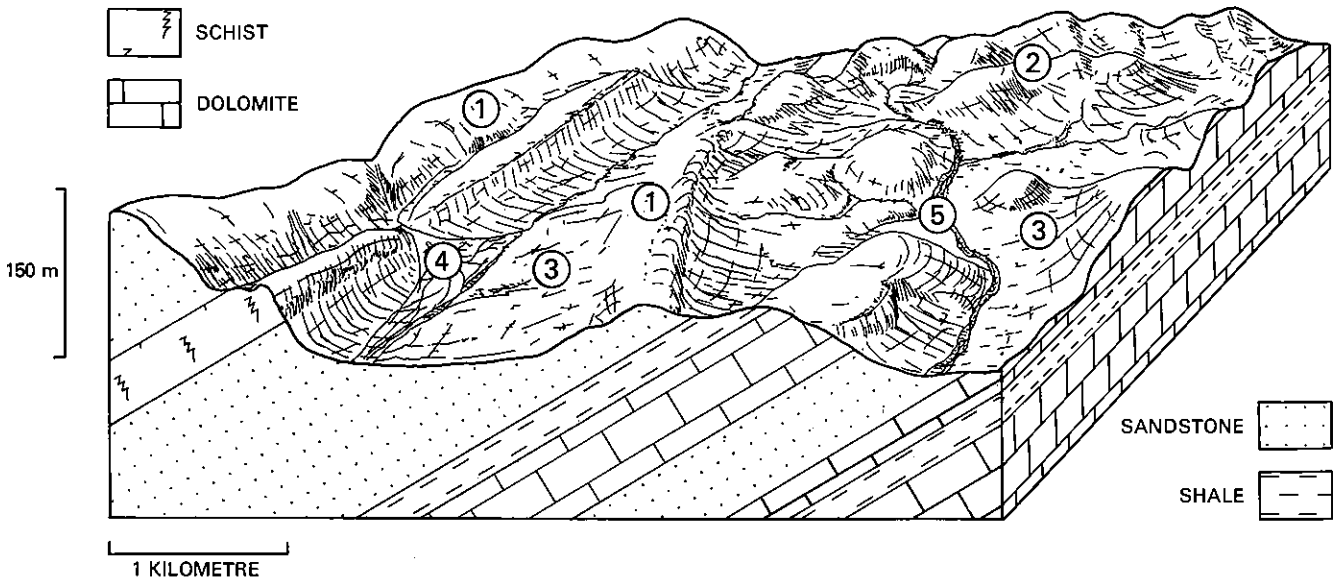
Estimated carrying capacity, good condition: 27 ha/s.u.

Range condition summary: No data but probably mostly good condition.



Unit

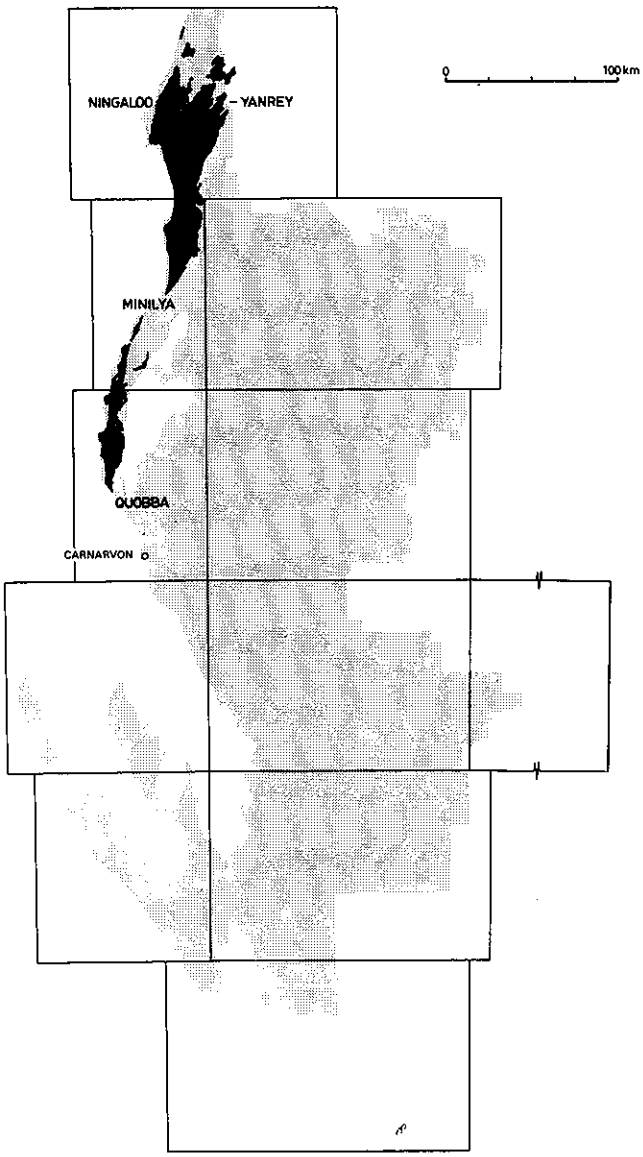
1. Ridges and hills
2. Dolomitic rises
3. Slopes and interfluves
4. Alluvial fans
5. Drainage floors



[ex Payne *et al.* 1982]

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Ridges and hills with rocky summits, up to 150 m above unit 5, mostly densely mantled with rock fragments. There is generally no soil development.	**Unit 1 Ridges and hills (35%) Traversed** Hummock grasslands dominated by *Triodia wiseana* with very scattered low shrubs.	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Inaccessibility to stock.
Rocky rises with benched, convex or concave upper slopes (up to 50% slope), densely mantled by (or outcropping) dolomite, up to 50 m above unit 3. Soils are limited to pockets of skeletal loams: principal profile form (probably) Um 5.21.	**Unit 2 Dolomitic Rises (35%) Traversed** Hummock grasslands dominated by *Triodia wiseana* with very scattered low shrubs.	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Local inaccessibility to stock.
Lower slopes and stony interfluves, most slopes < 3%, locally steeper where incised by drainage channels to 3 m, densely mantled with rock fragments, Soils are shallow red loams, principal profile forms (probably) Um 5.12, 5.21, 5.52.	**Unit 3 Slopes and intrfluvesS (25%) Traversed** Very scattered to scattered tall shrublands dominated by *Acacia* spp, with some low shrubs, mainly *Cassia* spp. Pastoral use limitations: None under	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourabe seasons. controlled stocking.
Small fans up to 1 km long, slopes < 2%. Soils are gravelly to pebbly sands and loams, principal profile form: Uc 1.23.	**Unit 4 Alluvial fans (1%) Traversed** Tall shrublands dominated by *Acacia aneura,* with understorey hummock grass *Triodia pungens* and low shrubs.	Pasture type: *Soft Spinifex.* Perennials augmented by numerous annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
Floors mostly < 200 m wide with single or multiple channels incised into bedrock. Soils are shallow stony to sandy bedloads.	**Unit 5 Drainage floors (4%) Traversed** Close tall shrublands dominated by *Acacia citrinoviridis* and other *Acacia* spp, with understorey low shrubs.	Pasture type: *Acacia Creek-line.* Perennials augmented by numerous annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.

Cardabia Land System 3095 km² (4.2% of survey area)



Undulating sandy plains with linear dunes, minor limestone plains and low rises, supporting mainly soft spinifex hummock grasslands with scattered acacias and other shrubs.

Geology: Quaternary aeolian sand and calcarenite, with late Tertiary calcrete duricrusts.

Geomorphology: Mainly depositional surfaces: undulating sandplains with some parabolic to linear dunes and irregular calcrete outcrops and rises; no drainage features, broad scale relief up to 70 m.

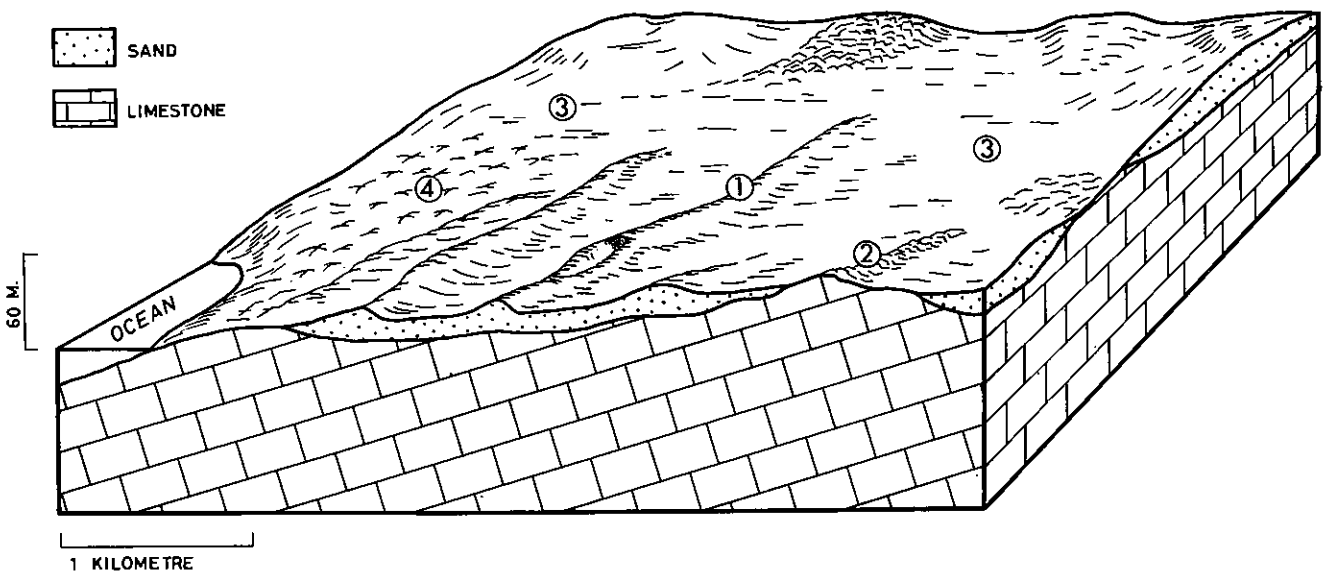
Pastoral use: Soft Spinifex (SOSP) and Hard Spinifex (HASP) pastures augmented by a range of useful drought-resistant shrubs, together conferring relatively high productivity to this major system. In some areas, Soft Spinifex pastures are being progressively replaced by Hard Spinifex and/or buffel grass. More appropriate management, including optimal use of fire, should improve degraded sites; unit 1 is highly susceptible to wind erosion when denuded of adequate cover.

Estimated carrying capacity, good condition: 7 ha/s.u.

Range condition summary: Good 87%; fair 12%; poor 1%.

Unit

1. Longitudinal dunes
2. Sandy plains
3. Stony rises
4. Calcrete plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal dunes (10%) 2 site inventories and traversed	
Longitudinal dunes, linear to reticulate, mainly 10-15 m above Unit 3. Soils are red to dark red sands, loamy sand or non-coherent sand, > 1 m deep, with or without carbonate concentrations, pH 7.0-8.0 with a neutral trend; principal profile forms: Uc 1.13, 2.13.	(i) Hummock grasslands with scattered shrubs e.g. *Petalostylis labicheoides* over *Triodia pungens* and *Plectrachne schinzii*, or (ii) moderately close to close tall shrublands dominated by *Acacia ramulosa* with understorey hummock grasses. Trees and tall shrubs (< 25-900/ha; 2-3 m): *A. ramulosa, A. coriacea, Gyrostemon ramulosus, Eremophila maitlandii, Stylobasium spathulatum, Acacia sclerosperma*; Low shrubs: (100-900/ha; < 1.5 m): *Petalostylis labicheoides, Acacia spathulifolia, Calytrix* spp, *Pityrodia* spp, *Rhagodia eremaea, Cassia chatelainiana*; Perennial grasses: *Triodia pungens, Plectrachne schinzii, Triodia basedowii, Cenchrus ciliaris.*	Pasture type: *Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Triodia pungens, Rhagodia eremaea.* Degraded areas are often invaded by *Cenchrus ciliaris.* Pastoral use limitations: High susceptibility to wind erosion when degraded.
	Unit 2 Sandy plains (75%) 8 site inventories and traversed	
Undulating sandy plains with rounded surfaces and slopes < 4%. Soils are red to brown sands, non-coherent sands to loamy sand, calcareous throughout or non-calcareous, with paler subsoils, usually > 1 m deep, pH 8.0-8.5 with an alkaline trend; principal profile forms: Uc 1.11, 1.12, 5.11, 5.12, 5.21, 5.22, 1.23.	Very variable; very scattered to scattered shrub-hummock grassland associations dominated by *Triodia* spp. Tall shrubs (0-750/ha; 2-3m): *Acacia tetragonophylla, A. sclerosperma, Exocarpos aphyllus*; Low shrubs (2500-12000/ha; < 1.5 m): *Ptilotus obovatus, Thryptomene baekeacea, Acacia spathulifolia, Olearia axillaris, Melaleuca* aff. *cardiophylla, Hakea stenophylla, Acanthocarpus preissii, Calytrix* spp; Perennial grasses: *Triodia pungens, T. basedowii, T.* spp.	Pasture type: *Hard Spinifex/Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Triodia pungens, Rhagodia preissii, Enchylaena tomentosa, Atriplex bunburyana, Cassia chatelainiana.* Undesirable perennials include: *Olearia axillaris*, reduced shrub cover. Pastoral use limitations: None under controlled stocking.
	Unit 3 Stony rises (5%) 3 site inventories and traversed	
Irregular limestone ridges and rises with surfaces sparsely to densely strewn with limestone pebbles and cobbles, slopes mostly < 4.5%. Soils are dark reddish-brown to reddish-yellow sands or sandy loams, calcareous throughout, shallow to full-depth, pH 8.0-8.5 with an alkaline trend; principal profile forms: Uc 5.11, 5.21, 1.43.	Hummock grasslands with very scattered low trees *Ficus platypoda* over *Triodia* spp. Trees and tall shrubs (< 25-50/ha; 2-3m): *Ficus platypoda, Heterodendrum oleaefolium, Acacia tetragonophylla*; Low shrubs (900-4000/ha; < 1m): *Thryptomene baeckeace, Ptilotus obovatus, Solanum lasiophyllum, Eremophila glabra, Enchylaena tomentosa*, Acanthocarpus *preissii*; Perennial grasses (up to 30% cover): *Triodia pungens, T. basedowii, T.* spp.	Pasture type: *Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Triodia pungens, Enchylaena tomentosa, Scaevola* spp. Pastoral use limitations: None under controlled stocking.
	Unit 4 Calcrete Plains (10%) 1 site inventory and traversed	
Small areas of undulating plains with shallow sandy soils over calcrete; occasional small stony outcrops. Soils are reddish-brown sands with paler subsoils, shallow to > 1m deep, pH 8.5 with an alkaline trend; principal profile form: Uc 5.11.	Scattered low shrublands dominated by *Thryptomene baekeacea* over hummock grasses *Triodia* spp. Low shrubs (< 1m): *Thryptomene baeckeace, Acanthocarpus preissii, Melaleuca* aff. *cardiophylla, Acacia spathulifolia, Scaevola* spp, *Indigofera* spp; Perennial grasses: *Triodia* spp, *Eriachne* aff. *obtusa.*	Pasture type: *Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Triodia pungens.* Pastoral use limitations: Slight susceptibility to wind erosion when degraded.

Carleeda Land System 215 km² (0.3% of survey area)

Undulating limestone plains and platforms with short marginal slopes to lower alluvial plains and drainage floors, supporting soft spinifex hummock grasslands with scattered acacia shrubs.

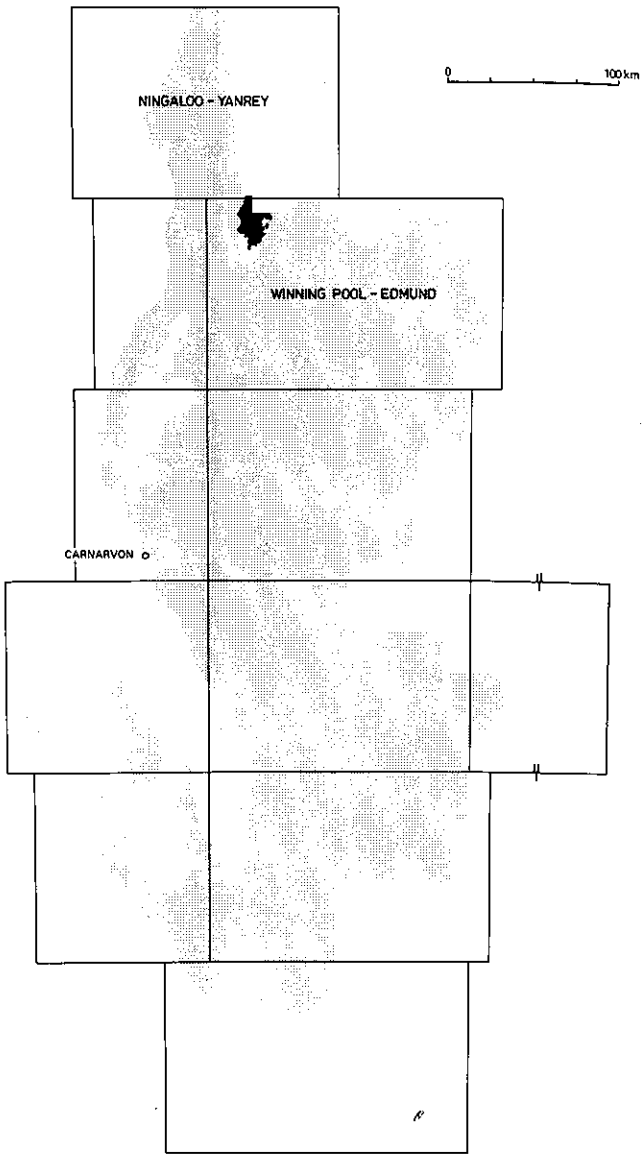
Geology: Late Tertiary calcrete duricrusts.

Geomorphology: Erosional and depositional surfaces: calcrete duricrusted flat platforms and plains raised slightly from disorganised flow zones and drainage foci, all of which drain internally; also minor fringing sandy plains and lower clay plains; broad relief up to 20 m.

Pastoral use: A highly productive land system with Soft Spinifex (SOSP) pastures and some Tussock Grass (TUGR) and Hard Spinifex (HASP) pastures. Requires periodic burning followed by a deferral of grazing to rejuvenate the spinifex and other grasses. This system is not normally susceptible to accelerated erosion.

Estimated carrying capacity, good condition: 6 ha/s.u.

Range condition summary: Good 93%; fair 0%; poor 7%.



Unit

1. Limestone platforms and plains
2. Sandy fringing plains
3. Flow zones
4. Alluvial plains
5. Drainage foci

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Limestone platforms and plains (55%) 1 site inventory and traversed	
Flat to gently sloping (< 1%) plains and slightly raised platforms with outcropping calcrete or gravel-strewn surfaces. Soils are dark reddish-brown sand, shallow to > 1 m deep, pH 8.0 with a neutral trend; principal profile form: Uc 1.23.	Very scattered to scattered low shrubland—hummock grass associations dominated by *Triodia pungens, Acacia* spp and *Scaevola tomentosa.* Tall shrubs: *Acacia bivenosa*; Low shrubs (< 1 m): *Scaevola tomentosa, Cassia oligophylla, Corchorus* spp, *Solanum lasiophyllum, Maireana planifolia;* Perennial grasses: *Triodia pungens, T. wiseana, Chrysopogan fallax, Eragrostis eripoda.*	Pasture type: *Soft Spinifex,* some *Hard Spinifex.* Perennial augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Triodia pungens, Eremophilla latrobei, Scaevola tomentosa.* Pastoral use limitations: None under controlled stocking and appropriate fire management.
	Unit 2 Sandy fringing plains (15%) Traversed	
Flat to gently sloping sandy-surfaced plains. Soils are probably dark red sands; principal profile form: Uc 5.11.	Hummock grasslands dominated by *Triodia pungens.*	Pasture type: *Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitation: None under controlled stocking and appropriate fire management.
	Unit 3 Flow zones (15%) 1 site inventory and traversed	
Narrow to fairly broad unchannelled flow zones below unit 1, draining internally. Soils are gradational calcareous types, dark reddish-brown fine sandy clay loam grading to light medium clay, > 1 m deep, pH 8.5 with neutral trend; principal profile form: Gc 2.22.	Fringing low woodlands or hummock grasslands dominated by *Eucalyptus* spp and *Triodia pungens,* often with *Chrysopogon fallax* and *Cenchrus ciliaris.* Trees: *Eucalyptus coolabah;* Tall shrubs (2-4 m): *Acacia tetragonophylla, A. victoriae, A. sclerosperma, A. bivenosa;* Low shrubs: *Cassia* spp, *Rhagodia eremaea, Ptilotus obovatus,* Perennial grasses: *Triodia pungens, Chrysopogon fallax, Cenchrus ciliaris, Eulalia fulva.*	Pasture type: *Soft Spinifex.* Desirable perennials include: *Triodia pungens, Chrysopogon fallax.* Pastoral use limitations: None under controlled stocking.
	Unit 4 Alluvial plains (10%)	
Marginal or inter-platform plains with clay soils.	Low shrublands dominated by *Cassia* spp with perennial grasses *Cenchrus ciliaris, Enneapogon polyphyllus.*	Pasture type: *Tussock Grass.* Pastoral use limitations: None under controlled stocking.
	Unit 5 Drainage foci (5%)	
Discrete drainage depressions with flat to gilgaied surfaces.	Open woodlands dominated by *Eucalyptus coolabah* with understorey perennial grasses *Triodia pungens* and *Chrysopogon fallax,* with some shrubs.	Pasture type: *Tussock Grass.* Pastoral limitations: None under controlled stocking.

Channel Land System 388 km² (0.5% of survey area)

Incised rocky streams and creek-lines with truncated marginal slopes and stony narrow fringing plains supporting scattered to very scattered shrublands of very varible composition.

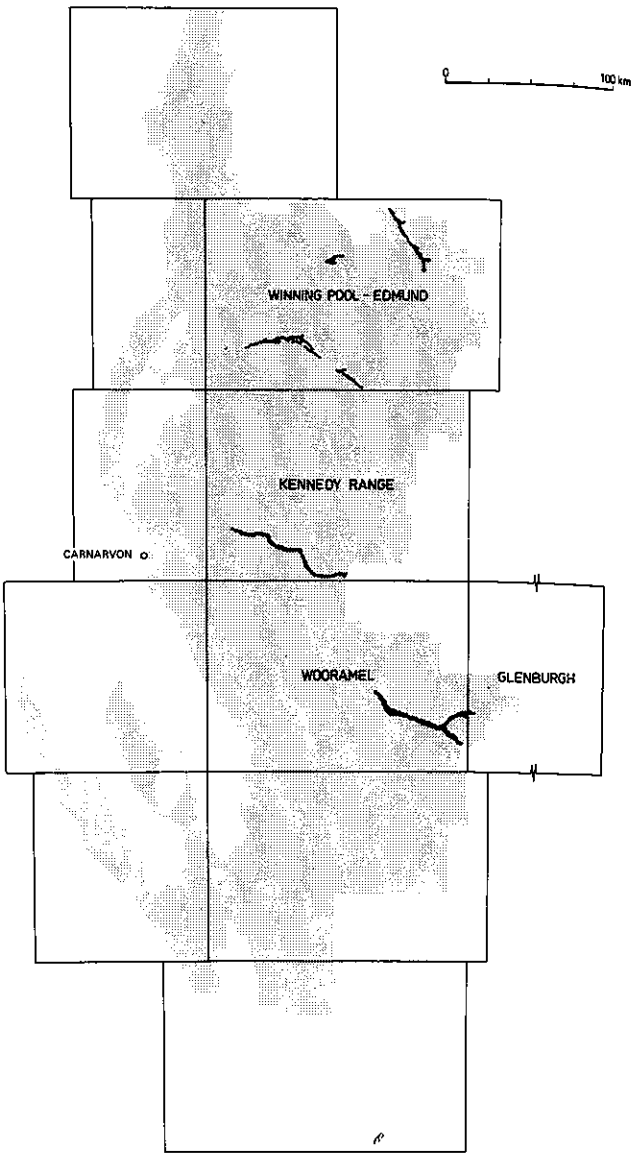
Geology: Quaternary and Tertiary alluvium, colluvium and calcrete, Permian sandstones and, locally, Early Proterozoic metamorphic rocks.

Geomorphology: Erosional surfaces dominated by extensively dissected sandstone slopes with rock outcrop and hardpan exposure, truncated by moderately intensive dendritic drainage incisions and major watercourses with sand and gravel bedloads; relief usually less than 20 m.

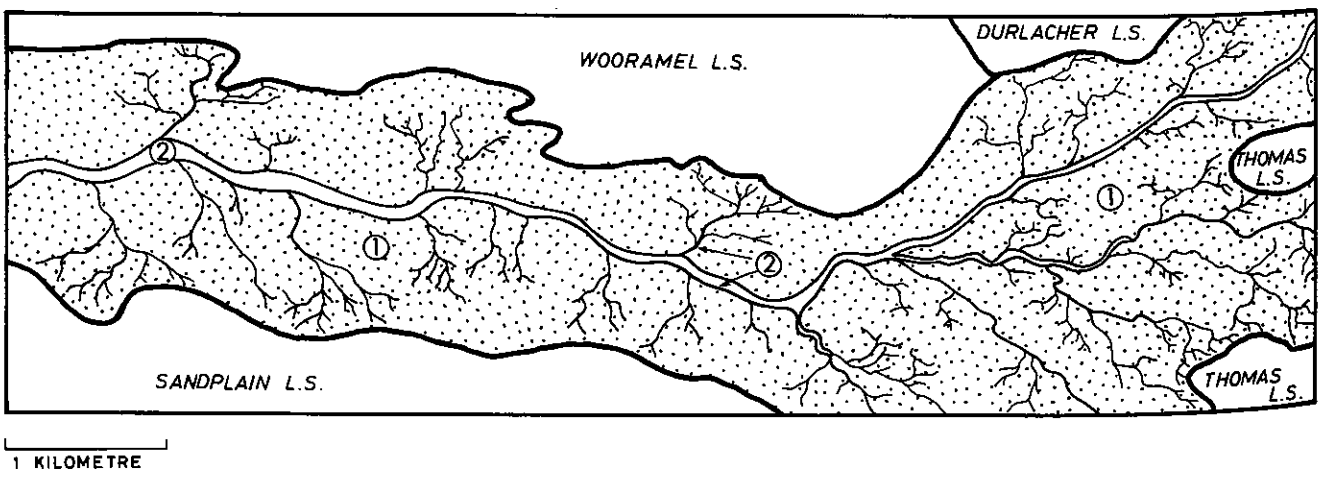
Pastoral use: Mainly Stony Short Grass Forb (SSGF) pastures of low pastoral value but locally more valuable Bluebush (BLUE) and Stony Chenopod (STCH) pastures.

Estimated carrying capacity, good condition: 6-23 ha/s.u. depending on pasture type.

Range condition summary: Good 29%; fair 47%; poor 24%.



Unit
1. Dissected slopes and fringing plains
2. Stream channels and banks



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Dissected slopes and fringing plains (85%) 7 site inventories and traversed	
Gravelly plains and slopes of dissected hardpan with incised dendritic drainage channels, truncated by major stream incisions and low breakaways. Soils are red or reddish-brown loams, duplex or clay types, very shallow to > 1 m deep with quartzite or calcrete gravelly mantles and inclusions, pH 6.5 with neutral or alkaline trends; principal profile forms: Gc 1.12, Dr 1.13, Uf 6.51.	(i) on shallow soils with exposed hardpan: very scattered to scattered shrublands dominated by *Acacia aneura, Cassia* and *Eremophila* spp.; (ii) locally on deeper, calcareous soils: very scattered to scattered shrublands dominated by *Acacia xiphophylla* or *A.* spp and *Maireana polypterygia.* Trees (0-175/ha; 2-6 m): *Acacia cuspidifolia, Eucalyptus coolabah*; Tall shrubs (75-300/ha; 2-4 m): *Acacia xiphophylla, A. victoriae, A. sclerosperma, A. ligulata*; Low shrubs (350-3200/ha; < 1.5 m): *Maireana polypterygia, Cassia desolata, Ptilotus polakii, Atriplex bunburyana, Eremophila* spp, *Ptilotus obovatus*; Perennial grasses: *Triodia* sp., *Enteropogon acicularis.*	Pasture type: Mainly *Stony Short Grass Forb*, locally *Stony Chenopod/Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp, *Ptilotus polakii, Tribulus platypterus.* Undesirable perennials include: *Eremophila youngii, Solanum lasiophyllum.* Pastoral use limitations: Areas of calcareous duplex soils are highly susceptible to water erosion where shrubs are depleted.
	Unit 2 Stream channels and banks (15%) Traversed	
Deeply incised watercourses up to 100 m wide, with bedloads of sand, gravels and cobbles.	Fringing low woodlands or shrublands dominated by *Eucalyptus coolabah* and *Acacia* spp.	Pasture type: *Acacia Creek-line* or unvegetated.

Chargoo Land System 198 km² (0.3% of survey area)

Flat saline alluvial plains subject to temporary inundation, characterized by numerous drainage depressions; low shrublands of saltbush and bluebush and tussock grasslands.

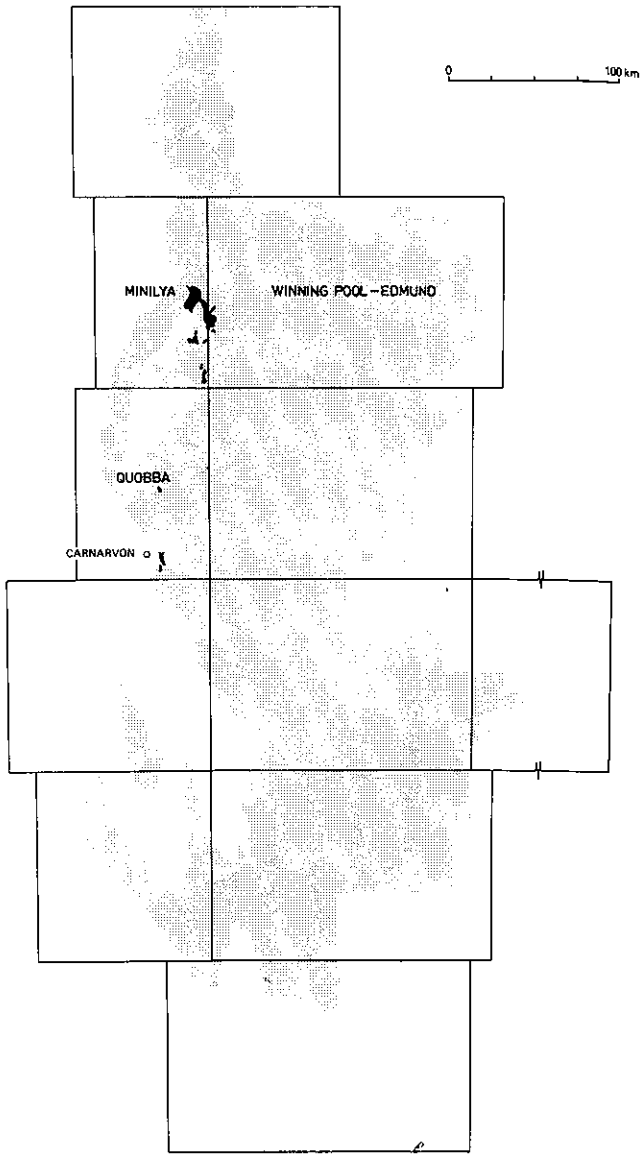
Geology: Quaternary clays, alluvium and aeolian sands.

Geomorphology: Depositional surfaces forming low-lying alluvial areas within riverine flood plains, featuring gilgai plains, drainage foci and disorganised flow zones; relief to 1 m.

Pastoral use: Highly productive riverine plains supporting Saltbush (SALT), Bluebush (BLUE) and Tussock Grass (TUGR) pastures. Major units 2 and 4 are susceptible to erosion by water and wind wherever perennial cover is lost. The whole system is subject to inundation during periodic floods of the Gascoyne, Minilya and Lyndon Rivers and Cardabia Creek.

Estimated carrying capacity, good condition: 4 ha/s.u.

Range condition summary: Good 44%; fair 43%; poor 13%.

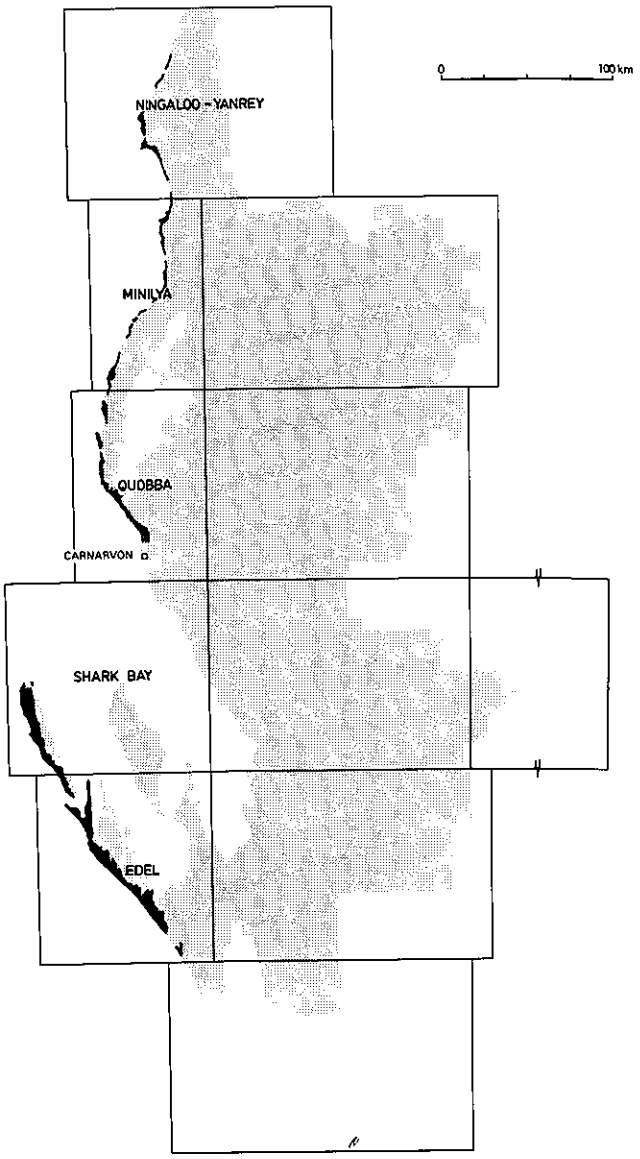


Unit

1. Sandy banks
2. Alluvial plains
3. Gilgai plains
4. Flood plains
5. Drainage depressions
6. Drainage floors

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Occasional low sandy rises. Soils are aeolian sands over wash deposits.	**Unit 1 Sandy banks (< 1%) Traversed** Scattered to close shrublands dominated by *Acacia* spp with understorey chenopod shrubs and perennial grasses.	
Weakly gilgaied or flat plains, slopes < 0.2%. Soils are brown to greyish-brown clays, light medium or medium over sandy or heavy clays, > 1 m deep. The pH 8.0- with an alkaline trend; principal profile forms: Ug 5.31, Uf 6.41.	**Unit 2 Alluvial plains (55%) 3 site inventories and traversed** Very scattered to close low shrublands dominated by *Atriplex* spp, *Chenopodium auricomum* and perennial grasses. Low shrubs (2600-26000/ha; < 1 m): *Atriplex amnicola, A. bunburyana Chenopodium auricomum, Maireana aphylla, Scaevola spinescens, Frankenia* spp; Perennial grasses: *Sporobolus mitchellii, Eragrostis setifolia, Eriachne benthamii, Cenchrus ciliaris.*	Pasture type: *Saltbush* . Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex* spp, *Chenopodium auricomum.* Pastoral use limitations: Locally susceptible to scalding and hummocking when degraded.
Low-lying plains with gilgaied surfaces, relief < 1 m, present as tightly anastomosing tracts within unit 2. Soils are dark reddish-grey or reddish-brown clays, medium to heavy, > 1 m deep, pH 7.0 with a neutral trend; principal profile forms: Ug 5.24, 5.28, 5.34.	**Unit 3 Gilgai plains (15%) 3 site inventories and traversed** (i) Very scattered to moderately close tall or low shrublands dominated by *Acacia farnesiana* or *Chenopodium auricomum*; (ii) tussock grasslands dominated by *Sporobolus mitchelli.* (i) Tall shrubs (2-3 m) *Acacia farnesiana, A. tetragonophylla, Scaevola spinescens*; Low shrubs (1-2 m): *Chenopodium auricomum, Maireana aphylla, Enchylaena tomentosa*; Perennial grasses: *Eragrostis australasica, Sporobolus mitchellii, Eriachne benthamii*; (ii) Perennial grasses (as above)	Pasture type: *Tussock Grass.* Desirable perennials include: *Sporobolus mitchellii, Eriachne benthamii.* Pastoral use limitations: Susceptible to flooding.
Areas mostly adjacent to the Delta land system: flood plains with duplex soils; often degraded with surface hummocking and scalding. Soils are reddish-brown duplex, loamy sand over fine sandy to sandy clays, > 1 m deep, pH 7.0 with an alkaline trend; principal profile form: Dr 4.13.	**Unit 4 Flood plain (15%) 1 site inventory and traversed** Scattered low woodlands dominated by *Acacia cuspidifolia.* Trees (2-4 m): *A. cuspidifolia*; Tall shrubs (2-3 m): *A. tetragonophylla, A. victoriae*; Low shrubs (< 1.5 m): *Ptilotus obovatus, Rhagodia* spp, *Maireana aphylla, M. polypterygia, Scaevola spinescens*; Perennial grasses: *Cenchrus ciliaris, Eragrostis xerophila.*	Pasture type: *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp, *Scaevola spinescens.* Undesirable perennials include: *Acacia victoriae.* Pastoral use limitations: Moderately susceptible to scalding and hummocking when degraded; susceptible to flooding.
Discrete to interconnecting drainage foci with clay soils, often gilgaied. Soils are brown heavy clays, > 1 m deep, pH 7.5; principal profile form: Uf 6.33	**Unit 5 Drainage depressions (10%) 1 site inventory and traversed** (i) Tussock grasslands dominated by *Sporobolus mitchellii.* Perennial grasses: *S. mitchellii*; (ii) Tussock grassland with an overstorey of *Acacia* spp. Tall shrubs (2-3 m): *A. tetragonophylla, A. farnesiana*; Perennial grasses: *Sporobolus mitchellii, Cenchrus ciliaris.*	Pasture type: *Tussock Grass.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Sporobolus mitchellii, Scaevola spinescens.* Pastoral use limitations: Susceptible to seasonal flooding.
Narrow unchannelled drainage zones within units 2 and 3. Soils are brown clays.	**Unit 6 Drainage floors (5%) 1 site inventory and traversed** Tussock grasslands, often dense, dominated by *Eriachne benthamii.*	Pasture type: *Tussock Grass.* Desirable perennials include: *E. benthamii.* Pastoral use limitations: Susceptible to seasonal flooding.

Coast Land System 1102 km² (1.5% of survey area)



Strongly developed coastal dunes with narrow swales, limestone plains, wave-cut platforms and beaches, supporting diverse tall and low shrublands.

Geology: Quaternary dune and beach deposits of unconsolidated or poorly consolidated quartz sand to quartzose lime sands over Quaternary aeolianite and Tertiary limestones.

Geomorphology: Coastal dunes, mainly very long-walled hairpin parabolics and swales, stable when heavily vegetated and undisturbed but highly susceptible to wind erosion which results in extensive northward developing blow-outs whenever foredunes or crests become degraded; no drainage features.

Pastoral use: Coastal Dune Shrub (CDSH) and Saltbush (SALT) pastures supporting a variety of palatable shrubs. Use is limited by a lack of stock watering points, lack of easy access over most areas and a constant risk of initiating major erosional cycles from sites of local degradation.

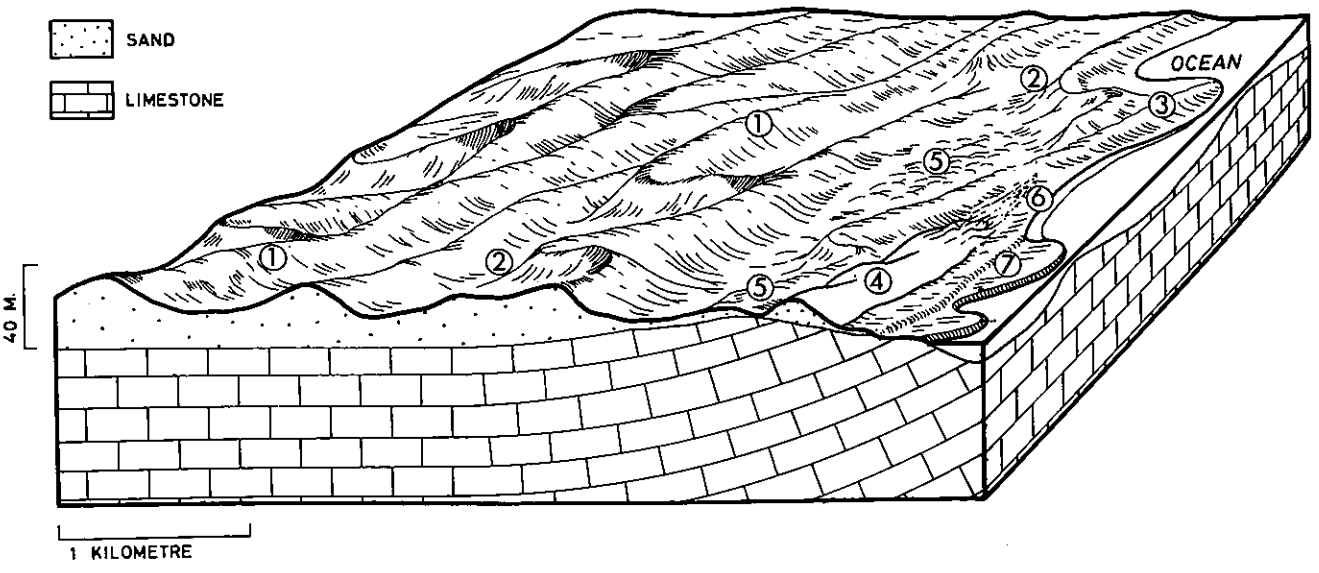
Estimated carrying capacity, good condition: 8 ha/s.u.

Range condition summary: Good 72%; fair 16%; poor 12%.

Unit

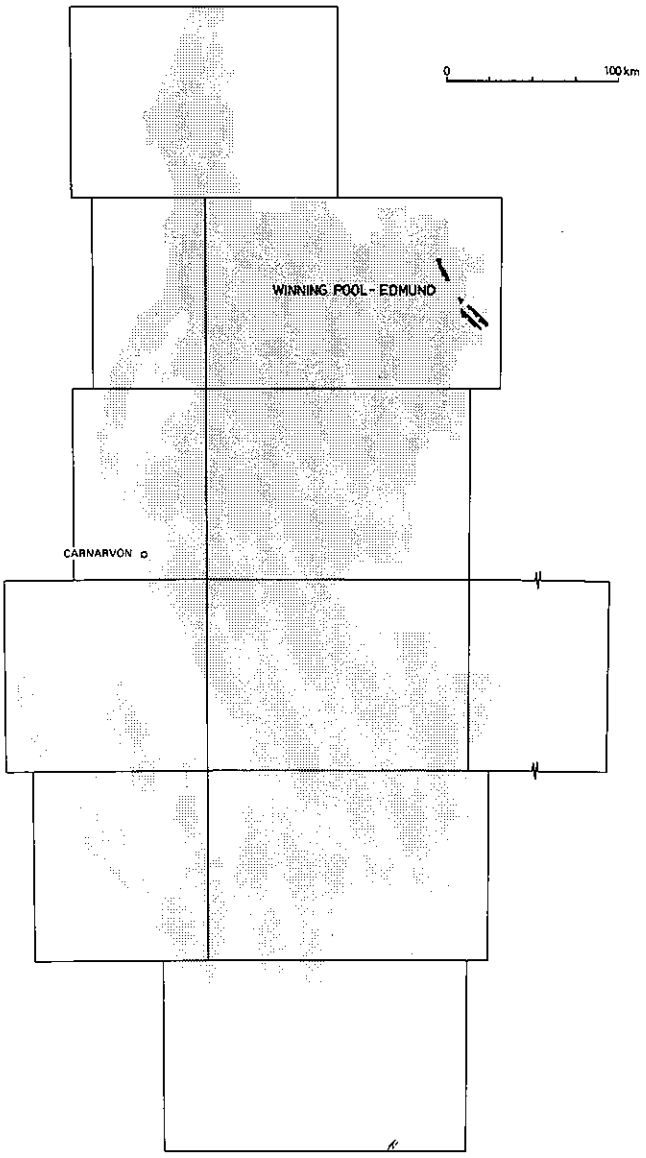
1. Parabolic dunes
2. Sandy swales
3. Beach foredunes
4. Blow-out dunes
5. Restricted limestone plains

6 and 7 Beaches and wave cut platforms



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Large or very large long-walled parabolic dunes, relief mainly 30-60 m above swales. Soils are non-coherent sands, light brown, light reddish-brown or pink, > 1 m deep, with or without a mantle of limestone gravel or pebbles, calcareous inclusions throughout, pH 8.5-9.0 with an alkaline trend; principal profile form: Uc 1.11	**Unit 1 Parabolic dunes (50%) 3 site inventories and traversed** Very scattered to close low shrublands dominated by (i) *Acacia coriacea*, or (ii) various heath-like thickets. (i) Low shrubs (< 2 m): *A. coriacea, Banksia ashbyi, Exocarpus aphyllus, Heterodendrum oleaefolium, Rhagodia* spp, *Ptilotus obovatus, Acanthocarpus preissii*; Perennial grasses: *Paspalidium tabulatum, Triodia pungens, Cenchrus ciliaris.* (ii) Tall shrubs (2-3 m; < 25 /ha): *Acacia ligulata, A. xanthina, Pittosporum phylliraeoides*; Low shrubs: (< 2 m; < 5,000->15,000/ha) *A. ligulata, Melaleuca huegelii, M.* aff. *cardiophylla, Scaevola crassifolia, Angianthus cunninghamii, Frankenia pauciflora, Acanthocarpus* spp, *Ptilotus divaricatus*; Perennial Grasses: *Triodia plurinervata, Plectrachne danthonioides.*	Pasture type: *Coastal Dune Shrub.* Formations of type (i) occur north of Gascoyne river, (ii) on Edel land and Dirk Hartog I. On exposed sites in far W, shrubs grow in cushion forms, < 0.5 m tall. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Rhagodia* spp, *Triodia pungens, Frankenia pauciflora.* Pastoral use limitations: Highly susceptible to massive wind erosion.
Interdunal corridors with undulating sandy floors. Soils are brown or reddish-brown sands, > 1 m deep, mainly calcareous, pH 8.5-9.0 with an alkaline trend; principal profile form: Uc 1.11.	**Unit 2 Sandy swales (40%) 4 site inventories and traversed** Very scattered to moderately close low shrublands, usually supporting a high proportion of chenopod species. Tall shrubs (< 25/ha): *Heterodendrum oleaefolium*; Low shrubs (< 1 m; < 5,000-> 15,000/ha): *Atriplex bunburyana, Rhagodia preissii, Threlkeldia diffusa, Acacia ligulata, Dipteracanthus corynothecus, Scaevola tomentosa, Acanthocarpus preissii, Ptilotus* spp; Perennial grasses: *Triodia* spp, *Plectrachne danthonioides, Paspalidium tabulatum, Cenchrus ciliaris, Eulalia fulva.*	Pasture type: *Saltbush/Coastal Dune Shrub* Desirable perennials include: *Atriplex bunburyana, Rhagodia* spp. *Dipteracanthus corynothecus.* Pastoral use limitations: Highly susceptible to wind erosion when degraded.
Steeply undulating primary dunes up to 30 m high. Soils are pink or light brown loose sands, > 1 m deep, pH 8.5; principal profile form: Uc 1.11.	**Unit 3 Beach fore-dunes (5%) 1 site inventory and traversed** (i) Associations of *Acacia coriacea - Spinifex longifolius.* (ii) Very low heath-like shrublands as unit 1 with *Spinifex longifolius* and *Sporobolus mitchellii.*	(i) N of Gascoyne R. (ii) on Edel Land.
Accumulations of loose sand from units 1 and 2 up to 23 km long and 30 m deep, with arcuate crests and steep north-facing slopes, followed by bare deflation bases on exposed limestone.	**Unit 4 Blow-out dunes (3%) Traversed** Mostly unvegetated, but *Frankenia* spp, *Acacia coriacea* and *A. xanthina* are pioneer stabilizers of deflated areas.	Blow-outs are self-perpetuating and progress northwards under the influence of prevailing southerly winds.
Narrow plains or gently undulating surfaces of duricrusted calcrete, often heavily strewn with boulders. Soils are shallow alkaline sands; principal profile form: Uc 1.13.	**Unit 5 Restricted limestone plains (2%) 1 site inventory and traversed** Scattered shrublands, variable in dominants. Tall shrubs: *A. coriacea, A. tetragonophylla, Ficus platypoda, Heterodendrum oleaefolium, Grevillea* sp.; Low shrubs: *Pimelea microcephala, Ptilotus obovatus, Scaevola crassifolia, Rhagodia* spp, *Solanum lasiophyllum*; Perennial grasses: *Cenchrus ciliaris, Triodia pungens.*	An uncommon unit south of the Gascoyne R. Perennials augmented by annual grasses, including *Cenchrus ciliaris.* On Edel land the tall shrubs and perennial grasses are generally absent.
Coastline features under storm and tidal influence.	**Unit 6 and 7 Beaches and wave-cut platforms (< 1%)** Largely unvegetated.	

Collier Land System (G) 114 km² (0.1% of survey area)



Low stony hills and ridges above flat to undulating stony plains and drainage floors; mulga shrublands and some spinifex.

Geology: Middle Proterozoic dolomite, shale, siltstone, sandstone and chert, with Quaternary colluvium.

Geomorphology: Erosional surfaces: low hills, long ridges, stony lower slopes and occasionally saline lower plains with colluvial mantles; saline and non-saline drainage floors adjacent to drainage channels of sparse to moderate density.

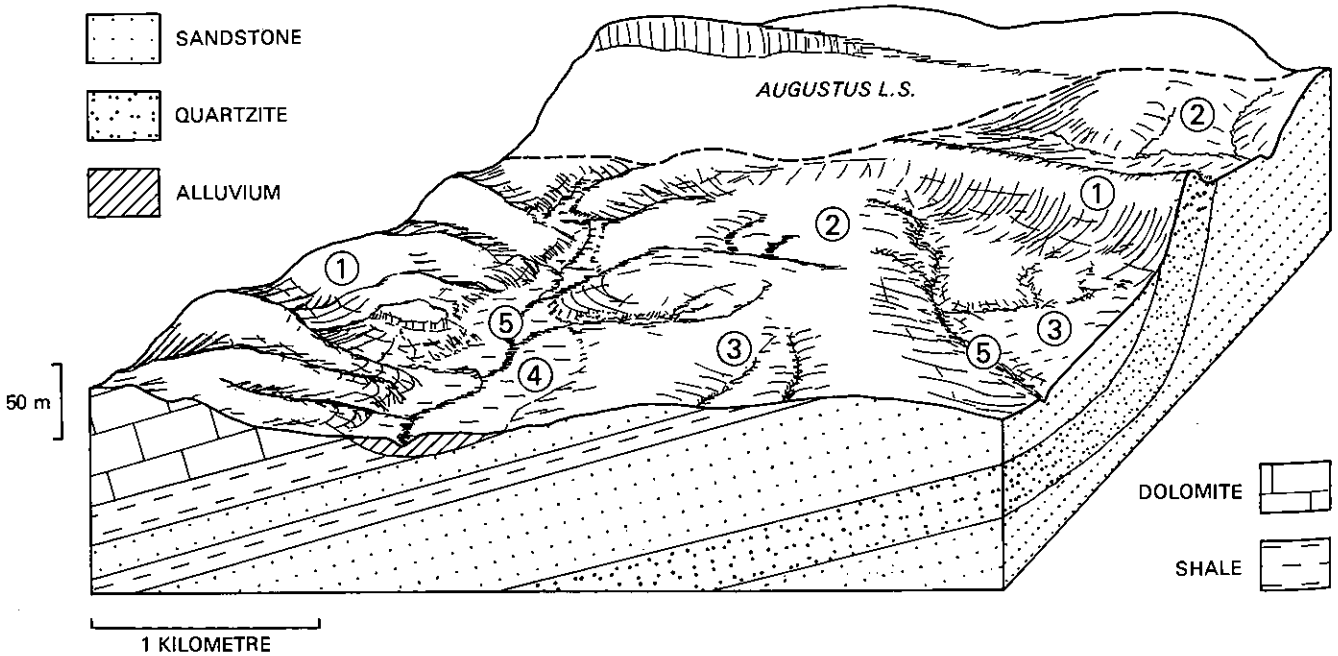
Pastoral use: Acacia Short Grass Forb (ASGF) and Stony Short Grass Forb (SSGF) pastures with minor areas of preferentially grazed Stony Chenopod (STCH) and Soft Spinifex (SOSP) pastures on the lower units. The higher units are unproductive with low drought durability, while the more productive unit 4 is susceptible to erosion when degraded.

Estimated carrying capacity, good condition: 18 ha/s.u.

Range condition summary: Good 60%; fair 33%; poor 7%.

Unit

1. Low hills and ridges
2. Stony uplands
3. Stony plains
4. Drainage floors and lower plains
5. Channels and banks



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Extensive upland areas of low rocky hills with short upper slopes (concave or convex) up to 45%, lower slopes (concave) 2-5%, outcrops and dense stony mantles; isolated ridges 1-6 km long; relief up to 50m. Soils are shallow loams on variable parent rocks; principal profile forms: (probably) Um 5.11, 5.21.	**Unit 1 Low hills and ridges (30%) Traversed** Very scattered to scattered low shrublands dominated by Acacia *aneura* and other *Acacia* spp. Low shrubs (< 2m): *A. aneura, A. tetragonophylla, Cassia sturtii, Eremophila fraseri*, Perennial grasses: *Triodia wiseana.*	Pasture type: Acacia *Short Grass* Forb Sparse perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
Almost flat to gently convex stony surfaces above Unit 3 (sometimes above Unit 1), with dense mantles of cobbles and pebbles, slopes up to 2%. Soils are shallow red to reddish-brown loams on hardpan or parent rock; principal profile forms: (probably) Um 1.43, 5.21, 5.31.	**Unit 2 Stony uplands (25%) Traversed** (i) Very scattered to scattered low shrublands dominated by *Acacia aneura*. Low shrubs (< 2m): *A. aneura, Eremophila freelingii, Cassia sturtii, C. helmsii, Solanum lasiophyllum*; this association mainly on siltstone and shale. (ii) Very scattered to scattered low shrublands dominated by *A. victoriae, Cassia oligophylla, C. desolata, Eremophila leucophylla*; this association mainly on dolomite.	Pasture type: *Acacia Short Grass Forb.* Sparse perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
Plains and interfluves with dense mantles of cobbles and pebbles, slopes < 1% except at margins of drainage dissections. Soils are shallow red gradational loams or clays; principal profile forms: (probably) Uf 6.21, Gc 1.21.	**Unit 3 Stony plains (25%) Traversed** Very scattered to scattered tall or low shrublands dominated by *Acacia aneura* and *A. subtessarogona*; Perennial grasses: *Triodia* spp.	Pasture type: *Acacia Short Grass Forb.* Sparse perenials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
Non-saline and saline plains, slopes < 1%, with variable surface mantles. Soils are red loams or clays; principal profile forms: (probably) Gn 1.13, Ug 5.38, Uf 6.12.	**Unit 4 Drainage floors and lower plains (15%) Traversed** Very scattered to scattered tall shrublands dominated by *Acacia aneura, A. eremaea, A. grasbyi*. Low shrubs (< 2m): *Rhagodia* spp, *Atriplex bunburyana, Maireana pyramidata, Cassia* spp; Perennial grasses: *Triodia pungens.*	Pasture type: *Acacia Short Grass Forb* or *Stony Chenopod* or *Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Mild susceptibility to erosion when degraded.
Incised drainage channels, angular to rectangular or dendritic draining into major creek-lines. Soils vary from bedloads of cobbles, pebbles, grit and sand to banks of alluvial sandy loam or sandy clay.	**Unit 5 Channels and banks (5%) Traversed** Scattered to close low woodlands or tall shrublands dominated by *Acacia aneura* and *A. kempeana* with low shrubs and sparse perennial grasses.	Pasture type: *Acacia Creek-line.* Perennials augmented by annual grasses and forbs in favourable seasons.

Cooloomia Land System 462 km² (0.6% of survey area)

Undulating sandplain and minor stony rises presenting a distinctive park-like landscape with clumped vegetation (discontinuous mallee woodlands and thickets of myrtaceous shrubs) mixed with open grassy slopes.

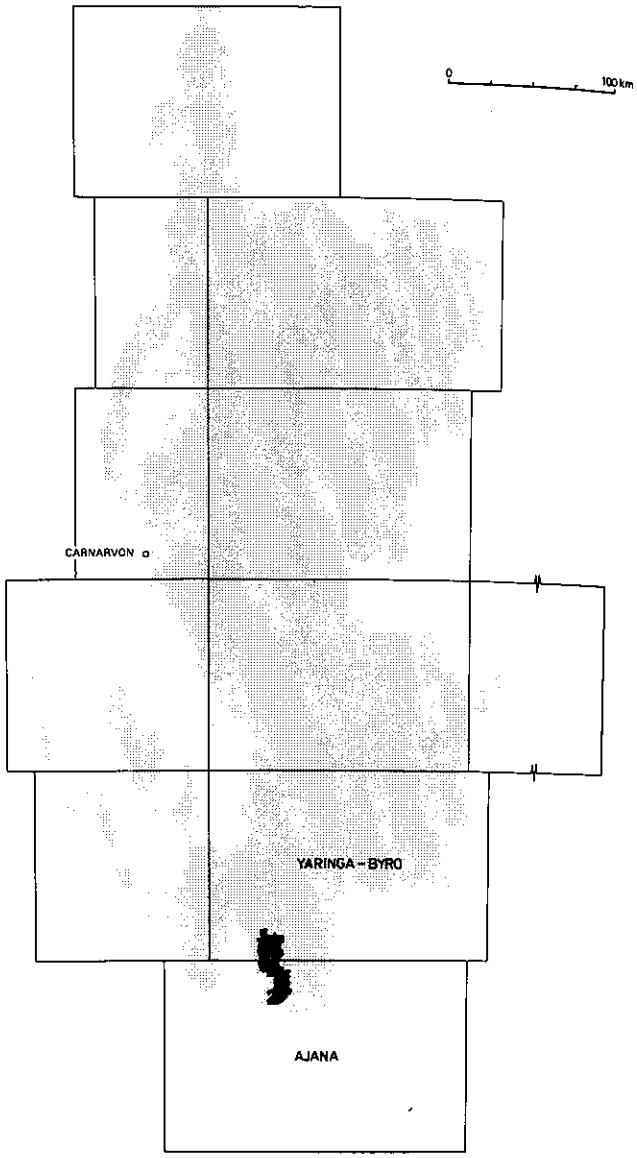
Geology: Quaternary aeolian sand and minor Tertiary calcrete.

Geomorphology: Depositional surfaces: plains, rounded rises and deeply concave swales, with isolated calcrete outcrops and patches of cobble-strewn slopes, no drainage development; relief up to about 15 m.

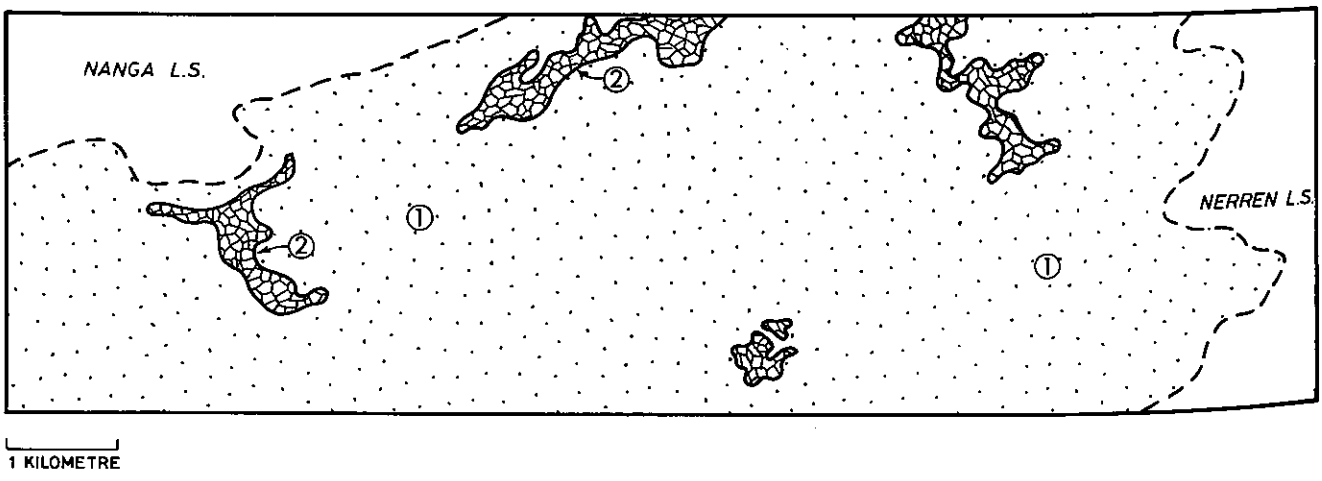
Pastoral use: Acacia and Eucalyptus Short Grass Forb (AEGF) pastures with moderate supplies of edible perennial shrubs and herbs; perennial grasses are very scarce. Use of this system in spring and summer should be geared to whatever production of annuals occurred in the previous winter to spring period.

Estimated carrying capacity, good condition: 12 ha/s.u.

Range condition summary: Good 56%; fair 37%; poor 7%.



Unit
1. Undulating sandy plains
2. Calcrete rises



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Undulating sandy plains (90%) 2 site inventories and traversed	
Undulating plains of moderate relief (< 20 m), slopes up to 10%. Soils are dark reddish brown sands, > 1 m deep, pH 6.5 with a neutral trend; principal profile form: Uc 1.23.	Mosaic of: (i) clumps of mallee eucalypts and other myrtaceous shrubs with chenopods (ii) thickets dominated by tall myrtaceous shrubs (iii)open slopes with very scattered low shrubs (iv) heath-like patches of close low myrtaceous shrubs. Trees (4-8 m): *Eucalyptus eudesmioides, Santalum lanceolatum*; Tall shrubs (2-5 m): *Lamarchea hakeifolia, Heterodendrum oleaefolium, Acacia sclerosperma, A. tetragonophylla, A. ligulata, Hakea stenophylla, Melaleuca cardiophylla, Dodonaea pachyneura*; Low Shrubs (< 2 m): *Pileanthus* spp, *Thryptomene* spp, *Rhagodia latifolia, Ptilotus obovatus, Solanum orbiculatum, S.* aff. *esuriale, Enchylaena tomentosa, Keraudrenia hermanniifolia, Calytrix* spp, *Acanthocarpus preissii*; Perennial grasses: *Stipa elegantissima, Eragrostis dielsii.*	Pasture type: *Acacia - Eucalyptus Short Grass forb.* some *Heath.* Open slopes (ii) support profuse annual grasses, native and exotic forbs in favourable seasons. Desirable perennials include: *Enchylaena tomentosa, Rhagodia* spp, *Eragrostis dielsii, Ptilotus obovatus.* Undesirable perennials include: *Keraudrenia hermanniifolia, Solanum orbiculatum.* Pastoral use limitations: inadequate groundwater availability.
	Unit 2 Calcrete rises (10%) 1 site inventory and traversed	
Low calcrete rises and restricted stony plains, relief < 5 m. Soils are dark reddish brown sands of very variable depth, sparsely strewn with limestone cobbles; pH 6.5 with a neutral trend; principal profile form: Uc 1.23.	Very scattered to moderately close shrublands dominated by *Acacia rostellifera* and *Ptilotus obovatus.* Tall shrubs: *A. rostellifera, A. tetragonophylla, Hakea stenophylla, Lamarchea hakeifolia, Dodonaea* spp, *Melaleuca* spp; Low shrubs: *Ptilotus obovatus, Enchylaena tomentosa, Rhagodia latifolia, R. preissii, Solanum orbiculatum, Thryptomene* spp, *Conostylis* sp.	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Enchylaena tomentosa, Rhagodia* spp. Pastoral use limitations: None under controlled stocking.

Coquina Land System 34 km² (0.04% of survey area)

Mostly unvegetated ridges of shell grit backed by coastal dunes supporting scattered tall acacia shrublands.

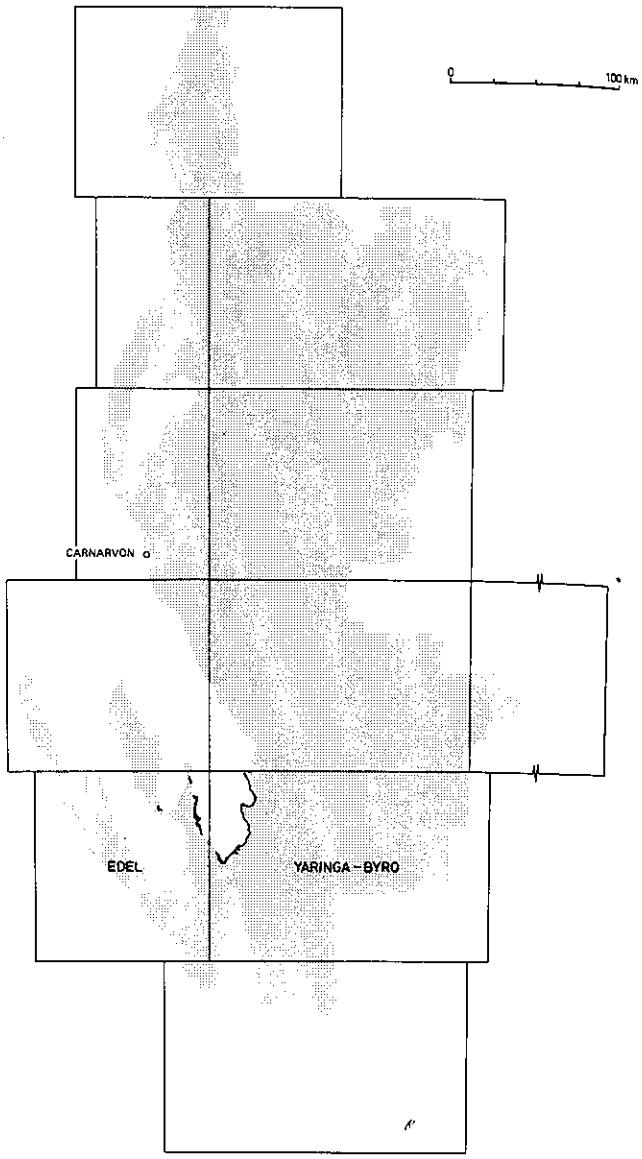
Geology: Holocene coquina - supra tidal deposits of shells from the bivalve mollusc *Fragum erugatum* and low dunes of calcareous sands and gravels.

Geomorphology: Storm ridges formed during the Bibra Marine phase of the final Pleistocene interglacial transgression, with older calcreted benches and ridges. In most localities the system is less than 1 km wide with relief less than 8 m; no organized drainage features.

Pastoral use: Unit 2 supports Coastal Dune Shrub (CDSH) pastures with some useful perennial shrubs.

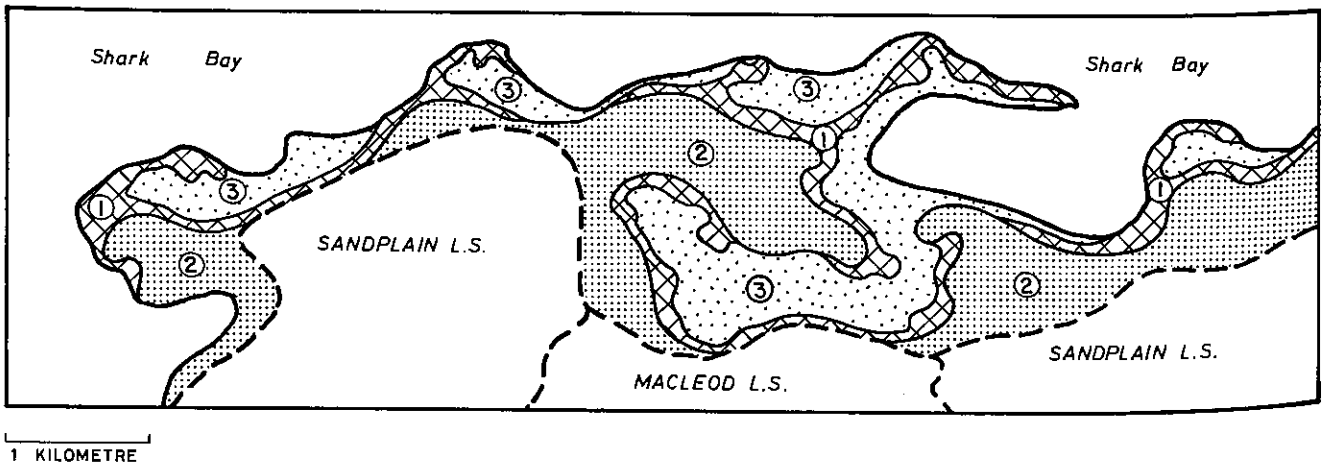
Estimates carrying capacity, good condition: 15 ha/s.u.

Range condition summary: Good 64%; fair 36%; poor 0%.



Unit

1. Beach shell ridges
2. Relic ridges and low dunes
3. Supra-tidal flats



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Beach shell ridges (30%) Traversed	
Loose to indurated and calcreted supra-tidal ridges of coquina shell deposits, up to 8 m above unit 3.	Usually unvegetated.	
	Unit 2 Relic ridges and low dunes (55%) 1 site inventory and traversed	
Undulating ridges and low dunes inland of unit 1. Soils are shallow greyish-brown sands with a high content of shell fragments and carbonate concretions, < 1 m deep, pH 8.5 with an alkaline trend; principal profile form: Uc 1.11.	Scattered tall shrublands dominated by *Acacia sclerosperma*. Trees (2-4 m): *Santalum lanceolatum, Heterodendrum oleaefolium, Eremophila oldfieldii*; Tall shrubs (2-4 m): *Acacia sclerosperma, A. tetragonophylla, Dodonaea pachyneura*; Low shrubs (< 2 m): *Scaevola tomentosa, Scholtzia* spp, *Lycium australe, Diplolaena dampieri, Ptilotus obovatus, Atriplex bunburyana.*	Pasture type: *Coastal Dune Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Ptilotus obovatus.* Pastoral use limitations: Lack of stock watering points in most areas.
	Unit 3 Supra-tidal flats (15%) Traversed	
Tidal mudflats.	Mostly unvegetated; occasional thickets of *Avicennia marina* or samphire flats dominated by *Halosarcia* spp.	

Cullawarra Land System 86 km² (0.1% of survey area)

Undulating rocky plains above the central sector of the Zuytdorp Cliffs supporting sparse low shrublands of saltbush with patches of taller *Acacia* and *Melaleuca* species.

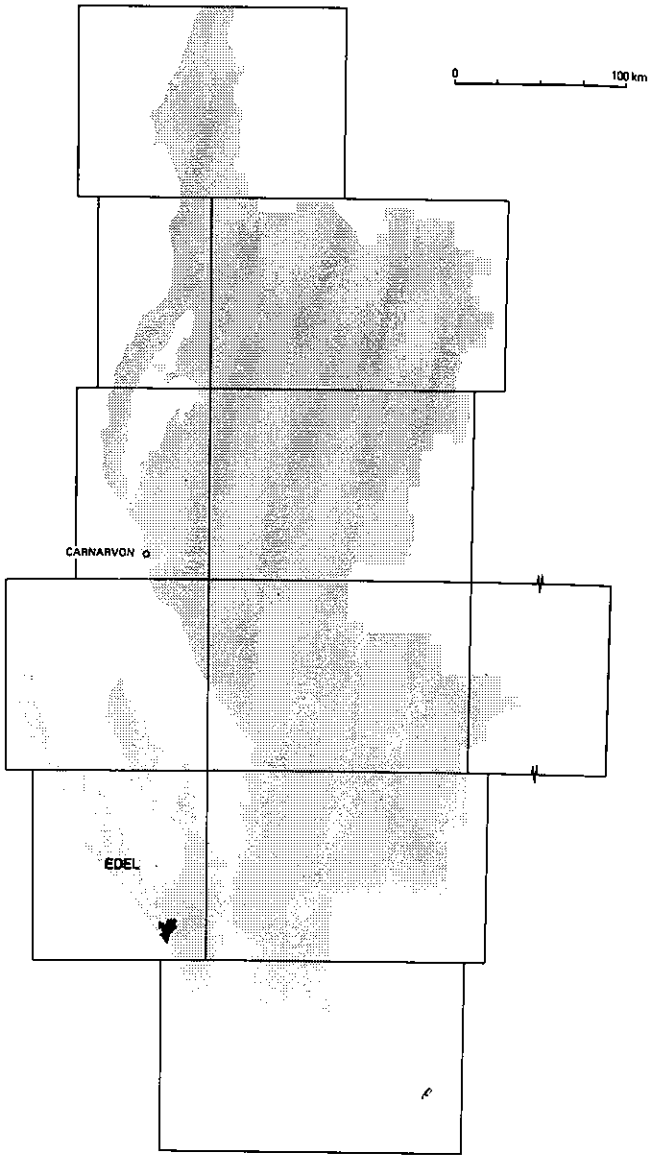
Geology: Quaternary Tamala limestone.

Geomorphology: Erosional surfaces with extensively rock-strewn plains, rises and low hills to nearly 300 m above sea level; mainly unchannelled drainage into small foci and depressions, or springs on sea cliff faces.

Pastoral use: Rather sparse Saltbush (SALT) pastures supplemented by regular winter growth of mainly exotic annuals. Soils are mainly skeletal and only very locally susceptible to erosion. Stock mustering and the control of goats is difficult, especially along the cliff tops.

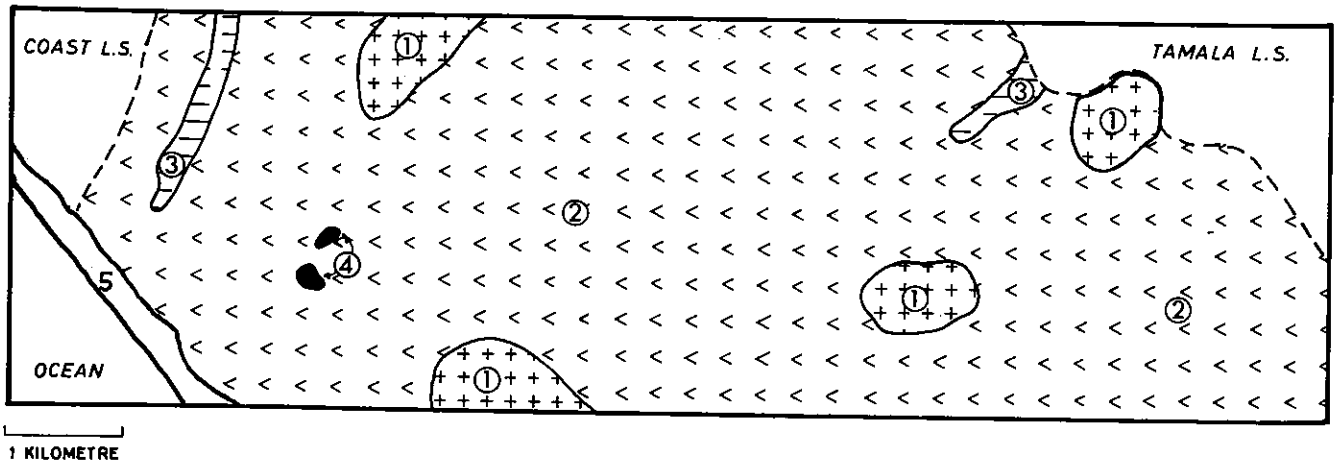
Estimated carrying capacity, good condition: 4 ha/s.u.

Range condition summary: Good 56%; fair 11%; poor 33%.



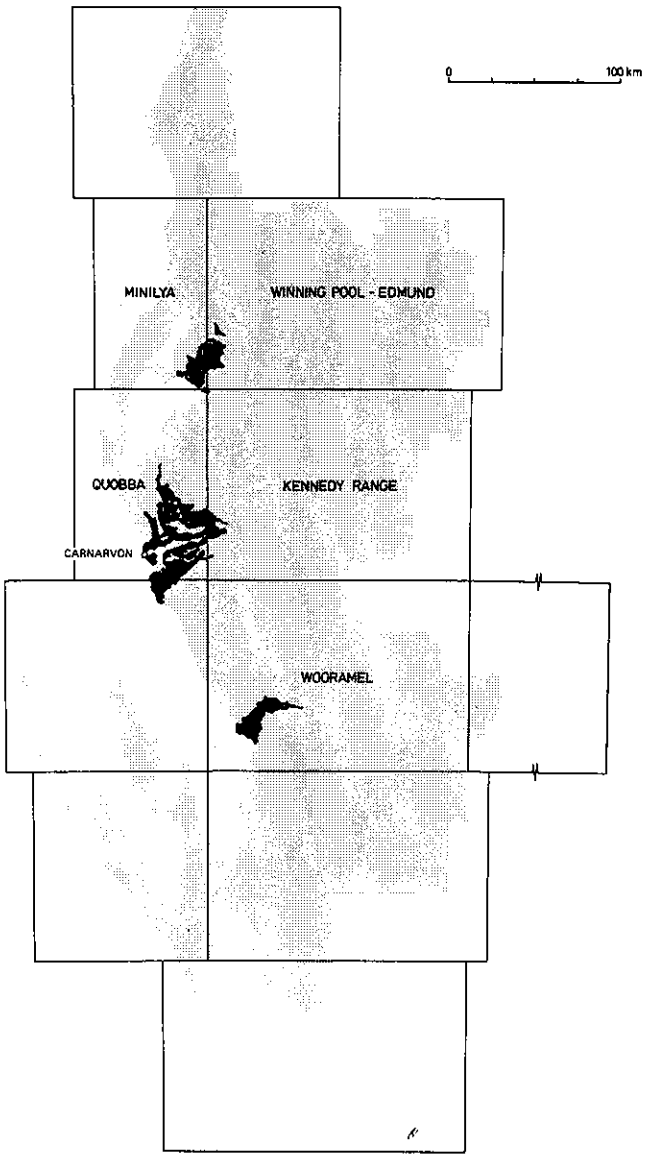
Unit

1. Boulder-strewn slopes and rises
2. Undulating plains of limestone
3. Sandy plains
4. Drainage foci and channels
5. Sea cliffs and terraces



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Boulder-strewn slopes and rises (25%) Traversed	
Elevated rocky plains, slopes and low hills of Tamala limestone up to 300 m above sea level. Soils are skeletal pockets of sands and loams.	Scattered tall shrublands dominated by *Melaleuca cardiophylla* and *Acacia tetragonophylla* with sparse low shrubs, mainly *Rhagodia* spp and *Ptilotus obovatus*.	Pasture type: *Saltbush*. Perennials augmented by annual grasses and forbs. Pastoral use limitations: None under controlled stocking.
	Unit 2 Undulating plains of limestone (70%) 1 site inventory and traversed	
Undulating elevated plains, often densely boulder-strewn, up to 200 m above sea level. Soils are shallow, dark reddish-brown fine sandy loam with limestone inclusions and calcareous concretions, pH 8.5 with an alkaline trend; principal profile form: Um 6.21.	Very scattered low shrubland dominated by *Atriplex bunburyana*, with occasional thickets of taller shrubs. Tall shrubs: *Acacia rostellifera, Melaleuca* aff. *cardiophylla, A. tetragonophylla*; Low shrubs: *Atriplex bunburyana, Rhagodia* spp, *Ptilotus obovatus, Pimelea* sp., *Diplolaena dampieri, Acanthocarpus preissii, Capparis* sp.	Pasture type: *Saltbush/Exotic Annuals*. Perennials augmented by annual grasses and forbs (*Avena* spp, *Medicago* spp, *Brassica* spp) Pastoral use limitations: None under controlled stocking.
	Unit 3 Sandy plains (4%) Traversed	
Restricted plains, nearly flat. Soils are calcareous sands or sandy loams.	Scattered low shrublands dominated by *Acacia ligulata, Exocarpos aphyllus, Rhagodia* spp, *Atriplex bunburyana* and *Ptilotus obovatus*.	Pasture type: *Saltbush*. Perennials augmented by annual grasses and forbs. Desirable perennials inlcude: *Atriplex bunburyana*. Undesirable perennials include: *Solanum orbiculatum*.
	Unit 4 Drainage foci and channels (< 1%) Traversed	
Small areas receiving run-on.	Close shrublands and thickets dominated by *Acacia rostellifera*.	
	Unit 5 Sea cliffs and terraces (< 1%)	
Boulder-strewn steep slopes, terraces and cliffs to 200 m above sea-level.	Very scattered low shrublands dominated by *Frankenia pauciflora*.	

Delta Land System 1660 km² (2.2% of survey area)



Flood plains of the major rivers, supporting low shrublands of bluebush and saltbush, widely degraded and eroded.

Geology: Quaternary alluvial clay, silt, sand and gravel.

Geomorphology: Depositional surfaces: flat alluvial plains with mounded surfaces, locally accentuated by erosional redistribution of soils. Major flood plains exhibit irregular channelled drainage and are flanked by slightly higher areas of alluvium overlain by broad, low sandy banks; up to 7 m relief over whole system.

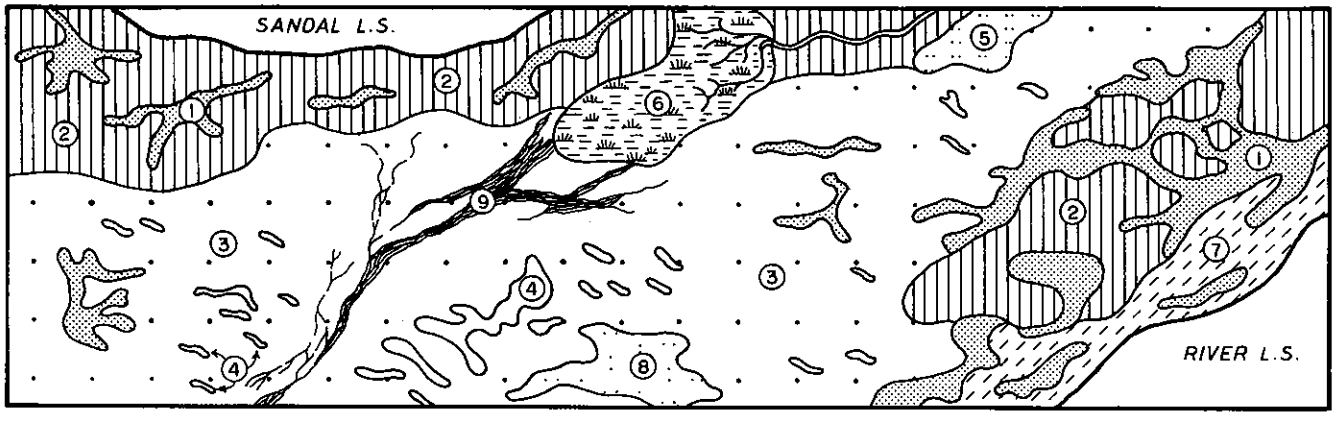
Pastoral use: A highly productive land system with Saltbush (SALT) and Bluebush (BLUE) pastures and considerable drought durability when in good condition. When degraded, units 2, 3, 4 and 7 are susceptible to major erosion by the combined actions of wind and water to scald, scour and hummock the destabilized upper soil horizons.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: Good 24%; fair 21%; poor 55%.

Unit

1. Sandy banks
2. Alluvial plains
3. Flood plains
4. Claypans
5. Hummocky plains with calcareous soils
6. Ephemeral swamps and drainage depressions
7. Levee backplains
8. Saline plains
9. Drainage zones



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Sandy banks (15%) 2 site inventories and traversed	
Broad sandy-surfaced banks, relief < 1 m. Soils are reddish-brown sands to fine sandy loam, grading with depth to sandy clay loams, > 1 m deep, pH 6.5-8.0; principal profile forms: Gc 1.22, Gn 2.12.	Scattered to close shrublands of variable dominance, usually *Acacia* spp, with an understorey of chenopod shrubs and perennial grasses. Trees (< 25/ha; 2-4 m): *Heterodendrum oleaefolium*; Tall shrubs (< 25-700/ha; 2-4 m): *Acacia victoriae, A. sclerosperma, A. tetragonophylla, Cassia helmsii, Eremophila maitlandii*; Low shrubs (25-4,000/ha; < 1 m): *Atriplex bunburyana, Eremophila leucophylla, Enchylaena tomentosa, Rhagodia eremaea, Chenopodium gaudichaudianum;* Perennial grasses: *Cenchrus ciliaris, C. setigerus.*	Pasture type: *Saltbush/Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Enchylaena tomentosa, Maireana tomentosa.* Undesirable perennials include: *Hakea preissii, Acacia victoriae.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Alluvial plains (20%) 9 site inventories and traversed	
Flat plains with slopes to 0.7%. Soils are reddish-brown, red or yellowish-red duplexes or juvenile types: sands, coarse, loamy or fine, over sandy clays or sandy loams, grading to clays with depth (except where profiles are interrupted by horizons of coarser alluvial sediments), > 1 m deep, pH 6.5-8.5 with neutral or alkaline trends; principal profile forms: Dr 1.13, Dy 4.13, Dr 1.12 and juvenile types.	Very scattered to scattered low shrublands (PFC 2 to 20%) dominated by *Atriplex* spp. Trees (0-100/ha; 2-5 m): *Acacia cuspidifolia*; Tall Shrubs (0-200/ha; 2-3 m): *Hakea preissii, Acacia sclerosperma, A. tetragonophylla*; Low shrubs (150-10,000/ha; < 1.5 m): *Maireana polypterygia, Ptilotus polakii, Atriplex vesicaria, A. bunburyana, Maireana aphylla, M. tomentosa, M. platycarpa, Ptilotus obovatus*; Perennial grasses: *Cenchrus ciliaris.*	Pasture type: *Saltbush/Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex* spp, *Maireana polypterygia, M. platycarpa.* Undesirable perennials include: *Solanum lasiophyllum, Acacia cuspidifolia.* Pastoral use limitations: Moderately susceptible to erosion by water and wind.
	Unit 3 Flood plains (45%) 10 site inventories and traversed	
Flat plains with slopes to 0.4%. Soils are reddish-brown (locally yellowish-red or reddish-grey) sand or loamy sand over sandy clay loams, sandy clays or heavier B horizons; pH 6.5-8.5 with neutral or alkaline trends; principal profile forms: Dr 1.12, 1.13, 4.13, Uf 6.31, 6.21, 6.33 and juvenile types.	Very scattered to scattered low shrublands (PFC 2 to 20%) dominated by *Maireana* spp, or *Atriplex vesicaria.* Trees (0-75/ha; 2-4 m): *Acacia cuspidifolia, Heterodendrum oleaefolium*; Tall shrubs (0-600/ha; 2-3 m): *A. victoriae, A. tetragonophylla, Hakea preissii, Eremophila maitlandii*; Low shrubs (700-3,300/ha; < 1 m): *Maireana polypterygia, M. aphylla, Atriplex vesicaria, Halosarcia spp, Solanum lasiophyllum, Maireana tomentosa, Atriplex bunburyana, Frankenia* spp, *Maireana platycarpa*; Perennial grasses: *Cenchrus ciliaris, C. setigerus.*	Pasture type: *Bluebush/Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. *Cenchrus* spp have become well established on Minilya R and progressively less so further south. Desirable perennials include: *Maireana polypterygia, M. tomentosa, M. aphylla, Atriplex vesicaria.* Undesirable perennials include: *Hakea preissii.* Pastoral use limitations: Highly susceptible to erosion by water and wind wherever perennial cover is significantly reduced; A horizons entirely lost from wide areas.
	Unit 4 Claypans (3%) Traversed	
Isolated claypans with flat, bare surfaces.	Mainly unvegetated, but some support clumps of *Eragrostis australasica* and *Chenopodium auricomum.*	
	Unit 5 Hummocky plains with calcareous soils (1%) 1 site inventory and traversed	
Occasional flat plains with hummocky surfaces. Soils are yellowish-red calcareous duplex types, sandy loams over sandy clays, > 1 m deep, pH 8.5 with an alkaline trend; principal profile form: Dy 3.53.	Scattered shrublands dominated by *Acacia xiphophylla.* Tall shrubs (2-4 m): *A. xiphophylla*; Low shrubs (< 1 m): *Atriplex bunburyana, Maireana polypterygia, M. tomentosa, Ptilotus obovatus, P. polakii, Scaevola spinescens.*	Pasture type: *Saltbush.* Pastoral use limitations: Moderately susceptible to erosion by water and wind.

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 6 Ephemeral swamps and drainage depressions (5%) 3 site inventories and traversed	
Low-lying areas with mounded or gilgaied surfaces. Soils are reddish-brown or reddish-grey medium clays becoming heavier with depth, > 1 m deep, pH 7.0-8.5; principal profile forms: Ug 5.34, 5.38, Uf 6.31.	Very scattered to moderately close low shrublands, variable in dominants, with or without an understorey of tussock grasses. Low shrubs (400-10,000/ha; < 1 m): *Chenopodium auricomum, Atriplex amnicola, A. vesicaria, Sclerostegia disarticulata, Cratystylis subspinescens, Ptilotus obovatus*; Perennial grasses: *Sporobolus mitchelli, Paspalidium* aff. *clementii, Eulalia fulva.*	Pasture type: *Saltbush.* Pastoral use limitations: Subject to seasonal inundation, otherwise stable under controlled stocking.
	Unit 7 Levee backplains (5%) 6 site inventories and traversed	
Plains with mounded surfaces adjacent to the major watercourses, sloping away to 0.7%. Soils vary in relation to scour lines and depositional hummocks: red, reddish-brown or yellowish-red sands or clays over silty or sandy clays or loams, locally underlain by layers of fluvial sand, pH 6.5-8.5 with neutral or alkaline principal profile forms: Uc 5.11, 5.21, Uf 6.12, 6.31 or juvenile types.	Very scattered to scattered shrublands (PFC < 5-20%) dominated by *Acacia victoriae* and *A. sclerosperma* with variable understorey shrubs. Trees (< 25/ha): *Eucalyptus coolabah*; Tall shrubs (50-450/ha; 2-4 m): *A. victoriae, A. sclerosperma, A. tetragonophylla, Hakea preissii*; Low Shrubs (500-9,000/ha; < 2 m): *Atriplex bunburyana, Maireana polypterygia, Rhagodia eremaea, Ptilotus obovatus, Solanum lasiophyllum, Scaevola spinescens*; Perennial grasses: *Cenchrus ciliaris* (locally profuse).	Pasture type: *Saltbush/Bluebush.* Desirable perennials include: *Atriplex bunburyana, Maireana* spp. Undesirable perennials include: *Hakea preissii.* Pastoral use limitations: Highly susceptible to water erosion during river floods; annual herbage liable to invasion by unpalatable *Asphodelus fistulosus.*
	Unit 8 Saline plains (3%) 1 site inventory and traversed	
Flat plains with sluggish through drainage. Soils are reddish-brown silty clay, > 1 m deep, pH 6.5-8.5 with an alkaline trend; principal profile form: Uc 6.31.	Very scattered low shrublands dominated by *Halosarcia indica, Maireana aphylla, M. platycarpa* and *M. polypterygia.*	Pasture type: *Samphire.* Pastoral use limitations: High salinity levels in pasture plants.
	Unit 9 Drainage zones (3%) 2 site inventories and traversed	
Narrow unchannelled disorganised drainage zones. Soils are reddish-brown or dusky red sands, sandy clays or silty clay, > 1 m deep, pH 6.5-7.0 with a neutral trend; principal profile forms: Uf 6.31, Uc 5.21.	Scattered to close tall shrublands dominated by *Acacia victoriae* and *A. tetragonophylla*, with or without sparse eucalypts. Trees (0-50/ha; 6-8 m): *Eucalyptus coolabah*; Tall shrubs (100-900/ha; 4-6 m): *Acacia victoriae, A. tetragonophylla, Scaevola spinescens, Hakea preissii*; Low shrubs (100-350/ha; < 1 m): *Chenopodium gaudichaudianum, Commicarpus australis, Rhagodia eremaea, Enchylaena tomentosa, Maireana aphylla, Ptilotus obovatus*; Perennial grasses: *Cenchrus ciliaris, C. setigerus, Enteropogon acicularis.*	Pasture type: *Tussock Grass/Saltbush.* Pastoral use limitations: Moderately susceptible to water erosion.

Divide Land System (G) 148 km² (0.2% of survey area)

Sandplains with minor dunes, supporting hard spinifex hummock grasslands with numerous shrubs.

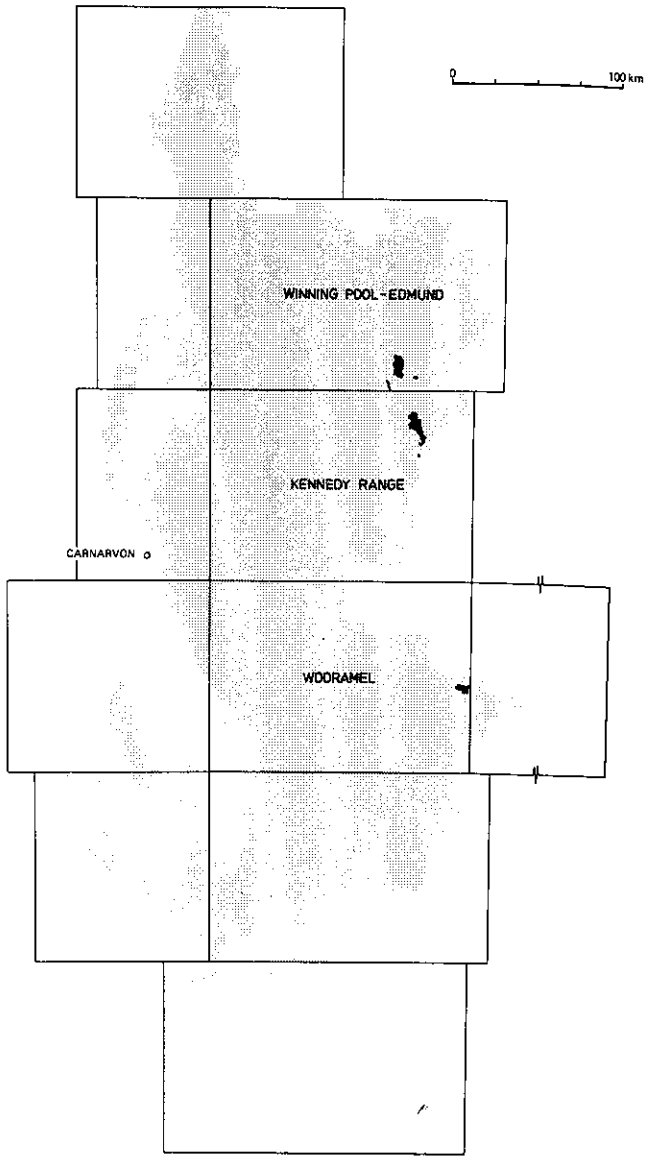
Geology: Quaternary deposits of uncertain origin: clay, silt, sand and gravel.

Geomorphology: Depositional surfaces: flat plains with deep, sandy soils receiving run-on where they abut hilly systems; otherwise no organised drainage and only occasional low longitudinal dunes, linear to reticulate; relief up to 5 m.

Pastoral use: Unproductive Hard Spinifex (HASP) and minor Acacia Creek-line (ACCR) pastures, generally low drought durability. There is no susceptibility to erosion.

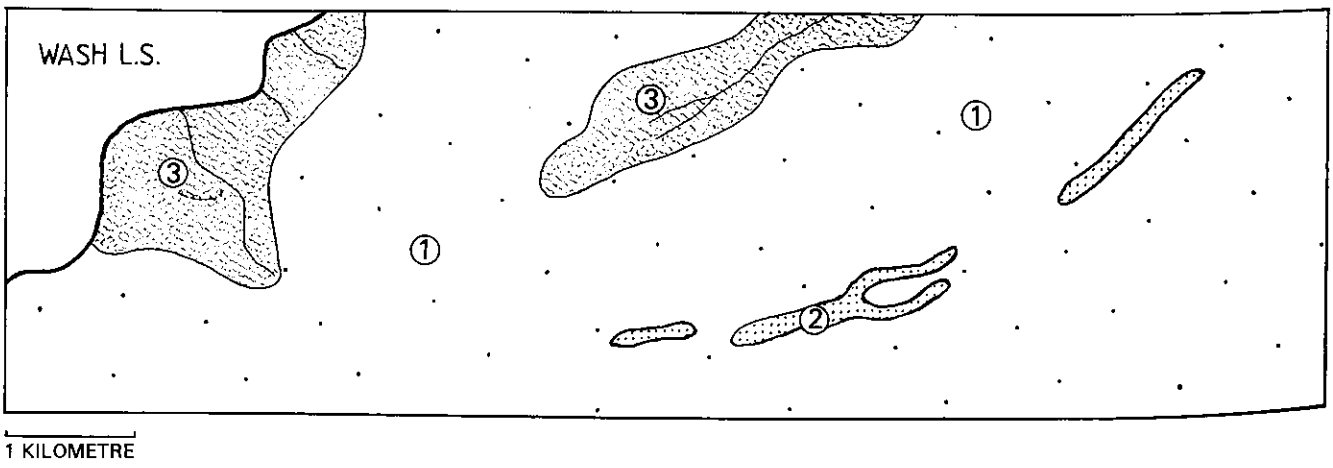
Estimated carrying capacity, good condition: 17 ha/s.u.

Range condition summary: Good 88%; fair 0%; poor 12%.



Unit

1. Longitudinal dunes
2. Sandy plains
3. Tracts receiving run-on



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal dunes (1%) Traversed	
Occasional low dunes, linear or reticulate; relief up to 5 m. Soils are red sands; principal profile form: probably Uc 1.23.	Scattered tall shrublands dominated by *Acacia ramulosa, A. sclerosperma* and *Triodia basedowii*	Pasture type: *Acacia Sandplain.*
	Unit 2 Sandy plains (90%) 1 site inventory and traversed	
Flat plains, slopes < 0.5%. Soils are dark red sands or sandy-surfaced loams grading to sandy clay loams, > 1 m deep, pH 5.5-6.0 with an acid trend; principal profile form: Uc 5.31.	Very scattered to scattered dominated by *Acacia ramulosa, A. pruinocarpa* with a hummock grass-understorey. Trees (4-6 m): *A. pruinocarpa, A. aneura*; Tall shrubs (2-3m): *A. ramulosa, A.* aff. *coolgardiensis, A. tetragonophylla*; Low shrubs (< 2 m): *Eremophila leucophylla, E. gibsonii, A.* sp.nov., *Dichrostachys* sp., *Keraudrenia* sp., *Dampiera incana*; Perennial grasses: *Triodia basedowii, Monachather paradoxa.*	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila leucophylla, Monachather paradoxa.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Tracts receiving run-on (9%) 1 site inventory and traversed	
Flat plains, slopes 0.5-1%, with mostly unchannelled dendritic drainage lines of low intensity. Soils are dark red sands, sand grading to loamy sand, > 1 m deep, pH 6.5; principal profile form: Uc 5.11.	Scattered to moderately close tall shrublands dominated by *Acacia linophylla/ramulosa, A. pruinocarpa* and *Triodia* spp. Trees (6-8m): *A. linophylla/ramulosa, A. sclerosperma, A. tetragonophylla, A. citrinoviridis*; Low shrubs (< 2 m): *Eremophila leucophylla, Maireana planifolia, Rhagodia eremaea Enchylaena tomentosa, Ptilotus obovatus, Solanum lasiophyllum*; Perennial grasses: *Triodia* spp.	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Enchylaena tomentosa, Rhagodia eremaea, Maireana planifolia.* Pastoral use limitations: None under controlled stocking.

Donovan Land System (A) 1041 km² (1.4% of survey area)

Gently sloping outwash plains and minor stony plains with alkaline loamy and clayey soils supporting tall shrublands of snakewood and other *Acacia* species and low shrublands of bluebush.

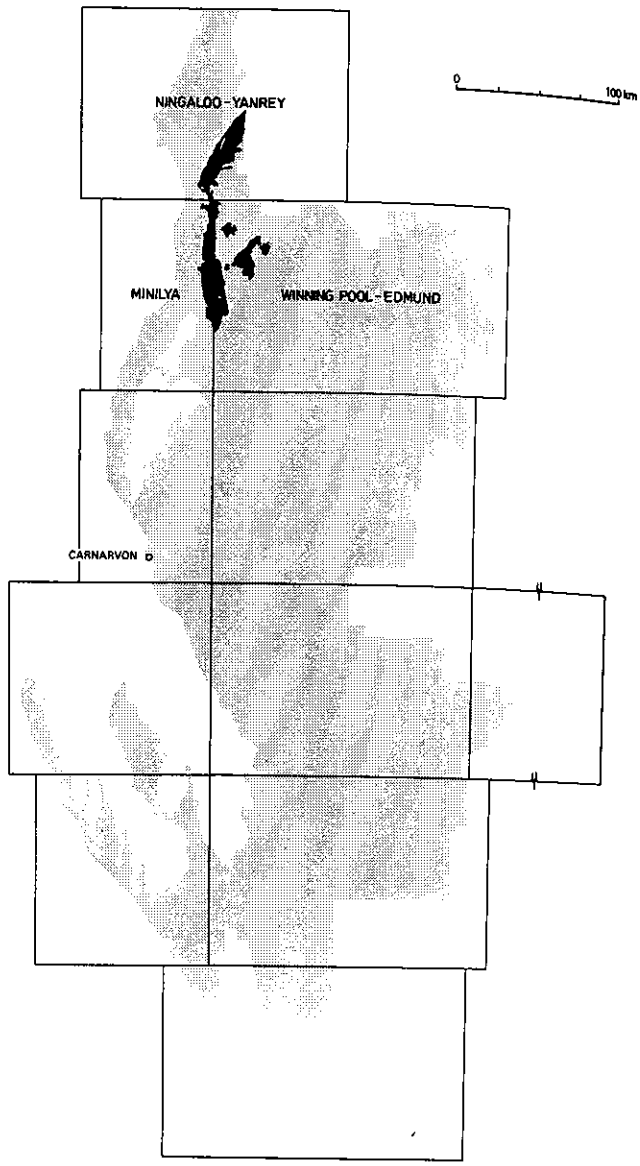
Geology: Quaternary alluvium and colluvium with minor Tertiary limestones (Trealla limestone and Giralia calcarenite).

Geomorphology: Mainly depositional surfaces receiving run-on from limestone hills of the adjacent Jubilee land system: broad, gently sloping outwash plains and alluvial fans with unchannelled or channelled drainage tracts receiving more concentrated sheet flow; minor stony outcrop plains with sparse parallel drainage patterns; relief up to 10 m.

Pastoral use: Highly productive Bluebush (BLUE), Acacia Mixed Shrub (ACMS), Tussock Grass (TUGR) and Soft Spinifex (SOSP) pastures conferring considerable drought durability when in good condition; some degraded areas have been stabilized and invaded by buffel grass, sometimes to the exclusion of shrubs and native perennial grasses formerly present. Unit 5 is mildly susceptible to water erosion.

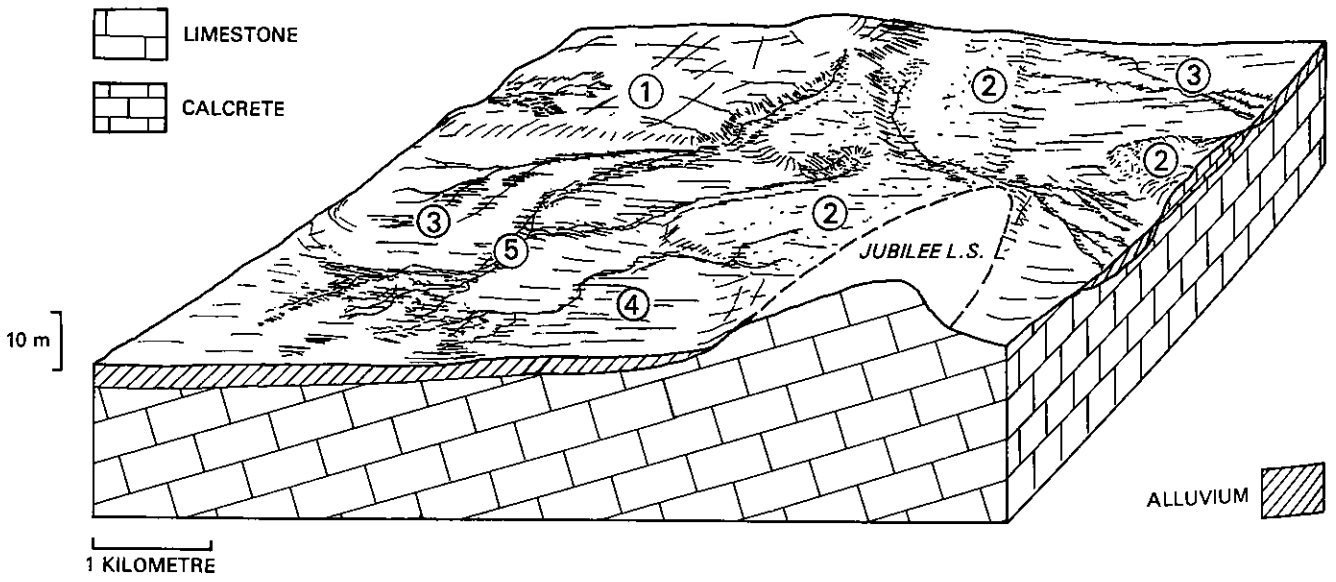
Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: Good 66%; fair 27%; poor 7%.



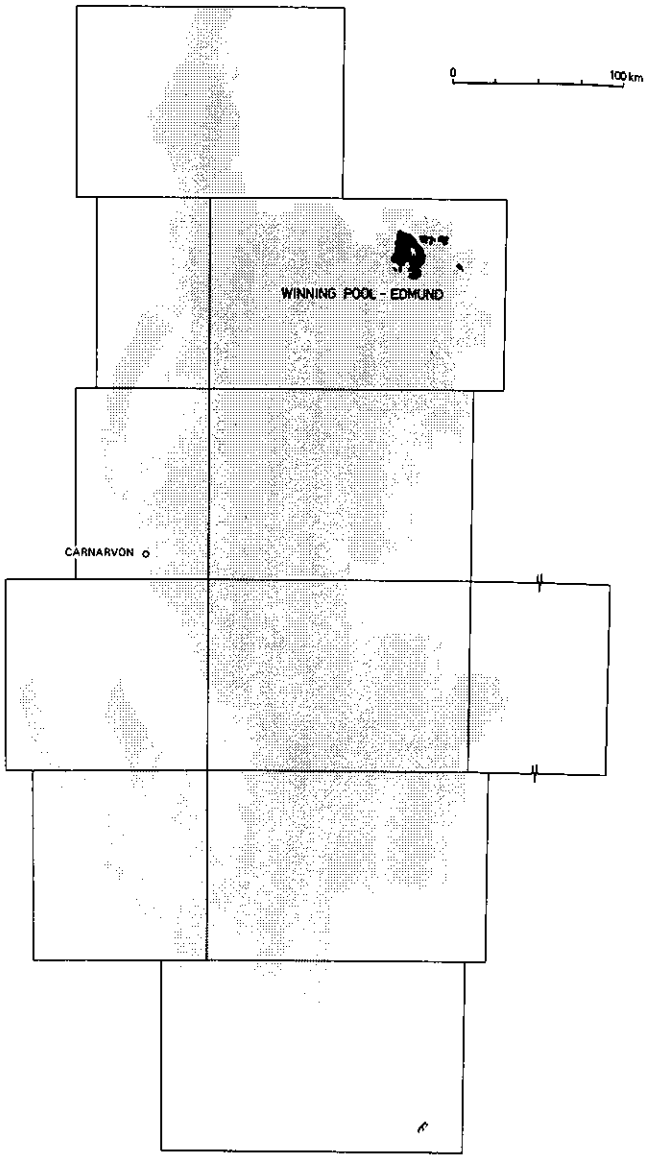
Unit

1. Stony plains
2. Calcrete rises
3. Gently undulating plains
4. Lower outwash plains and fans
5. Drainage tracts



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Stony plains (15%) 1 site inventory and traversed	
Limestone plains, gently sloping with a light to moderate mantle of pebble sized rock fragments and occasional areas of dissection. Soils are dark red to red gradational loams or clays, very shallow full depth, calcareous throughout, pH 8.5 with an alkaline trend; principal profile form: Gc 2.22, Um 5.12.	Moderately close to close tall shrublands dominated by *Acacia xiphophylla*. Tall shrubs (2-3 m): *A. xiphophylla*, A. *sclerosperma*, *A. victoriae*; Low shrubs (< 2m): *Atriplex bunburyana*, *Cassia desolata*, *Sida* spp, *Acacia tetragonophylla*, *Scaevola spinescens*, *Solanum lasiophyllum*; Perennial grasses: *Cenchrus ciliaris*.	Pasture type: *Saltbush/Acacia Mixed Shrub* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana*, *Eremophila latrobei*, *Enchylaena tomentosa*. Pastoral use limitations: None under controlled stocking.
	Unit 2 Calcrete rises (2%) Traversed	
Calcrete rises and platforms with undulating surfaces and gravelly mantles, relief up to 5 m above unit 3. Soils are probably shallow red sandy loams to sandy clay loams, calcareous throughout.	Hummock grasslands dominated by *Triodia pungens* with scattered low shrubs.	Pasture type: *Soft Spinifex*. Pastoral use limitations: None under controlled stocking.
	Unit 3 Gently undulating plains (20%) 1 site inventory and traversed	
Plains and interfluvial areas, slopes mainly < 1%, relief up to 8 m. Soils are reddish brown clay loams to clays, usually silty or fine sandy clay loam grading to fine sandy clay, calcareous throughout > 1 m deep, pH 8.5 with an alkaline trend; principal profile forms: Gc 2.22, Um 5.12.	Scattered tall shrublands dominated by *Acacia tetragonophylla* with an understorey of hummock grasses *Triodia* spp. Tall shrubs (2-3 m): *Acacia tetragonophylla*, *A. victoriae*; Low shrubs (2-3 m): *Maireana planifolia*, *Cassia desolata*, *Eremophila leucophylla*, *Sida* spp, *Maireana tomentosa*, *Lepidium platypetalum*; Perennial grasses: *Triodia* sp., *T. pungens*.	Pasture type: *Soft Spinifex*. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp, *Eremophila leucophylla*, *Triodia pungens*, *Lepidium platypetalum*. Pastoral use limitations: None under controlled stocking.
	Unit 4 Lower outwash plains and fans (55%) 7 site inventories and traversed	
Alluvial plains, slopes < 1%, with flat, lightly gravel-strewn or slightly mounded surfaces receiving sheet flow. Soils are reddish-brown alkaline loams or clays, fine sandy loams to medium clays with or without calcareous inclusions, > 1 m deep, pH 8.5; principal profile forms: Gc 2.22, Uf 6.21, Uf 6.33.	(i) Scattered low shrublands dominated by *Maireana polypterygia* and and perennial grasses *Cenchrus ciliaris*. (ii) Moderately close tall shrublands dominated by *Acacia xiphophylla* or *A. sclerosperma*, with an understorey of *Maireana polypterygia* or other low shrubs and perennial grasses. Tall shrubs (0-650/ha; 2-4 m): *A. xiphophylla*, *A. sclerosperma*, *A. victoriae*, *A. tetragonophylla*; Low shrubs (1200-4300/ha; 0.5-1.5 m): *Maireana polypterygia*, *Maireana tomentosa*, *Enchylaena tomentosa*, *Solanum lasiophyllum*, *Atriplex bunburyana*, *Rhagodia eremaea*; Perennial grasses: *Cenchrus ciliaris*, *Eragrostis setifolia*, *Triodia pungens*.	Pasture type: *Bluebush*. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia*, *M. pyramidata*, *Atriplex bunburyana*. Undesirable perennials include: *Solanum lasiophyllum*. Over some areas, *Acacia xiphophylla*-dominated communities have been succeeded by more open perennial grasslands, possibly as a result of fires. Pastoral use limitations: None under controlled stocking.
	Unit 5 Drainage Tracts (8%) 2 site inventories and traversed	
Unchannelled drainage tracts, slopes 0.4-0.6%, with little or no surface mantling. Soils are reddish-brown duplex or clay types, 80 cm to >1 m deep, Sandy loam over sandy clay or clay loams grading to light clay, pH 8.5-9.0 with an alkaline trend; principal profile forms: Dr 1.13, Uf 6.21.	Very scattered to close tall shrublands dominated by *Acacia tetragononophylla*. Tall shrubs (2-3 m): *A. tetragonophylla*, *A. xyphophylla*, *A. coriacea*, *Exocarpos aphyllus*, *A. oswaldii*; Low shrubs: *Ptilotus obovatus*, *Scaevola spinescens*, *Enchylaena tomentosa*, *Maireana integra*, *Sida* spp, *Cassia desolata*; Perennial grasses: *Cenchrus ciliaris* (up to 6% b.c.), *Eragrostis setifolia*, *Enteropogon acicularis*, *Triodia pungens*.	Pasture type: Tussock grass Perenials augremented by annual grasses Desirable perennials include: *Maireana* spp, *Ptilotus obvatus*, *Scaevola squiescens*, *Lepidium* sp., *Eragrostis satifolia* Pastoral use limitations: None under controlled stocking.

Duffy Land System 359 km² (0.5% of survey area)



Sandy plains and stony plains with isolated low hills and rises, supporting mainly hard and soft spinifex hummock grasslands.

Geology: Lower Proterozoic igneous rocks: mainly muscovite-biotite, granodiorite and adamellite.

Geomorphology: Erosional and depositional surfaces: minor low rocky hills and strike ridges with broad footslopes spreading stony mantling onto sandy-surfaced plains; drainage mainly internal and disorganised with more or less rilled and channelled tracts receiving sheet flow.

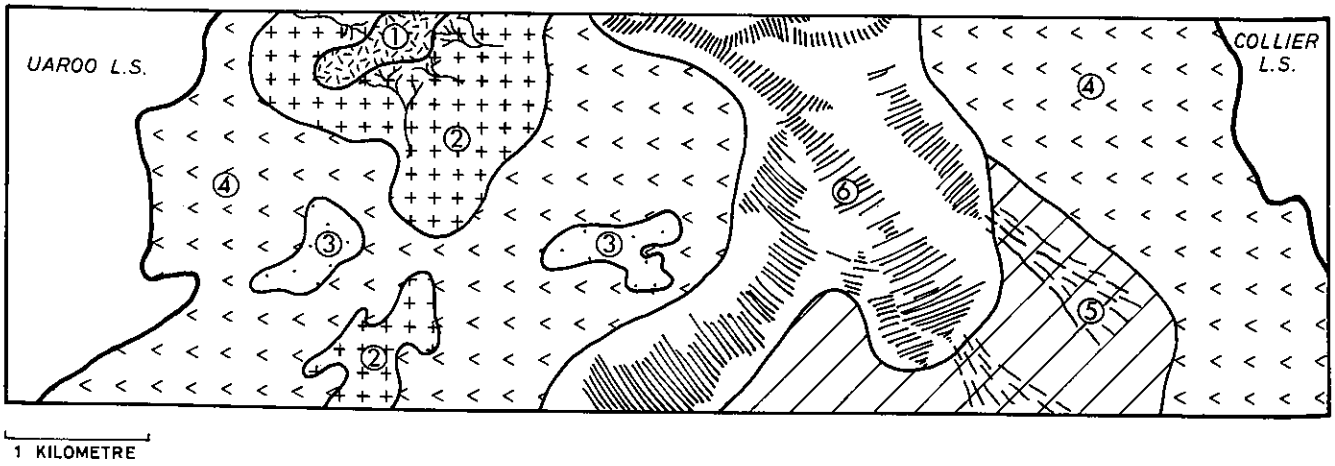
Pastoral use: Moderate productivity in favourable seasons and some drought durability conferred by areas of Soft Spinifex (SOSP) pastures and sparse palatable shrubs within units receiving run-on. The major unit (4) requires infrequent patch-burning, followed by grazing deferral, to maintain soft spinifex areas in productive condition. Unit 5 is susceptible to accelerated water erosion.

Estimated carrying capacity, good condition: 14 ha/s.u.

Range condition summary: Good 43%; fair 30%; poor 27%.

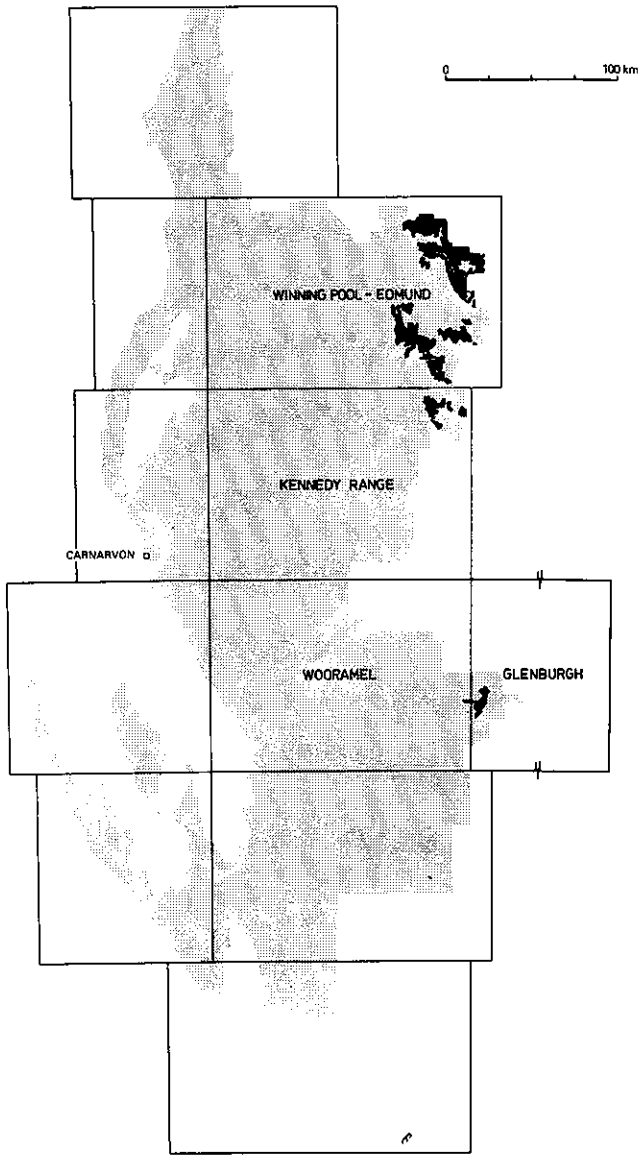
Unit

1. Hills and ridges
2. Low rises and interfluves
3. Sandy plains
4. Duplex plains
5. Drainage tracts
6. Lower plains with groved vegetation



Landform and soils	*Vegetation : formations and major species*	Comments and condition indicators
	Unit 1 Hills and ridges (1%) Traversed	
Low rocky hills and strike ridges up to 30 m above lower units. Soils are restricted to shallow pockets, probably skeletal.	Hummock grasslands dominated by *Triodia* spp or unvegetated rocky outcrop.	Pasture type: *Hard Spinifex.*
	Unit 2 Low rises and interfluves (14%) 1 site inventory and traversed	
Rounded rises and convex interfluvial areas with outcropping rocks or gravelly mantles, relief usually < 5m. Soils are dusky red duplex type, shallow to > 1 m deep, loamy sand over sandy clay loam grading to sandy clay, pH 6.5 with an alkaline trend; principal profile form: Dr 4.53.	Hummock grasslands dominated by *Triodia* spp and very scattered trees and shrubs. Trees: *Grevillea* sp.; Tall shrubs (2-4 m): *Acacia kempeana, A. tetragonophylla*; Low shrubs (1-2 m): *Eremophila fraseri, Cassia helmsii, C. desolata, Eremophila cuneifolia, Corchorus walcottii, Scaevola spinescens*; Perennial grasses: *Triodia* spp.	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 3 Sandy plains (5%) Traversed	
Restricted areas of sandy-surfaced plain. Soils are probably dark red sands grading to loams.	Hummock grasslands dominated by *Triodia* spp and very scattered tall shrubs *Acacia ancistrocarpa* and *A. inaequilatera.*	Pasture type: *Hard Spinifex.* Pastoral use limitations: None under controlled stocking.
	Unit 4 Duplex plains (50%) 2 site inventories and traversed	
Plains with flat surfaces, gently undulating, sparsely to lightly strewn with quartz gravels. Soils are dusky red duplex type 0.5 to > 1 m deep, loamy sand or sandy loam over sandy clay, quartz inclusions throughout, pH 6.5-7.0 with a neutral trend; principal profile forms: Dr 1.53, 1.52.	Hummock grasslands dominated by *Triodia* spp and very scattered shrubs. Tall shrubs (2-4 m): *Acacia inaequilatera, A. ancistrocarpa, A. victoriae*; Low shrubs (< 0.5 m): *Corchorus walcottii, C.* sp, *Cassia notabilis*; Perennial grasses: *Triodia* sp, *T. pungens, Eragrostis setifolia.*	Pasture type: *Hard Spinifex/Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking and appropriate fire management.
	Unit 5 Drainage tracts (10%) 1 site inventory and traversed	
Broad areas receiving sheet flow, surfaces mainly mounded and gently sloping, carrying rills and some channelling. Soils are dusky red duplex type, sandy loam over sandy clay; pH 6.5 with a neutral trend; principal profile form: Dr 4.12.	Scattered shrublands dominated by *Acacia* spp and *Cassia* spp. Trees: *Eucalyptus* aff. *aspera*; Tall shrubs (2-3 m): *Acacia xiphophylla, A. victoriae, A. tetragonophylla, A. aneura*; Low shrubs (< 1 m): *Cassia desolata, C. helmsii, Ptilotus obovatus, Rhagodia eremaea, Scaevola spinescens*; Perennial grasses: *Triodia* spp.	Pasture typpe: *Acacia Creek-line* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Moderate susceptibility to water erosion when degraded.
	Unit 6 Lower plains with groved vegetation (20%) Traversed	
Plains with sandy surfaces subject to sheet flow. Soils are probably gradational loams.	Narrow groves of tall shrublands oriented across the direction of flow and dominated by *Acacia subtessarogona*, with understorey shrubs and and hummock grasses *Triodia* spp.	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grass and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.

Durlacher Land System (G) 1441 km² (1.9% of survey area)



Stony plains, lower tributary drainage plains and low stony rises, supporting scattered tall shrublands of mulga and other acacias.

Geology: Lower Proterozoic adamellite, granodiorite, granite and schist with superficial Quaternary colluvium and alluvium.

Geomorphology: Mainly erosional surfaces: weathered ridges, slopes and nearly flat stony plains situated near the edges of the Lyndon Proterozoic hills, with tributary drainage systems depositing alluvium locally along dendritic drainage lines of low to moderate density; relief up to 60 m but usually lower.

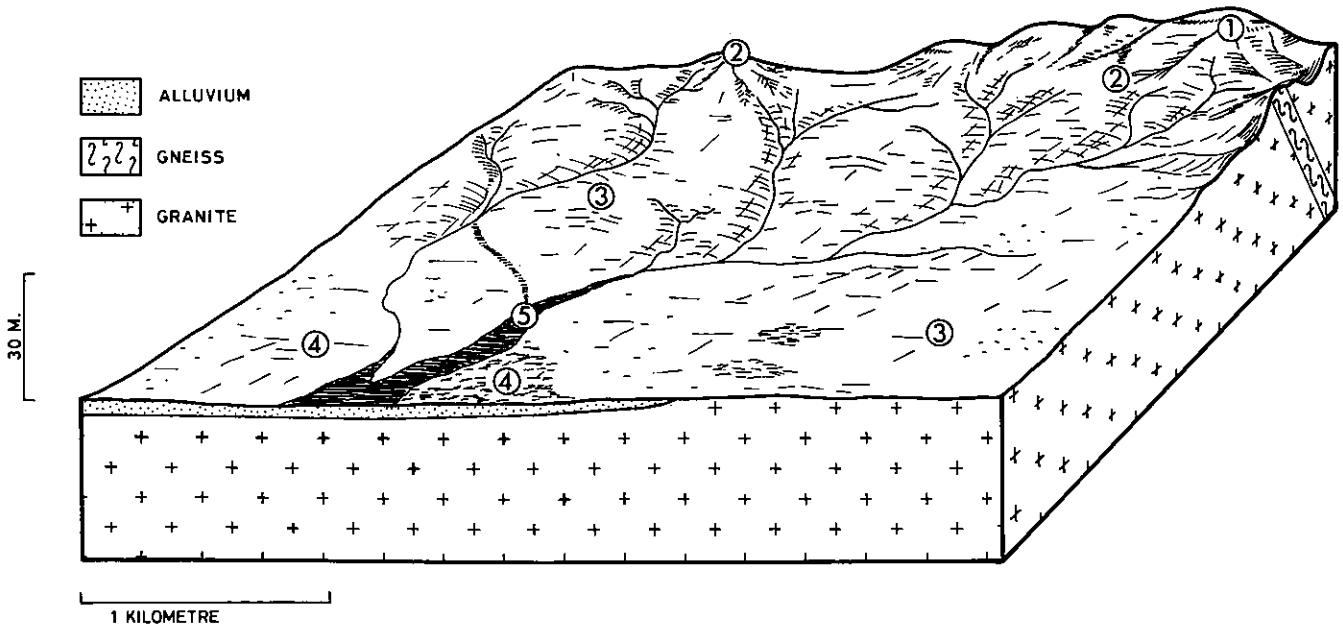
Pastoral use: Stony Chenopod (STCH) and Acacia Creek-line (ACCR) pastures on the lower units are moderately productive with many durable perennial shrubs and grasses when in good condition. Preferential use of units 4 and 5 makes them susceptible to over-use. In some areas, pasture degradation has led to serious erosion by sheeting and gullying.

Estimated carrying capacity, good condition: 12 ha/s.u.

Range condition summary: Good 16%; fair 45%; poor 39%.

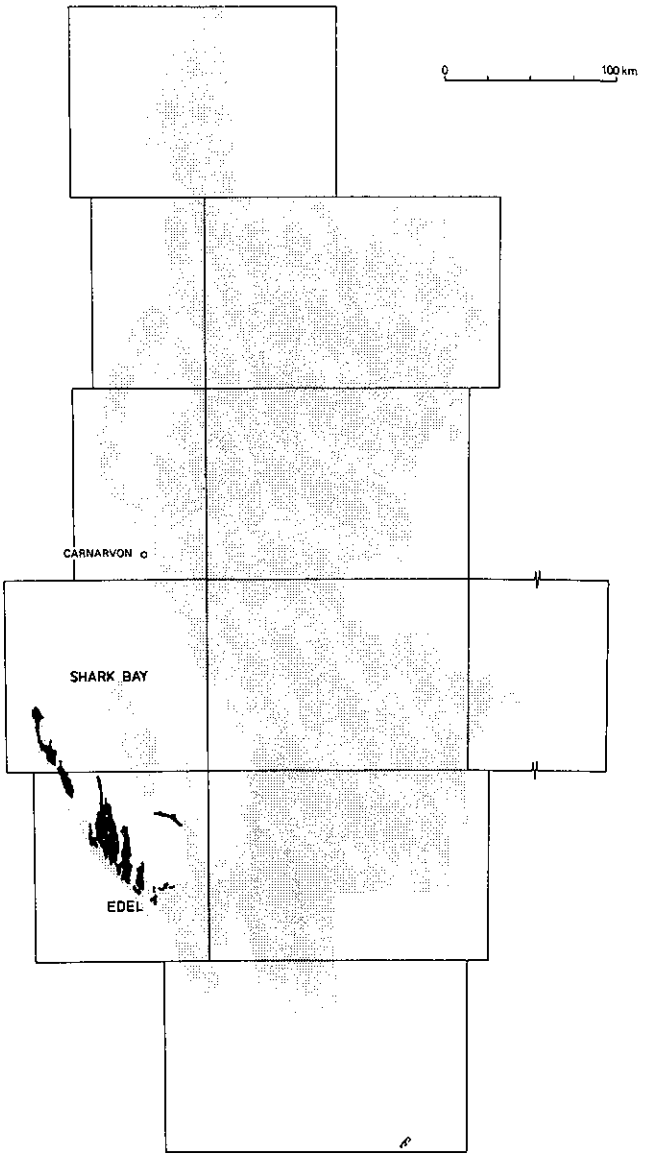
Unit

1. Low summits and ridges
2. Stony outcrops and upper
3. Stony plains
4. Tributary drainage fans and plains
5. Creek-lines and flow zones interfluves



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Low summits and ridges (10%) 1 site inventory and traversed	
Rounded summits and strike ridges, mostly 20-30 m above lower units and densely mantled by quartz pebbles or cobbles. Soils are very shallow skeletal types, dark red sandy loam, < 15 cm deep, pH 6.5; principal profile form: Uc 1.43.	Very scattered to scattered low woodlands dominated by *Acacia citrinoviridis* or *A. aneura*. Low trees and tall shrubs (2-6 m): *A. citrinoviridis, A. aneura, A. xiphophylla, Dodonaea pachyneura*; Low shrubs: *Eremophila latrobei, E. cuneifolia, Corchorus walcottii, Cassia* spp; Perennial grasses: *Eriachne helmsii, Cenchrus ciliaris.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila latrobei, Eriachne* spp. Pastoral use limitations: None under controlled stocking.
	Unit 2 Stony outcrops and upper interfluves (20%) 1 site inventory and traversed	
Gently sloping convex plains with gneissic rocky outcrops, moderately to densely mantled by quartz pebbles and cobbles. Soils are shallow loams or clays, dark red sandy clay loam or sandy clay, < 30 cm deep, pH 6.5; principal profile form: Um 1.43.	Very scattered to scattered tall shrublands or low woodlands dominated by *Acacia aneura*. Low trees and tall shrubs (2-3 m): *A. aneura, A. xiphophylla*; Low shrubs (< 2 m): *Eremophila freelingii, Ptilotus obovatus, Cassia nemophila, Maireana suedifolia, Acacia tetragonophylla.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp. Pastoral use limitations: None under controlled stocking.
	Unit 3 Stony plains (40%) 6 site inventories and traversed	
Flat plains with slopes < 0.5% (locally to 1.5%), moderately strewn with quartz gravels. Soils are dusky red or dark red duplex or clay types, sandy loams or clay loams over sandy clay loam or medium to heavy clays, pH 6.5-7.0 with a neutral trend; principal profile forms : Dr 4.12, Uf 6.11, 6.21.	Very scattered to moderately close tall shrublands dominated by *Acacia aneura* and *A. xiphophylla*. Low trees and tall shrubs (204 m; < 25-200/ha): *A. aneura, A. victoriae, A. xiphophylla, A. kempeana*; Low shrubs (0.5-1.5 m; 50-300/ha): *Maireana triptera, Eremophila cuneifolia, Corchorus walcottii, Cassia hamersleyensis, C. desolata, Scaevola spinescens, Maireana tomentosa, M. planifolia*; Perennial grasses: *Triodia pungens, Eragrostis xerophila, Cenchrus ciliaris.*	Pasture type: *Stony Chenopod. Perennials augmented by annual grasses and forbs in favourable seasons.* Desirable perennials include: *Maireana* spp, *Cassia hamersleyensis,* perennial grasses. Pastoral use limitations: Mild susceptibility to water erosion when degraded.
	Unit 4 Tributary drainage fans and plains (20%) 6 site inventories and traversed	
Depositional areas flanking the major drainage lines as narrow plains with slopes < 1%, locally with disorganised drainage foci, sparsely to lightly strewn with quartz gravels. Soils are dusky red or dark reddish-brown duplex, clay or gradational types, sandy loams or sandy clay loam over sandy clay loam to light clay, locally heavy clay, 40 cm to > 1m deep, pH 6.5-7.0 with neutral or alkaline trends; principal profile forms: Dr 4.12, 1.15, Uf 6.12, Gc 2.22.	Scattered to moderately close tall or low shrublands, usually dominated by *Acacia xiphophylla* with understorey associations including halophytic chenopods and perennial grasses. Tall shrubs (2-4 m; 75-400/ha): *A. xiphophylla, A. victoriae*; Low shrubs (< 1m; 250-23000/ha): *Atriplex bunburyana, Maireana pyramidata, Eremophila cuneifolia, Ptilotus polakii, Cassia desolata, C. hamersleyensis, Dipteracanthus corynothecus, Enchylaena tomentosa.* Perennial grasses: *Eragrostis xerophila, Enteropogon acicularis, Chrysopogon* sp.	Pasture type: *Stony Chenopod.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Maireana pyramidata, Ptilotus polakii, Cassia hamersleyensis, Frankenia* spp, *Chrysopogon* spp, *Enteropogon acicularis* Undesirable perennials include: *Acacia victoriae.* Pastoral use limitations: Moderately susceptible to water erosion when degraded.
	Unit 5 Creek-lines and flow zones (10%) 3 site inventories and traversed	
More or less channelled flow zones < 100 m wide, slopes < 0.6%. Soils vary according to their position in the narrow toposequence: dusky red or dark reddish-brown duplex, loamy or gradational types, > 1m deep but shallower within intergroves, fine sandy loams either grading to sandy clay loams and sandy clay at depth or directly over sandy clay loam, pH 5.5-6.5 with neutral or acid trends; principal profile forms: Dr 1.12, Gn 4.12, Uc 5.31.	Close tall shrublands or low woodlands either as groves or fringing communities, dominated by *Acacia aneura*, A. *xiphophylla* or *A. cuthbertsonii*. Low trees and tall shrubs (2-4 m; 250-750/ha): *A. aneura, A. xiphophylla, A. cuthbertsonii, A. subtessarogona, A. tetragonophylla, A. kempeana*; Low Shrubs (0.5-1.5 m; 500-5000/ha): *Cassia desolata, Eremophila cuneifolia, Dipteracanthus corynothecus, Eremophila leucophylla, Corchorus walcottii, Enchylaena tomentosa*; Perennial grasses: *Eriachne benthamii, E. helmsii, Chrysopogon fallax, Cenchrus ciliaris, Eragrostis xerophila.*	Pasture type: *Acacia Creek-line.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eriachne benthamii, Chrysopogon fallax, Dipteracanthus corynothecus, Eremophila latrobei.* Undesirable perennials include: *Corchorus walcottii, Solanum lasiophyllum, Cassia* spp. Pastoral use limitations: Locally susceptible to accelerated water erosion when degraded.

Edel Land System 835 km² (1.1% of survey area)



Undulating sandy plains with occasional dunes, limestone rises and saline flats; low acacia shrublands with some saltbush and heath communities.

Geology: Quaternary Tamala limestone with minor areas of mixed supra-tidal deposits and calcareous sand.

Geomorphology: Mainly depositional surfaces: undulating plains of aeolian calcareous sands with minor longitudinal dunes, small areas of outcropping limestone and saline plains with shallow sandy soils; no drainage features.

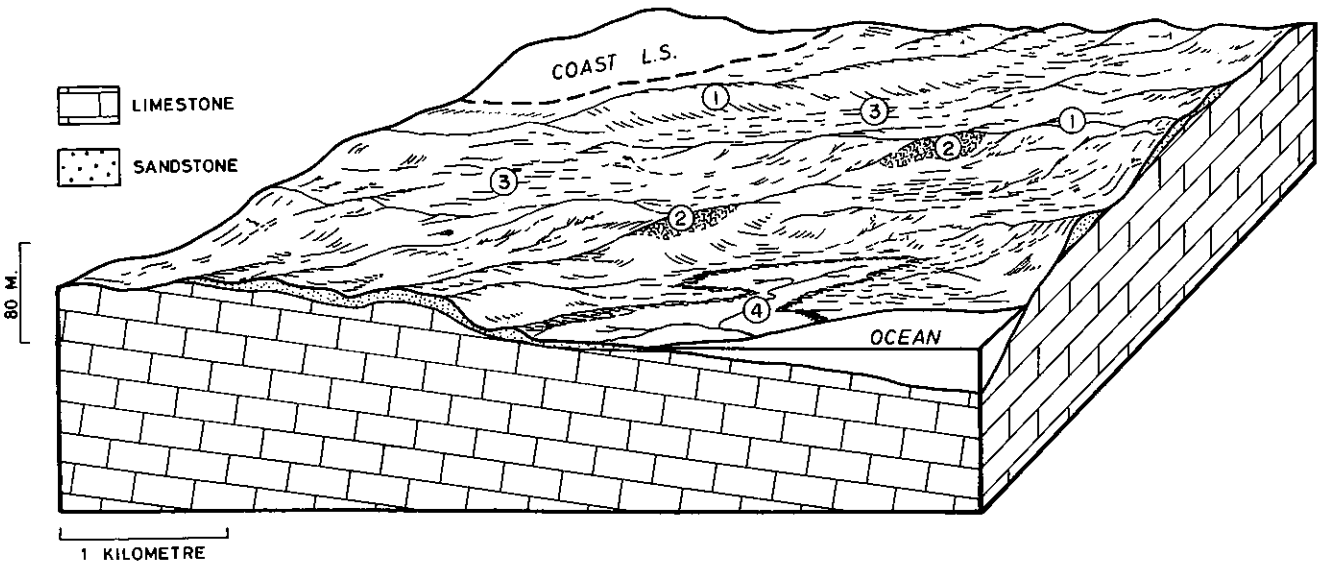
Pastoral use: Coastal Dune Shrub (CDSH) pastures with a high chenopod component together with Saltbush (SALT) pastures demand closely distributed water supplies of high quality as a pre-requisite for full use. Unit 3 is susceptible to invasion by tomato bush and unit 4 to wind erosion when locally over-used.

Estimated carrying capacity, good condition, 8 ha/s.u.

Range condition summary: Good 62%; fair 23%; poor 15%.

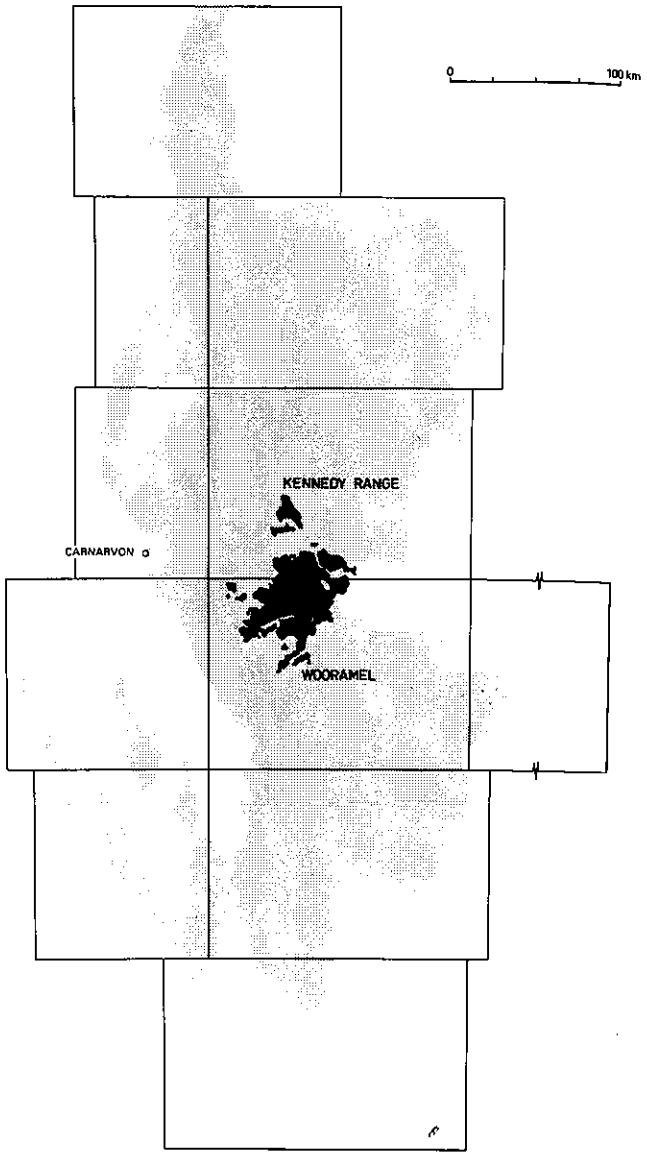
Unit

1. Longitudinal dunes
2. Stony rises and plains
3. Undulating sandy plains
4. Saline plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal dunes (5%) Traversed	
Longitudinal dunes and dune-like sandy crests over limestone ridges; relief up to 15 m. Soils are light reddish brown calcareous sands.	Close low shrublands dominated by *Acacia ligulata, Melaleuca* aff. *cardiophylla* and *Rhagodia* spp.	Pasture type: *Heath.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Stony rises and plains (10%) 3 site inventories and traversed	
Very restricted limestone plains and rises densely strewn with pebbles, cobbles or boulders, relief up to 30 m above unit 4. Soils are variable but very shallow sand, loamy sand or clayey sand, red, reddish-brown or yellowish brown with calcareous inclusions and concretions, pH 8.0-8.5 with neutral or alkaline trends; principal profile forms: Uc 1.11, 1.13, 1.23.	Very scattered to moderately close low shrublands dominated by a mixture of shrubs from both Eremaean and South-West Botanical Provinces (Beard 1976). Tall shrubs (> 2 m, < 25/ha): *Pittosporum phylliraeoides*; Low shrubs (< 1.5 m, 7,000-12,000/ha): *Pimelea* spp, *Diplolaena grandiflora, Scaevola spinescens, Atriplex bunburyana, Frankenia* spp, *Rhagodia* spp, *Dodonaea inaequifolia, Ptilotus obovatus.*	Pasture type: *Coastal Dune Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Indicators of good condition: *Atriplex bunburyana, Rhagodia* spp, *Scaevola* spp, *Enchylaena tomentosa.* Pastoral use limitations: Inadequate groundwater availability.
	Unit 3 Undulating sandy plains (80%) 16 site inventories and traversed	
Swales and undulating plains, slopes 1-8%, sparsely to moderately strewn with limestone gravels. Soils are sands or loamy sands of very variable colour, mainly yellowish-red or reddish-brown, > 1 m deep and calcareous throughout, pH 8.5-9.0 with an alkaline trend; principal profile forms: Uc 5.12, 1.12.	Scattered to closed shrublands, mainly dominated by *Acacia ligulata.* PFC 10% to > 50% except on degraded sites. Tall shrubs (2-4 m, 0-11,000/ha): *A. ligulata, A. xanthina, Exocarpos aphyllus, Pittosporum phylliraeoides, Heterodendrum oleaefolium*; Low shrubs (< 1.5 m, 1,500-15,000/ha): *Stylobasium spathulatum, Rhagodia latifolia, Ptilotus divaricatus, Threlkeldia diffusa, Pimelea microcephala, Scaevola spinescens, Atriplex bunburyana, Frankenia pauciflora*; Perennial grasses: *Stipa elegantissima, Aristida browniana, Danthonia caespitosa Triodia* spp (to 40% ground cover on Dirk Hartog I).	Pasture type: *Coastal Dune Shrub.* On degraded sites exotic annuals predominate: *Avena* spp, *Brassica tournefortii, Bromus diandrus.* Desirable perennials include: *Enchylaena tomentosa, Atriplex bunburyana.* Undesirable perennials include: *Solanum orbiculatum, Melaleuca* aff. *cardiophylla.* Pastoral use limitations: Mild susceptibility to wind erosion; inadequate groundwater availability.
	Unit 4 Saline plains (5%) 1 site inventory and traversed	
Low-lying saline plains, lightly to moderately strewn with limestone cobbles or pebbles. Soils are very shallow grey loamy sands with calcareous inclusions, pH 8.5; principal profile form: Uc 1.31.	Scattered low shrublands dominated by halophytes: *Atriplex vesicaria, Halosarcia indica, Frankenia* spp, *Maireana platycarpa, Carpobrotus* spp, *Halosarcia* spp.	Pasture type: *Saltbush.* Pastoral use limitations: High salinity levels in pasture plants.

Ella Land System 1943 km² (2.6% of survey area)



Aeolian sandplain with low dunes and sandy swales, clayey interdunal plains and discrete drainage foci; tall shrublands and low woodlands of wanyu and sand dune gidgee.

Geology: Quaternary aeolian sand and alluvial deposits of clay, silt, sand and gravel.

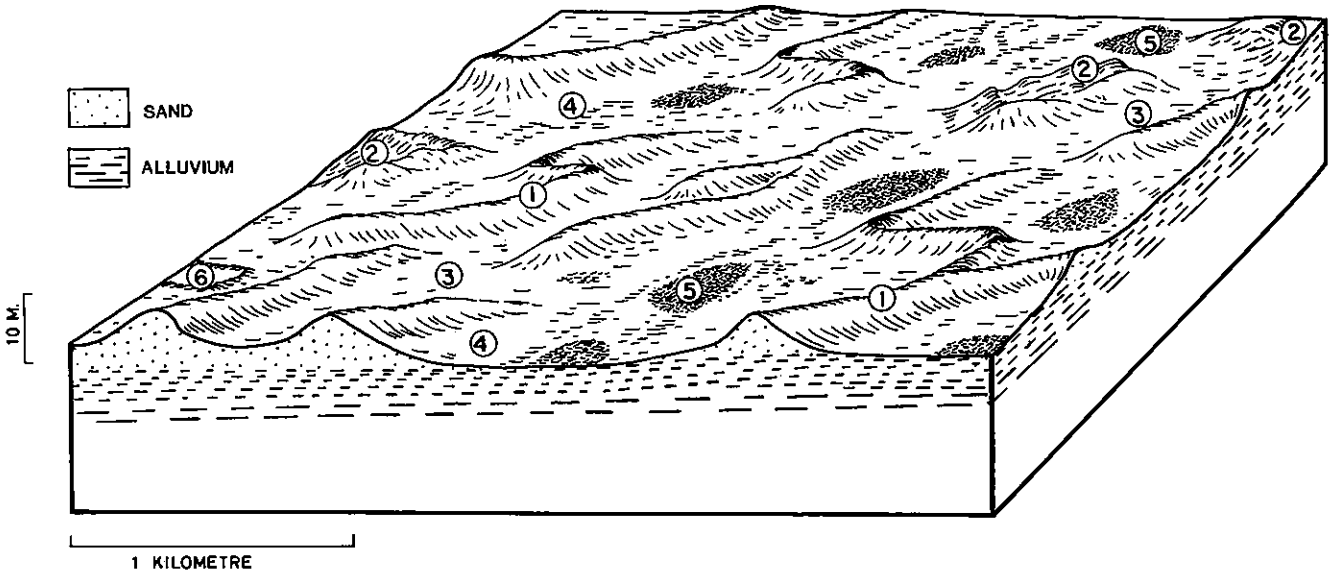
Geomorphology: Depositional surfaces: sandy plains of low relief, with sandy banks or low linear and reticulate dunes mostly 0.5-1 km apart and 6-10 m high, separated by sandy swales or plains with duplex soils and drainage foci.

Pastoral use: Acacia Sandplain (ACSA) pastures with various edible drought-resistant shrubs and sparse wanderrie grasses; unit 4 supports valuable Currant Bush Mixed Shrub (CBMS) pastures but is susceptible to invasion by inedible woody shrubs and more locally, to soil erosion.

Estimated carrying capacity, good condition: 8 ha/s.u.

Range condition summary: Good 36%; fair 42%; poor 22%.

Unit
1. Linear dunes
2. Sandy banks
3. Swales
4. Restricted plains
5. Drainage foci
6. Claypans

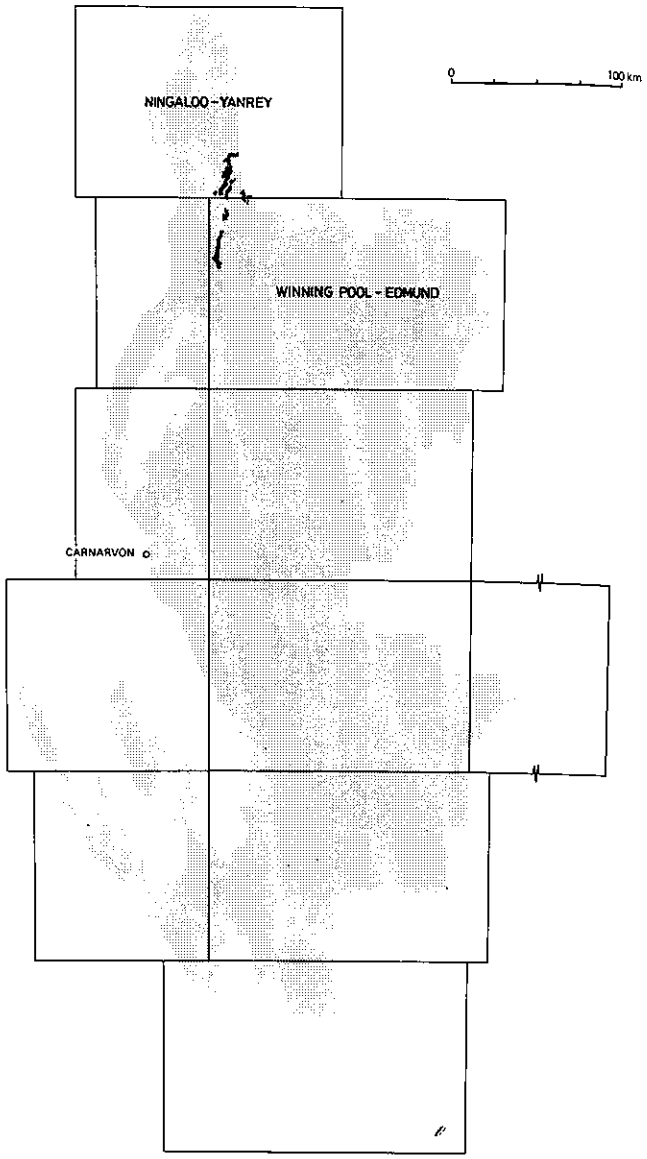


Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Linear dunes (40%) 4 site inventories and traversed	
Parallel to convergent longitudinal sand dunes mostly 6 to 15 m above surrounding swales and plains, slopes 4-10%, eastern walls steeper than western. Dune orientation approximates to SSE-NNW. Soils are unconsolidated dark red or dusky red sand, > 1 m deep, pH 6.0-7.0 with neutral or acid trends; principal profile form: Uc 1.23.	(i) Moderately close low woodlands dominated by *Acacia anastema*; or (ii) Moderately close tall shrublands dominated by *A. sclerosperma* and *A. ramulosa*. (i) Trees/tall shrubs (1100-3600/ha; 6-10 m): *A. anastema, A. ramulosa, Eremophila maitlandii, Stylobasium spathulatum*; Low shrubs (250-1500/ha; < 2 m): *Solanum lasiophyllum, Enchylaena tomentosa, Scaevola tomentosa, Cassia helmsii, Sida* aff. *virgata*; Perennial grasses: *Eragrostis lanipes*; (ii) Tall shrubs (150-225/ha; 2-4 m): *A. sclerosperma, A. ramulosa, Stylobasium spathulatum, Santalum spicatum*; Low shrubs (3000/ha; < 1.5 m): *Prostanthera wilkieana, Triumfetta chaetocarpa, Solanum lasiophyllum, Rhagodia eremaea, Enchylaena tomentosa.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Enchylaena tomentosa, Chenopodium gaudichaudianum, Eragrostis lanipes.* Undesirable perennials include: *Sida* spp. Pastoral use limitations: None under controlled stocking.
	Unit 2 Sandy banks (15%) 2 site inventories and traversed	
Sandy banks and rises up to 6 m above units 3 and 4; slopes to 3%. Soils are loamy sand or sand, > 1 m deep, pH 6.5 with a neutral trend, principal profile form: Uc 5.11.	Scattered to moderately close tall or low shrublands, with or without an upper storey of low trees. Trees (0-900/ha; 6-10 m): *A. anastema*; Tall shrubs (300-1000/ha; 2-3 m): *Eremophila maitlandii, Stylobasium spathulatum, A. sclerosperma, A. ramulosa, A. tetragonophylla*; Low shrubs (2000-3000/ha; < 2 m): *Solanum lasiophyllum, Eremophila leucophylla, Ptilotus obovatus, Chenopodium gaudichaudianum, Rhagodia eremaea, Maireana planifolia*; Perennial grasses: *Eragrostis lanipes, Eriachne helmsii.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila latrobei, E. leucophylla, Cassia chatelainiana, Maireana* spp. Undesirable perennials include: *Cassia desolata, Sida* spp. Pastoral use limitations: None under controlled stocking.
	Unit 3 Swales (15%) 3 site inventories and traversed	
Flat to gently sloping swales. Soils are dusky red gradational or duplex types, loamy sand or sandy loam over light sandy clay, > 1 m deep, pH 6.0-7.0 with neutral or alkaline trends; principal profile forms: Gn 2.12, Dr 1.12.	Scattered to close tall shrublands dominated by *Acacia subtessarogona, A. ramulosa* and *Scaevola spinescens.* Tall shrubs (100-400/ha; 2-6 m): *A. subtessarogona, A. ramulosa, A. sclerosperma, Scaevola spinescens, Hakea preissii, Eremophila maitlandii*; Low shrubs (2000-8000/ha; < 1.5 m): *Eremophila leucophylla, Ptilotus obovatus, Maireana planifolia, Rhagodia eremaea, Cassia desolata, C. helmsii, Eremophila latrobei, Chenopodium gaudichaudianum*; Perennial grasses: *Monachather paradoxa, Eriachne helmsii.*	Pasture type: *Currant Bush Mixed Shrub/ Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: as unit 2. Undesirable perennials include: *Cassia* spp, *Eremophila crenulata, Hakea preissii.* Pastoral use limitations: Mild susceptibility to increases in unpalatable shrubs.
	Unit 4 Restricted plains (20%) 5 site inventories and traversed	
Flat plains with slopes < 0.3%, generally situated between sandy banks and drainage foci. Soils are dark red or dusky red duplex, loamy sand or sandy loam over sandy clays bearing carbonate nodules, > 1 m deep, pH 6.0-7.0 with an alkaline reaction trend; principal profile forms: Dr 1.13, 1.16, Uc 5.21.	Scattered to moderately close tall shrublands, usually dominated by *Acacia xiphophylla.* Tall shrubs (0-400/ha; 2-4 m): *A. xiphophylla, A. victoriae, A. sclerosperma, Hakea preissii, Scaevola spinescens*; Low shrubs (300-3000/ha; 0.5-1.5 m): *Cassia desolata, Eremophila crenulata, Acacia tetragonophylla, Chenopodium gaudichaudianum, Eremophila leucophylla, Rhagodia eremaea, Cassia helmsii, Ptilotus obovatus*; Perennial grasses: *Monachather paradoxa, Enteropogon acicularis.*	Pasture type: *Currant Bush Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Present shrub communities may locally have replaced *Acacia xiphophylla-Atriplex bunburyana* communities as a response to over-grazing and wildfires. Desirable perennials include: *Atriplex bunburyana, Scaevola spinescens, Eremophila leucophylla, Rhagodia eremaea.* Undesirable perennials include: *Eremophila crenulata, Cassia* spp., *Hakea preissii.* Pastoral use limitations: Susceptibility to invasion by unpalatable shrubs.

Ella L.S.—Continued

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 5 Drainage foci (10%) 3 site inventories and traversed	
Flat or concave drainage floors, usually elliptical, 200-500 m long. Soils are dusky red gradational types, sandy clay loam or fine sandy clay grading to light medium clay, > 1 m deep, pH 6.0-6.5 with neutral or acid trends; principal profile forms: Gn 4.12, 3.12.	Close tall shrublands or low woodlands dominated by *Acacia subtessarogona* or *A. pruinocarpa* and *Ptilotus obovatus*. PFC 30 to 50%; Trees (0-300/ha; 4-8 m): *A. subtessarogona, A. pruinocarpa, A. ramulosa*; Tall shrubs (450-1800/ha; 2-6 m): *A. subtessarogona, A. tetragonophylla, A. ramulosa, Cassia helmsii*; Low shrubs (2500-9000/ha; < 2 m): *Ptilotus obovatus, Dodonaea viscosa, Chenopodium gaudichaudianum, Indigofera* sp., *Maireana planifolia, Abutilon* sp.	Pasture type: *Acacia Creek-line.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp., *Rhagodia* spp., *Ptilotus obovatus.* Pastoral use limitations: None under controlled stocking.
	Unit 6 Claypans (< 1%)	
Small isolated claypans.	No permanent vegetation.	

Firecracker Land System (A) 135 km² (0.2% of survey area)



Undulating limestone uplands and plains with friable soils, supporting low shrublands of Gascoyne bluebush.

Geology: Upper Cretaceous limestones: calcarenite and calcilutite.

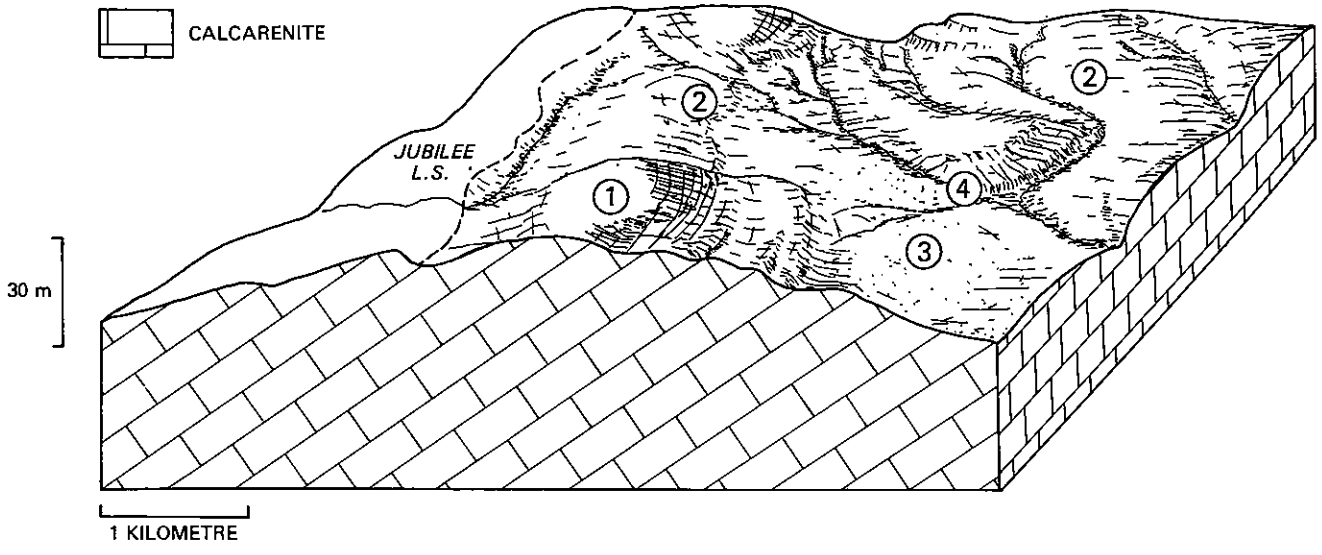
Geomorphology: Surfaces formed by partial dissection of the Giralia anticline: low hills and stony rises, upland plains and undulations, lower plains and creek-lines; drainage dendritic, incised and of moderate intensity over higher units, becoming sub-parallel and of lower intensity below; relief up to 40 m.

Pastoral use: Highly productive Bluebush (BLUE) pastures with effective drought durability when in good condition. Where heavily grazed, the plains and drainage units are susceptible to increases in undesirable tall shrubs; where pastures are degraded, soils are highly susceptible to accelerated water erosion, necessitating effective stock control and careful positioning of watering points.

Estimated carrying capacity, good condition: 5 ha/s.u.

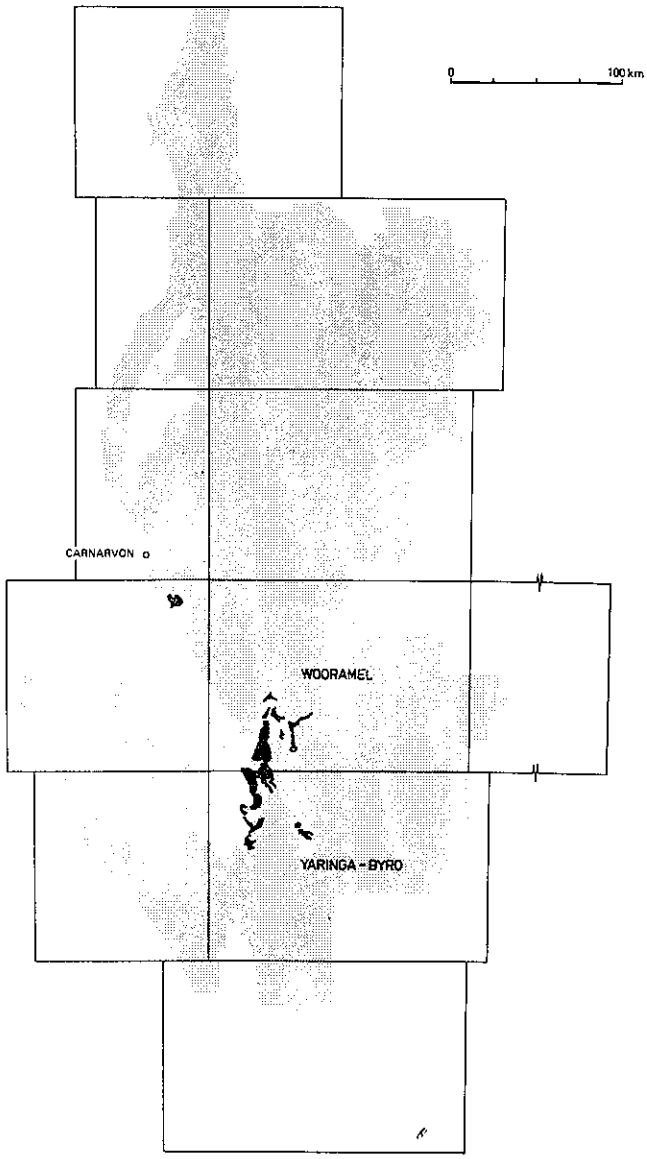
Range condition summary: Good 57%; fair 43%; poor 0%.

Unit
1. Low hills
2. Upland slopes and plains
3. Lower plains
4. Channels and creek-lines



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Long. low hills with convex to flat tops and crests up to 15 m above unit 2, flanked by concave to benched slopes of up to 10%, densely mantled by limestone fragments. Soils are probably reddish-brown to reddish-yellow silty clay or light clays, < 50 cm deep, calcareous and stony throughout principal profile form Uf 1.31.	**Unit 1 Low hills (5%) Traversed** Very scattered low shrublands dominated by *Maireana polypterygia* with or without tall shrubs *Acacia xiphophylla, A. victoriae* and *A. cuspidifolia*, or understorey hummock grasses dominated by *Triodia wiseana.*	Pasture type: *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia.* Undesirable perennials include: *Acacia victoriae, A. cuspidifolia.* Pastoral use limitations: None under controlled stocking.
Benched slopes and plains, slopes mainly 2-4% between drainage channels usually 10-15 m above unit 4. Soils are reddish-brown to reddish-yellow duplex or calcareous loamy types, sandy loam or silty loam over clay loams to clays, mostly > 1 m deep with limestone inclusions and a sparse mantle of limestone pebbles, pH 8.5; principal profile forms: Dy 1.13, Um 5.12, 5.13.	**Unit 2 Upland slopes and plains (80%) 1 site inventory and traversed** Scattered shrublands dominated by *Acacia xiphophylla* and *Maireana polypterygia.* Tall shrubs (2-3 m): *A. xiphophylla, A. victoriae, A. tetragonophylla, A. subtessarogona, A. cuspidifolia, Hakea preissii*; Low shrubs (< 2 m): *Maireana polypterygia, Atriplex bunburyana, Rhagodia eremaea, Cassia* spp, *Ptilotus obovatus, Dissocarpus paradoxus*; Perennial grasses: *Eragrostis xerophila, Cenchrus ciliaris, Triodia pungens.*	Pasture type: *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, M. platycarpa, Atriplex bunburyana.* Undesirable perennials include: *Acacia cuspidifolia, Hakea preissii.* Pastoral use limitations: Moderate susceptibility to erosion by wind and when degraded.
Flat to gently sloping plains, mostly discontinuous, sparsely mantled with limestone fragments. Soils are reddish-brown alkaline loams or loamy clays of variable depth.	**Unit 3 Lower plains (12%) Traversed** Scattered to moderately close tall shrublands dominated by *Acacia xiphophylla*; understorey shrubs *Maireana polypterygia, Atriplex bunburyana, Rhagodia eremaea, Dissocarpus paradoxus.*	Pasture type: *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, Atriplex bunburyana.* Pastoral use limitations: Moderate susceptibility to erosion by wind and water when degraded.
Dendritic to parallel incised channels and crecks, mostly 1-3 m deep and up to 20 m wide. Soils are very shallow calcareous loams, locally with decper sandy alluvium.	**Unit 4 Channels and creek-lines (3%) Traversed** Scattered tall shrublands dominated by *Acacia xiphophylla* and *A. victoriae*, with understorey chenopod shrubs *Atriplex bunburyana, Enchylaena tomentosa, Maireana* spp.	Pasture type: *Acacia Creek-line.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Moderate susceptibility to water erosion, causing gullying, on degraded areas.

Foscal Land System 446 km² (0.6% of survey area)



Calcrete mesas, buttes and dissected plateaux, stony slopes and broad low plains supporting tall and low acacia shrublands with saltbush and bluebush.

Geology: Cretaceous limestone, Tertiary calcrete and Quaternary colluvium.

Geomorphology: Erosional and depositional surfaces: dissected margins of the Carbla plateau and isolated calcrete buttes with relief up to 40 m; short, steep slopes above extensive depositional lower plains with low intensity rectangular drainage lines.

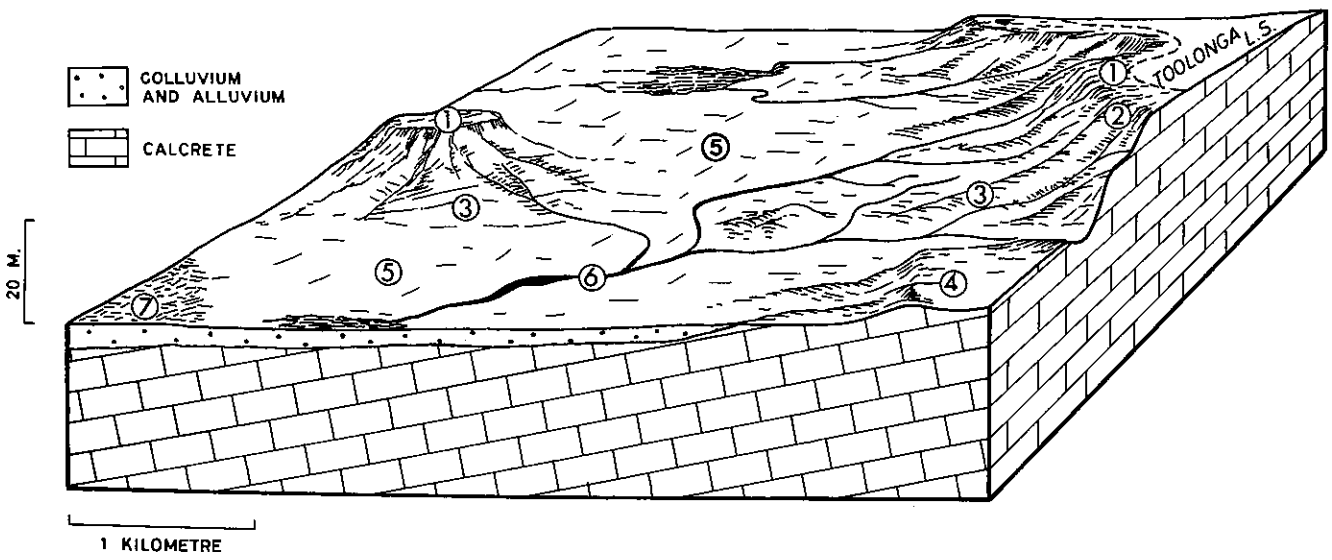
Pastoral use: Valuable Saltbush (SALT) and Bluebush (BLUE) pastures; groundwaters often brackish; over-use evident around some watering points; system not prone to accelerated erosion.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: Good 42%; fair 33%; poor 25%.

Unit

1. Mesas and plateau edges
2. Upper slopes
3. Lower slopes
4. Low rises
5. Low plains
6. Flow zones
7. Saline plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Mesas and plateau edges (10%) 2 site inventories and traversed	
Flat to gently undulating tops of dissected plateaux and mesas; slopes up to 0.3%, relief up to 50 m above lower units, sparse to moderate mantle of limestone gravel and cobbles. Soils occur as pockets of red or reddish brown sandy loam to sandy clay loam, shallow to > 1 m deep with calcareous inclusions and gypsiferous concretions, pH 8.5 with an alkaline trend; principal profile forms: Gc 1.12, 1.22.	Scattered to moderately close tall shrublands, dominated by *Acacia grasbyi*, with low shrubs usually dominated by *Eremophila leucophylla*. PFC 15 to 30%; Tall shrubs (175-200/ha; 2-3 m) : *Acacia grasbyi, A. tetragonophylla, A. victoriae, A. ligulata, A. ramulosa*; Low shrubs (1000-4500/ha; < 1 m): *Eremophila leucophylla, Atriplex vesicaria, A. bunburyana, Ptilotus obovatus, Rhagodia eremaea, Ptilotus divaricatus.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex vesicaria, A. bunburyana, Eremophila leucophylla.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Upper slopes (5%) 4 site inventories and traversed **Unit 3 Lower slopes (25%)**	
Steep (up to 100% slope) concave upper slopes with a mantle of cobbles; shallower (5-30% slope) lower slopes, sparsely strewn with pebbles or gravel. Soils are light to dark red or reddish brown gradational types, sandy clay loam to sandy clays, 40 cm to > 1 m deep with calcareous inclusions and gypsiferous concretions, pH 8.5 with an alkaline trend; principal profile forms: Gc 1.12, 1.22, 2.12, 2.22.	Very scattered to scattered shrublands dominated by either (i) *Acacia grasbyi* and *Maireana polypterygia* or (ii) low halophytes *Atriplex* spp and *Frankenia* spp. PFC 5 to 20%; Tall shrubs (0-250/ha; 2-3m): *A. grasbyi, A. tetragonophylla, A. victoriae, A. sclerosperma*; Low shrubs (1000-4000/ha; < 1 m): *Maireana polypterygia, Ptilotus obovatus, Atriplex vesicaria, Halosarcia* spp., *Rhagodia eremaea, Scaevola tomentosa, Frankenia* spp., *Atriplex nummularia*; Perennial grasses *Cenchrus ciliaris.*	Pasture type: *Bluebush/Acacia Mixed Shrub/Samphire.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, Atriplex vesicaria, A. bunburyana.* Pastoral use limitations: High salinity levels in pasture plants.
	Unit 4 Low rises (5%) 1 site inventory and traversed	
Low stony rises up to 10 m, with sparse pebble mantling. Soils occur as pockets of shallow, gradational, calcareous red sandy loams with calcrete concretions and gravel, pH 8.5 with an alkaline trend; principal profile form: Gc 1.12.	Scattered to moderately close tall or mixed shrublands, dominated by *Acacia grasbyi* with an understorey of *Atriplex bunburyana* or *Ptilotus obovatus*. Tall shrubs: *A. grasbyi, A. tetragonophylla, A. victoriae, A. galeata*; Low shrubs: *Atriplex bunburyana, Ptilotus obovatus, A. tetragonophylla, Rhagodia eremaea, Commicarpus australis, Solanum lasiophyllum, Scaevola spinescens.*	Pasture type: *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana.* Pastoral use limitations: None under controlled stocking.
	Unit 5 Low plains (50%) 5 site inventories and traversed	
Plains, nearly flat to moundy, slopes < 1.5%, sparsely strewn with limestone or calcrete gravels. Soils are red or dark red sandy-surfaced duplexes, mostly > 1 m deep, with inclusions and concretions of calcite and limestone, pH 7.0 to 8.5 with an alkaline trend; principal profile form: Dr 1.13.	Scattered to moderately close low shrublands, dominated by *Atriplex* spp., with very sparse tall shrubs, mostly *Acacia* spp. PFC 10 to 25%; Trees (< 25/ha; 2-4m): *A. sibilans, A. galeata*; Tall shrubs (25-50/ha; 2-3 m): *A. victoriae, A. sclerosperma, A. microcalyx, Heterodendrum oleaefolium, Eremophila pterocarpa, Acacia galeata*; Low shrubs (5000-17000/ha; < 1m): *Atriplex vesicaria, A. bunburyana, Maireana lanosa, Eremophila leucophylla, E. maitlandii, Ptilotus obovatus, Maireana platycarpa.*	Pasture type: *Saltbush.* Annual grasses and forbs present in favourable seasons. Desirable perennials include: *Atriplex* spp., *Maireana platycarpa, Eremophila leucophylla.* Undesirable perennials include: *Acacia victoriae.* Pastoral use limitations: Slight susceptibility to erosion when degraded; high salinity levels in pasture plants.
	Unit 6 Flow zones (5%) 1 site inventory and traversed	
Channelled or unchannelled flow zones, mostly narrow but up to 400 m wide. Soils are dark red or dark reddish brown gradational, sandy clay loam to sandy clay, < 1m deep with calcareous concretions, pH 7.5 with an alkaline trend, principal profile form: Gn 2.13.	Moderately close low shrublands, tending to form thickets, dominated by *Atriplex bunburyana* and sparse tall shrubs. PFC 25-30%; Tall shrubs: *Acacia tetragonophylla, A. ligulata, A. galeata*; Low shrubs: *Atriplex bunburyana, A. sclerosperma, Ptilotus obovatus, Solanum lasiophyllum, Chenopodium gaudichaudianum, Eremophila mackinlayi, Rhagodia eremaea.*	Pasture type: *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana.* Pastoral use limitations: High salinity levels of pasture plants.
	Unit 7 Saline plains (< 1%) Traversed	
Restricted, low lying, almost flat plains mostly very near the coast. Soils are probably red duplex types.	Very scattered to scattered low halophytic shrublands, dominated by samphires *Halosarcia* spp.	Pasture type: *Samphire.* Pastoral use limitations: Very high salinity levels of pasture plants.

Fossil Land System (G) 367 km² (0.5% of survey area)

Flat-topped sandstone hills dissected by narrow streams and drainage floors, supporting mulga shrublands.

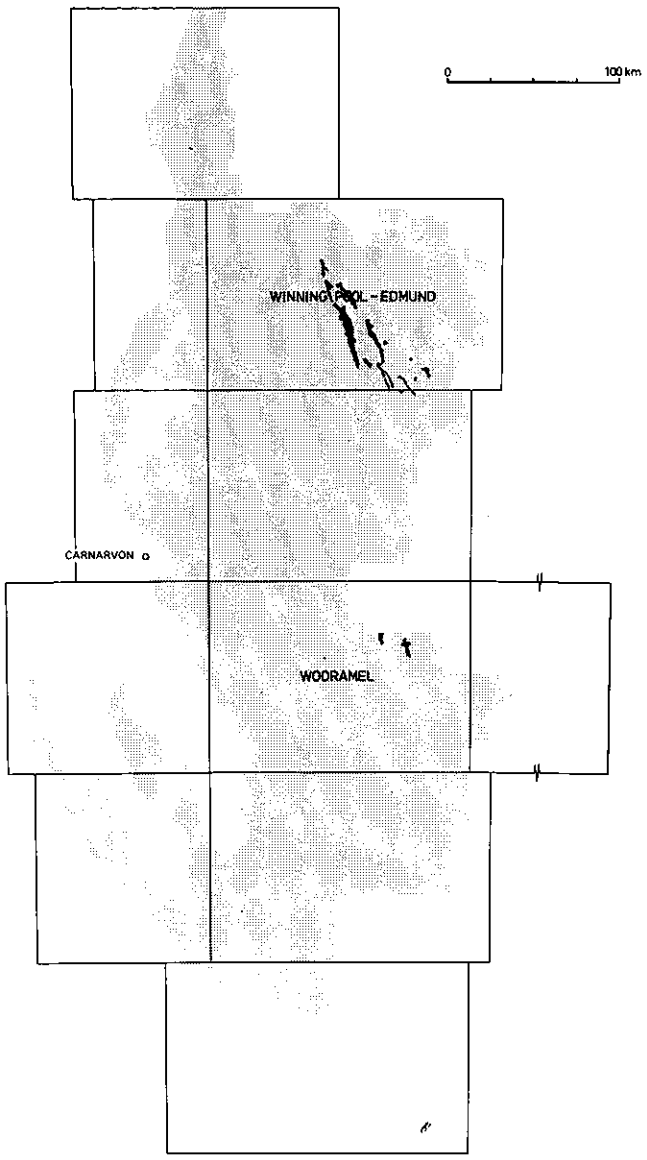
Geology: Permian sandstones of the Wooramel group, locally with Tertiary mantles on the summits.

Geomorphology: Erosional surfaces of dissected hills and mesas with stony summits up to 70 m above benched or concave slopes, parallel to rectangular drainage channels and floors.

Pastoral use: Acacia Short Grass Forb (ASGF) pastures of low seasonal productivity and very low drought reserve for stock. Some parts are not easily accessible for grazing purposes. This is a minor land system in the survey area and one inherently resistant to erosion.

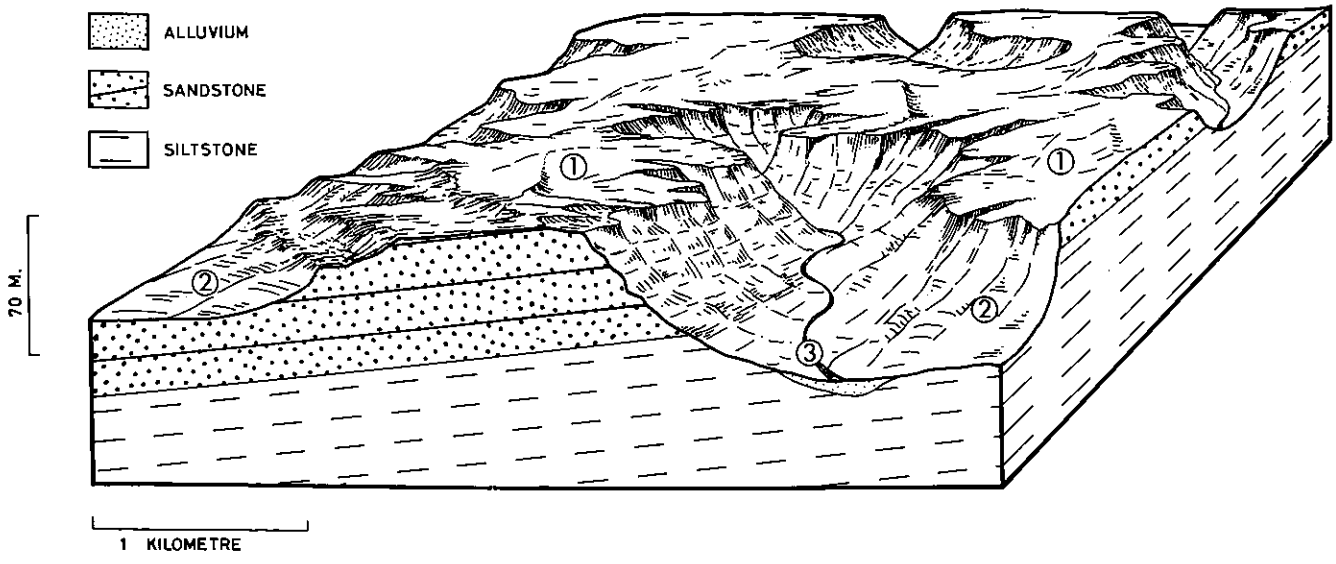
Estimated carrying capacity, good condition: 20 ha/s.u.

Range condition summary: Good 31%; fair 56%; poor 13%.



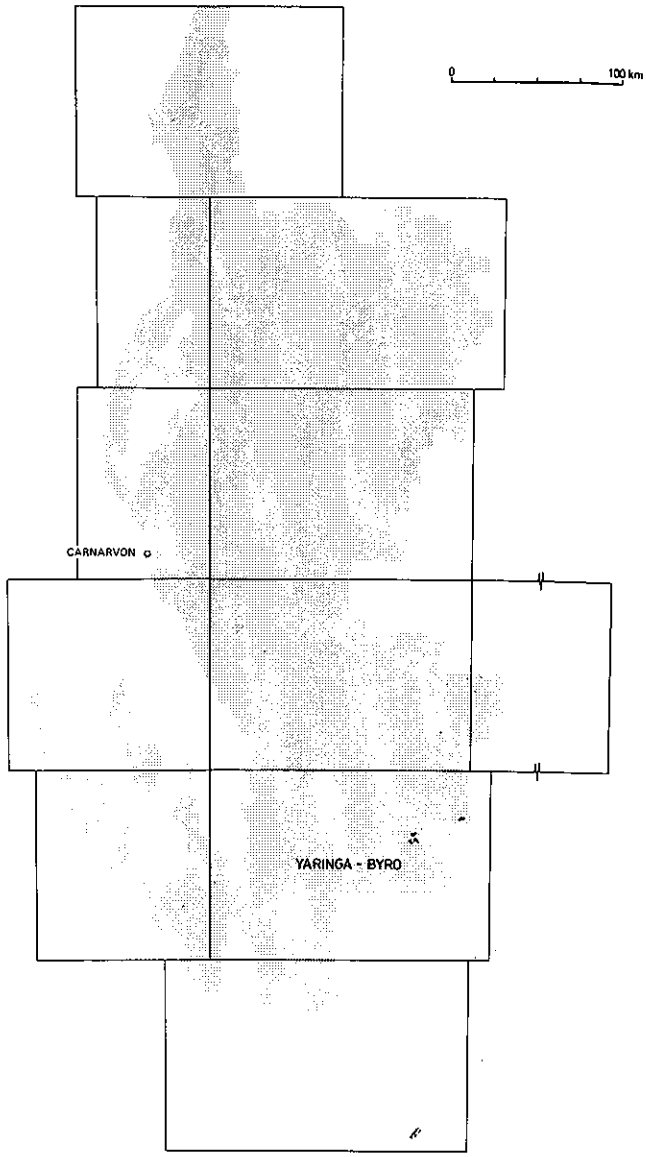
Unit

1. Hills and mesas
2. Slopes and dissected valleys
3. Channels and drainage floors



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Hills and mesas (40%) 2 site inventories and traversed	
Flat to gently undulating hilltops, densely strewn with sandstone cobbles or ferruginised silcrete, mostly 15-50 m above unit 3. Soils are very shallow reddish-brown loamy skeletal sands, pH 6.5 with a neutral trend.	Very scattered to moderately close tall shrublands dominated by *Acacia aneura* or *A. xiphophylla*. Tall shrubs (2-3m): *A. aneura, A. xiphophylla, A. ramulosa, Grevillea stenobotrya*; Low shrubs (< 1m): *Solanum lasiophyllum, Eremophila maitlandii, Sida* spp, *Ptilotus obovatus, Cassia oligophylla, Maireana tomentosa*; Perennial grasses: *Eragrostis lanipes, Monachather paradoxa, Cenchrus ciliaris, Triodia pungens*.	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Indicators of good condition: *Tribulus platypterus, Maireana tomentosa, Enchylaena tomentosa.* Pastoral use limitations: Locally inaccessible to stock.
	Unit 2 Slopes and dissected valleys (55%) 1 site inventory and traversed	
Irregular slopes, truncated or benched in accordance with the bedding sequence, sparsely to densely strewn with cobbles and pebbles. Soils are skeletal, shallow red sands, pH 6.5 with a neutral trend.	Scattered to moderately close tall shrublands dominated by *Acacia* spp. Trees (4-6m): *Acacia pruinocarpa*; Tall shrubs (4-6m): *Acacia subtessarogona, A. aneura*; Low shrubs (< 2m): *Ptilotus obovatus, Cassia helmsii, Dodonaea* spp, *Rhagodia* spp.	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Rhagodia* spp. Pastoral use limitations: None under controlled stocking.
	Unit 3 Channels and drainage floors (5%) Traversed	
Dendritic headstreams feeding rectangular patterns of channels and narrow valley floors.	Similar to unit 2.	Pasture type: *Acacia Short Grass Forb.* Pastoral use limitations: None under controlled stocking.

Garry land system 10 km² (0.01% of survey area)



Low plains with outcropping calcrete rises; a very local system supporting tall shrublands of mulga and some low shrublands of saltbush and bluebush.

Geology: Tertiary silcrete and Quaternary aeolian sand; duricrusted calcrete outcrops of uncertain age.

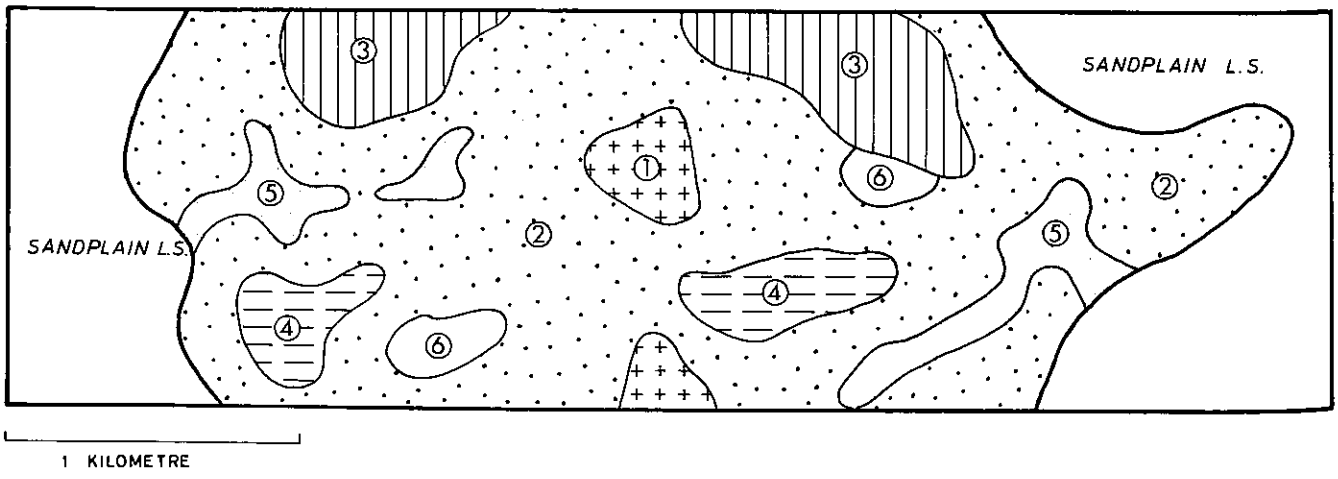
Geomorphology: Depositional surfaces: stony plains with outcropping calcrete rises, sandy banks, narrow plains receiving run-on with small claypans; relief up to 5 m.

Pastoral use: Acacia Short Grass Forb (ASGF) pastures with some small but valuable areas of Bluebush (BLUE) and Saltbush (SALT) pasture. A very minor land system that shows no susceptibility to erosion.

Estimated carrying capacity, good condition: 12 ha/s.u.

Range condition summary: good 0%; fair 100%; poor 0%

Unit
1. Calcrete rises
2. Stony plains
3. Sandy-surfaced plains
4. Plains receiving run-on
5. Sandy banks
6. Claypans



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Low calcrete rises to about 5 m above unit 2. Soils are shallow calcareous loams.	**Unit 1 Calcrete rises (5%) Traversed** Very scattered tall shrublands dominated by *Acacia tetragonophylla*. Tall shrubs: *A. tetragonophylla, A. sclerosperma, Eremophila* sp., *Scaevola spinescens.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by forbs and annuals in favourable seasons.
Gently sloping plains, sparsely to moderately strewn with silcreted sandstone or limestone pebbles and cobbles. Soils are dusky red shallow sands, loamy sand to sandy loam, pH 6.0-6.5 with a neutral trend; principal profile form: Uc 5.31.	**Unit 2 Stony plains (60%) 1 site inventory and traversed** Scattered tall shrublands or low woodlands dominated by *Acacia aneura* and *Eremophila platycalyx*. Tall shrubs (2-5 m): *A. aneura, A. ramulosa, Eremophila fraseri*; Low shrubs: *Eremophila platycalyx, Ptilotus obovatus, Acacia tetragonophylla, Maireana planifolia, Chenopodium gaudichaudianum, Solanum lasiophyllum.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by forbs and annuals in favourable seasons. Desirable perennials include: *Maireana planifolia.* Desirable perennials include: *Cassia* spp. Pastoral use limitations: None under controlled stocking.
Flat to gently sloping (< 0.5%) plains with sandy surfaces. Soils are dark red to reddish-brown shallow duplex, loamy sand over fine sandy clay, pH 7.0 with an alkaline trend; principal profile form: Dr 2.13.	**Unit 3 Sandy-surfaced plains (20%) 1 site inventory and traversed** Scattered low shrublands dominated by *Maireana pyramidata* and *Eremophila platycalyx*. Tall shrubs: *Eremophila pterocarpa, Hakea preissii*; Low shrubs: *Maireana pyramidata, Atriplex bunburyana, Maireana platycarpa, Enchylaena tomentosa, Scaevola spinescens*	Pasture type: *Bluebush* Perennials augmented by annual grasses and forbs in favourable seasons Desirable perennials include: *Maireana pyramidata, M. platycarpa, Atriplex bunburyana.* Undesirable perennials include: *Hakea preissii, Eremophila pterocarpa.* Pastoral use limitations: High salinity levels of pasture plants.
Gently sloping plains receiving run-on from units 1 and 2. Soils are probably gradational types.	**Unit 4 Plains receiving run-on (5%) Traversed** Moderately close tall shrublands dominated by *Acacia tetragonophylla, A. sclerosperma* and *Scaevola spinescens*. Low shrubs: *Ptilotus obovatus, Eremophila mackinlayi.*	Pasture type: *Acacia Mixed Shrub.*
Minor residual areas of sandy plains	**Unit 5 Sandy banks (5%) Traversed** Scattered to moderately close tall shrublands dominated by *Acacia ramulosa, A. tetragonophylla* and *Eremophila leucophylla*. Perennial grasses. *Monachather paradoxa, Eriachne helmsii.*	Pasture type: *Acacia Sandplain.*
Small claypans, sparsely strewn with pebbles or cobbles.	**Unit 6 Claypans (< 5%) Traversed** Fringes of very patchy, scattered low shrubs, mainly *Frankenia* spp or *Melaleuca uncinata.*	

Gearle land system 812 km² (1.1% of survey area)

Gently sloping alluvial plains based on Gearle siltstone supporting a grove pattern of snakewood, wait-a-while and tall and low shrublands.

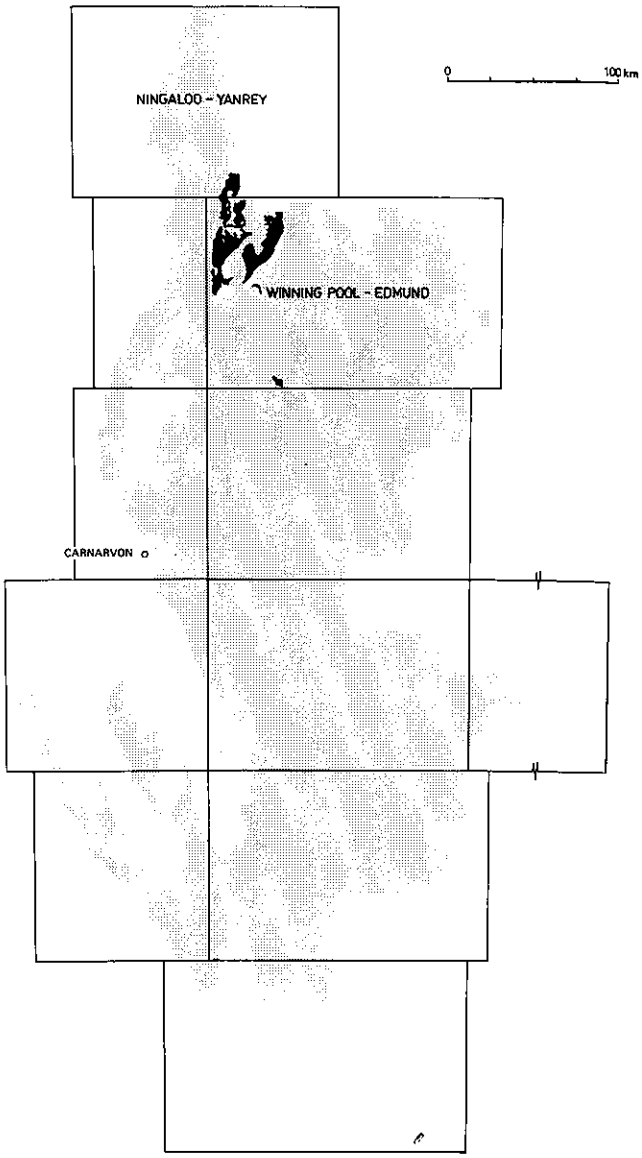
Geology: Lower Cretaceous Gearle siltstone and Windalia Radiolarite with minor Toolonga calcilutite and Quaternary alluvial and colluvial deposits.

Geomorphology: Depositional and erosional surfaces: footslopes and broad, gently sloping alluvial plains with occasional stony rises of limestone, radiolarite and chert, drainaged by more or less channelled flow zones, dendritic and of low intensity; relief mainly less than 15 m.

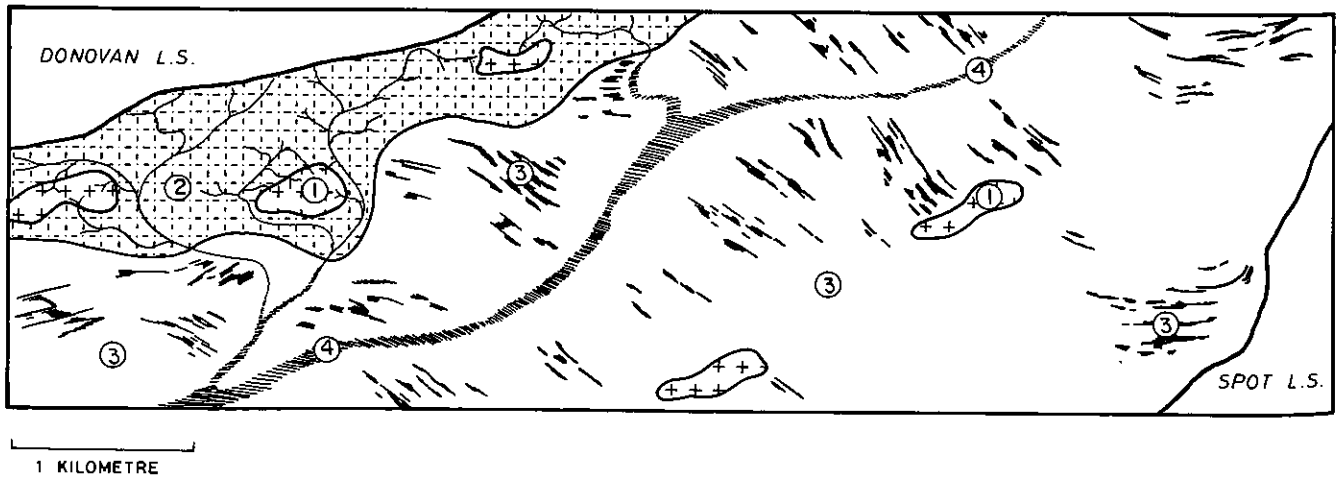
Pastoral use: Highly productive Bluebush (BLUE) and Saltbush (SALT) pastures, locally with dense tussock grasses under acacia groves and along drainage lines; major unit is susceptible to increases in undesirable shrubs and water erosion when degraded.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: good 31%; fair 28%; poor 41%.

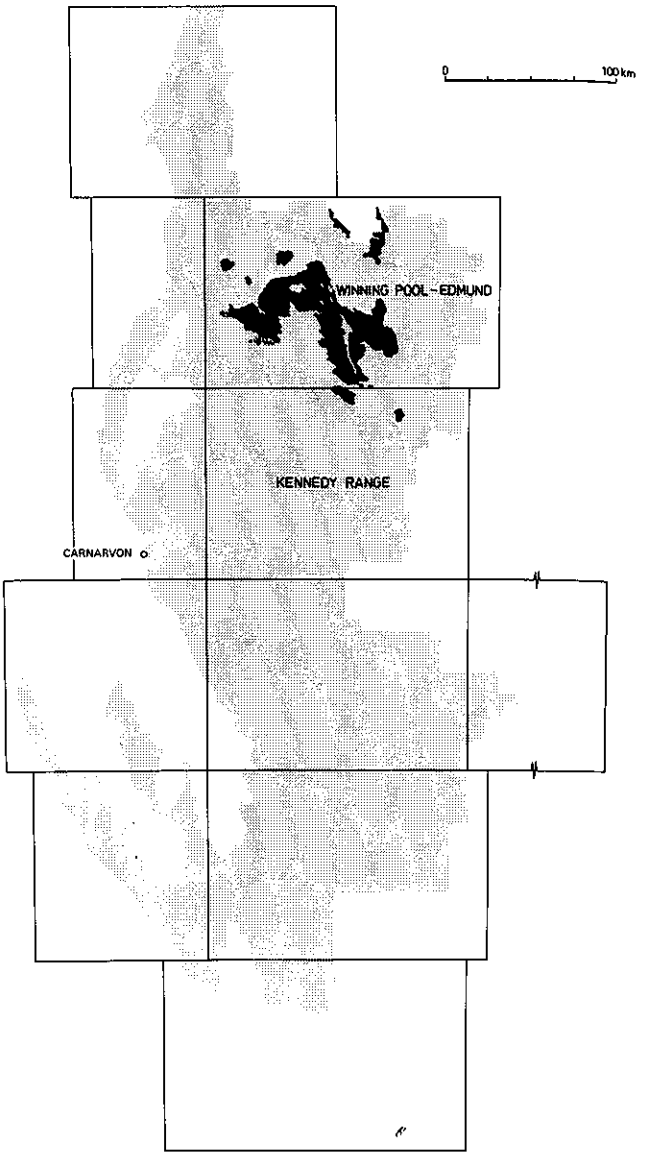


Unit
1. Stony rises
2. Footslope plains
3. Alluvial plains
4. Drainage flow zones



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Stony rises (5%) 1 site inventory and traversed	
Low rises, up to 10 m above units 2 or 3 and mainly 0.5-1 km long, moderately to heavily strewn with limestone and radiolarite gravels and pebbles. Soils are dark red calcareous loams, shallow to full depth, fine sandy clay loam grading to light clays, pH 8.5 with an alkaline trend; principal profile form: Gc 2.22.	Scattered low shrublands dominated by *Melaleuca* aff. *cardiophylla* or *Maireana polypterygia*. Low shrubs (1-2 m): *Melaleuca* aff. *cardiophylla, Maireana polypterygia, Cassia desolata, Acacia bivenosa, A. victoriae*; Perennial grasses: *Triodia lanigera.*	Pasture type: *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, Scaevola* spp. Pastoral use limitations: None under controlled stocking.
	Unit 2 Footslope plains (15%) 5 site inventories and traversed	
Gently sloping plains below the rises, slopes 0.5-3%, with flat to slightly mounded surfaces, lightly strewn with gravels. Soils are calcareous loams or loamy-surfaced duplex types: red to reddish-brown fine sandy loams overlying or grading to sandy clays, mainly > 1 m deep, with calcareous inclusions through subsoil horizons, pH 8.0-8.5 with an alkaline trend; principal profile forms: Gc 1.12, 1.21, 2.21, Dr 1.13, 2.13.	Very scattered to scattered low shrublands dominated by *Maireana polypterygia* and sparse tall shrubs. PFC 5 to 15%. Trees (0-25/ha; 2-4 m): *Acacia cuspidifolia*; Tall shrubs (0-200; 2-3 m): *A. victoriae, Heterodendrum oleaefolium*; Low shrubs (200-3000/ha; < 1 m): *Maireana polypterygia, Eremophila latrobei, Atriplex vesicaria, Solanum lasiophyllum, Maireana tomentosa*; Perennial grasses: *Cenchrus ciliaris, Eragrostis xerophila, E. setifolia.*	Pasture type: *Bluebush* or *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, Eremophila latrobei, Atriplex vesicaria, Eragrostis* spp. Undesirable perennials include: *Solanum lasiophyllum.* Pastoral use limitations: Slight susceptibility to water erosion when degraded.
	Unit 3 Alluvial plains (75%) 9 site inventories and traversed	
Flat to gently sloping (< 1.5%) plains, mostly lightly strewn with siltstone or radiolarite gravels. Soils are red to reddish-brown duplex or loams, mainly > 1 m deep, sands over sandy clays or loams grading to clay loams, usually with fragments of sedimentary rocks throughout the profile, pH 7.0-8.5 with neutral or alkaline trends; principle profile forms: Dr 1.12, 4.12, Um 6.42, 6.33, 5.12, Gc 1.22, 2.22.	Mainly moderately close tall shrublands in well-defined groves arranged at right angles to the direction of drainage, interrupting broad plains of low shrubs. Trees (0-150/ha; 2-4 m): *Acacia cuspidifolia*; Tall shrubs (0-300/ha, 2-4 m): *A. tetragonophylla, A. victoriae, A. subtessarogona, A. xiphophylla, Heterodendrum oleaefolium*; Low shrubs (200-12000/ha; < 2 m): *Atriplex bunburyana, A. vesicaria, Maireana polypterygia, M. tomentosa, Cassia helmsii, Ptilotus obovatus*; Perennial grasses: *Cenchrus ciliaris, Eragrostis setifolia, E. xerophila.*	Pasture type: *Bluebush* or *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex* spp, *Maireana* spp, *Eragrostis* spp. Undesirable perennials include: *Cassia desolata, Acacia victoriae, A. cuspidifolia* (on intergrove plains). Pastoral use limitations: Moderate susceptibility to water erosion when degraded.
	Unit 4 Drainage flow zones (5%) 1 site inventory and traversed	
Sluggish flow zones, mainly 50-100 m wide, more or less incised and channelled. Soils are heavy juvenile types: greyish-brown silty clays over gravels and heavier clays, > 1 m deep, pH 8.0.	Very scattered low woodlands with tall shrubs over tussock grasses dominated by *Eucalyptus coolabah, Acacia farnesiana* and *Cenchrus ciliaris*. Trees (8-10 m): *Eucalyptus coolabah*; Tall shrubs (3-4 m): *Acacia farnesiana, A. tetragonophylla, A. coriacea, A. sclerosperma*; Low shrubs (< 2 m): *Scaevola spinescens, Atriplex bunburyana*; Perennial grasses: *Cenchrus ciliaris, Chrysopogon fallax, Eulalia fulva, Enteropogon acicularis, Themeda australis.*	Pasture type: *Tussock Grass.* Desirable perennials include: *Chrysopogon fallax, Atriplex bunburyana.* Pastoral use limitaitons: None under controlled stocking.

Giralia land system 2262 km² (3.0% of survey area)



Linear dunes and broad sandy swales supporting hummock grasslands of hard and soft spinifex with scattered acacia shrubs.

Geology: Quaternary aeolian sand, colluvium and mixed deposits.

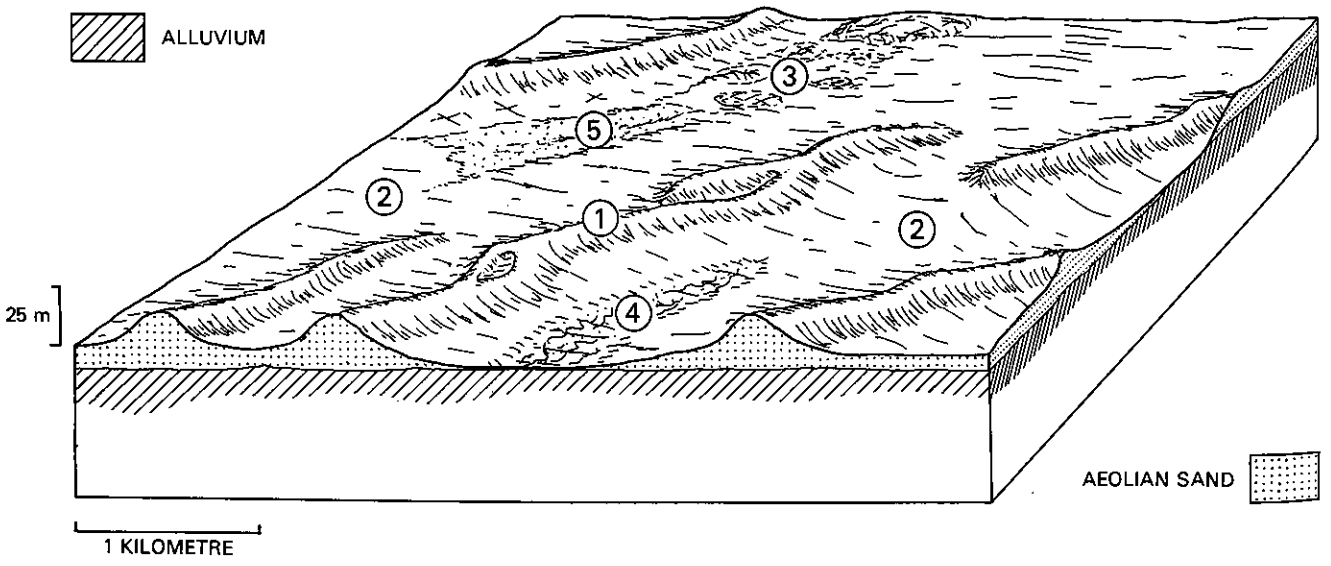
Geomorphology: Depositional surfaces - sandplains of low relief, with very long, parallel, linear dunes mostly 15-25 m high and about 2 km apart. Drainage is mostly internal by low intensity drainage floors and broad unchannelled flow zones.

Pastoral use: Hard Spinifex (HASP) and Soft Spinifex (SOSP) pastures, of which most of the latter occurs on dunes, calcrete plains and areas receiving run-on. Further north and east, such hummock grasslands have been shown to be most productive for pastoral purposes when burnt every 4-5 years and followed by a short grazing deferment.

Estimated carrying capacity, good condition: 10 ha/s.u.

Range condition summary: good 96%; fair 4%; poor 0%.

Unit
1. Longitudinal dunes
2. Swales and sandy-surfaced plains
3. Calcrete plains
4. Flow zones
5. Narrow drainage floors



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal dunes (15%) Traversed	
Longitudinal dunes, mostly linear and parallel, oriented NNW-SSE, 15-30m high, western walls steeper slope (< 25%) than eastern (< 15%). Soils are dark red unconsolidated sand, > 1m deep, pH 5.5-7.0; principal profile form: Uc 1.23.	Hummock grasslands dominated by *Plectrachne schinzii*. Tall or low shrubs: *Grevillea gordoniana*, *Pityrodia* spp, *Tephrosia* spp; Hummock grasses: *Plectrachne schinzii*, *Triodia pungens*.	Pasture type: *Soft Spinifex*. Perennials augmented by annual grasses and forbs infavourable seasons. Desirable perennials include: *Plectrachne schinzii*, *Triodia pungens*. Pastoral use limitations: Mild susceptibility to wind erosion immediately after fire.
	Unit 2 Swales and sandy-surfaced plains (70%) Traversed	
Broad sandy swales and interdunal plains, flat or gently sloping (< 2%). Soils are dark red sands, locally with loamy or clayey subsoils, > 1 m deep, pH 5.5 with a neutral trend; principal profile forms: Uc 5.11, 5.21, Gn 1.11, 1.12.	Hummock grasslands dominated by *Triodia lanigera*. Tall or low shrubs: *Acacia sclerosperma*, *A. ancistrocarpa*, *A. inaequilatera*, *A. translucens*, *A. victoriae*, *Eremophila leucophylla*; Hummock grasses: *Triodia lanigera*, *T. wiseana*, *T. pungens*.	Pasture type: *Hard Spinifex*. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila leucophylla*, *Triodia pungens*. Pastoral use limitations: None under controlled stocking.
	Unit 3 Calcrete plains (5%) Traversed	
Interdunal plains with stony or mounded surfaces, flat or gently sloping (< 2%). Soils are dark red shallow loamy sands overlying calcrete.	Hummock grasslands dominated by *Triodia pungens*. Tall or low shrubs: *Acacia bivenosa*, *Cassia* spp, *Chorizema ericifolia*, *Calytrix* spp; Hummock grasses: *Triodia pungens*.	Pasture type: *Soft Spinifex*. Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 4 Flow zones (10%) Traversed	
Interdunal corridors carrying through drainage, mostly almost flat and unchannelled; soils are dark red sands, or red earths, locally calcareous.	Moderately close tall shrublands dominated by *Acacia* spp with understorey hummock grasses. Trees: *Eucalyptus coolabah*; Tall shrubs: *Acacia sclerosperma*, *A. inaequilatera*, *A. victoriae*; Hummock grasses: *Triodia pungens*.	Pasture type: *Soft Spinifex*. Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitaitons: None under controlled stocking.
	Unit 5 Narrow drainage floors (< 1%) Traversed	
Unchannelled drainage floors receiving run-off from calcrete plains. Soils are dusky red alkaline clays.	Variable shrublands with hummock and tussock grasses.	Pasture type: *Soft Spinifex*. Pastoral use limitations: None under controlled stocking.

Glenburgh land system (G) 35 km² (0.05% of survey area)

Rugged granite hills, stony uplands and lower plains supporting scattered tall shrublands of mulga and other acacias.

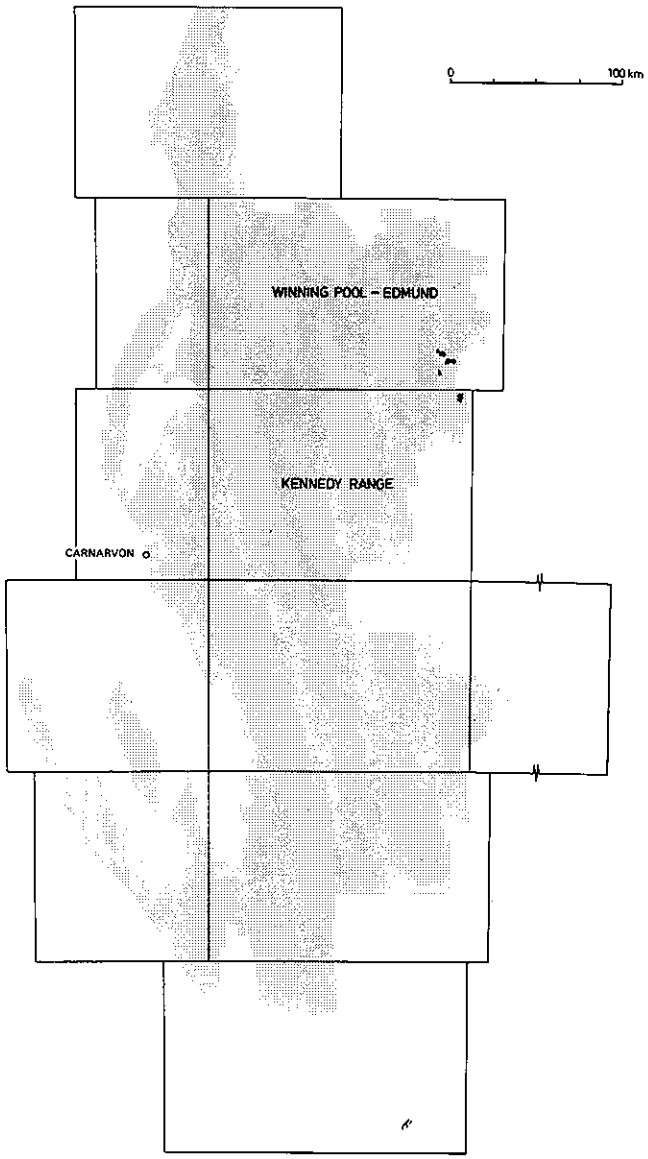
Geology: Lower Proterozoic schist, granite and granodiorite with quartz intrusions.

Geomorphology: Erosional surfaces: granite hills and outcrops above intrusive dykes, slopes, relatively unweathered tors, narrow plains and drainage lines; drainage channelled, dendritic to rectangular and sub-parallel, of low to moderate density; relief up to 90 m.

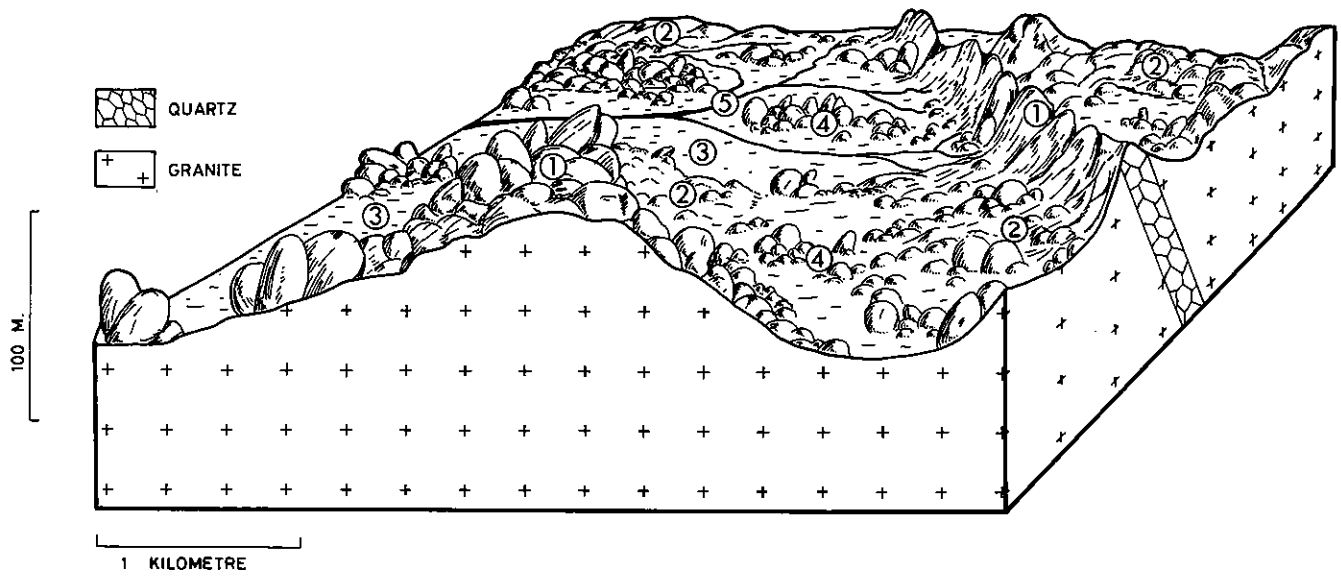
Pastoral use: Stony Short Grass Forb (SSGF) pastures supporting useful annuals and ephemerals in favourable seasons, but otherwise only sparse and patchy edible perennials. The lower units are susceptible to accelerated water erosion when degraded; the rocky upper units have limited access and very low pastoral value.

Estimated carrying capacity, good condition: 25 ha/s.u.

Range condition summary: good 100%; fair 0%; poor 0%.



Unit
1. Peaks and intrusive dykes
2. Hill slopes and interfluves
3. Plains between tors and outcrops
4. Tor fields
5. Drainage lines



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Peaks and intrusive dykes (30%)	
Peaks, hilltops and bare rocky summits, with or without quartz mantles shed from frequently intruding dykes. Soils are limited to pockets of skeletal coarse sands.	Very scattered low shrublands dominated by *Acacia aneura* occur over some areas, otherwise little or no perennial vegetation.	Pasture type: *Stony Short Grass Forb.* Pastoral use limitations: Inaccessibility and very low value to stock.
	Unit 2 Hill slopes and interfluves (40%)	
Rocky slopes and interfluves, with or without quartz mantles. Soils are limited to shallow pockets of sands.	Very scattered low shrublands dominated by *Acacia tetragonophylla* and *Cassia* spp. Low shrubs: *A. tetragonophylla*, *A. quadrimarginea*, *Eremophila platycalyx*, *Cassia helmsii*, *Dodonaea* sp.	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Low pastoral value.
	Unit 3 Plains between tors and outcrops (15%)	
Narrow plains and strewn slopes (up to 5% slope). Soils are reddish-brown sands, shallow to > 1 m deep.	Very scattered tall shrublands dominated by *Acacia aneura*. Tall shrubs: *A. aneura*, *Hakea lorea*; Low shrubs: *Eremophila fraseri*, *Solanum lasiophyllum*; Perennial grasses: *Triodia* sp. *Cymbopog on* sp.	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses in favourable seasons. Pastoral use limitations: Mild susceptibility to water erosion when degraded.
	Unit 4 Tor fields (10%)	
Granitic tors and boulder outcrops.	Fringing vegetation, similar to unit 2.	Pasture type: *Stony Short Grass Forb.* Pastoral use limitations: None under controlled stocking.
	Unit 5 Drainage lines (5%)	
Channelled drainage lines and banks initially sub-rectangular, converging to sub-parallel creek-lines. Soils are bedloads of coarse sands and cobbles.	Fringing tall shrublands dominated by *Acacia aneura*.	Pasture type: *Acacia Short Grass Forb.* Pastoral use limitations: Mild susceptibility to accelerated water erosion when degraded.

Gneudna land system 81 km² (0.1% of survey area)

Plains with calcareous soils and parallel bands of siltstone and limestone outcrop, supporting sparse shrublands of acacia and bluebush.

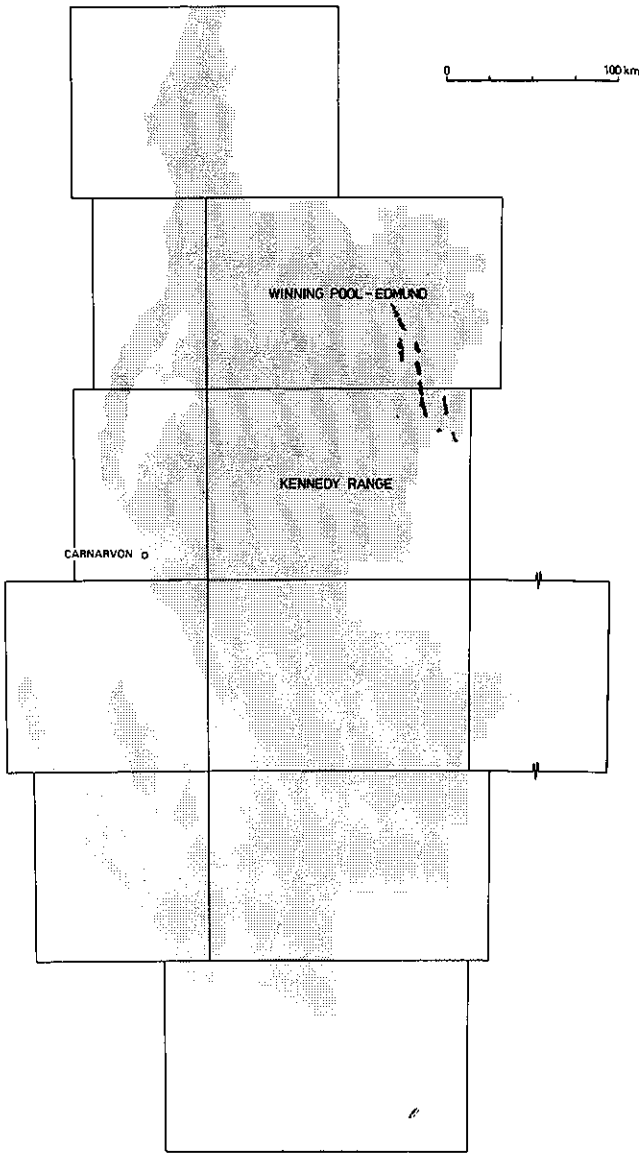
Geology: Devonian siltstone, calcarenite, calcilutite, calcirudite and dolomite.

Geomorphology: Mainly erosional surfaces: plains of low relief characterized by narrow parallel surface outcrops of siltstone and limestone, with areas of loamy plains, draining through channelled flats into small drainage foci; relief up to 3 m.

Pastoral use: Stony Chenopod (STCH) and Bluebush (BLUE) pastures, partly degraded to Stony Short Grass Forb (SSGF) pastures with much reduced drought durability and prone to soil erosion through the spread of drainage channelling and rilling over degraded areas; a very localized and minor system within the survey area.

Estimated carrying capacity, good condition: 7 ha/s.u.

Range condition summary: good 5%; fair 36%; poor 59%.



Unit
1. Sandy banks
2. Outcrop plains
3. Loamy plains
4. Drainage plains
5. Narrow channels
6. Drainage foci

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Sandy banks (3%) Traversed	
Occasional sandy banks and small sand sheets, relief < 1 m.	Scattered shrublands dominated by *Acacia linophylla/ramulosa* and *Eremophila leucophylla.*	Pasture type: *Acacia Sandplain.*
	Unit 2 Outcrop plains (50%) 1 site inventory and traversed	
Plains with flat to mounded surfaces, slopes 1-2%, sparsely strewn with limestone gravels and dissected by siltstone or limestone outcrop. Soils are red loamy sands to sandy loams, < 50 cm deep, with limestone inclusions throughout, pH 8.5 with an alkaline trend; principal profile form: Uc 5.21.	Scattered to close tall shrublands dominated by *Acacia xiphophylla* or *A. victoriae* and *A. cuthbertsonii*, with an understorey dominated by *Maireana polypterygia* or *Cassia desolata.* Tall shrubs (2-4m): *Acacia xiphophylla, A. victoriae, A. cuthbertsonii*; Low shrubs (< 2 m): *Cassia desolata, C. helmsii, Ptilotus obovatus, Acacia bivenosa, Rhagodia eremaea, Maireana polypterygia.*	Pasture type: *Stony Chenopod.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials inlcude: *Maireana polypterygia, M. planifolia.* Undesirable perennials include: *Acacia cuspidifolia, Cassia* spp. Pastoral use limitations: None under controlled stocking.
	Unit 3 Loamy plains (30%) 1 site inventory and traversed	
Plains with flat surfaces, slopes 1-2%, very sparsely strewn with gravels. Soils are red gradational loams with light clay subsoils, > 50 cm deep with ironstone and quartz inclusions, pH 8.5 with an alkaline trend; principal profile form: Gc 1.22.	Very scattered to scattered low woodlands or tall shrublands dominated by *Acacia cuspidifolia.* Trees (2-5m): *A. cuspidifolia, Heterodendrum oleaefolium*; Tall shrubs (2-3m): *Acacia xiphophylla, A. victoriae*; Low shrubs (< 1 m): *Maireana polypterygia, M. tomentosa, M. planifolia, Enchylaena tomentosa, Rhagodia eremaea, Eremophila cuneifolia, Cassia desolata, C. helmsii.*	Pasture type: *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp. Undesirable perennials include: *Cassia* spp. Pastoral use limitations: Mild susceptibility to water erosion when degraded.
	Unit 4 Drainage plains (15%) Traversed	
Restricted plains receiving run-on from units 2 and 3, almost flat but with surfaces commonly rilled and channelled by surface flows. Soils are sandy-surfaced gradational or duplex types.	Very scattered to scattered shrublands dominated by *Acacia* spp. Tall shrubs (> 2 m): *A. victoriae, A. xiphophylla, A. sclerosperma*; Low shrubs (< 2 m): *Cassia desolata, Eremophila cuneifolia, Rhagodia eremaea.*	Pasture type: formerly *Bluebush*, now degraded and effectively *Acacia Short Grass forb.* Desirable perennials include: *Maireana* spp. Pastoral use limitations: Moderate susceptibility to water erosion when degraded.
	Unit 5 Narrow channels (1%) Traversed	
Dendritic drainage channels, incised to < 50 cm, of moderate intensity.	Fringing vegetation similar to unit 4.	
	Unit 6 Drainage foci (1%) Traversed	
Small drainage foci with clay soils to 3m below unit 2.	Close shrublands dominated by *Acacia victoriae.*	

Inscription land system 152 km² (0.2% of survey area)

Gently undulating sandy plains, with limestone at shallow depth, bounded by sea cliffs and narrow beaches; shallow alkaline sands support heath vegetation with patches of taller acacia shrubs; restricted to Dirk Hartog Island.

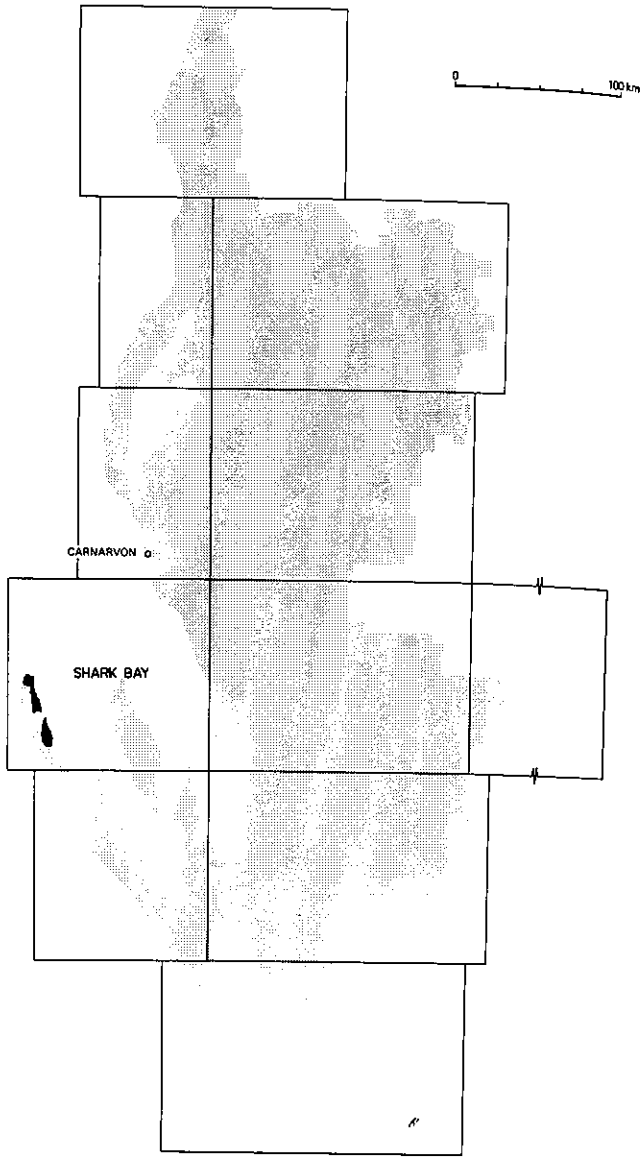
Geology: Quaternary limestones.

Geomorphology: Erosional surfaces: gently undulating plains of limestone with thin sand cover, minor outcrop plains, sea cliffs and wave cut platforms, relief mostly less than 20 m, but cliffs up to 40 m above sea level.

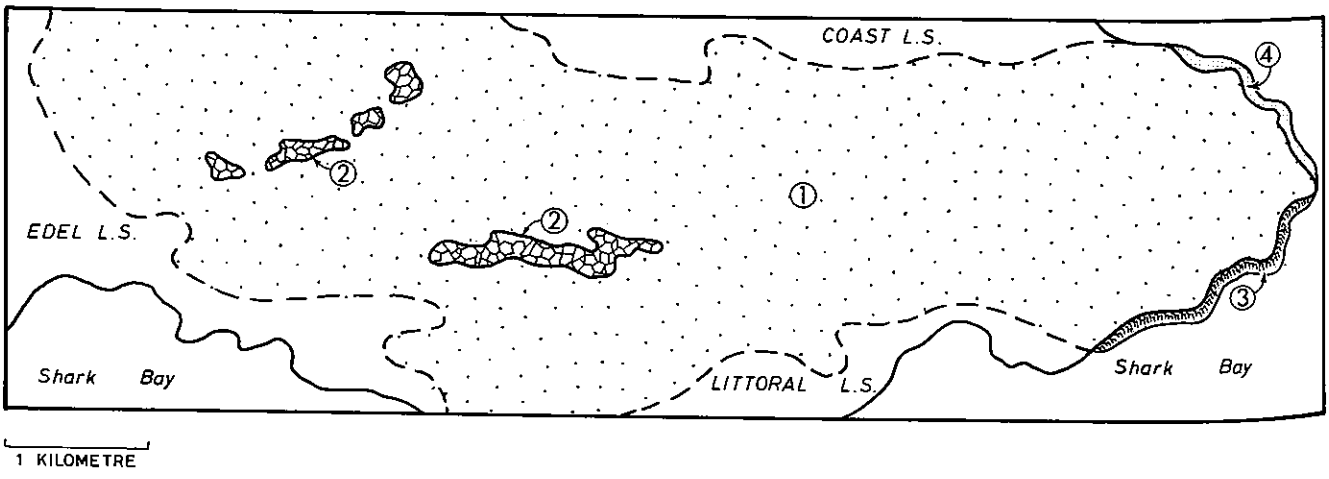
Pastoral use: Heath (HEAT) pastures of low or very low pastoral value, a few edible perennial shrubs, with very sparse herbs and annuals in season, system generally stable but would be prone to wind erosion if burnt or degraded.

Estimated carrying capacity, good condition: 30 ha/s.u.

Range condition summary: good 88%; fair 12%; poor 0%.



Unit
1. Plains with sand cover
2. Stony plains
3. Sea cliffs, wave-cut platforms and beaches



1 KILOMETRE

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Plains with thin sand cover (98%) 1 site inventory and traversed	
Gently undulating sandy plains, slopes < 3%. Soils are reddish-brown or brown sands or sandy loams of variable depth, pH 8.5 with an alkaline trend and calcareous inclusions throughout, overlying calcrete or limestone; principal profile form: Uc 5.12.	Closed low shrublands forming heaths with patches of moderately close low or tall shrubland. Shrubs (1-2.5 m) : *Acacia ligulata Diplolaena dampieri, Exocarpos sparteus*; (< 1m): *Melaleuca cardiophylla, Thryptomene baeckeacea, Acanthocarpus preissii, Scaevola* spp, *Frankenia* spp; Perennial grasses: *Plectrachne* sp.	Pasture type: *Heath*. Shrub associations probably seral following fires. Pastoral use limitations: Few palatable perennials but augmented by annual grasses and forbs in favourable seasons.
	Unit 2 Stony plains (2%) Traversed	
Very restricted stony plains and outcrop patches, usually < 200 m in extent, heavily mantled with limestone fragments. Soils are shallow reddish-brown sands over limestone.	Moderately close low to tall shrublands dominated by *Acacia ligulata*. Trees (2-4m) : *Pittosporum phylliraeoides*; Tall or low shrubs (1.5-3 m): *A. ligulata, Diplolaena dampieri Alyogyne cuneiformis*.	Pasture type: *Heath*.
	Unit 3 Sea cliffs, wave-cut platforms and beaches (< 1%) Traversed	
Limestone cliffs up to 40 m above sea level, bare limestone platforms and sandy beaches.	Close or closed low shrublands, mostly as mat-like patches of stunted shrubs. Low shrubs (< 0.5 m): *Melaleuca cardiophylla, Frankenia pauciflora, Atriplex* spp, *Rhagodia* spp, *Carpobrotus* spp.	Pasture type: *Heath* (on cliff tops); otherwise unvegetated.

James land system (G) 174 km² (0.2% of survey area)

Low hills, ridges and tors of granite and quartz, with stony lower plains, rises and drainage floors; scattered tall shrublands of mulga and other acacias.

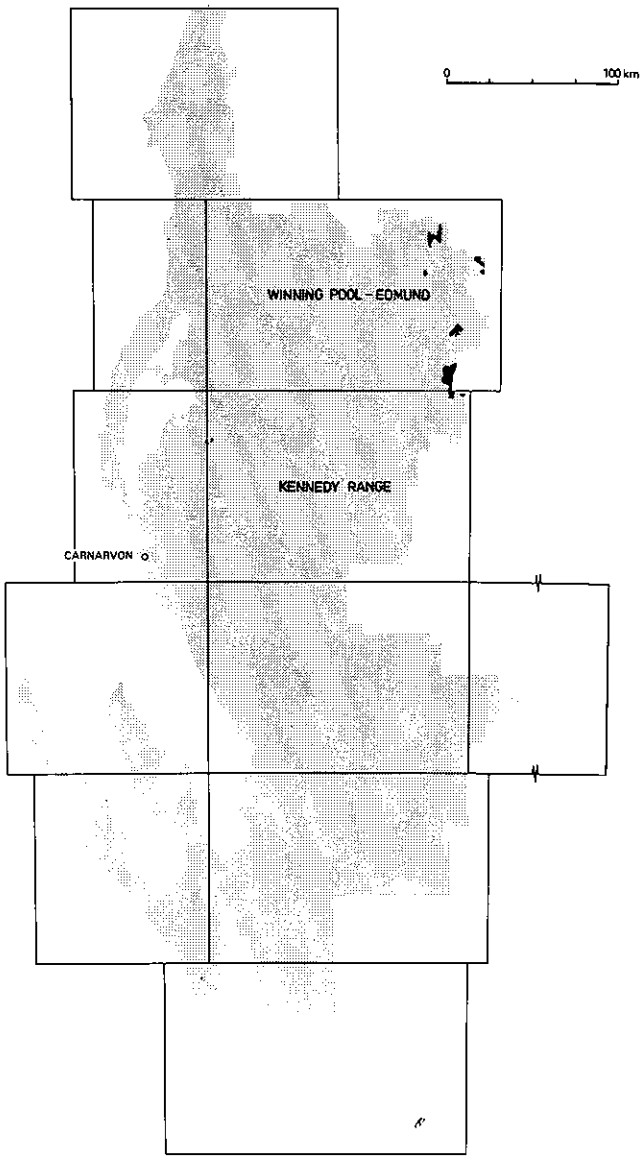
Geology: Archaean granites with minor areas of gneiss, schists and intrusive dykes.

Geomorphology: Erosional surfaces: low hills, ridges, dykes, tors and stony plains drained by scarcely incised dentritic channels of moderate density feeding major creek-lines on sandy-surfaced drainage floors; relief up to 40 m.

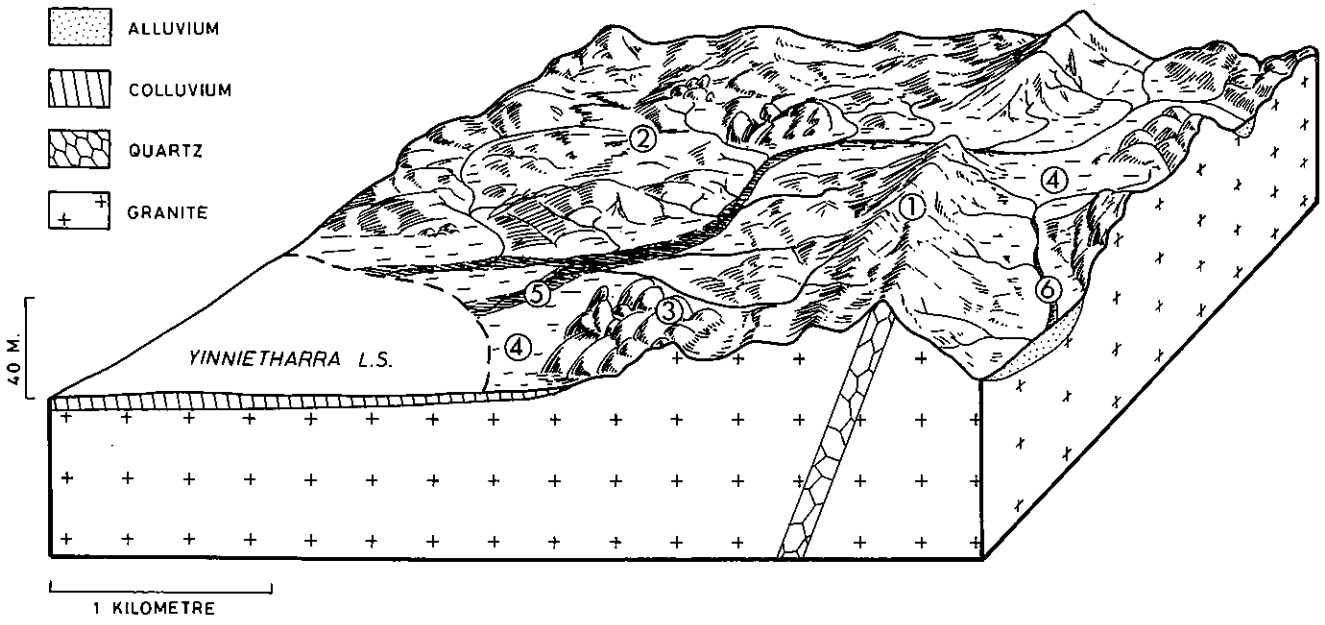
Pastoral use: Stony Short Grass Forb (SSGF) pastures, augmented with minor areas of Stony Chenopod (STCH) pastures, only limited dry season durability; units 4 and 5 are moderately susceptible to accelerated water erosion when their perennial cover is depleted.

Estimated carrying capacity, good condition: 22 ha/s.u.

Range condition summary: good 50%; fair 33%; poor 17%

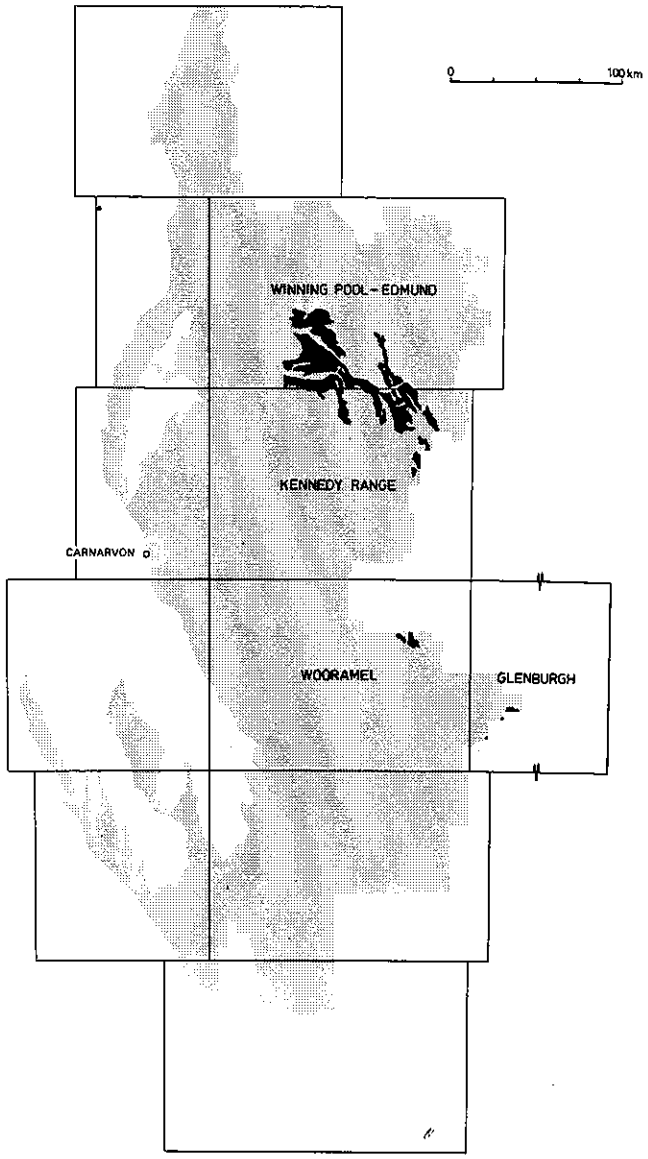


Unit
1. Hills and ridges
2. Undulating plains
3. Tors and outcrops
4. Lower plains
5. Drainage floors
6. Creek lines



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Hills and ridges up to 30 m above unit 2, mostly unweathered and irregularly mantled with boulders and rock fragments. Soils are confined to pockets of shallow skeletal sands, pH 6.5.	**Unit 1 Hills and ridges (20%) 2 site inventories and traversed** Very scattered shrublands dominated by *Acacia kempeana* and *A. tetragonophylla*. Tall shrubs (2-3 m): *A. kempeana, A. tetragonophylla, A. cuspidifolia*; Low shrubs (< 2 m): *Cassia helmsii, C. oligophylla, Eremophila fraseri, E. exilifolia, Hybanthus enneaspermus, Corchorus walcottii.*	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila latrobei.* Pastoral use limitations: None under trolled stocking.
	Unit 2 Undulating plains (40%)	
Undulating plains, stony slopes, tors and outcrops with shallow loamy soils.	**Unit 3 Tors and outcrops (10%) Traversed** Very scattered shrublands, dominated by *Acacia* spp and *Eremophila* spp. Trees and tall shrubs: *Acacia cuspidifolia, A. tetragonophylla*; Low shrubs: *Eremophila platycalyx, E. cuneifolia, E. freelingii, Cassia helmsii, C. oligophylla, C. luerssenii, Solanum lasiophyllum*; Perennial grasses: *Cymbopogon* sp.	Pasture types: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
Smaller areas with gentler slopes and sluggish drainage. Soils are probably reddish-brown duplex types.	**Unit 4 Lower plains (10%) Traversed** Very scattered shrublands, either (i) similar to those described under units 2 and 3 or (ii) low halophytic shrublands dominated by *Frankenia* spp and *Maireana polypterygia*.	Pasture type: *Stony Short Grass Forb* or *Stony Chenopod.* Pastoral use limitations: Moderate susceptibility to water erosion when degraded.
Gently sloping drainage floors with braided channels and sandy surfaces. Soils are probably reddish-brown duplex or clay types.	**Unit 5 Drainage floors (15%) Traversed** Very scattered to moderately close tall shrublands dominated by *Acacia eremaea* and *Eremophila* spp with other low shrubs, mainly *Rhagodia* sp. and *Maireana* spp.	Pasture type: *Stony Chenopod.* Desirable perennials include: *Maireana* spp, *Rhagodia* sp. Pastoral use limitations: Moderate susceptibility to water erosion when degraded.
Major drainage lines, usually incised to 1-3 m and carrying bedloads of sands, cobbles and pebbles.	**Unit 6 Creek-lines (5%) Traversed** Moderately close fringing communities dominated by tall shrubs *Acacia tetragonophylla, A. sclerosperma* and *A. grasbyi*, with low shrubs *Eremophila* spp, *Rhagodia* sp., *Solanum lasiophyllum.*	Pasture type: *Acacia Creek-line.* Pastoral use limitations: None under controlled stocking.

Jimba land system (G) 1612 km² (2.2% of survey area)



Gently sloping alluvial plains, mostly devoid of surface mantling, with disorganised and complex drainage features below minor ridges and pebbly plains; scattered tall and low acacia shrublands with some bluebush and other chenopods.

Geology: Permian siltstone, quartz greywacke and shale, mainly of the Artinskian series, with Quaternary alluvium and colluvium.

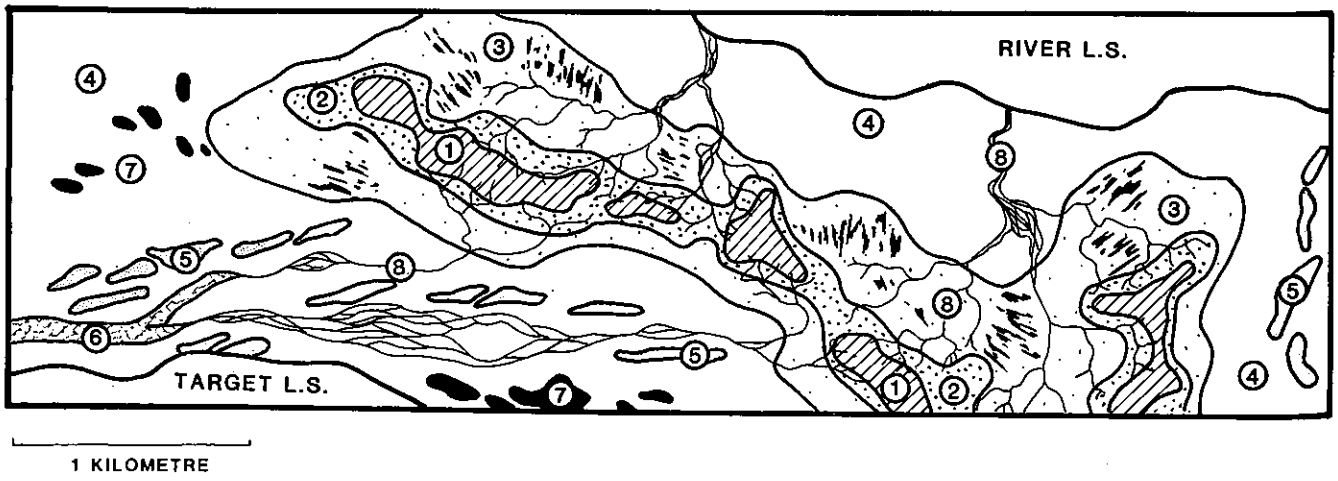
Geomorphology: Erosional and depositional surfaces: flattened ridges and low hills with terraced lower slopes, drainage plains with tributary flow lines, disorganised drainage tracts and low-lying plains with large drainage foci; relief up to 40 m though usually < 3 m over units 4-8.

Pastoral use: A major system supporting mainly Stony Chenopod (STCH) pastures, moderately to highly productive when in good condition, but exceptionally susceptible to broad-scale erosion. The soils are predominantly duplex types which lack protective surface mantles for the friable surface horizons. Regional slopes and drainage patterns dictate that wherever pastures are degraded, soil erosion results. Some areas are becoming stabilized by buffel and birdwood grasses.

Estimated carrying capacity, good condition: 13 ha/s.u.

Range condition summary: good 12%; fair 33%; poor 55%

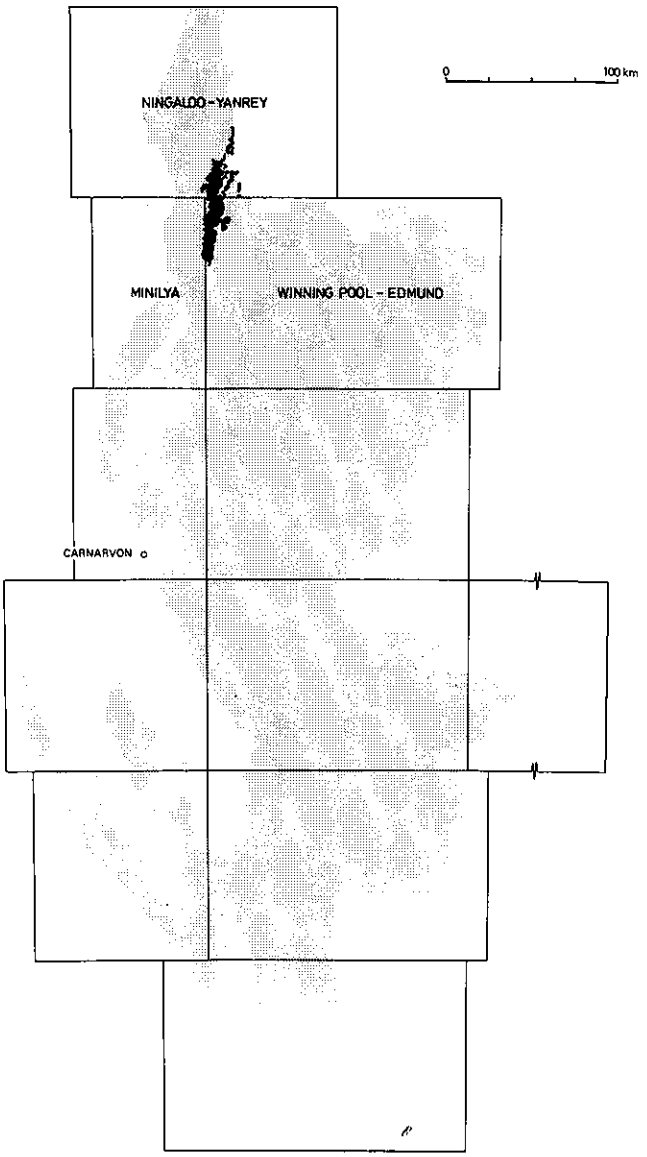
Unit
1. Low ridges and stoney rises
2. Upper slopes
3. Lower slopes
4. Diffuse drainage plains
5. Sandy banks
6. Unchannelled drainage floors
7. Drainage foci
8. Channels



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Low ridges and stony rises (15%) 1 site inventory and traversed	
Ridges and rounded rises up to 40 m (but usually much less) above lower units, moderate to dense mantle of cobbles and pebbles with some rock outcrop, shallow, reddish brown or red, alkaline sandy loam to sandy clay loam soils.	Scattered tall shrublands dominated by *Acacia xiphophylla* or other *Acacia* spp, with low shrubs dominated by *Cassia* and *Eremophila* spp. PFC 10 to 20%; Tall shrubs (2-3 m): *Acacia xiphophylla, A. victoriae, A. tetragonophylla*, Low shrubs (< 1 m): *Eremophila cuneifolia, E. latrobei, Cassia desolata, C. helmsii, Ptilotus obovatus, Enchylaena tomentosa, Rhagodia eremaea.*	Pasture type: *Acacia Short Grass Forb* or *Stony Chenopod.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Ptilotus obovatus, Eremophila latrobei, Enchylaena tomentosa.* Pastoral use limitations: None under controlled use.
	Unit 2 Upper slopes (10%) 1 site inventory and traversed	
Short, concave slopes below crests and rises, moderate to dense mantle of cobbles and pebbles, variable depth reddish brown or red alkaline sandy loam to sandy clay loam soils; principle profile form Gc 1.22.	As for unit 1.	As for unit 1.
	Unit 3 Lower slopes (15%) 2 site inventories and traversed	
Gentle, sometimes terraced slopes (0.5 to 1.5%) extending for up to 2 km below units 1 and 2, often dissected by shallow, parallel creek-lines; moderate mantle of pebbles or gravel, soils are reddish brown or red duplex 70 cm to > 1 m deep, pH 7.0 to 8.5 with an alkaline trend; principle profile forms: Dr 1.13, 4.13.	Scattered low woodland of *Acacia cuspidifolia* with *Eremophila* spp and other low shrubs or low shrublands with *Scaevola spinescens* and chenopods. PFC 10 to 20%; Trees (0-275/ha; 4-6 m): *Acacia cuspidifolia, Hakea preissii*, Tall shrubs (0-25/ha, 2-3 m) *A. xiphophylla*, Low shrubs (2000-5000/ha, < 1.5 m): *Eremophila cuneifolia, Scaevola spinescens, Ptilotus polakii, Maireana polypterygia, Enchylaena tomentosa, Rhagodia eremaea.*	Pasture type: *Stony Chenopod.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials inlcude: *Ptilotus polakii, Maireana polypterygia, Enchylaena tomentosa, Rhagodia eremaea.* Pastoral use limitations: None under controlled use.
	Unit 4 Diffuse drainage plains (40%) 12 site inventories and traversed	
Broad, gently sloping (0.2 to 1.2%) plains receiving sheet and channelled flow, stony mantle absent or sparse; moundy surfaces and zones with parallel or anastomosing gutters, runnels and channels incised up to 1 m; soils are reddish brown, red or dark red, predominantly duplex types mostly > 1 m deep and often with calcrete or gypsiferous inclusions, pH 6.5-8.5 with alkaline reaction trend, principal profile forms: Dr 1.12, 1.13, 1.53, 2.12, 4.12.	Very scattered to scattered tall and low shrublands dominated by *Acacia victoriae, Cassia* spp, *Eremophila* spp and chenopods. PFC 2.5 to 20%; Trees (0-275/ha; 2-4m): *Acacia cuspidifolia.* Tall shrubs (0-200/ha; 2-4m): *A. victoriae, A. xiphophylla, A. tetragonophylla*; Low shrubs (350-8500/ha; < 1 m): *Cassia desolata, Eremophila cuneifolia, E. pterocarpa, Ptilotus polakii, P. obovatus, Maireana polypterygia, M. pyramidata, Atriplex bunburyana, Scaevola spinescens, Enchylaena tomentosa, Solanum lasiophyllum*; Perennial grasses: Occasional *Eragrostis xerophila, Enteropogon acicularis.*	Pasture type: *Stony Chenopod* or *Saltbush/ Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Ptilotus polakii, Maireana polypterygia, M. pyramidata, Atriplex bunburyana, Enchylaena tomentosa.* Undesirable perennials include: *Acacia victoriae, A. cuspidifolia.* Pastoral use limitations: High susceptibility to wind and water erosion when degraded.
	Unit 5 Sandy banks (10%) 2 site inventories and traversed	
Linear banks up to 500 m long and 50 m wide arranged transverse and elongate to water flow on units 4, hummocky surfaces up to 2 m above surrounding plains, reddish brown or red loamy sand soils > 1 m deep, pH 6.0 to 7.5; principal profile forms: Uc 1.21, 5.21.	Scattered tall shrublands dominated by *Acacia ramulosa, A. sclerosperma* and other *Acacia* spp. PFC 10 to 20%; Trees (infrequent): *Acacia cuspidifolia*, Tall shrubs (300-400/ha, 2-4 m) *Acacia ramulosa, A. sclerosperma, A. tetragonophylla, A. wiseana, A. victoriae, Stylobasium spathulatum, Hakea preissii*, Low shrubs (1000-1500/ha < 1.5 m): *Cassia helmsii, C. desolata, Rhagodia eremaea, Scaevola spinescens, Enchylaena tomentosa, Corchorus walcottii, Pimelea microcephala*; Perennial grasses: *Eragrostis eriopoda, Cenchrus ciliaris, Triodia* sp.	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Enchylaena tomentosa, Rhagodia eremaea, Scaevola spinescens, Eragrostis eriopoda, Cenchrus ciliaris.* Pastoral use limitations: Slight susceptibility to erosion when vegetation degraded.

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 6 Unchannelled drainage floors (6%) 2 site inventories and traversed	
Stable unchannelled drainage zones up to 500 m wide with slopes < 0.5%, soils are duplex or clay types > 1 m deep, pH 7.0 to 8.0; principal profile forms Dr 4.12, Uf 6.33.	Moderately close woodland with *Acacia subtesserogona* or other *Acacia* spp with tussock grass understory; also tussock grasslands with sparse shrubs; Trees (4-6 m): *Acacia subtesserogona* Tall shrubs: *Acacia farnesiana, A. sclerosperma* Low shrubs: *Cassia luerssenii, C. helmsii, Scaevola spinescens, Rhagodia eremaea.* Perennial grasses: *Eragrostis xerophila, Eriachne benthamii, Chrysopogon fallax, Eulalia fulva,* some introduced *Cenchrus ciliaris, C. setigerus* with basal cover 1 to 5%.	Pasture type: *Acacia Creek-line* or *Tussock Grass.* Desirable perennials include: *Scaevola spinescens, Rhagodia eremaea* and perennial grasses. Pastoral use limitations: None under controlled stocking.
	Unit 7 Drainage foci (2%) 2 site inventories and traversed	
Discrete ellipsoid drainage foci up to 300 m in length by 100 m wide sparsely distributed over units 3 and 4, soils are reddish brown duplex types > 1 m deep pH 7.0, principal profile form Dr 1.12.	Close tall shrublands with *Acacia tetragonophylla* and numerous other *Acacia* spp and numerous low shrubs, PFC 30 to 50%; Trees (6-8 m): *Acacia citrinoviridis, A. coriacea* Tall shrubs (4-6 m): *Acacia tetragonophylla, A. xiphophylla, A. victoriae, A. sclerosperma, Heterodendrum oleaefolium,* Low shrubs (< 2 m): *Cassia desolata, C. helmsii, C. chatelainiana, Eremophila cuneifolia, E. latrobei, Rhagodia eremaea, Enchylaena tomentosa, Ptilotus obovatus, Pimelea microcephala, Maireana planifolia,* Perennial grasses: *Cenchrus ciliaris,* (basal cover 1 to 3%). *Enteropogon acicularis, Chrysopogon fallax.*	Pasture type: *Acacia Creek-line.* Desirable perennials include: *Cassia chatelainiana, Rhagodia eremaea, Eremophila latrobei, Enchylaena tomentosa, Ptilotus obovatus* and perennial grasses. Pastoral use limitations: None under controlled stocking.
	Unit 8 Channels (2%)	
Major channels and creeks, usually < 30 m wide and incised up to 3 m, sandy banks and bedloads.	Banks support moderately close tall shrublands or low woodlands *Acacia citrinoviridis, A. subtessarogona, A. tetragonophylla, Eucalyptus coolabah* with numerous low shrubs and grasses as for unit 7.	Pasture type: *Acacia Creek-line.* Desirable perennials: As for unit 7. Pastoral use limitations: None under controlled stocking.

Jubilee land system (A) 411 km² (0.6% of survey area)



Limestone hills and stony plains supporting mainly hard and soft spinifex hummock grasslands with scattered acacia shrubs.

Geology: Cretaceous and Tertiary marine limestones.

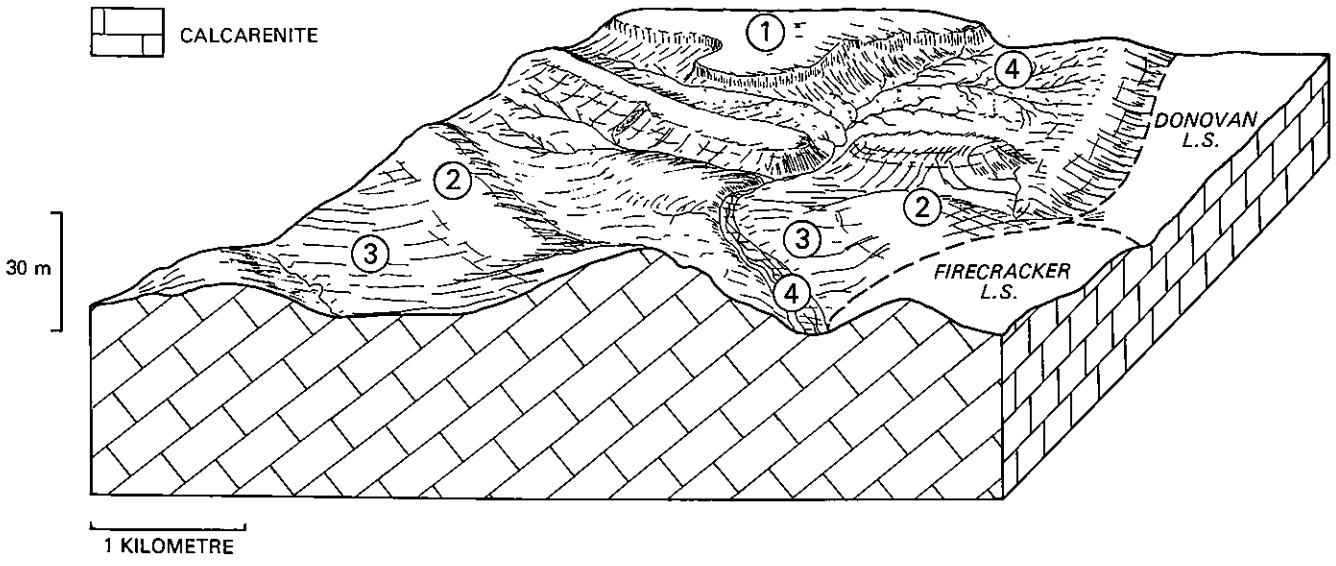
Geomorphology: Erosional surfaces: hills and low cuestas with short stony footslopes, extensive undulating stony plains above lower, flatter plains; drainage patterns sub-parallel of low to moderate density but incised and more dense in upper parts; relief up to 40 m.

Pastoral use: Mainly Hard Spinifex (HASP) and Soft Spinifex (SOSP) pasture; the more valuable Soft Spinifex (SOSP) pastures on unit 3 require periodic burning, followed by grazing deferral. Protection from fire is needed in the case of minor Bluebush (BLUE) pastures. A minor land system within the present survey area, not prone to erosion.

Estimated carrying capacity, good condition: 10 ha/s.u.

Range condition summary: good 86%; fair 14%; poor 0%.

Unit
1. Low hills and cuestas
2. Undulating stony plains
3. Lower plains
4. Drainage channels and floors



Jubilee L.S. [ex Payne *et al.* 1982]

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Low hills and cuestas (20%) Traversed	
Dissected hills with nearly flat to rounded crests and densely strewn slopes, strike-aligned cuestas up to 5 km long with slightly benched slopes and dense mantles of rock fragments. Soils show minimal development.	Hummock grasslands dominated by *Triodia wiseana* with very scattered shrubs, mainly *Acacia bivenosa*.	Pasture type: *Hard Spinifex*.
	Unit 2 Undulating stony plains (35%) Traversed	
Plains with undulations and slopes up to 4%, variably strewn with limestone fragments. Soils are reddish brown loams to silty clay loams with an alkaline trend, mainly < 70 cm deep principal profile forms: Gc 1,12, Um 5.11.	Hummock grasslands dominated by *Triodia wiseana*, with very scattered low shrubs, mainly *Acacia retivenia*, *Melaleuca* aff. *cardiophylla* and *Cassia* spp.	Pasture type: *Hard Spinifex*. Perennials augmented by annual grasses and forbs in favourable seasons.
	Unit 3 Lower plains (40%) Traversed	
Nearly flat plains, lightly strewn with limestone fragments. Soils are dark reddish-brown loams, grading to clay loams, with calcareous inclusions and alkaline trend, > 1 m deep; principal profile form: Gc 1.12.	(i) Hummock grasslands dominated by *Triodia pungens*, with very scattered shrubs, mainly *Acacia sclerosperma*, *A. victoriae*, *Cassia oligophylla*; (ii) tall shrublands dominated by *Acacia xiphophylla* with understorey shrubs *Maireana polypterygia*.	Pasture type: *Soft Spinifex*, with minor areas of *Bluebush*. Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking and appropriate fire management.
	Unit 4 Drainage channels and floors (5%) Traversed	
Intense upper streams incised up to 5 m into limestone, draining into subparallel floors of low intensity, up to 100 m wide, more or less channelled. Soils are reddish-brown clay loams to light clays with an alkaline trend, > 1 m deep; principal profile form: Gc 2.22.	(i) Hummock grasslands dominated by *Triodia wiseana*; (ii) tall shrublands dominated by *Acacia sclerosperma* and *A. tetragonophylla* with varied understorey shrubs. Association (ii) principally on the lower drainage floors.	Pasture type: *Hard Spinifex/Acacia Creek-line*. Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.

Kennedy land system 959 km² (1.3% of survey area)

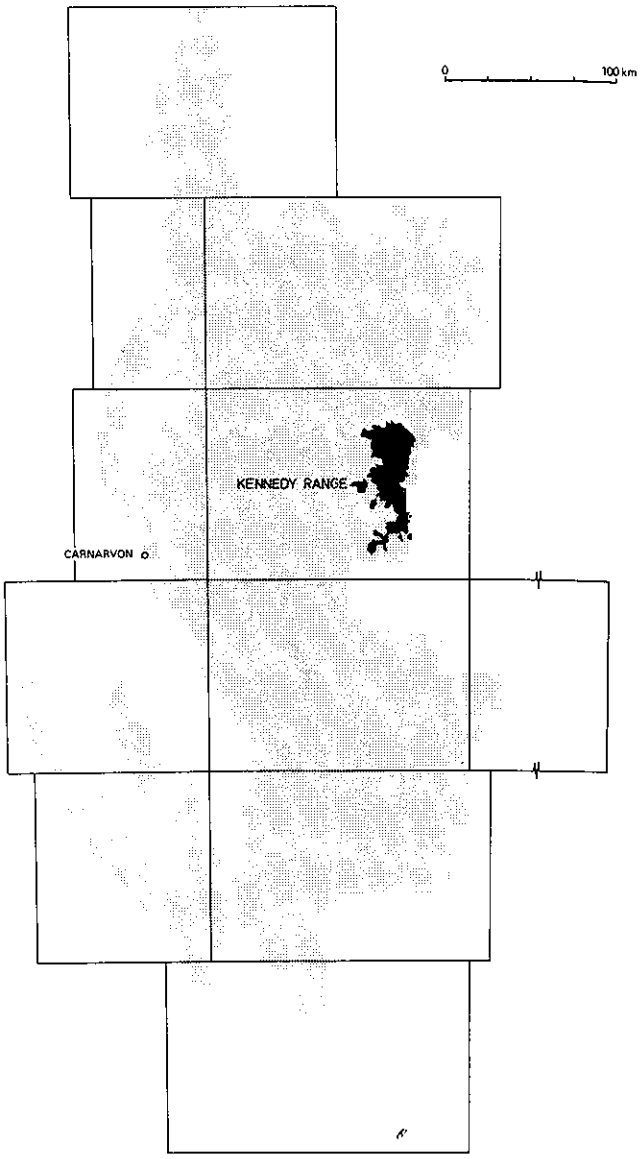
Elevated sandy plains with large linear to reticulate dunes, supporting hard spinifex grasslands with numerous shrubs including some South-West Botanical Province species.

Geology: Quaternary aeolian sand over Permian sediments.

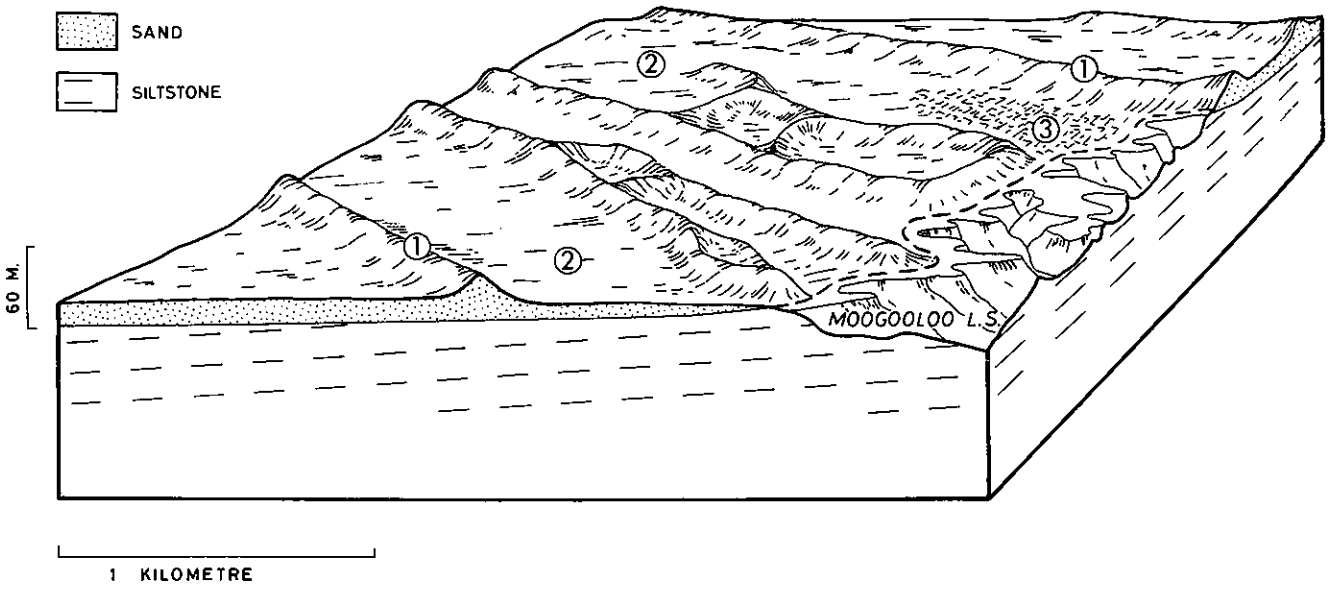
Geomorphology: Depositional surfaces: aeolian sandplain perched 90 m or higher above surrounding plains on a broad plateau of siltstone and other sedimentary rocks: linear to reticulate dunes and broad sandy swales without drainage features; relief up to 50 m.

Pastoral use: The bulk of this system lies within the Kennedy Range National Park; a small area within Williambury station is not in use for pastoral production. The pastoral potential would be poor to very poor and no stock watering points are available.

Range condition summary: good 100%; fair 0%; poor 0%.

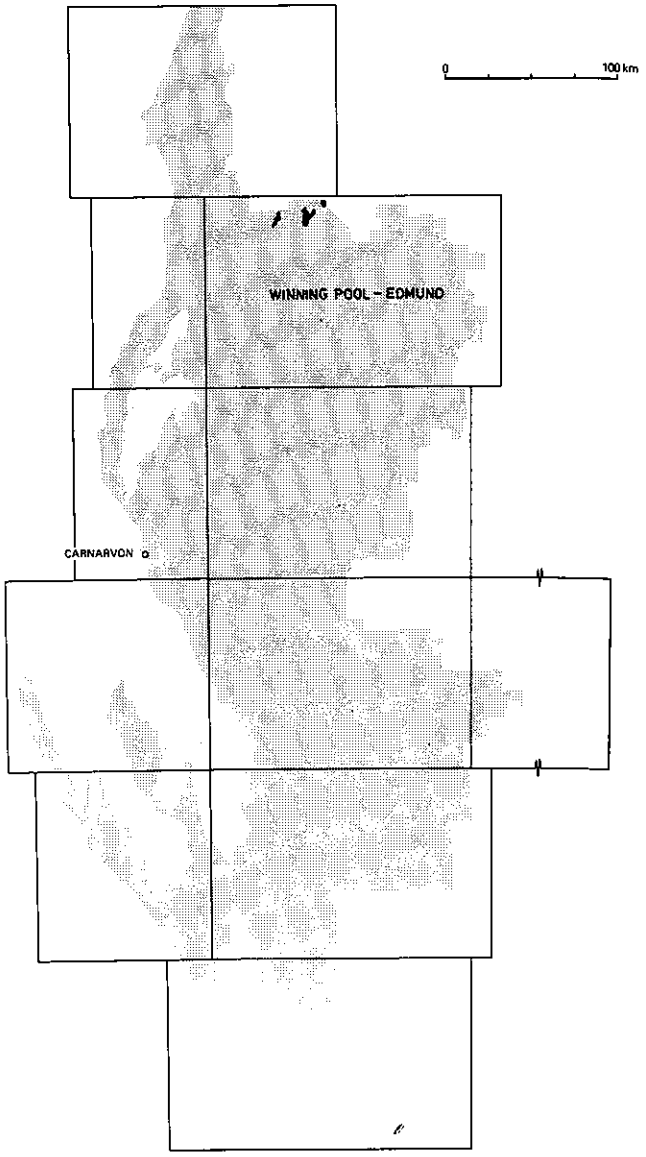


Unit
1. Longitudinal dunes
2. Swales and interdunal plains
3. Stony plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal dunes (20%) Traversed	
Linear to reticulate dunes, mostly 2-10 km long and 15-20 m high, aligned approximately SE to NW. Soils are red unconsolidated sands; principal profile form (probably) Uc 1.23.	Hummock grasslands dominated by *Triodia basedowii* and scattered to very scattered shrubs: *Acacia coriacea, A. ligulata, Banksia ashbyi, Calothamnus chrysantherus, Calytrix muricata, Grevillea* spp. Perennial grasses: *Triodia basedowii, Eriachne gardneri.*	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Not in use for pastoral purposes; very low potential productivity.
	Unit 2 Swales and interdunal plains (75%) Traversed	
Flat to concave sandy plains and swales. Soils are red unconsolidated sands; principal profile form (probably) Uc 1.23.	Hummock grasslands dominated by *Triodia basedowii* or *T. pungens*, with very scattered low shrubs and occasional thickets of mallee eucalypts. Trees: *Eucalyptus dichromophloia*; Low shrubs (< 2 m): *Pileanthus peduncularis, Calothamnus chrysantherus, Acacia ramulosa, Grevillea stenobotrya, G. eriostachya, Cassia* spp, *Ptilotus obovatus, Spartothamnella teucriiflora*; Perennial grasses: *Triodia basedowii, T. pungens, Monachather paradoxa.*	Pasture type: *Hard Spinifex/Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitation: Not in use for pastoral purposes; low potential productivity.
	Unit 3 Stony plains (5%) Traversed	
Restricted stony plains with shallow loamy soils, in areas adjacent to Moogooloo land system.	Very scattered tall shrublands dominated by *Acacia* spp.	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons.

Lake land system 62 km² (0.1% of survey area)



Extensive pans and lake beds, supporting little perennial vegetation, with narrow marginal sandy banks supporting spinifex hummock grasslands.

Geology: Quaternary lake bed and playa deposits: clay, silt, sand and gravel.

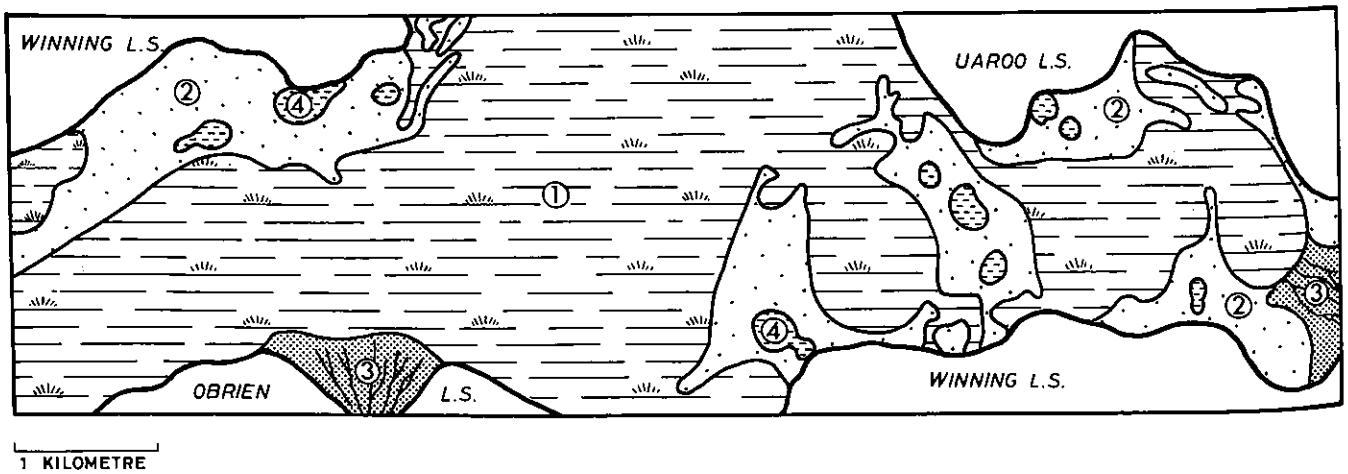
Geomorphology: Depositional surfaces: playas seasonally inundated by run-on received from the Winning and O'Brien land systems; no through drainage; minor accumulations of aeolian sand; relief 2-4 m.

Pastoral use: A flood-prone system with very low pastoral potential; forage confined to minor areas of Soft Spinifex (SOSP) pastures supported by the sandy unit 3.

Estimated carrying capacity, good condition: 60 ha/s.u.

Range condition summary: good 78%; fair 11%; poor 11%

Unit
1. Major pans and lakebeds
2. Sandy banks and sheets
3. Inflow zones
4. Claypans



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Major pans and lakebeds (80%) Traversed	
Broad flats with variable surfaces, crusted, puffy, mounded or flat. Soils are silty or clayey types.	Generally devoid of perennial vegetation, occasional clumps of tall shrubs *Melaleuca* sp. and perennial grasses *Eragrostis australasica.*	Pasture type: Unvegetated. Pastoral use limitations: Virtually no productivity for grazing purposes.
	Unit 2 Sandy banks and sheets (10%) Traversed	
Fringing low foredunes, sandy rises and hummocky sand sheets. Soils are red sands.	Irregular patches of tall shrubs *Melaleuca leiocarpa* fringing unit 1, otherwise dominated by hummock grasslands of *Triodia pungens* and *Eragrostis eriopoda.*	Pasture type: *Soft Spinifex.* Pastoral use limitations: Patchy and isolated distribution within otherwise unproductive surroundings.
	Unit 3 Inflow zones (5%) Traversed	
Broad tracts receiving concentrated sheet flow.	Patchy tall shrublands dominated by *Melaleuca* sp. without understorey shrubs or grasses.	Pasture type: Unvegetated. Pastoral use limitations: Virtually no productivity for grazing purposes.
	Unit 4 Claypans (5%) Traversed	
Claypans, mostly < 500 m long, with crusted surfaces.	Patchy fringing communities dominated by *Melaleuca* sp. and *Eucalyptus coolabah.*	Pasture type: Unvegetated. Pastoral use limitations: Virtually no productivity for grazing purposes.

Learmonth land system 285 km² (0.4% of survey area)

Sandy outwash plains marginal to the Cape Range, supporting mainly soft spinifex hummock grasslands with scattered acacia shrubs.

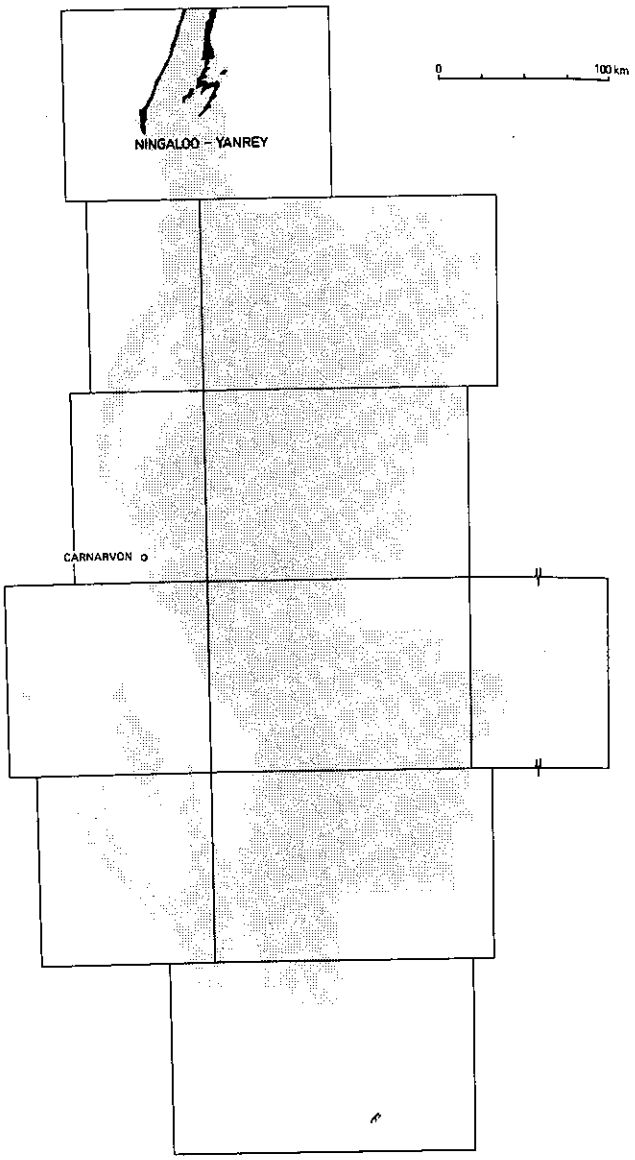
Geology: Tertiary Trella limestone, and Quaternary calcarenite, colluvium, alluvium and aeolian sand.

Geomorphology: Erosional and depositional surfaces: Pediment-like footslopes and lower depositional colluvial plains with mainly sandy surfaces, dissected by parallel drainage lines of low density, ending in fan-shaped outwash plains fringed by coastal dunes and beaches.

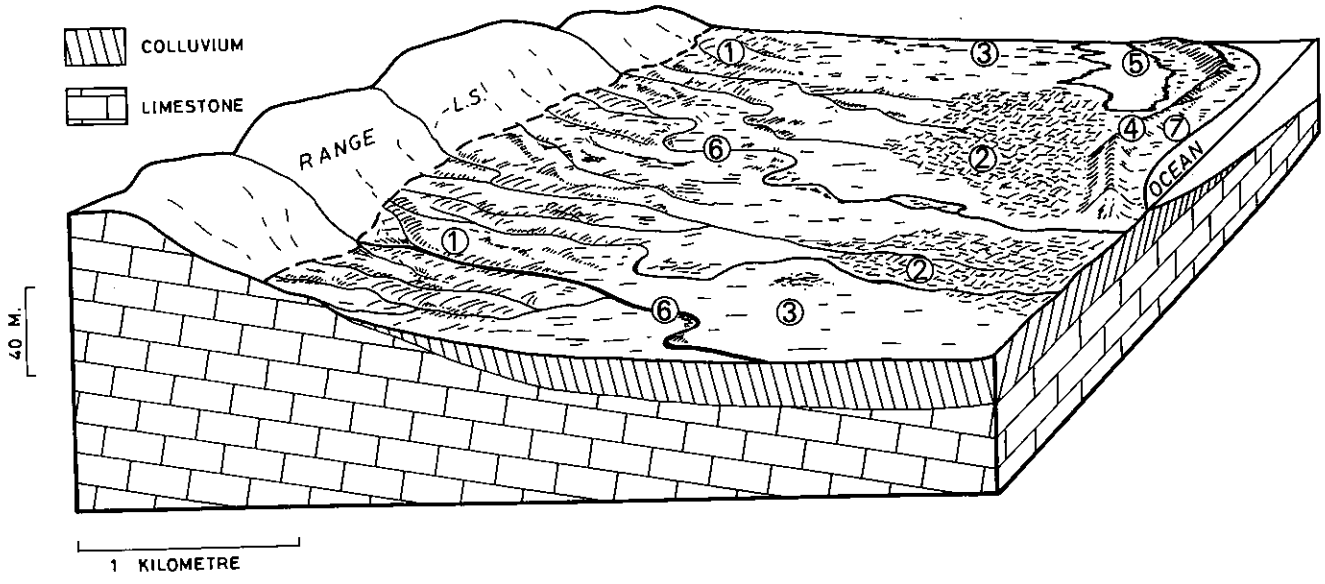
Pastoral use: Mainly Soft Spinifex (SOSP) pastures interspersed with areas of Acacia Mixed Shrub (ACMS) pastures supporting a range of palatable shrubs and perennial grasses which confer good drought durability. The Soft Spinifex pastures require periodic burning, followed by a deferral of grazing, to rejuvenate this palatable hummock grass. The system is not normally susceptible to accelerated erosion.

Estimated carrying capacity, good condition: 7 ha/s.u.

Range condition summary: good 81%; fair 13%; poor 6%.

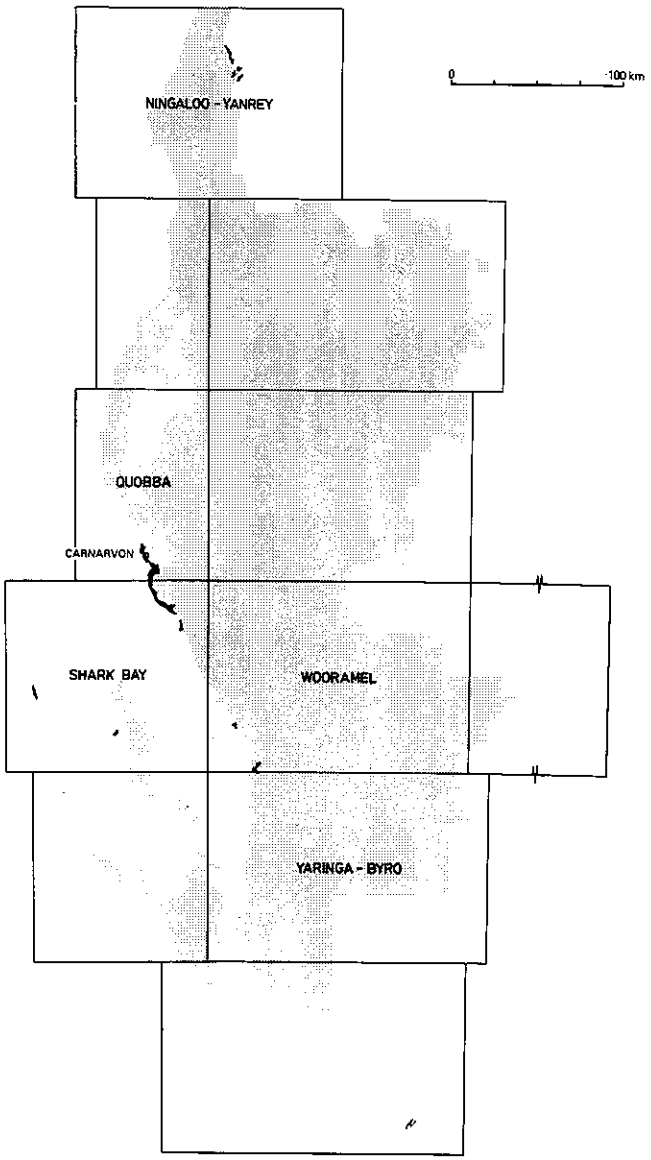


Unit
1. Stony footslopes
2. Outwash plains
3. Sandy plains
4. Coastal dunes
5. Saline plains
6. Drainage lines
7. Beaches and foredunes



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Stony footslopes (20%) 1 site inventory and traversed	
Gentle footslopes below the Cape Range, up to 42 m above lower units. Soils are shallow clay types, sandy clay grading to medium clay, lightly to moderately strewn with limestone gravels and with limestone inclusions throughout, pH 8.5 with an alkaline trend; principal profile form: Uf 6.12.	Hummock grasslands dominated by *Triodia pungens* and scattered low shrubs, mainly *Melaleuca* aff. *cardiophylla*. Low shrubs (< 1 m): *M.* aff. *cardiophylla, Acacia gregorii, A. ligulata, Diplopeltis eriocarpa, Cassia desolata*; Perennial grasses: *Triodia* spp.	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 2 Outwash plains (20%) 1 site inventory and traversed	
Plains with slopes generally < 1%, lightly strewn with limestone gravels. Soils are gradational calcareous loams, dark reddish-brown sandy clay, shallow to > 1m deep, pH 8.5 with an alkaline trend; principal profile form: Gc 1.22.	Moderately close tall shrublands dominated by *Acacia xiphophylla.* Tall shrubs: *A. xiphophylla, Heterodendrum oleaefolium*; Low shrubs (< 1m) : *Scaevola tomentosa, Lepidium platypetalum, Cassia desolata, C. chatelainiana, Ptilotus obovatus, Maireana planifolia*; Perennial grasses: *Chrysopogon fallax, Triodia pungens, Cenchrus ciliaris.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila latrobei, Lepidium platypetalum, Cassia chatelainiana, Chrysopogon fallax.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Sandy plains (50%) 3 site inventories and traversed	
Plains with slopes generally < 1%, surfaces more or less mounded. Soils are red to reddish-brown sand or loamy sand, usually > 1m deep, pH 8.0-8.5 with an alkaline trend and calcareous inclusions throughout; principal profile forms: Uc 5.11, 5.21.	Hummock grasslands dominated by *Triodia pungens* and a very scattered shrub overstorey. Tall shrubs (2-3 m, < 25/ha): *Acacia tetragonophylla, A. coriacea, Stylobasium spathulatun*; Low shrubs (1000-8000/ha; < 1m): *Olearia axillaris, Zygophyllum fruticulosum, Solanum lasiophyllum, Scaevola tomentosa, S. canescens, Acacia ligulata*; Perennial grasses: *Triodia pungens, Eriachne* spp, *Eragrostis eriopoda.*	Pasture type: *Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Triodia pungens.* Pastoral use limitations: None under controlled stocking and appropriate fire management.
	Unit 4 Coastal dunes (2%) Traversed	
Low hind-dunes. Soils are calcareous sands.	Hummock grasslands dominated by *Triodia pungens* with some low shrubs.	Pasture type: *Soft Spinifex.* Pastoral use limitations: None under controlled stocking.
	Unit 5 Saline plains (2%)	
Low-lying restricted plains with loamy soils, inland of unit 4.	Scattered low shrublands dominated by *Halosarcia* spp, *Atriplex bunburyana, Maireana polypterygia* and *Frankenia* spp.	Pasture type: *Samphire.* Pastoral use limitations: None under controlled stocking.
	Unit 6 Drainage lines (5%)	
Dendritic to parallel channelled drainage, incised to 3-4 m below unit 3 carrying bedloads of pebbles and cobbles.	Narrow fringing communities dominated by *Eucalyptus dichromophloia, Acacia ligulata* and *A. bivenosa* with understorey hummock grass *Triodia pungens.*	Pasture type: *Soft Spinifex.* Pastoral use limitations: None under controlled stocking.
	Unit 7 Beaches and foredunes (1%)	
Sandy beaches and foredunes in low energy situations on Exmouth Gulf.	Hummock grasslands dominated by *Spinifex longifolius* and low shrubs.	Pasture type: *Coastal Dune Shrub.*

Littoral land system 154 km² (0.2% of survey area)



Coastal fore-dunes, samphire flats and bare mudflats, sandy islets and mangrove fringes.

Geology: Quaternary tidal flat deposits, mostly mud and sand.

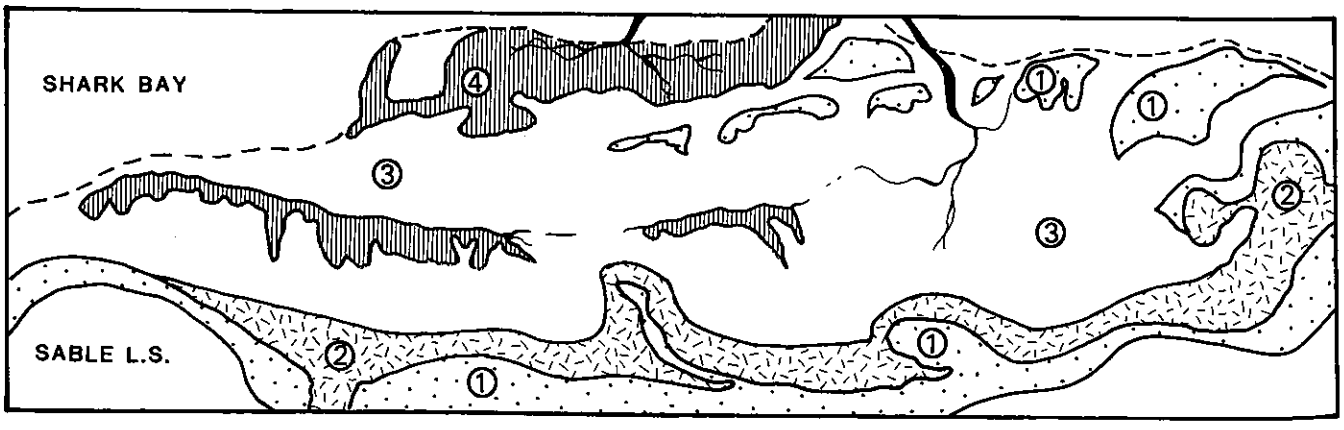
Geomorphology: Supra-tidal depositional plains of low relief, mainly as bare or samphire-covered mudflats, sandy beaches and islets below a low foredune of shelly sand.

Pastoral use: Fore-dunes support a limited range of palatable perennial shrubs; saline plants on both this unit and the samphire flats receive little grazing, being peripheral to extensive plains of saltbush and bluebush (Sable land system) in many areas. A minor land system that shows only slight susceptibility to accelerated wind erosion.

Estimated carrying capacity, good condition: 17 ha/s.u.

Range condition summary: good 96%; fair 4%; poor 0%.

Unit
1. Fore-dunes and sandy islets
2. Samphire-covered flats
3. Supra-tidal mudflats
4. Mangrove fringes



Littoral L.S.

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Longitudinal dunes, up to 10 m high. Soils are shelly sands.	**Unit 1 Foredunes and sandy islets (40%) Traversed** Very scattered low or mixed shrublands dominated by *Acacia sclerosperma, A. ligulata, A. tetragonophylla, Heterodendrum oleaefolium, Lycium australe, Rhagodia* spp and *Atriplex* spp.	Pasture type: *Coastal Dune Shrub.* Pastoral use limitations: Lack of suitable groundwater.
Flat, restricted plains with silty loam or silty clay soils, often intergrading with unit 3.	**Unit 2 Samphire-covered flats (20%) Traversed** Very scattered low shrublands dominated by *Halosarcia* spp.	Pasture type: *Samphire.*
Infrequently inundated mudflats up to 500 m broad, of shelly lime sand, silt and clay.	**Unit 3 Supra-tidal mudflats (35%) Traversed** Surfaces often covered with thick mats and crusts of marine algae, but no permanent vegetation.	
Narrow depressions and tidal channels.	**Unit 4 Mangrove fringes (5%)** Clumped low shrublands of *Avicennia marina.*	

Lyell land system 65 km² (0.1% of survey area)

Sandplains with reticulate dunes and saline interdunal plains supporting tall and low acacia shrublands and saltbush.

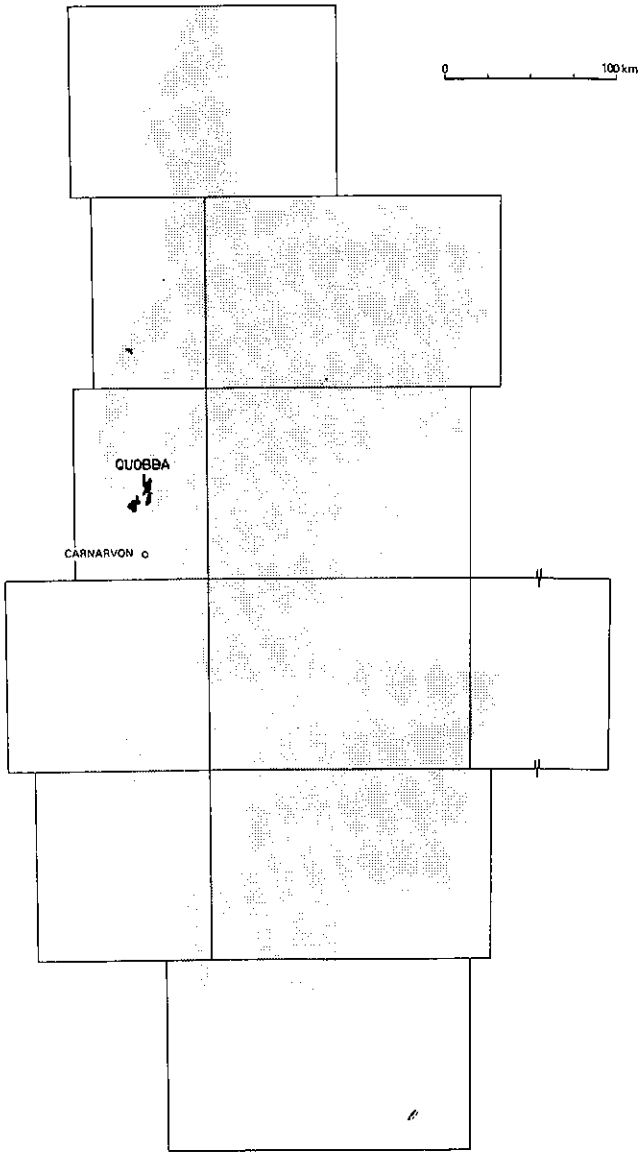
Geology: Quaternary aeolian sand.

Geomorphology: Depositional surfaces: long-walled reticulate and linear dunes up to 15 m above gently undulating sandplains and saline interdunal corridors, no drainage features.

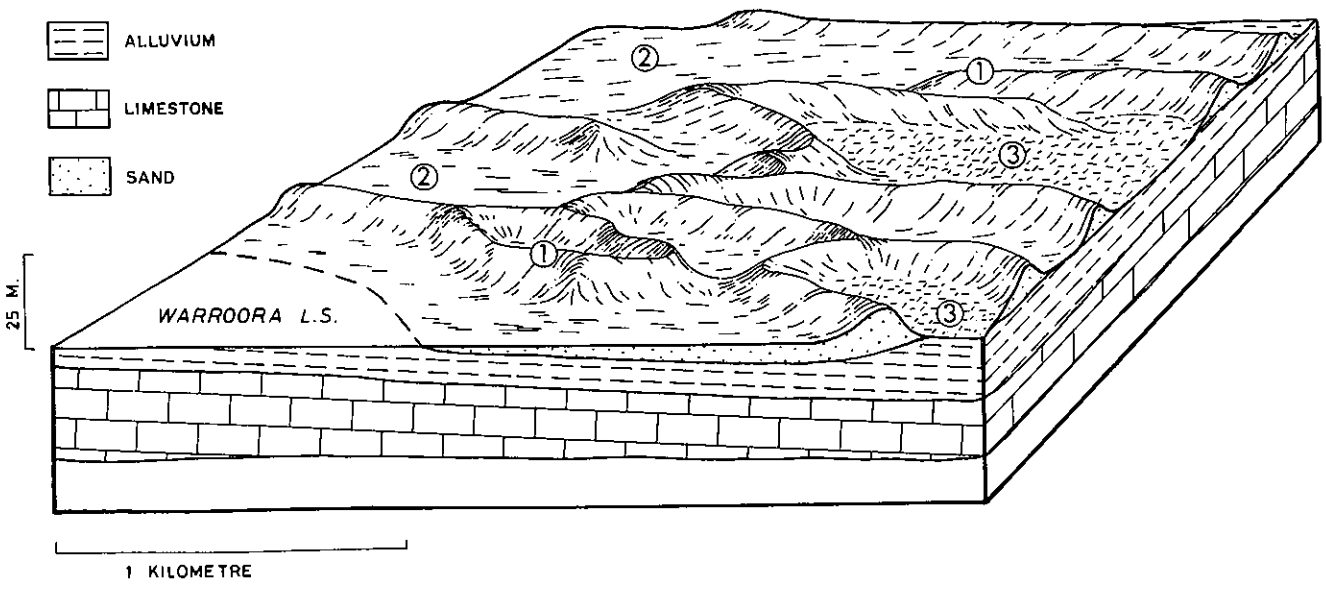
Pastoral use: Coastal Dune Shrub (CDSH) pastures with some Saltbush (SALT) and Bluebush (BLUE) pastures; a minor land system and not normally prone to erosion.

Estimated carrying capacity, good condition: 7 ha/s.u.

Range condition summary: good 93%, fair 7%; poor 0%.



Unit
1. Reticulate and linear dunes
2. Sand sheets
3. Interdunal corridors



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Reticulate & linear dunes (25%) 1 site inventory and traversed	
Reticulate to parallel longitudinal dunes, mostly 8-15 m above unit 3 and aligned approximately S to N. Soils are unconsolidated yellowish-red sand, > 1 m deep, pH 8.5 with an alkaline trend; principal profile form: Uc 1.12.	Scattered to moderately close low shrublands dominated by *Calytrix* spp. Tall shrubs (> 2 m): *Acacia coriacea, A. tetragonophylla, Banksia ashbyi, A. sclerosperma, Heterodendrum oleaefolium*; Low shrubs (< 1 m): *Calytrix* spp, *Rhagodia preissii, Threlkeldia diffusa, Pityrodia* sp.; Perennial grasses: *Eragrostis* aff. *eriopoda, Cenchrus ciliaris.*	Pasture type: *Coastal Dune Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Rhagodia preissii, Eragrostis* aff. *eriopoda.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Sand sheets (40%) 2 site inventories and traversed	
Gently undulating sandy surfaces, often mounded, slopes up to 1%. Soils are reddish-brown to yellowish-red sands, unconsolidated or slightly coherent, grading to clayey sand, > 1 m deep, with calcareous concretions and shell fragments throughout; pH 8.5 with an alkaline trend; principal profile forms: Uc 5.11, 1.12.	Moderately close to close shrublands dominated by *Acacia* spp or *Calytrix* spp. Tall shrubs (2-3m; 0-150/ha): *Acacia coriacea, A. tetragonophylla, Heterodendrum oleaefolium, Banksia ashbyi*; Low shrubs (3500-9500/ha; < 1.5 m): *Calytrix* spp, *Acanthocarpus preissii, Acacia tetragonophylla, Ptilotus obovatus, Rhagodia eremaea, Olearia axillaris*; Perennial grasses: *Cenchrus ciliaris, Eragrostis lanipes.*	Pasture type: *Coastal Dune Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, A. vesicaria, Enchylaena tomentosa.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Interdunal corridores (35%) 1 site inventory and traversed	
Flat to gently sloping interdunal plains and swales. Soils are reddish-brown sandy-surfaced duplex, sandy loam over sandy clay loam, > 1 m deep with calcareous concretions throughout, pH 8.5; principal profile form: Dr 1.13.	Scattered low shrublands dominated by *Acacia coriacea* and *Atriplex bunburyana*, or by *Maireana polypterygia* on soils with higher clay content. Low shrubs (< 1.5 m): *Atriplex bunburyana, Solanum lasiophyllum, Acacia coriacea, Atriplex paludosa, Maireana polypterygia, Cratystylis subspinescens, Chenopodium gaudichaudianum, Rhagodia eremaea.*	Pasture type: *Saltbush.* Perennials augmented by annual grasses and herbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Maireana polypterygia.* Undesirable perennials include: *Solanum lasiophyllum.* Pastoral use limitations Mild susceptibility to erosion: when degraded.

Lyons land system (G) 1126 km² (1.5% of survey area)

Claypans and restricted plains with longitudinal and reticulate dunes; tall acacia shrublands.

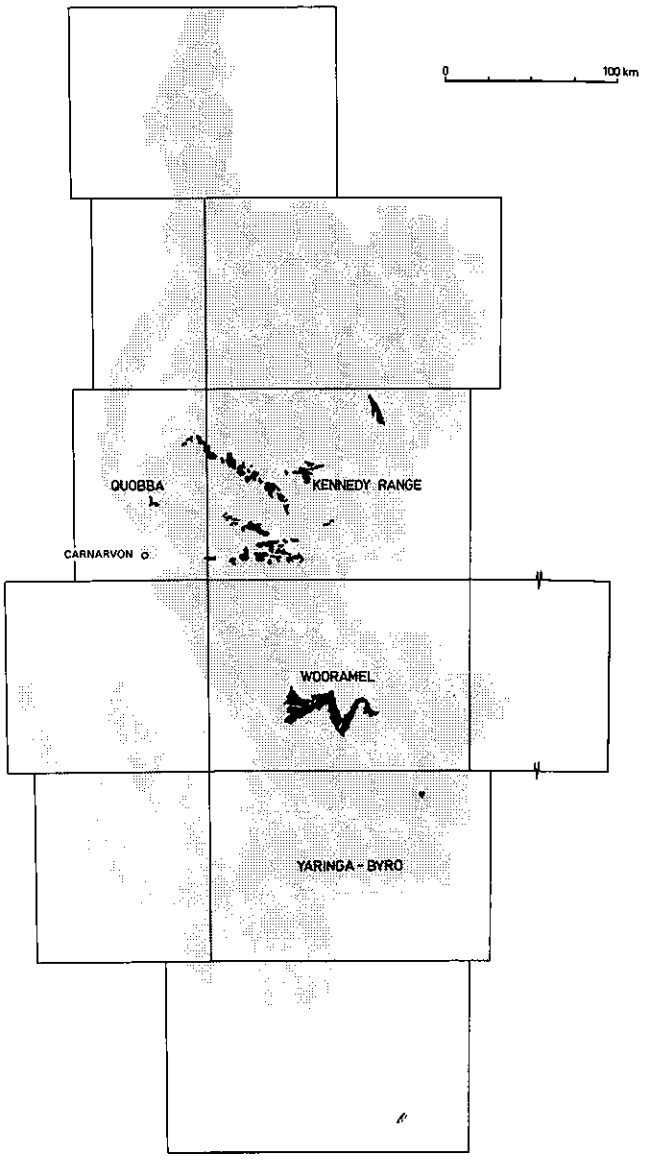
Geology: Quaternary aeolian sand and playa deposits.

Geomorphology: Depositional surfaces which are a zone of interaction between alluvial plains (of the lower Gascoyne and Wooramel Rivers) and extensive aeolian systems dominated by linear dunes. Mixed deposits have been sorted and re-deposited by wind and water over an area of disorganised drainage. The landscape is one of reticulate low dunes, restricted plains and elliptical claypans with up to 14 m relative relief.

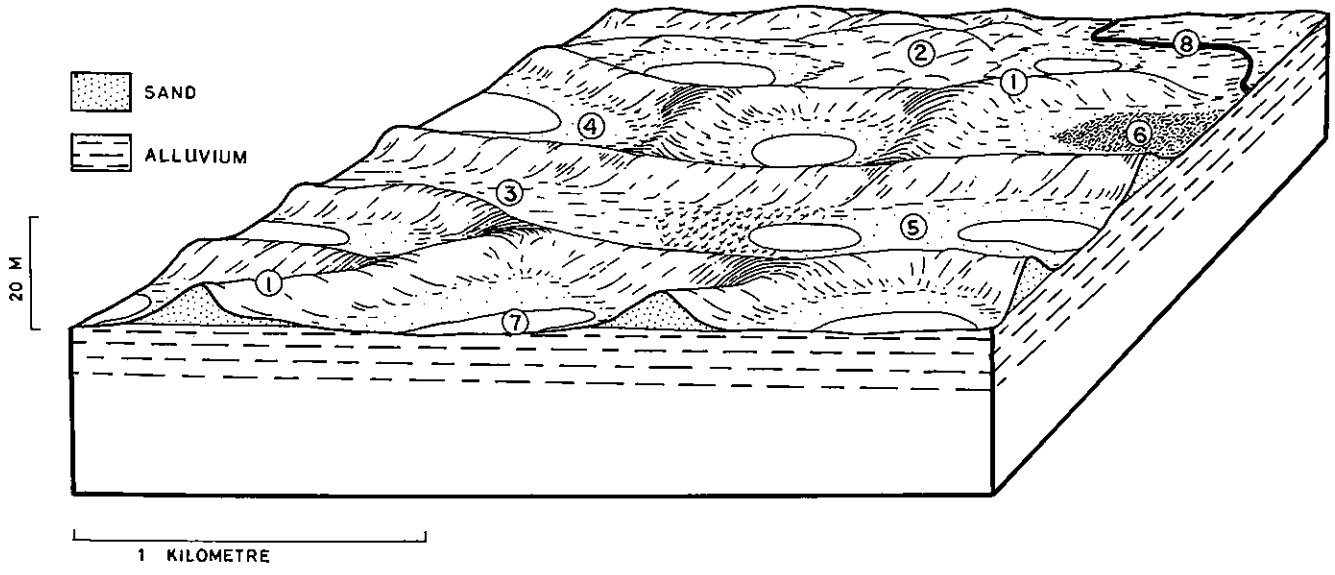
Pastoral use: Acacia Sandplain (ACSA) and Currant Bush Mixed Shrub (CBMS) pastures; unit 4 of the system is susceptible to mild erosion and shrub invasion.

Estimated carrying capacity, good condition: 10 ha/s.u.

Range condition summary: good 22%; fair 37%; poor 41%.



Unit
1. Longitudinal and reticulate dunes
2. Undulating sandy banks
3. Sandy swales
4. Alluvial plains
5. Stony plains
6. Drainage foci
7. Claypans
8. Drainage zones



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal and reticulate dunes (25%) 2 site inventories and traversed	
Longitudinal and reticulate dunes mostly 4-10 m above unit 6. Soils are non-coherent red sand, > 1 m deep, pH 6.5; principal profile form: Uc 1.23.	Scattered tall shrublands dominated by *Acacia sclerosperma* or sparse low woodlands dominated by *A. anastema*. PFC 10 to 25%; Trees (4-8 m): *A. anastema*; Tall shrubs (125-150/ha; 2-4 m): *A. murrayana, A. ramulosa, Stylobasium spathulatum, Grevillea stenobotrya*; Low shrubs (2000-3000/ha; < 1 m): *Chorizema ericifolium, Mirbelia ramulosa, Verticordia forrestii, Corynotheca lateriflora, Ptilotus obovatus, Pityrodia paniculata*; Perennial grasses: *Plectrachne schinzii* and *Cenchrus ciliaris* (N. of Gascoyne R. only), *Eragrostis lanipes, E. helmsii.*	Pasture type: *Acacia Sandplain. A. anastema* woodland only in the vicinity of the Wooramel R. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Rhagodia eremaea, Enchylaena tomentosa, Eragrostis* spp. Pastoral use limitations: None under controlled stocking.
	Unit 2 Undulating sandy banks (10%) 2 site inventories and traversed	
Undulating sandy banks and small sand sheets, relief up to 4 m. Soils are red sands grading to clayey sand or sandy loam, > 1 m deep, pH 6.5-8.0; principal profile forms: Uc 5.11, 5.13, Dr 1.13 locally (near unit 4).	Scattered tall or low shrublands, very variable in dominants. PCF 10 to 20%; Tall shrubs (175-225/ha; 2-3 m): *Acacia sclerosperma, A. wiseana, A. tetragonophylla, Heterodendrum oleaefolium, Eremophila maitlandii, Hakea preissii, Acacia victoriae, A. aneura*; Low shrubs (1000-5000/ha; < 2 m): *Scaevola spinescens, Maireana lanosa, Ptilotus obovatus, Rhagodia eremaea, Cassia helmsii, Chenopodium gaudichaudianum, Solanum lasiophyllum, Eremophila leucophylla*; Perennial grasses: *Triodia* sp. (< 10% hummock cover), *Eragrostis setifolia, Enteropogon acicularis.*	Pasture type: *Currant Bush Mixed Shrub/Acacia Sandplain.* Vegetation very locally dominated by *Acacia xiphophylla* and *Atriplex bunburyana. Triodia* sp. absent in areas near the Wooramel R. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Scaevola spinescens, Maireana* spp, *Enchylaena tomentosa, Cassia chatelainiana.* Undesirable perennials include: *Hakea preissii, Eremophila crenulata.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Sandy swales (15%) 2 site inventories and traversed	
Flat or gently concave swales, locally very sparsely strewn with radiolarite gravel. Soils are dark red loamy sands to sandy loams, locally duplex at lower points of the unit, > 1 m deep, pH 6.0-7.0 with neutral or alkaline trends; principal profile forms: Uc 5.11, Dr 1.13.	Scattered tall or mixed shrublands, composition similar to unit 2, but when in good condition often supporting higher densities of low shrubs, such as *Eremophila leucophylla, E. latrobei, Ptilotus obovatus, Tribulus platypterus, Rhagodia eremaea*; Perennial grasses as unit 2, also *Cenchrus ciliaris*	Pasture type: *Acacia Sandplain. Acacia subtessarogona* is locally dominant (tall shrub) in areas near the Gascoyne R. *Cenchus ciliaris* was not found in areas near the Wooramel R. Desirable perennials include: *Eremophila latrobei, Tribulus platypterus, Maireana planifolia, Scaevola spinescens* Pastoral use limitations: None under controlled stocking.
	Unit 4 Alluvial plains (15%) 3 site inventories and traversed	
Slightly undulating plains occurring as areas < 500 m wide between claypans or sandy banks; slopes < 0.5%. Soils are reddish brown duplex, sand over sandy clay, sometimes very sparsely strewn with quartz gravel, > 1 m deep, pH 6.5-7.0 with a neutral or alkaline trend; principal profile forms: Dr 1.12, 1.13.	*Scattered tall or mixed shrublands, usually dominated by Acacia victoriae* and *Scaevola spinescens.* PFC 10 to 20%; Tall shrubs (100-500/ha; 2-3 m): *Scaevola spinescens, A. victoriae, A. tetragonophylla, Hakea preissii, Eremophila pterocarpa,* Low shrubs (1000-5000/ha, < 2 m): *Eremophila pterocarpa; Eremophila crenulata, Rhagodia eremaea, Cassia helmsii, C. desolata, Solanum lasiophyllum, Sclerolaena* spp, *Chenopodium gaudichaudianum, Commicarpus australis*; Perennial grasses: *Eragrostis dielsii* (infrequent).	Pasture type: *Currant Bush Mixed Shrub.* Possibly the unit formerly supported saltbush *Atriplex* spp, but no evidence of this was found, though no ungrazed sites were located. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Scaevola spinescens, Cassia chatelainiana, Maireana planifolia. Rhagodia eremaea* Undesirable perennials include: *Eremophila crenulata, Hakea preissii, Acacia victoriae* Pastoral use limitations: Mild susceptibilities to accelerated water erosion and invasion by unpalatable shrubs.

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 5 Stony plains (2%) Traversed	
Restricted clay plains strewn with gravel or pebbles strew, bordering claypans or drainage foci.	Very scattered shrublands dominated by *Acacia victoriae*, *A. tetragonophylla* and *Cassia* spp.	Perennials augmented by annual grasses and forbs in favourable seasons.
	Unit 6 Drainage foci (5%) 2 site inventories and traversed	
Discrete drainage foci with flat or slightly concave floors, some being very sparsly strewn with mixed gravels. Soils are reddish brown gradational types, fine sandy clay loam to sandy clay or loamy sand to fine sandy loam, > 90 cm deep, pH 6.0-7.0 with a neutral trend; principal profile forms: Gn 2.12, 3.12.	Moderately close to close tall shrublands or low woodlands dominated by *Acacia tetragonophylla*, with or without an upper storey of low trees. PFC 20 to 50%; Trees (100/ha; 2-10 m): *Acacia subtessarogona*, *A. citrinoviridis*, *A. aneura*; Tall shrubs (< 200/ha; 2-4 m): *A. tetragonophylla*, *A. victoriae*, *Cassia luerssenii*; Low shrubs (1000/ha; 0.5-1.5 m): *Ptilotus obovatus*, *Chenopodium gaudichaudianum*, *Rhagodia eremaea*, *Eremophila crenulata*, *Maireana planifolia*, *Cassia helmsii*; Perennial grasses: *Enteropogon acicularis*, *Eragrostis setifolia*, *E. xerophila*.	Pasture type: *Acacia Creek-line*. Desirable perennials include: *Enteropogon acicularis*, *Rhagodia eremaea*. Pastoral use limitations: Vegetation may be locally too dense to permit free access by stock.
	Unit 7 Claypans (25%) 1 site inventory and traversed	
Claypans with crusted, glazed and cracked surfaces when dry, very variably strewn with radiolarite or mixed gravels. Soils are medium clays, about 50 cm deep, pH 7.5, principal profile form: Uf 6.31.	Fringing vegetation absent or isolated shrubs of *Acacia victoriae*; the pans otherwise have no perennial vegetation.	Patches of aquatic ephemerals develop during favourable seasons, probably mainly *Threlkeldia salsuginosa*
	Unit 8 Drainage zones (3%) Traversed	
Sluggish drainage tracts with alluvium.	Scattered tall shrublands or fringing low woodlands dominated by *Acacia aneura*.	Perennials augmented by annual grasses and forbs in favourable seasons

MacLeod land system 259 km² (0.3% of survey area)

Broad saline plains, with sandy banks and low rises above saline slopes and bare mudflats; bare surfaces and low shrublands of samphire and saltbush.

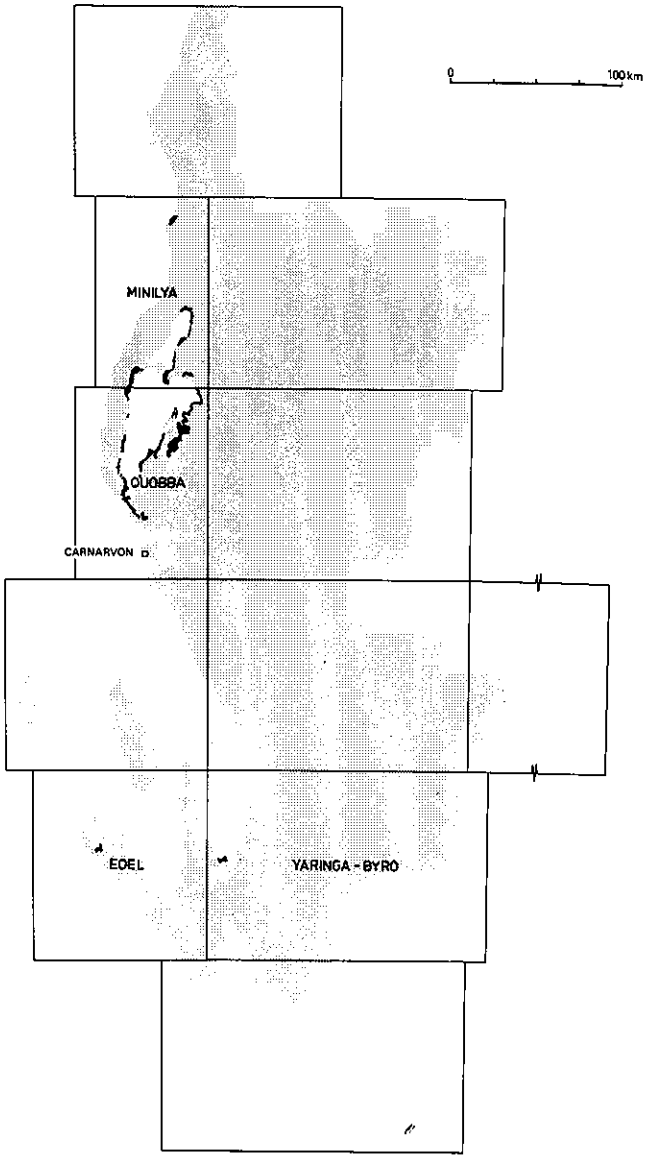
Geology: Quaternary deposits forming saline lake beds and gypsiferous sand dunes over fossil coral reef deposits which outcrop locally.

Geomorphology: Flat depositional plains with banks and rises (up to 10 m relief) draining onto mudflats or playa lakebeds via fringing clay plains with poorly developed parallel incisions.

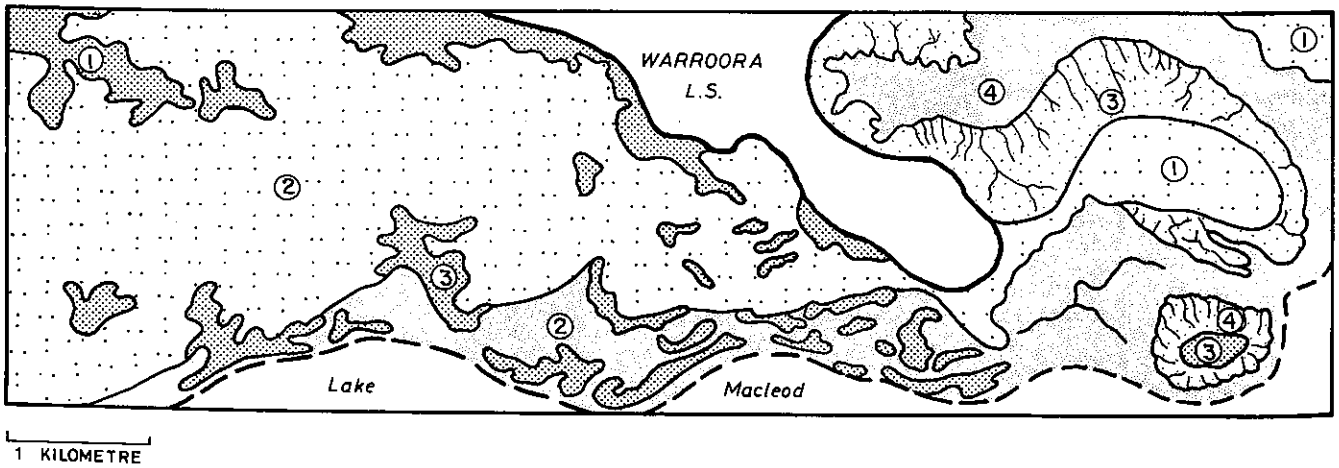
Pastoral use: Samphire (SAMP), Saltbush (SALT), and Bluebush (BLUE) pastures, all highly saline but providing useful shrub forage when good quality stock water is available to offset the high dietary intake of salts. Unit 1 and 3 are moderately susceptible to erosion when degraded.

Estimated carrying capacity, good condition: 17 ha/s.u.

Range condition summary: good 99%; fair 0%; poor 1%.



Unit
1. Sandy banks
2. Saline plains
3. Dissected slopes
4. Mudflats



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Sandy banks (20%) 1 site inventory and traversed	
Sandy banks, rises and lakebed islands with moundy surfaces and relief up to 10 m. Soils are gradational, brown sandy loam to sandy clay loam, > 1 m deep, pH 8.5 with an alkaline trend; principal profile forms: Gc 1.22 or gypsiferous juvenile types.	Very scattered to scattered low shrublands dominated by *Maireana polypterygia*, or *Atriplex vesicaria*. Trees (2-4 m): *Acacia cuspidifolia*; Tall shrubs (2-3 m): *A. victoriae*; Low shrubs (> 1 m): *Maireana polypterygia*, *Atriplex vesicaria*, *Ptilotus obovatus*, *Halosarcia* spp, *Lawrencia* spp, *Atriplex bunburyana*.	Pasture type: *Saltbush/Bluebush*. Desirable perennials include: *Maireana polypterygia*. Pastoral use limitations: Moderately susceptible to wind erosion.
	Unit 2 Saline plains (40%) 1 site inventory and traversed	
Flat plains; soils are highly saline and gypsiferous juvenile types, brown to yellow loams or sands, > 1 m deep, pH 8.0 with an alkaline trend.	Scattered low shrublands dominated by *Halosarcia halocnemoides*. Low shrubs (< 0.5 m): *H. halocnemoides*, *H. indica*, *Atriplex vesicaria*.	Pasture type: *Samphire*. Pastoral use limitations: High salinity levels of pasture plants.
	Unit 3 Dissected slopes (10%) 2 site inventories and traversed	
Plains sloping to 1.5% with irregular surfaces and parallel drainage incisions. Soils are yellowish red to reddish brown, light medium clay to sandy clay, > 1 m deep, pH 8.0-8.5 with an alkaline trend; principal profile form: Uf 6.34.	Very scattered to scattered low shrublands dominated by *Atriplex vesicaria* and *Halosarcia* spp. Low shrubs (500-3,000/ha): *A. vesicaria*, *Halosarcia* spp, *Maireana polypterygia*, *M. platycarpa*, *Ruellia primulacea*, *Lawrencia* spp.	Pasture type: *Samphire* or *Saltbush*. Pastoral use limitations: Moderate susceptibility to water erosion; high salinity levels of pasture plants.
	Unit 4 Mudflats (30%) Traversed	
Mudflats, lime silts and sands with gypsum and salt deposits.	Mainly unvegetated.	Subject to seasonal inundation.

Mallee land system 478 km² (0.6% of survey area)

Coastal dunes and sandy plains with limestone outcrops, supporting mallee eucalypts and hard spinifex.

Geology: Quaternary aeolian sand and calcarenite and Late Tertiary Trealla Limestone.

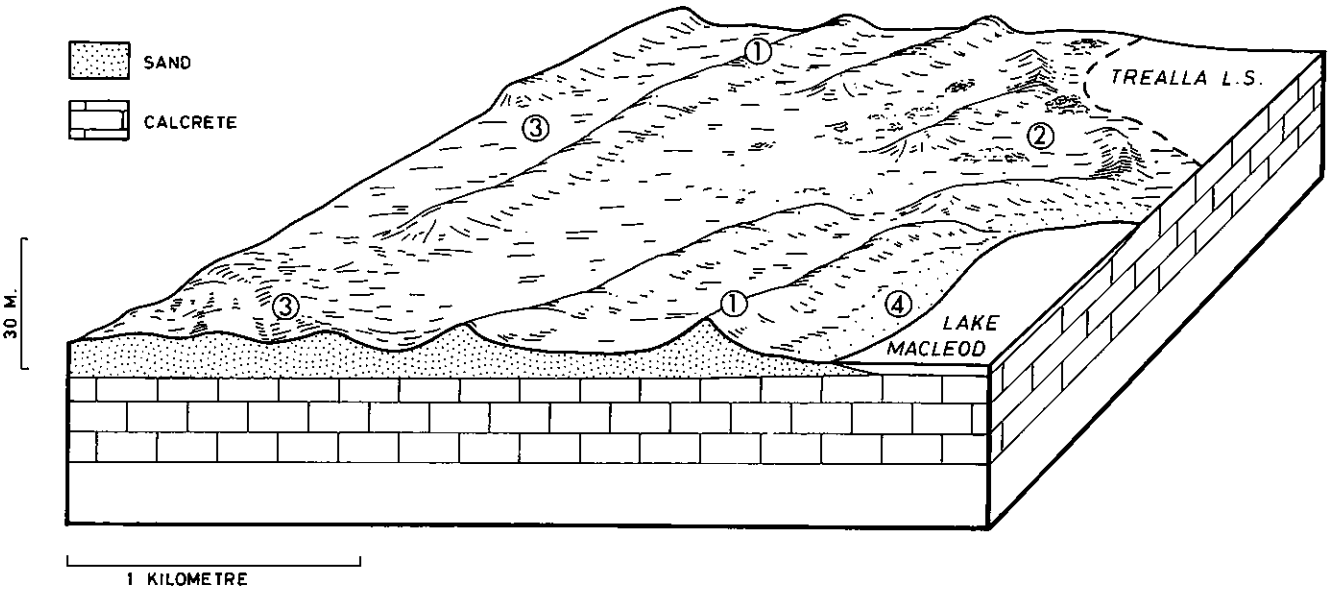
Geomorphology: Mostly depositional surfaces: longitudinal dunes, mostly linear and broad swales with sandy surfaces over limestones which outcrop as restricted plains near Lake MacLeod.

Pastoral use: Predominantly Hard Spinifex (HASP) with patches of Soft Spinifex (SOSP) pastures; may be kept productive by periodic burning, followed by a deferral of grazing to rejuvenate the soft spinifex, other grasses and herbs. A range of palatable shrubs on the major unit 3 further enhances the drought durability of the system. Unit 1 is susceptible to wind erosion, especially where heavily used and after burning.

Estimated carrying capacity, good condition: 10 ha/s.u.

Range condition summary: Good 67%; fair 25%; poor 8%.

Unit
1. Longitudinal dunes
2. Limestone plains
3. Swales and sandy plains
4. Fringing plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal dunes (12%) 1 site inventory and traversed	
Long-walled dunes, mostly linear 7-15 m high and 1-5 km long. Soils are unconsolidated sand, red to dark red, > 1 m deep, pH 6.5 with a neutral trend, principal profile form: Uc 1.23.	Scattered to moderately close tall shrublands dominated by *Eucalyptus eudesmioides* and *Acacia ramulosa*. Tall shrubs: *E. eudesmioides, A. ramulosa, A. sclerosperma, A. tetragonophylla, Grevillea* spp; Low shrubs (< 1 m): *Pityrodia* sp., *Calytrix longiflora, Olearia axillaris, Stylobasium spathulatum, Eremophila gibsonii*; Perennial grasses: *Triodia pungens, T.* spp, *Eragrostis lanipes, E. helmsii.*	Pasture type: *Hard Spinifex/Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Highly susceptible to wind erosion when degraded and/or burnt.
	Unit 2 Limestone plains (30%) Traversed	
Plains of outcropping limestone and thin calcareous soils, mostly occurring interdunally.	Tall shrublands dominated by thickets of mallee eucalypts and understorey hummock grasses, mainly *Triodia pungens.*	Pasture type: *Soft Spinifex.* Pastoral use limitations: None under controlled stocking and appropriate fire management.
	Unit 3 Swales and sandy plains (55%) 3 site inventories and traversed	
Plains with mounded surfaces, flat to sloping up to 2% as concave swales, with or without a very sparse mantle of limestone gravels or pebbles. Soils are dark red to dusky red sand or loamy sand, 50 cm to > 1 m deep, pH 6.5 to 8.5 with neutral or alkaline trend; principal profile forms: Uc 1.23, Gc 1.22.	Scattered to close tall shrublands or low woodlands dominated by mallee eucalypts and hummock grasses. Trees and tall shrubs (200-270/ha; 2-4 m): *Eucalyptus eudesmioiodes, E. prominens, Acacia tetragonophylla, A. ramulosa*; Low shrubs (2500-5000/ha; < 2 m): *Santalum spicatum, Heterodendrum oleaefolium, Stylobasium spathulatum, Pimelea microcephala, Scaevola spinescens, S. tomentosa, Enchylaena tomentosa, Rhagodia* spp, *Ptilotus obovatus, Acanthocarpus preissii*; Perennial grasses: *Triodia pungens, T.* spp (up to 25% cover). The tree-shrub-hummock grass associations often reflect changes in succession after burning. Pastoral use limitations: None under controlled stocking.	Pasture type: *Hard Spinifex/Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons.
	Unit 4 Fringing plains (3%) Traversed	
Plains with thin calcareous soils, locally calcreted and gravelly fringing Lake Macleod.	Very scattered tall shrublands dominated by *Acacia* spp, *Codonocarpus cotinifolius* and understorey hummock grasses, mainly *Triodia pungens.*	Pasture type: *Soft Spinifex.* Pastoral use limitations: None under controlled stocking.

Mantle land system (G) 307 km² (0.4% of survey area)

Gently undulating stony plains with sluggish drainage tracts, stony rises and low summits, scattered tall and low shrublands dominated by *Acacia* and *Eremophila* species.

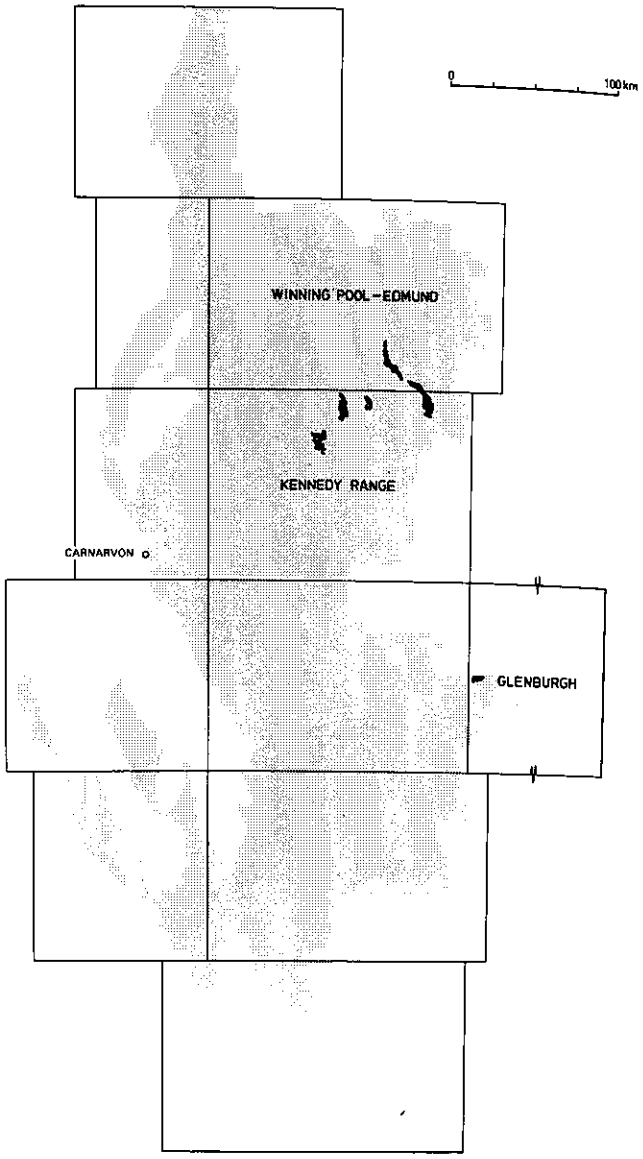
Geology: Permian siltstone, shale and greywacke of the Sakmarian Series.

Geomorphology: Erosional surfaces: rounded to flattened low summits and ridges above densely mantled slopes and plains with low density drainage patterns of partly internal but mostly through drainage; relief up to 36 m.

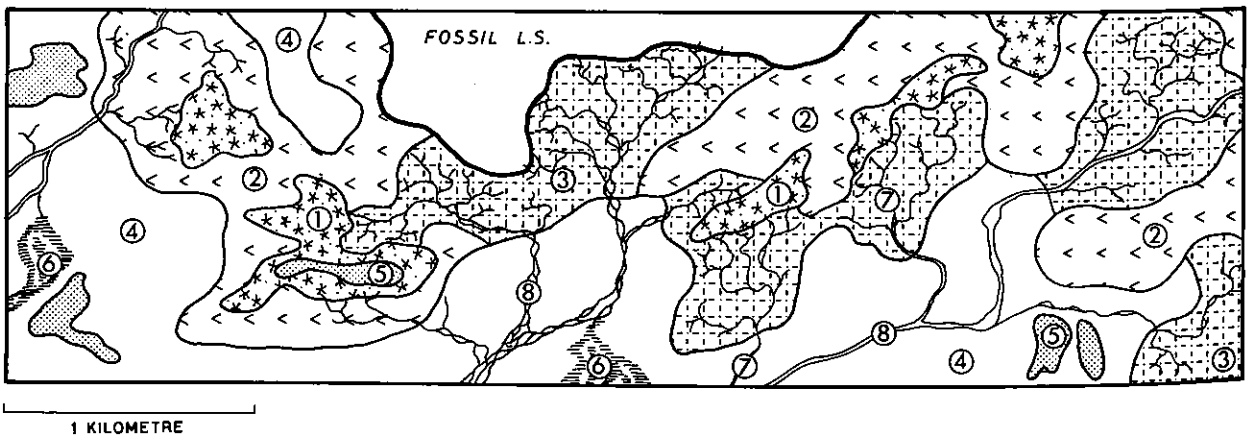
Pastoral use: Stony Chenopod (STCH) and Stony Short Grass Forb (SSGF) pastures; one of the more stable of the Permian-based land systems, because of extensive surface stone mantling of the otherwise easily eroded soils. Even so, productive areas which receive run-on remain susceptible to accelerated soil loss wherever the shrub pastures have become degraded, particularly on units 3 and 8.

Estimated carrying capacity, good condition: 15 ha/s.u.

Range condition summary: good 5%; fair 43%; poor 52%

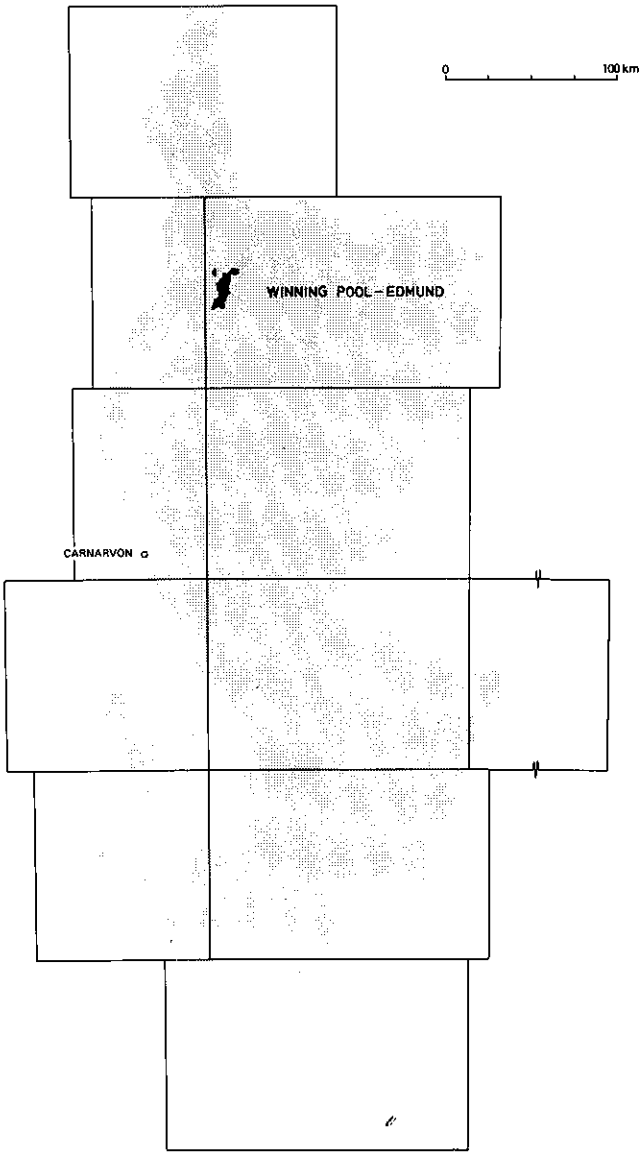


Unit
1. Rounded summits
2. Upper slopes and plains
3. Interfluves and creek-lines
4. Lower slopes and plains
5. Sandy banks
6. Sluggish drainage foci
7. Flow zones
8. Braided drainage floors



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Flat to convex summits, mainly densely mantled with granitic cobbles but locally bearing remnants of sandy banks. Soils are reddish-brown gradational loams or clayey types, fine sandy loam to fine sandy clay loam, < 50 cm deep, with granitic and limestone inclusions throughout, pH 8.0 with an alkaline trend; principle profile form: Gc 1.12.	**Unit 1 Rounded summits (10%) 1 site inventory and traversed** Very scattered to scattered low shrublands dominated by *Acacia victoriae, A. aneura* and *Eremophila* spp. Low shrubs (4500/ha; < 1 m): *Ptilotus obovatus, Eremophila cuneifolia, E. platycalyx, Cassia helmsii, C. desolata, Acacia victoriae, A. aneura*; Perennial grasses: *Enteropogon acicularis.*	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
Gently undulating upper slopes and stony plains above interfluvial slopes receiving run-on and dissected by slightly incised creek-lines, all moderately to densely strewn with pebbles and cobbles. Soils are reddish-brown clays, 50 cm to > 1 m deep, pH 7.0 with an alkaline trend.	**Unit 2 Upper slopes and plains (25%)** **Unit 3 Interfluves and creek-lines (15%) Traversed** Very scattered to scattered tall or low shrublands dominated by *Acacia cuspidifolia* and *Eremophila* spp. Trees and tall shrubs: *A. cuspidifolia, A. aneura, A. victoriae.* Low shrubs: *Eremophila cuneifolia, Cassia desolata, Solanum lasiophyllum, Maireana* spp, *Rhagodia eremaea.*	Pasture type: *Stony Chenopod/Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana pyramidata, Rhagodia eremaea.* Pastoral use limitations: Mild susceptibility to water erosion when degraded.
Gently sloping (< 1%) plains, lightly to moderately strewn with gravels or cobbles. Soils are reddish-brown clays or clay loams, usually < 1 m deep, pH 8.0 with an alkaline trend.	**Unit 4 Lower slopes and plains (35%) 1 site inventory and traversed** Very scattered to scattered tall shrublands dominated by groves or terraces of *Acacia* spp, *Eremophila* spp and *Cassia* spp. Trees and tall shrubs: *Acacia xiphophylla, A. cuspidifolia, A. victoriae, A. subtessarogona*; Low shrubs: *Eremophila cuneifolia, Cassia desolata, Exocarpos aphyllus, Maireana polypterygia, M. georgei, Rhagodia eremaea, Ptilotus polakii.*	Pasture type: *Stony Chenopod.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, M. georgei, Rhagodia eremaea.* Pastoral use limitations: Mild susceptibility to water erosion when degraded.
Areas of aeolian sand, usually < 500 m long, mainly on crests and low rises. Soils are probably reddish-brown sands, > 1 m deep, pH 6.5 with a neutral trend.	**Unit 5 Sandy banks (5%) Traversed** Scattered to moderately close tall shrublands dominated by *Acacia linophylla.* Trees and tall shrubs: *A. linophylla, A. aneura, A. subtessarogona*; Low shrubs: *Corchorus walcotti, Eremophila granitica, E. leucophylla, Rhagodia eremaea*; Perennial grasses: *Cenchrus ciliaris.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Rhagodia eremaea, Eremophila leucophylla.* Pastoral use limitations: None under controlled stocking.
Drainage floors and diffuse foci with internal drainage, flat and frequently with gilgaied surfaces. Soils are probably reddish-brown clay types, pH 8.0.	**Unit 6 Sluggish drainage foci (5%) Traversed** Very scattered to scattered low shrublands dominated by *Maireana* spp, *Frankenia* spp and *Halosarcia* spp.	Pasture type: *Stony Chenopod.* Desirable perennials include: *Maireana* spp, *Frankenia* spp. Pastoral use limitations: Liable to degradation of the vegetation through locally concentrating stock.
Narrow zones with concentrated through drainage. Soils are probably reddish-brown clays.	**Unit 7 Flow zones (< 1%) Traversed** Scattered to moderately close shrublands similar to unit 4, often with more *Cenchrus ciliaris.*	Pasture type: *Stony Chenopod* or *Acacia Creek-line.*
Narrow drainage floors with more or less incised and braided flow lines. Soils are probably reddish-brown clays.	**Unit 8 Braided drainage floors (5%) Traversed** Very scattered to scattered shrublands similar to units 6 or 7.	Pasture type: *Stony Chenopod* or *Acacia Creek-line.* Pastoral use limitations: Moderately susceptible to water erosion when degraded.

Marloo land system 111 km² (0.1% of survey area)



Weakly gilgaied alluvial plains with clay soils supporting tussock grasslands.

Geology: Quaternary alluvium.

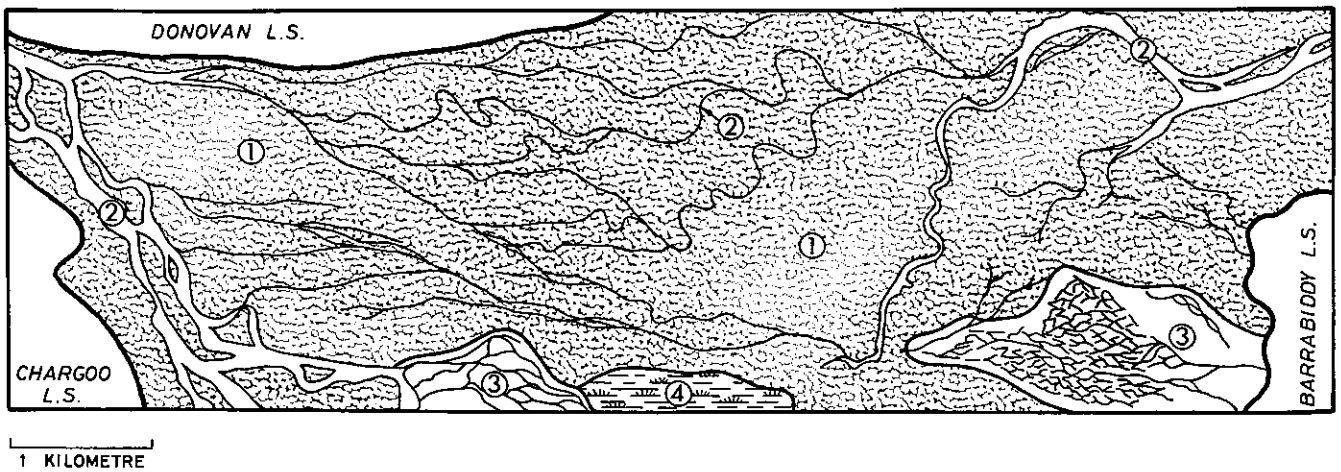
Geomorphology: Depositional surfaces: alluvial plains, subject to extensive seasonal flooding and waterlogging, at the confluence of Cardabia Creek and the Minilya River; drainage deltaic and partly internal, but mostly through to the Minilya River; relief up to 4 m.

Pastoral use: Highly productive Tussock Grass (TUGR) pastures which present no special management problems, although some areas have become degraded to mainly annual grasslands and would benefit from spelling for two or more growing seasons; a small but locally significant land system, not normally susceptible to erosion.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: good 55%; fair 36%; poor 9%

Unit
1. Alluvial plains
2. Channeled flow zones
3. Anastomosing drainage lines
4. Swamps and depressions



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Nearly flat plains with slopes about 0.2% and weakly gilgaied surfaces showing depressions at intervals of 2-4 m. Soils are reddish-brown or dark reddish-grey clays, heavy clay throughout or medium heavy grading to heavy, > 1 m deep, calcareous inclusions throughout, pH 8.5; principal profile form: Ug 5.38.	**Unit 1 Alluvial plains (70%) 2 site inventories and traversed** Tussock grasslands dominated by *Eragrostis xerophila*. Perennial grasses (up to 3% b.c.): *Eragrostis xerophila, E. setifolia, Astrebla squarrosa, A. elymoides, A. pectinata, Eriachne* aff. *sulcata*; Low shrubs: *Eremophila maculata, Rhagodia* sp.	Pasture type: *Tussock Grass.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eragrostis* spp, *Astrebla* spp. Pastoral use limitations: None with controlled stocking and appropriate seasonal use.
Flow zones carrying channelled drainage, usually not incised, with meanders, draining from and shedding to unit 1. Soils are weak red silty or sandy clays, > 1 m deep, with only juvenile textural development, pH 8.0 with a neutral trend.	**Unit 2 Channelled flow zones (15%) 1 site inventory and traversed** Open woodlands dominated by *Eucalyptus coolabah*. Trees (10-12 m): *E. coolabah*; Tall shrubs (4-6 m): *Acacia coriacea, A. farnesiana*; Perennial grasses: *Cenchrus ciliaris, C. setigerus, Chrysopogon fallax, Enteropogon acicularis, Sporobolus mitchellii.*	Pasture type: *Tussock Grass.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Chrysopogon fallax, Cenchrus* spp, *Scaevola spinescens.* Pastoral use limitations: None with controlled stocking.
Flat plains with anastomosing drainage lines, more or less channelled but not incised, acting as tributary plains draining into channelled zones (unit 2). Soils are deep clays.	**Unit 3 Anastomosing drainage lines (10%) Traversed** Tussock grasslands dominated by *Eragrostis* aff. *falcata*. Perennial grasses: *E.* aff. *falcata, Eulalia fulva*; Low shrubs: *Chenopodium auricomum.*	Pasture type: *Tussock Grass.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eragrostis* aff. *falcata.* Pastoral use limitations: None with controlled stocking.
Low lying areas with gilgaied or irregular surfaces subject to prolonged seasonal inundation. Soils are deep clays.	**Unit 4 Swamps and depressions (5%) Traversed** Open woodlands or tussock grasslands dominated by *Eucalyptus coolabah* and *Eragrostis* spp.	Pasture type: *Tussock Grass.* Pastoral use limitations: None with controlled stocking.

Mary land system 507 km² (0.7% of survey area)

Calcrete plains, with minor low rises, supporting tall shrublands of acacias and cassias.

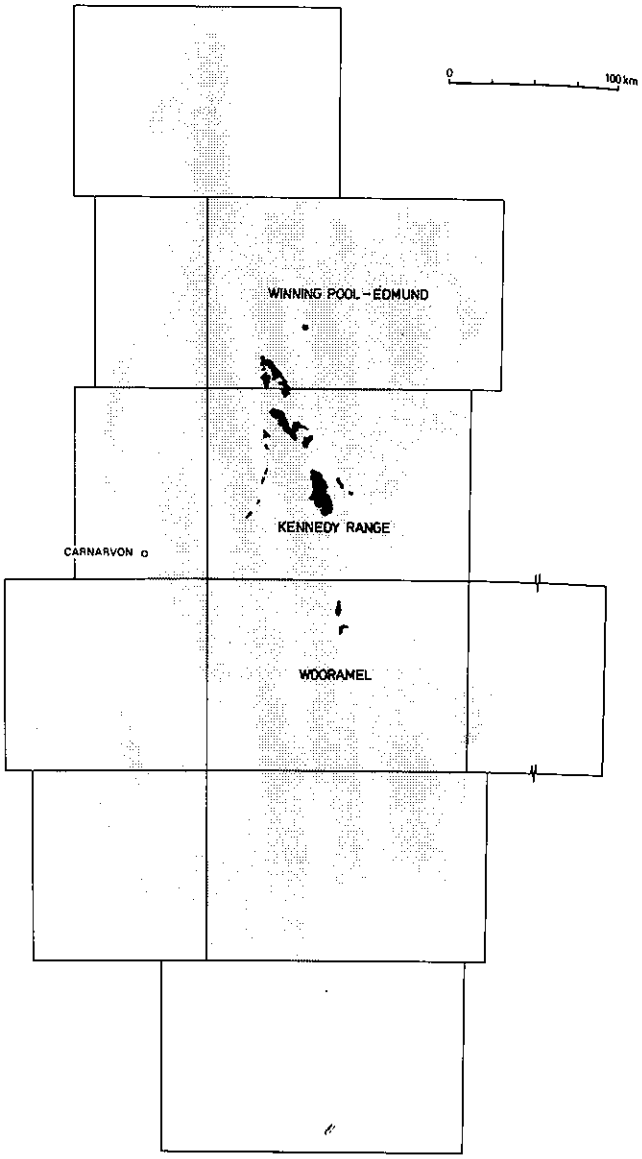
Geology: Tertiary calcrete, with Quaternary deposits of alluvium and colluvium.

Geomorphology: Erosional and depositional surfaces: gently sloping plains with calcrete at shallow depth, low calcrete rises and narrow flow zones; relief up to 8 m.

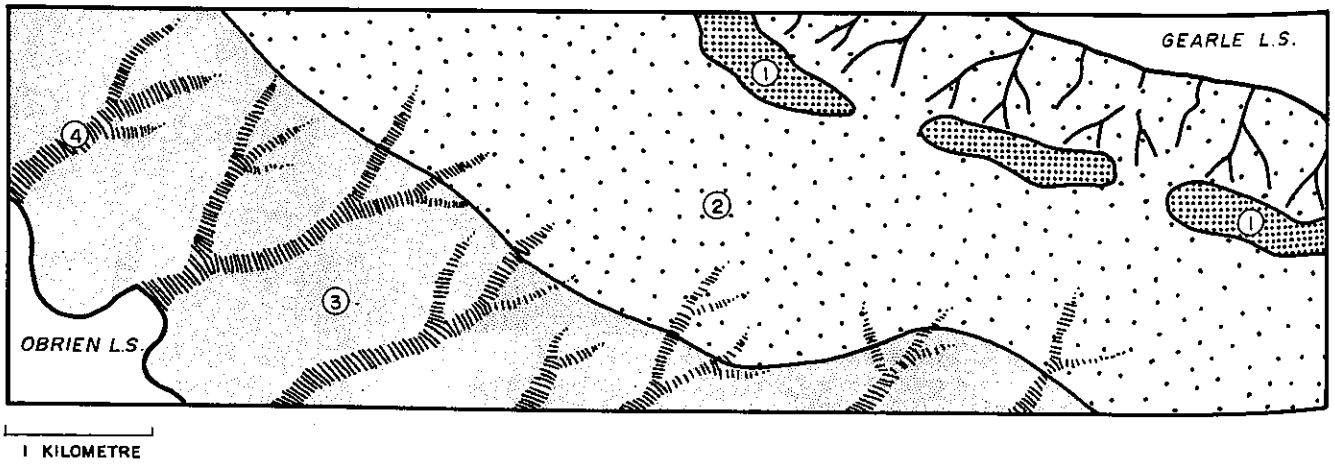
Pastoral use: Acacia Mixed Shrub (ACMS) pastures and minor Bluebush (BLUE) pastures; unit 3 slightly susceptible to erosion.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: good 39%; fair 49%; poor 12%.



Unit
1. Calcrete rises
2. Calcrete plains
3. Sandy-surfaced plains
4. Narrow flow zones



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Low rises and breakaways up to 7 m, surfaces strewn with limestone and calcrete fragments. Soils are red sand to sandy loams, < 80 cm deep with limestone inclusions, pH 8.5 with an alkaline trend; principal profile form: Uc 1.13, Gc 1.12.	**Unit 1 Calcrete rises (10%) 2 site inventories and traversed** Scattered tall or low shrublands dominated by *Acacia victoriae, A. sclerosperma* and *Cassia helmsii*. Trees (< 50/ha; 2-4 m): *Heterodendrum oleaefolium*; Tall shrubs (100/ha; 2-3 m): *A. victoriae, A. sclerosperma, Stylobasium spathulatum, Hakea preissii*; Low shrubs (3000/ha; 0.5-1.5 m): *Cassia helmsii, C. desolata, Maireana tomentosa, Acacia tetragonophylla, Ptilotus obovatus, Rhagodia eremaea.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Rhagodia eremaea, Enchylaena tomentosa.* Pastoral use limitations: None under controlled stocking.
Gently undulating plains of low relief (c. 2 m) with calcrete outcropping or at shallow depth, moderately strewn with limestone pebbles. Soils are dark red, sandy loam or duplex types, < 50 cm deep with limestone inclusions, pH 8.5; principal profile forms Gc 1.21, Dr 1.13.	**Unit 2 Calcrete plains (50%) 1 site inventory and traversed** Scattered tall shrublands dominated by *Acacia* spp. Tall shrubs (2-4 m): *A. subtessarogona, A. sclerosperma, A. pruinocarpa*; Low shrubs (< 2m): *Cassia helmsii, C. desolata, Rhagodia eremaea, Ptilotus obovatus, Maireana lanosa, Eremophila platycalyx*; Perennial grasses: *Cenchrus ciliaris, C. setigerus.*	Pasture type: *Acacia Mixed Shrub.* Pastures augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp, *Eremophila latrobei, Enchylaena tomentosa.* Pastoral use limitations: None under controlled stocking.
Flat to gently undulating plains, relief up to 5 m, sparsely strewn with calcrete or radiolarite gravels or pebbles. Soils are dark red to reddish brown sands or gradational calcareous types, 35 cm to > m deep with calcrete and radiolarite inclusions, pH 8.0-8.5; principal profile forms: Gc 1.21, 1.22, Uc 5.12, 5.21, Dr 1.52.	**Unit 3 Sandy-surfaced plains (35%) 7 sites inventories and traversed** Very scattered to moderately close shrublands dominated by *Acacia* spp. and very variable low shrubs. PFC 5 to 25%; Tall shrubs (100-450/ha; 2-4 m): *A. subtessarogona, A. sclerosperma, A. xiphophylla, A. victoriae, Heterodendrum oleaefolium, Eremophila pterocarpa*; LOW shrubs (900-8000/ha; < 2 m): *Cassia helmsii, C. desolata, Maireana lanosa, M. tomentosa, M. polypterygia, Eremophila leucophylla, E. latrobei, Ptilotus obovatus, Enchylaena tomentosa*; Perennial grasses: *Cenchrus ciliaris* (in northern areas only).	Pasture type: *Acacia Mixed Shrub* or *Bluebush.* Also, *A. xiphophylla - Atriplex bunburyana* (Saltbush) association occurs locally on duplex sites. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp, *Eremophila pterocarpa, E. latrobei.* Undesirable perennials include: *Hakea preissii, Eremophila pterocarpa, E. crenulata.* Pastoral use limitations: Slight susceptibility to water erosion when degraded; invasions by unpalatable shrubs.
Narrow drainage zones, some incised, of low density, dendritic to parallel. Soils are dark red and sandy-surfaced gradational or duplex, > 1 m deep, with or without radiolarite surface gravels and inclusions, pH 7.0-8.0 with a neutral trend, principal profile forms: Gn 2.12, Dr 1.12, Uc 5.21.	**Unit 4 Narrow flow zones (5%) 3 sites inventories and traversed** Scattered tall or low shrublands dominated by *Acacia subtessarogona* in which *Cenchrus ciliaris* has become widespread. PFC 15 to 20%; Tall shrubs (150-500/ha; 2-6 m): *A. subtessarogona, A. xiphophylla, A. sclerosperma, A. victoriae, Hakea preissii, Santalum lanceolatum*; Low shrubs (1000-2000/ha; 0.5-2 m): *Cassia helmsii, Rhagodia eremaea, Scaevola spinescens, Eremophila leucophylla, Chenopodium gaudichaudianum, Eremophila crenulata*; Perennial grasses: *Cenchrus ciliaris, Monachather paradoxa, Chrysopogon fallax, Eragrostis eriopoda, Eragrostis dielsii.*	Pasture type: *Tussock Grass.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eragrostis* spp, *Rhagodia eremaea, Scaevola spinescens, Chrysopogon fallax.* Undesirable perennials include: *Eremophila crenulata, Cassia helmsii.* Pastoral use limitations: Slight susceptibility to water erosion when degraded.

Moogooloo land system (G) 1320 km² (1.8% of survey area)

Intensely dissected plateaux, mesas and hills of sedimentary rocks with steep footslopes and dendritic drainage, supporting tall shrublands of mulga and other acacias.

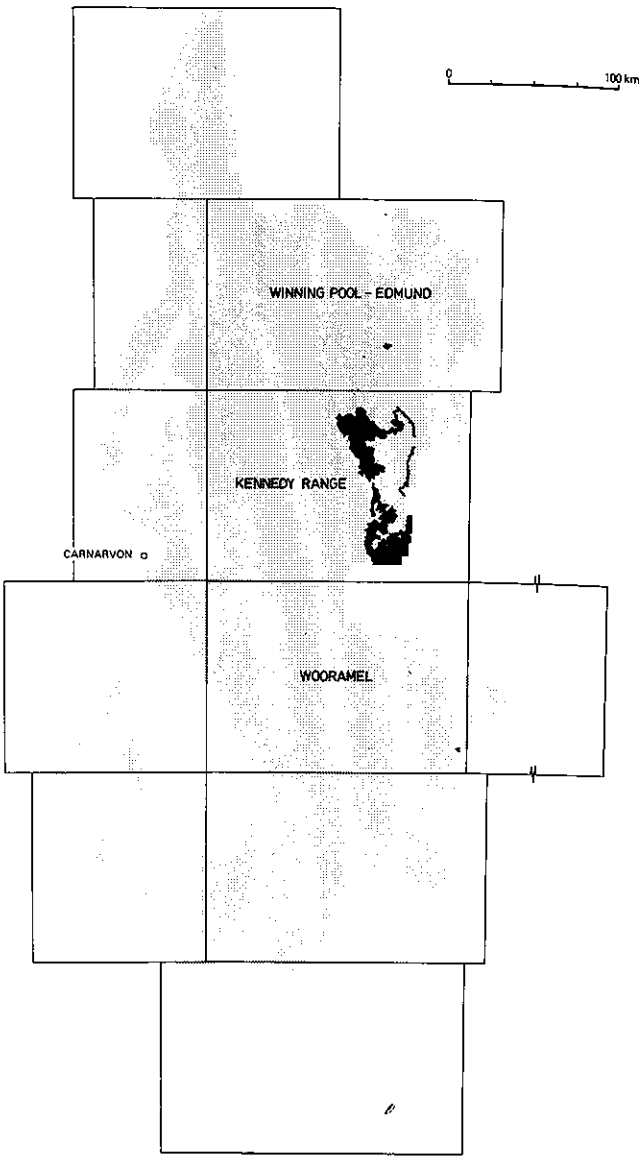
Geology: Permian quartz, sandstone, greywacke and siltstone of the Kennedy group.

Geomorphology: Erosional surfaces of residual flat-topped hills with stony slopes, narrow valley floors and high density dendritic drainage lines with incised channels.

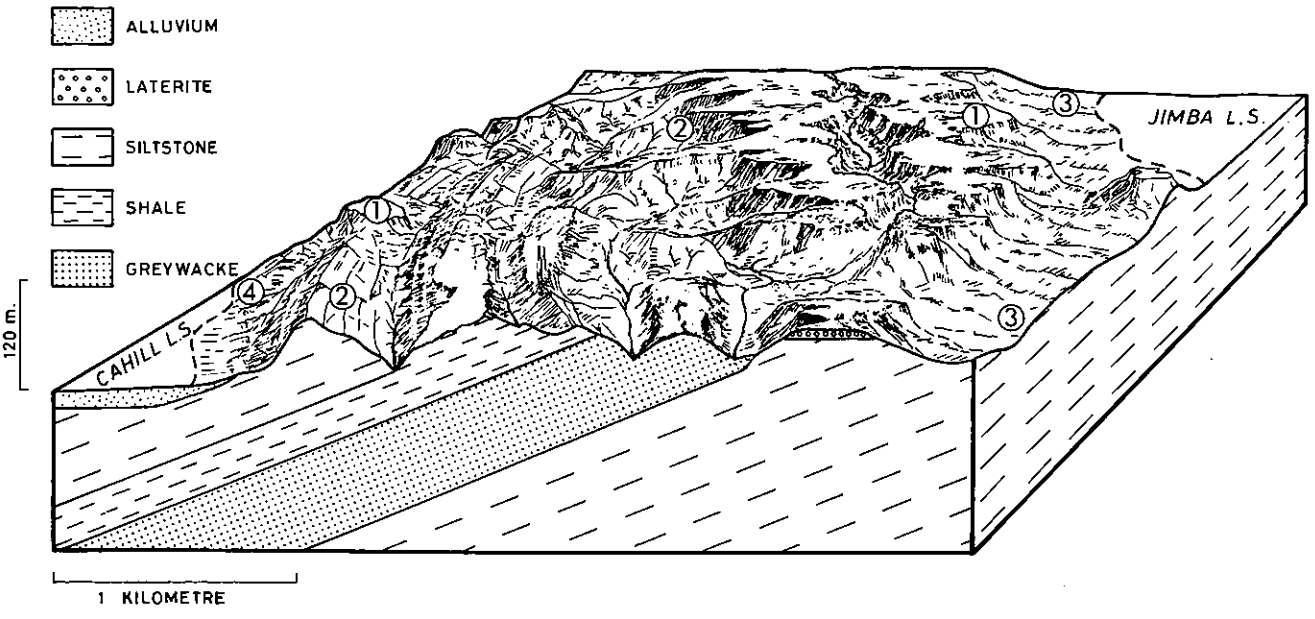
Pastoral use: Unproductive hilly pastures with some areas virtually inaccessible to stock. In favourable seasons, ephemerals and annuals provide some forage. Low densities of palatable shrubs when in good condition but drought reserves very limited.

Estimated carrying capacity, good condition: 30 ha/s.u.

Range condition summary: good 58%; fair 37%; poor 5%.

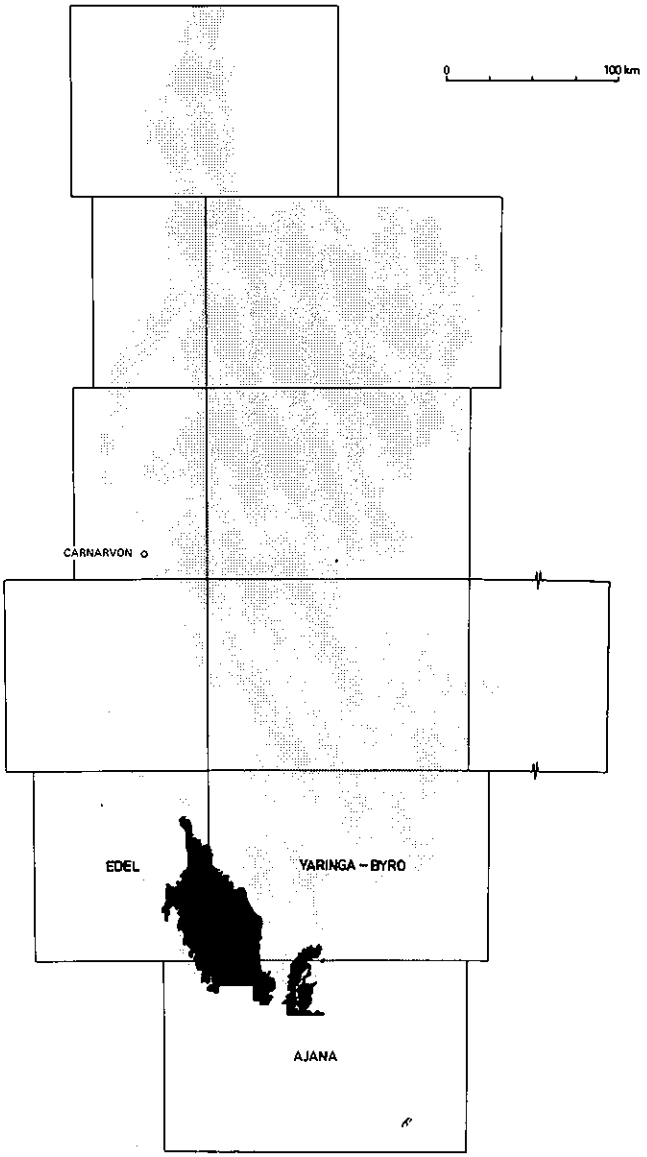


Unit
1. Mesas and hills
2. Stony slopes
3. Drainage floors and incised creek-lines
4. Marginal alluvial plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Mesas and hills (40%) 1 site inventory and traversed	
Mesas and low hills, relief up to 65 m, heavily strewn with sandstone cobbles and boulders. Soils are skeletal, very shallow red loamy sands, pH 6.0 with an acid trend.	Scattered to moderately close tall shrublands dominated by *Acacia aneura*. Trees (4-6 m): *A. pruinocarpa, A. aneura*; Tall shrubs (2-4 m): *A. aneura, A. tetragonophylla, A. pruinocarpa, Heterodendrum oleaefolium*; Low shrubs (< 1 m): *Cassia helmsii, A. luerssenii, Eremophila leucophylla, Rhagodia* spp, *Ptilotus obovatus, Solanum lasiophyllum.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp. Pastoral use limitations: Inaccessibility to stock.
	Unit 2 Stony slopes (40%) 2 site inventories and traversed	
Even to convex slopes and hillsides sloping up to 20%, heavily strewn with sandstone pebbles and cobbles. Soils are dark red to brown sands or loams, loamy sand or fine sandy loam grading to light sandy clay loam, > 1 m deep, pH 6.0 - 8.0; principal profile forms: Uc 5.12, Um 6.14.	Moderately close tall shrublands dominated by *Acacia* spp. Trees (75-100/ha; 2-6 m): *Acacia cuspidifolia, Grevillea* spp; Tall shrubs (200-450/ha; 2-4 m): *Acacia xiphophylla, Acacia* sp, *A. aneura, A. spectabilis*; Low shrubs (1200-2000/ha; < 1 m): *Cassia desolata, C. helmsii, Solanum lasiophyllun, Enchylaena tomentosa, Frankenia* spp, *Eremophila cuneifolia.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp, *Rhagodia eremaea, Enchylaena tomentosa.* Pastoral use limitations: Local inaccessibility to stock.
	Unit 3 Drainage floors and incised creek-lines (10%) Traversed	
Dendritic streams and drainage floors with sharply incised channels and creek-lines. Soils are variable, locally duplex types immediately below scree slopes, with sandy or cobbly bedloads.	Tall shrublands dominated by *Acacia aneura* and *A. subtessarogona* with understorey shrubs mainly *Cassia* spp.	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Local susceptibility to water erosion.
	Unit 4 Marginal alluvial plains (10%) Traversed	
Flat to gently sloping plains, lightly to sparsely mantled by gravels or pebbles. Soils are sandy surfaced duplex types.	Very scattered to scattered tall shrublands dominated by *Acacia victoriae, A. cuspidifolia* and *A. eremaea.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana.* Pastoral use limitations: Mild susceptibility to erosion by wind and water.

Nanga land system 3485 km² (4.7% of survey area)



Undulating plains of aeolian sand supporting diverse assemblages of South-West Botanical Province vegetation, mostly shrub heath and tree heath dominated by proteaceous and myrtaceous species.

Geology: Quaternary aeolian sand.

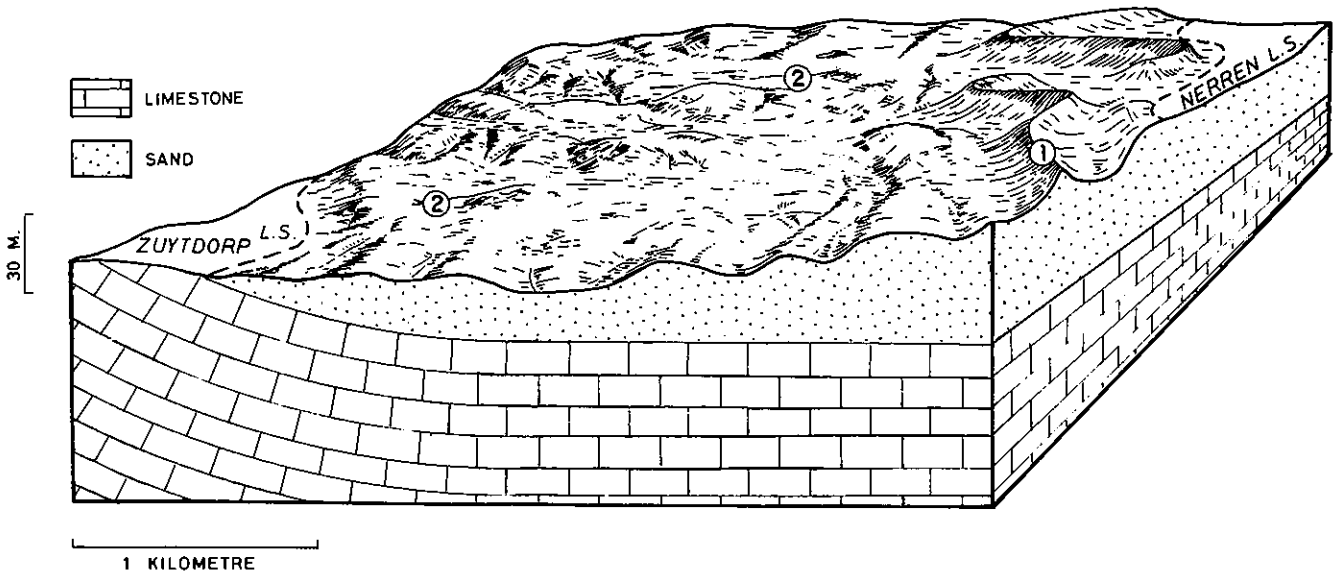
Geomorphology: Depositional surfaces: undulating sandplains with confused ridges, locally with longitudinal dunes; no drainage features.

Pastoral use: Heath (HEAT) pastures generally deficient in palatable perennial species, very low pastoral value. Very few permanent stock watering points have been established in southern parts, so large areas are very little used. There is no susceptibility to erosion except immediately after fires, to which the system is highly susceptible.

Estimated carrying capacity, good condition, 30 ha/s.u.

Range condition summary: good 97%; fair 3%; poor 0%.

Unit
1. Reticulate sand ridges
2. Undulating sandplains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Reticulate sand ridges (5%) 1 site inventory and traversed **Unit 2 Undulating sandplains (95%) 9 site inventories and traversed**	
Plains, undulating or strongly undulating relief up to 50 m, confused sandridges with slopes up to 8% but steeper on low longitude dunes, 10-15 m above the plains. Soils are mostly non-coherent red sands; more locally coarse sand, or of yellowish red, yellowish-brown or reddish-brown hues, > 1 m deep, non-calcareous (except near coastal limestone systems), pH 6.5-7.5 when without calcareous inclusions with a neutral trend; principal profile forms: Uc 1.23, 1.22, 5.11, 5.12.	Characteristically diverse and varied associations of the South-West Botanical Province (Beard 1976). (i) Tree heaths: close mixed shrublands lacking in obvious vertical stratification. Trees (2-6 m): *Eucalyptus foecunda, E. mannensis, Callitris columellaris, Bursaria spinosa, Banksia ashby; ashby;* Tall shrubs (2-4 m): *Hakea stenophylla, Alyxia buxifolia, Banksia sceptrum, Melaleuca* spp, *Calothamnus* spp; Low shrubs (< 2 m): *Grevillea* spp, *Acacia* spp, *Thryptomene* spp, *Conospermum stoechadis;* Graminoids: *Plectrachne danthonioides, Ecdeiocolea monostachya.* (ii) Close tall shrublands interspersed with patchy low woodland. Trees (4-8 m): *Eucalyptus obtusiflora, E. eudesmioides;* Tall shrubs: *Acacia coolgardiensis, Melaleuca* spp; Low shrubs: *Thryptomene* spp. (iii) Mallee-dominated moderately close to close tall shrublands. Trees (2-5 m): *E. roycei, E. mannensis, E. foecunda, E. jucunda;* Tall shrubs (2-5 m): *Lamarchea hakeifolia, Calothamnus* spp, *Eremaea* spp, *Grevillea gordoniana, Acacia* spp; Low shrubs: *Melaleuca* spp, *Thryptomene* spp, *Adenanthos acanthophyllus, Dodonaea inaequifolia;* Perennial grasses: *Plectrachne danthonioides.* (iv) Close or closed heaths of low shrubs, mainly near the coast. Low shrubs (< 1.5 m): *Melaleuc* aff. *cardiophylla, Calothamnus* spp, *Calytrix* spp, *Banksia lindleyana, Acacia* spp. (v) Scattered to moderately close low shrub regrowth after fire. Low shrubs (often only 1-2 species abundant at any one site): *Alyogyne cuneiformis, Pityrodia oldfieldii, P. cuneata, Gyrostemon ramulosus, Codonocarpus cotinifolius, Grevillea* spp, *Hakea* spp, *Newcastelia chrysophylla, Anthocercis littorea.*	Pasture type: *Heath.* Perennials augmented by annual grasses and forbs in favourable seasons. All associations are liable to carry periodic fires; many reflect successional stages of regrowth after burning. Desirable perennials include: *Dampiera spicigera, Lechenaultia linarioides, Sida* aff. *intricata, Anthobolus foveolatus, Atriplex bunburyana.* Undesirable perennials include: *Duboisia hopwoodii.* Pastoral use limitations: A general lack of palatable perennials evident in all major associations; very few watering points for stock; the hummocking graminoid *Ecdeiocolea monostachya* is locally Abundant and reported to be toxic (to horses), slight susceptibility to wind erosion e.g. after removal of vegetation by fire; burning does not appear to promote the growth of any palatable perennials

Nerren land system 1547 km² (2.1% of survey area)

Sandplains with scattered or clumped mallee and tree form eucalypts over wanyu-dominated tall shrublands.

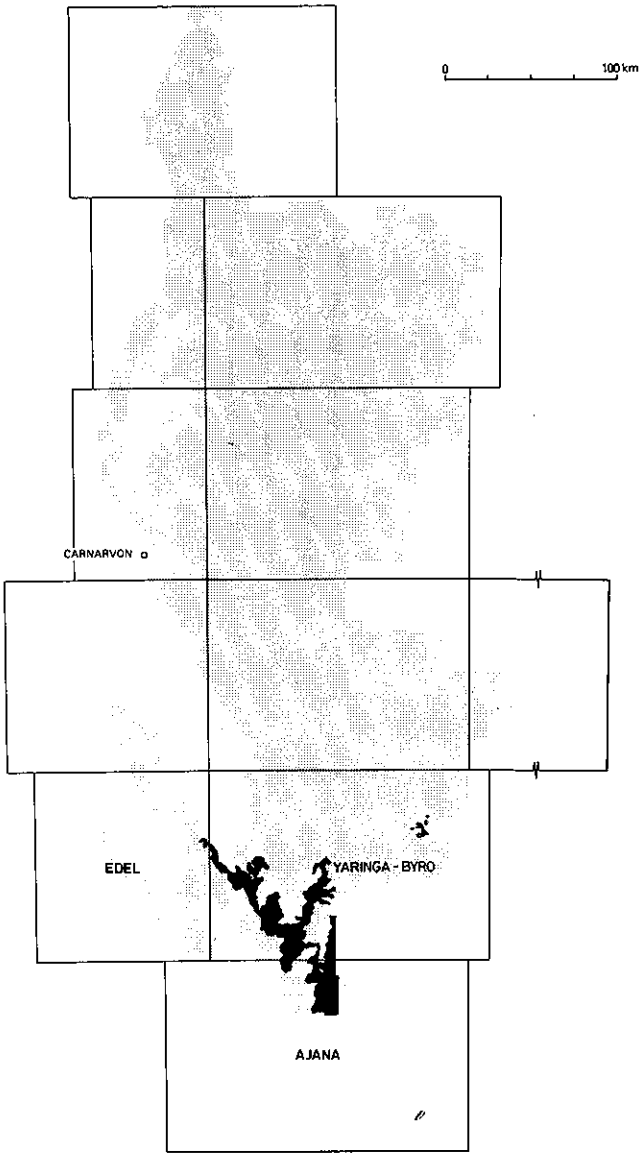
Geology: Quaternary aeolian sand.

Geomorphology: Depositional, gently sloping or rounded surfaces up to 20 m in relief, which compose the central southern portion of the Victoria sand plain; no drainage development; unit 2 has a very restricted distribution, in the west only.

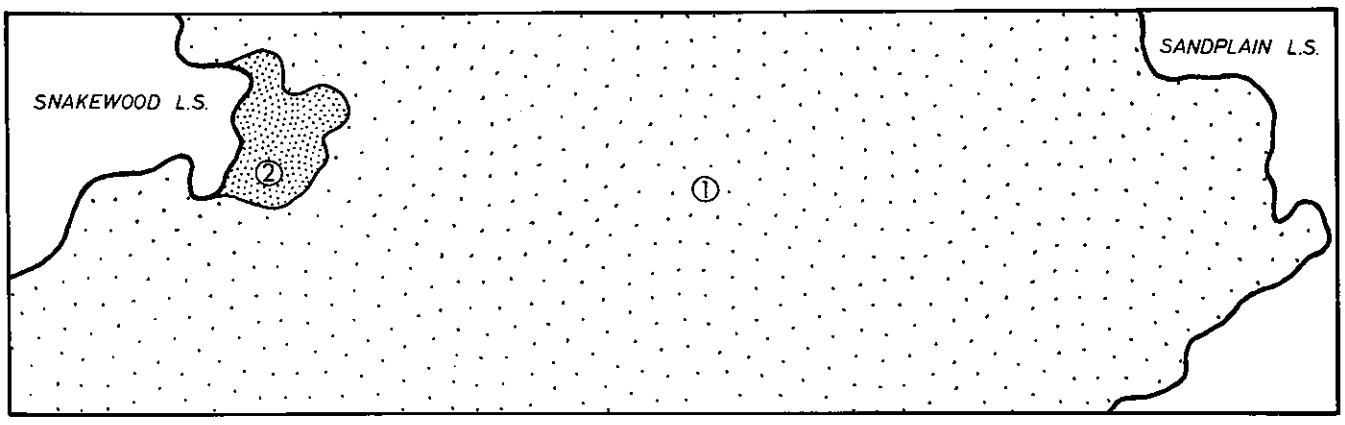
Pastoral use: Acacia and Eucalyptus Short Grass Forb (AEGF) pastures with poor to moderate supplies of edible perennial shrubs and herbs; perennial grasses generally absent. Use of this system is heavily dependant upon the seasonal productivity of annuals and there is little durability in dry periods; resistant to erosion.

Estimated carrying capacity, good condition: 14 ha/s.u.

Range condition summary: good 38%; fair 40%; poor 22%.

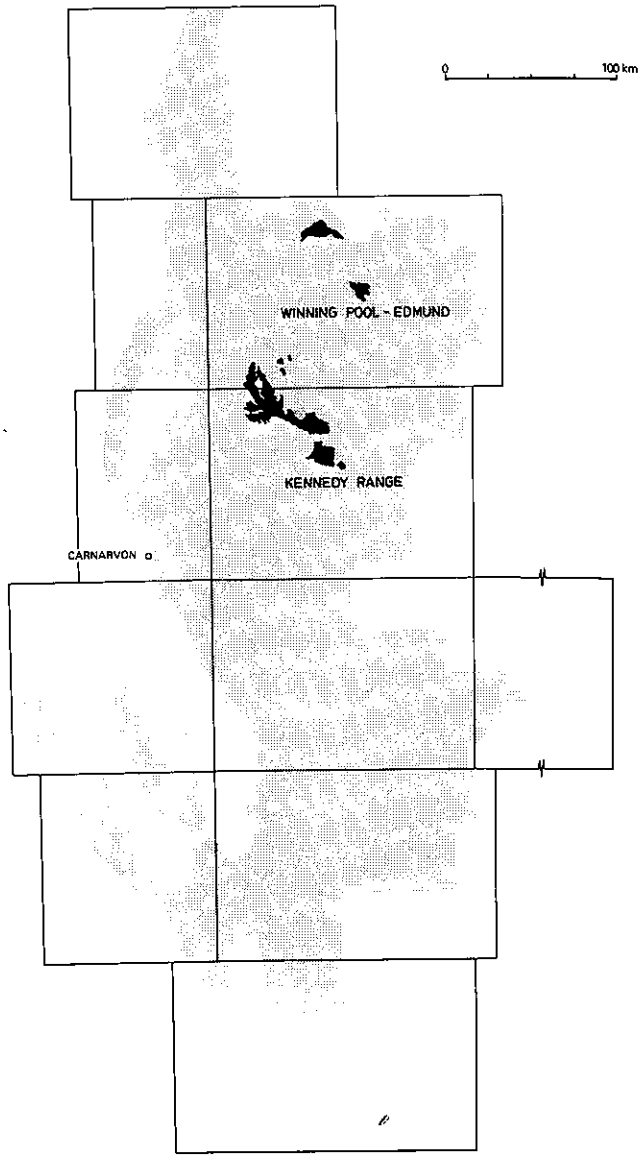


Unit
1. Broad sandy plains
2. Plains with tree steppe



Landform and soils	*Vegetation : formations and major species*	Comments and condition indicators
	Unit 1 Broad sandy plains (90%) 12 site inventories and traverse	
Extensive flat or gently undulating plains with mounded surfaces, relief up to 20 m and slopes < 4%. Soils are non-coherent or barely coherent dark red, red or yellowish-red sand or loamy sand, > 1 m deep, pH 5.5-6.5 with a neutral trend; principal profile forms; Uc 1.22, 1.23, 5.11, 5.12. Areas with alkaline reaction trend and with calcareous concretions in the profile occur towards the Toolonga plateau.	Moderately close to close tall shrublands dominated by *Acacia ramulosa*, with mallee form and tree form eucalypts forming a sparse or clumped upper storey. PFC 20 to 40%, much less on recently burnt areas. Trees (0-200/ha; 4-10 m): *Eucalyptus foecunda, E. obtusiflora, E. eudesmioides, E. mannensis, Bursaria spinosa, Santalum lanceolatum, Brachychiton gregorii, Callitris columellaris*; Tall shrubs (670±340/ha; 2-4 m): *A. ramulosa, Eremophila maitlandii, A. sclerosperma, A. tetragonophylla, A. roycei, Lamarchea hakeifolia, Heterodendrum oleaefolium, Acacia wiseana*; Low shrubs (2450 ± 1950/ha; < 1.5 m): *Ptilotus obovatus, Pimelea microcephala, Maireana planifolia, Rhagodia eremaea, Enchylaena tomentosa, Dicrastylis linearifolia, Thryptomene baeckeacea, Grevillea* spp; Perennial grasses: *Stipa elegantissima, Eragrostis lanipes, Monachather paradoxa* (all scarce).	Pasture type: *Acacia - Eucalyptus Short Grass Forb.* In far south, associations have more South-West Botanical Province species, (Beard 1976) less *A. ramulosa-Ptilotus obovatus* and are subject to more frequent fires. Such areas may represent the northern portions of another land system more typical of the Eurardy district. Young individuals of *Eucalyptus* spp were noticeably absent throughout. Desirable perennials include: *Maireana* spp, *Enchylaena tomentosa, Rhagodia* spp, perennial grasses, *Eremophila* spp on calcareous sites. Pastoral use limitations: inadequate groundwater availability; the hummocking graminoid *Ecdeiocolea monostachya* is locally abundant and reported to be toxic to horses at least.
	Unit 2 Plains with tree steppe (10%) 2 site inventories and traverse	
Restricted flat or gently undulating plains with mounded surfaces, very sparsely strewn with calcrete gravels. Soils are red or reddish brown gradational loams or sands with calcrete inclusions and calcareous concretions throughout, > 1 m deep, pH 8.5 with an alkaline trend; principal profile forms: Uc 5.12, Gc 1.12.	Scattered to moderately close low woodlands with an understorey of spinifex hummocks and sparse low shrubs. Trees (0-125/ha; 6-8 m): *Eucalyptus obtusiflora, Heterodendrum oleaefolium*; Tall shrubs (100-350/ha; 2-4 m): *Acacia tetragonophylla, Eremophila oldfieldii, A. sclerosperma, A. galeata, Scaevola spinescens, Exocarpos aphyllus*; Low shrubs (2000-7000/ha; < 1.5 m): *Ptilotus obovatus, Maireana villosa, Ptilotus divaricatus, Pimelea microcephala, Rhagodia* spp, *Cassia chatelainiana*; Perennial grasses: *Triodia plurinervata* (15-30% cover), *Stipa elegantissima.*	Pasture type: *Hard Spinifex.* This unit occurs locally in the north, on Hamelin station. Desirable perennials include: *Maireana* spp, *Scaevola* spp, *Cassia chatelainiana.* Pastoral use limitations: None under controlled stocking.

O'Brien land system 885 km² (1.2% of survey area)



Gently sloping tributary plains with groved vegetation and minor stony plains with tall and low shrublands of acacias.

Geology: Quaternary colluvial and alluvial deposits of variable depth: sand, gravel, clay and silt; minor areas of outcropping Cretaceous Windalia radiolarite.

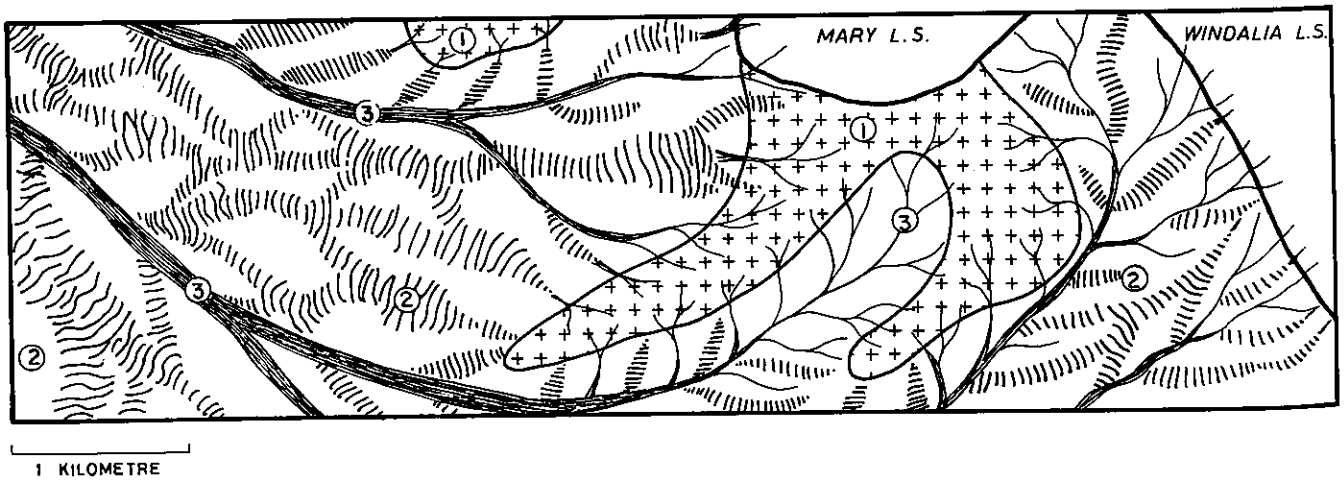
Geomorphology: Mainly erosional surfaces: plains of low relief (<4m) underlain by radiolarite at shallow depth; drainage of gravel-strewn plains is initially dendritic becoming parallel through nearly flat lower plains, mostly via unchannelled broad drainage tracts.

Pastoral use: Acacia Short Grass Forb (ASGF), Stony Chenopod (STCH) and Acacia Creek-line (ACCR) pastures, of moderate productivity, containing useful drought reserves of edible shrubs on plains and concentrated in groves and flow zones; there is minor susceptibility to erosion on the edges of the tributary plains.

Estimated carrying capacity, good condition: 10 ha/s.u.

Range condition summary: good 26%; fair 38%; poor 36%.

Unit
1. Stony plains and interfluves
2. Tributary plains
3. Drainage zones



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Stony plains and interfluves (20%) 4 site inventories and traversed	
Flat gravel-strewn plains, relief up to 3m, slopes < 1%. Soils are reddish brown, dark red or dusky red loams or sandy clay loams, 50 cm to > 1m deep with radiolarite and mixed gravels throughout the profile and as a surface mantle, pH 6.0-8.0; principal profile forms: Uc6.13, Uf6. 12, Gn 3.12.	Scattered to close tall or low shrublands dominated by *Acacia subtessarogona, A. aneura* or *A. xiphophylla* often with an *Eremophila leucophylla* - dominated understorey. Trees (0-50/ha; 4-6 m): *Acacia aneura, A. pruinocarpa, A. cuspidifolia, A. subtessarogona;* Tall shrubs (25-150/ha; 2-8m): *A. subtessarogona, A. xiphophylla, A. victoriae, Heterodendrum oleaefolium;* Low shrubs (1100-5500/ha; < 2 m): *Eremophila leucophylla, Maireana triptera, M. pyramidata, Solanum lasiophyllum, Ptilotus obovatus, Maireana planifolia;* Perennial grasses: *Triodia lanigera, Enteropogon acicularis.*	Pasture type: *Acacia Short Grass Forb./ Stony Chenopod.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana pyramidata, M. planifolia, Eremophila leucophylla.* The lower slopes and interfluves are often more saline and support more *Maireana* spp in the understorey. Pastoral use limitations: None under controlled stocking.
	Unit 2 Tributary plains (70%) 2 site inventories and traversed	
	(i) Intergrove areas	
Flat plains with slopes < 0.5%, lightly to moderately strewn with radiolarite or mixed gravels. Soils are dark red or dusky red gradational types, sandy loams grading to clay loams or sandy clays < 60 cm deep, pH 6.0 with an acid trend, principal profile forms: Gn 2.11, 2.12.	Very scattered to scattered tall shrublands dominated by *Acacia victoriae* and *A. subtessarogona.* Tall shrubs (75-100/ha; 2-6 m): *A. victoriae, A. subtessarogona, Heterodendrum oleaefolium;* Low shrubs: (300-1000/ha; < 1 m): *Solanum lasiophyllum, Maireana planifolia, Stylobasium spathulatum.*	Pasture type: *Acacia Short Grass Forb.* Desirable perennials include: *Maireana planifolia, Eremophila leucophylla.* Pastoral use limitations; locally susceptible to water erosion when degraded.
	(ii) Groves 3 site inventories and traversed	
Flat-surfaced zones 5-15 m wide and 100-500 m long intercepting borad sheet flow with slopes ~ 0.5%. Soils are dark red or dusky red clay or duplex types, > 1 m deep, pH 5.5-8.0 with a neutral trend; principal profile forms: Uf 6.13, 6.31, Dr 2.52.	Moderately close to close tall shrublands dominated by *Acacia subtessarogona* or *A. victoriae.* Trees and tall shrubs (500-1200/ha; 3-8 m): *A. subtessarogona, A. victoriae, A. tetragonophylla, A. sclerosperma, Stylobasium spathulatum, Heterodendrum oleaefolium;* Low shrubs (500-6000/ha): *Eremophila leucophylla, Rhagodia eremaea, Dipteracanthus corynothecus, Maireana planifolia, Scaevola spinescens;* Perennial grasses: *Eriachne helmsii,. Cenchrus ciliaris, C. setigerus.*	Pasture type: *Acacia Creek-line.* Desirable perennials include: *Dipteracanthus corynothecus, Scaevola spinescens, Maireana planifolia.* Pastoral use limitations: None under controlled stocking
	Unit 3 Drainage zones (10%) Traversed	
Narrow, dendritic, incised drainage lines becoming broader and largely unchannelled in lower parts, up to 700 m wide,	*Close shrublands of Acacia* spp, *Eremophila* spp, *Maireana* spp, *Rhagodia* spp with sparse perennial grasses (as unit 2).	Pasture type: *Acacia Creek-line.* Pastoral use limitations: None under controlled stocking.

Pells land system (G) 181 km² (0.2% of survey area)

Low hills, mesas and ridges of sedimentary rocks supporting tall shrublands of mulga and other acacias

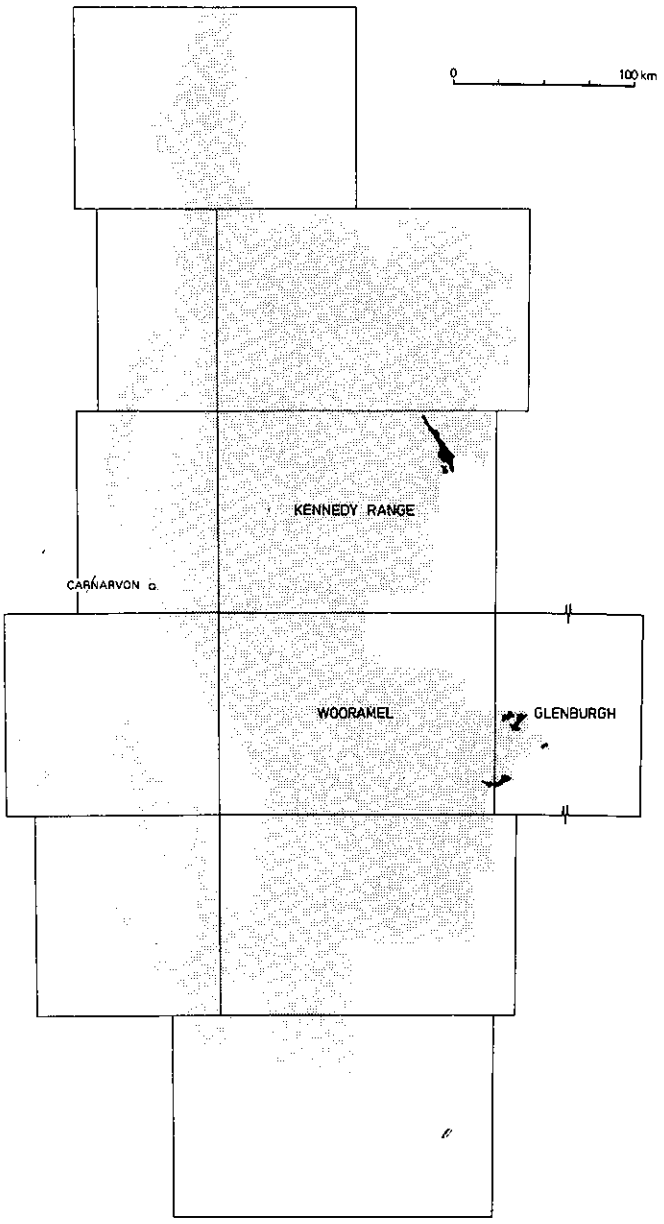
Geology: Permian sandstone, greywacke and siltstone of the Wooramel group, with fossiliferous sediments of the Callythara Formation; locally there are Quaternary wash deposits of sand.

Geomorphology: Erosional surfaces; relief mostly 20-30m. Some mesas remain mantled by laterite and lie above the surrounding low hills which have many long and low cuesta-like ridges and rocky slopes. Trellised drainage patterns of moderate density, more or less incised along wide valley floors with sandy banks.

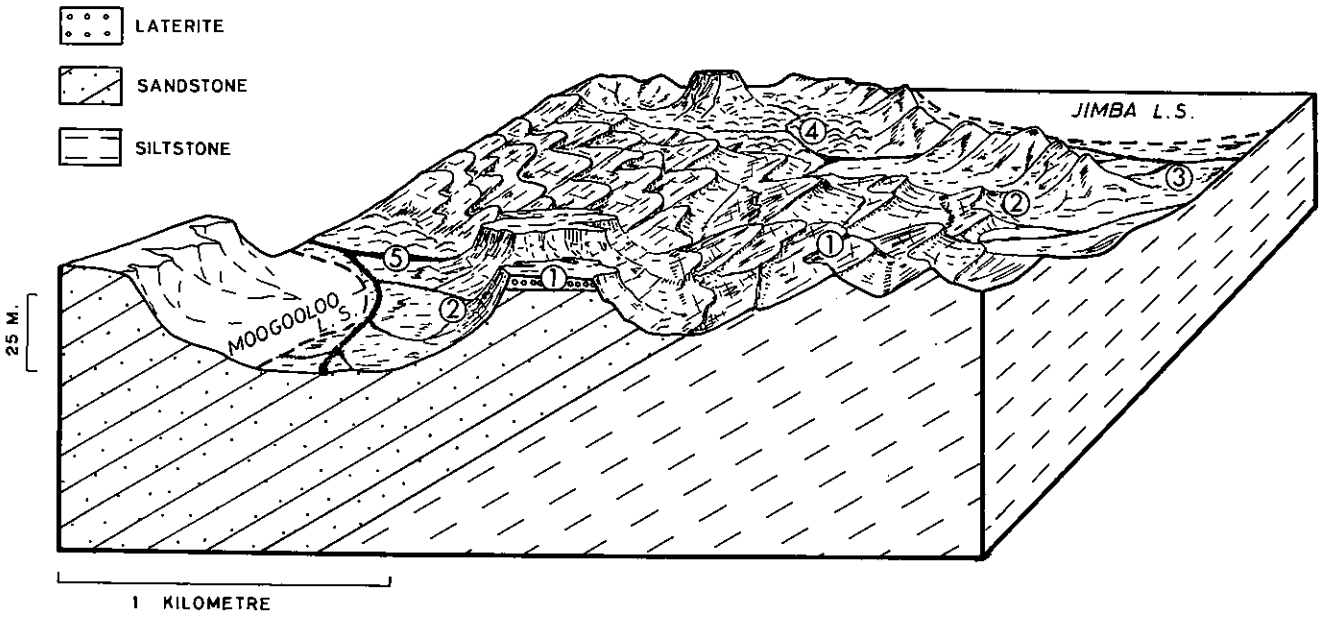
Pastoral use: Largely unproductive hilly pastures with some areas virtually inaccessible to stock. The alluvial unit 4 is more productive and accessible ; it is also susceptible to erosion when degraded.

Estimated carrying capacity, good condition: 20 ha/s.u.

Range condition summary: good 22%; fair 56%; poor 22%.



Unit
1. Mesas, hills and ridges
2. Stony slopes
3. Alluvial fans
4. Sandy banks
5. Drainage channels and incised creek-lines



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Mesas, hills and ridges (50%) Traversed	
Isolated mesas with mantles of sandstone fragments or laterite, ridges and rocky hills with NNW-SSE strike lines and steeply dipping bedding planes. Soils are shallow skeletal sands.	Very scattered to scattered shrublands dominated by *Acacia aneura*. Tall shrubs (2-3 m): *A. aneura, A. tetragonophylla*; Low shrubs: (< 1 m): *Solanum lasiophyllum, Cassia helmsii, Ptilotus polakii, Eremophila* spp.	Pasture type: *Acacia Short Grass Forb.* Pastoral use limitations: Frequently inaccessible to stock.
	Unit 2 Stony slopes (25%) 1 site inventory and traversed	
Rocky slopes, slopes to 4%, heavily strewn with limestone or sandstone cobbles. Soils are shallow reddish-brown fine sandy loams or sands, pH 8.0 with a neutral trend; principal profile form : Uc 1.13.	Scattered shrublands dominated by *Acacia aneura*. Tall shrubs (2-3 m): *A. aneura, A. victoriae*; Low shrubs (< 1.5 m): *Ptilotus obovatus, Maireana tomentosa, Cassia desolata, C. sturtii, Solanum lasiophyllum, Eremophila leucophylla, Acacia cuthbertsonii.*	Pasture type: *Acacia Short Grass Forb.* Desirable perennials include: *Maireana tomentosa, Enchylaena tomentosa, Eremophila leucophylla.* Pastoral use limitations: Locally inaccessible to stock.
	Unit 3 Alluvial fans (15%) Traversed	
Small alluvial fans, with some channelling, below stony slopes. Soils are probably reddish-brown duplex types, sand over clayey sands to sandy clays, 50 cm to 1 m deep, pH 6.5 with a neutral trend.	Scattered shrublands dominated by *Acacia victoriae* and low chenopod shrubs when in good condition. Tall shrubs: *A. victoriae, A. tetragonophylla, A. aneura, Hakea preissii*; Low shrubs: *Maireana polypterygia, Ptilotus polakii, Eremophila pterocarpa, Cassia helmsii, Solanum lasiophyllum, Eremophila cuneifolia, Frankenia* spp.	Pasture type: *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Indicators of good condition: *Maireana polypterygia, Ptilotus polakii.* Pastoral use limitations: moderate susceptibility to erosion.
	Unit 4 Sandy banks (5%) Traversed	
Restricted sandy banks between units 2 or 3 and 5. Soils are probably shallow sands, lightly strewn with pebbles, clay content increasing down profile, pH 7.0 with a neutral trend.	Scattered to moderately close tall shrublands dominated by *Acacia aneura*. Tall shrubs: *A. aneura, A. tetragonophylla*; Low shrubs: *Eremophila leucophylla, E. exilifolia, Rhagodia* spp, *Cassia helmsii*; Perennial grasses: *Monachather paradoxa.*	Pasture type: *Acacia Sandplain.* Desirable perennials include: *Eremophila leucophylla, Monachather paradoxa.*
	Unit 5 Drainage channels and incised creek-lines (5%) Traversed	
Incised trellised drainage lines with sandy bedloads.	Scattered to close tall shrublands dominated by *Acacia aneura.*	Pasture type: *Acacia Short Grass Forb.*

Peron land system 326 km² (0.4% of survey area)

Undulating plains of calcareous sand supporting low acacia shrublands and *Lamarchea hakeifolia* heaths.

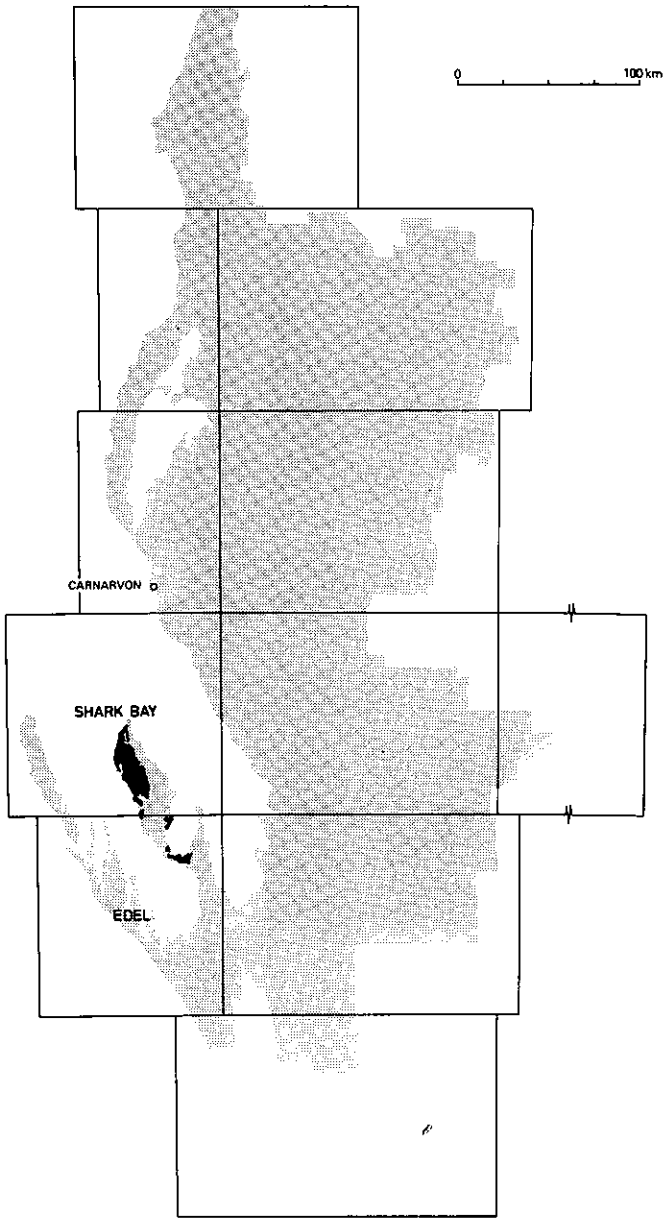
Geology: Quaternary aeolian sands with minor areas of birrida gypsiferous deposits.

Geomorphology: Depositional surfaces: undulating sandy plains and low coastal dunes; no organized drainage features.

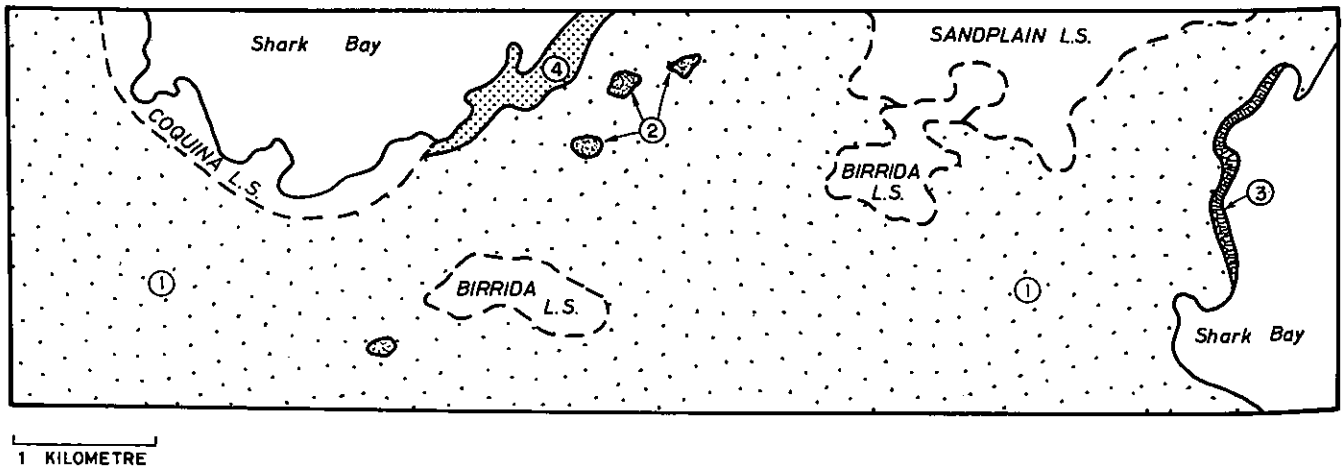
Pastoral use: Acacia Sandplain (ACSA) and Heath (HEAT) pastures supporting a range of palatable low shrubs. Sandy soils are slightly susceptible to wind erosion when exposed through loss of vegetation. Shrub associations are usually relatively dense and contain many unpalatable woody species resistant to degradation.

Estimated carrying capacity, good condition: 9 ha/s.u.

Range condition summary: good 46%; fair 36%; poor 18%.

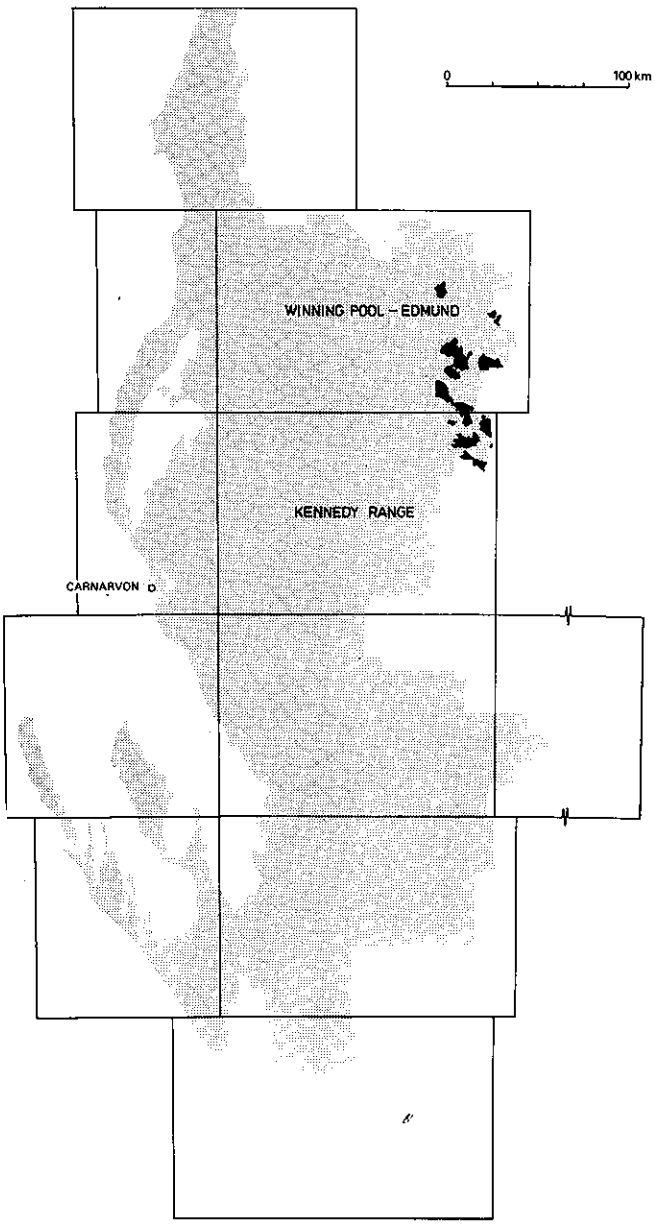


Unit
1. Undulating sandplains
2. Small birridas
3. Cliffs
4. Coastal dunes



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Undulating sandplains (95%) 6 site inventories and traversed	
Sandy surfaces, slopes < 4%, mostly 10-40 m above unit 3. Soils are red or reddish-brown sands > 1 m deep, sometimes calcareous, locally with clayey sand below 60 cm, pH 7.0-8.5 with an alkaline trend; principal profile forms: Uc 5,12, 5.11, 1.11, 1.13, 1.23.	(i) Low shrublands dominated by *Acacia ligulata*; (ii) low heaths with patchy thickets of stunted *Lamarchea hakeifolia*. (i) Scattered to moderately close shrublands. Tall shrubs (2-3 m; 0-400/ha): *Acacia ligulata, A. tetragonophylla, A. ramulosa, Exocarpos aphyllus*; Low shrubs (< 1.5 m; 5500-7000/ha): *A. ligulata, Mirbelia* spp, *Threlkeldia spp, Scaevola spinescens, Thryptoomene* spp, *Ptilotus divaricatus, P. obovatus, Rhagodia latifolia;* Perennial grasses: *Triodia plurinervata, Plectrachne danthonioides;* (ii) Moderately close to close low shrublands. Tall shrubs (2-3 m; 0-100/ha): *A. ligulata, Exocarpos aphyllus;* Low shurbs (< 1 m;. > 10,000/ha): *Lamarchea hakeifolia, Scholtzia* spp, *Thryptomene* spp, *Acanthocarpus preissii, Pt ilotus divaricatus; Perennial grasses: Stipa elegantissima, S.* aff. *crinata.*	Pasture type: *Acacia Sandplain* or *Heath.* Desirable perennials include: *Scaevola spinescens, Enchylaena tomentosa, Ptilotus obovatus; Atriplex bunburyana* occurs locally in the vicinity of birridas. Fires have occurred widely; *Acacia - Plectrachne* associations may represent earlier successional stages (than formation (ii)), or are geographical variants. Pastoral use limitations: Lack of stock watering points; mild susceptibility to erosion by wind when degraded.
	Unit 2 Small birridas (2%) Traversed	
Elliptical or rounded depressions < 500 m long, with nearly flat surfaces; soils are highly gypsiferous juvenile types.	Low halophytic shrublands dominated by *Halosarcia* spp.	Pasture type: *Samphire.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Cliffs (1%)	
	Unit 4 Coastal dunes (2%) 1 site inventory and traversed	
Low dunes and banks. Soils are light red sands, > 1 m deep, pH 8.0; principal profile form: Uc 1.23.	(i) Close low shrublands or closed thickets dominated by *Acacia ramulosa, Rhagodia preissii* and *Scholtzia* spp; (ii) associations of *Spinifex longifolius* and *Frankenia* spp mainly on foredunes near beaches.	Pasture type: *Coastal Dune Shrub.* Pastoral use limitations: Mild susceptibility to erosion by wind when degraded.

Phillips land system (G) 489 km² (0.7% of survey area)



Low hills and undulating uplands of crystalline rocks supporting mulga and other acacia-dominated tall shrublands.

Geology: Lower Proterozoic schist, gneiss, granite and quartzite with superficial Quaternary colluvium.

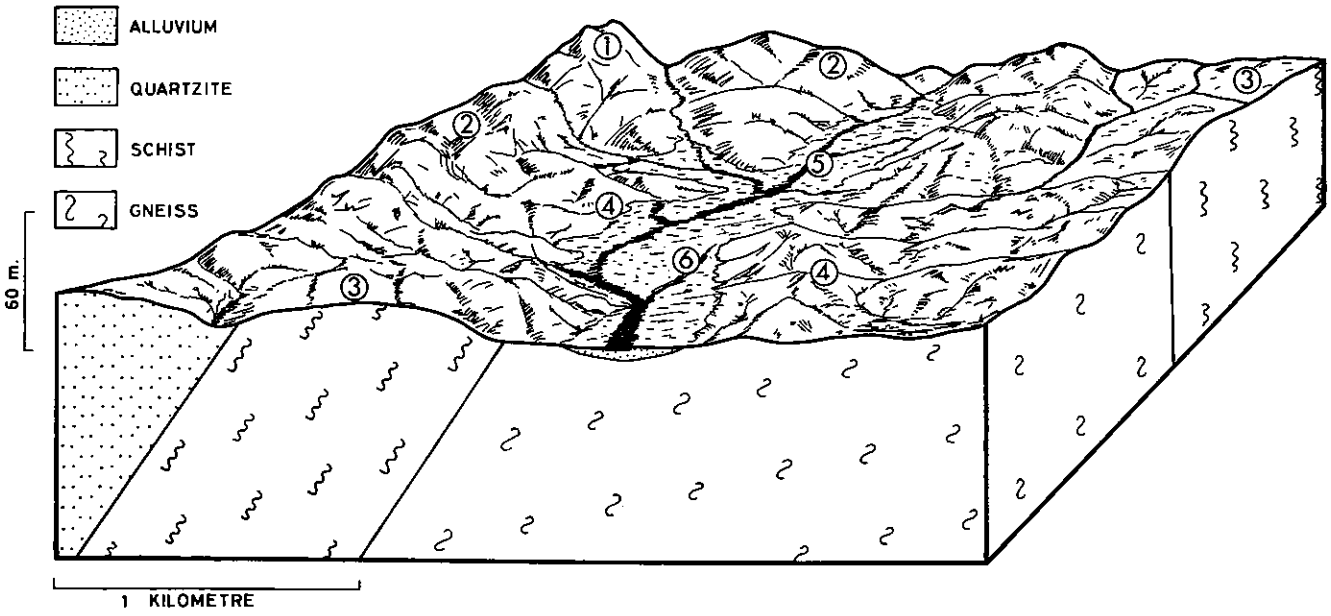
Geomorphology: Erosional surfaces: undulating hills, bare metamorphic residuals, doleritic and quartz ridges above cobble and pebble-strewn slopes, drainage floors and flats; mostly through drainage, dendritic to parallel and of moderate density, but parts internally-drained; relief up to 60 m.

Pastoral use: Acacia Short Grass Forb (ASGF) and Stony Chenopod (STCH) pastures with useful perennial shrubs and grasses on areas of the lower units receiving run-on, but otherwise of only poor to moderate productivity; units 3 and 6 are frequently more productive, but are liable to reflect the impact of concentrations of stock, in erosion of the duplex soils wherever perennials have been degraded.

Estimated carrying capacity, good condition: 18 ha/s.u.

Range condition summary: good 16%; fair 75%; poor 9%.

Unit
1. Ridges and hilltops
2. Uplands with rounded summits
3. Slopes with interfluves
4. Lower interfluves and plains
5. Drainage lines
6. Drainage flats



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Ridges and hilltops (5%) Traversed	
Rocky hilltops and ridge crests with scattered pockets of skeletal loams.	Usually only isolated low shrubs, mostly *Acacia* spp.	
	Unit 2 Uplands with rounded summits (30%) 2 site inventories and traversed	
Convex summits and slopes, with or without mantles of gneiss for quartzite pebbles or cobbles and doleritic intrusive dykes. Soils are shallow, dark red or dark-reddish brown loams or duplex types: fine sandy loam or sandy loam over sandy clay loam, up to 30 cm deep, pH 6.5; principal profile forms: Uc 1.43, Dr 4.12.	Scattered low shrublands dominated by *Acacia* spp and *Cassia pruinosa*. Tall shrubs (< 25/ha; 2-3 m): *A. tetragonophylla, A. aneura*; Low shrubs (800-1100/ha; < 2 m): *Eremophila fraseri, E. cuneifolia, Cassia pruinosa, C. helmsii, C. desolata, Scaevola spinescens.*	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include; *Scaevola spinescens, Acacia tetragonophylla.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Slopes and interfluves (30%) 1 site inventory and traversed	
Convex interfluvial slopes (mainly 1-3%), lightly to moderately mantled by quartz gravels or pebbles. Soils are shallow duplex type, dark red loamy sand over sandy clay, pH 7.5 with a neutral trend; principal profile form: Dr 4.12.	Scattered tall shrublands dominated by *Acacia xiphophylla* and *A. victoriae* with understorey *Maireana* spp. and *Eremophila* spp. Low trees and tall shrubs (2-4 m): *A. xiphophylla, A. victoriae, A. cuspidifolia, A. tetragonophylla*; Low shrubs (< 1m): *Eremophila cuneifolia, Ptilotus polakii, Scaevola spinescens, Maireana triptera, M. georgei, M. melanocoma, M. tomentosa, Cassia desolata, Enchylaena tomentosa.*	Pasture type: *Stony Chenopod.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp, *Scaevola spinescens.* Undesirable perennials include: *Acacia victoriae, Cassia* spp. Pastoral use limitations: Mild susceptibility to accelerated water erosion when degraded.
	Unit 4 Lower interfluves and plains (20%) Traversed	
Gently sloping surfaces, usually mantled by quartz gravels. Soils are shallow loamy or duplex types.	Scattered tall shrublands dominated by *Acacia aneura, A. tetragonophylla* and *Eremophila* spp.	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp. Pastoral use limitations: None under controlled stocking.
	Unit 5 Drainage lines (5%) 2 site inventories and traversed	
Flow lines, usually incised and channelled, slopes < 1%. Soils are dusky red or dark red sands or gradational loams (or sandy and cobbly bedloads), sand or loamy sand grading to sandy loam or clayey sand, pH 7.0 with a neutral trend; principal profile forms: Uc 5.21 Gn 2.12.	Moderately close to close fringing low woodlands or tall shrublands dominated by *Acacia citrinoviridis* and *Hakea suberea.* Low trees (< 50/ha; 2-4 m): *A. citrinoviridis, H. suberea*; Tall shrubs (250-650/ha; 2-4 m): *A. subtessarogona, A. tetragonophylla, A. cuthbersonii, A. aneura, A. sclerosperma.* Low shrubs (750-900/ha; 1-2 m): *Cassia helmsii, C. desolata, Maireana planifolia, Ptilotus obovatus, Rhagodia eremaea, Corchorus walcottii*; Perennial grasses: *Cenchrus ciliaris, Eulalia fulva, Chrysopogon fallax.*	Pasture type: *Acacia Creek-line.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials includes: *Rhagodia eremaea, Chrysopogon fallax.* Pastoral use limitations: None under controlled stocking.
	Unit 6 Drainage flats (15%) Traversed	
Flat to gently sloping narrow plains flanking major drainage lines, with occasional small drainage foci. Soils are probably dark red duplex types.	Scattered to close shrublands dominated by *A. aneura* and *A. tetragonophylla*, with some perennial grasses *Chrysopogon fallax, Eriachne flaccida, Eragrostis setifolia* and *Cenchrus ciliaris.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: Perennial grasses. Pastoral use limitations: Locally susceptible to erosion by wind and water when degraded.

Prairie land system (A) 2 km² (<0.01% of survey area)

Granite hills and stony plains supporting scattered tall shrublands of mulga and other acacias

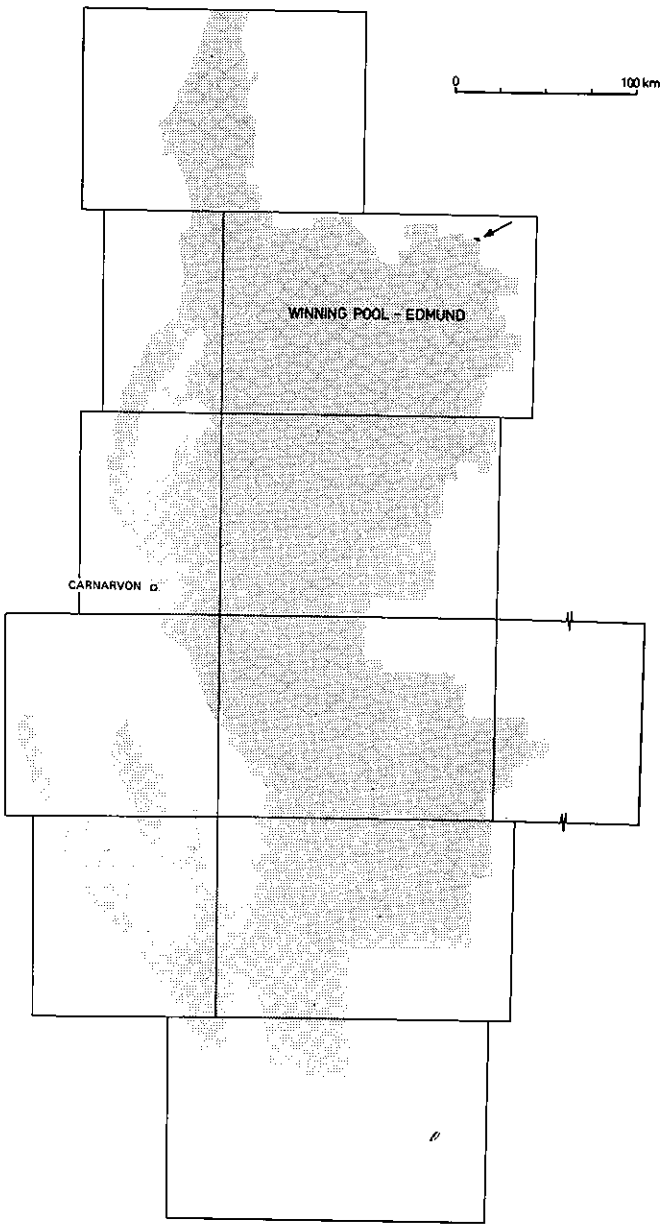
Geology: Archaean or Lower Proterozoic granite and gneiss with minor dolerite intrusions.

Geomorphology: Erosional surfaces: low hills with rounded, boulder-strewn crests and steep, benched upper slopes and short, gentler lower slopes; extensive stony plains and interfluves with or without dolerite dykes; rectangular to irregular tributary drainage of moderate density becoming braided and sub-parallel along major channels; relief up to 50 m.

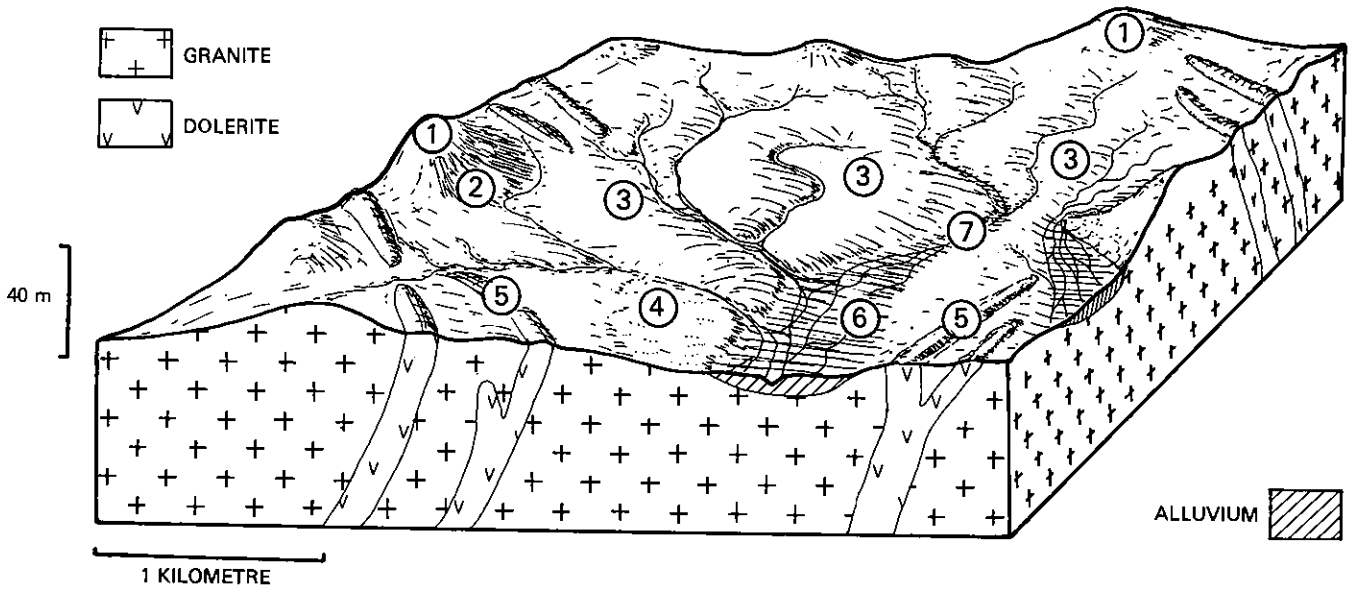
Pastoral use: Acacia Short Grass Forb (ASGF) pastures supporting abundant annuals and ephemerals in good seasons, when stocking rates can be temporarily increased, otherwise dry-season durability largely relies on the sparse chenopod shrubs of the lower units. Unit 6 is susceptible to water erosion. Only one very small area falls within this survey area.

Estimated carrying capacity, good condition: 15 ha/s.u.

Range condition summary: no data.



Unit
1. Low hills
2. Footslopes
3. Stony slopes and interfluves
4. Saline plains
5. Dolerite ridges
6. Drainage floors
7. Creek-lines and channels



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Rounded, boulder-strewn crests and benched upper slopes (slopes to 70 %) with boulders and tors. Soils are limited to pockets of very shallow sands or sandy clays.	**Unit 1 Low hills (25%) Traversed** Very scattered low shrublands dominated by *Cassia* ssp and Acacia ssp. Tall shrubs: *Acacia rhodophloia, Acacia* spp; Low shrubs: *Cassia helmsii Eremophila* spp, *Ptilotus obovatus.*	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
Concave footslopes, sloping to 5% mostly < 200 m wide, sparsely to moderately dense colluvial mantles. Soils are dark reddish-brown or dark red loamy or clayey coarse sands, up to 1 m deep; principal profile form: Uc 5.21.	**Unit 2 Footslopes (12%) Traversed** Very scattered to scattered low shrublands as under Unit 1.	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
Rounded slopes and rises, slopes mainly < 2%, dissected by drainage lines with incisions to 10 m below adjacent plains, densely mantled with granite cobbles and pebbles. Soils are reddish brown or dark red coarse sands or duplex types, loamy sand over sandy clay < 60cm deep; principal profile forms: Uc 1.23, Dr 4.51.	**Unit 3 Stony plains and interfluves (40%) Traversed** Very scattered to scattered tall shrublands dominated by *Acacia victoriae* Tall shrubs: *A. victoriae, A. rhodophloia, A.* spp; Low shrubs: *helmsii, Eremophila* spp.	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
Flat to gently sloping restricted plains with gravel-strewn surfaces. soils are red or yellowish-red duplex types, sands over clays, > 1 m deep; principal profile form: Dr 2.23.	**Unit 4 Saline plains (3%) Traversed** Low shrublands dominated by *Halosarcia indica* and *Frankenia* spp.	Pasture type: *Samphire.* Pastoral use limitations: None under controlled stocking.
Linear ridges up to 50 m wide and 5 m high, mainly < 500 m long, with side slopes up to 5%. Soils are shallow reddish-brown loamy sands; principal profile form: Uc 5.12.	**Unit 5 Dolerite ridges (3%) Traversed** Very scattered to scattered low shrublands dominated by *Cassia helmsii, Sida* spp and *Corchorus walcottii.*	Pasture type: *Acacia Short Grass Forb.* Pastoral use limitations: None under controlled stocking.
Sandy floors with or without gravelly mantle very gently sloping (< 1%), mostly < 300 m wide. Soils are dusky red to dark reddish-brown loamy or clayey sands, > 1 m deep; principal profile forms: Uc 5.11, 5.21.	**Unit 6 Drainage floors (8%)** Mixed tall and low shrublands dominated by *Acacia* spp. Low shrubs: *Cassia helmsii, Corchorus walcottii, Maireana pyramidata, Rhagodia eremaea.*	Pasture type: *Stony Chenopod.* Pastoral use limitations: Mild susceptibility to water erosion when degraded.
Single to braided channels up to 10 m wide with sandy inter-channel banks; also major channels up to 80 m wide. Soils are bedloads of coarse sands and banks of sand or loamy sand.	**Unit 7 Creek-lines and channels (8%) Traversed** Dense fringing low woodlands dominated by *Acacia cyperophylla* or *A. aneura.*	Pasture type: *Acacia Creek-line.* Pastoral use limitations: None under controlled stocking.

Range land system 988 km² (1.3% of survey area)

Dissected limestone plateaux, hills and ridges with gorges and steep stony slopes supporting hard spinifex, sparse shrubs and eucalypts.

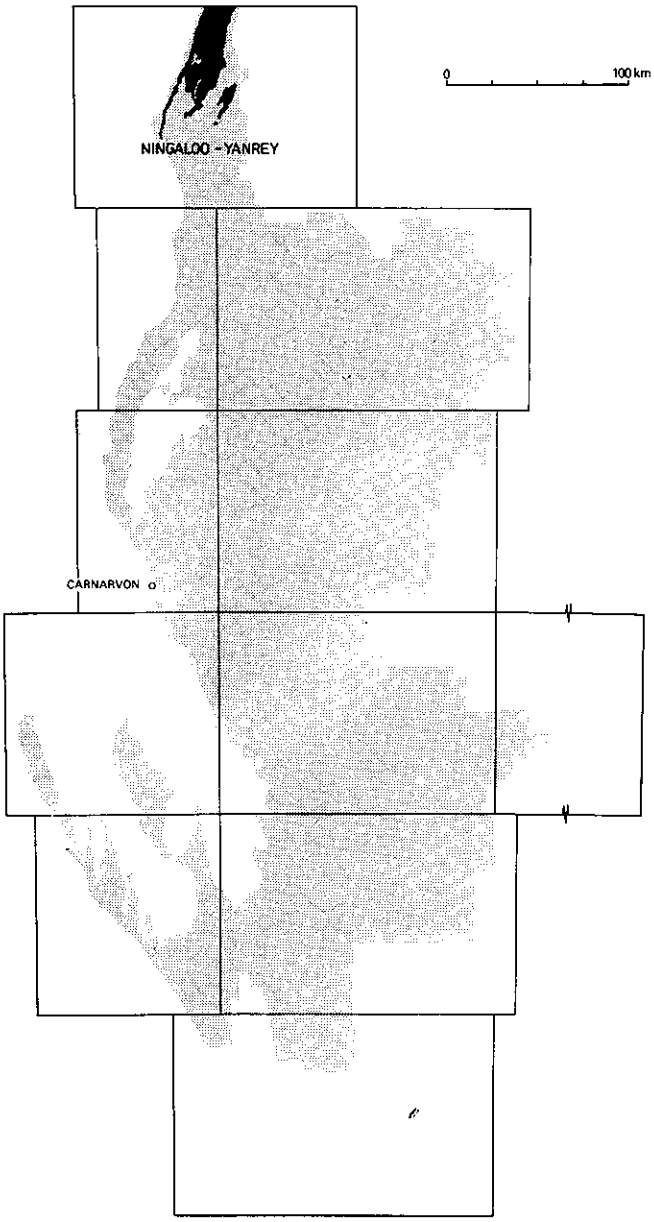
Geology: Tertiary limestones: Tulki and Trealla Formations.

Geomorphology: Erosional surfaces on a dissected anticlinal platcaux of 250-300 m relief: residual summits, hills and ridges with steep footslopes, dendritic drainage of high density draining east and west of the range, and locally internally into large depressions within the plateaux residuals.

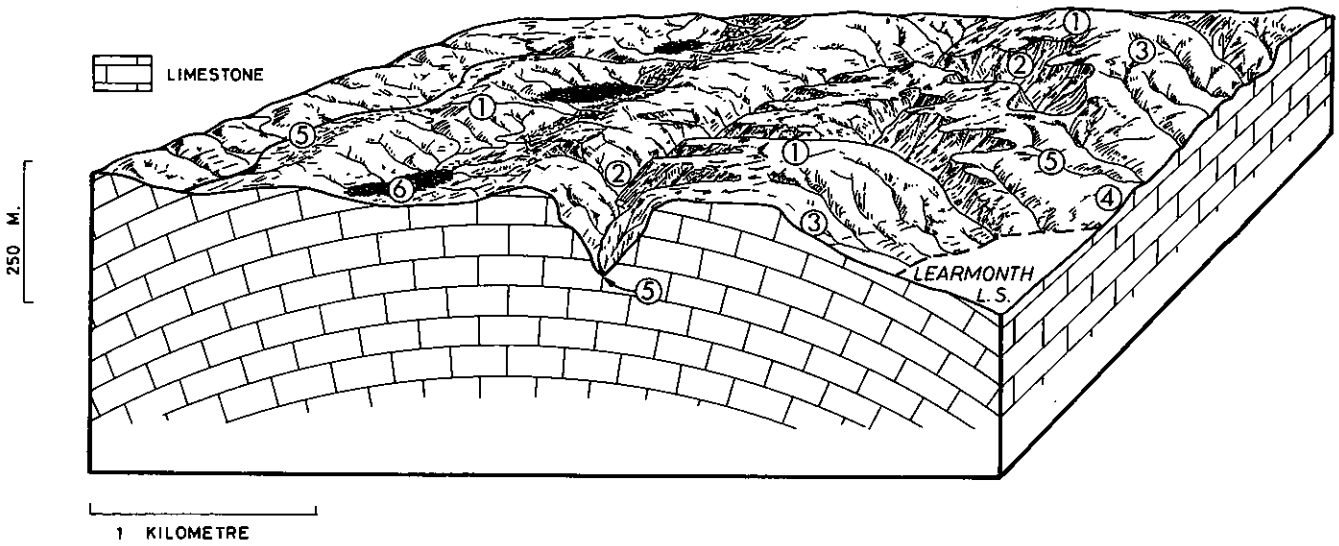
Pastoral use: Most of the higher units are inaccessible to stock, and only a fraction of the system is used for pastoral purposes. The predominantly Hard Spinifex (HASP) pastures are unproductive. The system is not susceptible to accelerated erosion.

Estimated carrying capacity, good condition: 40 ha/s.u.

Range condition summary: good 91%; fair 9%; poor 0%.



Unit
1. Hills, ridges and summits
2. Gorges and escarpments
3. Upper and lower slopes
4. Upper and lower slopes
5. Channels and creek-lines
6. Drainage depressions



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Hills, ridges and summits (40%) Traversed	
Residual summits of a plateau, dissected ridges and hills. Soils are limited to pockets of calcareous loams.	Hummock grasslands dominated by sparse *Triodia* spp and very scattered *Eucalyptus* spp. Trees and tall shrubs (3-6 m): *E. dichromophloia, E. prominens, E. oleosa, Brachychiton* sp., *Grevillea* sp.; Low shrubs: *Acacia gregorii, A. pyrifolia, A. tetragonophylla, Cassia oligophylla, Grevillea* spp, *Melalenca cardiophylla*; Perennial grasses: *Triodia* sp., *T. pungens.*	Pasture type: *Hard Spinifex* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila leucophylla, Tribulus platypterus.* Pastoral use limitations: Largely inaccessible to stock.
	Unit 2 Gorges and escarpments (25%) Traversed	
Steep and irregular slopes, often boulder-strewn. Soils are skeletal (or absent).	Very scattered low trees or hummock grasses as unit 1, and often *Ficus platypoda.*	Pasture type: *Hard Spinifex.* Pastoral use limitations: Largely inaccessible to stock.
	Unit 3 & 4 Upper and lower slopes (25%) 1 site inventory and traversed	
Rock-strewn slopes. Soils are dark red sandy calcareous loams, in shallow pockets, pH 8.5 with an alkaline trend; principal profile form: Uc 6.13.	Very scattered low shrublands with understorey hummock grasses. Tall shrubs: *Heterodendrum oleaefolium, Exocarpos aphyllus, Acacia ligulata*; Low shrubs: *Ptilotus obovatus, Cassia* spp, *Scaevola spinescens, Eremophila leucophylla, Solanum lasiophyllum, Maireana planifolia, Indigofera monophylla*; Perennial grasses: *Triodia* spp.	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 5 Channels and creek-lines (7%) Traversed	
Intensely dendritic drainage lines, often deeply incised. Soils are bedloads of pebbles, gravels and sands.	Fringing shrublands and hummock grasslands similar to units 1-4.	Pasture type: *Hard Spinifex.*
	Unit 6 Drainage depressions (3%) Traversed	
Internal foci draining portions of the dissected plateau, usually flat bottomed and rounded in shape.	Moderately close fringing shrublands, and more open central areas dominated by *Eucalyptus microtheca* and *Triodia* spp.	

River land system (A) 416 km² (0.6% of survey area)

Narrow, seasonally active flood plains and major channelled watercourses supporting moderately close, tall shrublands or woodlands of acacias and fringing communities of coolibah and river gum.

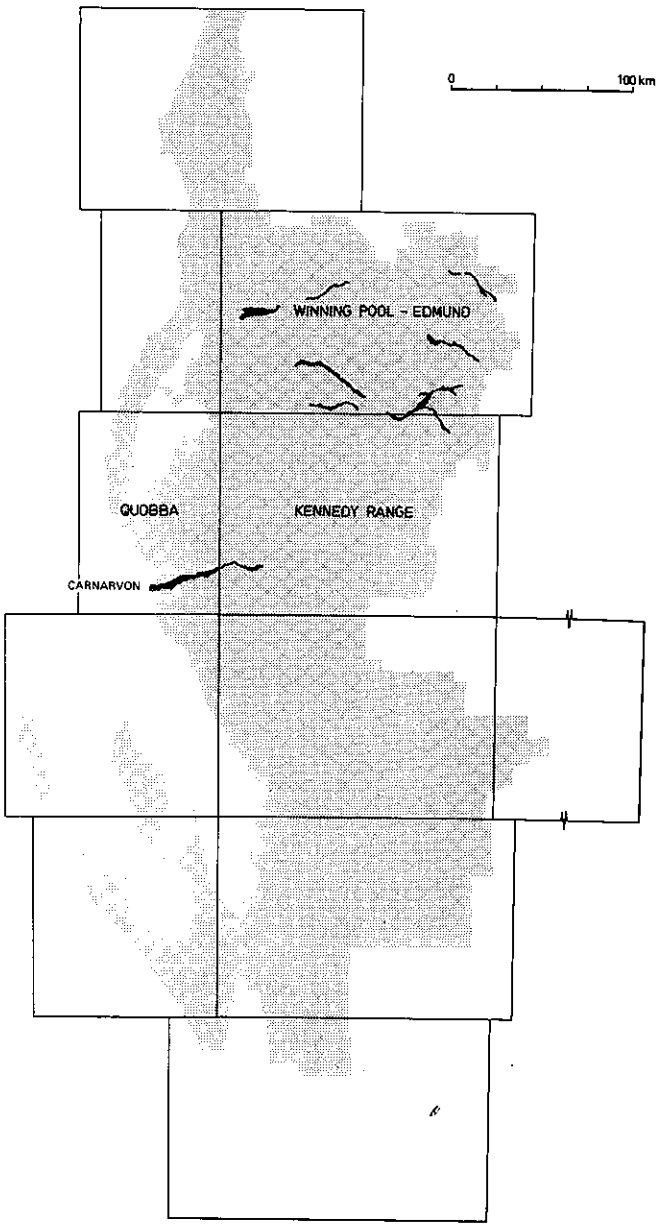
Geology: Quaternary alluvium.

Geomorphology: Depositional surfaces: flood plains with minor channels; flow zones adjacent to major watercourses; slightly higher sandy banks and narrow sandplains less regularly flooded; major channels; relief mainly 2-3m.

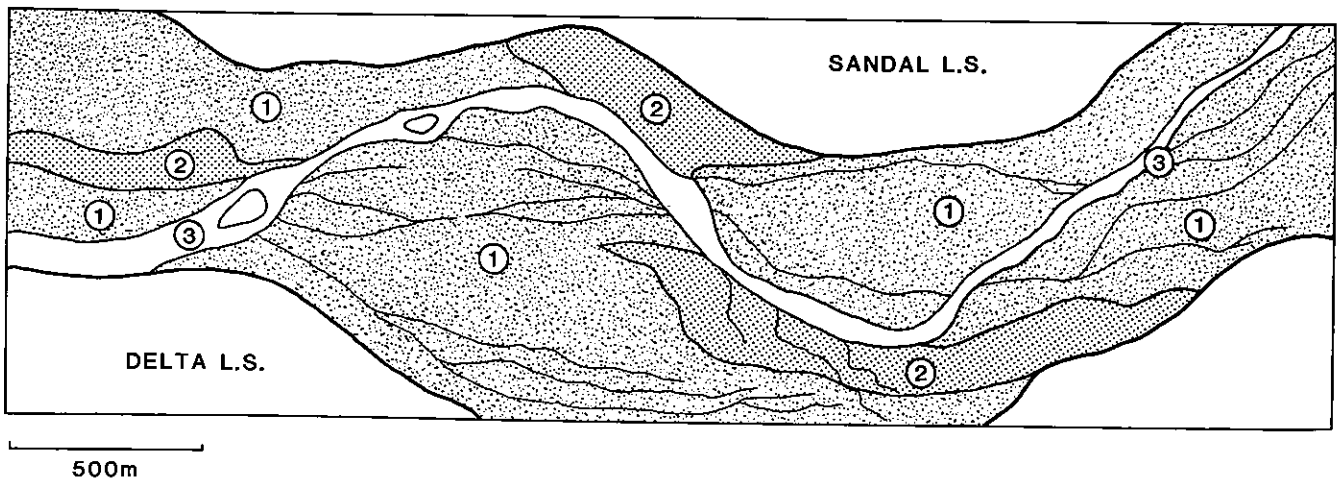
Pastoral use: Highly productive Acacia Creek-line (ACCR) and Tussock Grass (TUGR) pastures with shrubs including tall and berry saltbushes; frequently with buffel grass, which is locally dense in good seasons. The system tends to be preferentially grazed, particularly in dry years, is prone to overgrazing and requires occasional reductions in stock numbers, or spelling, to allow perennials to recover. Not normally susceptible to accelerated erosion.

Estimated carrying capacity, good condition: 6 ha/s.u.

Range condition summary: good 55%; fair 26%; poor 19%.

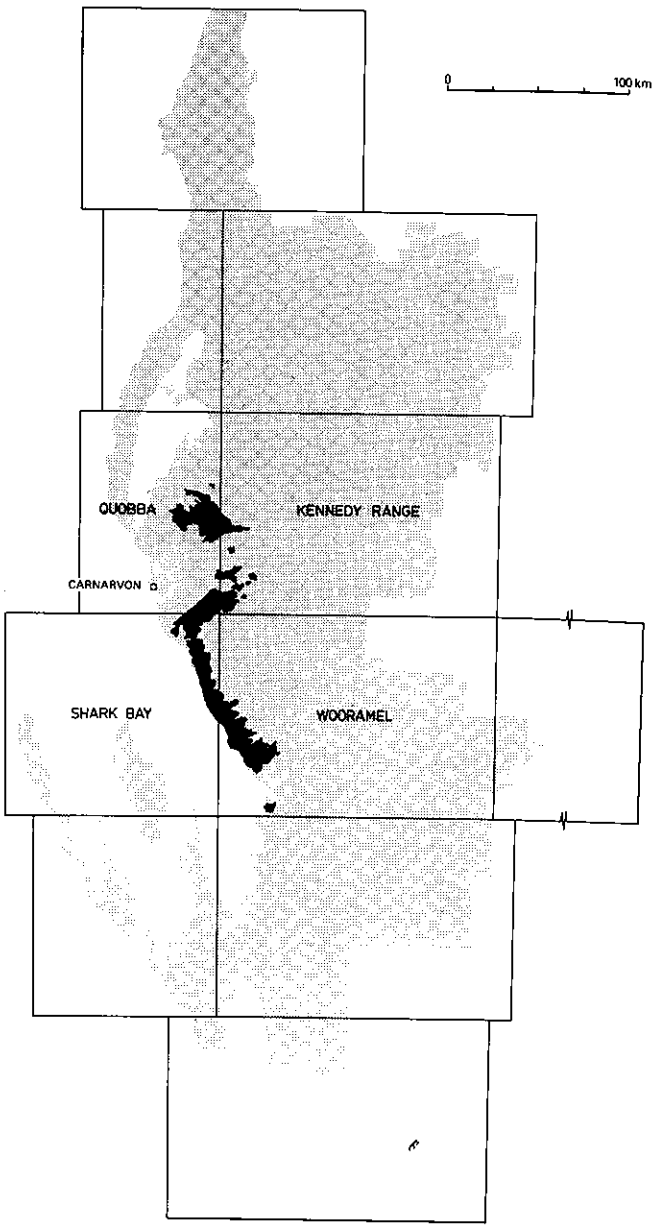


Unit
1. Flood plains
2. Sandy plains and margins
3. Watercourses



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Flood plains (75%) 1 site inventory and traversed	
Plains with flat, irregular or hummocky surfaces, carrying channels and runnels directing flow both away from and returning to major water-courses; slopes < 1%. Soils are red or dark red sands, loams or light clays with uniform or gradational profiles, > 1 m deep, pH 6.5, with a neutral trend; principal profile forms: Uc 5.11.	(i) Very scattered to close low woodlands dominated by *Eucalyptus coolabah, Acacia* spp and *Cenchrus ciliaris.* (ii) Scattered to close tall shrublands dominated by *Acacia victoriae, A. grasbyi* and and *A. citrinoviridis.* Trees (6-12 m): *Eucalyptus coolabah, E. camaldulensis, Acacia grasbyi, A. citrinoviridis, A. coriacea*; Tall shrubs (2-4 m): *A. victoriae, A. sclerosperma, Cassia desolata*; Low shrubs (0.5-1.5 m): *Cassia* spp, *Crotalaria cunninghamii, Atriplex bunburyana, Indigofera monostachya, Rhagodia eremaea, Corchorus walcottii*; Perennial grasses: *Cenchrus ciliaris, C. setigerus, Eriachne helmsii, Eragrostis setifolia.*	Pasture type: *Acacia Creek-line.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Rhagodia eremaea, Atriplex burburyana, Eragrostis setifolia, Cenchrus setigerus.* Pastoral use limitations: River frontage areas prone to overgrazing by local concentrations of stock; flood-prone.
	Unit 2 Sandy plains and margins (20%) 1 site inventory and traversed	
Raised sandy banks and marginal plains with hummocky surfaces, mostly < 300 m wide and 1-2 m above adjacent areas of unit 1, slopes mainly < 1%. Soils are red or dark red sands with uniform or gradational profiles, > 1 m deep, pH 6.5 with a neutral trend; principal profile form: Uc 5.13.	Scattered to moderately close tall shrublands dominated by *Acacia ramulosa* and *A. sclerosperma.* Trees and tall shrubs (3-4 m): *A. ramulosa, A. sclerosperma, Heterodendrum oleaefolium, A. tetragonophylla, Eremophila maitlandii*; Low shrubs (1-2 m): *Olearia axillaris, Cassia helmsii, Rhagodia eremaea, Eremophila leucophylla, Scaevola spinescens, Sida rohlenae, Solanum lasiphyllum, Pimelea microcephala*; Perennial grasses: *Eriachne helmsii, Cenchrus ciliaris, Eragrostis eriopoda, Triodia* spp.	Pasture type: *Acacia Creek-line* or *Tussock Grass.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Rhagodia eremaea, Enchylaena tomentosa, Phyllanthus* sp. nov., *Eregrostis eriopoda, Cenchrus ciliaris.* Undesirable perennials include: *Olearia axillaris, Hakea preisii, Cassia* spp. Pastoral use limitations: None under controlled stocking.
	Unit 3 Watercourses (5%) Traversed	
Major riverbeds and watercourses, 50-500 m wide, incised 4-10 m, with steep banks, carrying bedloads of coarse sand; minor channels and meandering runnels, incised and flanked by hummocky flood banks. Soils are probably dark red sands and silty loams (banks) with uniform or juvenile profiles (flood banks).	No vegetation in most parts of the major watercourses. Banks support close low woodlands or tall shrublands dominated by *Eucalyptus camaldulensis, E. coolabah, Acacia citrinoviridis, A. sclerosperma,* very variable low shrubs and *Cenchrus ciliaris.*	Pasture type: Unvegetated or *Acacia Creekline.* Pastoral use limitations: Flood-prone.

Sable land system 1554 km² (2.1% of survey area)



Nearly flat alluvial plains with occasional sandy rises, low shrublands of saltbush and Gascoyne bluebush and some tall acacia shrublands.

Geology: Quaternary deposits, mostly alluvial or colluvial clay, silt, sand and gravel, semi-consolidated when near river deltas; small areas of acolian sand.

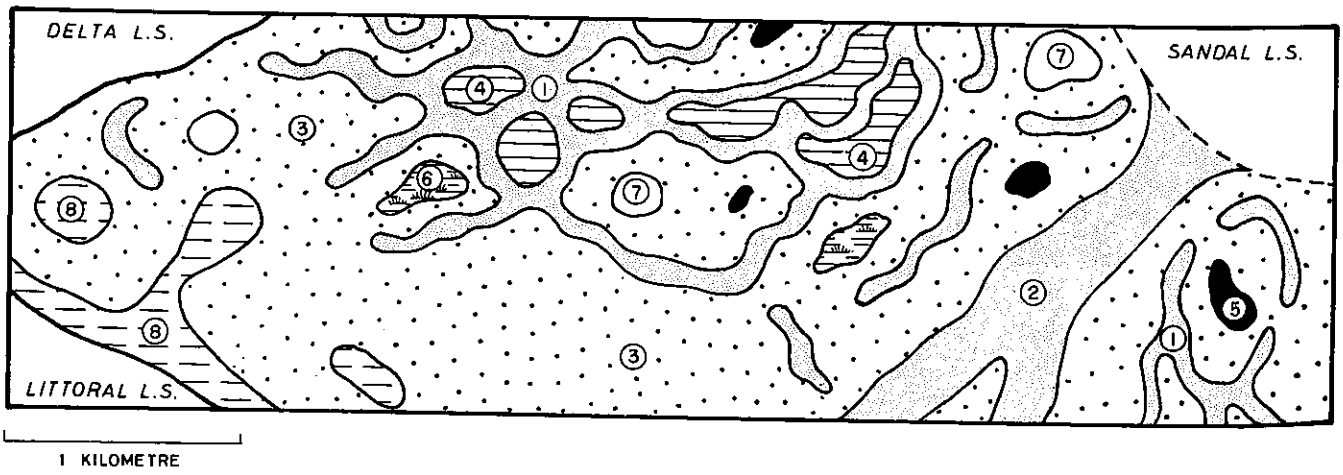
Geomorphology: Depositional surfaces: extensive, saline, alluvial plains with sandy-surfaced duplex soils; minor sandy banks and sand sheets up to 3 m above the surrounding plains; minor drainage foci; ephemeral swamps and highly saline flats; no organized external drainage.

Pastoral use: Valuable Bluebush (BLUE) and Saltbush (SALT) pastures; large areas receive little grazing through lack of high quality stock waters to offset the high salinity of the pastures. Where over-used, some areas have become devoid of bluebush and saltbush shrubs and are locally susceptible to erosion by wind and water.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: good 58%; fair 28%; poor 14%.

Unit
1. Sandy banks
2. Sand sheets
3. Alluvial plains
4. Interbanks
5. Drainage foci
6. Swamps
7. Claypans
8. Saline plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Sandy banks (5%) 5 site inventories and traversed **Unit 2 Sand sheets (5%)**	
Sandy banks up to 2 m above unit 4 and sand sheets up to 4 m relative relief, slopes < 0.5%. Soils are dark red sands or sandy-surfaced loams tending to duplex near units 3 or 4, usually > 1 m deep, pH 6.5-7.0 with neutral or alkaline trends; principal profile forms: Uc 1.11, 1.13, 1.23, Gn 2.12.	Very scattered to moderately close tall or low shrublands, usually dominated by *Acacia* spp and *Eremophila* spp on the sandy banks, often with *Atriplex bunburyana* co-dominant on unit 2. PFC 5 to 30%; Tall shrubs (200-1000/ha; 2-3 m): *Acacia sclerosperma, A. ramulosa, Eremophila maitlandii, Acacia tetragonophylla, Heterodendrum oleaefolium, Stylobasium spathulatum, Hakea preissii*; Low shrubs (1000-6000/ha; < 1.5 m): *Atriplex bunburyana, Ptilotus obovatus, Eremophila leucophylla, Chenopodium gaudichaudianum, Enchylaena tomentosa, Solanum lasiophyllum, Scaevola spinescens*; Perennial grasses: *Eriachne helmsii, Eragrostis lanipes, Cenchrus ciliaris.*	Pasture type; *Saltbush/Acacia Sandplain.* Near to the coast, *Atriplex paludosa* is sometimes co-dominant. *Cenchrus ciliaris* commoner N of Gascoyne R. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex* spp, *Enchylaena tomentosa, Scaevola spinescens.* Undesirable perennials include: *Hakea preissii, Eremophila maitlandii.* Pastoral use limitations: None.
	Unit 3 Alluvial plains (70%) 9 site inventories and traversed	
Flat to very gently undulating restricted plains, slopes < 0.3%. Soils are red to dark reddish-brown duplexes, loamy sand over clay/loams or clays > 1 m deep, pH 6.5-7.5, with alkaline or neutral trends and inclusions of calcrete, gypsum or limestone; principal profile forms: Dr 1.13, 1.12, 4.13.	Very sparse to sparse low shrublands dominated by *Maireana* spp and *Atriplex* spp with or without very sparse tall shrubs *Acacia* spp PFC < 2.5% (on degraded sites) to 20%; Trees (infrequent): *Acacia cuspidifolia, Heterodendrum oleaefolium*; Tall shrubs (0-150/ha; 2-3 m): *Acacia victoriae, A. tetragonophylla, A. xiphophylla, Hakea preissii*; Low shrubs (0-9000/ha; < 0.5 m): *Maireana polypterygia, M. platycarpa, Atriplex vesicaria, Frankenia* spp, *Ptilotus polakii, Chenopodium gaudichaudianum, Ptilotus obovatus, Eremophila pterocarpa.*	Pasture type: *Saltbush* or *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Degraded sites can lose all perennial cover. Desirable perennials include: *Maireana platycarpa, M. polypterygia, Atriplex bunburyana, A.vesicaria, Scaevola spinescens.* Undesirable perennials include: *Acacia cuspidifolia, Hakea preissii.* Pastoral use limitations: High salinity levels in pasture plants; locally susceptible to water erosion when degraded.
	Unit 4 Interbanks (10%) 1 site inventory and traversed	
Flat to concave restricted plains between sandy banks. Soils are dark reddish-brown duplex, loamy sand over fine sandy clay, > 1 m deep, pH 6.5 with an alkaline trend, with calcrete inclusions; principal profile form: Dr 1.13.	Sparse mixed shrublands dominated by (i) *Acacia xiphophylla, A. sclerosperma* and an understorey of *Atriplex bunburyana* when in good condition, or (ii) *Acacia victoriae, Eremophila pterocarpa* and *Sclerolaena* spp in poor condition. Tall shrubs: *Acacia xiphophylla, A. victoriae, A. sclerosperma, Hakea preissii, Acacia tetragonophylla, Scaevola spinescens*; Low shrubs: *Atriplex bunburyana, Ptilotus obovatus, Maireana tomentosa, Rhagodia eremaea, Chenopodium gaudichaudianum, Scaevola tomentosa, Eremophila mackinlayi, Eremophila* sp.	Pasture type: *Currant Bush Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Scaevola spinescens, Acacia xiphophylla.* Undesirable perennials include: *Eremophila pterocarpa, Hakea preissii.* Pastoral use limitations: None under controlled stocking.
	Unit 5 Drainage foci (2%) 2 sites inventories and traversed	
Seasonally inundated elliptical drainage foci. Soils are reddish-brown sandy loams, > 1 m deep, pH 6.5 with a neutral trend, sometimes lightly strewn with ironstone gravels; principal profile form: Gn 3.12.	Moderately close tall shrublands dominated by *Melaleuca uncinata* or *Acacia tetragonophylla,* sometimes with a fringe of *Eucalyptus coolabah.* Tall shrubs (500-900/ha; 2-4 m): *Melaleuca uncinata, Acacia tetragonophylla, Heterodendrum oleaefolium*; Low shrubs (750-5000/ha; 0.5-1.5 m): *Scaevola spinescens, Ptilotus obovatus, Rhagodia eremaea, Chenopodium gaudichaudianum, Scaevola tomentosa, Eremophila mackinlayi.*	Pasture type: *Currant Bush Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Scaevola spinescens, Heterodendrum oleaefolium.*

Sable L.S.—Continued

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 6 Swamps (2%) Traversed	
Seasonally inundated shallow elliptical swamps. Soils are probably more clayey than those of unit 5.	Fringing low woodlands and tall shrublands of *Eucalyptus coolabah* and *Melaleuca uncinata*, around open areas with patchy scattered shrublands of *Muehlenbeckia* sp. and *Atriplex amnicola* or *Eragrostis australasica-Eriachne benthamii* tussock grassland.	Pasture type: *Tussock Grass/Saltbush.*
	Unit 7 Claypans (1%) Traversed	
Small shallow claypans.	Very scattered shrublands or bare areas.	
	Unit 8 Saline plains (5%) 2 site inventories and traversed	
Low-lying flat plains mainly near the coast. Soils are dark red or red duplex, sands over sandy clays, > 80 cm deep, pH 7.0 with an alkaline trend, with inclusions of limestone, carbonate concretions or gypsum; principal profile form: Dr 1.13.	Scattered low shrublands of halophytes, mainly *Maireana platycarpa* and *Halosarcia* spp. Low shrubs (3500-5000/ha; < 0.5 m): *Halosarcia* spp, *Maireana platycarpa, M. atkinsiana, Atriplex vesicaria, M. oppositifolia, Carpobrotus* spp.	Pasture type: Samphire Desirable perennials includes: *Maireana platycarpa, M. atkinsiana.* Pastoral use limitations: High salinity levels in pasture plants, lack of shade in summer.

Salune land system 72 km² (0.1% of survey area)

Alluvial plains and saline flats interspersed with undulating sandy banks and low dunes; tall acacia shrublands and low shrublands of bluebush, saltbush and samphire.

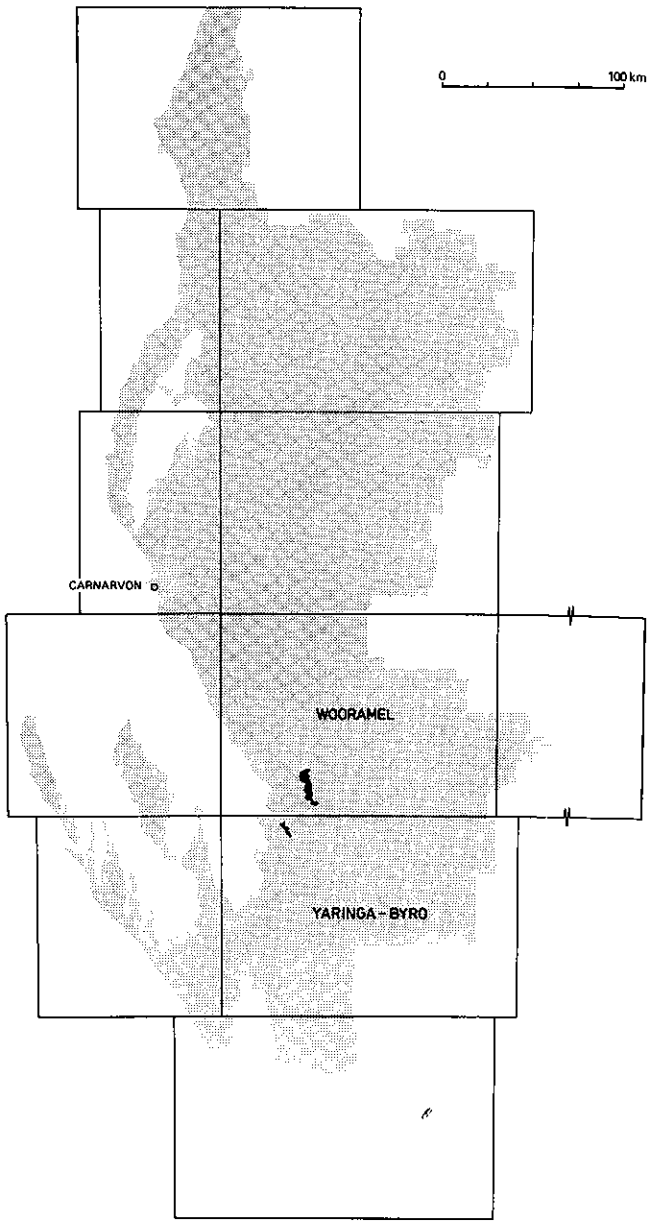
Geology: Quaternary deposits; alluvial and aeolian: clay, silt, sand and gravel.

Geomorphology: Depositional surfaces: nearly flat saline alluvial plains and aeolian sand deposits; internal drainage into saline flats and depressions; relief up to 8m.

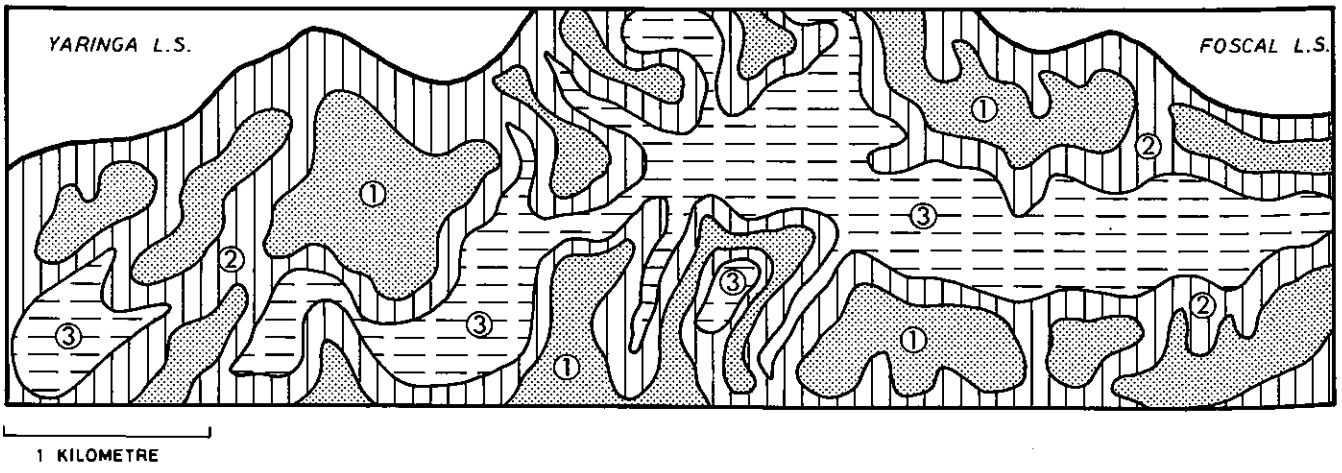
Pastoral use: Productive Bluebush (BLUE) and Saltbush (SALT) pastures, not extensive in total area; also Acacia Sandplain (ACSA) and Samphire (SAMP) pastures. A minor land system that shows no susceptibility to erosion.

Estimated carrying capacity, good condition: 11 ha/s.u.

Range condition summary: good 31%; fair 46%; poor 23%.



Unit
1. Sandy banks
2. Alluvial plains
3. Saline plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Sandy banks (45%) 1 site inventory and traversed	
Undulating sandy banks up to 8 m high slopes up to 4%. Soils are dark red non-coherent sand, > 1 m deep, pH 6.0-7.0; principal profile form: Uc 1.23.	Scattered to moderately close tall shrublands, dominated by *Acacia ramulosa* and *A. sclerosperma*. Trees (infrequent): *Santalum spicatum*; Tall shrubs: *A. ramulosa, A. sclerosperma, Eremophila maitlandii, Acacia wiseana, Scaevola spinescens, Cassia chatelainiana*; Low shrubs: *Chenopodium gaudichaudianum, Solanum lasiophyllum, Corchorus* sp., *Rhagodia eremaea, Enchylaena tomentosa*; Perennial grasses: *Eragrostis lanipes, Monachather paradoxa.*	Pasture type: *Acacia Sandplain.* Desirable perennials include: *Scaevola spinescens, Cassia chatelainiana, Enchylaena tomentosa, Monachather paradoxa.* Undesirable perennials include: *Eremophila maitlandii.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Alluvial plains (20%) 1 site inventory and traversed	
Plains sloping gently (< 0.5%) away from unit 1. Soils are dark red duplex, loamy sand over sandy clay, > 1 m deep containing carbonate concretions, pH 8.5 with an alkaline trend; principal profile form: Dr 1.13.	Scattered low shrublands dominated by *Maireana polypterygia* and *Atriplex vesicaria*, with very scattered trees and shrubs. Trees: *Acacia cuspidifolia*; Tall shrubs: *A. microcalyx, A. tetragonophylla*; Low shrubs: *Maireana polypterygia, Atriplex vesicaria, Maireana tomentosa, M. platycarpa, Eremophila pterocarpa, Solanum lasiophyllum.*	Pasture type: *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, Atriplex vesicaria.* Undesirable perennials include: *Eremophila pterocarpa.* Pastoral use limitations: High salinity levels of pasture plants.
	Unit 3 Saline plains (35%) Traversed	
Flat to gently sloping plains. Soils are probably deep clays.	Scattered low shrublands of halophytes, dominated by *Halosarcia* spp., *Maireana atkinsiana, Frankenia* spp.	Pasture type: *Samphire.* Pastoral use limitations: High salinity levels of pasture plants.

Sandal land system 5658 km² (7.6% of survey area)

Alluvial plains with numerous low sandy rises and banks with duplex and sandy soils supporting tall shrublands of acacias with currant bush; also low shrublands of Gascoyne bluebush and Gascoyne mulla-mulla.

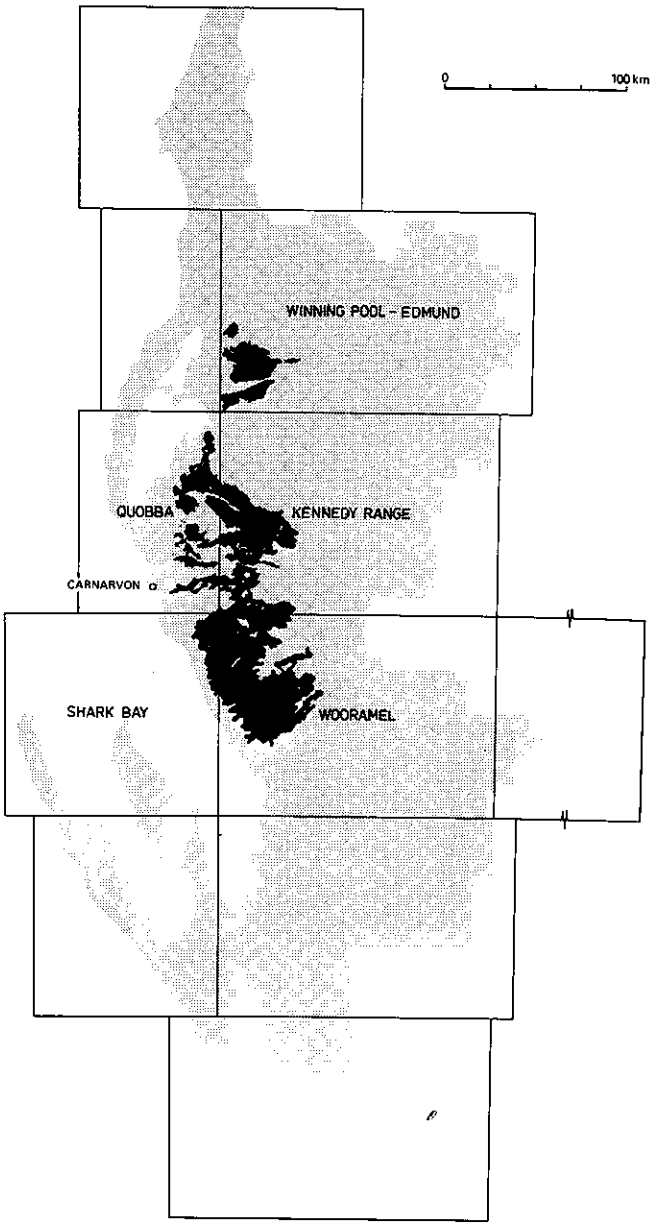
Geology: Quaternary alluvial deposits of clay, silt, sand and gravel with areas of aeolian sand.

Geomorphology: Depositional surfaces: nearly flat alluvial plains with a mosaic of sandy banks and rises up to 5 m above inter-bank plains; minor drainage foci, claypans and drainage tracts; drainage internal into discrete foci or along narrow sluggish tracts.

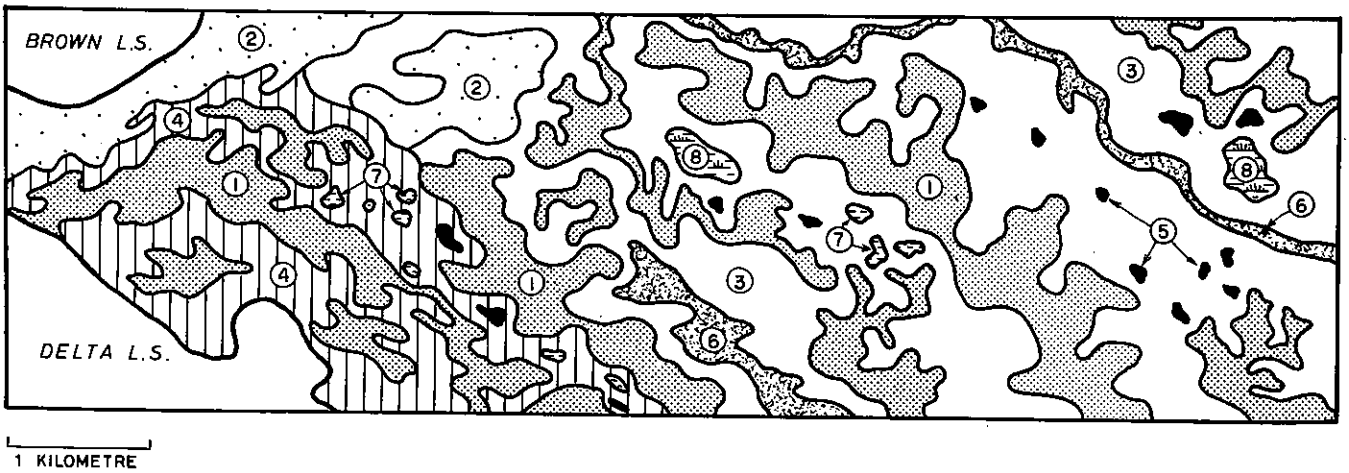
Pastoral use: Currant Bush Mixed Shrub (CBMS) and Acacia Sandplain (ACSA) pastures with minor areas of Bluebush (BLUE) and Saltbush (SALT). A highly productive land system with good drought durability and only slightly susceptible to erosion, but units 3 and 4 are highly susceptible to invasion by unpalatable woody shrubs. These have formed dense thickets on some degraded areas.

Estimated carrying capacity, good condition: 7 ha/s.u.

Range condition summary: good 27%; fair 45%; poor 28%.



Unit
1. Sandy banks
2. Restricted sandplains
3. Interbanks
4. Alluvial plains
5. Drainage foci
6. Drainage lines
7. Claypans
8. Ephemeral swamps



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Sandy banks (30%) **Unit 2 Restricted sandplains (10%) 10 site inventories and traversed**	
Sandy banks up to 4 m above unit 3, and restricted sandplains with slopes to 0.6%. Soils are dark red sands, > 1 m deep, pH 6.5-7.0 with a neutral trend; principal profile forms: Uc 5.11, 5.21.	Scattered to moderately close tall shrublands dominated by *Acacia sclerosperma* and *A. ramulosa*. PFC 10 to 30%; Trees (infrequent): *Santalum lanceolatum*; Tall shrubs (100-3000/ha; 2-4 m): *Acacia sclerosperma, Eremophila maitlandii, A. ramulosa, A. tetragonophylla, A. subtessarogona, A. grasbyi*; Low shrubs (300-5000/ha; < 2 m): *Solanum lasiophyllum, Enchylaena tomentosa, Ptilotus obovatus, Chenopodium gaudichaudianum, Rhagodia eremaea, Scaevola spinescens, S. tomentosa, Eremophila leucophylla*; Perennial grasses: *Eriachne helmsii, Eragrostis lanipes*, also *Cenchrus ciliaris* and *C. setigerus*.	Pasture type: *Acacia Sandplain*. Perennials augmented by annual grasses and forbs in favourable seasons. In southern areas, the low shrub layer is locally dominated by *Atriplex bunburyana*; *Cenchrus* spp. more abundant in N. Desirable perennials include: *Enchylaena tomentosa, Scaevola* spp, *Cassia chatelainiana, Atriplex bunburyana, Cenchrus setigerus*. Pastoral use limitations: None under controlled stocking.
	Unit 3 Interbanks (40%) 30 site inventories and traversed	
Flat or gently sloping plains between sandy banks, slopes mainly < 0.5%, some very sparsely strewn with quartz gravels. Soils are dark red, dusky red or reddish-brown duplex, sand to sandy loam over sandy clay loam to sandy clay, mostly > 1 m deep with various inclusions, mainly carbonates; pH 6.0-7.0 with alkaline or neutral trends; principal profile forms: Dr 1.13, 1.16, 1.12, 1.15.	Very scattered to moderately close tall or low shrublands, mostly dominated by *Acacia* spp and *Scaevola spinescens* when in good condition but very susceptible to invasion by undesirable shrubs, e.g. *Hakea preissii* and *Eremophila crenulata* when degraded. PFC < 5 to 30%; Trees (0-50/ha; 2-4 m): *Heterodendrum oleaefolium, Santalum lanceolatum, Acacia sibilans*; Tall shrubs (100± 235/ha; 2-4 m): *Acacia tetragonophylla, A. xiphophylla, A. sclerosperma, A. victoriae, Hakea preissii, Stylobasium spathulatum*; Low shrubs (2900±1600/ha): *Scaevola spinescens, Eremophila pterocarpa, E. latrobei, E. crenulata, Ptilotus obovatus, Maireana tomentosa, Rhagodia eremaea, Cassia helmsii, Ptilotus polakii, Atriplex bunburyana*; Perennial grasses: *Enteropogon acicularis, Eriachne helmsii, Cenchrus ciliaris*.	Pasture type: *Currant Bush Mixed Shrub*. Perennials augmented by annual grasses and forbs in favourable seasons. At some little grazed sites, *Atriplex bunburyana* is a dominant low shrub, but this saltbush is generally scarce or absent elsewhere, except in western areas on *Acacia xiphophylla*-dominated sites. Desirable perennials include: *Atriplex bunburyana, Cassia chatelainiana, Scaevola spinescens, Eremophila latrobei, Rhagodia eremaea, Ptilotus polakii*. Undesirable perennials include: *Hakea preissii, Eremophila crenulata, Cassia helmsii, C. desolata*. Pastoral use limitations: Degraded sites are highly susceptible to invasion by unpalatable shrubs and slightly susceptible to erosion.
	Unit 4 Alluvial plains (15%) 5 site inventories and traversed	
Flat plains with gentle slopes (< 0.4%). Soils are red or dark red sandy-surfaced duplex, > 1 m deep, often with carbonate concretions, pH 6.5-7.0 with alkaline or neutral trends; principal profile forms: Dr 1.13, 1.12, 1.15.	Very scattered to scattered low or mixed shrublands dominated by *Ptilotus polakii* and *Maireana polypterygia* when in good condition, but with increased tall shrubs when degraded. Trees (infrequent): *Acacia cuspidifolia*; Tall shrubs (0-250/ha; 2-4 m): *A. tetragonophylla, A. victoriae, A. xiphophylla, Hakea preissii*; Low shrubs (1500-5000/ha; < 1.5 m): *Ptilotus polakii, Maireana polypterygia, Rhagodia eremaea, Eremophila pterocarpa, Chenopodium gaudichaudianum, Ptilotus obovatus*; Perennial grasses: *Enteropogon acicularis*.	Pasture type: *Bluebush*. Perennials augmented by annual grasses and forbs in favourable seasons. On some areas in the west *Atriplex vesicaria* is a co-dominant low shrub. Desirable perennials include: *Maireana polypterygia, Ptilotus polakii, Enchylaena tomentosa*. Undesirable perennials include: *Eremophila pterocarpa, Cassia helmsii, Hakea preissii*. Pastoral use limitations: Degraded sites moderately susceptible to invasion by unpalatable shrubs.
	Unit 5 Drainage foci (2%) 4 site inventories and traversed	
Flat to concave drainage foci. Soils are reddish brown loams or clays, locally sandy-surfaced duplex, > 1 m deep, pH 6.5-7.0 with neutral or alkaline trends; principal profile forms: Gn 4.12, Uf 6.31, Dy 1.13.	Moderately close to close tall shrublands dominated by *Acacia* spp or *Melaleuca uncinata*. PFC 20 to 50%; Trees (infrequent): *Santalum* spp *Acacia subtessarogona*; Tall shrubs (300-1300/ha; 2-5 m): *Melaleuca uncinata, Acacia tetragonophylla, A. sclerosperma, A. ramulosa, Cassia chatelainiana*; Low shrubs (1800-8000/ha; 0.5-1.5 m): *Ptilotus obovatus, Indigofera* spp, *Maireana planifolia*; Perennial grasses: *Eragrostis setifolia, Eriachne helmsii, Eragrostis lanipes*.	Pasture type: *Acacia Creek-line*. Desirable perennials include: *Maireana planifolia, Rhagodia eremaea, Cassia chatelainiana*. Pastoral use limitations: None under controlled stocking.

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 6 Drainage lines (1%) 2 site inventories and traversed	
Unchannelled sluggish flow lines, slopes about 0.2%. Soils are dark reddish brown duplex, loamy sand over sandy clay, > 1 m deep, pH 6.5 with a neutral trend; principal profile forms: Dr 1.12, 2.12.	Moderately close to close tall shrublands dominated by *Acacia tetragonophylla* and *Eremophila crenulata*. Tall shrubs (800/ha; 2-4 m): *A. tetragonophylla, A. victoriae, Hakea preissii, Scaevola spinescens*; Low shrubs (3000-4500/ha; < 2 m): *Eremophila crenulata, E. mackinlayi, E. maculata, Rhagodia* spp, *Maireana tomentosa, Cassia* spp.	Desirable perennials include: *Scaevola spinescens*. Pastoral use limitations: Moderate susceptibility to invasion by unpalatable shrubs.
	Unit 7 Claypans (1%)	
Small bare claypans.	No perennial vegetation.	
	Unit 8 Ephemeral swamps (1%) 2 site inventories and traversed	
Small depressions, either gilgaied or with boulder-strewn convex centres on gypsiferous sites. Soils are dark red or reddish-brown sandy-surfaced clays of variable depth, pH 5.5-8.0 with neutral or alkaline trends; principal profile forms: Gc 2.22, Uf 6.13.	Very sparse to sparse tall shrublands or tussock grasslands dominated by *Acacia sclerosperma*, or *Eucalyptus coolabah* and perennial grasses. Trees: *E. coolabah*; Tall shrubs: *Acacia sclerosperma, Melaleuca uncinata*; Low shrubs: *Chenopodium auricomum, Atriplex amnicola, Frankenia* spp, *Maireana lanosa, Enchylaena tomentosa*; Perennial grasses: *Eriachne flaccida* (up to 2% b.c.).	Pasture type: *Tussock Grass* or *Saltbush*. Desirable perennials include: *Atriplex amnicola, Enchylaena tomentosa, Maireana lanosa*, perennial grasses. Pastoral use limitations: None under controlled stocking.

Sandiman land system (G) 208 km² (0.3% of survey area)

Undulating stony uplands with low breakaways, slopes and ridges, supporting very scattered shrublands of mulga and other acacias.

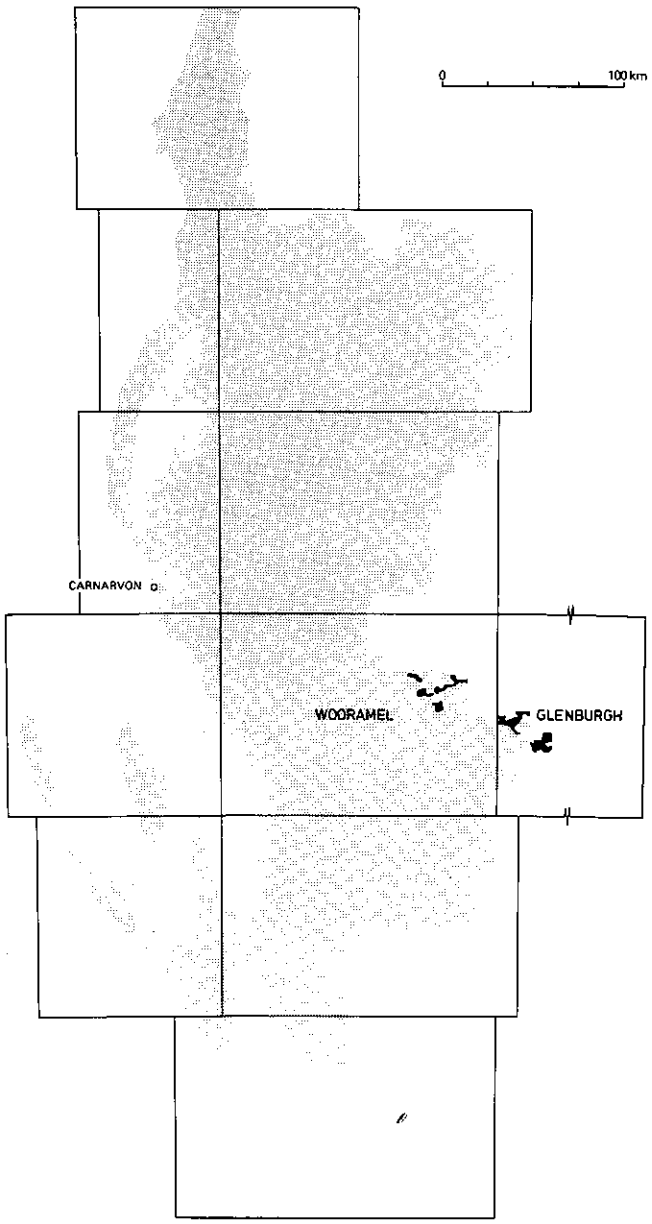
Geology: Permian greywacke, sandstone and siltstone, locally with tillitic shale, mainly of the Sakmarian Series.

Geomorphology: Mainly erosional surfaces, extensively mantled by cobbles and pebbles: residual plateaux, summits and ridges, trellised drainage into narrow floors with incised channels and, locally, to narrow plains with gilgaied surfaces.

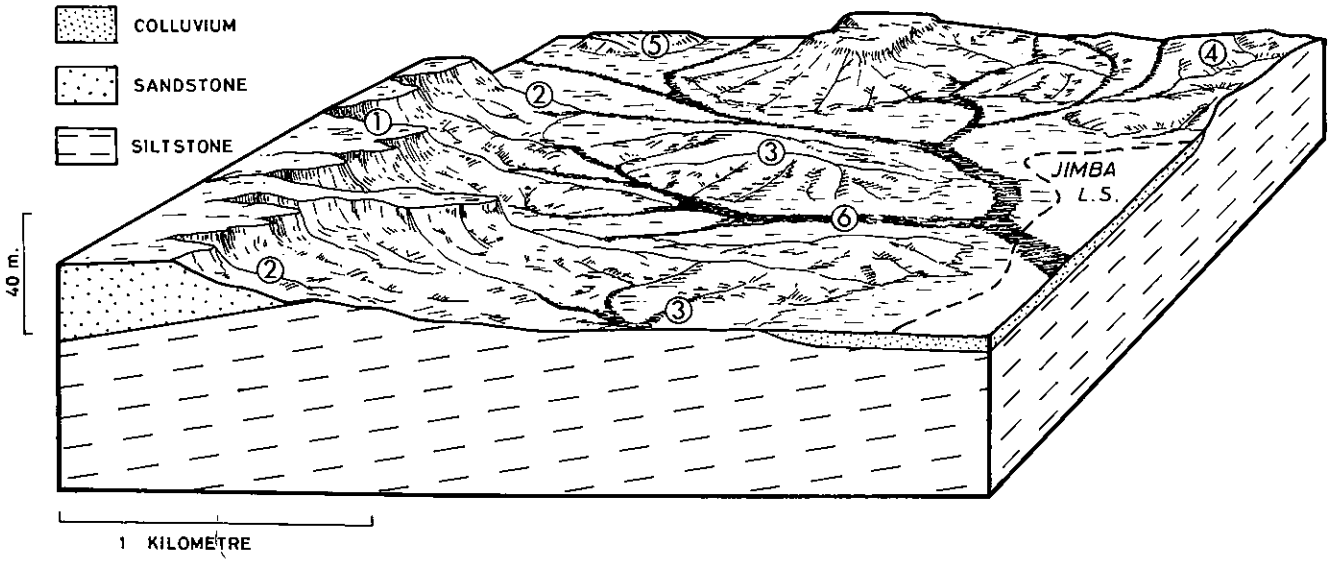
Pastoral use: Moderately productive Stony Chenopod (STCH) and Stony Short Grass Forb (SSGF) pastures with moderate dry season durability when in good condition. Where degraded, the sparse shrublands provide little other than annual forage; the lower units are more extensively mantled and less susceptible to erosion than other Permian age systems.

Estimated carrying capacity, good condition: 15 ha/s.u.

Range condition summary: good 7%; fair 67%; poor 26%

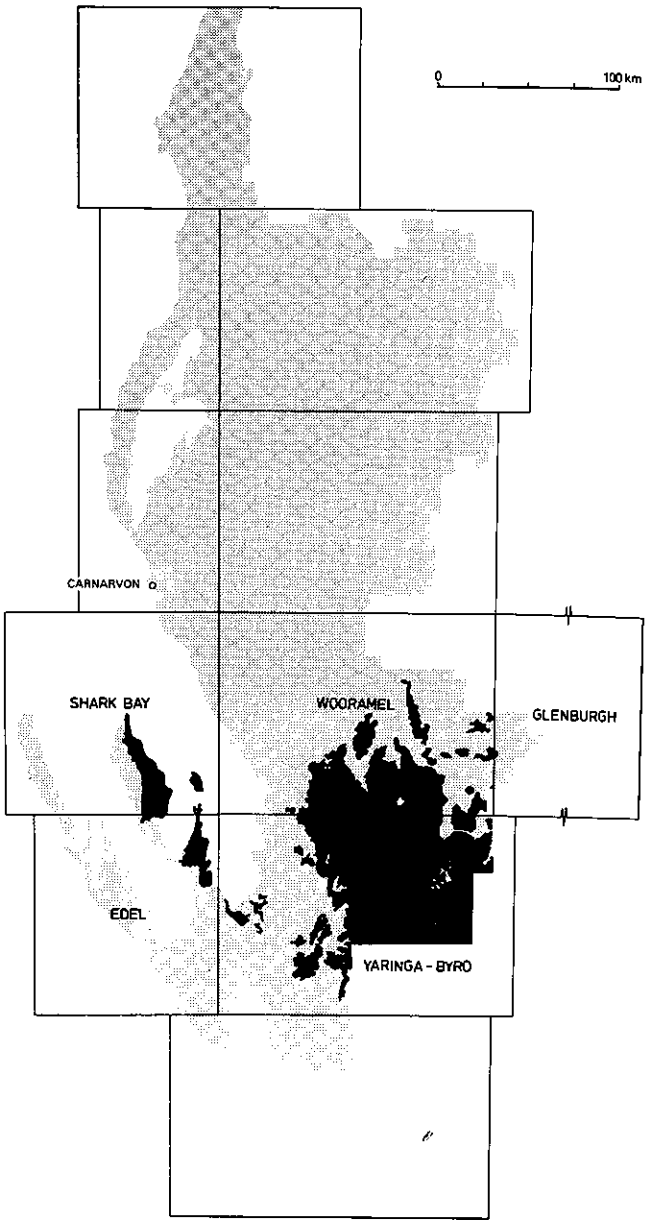


Unit
1. Plateaux, breakaways and ridges
2. Upper slopes
3. Lower slopes
4. Terraced slopes and banks
5. Sandy banks and dunes
6. Drainage floors



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Residual platcaux, with breakaways and long ridges of slightly less relief, several km long in places. Soils are shallow and heavily mantled by cobbles and pebbles; reddish-brown clays, pH 7.0 with neutral or alkaline trends.	**Unit 1 Plateaux, breakaways & ridges (15%) Traversed** Very scattered shrublands dominated by *Acacia aneura*. Tall shrubs: *A. aneura, A. tetragonophylla, A. victoriae, A. eremaea*; Low shrubs: *Cassia desolata, Eremophila cuneifolia, E. freelingii, Solanum lasiophyllum.*	Pasture type: *Stony Chenopod.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana melanocoma, M. georgei, Tribulus platypterus.* Pastoral use limitations: None under controlled stocking.
Upper slopes with steep gradients, densely mantled with cobbles and pebbles or boulders; lower slopes with moderate or dense mantling and slopes 2-10%. Soils are reddish-brown or brown clayey types, locally loamy-surfaced duplex, < 1 m deep, pH 6.5 to 8.0 with neutral trend.	**Unit 2 Upper slopes (20%)** **Unit 3 Lower slopes (40%) 1 site inventory and traversed** Very scattered shrublands dominated by *Acacia xiphophylla/eremaea* and *A. aneura*. Tall shrubs: *A. xiphophylla/eremaea, A. aneura, A. cuspidifolia, A. cuthbertsonii, A. tetragonophylla, A. victoriae*; Low shrubs: *Eremophila cuneifolia, Cassia helmsii, Maireana polypterygia, Ptilotus polakii, Frankenia* spp.	Pasture type: *Stony Chenopod.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, Ptilotus polakii, Frankenia* spp. Pastoral use limitations: Moderate susceptibility to water erosion, with gullying on unit 3, when degraded.
Terraced tributary drainage slopes averaging 1% slope. Soils are densely mantled or virtually bare in alternating zones forming a transversely 'banded' terrace, reddish-brown clayey types, > 1 m deep, pH 8.0.	**Unit 4 Terraced slopes and banks (5%) Traversed** Very scattered shrublands dominated by *Acacia xiphophylla/eremaea* and *A. tetragonophylla* with low shrubs including *Maireana pyramidata* and *M. polypterygia.*	Pasture type: *Stony Chenopod.* Pastoral use limitations: None under controlled stocking.
Banks and isolated dunes < 3 m above unit 6. Soils are probably reddish-brown sands, pH 7.0 to 8.0.	**Unit 5 Sandy banks and dunes (5%) Traversed** Very scattered shrublands dominated by *Acacia ramulosa.*	Pasture type: *Acacia Sandplain.* Pastoral use limitations: Susceptible to wind erosion and/or accretion of eroded material from other units when degraded.
Narrow floors with incised drainage lines carrying bedloads of sands and cobbles, but otherwise soils are probably reddish-brown to brown clayey types, pH 7.0 to 8.0.	**Unit 6 Drainage floors (15%) Traversed** Very scattered to scattered tall shrublands dominated by *Acacia aneura* and *A. xiphophylla/eremaea*, usually as fringing communities along the drainage lines, with very scattered low shrublands dominated by *A. victoriae* and *Frankenia* spp around gilgaied areas.	Pasture type: *Stony Chenopod.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Susceptible to accelerated water erosion when fringing communities are degraded.

Sandplain land system 9866 km² (13.2% of survey area)



Extensive red sand plains with tall shrublands of wanyu and under-story shrubs or low woodlands of sandplain gidgee.

Geology: Quaternary aeolian sand.

Geomorphology: Depositional surfaces: flat to gently undulating extensive sand sheets, generally without dune development; drainage features absent; broad scale relief up to 50 m; major system of the Victoria sand plain.

Pastoral use: Acacia Sandplain (ACSA) pastures, in some areas more productive years after the passage of fires and subsequent changes in the vegetation (Curry 1986). The system is not prone to erosion. It is unusually productive on the peninsulas of Shark Bay.

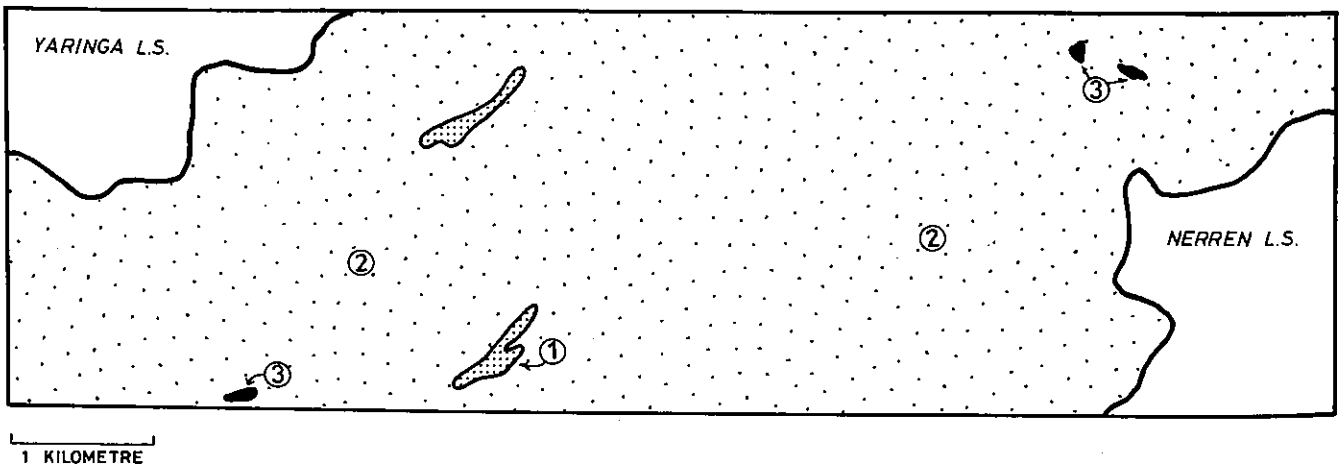
Estimated carrying capacity, good condition: 12 ha/s.u.

Nanga and Peron stations 8 ha/s.u.

Faure Island 5 ha/s.u.

Range condition summary: good 50%; fair 37%; poor 13%.

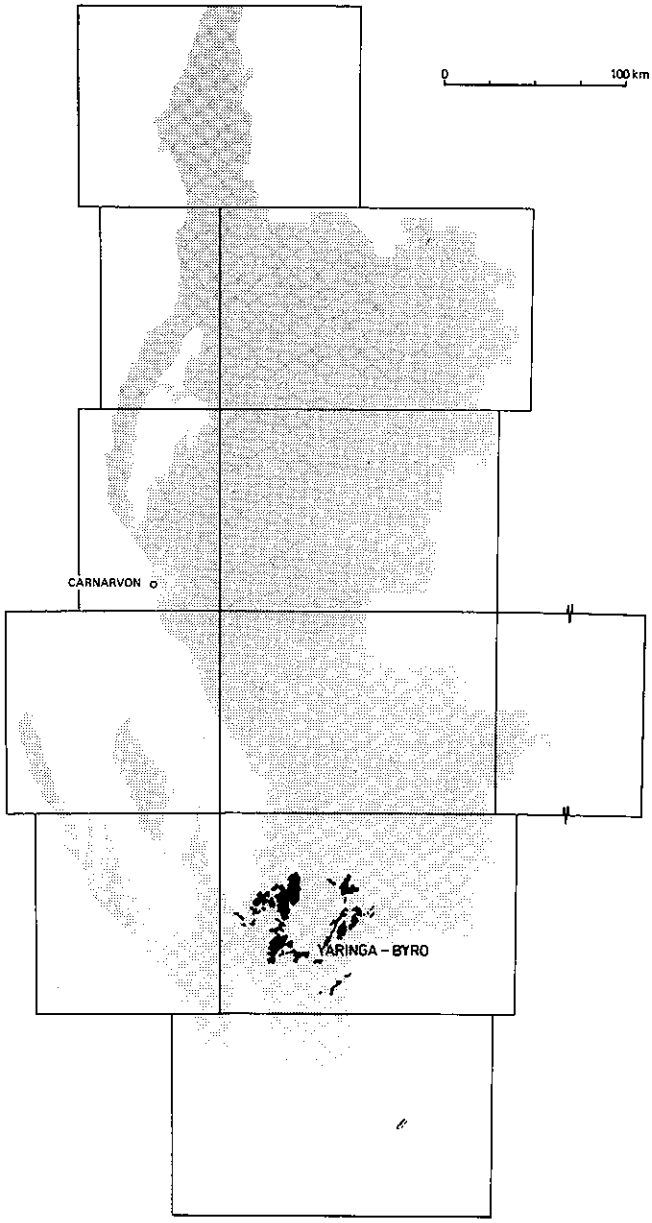
Unit
1. Low duncs and sandy banks
2. Broad sandy plains
3. Drainage foci



Sandplain L.S.

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Low dunes and sandy banks (4%) Traversed	
Occasional low longitudinal dunes up to 10 m high. Soils are dark red sands.	Similar to unit 2 with more *Grevillea* spp, *Acacia sclerosperma* and *Cassia* spp.	as unit 2
	Unit 2 Broad sandy plains (95%) 36 site inventories and traversed	
Flat or gently undulating plains, often very extensive and rather uniform; relief up to 42 m but slopes mostly < 0.5%. Soils are dark red or dusky red sand, loamy sand or clayey sand, > 1 m deep, pH 5.5-7.0 with neutral or acid trends; principal profile forms: Uc 5.21, Uc 1.23 and Uc 5.22 (Faure Island only, where locally calcareous with an alkaline trend).	(i) Moderately close tall shrublands dominated by *Acacia ramulosa*, widely succeeded by variable mixed or low shrublands after fire; (ii) Low woodlands dominated by *A. anastema*. (i) PFC 20 to 40%; Trees (< 25/ha; 4-10 m): *Eucalyptus dichromophloia, E. eudesmioides, Acacia pruinocarpa, Santalum spicatum, Canthium lineare, Grevillea stenobotrya*; Tall shrubs (430 *F* 390/ha; 2-4 m): *A. ramulosa, A. murrayana, A. wiseana, A. roycei, A. sclerosperma, A. tetragonophylla, Eremophila maitlandii, E. latrobei, E. spectabilis, E. cordata, Dicrastylis linearifolia, Verticordia* sp., *Solanum orbiculatum*; Low shrubs (2200 *F* 1700/ha; 0.5-1.5 m) *Eremophila leucophylla, Ptilotus obovatus, Rhagodia eremaea, Chenopodium gaudichaudianum, Solanum lasiophyllum, Enchylaena tomentosa, Scaevola tomentosa, Sida* aff. *virgata*; Perennial grasses (scarce, often absent): *Eragrostis lanipes, Monachather paradoxa*; (ii) PCF 20 to 25%; Trees (50-900/ha; 4-8 m): *Acacia anastema, Eucalyptus dichromophloia*; Tall shrubs (75-400/ha; 2-4 m): *A. ramulosa, Stylobasium spathulatum, A. murrayana, Santalum spicatum*; Low shrubs (400-7500/ha; 0.5-2 m): *Eremophila leucophylla, Triumfetta chaetocarpa, Ptilotus schwartzii, Verticordia forrestii, Eremophila latrobei*; Perennial grasses: *Eragrostis lanipes, Monachather paradoxa*;	Pasture type: *Acacia Sandplain*. Tall shrublands (i) show marked successional trends after burning: *A. ramulosa* dominance lost to *Gyrostemon ramulosus* and *Codonocarpus cotinifolius* in early years, after which variable seral shrublands are dominated by *A. sclerosperma* and *Ptilotus obovatus* or *Grevillea* spp or *A. murrayana*. 10-60 years after burning sites in good condition often show increased *Ptilotus obovatus, Maireana planifolia, Solanum lasiophyllum* and *Dicrastylis linearifolia* but lack *Eremophila* spp. The low woodlands of *A. anastema* occur mainly on higher parts of undulating sandplains between Winderie and Woodleigh stations. Desirable perennials include: *Maireana planifolia, Cassia chatelainiana, Eremophila latrobei, E. leucophylla, Monachather paradoxa, Eragrostis lanipes*. Undesirable perennials include: *Solanum orbiculatum, Stylobasium spathulatum, Eremophila maitlandii*. Pastoral use limitations: Inadequate groundwater supplies in south; sparseness of understorey species in denser *A. ramulosa* stands.
	Unit 3 Drainage foci (< 1%)	
Small to medium-size (1 km) depressions; soils are probably red gradational loams.	Moderately dense shrublands dominated by *A. ramulosa, A. tetragonophylla* or *Melaleuca uncinata*; exceptionally *A. xiphophylla - Atriplex bunburyana*.	Not a generally distributed unit

Snakewood land system 827 km² (1.1% of survey area)



Plains with red duplex soils supporting tall shrublands of snakewood with an understorey of silver saltbush.

Geology: Quaternary sandplain deposits and minor outcrops of Tertiary calcrete.

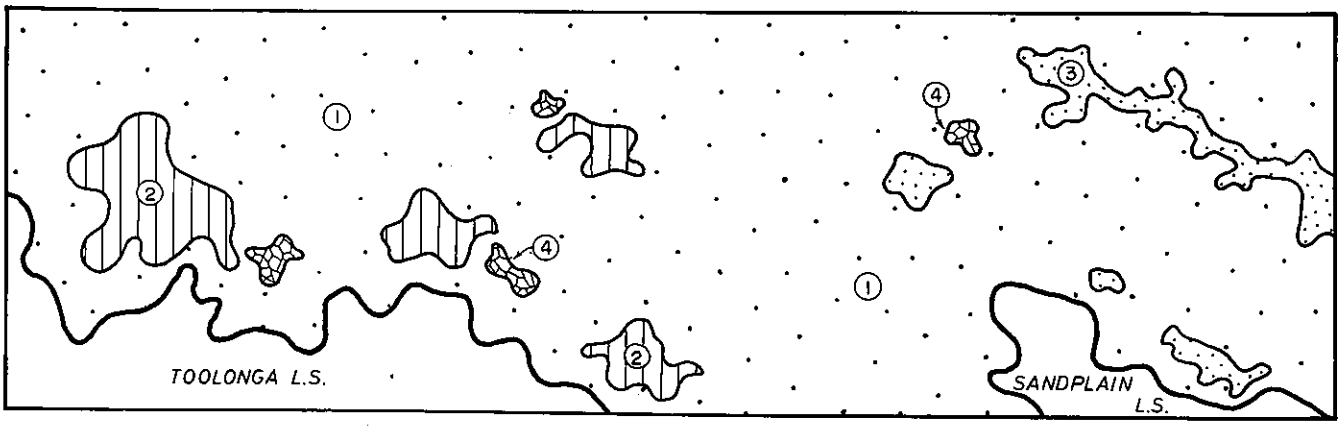
Geomorphology: Erosional and depositional surfaces: flat plains with sandy surfaces and minor calcrete plains; no drainage features.

Pastoral use: A highly productive Saltbush (SALT) pasture system which supports a variety of other palatable shrubs when in good condition. When degraded, saltbush is replaced by *Maireana lanosa*, cottonbush and tomato bush; snakewood alliances may be replaced by other acacias after fires. Major unit 4 is slightly susceptible to erosion.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: good 20%; fair 21%; poor 59%.

Unit
1. Limestone plains
2. Sandy banks and sand sheets
3. Plains with gradational soils
4. Plains with duplex soils



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Limestone plains (3%) Traversed	
Undulating stony plains with outcrops of calcrete and limestone, strewn with limestone pebbles or cobbles, relief up to 5 m. Soils are shallow gradational types with calcareous inclusions.	Scattered to moderately dense tall shrublands dominated by *Acacia drepanophylla, A. grasbyi* and *A. tetragonophylla* with *Ptilotus obovatus* pre-eminent in the understorey shrubs.	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Cassia chatelainiana, Eremophila latrobei, Atriplex bunburyana.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Sandy banks and sand sheets (5%) Traversed	
Flat to slightly undulating sand sheets and low banks. Soils are red sands, mostly > 1 m deep; principal profile form : probably Uc 5.11.	Moderately close tall shrublands dominated by *Acacia ramulosa*, locally succeeded after fire by shrublands dominated by *A. sclerosperma, Grevillea stenobotrya* and *Ptilotus obovatus.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana planifolia, Cassia chatelainiana.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Plains with gradational soils (12%) 1 site inventory and traversed	
Flat plains with gradational soils overlying limestone and very lightly strewn with calcrete gravels. Soils are reddish-brown gradational types, sandy clay loam to fine sandy clay, > 1 m deep with calcrete inclusions and carbonate concretions, pH 8.5 with an alkaline trend; principal profile form : Gc 2.12.	Moderately close shrublands dominated by *A. grasbyi* and *Ptilotus obovatus.* Tall shrubs (2-3 m): *A. grasbyi, A. tetragonophylla, A. sclerosperma, A. galeata*; Low shrubs (< 1.5 m): *Ptilotus obovatus, Chenopodium gaudichaudianum, Enchylaena tomentosa, Rhagodia eremaea, P. divaricatus, Solanum lasiophyllum*; Perennial grasses: *Stipa elegantissima.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Enchylaena tomentosa, Lepidium* sp. Pastoral use limitations: None under controlled stocking.
	Unit 4 Plains with duplex soils (80%) 6 site inventories and traversed	
Flat plains with a moundy surface; slopes usually < 0.5%, lightly strewn with calcrete gravels. Soils are red or dark red duplex, sand to sandy loam over sandy clay loam to sandy clay, with carbonate concretions in B horizon at least, > 1 m deep, pH 7.0-9.0 with an alkaline trend; principal profile forms : Dr 1.13, locally Gc 1.12.	Moderately close to close tall shrublands dominated by *Acacia xiphophylla* and *Atriplex bunburyana.* Trees (2-4 m; < 25/ha): *Heterodendrum oleaefolium, Eremophila oldfieldii, Santalum lanceolatum*; Tall shrubs (2-4 m; 50-700/ha): *A. xiphophylla, A. galeata, A. sclerosperma, A. tetragonophylla, A. victoriae, A. grasbyi*; Low shrubs (< 1 m; 500-9000/ha): *Atriplex bunburyana, Ptilotus obovatus, Enchylaena tomentosa, Maireana lanosa, Rhagodia eremaea, Scaevola spinescens*; Perennial grasses: *Stipa elegantissima.*	Pasture type: *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Enchylaena tomentosa, Acacia xiphophylla.* Undesirable perennials include: *A. victoriae, Maireana lanosa, Solanum orbiculatum.* Pastoral use limitations: Slight susceptibility to erosion when degraded.

Spot land system 634 km² (0.9% of survey area)

Alluvial plains with low, reticulate sandy banks and rises, supporting tall acacia shrublands with numerous low shrubs and some hard spinifex.

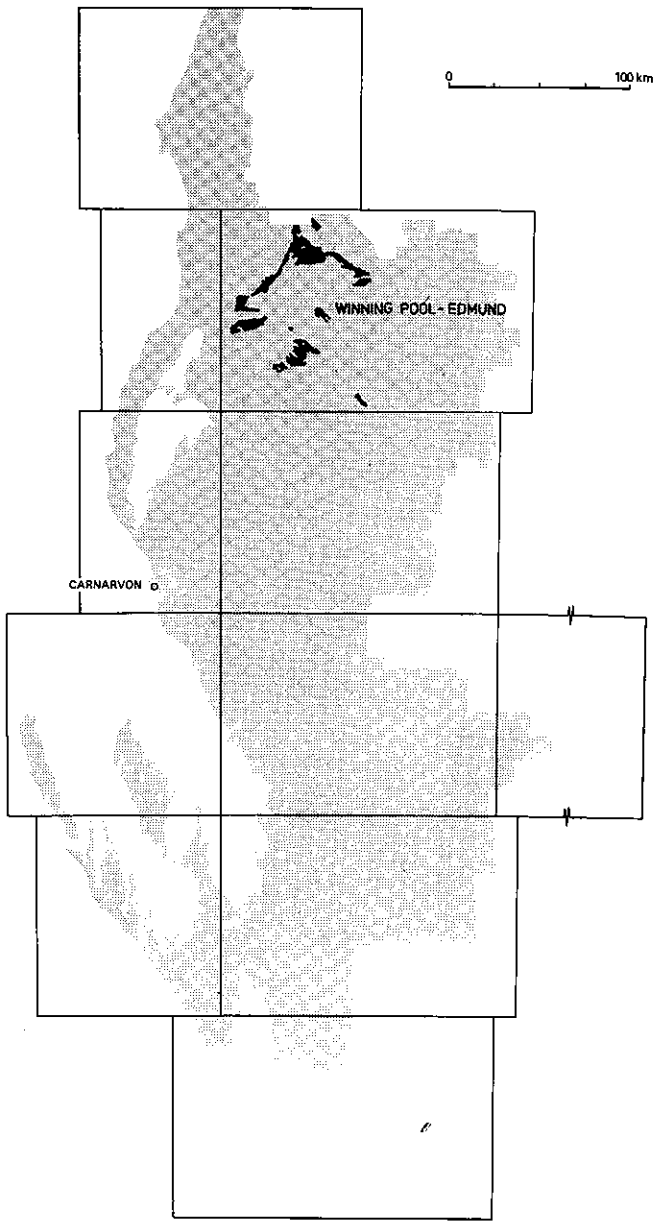
Geology: Quaternary alluvial, colluvial and aeolian deposits of clay, silt, sand and gravel.

Geomorphology: Depositional surfaces: almost flat plains with numerous fine networks of aeolian sandy rises and banks over the alluvial deposits; drainage mainly internal; relief up to 2 m.

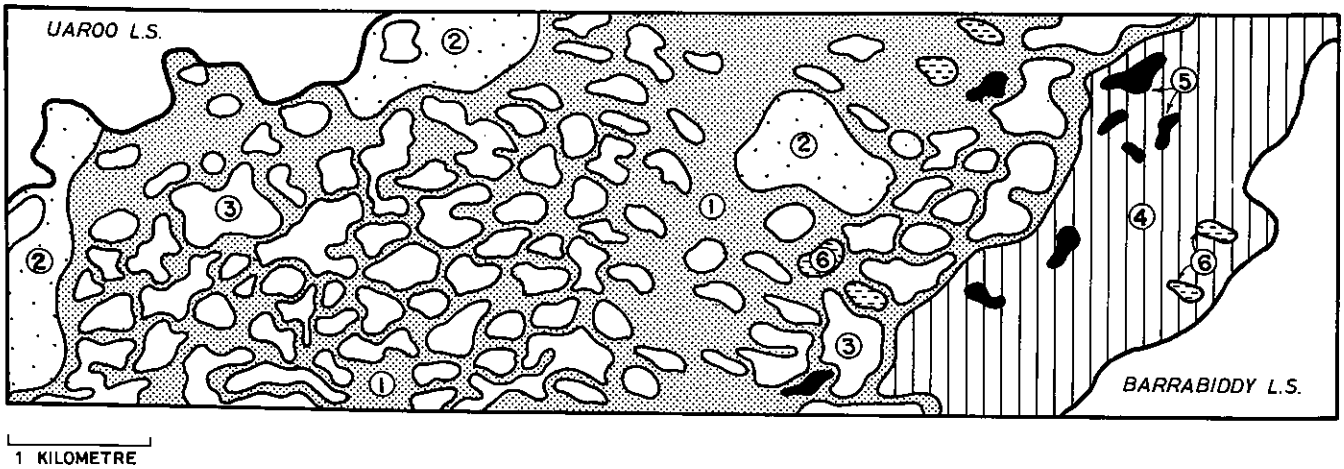
Pastoral use: A productive alluvial system supporting Currant Bush Mixed Shrub (CBMS) and Bluebush (BLUE) pastures where it remains in good condition; otherwise shows widely degraded tall shrub associations over its major alluvial units; the sandy units 1 and 2 possess fewer drought resistant forage shrubs but exhibit good seasonal responses to rainfall; unit 4 is susceptible to erosion when degraded.

Estimated carrying capacity, good condition: 6 ha/s.u.

Range condition summary: good 35%; fair 32%; poor 33%.

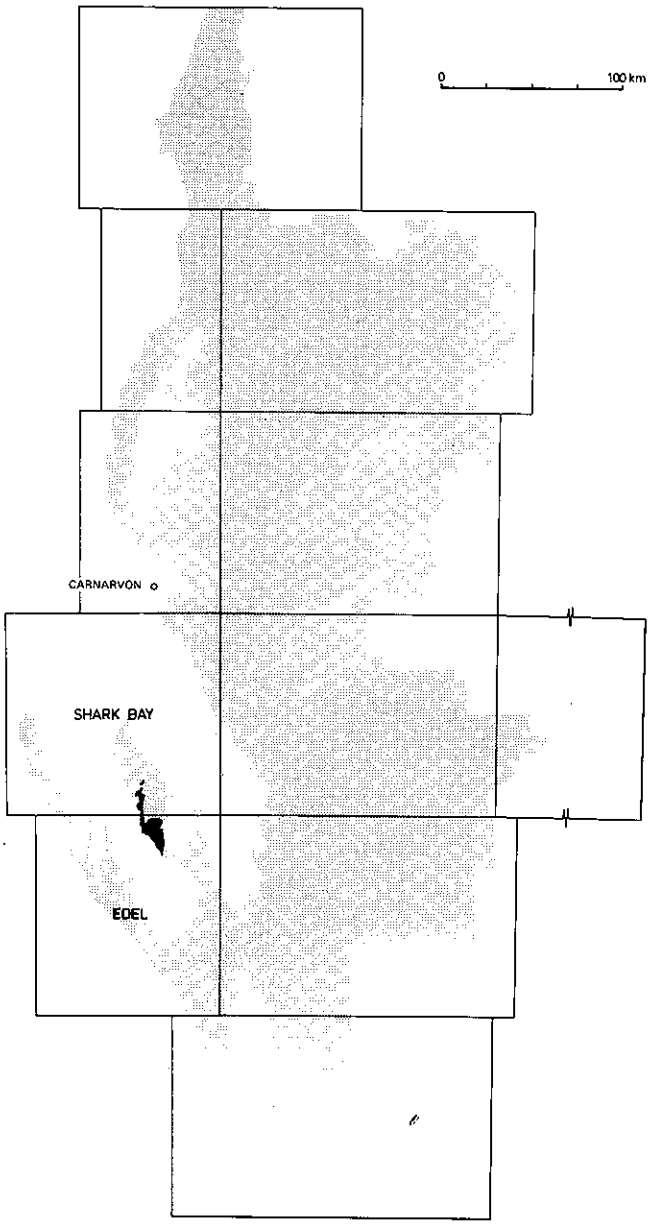


Unit
1. Sandy banks
2. Restricted sandplains
3. Interbank plains
4. Alluvial plains
5. Drainage foci
6. Claypans



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Sandy banks (20%) 1 site inventory and traversed	
Narrow sandy banks and rises, mostly in reticulate arrangement up to 2 m above unit 5. Soils are dark red sands or sandy loams, grading to light sandy clay loam, > 1 m deep, pH 6.5 with a neutral trend; principal profile form: Uc 5.21.	Moderately close tall shrublands dominated by *Acacia sclerosperma*. Trees (2-4 m): *Heterodendrum oleaefolium*; Tall shrubs (3-4 m): *Acacia sclerosperma, A. victoriae, A. tetragonophylla*; Low shrubs (< 2 m): *Corchorus walcottii, Eremophila leucophylla, Rhagodia eremaea, Cassia desolata, Enchylaena tomentosa, Ptilotus obovatus*; Perennial grasses: *Eriachne helmsii, Cenchrus ciliaris, Aristida browniana, Triodia* sp.	Pasture type: *Acacia Sandplain/Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Indicators of good condition: *Enchylaena tomentosa, Rhagodia eremaea.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Restricted sandplains (5%) Traversed	
Flat-surfaced plains; soils are probably full-depth sands.	Hummock grasslands dominated by *Triodia* spp. Tall shrubs: *Acacia sclerosperma, A. subtessarogona*; Low shrubs: *Cassia oligophylla, Maireana planifolia, Eremophila leucophylla, E. cuneifolia*; Perennial grasses: *Triodia* spp, *Eragrostis eriopoda, Chrysopogon fallax.*	Pasture type: *Hard Spinifex.* Desirable perennials include: *Eragrostis eriopoda, Maireana planifolia.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Interbank plains (50%) Traversed	
Flat to gently sloping plains and restricted plains bordered by unit 1. Soils are probably dark red duplex types.	Tall shrublands dominated by *Acacia xiphopylla.* Tall shrubs: *A. xiphophylla, A. victoriae*; Low shrubs: *Cassia* spp, *Ptilotus obovatus, Scaevola spinescens, Solanum lasiophyllum, Rhagodia eremaea.*	Pasture type: *Currant Bush Mixed Shrub.* Some areas probably formerly supported saltbush or *Bluebush* associations. Desirable perennials include: *Scaevola spinescens, Maireana polypterygia, Rhagodia eremaea.* Undesirable perennials include: *A. victoriae, Cassia* spp. Pastoral use limitations: Pastures generally degraded; mild susceptibility to erosion by water and wind.
	Unit 4 Alluvial plains (20%) 1 site inventory and traversed	
Flat to gently sloping plains receiving sluggish sheet flow. Soils are dark red duplex, loamy sand over sandy clay, pH 6.5 with an alkaline trend; principal profile form: Dr 1.13.	Moderately close to close tall shrublands dominated by *Acacia xiphopylla.* Tall shrubs (2-4 m): *A. xiphopylla, Stylobasium spathulatum*; Low shrubs (0.5-1 m): *Cassia desolata, Maireana polypterygia, M. planifolia, Ptilotus polakii, P. obovatus, Eremophila cuneifolia, Rhagodia eremaea.*	Pasture type: *Bluebush.* Desirable perennials include: *Maireana polypterygia, Ptilotus polakii, Atriplex bunburyana.* Undesirable perennials include: *Cassia* spp, *Acacia victoriae.* Pastoral use limitations: Moderate susceptibility to erosion by wind and water when degraded.
	Unit 5 Drainage foci (3%)	
Irregularly-shaped discrete foci with flat surfaces and clay soils.	Close tall shrublands dominated by *Acacia* spp with understorey perennial grasses *Eulalia fulva* and *Eriachne benthamii*	Pasture type: *Acacia Creek-line.* Pastoral use limitations: None under controlled stocking.
	Unit 6 Claypans (2%)	
Small claypans.	Mainly unvegetated.	

Taillefer land system 190 km² (0.3% of survey area)



Plains of calcareous sand, minor limestone ridges, low coastal dunes and sea cliffs; Hard Spinifex (HASP) hummock grasslands with numerous shrubs; a minor land system confined to southern parts of the Peron Peninsula.

Geology: Quaternary sandplain and beach dune deposits with minor outcrops of Tamala limestone.

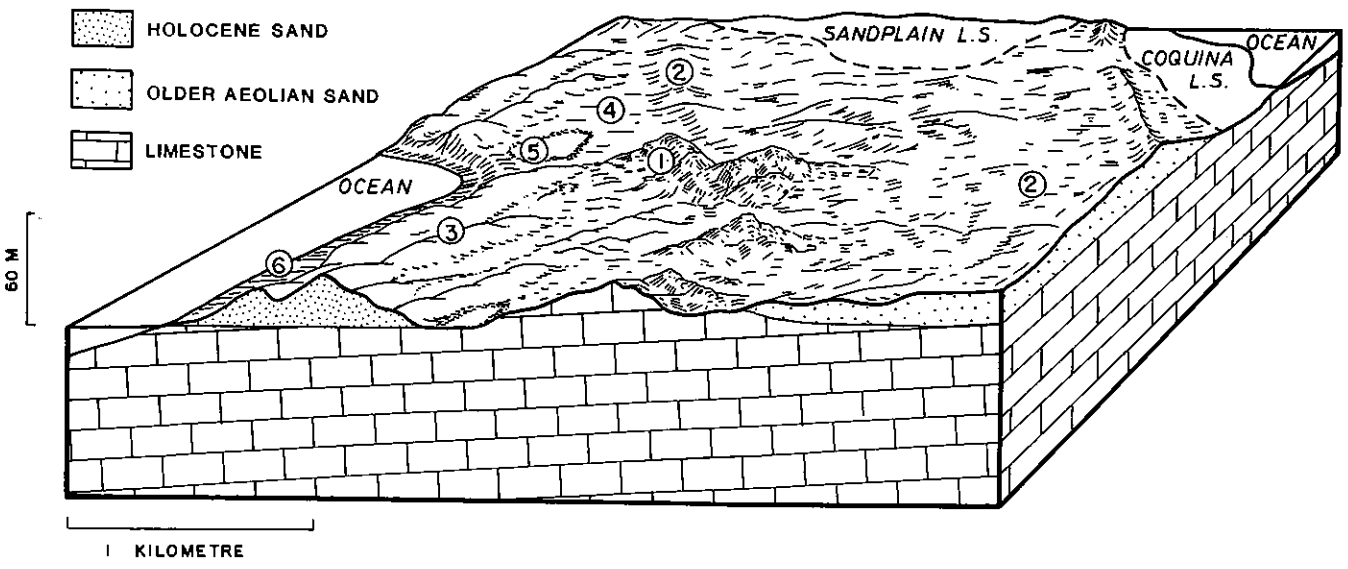
Geomorphology: Mostly depositional surfaces: undulating coastal sand plains with isolated rocky ridges; low longitudinal dunes near the ocean; occasional birridas; depositional surfaces otherwise lacking in drainage features.

Pastoral use: Hard Spinifex pastures with unusually high densities of palatable browse shrubs when in good condition, minor areas of Saltbush (SALT) and Coastal Dune Shrub (CDSH) pastures. Fire-affected areas which have lost most of their ground cover are erosion-prone and in need of stabilization. Established exotic pasture plants e.g. buffel grass and burr-medics *Medicago* spp. are useful short-term stabilizers.

Estimated carrying capacity, good condition: 11 ha/s.u.

Range condition summary: good 17%; fair 43%; poor 40%.

Unit
1. Limestone ridges
2. Plains of calcareous sand
3. Coastal dunes
4. Low plains
5. Birridas
6. Beaches



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Limestone ridges (7%) 1 site inventory and traversed	
Rocky ridges and outcrops, relief up to 60 m; slopes very variable, mostly densely strewn with limestone pebbles or cobbles. Soils are < 50 cm deep, reddish-brown loamy sand with limestone inclusions, pH 8.5 with an alkaline trend; principal profile form: Uc 1.13.	Hummock grasslands dominated by *Triodia plurinervata* and clumps of low shrubs. Low shrubs: *Templetonia* sp., *Scaevola spinescens, Pimelea microcephala, Solanum orbiculatum, Scaevola tomentosa, Acacia tetragonophylla*; Perennial grasses: *Triodia plurinervata.*	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Enchylaena tomentosa, Scaevola* spp. Pastoral use limitations: None under controlled stocking.
	Unit 2 Plains of calcareous sand (80%) 4 site inventories and traversed	
Flat to undulating plains, relief up to 55 m above unit 6. Soils are reddish-brown to yellowish red sand or loamy sands, > 1 m deep, lightly strewn with calcrete gravels and with limestone inclusions throughout, pH 8.5 with an alkaline trend; principal profile form : Uc 5.12.	Hummock grasslands dominated by *Triodia plurinervata* mixed with low perennial herbs and shrubs. Low shrubs (800-11,000/ha; < 0.5 m): *Ptilotus obovatus, Pimelea microcephala, Mirbelia* spp., *Rhagodia latifolia, Ptilotus divaricatus, Acacia ligulata, Acanthocarpus preissii, Enchylaena tomentosa, Stylobasium spathulatum.* Perennial grasses: *Triodia plurinervata* (1-50% cover), *Cenchrus ciliaris, Stipa elegantissima, Eragrostis eriopoda.*	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Ptilotus obovatus, Enchylaena tomentosa.* Pastoral use limitations: Moderately susceptible to wind erosion when degraded; after fire, losses of hummock grass and shrubs increase the erosion risk.
	Unit 3 Coastal dunes (8%) 1 site inventory and traversed	
Low dunes, mostly short-walled and parabolic. Soils are reddish-yellow sand, > 1 m deep with shell fragments, pH 8.5 with an alkaline trend; principal profile form: Uc 1.12.	Hummock grasslands dominated by *Spinifex longifolius* and *Acacia* spp. Tall shrubs: *Acacia tetragonophylla, A. ligulata, Exocarpos aphyllus, Alyogyne* sp. Low shrubs: *Solanum orbiculatum, Pimelea microcephala, Scaevola tomentosa.* Perennial grasses: *Spinifex longifolius, Triodia plurinervata.*	Pasture type: *Hard Spinifex/Coastal Dune Shrub.* Pastoral use limitations: Moderately susceptible to wind erosion when degraded.
	Unit 4 Low plains (3%) 1 site inventory and traversed	
Low-lying plains, slopes < 3% and with moundy surfaces. Soils are red sand or loamy sand, > 1 m deep with limestone inclusions throughout, pH 8.5 with an alkaline trend; principal profile form: Uc 5.12.	Scattered low shrublands dominated by *Atriplex bunburyana* and *Ptilotus obovatus.* Low shrubs: *A. bunburyana, P. obovatus, Solanum* aff. *esuriale, S. orbiculatum, Stylobasium spathulatum, Acanthocarpus preissii.* Perennial grasses: *Stipa elegantissima, Stipa* sp.	Pasture type: *Saltbush.* Desirable perennials include: *Atriplex bunburyana, Ptilotus obovatus.* Undesirable perennials include: *Solanum* spp. Pastoral use limitations: Moderately susceptible to wind erosion when degraded.
	Unit 5 Birridas (1%) Traversed	
Elliptical or rounded depressions < 500 m long, with nearly flat surfaces; soils are highly gypsiferous juvenile types.	Low halophytic shrublands dominated by *Halosarcia* spp.	Pasture type: *Samphire.* Pastoral use limitations: High salinity levels of pasture plants.

Tamala land system 136 km² (0.2% of survey area)

Plains with a thin covering of sand over limestone, interspersed with stony rises; former saltbush and acacia shrublands, widely degraded and now replaced by winter pastures of exotic annuals.

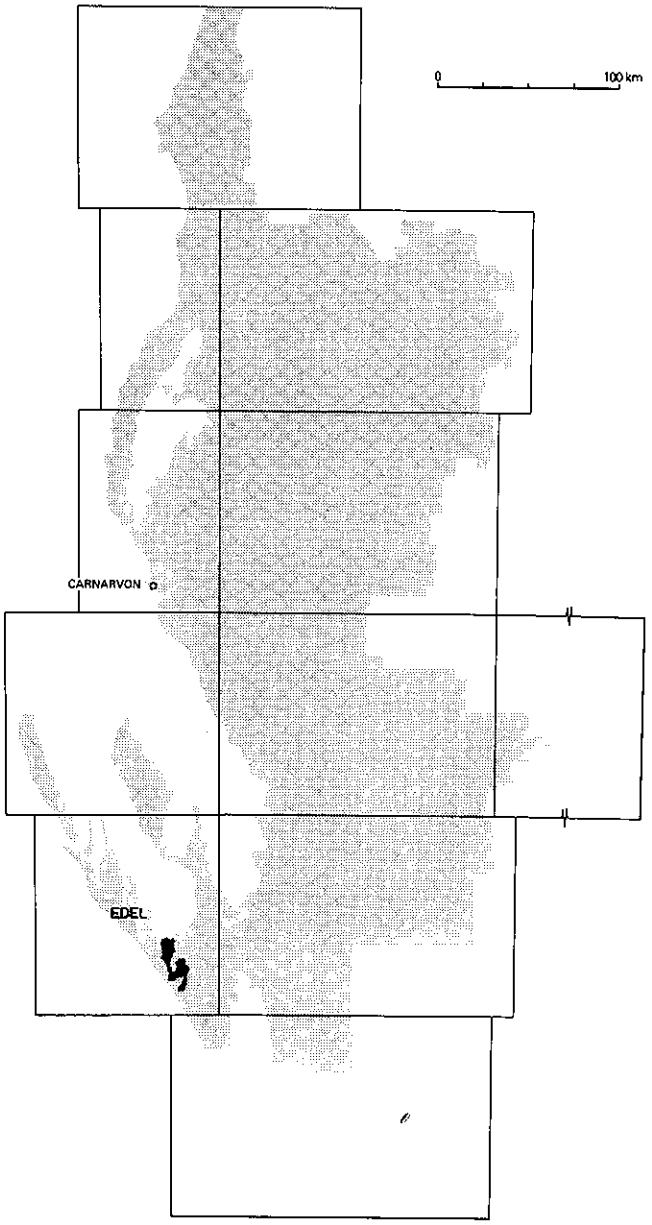
Geology: Quaternary Tamala limestone.

Geomorphology: Boulder-strewn limestone plains and rises interspersed with sandy-surfaced plains and sand sheets; currently much local redistribution of topsoil material through wind erosion; no drainage features.

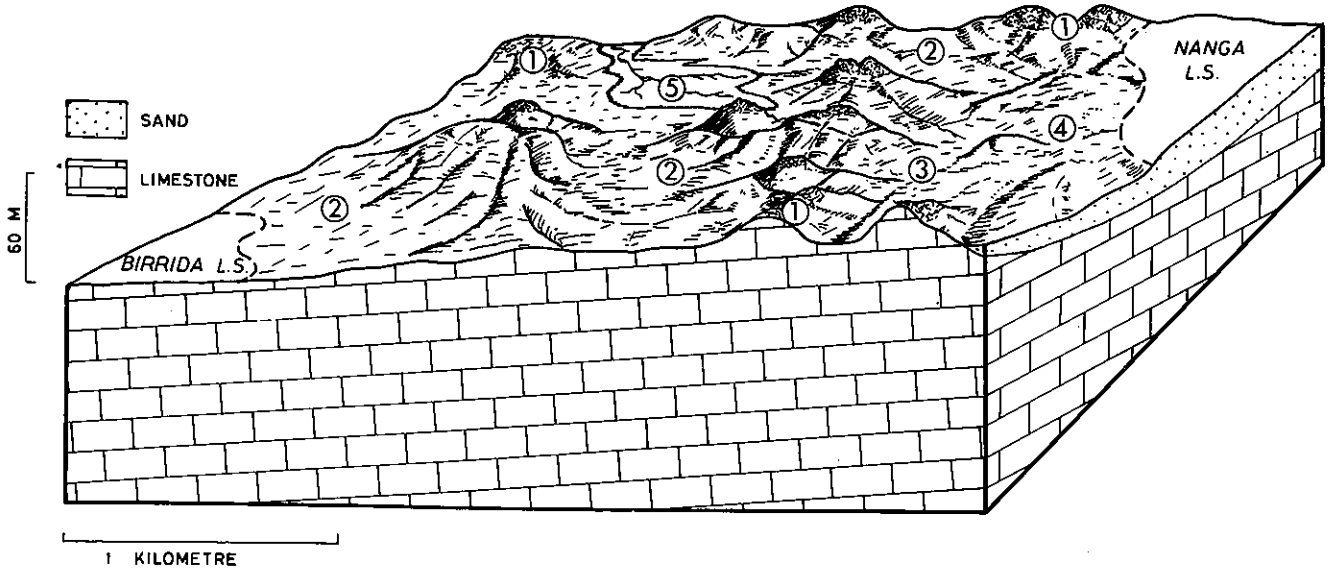
Pastoral use: Former Saltbush (SALT) and Acacia Mixed Shrub (ACMS) pastures have been widely degraded by stock and feral animals. In an area receiving reliable winter rainfall, exotic annuals (burr-medics, grasses and others) have become widespread and provide a buffer against further erosion of the shallow soils. Under favourable seasonal conditions such pastures have produced 700-1000 kg available biomass/ha.year.

Estimated carrying capacity, good condition, 3 ha/s.u.

Range condition summary: good 13%; fair 30%; poor 57%.



Unit
1. Limestone rises
2. Sandy-surfaced plains
3. Limestone plains
4. Sheets of calcareous sand
5. Restricted saline plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Limestone rises (30%) 3 site inventories and traversed	
Rounded rises, mostly 10-40 m above surrounding plains, slopes 3-6%, lightly to heavily strewn with limestone cobbles and boulders. Soils are shallow reddish-brown, reddish-yellow or grey loams, with or without windblown surface deposits of sand, calcareous throughout the 15-20 cm depth, pH 8.0-8.5 with an alkaline trend; principal profile forms: Um 6.21, 6.24; Dd 3.13 formed locally by accretion of windblown material.	Very scattered to moderately close shrublands, often degraded, dominated by *Acacia tetragonophylla, Heterodendrum oleaefolium* and exotic annuals. Tall shrubs (2-3 m, < 350/ha): *A. tetragonophylla, H. oleaefolium, Melaleuca cardiophylla, Exocarpos aphyllus*; Low shrubs (< 1.5 m; 150-3,000/ha): *Acanthocarpus preissii, Threlkeldia diffusa, Rhagodia preissii, R. eremaea, Enchylaena tomentosa, Ptilotus divaricatus*; Perennial grasses: *Stipa elegantissima, S.* aff. *crinata.*	Pasture type: *Exotic Annual/Acacia Mixed Shrub.* Perennials heavily augmented by annuals: *Avena* aff.*barbata, Medicago polymorpha, Medicago* sp., *Brassica tournefortii, Hordeum* spp, *Emex australis, Centaurea melitensis.* Pastoral use limitaitons: None under controlled stocking.
	Unit 2 Sandy-surfaced plains (45%) 4 site inventories and traversed	
Undulating plains, slopes mainly 1-2%, lightly strewn with calcrete gravels. Soils are weak red or reddish-brown sands, > 1 m deep with limestone inclusions throughout, pH 8.5 with an alkaline trend; principal profile form: Uc 5.12.	Variable shrublands, often degraded to annual grassland medic pastures with very scattered shrubs. Trees: *Santalum lanceolatum*; Tall shrubs (2-3 m; 0-600/ha): *Acacia ligulata, A. rostellifera, Heterodendrum oleaefolium, Eremophila oldfieldii, Lycium* sp.; Low shrubs (< 2 m; 100-5,000/ha): *Solanum orbiculatum, Ptilotus obovatus, Pimelea microcephala, Acanthocarpus preissii, Enchylaena tomentosa, Rhagodia latifolia*; Climbers: *Ptilotus divaricatus, Clematis microphylla*; Perennial grasses: *Stipa elegantissima.*	Pasture type: *Exotic Annnual/Saltbush/Acacia Mixed Shrub.* Perennials often degraded and/or cleared and replaced by annuals: *Avena* aff. *barbata, Medicago minima, M. polymorpha, Brassica tournefortii, Aristida* spp, *Helipterum* spp. Pastoral use limitations: Highly productive annuals grow under a regular pattern of winter rainfall; they protect the soil surface, but when overgrazed there is a high susceptibility to wind erosion and/or invasion by *Solanum orbiculatum.*
	Unit 3 Limestone plains (10%) 1 site inventory and traversed	
Gently undulating, very stony plains, heavily strewn with limestone boulders. Soils are shallow dusky red sandy loams, pH 8.0 with a neutral trend; principal profile form:. Uc 6.11.	Scattered to moderately close tall shrublands dominated by *Acacia tetragonophylla* and *A. coriacea.* Tall shrubs (2-3 m): *A. tetragonophylla, A. coriacea*; Low shrubs (< 1 m): *Ptilotus obovatus, Solanum orbiculatum, Pimelea microcephala, Sida* aff. *calyxhymenia, Capparis* sp.	Pasture type: *Exotic Annual/Acacia Mixed Shrub.* Pastoral use limitations: Degraded areas frequently subject to invasion by *Solanum orbiculatum.*
	Unit 4 Sheets of calcareous sand (10%) 2 site inventories and traversed	
Undulating plains of calcareous sand, slopes up to 3%. Soils are reddish-brown sands, yellower with depth, > 1 m deep with limestone inclusions throughout, pH 8.5 with an alkaline trend; principal profile form: Uc 5.12.	Scattered to moderately close tall shrublands dominated by *Acacia ligulata.* Tall shrubs (2-5 m; 50-650/ha): *A. ligulata, A. galeata*; Low shrubs (< 1 m; 200-15,000/ha): *Acanthocarpus preissii, Threlkeldia diffusa, Ptilotus obovatus, Enchylaena tomentosa, Ptilotus divaricatus, Rhagodia preissii.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs. Indicators of good condition: *Maireana tomentosa, Enchylaena tomentosa.* Pastoral use limitations: Moderate susceptibility to wind erosion when degraded.
	Unit 5 Restricted saline plains (5%) Traversed	
Flat or moundy plains with saline and/or gypsiferous soils.	Very scattered to scattered low shrublands dominated by halophytes: *Halosarcia* spp, *Frankenia* spp, *Atriplex bunburyana, A. vesicaria.*	Pasture type: *Samphire.* Pastoral use limitations: High salinity levels in pasture plants.

Tarcumba land system 183 km² (0.25% of survey area)

Flat plains with shallow, calcareous, sandy-surfaced soils overlying calcrete; vegetation is dominated by tall acacia shrublands.

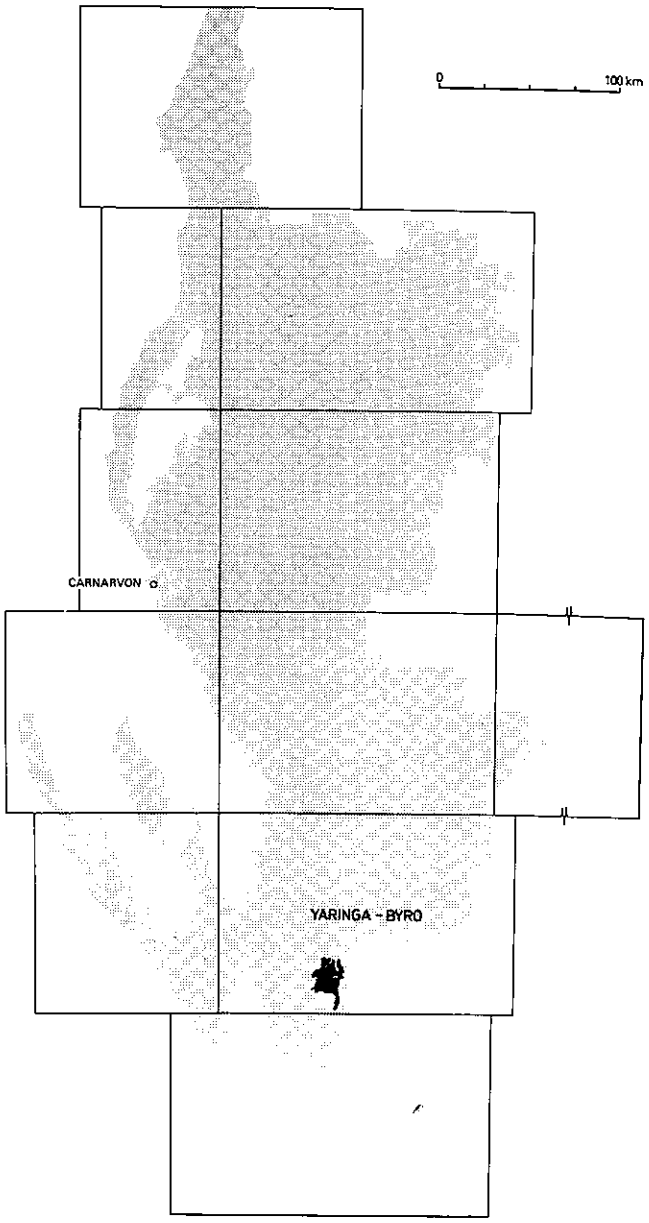
Geology: Quaternary colluvium: poorly sorted clay, silt, sand and gravel deposited by sheet flooding; minor aeolian sand.

Geomorphology: Depositional surfaces of low plains and broad drainage tracts fringing the Carbla plateau and continuing to the south as the York land system; subject to sheet flow without incised drainage.

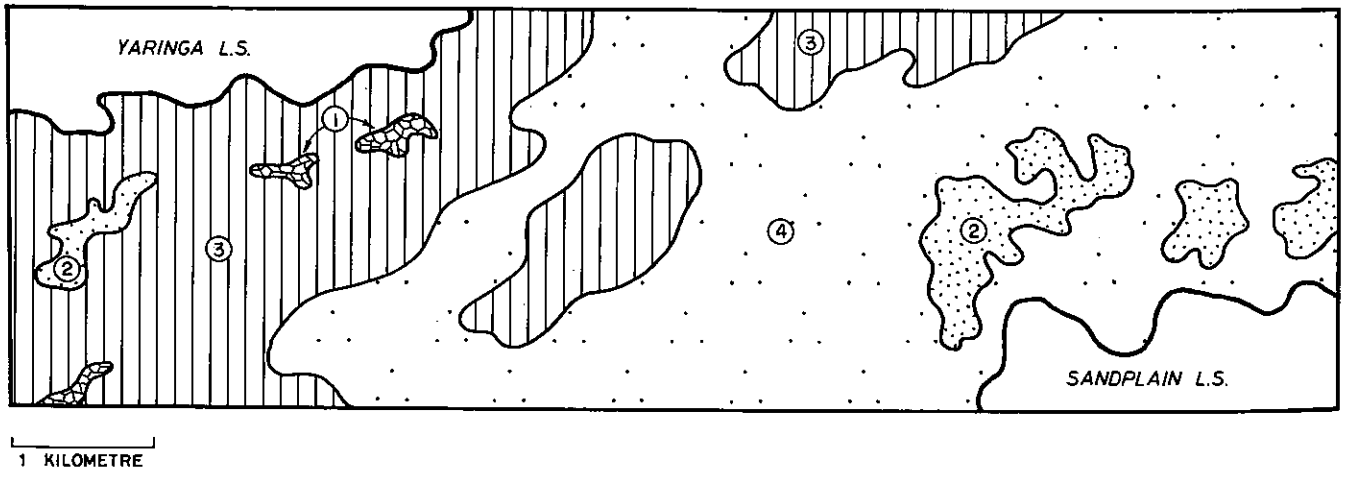
Pastoral use: Acacia Mixed Shrub (ACMS) pastures with a wide range of palatable and drought-resistant shrubs when in good condition; remnants of saltbush on unit 4 suggest that cottonbush may have increased at the expense of saltbush in the low shrub layer. This is a very flat land system not prone to erosion.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: good 10%; fair 61%; poor 29%.

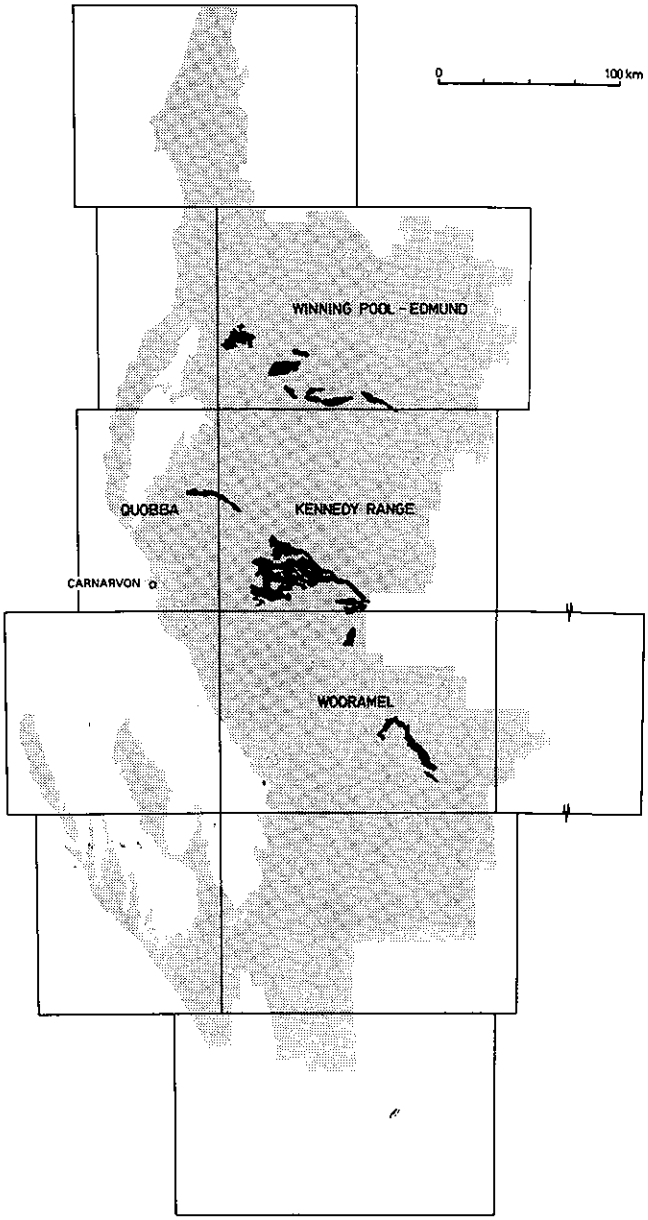


Unit
1. Limestone plains
2. Sandy plains and banks
3. Plains with shallow soil
4. Unchannelled drainage plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Limestone plains (5%) Traversed only	
Small areas of limestone plains with outcrops of low relief (< 2m) and undulating cobble-strewn surfaces. Soils are shallow calcareous gradational loams.	Scattered tall shrublands dominated by *Acacia grasbyi, A. drepanophylla* and *Ptilotus obovatus.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 2 Sandy plains and banks (10%) 1 site inventory and traversed	
Gently undulating plains and sandy banks, relief to 1m, some sparsely strewn with limestone cobbles or pebbles. Soils are dark red loamy sand, > 1 m deep, pH 6.5 with a neutral trend; principal profile form: Uc 5.21.	Scattered to moderately close tall shrublands dominated by *Acacia ramulosa.* Trees: *Santalum lanceolatum, Heterodendrum oleaefolium*; Tall shrubs: *A. ramulosa, A. sclerosperma, A. tetragonophylla, Eremophila maitlandii*; Low shrubs: *Ptilotus obovatus, Solanum lasiophyllum, Cassia chatelainiana, Sida* spp, *Solanum orbiculatum*; Perennial grasses: *Stipa elegantissima.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 3 Plains with shallow soil (40%) 2 site inventories and traversed	
Flat or slightly mounded plains with limestone at shallow depth. Soils are dark red or dusky red gradational; loamy sand to sandy clay loam, often with a very sparse mantle of calcrete gravel, pebbles or cobbles, about 1 m deep, pH 7.0-7.5 with a neutral trend; principal profile form: Gn 3.12.	Moderately close tall shrublands dominated by *Acacia grasbyi, A. tetragonophylla* and *Ptilotus obovatus.* Trees (scarce): *Eremophila oldfieldii, Santalum lanceolatum*; Tall shrubs (400/ha; 2-4 m): *Acacia grasbyi, A. tetragonophylla, A. ramulosa, Heterodendrum oleaefolium, Eremophila maitlandii, Cassia chatelainiana*; Low shrubs (4500-5000/ha; < 1.5m); *Ptilotus obovatus, P. schwartzii, Solanum lasiophyllum, Rhagodia eremaea, Sida calyxhymenia, Enchylaena tomentosa.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Sida calyxhymenia, Cassia chatelainiana, Enchylaena tomentosa.* Pastoral use limitaitons: None under controlled stocking.
	Unit 4 Unchannelled drainage plains (45%) 2 site inventories and traversed	
Plains with slightly mounded surfaces, slopes < 0.5%. Soils are red calcareous loams or sandy clays, > 1 m deep with calcareous inclusions throughout the profile, pH 8.0-8.5 with an alkaline trend; principal profile forms: Uc 5.22, Gc 2.22.	Scattered to moderately close tall shrublands dominated by *Acacia galeata.* Trees (0-150/ha; 2-6m): *Acacia galeata, Santalum lanceolatum, Heterodendrum oleaefolium*; Tall shrubs (200-300/ha; 2-4 m): *A. galeata, A. sclerosperma, A. tetragonophylla, Eremophila oldfieldii, A. ramulosa, Hakea preissii*; Low shrubs (4000-10,000/ha; < 1.5 m): *Ptilotus obovatus, Cassia chatelainiana, Enchylaena tomentosa, Chenopodium gaudichaudiana, Pimelea microcephala, Sida* spp; Perennial grasses: *Stipa elegantissima.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Maireana* spp, *Cassia chatelainiana, Enchylaena tomentosa.* Pastoral use limitations: None under controlled stocking.

Target land system 1235 km² (1.7% of survey area)



Gently sloping plains with sandy banks and narrow interbank plains; tall acacia shrublands.

Geology: Quaternary deposits: alluvial and aeolian clay, silt, sand and gravel.

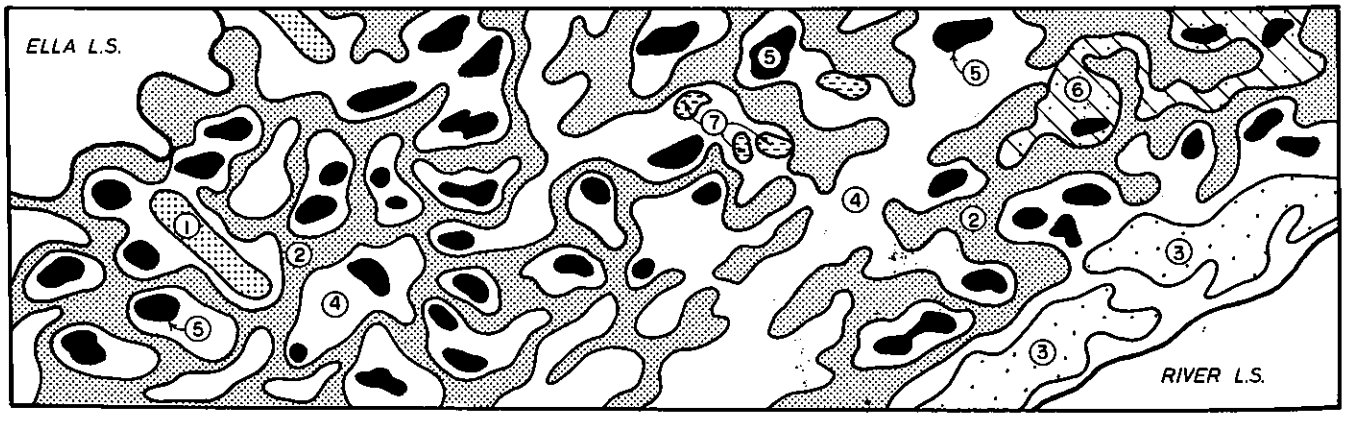
Geomorphology: Depositional surfaces of low plains composed of a mosaic of sandy banks, interbank plains with clay subsoils and numerous small discrete drainage foci; relief up to 10 m.

Pastoral use: Currant Bush Mixed Shrub (CBMS) and Acacia Sandplain (ACSA) pastures with a wide variety of palatable shrubs and sparse perennial grasses; units 4 and 6 frequently show minor erosion and are susceptible to invasion by unpalatable shrubs.

Estimated carrying capacity, good condition: 7 ha/s.u.

Range condition summary: good 23%; fair 43%; poor 34%.

Unit
1. Longitudinal dunes
2. Sandy banks
3. Sandy plains
4. Interbank plains
5. Drainage foci
6. Saline plains
7. Claypans



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal dunes (1%) Traversed	
Occasional low longitudinal dunes. Soils are loose red sand; principal profile form probably Uc 1.23.	Scattered tall shrublands dominated by *Acacia* sp.	
	Unit 2 Sandy banks (30%) 2 site inventories and traversed	
Undulating sandy banks up to 4 m above unit 4, slopes < 2%. Soils are dusky red or dark red sand to sandy loam, > 1 m deep, pH 6.5-7.5 with a neutral trend; principal profile form: Uc 5.21.	Scattered to moderately close tall shrublands dominated by *Acacia sclerosperma* and *A. ramulosa*. Trees (infrequent): *Heterodendrum oleaefolium*; Tall shrubs (200-600/ha; 2-4 m): *A. sclerosperma, A. ramulosa, A. tetragonophylla, Cassia helmsii*; Low shrubs (1700-2500/ ha; < 1.5 m): *Ptilotus obovatus, Enchylaena tomentosa, Eremophila leucophylla, Olearia axillaris, Corchorus walcottii, Maireana* spp; Perennial grasses: *Cenchrus ciliaris, Triodia* sp.	Pasture type: *Acacia Sandplain*. Perennials augmented by annual grasses and forbs in favourable seasons. Perennial grasses scarce or absent in south. Desirable perennials include: *Enchylaena tomentosa, Rhagodia eremaea*. Pastoral use limitations: None under controlled stocking.
	Unit 3 Sandy plains (10%) 3 site inventories and traversed	
Sandy plains with up to 2 m relative relief and slopes < 0.5%. Soils are dusky red or dark red sandy loams or sandy-surfaced duplex, > 1 m deep, pH 6.0-7.0 with neutral or acid trends; principal profile forms: Dr 4.12, Uc 5.21.	Scattered to close tall shrublands or hummock grasslands dominated by *Acacia* spp and *Stylobasium spathulatum*, or *Triodia basedowii*. Tall shrubs (< 25-500/ha; 2-5 m): *Acacia ramulosa, A. sclerosperma, A. tetragonophylla, A. xiphophylla, Stylobasium spathulatum*; Low shrubs (1300-4000/ha; < 2 m): *Ptilotus obovatus, Rhagodia eremaea, Eremophila leucophylla, Cassia helmsii, C. luerssenii, Corchorus walcottii*; Perennial grasses: *Triodia basedowii* (up to 40% cover), *Monachather paradoxa, Eriachne helmsii*.	Pasture type: *Acacia Sandplain* or (mainly in N) *Hard Spinifex*. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana planifolia, Eremophila leucophylla, Rhagodia eremaea*. Pastoral use limitations: None under controlled stocking.
	Unit 4 Interbank plains (40%) 8 site inventories and traversed	
Internally drained interbank plains with slopes < 2%. Soils are red or reddish brown sandy-surfaced duplex or gradational types, some with quartz or siliceous gravel inclusions, > 1 m deep, pH 6.0-7.0 with a neutral trend; principal profile forms: Dr 2.12, 1.12, 1.13, 4.12, Uc 5.21, Gn 2.12.	Very scattered to moderately close tall or mixed shrublands dominated by *Acacia* spp, *Eremophila* spp and *Cassia desolata*. PFC 5 to 30%; Tall shrubs (0-1500/ha; 2-4 m): *Acacia victoriae, A. tetragonophylla, A. xiphophylla, A. sclerosperma, Hakea preissii, Stylobasium spathulatum*; Low shrubs (500-3000/ha; < 2 m): *Ptilotus polakii, Eremophila leucophylla, E. pterocarpa, E. crenulata, Cassia* spp, *Scaevola spinescens, Rhagodia eremaea, Ptilotus obovatus*; Perennial grasses: *Cenchrus ciliaris, Eriachne helmsii, Enteropogon acicularis, Eragrostis eriopoda*.	Pasture type: *Currant Bush Mixed Shrub/ Bluebush*. Perennials augmented by annual grasses and forbs in favourable seasons. Locally, *A. xiphophylla*-dominated shrublands have been killed, probably by fires. Desirable perennials include: *Maireana* spp, *Cassia chatelainiana, Ptilotus polakii, Scaevola spinescens, Rhagodia eremaea*. Undesirable perennials include: *Eremophila crenulata, Hakea preissii, Cassia* spp. Pastoral use limitations: Degraded sites are susceptible to invasion by unpalatable shrubs.
	Unit 5 Drainage foci (15%) 4 site inventories and traversed	
Discrete drainage foci with flat to slightly concave profiles. Soils are reddish-brown or brown loams or clays, > 1 m deep, pH 6.0-7.0, some with ferruginous gravel throughout the profile;principal profile forms: Gn 3.12, 3.92, Uf 6.21, Dr 2.12.	Moderately close to close tall shrublands dominated by *Acacia tetragonophylla*. PFC 25-50%; Trees (6-8 m): *A. subtessarogona*; Tall shrubs (200-500/ha; 2-6 m): *A. tetragonophylla, A. victoriae, Scaevola spinescens, Acacia sclerosperma, A. coriacea*; Low shrubs (8000-12000/ ha;): *Ptilotus obovatus, Eremophila mackinlayi, Rhagodia eremaea, Indigofera* spp; Perennial grasses (up to 2% b.c.) *Eulalia fulva, Eriachne gardneri, E. flaccida, Enteropogon acicularis, Eriachne benthamii, Cenchrus* spp.	Pasture type: *Currant Bush Mixed Shrub*. Perennial grasses are scarce or absent in south. Desirable perennials include: *Scaevola spinescens, Rhagodia eremaea*, perennial grasses. Undesirable perennials include: *Hakea preissii*. Pastoral use limitations: Dense vegetation may restrict access to stock.
	Unit 6 Saline plains (4%) Traversed	
Interbank plains with saline soils and external drainage. Soils are probably red duplex types.	Scattered shrublands dominated by *Atriplex bunburyana, Frankenia* spp and *Ptilotus polakii*.	Pasture type: *Saltbush*. Degraded sites are susceptible to shrub invasion by *Hakea preissii, Acacia victoriae, A. cuspidifolia* and *Eremophila* spp.
	Unit 7 Claypans (< 1%) Traversed	
Small shallow claypans mostly < 500 m long.	No perennial vegetation.	

Thomas land system (G) 146 km² (0.2% of survey area)

Lateritized mesas, low hills and stony plains of granite and gneiss supporting scattered tall acacia shrublands.

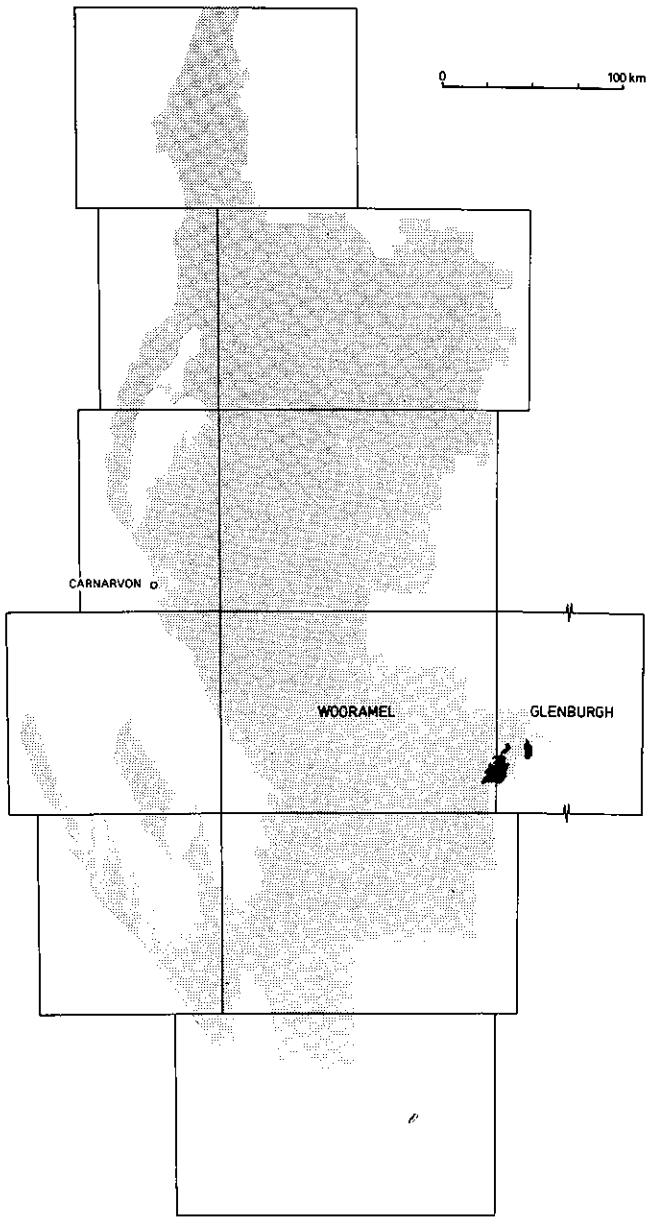
Geology: Lower Proterozoic quartzite, gneiss and granite frequently capped with Tertiary duricrust.

Geomorphology: Mainly erosional surfaces: lateritised breakaways, quartzite-based mesas and residuals, low rounded hills and unweathered summits above stony plains and small alluvial fans; drainage dendritic, mostly incised and of moderate density; relief up to 35 m.

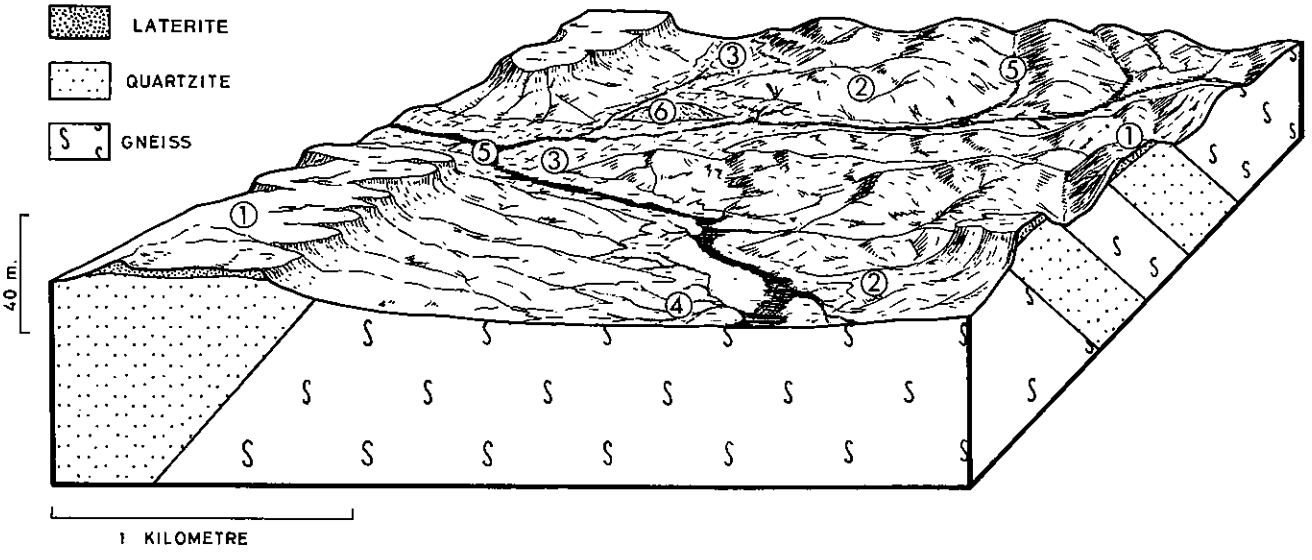
Pastoral use: Acacia Short Grass Forb (ASGF) and Stony Chenopod (STCH) pastures, moderately productive in good seasons when ephemeral herbs and grasses provide useful feed. In dry seasons, very scattered palatable shrubs provide limited forage reserves. Unit 4 is vulnerable to gullying and surface sealing where shrubs have been lost.

Estimated carrying capacity, good condition: 25 ha/s.u.

Range condition summary: Good 59%; fair 35%; poor 6%.

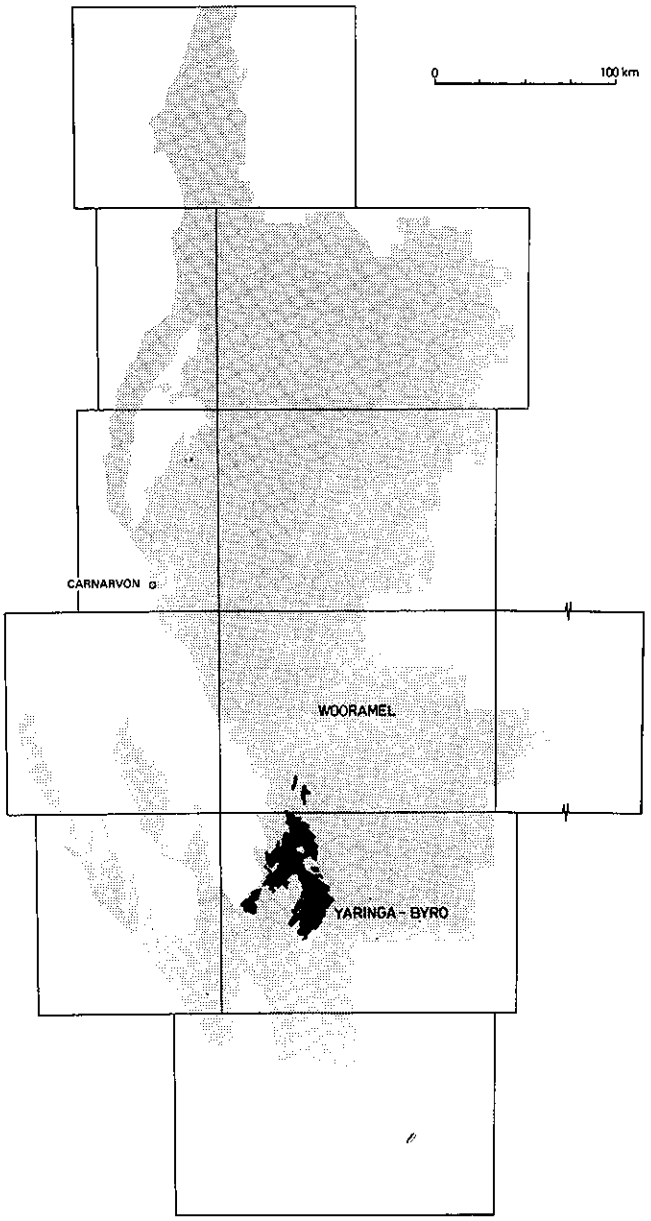


Unit
1. Hilltops, breakaways and mesas
2. Slopes and interfluves
3. Lower plains
4. Alluvial fans and floors
5. Drainage lines
6. Sandy banks



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Flat to gently sloping hill tops, deeply weathered with lateritised, stripped or boulder-strewn surfaces. Soils are confined to pockets of red sandy loam, < 50 cm deep with quartz inclusions; principal profile form: Uc 1.43	**Unit 1 Hilltops, breakaways and mesas (25%) 1 site inventory and traversed** Very scattered to moderately close tall shrublands dominated by *Acacia aneura*. Low trees and tall shrubs: *A. aneura, A. pruinocarpa, A. tetragonophylla*. Low shrubs: *Ptilotus schwartzii, Eremophila latrobei, Maireana georgei, M. planifolia*.	Pasture type: Stony Chenopod. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp, *Eremophila latrobei*. Pastoral use limitations: None under controlled stocking.
Crests, slopes and interfluvial plains, mostly sloping 1-4%, moderately to densely strewn with quartzite cobbles or pebbles. Soils are reddish-brown loamy types, fine sandy loam grading to sandy clay loam, < 50 cm deep, pH 7.5 with a neutral trend; principal profile form: Gn 3.12	**Unit 2 Slopes and interfluves (45%) 1 site inventory and traversed** Scattered to moderately close tall shrublands dominated by *Acacia aneura* and *A. ligulata*. Tall shrubs: *A. aneura, A. ligulata, A. xiphophylla, A. tetragonophylla, A. victoriae*; Low shrubs: *Ptilotus obovatus, Eremophila fraseri, E. freelingii, Maireana triptera, M. melanocoma, Rhagodia eremaea*.	Pasture type: *Stony Chenopod*. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp. Pastoral use limitations: None under controlled stocking.
Gently sloping plains, moderately to densely strewn with cobbles or pebbles. Soils are shallow loamy types.	**Unit 3 Lower plains (15%) Traversed** Scattered tall shrublands dominated by *Acacia aneura*, with low shrubs including *Maireana triptera* and *Halosarcia* spp.	Pasture type: *Stony Chenopod*. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana triptera, Halosarcia* spp. Pastoral use limitations: None under controlled stocking.
Small alluvial fans and drainage floors immediately below slopes (unit 2). Soils are reddish-brown duplex type, with surface mantles of gravel or pebbles.	**Unit 4 Alluvial fans and floors (10%) Traversed** Very scattered to scattered tall shrublands dominated by *Acacia xiphophylla* and *Hakea preissii*. Low shrubs: *Cassia helmsii, Eremophila cuneifolia, Maireana polypterygia, Halosarcia* spp.	Pasture type: *Stony Chenopod*. Pastoral use limitations: Moderately susceptible to erosion, mainly by water, when degraded.
Channels and creek-lines, usually incised, carrying bedloads of sands and cobbles.	**Unit 5 Drainage lines (3%) Traversed** Close fringing tall shrublands dominated by *Acacia aneura*, and *A. holosericea*.	Pasture type: *Acacia Creek-line*. Pastoral use limitations: None under controlled stocking.
Small sandy banks, usually adjacent to unit 4. Soils are reddish-brown sands.	**Unit 6 Sandy banks (2%) Traversed** Very scattered to scattered tall shrublands dominated by *Eucalyptus oleosa, Acacia aneura* and low shrubs as unit 4.	Pasture type: *Stony Chenopod*. Pastoral use limitations: None under controlled stocking.

Toolonga land system 1182 km² (1.6% of survey area)



Gently undulating calcrete outcrop plains with local and internal drainage; tall acacia shrublands.

Geology: Tertiary calcrete with an authigenic limestone duricrust and Quaternary colluvial deposits.

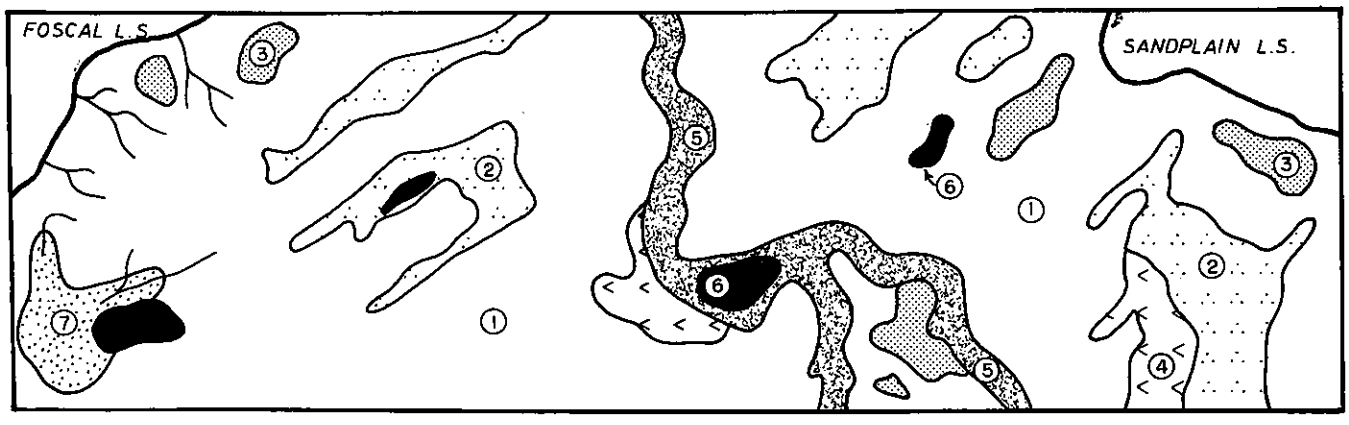
Geomorphology: Erosional surfaces with minor superficial deposits of sand and colluvium: extensive gently undulating calcrete plains of low relief (up to 10 m); minor areas of sandplain; plains with ferruginized surface mantle; drainage foci and saline plains; drainage internal or by narrow disorganized and usually unchannelled flow zones. This is the major land system of the Carbla Plateau.

Pastoral use: Acacia Mixed Shrub (ACMS) pastures, moderately productive but relying heavily on cotton bush as a shrub reserve in dry years. Some areas are degraded but show no susceptibility to erosion.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: good 11%; fair 47%; poor 42%.

Unit
1. Limestone plains
2. Plains with duplex soils
3. Sandy plains and banks
4. Stony plains
5. Flow zones
6. Drainage depressions
7. Low saline plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Limestone plains (65%) 6 site inventories and traversed	
Undulating stony plains with outcrops of calcrete and limestone, moderately or densely strewn with limestone pebbles or cobbles; relief up to 10 m. Soils are shallow, mostly occurring in pockets up to 1 m deep, red, dark red or reddish brown gradational types, sandy loams to sandy clay loams, with inclusions of carbonates and limestone gravels; pH 7.0-9.0 with alkaline or neutral trends; principal profile forms: Gc 1.22, 1.21, 2.12, Uc 5.21.	Scattered to moderately close tall shrublands dominated by *Acacia grasbyi, A. drepanophylla* and *Ptilotus obovatus*. PFC: 15 to 25%; Trees (0-25/ha; 2-4 m): *Santalum spicatum, S. lanceolatum, Heterodendrum oleaefolium*; Tall shrubs (50-400/ha; 2-4 m): *A. drepanophylla, A. grasbyi, A. tetragonophylla, A. sclerosperma, Scaevola tomentosa, S. spinescens*; Low shrubs (2000-4000/ha; < 1.5 m): *Ptilotus obovatus, Eremophila leucophylla, Enchylaena tomentosa, Rhagodia eremaea, Maireana planifolia, Solanum lasiophyllum, Cassia chatelainiana, Eremophila latrobei.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Cassia chatelainiana, Eremophila latrobei, E. leucophylla, Atriplex bunburyana, Ptilotus obovatus, Tribulus platypterus.* Undesirable perennials include: *Solanum orbiculatum.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Plains with duplex soils (15%) 4 site inventories and traversed	
Flat to slightly undulating restricted plains, some very sparsely strewn with calcareous gravels or pebbles. Soils are red or dark red duplex, sandy loam over sandy clay, with calcareous concretions, 75 cm to > 1 m deep, pH 8.0-8.5 with an alkaline trend; principal profile form: Dr 1.13.	Scattered to moderately close tall shrublands, usually dominated by *Acacia xiphophylla*. PFC 10-25%; Trees (scarce): *Heterodendrum oleaefolium*; Tall shrubs (75-300/ha; 2-4 m): *Acacia xiphophylla, A. grasbyi, A. tetragonophylla, A. sclerosperma, A. victoriae*; Low shrubs (500-7000/ha; < 1.5 m): *Ptilotus obovatus, Solanum lasiophyllum, Atriplex bunburyana, Solanum orbiculatum, Enchylaena tomentosa, Chenopodium gaudichaudianum.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. *Atriplex bunburyana* probably was formerly dominant in the low shrub layer on many sites. Desirable perennials include: *Atriplex bunburyana, Enchylaena tomentosa, Ptilotus obovatus.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Sandy plains and banks (5%) Traversed	
Gently undulating sandy banks and plains, mostly < 1 km in extent. Soils are probably dark red loamy sands.	Tall shrublands usually dominated by *Acacia ramulosa, Ptilotus obovatus* and *Eremophila leucophylla.*	Pasture type: *Acacia Sandplain.* Pastoral use limitations: None under controlled stocking.
	Unit 4 Stony plains (5%) 2 site inventories and traversed	
Flat plains with slopes < 0.5%, densely strewn with ironstone or mixed pebbles and gravels. Soils are dark red or dusky red sandy clays, shallow to > 1 m deep, pH 6.0-7.5 with neutral or acid trends; principal profile forms: Uc 6.13, Uf 6.31.	Very scattered to scattered tall shrublands dominated by *Acacia* spp. Trees (< 25/ha): *A. aneura*; Tall shrubs (0-50/ha; 2-3 m): *A. tetragonophylla, A. sclerosperma, A. victoriae*; Low shrubs (300-800/ha; < 2 m): *Ptilotus obovatus, Eremophila latrobei, Cassia helmsii, Maireana planifolia, Scaevola spinescens, Enchylaena tomentosa.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila latrobei, Maireana planifolia, Enchylaena tomentosa.* Undesirable perennials include: *Eremophila crenulata.* Pastoral use limitations: None under controlled stocking.
	Unit 5 Flow zones (5%) 2 site inventories and traversed	
Unchannelled flow zones up to 500 m wide and often ill-defined, slopes up to 0.5%; some are very sparsely strewn with limestone gravels or pebbles. Soils are dusky red sandy clays, shallow to > 1 m deep, pH 6.5-7.0; principal profile forms: Uf 6.12, 6.31.	Moderately close to close tall shrublands dominated by *Acacia ramulosa, A. tetragonophylla* and *Ptilotus obovatus*. Tall shrubs: *A. ramulosa, A. tetragonophylla, A. grasbyi, A. drepanophylla*; Low shrubs: *Ptilotus obovatus, Solanum lasiophyllum, Eremophila mackinlayi, E. leucophylla, E. crenulata, Rhagodia eremaea*; Perennial grasses: *Stipa elegantissima.*	Pasture type: *Acacia Mixed Shrub.* Desirable perennials include: *Maireana planifolia, Rhagodia eremaea.* Pastoral use limitations: Slight susceptibility to water erosion.

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 6 Drainage depressions (3%) 2 site inventories and traversed	
Isolated low-lying areas with gilgaied surfaces, subject to seasonal flooding. Soils are reddish brown medium clays, > 1 m deep, with ironstone, calcrete or other gravelly inclusions, pH 7.0-7.5 with neutral or alkaline trends; principal profile form: Ug 5.38.	Moderately close to close low shrublands, some with trees, others without. Trees (2-6 m): *Eucalyptus coolabah, Heterodendrum oleaefolium*; Tall shrubs (2-3 m): *Acacia tetragonophylla, A. victoriae, Scaevola spinescens, Exocarpos aphyllus, Hakea preissii*; Low shrubs (0.5-2 m): *Muehlenbeckia cunninghamii, Atriplex amnicola, Eremophila maculata, E. mackinlayi, Rhagodia eremaea.*	Pasture type: *Saltbush.* Desirable perennials include: *Scaevola spinescens, Atriplex amnicola, Eragrostis lanipes, Stipa elegantissima.*
	Unit 7 Low saline plains (2%) 3 site inventories and traverse	
Flat or gently sloping plains, some sparsely strewn with calcrete pebbles or ironstone gravels. Soils have puffy or flat surfaces, are reddish-brown or yellowish-red sandy-surfaced duplexes or gradationals, shallow to > 1 m deep, with carbonate concretions, pH 7.0-8.5 with neutral or alkaline trends; principal profile forms: Dr 1.13, 1.15, Gc 1.22.	Very scattered to scattered low shrublands dominated by halophytes, mainly *Atriplex bunburyana*, or *Maireana polypterygia*. Tall shrubs (25-150/ha; 2-3 m): *Acacia victoriae, A. tetragonophylla, A. sclerosperma, Pimelea microcephala*; Low shrubs (2000-6000/ha; < 2 m): *Atriplex bunburyana, Maireana polypterygia, Melaleuca uncinata, Maireana tomentosa, Solanum orbiculatum, Enchylaena tomentosa.*	Pasture type: *Saltbush.* Perennials augmented by annual grasses and herbs in favourable seasons. Desirable perennials include: *Maireana* spp, *Atriplex bunburyana.*

Trealla land system 688 km² (0.9% of survey area)

Elevated plains and marginal slopes with shallow soils over limestone, supporting moderately close tall acacia shrublands and minor areas of low shrublands of bluebush.

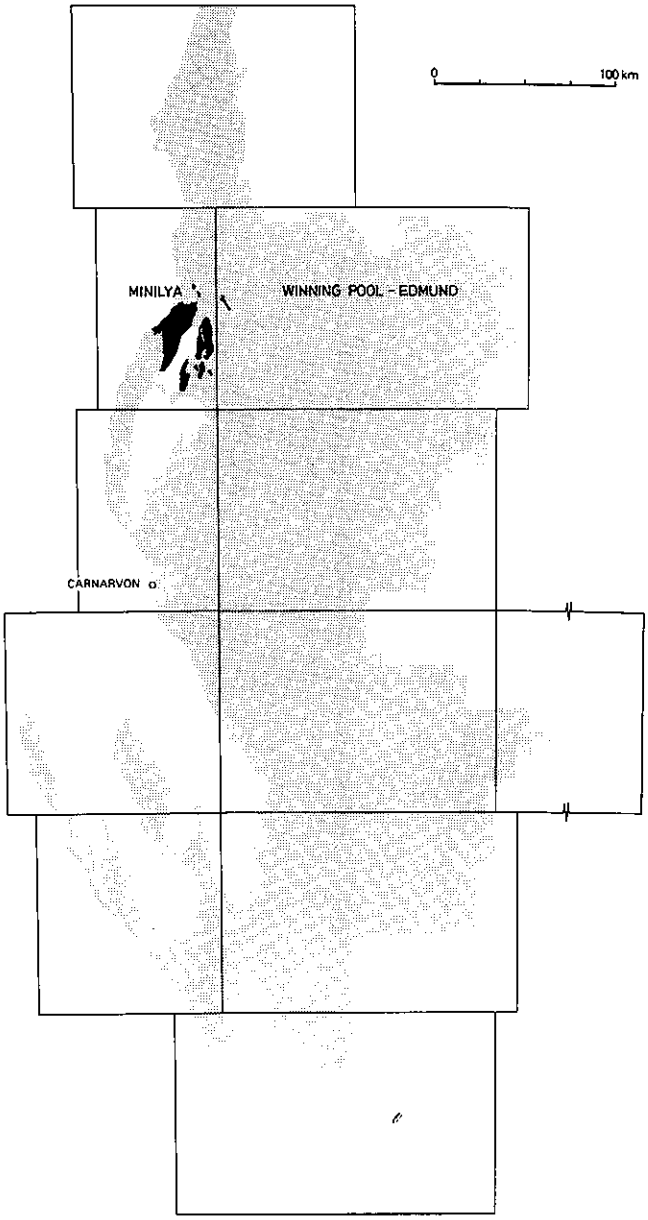
Geology: Miocene fossiliferous calcirudite and calcarenite.

Geomorphology: Gently sloping erosional plains strewn with limestone pebbles and stony outcrops with internal or disorganized drainage; also marginal slopes with incised drainage (towards Lake MacLeod).

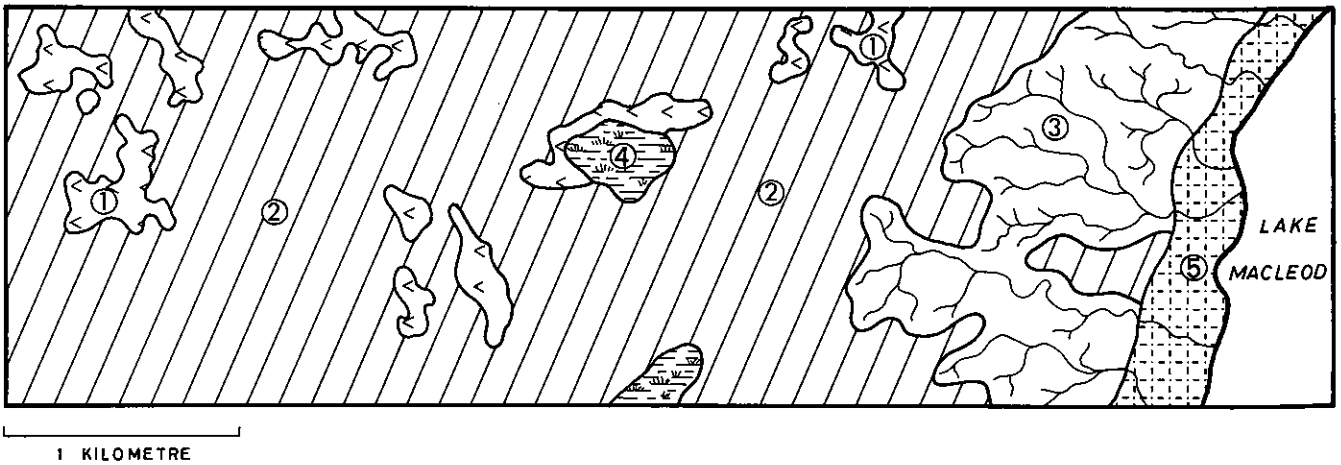
Pastoral use: A moderately to highly productive land system with Acacia Mixed Shrub (ACMS) pastures with a wide variety of palatable shrubs but perennial grasses are scarce or absent. The system is not prone to erosion.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: good 66%; fair 29%; poor 5%.



Unit
1. Limestone plains
2. Flat plains over limestone
3. Dissected slopes
4. Drainage depressions
5. Lower footslopes



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Limestone plains (10%) 1 site inventory and traversed	
Elevated stony plains, up to 70 m above unit 5, with outcropping limestone and pebble mantle. Soils are shallow reddish-brown gradational, calcareous loams to fine sandy clays, pH 8.0 with an alkaline trend; principal profile form: Gc 1.22.	Scattered to close tall shrublands dominated by *Acacia victorae*. Tall shrubs (2-3 m): *A. victoriae, A. sclerosperma, Scaevola spinescens*; Low shrubs (< 2 m): *Maireana polypterygia, Acacia tetragonophylla, Cassia desolata, Eremophila leucophylla, Solanum lasiophyllum.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, Eremophila leucophylla.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Flat plains over limestone (75%) 1 site inventory and traversed	
Flat plains, very lightly strewn with limestone pebbles. Soils are gradational, calcareous, red loams, fine sandy loam to fine sandy clay loam with limestone inclusions throughout, pH 8.5 with an alkaline trend; principal profile form: Gc 1.12.	Moderately close tall shrublands dominated by *Acacia sclerosperma.* Tall shrubs (2-3 m) : *A. sclerosperma, A. tetragonophylla, A. ramulosa, A. victoriae, A. xiphophylla, Exocarpos aphyllus*; Low shrubs (< 2m): *Eremophila leucophylla, Ptilotus obovatus, Eremophila latrobei, Scaevola spinescens, Cassia helmsii, Maireana tomentosa, Enchylaena tomentosa, Scaevola tomentosa.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable season. Desirable perennials include: *Eremophila latrobei, E. leucophylla, Scaevola spinescens, Enchylaena tomentosa.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Dissected slopes (10%) 1 site inventory and traversed	
Plains with channelled dendritic drainage, slopes up to 5%, moderately to heavily strewn with limestone pebbles. Soils are dark red shallow calcareous loams < 50 cm deep, pH 8.5 with an alkaline trend; principal profile form: Um 1.33.	Moderately close tall or low shrublands dominated by *Acacia xiphophylla* Tall shrubs (2-3 m): *A. xiphophylla, Exocarpos aphyllus*; Low shrubs (< 1m): *Ptilotus obovatus, Corchorus walcottii, Enchylaena tomentosa, Maireana polypterygia, Rhagodia eremaea, Scaevola tomentosa*; Perennial grasses: *Triodia pungens, Cenchrus ciliaris.*	Pasture type : *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, Enchylaena tomentosa.* Pastoral use limitations: None under controlled stocking.
	Unit 4 Drainage depressions (2%) 1 site inventory and traversed	
Broad depressions with flat micro-relief. Soils are dark red gradational calcareous loams, > 1 m deep, pH 8.5 with an alkaline trend; principal profile forms: Gc 1.22 and probably heavier types.	(i) Low woodlands dominated by *Eucalyptus coolabah*, or (ii) close tall shrublands dominated by *Acacia tetragonophylla*, or *A. sclerosperma.* Tall shrubs (2-3 m): *A. sclerosperma, A. tetragonophylla, A. ramulosa, A. coriacea*; Low shrubs (< 2 m) : *Ptilotus obovatus, Cassia helmsii, C. luerssenii, Enchylaena tomentosa, Rhagodia eremaea, Heterodendrum oleaefolium.*	Pasture type: *Acacia Mixed Shrub.* Pastoral use limitations: none under controlled stocking.
	Unit 5 Lower footslopes (3%) Traversed	
Probably gradational loams.	Low shrublands dominated by *Maireana polypterygia.*	Pasture type: *Bluebush.* Pastoral use limitations: None under controlled stocking.

Two Hills land system (G) 123 km² (0.2% of survey area)

Long, low hills and stony footslopes of sedimentary rocks, supporting tall shrublands of mulga and other acacias.

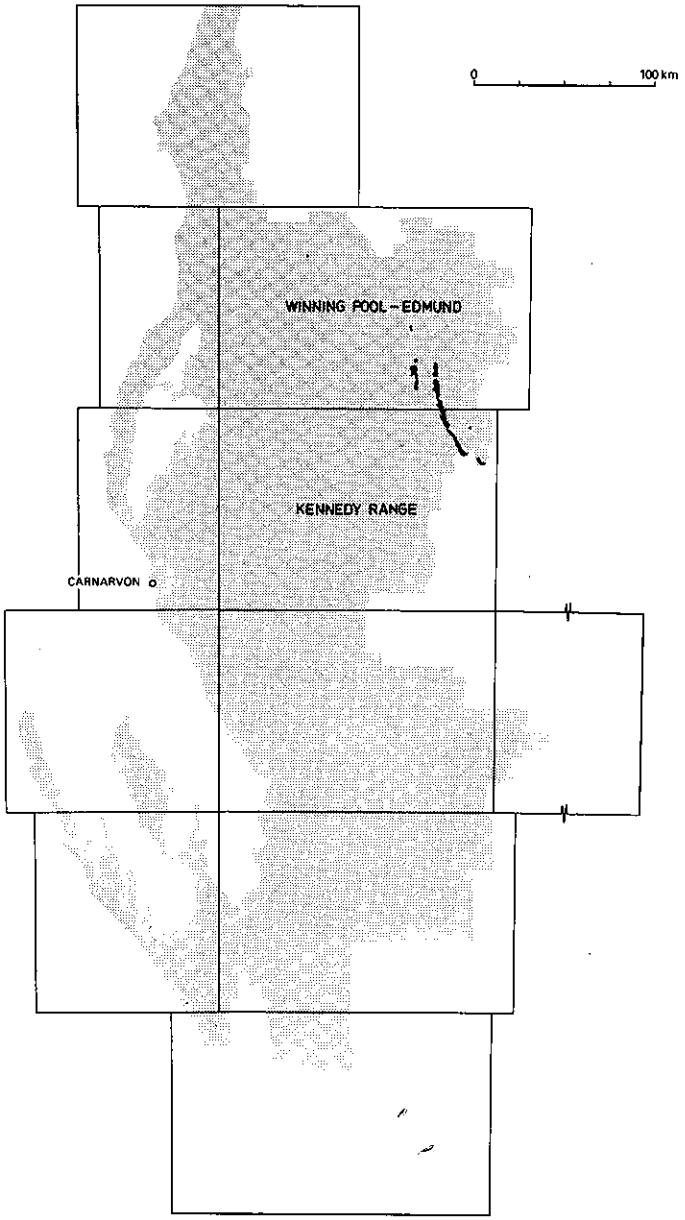
Geology: Devonian sandstone, siltstone and greywacke.

Geomorphology: Mainly erosional surfaces: low hilltops and ridges above concave foot slopes; drainage external via trellised or dendritic creek-lines; relief up to 40 m.

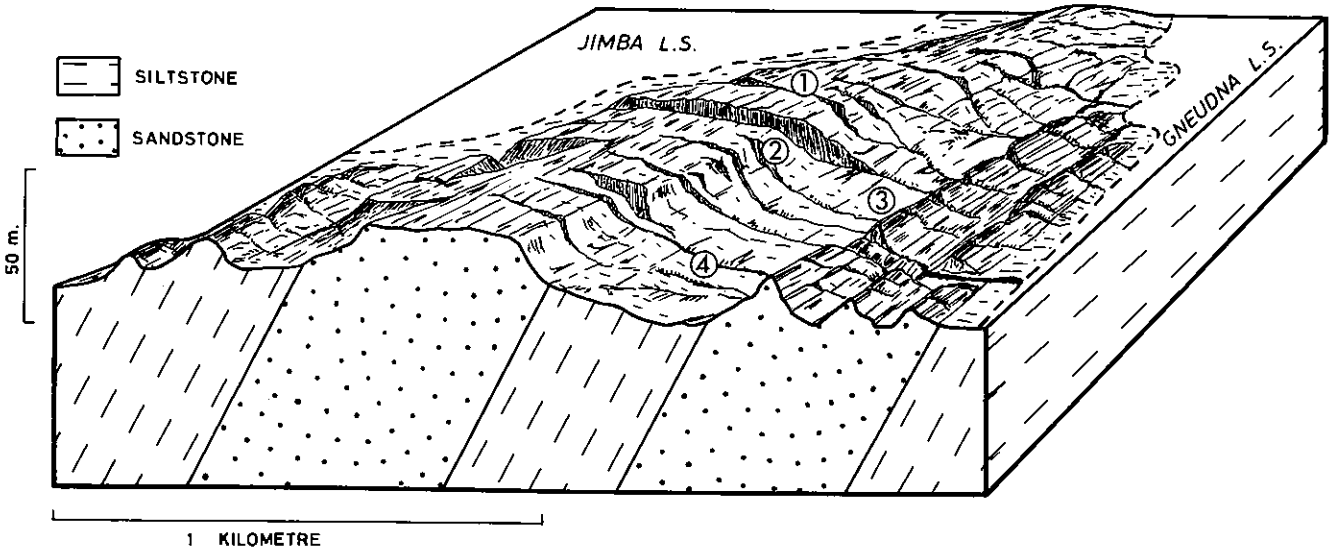
Pastoral use: Stony Short Grass Forb (SSGF) pastures with very low durability during dry seasons but some useful annual forage in good seasons. A minor land system, not normally susceptible to accelerated erosion.

Estimated carrying capacity, good condition: 25 ha/s.u.

Range condition summary: good 38%; fair 50%; poor 12%



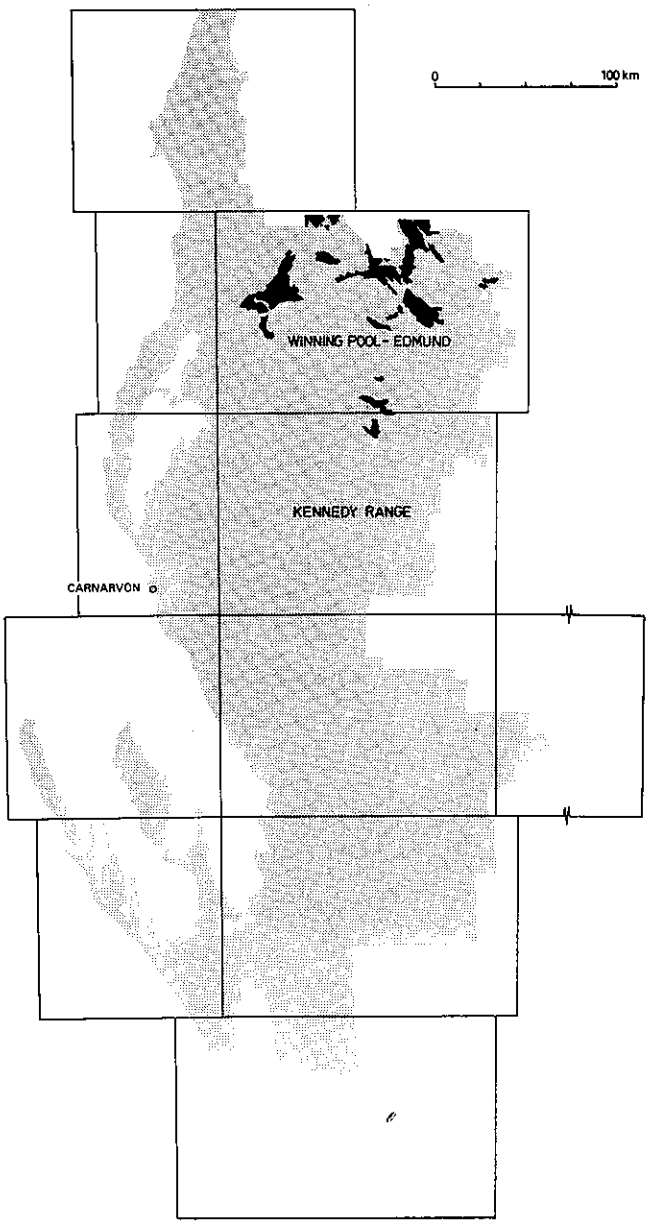
Unit
1. Low hills
2. Upper slopes
3. Lower slopes
4. Creek-lines



Two Hills L.S. **[ex Wilcox and McKinnon 1972]**

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Low hills (45%)	
Hills with more or less flattened tops, irregularly dissected by deeply incised tributary drainage lines, and long ridges, generally 10-30 m above unit 4. Soils are probably shallow loamy types with variable surface mantling.	Very scattered tall shrublands dominated by *Acacia cuspidifolia* and *A. tetragonophylla*. Low shrubs: *Eremophila cuneifolia*, *E. freelingii*, *Solanum lasiophyllum*, *Ptilotus* spp.	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Low potential.
	Unit 2 Upper slopes (10%) **Unit 3 Lower slopes (40%)**	
Steep upper slopes, heavily mantled by cobbles and pebbles; shallower lower slopes with variable mantling. Soils are probably shallow gradational types.	Very scattered tall shrublands dominated by *A. tetragonophylla*, with *Eremophila* spp and *Ptilotus* spp as predominant low shrubs except on saline areas where *Maireana triptera* occurs.	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: Low potential.
	Unit 4 Creek-lines (5%)	
Narrow creek-lines, frequently incised.	Fringing communities dominated by *Acacia* spp.	Pasture type: *Stony Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.

Uaroo land system (A) 1285 km² (1.7% of survey area)



Broad sandy plains, pebbly plains and drainage tracts supporting hard and soft spinifex hummock grasslands with scattered acacia shrubs.

Geology: Quaternary sand, colluvium and alluvium.

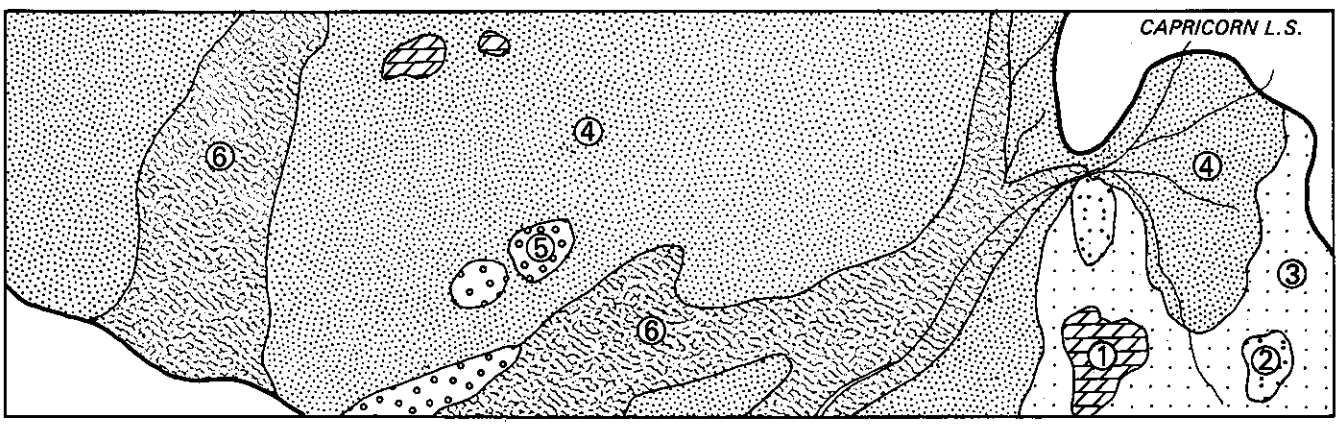
Geomorphology: Mainly depositional surfaces: almost flat to gently sloping sandy plains with minor stony plains and plains with calcrete at shallow depth; occasional stony rises and low hills; some through drainage by broad unchannelled tracts receiving sheet flow; relief mainly less than 5m.

Pastoral use: Hard Spinifex (HASP) pastures of generally low productivity and drought durability, but enhanced by minor areas of Soft Spinifex (SOSP); pastures require periodic burning followed by a deferral of grazing, to rejuvenate the spinifex, other grasses and herbs. This system is not normally susceptible to accelerated erosion.

Estimated carrying capacity, good condition: 12 ha/s.u.

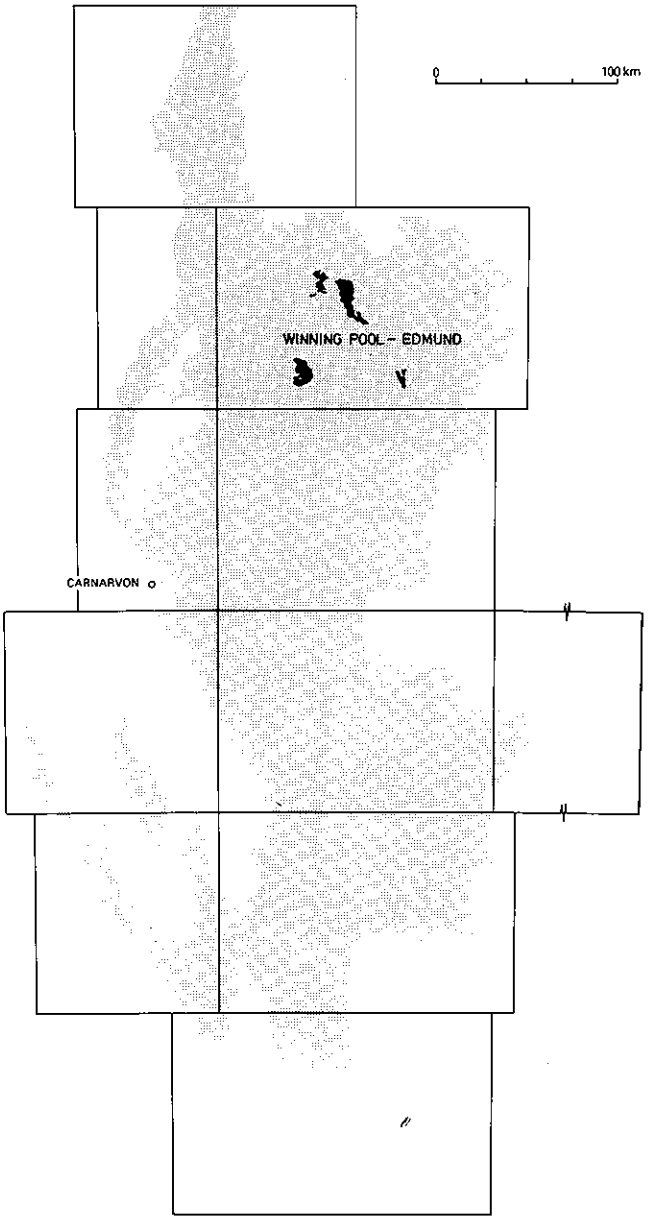
Range condition summary: good 95%; fair 4%; poor 1%.

Unit
1. Low hills
2. Low stony rises
3. Pebbly plains
4. Sandy-surfaced plains
5. Calcrete plains
6. Drainage tracts



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Isolated low hills and ridges up to 1 km long, with steep stony footslopes, up to 30 m above unit **4**. Soils are skeletal, with dense mantles of rocks.	**Unit 1 Low hills (1%) Traversed** Hummock grasslands dominated by *Triodia lanigera, T. wiseana* and low shrubs.	Pasture type: *Hard Spinifex.*
Rises with stony slopes and rocky outcrops, up to 15m above unit 4. Soils are dark red to reddish-brown sands or loams, mostly shallow; principal profile forms probably Uc 1.23, Um 1.43.	**Unit 2 Low stony rises (2%) Traversed** (i) Hummock grasslands dominated by *Triodia pungens*, or (ii) tall shrublands dominated by *Acacia xiphophylla* and *Triodia* spp.	Pasture type: *Soft Spinifex.*
Gently sloping (< 1%) plains, densely pebble or gravel-mantled, occurring as margins to (occasionally patches within) unit 4. Soils are probably dark reddish-brown to dark red gradational types, sands to loams grading to sandy clay, 0.5 to > 1 m deep, principal profile forms probably Gn 1.12, 2.12, 2.13, Dr 2.12.	**Unit 3 Pebbly plains (10%) Traversed** Hummock grasslands dominated by *Triodia* spp, more locally tall shrublands dominated by *Acacia xiphophylla* with very scattered low shrubs.	Pasture type: *Hard Spinifex/Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking and appropriate fire management.
Flat to gently sloping broad plains with more or less mounded surfaces. Soils are dark red sands grading to loams, > 1 m deep; principal profile forms probably Uc 5.11, Gn 1.12, Dr 2.12.	**Unit 4 Sandy-surfaced plains (67%) Traversed** Hummock grasslands dominated by *Triodia lanigera* with overstorey trees *Eucalyptus setosa* and *E. aspera* or tall shrubs *Acacia ancistrocarpa* and *A. inaequilatera.*	Pasture type: *Hard Spinifex/Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking and appropriate fire management.
Flat to gently sloping restricted plains, usually densely mantled with calcareous gravels. Soils are dark red loamy sands to silty loams, usually < 25 cm deep and calcareous throughout; principal profile forms probably Uc 1.13, Um 1.33.	**Unit 5 Calcrete plains (5%)** Hummock grassland dominated by *Triodia wiseana* and *T. lanigera.*	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking and appropriate fire management.
Broad, unchannelled tracts receiving sheet flow, mostly unchannelled but locally with braided channelling of low intensity. Soils are dark reddish-brown to dark red gradational loams or duplex types, principal profile forms: Gn 1.12, 2.12, Uc 5.31, Um 5.52, Dr 2.13, 2.51.	**Unit 6 Drainage tracts (15%)** Close tall shrublands dominated by *Acacia tetragonophylla, A. ancistrocarpa, A. wanyu, A. aneura* with understory low shrubs and perennial grasses (including *Triodia pungens*).	Pasture type: *Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.

Wandagee land system 297 km² (0.4% of survey area)



Saline and non-saline plains with clay soils and featuring elongate stony outcrops broad drainage zones: scattered tall acacia shrublands with numerous low shrubs including saltbush.

Geology: Permian fossiliferous siltstone and quartz grey-wacke, Quaternary alluvium and colluvium.

Geomorphology: Mainly erosional surfaces: flat to gently sloping plains of low relief, sometimes with gilgai micro-relief; characteristically dissected by nearly parallel linear outcrops of sedimentary rocks; drainage partly internal, mostly disorganized and of low intensity but locally channelled and dendritic.

Pastoral use: Highly productive Saltbush (SALT), Bluebush (BLUE) and Acacia Creek-line (ACCR) pastures with minor units dominated by Hard Spinifex (HASP). The system supports a wide range of palatable shrubs and perennial grasses to confer high drought durability when in good condition. Major units 3 and 4 are susceptible to mild erosion when the vegetation is degraded.

Estimated carrying capacity, good condition: 6 ha/s.u.

Range condition summary: good 21%; fair 30%; poor 49%.

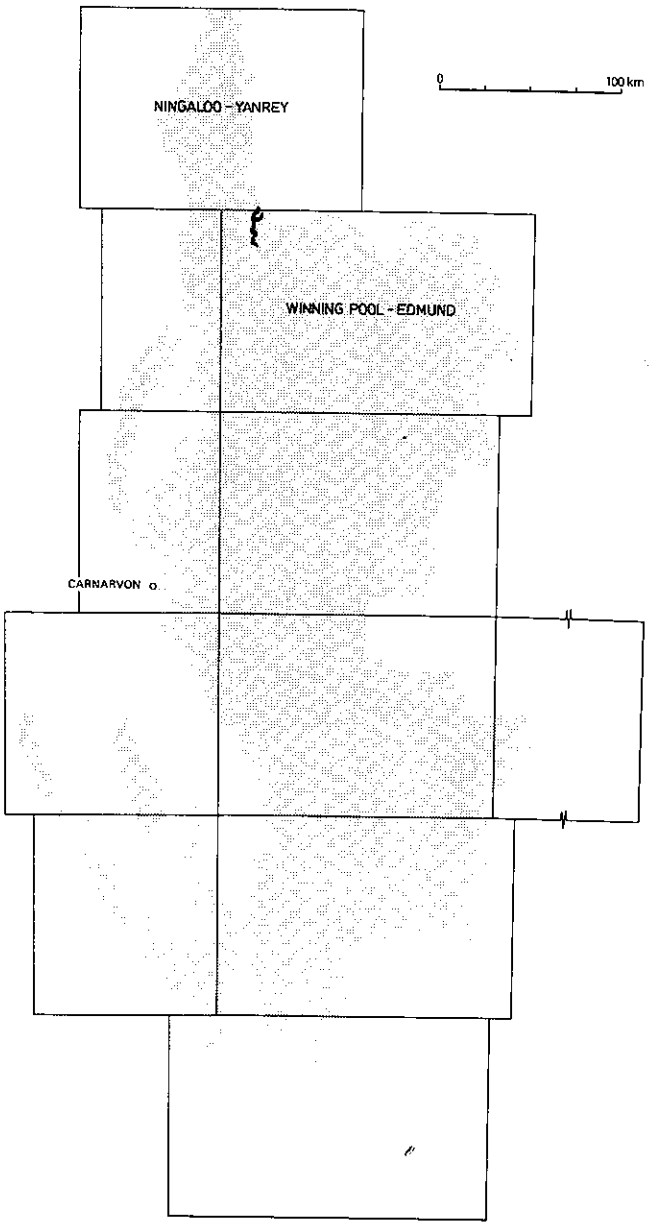
Unit
1. Low stony rises
2. Sandy banks
3. Saline plains
4. Plains with scattered rock outcrops
5. Narrow plains with sandy surfaces
6. Drainage floors
7. Gilgaied plains
8. Drainage foci
9. Ephemeral swamps

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Low stony rises (10%) 2 site inventories and traversed	
Linear stony rises, mostly 200-300 m wide and 2-6 m high, moderately to heavily strewn with rock fragments of all sizes. Soils are reddish-brown sands or gradational sandy loams, shallow to > 1 m deep, pH 6.5-8.0 with a neutral trend; principal profile forms: Uc 1.23, Gc 2.12.	(i) Hummock grasslands dominated by *Triodia lanigera* or (ii) scattered tall shrublands dominated by *Acacia tetragonophylla* and *Atriplex bunburyana*. Tall shrubs (0-125/ha; 2-3 m): *Acacia tetragonophylla, A. victoriae, A. sclerosperma*; Low shrubs (600-1100/ha; < 1m): *Atriplex bunburyana, Cassia desolata, Corchorus crassifolius, Eremophila cuneifolia, Solanum lasiophyllum*; Perennial grasses: *Triodia lanigera*(up to 20% cover), *Cenchrus setigerus, C. ciliaris.*	Pasture type: *Hard Spinifex* or *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Maireana polypterygia, Eremophila latrobei.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Sandy banks (5%) 1 site inventory and traversed	
Sandy banks and small areas of sandplain up to 1 m above unit 3. Soils are dark red loamy sand, mostly shallow, pH 8.0 with a neutral trend; principal profile form: Uc 1.13.	(i) Hummock grasslands dominated by *Triodia* spp. or (ii) scattered to close tall shrublands dominated by *Acacia subtessarogona.* Tall shrubs (3-4 m): *A. subtessarogona*; Low shrubs (< 2 m): *Solanum lasiophyllum, Cassia helmsii, Corchorus crassifolius, Sida platycalyx, Ptilotus obovatus*; Perennial grasses: *Triodia* spp, *Eragrostis eriopoda, Cenchrus ciliaris, Eriachne helmsii.*	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 3 Saline plains (40%) 3 site inventories and traversed	
Flat surfaced or gilgaied plains, slopes < 0.5%, locally strewn with siltstone or sandstone gravelly mantle. Soils are reddish-brown clays, shallow to > 1 m deep, light to medium clays with or without inclusions of sedimentary rock fragments and gypsum, pH 7.0 to 8.0 with a neutral trend; principal profile forms: Uf 6.13, 6.33, Ug 5.31.	Very scattered to scattered tall shrublands dominated by *Acacia* spp and *Atriplex bunburyana.* Trees: (< 25-125/ha; 2-6 m): *Acacia cuspidifolia;* Tall shrubs (0-75/ha; 2-3 m): *A. victoriae, A. xiphophylla*; Low shrubs (50-2700/ha; < 2m): *Atriplex bunburyana, Rhagodia eremaea, Maireana aphylla, Acacia tetragonophylla, Eremophila latrobei*; Perennial grasses: *Eragrostis xerophila.*	Pasture type: *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Dipteracanthus corynothecus.* Undesirable perennials include: *Acacia cuspidifolia.* Pastoral use limitations: Slight susceptibility to erosion by wind and water when degraded.
	Unit 4 Plains with scattered rock outcrops (20%) 1 site inventory and traversed	
Plains with disorganised drainage and often convex surfaces, generally with no surface mantling but occasionally with rock outcropping. Soils are reddish-brown fine sandy clay loam, mainly > 1 m deep, pH 8.0 with a neutral trend; principal profile form: Um 5.12.	Moderately close tall shrublands dominated by *Acacia xiphophylla.* Tall shrubs (3-5 m): *A. xiphophylla, A. subtessarogona, Heterodendrum oleaefolium*; Low shrubs (1-2 m): *Ptilotus obovatus, Eremophila latrobei, Cassia oligophylla, C. helmsii, Eremophila leucophylla, Maireana polypterygia.*	Pasture type: *Bluebush.* Desirable perennials include: *Maireana polypterygia, Eremophila latrobei.* Undesirable perennials include: *Acacia cuspidifolia, Cassia* spp. Pastoral use limitations: Slight susceptibility to erosion by wind and water when degraded.
	Unit 5 Narrow plains with sandy surfaces (10%) Traversed	
Flat to gently sloping plains with a disorganised drainage. Soils are probably shallow gradational sands or loams.	Scattered tall shrublands dominated by *Acacia subtessarogona* and *Triodia* spp.	Pasture type: *Hard Spinifex.* Pastoral use limitations: None under controlled stocking.
	Unit 6 Drainage floors (5%) Traversed	
Drainage tracts, mostly < 100 m wide, more or less channelled, receiving drainage from units 1, 2, 3 and 4.	Close fringing shrublands dominated by *Acacia subtessarogona* or *A. aneura*, with understorey shrubs and perennial grasses.	Pasture type: *Acacia Creek-line.* Pastoral use limitations: Slight susceptibility to erosion by wind and water when degraded.

Wandagee L.S.—Continued

Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Restricted plains with gilgaied surfaces. Soils are probably medium to heavy clays, > 1 m deep.	**Unit 7 Gilgaied plains (5%) Traversed** Tussock grasslands dominated by *Eragrostis xerophila.*	Pasture type: *Tussock Grass.* Pastoral use limitations: None under controlled stocking.
Flat-bottomed, irregularly shaped, small foci, mostly < 1 ha in area. Soils are dark red duplex, light sandy clay loam over sandy to light clays, > 1 m deep, pH 8.5 with an alkaline trend; principal profile form: Dr 2.13.	**Unit 8 Drainage foci (3%) 1 site inventory and traversed** Close tall shrublands dominated by *Acacia tetragonophylla.* Trees: *Acacia aneura*; Tall shrubs (2-4 m): *A. tetragonophylla, A. victoriae, A. xiphophylla, Heterodendrum oleaefolium, Cassia chatelainiana*; Low shrubs (0.5-1.5 m): *Ptilotus obovatus, Eremophila leucophylla, Cassia oligophylla, Eremophila cuneifolia*; Perennial grasses: *Triodia lanigera, Cenchrus ciliaris.*	Pasture type: *Acacia Creek-line.* Desirable perennials include: *Rhagodia eremaea, Cassia chatelainiana.* Pastoral use limitations: None under controlled stocking.
Seasonally-inundated swamps and drainage depressions, sometimes clustered. Soils are cracking clays.	**Unit 9 Ephemeral swamps (2%) Traversed** Low woodlands dominated by *Eucalyptus coolabah* and perennial grasses *Eriachne benthamii, Eulalia fulva, Chrysopogon fallax.*	Pasture type: *Tussock Grass.* Pastoral use limitations: None under controlled stocking.

Wapet land system 42 km² (0.1% of survey area)



Low rises and stony plains based on radiolarite, supporting hard spinifex hummock grasslands with scattered shrubs.

Geology: Early Cretaceous Windalia Radiolarite.

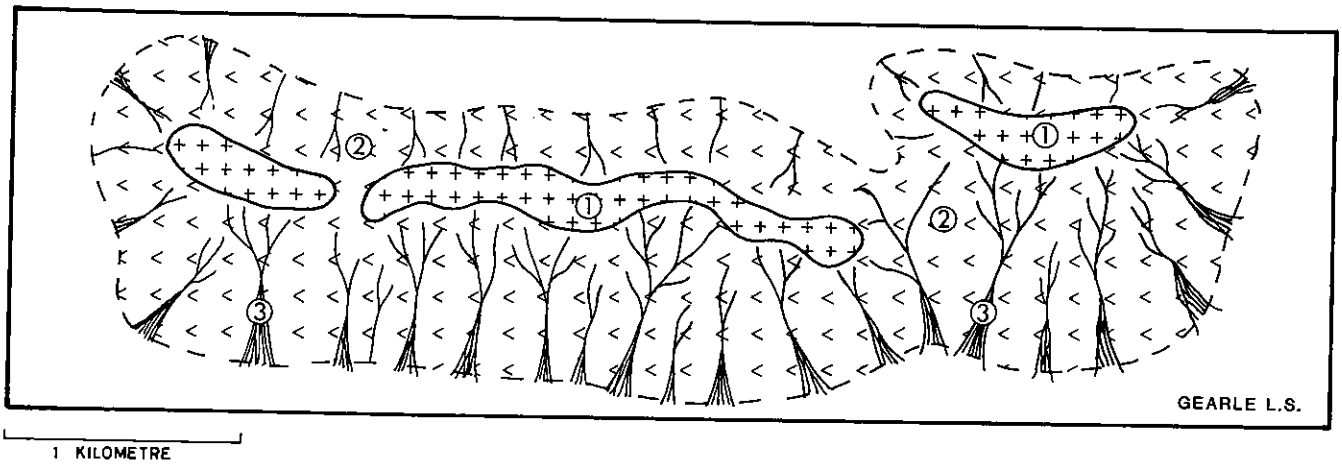
Geomorphology: Mainly erosional surfaces: stony rises, often several kilometres long, above gently sloping plains with radially-arranged incised drainage zones, fed by dendritic streams of low to moderate density; relief up to 20 m.

Pastoral use: Hard Spinifex (HASP) pastures of low to moderate productivity, some drought durability being conferred by areas of Gascoyne bluebush and sparse tussock grasses within the spinifex-dominated landscape. A very minor system, not normally susceptible to accelerated erosion.

Estimated carrying capacity, good condition: 20 ha/s.u.

Range condition summary: good 100%; fair 0%; poor 0%.

Unit
1. Stony rises
2. Lower stony plains
3. Channelled drainage lines



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Stony rises (15%) Traversed	
Stony rises up to 20 m above unit 3, densely mantled by angular fragments of radiolarite. Soils are probably skeletal.	Hummock grasslands dominated by *Triodia* spp and very scattered overstorey trees *Eucalyptus obtusiflora* and *E.* sp.	Pasture type: *Hard Spinifex.* Pastoral use limitations: Very low seasonal productivity and few desirable perennials.
	Unit 2 Lower stony plains (75%) Traversed	
Slopes and plains, variably strewn with radiolarite fragments. Soils are probably gradational loams, slightly acidic at higher sites but neutral over lower areas.	(i) Hummock grasslands dominated by *Triodia* spp, with very scattered trees *Eucalyptus* spp and low shrubs; (ii) mixed low shrubland - hummock grassland associations dominated by *Maireana polypterygia* and *Triodia* spp.	Pasture type: *Hard Spinifex/Bluebush.* Areas with *M. polypterygia* are relatively minor, usually adjacent to Gearle land system. Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 3 Channelled drainage lines (10%) Traversed	
Drainage lines, mostly narrow and incised, to 5 m, dendritic and of moderate intensity. Soils are probably gradational loams.	Hummock grasslands dominated by *Triodia* spp, with sparse perennial grasses and overstorey trees *Eucalyptus coolabah*, *E.* sp.	Pasture type: *Hard Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.

Warroora land system 831 km² (1.1% of survey area)

Flat to gently sloping saline alluvial plains, with minor areas of sand and limestone, supporting tall acacia shrublands and low shrublands of saltbush, bluebush and samphire.

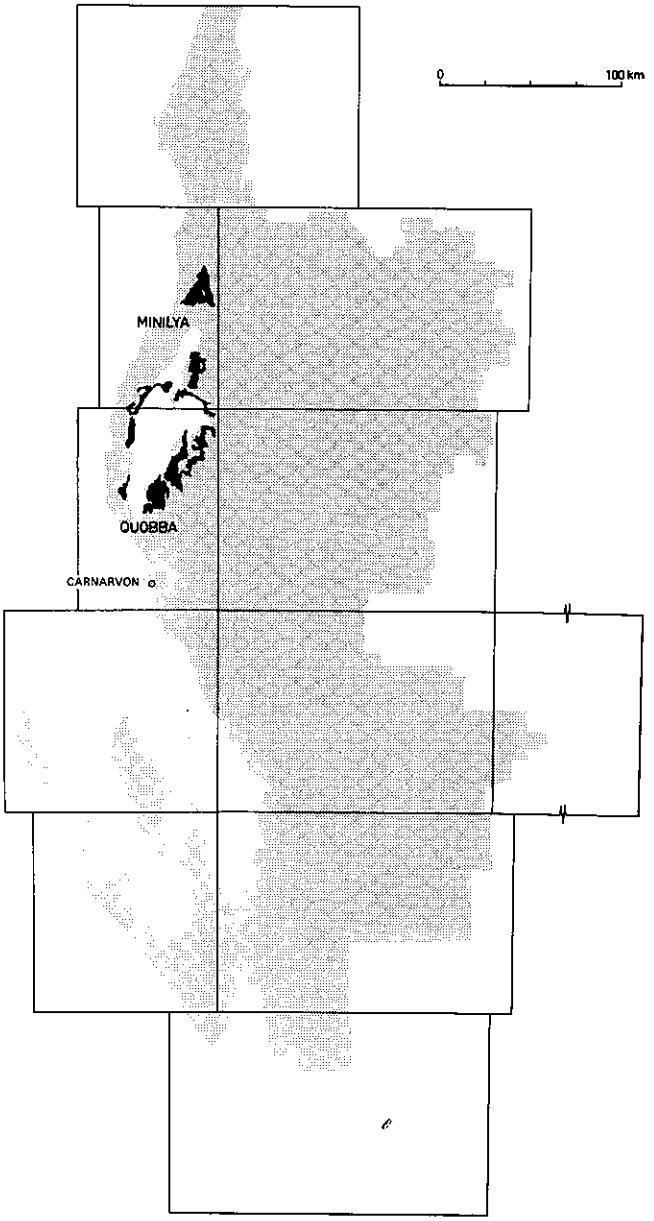
Geology: Quaternary calcarenite, coquinite, alluvium and colluvium with minor aeolian sand.

Geomorphology: Depositional surfaces of calcareous alluvium and colluvium, with minor areas of limestone outcrop and aeolian sand, forming flat to gently sloping plains, drainage internally into depressions and sluggish tracts; relief up to 4 m.

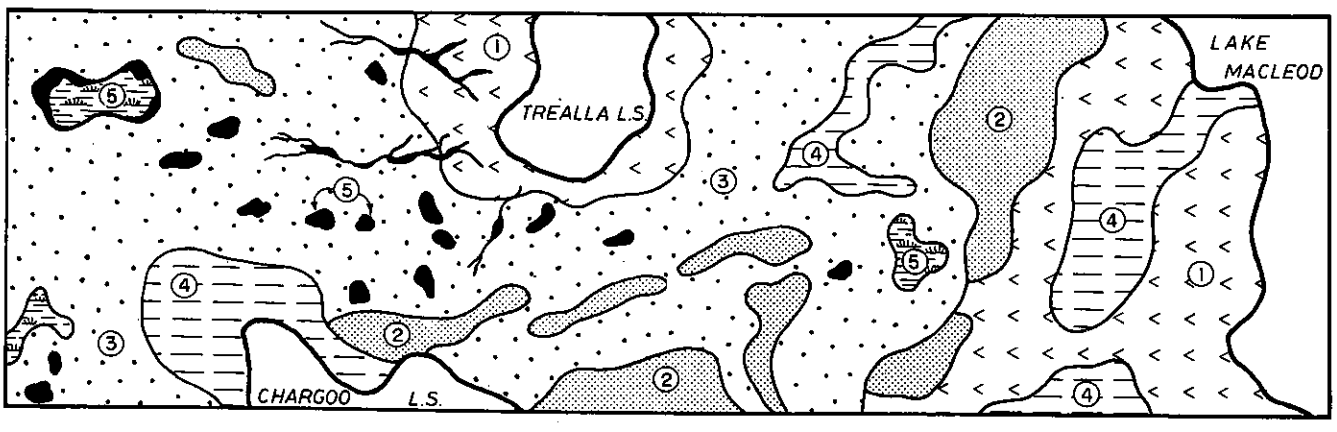
Pastoral use: Highly productive Saltbush (SALT) and Bluebush (BLUE) pastures of considerable drought durability and not usually susceptible to erosion; the saline nature of the palatable shrubs which dominate major units 3 and 4 necessitates a close distribution of watering points for optimum use by stock.

Estimated carrying capacity, good condition: 6 ha/s.u.

Range condition summary: good 89%; fair 10%; poor 1%.



Unit
1. Limestone outcrop plains
2. Sandy banks
3. Alluvial plains
4. Saline plains
5. Ephemeral swamps and drainage depressions



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Limestone outcrop plains (15%) 2 site inventories and traversed	
Plains with flat to mounded surfaces, slopes < 0.5% sparsely to moderately strewn with limestone pebbles and gravels, up to 4 m above unit 5. Soils are dark red or reddish-brown fine sandy loam to sandy clay loam, < 40 cm deep with calcareous inclusions throughout, pH 8.0-8.5 with alkaline or neutral trends, principal profile forms: Um 5.11, Uc 6.13.	Scattered low shrublands dominated by *Maireana polypterygia* or *Atriplex bunburyana* and *Acacia xiphophylla*. Trees and tall shrubs (< 25-250/ha; 2-4 m): *A. xiphophylla, A. tetragonophylla, A. cuspidifolia, Heterodendrum oleaefolium, A. sclerosperma*; Low shrubs (9000-10000/ha; < 1 m): *Maireana polypterygia, Atriplex bunburyana, Ptilotus obovatus, Dipteracanthus corynothecus, Maireana tomentosa, Rhagodia eremaea*; Perennial grasses: *Cenchrus ciliaris, Eragrostis xerophila.*	Pasture type: *Saltbush* or *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, Atriplex bunburyana.* Undesirable perennials include: *A. cuspidifolia.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Sandy banks (15%) 6 site inventories and traversed	
Low sandy banks with mounded surfaces and slopes up to 4%, with or without a sparse mantle of limestone gravels. Soils are reddish-brown, yellowish-red or red sand or loamy sand, often grading to sandy clay loams below 50 cm, with or without limestone and shell fragments, mostly > 1 m deep pH 8.0-8.5 with alkaline or neutral trends; principal profile forms: Uc 1.12, 1.11, Gc 1.12.	Very scattered to moderately close tall shrublands dominated by *Acacia tetragonophylla, A. sclerosperma* and *Atriplex paludosa.* PFC 5 to 30%. Tall shrubs (350-700/ha; 2-3 m): *Acacia sclerosperma A. tetragonophylla, A. victoriae, Eremophila maitlandii, Heterodendrum oleaefolium, Hakea preissii*; Low shrubs (550-9000/ha < 2 m): *Atriplex paludosa, Ptilotus obovatus, Atriplex bunburyana, Rhagodia preissii, Cratystylis subspinescens, Enchylaena tomentosa*; Perennial grasses: *Triodia pungens, Cenchrus ciliaris.*	Pasture type: *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Understorey dominated by *Triodia pungens* locally around L. MacLeod. Desirable perennials include: *Atriplex* spp, *Maireana tomentosa, Enchylaena tomentosa.* Undesirable perennials include: *Hakea preissii.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Alluvial plains (40%) 7 site inventories and traversed	
Plains with flat to mounded surfaces, slopes < 0.5%, higher parts locally with mantles of limestone gravels to cobbles. Soils are duplex or gradational calcareous types, shallow near unit 1 but mainly > 1 m deep, reddish-brown or red loamy sands over sandy clays or sandy loams, otherwise gradational with limestone and shell fragments throughout, pH 7.0-8.5 with alkaline or neutral trends; principal profile forms: Dy 1.13, Dr 1.13, Gc 1.12.	Scattered low shrublands dominated by *Atriplex vesicaria* or *Maireana polypterygia.* PFC 10 to 20%. Trees and tall shrubs (< 25/ha; > 2 m): *Acacia cuspidifolia, A. victoriae, A. tetragonophylla, Exocarpos aphyllus*; Low shrubs (2000-24000/ha; < 1 m): *Atriplex vesicaria, Maireana polypterygia, Atriplex paludosa, A. bunburyana, M. platycarpa, Frankenia* spp, *Cratystylis subspinescens, Ptilotus obovatus*; Perennial grasses: *Cenchrus ciliaris.*	Pasture type: *Saltbush* or *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polyptergyia, Atriplex vesicaria.* Undesirable perennials include: *Acacia victoriae, Eremophila pterocarpa.* Pastoral use limitations: Mild susceptibility to erosion when degraded; high salinity levels of pasture plants.
	Unit 4 Saline plains (20%) 1 site inventory and traversed	
Flat plains with highly saline alluvial deposits. Soils are red duplex, > 1 m deep, fine sandy loam over sandy clay loam to medium clays, shell fragments throughout, pH 8.5 with an alkaline trend; principal profile form: Dy 1.13.	Scattered low shrublands dominated by *Halosarcia* spp, and *Atriplex vesicaria.* Low shrubs (< 0.5 m): *Halosarcia* spp, *Atriplex vesicaria, Maireana tomentosa, Threlkeldia diffusa.*	Pasture type: *Samphire.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex vesicaria.* Pastoral use limitations: High salinity levels of pasture plants.
	Unit 5 Ephemeral swamps and drainage depressions (10%) 1 site inventory and traversed	
Flat-bottomed drainage foci of irregular size and shape; soils are reddish-brown clay loams or clays mainly > 1 m deep; principal profile form: Gc 2.21.	Close shrublands, mainly tall and dominated by *Melaleuca uncinata* or *Acacia tetragonophylla.* Low shrubs (< 2 m): *Ptilotus obovatus, Rhagodia eremaea.*	Desirable perennials include: *Rhagodia eremaea, Atriplex* spp. Pastoral use limitations: None under controlled stocking.

Wash land system 800 km² (1.1% of survey area)

Loamy alluvial plains and drainage zones receiving run-on from Permian hills systems, supporting low acacia woodlands or tall shrublands, often groved.

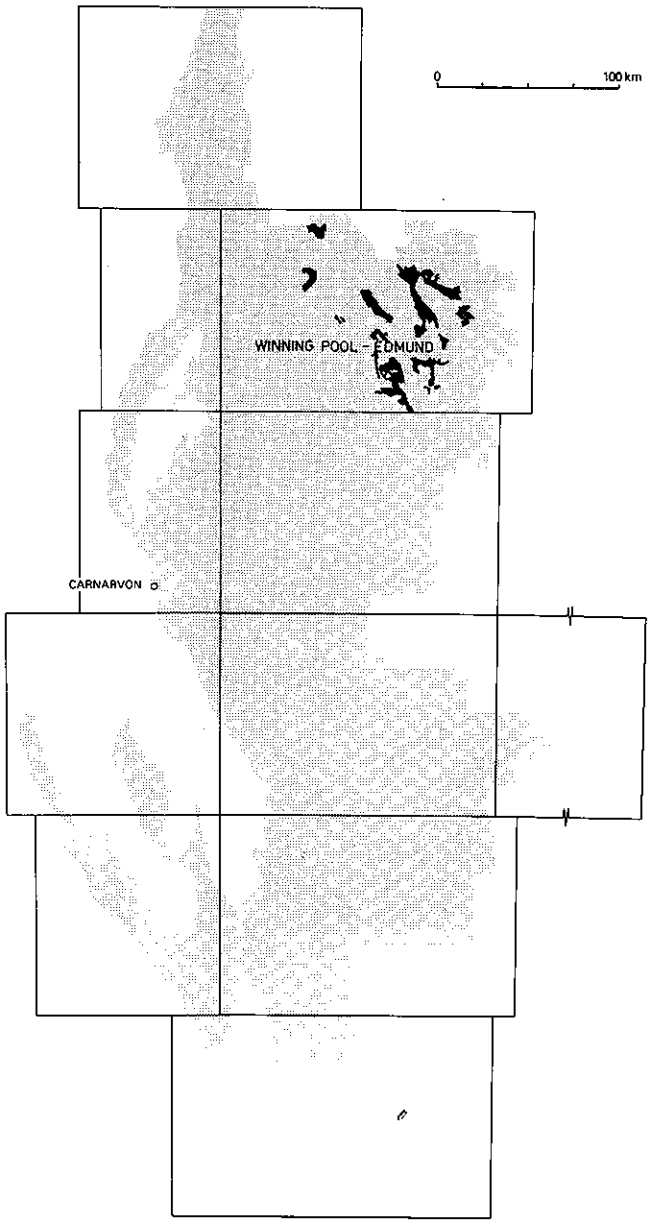
Geology: Quaternary alluvium and colluvium: clay, silt, sand and gravel.

Geomorphology: Depositional surfaces: broad, almost flat to gently sloping plains with both internal and through drainage, peripheral drainage plains receiving run on and drainage tracts receiving more concentrated, sometimes channelled, through flow; relief up to 7 m.

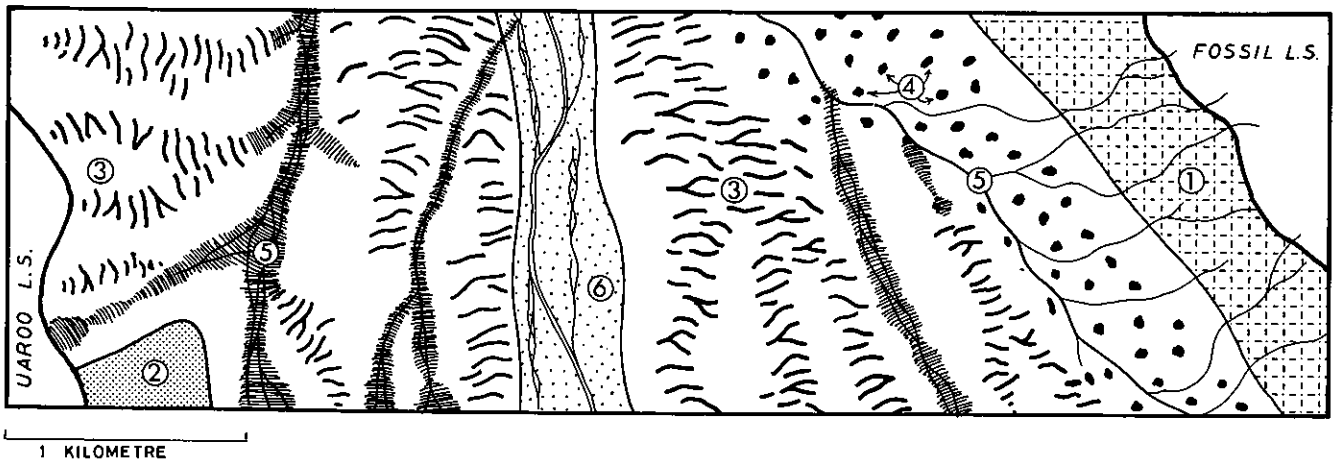
Pastoral use: Acacia Short Grass Forb (ASGF) pastures with more low forage and perennial grasses than most, also Acacia Creek-line (ACCR) and Tussock Grass (TUGR) pastures, moderate to high productivity and moderate drought durability when in good condition; in poor condition units 3, 5 and 6 are susceptible to local erosion.

Estimated carrying capacity, good condition: 8 ha/s.u.

Range condition summary: good 31%; fair 45%; poor 24%.



Unit
1. Marginal slopes
2. Sandy plains
3. Alluvial plains
4. Drainage foci
5. Drainage tracts
6. Flood plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
Gently sloping sandy-surfaced plains receiving drainage from adjacent hill systems. Soils are probably shallow loamy sands.	**Unit 1 Marginal slopes (10%) Traversed** Scattered tall shrublands dominated by *Acacia* spp with understorey shrubs (mainly *Eremophila leucophylla*) and sparse perennial grasses *Cenchrus ciliaris*, *Triodia* spp (locally).	Pasture type: *Acacia Short Grass Forb.* Pastoral use limitations: None under controlled stocking.
Flat to gently sloping restricted sandplains with mounded surfaces, often sparsely strewn with limestone gravels. Soils are dark red sands, loamy sand grading to sandy loam, > 1 m deep, with occasional calcareous inclusions, pH 7.0 with a neutral trend; principal profile form: Uc 5.21.	**Unit 2 Sandy plains (4%) 1 site inventory and traversed** Scattered low shrublands dominated by *Acacia linophylla* and *Eremophila leucophylla*. Tall shrubs (> 2 m): *Acacia linophylla, A. tetragonophylla, A. victoriae*; Low shrubs (1-2 m): *Eremophila leucophylla, Indigofera monophylla, Cassia desolata, Ptilotus obovatus, Rhagodia eremaea, Sida* spp; Perennial grasses: *Cenchrus ciliaris.*	Pasture type: *Acacia Sandplain.* Desirable perennials include: *Rhagodia eremaea, Maireana planifolia.* Pastoral use limitations: None under controlled stocking.
Flat to mounded plains with gentle slopes (< 0.7%), with or without a sparse cover of quartzite or mixed gravels. Within groves, soils are either shallow dark reddish-brown loamy-surfaced duplex or dusky red loams pH 6.5, and in inter-groves either dark red to dusky red duplex (sandy loam over sandy clay loam) or gradational loams of similar hue > 1 m deep, pH 6.5 with a neutral trend, principal profile forms: Gn 4.12, 2.12, Dr 1.12, Uf 6.21, Um 6.13, Gc 1.22.	**Unit 3 Alluvial plains (65%) 7 site inventories and traversed** Scattered to moderately close tall shrublands dominated by *Acacia* spp and narrow groves of moderately close to close tall shrublands of similar composition. Trees (mainly confined to groves, < 25-900/ha; 4-8 m): *A. subtessarogona, A. citrinoviridis, Hakea suberea, A. cuspidifolia, Heterodendrum oleaefolium*; Tall shrubs (3-6 m): *A. subtessarogona; A. sclerosperma, A. cuspidifolia, A. tetragonophylla, A. xipohophylla, Dodonaea viscosa*; Low shrubs (400-2800/ha; < 2m): *Eremophila leucophylla, E. cuneifolia, Cassia desolata, Ptilotus obovatus, Solanum lasiophyllum, Maireana planifolia*; Perennial grasses: *Chrysopogon fallax, Triodia pungens, Eragrostis eriopoda, Eriachne helmsii, Monachather paradoxa, Cenchrus ciliaris.*	Pasture type: *Acacia Creek-line* and *Acacia Short Grass Forb* with with a higher potential than usual attributable to perennial grasses. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana planifolia, Cassia chatelainiana, Eremophila latrobei, Chrysopogon fallax.* Undesirable perennials include: *Acacia cuspidifolia.* Pastoral use limitations: Slight susceptibility to erosion by wind and water when degraded.
Frequent interfluvial foci, flat-bottomed and mostly < 100 m long. Soils are dark red gradational, loamy sand grading to sandy clay loams > 50 cm deep, pH 7.0 with a neutral trend; principal profile form: Uf 6.12.	**Unit 4 Drainage foci (5%) 1 site inventory and traversed** Close low woodlands dominated by *Acacia subtessarogona*. Trees (6-10 m): *A. subtessarogona*; Tall shrubs (2-3 m): *Cassia helmsii, Acacia sclerosperma, Stylobasium spathulatum, Rhagodia eremaea*; Low shrubs (< 2 m): *Ptilotus obovatus, Eremophila leucophylla, Acacia tetragonophylla, Maireana planifolia, Cassia desolata.*	Pasture type: *Acacia Short Grass Forb.* Perennials augumented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana planifolia, Rhagodia eremaea.* Pastoral use limitations: None under controlled stocking.
Drainage tracts, usually unchannelled. Soils are dark reddish brown sandy clays, > 1 m deep, pH 6.0 with a neutral trend; principal profile form: Uf 6.12.	**Unit 5 Drainage tracts (5%) 1 site inventory and traversed** Close low woodlands or tall shrublands dominated by *Acacia citrinoviridis*. Trees (4-8 m): *A. citrinoviridis, A. kempeana, A. aneura*; Tall shrubs (2-4 m): *A. tetragonophylla, A. victoriae, A. cuthbertsonii*; Low shrubs (< 2 m): *Cassia desolata, Eremophila cuneifolia, Ptilotus obovatus; Corchorus walcottii*; Perennial grasses: *Chrysopogon fallax.*	Pasture type: *Acacia Creek-line.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Chrysopogon fallax.* Undesirable perennials include: *Acacia victoriae.* Pastoral use limitations: Slight susceptibility to local water erosion when degraded.
Flat to mounded plains carrying channelled through drainage; slopes mainly about 0.5%. Soils have very variable A horizons, sands to fine sandy clays but generally with sandy clay B horizons, red to dark reddish brown, > 1 m deep, pH 6.5-7.0 with a neutral trend; principal profile forms: Gn 3.12, 4.12, Dr 4.12, Ug 5.28 and juvenile.	**Unit 6 Flood plains (10%) 5 site inventories and traversed** Very scattered to moderately close tall shrublands and low woodlands dominated by *Eucalyptus coolabah, Acacia tetragonophylla* and *Eriachne benthamii*. Trees (< 25-150/ha; 2-10 m): *Eucalyptus coolabah, Acacia cuspidifolia*; Tall shrubs (< 25-300/ha): *A. tetragonophylla, A. victoriae, A. subtessarogona, A. xiphophylla, A. cuthbertsonii*; Low shrubs (600-1400/ha; < 2 m): *Cassia desolata, Rhagodia eremaea, Corchorus walcottii, Enchylaena tomentosa, Solanum lasiophyllum*; Perennial grasses: *Eriachne benthamii, Chrysopogon fallax, Eulalia fulva.*	Pasture type: *Tussock Grass.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Chrysopogon fallax, Rhagodia eremaea.* Undesirable perennials include: *Acacia victoriae, Solanum lasiophyllum.* Pastoral use limitations: Moderate susceptibility to erosion when degraded.

Windalia land system 850 km² (1.1% of survey area)

Narrow, dissected upper interfluvial plains and broad lower plains supporting tall shrublands of various acacias.

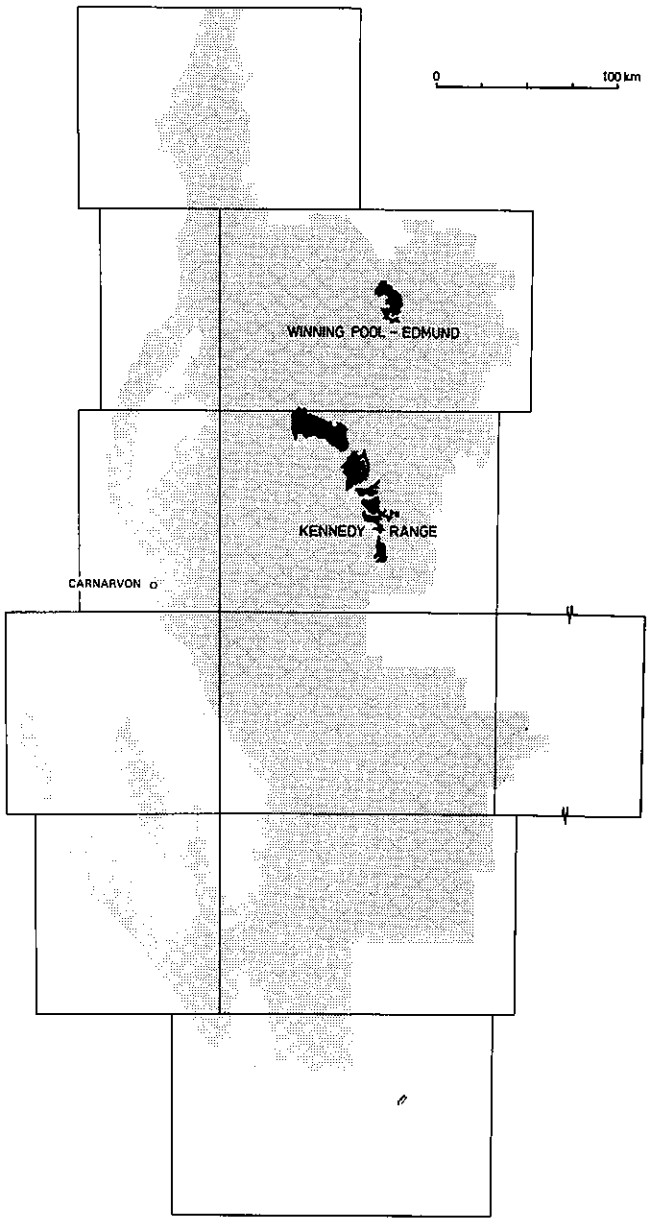
Geology: Cretaceous Windalia Radiolarite with minor Quaternary alluvium and colluvium.

Geomorphology: Gently sloping peneplains surrounding isolated residual mesas and rises; erosional surfaces mantled by radiolarite fragments; drainage dendritic to radial and of moderate intensity, mainly unchannelled.

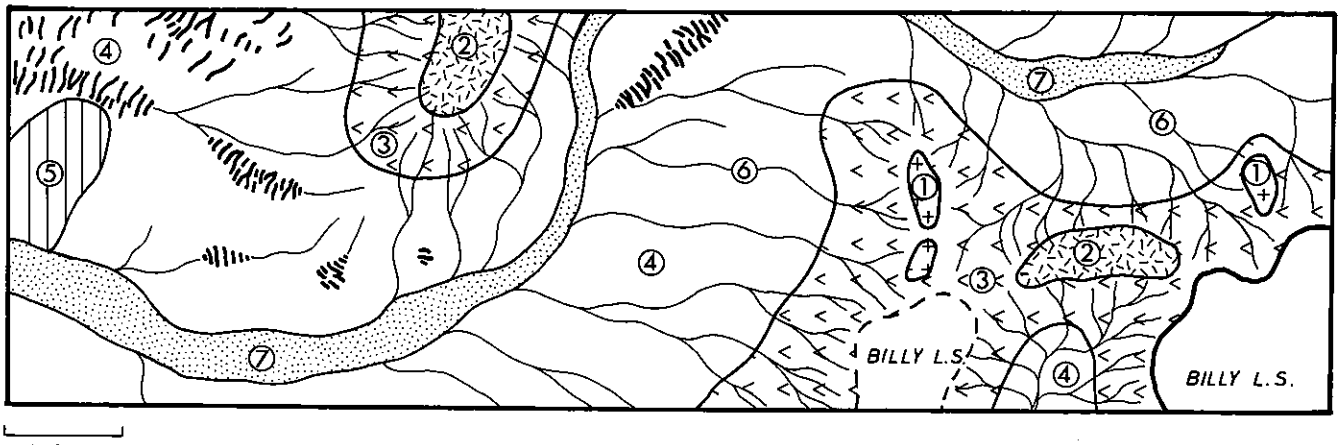
Pastoral use: Predominantly Acacia Short Grass Forb (ASGF) pastures, but some more productive Stony Chenopod (STCH) and Acacia Creek-line (ACCR) pastures also occur; when in good condition a fair supply of palatable shrubs confer some drought durability. Extensive mantling by radiolarite pebbles and gravels reduces the risk of erosion on the interfluvial slopes and alluvial units.

Estimated carrying capacity, good condition: 15 ha/s.u.

Range condition summary: good 45%; fair 35%; poor 20%.



Unit
1 & 2 Low mesas and stony rises
3. Upper interfluvial plains
4. Lower plains
5. Alluvial plains
6. Drainage tracts and drainage lines



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Units 1 & 2 Low mesas and stony rises (5%) 1 site inventory and traversed	
Mesas, plateaux and stony rises mostly 40-55 m above unit 7, moderately to densely strewn with radiolarite pebbles. Soils are dark red loamy sands, shallow to very shallow, with radiolarite fragments, pH 7.0 with a neutral trend; principal profile form: Uc 1.23.	Scattered tall shrublands dominated by *Acacia subtessarogona*. Trees and tall shrubs (2-6 m): *A. subtessarogona, A. sclerosperma, A. victoriae*; Low shrubs (< 2 m): *Cassia helmsii, Solanum lasiophyllum, Heterodendrum oleaefolium, Eremophila leucophylla, Corchorus walcottii.*	Pasture type: *Acacia Short Grass Forb.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Upper interfluvial plains (30%) 3 site inventories and traversed	
Flat to convex surfaces, slopes 2-4%, moderately to densely strewn with radiolarite gravels. Soils are red to reddish-brown loamy sands to sandy loams, 40-80 cm deep, with radiolarite fragments, pH 6.0-8.0 with neutral or acid trends; principal profile forms: Gn 2.12,Uc 6.11, Um 5.21.	Very scattered to close tall shrublands dominated by *Acacia subtessarogona*. Tall shrubs (< 25-600 ha): *A. subtessarogona, A. aneura, A. victoriae, A. pruinocarpa, Canthium* spp; Low shrubs (1400-3500/ha; < 1 m): *Eremophila leucophylla, Cassia desolata, Frankenia* spp, *Ptilotus schwartzii, Cassia helmsii, Tribulus platypterus.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Phyllanthus* sp., *Tribulus platypterus, Maireana* spp. Undesirable perennials include: *Acacia victoriae, Cassia* spp. Pastoral use limitations: Slight susceptibility to water erosion when degraded.
	Unit 4 Lower plains (50%) 2 site inventories and traversed	
Flat plains with slopes < 0.5%, sparsely to moderately strewn with radiolarite or conglomerate gravels. Soils are red or dark red sands or loams, loamy sand grading to light sandy clay loam, 0.5-> 1 m deep, pH 5.5-6.5 with an acid trend; principal profile form: Uc 5.21.	Tall or low shrublands with vegetation tending to an irregular groving of denser patches dominated by *Acacia subtessarogona*, and *Eremophila leucophylla*. Trees (0-150/ha; 4-6 m): *Acacia aneura, A. pruinocarpa*; Tall shrubs (< 25-150/ha; 2-6 m); *A. subtessarogona, A. aneura, Hakea preissii*; Low shrubs (450-5500/ha): *Eremophila leucophylla, Frankenia* spp, *Eremophila* aff. *leucophylla, Cassia helmsii, Solanum lasiophyllum, Phyllanthus* sp. (RC 1928).	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include. *Phyllanthus* sp., *Eremophila leucophylla, Ptilotus polakii, Maireana planifolia.* Undesirable perennials include: *Hakea preissii.* Pastoral use limitations: None under controlled stocking.
	Unit 5 Alluvial plains (10%) 1 site inventory and traversed	
Localised areas of flat to gently sloping alluvial, often saline, plains, lightly to moderately strewn with radiolarite gravels. Soils are red duplex type, loamy sand over sandy clay, > 1 m deep with radiolarite fragments throughout, pH 6.5 with a neutral trend, principal profile form: Dr 1.12.	Scattered shrublands dominated by *Acacia xiphophylla* and *A. victoriae.* Tall shrubs (> 2 m): *A. xiphophylla, A. victoriae, A. cuspidifolia*; Low shrubs (< 1 m): *Ptilotus polakii, Eremophila cuneifolia, Cassia desolata, Acacia tetragonophylla, Lawrencia* spp, *Frankenia* spp; Perennial grasses: *Cenchrus ciliaris.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Ptilotus polakii, Enchylaena tomentosa, Scaevola spinescens.* Undesirable perennials include: *Acacia victoriae, Solanum lasiophyllum.* Pastoral use limitations: Slight susceptibility to water erosion when degraded.
	Unit 6 & 7 Drainage lines and tracts (5%) 1 site inventory and traversed	
Upper unchannelled lines of moderate intensity feeding broad lower tracts, more or less channelled, in dendritic to radial patterns. Soils are sandy, loamy or clayey types, > 1 m deep, pH 7.0 with a neutral trend and radiolarite fragments throughout; principal profile form: Um 5.52.	Fringing shrublands, often close or closed, dominated by *Acacia subtessarogona*. Tall shrubs: *A. subtessarogona, A. aneura, A. sclerosperma, A. tetragonophylla, Santalum lanceolatum, Pimelea microcephala*; Low shrubs: *Ptilotus obovatus, Cassia helmsii, Eremophila leucophylla, Rhagodia eremaea, Enchylaena tomentosa, Corchorus walcottii.*	Pasture type: *Acacia Creek-line.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Enchylaena tomentosa, Rhagodia eremaea.* Pastoral use limitations: None under controlled stocking.

Winning land system 722 km² (1.0% of survey area)

Low hills and broad plains supporting tall shrublands of snakewood and other acacias with some saltbush and soft spinifex.

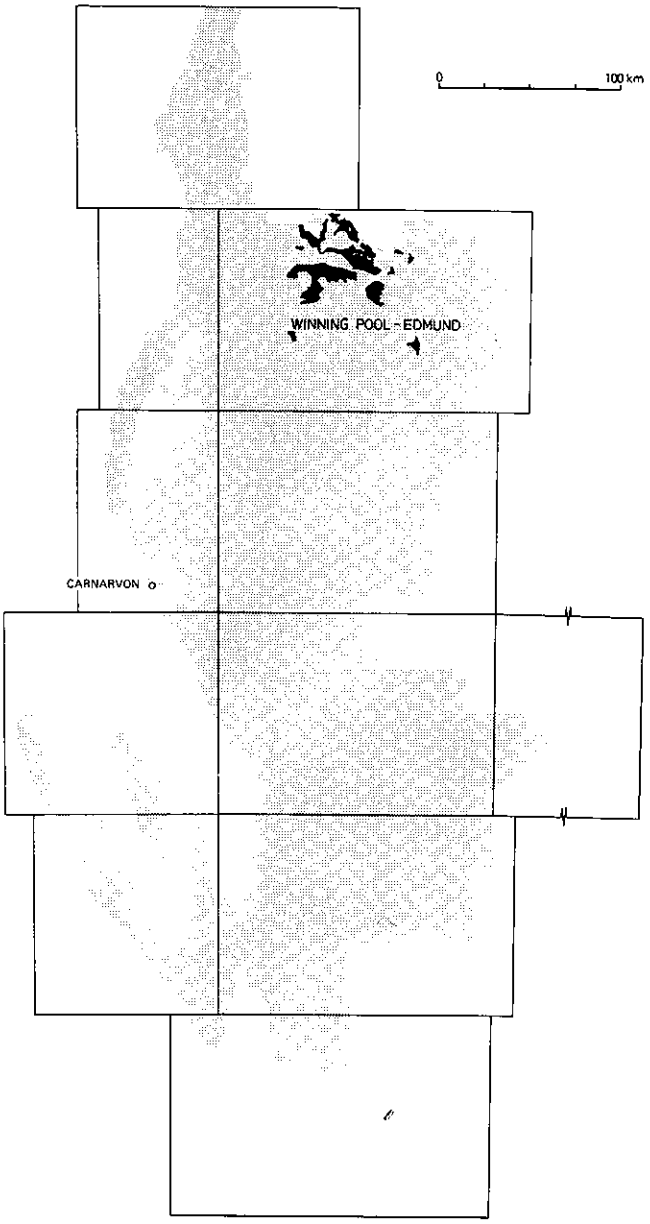
Geology: Lower Cretaceous siltstones of the Winning group.

Geomorphology: Erosional and depositional surfaces: low hills and ridges with stripped margins and incised parallel drainage above interfluvial slopes and lower plains with duplex soils and receiving run-on; relief up to 45 m but mostly 15-25 m.

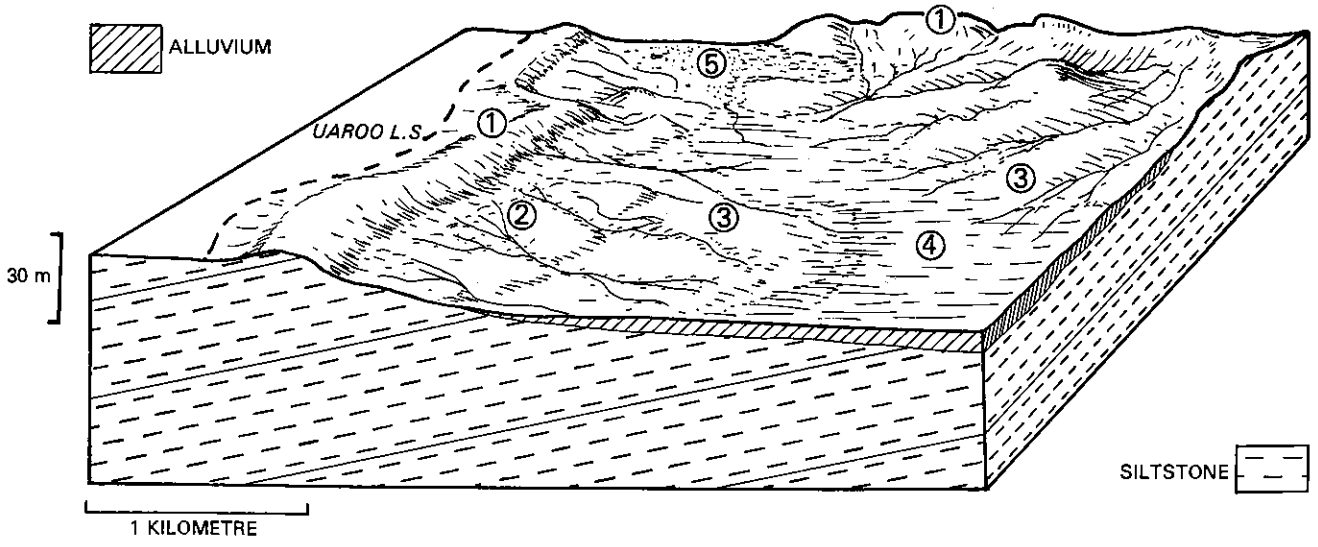
Pastoral use: A productive system of Bluebush (BLUE) and Soft Spinifex (SOSP) pastures, conferring drought durability when in good condition, but major units 3 and 4 susceptible to scalding and sealing when degraded.

Estimated carrying capacity, good condition: 6 ha/s.u.

Range condition summary: good 12%; fair 29%; poor 58%.



Unit
1. Low hills and rises
2. Dissected slopes
3. Interfluvial lower slopes
4. Low plains
5. Sandy plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Low hills and rises (10%) Traversed	
Rounded or flat-topped hills, 15-45 m above unit 4, ridges and stripped margins with parallel dissections, usually densely mantled with cobbles and boulders. Soils are skeletal, in pockets.	Hummock grasslands dominated by *Triodia lanigera* and *T. pungens*, with a very scattered upper storey of shrubs *Acacia bivenosa* and *Cassia* spp.	Pasture type: *Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 2 Dissected slopes (15%) Traversed	
Narrow slopes (mainly 1 to 4%) with parallel to dendritic drainage channels of moderate to high density and incised to 1m depth. Soils are reddish-brown calcareous sandy loams over calcrete, mostly shallow and densely mantled with calcareous gravels; principal profile form probably Um 1.13.	Very scattered low shrublands dominated by *Acacia victoriae*, *Cassia* spp, *Eremophila* spp with an understorey of *Triodia pungens* and other hummock grasses	Pasture type: *Soft Spinifex.* Perennials augmented by annual grasses and forbs in favourable seasons Pastoral use limitations: None under controlled stocking.
	Unit 3 Interfluvial lower slopes (30%) 2 site inventories and traversed	
Flat to puffy, convex surfaces, slopes 1-1.5%, up to 4m above drainage lines, moderately to densely mantled with quartzite gravels and pebbles. Soils are dark red duplex or juvenile types, sandy loam to fine sandy clay loam over sandy clay loam or sandy loam, 70 cm to > 1 m deep, pH 6.5-8.0 with neutral or alkaline trends; principal profile form: Dr 1.13.	Scattered tall shrublands dominated by *Acacia xiphophylla* or *A. cuspidifolia*, with understorey *Ptilotus polakii*. Trees and tall shrubs (< 25-250/ha; 2-4 m): *A. cuspidifolia, A. xiphophylla A. victoriae, A. tetragonophylla*; Low shrubs (1000-7500/ha, < 2 m): *Ptilotus polakii, Scaevola spinescens, Eremophila cuneifolia, E. latrobei, E. leucophylla, Frankenia* spp, *Maireana polypterygia*; Perennial grasses: *Enteropogon acicularis.*	Pasture type: Bluebush. Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana polypterygia, Ptilotus polakii, Scaevola spinescens.* Undesirable perennials include: *Acacia cuspidifolia, A. victoriae.* Pastoral use limitations: Mild susceptibility to water erosion when degraded.
	Unit 4 Low plains (40%) 3 site inventories and traversed	
Flat to gently sloping plains with mounded surfaces, locally with a sparse mantle of calcrete gravels. Soils are dark red to reddish-brown duplex or calcareous gradational types, sandy loams over fine sandy to light medium clays, > 1 m deep, with or without calcareous and quartzite inclusions, pH 7.0 with an alkaline trend; principal profile forms: Dr 1.12, 1.13, Gc 2.22.	Very scattered to scattered shrublands dominated by *Acacia xiphophylla.* Tall shrubs (< 25-175/ha; 2-3 m): *A. xiphophylla, A. tetragonophylla, Hakea preissi*; Low shrubs (250-5500/ha; < 1.5 m): *Atriplex bunburyana, Maireana pyramidata, Eremophila cuneifolia, Ptilotus polakii, Cassia desolata, Enchylaena tomentosa, Rhagodia eremaea*; Perennial grasses: *Enteropogon acicularis, Eragrostis xerophila.*	Pasture type: *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana* spp, *Atriplex bunburyana, Ptilotus polakii.* Undesirable perennials include: *Hakea preissii, Solanum lasiophyllum.* Pastoral use limitations: Mild susceptibility to erosion, by wind and water, when degraded.
	Unit 5 Sandy plains (5%) Traversed	
Flat plains, mainly low-lying and isolated. Soils are dark red loamy sands.	Hummock grasslands dominated by *Triodia pungens*, with a few tall shrubs, mainly *Acacia xiphophylla, A. victoriae.*	Pasture type: *Soft Spinifex.* Pastoral use limitations: None under controlled stocking.

Wooramel land system (G) 643 km² (0.9% of survey area)

Sandy plains and hardpan plains supporting wanyu shrublands and mulga woodlands.

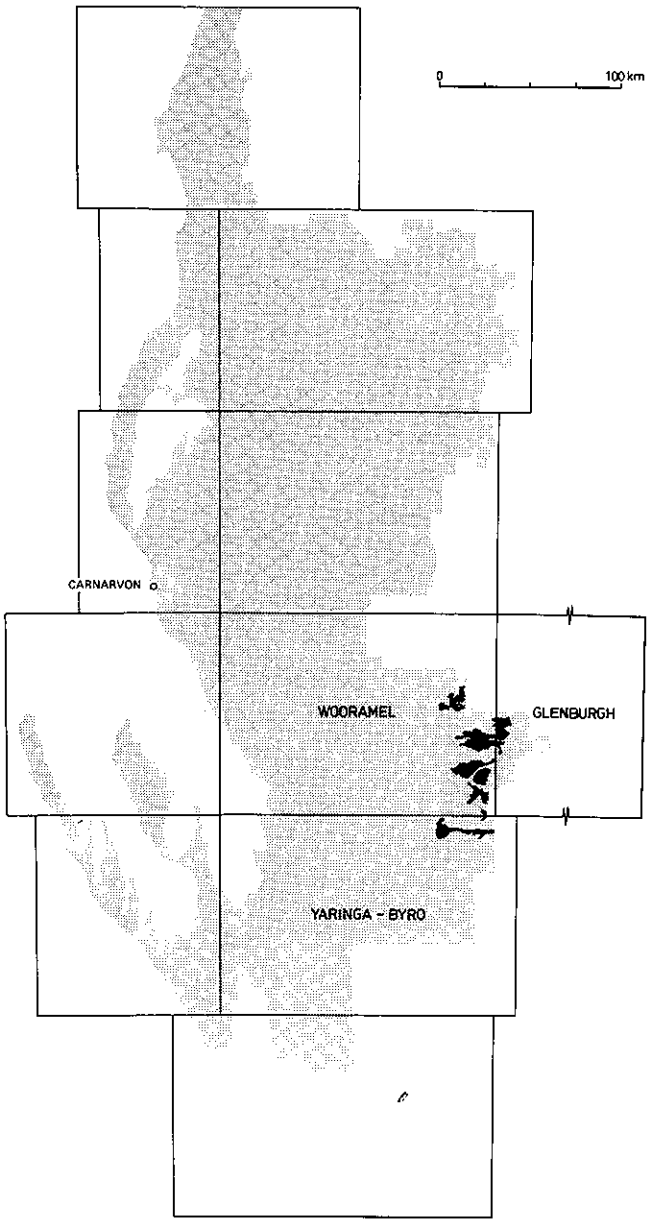
Geology: Quaternary partly consolidated alluvial and colluvial deposits and aeolian sand.

Geomorphology: Depositional surfaces: flat to gently undulating plains of alluvium, sandy banks and sandy plains with minor areas of hardpan plains and stony plains dissected by sluggish drainage zones; relief up to 8 m.

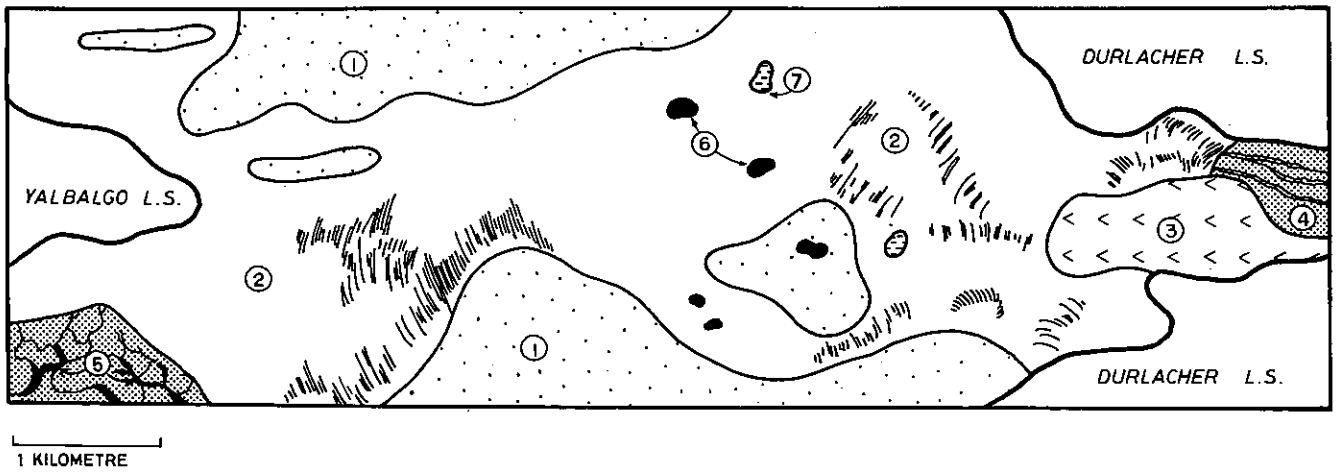
Pastoral use: Acacia Sandplain (ACSA) and Acacia Short Grass Forb (ASGF) pastures; system not prone to erosion.

Estimated carrying capacity, good condition: 14 ha/s.u.

Range condition summary: good 36%; fair 28%; poor 36%.



Unit
1. Sandy banks and sand sheets
2. Sandy-surfaced plains
3. Hardpan plains
4. Stony plains
5. Narrow drainage lines
6. Drainage foci
7. Claypans



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Sandy banks and sand sheets (30%) 2 site inventories and traversed	
Sandy banks and sand sheets up to 2 m above units 2 or 3, slopes up to 1%. Soils are dark red or dark reddish brown loamy sands with increasing clay content down profile, > 1 m deep, locally with sparse quartz gravel strew and siliceous or ferruginous inclusions, pH 5.5-6.0 with an acid trend; principal profile form: Uc 5.21.	(i) Scattered to moderately close tall shrublands dominated by *Acacia ramulosa* and *Eremophila leucophylla*. (ii) Moderately close low shrublands dominated by *E. leucophylla* with scattered low trees and tall shrubs. PFC 10 to 25%; Trees (< 25/ha): *Eucalyptus dichromophloia, Acacia pruinocarpa, A. aneura, Canthium lineare*; Tall shrubs (25-125/ha; 2-3 m): *Acacia ramulosa*; Low shrubs (1000-3000/ha, 0.5-1.5 m): *Eremophila leucophylla, Chorizema ericifolium, Acacia* aff. *coolgardiensis, Ptilotus schwartzii, Eremophila latrobei, Solanum lasiophyllum*; Perennial grasses: *Monachather paradoxa, Eragrostis lanipes, Eriachne helmsii.*	Pasture type: *Acacia Sandplain.* Low shrub association (ii) is probably a slow-changing, mid-successional stage following loss of the *A. ramulosa* tall shrub layer to fire, drought or senescence. Increased *Eremophila leucophylla* (on sites in good condition) provides useful drought reserve. Annual grasses and forbs present in favourable seasons. Desirable perennials include: *Maireana planifolia, Eremophila latrobei, E. leucophylla.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Sandy-surfaced plains (55%) 8 sites inventories and traversed	
Flat plains with or without sparse surface gravels, slopes 0.1-0.8%. Soils are dark red or dusky red sandy clay loam or clayey sand grading to light sandy clay loam, 45 cm to > 1 m deep, with or without weak pan development or gravel inclusions (quartz, ironstone or mixed), pH 5.5-6.5 with acid or neutral trends; principal profile forms: Gn 4.12, 4.11, 2.11, Um 6.13, 6.23, Uc 5.11, 5.13	Moderately close tall shrublands often occurring as groves, with sparse trees, dominated by *Acacia aneura, A. ramulosa* and *Eremophila leucophylla*. PFC 15 to 30%; Trees (0-400/ha, 4-8 m): *A. aneura, A. pruinocarpa, Eucalyptus coolabah, Canthium lineare, C. attenuatum*; Tall shrubs (50-500/ha; 2-3 m): *Acacia ramulosa, A.* aff. *coolgardiensis, A. tetragonophylla, Cassia* spp, *Scaevola spinescens*; Low shrubs (800-4000/ha, 0.5-2 m): *Eremophila leucophylla, Ptilotus obovatus, Cassia desolata, Maireana planifolia, Chorizema ericifolium, Eremophila gibsonii*; Perennial grasses: *Monachather paradoxa, Eriachne helmsii, Eragrostis lanipes.*	Pasture type: *Acacia Sandplain* or *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila latrobei, Maireana planifolia, Maireana convexa.* Undesirable perennials include: *Chorizema ericifolium, Cassia desolata.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Hardpan plains (5%) 1 site inventory and traversed	
Flat plains with little or no slope. Soils are dark red sandy loam containing quartz gravel, underlain by hardpan at variable depth, pH 5.0-6.0 with an acid trend; principal profile form: Uc 5.21.	Moderately close shrublands about 2 m high, dominated by *Acacia* aff *coolgardiensis* with sparse tall and low shrubs. Tall shrubs (600/ha, 2-3 m): *A. ramulosa, A. murrayana, A. cuthbertsonii*; Low shrubs (2000/ha;1-2 m): *Acacia* aff *coolgardiensis, Eremophila leucophylla, Eremophila gibsonii, Ptilotus schwartzii, Maireana planifolia, Maireana convexa*; Perennial grasses: *Monachather paradoxa, Eriachne helmsii.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana planifolia, M. convexa.* Pastoral use limitations: None under controlled stocking.
	Unit 4 Stony plains (5%) Traversed	
Small areas of gently undulating plains with a sparse to moderate mantle of calcrete, quartzitic and ferruginised pebbles. Soils are shallow acidic loams underlain by hardpan.	Very scattered or scattered shrublands of *Acacia aneura, A. cuthbertsonii, A. tetragonophylla, Eremophila fraseri, E. freelingii, Cassia desolata, C. helmsii.*	Pasture type: *Acacia Short Grass Forb.* Very sparse edible perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 5 Narrow drainage lines (< 1%) 1 site inventory and traversed	
Mixed alluvial deposits, locally calcreted. Sluggish unchannelled drainage zones, slopes 0.1-0.3%. Soils are dark red sandy clay loam, > 1 m deep, pH 6.5 with a neutral trend; principal profile form: Um 6.24.	Moderately close low woodlands dominated by *Acacia aneura.* Trees and tall shrubs (300/ha; 2-5 m): *A. aneura, Eucalyptus coolabah, Acacia ramulosa, A. tetragonophylla, A. pruinocarpa*; Low shrubs (700/ha; 1-2 m): *Ptilotus obovatus, Sida calyxhymenia, Chenopodium gaudichaudianum, Spartothamnella teucriiflora, Rhagodia eremaea*; Perennial grasses: *Monachather paradoxa.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 6 Drainage foci (1%)	
Small, rounded foci with clay soils.	Close shrublands dominated by *Acacia tetragonophylla, A. aneura* and *A. cuthbertsonii.*	Pasture type: *Acacia Creek-line.* Pastoral use limitations: None with controlled stocking.
	Unit 7 Claypans (1%)	
Small, bare claypans.	Usually unvegetated.	

Yagina land system 120 km² (0.2% of survey area)

Stony plains and alluvial plains with occasional low dunes and claypans; sparse tall shrublands.

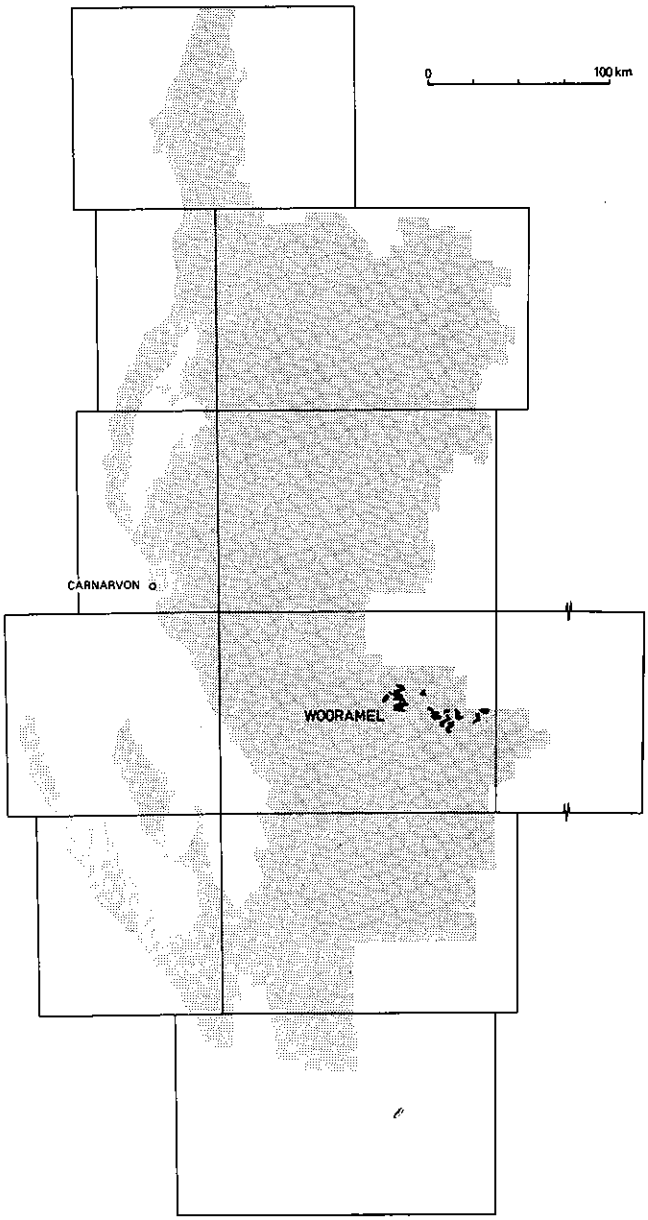
Geology: Quaternary, mixed alluvium and other poorly sorted deposits; minor areas of aeolian sand.

Geomorphology: Depositional surfaces with internal drainage; stony plains, hardpan plains, alluvial plains, sandy banks, low dunes and claypans; relative relief mostly < 6 m.

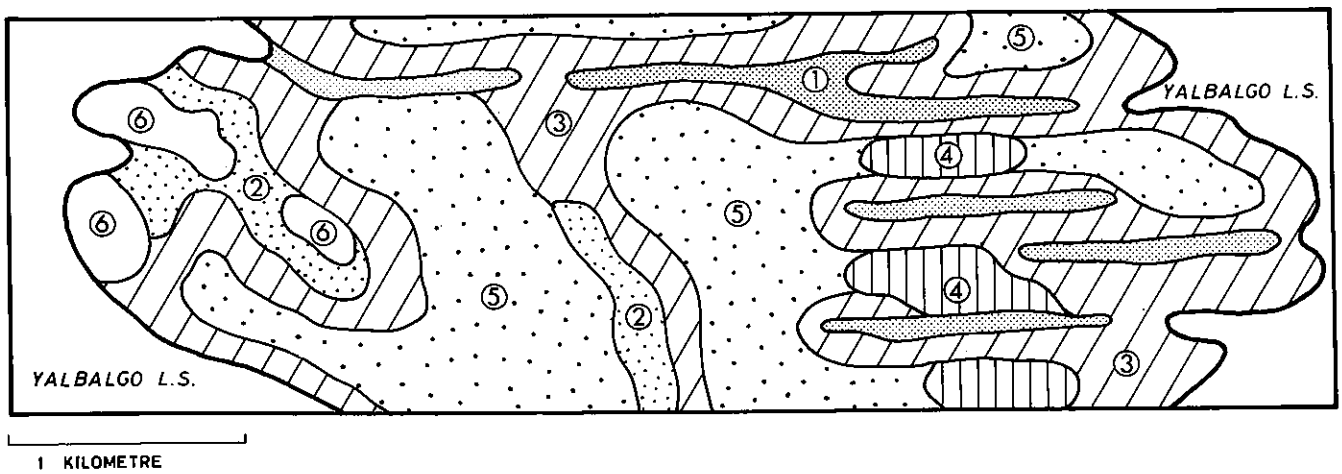
Pastoral use: Acacia Short Grass Forb (ASGF) pasture of which the most productive unit (alluvial plains) is now mostly degraded; system not prone to erosion.

Estimated carrying capacity, good condition: 14 ha/s.u.

Range condition summary: good 20%; fair 55%; poor 25%.



Unit
1. Longitudinal dunes
2. Sandy banks
3. Hardpan plains
4. Alluvial plains
5. Stony plains
6. Claypans



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal dunes (10%) Traversed	
Small linear dunes up to 10 m high. Soils are probably dark red unconsolidated sands, > 1 m deep, pH 5.5-6.0 with acid or neutral trends; principal profile form: Uc 1.23.	Scattered tall shrublands dominated by *Acacia ramulosa*. Tall shrubs (2-4 m): *A. ramulosa, A. sclerosperma, Hakea suberea*; Low shrubs (< 1.5 m): *Eremophila leucophylla, Solanum lasiophyllum, Chorizema ericifolium*; Perennial grasses: *Monachather paradoxa, Eriachne helmsii.*	Pasture type: *Acacia Sandplain.* Desirable perennials include: *Monachather paradoxa.* Undesirable perennials include: *Chorizema ericifolium.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Sandy banks (10%) Traversed	
Sandy banks 1-2 m above adjacent plains. Soils are probably dark red or reddish brown loamy sands.	Scattered tall shrublands similar to unit 1, but *Acacia aneura* more frequently co-dominant.	Pasture type: *Acacia Sandplain.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Hardpan plains (25%) 2 site inventories and traversed	
Plains, gently sloping (up to 1%), sparsely strewn with quartzite pebbles or gravels. Soils are dusky red or dark red, shallow sandy clay loam over hardpan, or deeper (> 1 m) sandy-surfaced loams with siliceous gravel inclusions, pH 5.5-6.5 with acid or neutral trends; principal profile forms: Um 1.43, Gn 2.11.	Scattered to moderately close tall shrublands dominated by *Acacia aneura* and variable low shrubs. PFC 15 to 25%; Trees (< 100/ha; 4-6 m): *A. aneura*; Tall shrubs (100-225/ha; 2-3 m): *A. ramulosa, A. tetragonophylla, A.* aff. *coolgardiensis, Grevillea* sp., *Eremophila fraseri*; Low shrubs (1000-2000/ha; < 1 m): *E. leucophylla, E. platycalyx, E. fraseri, Maireana planifolia, Cassia helmsii, Chorizema ericifolium*; Perennial grasses: *Monachather paradoxa.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila latrobei, Rhagodia eremaea, Maireana planifolia.* Pastoral use limitations: None under controlled stocking.
	Unit 4 Alluvial plains (10%) Traversed	
Narrow alluvial plains mainly occurring as the central parts of broad, flat swales between low dunes. Soils are probably dark red duplex types.	Scattered tall shrublands dominated by *Acacia xiphophylla.* Tall shrubs: *A. xiphophylla, A. tetragonophylla, Hakea preissii, Eremophila pterocarpa*	Pasture type: *Acacia Short Grass Forb.* Probably formerly *Saltbush* (*Acacia xiphophylla - Atriplex bunburyana* shrublands). Perennials augmented by annual grasses and forbs in favourable seasons. Undesirable perennials include: *Hakea preissii, Eremophila pterocarpa.* Pastoral use limitations: Liable to invasion by unpalatable shrubs when degraded.
	Unit 5 Stony plains (40%) 2 site inventories and traversed	
Stony plains with up to 6 m relative relief and 12% slope, very sparsely to densely strewn with ironstone gravel and quartzite cobbles. Soils are dark red loamy sand to sandy loam 50 cm deep or less, pH 5.5-6.0, principal profile forms: Uc 1.43, Uc 6.13.	Very scattered to scattered shrublands; (i) low shrublands dominated by *Acacia* aff. *coolgardiensis*; Tall shrubs (< 25/ha; 1.2-2 m): *A. ramulosa, A. tetragonophylla;* Low shrubs (1800/ha; 0.5-2 m): *A.* aff. *coolgardiensis, Ptilotus schwartzii, Maireana planifolia, Chorizema ericifolium, Eremophila leucophylla, E. gibsonii, Sida virgata*; Perennial grasses: *Monachather paradoxa, Eragrostis lanipes*; (ii) Very sparse low shrublands dominated by *Eremophila fraseri* and *Cassia* spp; Tall shrubs: *Acacia victoriae, A. aneura*; Low shrubs (650/ha; 0.5-2 m): *Eremophila fraseri, Cassia luerssenii, C. desolata, C. helmsii, Maireana planifolia, Eremophila latrobei.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eremophila latrobei, E. leucophylla, Maireana planifolia.* Pastoral use limitations: None under controlled stocking.
	Unit 6 Claypans (5%) Traversed	
Bare, flat claypans with crusted, glazed and cracked surfaces when dry, fringed by sandy banks	No perennial vegetation other than a scattered to moderately close fringing shrubbery of *Melaleuca uncinata, Sclerolaena* spp and occasionally trees *Eucalyptus coolabah.*	

Yalbalgo land system (G) 7864 km² (10.6% of survey area)

Aeolian sandplain with linear and occasionally reticulate dunes and broad swales supporting tall acacia shrublands with under-storey shrubs or hard spinifex.

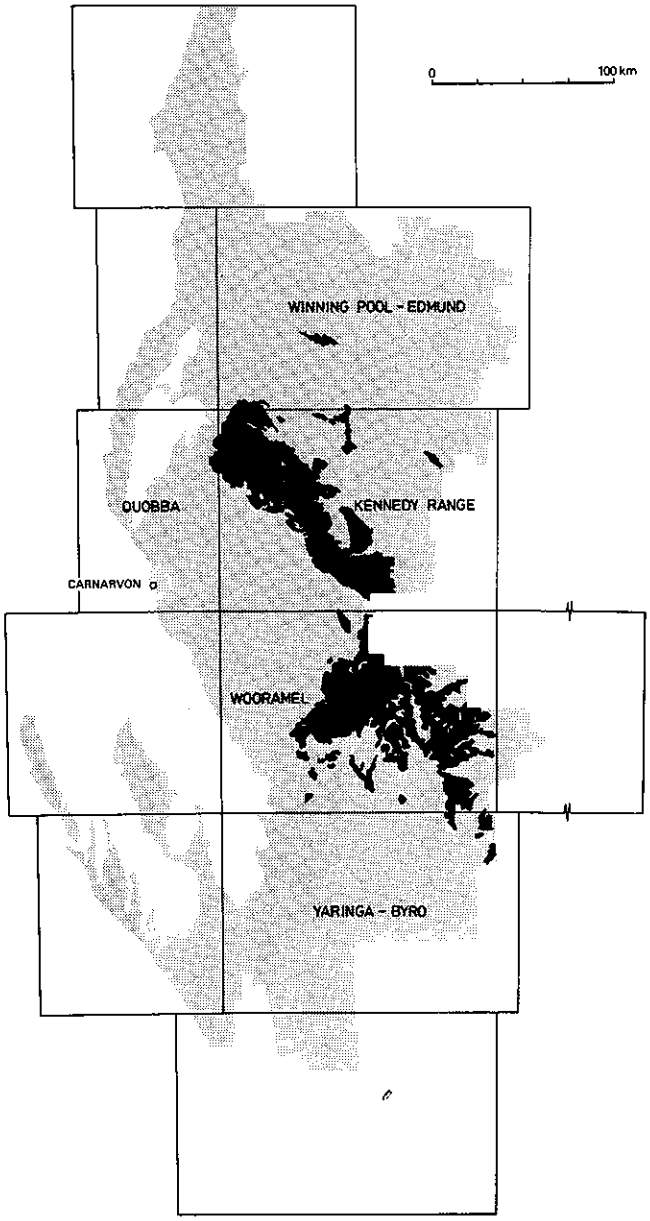
Geology: Quaternary aeolian sand.

Geomorphology: Depositional surfaces: sandy plains of low relief, with very long parallel to reticulate dunes, mostly 0.5-1.5 km apart and 10-15 m high. Drainage patterns are absent or represented only by scattered foci which drain minor interdunal plains.

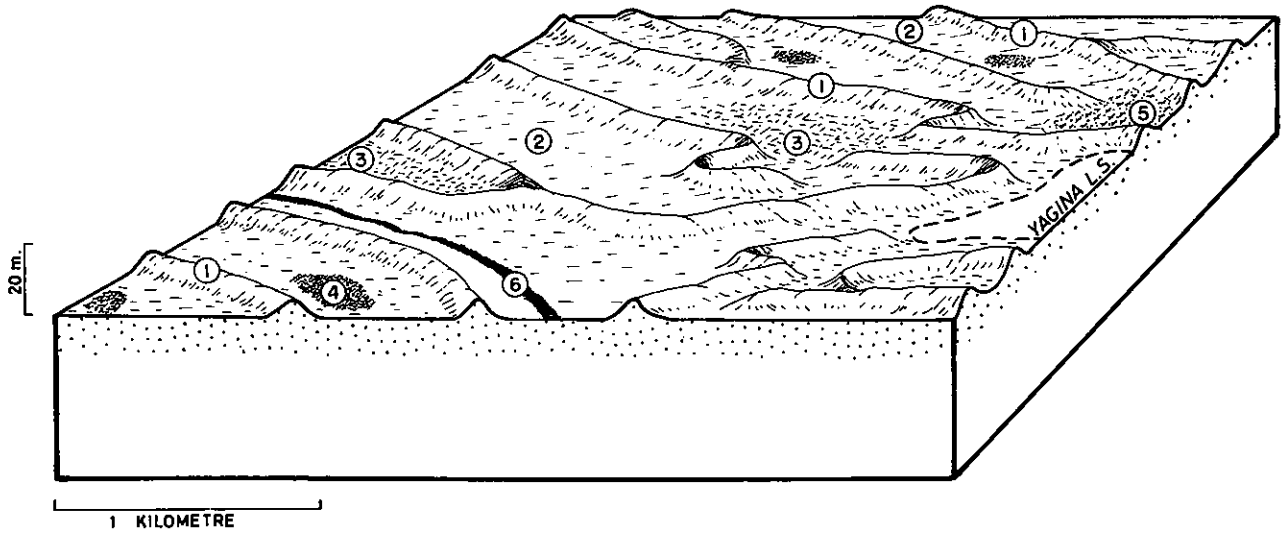
Pastoral use: Acacia Sandplain (ACSA) pastures with some edible drought-resistant low shrubs and sparse wanderrie grasses; Hard Spinifex (HASP) pasture locally in the north and east. The dunes are stable and the system is not prone to erosion.

Estimated carrying capacity, good condition: Acacia Sandplain 12 ha/s.u., Hard Spinifex 20 ha/s.u.

Range condition summary: good 47%; fair 37%; poor 16%.



Unit
1. Linear dunes
2. Sandy swales
3. Interdunal plains
4. Drainage foci
5. Restricted stony plains
6. Sandy drainage floors



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Linear dunes (25%) 5 site inventories and traversed	
Convergent to parallel longitudinal sand dunes, frequently 5-10 km long and mostly 10 to 20 m above intervening swales and plains, slopes up to 21%. Dune orientation approximates to E-W trending ENE-WSW in eastern areas. Soils are unconsolidated dark red or dusky red sand, > 1 m deep, pH 5.5-7.0 with neutral or acid trends; principal profile form: Uc 1.23.	(i) Very scattered to moderately close tall shrublands dominated by *Acacia sclerosperma* and *A. ramulosa*; (ii) moderately close low wood-lands dominated by *A. anastema*. (i) Tall shrubs (350-450/ha;): *A. ramulosa, A. sclerosperma, A. murrayana, Grevillea stenobotrya, Eremophila maitlandii*; Low shrubs (1400-2500/ha; < 2 m): *Gyrostemon ramulosus, Corynotheca lateriflora, Pityrodia* spp, *Pimelea microcephala, Solanum lasiophyllum, Verticordia* sp.; Perennial grasses: *Plectrachne schinzii, Eragrostis lanipes, Eriachne helmsii*; (ii) Trees (100-500/ha; 4-8 m): *A. anastema*; Low shrubs: *Corynotheca lateriflora, Cynanchum* spp, *Solanum lasiophyllum, Pityrodia* spp; Perennial grasses: *Eragrostis lanipes.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Low wood-lands of *A. anastema* occur only in the south of the region, *Plectrachne schinzii* only in the north. Desirable perennials include: *Eragrostis lanipes.* Pastoral use limitations: Steep slopes and soft sand discourage stock from. crossing dunes.
	Unit 2 Sandy swales (60%) 14 site inventories and traversed	
Broad sandy swales, flat or gently sloping (up to 1%). Soils are dark red or dusky red loamy sand or sandy loam, > 1 m deep, pH 5.5-8.0 with neutral or acid trends; principal profile forms: Uc 5.21, 1.23.	Very scattered to moderately close tall shrublands usually dominated by *Acacia ramulosa.* Trees (0-100/ha; 2-8 m): *A. anastema, A. pruinocarpa, Eucalyptus eudesmioides*; Tall shrubs (260±190/ha; 2-4 m): *Acacia ramulosa, A. subtessarogona, A. sclerosperma, A.* aff. *coolgardiensis, Stylobasium spathulatum, A. murrayana*; Low shrubs (1500±900; < 2 m): *Eremophila leucophylla, Maireana planifolia, Solanum lasiophyllum, Cassia helmsii, Ptilotus obovatus, Rhagodia eremaea*; Perennial grasses: *Triodia* sp., *Eragrostis lanipes, Monachather paradoxa, Eriachne helmsii, Plectrachne schinzii.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Ground cover of *Plectrachne schinzii* only in the north. Desirable perennials include: *Maireana* spp, *Tribulus platypterus, Cassia chatelainiana, Monachather paradoxa.* Undesirable perennials include: *Chorizema ericifolium, Cassia helmsii.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Interdunal plains (10%) 6 site inventories and traversed	
Flat plains, some sloping up to 1% and subject to sheet flow. Very sparse surface gravels occur locally. Soils have a higher clay content than unit 2 and are underlain by gravels or weak pan development: dusky red or dark red sandy loams to light sandy clay loams with increasing clay content down profile, 30 cm to > 1 m deep, pH 5.5-6.5 with neutral or acid trends; principal profile forms: Uc 5.21, 1.43, Um 6.24, Gn 3.11.	Scattered to moderately close tall shrublands dominated by *Acacia pruinocarpa* and *A. ramulosa.* Trees (up to 125/ha; 4-8 m): *A. pruinocarpa, A. aneura, Eucalyptus coolabah, Canthium lineare*; Tall shrubs (100-1000/ha; 2-4 m): *A. ramulosa, A.* aff. *coolgardiensis, A. tetragonophylla, A. sclerosperma*; Low shrubs (100-300/ha; < 1.5 m): *Ptilotus obovatus, Cassia helmsii, Eremophila leucophylla, E. fraseri, E. latrobei, Maireana planifolia*; Perennial grasses: *Monachather paradoxa, Eragrostis lanipes, Eriachne helmsii.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Tribulus platypterus, Eremophila latrobei, E. leucophylla, Monachather paradoxa.* Undesirable perennials include: *Chorizema ericifolium, Eremophila fraseri.*
	Unit 4 Drainage foci (1%) 2 site inventories and traversed	
Discrete foci with flat or mounded surfaces. Soils are dusky red sandy loam, < 1 m deep, pH 5.5-6.0 with an acid trend; principal profile form: Uc 5.21	Close tall shrublands dominated by *Acacia pruinocarpa* and *A. ramulosa.* Trees (5-10 m; > 25/ha): *A. pruinocarpa;* Tall shrubs (250-350/ha; 2-5 m): *A. ramulosa, A. tetragonophylla;* Low shrubs (2000-4500/ha; < 1 m): *Ptilotus obovatus, Eremophila leucophylla, E. latrobei, Maireana planifolia;* Perennial grasses: *Monachather paradoxa.*	Pasture type: *Acacia Sandplain.* Desirable perennials include: *Eremophila Latrobei, Tribulus platypterus, Maireana planifolia.*
	Unit 5 Restricted stony plains (2%) 1 site inventory and traversed	
Restriced interdunal plains with rock outcropping (or at shallow depth) and strewn with quartzite cobbles. Soils are red loamy sand, < 50 cm deep, pH 5.5 with an acid trend; principal profile form: Uc 1.43.	Moderately close low shrublands by *Acacia* aff. *coolgardiensis.* Trees: *A. pruinocarpa:* Tall shrubs: *A. ramulosa;* Low shrubs: *A.* aff. *coolgardiensis, Ptilotus schwartzu, Remophila latrobei, Solanum orbiculatum, Cassia chatelaintana;* Perennial grasses: *Monachather paradoxa.*	Pasture type: *Acacia Short Grass Forb.* Desirable perennials include: *Eremophilia latrobei, Cassia chatelainiana.*
	Unit 6 Sandy drainage floors (1%)(hs2p)Traversed	
Drainage tracts with minor channelling. Soils are probably sandy loams	*Variable woodlands or shrublands dominated by Eucalyptus coolabah, Acacia* spp. and space perennial grasses *Cenchrus ciliaris.*	

Yalkalya land system 131 km² (0.2% of survey area)

Saline alluvial plains and stony rises and platforms of calcrete, supporting scattered tall acacia shrublands and low shrublands of saltbush, bluebush and frankenia.

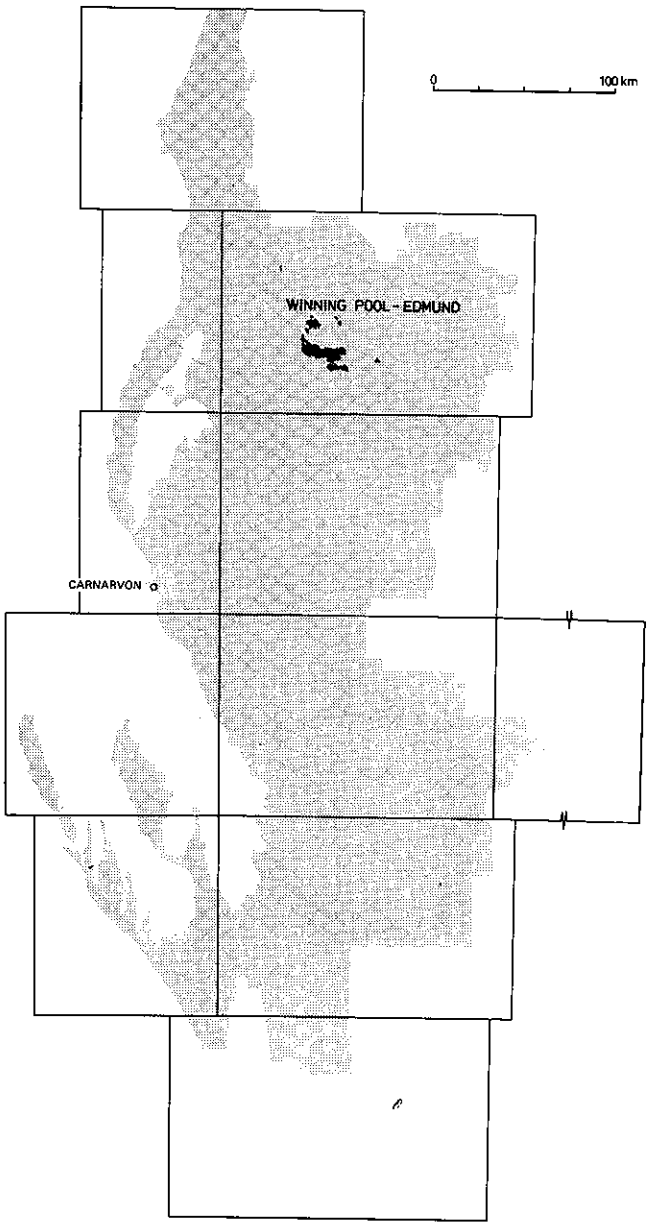
Geology: Quaternary alluvium: clay, silt, sand and gravel, partly calcreted; local colluvium.

Geomorphology: Mainly depositional surfaces: alluvial slopes and plains receiving sheet flow above seasonally inundated plains with braided through drainage and scattered drainage foci, minor calcrete outcrop plains.

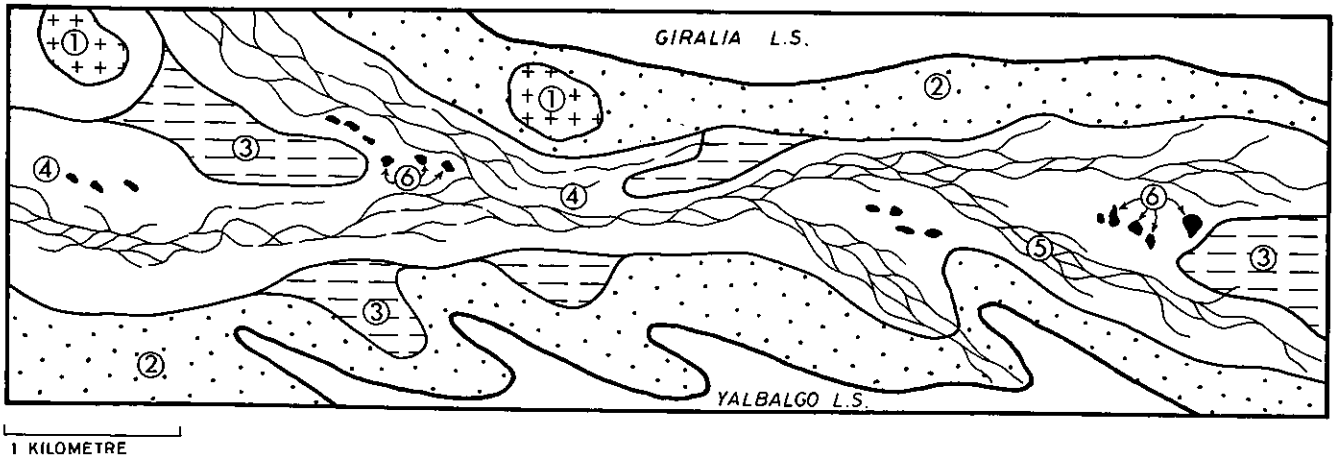
Pastoral use: Saltbush (SALT) and Bluebush (BLUE) pastures with highly productive and drought resistant chenopod shrubs when in good condition, minor Hard Spinifex (HASP) pastures. High salinity levels necessitate a close distribution of watering points for optimal use; units 2, 4 and 5 are susceptible to erosion, mainly by water.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: good 58%; fair 17%; poor 25%.



Unit
1. Calcrete rises
2. Upper plains
3. Lower saline plains
4. Flood plains
5. Drainage lines
6. Drainage foci



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Calcrete rises (5%) 1 site inventory and traversed	
Low rises and platforms with mounded or rocky calcreted surfaces, sparsely to densely strewn with pebbles or gravels, up to 6 m above lower units. Soils are red loamy sands usually shallow (< 50 cm) but sometimes > 1 m calcareous throughout; pH 8.0 with an alkaline trend; principal profile form: Uc 1.13.	Hummock grasslands with very scattered, mainly low shrub overstorey. Tall shrubs: *Acacia xiphophylla, A. victoriae*; Low shrubs (< 1.5 m): *Eremophila latrobei, E. cuneifolia, Maireana polypterygia, Cassia desolata, Maireana planifolia, Rhagodia eremaea*; Perennial grasses: *Triodia* spp (up to 45% ground cover).	Pasture type: *Hard Spinifex.* Indicators of good condition: *Maireana* spp., *Eremophila latrobei.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Upper plains (40%) Traversed	
Gently sloping, flat-surfaced plains Soils are reddish brown sandy-surfaced duplex, loamy sand over sandy clay, > 1 m deep, pH 6.5 with a neutral trend; principal profile form: Dr 1.12	Very scattered to scattered shrublands dominated by *Acacia* spp and *Maireana* spp. Tall shrubs: *Acacia victoriae, A. xiphophylla*; Low shrubs (< 1.5 m): *Maireana polypterygia, M. planifolia, M. pyramidata, Atriplex vesicaria.*	Pasture type: *Bluebush.* Perennials augmented by annual grasses and forbs in favourable seasons. Indicators of good condition: *Maireana polypterygia, Atriplex vesicaria.* Pastoral use limitations: Mild susceptibility to erosion when degraded; high salinity levels of pasture plants.
	Unit 3 Lower saline plains (10%) 1 site inventory and traversed	
Flat to gently sloping plains with slightly mounded surfaces. Soils are reddish-brown, sandy-surfaced duplexes, loamy sand or sandy loam over sandy clay, > 1 m deep, pH 6.5 with a neutral trend; principal profile form: Dr 1.12.	Scattered low shrublands dominated by *Frankenia* spp. Tall shrubs: *Acacia victoriae, A. tetragonophylla, A. xiphophylla, Hakea preissii*; Low shrubs (< 1m): *Frankenia* spp, *Atriplex vesicaria, Maireana platycarpa, M. polypterygia.*	Pasture type: *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Indicators of good condition: *Atriplex vesicaria.* Pastoral use limitations: High salinity levels of pasture plants.
	Unit 4 Flood plains (40%) 1 site inventory and traversed	
Low-lying plains with flat to mounded surfaces. Soils are red sandy-surfaced duplex, sand over sandy clay, > 1 m deep, pH 6.5 with a neutral trend; principal profile form: Dr 5.13.	Very scattered to scattered low shrublands dominated by *Atriplex vesicaria* and *Acacia* spp. Tall shrubs (2-3 m): *Acacia xiphophylla, A. victoriae, A. tetragonophylla, Hakea preissii*; Low shrubs (< 1m): *Atriplex vesicaria, Maireana pyramidata, Ptilotus polakii, Cassia desolata, Eremophila cuneifolia, Enchylaena tomentosa, Frankenia* spp; Perennial grasses: *Enteropogon acicularis.*	Pasture type: *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex vesicaria.* Undesirable perennials include: *Acacia victoriae, Hakea preissii.* Pastoral use limitations: High salinity levels of pasture plants; mild susceptibility to erosion (with unit 5) when degraded.
	Unit 5 Drainage lines (4%) Traversed	
More or less channelled braided drainage lines of moderate intensity. Soils are probably red duplex and clay types.	Moderately close shrublands similar composition to unit 4, but includes perennial grasses *Chrysopogon fallax* and *Eragrostis* spp.	Pasture type: *Saltbush.* Desirable perennials include: Shrubs as unit 4, *Chrysopogon fallax.* Pastoral use limitations: Mild susceptibility to water erosion when degraded.
	Unit 6 Drainage foci (1%) Traversed	
Small discrete foci with clay soils.	Close shrublands dominated by *Acacia* spp.	

Yarcowie land system (A) 76 km² (0.1% of survey area)

Plains with gilgaied soils supporting tussock grasslands or grassy tall and low shrublands.

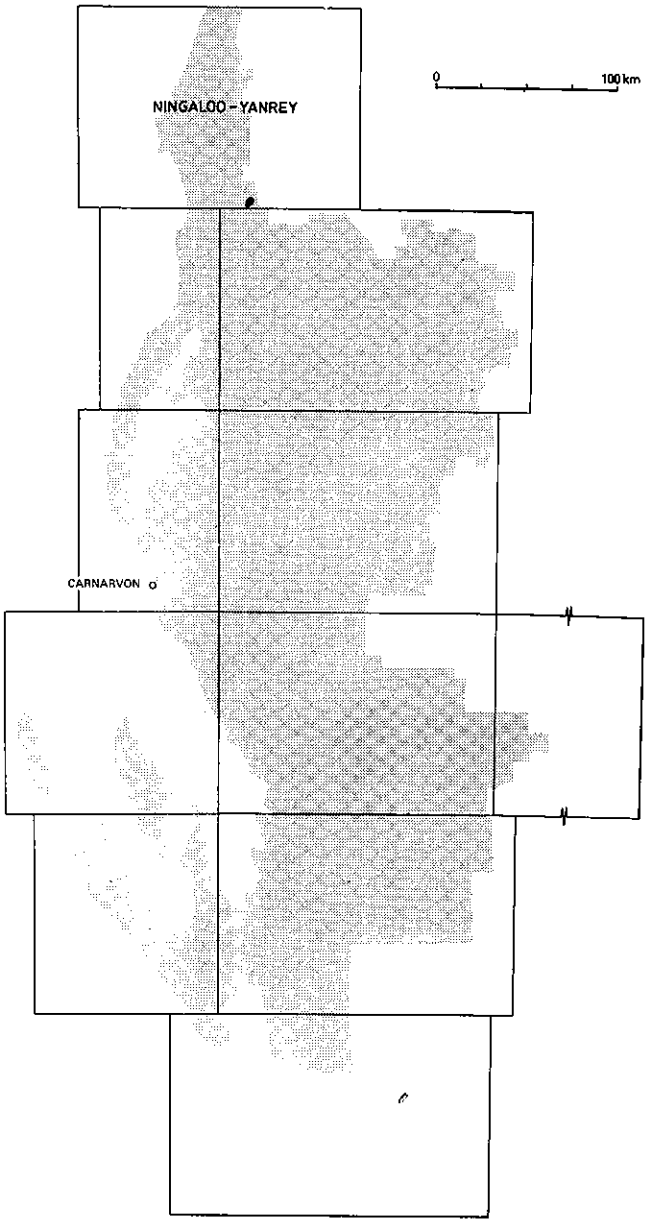
Geology: Lower Cretaceous bentonitic siltstone.

Geomorphology: Mainly erosional surfaces: nearly flat plains with gilgaied soils developed on weathered siltstone, with more sloping marginal areas; drainage mainly through meandering incised channels of low to moderate density; relief mainly 2-4 m.

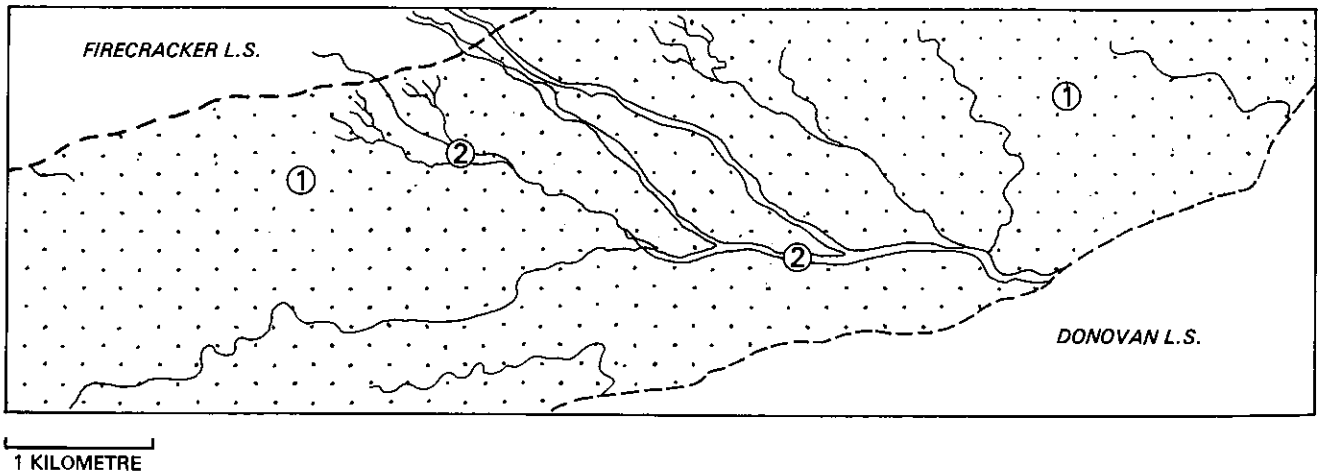
Pastoral use: Predominantly Tussock Grass (TUGR) pastures which are augmented by various palatable shrubs when in good condition; over-use results in loss of both desirable shrubs and perennial grasses, lowering the dry season durability of these plains. A very minor land system in this area, only the more sloping marginal plains are susceptible to water erosion.

Estimated carrying capacity, good condition: 6 ha/s.u.

Range condition summary: good 30%; fair 50%; poor 20%



Unit
1. Gilgai plains
2. Channels



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Gilgai plains (95%) 2 site inventories and traversed	
Very gently sloping plains (slopes < 0.5% except on margins, where steeper) with gilgaied surfaces showing depressions at intervals around 10 m. Soils are reddish-brown clays of uniform or gradational texture, 35 cm to > 1 m deep, pH 8.0 to 8.5 with neutral or alkaline trends; principal profile forms: Gc 2.22, Uf 6.21.	Very scattered tall shrublands over tussock grasses. Low trees and tall shrubs: *Acacia cuspidifolia, A. tetragonophylla, Heterodendrum oleaefolium*; Low shrubs (0.5-1.5 m): *Rhagodia eremaea, Maireana polypterygia, Ptilotus obovatus, Cassia chatelainiana, Solanum lasiophyllum, Eremophila leucophylla*; Perennial grasses (up to 4% b.c.): *Eragrostis xerophila, E. setifolia, Astrebla elymoides, Cenchrus ciliaris.*	Pasture type: *Tussock Grass.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Eragrostis* spp, *Astrebla elymoides, Maireana polypterygia, Atriplex bunburyana.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Channels (5%) Traversed	
Channelled drainage lines, meanders and creeks up to 10 m wide, incised to 1 m, locally deeper with gully erosion on sloping marginal areas. Soils are silty sands or loams over clayey types.	Very scattered shrubland-tussock grass fringing communities dominated by *Acacia xiphophylla, A. cuspidifolia* and *Eragrostis xerophila.*	Pasture type: *Tussock Grass.* Pastoral use limitatisons Mild susceptibility to water erosion when perennial grasses and shrubs are degraded.

Yaringa land system 872 km² (1.2% of survey area)

Sandy plains with poorly developed dunes and restricted inter-bank plains, supporting tall shrublands of wanyu and other acacias.

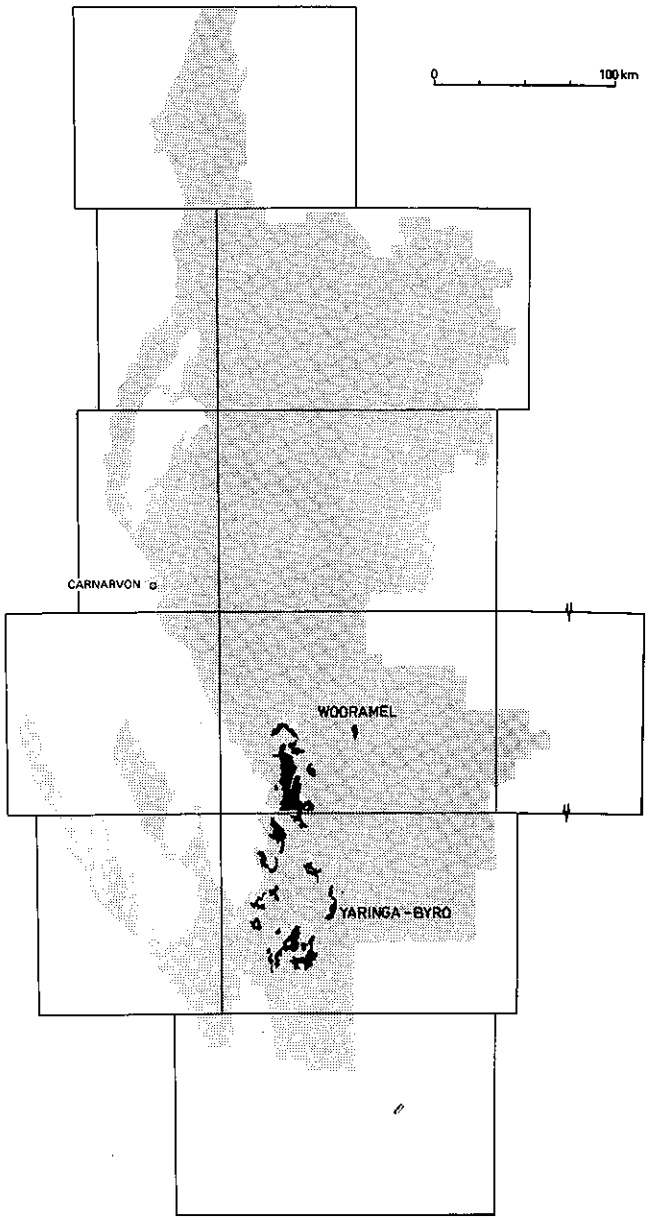
Geology: Quaternary aeolian sandplain deposits and Tertiary calcrete duricrusting on Cretaceous Toolonga calcilutite.

Geomorphology: Depositional surfaces: plains of shallow red sands overlying calcrete and limestone with weak longitudinal dune development in some areas; relief up to 11m and drainage features limited to scattered depressions.

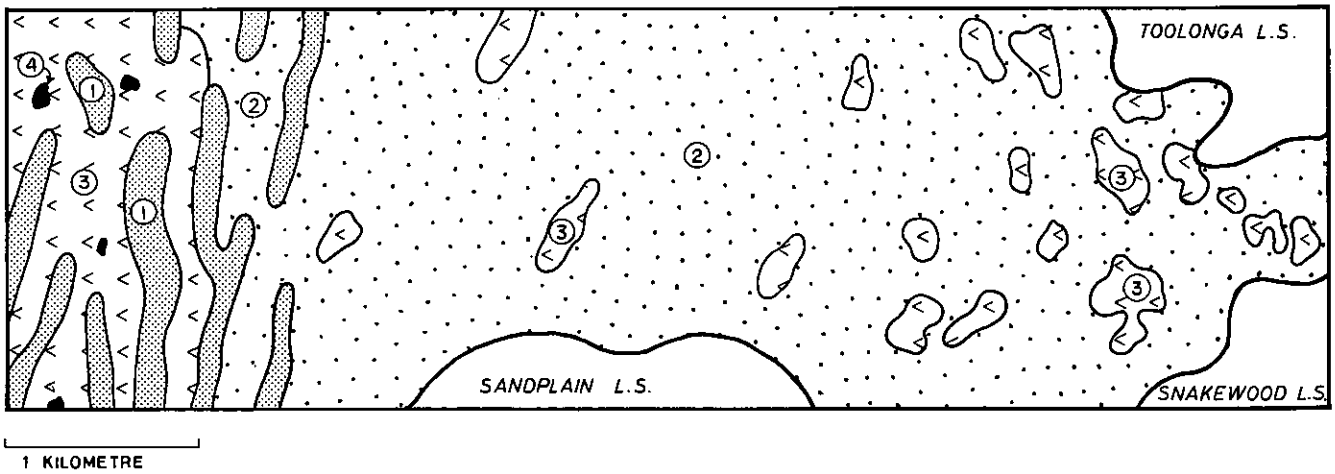
Pastoral use: Acacia Sandplain (ACSA) and Acacia Mixed Shrub (ACMS) pastures with moderate supplies of palatable shrubs; perennial grasses very scarce or absent; not prone to erosion.

Estimated carrying capacity, good condition: 9 ha/s.u.

Range condition summary: good 33%; fair 41%; poor 26%.



Unit
1. Longitudinal dunes
2. Sandplains and sandy banks
3. Gravelly plains
4. Drainage foci



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Longitudinal dunes (5%) 1 site inventory and traversed	
Linear dunes, 5-12 m high. Soils are dark red non-coherent sands, > 1 m deep, pH 6.5 with an alkaline trend; principal profile form: Uc 1.23.	Moderately close tall shrublands dominated by *Acacia sclerosperma* and *A. ramulosa*. Tall shrubs (2-3 m): *A. sclerosperma, A. ramulosa, A. murrayana, Eremophila maitlandii, Grevillea stenobotrya, Gyrostemon ramulosus*; Low shrubs (< 1.5 m): *Rhagodia eremaea, Chenopodium gaudichaudianum, Scaevola tomentosa, Cynanchum* spp, *Enchylaena tomentosa, Malleostemon* spp, Perennial grasses: *Eragrostis lanipes.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Enchylaena tomentosa, Rhagodia eremaea.* Undesirable perennials include: *Eremophila maitlandii.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Sandplains and sandy banks (75%) 2 site inventories and traversed	
Slightly undulating sandplains with sandy banks, up to 2 m above unit 3. Soils are dusky red or dark red loamy sands, approximately 80 cm deep, not calcareous (sometimes very lightly strewn with calcrete gravels) but overlying calcrete, pH 7.5 with a neutral trend; principal profile forms: Uc 5.11, 5.21.	Moderately close to close tall shrublands dominated by *Acacia* spp and *Ptilotus obovatus*. Tall shrubs (300-450/ha; 2-3 m): *A. ramulosa, A. sclerosperma, A. tetragonophylla, Eremophila maitlandii, Stylobasium spathulatum, E.* aff. *gilesii*; Low shrubs (3000-4000/ha; < 1.5 m): *Ptilotus obovatus, Rhagodia eremaea, Cassia helmsii, Solanum lasiophyllum, Eremophila latrobei, E. leucophylla*; Perennial grasses: *Monachather paradoxa.*	Pasture type: *Acacia Sandplain.* Perennials augmented by annual grasses and forbs in favourable seasons. Low shrubs often denser on sites burnt > 10 years previously. Desirable perennials include: *Eremophila latrobei, Tribulus platypterus, Monachather paradoxa, Maireana planifolia.* Undesirable perennials include: *Solanum lasiophyllum, S. orbiculatum.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Gravelly plains (20%) 1 site inventory and traversed	
Flat plains between sandy banks or low dunes, moderately strewn with mixed gravels. Soils are shallow loam to dark red loams or clays, sandy clay loam to fine sandy clay, with carbonate concretions, pH 7.5-8.5 with a neutral trend; principal profile form: Uf 6.12.	Scattered shrublands dominated by *Acacia drepanophylla*. Tall shrubs (2-5 m): *A. drepanophylla, A. tetragonophylla, A. grasbyi, A. ramulosa, A. pruinocarpa*; Low shrubs (< 2 m): *Ptilotus obovatus, Cassia helmsii, Eremophila latrobei, E. leucophylla, E. platycalyx, Tribulus platypterus.*	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Tribulus platypterus, Maireana planifolia, Scaevola tomentosa.* Pastoral use limitations: None under controlled stocking.
	Unit 4 Drainage foci (< 1%)	
Small, flat-bottomed drainage depressions with clay soils.	Close shrublands dominated by *Acacia tetragonophylla.*	Pastoral use limitations: None under controlled stocking.

Yinnietharra land system (G) 606 km² (0.8% of survey area)

Scattered granite tors and domes above stony slopes, broad sandy plains with groved vegetation and wide drainage tracts; scattered to moderately close tall shrublands of mulga and other acacias.

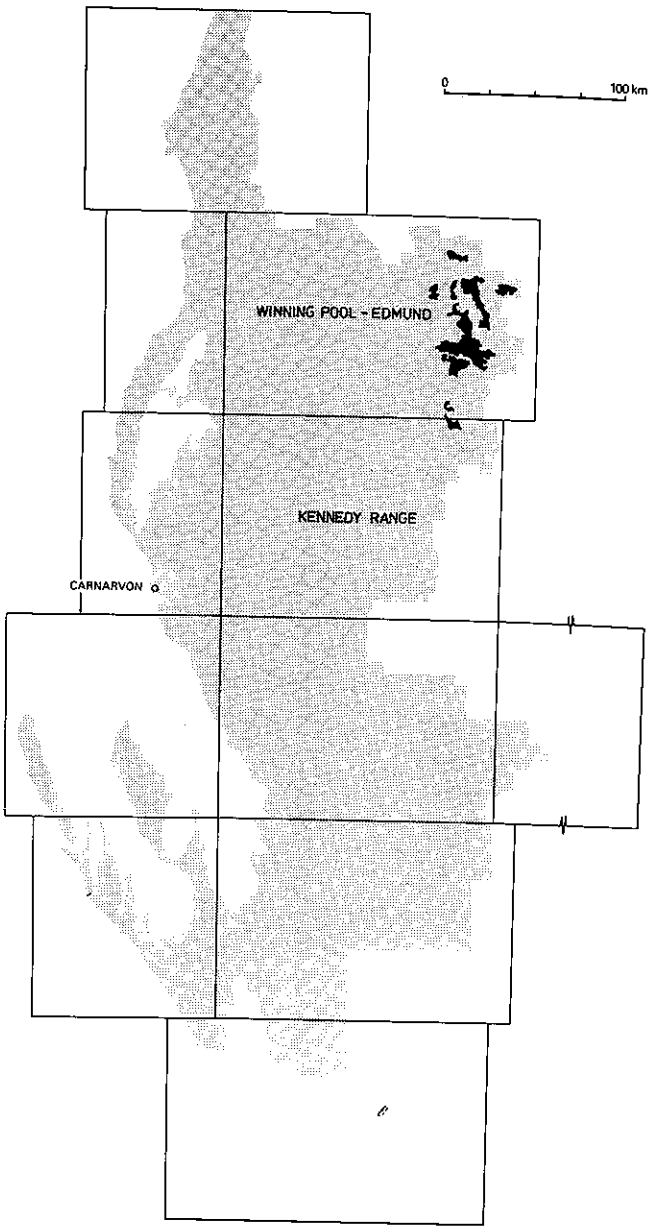
Geology: Early to Middle Proterozoic granites and paragneiss with Quaternary alluvial and colluvial deposits.

Geomorphology: Erosional and depositional surfaces: granitic residuals and outcrops above stony slopes, with radial drainage extending across gently sloping sandy-surfaced plains to meet finely-braided, broad drainage floors; relief up to 35m.

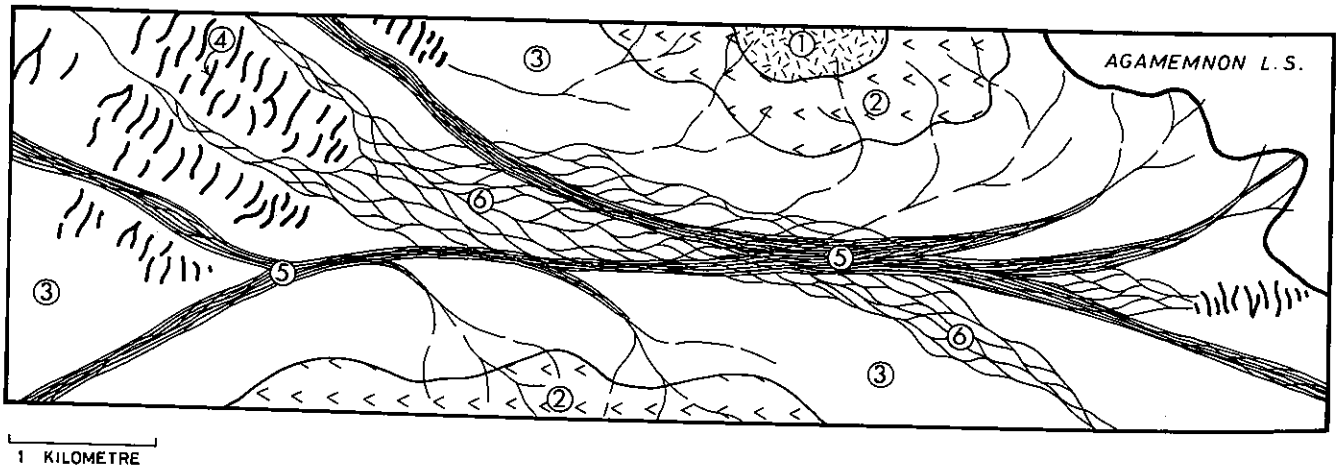
Pastoral use: Predominantly Acacia Short Grass Forb (ASGF) pastures with some Stony Chenopod (STCH) and Acacia Creek-line (ACCR) pastures, lower units probably formerly supported more productive shrub and perennial grass associations. Units 5 and 6 are susceptible to water erosion.

Estimated carrying capacity, good condition: 11 ha/s.u.

Range condition summary: good 24%; fair 38%; poor 38%.



Unit
1. Tors, domes and rocky hills
2. Stony slopes
3. Sandy-surfaced plains
4. Plains with groved vegetation
5. Braided drainage zones
6. Flood plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Tors, domes and rocky hills (5%) Traversed	
Hilltops, domes, tors and other outcrops of bare granite rocks, mostly widely separated by the major units. Soils are limited to pockets of skeletal sands.	Very scattered and clumped low shrublands dominated by *Acacia* spp and *Eremophila* spp.	Pasture type: *Acacia Short Grass Forb.* Pastoral use limitations: None under controlled stocking.
	Unit 2 Stony slopes (15%) 2 site inventories and traversed	
Upper interfluvial slopes, gradients < 1% but steeper on highest levels, lightly to moderately strewn with mixed gravels and carrying radial drainage lines of low intensity. Soils are dark red or dusky red duplex types, < 50 cm deep, sandy loam over sandy clay loam or sandy clay with quartz inclusions throughout, pH 6.0-6.5 with a neutral trend; principal profile forms: Dr 1.12, 1.52.	Very scattered to scattered low shrublands dominated by *Eremophila fraseri* and *Cassia helmsii*. Trees and tall shrubs (50-350/ha; 2-3 m): *Hakea suberea, Acacia subtessarogona, A. tetragonophylla, A. kempeana, Scaevola spinescens*; Low shrubs: *Eremophila fraseri, Cassia helmsii, Solanum lasiophyllum, Eremophila leucophylla, Corchorus walcottii, Maireana planifolia, Cassia desolata*; Perennial grasses: *Triodia* spp.	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Scaevola spinescens, Maireana planifolia.* Pastoral use limitations: None under controlled stocking.
	Unit 3 Sandy-surfaced plains (45%) 3 site inventories and traversed	
Plains with flat to mounded surfaces, slopes < 0.5%, carrying dendritic flow lines of low intensity. Soils are dark red or dusky red duplex or gradational types, loamy sand or sandy loam over sandy clay or clay loams, > 1 m deep, pH 6.0-6.5 with a neutral trend, with or without quartz gravels throughout; principal profile forms: Dr 1.12, 4.52, Gn 1.12.	Scattered to moderately close tall shrublands dominated by *Acacia subtessarogona* and *A. tetragonophylla*. Trees and tall shrubs (< 25-200/ha; 2-4 m): *Grevillea* sp., *A. subtessarogona, A. tetragonophylla, A. kempeana, Scaevola spinescens*; Low shrubs (100-1500/ha; < 1.5m): *Cassia desolata, C. helmsii, Eremophila leucophylla, Maireana planifolia, Ptilotus obovatus, Stylobasium spathulatum*; Perennial grasses: *Eriachne helmsii, Chrysopogon fallax.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Maireana planifolia, Rhagodia eremaea, Ptilotus polakii, Chrysopogon fallax.* Pastoral use limitations: None under controlled stocking.
	Unit 4 Plains with groved vegetation (10%) Traversed	
Plains with groved vegetation intercepting sheet flow. Soils are probably dark red loams over hardpan.	Narrow groves of close tall shrublands dominated by *Acacia aneura.* with broad sparsely vegetated intergroves. Trees and tall shrubs: *A. aneura, A. tetragonophylla, A. subtessarogona*; Low shrubs: *Eremophila leucophylla, E. cuneifolia, Rhagodia eremaea, Sida calyxhymenia, Sida* spp.	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Pastoral use limitations: None under controlled stocking.
	Unit 5 Braided drainage zones (10%) 1 site inventory and traversed	
Nearly flat drainage zones up to 400 m wide carrying braided channels, and mounded micro-relief. Soils are coarse-textured sands, dark red clayey to loam sands, > 1 m deep, pH 6.5 with a neutral trend; principal profile form: Uc 5.21.	Close fringing low woodlands or shrublands dominated by *Acacia citrinoviridis*. Trees (2-8m): *A. citrinoviridis, A. aneura, Santalum lanceolatum*; Tall shrubs (2-3 m): *Acacia cuthbertsonii, Scaevola spinescens, Cassia chatelainiana, Acacia victoriae*; Low shrubs (< 1m): *Cassia desolata, C. helmsii, Rhagodia eremaea, Eremophila fraseri, Corchorus walcottii*; Perennial grasses: *Chrysopogon fallax, Cenchrus ciliaris.*	Pasture type: *Acacia Creek-line.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Chrysopogon fallax, Rhagodia eremaea.* Pastoral use limitations: Mild susceptibility to water erosion when degraded.
	Unit 6 Flood plains (15%) 3 site inventories and traversed	
Plains carrying braided drainage lines, with slopes < 1%. Soils are dark red or dusky red duplex types, loamy sand or sandy loam over sandy clay or light clay, > 1 m deep, pH 6.5-7.5 with a neutral trend, with or without quartz gravels throughout, principal profile forms: Dr 4.12, 1.12.	Very scattered to scattered tall or low shrublands dominateed by *Cassia desolata, Acacia xiphophylla* and *A. cuspidifolia*. Trees and tall shrubs (< 25-125/ha;2-6 m): *Acacia xiphophylla, A. cuspidifolia, A. victoriae, Hakea preissii, A. cuthbertsonii, A. citrinoviridis*; Low shrubs (200-2000/ha; 0.5-2 m): *Cassia desolata, C. helmsii, Eremophila cuneifolia, Maireana planifolia, Rhagodia eremaea, Ptilotus obovatus*; Perennial grasses: *Cenchrus ciliaris.*	Pasture type: *Acacia Short Grass Forb.* Perennials augmented by annual grasses and forbs in favourable seasons. Existing shrub associations may represent grazing-induced communities of poor value, but original associations unknown. Pastoral use limitations: Moderate susceptibility to water erosion when degraded.

York land system 62 km² (0.1% of survey area)

Flat, low-lying clay plains, with minor areas of sandy-surfaced plains, supporting mainly open woodlands of York gum above low shrublands of saltbush and cottonbush.

Geology: Quaternary colluvium; poorly sorted clay, silt, sand and gravel deposited by sheet flooding and soil creep.

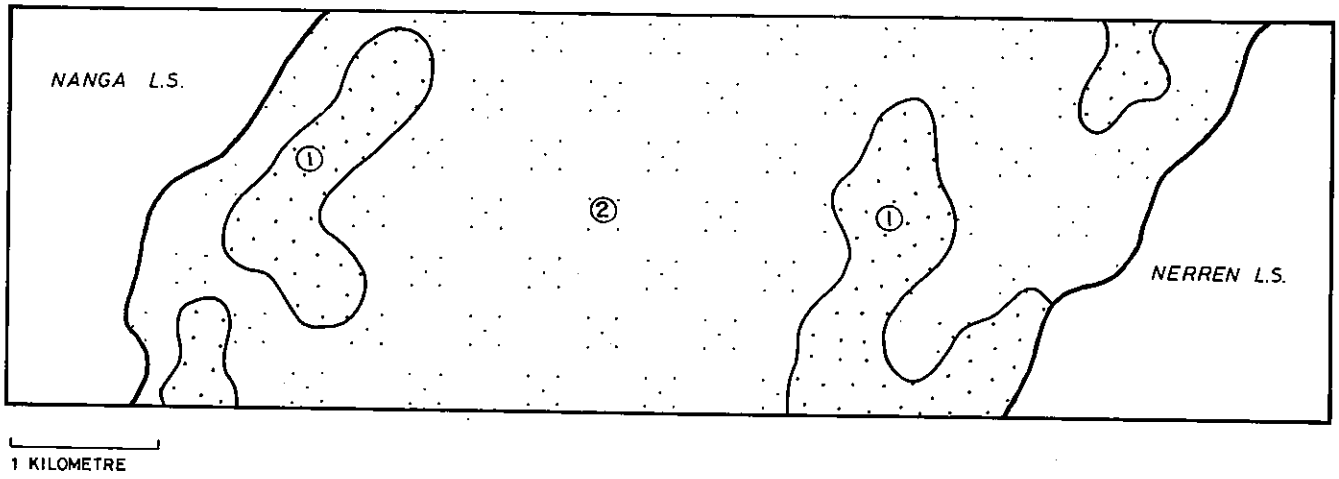
Geomorphology: Depositional, weakly gilgaied surfaces of former sluggish drainage tracts running south and west from the Toolonga plateau; relief generally < 3 m.

Pastoral use: A small but productive system supporting valuable Saltbush (SALT) pastures, plus cottonbush, currant bush and other useful perennial shrubs when in good condition, contrasting with the adjacent sandy systems Nanga and Nerren which have less drought reserve. The system is not prone to erosion.

Estimated carrying capacity, good condition: 5 ha/s.u.

Range condition summary: good 17%; fair 58%, poor 25%.

Unit
1. Loamy plains
2. Clay plains



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Loamy plains (10%) 1 site inventory and traversed	
Flat plains, slightly higher (< 1 m) than unit 2, lacking gilgai development. Soils are dark red calcareous gradational, sandy clay loam to sandy clay, > 1 m deep with calcareous concretions throughout, pH 8.0-8.5; principal profile form: Gc 2.22.	Scattered to moderately close tall shrublands dominated by *Acacia tetragonophylla*. Trees: *Eremophila oldfieldii*; Tall shrubs (2-4 m): *A. tetragonophylla, A. ramulosa, Hakea preissii, A. sclerosperma, Heterodendrum oleaefolium, Dodonaea pachyneura*; Low shrubs: *Ptilotus obovatus, P. divaricatus, Cassia* sp., *C. chatelainiana, Atriplex bunburyana, Enchylaena tomentosa*, Perennial grasses: *Stipa elegantissima*.	Pasture type: *Acacia Mixed Shrub.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Cassia chatelainiana* Undesirable perennials include: *Hakea preissii, Sida* spp. Pastoral use limitations: None under controlled stocking.
	Unit 2 Clay plains (90%) 2 site inventories and traversed	
Flat plains with weak gilgai development in shallow depressions. Soils are reddish-brown clays or gradationals, sandy clay loam or light medium clay over medium to heavy clays, > 1 m deep with calcareous inclusions in B horizon, pH 7.5-8.5; principal profile forms: Uf 6.13, Gc 2.21; Ug 5.38 in depressions.	Scattered to moderately close woodlands dominated by *Eucalyptus loxophleba* and understorey *Atriplex bunburyana*. Trees (8-10 m): *Eucalyptus loxophleba, E.* sp. nov.; Tall shrubs (150-250/ha; 2-4 m): *Acacia tetragonophylla, A.* aff. *acutata, A. galeata, Eremophila oldfieldii, Hakea preissii, Pimelea microcephala*; Low shrubs: *Atriplex bunburyana, Ptilotus obovatus, Eremophila maculata, Cassia phyllodinea, Scaevola spinescens, Maireana tomentosa.*	Pasture type: *Saltbush.* Perennials augmented by annual grasses and forbs in favourable seasons. Desirable perennials include: *Atriplex bunburyana, Scaevola spinescens, Enchylaena tomentosa, Cassia chatelainiana.* Pastoral use limitations: None under controlled stocking.

Zuytdorp land system 311 km² (0.4% of survey area)

Elevated plains and low hills near the Zuytdorp coastline with varied assemblages of South-West Botanical Province vegetation: low heaths, mallee shrublands and paper bark thickets.

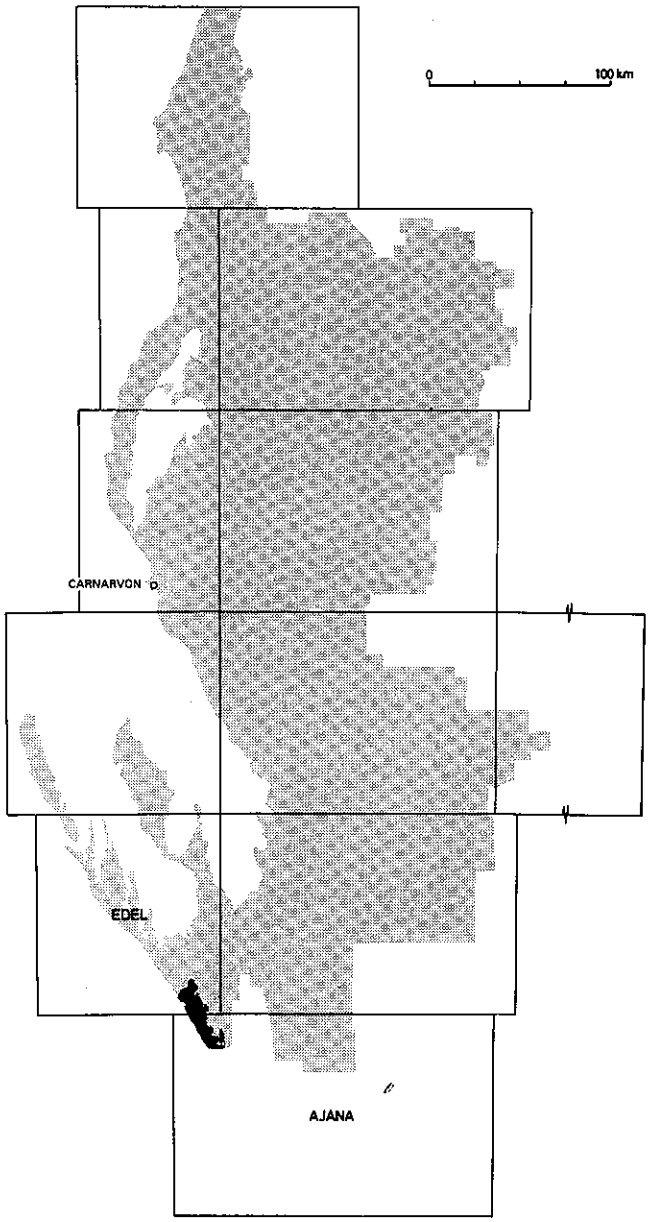
Geology: Quaternary Tamala limestone

Geomorphology: Very steep stony slopes and cliffs rising from sea level to an elevated plateau at 200m above sea level, continuing inland as limestone plains and low rounded hills with thin to full depth sandy soils mantled by limestones fragments; no drainage features.

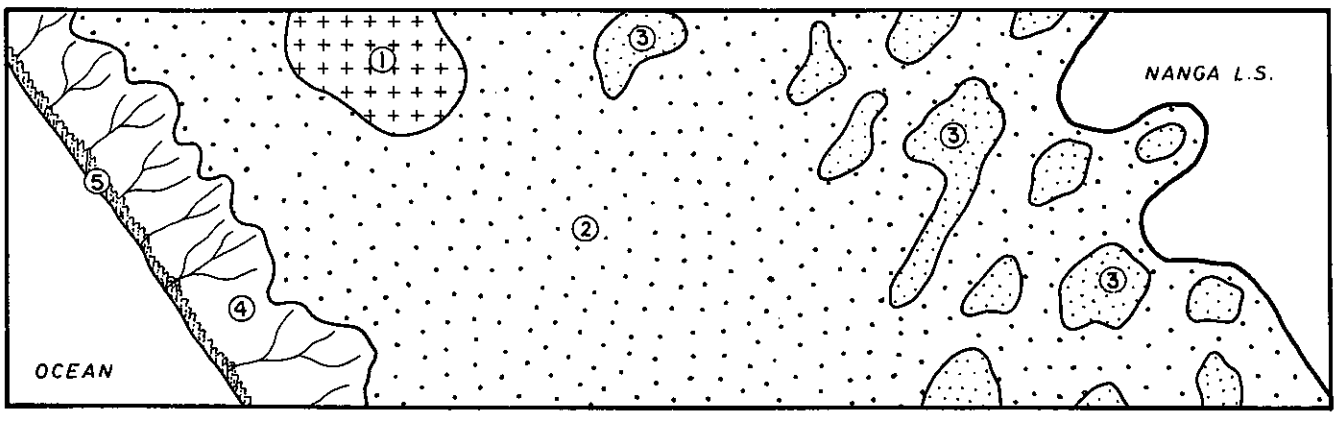
Pastoral use: Heath (HEAT) pastures generally deficient in palatable perennial species, very low pastoral value. Ground water is generally unobtainable. There is no susceptibility to erosion, but a high susceptibility to fire.

Estimated carrying capacity, good condition, 30 ha/s.u.

Range condition summary: good 89%; fair 11%; poor 0%.



Unit
1. Low stony hills
2. Limestone plains
3. Sandy plains over limestone
4. Dissected seaward slopes
5. Cliffs



Landform and soils	Vegetation : formations and major species	Comments and condition indicators
	Unit 1 Low stony hills (10%) 2 site inventories and traversed	
Undulations and low hills, lightly to moderately strewn with limestone cobbles. Soils are shallow, very dark grey fine sandy loam, with limestone inclusions and calcareous concretions, pH 8.5 with an alkaline trend; principal profile form: Um 6.21.	Close or closed tall shrublands dominated by *Melaleuca cardiophylla*. Tall shrubs (2-4 m): *M. cardiophylla*; Low shrubs (< 1 m): *Threlkeldia diffusa, Rhagodia* spp, *Enchylaena tomentosa.*	Pasture type: *Heath.* Desirable perennials include: *Enchylaena tomentosa, Rhagodia* spp. Pastoral use limitations: None under controlled stocking.
	Unit 2 Limestone plains (50%) 1 site inventory and traversed	
Elevated stony plains, undulating and with patches of thin sand cover or stony outcrops, lightly strewn with limestone cobbles and boulders. Soils are very shallow brown sands with limestone inclusions, pH 7.0 with a neutral trend; principal profile form: Uc 1.21.	Close low shrublands or heaths of the South-West Botanical Province (Beard 1976). Low shrubs (< 1 m): *Beaufortia dampieri, Grevillea thelemanniana, Acacia spathulifolia, A. leptospermoides, Pimelea* sp., *Calothamnus kalbarriensis, Loxocarya* spp, *Geleznowia verrucosa, Carpobrotus* spp.	Pasture type: *Heath.* Perennials augumented by annual grasses and forbs. Pastoral use limitations: Lack of palatable species.
	Unit 3 Sandy plains over limestone (30%) 2 site inventories and traversed	
Elevated sandy plains, gently undulating. Soils are yellow or brown sands, > 1 m deep, pH 6.5-7.5; principal profile forms: Uc 1.12, 1.22.	(i) Close mallee shrublands dominated by *Eucalyptus erythrocorys* and *E. obtusiflora* or (ii) diverse heaths dominated by myrtaceous and proteaceous shrubs. (i) Trees (2-6 m): *E. erythrocorys, E. obtusiflora, E. socialis*; Tall shrubs: *Acacia rostellifera, Melaleuca cardiophylla, Hakea stenophylla*; Low shrubs (< 1 m): *Conospermum* spp, *Olearia axillaris, Melaleuca* spp, *Calothamnus kalbarriensis, Pimelea microcephala.* (ii) Tall shrubs (2-4 m): *Banksia sceptrum, B. ashbyi*; Low shrubs (< 2 m): *Hakea* spp, *Grevillea* spp, *Banksia lindleyana, Melaleuca* spp, *Calothamnus* spp, *Thryptomene* spp; Graminoids: *Plectrachne danthonioides, Ecdeiocolea monostachya.*	Pasture type: *Heath.* Perennials augumented by annual grasses and forbs. Communities are strongly successional after periodic fires. Pastoral use limitations: Lack of palatable species and lack of ground-waters.
	Units 4 & 5 Dissected seaward slopes and cliffs (10%) Traversed	
Steep (up to 100%) slopes with limestone boulders and thin sandy soils above sea cliffs; relief mainly about 200 m.	Very scattered low shrublands and thickets (mainly of *Diplolaena dampieri*). Low shrubs: *Scaevola crassifolia, Westringia* sp., *Frankenia pauciflora, Carpobrotus aequilaterus, Olearia axillaris, Acacia ligulata.*	Pasture type: *Heath.* Perennials augmented by annual grasses and forbs. Pastoral use limitations: Stock control on very difficult terrain.

Soils

The only significant published work on soils of the Carnarvon Basin is that of Bettenay *et al.*, (1967) who mapped soils within the survey area at a scale of 1:2,000,000 after their relatively general survey of a broader area. Table 12 lists the major soil types they mapped and indicates which soil type is dominant or significant in each geomorphic district of the present survey area.

Table 12. Dominant soils of the survey area

Soil type	Geomorphic district of major occurrence
Calcareous sands Uc 1.1	Coastal Dunes Tamala Limestone Plains
Red earthy sands Uc 5.21	Ridge Dunes Victoria Sand Plain
Moderately deep to deep calcareous and siliceous loams Um 1.1, Um 1.2	Lake MacLeod and Saline Plains
Shallow calcareous or siliceous loams Um 1.3, Um 1.4	Cape Range Permian Hills
Non-calcareous loams Um 5.2	Giralia Range Alluvial Plains Winning Plains
Brown calcareous earths Gc 1.12, Gc 1.22	Carbla Plateau Giralia Range
Alkaline red earths Gn 2.13	Victoria Sand Plain Towera Stony Plains
Alkaline red duplex soils (desert loams) Dr 2.33	Alluvial Plains Wandagee Plains

To characterize in more detail the soil types and their patterns of distribution across each type of landscape, soil descriptions were routinely taken at inventory points during the course of the survey. Topographically related soil sequences or catenas occur regularly. Wherever the geology of the parent material is similar, the variations in soil characteristics across the local topography are attributable to differences in relief and drainage between adjacent land units. In other cases, where the parent material varies across the topography, soil genesis has been influenced by the heterogeneous nature of that parent material as well as by topography and hydrology.

An understanding of soil catena relationships within a landscape is important in any system of land management. This general account complements the specific data listed under the texts on each land system.

Wherever there is a soil type of particular importance, whether for its production potential, erosion risk, ability to support a specific pasture, or potential for some other use, the soil can be characterized and its likely extent delineated.

General soil characteristics

The soils in the survey area have many features that are common to the majority of arid to semi-arid soils in Australia. Most obvious is the predominantly red colouration of the soil caused by soil particles covered by oxides of iron (Cook and Warren 1973). This feature often does not exceed the depth of the solum, presumably because of the limited penetration of moisture. Towards the coast, sandy calcareous soils are often lighter in colour due to littoral shell fragments and oxide leaching, while the browner calcareous earths tend to differ in colour because of the high concentrations of carbonates and lower concentrations of iron oxides.

Organic matter content is low and generally concentrated within the top few millimetres. Generally, topsoils show little evidence of organic accumulation, or of bleaching of the underlying horizon. Chemically, the soils show great variability in soluble salt content, according to the type of parent material from which the soil is derived and its position in the landscape. Much less variable are the characteristically depauperate levels of key nutrients - very low levels of nitrogen (mainly 100-500 ppm) and only small amounts of phosphorus (mainly 5-20 ppm) - present in the top 10 cm of the profile (Payne *et al.* 1982). While large areas of arid Australia have only shallow soils developed over ancient crystalline rocks or siliceous hardpans, much of the Carnarvon Basin has deeper soils developed on alluvium or wind-deposited sand sheets.

A lack of soil structure or the presence of only weak pedality in the B horizon is a common feature of soils in the survey area. This is a consequence of the extensive aridity associated with the history of soil-forming processes and the lack of biological influences on the soil. The widespread calcareous and siliceous sands are single grained and have no natural aggregate structure, i.e. they are apedal. Within the earthy sands, soil particles are bonded by a matrix of clay and sesquioxides throughout the profile to produce a massive earthy coherent soil. The B horizons of the duplex soils are weakly to moderately structured. Strongly structured soils in the survey area are few.

Soil genesis

1. Alluvial areas

Bettenay (1967) showed that alluvial soils in the Carnarvon Basin were associated with the major river systems: the Gascoyne, Wooramel and Minilya Rivers, and, to a lesser extent, Cárdabia Creek. Alluvial soils have developed on Quaternary alluvium and colluvium derived from weathering and subsequent erosion of the uplifted Proterozoic hinterland. Their development may also have been influenced by sheet flooding, deflation and deposition of material from previous erosion cycles and soil building processes.

The hard-setting duplex soils of the alluvial areas have an alkaline soil reaction trend. This is caused by carbonates and salts (particularly of calcium and sodium) leaching down the soil profile into a repeatedly saturated subsoil. Characteristically for an arid environment, the leaching is relatively shallow.

The red earths and red sands which occur in the same areas sometimes have alkaline soil reaction trends but only rarely in the south-east of the survey area, where the soils tend to be acidic due to different (highly leached) parent materials.

The recent and continuing formation of alluvial soils is evident on the major active river floodplain systems through frequent episodes of erosion and deposition. Juvenile alluvial soils, characterized by poorly sorted and mixed soil horizons, are found in and adjacent to river channels and banks.

2. Sand dunes and low sandy banks

Deep calcareous sands, siliceous sands and red earthy sands have developed on weathered parent material which was transported and deposited by wind during the driest periods of the Pleistocene epoch. In coastal areas sands are leached, calcareous and may contain shell fragments indicating a littoral origin. Further inland, red siliceous sands form long, linear dunes. Aeolian sorting of sand particles is indicated by the lack of pedological organization. The red earthy sands occurring on the alluvial plain as low sandy banks may also be of aeolian origin, or may be formed *in situ*. These soils are derived from highly siliceous parent material and often occur as remnants of deep weathering profiles, such as those remaining on parts of the Old Plateau in the Murchison catchment, further east.

3. Coastal sediments

At Lake McLeod, highly saline soils have developed from Tertiary marine sediments. Although the lake was cut off from the sea in the late Pleistocene, oceanic water enters the northern section through sub-surface connections. These highly calcareous soils, together with fluvial deposits from major river systems, littoral and siliceous aeolian sands, form highly saline tidal flats, lake beds and plains which usually contain shell fragments and gypsum.

4. Hills and ranges

Lithosols or skeletal soils occur in the hills and ranges throughout the survey area. Normally they are very shallow sands, loams or clay loams, that lack horizon development and contain rock fragments. They vary considerably according to their parent materials. They are the result of physical and chemical weathering of rocks, *in situ* or as colluvium.

Soil distribution

The distribution of the various soils in the survey area is described first by the primary profile form according to Northcote (1979) and then according to 'geomorphic district' (see table 4).

Soil distribution by Primary Profile Forms

Uniform coarse textured soils (Uc)

Sandy soils are widespread and occur over more than 50% of the survey area. Siliceous sands and earthy sands (Uc 1.23, 5.21) occur over very large areas in the south, in the Victoria Sand Plain geomorphic district and in the centre in the Ridge Dune district. Deep (> 1 m) calcareous sands and earthy sands (Uc 1.11, 5.12) predominate on dunes and undulating sand plains of the Coastal Dune district.

Calcareous, siliceous, brownish and earthy sands (Uc 1.12, 1.23, 5.11, 5.21) in the Carbla Plateaux, Alluvial Plains and Tamala Limestone Plains geomorphic districts occur on sand dunes, low banks, and sandy plains. They also occur in another five districts on minor dunes and sand plains. Shallow, firm siliceous sands or lithosols (Uc 1.43) occur on stony hills and footslopes.

Uniform medium textured soils (Um)

These soils are not widely distributed and occupy only about 4% of the survey area. They occur to a minor extent in eight of the 15 geomorphic districts.

Stony, non-calcareous or earthy loams (Um 5.21, 5.52) of variable depth occur on gibber plains and drainage floors in the Mardathuna Plains district. Shallow, stony, calcareous loams (Um 5.11, 5.12) are also locally important on calcrete platforms in the same district and on limestone plains in the Giralia Range district. More structured calcareous loams (Um 6.21, 6.24, 6.33, 6.42) occur in the Tamala Limestone Plains and the Winning Plains districts. Shallow, skeletal loams (Um 1.43) are found on some hills, ridges and footslopes in other districts.

Uniform fine textured soils (Uf)

Non-cracking clay soils are locally important. They occupy about 4% of the survey area with significant occurrences in seven of the geomorphic districts. Structured, stony clays of variable depth (Uf 6.11, 6.12, 6.13, 6.21, 6.33) are common in the north-east on stony plains, lower plains and drainage floors associated with the Lyndon Proterozoic Hills, Towera Stony Plains, Wandagee Permian Plains and Winning Plains districts.

Minor occurrences of deeper, friable, structured non-cracking clays (Uf 6.13, 6.21, 6.31, 6.33, 6.34, 6.41) are found on some saline alluvial plains and flow zones in the Alluvial and Lake McLeod and Saline Plains districts. These soils often grade into gilgai (Ug) cracking clay soils. The dominant soil types in these districts are duplex varieties.

Areas of variable depth calcareous clays (Uf 6.12) also occur on stony lower plains in the Cape Range district.

Uniform fine-textured seasonally cracking soils (Ug)

In terms of total area these soils are of little significance in the survey area (< 0.5%). However, they are locally important in a few districts as they support valuable tussock grass pastures. Grey-brown or red self-mulching cracking clays (Ug 5.28, 5.38, 5.31, 5.34) occur on gilgai plains and drainage foci in the Alluvial Plains, Lake McLeod and Saline Plains and Winning geomorphic districts. They are also occasionally found on restricted low drainage tracts and groves in a few other districts.

Calcareous gradational soils (Gc)

These soils occupy about 12% of the survey area and are quite widely distributed, having being recorded in 10 of the 17 geomorphic districts. Within the Giralia Range district in the north-west of the survey area, calcareous earths of variable depth (Gc 1.12, 1.22) occur on footslopes, stony plains and outwash plains derived from limestone. In the Carbla Plateau district, shallow, stony calcareous earths (Gc 1.12, 1.22, 2.12, 2.22) occur on plains and footslopes. Deep (> 100 cm) calcareous earths (Gc 2.22) occur on alluvial plains and drainage floors in many districts, particularly the Winning Plains district.

Non-calcareous gradational soils (Gn)

These soils were recorded in only six of the geomorphic districts, occupying about 4% of the survey area. Red earths (Gn 2.11, 2.12, 3.12) predominate on stony plains and alluvial plains in the Mardathuna Plains district. Red structured earths and massive earths (Gn 2.11, 2.12, 3.11, 3.12 and 4.12) also occur on drainage floors, drainage foci, groves and swales of the Alluvial Plains, Towera Stony Plains, Winning Plains and Ridge Dune districts.

Red duplex (texture contrast) soils (Dr)

Red duplex soils are common in 10 of the 15 geomorphic districts and occupy about 14% of the total survey area. Crusting red duplex and friable red duplex soils (Dr 1.12, 1.13, 4.12) occur in the Alluvial Plains district. These soils are usually stone free, > 1 m deep and have an alkaline reaction trend. They are also common on alluvial plains and drainage floors of the Carbla Plateau, Wandagee Permian Plains, Lyndon Proterozoic Hills and the Towera Stony Plains districts.

Red duplex soils are generally sensitive to disturbance because the light textured surface horizons are readily removed by wind and water action if the vegetative cover is depleted. Large, bare scalds can develop on exposed clay B horizons; when polished and impermeable they are most unfavourable surfaces for plant establishment.

Soil distribution by Geomorphic Districts

Each geomorphic district consists of a group of land systems of similar lithology and surface topography. Distinctive catenary sequences have developed in each district and these are illustrated and described below.

Alluvial Plains District

Red duplex soils are the most common and occur widely on alluvial plains of the Delta, Sable, Barrabiddy, Lyell, Target and Lyons land systems. Most inter-bank plains of the Sandal land system have such soils.

Soil depth is commonly > 1 m. The profile consists of a thin layer (10-45 cm) of sand, loamy sand or sandy loam, over sandy clay loam or sandy clay. Colour is usually dark red or dusky red, but may be yellowish-red or reddish-brown towards the coast. The soils are predominantly calcareous and often contain abundant gravels in the B horizon. Non-calcareous duplex soils (Dr 1.12, 1.15, 2.12, 4.12) are less common. Soil surface pH varies from 6.5 to 8.5, with subsoils either neutral or alkaline.

Vegetation on the red duplex soils is mainly of mixed low and tall shrublands, with Gascoyne bluebush, Gascoyne mulla-mulla, currant bush, needle bush and various acacias. Where the vegetation is depleted, soils are often extremely susceptible to erosion. Surface layers of sand are readily removed by wind and water action exposing the clayey B horizon. In their eroded state these formerly duplex soils were recorded as non-cracking clays (Uf 6.21, 6.31). Considerable areas of scalded clay surfaces occur on the Delta land system. On the Sandal, Sable and Target systems, the duplex units have hard-setting surfaces and receive little through drainage.

Deep sandy soils occur on the dunes, sandy banks and sandplains of the Lyons, Sable, Sandal, Delta, River and Target land systems. These soils are highly porous and are either loose siliceous sands (Uc 1.23) or earthy sands (Uc 5.11, 5.21) and the soil colour is usually red or dark red. They are predominantly non-calcareous, with a pH ranging from 6.0 to 7.5, and less commonly to 8.5. Shrublands of wanyu and silver-barked wattle characterize the taller vegetation.

Minor areas of deep calcareous sands (Uc 1.12) occur on the coastal margins on the Brown and Littoral land systems. Such soils often contain marine shell or limestone gravel, with a pH about 8.5 throughout the profile.

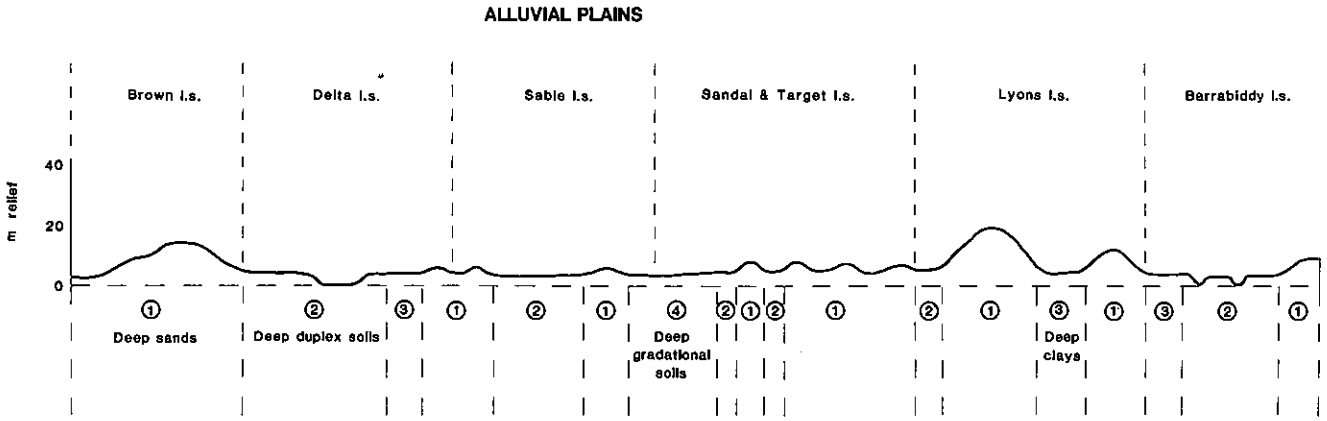
Uniform fine textured non-cracking clays (Uf 6.13, 6.21, 6.31, 6.33) occupy about 10% of the district on the saline plains, alluvial plains and lower areas of the Delta, Sandal, Barrabiddy and Target land systems. Soils are usually > 1 m deep. Textures may be silty clay, sandy clay, fine sandy clay, medium or heavy clay. Colour is dusky red or reddish brown, with a pH ranging from 7.0 to 8.5.

Brown and red self-mulching cracking clays (Ug 5.38) with gilgaied micro-relief are not common in the district, but are important on the plains of the Marloo land system. Similar soils (Ug 5.28, 5.34) occur in minor areas on the alluvial and saline plains of the Delta land system. These have textures of medium to heavy clay, dark reddish-grey or dark reddish-brown. The surface pH ranges from 7.0 to 8.5.

Non-calcareous red gradational soils (Gn 2.12, 3.12, 4.12) commonly occur as minor component soils in lower drainage areas of the Lyons, Target, Sable and Sandal land systems. These soils are either sands over loams or loams over clays. Soils are dark red or reddish-brown and usually >1m deep. Surface pH ranges from 6.0 to 8.0.

Table 13. Alluvial Plains Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Sand dunes, sandy banks and sandy plains	37	Siliceous sands (Uc 1.23), earthy sands (Uc 5.21), sands (Uc 5.11); also Uc 1.12, 5.13, 1.11	> 100	0	6.5	7.0
2	Alluvial plains	51	Red duplex soils (Dr 1.13, 1.12, 4.12); also Dr 1.15, 1.16, 2.12, 2.13, 4.13	> 100	0	6.5-7.0	8.0-8.5
3	Saline, alluvial and gilgai plains and flow zones	10	Non-cracking clays (Uf 6.31, 6.21), also Uf 6.13, 6.33; self-mulching cracking clays (Ug 5.38); also Ug 5.28, 5.34	> 100	0	6.5-8.5	7.0-8.5
4	Drainage floors and foci	2	Red gradational soils (Gn 2.12, 3.12, 4.12); also Gn 1.12, 2.13, 4.13	> 100	0	6.5-7.0	6.5-8.0



Cape Range District

This district is characterized by calcareous lithosols (skeletal soils) which occur on the plateaux and steep footslopes of the Range land system. The soils are formed predominantly *in situ*, and are located in small pockets surrounded by outcrop limestone. Soils are 10-40 cm deep with limestone cobbles and stone as a surface mantle and in the profile. Textures are variable and may be loamy sand, sandy loam or fine sandy loam. Soils are usually dark reddish-brown and the surfaee pH is usually about 8.5. The vegetation is predominantly either soft or hard spinifex with occasional small trees and shrubs.

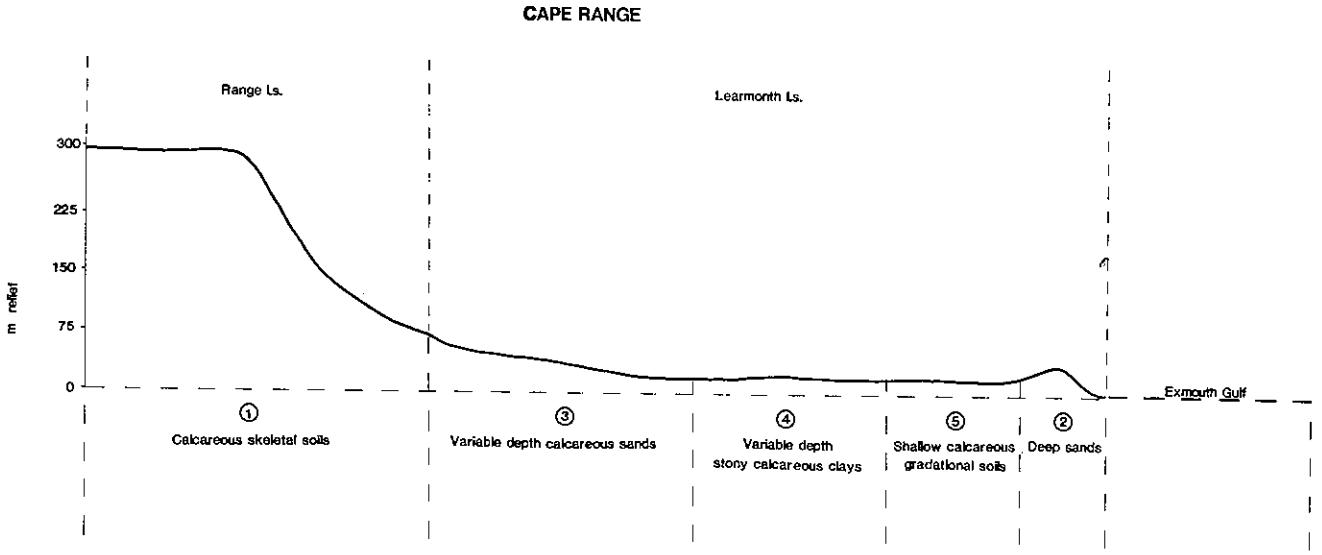
In the Learmonth land system, brownish or earthy sands (Uc 5.11, 5.21) oceur on the sandplains and calcareous sands (Uc 1.11) occur on the coastal dunes and beaches. Brownish or earthy sands range in depth from 60-100 cm or more over limestone. These soils have uniform textures of loamy sand and are red or reddish-brown. Inclusions of calcium carbonatc are common throughout the profile, and soil pH is approximately 8.5 throughout the profile. The soils support hummock grasslands of soft spinifex.

Uniform fine textured non-cracking clays (Uf 6.12) occur on the stony plains of the Learmonth land system. These arc up to 55 cm deep over limestone. Soil texture is sandy clay over medium clay, with limestone gravel on the surface and throughout the profile. Soils are reddish-brown and surface pH is 8.5.

Shallow, stony calcareous gradational soils (Gc 1.22) occur on the lower outwash plains of the Learmonth land system. These soils are shallow to medium depth and overlie limestone. They are usually dark reddish-brown loams over clays with a pH about 8.5.

Table 14. Cape Range Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Limestone plateaux and gorges	71	Skeletal soils	10-40	> 50	8.5	8.5
2	Coastal dunes and beaches	1	Calcareous sands (Uc 1.11)	> 100	0	8.5	8.5
3	Sandplains	12	Brownish or earth sands (Uc 5.11, 5.21)	60-> 100	0	8.0-8.5	8.5
4	Stony lower plains	10	Non cracking clays (Uf 6.12)	55	2-5	8.5	8.5
5	Lower outwash plains	6	Stony calcareous gradational soils	< 50	2-5	8.5	8.5



Carbla Plateau District

Shallow, stony calcareous gradational soils are most common within this district. They are found on the broad undulating stony plains of the Toolonga and Yaringa land systems and on mesas of the Foscal land system. They support a distinctive mixed tall shrubland, usually dominated by Hamelin wattle. Where limestone outcrop is the dominant feature, these soils may occur with skeletal soils which may occur nearby. The calcareous gradational soils (Gc 1.12, 1.21, 1.22, 2.12, 2.22) are usually sandy, but also occur as loams grading to clays. They have stony limestone surfaces with profiles that often contain limestone or calcrete as inclusions. Soil depth varies from 20-70 cm, with occasional deeper pockets. The soils are red or reddish-brown, surface pH ranges from 8.0 to 9.0 and reaction trend is alkaline or neutral.

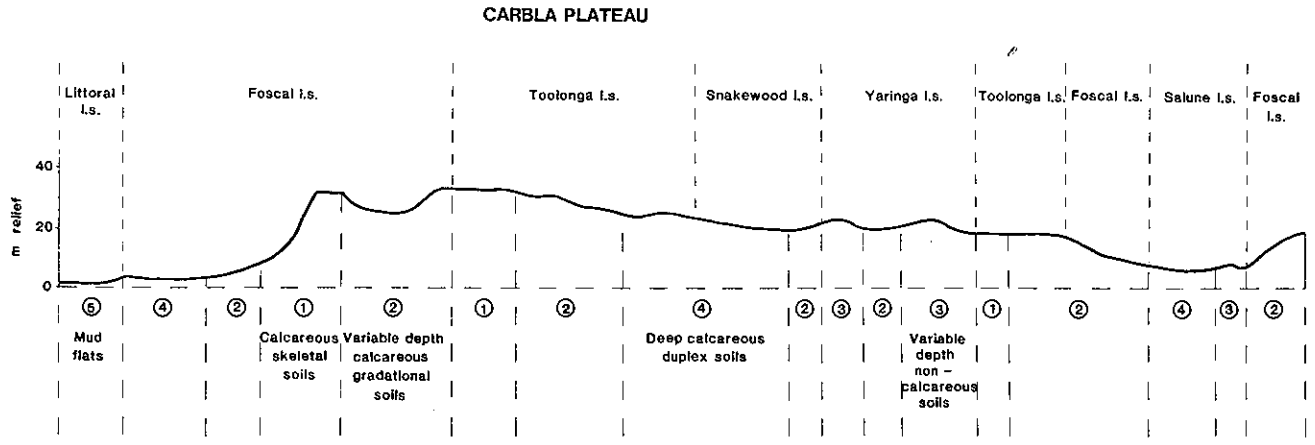
Crusty red duplex soils (Dr 1.13) occur on the alluvial plains of Foscal, Snakewood, Toolonga and Salune land systems. They have a sparse limestone or calcrete gravel surface mantle and the profile is characterized by a thin sheet (15-40 cm) of sandy loam or, less commonly, loamy sand over sandy clay loam or sandy clay. These soils are dark red or red and have highly calcareous B horizons, with calcrete gravels becoming more abundant with depth. They commonly support shrublands of snakewood and silver saltbush.

Uniform sandy soils are common within the district. Earthy sands (Uc 5.21) occur on the broad, undulating sandplains and on occasional dunes (Uc 1.23) of the Yaringa land system. Soil depth is usually > 1 m although limestone is sometimes present at shallower depths. The sands are non-calcareous, dark red uniform loamy sands and the surface pH between 6.0 and 7.5. The principal vegetation is tall shrubland dominated by wanyu.

Minor areas of calcareous sands (Uc 1.11) occur on the narrow coastal plains and dunes of the Coast, Coquina and Littoral land systems. These soils have textures of sand or, less commonly, loamy sands and are > 1 m in depth. They are highly calcareous and, in the case of Coquina land system, contain large quantities of marine shells *Fragum erugatum*. Soils vary from light reddish-brown to brown.

Table 15. Carbla Plateau Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Limestone plateaux	2	Skeletal soils	0	> 50	-	-
2	Stony plains and footslopes	38	Calcareous gradational soils (Gc 1.12, 1.22, 2.12, 2.22); also Gc 1.21	20-100	2-5	8.5-9.0	8.5-9.0
3	Sandplains and sandy banks	25	Earthy sands (Uc 5.21), siliceous sands (Uc 1.23); also Uc 5.11	40-> 100	0	6.0-7.5	6.0-7.5
4	Alluvial and raised plains	32	Crusty red duplex soils (Dr 1.13); also Dr 1.15	> 100	2-5	7.0-8.5	8.5-9.0
5	Tidal, supratidal mud flats and coastal dunes	3	Calcareous sands (Uc 1.11)	> 100	0	8.5	9.0



Coastal Dunes District

Soils in this district are almost entirely uniform sandy soils. On sandplains of the Cardabia land system, on stations such as Quobba, Cardabia and Ningaloo, the soils are calcareous brownish or earthy sands (Uc. 5.11; 5.12; 5.21). They have deep profiles and textures of sand over loamy sand. Limestone fragments may be present as a surface mantle or within the profile. Colour is reddish-brown and the surface pH is approximately 8.5. Vegetation on these soils is characterized by hummock grasslands of soft spinifex with some hard spinifex.

Deep, highly calcareous brownish sands (Uc 5.12) are widespread elsewhere in the district such as on the sandplains of Edel and Inscription land systems. Here, the soils have sparse calcrete gravels on the surface and profiles contain abundant calcium carbonate. The texture is sand over loamy sand and surface pH is about 8.5. Colour is usually yellowish-red or reddish-brown. These sands support mainly wattle shrublands of *Acacia ligulata*, with diverse low shrubs and grasses.

Deep, loose calcareous sands (Uc 1.11, 1.12, 1.13) with little or no pedologic development occur on the coastal parabolic dunes, linear dunes and in swales of the Coast, Cardabia, Edel and Coquina land systems. Colour is very variable, the more common being reddish-brown, red, brown or pink. Surface pH varies between 8.5 and 9.0. These soils usually support diverse low heathy shrublands.

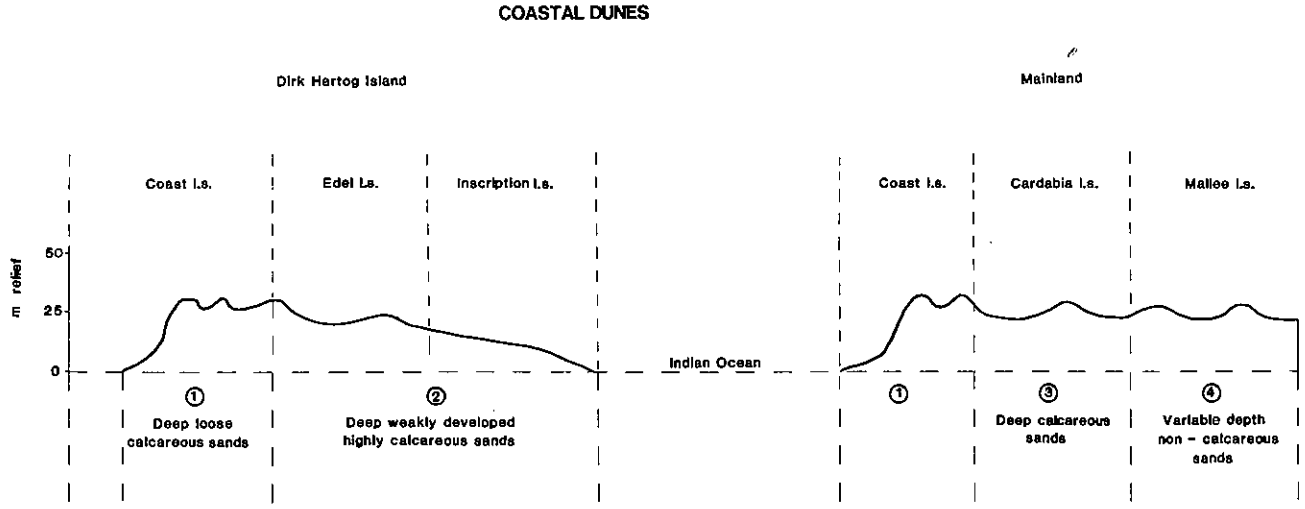
Non-calcareous siliceous sands (Uc 1.23) occur on the linear dunes and sandplains of the Mallee land system: deep sands occur on the dunes; shallow sands (10-55 cm) over limestone occur on the sandplains. They are red or dark red and pH ranges from 6.5 to 7.0. The vegetation is characterized by low mallee eucalypts and hard spinifex.

The Coastal dunes district is subject to strong prevailing southerly winds and the unconsolidated dune sands, particularly within the Coast land system, are prone to severe wind erosion wherever the soil surface and stabilizing vegetation have been disturbed or degraded.

Many of the major dune blow-outs that feature prominently in the district are traceable to disturbance foci, such as stock watering points, fence-lines or over-used vehicle tracks on sensitive coastal sites. Once initiated, blow-outs generally progress uncontrollably, sometimes for many kilometres.

Table 16. Coastal Dunes Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Coastal dunes and swales	28	Deep, loose calcareous sands (Uc 1.11); also Uc 1.12, 1.13	> 100	0	8.5-9.0	8.5-9.0
2	Undulating raised coastal sandplains	17	Calcareous brownish sands (Uc 5.12)	> 100	2-5	8.5	8.5
3	Broad undulating coastal sandplains	46	Calcareous brownish or earth sands (Uc 5.11, 5.21); also Uc 5.12, 5.22	> 100	0-5	8.0-8.5	8.5
4	Dunes and sandplains	9	Siliceous sands (Uc 1.23)	55-> 100	0	6.5	7.0



Giralia Range District

This district is characterized by gradational calcareous soils (Gc 1.12, 1.22, 2.22). These occur over limestone on the stony plains of Jubilee, Trealla and Donovan land systems. Soil depth is usually 30-75 cm, and profiles contain abundant limestone inclusions. Soils are red or reddish-brown fine sandy loam over fine sandy clay loam or fine sandy clay loam over fine sandy clay. Soil surface pH is between 8.0 and 8.5. These soils support acacia-dominated shrublands with sparse low shrubs and hard or soft spinifex.

Deep, red calcareous gradational soils (Gc 1.12, 2.22) also occur on the alluvial plains and lower plains of the Donovan and Jubilee land systems. Soil textures here are usually sandy clay loam or fine sandy clay loam over sandy clay or fine sandy clay. Soils are reddish-brown or red and surface pH is usually about 8.5. These soils support tall shrublands of snakewood and low shrublands of Gascoyne bluebush and silver saltbush.

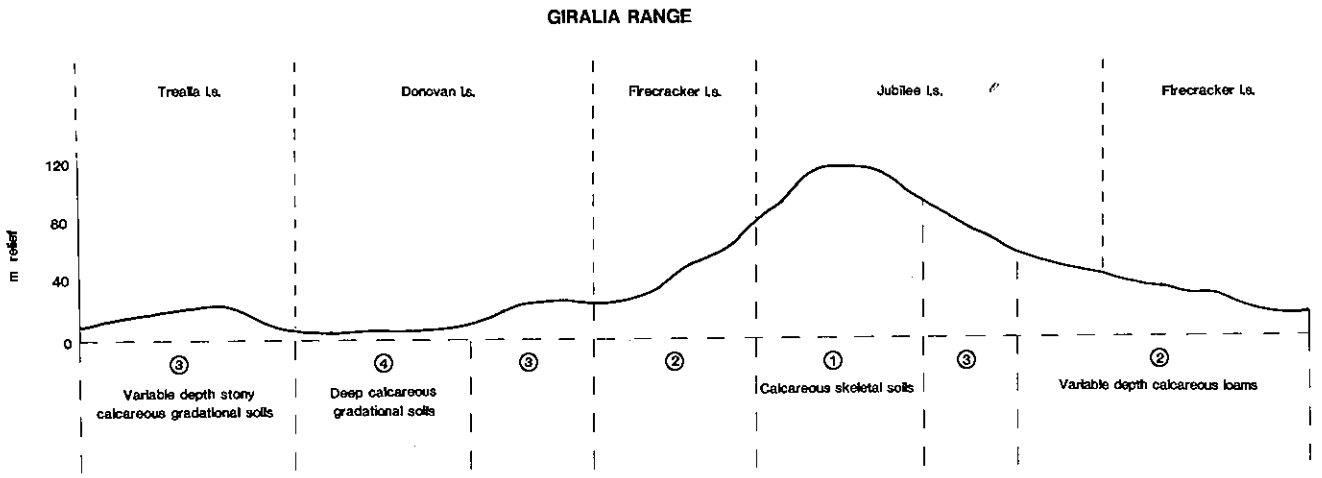
Other commonly occurring soils in the district are calcareous loams (Um 1.33, 5.11, 5.12, 6.33). Deep loams occur on the gently undulating plains of the Donovan land system. These soils are reddish-brown silty loams with calcrete inclusions throughout the profile. Loams with depths < 70 cm over limestone are found on the stony plains and lower plains of the Jubilee and Firecracker land systems and on the dissected slopes of the Trealla land system. These soils have stony limestone surfaces and profiles, and are red or reddish-brown. Soil surface pH ranges from 8.0 to 8.5. Acacia shrublands with hard or soft spinifex or, more locally, low chenopod shrublands, occur on these soils.

Minor areas of shallow, powdery, calcareous loams (Um 5.11) occur on the hills and cuestas of the Jubilee land system. These soils are formed *in situ* in isolated pockets surrounded by outcrop limestone. They are usually < 40 cm deep. Soils are red or reddish-brown, with a uniform texture of fine sandy loam.

The calcareous loams and gradational types on the slopes and plains of the Firecracker land system are sensitive to water erosion and require careful management. They support low chenopod shrublands which are attractive to livestock.

Table 17. Giralia Range Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Limestone hills and cuestas	5	Skeletal soils (Um 5.11)	0-30	> 50	8.5	8.5
2	Limestone plains	6	Calcareous loams (Um 6.33, 5.11, 5.12);	30-70	5-25	8.5	8.5
3	Footslopes and stony plains	51	Calcareous gradational soils (Gc 1.22, 1.12)	30-75	5-25	8.5	8.5
4	Alluvial and lower plains	38	Deep calcareous gradational soils (Gc 2.22)	> 100	0-1	8.5	8.5



Lake MacLeod and Saline Plains District

The juvenile soils on the bed of Lake MacLeod make up about 62% of the area of this district. They are characterized by extremely saline deposits of sand, silt, clay, marine shells and gypsum, and are subject to seasonal inundation from the discharge of the Minilya and Lyndon Rivers. Soil materials are poorly sorted, with gritty loams over clays often overlying coarse sand. Similar poorly developed soils occur on the mudflats of the MacLeod land system. Vegetation is restricted to the extreme edges and where sand has formed banks and hummocks above the lake bed.

Highly calcareous, red (Dr 1.13, 4.13) and yellow (Dy 1.13) duplex soils occur on the alluvial plains of the Warroora land system and also on parts of the Chargoo land system. Texture ranges are sand or loamy sand over sandy clay or fine sandy clay. The soil profile often contains inclusions of limestone, marine shell and gypsum, and the pH ranges from 7.0 in the sandy A horizon to 8.5 in the clayey B horizon. These soils support low chenopod shrublands of Gascoyne bluebush.

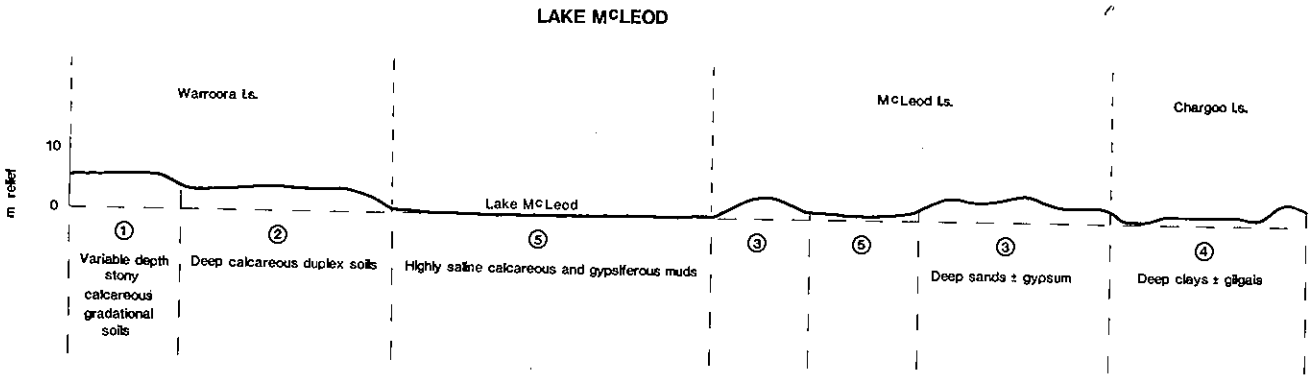
Calcareous red gradational soils (Gc 1.12, 2.21) of variable depth, over limestone, occur on stony plains of the Warroora land system and, to a lesser extent, on the McLeod land system. These are red or reddish-brown and textures predominantly loams over clay or, less commonly, sands over loams. Limestone gravels and cobbles occur throughout the profile. Surface pH varies from 8.0 to 8.5. These soils support mixed chenopod pastures.

Uniform clays are restricted to the Chargoo land system. Seasonally cracking soils (Ug 5.24, 5.28, 5.31, 5.34) with gilgaied micro-relief are common on the alluvial plains, gilgai plains and drainage depressions of this system. Non-cracking clays (Uf 6.33, 6.41) also occur. Soils are > 1 m deep, with surface pH of 7.0 to 8.0 and generally neutral reaction trends. Textures range from light medium clay to heavy clay and they are usually dark reddish-grey or brown. Vegetation supported by these soils is a mosaic of tussock grasses and low chenopod shrubs.

Deep calcareous sands (Uc 1.11, 1.12) occur on the sandy banks of the Warroora and McLeod land systems. These are yellowish-red and often contain considerable inclusions of gypsum and marine shells.

Table 18. Lake McLeod Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Stony plains	12	Calcareous gradational soils (Gc 1.12); also Gc 1.22, 2.21	20-90	1-25	8.0-8.5	8.5
2	Alluvial plains	13	Calcareous red duplex soils (Dr 1.13, 4.13), calcareous yellow duplex soils (Dy 1.13)	> 100	0	7.0-8.5	8.5
3	Sandy banks	7	Cracking clay soils (Ug 5.34, 5.28, 5.31); non-cracking clay soils (Uf 6.21, 6.34, 6.33, 6.41)	> 100	0	7.0-8.5	8.0-9.0
4	Mud flats i.e. Lake McLeod	62	Saline, calcareous or gypsiferous muds	> 100	0	8.0	8.5



Lyndon Proterozoic Hills District

Shallow siliceous sands, or lithosols (Uc 1.43) make up about 64% of the soils within the district. They occur on the summits, low hills and rises of the Agamemnon, Phillips, James, Augustus, Thomas, Collier, Glenburgh and Capricorn land systems. They have been formed either *in* situ or from colluvium and are located in shallow pockets (5-30 cm deep) associated with massive gneissic, granitic or sandstone outcrops. Soil textures vary from sand to fine sandy loam. Boulders and stone are common as surface mantles and as profile inclusions. Soilss are usually red or dark red and the surface pH is usually about 6.5 with a neutral trend.

Friable red duplex soils (Dr 4.12) make up about 20% of the soils within the district and are found on the alluvial plains of Agamemnon, James and Thomas land systems. They probably also occur on the plains of the Phillips land system and on the drainage floors of the Phillips, Agamemnon, James and Thomas land systems although these units were not sampled. These soils are of variable depth, from 40 cm to > 1 m. They often have stony mantles of gneiss or quartz and profiles may contain gneiss, quartz or mica. Soil textures are mainly loamy sand or sandy loam over sandy clay loam or sandy clay. Soils are either dark red or reddish-brown and pH varies from 6.5 to 8.0.

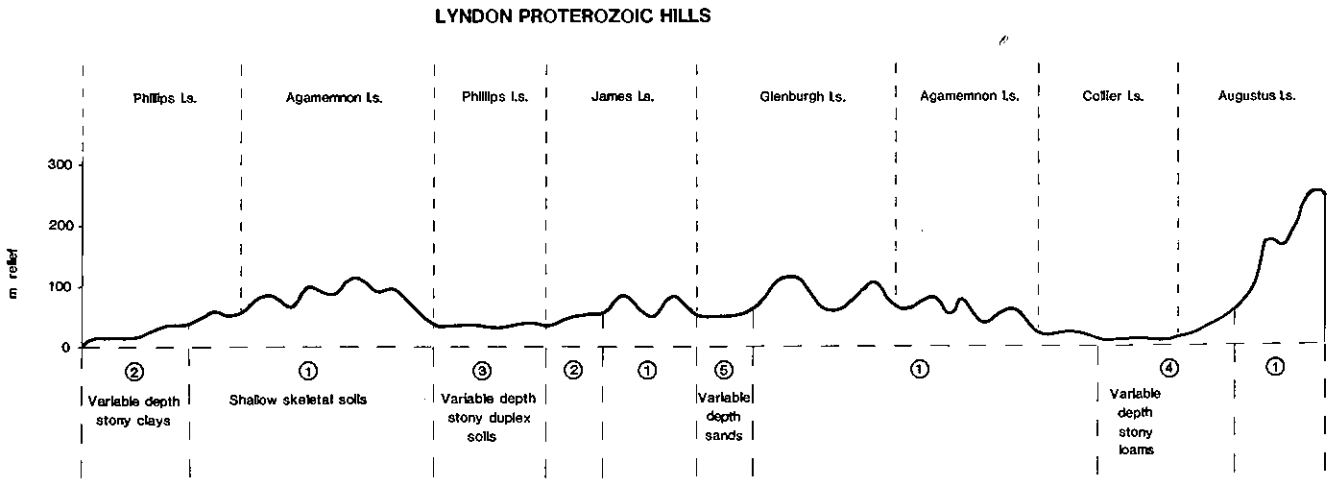
Stony uniform clays are common on the stony plains of the Phillips and James land systems. These soils vary in depth from 40 cm to > 1 m and their surfaces are often mantled by pebbles or cobbles of gneiss or granite, with profiles contain similar inclusions. Soils are reddish-brown and pH varies from 6.5 to 7.0.

Non-calcareous loams (Um 5.21, 5.22) occur less widely, on the stony plains of the Augustus, Collier and Capricorn land systems. They are of variable depth, usually < 1 m, and are densely strewn with pebbles or cobbles. Soil textures vary from fine sandy loam to sandy clay loam. Soils are reddish-brown and surface pH varies from 6.0 to 8.0.

Uniform coarse siliceous sands (Uc 1.23) are also relatively minor soils and occur on drainage floors and as bedloads in channels on several land systems. They also occur on the sandplains of Glenburgh land system and the sandy banks of Thomas land system. These soils are usually deep reddish-brown sands or loamy sands with surface pH varying from 6.5 to 8.0.

Table 19. Lyndon Proterozoic Hills Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Gneissic and granitic ranges and hills	64	Skeletal soil (Uc 1.43)	5-30	>50	6.5	6.5
2	Stony plains	11	Stony uniform clays (Uf 6.13)	40->100	11-25	6.5-8.0	6.5-8.0
3	Alluvial plains and drainage floors	19	Friable red duplex soils (Dr 4.12)	40->100	11-25	6.5-7.5	6.5-8.0
4	Stony lower plains	4	Non-calcareous loams (Um 5.21, 5.22)	< 100	11-25	6.0-8.0	6-8.0
5	Drainage flows and channels	2	Siliceous sands (Uc 1.23)	> 100	1-5	6.5-8.0	6.5-8.0



Mardathuna Plains District

Non-calcareous red gradational soils (Gn 2.11, 2.12, 3.12) dominate this district on the broad plains of the O'Brien and Windalia land systems. Windalia Radiolarite fragments are common as a surface mantle and as inclusions within the profile. Soil depth varies from 50 cm to > 1 m and textures are either sandy loams over clay loams or sands over loams. Soils are either dark red or dusky red, and the surface pH is between 6.0 and 6.5.

Calcareous gradational soils are also common and occur over limestone on the lower footslopes and plains of the Mary and Gearle land systems. Limestone or Windalia Radiolarite gravels or cobbles form a surface mantle and occur throughout the profile. Textures are predominantly clay loams over clays with some loamy sands over loams. Soils are either reddish-brown or red and the surface pH varies between 7.5 and 8.5.

Non-calcareous loams (Um 5.21, 5.52) occur on the stony plains and narrow drainage floors of the Windalia land system. Depth varies from 40 cm to >1m and textures range from uniform loamy fine sand to uniform silty clay loam. Radiolarite gravels and cobbles occur on the surface and throughout the profile. Soils are reddish-brown and surface pH varies between 7.0 and 8.0.

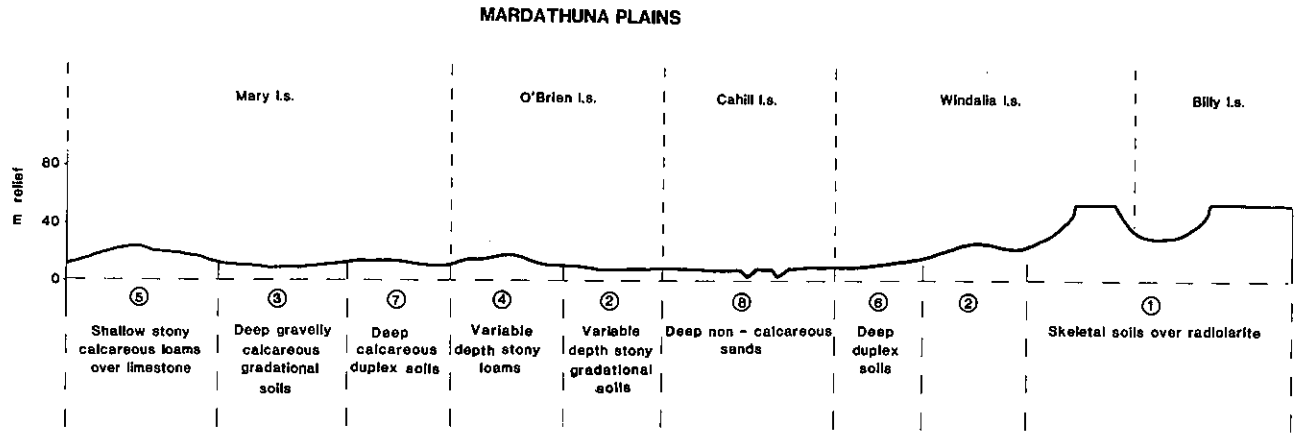
Calcareous, shallow loams (Um 5.11) occur on the calcrete platforms of the Mary land system. They vary in depth from 10-40 cm and overlie limestone. Limestone occurs as surface outcrops, mantles and as profile inclusions. Soils are dark red or red and their pH is consistently about 8.5. Soil textures are either uniform fine sandy loam or uniform loam, fine sandy.

Lithosols (skeletal soils) are restricted to the higher land units within this district. They occur as shallow pockets surrounded by rock outcrop. Non-calcareous skeletal soils occur on the plateaux, mesas, hills and upper footslopoes of the Billy and Windalia land systems. Calcareous skeletal soils occur on the low rises of the Mary land system.

Minor areas of duplex soils occur in the district. Non-calcareous red duplex soils (Dr 1.12, 2.52) occur on alluvial plains of the O'Brien and Windalia land systems and calcareous red duplex soils (Dr 1.13, 2.13) occur on alluvial plains of the Mary and Gearle systems.

Table 20. Mardathuna Plains Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	ph surface	ph Sub-surface
1	Radiolarite plateaux and mesas	7	Skeletal soils (Uc 1.43);	0-30	>50	6.0-6.5	6.0-6.5
2	Stony and alluvial plains	36	Non-calcareous gradational soils (Gn 2.12 2.11, 3.12)	50->100	6-10	6.0-6.5	6.0-6.5
3	Stony and alluvial plains	11	Calcareous gradational soils (Gc 1.12, 1.22, 1.21. 2.21)	40->100	1-5	7.5-8.5	8.0-8.5
4	Gibber plains and drainage floors	17	Non-calcareous loams (Um 5.21, 5.25)	40->100	50	7.0-8.0	7.0-8.0
5	Calcrete platforms	12	Calcareous shallow loams (Um 5.110)	10-40	11-25	8.5	8.5
6	Alluvial plains	3	Non-calcareous red duplex soils (Dr 1.12); also Dr 1.52, 2.52, 4.12)	>100	1-5	6.5-8.0	6.5-8.0
7	Alluvial plains	2	Calcareous red duplex soils (Dr 1.13)	>100	0	8.0-8.5	8.5
8	Sandplains	12	Brownish or earthy sands (Uc 5.11, 5.21); also Uc 5.13	>100	0	6.0-7.5	7.0-7.5



Permian Hills District

Lithosols (skeletal soils) are by far the most common in this district. These soils have developed *in situ* or from colluvium and occur on the plateaux, mesas, hills and upper footslopes of the Moogooloo and Fossil land systems and on higher parts of Sandiman, Two Hills and Pells land systems. These soils occur in shallow pockets (5 - 30 cm deep) surrounded by sandstone outcrop. Stony mantles and profiles are common. Soils are red or reddish-brown and textures are uniform sand or loamy sand. Soil surface pH varies from 6.0 to 6.5.

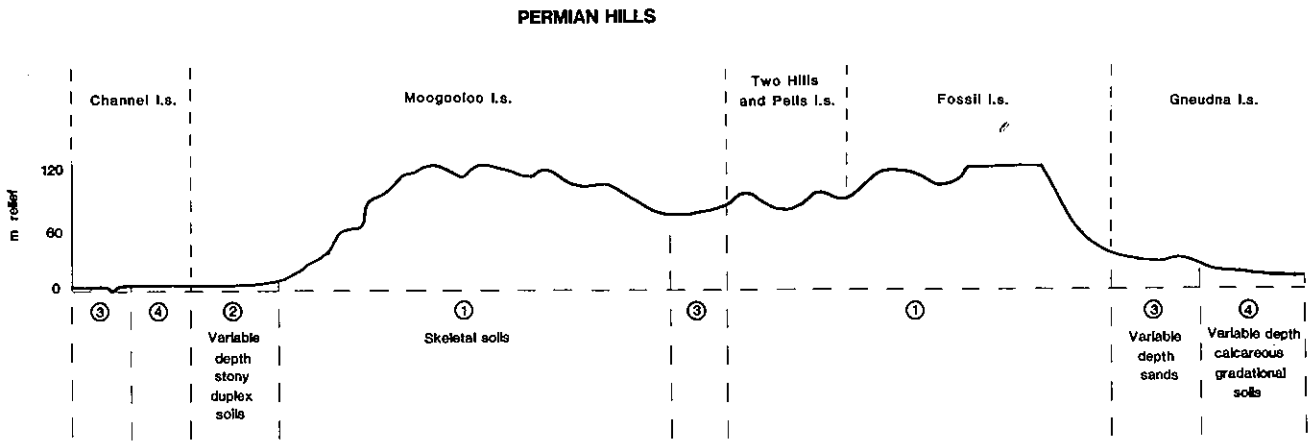
Less extensively, crusty, red duplex soils (Dr 1.12, 1.13) occur on the stony plains, flood plains and alluvial fans of Moogooloo, Pells, Sandiman and Channel land systems. They are of variable depth (although commonly >1m), with stony surfaces and profiles. They have a thin A horizon (15-40 cm deep) of sandy loam or fine sandy loam over fine sandy clay, light-medium clay or medium clay. Soils are reddish-brown or dark red. These soils may be calcareous (Dr 1.13) or non-calcareous (Dr 1.12) with surface pH from 7.5 to 8.5 or 6.5 to 8.0 respectively and trending alkaline or neutral.

Calcareous and siliceous sands (Uc 1.13, 1.22) and earthy sands (Uc 5.21) occur on the sandy banks and some stony plains and narrow drainage floors on the Moogooloo, Sandiman, Pells, Gneudna and Channel land systems. Soil depth varies from 40cm to > 1 m and the texture is predominantly uniform loamy sand (less commonly fine sandy loam) and the colour is red or dark red. Calcareous soils have a surface pH around 8.5, and non-calcareous between 6.0 and 6.5.

Calcareous gradational soils (Gc 1.12, 1.22) occur on the dissected slopes of the Channel land system and the alluvial plains of the Gneudna land system. They are 80 cm to > 1 m and commonly have surface mantles of quartz or calcrete and calcrete gravels throughout the profile. These soils are red or reddish-brown fine sandy loam over sandy clay loam or fine sandy clay loam over light clay. The surface pH varies from 8.0 to 8.5.

Table 21. Permian Hills Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Sandstone plateaux, mesas hills and footslopes	76	Skeletal soils	5-30	>50	6.0-6.5	6.0-6.5
2	Stony plains	11	Crusty red duplex soils (Dr 1.12, 1.13)	55->100	11-25	6.5-7.5	8.0-8.5
3	Sandy banks and drainage floors	7	Earthy sands (Uc 5.21), calcareous sands (Uc 1.13) or siliceous sands (Uc 1.22)	40->100	5-50	6.5-8.5	6.5-8.5
4	Alluvial plains and dissected slopes	7	Calcareous gradational soils (Gc 1.12, 1.22)	80->100	1-50	8.0-8.5	8.0-8.5



Ridge Dunes District

Deep, brownish, earthy or siliceous sands (Uc 5.11, 5.21, 1.23) account for over 80% of the soils in this district. Earthy sands (Uc 5.21) occur on the sandplains, swales and interdunal plains of the Yalbalgo, Giralia, Uaroo, Kennedy and Divide land systems. These soils are highly porous and are >1m deep. Textures are either uniform loamy sands or sandy loams or, less commonly, light sandy clay loams. Soil profiles are usually free of inclusions, with the exception of ferruginous gravels in soils on the interdunal plains of the Yalbalgo land system. Soils are either dusky red or dark red. Soil pH trend is predominantly neutral, ranging from 6.0 to 7.0, although acidic soils between pH 5.0 and 6.0. were found on Towrana station. Siliceous sands (Uc 1.23) occur on the linear dunes and sandy banks of the Yalbalgo, Giralia, Kennedy, Yagina, Spot and Ella land systems. These are loose, highly porous and > 1 m deep. Soils are predominantly uniform sands or less commonly loamy sands and profiles contain no gravel. Soils are dark red or dusky red. Soil surface pH varies from 6.0 - 7.0 and is always of neutral trend.

In the northern part of the district, vegetation is characterized by hummock grasslands of hard spinifex with a scattered shrub over-storey. The central part is a transitional zone between spinifex and shrub pastures while the southern part supports moderately dense tall shrublands or low woodlands.

Other soils of minor importance in the district are gradational, duplex and skeletal types.

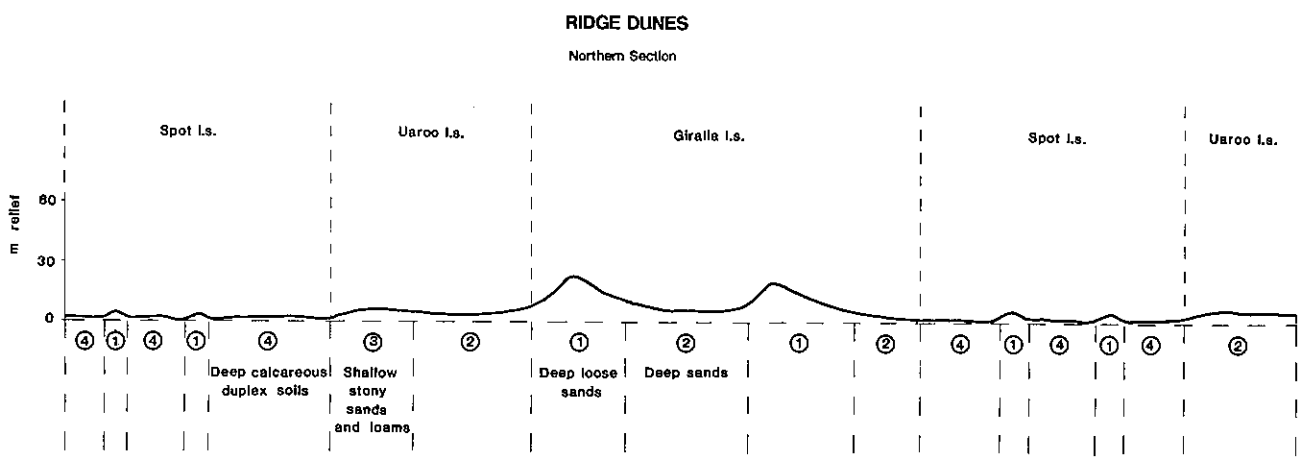
Non-calcareous, red gradational soils (Gn 2.11, 2.12, 3.12, 4.12) occur on the interdunal and alluvial plains of the Yalbalgo, Ella, Yagina and Wash land systems. These soils are predominantly > 1 m deep. Soil textures may be sand over loam or loam over clay, soils are dusky red or dark red, and surface pH ranges between 5.5 and 8.0.

Calcareous red duplex soils (Dr 1.13) >1m deep occur on the inter-banks, swales and alluvial plains of Ella and Spot land systems. Soil surfaces may be sparsely mantled by quartz or radiolarite gravels. The A horizons range in depth from 15-45 cm and have textures of loamy sand or sandy loam. B horizons have textures of sandy clay loam, sandy clay or fine sandy clay. Soils are dark red or dusky red. Soil surface pH varies between 6.5 and 7.0, and trends alkaline with depth.

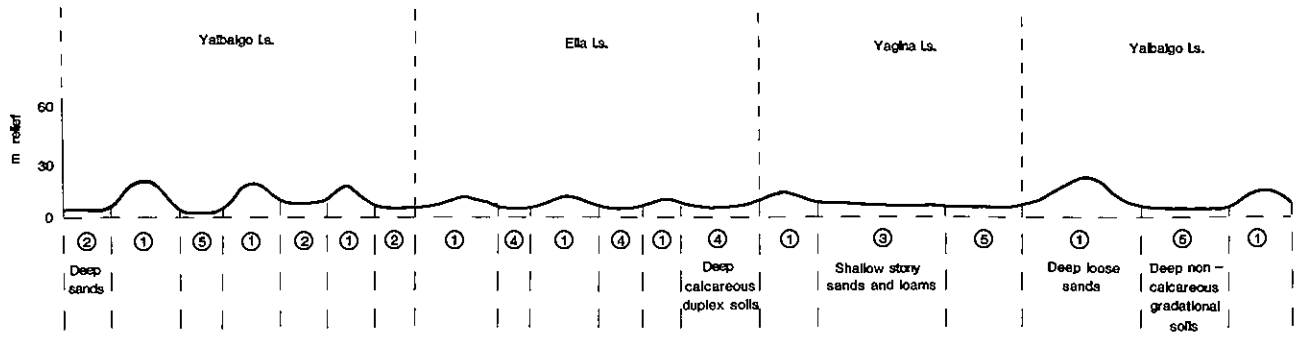
Shallow, stony, firm siliceous sands (Uc 1.43) and siliceous loams (Um 1.43) occur on the low, stony rises of the Uaroo land system and the undulating and stony plains of the Yagina land system. These soils are generally 20-40 cm deep with textures of sandy loam, fine sandy loam or sandy clay loam. Soils are dark red and soil pH is alkaline on the Uaroo land system and acidic on the Yagina land system.

Table 22. Ridge Dunes Geomorphic District

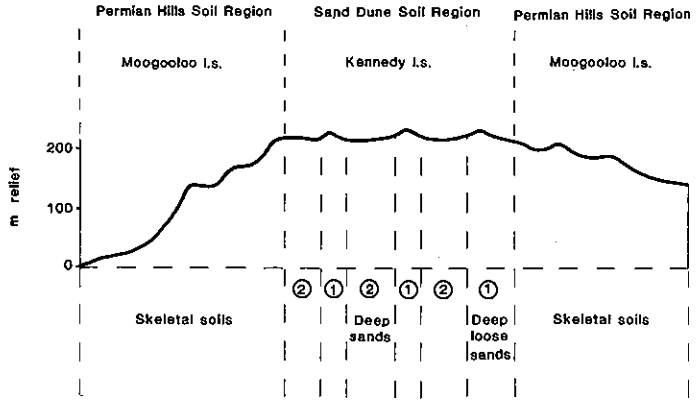
Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Sand dunes and sandy banks ranges and hills	18	Siliceous sands (Uc 1.23)	>100	0	6.0-7.0	6.0-7.0
2	Sandplains and swales	63	Earthy sands (Uc 5.21); also brownish sands (Uc 5.11)	>100	0-1	6.0-7.0	6.0-7.0
3	Stony rises and plains	4	Firm siliceous sands (Uc 1.43 and) loams (Um 1.43)	20-40	25-50	7.0-8.0	7.0-8.5
4	Interbanks and alluvial plains	7	Calcareous red duplex soils (Dr 1.13, 1.12); also Dr 4.12, 1.16	>100	0-1	6.5-7.0	6.5-9.0
5	Swales and alluvial plains	8	Non-calcareous red gradational soils	65->100	0-1	5.5-7.0	6.0-8.0



Central and Southern Section



Eastern Section



Tamala Limestone Plains District

Deep, highly calcareous sands (Uc 5.12, 1.12) account for about 48% of the soils within the district. Brownish sands (Uc 5.12) occur on the undulating plains and sandplains of the Taillefer and Tamala land systems. These soils have sparse calcrete gravels on the surface and throughout the profile. Profiles also contain abundant free calcium carbonate and the soil pH is about 8.5. A layer of sand to 40 cm overlies loamy sand, to a depth > 1 m. Soils are usually reddish-brown. The vegetation is characterized by shrublands of *Acacia ligulata*, with diverse small shrubs and winter-growing annuals.

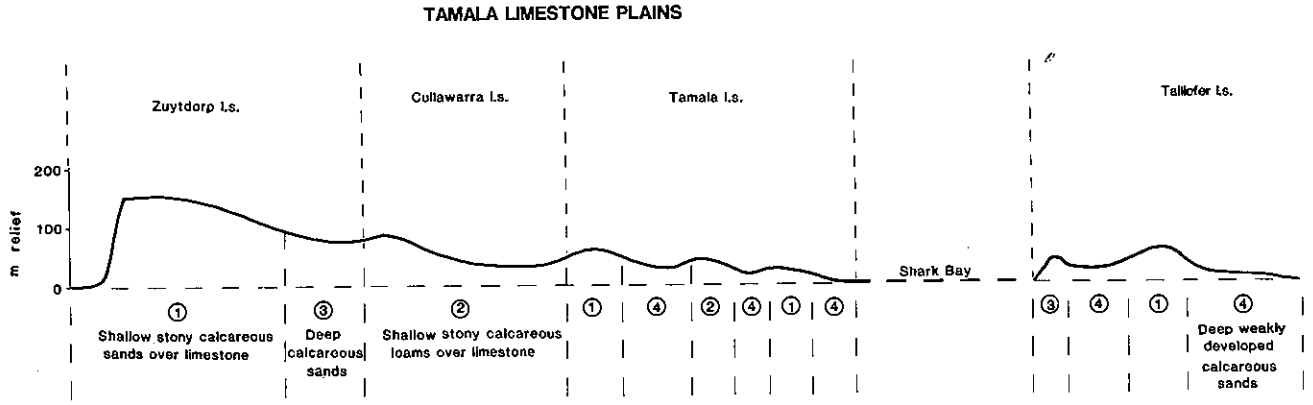
Calcareous (Uc 1.12) sands with minimal profile development occur on the coastal dunes of the Taillefer land system and the sandplains of the Zuytdorp land system. These soils have profiles > 1 m deep and are reddish-yellow or yellow. The coastal dune soils often contain marine shell inclusions and have a surface pH of about 8.5. Sandplain soils are predominantly free of calcareous inclusions and pH is between 6.5 and 7.0.

Shallow lithosols (skeletal sandy soils: Uc 1.13, 1.21, 6.11) occur over about 30% of the soils within the district. These soils are found on the low hills and stony plains of the Zuytdorp, Tamala and Taillefer land systems. They are usually 10-40 cm deep and occur in pockets surrounded by outcropping limestone. The surface often has a mantle of limestone cobbles or pebbles and profiles often contain similar inclusions. Soil texture is either sand or loamy sand and surface pH 7.0 with neutral trend or 8.5 with alkaline trend.

Shallow friable calcareous loams (Um 6.21, 6.24) occur on the stony plains of the Cullawarra land system and on the low rises of the Zuytdorp, Tamala and Cullawarra land systems. These soils occur adjacent to outcropping limestone, and have a dense mantle of limestone cobbles and boulders. Soils are mostly 15-40 cm deep over sheet limestone. Limestone cobbles occur throughout the profile. Textures may be sandy loam, loam fine sandy or sandy clay loam. Soils are dark reddish-brown or very dark grey; pH ranges from 8.0 to 8.5.

Table 23. Tamala Limestone Plains Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Plains of stony sands over limestone	30	Skeletal sandy soils (Uc 1.13, 1.21)	10-40	10-25	7.0-8.5	7.0-8.5
2	Stony plains and low rises	22	Shallow friable calcareous loams (Um 6.21, 6.24)	15-40	25->50	8.0-8.5	8.0-8.5
3	Sandplains and coastal dunes	15	Calcareous sands (Uc 1.12, 1.22)	>100	0	6.5-8.5	6.5-8.5
4	Undulating plains and sand-Plains	33	Calcareous brownish sands (Uc 5.12)	>100	1-5	8.5	8.5



Towera Stony Plains District

Stony red duplex soils (Dr 1.12, 1.52, 4.12) are the most common soils in the district and occur on the lower undulating stony plains and alluvial plains of the Durlacher, Yinnietharra and Duffy land systems. These soils have a generally sparse mantle of quartz gravel (cover usually < 5%). Soil depth varies from 50 cm to > 1 m over rock or, in some instances, ferruginous hardpan. Surface layers (15-30 cm deep) of sandy loam or fine sandy loam overlie sandy clay or light-medium clay. Quartz gravel inclusions are common throughout the profile and soil reaction trends are predominantly neutral, with surface pH ranging from 6.0 to 8.0, less commonly to 8.5.

Uniform non-cracking clays (Uf 6.12, 6.21) and seasonal cracking clays with gilgaied micro-relief (Ug 5.38) occur on the stony plains and groves of the Durlacher and Yinnietharra land systems. These soils are > 1 m deep with textures of sandy clay, light-medium clay or, less commonly, medium or heavy clay. Soils are dark red or dark reddish-brown, with pH ranging from 6.5 to 8.5. Quartz gravels occur as a sparse surface mantle or throughout the profile.

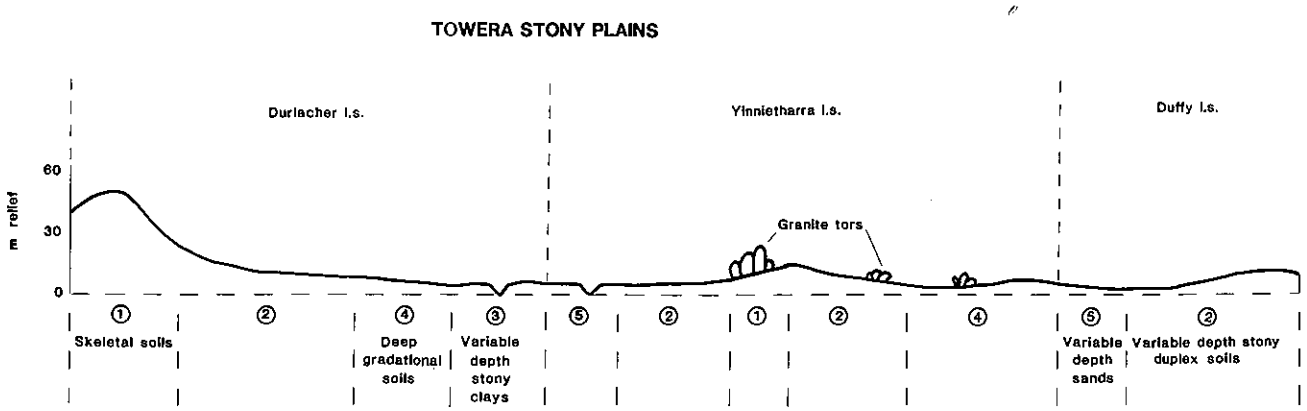
Deep, gradational, red earths (Gn 1.12, Gn 4.12) and less commonly calcareous red earths (Gc 2.22) occur on the undulating plains of the Yinnietharra land system and on the drainage floors of the Duffy land system. Soil textures may be sand over loam or loam over clay and colours are dark red or dusky red. Quartz gravels may occur as a sparse mantle or throughout the profile. Soil pH normally varies from 6.5 to 7.0 and to 8.0 in calcareous soils.

Shallow uniform siliceous sands (Uc 1.43) or loams (Um 1.43) occur on the ridges of the Durlacher land system and, to a lesser extent, on the Yinnietharra and Duffy land systems. These are lithosols or skeletal soils formed *in situ* and are located in shallow pockets 5-20 cm deep surrounded by rock outcrop. Quartz cobbles and gravels occur on the surface and throughout the profile. Textures are uniform sandy loam or sandy clay loam respectively. Soils are normally dark red and pH varies from 6.0 to 6.5.

Minor areas of shallow to deep earthy sands (Uc 5.21) occur on the sandplains of the Duffy land system and the broad braided drainage floors of the Yinnietharra land system.

Table 24. Towera Stony Plains Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Quartz strike ridges and granite domes	7	Skeletal soils	5-20	>50	6.0-6.5	6.0-6.5
2	Alluvial and stony plains	52	Stony red duplex soils (Dr 4.12, 1.12, 1.52); also Dr 1.15, 1.53, 4.52, 4.53	35->100	5-25	6.0-7.5	6.5-8.0
3	Stony plains and groves, sometimes gilgaied	27	Non-cracking clay soils (Uf 6.11, 6.12, 6.21); cracking clay soils (Ug 5.38)	30->100	11-25	6.5-7.5	8.0-8.5
4	Plains and drainage floors	10	Deep gradational red earths (Gn 1.12, 4.12); calcareous red earths (Gc 2.22)	>100	0	6.0-6.5	6.7-7.0
5	Sandplains and drainage floors	4	Earthy sands (Uc 5.21, 5.31)	50>100	1	5.5-6.5	6.0-6.5



Victoria Sandplain District

The district is characterized by the predominance (97%) of sand soils.

Slightly coherent, earthy sands (Uc 5.21) are dominant, and occur on the flat to undulating plains of the extensive Sandplain land system. These soils also occur on the smaller sandplains of the Wooramel and Tarcumba land systems. Soil profiles are > 1 m deep and textures are sand over loamy sand or, less commonly, sandy loam. Soils are usually dark red and surface pH is commonly between 6.5 and 7.5. More acidic soils (pH 5.0-6.5) occur in the extreme east of the district. Vegetation is characterized by wanyu shrublands.

Loose siliceous or brownish sands (Uc 1.23, 5.11) occur on the broad undulating plains of the Nerren, Nanga and Cooloomia land systems. These dark red, non-calcareous sands are deep and highly porous. Textures are either sand or loamy sand, and pH ranges from 5.5 to 8.0. The soils support shrublands of wanyu with scattered eucalypts or scrub heath and tree heath.

Calcareous brownish sands (Uc 5.11, 5.12) occur on the sandplains of the Peron land system. These soils are deep, highly porous sands or loamy sands. They are red or reddish-brown and soil surface pH varies from 7.0 to 8.5.

Deep, loose calcareous sands (Uc 1.13) occur on the coastal dunes of the Peron land system. These profiles contain calcareous material such as marine shell and soil pH is always about 8.5.

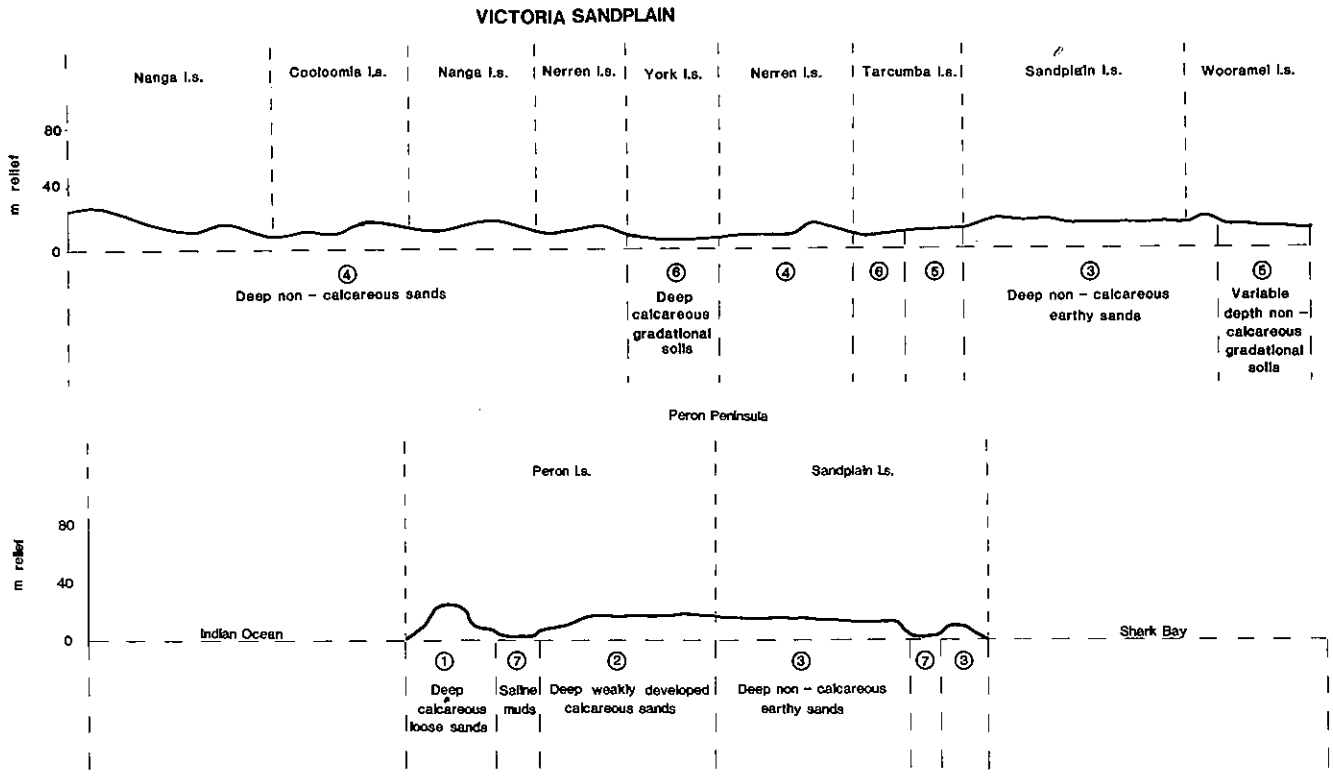
Other minor but locally important soils are non-calcareous red gradational soils (Gn 2.11, 3.12, 4.11, 4.12). These occur on the undulating plains of the Wooramel land system and the alluvial plains of the Tarcumba land system. Soil depth varies from 65 cm to > 1 m. Textures are usually sands over sandy loams and occasionally clay loams over clays. Soils are usually dusky red or dark red and surface pH between 6.0 and 8.0.

Minor areas of calcareous red gradational soils (Gc 1.12, 2.21, 2.22) occur on the alluvial plains of the York land system and the undulating plains of the Tarcumba land system. They are usually >1m deep and textures vary from loam to clay. Profiles contain free calcium carbonate and, in some cases, calcrete gravels. Soils are dark red or reddish-brown and surface pH is 7.5 to 8.5.

On the Peron Peninsular, within the Sandplain and Peron land systems, elliptical salt flats known as birridas occur extensively. These birridas are evaporite pans and may extend up to 9 km in length, but are usually much smaller. They contain highly saline and gypsiferous deposits of clay, silt and sand.

Table 25. Victoria Sand Plain Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Coastal dunes	1	Calcareous sands (Uc 1.13)	>100	0	7.5	8.5
2	Coastal sandplains	2	Calcareous brownish sands (Uc 5.12, 5.11)	>100	0-1	7.0-8.5	8.0-8.5
3	Sandplains	60	Earthy sands (Uc 5.21); also Uc 5.22, 5.31	>100	0	5.5-7.0	5.5-7.5
4	Undulating sandplains and confused dunes	34	Siliceous sands (Uc 1.23, 1.22) or brownish sands (Uc 5.11)	>100	0	5.5-8.0	6.0-8.0
5	Plains and alluvial plains	12	Non-calcareous red gradational soils (Gn 3.12, 4.12); also Gn 4.11, 2.11	65->100	1-5	5.5-7.5	6.0-8.0
6	Plains and alluvial plains	1	Calcareous red gradational soils (Gc 1.12 2.21,2.22)	>100	0-1	7.5-8.5	8.0-8.5
7	Evaporite pans - Birridas	1	Saline muds and gypseous deposits	>100	0	8.0-8.5	8.5



Wandagee Permian Plains District

Duplex soils comprise about 43% of the soils in the district: some are calcareous (Dr 1.13, 1.53, 2.13, 4.13); some non-calcareous (Dr 1.12, 2.12, 4.12). They are common on the lower footslopes and undulating lower plains of the Jimba land system, the undulating plains of the Mantle land system, and the alluvial plains and flood plains of Yalkalya and Wash land systems. These soils have thin loamy A horizons (10-35 cm deep) with textures ranging from sandy loam to light sandy clay loam. The clayey B horizons vary from sandy clay to heavy clay textures. Depth is predominantly > 1 m, but occasionally shallower (40-80 cm). Surfaces sometimes have gravelly or pebbly mantles of sandstone, quartz or radiolarite. Profiles often contain similar inclusions to the mantle. Soils are red, dark red or reddish-brown. Soil surface pH varies from 6.0 to 8.0 with neutral or alkaline trends.

Duplex soils normally support highly productive low shrub associations - such as Gascoyne bluebush and saltbush. Where the shrub populations are seriously depleted, the soils have become susceptible to accelerated erosion with widespread loss of topsoils and subsequent surface scalding and rilling.

Calcareous red gradational soils (Gc 1.12, 1.22, 2.12) are common in this district. They occur mainly on the low hills and footslopes of the Jimba and Mantle land systems and the alluvial plains of the Wash land system. They often have variable stony mantles of either calcrete, siltstone, quartz or granite. Profiles may contain similar inclusions and abundant calcium carbonate. Soil depth varies from 30 cm to > 1 m. Soils are apedal with textures from sands over loams or loams over clays and reddish-brown or red.

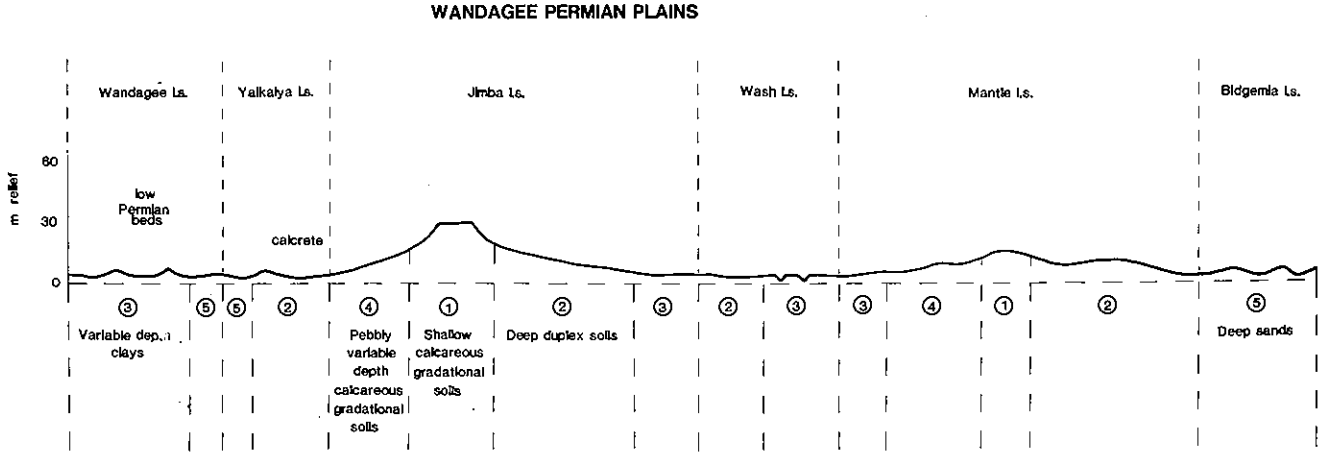
Uniform non-cracking clays (Uf 6.12, 6.13, 6.21, 6.33) occur on the lower units of Jimba, Wash and Wandagee land systems. Seasonal cracking clays with gilgaied micro-relief (Ug 5.31) occur only as a minor component. Depth is usually >1m but shallower soils (25-60 cm deep) also occur. Surface mantles of quartz or sandstone occur mixed or separately. Textures are variable, but are usually sandy clay, light clay or light-medium clay. Soils are predominantly reddish-brown and surface pH varies from 6.5 to 8.0 with neutral trend.

Minor sandy soils occur: calcareous sands (Uc 1.13) on low hills; siliceous sands (Uc 1.23) on sand dunes and sandy banks (Uc 1.23); and earthy sands (Uc5.21) on the sandy plains of the Yalkalya, Wandagee, Jimba and Bidgemia land systems. Soils are uniform sands or loamy sands, which are predominantly deep and non-calcareous. Soils are dark red or red and the pH ranges from 6.0 to 8.0. Shallow, red calcareous sands are less common and occur on the low rises of the Yalkalya land system.

Lithosols (skeletal soils) occur as a minor component on hills and rocky residuals within this district.

Table 26. Wandagee Permian Plains Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Ridges and summits	7	Skeletal soils	0-30	25-50	8.0-8.5	8.5
2	Lower footslopes and plains	43	Non-calcareous red soils (Dr 1.12, 4.12); calcareous red duplex soils (Dr 1.13, 4.13)	40->100	1-25	6.0-8.0	7.0-8.5
3	Plains and drainage floors	21	Uniform non-cracking clays (Uf 6.12, 6.33 also Uf 6.13, 6.21	25->100	1.25	6.0-8.0	6.0-8.0
4	Low hills and footslopes	18	Calcareous gradational soils (Gc 1.22,) 1.12, 2.12)	30->100	11.50	8.0-8.5	8.0-8.5
5	Deep sands	11	Calcareous sands (Uc 1.13); siliceous sands (Uc 1.23); earthy sands (Uc 5.21)	>100	0-1	6.5-8.0	6.5-8.0



Winning Plains District

This district is characterized by a high proportion of calcareous soils with numerous principal profile forms being represented.

Highly calcareous gradational soils (Gc 2.22) occur over about one-third of the district. These soils are common on the lower footslopes and alluvial plains of the Gearle and Donovan land systems. They are reddish-brown and often have limestone gravels on the surface. Their profiles are usually deeper than 1 m and contain limestone or calcrete gravels and abundant calcium carbonate. Soil pH varies from 7.5 to 8.5 and textures are predominantly sandy clay loam or fine sandy clay loam over fine sandy clay or light-medium clay.

Highly calcareous red duplex soils (Dr 1.13, 2.13) commonly occur on the alluvial plains and lower drainage areas of the Winning land system. Duplex soils also occur on minor areas on the footslopes of the Gearle land system and the lower plains of the Donovan land system. They are dark red and predominantly free of surface mantle. Profiles are usually > 1m deep and contain abundant calcium carbonate. Profiles may also contain inclusions of limestone, quartz or gypsum. Soil pH ranges from 6.5 to 8.5 and the textures are usually sandy loams over sandy clays.

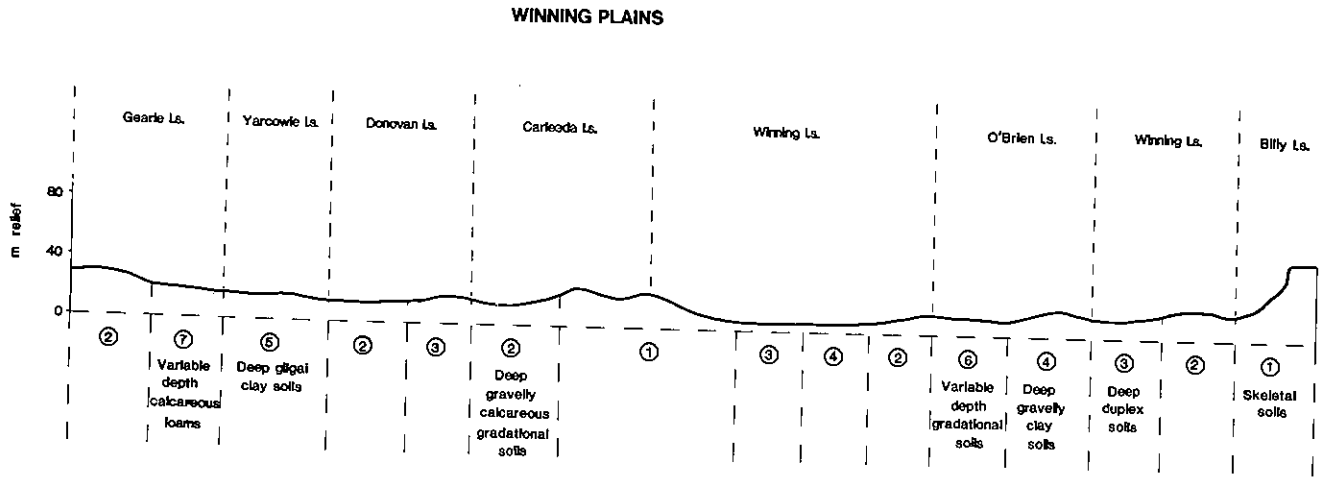
Lithosols (skeletal soils) occur on the upper units of the Billy, Winning, Carleeda and Gearle land systems. These soils are very shallow with depths between 10 and 40 cm, and occur in pockets surrounded by rock outcrop. Depending on parent material, such profiles may contain pebbles or cobbles of radiolarite or limestone and soil textures may be uniform sand, sandy loams or fine sandy loam. Soils are reddish-brown or red and surface pH varies between 6.0 and 7.0 (over radiolarite) and 7.5 to 8.5 (over limestone).

Non-cracking calcareous clays (Uf 6.21) occur on the alluvial plains and drainage areas of the Donovan land system. Seasonal cracking clays with gilgaied micro-relief (Ug 5.38) also occur on the Yarcowie land system. These soils are reddish-brown and > 1 m deep. Profiles often contain inclusions of calcrete and calcium carbonate. Surface soil pH is about 8.5, and textures range from light medium clay to medium heavy clay. Non-cracking clays (Uf 6.12, 6.13) also occur on the gibber plains and groves of the O'Brien land system. These soils are non-calcareous, reddish-brown and have profiles > 1m deep; they often have gravelly surfaces and profiles. Textures range from sandy clay to light-medium clay and the surface pH is between 7.0 and 8.0.

Calcareous powdery and friable loams (Um 5.12, 6.33, 6.42) occur on the alluvial plains of the Gearle and Donovan land systems. They are reddish-brown and have gravelly surfaces of limestone, siltstone or mudstone. Profiles may contain similar inclusions in addition to calcium carbonate. These soils are usually 60 cm to > 1 m deep and textures are uniform loam, fine sandy or fine sandy clay loam. Surface soil pH is 8.0 to 8.5.

Table 27. Winning Plains Geomorphic District

Unit No.	Landform	Approximate area (%)	Soil type and principal profile forms	Depth (cm)	Surface stone (%)	pH surface	pH sub-surface
1	Plateaux, upper footslope and low hills	16	Skeletal soils	0-30	10->50	6.0-8.0	6.0-8.5
2	Alluvial plains and lower footslopes	34	Calcareous gradational soils (Gc 2.22)	>100	0-5	8.5	8.0
3	Alluvial plains and drainage floors	17	Calcareous red soils (Dr 1.13, 1.12, 2.13)	80->100	0-2	6.5-8.5	8.0-8.5
4	Plains, drainage floors and groves	13	Calcareous non-cracking clay soils (Uf 6.21); also Uf 6.12, 6.13	>100	0-1	7.0-8.5	8.0-8.5
5	Gilgai plains	3	Cracking clay soils (Ug 5.38)	>100	0-1	8.5	8.5
6	Stony plains and groves	6	Non-calcareous gradational soils (Gn 2.12, 2.11, 3.12)	50->100	1-25	6.0-6.5	6.0-6.5
7	Plains and drainage floors	11	Calcareous friable or powdery loams (Um 6.33, 5.12, 6.42)	60->100	0-1	8.0-8.5	8.5



Pasture Types

Within the 89 land systems described for the area, there are a smaller number of basic vegetation alliances that can be recognized as broad pasture types. Seventeen pasture types have been identified and described, each type tending to develop wherever the geomorphology, soil type, hydrology and climatic influences are very similar. 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 over-riding importance. Even so, each 'pasture type' can be said to represent a broad working group of similar vegetation associations. Pasture types and the edaphic factors influencing their distribution are listed below.

1. Perennial pastures

A. Pastures dominated or influenced by plants of the South-West Botanical Province.

(i) On deep sands

Acacia and Eucalyptus Short Grass Forb (AEGF)

Heath (HEAT)

B. Pastures dominated by plants of the Eremaean (arid zone) Botanical Province.

(i) On deep sands

Acacia Sandplain (ACSA)

Coastal Dune Shrub (CDSH)

Hard Spinifex (HASP)

Soft Spinifex (SOSP)

(ii) On shallow stony loams

Acacia Mixed Shrub (ACMS)

Acacia Short Grass Forb (ASGF)

Stony Chenopod (STCH) (and some on duplex soils)

Stony Short Grass Forb (SSGF)

(iii) On saline loams, clays and duplex types

Bluebush (BLUE)

Currant Bush Mixed Shrub (CBMS)

Samphire (SAMP)

Saltbush (SALT)

(iv) On alluvial loams and clays

Acacia Creek-line (ACCR)

Tussock Grass (TUGR)

2. Annual pastures

In higher rainfall (> 250 mm) area of Shark Bay dominated by introduced winter pasture and weed species, calcareous sandy soils.

Exotic Annual (EXAN)

Summary of key characteristics

Table 28 summarizes the pasture types in terms of extent, pasture characteristics and present condition. More detailed descriptions of each pasture type, compiled from observations and measurements made at inventory sites throughout the survey area, are also presented below, in order of decreasing area.

The following terminology is used to describe the extent of perennial vegetation cover, as a percentage of ground area (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

Table 28. Summary of pasture types of the survey area

Pasture type	Area km²	per cent	Landforms and vegetation characteristics	Condition
Acacia Sandplain (ACSA)	25,000	33.6	Extensive sandplains and dunefields, also low sandy banks, deep red sands; tall moderately close shrublands of *Acacia ramulosa* or low woodlands of *A. anastema* with wanderrie grasses; moderate pastoral value	Not normally susceptible to erosion, pastures generally in good or fair condition, use of fire as management tool needs investigation
Hard Spinifex (HASP)	6,900	9.3	Sandplains and dune fields, also stony plains and partly inaccessible rugged hills, deep sands and skeletal soils; hummock grasslands with numerous shrubs, pastoral value usually low or very low.	Sandy systems susceptible to wind erosion if vegetation lost, but stabilize rapidly after rain, little vegetation degradation, periodic burning required.
Acacia Short Grass Forb (ASGF)	5,600	7.5	Stony plains, footslopes, hills and plateaux, shallow sands and loams with variable surface mantles; tall shrublands with prominent low shrub layer mostly of eremophilas and cassias forbs and annual grasses, low pastoral value.	Generally resistant to erosion, pasture condition mostly fair or good but some localized areas show considerable loss of palatable shrubs.
Soft Spinifex (SOSP)	4,800	6.4	Coastal sandplains, sand dunes, some limestone plains and drainage floors, mostly deep sands and loams; hummock grasslands (*Triodia pungens, Plectrachne schinzii*) with sparse shrubs, high pastoral value.	Susceptible to wind erosion immediately after fire but stabilizes rapidly after rain. Pasture condition mostly good, some localized increases in undesirable shrubs, periodic burning required; some areas invaded by *Cenchrus ciliaris*.
Bluebush (BLUE)	4,700	6.3	Alluvial plains, gently undulating limestone plains, footslopes and drainage floors, alkaline loams and duplex soils; low shrublands of *Maireana polypterygia, M. platycarpa* and others with some tall shrubs, pastoral value high.	Some systems (e.g. Firecracker and sloping parts Gearle) are susceptible to erosion with gullies, micro -terracing and sheeting, flat sites elsewhere are generally less susceptible, pasture condition varies from very good to very poor.
Currant Bush Mixed Shrub (CBMS)	4,200	5.6	Alluvial plains, deep alkaline duplex soils; mostly moderately close tall shrublands many shrub species, but dominated by acacias, eremophilas and cassias, high pastoral potential.	Generally not susceptible to erosion, but some local areas of scalding and hummocking, pastures mostly degraded and shrub invasion common,
Heath (HEAT)	3,800	5.1	Sandy plains and sand ridges, non calcareous sands usually > 1 m deep, but also shallower over limestone; closed heath, scrub heath and tree heath vegetation, very low pastoral potential.	Not susceptible to erosion, not developed and pastures too poor to be used for grazing.
Saltbush (SALT)	3,500	4.7	Alluvial plains, tributary drainage plains and drainage floors, saline loams, clays and duplex soils usually alkaline and > 1 m deep; low shrublands of *Atriplex* and very scattered tall shrubs, high pastoral value when in good condition.	Duplex soils are sensitive to erosion, scalding hummocking and rilling common on Delta land system, pasture condition varies from very good to severely degraded, shrub invasion common.
Acacia Mixed Shrub (ACMS)	3,200	4.3	Gently sloping plains on limestone, variable depth calcareous soils over limestone or calcrete commonly with surface mantle, moderately close tall shrublands of *Acacia drepanophylla* and numerous other *Acacia* spp, high pastoral value.	Not susceptible to erosion, pasture condition is variable, some extensive parts show considerable pasture degradation.

Table 28. continued...

Pasture type	Area km²	per cent	Landforms and vegetation characteristics	Condition
Stony Chenopod (STCH)	3,000	4.0	Footslopes and stony plains and interfluves, variable depth duplex soils with moderate to heavy surface mantles; scattered tall and low shrublands, moderate pastoral value.	Generally not susceptible to erosion because of protection afforded by stony mantle, minor to moderate pasture degradation is common.
Stony Short Grass Forb (SSGF)	2,300	3.1	Rough hills, plateaux, footslopes and undulating stony plains, sands and loams over parent rock at shallow depth, heavy surface mantles; very scattered shrublands, low or very low pastoral value.	In most cases the stony surface mantle affords protection from erosion; pasture condition mostly good or fair, some local degradation.
Coastal Dune Shrub (CDSH)	1,900	2.6	Coastal sandplains and dunes, mostly deep calcareous sands with some shallower sands over limestone, moderately close to closed low shrublands, high pastoral value.	Very high inherent susceptibility to wind erosion on the Coast land system, numerous large blowouts, elsewhere less susceptibility with stable pastures in good condition.
Acacia and Eucalyptus Short Grass Forb (AEGF)	1,900	2.6	Almost flat or gently undulating sandplains, non-calcareous sands > 1 m deep, tall moderately close shrublands, *Acacia ramulosa* with scattered emergent *Eucalyptus* spp. as mallee and tree forms, moderate pastoral value.	Not susceptible to erosion, pasture condition mostly fair or good.
Acacia Creek-line (ACCR)	1,800	2.4	Levees, banks, narrow drainage floors, drainage foci and groves, alluvial loams, clays and duplex soils; moderately close tall shrublands or woodlands *Acacia aneura*, *A. citrinoviridis* and numerous other shrubs, high pastoral value.	Some units moderately susceptible to erosion others stable, pasture condition varies from good to poor, occasional gullying and rilling on drainage floors and rills through degraded groves.
Tussock Grass (TUGR)	700	0.9	Gilgai plains, drainage foci, swamp margins and alluvial plains, mostly clay soils > 1 m deep, tussock grasslands with sparse shrubs or grassy woodlands and shrublands, pastoral value usually high.	Generally not susceptible to erosion, pasture condition mostly fair or good, buffel grass has ability to colonize and eventually stabilize many degrades sites Recently colonized sites with poor total cover are still seriously degraded.
Samphire (SAMP)	300	0.4	Saline and gypsiferous plains, lake margins and banks, saline clays and loams, some sandy soils; low shrublands of samphire, low or very low pastoral value.	Not susceptible to erosion except some sandy margins, highly saline low potential pastures mostly in good condition.
Exotic Annual (EXAN)	100	0.1	Gently undulating sandy plains and limestone plains, variable depth calcareous sands and loamy sands, annual herb fields and some shrubs, very high pastoral potential.	Introduced annual pastures provide reasonable stability except if drought-affected over used or when sandy plains become susceptible to wind erosion.
Unvegetated (UNVE) salt lake beds claypans, river channels	800	1.1		
	74,000	100.0		

Relationships between pasture productivity, suggested stocking rates and management

Although there are only scant data on vegetation productivity and animal performance for pastures within the survey area there is some information available from adjacent pastoral areas with similar pastures and environments. Wilcox and McKinnon (1972) presented dry matter production figures for various pasture types in successive years. Many of these pastures such as Stony Chenopod, Acacia Short Grass Forb and Stony Short Grass Forb are similar to those found in the present survey area. Wilcox and McKinnon also presented stocking rates based on pasture productivity and these rates, and those suggested by Payne *et al.* (1982) for similar pastures on the Ashburton River survey area, were adopted as a base for estimating suggested stocking rates for pastures within the present survey area. However, because of the rather more favourable climatic conditions of the present survey area compared to the more inland Gascoyne and Ashburton areas, the estimates are generally somewhat higher.

Gascoyne bluebush *Maireana polypterygia* pasture in good condition near Carnarvon offer stock up to 1,000 kg of perennial forage/ha in good seasons (Holm, personal communication). No loss of bluebush shrubs occurred over three years at continuous stocking rates of about 5 ha. This rate has been adopted for the Bluebush (BLUE) pasture type when in good condition. Table 29 shows suggested stocking rates for all pasture types, at three condition levels, within the survey area.

It is stressed that these stocking rates are only as 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. Figures quoted are based upon productivity during a year of modal rainfall (generally 10-20% below the mean).

The actual grazing value and appropriate stocking of a particular pasture at any time varies enormously with seasonal conditions, perennial pasture condition (see table 29) and the degree of recent use. Browse and herbage accruing from periods of growth will, in practice, be taken not only by stock, but by many other herbivores including feral goats, kangaroos, rabbits and small mammals, 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.

As a result of the survey it was possible to determine which pasture types (on a land system basis) occurred on each station and the area of each pasture type on each station. The condition of pasture types on each station was known from traverse data. By using the suggested stocking rates shown in table 29, it was possible to calculate the estimated carrying capacity for the observed range condition of each station in the survey area.

These calculations are detailed in the individual station reports presented in appendix 1. The estimated carrying capacities are purely guideline figures to assist managers with the planning or revising of management programmes.

Acacia Sandplain pasture type (ACSA)

1. Area 25,000 km² (33.6%)

2. Distribution and soil types

The Acacia Sandplain (ACSA) pasture type is the largest and most widely distributed pasture within the survey area. It occurs on sandy banks, sand sheets and dunes of the broad depositional land systems. By far the most important areas of this pasture are formed on Sandplain and Yalbalgo land systems where they cover vast areas. Other important areas of this pasture occur on the Ella and Sandal land systems. Smaller, but significant, areas are found on the Brown, Lyons, Target, Wooramel and Yaringa land systems. It forms a minor component on several others and in total occurs on 26 different land systems.

Table 29. Suggested stocking rates of pasture types at three condition levels

Pasture type	Condition level					
	Good		Fair		Poor	
	sheep units/km²	ha/s.u	s.u/km²	ha/s.u	s.u/km²	ha/s.u
Acacia Creek-line (ACCR)	20	5	10	10	5	20
Acacia Mixed Shrub (ACMS)	20	5	10	10	6.3	16
Acacia Sandplain (ACSA)						
Peron and Nanga and Faure stations	12.5	8	8.3	12	4	25
Other stations	8.3	12	6.3	16	4	25
Acacia and Eucalyptus Short Grass Forb (AEGF)	7.1	14	5.6	18	4	25
Bluebush (BLUE)	20	5	12.5	8	6.3	16
Currant Bush Mixed Shrub (CBMS)	20	5	12.5	8	6.3	16
Exotic Annual (EXAN)	45	2.2	—	—	—	—
Hard Spinifex (HASP)						
Taillefer land system	8.3	12	6.3	16	4	25
All other land systems	5	20	3.3	30	2.5	40
Heath (HEAT)	3.3	30	2.5	40	2	50
Acacia Short Grass Forb (ASGF)	5	20	3.3	30	2.5	40
Saltbush (SALT)	20	5	12.5	8	6.3	16
Stony Short Grass Forb (SSGF)	4	25	3.3	30	2	50
Stony Chenopod (STCH)	8.3	12	5	20	3.3	30
Samphire (SAMP)	4	25	3.3	30	2	50
Coastal Dune Shrub (CDSH)	12.5	8	7.1	14	4	25
Soft Spinifex (SOSP)	16.7	6	8.3	12	4	25
Tussock Grass (TUGR)	50-17	2-6	20-8	5-12	4	25

In the mid to north-east portions of the survey area on the Bidgemia, Ella, Lyons, Sandal and Target land systems Acacia Sandplain pastures are commonly associated with Current Bush Mixed Shrub (CBMS) pastures. In the south-east they are associated with Acacia Short Grass Forb (ASGF) pastures on the Wooramel land system. Towards the northern extremities of the Yalbalgo land system the Acacia Sandplain pastures occur on the swales and dune crests, and are associated with Hard Spinifex (HASP) pasture on dune slopes. Elsewhere, Acacia Sandplain occurs adjacent to Heath (HEAT), Acacia Mixed Shrub (ACMS), Samphire (SAMP) and Saltbush (SALT) pasture types.

The predominant soil types are non-calcareous deep red sands which exhibit acid or neutral soil reaction trends through their profiles. Surface mantling is uncommon and, when present, fragment size ranges only to 40 mm and coverage is < 1% of the total soil surface area. Minor inclusions of calcrete, lime concretions or radiolarite are occasionally present within the profile.

3. Physiognomy and composition

Acacia Sandplain pasture generally has the form of a tall (2-4 m) moderately-close shrubland with projected foliar cover (PFC) of 20-25%. However, depending on site situation, fire history and pasture condition, PFC may range between 10-50%. In some areas, after burning, it occurs as a low (<2m) shrubland. Elsewhere it occurs as low woodland (< 6 m) or, woodland (>6m).

When occurring as a tall shrubland the tree component is minor or absent (usually < 50 plants/ha) and consists of occasional sand dune gidgee *Acacia anastema*, mulga *A. aneura* and/or black gidgee *A.pruinocarpa*. The dominant tall shrub is usually wanyu *A.ramulosa*. Other very common tall shrubs are silver bark wattle *A.sclerosperma*, curara *A. tetragonophylla*, fire wattle *A.murrayana*, sandplain poverty bush *Eremophila maitlandii*, Wilcox bush *E.leucophylla*, pebble bush *Stylobasium spathulatum*, spreading gidgee *Acacia subtessarogona*, needle myall *A. roycei* and kerosene bush *A. wiseana*.

In some situations, such as on the rises and dune crests of the Ella, Lyons, Sandplain and Yalbalgo land systems, the tree component becomes dominant. Tree densities may be up to 3,500 plants/ha and the vegetation assumes the form of a woodland. Sand dune gidgee is the dominant tree.

Total low shrub densities vary markedly and range from 0-12,000 plants/ha. Densities are largely dependent upon the local fire history. Areas dominated by mature, tall wanyu at high densities are usually characterized by a paucity of low shrubs. Very variable densities of wanderrie grasses are present at least in good seasons. Conversely, post-senescent or previously burnt areas often support dense stands of low shrubs.

On burnt areas the most widely distributed low shrubs are cotton bush *Ptilotus obovatus*, flannel bush *Solanum lasiophyllum*, tall saltbush *Rhagodia eremaea*, Wilcox bush, earlobe saltbush *Chenopodium gaudichaudianum*, flat leaf bluebush *Maireana planifolia*, ruby saltbush *Enchylaena tomentosa*, warty leaf poverty bush *Eremophila latrobei*, horse mulla-mulla *Ptilotus schwartzii*, crinkle leaf cassia *Cassia helmsii* and (mainly on areas which have experienced fires or disturbance in recent years) fire bush *Gyrostemon ramulosus*. Of these, cotton bush and flannel bush have the widest distributions and, after fire or other disturbance, may occur at densities over 3,000 or 4,000 plants/ha, respectively.

Perennial grasses are commonly encountered and form an important component of this pasture type except in the far south of the area where they are generally scarce or absent. Broad-leaf wanderrie *Monachather paradoxa* and creeping wanderrie *Eragrostis lanipes* are found on most sites and occur with basal covers to 0.5%. Buffel grass *Cenchrus ciliaris* and buck wanderrie *Eriachne helmsii* are of more local importance, occurring with basal covers of up to 0.5 and 0.2%, respectively. Feather speargrass *Stipa elegantissima* is also locally important, but because of its growth habit basal cover is difficult to estimate. The hummock grasses hard spinifex *Triodia* sp., *Triodia plurinervata* and oat-eared spinifex *Plectrachne schinzii* are occasionally of local importance.

In the south, on the Sandplain land system, large areas of this pasture have changed in physiognomy and composition after natural bushfire events, as observed by Curry (1986). Major fires have removed the *Acacia* dominated upper stratum (predominantly wanyu) and a very slow pyric succession results. Curry concluded that during the first four or five years after a fire, fire bush and native poplar *Codonocarpus cotinifolius* can become dominant. Within 15 or 20 years these are gradually replaced by a very-scattered tall shrub layer which is dominated by silver bark wattle, fire wattle or rattle bush *Grevillea stenobotrya*. Cotton bush and flannel bush may dominate the perennials in a productive understorey at this stage and for many years afterwards.

From this point until perhaps 50 years or more into the succession, tall shrubs gradually regain dominance. Large specimens of silver bark wattle, fire wattle, kerosene bush, curara, pebble bush and sandplain poverty bush become common. It is only during this later stage of succession that recruitment of wanyu commences and, about 40 years after burning, it may be co-dominant within the stand. Cotton bush, *Solanum* spécies and several other palatable low shrubs dominate the thinning understorey. Evidence suggests that after about 50 years there is a reversion to a wanyu dominated tall shrubland as the faster growing pyric shrubs senesce and die.

4. Pastoral value

Acacia Sandplain pastures are typically of moderate pastoral value. However, densities of palatable species vary widely, depending upon such things as fire history and the level of use by stock and so too does the pastoral value. Generally, because of the low density of palatable low shrubs and the fairly short lived nature of the wanderrie grasses, this pasture type has only poor to moderate value as a drought reserve. The situation is evidently better after fire since palatable species may occur at high densities and, where these areas are of considerable size and sufficient water is provided, they may be used to carry breeding stock.

Stock waters are often poorly distributed and are virtually unobtainable on some areas in the far south of the survey area. This, together with the sometimes poor quality of existing waters, has led to an under-use of large areas and full pastoral value is not realized.

5. Common perennial species

Trees:

Acacia anastema
Acacia aneura
Acacia pruinocarpa
Canthium lineare
Codonocarpus cotinifolius
Eucalyptus eudesmioides
Grevillea stenobotrya
Santalum spicatum

Tall shrubs:

Acacia murrayana
Acacia ramulosa
Acacia roycei
Acacia sclerosperma
Acacia subtessarogona
Acacia tetragonophylla
Acacia victoriae
Acacia wiseana
*Cassia chatelainiana**
*Eremophila leucophylla**
*Eremophila maitlandii***
Grevillea eriostachys
Gyrostemon ramulosus
Heterodendrum oleaefolium
*Solanum orbiculatum***
Stylobasium spathulatum

Low shrubs:

Acacia roycei
Acacia tetragonophylla
Boerhavia repandra
*Cassia chatelainiana**
Cassia desolata
Cassia helmsii
*Chenopodium gaudichaudianum**
Chorizema ericifolium
*Enchylaena tomentosa**
*Eremophila latrobei**
*Eremophila leucophylla**
*Eremophila maitlandii***
Hakea sp.
*Gyrostemon ramulosus**
*Maireana planifolia**
Pimelea microcephala
*Ptilotus obovatus**
Ptilotus schwartzii
*Rhagodia eremaea**
Rhagodia sp.*
*Scaevola spinescens**
*Scaevola tomentosa**
Solanum lasiophyllum
Stylobasium spathulatum

Perennial grasses:

Cenchrus ciliaris
Eragrostis lanipes
*Eriachne helmsii***
Monachather paradoxa
*Stipa elegantissima**
Triodia sp.

Annuals, biennials and herbs:

Aristida contorta
Brassica tournefortii
Eriachne aristidea
Helipterum species
Ptilotus polystachyus
Ptilotus sp.
Salsola kali
Solanum sp.
Zygophyllum sp.

* desirable indicator species
** undesirable indicator species

6. Condition statements

6.1 Good to excellent condition

In good to excellent condition, unburnt wanyu dominated stands and 'gidgee woodlands' are characterized by a narrow range of species forming a sparse understorey. The desirable low shrubs such as warty leaf poverty bush, Wilcox bush and tall saltbush are found scattered beneath the dominant upper stratum. Cotton bush and flannel bush are occasionally present at low densities and wanderrie grasses sometimes form a sparse ground layer.

In burnt situations the upper stratum is markedly reduced and the range of low shrubs tends in increase. Cotton bush, flannel bush and crinkle leaf cassia are usually common and, together with the desirable flat leaf bluebush, Wilcox bush, tall saltbush and earlobe saltbush, dominate the low shrub component. The desirable ruby saltbush and tall cassia are less common, however, they often form an important component of the lower stratum and can also be included as desirable indicator species.

Sandplain poverty bush and tomato bush *Solanum orbiculatum*, are widely spread undesirable indicator species and may occur at densities of up to 400, 250 and 200 plants/ha, respectively, even within good condition stands.

This pasture type is usually not prone to erosion and when in good to excellent condition no erosion is present.

6.2 Fair condition

In fair condition, the range of species found remains fairly consistent, however, changes in the densities of desirable species do occur.

Within areas which have been burnt in the last 10-15 years the low shrubs cotton bush and flannel bush tend to increase their proportion of the stand as other, more palatable, species disappear under grazing. The density and vigour of desirable indicators show a decline from their good condition levels, while densities of the undesirables, sandplain poverty bush, pebble bush and tomato bush, may increase marginally.

Unburnt areas in fair condition support a small proportion of desirable low shrubs and individuals may show poor vigour as a result of being excessively grazed. Undesirable species are uncommon and generally do not increase, however, the unpalatable buck wanderrie grass may increase under grazing in some situations.

In fair condition there is rarely any erosion.

6.3 Poor to very poor condition

Previously burnt areas in poor condition support a very reduced range of species compared with their potential. There are few, if any, desirable indicators and those remaining often show poor vigour and over-use. The shrubs cotton bush and flannel bush receive heavier use as the more palatable species disappear and they too become less common. Conversely, pebble bush, sandplain poverty bush and tomato bush usually continue to increase and, together, may dominate the stand; this is often the case around heavily used watering points.

There are usually large areas of bare ground and minor wind or water erosion may be present.

Unburnt wanyu and sand dune gidgee-dominated areas in very poor condition support no desirable species whatsoever. Isolated species such as flannel bush, pebble bush and buck wanderrie grass may form the remnants of the understorey. There is no erosion.

7. Management

With adequate waters and conservative stocking rates these pastures are capable of carrying stock on a year-long basis. Some areas are not yet adequately watered and additional supplies should be considered.

Grazing should be deferred for at least one growing season immediately following a bushfire. This will allow valuable herbs and low shrubs to establish. Relatively highly productive pastures should result and, when paddocked together with unburnt sections, they form a favourable environment for stock. Unburnt areas provide shelter, palatable wanyu seed pods and wanderrie grass (in favourable seasons) and the recently burnt sections providing a wide range of palatable low shrubs and annuals.

Good seasons provide the opportunity to run higher numbers of stock on these pastures. Stock do well when they preferentially graze grasses and forbs, but stocking rates should be adjusted when annual feed is running low so that perennial drought reserves are not over grazed.

Recommended levels of use (per annum):

Good to excellent condition	- 12 ha/s.u.
Fair condition	- 16 ha/s.u.
Poor to very poor condition	- 25 ha/s.u.

These recommended levels are for mature unburnt wanyu stands. After fire the productivity of the pastures for grazing is improved and carrying capacity can be higher. On the Peron Peninsula and Faure Island, Acacia Sandplain pastures are more productive than elsewhere due to more useful understorey shrubs, such as ruby saltbush, bladder saltbush and tall saltbush.

Hard Spinifex pasture type (HASP)

1. Area 6,945 km² (9.3%)

2. Distribution and soil types

Hard Spinifex (HASP) pastures are confined almost exclusively to the mid-northern and north-west coastal portions of the survey area. They are commonly associated with the dune, swale and plain units of the sandy land systems and with the hill, ridge and stony plain units of very rocky systems. The most extensive and uniform expression of these pastures occurs on the Range (rocky) and Kennedy (sandy) land systems. Hard Spinifex pastures occupy 40-60% of the Cardabia, Giralia and Uaroo land systems where they are co-dominant with Soft Spinifex (SOSP) pastures. Important areas of Hard Spinifex also occur on the Yalbalgo system (northern parts only) and on the Mallee, Jubilee, Spot and Duffy land systems. Less significant areas occur on several other systems including Carleeda, Divide, Learmonth, Wandagee and Wapet.

Restricted areas of Hard Spinifex pasture also occur in the south-western area of the survey area. It is found on the Peron peninsula and Dirk Hartog Island where it is the dominant pasture on the Taillefer land system and forms a minor association with Heath (HEAT) pastures on the Nanga system.

Soil profiles are principally full depth (> 1 m) and consist of siliceous sands, which may or may not be calcareous; calcrete gravels and lime concretions occur within calcareous profiles. A very sparse surface mantle (generally < 1% cover) consisting of calcrete or limestone fragments up to 75mm in diameter, is often present. However, mantle cover is variable, ranging from nil on the sandy plains of the Giralia and Yalbalgo systems to well over 50% on the stony rises of the Cardabia, Taillefer and Wandagee systems. Calcareous gradational and duplex textured soils occur only very occasionally as do skeletal lithosols which are associated with the hilly and rocky systems.

3. Physiognomy and composition

Hard Spinifex pastures are predominantly hummock grasslands and are invariably dominated by one of several hard spinifex species *Triodia* spp., sometimes to the virtual exclusion of other ground layer species. Communities occurring include: buck spinifex *Triodia basedowii* on the Cardabia, Divide and Kennedy land systems; *T. lanigera* and limestone spinifex *T. wiseana* on the Giralia and Uaroo land systems; limestone spinifex on the Jubilee land system; various unidentified *Triodia* spp. on the Cardabia, Duffy, Mallee and Range land systems; and *T. plurinervata* on the Taillefer land system near Shark Bay. Soft Spinifex *T. pungens* is often associated with communities occurring in the northern half of the survey area and it is sometimes co-dominant within the stand. Composition and physiognomy, however, does vary and occasionally these pastures are found as tall (> 2 m) and low (< 2 m) shrublands.

Projected foliar cover (PFC) is far more variable than the structure and may range from 0% to over 40% depending mainly upon the fire history of the area in question. As a general rule, old stands occur with a high PFC and a low moisture content within the foliage. Fires, either naturally occurring or otherwise initiated, often kill senescent stands and remove the ground cover totally.

On recently burnt country spinifex seedlings establish readily after one reasonable season, but cover subsequently remains low for one or two seasons. In some situations (particularly on the Cardabia and Learmonth land systems) perennial shrubs emerge as pioneers together with spinifex and, compared with the climax stand, a much larger suite of species is evident. As such a stand matures it is often classified as a shrubland and PFC of the shrub component may reach 25%. Fire responsive shrubs include umbrella wattle *Acacia ligulata*, *A.spathulifolia*, poverty wattle *A. translucens*, *Bonamia rosea*, star flower *Calytrix* species, cockroach bush *Cassia notabilis*, *Corchorus walcottii*, *Hannafordia quadrivalvis*, *Phyllanthus* sp., *Scaevola canescens*, pebble bush *Stylobasium spathulatum*, and *Thryptomene baeckeacea*. However, as the stand approaches its climax state (commonly five years after fire) it will normally resume the form of a hummock grassland as the shrub component diminishes through senescence or through competition and crowding by spinifex (Suijdendorp, 1967). The shrub cover usually falls to below 15%.

The composition of the upper stratum within Hard Spinifex pastures is variable and very scattered. Tree species that occur occasionally include various eucalypts *Eucalyptus* spp., gidgee *Acacia pruinocarpa*, spreading gidgee *A.subtessaragona*, minga bush *Heterodendrum oleaefolium* and native fig *Ficus platypoda*. A more diverse range of tall shrubs occurs and the most widely distributed include umbrella wattle, silver bark wattle *A. sclerosperma*, curara *A. tetragonophylla* and *Eremophila oldfieldii*.

A wide range of low shrubs occur (over 50 species recorded) and the most diverse stands are associated with early pyric successional stages. The more widely distributed species include umbrella wattle, grey cassia *Cassia desolata*, low paper bark *Melaleuca* aff. *cardiophylla*, *Pimelea microcephala*, cotton bush *Ptilotus obovatus*, currant bush *Scaevola spinescens*, ragged leaf scaevola *Scaevola tomentosa*, flannel bush *Solanum lasiophyllum*, pebble bush and *Corchorus* sp. Densities of individual species rarely exceed 1500/ha.

Perennial grasses other than *Triodia* sp. also occur. Of local importance is the tussock grass northern wanderrie grass *Eriachne* aff. *obtusa* which occurs with a basal cover up to 1%. Hummock grasses *Plectrachne danthonioides* and coastal spinifex *Spinifex longifolius* are locally dominant, with up to 20 and 25% ground cover, respectively. Buffel grass *Cenchrus ciliaris*, broad-leafed wanderrie grass *Monochather paradoxa*, and feather spear grass *Stipa elegantissima* are occasionally present but offer very little cover, except on parts of the Taillefer land system where buffel flourishes in good seasons.

Where shrubs are more prominent than the hummock grass layer, the association is classified as either low or tall shrubland. Such is the usual case on the Mallee land system, which supports mallee shrublands or low open woodland with various mallee-form eucalypts prominant in the upper storey. Widely spread shrub and mallee species include curara, mallalie *Eucalyptus eudesmioides*, *E.prominens*, minga bush, currant bush, ragged leaf scaevola and cotton bush. The spinifex ground layer is present but cover rarely exceeds 20%.

4. Pastoral value

Mature communities dominated by hard spinifex offer only a few palatable species at low density; pastoral value is low to very low. The *T.plurinervata* community characteristic of the Taillefer land system contains more useful low shrubs than usual and is of moderate pastoral value.

Recently burnt spinifex stands support more useful forage than long unburnt stands. Small shrubs, spinifex seedlings and annual forbs and grasses (in season) are prominent after fire and are more acceptable to stock than the large, spiny hard spinifex hummocks present in mature stands. Pastoral value in these areas is moderate.

Accessibility is generally good except on the hilly systems (Range and Capricorn) where steeply sloping and rocky landscapes deter entry by stock.

5. Common perennial species

Trees (and mallees):

Acacia pruinocarpa
Acacia subtessaragona
Eucalyptus eudesmioides
Eucalyptus mannensis
Eucalyptus prominens
Eucalyptus obtusiflora
Ficus platypoda
Heterodendrum oleaefolium

Tall shrubs:

Acacia inaequilatera
Acacia microcalyx
Acacia murrayana
Acacia sclerosperma
Acacia spathulifolia
Acacia tetragonophylla
Banksia ashbyi
Calothamnus kalbarriensis
Eremophila oldfieldii
Exocarpos aphyllus
Grevillea gordoniana

Low shrubs

Acacia aphylla
Acacia biyenosa
Acacia ligulata
Acacia preissiana
Acacia pyrifolia
Acacia spathulifolia
*Acacia translucens***
Acanthocarpus preissii
Bonamia rosea
Calytrix sp.
*Cassia chatelainiana**
Cassia desolata
Cassia helmsii
Cassia luerssenii
*Cassia notabilis***
*Enchylaena tomentosa**
Eremophila cuneifolia
*Eremophila latrobei**
*Eremophila leucophylla**
*Eremophila maitlandii***
Hannafordia quadrivalvis
Indigofera monophylla
*Maireana planifolia**
Maireana villosa
Melaleuca aff *cardiophylla*
Pimelea microcephala
Ptilotus aff *drummondii*
Ptilotus obovatus
*Rhagodia eremaea**
Rhagodia latifolia
Scaevola canescens
*Scaevola spinescens**
*Scaevola tomentosa**
Solanum lasiophyllum
Stylobasium spathulatum
Thryptomene baeckeaceae

Perennial grasses:

Cenchrus ciliaris
Eragrostis eriopoda
Eriachne aff *obtusa*
Monachather paradoxa
Plectrachne danthonioides
Spinifex longifolius
*Stipa elegantissima**
Triodia basedowii
Triodia lanigera
Triodia plurinervata
Triodia pungens
Triodia species

Annuals, biennials and herbs:

Aristida contorta
Brassica tournefortii
*Corchorus walcottii***
Corchorus sp.**
Euphorbia sp.
Ptilotus exaltatus
Ptilotus sp.
Salsola kali
Solanum sp.
Zygophyllum sp.

* desirable indicator species
** undesirable indicator species

6. Condition statements

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

Heavily used desirable species, if present, may be the only indicators of a declining pasture condition. The low shrubs ruby saltbush *Enchylaena tomentosa*, tall cassia *Cassia chatelainiana*, warty leaf poverty bush *Eremophila latrobei*, Wilcox bush *E. leucophylla*, flat leaf bluebush *Maireana planifolia*, tall saltbush *Rhagodia eremaea*, currant bush, ragged leaf scaevola and the perennial feather spear grass *Stipa elegantissima* occur and their presence as seedlings or healthy robust individuals should indicate good condition. However, their absence alone does *not* indicate a poorer condition.

It appears that in northern areas on the Giralia and Uaroo land systems shrub invasion can be a problem and is best regarded as a decline to fair or poor condition. 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 spinifex and a stable but less productive shrubby association develops.

Burnt areas of the Cardabia land system in the north-west of the survey area are often dominated by low paper bark and other heath-forming species more typical of the South-West Botanical Province (Beard 1976). The significance of these species is poorly understood but it is possible that they represent a fire-induced seral stage rather than a shrub invasion. Research into the response of Hard Spinifex and Soft Spinifex pastures to various burning regimes is currently being undertaken in an attempt to clarify these situations.

Moderate wind erosion in the form of wind piling and hummocking is common on burnt areas which have not yet stabilized with seasonal growth. Such areas may appear badly degraded until after good rain when they are generally recolonized by spinifex and other species and stabilization follows.

In general Hard Spinifex pastures are in good to excellent condition and there is no erosion.

7. Management

Hard Spinifex pastures are generally of limited use to stock. However, carefully prescribed fires can be used as an effective management tool to improve carrying capacities. Burning of senescent tussocks allows the establishment of more nutritious and palatable shrub and grass species, including spinifex seedlings. A hot summer burn on a windy day will carry well and tussocks will be killed outright. It is considered to be less beneficial to burn in winter since conditions favour the establishment of unpalatable species and shrub invasion may become a problem.

Paddocks should be spelled for 6-8 weeks over the growing season following the fire 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 (Suijdendorp, 1967).

Spinifex can be expected to resume its stand dominance within about five years after a burn. Spinifex paddocks can 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 period. 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 heavier use of spinifex pastures on an opportunistic basis by using the palatable ephemeral growth in good seasons and spelling the favoured pastures at a time when their rejuvenation will be at a maximum.

Recommended levels of use (per annum):

Young stands with high numbers of palatable species	
Taillefer land system	12 ha/s.u.
Other land systems	20 ha/s.u.
Older stands with only a low to moderate number of palatable species	
Taillefer land system	16 ha/s.u.
Other land systems	30 ha/s.u.
Old stands or stands with few, if any, palatable species	
Taillefer land system	25 ha/s.u.
Other land systems	40 ha/s.u.

Acacia Short Grass Forb pasture type (ASGF)

1. Area 5,600 km² (7.5%)

2. Distribution and soil types

Acacia Short Grass Forb (ASGF) pastures are restricted to the mid-eastern and north-eastern parts of the survey area and occur predominantly on hills, ridges, plateaux, footslopes and stony plains of hill land systems based on Permian age sedimentary rocks. Such systems include Moogooloo, Windalia, Jimba and Fossil. Also, large areas of these pastures grow on systems based on crystalline rocks, such as on the stony plains and convex rises of the Durlacher land system and the granitic hills and plains of the Yinnietharra land system. Significant areas of the pasture type are also found on land units situated at lower points within the landscape such as tributory alluvial plains and interfluves (O'Brien land system) or broad drainage zones receiving sheet flow (Wooramel land system).

Soils supporting Acacia Short Grass Forb pastures are generally sandy or loamy lithosols, reddish-brown to dark red. Sola are commonly 20-50 cm in depth and contain abundant fragments of the underlying parent material (usually sandstone, radiolarite or granite). Moderate to heavy surface mantles of either quartz, radiolarite or sandstone occur on most sites and fragments reach 600 mm in diameter. Red, texture contrast, gradationally textured and uniform-fine textured soil profiles are also present on restricted areas of the lower systems; these soils are generally < 1 m deep.

3. Physiognomy and composition

Acacia Short Grass Forb pastures occur predominantly as tall (> 2 m), very scattered or scattered shrublands with projected foliar cover (PFC) ranging from 5-20%. They also occur as low (< 2 m) shrublands and, less commonly, as low (< 6 m) open woodlands (e.g. Windalia and Durlacher systems).

Where occurring as woodland, the dominant trees are usually either black mulga *Acacia citrinoviridis* and mulga *A. aneura* as on the Durlacher land system, or spreading gidgee *A. subtessarogona* as the sole dominant, as on the Windalia land system.

Occasional trees occur within the shrubland communities but their combined densities rarely exceed 100 plants/ha. In addition to mulga, black mulga and spreading gidgee, other trees which may be sparsely distributed include gidgee *A.pruinocarpa*, wild orange *Canthium lineare* and *C.attenuatum*, corkwood *Hakea suberea* and *Grevillea* sp.

The upper stratum of Acacia Short Grass Forb shrublands is dominated by several tall shrub species from the genus *Acacia*. The most widespread are mulga, black mulga, wanyu *A. ramulosa*, curara *A. tetragonophylla*, bardie bush *A.victoriae* and snakewood *A. xiphophylla*. Mulga dominance is generally restricted to the hilly land systems such as Moogooloo and Fossil, and spreading gidgee to the lower systems Yinnietharra, Windalia, O'Brien and Wash. Other tall shrubs include sand plain wattle *A. kempeana*, gidgee, turpentine bush *Eremophila fraseri* and minga bush *Heterodendrum oleaefolium*. Total tall shrub densities may range from 25 to over 800 plants/ha but are more often in the vicinity of 200 or 300/ha.

A broad range of low shrubs occur throughout the distribution of these pastures and most good condition sites are characterized by a diverse ground storey. Grey cassia *Cassia desolata*, crinkle leaf cassia *C.helmsii*, Wilcox bush *Eremophila leucophylla* and cotton bush *Ptilotus obovatus* all feature prominently. Other widely spread low shrubs include royal poverty bush *Eremophila cuneifolia*, turpentine bush, warty leaf poverty bush *E.latrobei*, flat leaf bluebush *Maireana planifolia*, horse mulla-mulla *Ptilotus schwartzii* and flannel bush *Solanum lasiophyllum*. Total densities vary with pasture condition and site situation but range up to 5500 plants/ha.

Perennial grasses are frequently absent and are only of local significance on the more sandy units. Creeping wanderrie *Eragrostis lanipes*, buck wanderrie *Eriachne helmsii* and wanderrie *Monachather paradoxa* occur on such units but basal cover rarely exceeds 0.1%.

4. Pastoral value

Pastoral value of this pasture type is generally low or at best moderate. The desirable perennial shrubs are durable in times of drought and provide valuable reserves when stocked conservatively, but are generally very scattered.

Over use in some areas has resulted in the removal of palatable species and has rendered pastoral value low or very low.

Accessibility to stock is a problem on some of the very hilly systems, such as Moogooloo and Pells, where pastoral value is effectively low or very low.

5. Common perennial species

Trees:

Acacia aneura
Acacia citrinoviridis
*Acacia cuspidifolia***
Acacia pruinocarpa
Acacia subtessarogona
Canthium attenuatum
Canthium lineare
Grevillea stenobotrya
Hakea suberea

Tall shrubs:

Acacia aneura
Acacia cuthbertsonii
Acacia kempeana
Acacia pruinocarpa
Acacia ramulosa
Acacia subtessarogona
Acacia tetragonophylla
*Acacia victoriae***
Acacia xiphophylla
Eremophila fraseri
Eremophila freelingii
*Hakea preissii***
Heterodendrum oleaefolium

Low shrubs:

Acacia tetragonophylla
Cassia desolata
Cassia helmsii
Cassia luerssenii
*Dipteracanthus corynothecus**
*Enchylaena tomentosa**
Eremophila cuneifolia
Eremophila fraseri
Eremophila freelingii
*Eremophila latrobei**
*Eremophila leucophylla**
Eremophila platycalyx
*Maireana planifolia**
*Maireana tomentosa**
Phyllanthus sp.
*Ptilotus obovatus**
Ptilotus polakii
Ptilotus schwartzii
*Rhagodia eremaea**
*Scaevola spinescens**
Solanum lasiophyllum

Perennial grasses:

Cenchrus ciliaris
Cymbopogon ambiguus
Eragrostis lanipes
Eriachne helmsii
Monachather paradoxa
Triodia sp.

Annuals biennials and herbs:

Aristida contorta
Atriplex semilunaris
Eriachne aristidea
Ptilotus sp.
Solanum sp.

* desirable indicator species
** undesirable indicator species

6. Condition statements

6.1 Good to excellent condition

Good pasture condition is indicated by the density and composition of the low shrub layer. A robust and diverse low shrub layer with scattered palatable species indicates good condition. Widespread desirable indicator species are warty leaf poverty bush, Wilcox bush, flat leaf bluebush and cotton bush. Other palatable species of local importance are ruby saltbush *Enchylaena tomentosa*, felty bluebush *Maireana tomentosa*, Gascoyne mulla-mulla *Ptilotus polakii*, tall saltbush *Rhagodia eremaea*, *Dipteracanthus corynothecus* and currant bush *Scaevola spinescens*.

Less palatable and unpalatable shrubs are invariably present. Grey cassia, crinkle leaf cassia and flannel bush are the most widely spread and may be dominant in the low shrub layer. Other such shrubs include the poverty bushes royal poverty bush, turpentine bush and *Eremophila freelingii*, species which have more localized distributions and generally occur at relatively low densities.

In good condition total low shrub densities are commonly between 1500 and 3000/ha. There is no erosion.

6.2 Fair condition

When in fair condition the density of desirable indicator species is reduced compared to good condition. Few young desirable plants are present and some of the more sensitive indicators such as warty leaf poverty bush, ruby saltbush and flat leaf bluebush may exist only as occasional over-browsed moribund individuals.

In some areas, the undesirable species wait-a-while *Acacia cuspidifolia*, bardie bush and needle bush *Hakea preissii* increase their densities marginally, presumably taking advantage of reduced inter-species competition. However, in general, their populations remain roughly constant and fair condition is reflected by a lower total shrub cover - a direct result of the loss of the more palatable species. Total low shrub densities are usually in the vicinity of 1000/ha and there is no erosion.

6.3 Poor to very poor condition

Pastures in poor condition support few, if any, desirable species and the effects of overgrazing are obvious. Grazing pressure is often redirected toward the less palatable shrubs and these species may also be heavily grazed and show a decline in density. Under-stories are sparse, sometimes with only undesirable species and species with no grazing value remaining. Pastures in poor condition no longer have drought durability and can only be grazed on an opportunistic basis to take advantage of annual pastures in season. Total low shrub densities may reach 700/ha.

Erosion is very uncommon within Acacia Short Grass Forb pastures where soils are stable and mostly protected by a mantle of stones. Even when pastures are in very poor condition there is generally no erosion present.

7. Management

Strategic fencing and optimal spacing of water supplies are necessary for full use of these pastures. Where possible they should be fenced separately from more attractive pasture types so that the latter are not preferentially grazed and degraded. In doing this stock can be run on the Acacia Short Grass Forb pastures at rates which ensure the maintenance of desirable perennial shrubs. Stocking rates may be temporarily increased in good seasons to take advantage of the abundant annual forage. This will allow seasonal spelling of better pastures elsewhere at a time when their rejuvenation potential is at a maximum.

To maintain pastures in good condition or to improve their condition, attention should be given to the vigour and density of those palatable indicator plants mentioned in section 6.1. By monitoring their vigour and populations the condition trend of the pastures can be determined and stocking rates and duration of grazing adjusted as necessary.

Recommended levels of use (per annum):

Good to excellent condition	- 20 ha/s.u.
Fair condition	- 30 ha/s.u.
Poor to very poor condition	- 40 ha/s.u.

Soft Spinifex pasture type (SOSP)

1. Area 4,800 km² (6.4%)

2. Distribution and soil types

Soft Spinifex (SOSP) pastures are conspicuous in the north-west coastal parts of the area between Quobba and Exmouth Gulf stations. They are normally associated with landforms developed from marine deposits which are often covered with a veneer of aeolian sand. They occur on longitudinal dunes and swales, undulating sandy plains, limestone rises, platforms and low hills, loamy plains and interfluves and some flow zones.

The largest area of Soft Spinifex pasture is found on the sandy plains of the Cardabia land system. Important areas occur on the Giralia and Uaroo land systems and smaller, but significant, areas are found on several other land systems including Mallee, Learmonth, Jubilee and Donovan. Soft Spinifex pastures are commonly found in association with Hard Spinifex (HASP) pastures and sometimes form mixtures with Bluebush (BLUE) and Acacia Mixed Shrub (ACMS) pastures.

The soils are principally full depth (> 1 m), calcareous, reddish sands with an alkaline soil reaction. Shallower, coarse textured soils are also found on the limestone rises of some systems (such as Cardabia, Uarooo and Winning) and are usually heavily mantled with limestone or calcrete fragments. Smaller areas of full depth, calcareous, gradationally textured loamy soils occur on the plains of the Carlceda and Jubilee systems.

3. Physiognomy and composition

Physiognomy and composition is quite variable on this pasture type and is a function of the past fire regimes and prevailing climatic conditions. Pastures may take the form of hummock grasslands, tall or low shrublands and, very occasionally, low woodlands.

Pastures occur most commonly as hummock grasslands. Ground stories are dominated by soft spinifex *Triodia pungens* and, in minor areas, oat-eared spinifex *Plectrachne schinzii*. These species may account for nearly all of the total projected foliar cover (PFC) which may be up to 50%. In such situations shrubs are only sparsely distributed, if present at all.

Hummock grasslands with high PFC are prone to fire. Evidence of past burns is obvious in many areas where the vegetation has been completely removed or where sub-climax stages exist. Early seral stages often take the form of low shrubland, as pioneer perennial shrubs become dominant, together with spinifex seedlings. Low shrubs include umbrella wattle *Acacia ligulata, A.spathulifolia,* poverty wattle *A.translucens,* star flower *Calytrix* sp., *Grevillea* species, coastal daisy bush *Olearia axillaris, Tephrosia rosea* and *Thryptomene baeckeacea.* Other species include cockroach bush *Cassia notabilis*, caper bush *Diplopeltis eriocarpa*, woolly corchorus *Corchorus walcottii,* fire bush *Gyrostemon ramulosus,* caltrop *Tibulus occidentalis* and *Triumfetta appendiculata.* About five years after burning, soft spinifex may regain dominance as the shrubs either senesce or are crowded out by the expanding spinifex hummocks (Suijdendorp, 1967). Pastures will resume their form as hummock grasslands with little or no shrub cover.

Soft Spinifex pastures also occur within low or tall shrublands. Spinifex cover rarely exceeds 10% in these shrub dominated situations. The more widespread low shrubs include bloodbush *Cassia oligophylla*, ruby saltbush *Enchylaena tomentosa*, cotton bush *Ptilotus obovatus* and flannel bush *Solanum lasiophyllum.* Low shrubs of more local importance are marpoo *Acacia bivenosa*, sticky hop bush *Dodonaea viscosa, Rhagodia preissii*, ragged leaf scaevola *Scaevola tomentosa* and *Threlkeldia diffusa.* Tall shrubs which are often present and may gain dominance include wanyu *Acacia ramulosa*, silver bark wattle *A. sclerosperma*, curara *A. tetragonophylla* and pebble bush *Stylobasium spathulatum.* PFC of the shrubs may reach 30%.

On some areas of the mallee land system, mallee eucalypts such as mallalie *Eucalyptus eudesmioides* and *E. prominens* dominate in the upper stratum.

Hard spinifex (*Triodia* species) is occasionally co-dominant with soft spinifex. For example, buck spinifex *T. basedowii* occurs with a PFC of up to 10% in some soft spinifex stands on the Cardabia land system. With the exception of hop-a-long grass *Paraneurachne muelleri* which forms useful stands in several areas, other perennial grasses are of limited importance on this pasture type.

4. Pastoral value

Soft Spinifex pastures are generally of moderate to high pastoral value. On recently burnt areas, which support highly palatable spinifex seedlings and a high cover of herbaceous and young perennial shrubs, forage value is high. Crude protein levels as high as 9% in *T. pungens* seedlings were reported by Suijdendorp (1981). Conversely, in older stands the larger spinifex hummocks are less palatable to stock and there are relatively few palatable shrubs. Consequently, grazing value is reduced to a moderate and sometimes low level.

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

Many areas remain under-supplied with water and their full potential has not been realized.

5. Common perennial species

Tall shrubs (and mallees):

Acacia ancistrocarpa
Acacia pyrifolia
Acacia ramulosa
Acacia sclerosperma
Acacia tetragonophylla
Eremophila maitlandii
Eucalyptus eudesmioides
Eucalyptus prominens
Exocarpos aphyllus
Gyrostemon ramulosus
Heterodendrum olaeafolium
Psoralea cinerea
Stylobasium spathulatum

Low shrubs:

Acanthocarpus preissii
*Acacia bivenosa***
Acacia ligulata
Acacia spathulifolia
*Acacia translucens***
Banksia ashbyi
Bonamia rosea
Calytrix sp.
*Cassia chatelainiana**
Cassia helmsii
*Cassia notabilis***
Cassia oligophylla
Diploleana incana
*Dipterocanthus corynothecus**
Dodonaea viscosa
*Enchylaena tomentosa**
Euphorbia sp.
Gossypium sp.
Grevillea sp.
Hybanthus enneaspermus
Maireana planifolia
Mirbelia sp.
Petalostylis labicheoides
Pityrodia sp.
*Psoralea martinii**
*Rhagodia eremaea**
*Rhagodia preissii**
Scaevola canescens
*Scaevola tomentosa**
*Tephrosia rosea***
Thryptomene baeckeacea

Perennial grasses:

Cenchrus ciliaris
Chrysopogon fallax
Eriachne helmsii
Eragrostis eriopoda
*Paraneurachne muelleri**
Plectrachne schinzii
Triodia basedowii
*Triodia pungens**
Triodia wiseana
Triodia sp.

Annuals biennials and herbs:

Amaranthus species
Aristida contorta
*Corchorus sidoides***
*Corchorus walcottii***
*Diplopeltis eriocarpa***
Eriachne aristidea
Ptilotus exaltatus
Salsola kali
*Tribulus occidentalis***
*Tribulus terrestris***
Triumphetta appendiculata
Zygophyllum sp.

* desirable indicator species
** undesirable indicator species

6. Condition statements

In general, Soft Spinifex pastures are in good condition throughout and there is no erosion.

The situation is complicated somewhat in areas which support thick stands of 'heath forming' species, such as *Calytrix* and *Grevillea*, that are more typical of the South-West Botanical Province described by Beard (1976). It may initially appear that condition has declined due to a 'scrub invasion' by these species, but it is more likely that such stands are simply early seral stages of a hummock grassland or shrubland previously dominated by spinifex and recently burnt.

On the Giralia and Uaroo land systems, however, it is strongly suspected that 'scrub invasions' do occur after a winter burn. The unpalatable low shrub poverty wattle seems to thrive and establishes in thick stands, at the expense of spinifex. A stable less productive disclimax situation is reached. On most land systems winter burning appears also to promote the vigorous growth of undesirable short-lived perennial species. Cockroach bush, caper bush *Diplopeltis eriocarpa* and caltrop are the best examples and have the potential to form thick, unproductive stands after winter rains (Kok personal communication).

The low shrub marpoo is normally killed outright by a 'hot' fire. However, in areas of very shallow soil, where foliar cover is insufficient to fuel an extensive fire, marpoo often appears to increase its numbers at the expense of more palatable species (Kok personal communication). In such areas it is regarded as an undesirable increaser.

Research into the response of Soft Spinifex and Hard Spinifex pastures to various burning regimes is currently being undertaken by the Department of Agriculture in an attempt to clarify the above situations.

In other areas desirable perennial shrubs form an integral part of plant stands and can be used as condition indicators. The palatable low shrubs, silver saltbush *Atriplex bunburyana*, tall cassia *Cassia chatelainiana*, *Dipteracanthus corynothecus*, ruby saltbush, tall saltbush *Rhagodia eremaea*, *R.preissii* and ragged leaf scaevola occur locally and, when present as robust mature individuals or seedlings, indicate good condition.

Wind erosion is common on burnt areas which have not received rain. Such areas are devoid of vegetation and there is little protection for the sandy soils. However, spinifex seedlings, herbaceous shrubs and annuals rapidly recolonize and stabilize such areas after rain.

7. 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 wherever possible and cleared lines) and rotational use.

There is evidence from the Pilbara area that time of burning influences the resulting species composition of the pasture (Suijdendorp 1967) and summer burning, to encourage grass species rather than shrubs, herbs and forbs, is recommended in that environment. Holm and Allen (unpublished data) indicate that the nutritional value of other grasses in Soft Spinifex pastures in the survey area is no better than that of the spinifex and suggests that the contribution of herbaceous species to animal nutrition warrants study. Although the suggestion is that winter burning may encourage shrub invasion, the optimal time of burning on these pastures in the survey area is not clearly established. Burning should be accompanied by deferrment from grazing for 6-8 weeks after the following season to ensure that spinifex seedlings and other species have time to establish and develop before grazing commences.

Soft spinifex plants will usually regain dominance in a stand within about five years. By that stage 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 more acceptable stages of growth with a wide range of plant species available for grazing.

Where possible Hard Spinifex and Soft Spinifex pastures should be fenced separately from other pastures such as the shrub-based types Bluebush and Acacia Mixed Shrub.

Recommended levels of use (per annum):

Young stands with high numbers of palatable species and no over use apparent	- 6 ha/s.u.
Older stands with only low to moderate numbers of palatable species	- 12 ha/s.u.
Old stands or stands with few, if any, palatable browse species	- 25 ha/s.u.

Bluebush pasture type (BLUE)

1. Area 4,690 km² (6.3 per cent)

2. Distribution and soil types

Bluebush (BLUE) pastures are most widespread in the coastal portions of the survey area extending from Carbla station in the south of the survey area, to the northern most boundary at Exmouth Gulf. They often cover extensive areas on the alluvial plain units of the broad alluvial land systems, such as Delta and Gearle. Less commonly, they occur within other areas; for example, on the footslopes of the Foscal and Trealla land systems, on the outwash plains of the Donovan land system and on the upper convex plains of the Firecracker land system.

The most important areas of the Bluebush pasture type are on the Sandal, Delta and Sable land systems. Large areas also occur on the Donovan, Gearle, Warroora and Winning land systems and minor areas are found on several systems including Firecracker, Foscal, Gneudna, and Yalkalya.

Bluebush pasture occurs within broad areas alongside other useful and less useful pastures. On the Delta, Foscal, Gearle, Sable, Warroora, and Yalkalya land systems they are found, in similar proportion, with Saltbush (SALT) pastures. Associations are found alongside Tussock Grass (TUGR) pastures in northern areas on the Yarcowie land system, with Acacia Mixed Shrub (ACMS) pastures on the Donovan land system and Current Bush Mixed Shrub (CBMS) and Acacia Sandplain (ACSA) pastures on the Sandal land system.

Soils are typical of those found in other alluvial situations; full depth (>1 m), calcareous, red-duplex soils are by far the most widespread. However, other soils such as yellow-duplex, uniform medium and fine textured, gradationally textured and gilgaied soils occur locally. Uniform coarse textured soils are encountered only very occasionally. Surface mantling, other than an occasional sparse scattering of small diameter material, is uncommon.

3. Physiognomy and composition

Four major plant communities have been included in the broad Bluebush pasture type. These communities are:

- Gascoyne bluebush *Maireana polypterygia* - low bluebush *M. platycarpa*
- Gascoyne mulla-mulla *Ptilotus polakii*
- Spiny bluebush *Maireana aphylla*
- Sago bush *Maireana pyramidata*

The first two communities are by far the most widespread, spiny bluebush is of local importance and sago bush communities are of only limited occurrence in the area.

Bluebush pastures are typically low (< 1 m), very scattered or scattered shrublands with projected foliar cover (PFC) ranging from < 2-20%. The PFC for any community at any particular site depends upon numerous factors including condition status, age composition, position within the landscape, seasonal conditions etc.

Less frequently, Bluebush pastures have a prominent over-storey of tall shrubs and are tall (> 2 m) very scattered or scattered shrublands with PFC again ranging from < 2-20%. Bluebush association also occur occasionally as scattered woodlands (PFC 5-10%) and, on severely degraded sites, where only remnant bluebushes remain, as herb-fields (PFC < 2%).

It is unusual for more than two species of *Maireana* to be common within any one stand, rather, one species usually clearly dominates with others either only a minor constituent or absent. It is because of this tendency towards monspecific dominance that the four bluebush communities can be easily recognized. Gascoyne mulla-mulla *Ptilotus polakii* is included in the broad pasture type because of its bluebush-like growth habit and characteristically patchy occurrence on alluvial soils.

3.1 Gascoyne bluebush community

Found on the alluvial units of many land systems, the Gascoyne bluebush community is the most widespread bluebush community within the area. Gascoyne bluebush generally forms a relatively uniform low shrubland 0.5-1 m tall and occurs at densities up to 4,000 plants/ha. Broad plains of Gascoyne bluebush frequently contain a proportion of low bluebush *M. platycarpa*; particularly on low-lying areas with more saline soils where low bluebush may predominate.

Occasionally tall shrubs such as snakewood *Acacia xiphophylla*, curara *A.tetrogonophylla*, bardie bush *A. victoriae* and spreading gidgee *A.subtessarogona* have become frequent with combined densities of up to 600 tall shrubs/ha, but more often they form only a very scattered upper stratum or are absent. The tree wait-a-while *Acacia cuspidifolia* is present in some situations at densities of < 100 plants/ha.

Many low shrubs are associated with Gascoyne bluebush and several of these commonly form an important component of the lower strata. Of these, the most widespread are bladder saltbush *Atriplex vesicaria*, silver saltbush *A.bunburyana*, low bluebush, cotton bush *Ptilotus obovatus*, Gascoyne mulla mulla, flannel bush *Solanum lasiophyllum*, tall saltbush *Rhagodia eremaea* and frankenia *Frankenia* sp. Bladder saltbush, low bluebush and frankenia often form mixed stands of up to 4,000 plants/ha. Wilcox bush *Eremophila leucophylla*, warty leaf poverty bush *E. latrobei*, grey cassia *Cassia helmsii* and sage *Cratystylis subspinescens* are of local importance, usually occurring at densities < 1,000 plants/ha. Total low shrub densities may exceed 10,000/ha in favourable situations but are more commonly in the vicinity of 4,000/ha on pastures in good condition.

Perennial grasses are sometimes present but only provide a very sparse cover. Buffel grass *Cenchrus ciliaris* is the most common and usually occurs with a basal cover of < 1%.

3.2 Gascoyne mulla mulla community

Gascoyne mulla-mulla and Gascoyne bluebush are found as dominant low shrubs in virtually identical environments and sites vary from the two being co-dominants to being completely exclusive of one another.

Gascoyne mulla-mulla tends to increase its dominance eastward - away from the coast. The reason for this is unclear and there are at least two possible explanations. The first is that Gascoyne mulla mulla dominance is inversely related to soil salinity i.e. there is a general decrease in salinity moving from west to east. The second infers that this community is actually a disturbed or successional stage of some Gascoyne bluebush communities. It is possible that in some areas Gascoyne mulla-mulla has increased where Gascoyne bluebush has decreased after being adversely affected by disturbances such as fire and grazing, particularly in the east of the area.

Physiognomy and composition of this community is very similar to that of the Gascoyne bluebush community described previously.

3.3 Spiny bluebush community

The spiny bluebush community is of restricted distribution occurring in local depressions on alluvial plains and in swamp situations. Spiny bluebush densities were estimated at up to 650 plants/ha, but elsewhere it was observed that they occur at greater densities in the most favourable situations. This community is always found as a low shrubland (often as a mosaic of bare ground and robust spiny bluebushes). Other low shrubs which may occur at low densities include silver saltbush, tall saltbush, lignum *Muehlenbeckia cunninghamii,* curara and warty leaf poverty bush. The tall shrubs bardie bush *Acacia victoriae* and false mesquite *A. farnesiana* are occasionally found at densities < 100 plants/ha.

3.4 Sago bush community

The sago bush community is not widespread in the area. Locally, it occurs in stands of up to about 6,000 plants/ha. The distribution of this community differs from the others in that it is found most commonly on run-on sites of erosional land systems such as Winning, Durlacher and O'Brien which form the catchment areas of major river systems, and it is not

restricted to alluvial situations. An over-storey of tall shrubs sometimes forms a sparse canopy and may include snakewood, bardie bush and needle bush *Hakea preissii*. A relatively wide range of low shrubs includes silver saltbush, ruby saltbush *Enchylaena tomentosa*, Gascoyne mulla mulla, silver poverty bush *Eremophila pterocarpa*, and royal poverty bush *Eremophila cuneifolia*.

4. Pastoral value

Bluebush pastures are extremely drought durable and form a reliable high quality (foliage 15-23% protein) food source for stock, especially when annual feed is scarce or absent. Overall grazing capacity is high.

The durability and palatability of the shrubs allows stock to be carried on a year-long basis and, provided grazing pressures are conservative, the pastures can be maintained in good condition. Unfortunately, in some cases where Bluebush pastures occur as small inclusions within less productive pasture types or around heavily used watering points, overgrazing has caused severe degradation and pastoral value is far below its potential. Degraded areas may produce prolific annual herbage in good seasons, but otherwise have little dry season durability. Shrub regeneration is usually slow due to the rarity of germination and recruitment events. Recognition of such events, through regular pasture observation, is vital as a first step in ensuring that recruitment of young bluebushes can take place. Appropriate management of young bluebushes probably involves seasonal grazing deferred or strategic spelling to maximize survival and growth.

Bluebush shrubs have a relatively high salt content and stock waters need to be well distributed and of good quality, that is low salinity, otherwise total salt intake will be excessive and will adversely effect animal productivity.

5. Common perennial species

Trees:

Acacia cuspidifolia
Heterodendrum oleaefolium

Tall shrubs:

Acacia grasbyi
Acacia sclerosperma
Acacia subtessarogona
Acacia tetragonophylla
*Acacia victoriae****
Acacia xiphophylla
Eremophila maitlandii
*Eremophila pterocarpa****
*Hakea preissii****
Heterodendrum oleaefolium
Stylobasium spathulatum

Low shrubs:

Acacia tetragonophylla
*Atriplex bunburyana**
*Atriplex vesicaria**
Boerhavia repandra
*Cassia chatelainiana**
*Cassia desolata****
*Cassia helmsii****
*Chenopodium gaudichaudianum**
*Cratystylis subspinescens**
*Enchylaena tomentosa**
Eremophila cuneifolia
*Eremophila latrobei**
Eremophila leucophylla
Frankenia sp.*
Halosarcia sp.
*Maireana aphylla**
*Maireana polypterygia**
*Maireana platycarpa**
*Maireana pyramidata**
Maireana tomentosa
Ptilotus obovatus
*Ptilotus polakii**
*Rhagodia eremaea**
Solanum lasiophyllum
Solanum sp.

Perennial grasses:

Cenchrus ciliaris
*Enteropogon acicularis**
Eragrostis xerophylla

Annuals, biennials and herbs:

Aristida contorta
Atriplex inflata
Atriplex semilunaris
Atriplex spongiosa
Dactyloctenium radulans
Lawrencia sp.

Maireana carnosa
Salsola kali

* desirable indicator species
** undesirable indicator species

6. Condition statements

The Gascoyne bluebush community represents the most common community of the Bluebush pasture type within the survey area and as insufficient data are available on the other, more restricted, Bluebush communities condition statements are based on Gascoyne bluebush shrublands.

6.1 Good to excellent condition

Depending upon the soil type, other site variables and the size distribution of the shrubs, most Gascoyne bluebush stands vary from 1,000-4,000 plants/ha, most commonly about 2,000/ha. An even cover of vigorous and robust mature and young plants indicates good pasture condition.

Other important indicators of good condition are silver saltbush, bladder saltbush and low bluebush. Disappearance of the preferentially-grazed low bluebush may be a sensitive indication of condition decline. Other desirable indicators of local importance are warty leaf poverty bush, felty leaf bluebush *Maireana tomentosa* and ragged leaf scaevola *Scaevola tomentosa*.

Moderately palatable species are sometimes quite abundant and those with significant contribution include cotton bush (up to 1,500/ha), tall saltbush (up to 350/ha), flannel bush (up to 375/ha) and Gascoyne mulla mulla (up to 250/ha). The undesirable grey cassia *Cassia desolata*, crinkle leaf cassia *C.helmsii*, needle bush, silver poverty bush *Eremophila pterocarpa* and bardie bush may be present, but at relatively low densities.

Total low shrub densities vary widely from 1,000 to over 9,000 shrubs/ha (commonly about 4,500/ha) and PFC is usually between 5 and 20%, but sometimes more in good seasons.

In good to excellent condition both the hardy perennial species and the ephemerals afford the soil surface adequate protection from the forces of wind and water and no erosion is present.

6.2 Fair condition

A decline in condition from good to fair is immediately obvious by the reduction in total PFC. PFC is generally within the range of 5-10% but may be as low as 2.5%. A reduction in density of Gascoyne bluebush (density range 200-1500/ha) is the major cause of this decline. However, the decline in density of other desirable low shrubs follows the same trend. Low bluebush becomes rare or absent in what were mixed Gascoyne bluebush-low bluebush shrublands. Decline in bluebush densities appears to reduce competition for supplies of soil nutrients and moisture in the inter-shrub spaces, and increased seasonal growth of annuals and ephemerals often results.

Moderately palatable species tend to remain at fairly constant densities as do any undesirables which may have been present when the site was in good condition. However, their overall contribution to the total plant stand, relative to desirable shrub species, increases.

There may be minor erosion in the form scalding, rilling and gullying or sheeting but generally no erosion is present on fair condition sites.

6.3 Poor to very poor condition

Poor condition is characterized by a further decline in perennial PFC, the development of bare areas or presence of accelerated soil erosion and, in some cases, a marginal increase in the density of undesirable species.

Gascoyne bluebush densities are reduced considerably, commonly to < 400 plants/ha and shrubs may show very poor vigour, often being grazed back to the unpalatable woody material. Sensitive indicators such as warty leaf poverty bush and low bluebush have usually disappeared altogether. Generally, both species diversity and shrub densities are far below their potential and in extreme cases perennial species are completely absent.

Scalding and hummocking by wind is common in minor or moderate degrees, but water erosion is primarily responsible for the more serious cases of soil degradation. Moderate to severe gully and sheet erosion can develop on sloping areas receiving more concentrated flow and sheeting occurs on broader areas where little or no channeling takes place. In many cases erosion has completely removed the crusted but otherwise weakly coherent surface soil exposing a clay subsurface which is sealed and poorly permeable to water. Run-off rates after rain are very high and may exacerbate erosion problems further down the slope.

7. Management

Bluebush pastures form large areas of high potential productive and durable pasture within the survey area. Their condition is extremely variable throughout, and suitable management practices should be employed to meet the circumstances of the area being considered. Areas in good condition provide well for dry seasons and for breeding stock, but require regular monitoring of levels of shrub use and consequent adjustments in stocking rates.

In some areas pastures show little or no evidence of use by stock. This is generally because suitable water supplies have not been developed or existing waters contain high levels of salt and grazing distances are restricted. In such situations there is a need to develop closely distributed (and/or better quality) water supplies to ensure a more even use and avoid local degradation.

Areas in good condition generally produce only modest amounts of annuals and are not normally susceptible to bushfires. Stands in fair to poor condition may support fuel loads sufficient to carry fires following unusually wet seasons. Fire protection is important because bluebushes are fire sensitive and fires will cause high mortality rates and loss of seed stores.

In some areas where Bluebush pastures are well supplied by stock watering points or occur as small inclusions within less productive pastures, they are sometimes over used and degradation has resulted. Additional fencing and the exclusion of stock for several growing seasons may be required to return these pastures to a productive state. However, in severe cases where few perennials remain and the seed store is negligible, cultivation and reseeding techniques may be required, followed by several seasons of complete spelling. Complete spelling has been reported to be highly successful as a management response to the recognition of a major establishment event by seedling Gascoyne bluebushes. Such recruitments accrue benefits in pastoral productivity and range conservation over many years.

Where pastures are in fair to poor condition, desirable bluebush species should be monitored for changes in their density and vigour. Erosion should also be monitored; the presence of accelerating erosion being a sure sign of declining condition. In good seasons opportunistic grazing practices should be employed to take advantage of other highly productive annual pastures which temporarily abound.

Although the bluebushes considered here are extremely long-lived and durable shrubs, once removed they have a poor capacity to re-colonize because of the poor viability of their seed and the infrequent occurrence of climatic conditions conducive to seedling establishment. Sound management techniques involving strategic fencing, adequate good quality water supplies and conservative stocking rates are necessary to ensure long term productivity.

Recommended levels of use (per annum):

Good to excellent condition	- 5 ha/s.u.
Fair condition	- 8 ha/s.u.
Poor to very poor condition	- 16 ha/s.u.

Currant Bush Mixed Shrub pasture type (CBMS)

1. Area 4,150 km² (5.6 per cent)

2. Distribution and soil types

Currant Bush Mixed Shrub (CBMS) pastures are common on the interbanks and plains of alluvial plain land systems. By far the most extensive occur on the Sandal land system which accounts for over half the total area of this pasture type. Smaller, but still important areas, occur on the Target, Ella, Spot, and Lyons land systems. Less significant areas are found on the Bidgemia land system.

Currant Bush Mixed Shrub pastures rarely extend uniformly over extensive areas. Rather, they typically grow in combination with Acacia Sandplain (ACSA) pastures and together these display an alternating pattern or mosaic on aerial photographs and on the ground with Currant Bush Mixed Shrub on the lower plains of the landscape and Acacia Sandplain pastures on the higher banks, dunes and other sandy units. In northern areas Hard Spinifex (HASP) pastures replace the Acacia Sandplain pasture type on sandy areas such as the Spot land system.

The soils are invariably red texture contrast varieties with thin sandy or loamy A horizons changing abruptly to clayey B horizons. A thin surface crust which readily separates from the underlying soil is usually present and alkaline soil reaction trends are the norm. Sola are deep (> 1 m) and small inclusions of lime, quartz and limestone are occasionally present. Surface mantles are generally absent though quartz gravels sometimes occur as very sparse surface covers (< 1%).

3. Physiognomy and composition

Currant Bush Mixed Shrub pastures normally occur as moderately close tall (>2 m) shrublands with a projected foliar cover (PFC) of 20-30%. Less frequently they occur as very scattered to scattered low shrublands (PFC <20%) or as very scattered tall shrublands (PFC < 10%).

A rich assemblage of both low and tall shrubs characterize these pastures. Currant bush *Scaevola spinescens*, occurring as either a low or tall shrub is the most distinctive single species and is locally dominant within the stand.

Other major tall shrubs include curara *Acacia tetragonophylla*, bardie bush *A.victoriae*, needle bush *Hakea preissii*, minga bush *Heterodendrum oleaefolium* and pebble bush *Stylobasium spathulatum*. Total tall shrub densities are often about 300-400 plants/ha.

Total low shrub densities vary far more widely than those of the tall shrubs and may range from 100 to over 20,000 plants/ha, however they are more commonly in the vicinity of 3000 or 4000/ha. Widely distributed low shrubs include grey cassia *Cassia desolata*, earlobe saltbush *Chenopodium gaudichaudianum*, ruby saltbush *Enchylaena tomentosa*, waxy leaf poverty bush *Eremophila crenulata*, flat leaf bluebush *Maireana planifolia*, felty leaf bluebush *M. tomentosa*, cotton bush *Ptilotus obovatus*, Gascoyne mulla mulla *P.polakii*, tall saltbush *Rhagodia eremaea* and flannel bush *Solanum lasiophyllum*.

Perennial grasses achieve little cover on these pastures and are often absent. Of local significance are erect wind grass *Aristida browniana*, buffel grass *Cenchrus ciliaris* and curly windmill grass *Enteropogon acicularis*.

4. Pastoral value

Pastures in good or fair condition support a broad range of palatable shrub species with excellent drought durability and there is an abundance of palatable annual species in season. When in good or fair condition pastoral value is high and the pastures are suitable for grazing on a year-long basis by all classes of stock.

Unfortunately many Currant Bush Mixed Shrub pastures have been over used in the past with consequent loss of desirable species. Drought durability is considerably reduced in such circumstances although the pastures are still highly productive in terms of annual species in good seasons.

Dramatic increases in undesirable shrubs such as needle bush, waxy leaf poverty bush, grey cassia and other *Cassia* species have occurred in some parts. In such cases pastoral value is greatly reduced and is well below its potential.

5. Common perennial species

Trees:

Acacia sibilans
Heterodendrum oleaefolium

Tall shrubs:

Acacia ligulata
Acacia ramulosa
Acacia sclerosperma
Acacia subtessarogona
Acacia tetragonophylla
*Acacia victoriae***
Acacia xiphophylla
Eremophila maitlandii
*Eremophila pterocarpa***
*Hakea preissii***
Heterodendrum olaeafolium
*Scaevola spinescens**
Stylobasium spathulatum

Low shrubs:

Acacia tetragonophylla
*Acacia victoriae***
Acanthocarpus preissii
*Atriplex bunburyana**
*Cassia chatelainiana**
*Cassia desolata***
*Cassia helmsii***
Cassia oligophylla
*Chenopodium gaudichaudianum**
Commicarpus australis
*Enchylaena tomentosa**
Eremophila cuneifolia
*Eremophila latrobei**
*Eremophila leucophylla**
Eremophila mackinlayi
*Eremophila maculata**
Eremophila maitlandii
*Eremophila crenulata***
*Maireana planifolia**
*Maireana tomentosa**
Ptilotus divaricatus
Ptilotus aff drummondii
*Ptilotus polakii**
Ptilotus obovatus
*Rhagodia eremaea**
*Scaevola spinescens**
Solanum lasiophyllum
Stylobasium spathulatum

Perennial grasses:

Aristida browniana
*Cenchrus ciliaris**
*Enteropogon acicularis**
Eriachne helmsii
*Monachather paradoxa**
Stipa elegantissima

Annuals, biennials and herbs:

Aristida contorta
Atriplex semilunaris
Boerhavia diffusa
Eragrostis dielsii
Salsola kali
Solanum sp.
Zygophyllum sp.

* desirable indicator species
** undesirable indicator species

6. Condition statements

6.1 Good to excellent condition

In good to excellent condition these mixed shrublands support an abundance of palatable shrub species including: tall cassia, earlobe saltbush, ruby saltbush, warty leaf poverty bush, Wilcox bush, flat leaf bluebush, felty leaf bluebush, currant bush, cotton bush and tall saltbush. The distribution of these species is irregular and it would be rare for them all to be growing on the one site. However, when a range of them are present as healthy individuals they indicate good pasture condition. The individual densities of such indicators are relatively low and rarely exceed 200/ha, but combined as a stand they provide large amounts of dry season forage.

Undesirable species occur as elements within communities in good condition, but only as scattered individuals with densities in the range of 50-500/ha.

Total shrub densities vary widely on pastures in good condition but are often between 3000 and 5000/ha. PFC may range from 5-50%, but is usually between 20 and 25%.

No erosion is present on pastures in good or excellent condition.

6.2 Fair condition

Fair condition is indicated by a partial, but obvious loss of those palatable species mentioned in section 6.1. The most palatable, preferentially browsed species such as tall cassia, ruby saltbush and

warty leaf poverty bush may be present only as large, old individuals. Other durable and persistent desirable species such as currant bush and tall saltbush are usually still widely distributed, but may show poor vigour and lack young age class plants.

Seedlings and young plants of undesirables such as needle bush and bardie bush are sometimes conspicuous in fair condition stands, especially in dry conditions when they are most visible.

Total shrub densities are commonly in the vicinity of 3000/ha. This is a lower figure than that for good condition pastures since selective grazing has led to the loss of individuals of the very sensitive species. PFC may range from < 5-25%, but is commonly 10-15%.

In fair condition there is generally no erosion but occasionally minor erosion is apparent.

6.3 Poor to very poor condition

Pastures in this condition exhibit low species diversity and a domination by undesirables. Bardie bush, needle bush, waxy leaf poverty bush, grey cassia or silver poverty bush can predominate; other undesirables may follow this same trend more locally. Palatable species are often absent, dead or exist only as occasional heavily browsed relics.

Depending upon which species dominate the site and how large the individual shrubs become total shrub densities may be higher or lower than when in good condition, averaging 2000/ha. PFC ranges from about < 5-50% depending on whether or not an invasion by undesirables has occurred. Cover levels of 20-25% are common which are similar to those for good condition, but cover is afforded by undesirable rather than desirable species.

Erosion is uncommon within these pastures even when they are in poor or very poor condition. However, minor to moderate water or wind erosion occurs locally in the form of an accumulation of wind-blown soil around plant bases, or more prominent pedestalling, with surface soil loss and scalding between shrubs.

7. Management

Currant Bush Mixed Shrub pastures in good condition are very productive both seasonally and perennially. Management should aim at maintaining desirable species in the stand. This will involve monitoring the density and vigour of indicator species and adjusting stocking rates in response to positive or negative changes. In some cases it may require the installation of additional water supplies or extra fencing to distribute grazing more evenly within paddocks.

A large proportion of these pastures are in fair or poor condition and management should be aimed at returning them to a more productive state. This will require careful control of the season, duration and intensity of grazing. Paddocks can be stocked to take advantage of annual feed, but stock should be removed early to protect and encourage the recovery of desirable perennials.

On areas where shrub invasion has occurred there are, as yet, no practical methods of removing the undesirable shrubs other than by expensive mechanical removal. Fire is a possible tool for shrub control and is currently being investigated by the Department of Agriculture. However, its use is limited through the normally low fuel loads that shrub-invaded sites will support. Complete spelling for several growing seasons may be needed in order to build up sufficient ground fuel supplies to carry a fire. That fires will kill many problem shrub species, especially when young, is now well-established (Hodgkinson and Harrington, 1986).

Recommended levels of use (per annum):

Good to excellent condition	- 5 ha/s.u.
Fair condition	- 8 ha/s.u.
Poor to very poor condition	- 16 ha/s.u.

Heath pasture type (HEAT)

1. Area 3,780 km² (5.1%)

2. Distribution and soil types

The Heath (HEAT) pasture type is a broad class of complex plant assemblages that are generally unsuited to pastoral development and production. It is restricted to the winter rainfall dominated extreme south-western portion of the area in the vicinity of Shark Bay. Occurring on the sand ridges, plains and dunes of six different land systems, it often covers extensive areas without inclusions of other pasture types, especially on Tamala and Nanga stations.

The Inscription and Zuytdorp land systems are completely dominated by Heath pastures but only occupy about 460 km² in total. By far the largest extent of Heath pastures is found on the Nanga system where they make up 90% of the system and occupy roughly 3,140 km². Heath pastures also occupy small areas on the Edel, Peron and Cooloomia land systems where they form minor associations with Coastal Dune Shrub (CDSH), Acacia Sandplain (ACSA) and Acacia and Eucalyptus Short Grass Forb (AEGF) pastures, respectively.

Soils are predominantly non-calcareous sands > 1 m deep and lack surface mantle or inclusions. Exceptions occur on the Zuytdorp and Inscription land systems where sheet limestone is often encountered at depths < 1 m (sometimes outcropping) and mantles and inclusions of limestone are common; these soils are usually calcareous. Isolated pockets of uniformly medium textured soil profiles occur on the low hills of the Zuytdorp land system.

3. Physiognomy and composition

Heath pastures occur on vegetation systems of the South-Western Botanical Province. They are characterized by the distinct absence of Eremaean arid zone species and a predominance of species of the families Myrtaceae and Proteaceae. The Heath pasture type exhibits variable structure and densities and extremely diverse floristic composition due to many factors including fire and associated successional stages, soil depth and the degree of shelter afforded by the topography.

The vegetation formations which occur may be loosely categorized as follows:

a) Scattered to closed heathland with all shrubs < 1 m high, on areas which have experienced recent fire or on the seaward units of the Zuytdorp and Inscription land systems;

b) Tree heath on the Nanga land system where eucalypts (mallee form) and other trees occur in isolated clumps or form bands along the sandy rises and dune crests above closed lower layers;

c) Scrub heath, with a scattered shrub layer > 2 m above irregularly stratified closed lower layers. Projected foliar cover (PFC) ranges from 15 to over 75%.

Widespread tree and mallee species which occur in tree heath situations include Ashby's banksia *Banksia ashbyi*, kurrajong *Brachychiton gregorii*, native pine *Callitris columellaris*, mallalie *Eucalyptus eudesmioides*, narrow leaf red mallee *E. foecunda* and *E. oleosa*. The mallees *E. beardiana* and *E.roycei* occur locally and are endemic to this area. Illyarrie *E.erythrocorys* is common where limestone occurs at shallow depth on the Zuytdorp system.

Important tall shrubs include *Acacia rostellifera*, Australian blackthorn *Bursaria spinosa*, one-sided bottlebrush *Calothamnus formosus*, *Grevillea gordoniana*, *Hakea stenophylla* and false paperbark *Lamarchea hakeifolia*.

The lower strata support the most diverse range of low shrubs within the survey area. Some of the more common species are umbrella wattle *Acacia ligulata*, native hibiscus *Alyogyne pinoniana*, *Banksia lindleyana*, *Beaufortia dampieri*, star flowers *Calytrix* spp., sheoak *Casuarina* sp., smoke bush *Conospermum stoechadis*, *Grevillea thelemanniana*, paper bark *Melaleuca cardiophylla*, *Scaevola crassifolia* and *Thryptomene baeckeacea*. The sedge-like *Ecdeiocolea monostachya* and hummock grass *Plectrachne danthonioides* often form significant stands within the ground stratum, the latter with PFC up to 50%. *Acanthocarpus preissii*, a low tussocky perennial, is widespread on shallow calcareous soils.

Fire is a naturally occurring phenomenon within such highly combustible shrublands, especially in western parts. Early successional stages support a scattered to moderately close (PFC 10-30%) low shrub regrowth from seedlings and fire-adapted resprouters. Common species in these situations include *Anthocercis littorea*, native hibiscus *Alyogyne cuneiformus*, native poplar *Codonocarpus continifolius*, fire bush *Gyrostemon ramulosus*, *Newcastelia chrysophylla*, *Pityrodia oldfieldii*, *P.cuneata*, *Grevillea* and *Hakea* spp. There is however, no evidence that increasing the frequency of fires, either by unplanned ignition or prescribed burning, achieves any improvement in pastoral value from the largely inedible regrowth.

4. Pastoral value

There is a general lack of both stock waters and palatable plants on Heath pastures and pastoral value is very low.

Some palatable species do occur but their distributions are narrow and/or their densities are low. On the low hills of the Zuytdorp land system some palatable Eremaean species such as ruby saltbush *Enchylaena tomentosa* and *Rhagodia* sp. are locally common. Other palatable plants include: fire bush, *Dampiera spicigera*, *Lechenaultia linarioides*, *Anthobolus foveolatus* and *Ecdeiocolea monostachya* which has been reported to be toxic to horses.

The palatability of regrowth after fire and the ability of these pastures to support annuals in good seasons are not clearly understood. However, it would appear that these pastures provide very little forage for stock and apart from occasional opportunistic use, they are unsuitable for pastoral pursuits.

5. Common perennial species

Trees (or mallees):

Banksia ashbyi
Brachychiton gregorii
Callitris columellaris
Eucalyptus erythrocorys
Eucalyptus eudesmioides
Eucalyptus foecunda
Eucalyptus obtusiflora
Eucalyptus oleosa
Eucalyptus roycei

Tall shrubs:

Acacia ligulata
Acacia rostellifera
Adenanthos acanthophyllus
Alyxia buxifolia
Banksia ashbyi
Banksia sceptrum
Bursaria spinosa
Calothamnus formosus
Codonocarpus continifolius
Grevillea gordoniana
Gyrostemon ramulosus
Hakea stenophylla
Lamarchea hakeifolia
Stylobasium spathalatum

Low shrubs:

Acacia acuminata
Acacia leptospermoides
Acacia ligulata
Acanthocarpus preissii
Alogyne cuneiformas
Alogyne pinoniana
*Anthobolus foveolatus**
*Anthocercis littorea**
Banksia lindlayana
Beaufortia dampieri
Calothamnus kalbarriensis
Calytrix species
Casuarina sp.
Conospermum stoechadis
Corchorus sp.
Dampiera incana
*Dampiera spicigera**
Dicrostylis costelloi
Dodonea inaequifolia
Grevillea species
Grevillea thelemanniana
Hakea sp.
Lamarchea hakeifolia
*Lechenaultia linarioides**
Melaleuca cardiophylla
Melaleuca oldfieldii
Newcastelia chrysophylla
Olearia axillaris
Petrophile conifera
Pityrodia cuneata
Pityrodia oldfieldii
*Ptilotus divaricatus**
*Ptilotus obovatus**
Rhagodia sp.*
*Scaevola spinescens**
*Scaevola tomentosa**
Thryptomene baeckeacea

Perennial grasses:

*Ecdeiocolea monostachya***
Plectrachne danthonioides
*Stipa elegantissima**
Triodia sp.

Annuals, biennials and herbs:

Brassica tournefortii
Emex australis
Haloragis sp.
Salsola kali

* desirable indicator species
** undesirable indicator species

6. Condition statement

No definitive condition statements can be made for Heath pastures. They have not been generally developed for grazing and little grazing induced pasture degradation or erosion is in evidence. Areas denuded by fire are quickly re-colonized and show no erosion.

Recommended levels of use (per annum):

Good to excellent condition - 30 ha/s.u.

Saltbush pasture type (SALT)

1. Area 3,500 km² (4.7%)

2. Distribution and soil types

Saltbush (SALT) pastures occur throughout the survey area and are commonly found on the alluvial and flood plain units of the alluvial plain land systems, or on the low saline plains of internally or poorly drained systems. The most extensive areas are on the Delta, Snakewood and Sable land systems. Important areas occur on the Foscal, Gearle and Warroora land systems and the remaining areas are found as pockets throughout several other systems including Barrabiddy, Chargoo, Cullawarra and Wandagee.

On the Delta, Foscal, Gearle, Sable, Warroora and Yalkalya land systems Saltbush pastures are found in close association with Bluebush (BLUE) pastures and together account for most of the pasture present. Saltbush pastures are also found in association with Tussock Grass (TUGR) pastures in northern areas on the Barrabiddy and Chargoo land systems, Acacia Mixed Shrub (ACMS) pastures on the Snakewood and York land systems in southern areas, and Exotic Annual (EXAN) pastures on the Cullawarra land system peculiar to Tamala station.

Soils associated with this pasture are predominantly full depth (> 1 m) types with alkaline soil reaction trend and have little or no surface mantle. Red duplex, gradational, fine or medium uniform-textured soils are the most common in the alluvial situation and account for the majority of soils found. Occasionally Saltbush pastures are associated with uniform coarse textured soils such as on the sand sheets of the Edel and Brown land systems.

3. Physiognomy and composition

Saltbush pastures occur most commonly either as low (< 1 m) shrub 'steppe' or as an understorey to tall (> 2 m) scattered acacia shrublands. Both types have projected foliar cover (PFC) of about 15-20% when in good condition. They are otherwise found as very scattered shrublands with PFC <10% and, on severely degraded sites, as open herb-fields with negligible cover. In all but the latter situations the low shrub layer is clearly the dominant stratum and a single *Atriplex* saltbush species will usually dominate the stand.

Four saltbush communities constitute the Saltbush pasture type. These communities are:

- Silver saltbush *Atriplex bunburyana*
- Bladder saltbush *A. vesicaria*
- Swamp (river) saltbush *A. amnicola*
- Marsh saltbush *A. paludosa*

The latter two communities have a very restricted range (*A. amnicola* on riverine levees and in drainage foci, and *A. paludosa* locally on saline coastal plains) and are not further described here.

3.1 Silver saltbush community

When in good condition the silver saltbush community occurs as a tall (>2m) scattered shrubland with PFC of 15-20%. The upper stratum is dominated by various tall shrubs, but their densities rarely exceed 200 plants/ha. Snakewood *Acacia xiphophylla*, bardie bush *A. victoriae*, curara *A.tetragonophylla* and minga bush *Heterodendrum oleaefolium* are all widely distributed. Needle bush *Hakea preissii*, silver bark wattle *A.sclerosperma*, *A. galeata* and minni ritchi *A.grasbyi* are also frequently present. The trees, wait-a-while *A. cuspidifolia*, Gascoyne myall *A.sibilans*, minga bush, and York gum *Eucalyptus loxophleba* occur locally and their recorded densities have always been < 175 plants/ha.

Areas supporting the silver saltbush community are characterized by a wide range of perennial low shrubs. The following species are widely distributed within this community; silver saltbush, tall saltbush *Rhagodia eremaea*, grey cassia *Cassia desolata*, carlobe saltbush *Chenopodium gaudichaudianum*, ragged leaf scaevola *Scaevola tomentosa*, felty bluebush *Maireana tomentosa*, flat leaf bluebush *M. planifolia*, ruby saltbush *Enchylaena tomentosa*, Gascoyne mulla mulla *Ptilotus polakii*, and narrow leaf mulla-mulla *P. divaricatus*. Cotton bush *P. obovatus*, flannel bush *Solanum lasiophyllum*, curara, and currant bush *Scaevola spinescens* are also common elements. Silver saltbush densities are typically 3000-4000 plants/ha. However, depending on the site situation and condition status, densities may range from 50 to at least 8000 plants/ha.

3.2 Bladder saltbush community

The bladder saltbush community occurs typically on lower-lying, less sandy situations than silver saltbush. A scattered low shrubland (PFC 10-15%) when in good condition, it may open out to form a very scattered low shrubland (PFC 5-10%) with declining pasture condition. This community has a very sparse upper storey with the foliar cover almost entirely in the low shrub layer. Trees and tall shrubs may be absent and rarely exceed 25 plants/ha. The diversity of low shrub species is somewhat less than that found within the silver saltbush community but total low shrub densities are similar. The low shrubs bladder saltbush *Atriplex vesicaria*, sage *Cratystylis subspinescens*, flannel bush, felty bluebush, cotton bush, tall cassia, tall saltbush, Wilcox bush *Eremophila leucophylla,* samphires *Halosarcia* spp. and frankenias *Frankenia* spp. are all widely distributed. Bladder saltbush is commonly found at densities greater than 10,000 plants/ha on sites in good condition.

4. Pastoral value

In good condition, Saltbush pastures are characterized by a high density of palatable low shrubs. Pastoral value is augmented by abundant annual herbs and grasses in favorable seasons. Due to the high amounts of good quality forage available the pastures are suitable for breeding stock and for use in drought periods. Hence the pastoral value is high.

Despite their value, large areas of these saline pastures remain unused or poorly used, either because of a lack of good quality stock water, or poor water distribution, or both. In these areas the pastures remain virtually ungrazed. Conversely, in some areas, where stock waters are of good quality, overgrazing has resulted in severe degradation and pastoral value is far below its potential.

5. Common perennial species (all communities)

Trees:

*Acacia cuspidifolia***
Acacia galeata
Acacia sibilans
Heterodendrum oleaefolium

Tall shrubs:

Acacia ligulata
Acacia ramulosa
Acacia sclerosperma
Acacia tetragonophylla
*Acacia victoriae***
Acacia xiphophylla
*Eremophila pterocarpa***
Exocarpos aphyllus
*Hakea preissii***
Heterodendrum oleaefolium
Pittosporum phylliraeoides

Low shrubs:

Acacia tetragonophylla
*Atriplex amnicola**
*Atriplex bunburyana**
*Atriplex paludosa**
*Atriplex vesicaria**
*Cassia chatelaineana**
Cassia desolata
*Chenopodium gaudichaudianum**
*Cratystylis subspinescens**
*Enchylaena tomentosa**
*Eremophila leucophylla**
Frankenia sp.
*Hakea preissii***
*Maireana planifolia**
*Maireana platycarpa**
*Maireana polypterygia**
*Maireana tomentosa**
Ptilotus aff. *drummondii*
Ptilotus obovatus
Rhagodia eremaea
*Scaevola spinescens**
*Scaevola tomentosa**
Solanum lasiophyllum
*Solanum orbiculatum***
Stylobasium spathulatum

Perennial grasses:

Aristida browniana
*Cenchrus ciliaris**
*Stipa elegantissima**

Annuals, biennials and herbs:

Aristida contorta
Atriplex inflata
Atriplex semilunaris
Atriplex spongiosa
Danthonia caespitosa
Dissocarpus paradoxa
Maireana carnosa
Ptilotus exaltatus
Salsola kali
Zygophyllum sp.

* desirable indicator species
** undesirable indicator species

6. Condition statements

6.1 Silver saltbush community

6.1.1 Good to excellent condition

The abundance and vigour of silver saltbush is the most useful indicator of condition. In good to excellent condition silver saltbush dominates the stand with densities in the order of 3,000-8,000 plants/ha. The low shrubs ruby saltbush, felty bluebush, ragged leaf scaevola, Gascoyne bluebush and flat leaf bluebush are also indicators of good condition. However, they all have patchy distributions and their absences do not necessarily imply poorer condition.

The shrubs cotton bush, tall saltbush and flannel bush are commonly present at densities of about 500-1000 plants/ha and the undesirables wait-a-while, tomato bush, bardie bush and needle bush may be present, but at very low densities.

Generally, when this community is in good condition there is no erosion.

6.1.2 Fair condition

Fair condition is indicated by a decline in the density and vigour of silver saltbush. Densities of silver saltbush are typically 1000-2000 plants/ha with some plants being severely grazed back to unpalatable woody material. The other palatable indicator species mentioned in section 6.1.1, may still be present, but only in small numbers. Cotton bush may increase its proportion of the stand in these situations as the more palatable shrubs disappear. The undesirable shrubs do not tend to increase their density very much and may still be present at very low densities.

Soil erosion is usually absent but occasionally minor wind erosion occurs.

6.1.3 Poor to very poor condition

Silver saltbush densities are low, very low or zero and other desirable shrubs are scarce or absent. PFC is reduced to below 10% and the total amount of perennial forage is severely reduced. In extreme situations PFC may be below 2.5% and saltbush shrubs may occur only as occasional remnants. Elsewhere, degraded sites have been invaded by undesirable shrubs such as prickly acacia, needle bush and silver poverty bush *Eremophila pterocarpa*.

Minor and moderate wind erosion, in the form of large scalds and hummocking, and water erosion as rilling, gullying or sheeting is common.

6.2 Bladder saltbush community

6.2.1 Good to excellent condition

Bladder saltbush clearly dominates the stand and occurs at densities of up to 25,000 plants/ha, averaging about 8000/ha. It is itself the most useful desirable indicator species. Other desirables such as tall cassia, sage, Wilcox bush and various bluebushes are usually present.

The undesirables bardie bush, needle bush, wait-a-while and silver poverty bush may be present in the sparse upper stratum. There is little or no erosion.

6.2.2 Fair condition

In fair condition bladder saltbush densities are usually within the range 4000-5000 plants/ha, a marked decline from levels found on good condition sites. Other palatable low shrubs will normally be present, but only at low densities.

Minor to moderate soil erosion is often present on pastures in this condition.

6.2.3 Poor to very poor condition

In poor to very poor condition bladder saltbush densities are within the range of a few to 2000 plants/ha. Other desirable species are rarely present and the range of perennial species found on these sites is usually narrow. PFC is correspondingly low (5-10%).

Bladder saltbush communities in this condition often appear as a mosaic of vegetation remnants more or less surrounded by bare scalded soil. The vegetation clumps are slightly elevated due to both the deflation of surrounding soils, through wind and water erosion, and the local re-deposition of these soils. Moderate erosion in the form of scalding, hummocking, gullying and sheeting is usually in evidence.

7. Management

Saltbush pastures are sensitive to use and the soils will usually erode if not managed correctly. In some cases, especially on sites with duplex soils, degradation has occurred and the saltbush shrubs exist only in remnant patches. These areas will require protection from grazing for a number of seasons and, in extreme cases, may require cultivation treatments and seeding.

Some large areas of Saltbush pastures are not fully used because of the absence of good quality stock waters. The provision of additional supplies either by piping from existing good quality supplies, desalination of existing supplies or surface storages are options which need to be considered in management planning for optimal use of such areas.

Saltbush is more sensitive to the effects of grazing and management than other chenopod shrubs, such as the bluebushes, and complete control of the numbers of livestock and season of use are necessary if saltbush stands are to be maintained or revitalised. Where large areas of saltbush exist they should be separately paddocked, without other pasture types, to simplify management.

Saltbush pastures should be monitored for changes in the density and vigour of the component saltbush species and for active soil erosion. In the case of an adverse change, stocking rates should be adjusted and seasonal spelling should be implemented to allow invigoration and seedling development of desirable species.

Recommended levels of use (per annum):

Good to excellent condition	- 5 ha/s.u.
Fair condition	- 8 ha/s.u.
Poor to very poor condition	- 16 ha/s.u.

Acacia Mixed Shrub pasture type (ACMS)

1. Area 3,200 km² (4.3%)

2. Distribution and soil types

This pasture type occurs widely throughout the survey area forming significant portions of 13 land systems. The most extensive areas are formed on plains of low relief with underlying or outcropping limestone such as on the Toolonga and Trealla land systems. Important areas are also found on the Donovan, Mary, Tarcumba and Yaringa land systems while minor areas occur on several other systems including Learmonth, Snakewood and Tamala.

Soils associated with this pasture type are calcareous, of variable depth and usually have outcropping limestone or a calcrete surface mantle. Surface mantles of quartz or radiolarite are common in northern parts of the survey area. Outcropping parent material and mantle may account for up to 50% of soil surface area with fragment size ranging up to 25 cm in diameter. A broad range of soil textures are found including uniform-textured soils (sands to clays), calcareous gradational soils and red duplex soils.

3. Physiognomy and composition

Acacia Mixed Shrub (ACMS) pastures occur nearly always, as tall (> 2 m) shrublands with total projected foliar cover (PFC) of about 20-25% but this may range from 2 to > 50% depending on condition and site situation. Occasionally the form varies and it is found as a low (< 2 m) scattered shrubland with PFC ranging from 5-20%.

The upper storey is dominated by a wide range of tall shrubs with *Acacia* being the most widespread genus. Wanyu *Acacia ramulosa*, silver bark wattle *A.sclerosperma*, curara *A. tetragonophylla*, Hamelin wattle *A.drepanophylla* and bardie bush *A. victoriae* are the most common acacias. The tall shrubs, broom bush *Exocarpos aphyllus* and minga bush *Heterodendrum oleaefolium* are also common in this stratum. The average density of the tall shrubs is about 350 plants/ha, however actual densities range widely.

The tree component of the upper storey is generally minor and commonly absent. Species diversity is correspondingly low with the most widespread low trees being minga bush, mulga *Acacia aneura*, and sandalwood *Santalum spicatum*.

The variety of species within the lower strata of this pasture type is very high with over 50 species of low shrubs and perennial grasses present. Cotton bush *Ptilotus obovatus* is by far the most common low shrub; its density has been measured at up to 8000 plants/ha and it occurs throughout the distribution of this pasture type at all condition levels. Other widespread low shrubs are ruby saltbush *Enchylaena tomentosa*, Wilcox bush *Eremophila leucophylla*, flat leaf bluebush *Maireana planifolia*, tall saltbush *Rhagodia eremaea*, flannel bush *Solanum lasiophyllum*, crinkle leaf cassia *Cassia helmsii*, grey cassia *C. desolata*, tall cassia *C. chatelainiana*, carlobe saltbush *Chenopodium gaudichaudianum*, ragged leaf scaevola *Scaevola tomentosa* and felty leaf bluebush *Maireana tomentosa*. Perennial grasses form only a minor component and are sparsely distributed. The introduced species buffel grass *Cenchrus ciliaris* has successfully colonized some areas, notably on parts of the Mary and Donovan land systems, where it forms stands with up to 0.5% basal cover. Other perennial grasses such as ribbon grass *Chrysopogon fallax*, feather spear grass *Stipa elegantissima* and spinifex *Triodia* spp. are all very sparse. Spinifex only occurs in northern parts where its ground cover is usually < 10%.

4. Pastoral value

Because of the wide range of palatable low shrubs, this pasture type is of high pastoral value. When in good condition the pastures are highly productive, drought durable and capable of carrying breeding stock. Pastoral value is augmented by numerous annual forbs and grasses in good seasons. Pastures are completely accessible to stock due to the gentle topography of the associated landforms.

5. Common perennial species

Trees:

Acacia aneura
Acacia drepanophylla
Acacia galeata
Acacia pruinocarpa
Eremophila oldfieldii
Heterodendrum oleaefolium
Santalum lanceolatum
Santalum spicatum

Tall shrubs:

Acacia drepanophylla
Acacia grasbyi
Acacia ligulata
Acacia ramulosa
Acacia sclerosperma
Acacia tetragonophylla
*Acacia victoriae***
Acacia xiphophylla
Eremophila maitlandii
Eremophila crenulata
Eremophila pterocarpa
Exocarpos aphyllus
Hakea preissii
Heterodendrum oleaefolium

Low shrubs:

Acacia tetragonophylla
*Cassia chatelainiana**
Cassia desolata
Cassia helmsii
Chenopodium gaudichaudianum
*Enchylaena tomentosa**
*Eremophila latrobei**
*Eremophila leucophylla**
Heterodendrum oleaefolium
*Maireana planifolia**
*Maireana tomentosa**
Ptilotus divaricatus
Ptilotus obovatus
Ptilotus schwartzii
Rhagodia eremaea
Rhagodia sp.
*Scaevola spinescens**
*Scaevola tomentosa**
Solanum lasiophyllum
*Solanum orbiculatum***
*Tribulus platypterus**

Perennial grasses:

Cenchrus ciliaris
*Stipa elegantissima**
Triodia pungens
Triodia spp.

Annuals, ephemerals and biennials:

Aristida contorta
Boerhavia diffusa
Danthonia caespitosa
Enneapogon sp.*
Maireana carnosa
Salsola kali
Sclerolaena spp.

* desirable indicator species.
** undesirable indicator species.

6. Condition statements

6.1 Good to excellent condition

In this condition the pastures contain a wide range of perennial shrubs of high forage value. Desirables such as Wilcox bush (a highly palatable form), ruby saltbush and felty leaf bluebush occur in relatively high densities and are indicators of good pasture condition. In southern areas on the Toolonga and Tarcumba land systems, tall cassia, ragged leaf scaevola, tall saltbush, corky-bark kallstroemia *Tribulus platypterus* and warty leaf poverty bush *Eremophila latrobei* can be included as additional indicators of good pasture condition.

The hardy perennial cotton bush is normally present, but is not a sensitive indicator as it usually remains common even when pastures are in fair or poor condition.

Species growing as undesirables on other pasture types are often present, but only at low densities. They include bardie bush, grey cassia, waxy leaf poverty bush *Eremophila crenulata*, silver poverty bush *E. pterocarpa*, needle bush *Hakea preissii* and tomato bush *Solanum orbiculatum*.

This pasture type is not prone to erosion.

6.2 Fair condition

In fair condition the majority of the desirable low shrubs, including all the indicators previously mentioned, will still be present but at reduced densities. Less palatable species such as cotton bush and flannel bush increase their proportion of the stand and sometimes become dominant.

In some situations undesirable species such as bardie bush and tomato bush may increase, but in general, declining condition is not accompanied by major increases of undesirable species.

There is no erosion.

6.3 Poor to very poor condition

The range of species and their densities are markedly reduced from those levels found in good or fair condition. The range of low shrubs is frequently reduced to 50% or less and PFC generally declines to about 10-15%. Desirable indicator species are absent or only very sparsely distributed and frequently show detrimentally high levels of use or poor vigour.

Poor pasture condition is frequently encountered near heavily used watering points and is often made conspicuous by the occurrence of moderately thick stands of tomato bush. Otherwise, poor condition is simply indicated by a loss of desirables and a lower overall PFC rather than by marked increases in the densities of undesirables. Unpalatable species such as grey cassia, crinkle leaf cassia and tomato bush predominate in the low shrub stand.

Even when in poor to very poor condition the soil surfaces rarely become eroded. Pastoral value is decreased to a moderate to low level but the moderately palatable species cotton bush, tall saltbush, and flannel bush still provide some forage.

7. Management

Condition of these pastures is variable, some extensive parts show considerable depletion of desirable shrubs, elsewhere condition is good. There is no significant erosion. The pasture type is valuable, drought tolerant and potentially capable of carrying quite high numbers of stock, given that responsive management practises are used.

In good to excellent or fair condition, pastures may be grazed on a year-long basis although regular grazing deferral may prove more effective. Attention should be paid to the level of grazing on the desirable perennial indicators i.e. if they are becoming sparse or severely eaten back to the woody material a reduction in stocking rate is indicated.

Pastures in poor to very poor condition should be spelled after major rains to allow for recovery of the remaining desirable shrubs and seedling establishment. Ideally spelling should be over the full length of the growing season for maximum benefit.

Since control of stocking rates and period of use are the necessary management practises, adequate fencing and watering points are essential.

Recommended levels of use (per annum):

Good to excellent condition	- 5 ha/s.u.
Fair condition	- 10 ha/s.u.
Poor to very poor condition	- 16 ha/s.u.

Stony Chenopod pasture type (STCH)

1. Area 3,000 km² (4.0%)

2. Distribution and soil types

Stony Chenopod (STCH) pastures occur on tributary plain land systems and more elevated plains systems where they occupy the more saline portions of footslopes, stony plains, alluvial plains and stony interfluves in the north-east of the survey area. They grow widely on the Jimba and Durlacher land systems and form small areas on several other land systems including Mantle, O'Brien, Phillips, Sandiman, Winning and Yinnietharra.

Stony Chenopod pastures frequently grow in a mosaic with Acacia Short Grass Forb (ASGF) and Stony Short Grass Forb (SSGF) pastures on many land systems; the latter pastures occupying less saline areas or land units. Associations of the broad Stony Chenopod type are also found alongside Bluebush (BLUE), Saltbush (SALT) and Acacia Creek-line (ACCR) pastures.

Red, texture-contrast soils predominate and their sandy or loamy topsoils are usually non hard-setting. Sola are <1 m deep except on Jimba land system where they are usually full depth (>1 m) with deep clayey B horizons grading into weathering sedimentary rock. Moderate to heavy surface mantles (10- > 50% cover) of quartz or mixed rock fragments to 75 mm in diameter are nearly always present. Soil reaction trends are neutral to alkaline and inclusions of quartz within the solum are common.

3. Physiognomy and composition

This pasture type occurs most commonly as a very scattered tall (> 2 m) or low (< 2 m) shrubland with projected foliar cover (PFC) of 5-10%. Occasionally PFC may reach 20%, however, cover levels are strongly influenced by the position of the site within the landscape as this influences water relationships and soil depth.

The upper stratum is generally sparse. Wait-a-while *Acacia cuspidifolia* is usually the only tree and is rarely present at densities higher than 200/ha. Tall shrubs usually form the upper stratum and are more abundant than trees. Snakewood *A. xiphophylla* and bardie bush *A.victoriae* occur widely and other acacias such as *A. cuthbertsonii*; spreading gidgee *A.subtessarogona*, and curara *A. tetragonophylla* are occasionally present. Total tall shrub densities vary from 25-275/ha.

The ground storey supports a diverse range of perennial shrubs, many of which are halophytic. They include three-winged bluebush *Maireana triptera*, grey cassia *Cassia desolata*, ruby saltbush *Enchylaena tomentosa*, royal poverty bush *Eremophila cuneifolia*, Gascoyne bluebush *Maireana polypterygia*, Gascoyne mulla mulla *Ptilotus polakii*, tall saltbush *Rhagodia eremaea* and currant bush *Scaevola spinescens*.

Total low shrub densities are commonly in the vicinity of 2500/ha with the shrubs often in patches and clumps. Low shrubs are frequently concentrated underneath the occasional trees and large shrubs and are relatively sparse in the stony intervening areas.

The only common perennial grass is curly windmill grass *Enteropogon acicularis;* but it is very sparse (basal cover up to 0.1%) and contributes little to the total forage resource.

4. Pastoral value

These pastures are of moderate pastoral value. The amount of available forage is low when compared to highly productive pasture types such as Saltbush and Bluebush. However, after good rains, pastoral value is temporarily increased by the flush of growth from annual species.

As noted above Stony Chenopod pastures are usually found in association with Stony Short Grass Forb and Acacia Short Grass Forb pastures. Together these pasture types cover extensive areas and can cover whole paddocks. Stony Chenopod pastures support more useful shrubs, are more productive than the other two pasture types and are preferentially grazed. They are widely degraded and pastoral value is often well below potential. In other locations, where stock water has not been provided, they are under used.

5. Common perennial species

Trees:

*Acacia cuspidifolia***

Tall shrubs

Acacia aneura
Acacia cuthbertsonii
Acacia subtessarogona
Acacia tetragonophylla
*Acacia victoriae***
Acacia xiphophylla
Heterodendrum oleaefolium

Low shrubs:

Acacia xiphophylla
*Cassia desolata***
*Cassia hamersleyensis**
Cassia helmsii
Cassia luerssenii
*Enchylaena tomentosa**
Eremophila cuneifolia
*Eremophila latrobei**
*Maireana planifolia**
*Maireana polypterygia**
*Maireana tomentosa**
Maireana triptera
*Ptilotus polakii**
*Rhagodia eremaea**
*Scaevola spinescens**

Perennial Grasses:

Enteropogon acicularis
Eragrostis xerophila

Annuals, biennials and herbs:

Aristida contorta
Atriplex inflata
Atriplex semilunaris
Dissocarpus paradoxus
Lawrencia sp.
Ptilotus exaltatus
Salsola kali
Sclerolaena sp.

* desirable indicator species
** undesirable indicator species

6. Condition statements

6.1 Good to excellent condition

The presence of a number of desirable low shrubs concentrated around the bases of larger shrubs and trees, such as snakewood and wait-a-while and persisting elsewhere is indicative of good condition. The low shrubs ruby saltbush, warty leaf poverty bush, Gascoyne bluebush and tall saltbush are common desirable indicator species. Others of a more local distribution include flat leaf bluebush *Maireana planifolia*, felty leaf bluebush *M. tomentosa* and currant bush.

Bardie bush and wait-a-while are often present at very low densities. They are both potential increaser species and are classed as undesirable.

Although the soils are mainly duplex varieties which are elsewhere inherently erodible, the degree of protection afforded by the heavy stony mantles (a feature of this pasture type) is usually sufficient to prevent erosion.

6.2 Fair condition

Fair condition sites show an obvious loss of desirable species. Desirable species may only be occasionally present on open areas, but are still reasonably common under the larger shrubs. Sensitive indicators such as ruby saltbush and warty leaf poverty bush occur only as old, heavily used, individuals. On some sites, less palatable species such as three-winged bluebush and royal poverty bush may increase their dominance in the stand.

The undesirables bardie bush, wait-a-while and grey cassia may occur more frequently as seedlings and young age class plants and marginally increase their contribution to the overall plant stand.

There is invariably no accelerated soil erosion.

6.3 Poor to very poor condition

The trend of declining cover and density of desirable low shrubs is continued with a change from fair to poor condition. Desirable indicators are often absent or may exist only as moribund relics. The less palatable browse species such as three-winged bluebush *Maireana triptera* may show use and reduced densities. The undesirables grey cassia and bardie bush often continue to increase their proportion of the stand but only rarely become moderately dense.

In general, the total PFC remains fairly constant with a decline to poor condition. The removal of desirables may not drastically reduce foliar cover as many grow beneath the crowns of taller shrubs which have remained intact. Minor increases in the density and size of undesirables will also have a compensating effect.

There is no erosion.

7. 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 productive and 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.

Recommended levels of use (per annum):

Good to excellent condition	- 12 ha/s.u.
Fair condition	- 20 ha/s.u.
Poor to very poor condition	- 30 ha/s.u.

Stony Short Grass Forb pasture type (SSGF)

1. Area 2,300 km² (3.1%)

2. Distribution and soil types

Stony Short Grass Forb (SSGF) pastures occur on the more elevated and hilly land systems in the north to north-eastern parts of the survey area. They occur on the summits, plateaux and upper stony plain units of the landscape, but account for only a small proportion of the total survey area. The largest areas in which these pastures predominate are the Agamemnon and Phillips land systems. Smaller but significant areas are found on Billy, Channel, James, Thomas, Two Hills and Mantle land systems. Minor areas are found on several others including Collier and Glenburg land systems.

Stony Short Grass Forb pastures are invariably associated with Stony Chenopod (STCH), Acacia Short Grass Forb (ASGF) or Acacia Creek-line (ACCR) pastures.

The soils are usually shallow (< 50 cm) red lithosols with sandy or loamy textures throughout their profiles. Soil reaction trend is slightly acid to neutral and inclusions of parent material are common within the solum. Surface mantles are a feature of this pasture type and fragments of quartz, mixed or gneissic material often provide a heavy cover (> 50%). Uniformly fine-textured and texture-contrast soils also occur but are of much less significance.

3. Physiognomy and composition

Stony Short Grass Forb pastures occur mostly as very scattered or scattered low (< 2 m) shrublands with projected foliar cover (PFC) ranging from 2-15%. As such, upper strata are very sparse, if not absent. Trees occur rarely and sparse tall shrubs include several Acacia spp. such as mulga *Acacia aneura*, *A. cuthbertsonii* and curara *A. tetragonophylla*. Low shrubs form the dominant layer, although they are relatively sparse and contain fewer desirable species when compared with the similar, and often adjacent, Acacia Short Grass Forb pastures. Common low shrubs include grey cassia *Cassia desolata*, crinkle leaf cassia *C. helmsii*, royal poverty bush *Eremophila cuneifolia*, cotton bush *Ptilotus obovatus* and flannel bush *Solanum lasiophyllum*.

Pastures also occur as tall (> 2 m) scattered (PFC 10-20%) shrublands in restricted areas where mulga and curara are often the dominant tall shrubs. Apart from the dominance of tall shrubs, other features of the vegetation are the same as in the low shrubland situation, since site potential is similarly very low.

Perennial grasses are generally absent and do not form an important component on this pasture type. However, those which sometimes occur with very low basal cover are: buffel grass *Cenchrus ciliarus*, curly windmill grass *Enteropogon acicularis* and buck wanderrie grass *Eriachne helmsii*.

After good seasonal rains annual species provide considerable cover and become a very important consideration when planning management strategies. Wind grass *Aristida contorta* is by far the most common and important species in this respect, but others include tall mulla mulla *Ptilotus exaltatus* and roly-poly *Salsola kali*.

4. Pastoral value

Rugged terrain and lack of water have rendered some parts of these pastures inaccessible to stock. However, most parts are accessible, but overall potential and pastoral value is very low.

Poor water relations (high run-off) and shallow soils have limited the establishment of the perennial vegetation. Palatable perennials are scarce and drought durability of the pastures is low. As a consequence, pastures are barely suitable for carrying stock on a year-long basis unless other, more productive pastures, (such as Stony Chenopod) form a reasonable proportion of the paddock in question.

Pastoral value is increased however, by the flush of annual species after good seasonal rains. During such times pastures are capable of carrying many more stock for the short period that green feed is abundant.

5. Common perennial species

Trees:

Acacia aneura
*Acacia cuspidifolia***

Tall shrubs:

Acacia aneura
Acacia cuthbertsonii
Acacia sclerosperma
Acacia tetragonophylla
*Acacia victoriae***
*Hakea preissii***

Low shrubs:

Acacia cuthbertsonii
Acacia tetragonophylla
*Acacia victoriae***
Cassia desolata
Cassia helmsii
Cassia luerssenii
*Enchylaena tomentosa**
Eremophila cuneifolia
Eremophila fraseri
Eremophila freelingii
*Eremophila latrobei**
Eremophila macmillaniana
*Pilotus obovatus**
*Rhagodia eremaea**
*Scaevola spinescens**
Sida physocalyx
Solanum lasiophyllum

Perennial grasses:

Cenchrus ciliaris
Enteropogon acicularis
Eriachne helmsii

Annuals, biennials and herbs:

Aristida contorta
Atriplex semilunaris
Ptilotus exaltatus
Salsola kali
Solanum sp.

* desirable indicator species
** undesirable indicator species

6. Condition statements

6.1 Good to excellent condition

In good condition total low shrub densities are commonly around 1500/ha but may vary between 600 and 4000/ha according to site potential. Species of marginal palatability usually predominate in the stand with grey cassia, crinkle leaf cassia, royal poverty bush and flannel bush occuring widely, often at densities of about 400 plants/ha. Similar species of a more local importance include *Cassia luerssenii*

and silver cassia *C.pruinosa* and these species may occur at densities up to 400 and 900/ha, respectively. Bardie bush *Acacia victoriae*, wait-a-while *A.cuspidifolia* and needle bush *Hakea preissii* may occur at densities below 50 plants/ha.

As with most pasture types, the density and vigour of palatable perennial shrubs indicates condition status. Such species are generally sparsely distributed on this pasture type. Cotton bush is the major species in this category, however, warty leaf poverty bush *Eremophila latrobei*, ruby saltbush *Enchylaena tomentosa*, George's bluebush *Maireana georgei*, tall saltbush *Rhagodia eremaea* and currant bush *Scaevola spinescens* are all important locally. The presence of any of these species as healthy robust individuals, reflects good condition.

As a heavy stony mantle is usually present this affords a high degree of protection to the underlying soil and erosion is uncommon.

6.2 Fair condition

In fair condition various cassias and poverty bushes have an obvious dominance within the stand, although this is also the case in many good condition stands. The major distinction from good condition sites is an over use of any desirable species to such an extent that their densities have been reduced, or they exist only as overgrazed and moribund individuals. There is no erosion.

6.3 Poor to very poor conditions

In poor condition even the marginally palatable species show marked use by stock and also a decline in density. Desirable species are absent or exist only as occasional relic individuals. Pastures are characterized by bare stony ground with only a few individual shrubs remaining.

Erosion is usually absent but moderate water erosion in the form of rilling or gullying may occur on sites with little or no surface mantle.

7. Management

Stony Short Grass Forb pastures offer sparse grazing at very low stocking rates. In areas where sufficient water is available to ensure even grazing pressure, stock can be run on a year-long basis at the recommended rates. In most areas this is not the case and additional supplies are desirable.

It is generally recommended that a given 'pasture type' should be fenced separately from other pastures to aid in management and, if possible, this pasture type is no exception. However, on several of the land systems on which Stony Short Grass Forb pastures occur, small inclusions of Acacia Creek-line (occuring on drainage tracts or groves) or larger inclusions of Stony chenopod pastures make separate fencing impractical. These latter pastures support a more useful range of shrubs and are favoured by stock. It is the density and vigour of desirable species within these more productive pastures which should be monitored for condition changes.

Opportunistic use should be made of Stony Short Grass Forb pastures in good seasons when there will be an abundance of windgrass and other annuals. During these times stocking rates can be increased markedly and better quality pastures may be spelled during the period when rejuvenation of shrubs will be at a maximum.

Recommended levels of use (per annum)

Good to excellent condition	- 25 ha/s.u.
Fair condition	- 30 ha/s.u.
Poor to very poor condition	- 50 ha/s.u.

Coastal Dune Shrub pasture type (CDSH)

1. Area 1,900 km² (2.6%)

2. Distribution and soil types

Coastal Dune Shrub (CDSH) pastures are restricted to two coastal areas within the survey area, the first being north of the Gascoyne River along the entire coastal strip to Ningaloo station and the second on the peninsulas and islands of Shark Bay. They occur on six different land systems, in all cases on dunes, swales or sand sheet units.

Coastal Dune Shrub pastures occur on the Coast, Edel, Lyell, Coquina, Littoral and Taillefer land systems. They are the only pasture type of the Coast land system and the predominant pasture type on the Edel system where they occur in association with Heath (HEAT) pastures; together these two systems account for over 90% of this pasture's total area. On the Lyell, Coquina and Littoral systems associations intergrade with Saltbush (SALT) pastures, unvegetated beach-shell ridges, Samphire (SAMP) pastures and bare mud flats, respectively. Coastal Dune Shrub pastures occur as minor inclusions within Hard Spinifex (HASP) pastures on the Taillefer land system.

The soils are characteristically full depth (> 1 m) yellow to reddish-brown calcareous sands. Limestone, lime concretions and shell grit (on the Littoral land system) are common inclusions within profiles. Surface mantles of calcrete and limestone are common, especially on stony rises of the Edel land system where the diameter of surface material may be > 60 cm and may provide a cover of up to 50%. Areas of shallow soils (< 1 m) occur on the Edel land system and parts of the Coast system, where the underlying limestone is close to the surface.

3. Physiognomy and composition

Coastal Dune Shrub pastures occur mostly as low (< 2 m) shrublands with extremely variable projected foliar cover (PFC). PFC varies from 2- > 50% depending on fire history, range condition, site situation and the amount of surface mantle.

Toward the southern extremities of Shark Bay the vegetation of the Coast land system may occur with an exceptionally high PFC (> 50%). This is mainly due to the transitional nature of the vegetation in this area where an increase is noticeable in the numbers of heath species, typical of the South-Western Botanical Province (Beard 1976), such as star flower *Calytrix* spp., *Scholtzia* spp. and *Thryptomene baeckeacea*.

On the Coquina, Edel and Lyell land systems tall shrubs sometimes become more dominant and pastures take the form of tall shrublands (> 2 m). However, tall shrubs are usually sparsely distributed and species seldom occur at densities over 100/ha. Those that do include *Acacia bivenosa*, coastal jam *A.coriacea*, *A.ligulata*, *A. rostellifera*, sandplain poverty bush *Eremophila maitlandii*, minga bush *Heterodendrum oleaefolium*, and desert willow *Pittosporum phylliraeoides*. Total tall shrub densities rarely exceed 200 shrubs/ha.

The lower stratum is dominated by low shrubs with over 30 species recorded. These include star flower (occuring at up to 9000/ha), frankenia *Frankenia* spp. (up to 450/ha); flat leaf bluebush *Maireana planifolia*, cotton bush *Ptilotus obovatus*, tall saltbush *Rhagodia eremaea*, *R. latifolia*, *R.preissii*, currant bush *Scaevola spinescens* and *Threlkeldia diffusa*. Species occurring at relatively high densities and of local importance are *Pimelea* spp. (up to 5500/ha), *Dipteracanthus corynothecus* (up to 5000/ha), *Zygophyllum* spp. (up to 3000/ha) and *Diplolaena grandiflora* (up to 2500/ha). Total low shrub densities exceed 10,000 shrubs/ha in favourable situations but are more commonly in the vicinity of 5000/ha.

Perennial grasses are generally sparsely distributed within the ground storey and offer little cover. They include *Aristida browniana*, buffel grass *Cenchrus ciliaris*, *Danthonia caespitosa*, feather spear grass *Stipa elegantissima*, *Paspalidium tabulatum* and coastal spinifex *Spinifex longifolius*; the latter is restricted to beaches and foredunes.

In areas where severe wind erosion has occurred the composition of these pastures has changed markedly. On isolated areas of the Coast land system blowouts and other deflation processes have stripped several metres of soil exposing the underlying limestone pavement. On the actively eroding parts of these blowouts, barchanoid dunes and other mobile sand accretions are prominent, gradually changing to areas of residual hummocks and stripped surfaces with limestone gravels and stones on the deflated areas toward the prevailing wind. In the latter areas some stabilization is occurring and common pioneer species include *Acacia bivenosa*, *A. ligulata*, *Frankenia pauciflora*, *Scaevola crassifolia*, *Trichodesma zeylanicum* and *Swainsona pterostylis*.

4. Pastoral value

Coastal Dune Shrub pastures support many palatable perennial species and in good seasons feed is augmented by an abundance of annual species of high forage value. Pastures are drought resistant and suitable for carrying stock on a year-long basis, provided stocking rates are conservative and the siting of fences and watering points does not tend to concentrate stock on dunes or coastal sites. Overall pastoral value is high.

Generally pasture condition is fair or good and most erosion is on the Coast land system. On western parts of this system localized pasture degradation as a result of fire, overgrazing around watering points or along east-west fencelines and possibly other disturbances, coupled with strong prevailing southerly winds, have resulted in massive blowouts.

5. Common perennial species

Tall shrubs:

Acacia bivenosa
Acacia coriacea
Acacia ligulata
Acacia ramulosa
Acacia rostellifera
Acacia sclerosperma
Acacia tetragonophylla
Acacia xanthina
Acacia xiphophylla
Eremophila maitlandii
Stylobasium spathulatum

Low Shrubs:

Acacia ligulata
Acacia tetragonophylla
Acanthocarpus preissii
Angianthus cunninghamii
*Atriplex bunburyana**
Calytrix sp.
Cassia helmsii
Diplolaena grandiflora
*Dipteracanthus corynothecus**
Dodonaea inaequifolia
*Enchylaena tomentosa**
*Eremophila leucophylla**
Exocarpos aphyllus
Exocarpos sparteus
Frankenia sp.
Hetrodendrum oleaefolum
*Maireana planifolia**
Pimelea microcephala
Pityrodia sp.
*Ptilotus divaricatus**
Ptilotus obovatus
Rhagodia eremaea
*Rhagodia latifolia**
*Rhagodia preissii**
Scaevola crassifolia
*Scaevola spinescens**
*Scaevola tomentosa**
Scholtzia sp.
Solanum lasiophyllum
Solanum orbiculatum
Stylobasium spathulatum
Swainsona pterostylis
Threlkeldia diffusa
Thryptomene baeckeacea
Tetragonia sp.
Zygophyllum sp.

Perennial grasses:

Cenchrus ciliaris
Danthonia caespitosa
Eulalia fulva
Paspalidium tabulatum
Spinifex longifolius
Sporobolus mitchellii
Stipa aff *crinata*
*Stipa elegantissima**
Triodia sp.

Annuals, biennials and herbs:

Avena aff *barbata*
Brassica tournefortii
Bromus diandrus
Euphorbia drummondii
Medicago polymorpha
Salsola kali
Zygophyllum sp.

* desirable indicator species.
** undesirable indicator species.

6. Condition statements

6.1 Good to excellent condition

Pastures in good condition may support a broad range of desirable perennial low shrubs, often occurring at relatively high densities. The most abundant are flat leaf bluebush, *Rhagodia preissii* and currant bush. Of local importance are silver saltbush *Atriplex bunburyana*, ruby saltbush *Enchylaena tomentosa*, minga bush, *Rhagodia latifolia*, *Dipteracanthus corynothecus*, and ragged leaf scaevola *Scaevola tomentosa*. All of these species are palatable and sought after by stock, and when present as vigorous individuals indicate good pasture condition. Other useful but perhaps less palatable species such as cotton bush and tall saltbush often form significant stands of between 200 and 2000 plants/ha.

In good condition total low shrub densities range from 3000-12000/ha but are commonly in the vicinity of 6000/ha. PFC varies, mostly between 25-30%. No erosion is present.

6.2 Fair condition

A decline to fair condition is accompanied by a decrease in total low shrub densities, a decline in PFC, in some cases a reduction in species diversity and, less commonly, soil erosion.

The density of those desirable indicators mentioned in section 6.1 will have decreased. The most attractive species such as silver saltbush and ruby saltbush may exist as only a few heavily grazed individuals.

The moderately palatable cotton bush and tall saltbush will still be present and their proportion of the stand may have increased marginally.

6.3 Poor to very poor condition

On poor condition sites vegetation cover is extremely sparse and active wind erosion is common. In some situations erosion has been stabilized by pioneer species as is the case at the windward end of blowouts on the Coast land system (as described in section 3) however, these pioneer species are of very limited use to stock and, indeed, should not be grazed.

Only few indicator species remain (if any at all) and these frequently show poor vigour due to both overgrazing and, on the Coast land system, from sandblasting. Moderately palatable species share a similar fate and in extreme cases are removed from the stand.

Moderate to severe wind erosion causing soil deflation is common. In the most spectacular situations wind erosion has caused massive blowouts where mobile hairpin parabolic dunes proceed north with the prevailing wind, removing several metres of sand soil and exposing the underlying Tamala limestone.

Annual pastures have stabilized severely degraded poor condition sites on the Edel land system. Such sites are characterized by very scattered low shrubs of which the undesirable tomato bush *Solanum orbiculatum* usually predominates. The ground surface supports a dense cover of annual species protecting the soil from further erosion. These species include various medics *Medicago* spp., brome grass *Bromus diandrus* and wild oat *Avena* spp. These pastures are evidently stable and are examined further in the description of the Exotic Annual (EXAN) pasture type.

7. Management

Coastal Dune Shrub pasture are sensitive to grazing or other vegetation disturbance (such as by trampling, fire or excessive vehicular access) and wind erosion can become a severe problem. Constant monitoring of the density and vigour of plant cover and of soil surface condition is necessary to ensure stability and stocking rates should be adjusted accordingly. Areas close to elevated, exposed coastlines are particularly vulnerable to wind erosion.

Because of high inherent susceptibility to wind erosion Coastal Dune Shrub pastures on parts of the Coast land system should not be grazed. Elsewhere and on other systems where the erosion hazard is much less the pastures can be safely grazed. Some areas are little used for grazing or not used due to the lack of permanent water supplies. For their optimal use the provision of additional supplies from new bores or by piping away from degraded watering points or the development of surface storages are options which should be considered.

Stocking rates can probably be increased in good seasons to take advantage of the resulting flush of annual species. However, this should only be a temporary procedure and when annual feed is again sparse a reduction or deferral of use should follow, ensuring the maintenance of perennial drought reserves.

Recommended levels of use (per annum):

Good to excellent condition	8 ha/s.u.
Fair condition	- 14 ha/s.u.
Poor to very poor condition	- 25 ha/s.u.

Acacia and Eucalyptus Grass Forb pasture type (AEGF)

1. Area 1,900 km² (2.6%)

2. Distribution and soil types

Acacia and Eucalyptus Short Grass Forb (AEGF) pastures are restricted to the very southern portions of the survey area. They are found only on the Nerren and Cooloomia land systems which together form considerable proportions of pastoral leases in the south of the survey area. These pastures are always associated with the continuous sand sheets of these flat or gently undulating land systems. Their botanical composition is similar to Acacia Sandplain (ACSA) pastures but with increased heath elements of the South-Western Botanical province (Beard 1976).

On Nerren land system this pasture type accounts for nearly all pastures present with only very minor areas of Hard Spinifex (HASP) pastures, in its north-west reaches, on Hamelin station. Acacia and Eucalyptus Short Grass Forb pastures occupy about 90% of the Cooloomia land system with Acacia Mixed Shrub (ACMS) pastures making up the balance on the low calcrete rises of the system.

Soils are invariably deep sands. In most cases they are non-calcareous, non-coherent to slightly coherent with no surface mantle. Soil reaction trend is typically acid or neutral. There are local occurrences of alkaline calcareous sands.

3. Physiognomy and composition

These pastures usually form tall, moderately close shrublands with total projected foliar cover (PFC) of 20-25%. They are characterized by a prominent and frequently clumped mallee shrub or tree stratum up to 10 m tall. Several species of eucalypts occur in this upper stratum. Narrow leaf red mallee *Eucalyptus foecunda* is the most widespread and often occurs at densities of about 100 plants/ha. Other tree or mallee species include *E. mannensis*, mallalie *E.eudesmioides*, variable barked bloodwood *E. dichromophloia*, sandalwood *Santalum spicatum*, Australian blackthorn *Bursaria spinosa*, kurrajong *Brachychiton gregorii* and native pine *Callitris columellaris*. Total tree densities rarely exceed 200 plants/ha.

Tall shrubs other than mallees dominate the stand with total densities of up to 1400 plants/ha. False paperbark *Lamarchea hakeifolia* and wanyu *Acacia ramulosa* are the most common and widespread species. Other common tall shrubs are curara *Acacia tetragonophylla*, needle myall *A. roycei*, silver bark wattle *A. sclerosperma*, sandplain poverty bush *Eremophila maitlandii*, Oldfield's poverty bush *E. oldfieldii*, pebble bush *Stylobasium spathulatum* and minga bush *Heterodendrum oleaefolium*.

The lower strata are dominated by low shrubs and perennial herbs. Cotton bush *Ptilotus obovatus* and ruby saltbush *Enchyaena tomentosa* are the most common and widespread. Cotton bush populations of at least 2,000/ha occur locally. Other major species are tall saltbush *Rhagodia eremaea*, wanyu, sandplain poverty bush and flat leaf bluebush *Maireana planifolia*. Many different species are of local importance and are sometimes found at relatively high densities. Included in these are curara, earlobe saltbush *Chenopodium gaudichaudianum*, native lily *Dianella revoluta*, pebble bush, *Calytrix longiflora*, sheoak *Casuarina*

sp., *Grevillea* spp. and *Thryptomene baeckeacea*. Low shrub densities are usually in the vicinity of 3,000 plants/ha, but range from 600 to at least 7,000/ha.

Perennial grasses are often present within the ground storey but only as a very sparse cover. Broad leaf wanderrie *Monochather paradoxa*, creeping wanderrie *Eragrostis lanipes* and feather spear grass *Stipa elegantissima* occur with basal covers up to 0.1%. In good winter seasons there are numerous palatable annual grasses and forbs.

At the southern extremities of the survey area the vegetation is probably more typical of the Eurardy vegetation system (Beard 1976). The more frequent occurrence of species of *Grevillea, Lamarchea* and *Thryptomene* indicates the stronger influence of the nearby South-West Botanical Province.

4. Pastoral value

As a whole pastoral value is moderate. When in good condition, most areas provide reasonable densities of palatable perennial species for moderate drought reserves. Limited availability of stock watering points has resulted in local over-use and under-use of these pastures elsewhere. With sufficient waters and conservative stocking rates, pastures are capable of carrying stock on a year-long basis.

Tall shrubs and trees provide useful shelter and shade and breeding stock may be carried on these pastures in good seasons when pastoral value is greatly increased by the flush of highly palatable annual species.

Very infrequent fires have influenced the vegetation composition in some areas, but there are insufficient data on the pattern of pyric succession within these pastures to judge whether or not fire may affect pastoral value to a significant extent.

5. Common perennial species

Trees:

Brachychiton gregorii
Brachychiton sp.
Bursaria spinosa
Callitris columellaris
Eucalyptus dichromophloia
Eucalyptus eudesmioides
Eucalyptus foecunda
Eucalyptus mannensis
Eucalyptus obtusiflora
Eucalyptus oldfieldii
Eucalyptus oleosa
Heterodendrum oleaefolium
Santalum spicatum

Tall shrubs:

Acacia ramulosa
Acacia roycei
Acacia sclerosperma
Acacia tetragonophylla
Cassia nemophila
Dodonaea pachyneura
*Eremophila maitlandii**
Eremophila oldfieldii
Hakea stenophylla
Heterodendrum oleaefolium
Lamarchea hakeifolia
Melaleuca aff *cardiophylla*
Stylobasium spathulatum

Low shrubs:

Acacia ramulosa
Acacia sp.
Acacia tetragonophylla
Calytrix longiflora
*Cassia chatelainiana**
*Chenopodium gaudichaudianum**
Dianella revoluta
Ecdeiocolea monostachya
*Enchylaena tomentosa**
*Eremophila maitlandii**
*Maireana planifolia**
Pimelea microcephala
*Ptilotus obovatus**
*Ptilotus schwartzii**
*Rhagodia eremaea**
Stylobasium spathulatum
Thryptomene baeckeacea

Perennial grasses:

*Eragrostis lanipes**
*Monachather paradoxa**
*Stipa elegantissima**

Annuals, biennials and herbs:

Aristida contorta
Brassica sp.
Brassica tournefortii
Helipterum sp.
Ptilotus sp.
Salsola kali
Solanum sp.
Zygophyllum sp.

* desirable indicator species.
** undesirable indicator species.

6. Condition statements

6.1 Good to excellent condition

The presence of palatable species in the low shrub layer of this pasture is the best indicator of good range condition. Of these, cotton bush and ruby saltbush commonly occur at densities of about 900 and 300 plants/ha respectively. Indicators of more local importance are earlobe saltbush (up to 1,750/ha), flat leaf bluebush (up to 1,000/ha) and sandplain poverty bush (up to 400/ha). The presence of desirable perennial grasses appears to be too unreliable for general use as an indicator of range condition within the low shrub layer. It is important, when monitoring the density and vigour of desirables, to realize that the lack of some of the above indicators to one particular area need not infer a declining condition.

Undesirable species are few. Pebble bush, *Stylobasium spathulatum* may be the most common increaser.

There is no run-off as water infiltration rates are high on the sandy soils associated with these pastures and this, coupled with the high degree of protection from wind afforded by the generally dense vegetation, minimizes erosion risks.

6.2 Fair condition

Fair condition is characterized by an obvious loss of desirables such as cotton bush and ruby salt bush. Their distribution is very patchy and densities rarely exceed 100 plants/ha. Other desirable indicator species such as earlobe saltbush and flat leaf bluebush occur only occasionally.

No erosion is present.

6.3 Poor to very poor condition

In poor to very poor condition desirable indicator species are absent. Only a very sparse scattering of unpalatable plants such as sandplain sedge *Ecdeiocolea monostachya*, native lily *Dianella revoluta* and a few myrtaceous and proteaceous shrubs remain in the lower stratum. In good seasons a wide range of valuable annual species temporarily abound.

Total PFC varies little with decline to poor condition. This is because the stable upper stratum provides the most significant cover rather than those species which have disappeared from the understorey.

There is no erosion.

7. Management

These pastures occur fairly uniformly over extensive areas, simplifying management. Pastures are predominantly in good condition and dry stock may be run at the recommended stocking rates on a year-long basis or used mainly in good seasons to take advantage of the resulting flush of annual species. When annual feed becomes sparse stocking rates should be readjusted to ensure perennial drought reserves are not over-used.

As mentioned in section 4, large areas of these pastures are poorly watered. It would be advantageous for additional, optimally situated, supply points to be installed to disperse stock and create a more even grazing pressure on these pastures.

Recommended levels of use (per annum)

Good to excellent condition	- 14 ha/s.u.
Fair condition	- 18 ha/s.u.
Poor to very poor condition	- 25 ha/s.u.

Acacia Creek-line pasture type (ACCR)

1. Area 1,800 km² (2.4%)

2. Distribution and soil types

Although Acacia Creek-line (ACCR) pastures only occupy a small portion of the survey area they are common on many land systems. They occur as narrow riverine or fringing communities on the levees and banks of major rivers and creeks and on narrow drainage floors receiving channelled through flow or concentrated sheet flow. They also occur on internal drainage foci and as groves on plains receiving sheet flow. Drainage foci and groves occur throughout the survey area, but are relatively small in size, rarely exceeding 200 m in diameter or length.

Land systems where Acacia Creek-line pastures are a major component of the total pasture on offer are River, Wash, O'Brien, Ella and Target.

The association of Acacia Creek-line pastures with concentrated drainage suggests that natural erosional or depositional alluvial processes are active in the majority of situations, hence soils are extremely variable. Full depth (> 1 m) red, reddish-brown or reddish-grey clayey soils of duplex, gradational and uniform-fine textured profiles occur and most exhibit neutral soil reaction trends. Pockets and bedloads of fine river gravels also occur on the major drainage tracts as do juvenile soils in recently depositional sites; these become less clayey with depth. Surface mantles are uncommon and inclusions of quartz or radiolarite are only occasionally present within the solum.

3. Physiognomy and composition

These pastures are characterized by tall (4-8 m) moderately close to close shrublands of *Acacia* spp. or as close woodlands. Projected foliar cover (PFC) is usually between 30 and 50% but may range from 15- > 50%.

Within the tree stratum mulga *Acacia aneura*, black mulga *A.citrinoviridis* and spreading gidgee *A. subtessarogona* are often present with corkwood *Hakea suberea* and *Santalum lanceolatum* occurring occasionally. Total tree densities range from about 25 to 900/ha.

A reasonable diversity of tall shrubs occur and the most widespread are silver bark wattle *A. sclerosperma*, curara *A. tetragonophylla*, bardie bush *A.victoriae* and currant bush *Scaevola spinescens*. Tall shrubs of more local importance are tall cassia *Cassia chatelainiana*, crinkle leaf cassia *C.helmsii*, minga bush *Heterodendrum olaeafolium*, tall saltbush *Rhagodia eremaea* and pebble bush *Stylobasium spathulatum*. Tall shrub densities range from 150 > 1100/ha.

The lower strata are dominated by a broad range of low shrubs and in many situations, perennial grasses. The shrubs tall cassia, grey cassia *Cassia desolata*, royal poverty bush *Eremophila cuneifolia*, Wilcox bush *E.leucophylla*, flat leaf bluebush *Maireana planifolia*, cotton bush *Ptilotus obovatus* and tall saltbush are all very likely to occur. In favourable situations cotton bush and royal poverty bush may reach higher densities (5500 and 1500/ha, respectively). The total density of low shrubs is very variable and may range from 350-6700/ha.

Perennial grasses often form a sparse to moderately dense cover. Species common on favourable sites (with maximum basal cover) were: buffel grass, *Cenchrus ciliaris* (< 3%), swamp wanderrie grass, *Eriachne benthamii* (< 1.5%), silky brown top, *Eulalia fulva* (< 1.0%), Roebourne plains grass, *Eragrostis xerophila* (< 0.5%) and ribbon grass, *Chrysopogon fallax* (<0.4%).

4. Pastoral value

Acacia Creek-line pastures occupy sites in the landscape which are specially favoured with run-on. Soils are usually full depth loamy or clayey types and the sites exhibit a more favourable long-term soil moisture balance than adjacent, run-off areas. Palatable perennial shrubs and grasses can be numerous and productive and provide good drought reserves. Pastoral value is therefore high.

As these pastures commonly occur as minor inclusions within less productive pastures types such as Acacia Short Grass Forb (ASGF) and Stony Short Grass Forb (SSGF), they are often favoured for grazing and, in some areas, have become degraded rendering pastoral value well below its potential.

5. Common perennial species

Trees:

Acacia aneura
Acacia citrinoviridis
Acacia coriacea
Acacia linophylla
Acacia subtessarogona
Eucalyptus coolibah
Hakea suberea
Santalum lanceolatum
Santalum spicatum

Tall Shrubs:

Acacia cuthbertsonii
Acacia kempeana
Acacia sclerosperma
Acacia tetragonophylla
Acacia victoriae
Acacia xiphophylla
*Cassia chatelainiana**
Cassia desolata
Cassia helmsii
Hakea preissii
Heterodendrum oleaefolium
Stylobasium spathulatum
Rhagodia eremaea
*Scaevola spinescens**
Stylobasium spathulatum

Low shrubs:

*Atriplex amnicola**
*Cassia chatelainiana**
Cassia desolata
Cassia helmsii
Cassia oligophylla
*Chenopodium gaudichaudianum**
*Dipteracanthus corynothecus**
*Enchylaena tomentosa**
Eremophila cuneifolia
Eremophila fraserii
*Eremophila latrobei**
*Eremophila leucophylla**
Indigofera sp.
*Maireana planifolia**
Ptilotus obovatus
*Rhagodia eremaea**
Solanum lasiophyllum
Solanum orbiculatum

Perennial grasses:

Cenchrus ciliaris
*Chrysopogon fallax**
*Enteropogon acicularis**
Eragrostis eriopoda
*Eragrostis xerophila**
*Eriachne benthamii**
*Eriachne flaccida**
Eriachne gardneri
*Eulalia fulva**
*Triodia pungens**

Annuals, biennials and herbs:

Aristida contorta
Atriplex semilunaris
Cleome viscosa
Enneapogon sp.
Eriachne aristidea
Ptilotus polystachyus
Salsola kali
Solanum sp.

* desirable indicator species.
** undesirable indicator species.

6. Condition statements

6.1 Good to excellent condition

The composition and cover of the upper strata remain relatively constant, regardless of changes in condition. Under declining conditions there may be deaths of upper storey species in grove situations, but generally it is within the lower strata that condition changes are best exhibited.

A range of palatable low shrubs thriving within a diverse under-story is indicative of good condition. Palatable indicators of widespread importance are tall cassia, Wilcox bush, flat leaf bluebush, tall saltbush and currant bush. Those of a more restricted or localized importance are river saltbush *Atriplex amnicola*, ruby saltbush *Enchylaena tomentosa*, warty leaf poverty bush *Eremophila latrobei*, fuchsia bush *E. maculata* and *Dipteracanthus corynothecus*. The less palatable grey cassia, crinkle leaf cassia and royal poverty bush are widespread but rarely dominate the stand.

Total low shrub numbers are extremely variable even on good condition sites and densities may range from 400-6700/ha, largely dependent upon the position of the site within the landscape. Sites with the most favourable water relations, such as groves, drainage foci and major drainage tracts, support the densest stands. Minor channels and creek-lines which have less favourable water relations tend to have sparser under-stories.

Palatable perennial grasses are usually present and the distribution of individual species is frequently controlled by soil type. Desirable grasses of local importance are buffel grass, ribbon grass, curly windmill grass and crab hole grass *Eriachne flaccida*.

There is generally no accelerated erosion within this pasture type when it is in good condition.

6.2 Fair condition

Fair condition is reflected by a reduced vigour and density of the desirable indicators, detectable increases in some of the less palatable species and sometimes by minor accelerated erosion.

Very sensitive indicators such as ruby saltbush, warty leaf poverty bush and tall cassia may exist only as moribund individuals or may have been removed completely. Perennial grasses persist only in patches and are generally heavily used.

With declining condition grey cassia, crinkle leaf cassia and royal poverty bush often increase their relative proportion in the stand and can become dominant in the lower strata.

The removal of vegetation may have resulted in minor water erosion on sensitive sites such as some drainage floors with through flow and on areas with duplex soils. In general however, little acccelerated erosion is present.

6.3 Poor to very poor condition

With a decline to poor condition the less palatable browse species may show use by stock and a decline in number. Desirable species exist only as occasional relics or are absent and species diversity is often severely reduced. Minor water erosion in the form of more active gullying is occasionally present along major flow lines or as rilling over areas with less intense flow.

7. Management

Acacia Creek-line pastures are very important when considering the management of individual paddocks. Even though they are often only small inclusions within broader and usually less productive pastures, they are preferred by stock and will reflect concentrated grazing pressures. Management should be aimed at maintaining the health and vigour of the desirable indicator species.

Recommended levels of use (per annum):

Good to excellent condition	- 5 ha/s.u.
Fair condition	- 10 ha/s.u.
Poor to very poor condition	- 20 ha/s.u.

Tussock Grass pasture type (TUGR)

1. Area 700 km² (0.9%)

2. Distribution and soil types

The Tussock Grass (TUGR) pasture type occupies a very small proportion of the survey area and is generally restricted to northern parts where it can be regarded as outliers of the moister tropical summer rainfall grasslands more widely distributed to the north of this survey area.

The establishment of tussock grasses is favoured in run-on areas supporting heavier soils such as gilgai plains, drainage foci, swamp margins and alluvial plains. Land systems with such units generally have low relief and sluggish or internal drainage patterns.

Tussock Grass pastures predominate on the Marloo and Yarcowie land systems (170 km²) and form an important component on the Barrabiddy, Cahill, Chargoo, Gearle, River and Wash land systems. Minor areas are also found on the Carleeda, Delta, Donovan, and Wandagee systems where it shows structural gradations with the Acacia Creek-line (ACCR) pasture type.

The soils are variable but are predominately heavier-textured varieties. Brown and grey clays occur on the gilgai plains unit and exhibit seasonal cracking. Non-cracking clays, duplex and gradational-textured profiles occur in most other areas; sola are invariably full depth (> 1 m), soils varies from reds through to browns; soil reaction may be neutral throughout or become more alkaline with depth; inclusions of lime, radiolarite or mica may be present. Sparse surface mantles of small diameter material are quite common.

Uniform coarse-textured profiles of sands or loamy sands form important areas on the Cahill land system and parts of the Delta and Wandagee land systems. Sola are usually full depth and neutral to slightly acid throughout.

3. Physiognomy and composition

Tussock Grass pastures occur with differing structural forms ranging from open tussock grasslands to open grassy woodlands, tall shrublands and low shrublands. Cover of the shrubs and trees is correspondingly variable and may range from very scattered to moderately close (PFC 5-30%). The unifying feature is a prominent understorey of tussock grasses. Common grass communities are:

- Roebourne plains grass *Eragrostis xerophila*
- Buffel grass *Cenchrus ciliaris*
- Ribbon grass *Chrysopogon fallax*
- Swamp wanderrie grass *Eriachne benthamii*
- Rats tail grass *Sporobolis mitchellii*

Roebourne plains grass and Buffel grass communities are by far the most important. The last three communities are found only very locally and are not further described here.

3.1 Roebourne plains grass community

This community forms on the restricted gilgai plains of the Barrabiddy, Durlacher, Marloo and Yarcowie land systems and on some alluvial plain areas of the Wash land system. It occurs as an open tussock grassland on the Marloo and Yarcowie land systems, a very scattered (PFC 2-10%) tall shrubland on the Barrabiddy and Durlacher land systems and as a scattered (PFC 10-20%) low shrubland on the Wash land system.

In the open tussock grassland situation Roebourne plains grass occurs with basal cover (b.c.) of up to 4%. The b.c. of other grasses usually present within the stand include bull mitchell grass *Astrebla squarrosa* (< 0.6%); never fail grass *Eragrostis setifolia* (< 0.4 5); weeping mitchell grass *A.elymoides* (< 0.3%); and barley mitchell grass *A.pectinata* (< 0.2%). Shrub species are uncommon and their PFC is generally < 2%; those occurring include curara *Acacia tetragonophylla,* fuchsia bush *Eremophila maculata* and Gascoyne bluebush *Maireana polypterygia.* Wait-a-while *Acacia cuspidifolia* occurs as a low tree on the Yarcowie land system.

In shrubbier situations tussock grasses become more sparse and Roebourne plains grass rarely occurs with a b.c. > 1%. Never fail grass, buffel grass and swamp wanderrie grass are often present. Dominant shrubs include bardie bush *Acacia victoriae* and snakewood *A. xiphophylla*, occurring as tall shrubs, and grey cassia *Cassia desolata*, *C. hamersleyensis*, royal poverty bush *Eremophila cuneifolia* and cotton bush *Ptilotus obovatus*, occurring as low shrubs. Total shrub densities are commonly 1000-2000/ha.

3.2 Buffel grass community

Buffel grass is an introduced species which has colonized many areas in northern Australia and is gradually extending its range southwards. Buffel grass is found throughout the survey area on the more sandy soils and in coastal areas with a low incidence of frost. Buffel grass is a vigorous competitor and has often flourished over degraded areas of native grasses and shrubs or acted as a pioneer stabilizing disturbed or eroded areas.

However, areas large enough to be managed as Tussock Grass pastures are more restricted. The most extensive areas occur on the Brown, Cahill, Cardabia, Coast, Lyell and River land systems. Smaller, but important colonizations occur on several other systems including Barrabiddy, Delta, Donovan, Gearle, Sable, Warroora and Wash.

Buffel grass-invaded communities are of varying structure and composition. They occur as open tussock grassland, tall shrublands or low woodland with a grassy understorey. The projected foliar cover (PFC) of the shrubs is correspondingly variable ranging from none on parts of the Brown and Cardabia land systems, to over 30% on parts of the Delta land system. Widespread tall shrubs include silver bark wattle *Acacia sclerosperma*, wanyu *A. ramulosa* and curara, while on stabilized alluvial areas, wait-a-while, bardie bush and needle bush *Hakea preissii* occur as dominants. Low shrubs include silver saltbush *Atriplex bunburyana*, grey cassia, crinkle leaf cassia *Cassia helmsii*, ruby saltbush *Enchylaena tomentosa*, Wilcox bush *Eremophila leucophylla*, cotton bush, Gascoyne bluebush and currant bush *Scaevola spinescens.*

Buffel grass is dominant in the ground storey and occurs with basal cover ranging from 1% to at least 8%. Other perennial grasses include birdwood grass *Cenchrus setigerus,* curly windmill grass and silky brown top, *Eulalia fulva* all of which normally occur with basal covers < 1%, although birdwood grass is locally co-dominant on the Delta land system with a basal cover up to 2%.

Tree species are usually absent within this community, although a sparse over-storey of coolibah, *Eucalyptus coolabah*; sometimes occurs in alluvial areas on the Gearle and River land systems.

4. Pastoral value

4.1 Roebourne plains grass community

This community is of moderate pastoral value. Ephemerals, perennial grasses and shrubs provide nutritious grazing after rain, but feed quality and quantity declines rapidly in dry periods and at these times the pastures provide only a sub-maintenance ration for livestock.

4.2 Buffel grass community

The pastoral value of the buffel grass community is high to 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, feed value falls rapidly during dry periods and pastures are not as durable as the shrub-based pasture types or sub-climax Soft Spinifex (SOSP) pastures.

5. Common perennial species

Trees:

Acacia citrinoviridis
Acacia coreacea
Acacia cuspidifolia
Acacia grasbyi
Acacia sibilans
Eucalyptus coolabah
Heterodendrum oleaefolium

Tall shrubs:

Acacia bivenosa
*Acacia cuspidifolia***
Acacia cuthbertsonii
Acacia farnesiana
Acacia sclerosperma
Acacia subtesserogona
Acacia tetragonophylla
*Acacia victoriae***
Acacia xiphophylla
*Hakea preissii***
Heterodendrum oleaefolium

Low shrubs:

*Atriplex bunburyana**
Cassia desolata
*Cassia hamersleyensis**
Cassia helmsii
Cassia oligophylla
*Enchylaena tomentosa**
Eremophila cuneifolia
*Eremophila maculata**
Eremophila maitlandii
Maireana planifolia
Ptilotus obovatus
*Rhagodia eremaea**
*Rhagodia preissii**
*Scaevola spinescens**
Solanum lasiophyllum

Perennial Grasses:

*Astrebla elymoides**
*Astrebla pectinata**
Astrebla squarrosa
Cenchrus ciliaris
Cenchrus setigerus
*Chrysopogon fallax**
*Enteropogon acicularis**
*Eragrostis setifolia**
Eragrostis xerophila
*Eriachne benthamii**
*Eriachne helmsii***
Eulalia fulva
*Paspalidium tabulatum**
*Sporobolus mitchellii**
*Themeda australis**
Triodia pungens

Annuals, biennials and herbs:

Aristida contorta
Atriplex inflata
Atriplex semilunaris
Babbagia acroptera
Corchorus walcottii
Ptilotus exaltatus
Salsola kali
Solanum sp.
Stemodia grossa
Trichodesma zeylanicum

* desirable indicator species.
** undesirable indicator species.

6. Condition statements

6.1 Roebourne plains grass community

The condition of this community is fair or good throughout its distribution and there is no erosion.

Condition is best reflected by the species composition and cover within such stands. Species which are most sensitive to grazing such as never fail grass, barley mitchell grass, fuschia bush and Gascoyne bluebush tend to reflect condition changes best. Roebourne plains grass, although moderately palatable, is quite resistant to grazing and is not a good indicator species.

Declining condition is evidenced by an obvious over-use by stock and the disappearance of those sensitive indicator species mentioned above. In the case of severe over-grazing, Roebourne plains grass may become very sparse. Erosion is uncommon.

6.2 Buffel grass pastures

This community often provides fairly dense ground cover and is generally in good condition. However, where buffel grass is acting as a primary colonizer, such as on degraded sandy plains and banks of the Delta land system, the overall condition may be still only fair or poor. Degraded areas commonly support the undesirable increaser shrubs wait-a-while, bardie bush and needle bush and remnant desirable species such as silver saltbush, Gascoyne bluebush and currant bush.

Desirable indicator species are quite variable in their occurrence as they do not share the same adaptability as buffel grass and are more restricted by environmental conditions. Desirable shrubs and grasses which are locally important as condition indicators (other than those mentioned in 6.1 above) include curly windmill grass, silky brown top, Wilcox bush, ruby saltbush and felty leaf bluebush *Maireana tomentosa*. In good condition such species will persist and regenerate whereas under declining conditions they become moribund and may disappear from the stand. Buffel grass is not a good indicator species as it is resistant to grazing and usually persists in all but the most extremely over-grazed situations. Concern has been expressed about possible general suppression of shrub seedlings within buffel grass stands (Cheam 1984) but little local confirmation of such an effect has been noted to date.

7. Management

7.1 Roebourne plains grass community

For optimal animal productivity the best use of this pasture appears to be heavy, short term (4-6 months) stocking when feed is green and plants are actively growing. This type of management will necessitate spelling of pastures for up to six months after a good season, enabling grasses to recover and reproduce.

The above practice requires separate fencing from other pasture types. This is often not possible since Roebourne plains grass communities commonly occur as small inclusions within other pasture types. This being the case, constant attention should be given to the health and vigour of the desirable indicator species, especially if surrounding pastures are less productive and stocking rates should be adjusted to suit the situation.

Recommended levels of use (per annum):

Good to excellent condition	- 6 ha/s.u.
Fair condition	- 12 ha/s.u.
Poor to very poor condition	- 25 ha/s.u.

7.2 Buffel grass community

This pasture community should be stocked to maintain the buffel grass tussocks in fairly short condition as this will encourage growth 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. However, when pastures are completely dry or if they become tall and rank, the buffel grass is less palatable to stock.

Managing paddocks which contain buffel grass pastures and shrub pastures such as Bluebush (BLUE) or Acacia Short Grass Forb (ASGF) requires special care; as do buffel pastures which include perennial shrub species. If high stocking rates are maintained into long dry periods, the shrubs will become more attractive to stock than the grasses and may be damaged by over use. Levels of use on the shrubs in the paddock should be closely observed and stock shifted before severe defoliation occurs. Management is simplified if paddocks are arranged or can be arranged to contain one or other of the pasture types. Where buffel pastures are associated with native pastures such as Hard Spinifex (HASP) or Soft Spinifex (SOSP) it is not necessary to paddock the different pastures separately. In fact, a buffel grass - soft spinifex mixture is probably ideal and desirable. Both pasture types can sustain heavy use and the different virtues of each, such as rapid initial growth of the buffel and good drought value of the soft spinifex, complement each other.

Occasional spelling of 4-8 weeks over a growing season is desirable and will ensure the stands sets plentiful seed. However, to spell for a longer period is inadvisable the grass will quickly become unattractive to stock if left ungrazed.

Recommended levels of use during the growing season:

Good to excellent condition	- 2 ha/s.u.
Fair condition	- 5 ha/s.u.
Poor to very poor condition	- 25 ha/s.u.

Samphire pasture type (SAMP)

1. Area 300 km² (0.4%)

2. Distribution, composition and management

The Samphire (SAMP) pasture type is of only local importance within the survey area and has limited pastoral value. Areas are found mainly on the McLeod land system north of Carnarvon and on the Birrida land system in the Shark Bay area. Very restricted areas also occur on the Littoral, Salune, Tamala, Delta, Sable and Foscal land systems.

This pasture is based on saline and often highly gypsiferous plains and sandy banks and consequently support strongly halophytic vegetation. Various samphire *Halosarcia* species predominate, but other shrubs such as *Acacia rostellifera*, *Lawrencia* sp. and *Scaevola crassifolia* are also widespread. The more palatable bladder saltbush *Atriplex vesicaria*, buffel grass *Cenchrus ciliaris*, felty leaf bluebush *Maireana tomentosa* and cotton bush *Ptilotus obovatus* are often present at low densities. The vegetation usually takes the form of a very scattered low shrubland with projected foliar cover (PFC) ranging from 2-10%.

The palatability and actual levels of use of this very saline pasture type depends to a large extent upon the salinity of the local watering points and the extent to which the samphire dominates in the community.

Pastoral value is increased in good seasons when the spaces between the perennial shrubs are colonized by an abundance of herbs and, occasionally, buffel grass tussocks. However, pastoral value is generally low.

Recommended level of use (per annum):

Good to excellent condition	- 25 ha/s.u.
Fair condition	- 30 ha/s.u.
Poor to very poor condition	- 50 ha/s.u.

Exotic Annual pasture type (EXAN)

1. Area 100 km² (0.1%)

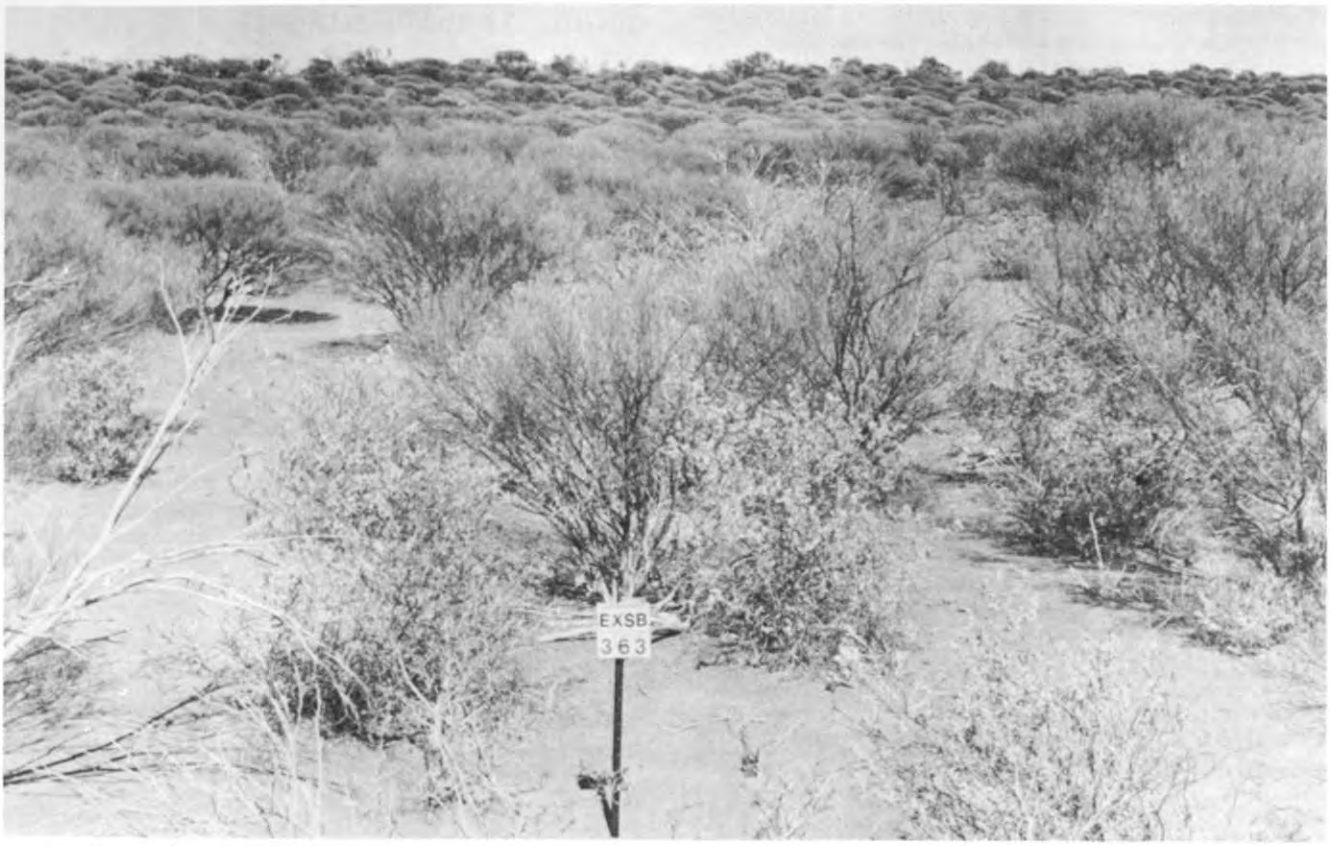
2. Distribution, composition and management

Exotic Annual (EXAN) pastures occur on sandy-surfaced plains and limestone plains of the semi-arid winter rainfall areas within the Tamala and Cullawarra land systems near Shark Bay. They are of very restricted occurrence but are locally important because of their unusually high levels of seasonal productivity.

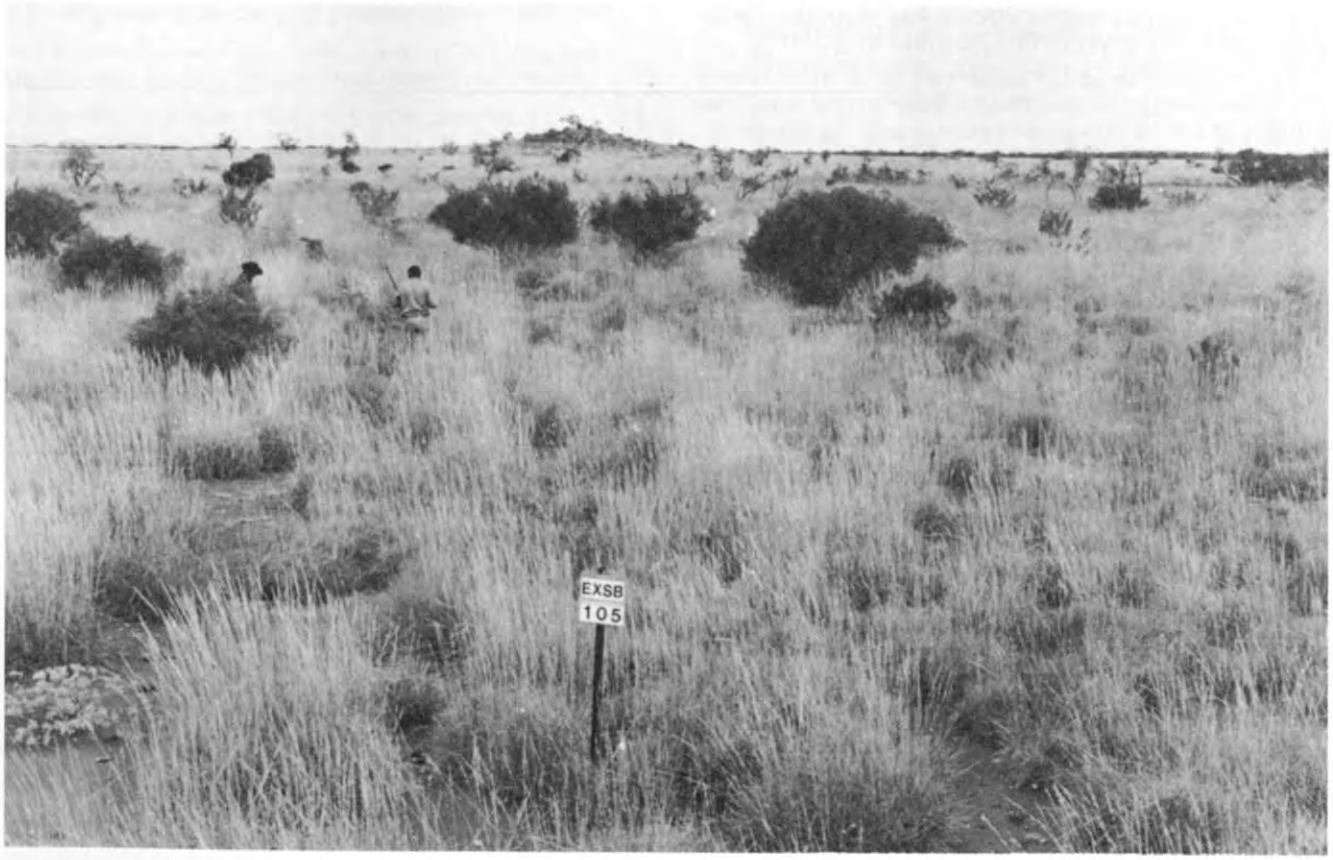
Pastures consist almost entirely of annual species and are based on degraded plains thought previously to support Acacia Mixed Shrub (ACMS) or Saltbush (SALT) pastures. Degradation and general loss of perennial vegetation has been caused by various combinations of clearing, burning and over-grazing by both domestic and feral animals, mainly rabbits and goats. Exotic species which have colonized and effectively stabilized many of these areas include *Medicago minima*, *M. polymorpha*, wild oat *Avena* aff. *barbata*, wild turnip *Brassica tournefortii* and barley grass, *Hordeum* sp. The undesirable perennial shrub tomato bush *Solanum orbiculatum* has invaded some sites.

Exotic Annual pastures are, in most years, productive winter pastures that stabilize otherwise erodible soils and can be grazed on a year long basis. However, heavy use in late summer and early autumn should be avoided in order to minimize the risk of wind erosion on the sandy soils. At this time of year stock are best moved to more durable pastures supporting palatable perennial species.

Recommended levels of use (per annum): 2 ha/s.u.

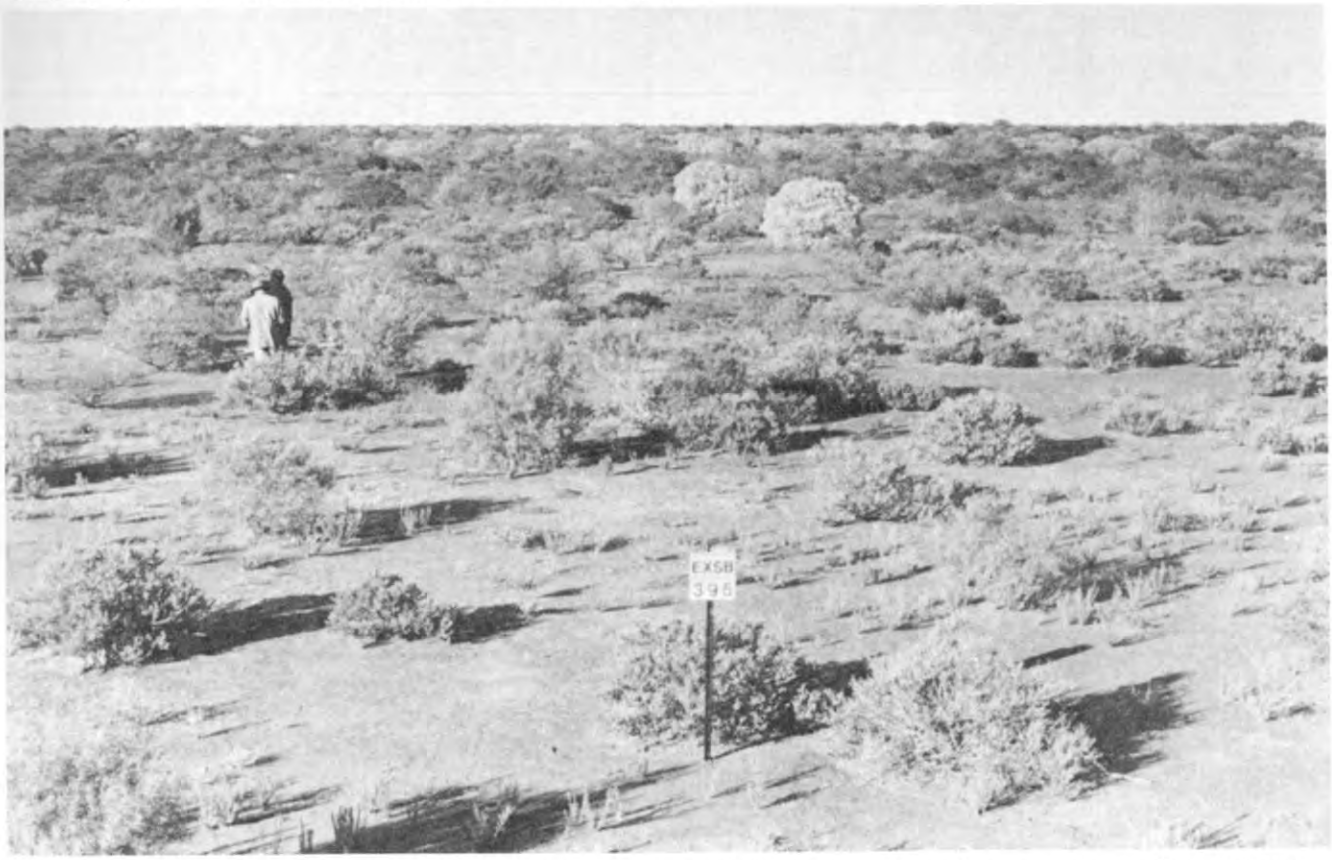


13. Acacia Sandplain (ACSA) pasture type is typified by shrub associations dominated by wanyu *Acacia ramulosa*, Wilcox bush *Eremophila leucophylla* and cottonbush *Ptilotus obovatus* over large parts of the southern half of the area. The scene depicted is a swale in the Yalbalgo land system on Towrana station.

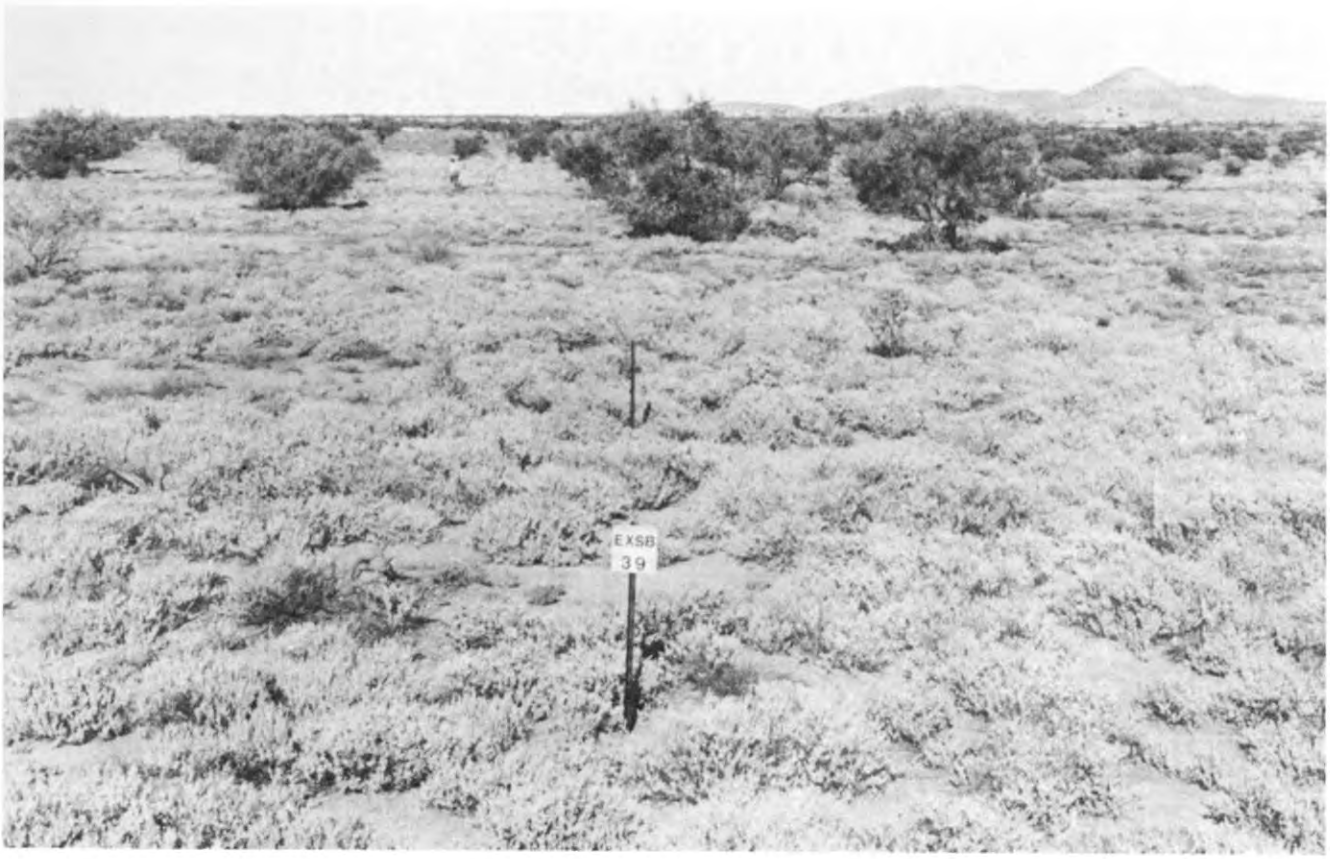


14. Soft Spinifex (SOSP) pasture type, Duffy land system, Towera station. Mature soft spinifex *Triodia pungens* with very scattered poverty wattle *Acacia translucens*; the hummocks are more palatable to stock when younger. This pasture type is nutritious and productive but requires carefully prescribed burning every few years.

15. Bluebush (BLUE) pasture type, Sable land system, Boolathana station. Flat saline alluvial plains with duplex soils, supporting Gascoyne bluebush *Maireana polypterygia* - dominated low shrubland. In good condition this pasture type provides high quality forage through the summer and in times of drought. Bluebush plains are extensive in the west of the survey area.



16. Currant Bush Mixed Shrub (CBMS) pasture type, Sandal land system on Marron station. This pasture type is widespread on slightly saline duplex soils away from the coast and river deltas. It typically supports very variable mixed shrublands with many desirable species, of which currant bush *Scaevola spinescens* is conspicuous and often common except where serious degradation has occurred. Pastoral value is high, with a good annual response of winter herbs.



17. Saltbush (SALT) pasture type, Gearle land system, Cardabia station. Good cover of bladder saltbush *Atriplex vesicaria,* with wait-a-while *Acacia cuspidifolia.*

18. Closed thicket of the Acacia Creek-line (ACCR) pasture type, Wash land system, Middalya station. Major creek-lines and drainage foci with clay soils support heavy vegetation such as this as a component of many land systems. They normally support tangled undergrowths of low shrubs which include many desirable species.

19.Tussock Grass (TUGR) pasture type. Introduced buffel grass *Cenchrus ciliaris* on a drainage floor of the Donovan land system, Bullara station.

Range Condition and Regeneration Requirements

In concept, range condition is a measure of the degree to which the vegetation and soil resources of a particular site, land unit or land system deviate from the 'optimal' condition which could be expected at that site, land unit or land system under a specific type of land use - in this case pastoral use. This differs somewhat from the traditional concept (Dyksterhius 1949) of deviation from climax vegetation in that it recognizes that climax vegetation cannot be defined in many cases and that it is not always the most productive for pastoral purposes.

Three broad classes of 'range condition' were derived (see section on Survey Methods) from assessments of soil erosion and pasture condition made during traverses of the survey area. These levels of range condition are referred to as good, fair and poor.

Country is in good range condition when grazing resources are either near optimal or not seriously diminished from the ideal for the particular country type.

Country in fair range condition is in reasonable order, but careful management is required to ensure that condition and productivity does not deteriorate further. Changes in management practices may be necessary to maintain or improve condition.

Country in poor range condition will not sustain grazing at anywhere near its potential level and changes in management to initiate improvement are required. Country in this condition is degraded with perennial pastures producing at well below potential. Active soil erosion may or may not be present. In extreme cases, complete protection from grazing and other special remedial treatments are required to effect recovery.

A condition statement for the whole survey area was compiled (see table 30) by examining all of the traverse data recorded during the survey. The table presents an overall summary, obtained by traversing along many station access tracks or otherwise through most areas currently used for pastoralism. It was not possible to traverse some areas of rugged hill country in the far north and the north-east of the survey area, nor was this necessary as such country is of very low or negligible pastoral value and, as inspections on foot revealed, was invariably in good range condition.

Table 30 Traverse summary, total over all land systems*

Wind erosion	%	Water erosion	%	Total erosion	%	Pasture condition	%	Range condition	%
Nil	94	Nil	93	Nil	90	Very good	18	Good	45
Minor	4	Minor	4	Minor	6	Good	28	Fair	32
Moderate	1	Moderate	2	Moderate	2	Fair	32	Poor	23
Severe	1	Severe	1	Severe	1	Poor	17		
						Very poor	5		

* 10,952 traverse recordings were made on 86 land systems

Two per cent of the traverse observations recorded moderate erosion and 1% recorded severe erosion. This indicates that, on a regional basis, soil erosion is a local rather than a general problem. However, it is a serious problem on a number of susceptible land systems on some stations. These problem areas are discussed later in more detail.

Seventy-eight per cent of traverse observations indicated pasture condition in the fair to very good range. On a regional basis a high proportion of pastures are in acceptable condition. However, some important pasture types are seriously degraded (22% of traverse observations indicated poor or very poor pasture condition) with considerable loss of desirable perennials or, in some cases, marked increases in undesirable species.

The range condition assessment of the whole survey area was as follows: 45% of traverse observations indicated good range condition, 32% indicated fair condition and 23% indicated poor range condition.

Condition statements were also derived for individual land systems. Table 31 groups the land systems of the survey area in decreasing order of pastoral value and indicates the condition status of each system. Similar data are available for each land unit of each land system, but are not presented here.

Table 31 also shows the area of extreme degradation on each land system. Such areas show severe pasture degradation and serious erosion and are of particular concern. A total of 647 km² (0.9% of the survey area) falls into this category. Special remedial treatments, including complete removal from use, are required to bring about recovery.

Table 31 Condition summary of land systems within the survey area

Pastoral value	Land system	Area (km²)	No. of traverse observations	Per cent of observations in range condition shown			Extreme degradation	
				Good %	Fair %	Poor %	Area (km²)	per cent of system %
Very high	Barrabiddy	152	50	10	32	58	24	15.8
< 5 ha/	Chargoo	198	40	44	43	13	—	—
sheep unit	Cullawarra	86	9	56	11	33	—	—
	Tamala	136	60	13	30	57	—	—
Sub totals		572	159	23	33	44	24	

Table 31 continued...

Pastoral value	Land system	Area (km²)	No. of traverse observations	Per cent of observations in range condition shown			Extreme degradation	
				Good %	Fair %	Poor %	Area (km²)	per cent of system %
High 5-9 ha/ sheep unit	Bidgemia	136	22	—	27	73	13	9.6
	Cardabia	3,095	466	87	12	1	—	—
	Cahill	389	94	45	45	10	0.5	0.1
	Carleeda	215	14	93	—	7	—	—
	Coast	1,102	200	72	16	12	86	7.8
	Delta	1,660	500	24	21	55	359	21.6
	Donovan	1,042	199	66	27	7	2	0.2
	Edel	835	235	62	23	15	18	2.2
	Ella	1,943	321	36	42	22	—	—
	Firecracker	135	7	57	43	—	—	—
	Foscal	446	115	42	33	25	2	0.4
	Gearle	812	176	31	28	41	14	1.7
	Gneudna	81	22	5	36	59	—	—
	Learmonth	285	77	81	13	6	—	—
	Lyell	65	14	93	7	—	—	—
	Marloo	111	11	55	36	9	—	—
	Mary	507	89	38	50	12	—	—
	Peron	326	73	46	36	18	—	—
	River	416	57	55	26	19	—	—
	Sable	1,554	258	58	28	14	5	0.3
	Sandal	5,658	1,078	27	45	28	—	—
	Snakewood	827	61	20	21	59	—	—
	Spot	634	91	35	32	33	3	0.5
	Tarcumba	183	31	10	1	29	—	—
	Target	1,235	296	23	43	34	—	—
	Toolonga	1,182	229	11	47	42	—	—
	Trealla	688	82	66	29	5	2	0.3
	Wandagee	296	103	21	30	49	4	1.4
	Winning	723	106	12	29	59	28	3.9
	Warroora	831	178	89	10	1	—	—
	Wash	800	127	31	45	24	13	1.6
	Yarcowie	76	10	30	50	20	—	—
	Yalkalya	131	12	58	17	25	—	—
	York	62	12	17	58	25	—	—
	Yaringa	872	120	33	41	26	—	—
Sub totals		29,353	5,486	42	32	26	531.5	
Moderate 10-19 ha/ sheep unit	Brown	429	64	54	38	8	—	—
	Birrida	135	37	87	8	5	—	—
	Cooloomia	462	41	56	37	7	—	—
	Channel*	389	21	29	47	24	—	—
	Collier	114	12	58	42	—	—	—
	Coquina	34	11	64	36	—	—	—
	Duffy	359	86	43	30	27	10	2.8
	Divide	148	25	88	—	12	—	—
	Durlacher	1,441	246	16	45	39	—	—
	Giralia	2,262	108	96	4	—	—	—
	Garry	10	2	—	100	—	—	—
	Jimba	1,612	308	18	39	43	52	3.2
	Jubilee	411	21	86	14	—	—	—
	Littoral	154	47	96	4	—	—	—
	Lyons	1,126	217	22	37	41	6	0.5
	McLeod	259	75	99	—	1	—	—
	Mallee	478	65	67	25	8	—	—
	Mantle	307	65	5	43	52	—	—
	Nerren	1,547	288	38	40	22	—	—
	O'Brien	885	183	26	38	36	—	—
	Phillips	489	63	24	67	9	—	—
	Prairie	2	Not traversed					
	Sandiman	208	46	7	67	26	—	—
	Sandplain**	9,866	1,231	50	37	13	—	—
	Salune	72	13	31	46	23	—	—
	Taillefer	190	35	17	43	40	15	7.9
	Uaroo	1,285	149	95	4	1	—	—
	Windalia	850	93	4	35	20	0.5	< 0.1
	Wooramel	643	160	36	28	36	—	—
	Yalbalgo***	7,865	934	47	37	16	—	—
	Yagina	120	20	20	55	25	—	—
	Yinnietharra	606	109	24	38	38	8	1.3
Sub totals		34,758	4,775	44	35	21	91.5	
Low 20-30 ha/ sheep unit	Agamemnon	929	54	68	26	6	—	—
	Billy	328	20	50	45	5	—	—
	Capricorn	37	Not traversed					
	Fossil	367	16	31	56	13	—	—
	Glenburgh	35	1	100	—	—	—	—
	James	174	6	50	33	17	—	—
	Kennedy	959	11	100	—	—	—	—
	Pells	181	9	22	56	22	—	—
	Thomas	146	17	59	35	6	—	—
	Two Hills	123	8	38	49	13	—	—
	Wapet	42	7	100	—	—	—	—
Sub totals		3,321	149	60	33	7	—	

Table 31 continued...

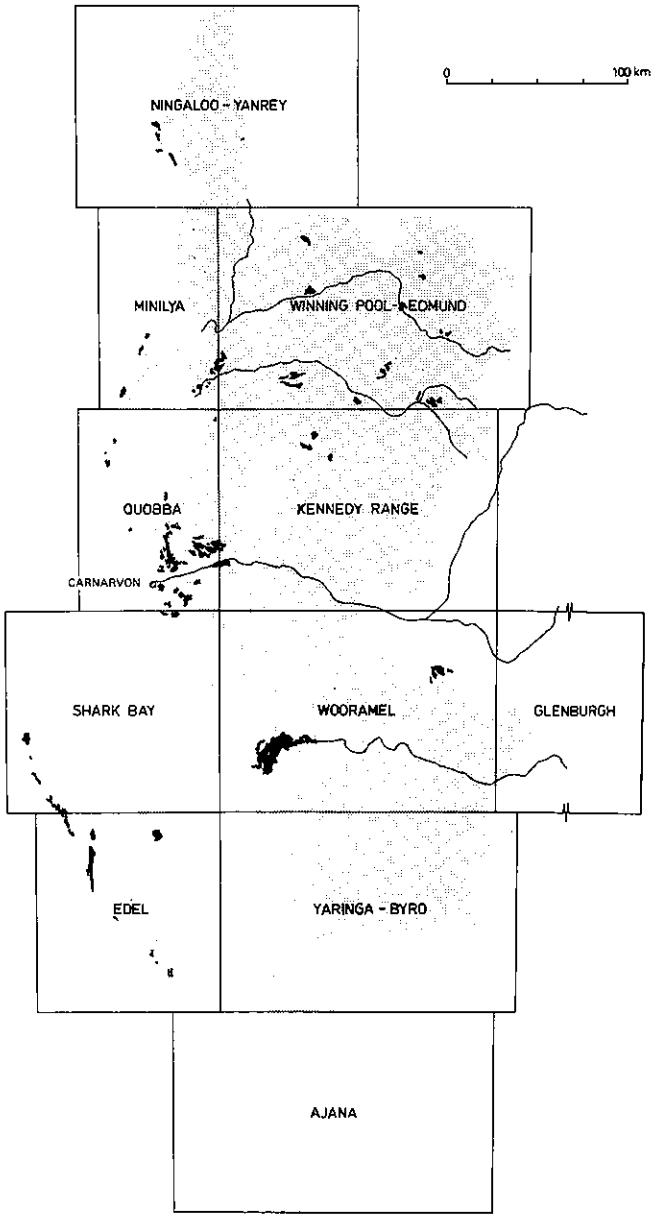
Pastoral value	Land system	Area (km²)	No. of traverse observations	Per cent of observations in range condition shown			Extreme degradation	
				Good %	Fair %	Poor %	Area (km²)	per cent of system %
Very low 30 ha/ sheep unit	Augustus	130	Not traversed					
	Inscription	152	49	88	12	—	—	—
	Lake	62	9	78	11	11	—	—
	Moogooloo	1,320	19	58	37	5	—	—
	Nanga	3,485	259	97	3	—	—	—
	Range	988	11	91	9	—	—	—
	Zuytdorp	311	36	89	11	—	—	—
Nil	Margins to Lake McLeod	37						
Sub totals		6,485	383	92	7	1	—	
Grand total	74,489	10,952	45	32	23	647	—	

* Parts of this system are also of high or low pastoral potential

** Restricted parts of this system (on Faure, Nanga and Peron stations) are of high pastoral value.

*** Some parts of this system are of low pastoral value.

Figure 21. Areas of extreme degradation in the survey area.



The extent and regional location of areas of extreme degradation are shown in Figure 21 and on the 1:250,000 scale land system maps accompanying this report. Although patches of extreme degradation are recorded on 21 of the 89 land systems in the survey area they are, in general, confined to seven land systems in three geomorphic provinces. These are:

- Land systems Barrabiddy and Delta associated with the Minilya, Gascoyne and Wooramel Rivers - Alluvial Plains geomorphic province.
- Land systems Bidgemia, Wandagee and Jimba in the north-east and central east - Wandagee Permian Plains province.
- Land systems Coast and Taillefer on Edel land, Dirk Hartog Island and along the coastline north of Carnarvon - Coastal Dune province.

In addition there are a number of other systems, such as Gearle and Winning, which have restricted areas of severe degradation.

Range condition of land systems of high to very high pastoral value

All systems in this category are readily accessible to stock (except when occasionally flooded for short periods) and support attractive Saltbush (SALT), Bluebush (BLUE) and other shrub pastures or perennial grasses (including Soft Spinifex (SOSP). They have been extensively grazed since early settlement except in some parts where groundwater supplies are excessively saline.

As shown in table 31 the condition of these systems is extremely variable. Some high value systems such as those based on Soft Spinifex (e.g. Cardabia, Carleeda) are relatively stable and show little pasture degradation or erosion. Many sandly plain and alluvial plain systems are largely in good or fair range condition with no erosion.
However, other systems, notably Barrabiddy, Bidgemia, Coast, Delta, Gearle and Winning, have extensive areas in poor range condition and some areas of extreme degradation. A total of about 556 km² or 1.9% of high and very high pastoral value country shows extreme degradation and is of particular concern. The majority of this degradation (359 km²) occurs on the Delta land system.

In the following section only those systems with significant areas of pasture degradation or soil erosion are discussed.

Barrabiddy land system

This small alluvial plain system flanks the Barrabiddy Creek in the north-east of the survey area on Wandagee and Minilya stations. Parts of the system are still highly productive but elsewhere Saltbush pastures are seriously degraded. Desirable low shrubs are much reduced in density and have been replaced by less desirable types such as prickly acacia *Acacia victoriae* and wait-a-while *A. cuspidifolia*. Water erosion, in the form of rilling, guttering and surface sheeting is active.

About 24 km² (16%) of the system on Wandagee station is extremely degraded and a programme of rehabilitation is required. This would involve the systematic closure of sections to grazing for a number of consecutive growing seasons. Buffel grass *Cenchrus ciliaris* is well established on parts of the system and its spread should be encouraged.

Bidgemia land system

This system is restricted to the north-east of the Wooramel map sheet and a few locations on the Kennedy Range sheet. It consists of tributary drainage plains with broad low dunes and sandy banks and, when in good condition, is of high pastoral potential.

Most of the system is in poor range condition, Currant Bush Mixed Shrub (CBMS) and Bluebush pastures are depleted. None of the system is in good range condition. Soils of the interdunal plains are texture contrast types which are highly susceptible to water erosion once the vegetative cover is reduced. Surface stripping, scalding and minor gullying is common and about 13 km² (9.6%) of the system shows extreme degradation. This area, on Winderie station, needs complete protection from grazing and possibly some cultivation and seeding treatments until recovery is effected.

Coast land system

This large system occurs as a strip, up to 6-7 km wide but usually much narrower, adjacent to much of the coastline from the south to the north of the survey area on Tamala, Carrarang, Dirk Hartog, Boolathana, Quobba, Gnaraloo, Warroora, Cardabia and Ningaloo stations. It consists of large, long walled parabolic dunes with narrow swales, minor limestone plains and wave cut platforms and beaches. Large parts of the system are little used for grazing due to the lack of stock waters while other parts are intensively grazed.

Pasture is the Coastal Dune Shrub (CDSH) type which is largely in good or fair condition (see table 31). However, about 86 km² or nearly 8% of the system consists of large, mobile sand drifts and blow-outs. Several of the major blow-outs have their origins near obvious sites of disturbance (stock watering points, fence lines, access tracks etc.) while the origin of others is unclear. Once initiated, the degradation is long term and self-perpetuating under the strong prevailing southerly winds. Blow-outs progress northwards, re-working previously stable crests and arms of the dunes and leaving deflation basins behind.

Because of the very high susceptibility of the system to wind erosion most is unsuited to pastoral use and should not be further developed. The system is also at high risk to other forms of use or development.

Delta land system

This extensive flood plain system is associated with the western reaches of the three major rivers of the area - the Minilya, Gascoyne and Wooramel. It is subject to occasional major sheet and channelled flooding from the rivers and more frequent short term inundation from local falls. When in good condition the system supports highly productive perennial pastures of saltbush (mainly *Atriplex vesicaria* and *A. bunburyana*) and bluebush (dominants *Maireana polypterygia, M. platycarpa or M. aphylla*) with numerous annual species in season.

Range condition varies with some parts still being highly productive. However, more than half the traverse records indicate poor range condition and the system is the most degraded encountered within the survey area with about 360 km² (21.6%) showing extreme degradation. This is more than half of the total area of extreme degradation in the survey area. Nearly all desirable perennial shrubs have been lost from such areas and the soil surface is scalded, scoured and hummocked by wind and water. In some situations undesirable woody shrubs such as needle bush *Hakea preissii* have greatly increased in density.

The severely degraded areas occur either as small patches only a hundred metres or so in extent between areas with good shrub cover or as larger scalds and hummocked plains up to 3-4 km in extent. Significant areas of extreme degradation occur on Wooramel (145 km²), Brickhouse (104 km²), Minilya (36km²) and Boolathana (29 km²) stations.

Programmes of rehabilitiation are already in progress on many such areas, but are urgently required on other severely degraded parts in order to prevent further deterioration and to restore productive capacity. Such programmes should involve complete protection from grazing in the initial stages, with cultivation and seeding treatments. In some cases existing paddocks can be closed to use, but elsewhere additional fencing will be required to isolate areas requiring treatment.

Cultivation is required on the hard scalds in order to improve water infiltration rates and to provide a seedbed. Cultivation treatments would include strip contour ploughing and banking, pitting, furrowing and water ponding. Seeding with native saltbush and bluebush species would be essential in areas where there are no natural seed sources nearby. Buffel grass should be sown on areas with sandy or loamy soils and is also showing some ability to colonize on heavier soil types.

There is no doubt that rehabilitation can be achieved over many areas but it will be a difficult and expensive task. It is not possible to indicate the time period necessary for recovery but generally, given good growing seasons, reasonable revegetation responses could be expected within four or five years. Initially no grazing should be permitted but, in subsequent years, controlled, short term stocking may benefit the recovery process.

Although parts of the Delta system are extremely degraded and are currently producing at far below potential, regeneration programmes have shown that the system has the ability to recover if treated as outlined. Rainfall is more assured than more inland pastoral areas and recent results of plant introduction trials in the Carnarvon area have been encouraging.

Gearle land system

This gently sloping plain system is largely confined to the north of the survey area and is represented on the Winning Pool - Edmund map sheet with lesser occurrences shown on the Kennedy Range sheet.

The system supports highly productive Saltbush and Bluebush pastures, many of which are in good or fair conditions. However, about 40% of the traverse records indicate poor range condition and 14 km² (1.7%) of the system is extremely degraded. Degradation is evidenced by partial loss and in extreme cases, almost complete loss of the desirable low shrubs Gascoyne bluebush *Maireana polypterygia* and bladder saltbush *Atriplex vesicaria*, frequently accompanied by minor soil erosion and occasionally by moderate or severe erosion.

The areas of severe degradation are confined to Hill Springs (11 km²) and Mardathuna (3 km²) stations. These areas should be protected from grazing until pastures have recovered.

Winning land system

This system occurs only on Mia Mia and Winning stations in the north of the survey area. It consists of flat to gently sloping plains with minor low hills, rises and dissected slopes. The plains support a characteristic scattered tall shrubland of snakewood *Acacia xiphophylla* with numerous under-shrubs. Pastures are productive Bluebush and Stony Chenopod (STCH) types with Gascoyne bluebush *Maireana polypterygia*, Gascoyne mulla mulla *Ptilotus polakii*, silver saltbush *Atriplex bunburyana* and other useful low shrubs. They are attractive to livestock and have frequently received excessive use in the past. They are nearly all more or less degraded and range condition is predominantly poor (58% of traverse records) or fair (29%). In addition 28 km² or nearly 4% of the system shows extreme degradation with almost complete loss of desirable shrubs and some active erosion in the form of sheeting, rilling and guttering.

Areas of extreme degradation should be withdrawn from grazing by closing up existing paddocks or the provision of additional fencing. It is not possible to predict the time required for recovery. However, where there are still relic stands of desirable shrubs to act as seed sources, the system has the potential to respond to destocking and recover reasonably rapidly - possibly in four to five years. Where loss of perennial vegetation is more complete it is necessary to consider using cultivation and seeding methods to encourage the recovery process.

Wash land system

This productive system occurs in the north-east of the survey area on the Winning Pool - Edmund map sheet. It consists of broad, loamy alluvial plains with groved vegetation and small drainage foci, and drainage tracts receiving more concentrated sheet and channelled flow. It supports Acacia Short Grass Forb (ASGF) pastures with more useful low shrubs and perennial grasses than usual and Acacia Creek-line (ACCR) and Tussock Grass (TUGR) pastures. These pastures are dense in groves, drainage foci and along some drainage tracts.

Most of the system is stable under grazing and is in fair or good range condition. However, restricted parts have lost numerous desirable low shrubs and are degraded to poor condition, and the duplex soils along drainage tracts are sensitive to erosion. About 13 km² (1.6%) of the system is extremely degraded with very little vegetative cover and moderate and severe soil erosion. These areas, on Middalya (7 km²) and Lyndon (6 km²) stations, require rehabilitation programmes including complete protection from grazing.

Range condition of land systems of moderate pastoral value

The traverse data (see table 31) indicates that the 32 land systems of moderate pastoral value are mostly in good or fair range condition. Even so, 21% of the traverse records did indicate poor range condition with degraded pastures and occasional erosion. Areas in such condition require careful management in terms of control of stock numbers and season of use.

A total of about 92 km² of extreme degradation occurs and this is largely confined to land systems Duffy, Jimba, Lyons, Taillefer and Yinnietharra.

Duffy land system

The system occurs in the far north-east of the survey area on Towera station. It consists of sandy plains, broad drainage tracts and isolated low hills and stony rises.

Pastures of the sandy plains and stony areas are Hard Spinifex (HASP) and Soft Spinifex which are in good or fair condition. However, some broad drainage tracts with more attractive Acacia Short Grass Forb and Acacia Creek-line pastures are extremely degraded with gross loss of desirable shrubs and locally moderate water erosion. About 10 km² of country within existing paddocks is affected. In order to encourage pasture recovery this area needs to be destocked for a number of consecutive growing season and grazed at very conservative rates at other times.

Jimba land system

This fairly large system occurs in the north-east and east of the survey area on the Winning Pool-Edmund, Kennedy Range and Wooramel map sheets. It is based on sedimentary rocks of Permian age and consists of gently sloping plains and broad drainage tracts, mostly devoid of surface mantling and minor pebbly plains and stony ridges.

The system supports moderately productive Stony Chenopod, Acacia Short Grass Forb and some Saltbush pastures. Much of the pasture is seriously depleted and soil erosion is common. Forty-three per cent of traverse records indicate poor range condition and about 52 km² (3.2%) of the system shows extreme degradation with very poor vegetative cover and scalded, rilled and hummocked soil surfaces.

Significant areas of extreme degradation exist on Williambury (24 km²), Middalya (14 km²) and Winderie (14 km²) stations.

Because of the texture contrast nature of the soils and the general lack of a stony mantle to protect the surface, the system is inherently highly susceptible to soil erosion once plant cover is depleted. The poor condition of the system clearly shows that the ability of this fragile country to support stock has been over estimated in the past. Grazing on the system needs to be strictly controlled in terms of stock numbers and season of use and proper grazing management must involve leaving a reasonable residue of plant material as ground cover to protect the soil surface.

The areas of extreme degradation listed previously should be closed to grazing for such time as is necessary for recovery to be effected. Cultivation and seeding treatments should be attempted on some parts.

Lyons land system

The Lyons system is represented mainly on the Kennedy Range and Wooramel map sheets. It consists of claypans with narrow, adjacent alluvial plains surrounded by sandy banks and large, linear and reticulate sand dunes. The component units of the system vary considerably in their response and sensitivity to grazing. The sandy parts support Acacia Sandplain (ACSA) pastures which are predominantly in fair condition and without any erosion. The narrow plains which lie between the dunes and the claypans support Currant Bush Mixed Shrub pastures which are attractive to livestock and receive preferential grazing. Although they still support some useful low shrubs and numerous annuals in season, they are largely degraded to poor condition (about 6 km^2 of extreme degradation occurs on Wooramel station). Desirable species such as currant bush *Scaevola spinescens* tall saltbush *Rhagodia eremaea* and ruby saltbush *Enchylaena tomentosa* are depleted and drought durability has been reduced. Undesirable woody shrubs such as needle bush *Hakea preissii* and waxy leaf poverty bush *Eremophila crenulata* have increased markedly in some situations. The plain unit is moderately susceptible to erosion and scalding and shallow rilling is common.

Such a mixture of land units with different sensitivities to grazing makes overall management of the system difficult. Some loss of desirable shrubs is inevitable if maximum use is to be made of the other pasture components, but severe pasture depletion accompanied by erosion has occurred in some areas. Areas in poor condition should be spelled for a number of consecutive growing seasons and conservatively grazed at other times.

Taillefer land system

The system is found only on the Peron Peninsula in the Shark Bay area. It consists of undulating plains of calcareous sand, minor limestone ridges and low coastal dunes supporting spinifex hummock grasslands *Triodia plurinervata* with numerous shrubs and minor areas of low shrublands of silver saltbush *Atriplex bunburyana*.

The Hard Spinifex pastures of the system are more productive than usual; when in good condition, they have a fairly high density of desirable low shrubs such as cotton bush *Ptilotus obovatus*, climbing mulla mulla *P.divaricatus* and ruby saltbush *Enchylaena tomentosa*.

Many parts of the system are in good or fair range condition, but significant areas are degraded (40% of traverse records indicate poor range condition). In the south of Peron station 15 km^2 was severely degraded at the time of survey with very little vegetative cover and active wind erosion. Degradation of this kind occurs episodically and may become evident in the first few years after fire has burnt out the spinifex pasture and particularly if poor seasons or excessive grazing follow the fire.

Because of its sensitivity to wind erosion the system requires very careful management. Degradation can be prevented or mitigated by deferral of grazing after a fire, more appropriate grazing pressure and by encouraging the spread of buffel grass *Cenchrus ciliaris* as a primary stabilizer.

Yinnietharra land system

The Yinnietharra system is confined to Towera, Lyndon and Williambury stations in the north-east of the survey area. It consists of scattered granite tors, domes and low hills above stony slopes and broad, gently sloping sandy surfaced plains and low drainage tracts. Pastures are mainly Acacia Short Grass Forb with some Stony Chenopod and Acacia Creek-line types.

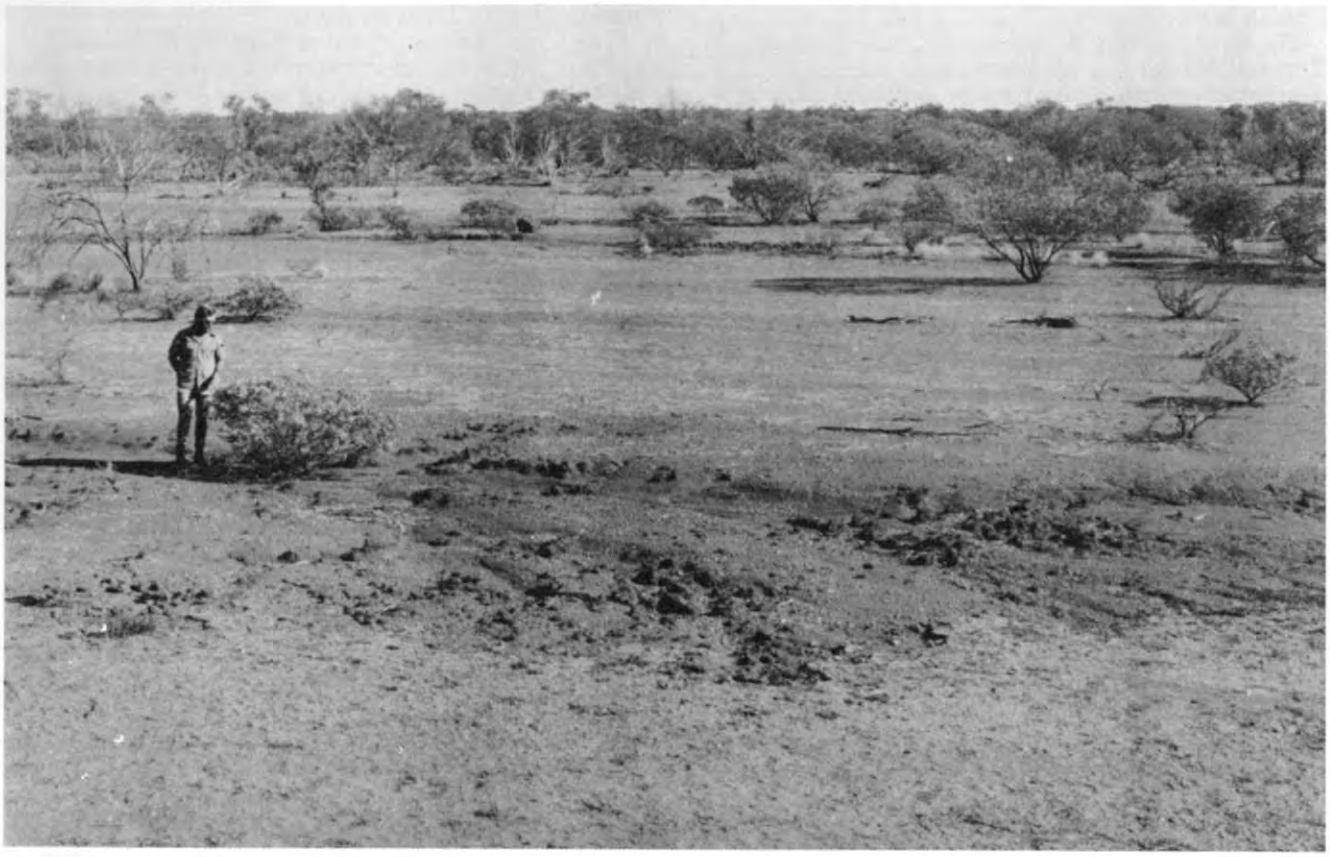
Range condition of the system varies from good to poor and is largely dependent on soil type, distance from stock water and grazing history. Considerable loss of desirable shrubs has occurred in some parts and broad plains and drainage tracts with duplex soils are inherently susceptible to water erosion. Thirty-eight per cent of traverse records indicate poor range condition and about 9 km^2 of the system on Lyndon station shows extreme degradation with almost complete loss of perennial vegetation and active soil erosion. A rehabilitation programme involving complete protection from grazing with additional fencing to effect this is required and possibly some cultivation and seeding work needs to be commenced.

Range condition of land systems of low to very low pastoral value

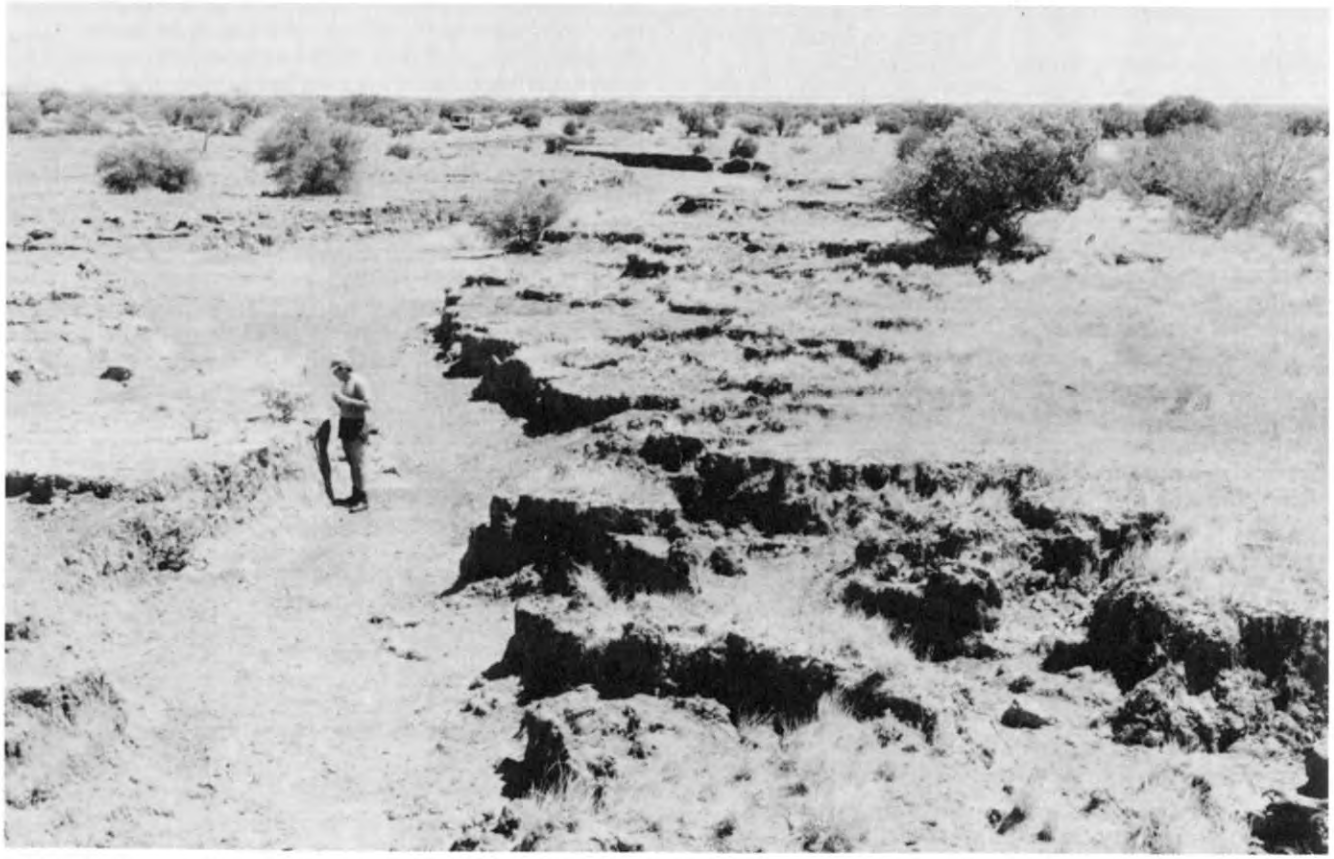
Some of the systems in this category are rough hill and mountain systems (e.g. Agamemnon, Fossil, Glenburgh, Augustus and Range) difficult of access and supporting sparse shrub pastures or hard spinifex. The major units of hill crests, plateaux, footslopes and stony plains are nearly always in good or fair range condition and there is no accelerated erosion. Some of the minor units such as narrow drainage floors are degraded because they support better quality pastures which have been preferentially grazed. However, there are no major degradation problems.

Other systems, although still hilly, have larger areas of footslopes and lower plains and are readily accessible to livestock. They supply some useful rough grazing and range condition is predominently good or fair. Although these systems have little drought durability they support numerous annuals in good seasons and opportunistic use should be made of these. In good years these systems should be used to carry stock from degraded pastures on better quality systems that require destocking or reduced stocking to encourage recovery.

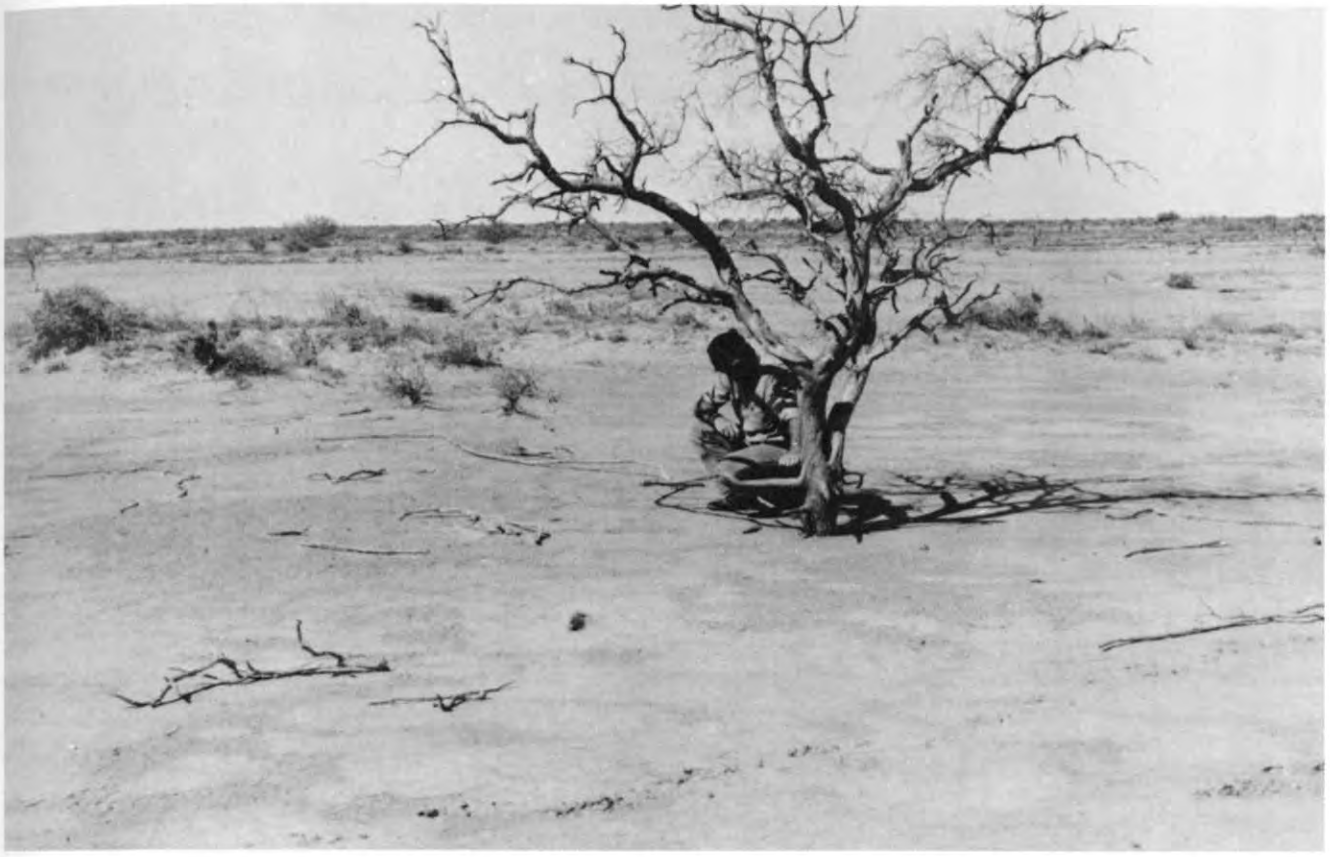
Other systems in this category support vegetation types which contain very few useful or palatable species for livestock. The Heath (HEAT) pastures of the Inscription, Nanga and Zuytdorp systems are examples. These are of very low carrying capacity, have generally not been developed for pastoral use and could not be developed economically.



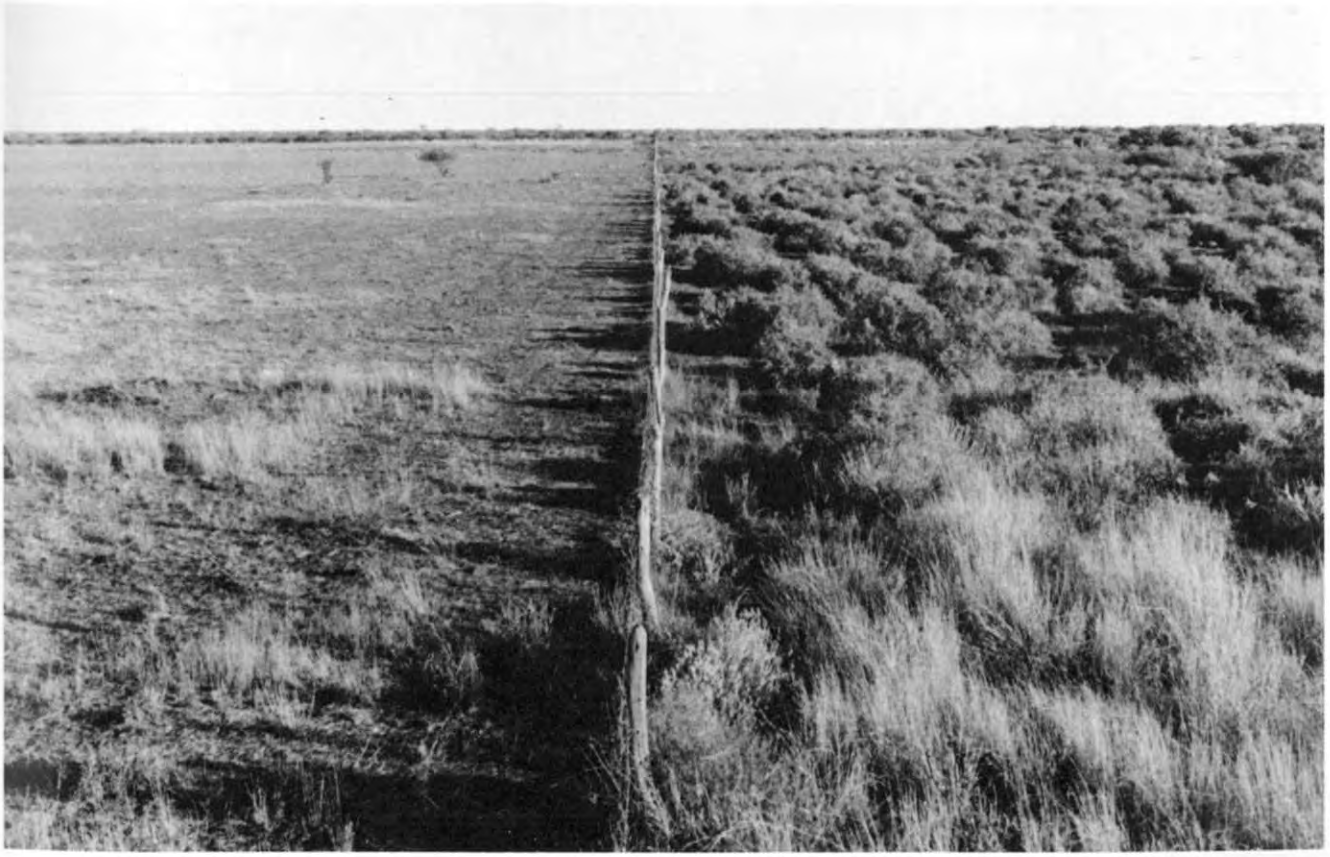
20. Accelerated water erosion on the Wash land system, which has a shallow loamy soil over hardpan. As a result of losses in shrub cover, infiltration rates decline and overland flow rates accelerate, causing soil loss by sheeting and rilling.



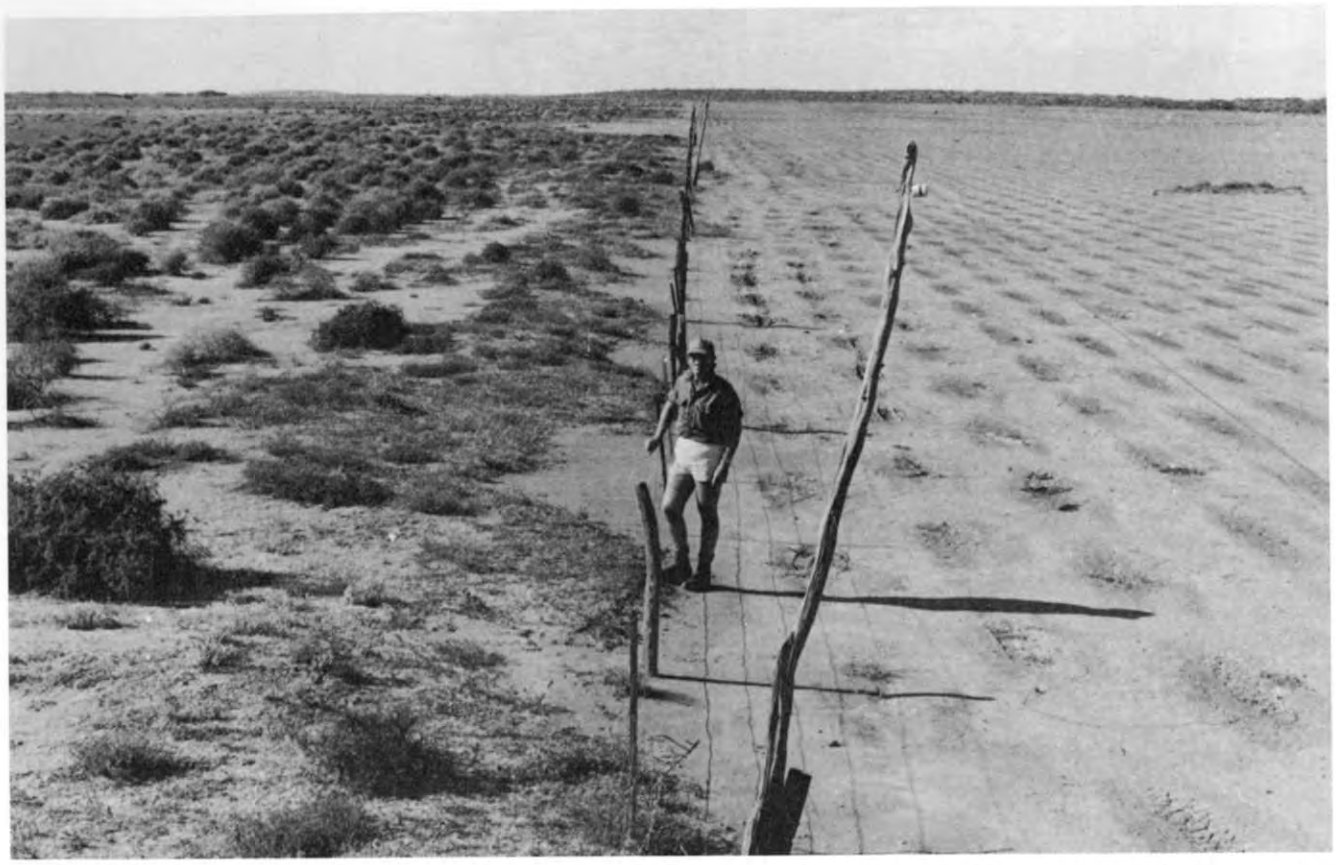
21. Serious gully erosion is only a local problem in the survey area, being largely confined to sloping plains with deep duplex or loamy soils receiving concentrated run-on from degraded areas. Alluvial plain, Gearle land system.



22. Severe degradation and erosion on an alluvial plain of the Delta land system. Note the scalded, sealed soil surface, root exposure and the original soil surface level.



23. Fenceline effect depicting complete removal of spiny bluebush *Maireana aphylla* shrubland through overgrazing an alluvial plain of the Delta land system.



24. Pitting treatments that create niches to trap wind-blown seeds and pond rainwater for seedling establishment as seen here on an alluvial plain of a Sable land system, are costly, labour intensive and often slow to take effect.

25. Massive wind erosion, Coast land system. Extreme fragility of the parabolic dunes renders them liable to blow-outs and complete loss of soil downwind from points of degradation and disturbance, such as along east-west fences and stock watering points near the coastline. In other instances, blow-outs may have been initiated by storms and wave action. Once in progress, blowouts are virtually unstoppable.

Acknowledgments

This survey could not have been conducted without the co-operation, advice and assistance of pastoralists throughout the area. The authors also wish to thank Messrs J. O'Brien, L.J. Merritt, R.J. Cranfield and J. De Salis for their assistance with the field work; staff of the Western Australian Herbarium (particularly R.J. Cranfield) for identifying many difficult specimens of plants collected and M. D'Antuono for assistance with data management and analysis; P. Commander, N.G. Marchant, K. Tinley, M. Wells and D.G. Wilcox commented critically on various sections of the manuscript. The Carnarvon Regional Office of the Department of Agriculture assisted the survey in many ways, for which we wish to record our thanks. Finally, the staff of the Department of Agriculture's Word Processing Centre typed up and re-worked the drafts of our manuscript with patience and precision.

References

Anon. (1915). Report of proceedings of the Second Interstate Conference on Artesian Water, Brisbane, 1914, Appendix D, pp. 252-259.

Anon. (1921). Progress in Western Australia since 1914 conference, and Appendix N. Report of Proceedings of the Third Interstate Conference on Artesian Water, Adelaide 1921, pp. 29-31 and 54-56.

Anon. (1925). Appendix A: Statement of progress in Western Australia 1921 conference. Report of Proceedings of the Fourth Interstate Conference on Artesian Water, Perth 1924. pp. 16-17.

Anon. (1978). A basis for soil conservation policy in Australia. Commonwealth and State Government Collaborative Soil Conservation Study 1957-77, Report No. 1. Department of Environment, Housing and Community Development, Australian Government Publishing Service, Canberra.

Bagnouls, F. and H. Gaussen (1957). Climats biologiques et leur classification. *Annales de Geographie 355*: 193-220.

Battye, J.S. (Ed.) (1915). The history of the north-west of Australia embracing Kimberley, Gascoyne and Murchison Districts. Perth, Western Australia.

Beard, J.S (1975). Vegetation survey of Western Australia, Pilbara 1:1000000 vegetation series - Explanatory notes to sheet 5. University of Western Australia Press.

Beard, J.S (1976). Vegetation survey of Western Australia, Murchison 1:1000000 vegetation series - Explanatory notes to sheet 6. University of Western Australia Press.

Beard, J.S (1982). Late Pleistocene aridity and aeolian landforms in Western Australia. pp. 101-106 *In:* Evolution of the flora and fauna of arid Australia, by W.R. Barber and P.M. Greenslade (eds.) Peacock Publications, Frewville, South Australia.

Bettenay, E., Churchward, H.M. and McArthur, W.M. (1967). Atlas of Australian Soils, Explanatory Data for Sheet 6, Meekatharra - Hamersley Range Area. CSIRO and Melbourne University Press.

Bowler, J.M. (1982). Aridity in the late Tertiary and Quaternary of Australia pp. 35-45 *In:* Evolution of the flora and fauna of arid Australia, by W.R.Barker and P.J.M. Greenslade (eds.) Peacock Publications, Frewville, South Australia.

Bowler, J.M. and R. Jones (1979). Australia was a land of lakes. *Geographical Magazine 51*: 679-685.

Brooker, M.G. and M.G. Ridpath (1980). The diet of the Wedge-tailed Eagle. *Aquila audax* in Western Australia. *Australian Wildlife Research 7*: 433-452.

Burbidge, A.A. and A.S. George (1978). The flora and fauna of Dirk Hartog Island, Western Australia. *Journal of the Royal Society of Western Australia 60*: 71-90.

Burvill, G.H. (Ed.). Agriculture in Western Australia 1829-1979. (University of Western Australia Press, 1979).

Carmody, R.W. Shark Bay - Its Story 1616-1969. A thesis (Unpublished).

Cheam, A.H. (1984). A 'natural' herbicide against Caltrope? *Journal of Agriculture, Western Australia* **1**:42.

Christensen, P.E.S. (1980). A sad day for native fauna. *Forest Focus* **23**: 3-12.

Christian, C.S. and Stewart, G.A. (1953). Summary of general report on survey of Katherine - Darwin Region 1946. *Land Research Series* 1, p.24.

Christian, C.S. and Stewart, G.A. (1968). Methodology of integrated survey. Aerial Surveys and Integrated Studies, UNESCO, Paris, p. 233-280.

Clarke, E. de C. (1926). Natural regions in Western Australia. *Journal of the proceedings of the Royal Society of Western Australia* **12**: 117-132.

Coblentz, B.E. (1977). Some range relationships of feral goats on Santa Catalina Island, California. *Journal of Range Management* **30**: 415-419.

Condon, M.A. (1965-68). The geology of the Carnarvon Basin, Western Australia. Part I: Pre-Permian stratigraphy; (1965), Part II: Permian stratigraphy; (1967), Part III: Post-Permian stratigraphy; (1968). *Australian Bureau of Mineral Resources Bulletin 77.*

Cook, R.W. and Warren, A. (1973). Geomorphology in Deserts. B.T. Batsford. Ltd. London.

Curry, P.J. (1986). Fire-induced changes in grazed wanyu (*Acacia ramulosa*) shrublands on the Victorian sandplain, Western Australia. In Rangelands: A Resource Under Seige, 597-8. Proceedings of 2nd International Rangelands Congress Adelaide, May 1984. Australian Academy Science/Cambridge University Press.

Curry, P.J., Payne, A.L., Wilcox, D.G. (1983). Suggested descriptive terms for classes of foliar cover in arid zone shrublands. *Range Management Newsletter* **83** (3): 12-13.

Davies, S.J.J.F. (1978). The food of emus. *Australian Journal of Ecology* **3**: 411-422.

Dyksterhuis, E.J. (1949). Condition and management of rangeland based on quantitative ecology. *Journal of Range Management* **2**: 104-115.

Ealey, E.H.M. (1967). Ecology of the euro *Macropus robustus* (Gould), in North-Western Australia I. The environment and changes in euro and sheep populations. *CSIRO Wildlife Research* **12**: 9-25.

Fitzgerald, B.M., and Veitch, C.R.(1985). The cats of Herekopare Island, New Zealand, their history, ecology and effects on birdlife. *New Zealand Journal of Zoology* **12**: 319-330.

Fitzpatrick, E.A., Slatyer, R.O. and Krishnan, A. (1967). Incidence and duration of periods of plant growth in central Australia as estimated from climatic data. *Agricultural Meteorology* **4**, 389-404.

Gardiner, H.G. (1986). Dynamics of perennial plants in the mulga (*Acacia aneura* F. Muell) zone of Western Australia. I Rates of population change; II Survival and perennial shrubs and grasses. *Australian Rangeland Journal* **8**: 18-35.

Gentilli, J. (ed) (1971). Climates of Australia and New Zealand. Vol. 13 *In:* World survey of climatology Elsevier: Amsterdam.

Gentilli, J. and Fairbridge, R.W. (1951). The physiographic regions of Australia: (notes accompanying) a geomorphological map of Australia. University of Western Australia Press.

Graetz, R.D. (1981). Plant-animal interactions. *In:* Arid land ecosystems: structure, functioning and management. Vol. 2. by Goodall, D.W. and R.A.Perry (eds). Cambridge University Press.

Grice, D., Caughley, G. and Short, J. (1985). Density and distribution of emus. *Australian Wildlife Research* **12**: 69-73.

Hallam, S.J. (1985). The History of Aboriginal Firing. *In:* Fire Ecology and Management of Western Australian Ecosystems. Proceedings of May 1985 Symposium. WAIT Environmental Studies Group Report No. 14 pp. 7-20.

Hamann, O. (1979). Regeneration of vegetation on Santa Fé and Pinta Islands, Galapagos, after the eradication of goats. *Biological Conservation* **15**: 215-236.

Hodgkinson, K.C. and G.N. Harrington (1986). The case for prescribed burning to control shrubs in eastern semi-arid woodlands. *Australian Rangeland Journal* 7:64-74.

Hubach, P.H. (1981). The fox in Australia. Agriculture Protection Board of W.A., Forrestfield. August 1981. 20 pp.

Johnson, D. (1974). Sedimentation in the Gascoyne River delta, Western Australia: PhD Thesis (unpublished). University of Western Australia.

Johnstone, M.H., Jones, D.K., Pearson, G.R., Smith, D.N. and Thomas, B.M. (1976). The Phanerozoic of the Perth and Carnarvon Basins, Western Australia 25th International Geological Congress Excursion guide no. 39C, Sydney.

Jutson, J.T. (1934). An outline of the physiographical geology (physiography) of Western Australia. *Geological Survey Western Australian Bulletin* 95 (revised and reprinted from Bulletin No. 61, 1914).

King, D.R. (1984). Rabbits north of Carnarvon. *Journal of Agriculture Western Australia* **25**: 7-8.

Lange, R.T. and C.R. Graham (1983). Rabbits and the failure of regeneration in the Australian arid zone *Acacia*. *Australian Journal of Ecology* **8**: 377-381.

London, C. and R.R. Lamacraft (1976). Standard for testing and assessing range conditions in central Australia. *Australian Rangeland Journal* **1**: 40-48.

Loeffler, E. and Ruxton, B.P. (1969). Relief and landform map of Australia. In Australia Water Resources Council Hydrological Series 2.

Mabbutt, J.A. (1968). Review of concepts of land classification. In Stewart, G.A. (ed.). Land evaluation. Macmillan, Melbourne, 11-28.

Mabbutt, J.A. (1973). Landform types in Australia. Booklet and map in the Atlas of Australian Resources, 2nd series Department of Geography, University of New South Wales, Sydney.

Mackay, N.J. (1963). An assessment of the underground water resources of Western Australia, *Western Australia Geological Survey Annual Report* 1962 p. 8-13.

Maitland, A.G. (1913). The artesian water resources of Western Australia. Report of Proceedings of Interstate Conference on Artesian Water, Sydney 1912. Appendix M and N. p. 115-158.

Maitland, A.G. and Montgomery, A. (1919). Map of Western Australia showing the known Artesian Basins, in Geological Survey of Western Australia Bulletin No. 89.

McNamara, K.J. and R.I.T. Prince (1986). Kangaroo mangement in Western Australia. Wildlife Mangement Programme No. 3. Department of Conservation and Land Management, Western Australia 32 pp.

Mitchell, A.A., McCarthy, R. and Hacker, R.B. (1979). A range inventory and condition survey of part of the Western Australian Nullabor Plain, 1974. *Western Australian Department of Agriculture Technical Bulletin* No. 47.

Nicholls, N. (1983). Predictability of the 1982 Australian Drought *Search* **14**: 154-155.

Northcote, K.H. (1979). A Factual Key for the Recognition of Australian Soils. 4th Edition, Rellim Technical Publications, Adelaide, South Australia.

Oliver, A.J.O. (1986). Social behaviour and dispersal in the red kangaroo - PhD Thesis (unpublished). Murdoch University, Western Australia.

Payne, A.L., Kubicki, A., Wilcox, D.G. and Short, L.C. (1979). A report on erosion and range condition in the West Kimberley area of Western Australia. *Western Australia Department of Agriculture Technical Bulletin* No. 42.

Payne, A.L., Mitchell, A.A. and Holman, W.F. (1982). An inventory and condition survey of rangelands in the Ashburton River catchment, Western Australia. *Western Australia Department of Agriculture Technical Bulletin* No. 62.

Rognon, P. and Williams, M.A.J. (1977). Late Quaternary climatic changes in Australia and North Africa: a prelimary interpretation. *Palaeogeography, Palaeoclimatology and Palaeoecology*. **21**: 285-327.

Suijdendorp, H. (1967). A study of the influence of management practices on spinifex (*Triodia pungens*). University of Western Australia M.Sc. (Agric.) Thesis (unpublished).

Suijdendorp, H. (1981). Responses of the hummock grasslands of north western Australia to fire. *In:* Gill, A.M., Groves, R.H. and Noble I.R. (eds) Fire and the Australian biota. Australian Academy of Science, Canberra.

Thomas, B.M. and Smith, D.N. (1974). A summary of the petroleum geology of the Carnarvon Basin. *Australian Petroleum Exploration Association Journal* **14**: 66-76.

Thomas, B.M. and Smith, D.N. (1976). Carnarvon Basin. In Leslie, R.B., Evans, H.J. and Knight, C.L. (Eds). Economic geology of Australia and New Guinea. *Australian Institute of Mining and Metallurgy Monograph* No. 7.

Thomson, P.C. (1984). Dingoes and sheep in pastoral areas. *Journal of Agriculture Western Australia* **25**: 27-31.

Tidmarsh, C.E.M. and Havenga, C.M. (1955). The wheel point method of survey and measurement of semi-arid grasslands and Karoo vegetation in South Africa. *Botanical Survey of South Africa Memoir* No. 29.

van de Graaff, W.J.E., Denman, P.D., Hocking, R.M. and Baxter, J.L. (1980). Explanatory notes on the Yanrey-Ningaloo 1:250,000 Geological Sheet. Government Printer, Perth.

Wilcox, D.G. and McKinnon, E.A. (1972). A report on the condition of the Gascoyne catchment, Western Australia. *Department of Agriculture Technical Report* no. 2.

Wilson, A.D. and Harrington, G.N. (1984). Grazing ecology and animal production. *In:* Management of Australia's Rangelands, by G.N. Harrington, A.D. Wilson and M.D. Young (eds) CSIRO, Melbourne.

Wood-Jones, F. (1925). The Mammals of South Australia. Govt. Printer, Adelaide. (Reprinted 1969).

APPENDIX 1
Station Reports

Station reports are presented alphabetically, using a standardized format. Reports should be read in conjunction with the relevant 1:250,000 scale land system maps which show cadastral boundaries, land system boundaries, watering points, major topographic features, traverse routes and recordings, range evaluation (inventory) sites and severely degraded and eroded areas.

Each report presents a summary description of land systems on the station and their areas and pastoral value. Condition statements derived from traverse records are presented for each land system. Statements for component units of each land system are not presented here, but these data are available.

Descriptive statements of the range condition of each land system are made together with management recommendations where necessary.

The table at the end of each station report lists all land systems and their component pasture types present on the station. The areas of each pasture type in good, fair and poor range condition are indicated, as determined from traverse records obtained during the survey.

Suggested stocking rates for modal seasonal conditions are presented with each pasture type for each level of condition (table 29). The total carrying capacity of each pasture type and land system on each station has been estimated in this way. A table for each station shows the recommended sheep unit capacity of the land systems for their present range condition. One sheep unit is defined as a dry ewe or a wether; for properties running cattle the generally accepted conversion rate of 8 sheep units has been used to convert cattle numbers. The table also indicates the capability sheep unit capacity if the systems were all in good range condition. Recommended and capability sheep capacities for the whole station are obtained by summation and rounded to the nearest 50.

A summary (table 32) of all stations is presented before the individual reports. The table includes a column showing the ratio of recommended sheep unit capacity:capability sheep unit capacity. This figure gives an indication of how far removed the present range condition of each station is from uniformly good condition and is a measure of the degree of degradation that has occurred. A figure of 1.0 indicates that present condition is all good to optimal. The lower the fraction the greater the departure is from ideal condition.

Individual reports presented here are for the following stations:

Boolathana, Boologooro, Brickhouse, Bullara, Callagiddy, Callytharra Springs, Carbla, Cardabia, Carey Downs, Carrarang, Coburn, Cooralya, Dirk Hartog, Doorawarrah, Edaggee, Ella Valla, Exmouth Gulf, Faure, Gilroyd, Gnaraloo, Hamelin, Hill Springs, Lyndon, Manberry, Mardathuna, Marron, Meadow, Meedo, Meeragoolia, Mia Mia, Middalya, Minilya, Mooka, Nanga, Nerren Nerren, Ningaloo, Peron, Pimbee, Quobba, Talisker, Tamala, Towrana, Towera, Wahroonga, Wandagee, Warroora, Williambury, Winderie, Winning, Woodleigh, Wooramel, Yalardy, Yalbalgo and Yaringa.

Table 32. Conditions and carrying capacity summary of stations.

Station	Area km²	Range condition km²			Extreme degradation km²	Total sheep capacity		Ratio recommend: capability cattle (C)	Present stock nos (1982) sheep(S)	Remarks
		Good	Fair	Poor		Recommended capability				
Boolathana	1455	809	397	206	43	16650	21950	0.76	10000 (S) 110 (C)	Mostly high potential country, condition fair to good except parts Sandal, Delta and Coast l.s. severely degraded, some parts inadequately watered.
Boologooro	741	497	155	89	-	8800	10700	0.82	5600 (S)	Mostly high potential country, condition predominantly good or fair, insufficient or saline stock waters in parts.
Brickhouse	2263	827	720	612	104	24450	37950	0.64	29000 (S) 336 (C)	High pastoral potential, condition variable but extensive parts Delta l.s. severely degraded, some parts inadequately watered.
Bullara	1109	999	84	24	2	17000	18050	0.94	11638 (S) 105 (C)	Soft spinifex and bluebush country largely in good range condition, some parts inadequately watered.
Calligiddy	654	173	324	157	-	6550	10000	0.66	7859 (S)	High pastoral potential country, condition predominantly fair.
Callytharra Springs	673	466	133	74	-	3950	4500	0.88	230 (S) 196 (C)	Mostly sandplain country with some rough hills, very incompletely developed.
Carbla	957	200	453	304	-	8800	17100	0.51	4051 (S)	Mostly high potential limestone country, parts degraded to fair or poor condition, no significant erosion, some extensive parts inadequately watered.

Table 32. Continued

Station	Area km²	Range condition km²			Extreme degradation km²	Total sheep capacity		Ratio recommend: capability cattle (C)	Present stock nos (1982) sheep(S)	Remarks
		Good	Fair	Poor		Recommended capebility				
Cardabia	1998	1524	407	67	-	28450	32900	0.86	17349 (S) 321 (C)	Soft spinifex and bluebush country of high pastoral potential generally in good condition. Gearle and Firecracker systems need careful management.
Carey Downs	955	480	285	190	-	4900	6250	0.78	4416 (S)	Sandplain, stony plains and rough hills, condition variable but mostly fair or good, eastern parts not developed.
Carrarang	805	586	86	97	36	8000	97000	0.82	1747 (S)	Sandplain and dunes, range condition good except Coast l.s. highly sensitive and subject to blowouts, poorly developed and inadequately watered.
Coburn	1005	448	345	212	-	5150	7050	0.73	3022 (S)	Mostly sandplain in fair to good condition, inadequately watered.Nanga l.s. too poor to develop for pastoralism.
Cooralya	1619	586	762	271	-	13350	18650	0.72	21000 (S)	Sandplain and alluvial plains moderate to high potential, condition predominantly fair.
Dirk Hartog	616	475	103	20	18	5450	6300	0.87	3150 (S)	Sandy plains and coastal dunes, condition mostly good, Inscription l.s. too poor to develop for pastoralism, massive blowouts occur on sensitive Coast l.s., only partly developed and insufficient waters.
Doorawarrah	2193	525	1050	618	-	16900	27350	0.62	11498 (S)	Plains country of moderate to high pastoral value, pastures generally degraded to fair or poor condition.
Edaggee	679	167	311	201	-	6700	10450	0.64	7000 (S)	Alluvial plains with high pastoral value but pastures generally degraded and shrub invaded, inadequatély watered.
Ella Valla	761	321	320	120	-	7000	9650	0.73	7084 (S)	Sandy plains and low dunes moderate to high pastoral potential, condition variable but largely fair or good, no significant erosion.
Exmouth Gulf	930	864	66	-	-	8050	8250	0.98	10259 (S)	Sandy plains and rugged limestone ranges, condition good, most of Range l.s. is unsuitable for pastoralism.
Gilroyd	809	353	386	70	-	5600	6700	0.84	3195 (S)	Sandplain and dunes, moderate pastoral value, condition fair or good, additional water points needed.
Gnaraloo	913	625	225	51	12	10350	12550	0.82	4180 (S) 9 (C)	Sandplain and limestone country, moderate to high pastoral potential, condition mostly good, blowouts on Coast l.s., parts inadequately watered.
Hamelin	2028	584	624	820	-	16650	29900	0.56	8136 (S)	Sandy plains and limestone plains, moderate to high pastoral value, pastures generally degraded to fair or poor condition, some extra waters needed.

Table 32. Continued

Station	Area km²	Range condition km²			Extreme degradation km²	Total sheep capacity		Ratio recommend: capability cattle (C)	Present stock nos (1982) sheep(S)	Remarks
		Good	Fair	Poor		Recommended capability				
Hill Springs	1232	682	376	162	12	10600	13900	0.76	10000 (S)	Sandplain, dunes, stony plains of moderate value, range condition fair or good except Gearle l.s. which is seriously degraded, parts of station are not in use.
Lyndon	2482	1116	913	439	14	14950	20700	0.72	15648 (S)	Stony plains, alluvial plains and rough hills, moderate pastoral potential, condition generally good or fair but some severe degradation, some extra waters needed.
Manberry	854	165	450	239	-	5650	8350	0.68	6596 (S) 74 (C)	Sandy plains and dunes, moderate pastoral value, condition mostly fair but variable, some parts little used due to lack of waters.
Mardathuna	2433	1422	670	337	4	18600	23900	0.78	15500 (S) 500 (C)	Sandplain. alluvial plains, stony plains and rough plateaux, overall moderate value, condition mostly good or fair but Gearle l.s. severely degraded.
Marron	805	400	276	129	-	7500	10250	0.73	6250 (S) 38 (C)	Alluvial plains, sandplain and dunes moderate to high pastoral value, condition mostly good or fair but some degradation.
Meadow	832	405	323	104	-	6100	8500	0.72	1945 (S)	Mostly sandplain of moderate pastoral value, condition mostly good or fair, inadequately watered.
Meedo	1465	549	619	297	-	9250	12850	0.72	6928 (S) 10 (C)	Sandplain, dunes and alluvial plains of moderate pastoral value, condition fair to good but Lyons l.s. generally degraded.
Meeragoolia	260	42	111	107	-	2050	3900	0.53	4000 (S)	Alluvial plains of high pastoral value, pastures are shrub-invaded and degraded to fair or poor condition.
Mia Mia	2089	1301	492	287	9	21450	29400	0.73	24474 (S)	Sandplain and alluvial plains, moderate to high pastoral value, sandplain in good condition, elsewhere condition variable, Winning and Spot l.s. degraded.
Middalya	1997	1163	491	322	21	15200	19350	0.79	12300 (S)	Sandplain, alluvial and stony plains, hills, moderate pastoral value, condition mostly good but variable, parts Jimba l.s. severely degraded, some parts little used due to lack of waters.
Minilya	2733	1640	748	307	38	31050	40700	0.76	25000 (S) 1500 (C)	Sandy plains and alluvial plains of moderate and high pastoral value, condition variable, severe degradation on some alluvial systems, north-east parts inadequately watered.
Mooka	809	559	181	69	-	4700	5450	0.86	2418 (S)	Mostly sandy plains and dunes, moderate pastoral value, condition predominantly good or fair, western parts undeveloped.

Table 32. Continued

Station	Area km²	Range condition km²			Extreme degradation km²	Total sheep capacity		Ratio recommend: capability cattle (C)	Present stock nos (1982) sheep(S)	Remarks
		Good	Fair	Poor		Recommended capability				
Nanga	1751	1504	184	63	-	7700	8850	0.87	3000 (S)	Sandplain with very low value heath pastures, better pastures in north, range condition of used areas is fair, Nanga system too poor for pastoralism.
Nerren Nerren	1775	1153	412	210	-	9650	11400	0.85	4682 (S)	Sandplains of very low and moderate pastoral value, condition mostly good, additional waters required, Nanga system too poor for development.
Ningaloo	497	388	91	2	16	5950	6800	0.88	5817 (S)	Sandplain and dunes, generally high pastoral value, condition mostly good, large blowouts on sensitive Coast l.s., station poorly watered.
Peron	1052	421	372	244	15	8350	11650	0.72	7000 (S)	Sandy plains, moderate to high pastoral value, condition varies from good to poor, Taillefer system susceptible to wind erosion, parts inadequately watered.
Pimbee	565	153	279	133	-	3600	4850	0.74	3000 (S)	Sandplain and dunes, moderate pastoral value, condition mostly fair, some local pasture degradation, a few extra waters needed.
Quobba	750	555	172	18	5	9050	10350	0.87	4737 (S)	Sandplain, dunes and limestone plains, high pastoral value, condition mostly good but some local pasture degradation, large blowouts on sensitive Coast l.s., additional waters needed.
Talisker	2873	1479	1148	246	-	20800	24300	0.86	5150 (S)	Sandplain of moderate pastoral value, good or fair condition, much of station undeveloped due to lack of groundwater supplies.
Tamala	1297	1035	149	104	9	11500	13350	0.86	8500 (S) 32 (C)	Sandplain, dunes, limestone plains, pastoral value very low to very high, condition mostly good except large blowouts on sensitive Coast l.s., inadequately watered.
Towera	2061	1089	674	288	10	13950	17550	0.79	3238 (S)	Sandy plains, stony plains and hills, moderate pastoral value, variable condition, some local areas of severe degradation, some extra waters needed.
Towrana	1627	474	791	362	-	10200	13700	0.74	2908 (S)	Mostly sandplain and dunes, moderate pastoral value, condition mostly fair but some pastures degraded to poor.
Wahroonga	830	362	265	203	-	6150	9300	0.66	5804 (S)	Sandplain, dunes and alluvial plains, moderate to high pastoral potential, condition varies good to poor, some pastures are shrub invaded, additional waters needed.
Wandagee	1924	776	630	490	28	16550	24800	0.67	21545 (S) 40 (C)	Alluvial plains and sandplain, moderate to high pastoral potential, condition variable, some extensive areas of severe degradation, parts inadequately watered.

Table 32. Continued

Station	Area km²	Range condition km²			Extreme degradation km²	Total sheep capacity		Ratio recommend: capability cattle (C)	Present stock nos (1982) sheep(S)	Remarks
		Good	Fair	Poor		Recommended capability				
Warroora	1077	812	259	5	1	16350	18500	0.88	10084 (S)	Sandplain, alluvial plains and limestone plains of high pastoral value, range condition good or fair, inadequately watered.
Williambury	2728	1125	1028	551	24	14050	20150	0.70	8000 (S) 120 (C)	Stony plains, alluvial plains, rough hills, overall pastoral value moderate, condition varies good to poor, severe degradation on parts of Jimba l.s.
Winderie	692	152	372	141	27	3900	5800	0.67	6294 (S)	Sandplain, dunes, and alluvial plains of moderate pastoral value, condition mostly fair, severe degradation on parts Bidgemia and Jimba l.s.
Winning	1585	682	337	544	22	13450	22300	0.60	17000 (S) 220 (C)	Sandy plains and alluvial plains, pastoral value moderate to high, condition variable but considerable pasture depletion and parts of Winning l.s. severely degraded.
Woodleigh	2331	1330	790	211	-	17050	19650	0.87	14600 (S) 20 (C)	Sandplain of moderate pastoral value, condition mainly good or fair, some large areas inadequately watered.
Wooramel	1414	508	360	378	168	13000	22550	0.58	4253 (S)	Alluvial plains of high pastoral value, condition varies from good to poor, large parts Delta l.s. severely degraded, additional waters needed.
Yalardy	1012	719	205	88	-	7550	8350	0.90	4000 (S)	Sandplain and dunes, moderate pastoral value, condition mostly good or fair, some large parts inadequately watered.
Yalbalgo	865	242	460	163	-	6300	9050	0.70	5000 (S) 15 (C)	Sandplain and dunes of moderate to high pastoral value, condition mostly fair, some large areas inadequately watered.
Yaringa	1227	440	479	308	-	10000	13550	0.74	4620 (S)	Sandplain and limestone plains of moderate to high pastoral value, condition varies from good to poor, large areas inadequately watered.
TOTALS	71145	36396	22351	11760	638	596200	801350	-	455078(S) 3658 (C) =484342	sheep units

Boolathana station - Carnarvon Shire

Area 1,455 km²

Location

Boolathana station is located on the Quobba 1:250,000 map sheet. The homestead is about 35 km north by road from Carnarvon and the station has common boundaries with Quobba, Boologooro, Cooralya, Doorawarrah and Brickhouse stations and the Carnarvon townsite. In the west the station has about 23 km of Indian Ocean coastline and in the north-west it abuts onto Lake McLeod.

Description

All of the station is accessible to livestock and more than 90% of the country is of high pastoral value.

The largest and most valuable land systems on the station are Sable (24.1% of the station area), Sandal (17.9%), Delta (16.1%) and Waroora (13.4%). These systems all consist of almost flat saline and non-saline alluvial plains with varying proportions of low sandy banks and rises. They support extensive low shrublands of saltbush and bluebush and patches of tall acacia shrublands on the sandy rises. The Delta system is marginally lower than the other systems and consists of active floodplains with numerous scalds and scoured areas associated with flooding from the Gascoyne River.

Two sand dune systems, Lyell (4.5%) and Coast (4.3%) occur in the west. These systems and the gently undulating sandy plains of the Brown system (12.3%) support acacia shrublands with useful low shrubs including saltbush. The introduced buffel grass is well established on parts of these systems and on sandy elements of many other systems throughout the station.

All land systems found in the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Boolathana station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Brown - gently undulating sand plains and occasional dunes; tall mixed acacia shrublands, also buffel grass.	12.3
	McLeod - samphire flats and sandy plains with bare marginal mudflats; samphire and saltbush low shrublands.	3.7
	Mallee - undulating sandy plains with limestone at shallow depth; mallee shrublands with soft and hard spinifex.	0.7
	Lyons - sandy alluvial plains with numerous claypans and reticulate and linear dunes; currant bush and acacia mixed shrublands.	0.5
		17.2
High (5-9 ha/s.u.)	Sable - nearly flat saline alluvial plains, minor sandy banks; saltbush and bluebush shrublands.	24.1
	Sandal - alluvial plains with numerous low sandy rises and banks, duplex and sand soils; currant bush and acacia mixed shrublands and bluebush.	17.9
	Delta - almost flat, active alluvial floodplains, low shrublands of saltbush and bluebush	16.1
	Warroora - nearly flat, saline alluvial plains, sluggish drainage tracts and prominent drainage foci, minor limestone outcrop plains and sandy banks; low shrublands of saltbush and bluebush.	13.4
	Lyell - linear and reticulate dunes with saline interdunal plains; acacia shrublands and saltbush.	4.5
	Coast - large, long walled parabolic coastal dunes and narrow swales, unstable blowout areas, narrow swales, rocky wave cut platforms and beach; mixed low shrubs, also buffel grass.	4.3
	Target - plains with sandy banks, more clayey interbank areas and numerous small drainage foci; currant bush mixed shrublands and acacia shrublands	0.1
		80.4
Very high (> 5 ha/s.u.)	Chargoo - nearly flat, saline alluvial plains with numerous drainage foci and swampy depressions, chenopod shrublands and tussock grasses.	0.2
	Bare surfaces of Lake McLeod	2.2
		100.0

Table 2. Condition statements derived from traverse records (257 recordings on 8 land systems)

Boolathana

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Brown	20	100	—	—	—	30	30	30	10	—	60	30	10
Coast	1	100	—	—	—	—	100	—	—	—	100	—	—
Delta	99	39	26	23	12	8	33	18	14	27	39	19	42
Lyell	14	100	—	—	—	43	50	7	—	—	93	7	—
MacLeod	9	100	—	—	—	89	11	—	—	—	100	—	—
Sable	40	100	—	—	—	20	30	35	15	—	50	35	15
Sandal	31	80	10	10	—	3	32	49	13	3	35	46	19
Warroora	43	100	—	—	—	42	49	9	—	—	91	9	—
Total over all land systems	257	74	11	10	5	21	35	23	10	11	56	23	21

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 22 sites on 8 land systems.

Range condition and recommendations

1. Sable land system (24.1%)

Saltbush (SALT) and Bluebush (BLUE) pastures on this system are mostly in fair to very good condition although some localized areas show shrub depletion to poor condition. There is no erosion on the system and over all range condition is predominantly fair or good.

2. Sandal land system (17.9%)

This system supports valuable Currant Bush Mixed Shrub Pastures (CBMS) and some Bluebush (BLUE) on the duplex soils of the alluvial plains and Acacia Sandplain pastures (ACSA) on the sandy banks. Condition of the Currant Bush Mixed Shrub pastures is about evenly distributed between good, fair and poor with the poorer areas showing loss of desirable shrubs such as currant bush, Gascoyne bluebush and tall saltbush. The Acacia Sandplain pastures are nearly all in fair or good condition. Localized parts of the system show minor and moderate erosion in the form of patchy scalding and surface sheeting.

Taken over all the traverse data indicates that about 20% of this system is in poor range condition, with 45% and 35% being in fair and good range condition respectively. The poorer parts of the system could be readily improved by spelling from grazing over a number of growing seasons.

3. Delta land system (16.1%)

The alluvial flood plains of this system support mixed Saltbush (SALT) and Bluebush (BLUE) pastures. Condition of the pastures varies from very good to very poor. More than 40% of the traverse recordings indicated poor or very poor pasture condition with desirable shrubs such as bladder saltbush and low bluebush severely depleted or absent. On some sites, notably to the north of the homestead, the undesirable needle bush appears to be increasing.

Wind and water erosion is common on the system and has resulted in extensive bare scalded surfaces and areas with hummocking and shallow scouring. About 29 km² (12%) of the system shows extreme pasture degradation with moderate to severe erosion. These areas should not be used for grazing and require special remedial treatments including cultivation works and seeding to facilitate rehabilitation. Cultivation treatments have already been attempted over large areas and have met with mixed success.

4. Warroora land system (13.4%)

This system is nearly all in good range condition with Bluebush (BLUE) and Saltbush (SALT) pastures in good or very good condition and no erosion. Some parts are not fully used due to the distance from water and/or the fairly high levels of salt in some of the stock waters.

5. Brown land system (12.3%)

This system supports Acacia Sandplain pastures with an overstorey of silver bark wattle with other shrubs such as tall saltbush, sand plain poverty bush, and Wilcox bush and various grasses. Pasture condition is mostly fair to very good and there is no erosion. Considerable death of shrubs has occurred in the past on some heavily used areas, but these now support good stands of the introduced buffel grass.

6. Lyell land system (4.5%)

This sand dune system supports Coastal Dune Shrub pastures (CDSH) with low shrubs such as coastal jam and *Calytrix* sp. on the dunes and a wide range of more useful shrubs such as silver saltbush, *Rhagodia* sp.; and other chenopods on the inter-dunal plains. Pasture condition is good or very good and there is no erosion.

7. The remaining six land systems on the station collectively occupy 9.5% of the station area. Pastures are in good or very good condition and there is no erosion except for one large sand blowout on the Coast system.

8. In general the station is well subdivided into paddocks. Although the station has numerous watering points, some areas in the north, north-east and elsewhere are inadequately watered and some of the supplies are very saline. High salt intake by sheep (resulting from a combination of salty stock waters and saline pastures) means that grazing radii from water are shortened and pasture usage is restricted. As a consequence, many areas of Saltbush and Bluebush pastures have been under used. These areas need to be brought into production with more and/or better quality water supplies. This would enable the stocking pressure to be reduced on severely degraded parts of the station and facilitate rehabilitation works on those parts (which are almost exclusively confined to the Delta land system- see 3).

9. The recommended sheep unit capacity for present condition is 16,650.

10. The capability sheep unit capacity if all country was in good range condition is estimated at 21,950.

Individual station report

Boolathana station - 145,480 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sable	351	SALT	69	65	24	—	2,343	3,160
		BLUE	62	57	21	—	2,084	2,800
		ACSA	29	14	10	—	369	442
Sandal	261	CBMS	33	43	42	—	1,460	2,360
		ASCA	41	58	5	—	724	867
		BLUE	15	16	8	—	550	780
Delta	235	BLUE	32	22	37	15	1,146	2,120
		SALT	28	20	32	14	1,010	1,800
		ASCA	28	7	—	—	277	292
Warroora	194	BLUE	76	11	—	—	1,658	1,740
		SALT	68	10	—	—	1,485	1,560
		SAMP	29	—	—	—	116	116
Brown	178	ASCA	96	48	16	—	1,164	1,133
		SALT	6	6	6	—	233	360
Lyell	65	CDSH	39	3	—	—	509	525
		SALT	21	2	—	—	445	460
Coast	62	CDSH	35	8	5	14	515	775
McLeod	54	SAMP	27	—	—	—	108	108
		SALT	11	—	—	—	220	220
		No veg	16	—	—	—	—	—
Mallee	10	HASP	5	1	—	—	28	30
		SOSP	3	1	—	—	58	67
Lyons	8	ACSA	2	2	—	—	29	33
		CBMS	—	2	—	—	25	40
		ACCR	—	—	—	—	—	—
		No veg	2	—	—	—	—	—
Chargoo	3	SALT	1	1	—	—	33	40
		TUGR	1	—	—	—	33	33
		BLUE	—	—	—	—	—	—
Target	2	CBMS	—	1	—	—	13	20
		ACSA	1	—	—	—	8	8
		ACCR	—	—	—	—	—	—
Lake McLeod	32	No veg	32	—	—	—	—	—
Totals	1,455		809	397	206	43	16,643	21,969

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 16,650

Capability 21,950

Declared stock numbers (sheep units or equivalents) 1968-1984 (no data for 1982):

average (mean) 18,693

highest (1974) 23,970

lowest (1980) 9,295

Boologooro station - Carnarvon Shire

Area 741 km²

Location

Boologooro station is located on the Quobba and Kennedy Range 1:250,000 map sheets. The homestead is adjacent to the North-West Coastal Highway about 80 km north of Carnarvon. The station has common boundaries with Minilya, Cooralya and Boolathana stations and with Lake McLeod to the west.

Description

The largest land system on the station is Sandal (48.6% of the station area) which occurs in central and southern parts. It consists of alluvial plains with duplex soils and numerous low sandy rises and banks. It supports mixed shrublands of currant bush, various acacias and some Gascoyne bluebush. Pastoral value is high.

The Warroora system (21.4%) occurs in the west and consists of almost flat saline alluvial plains with low shrublands of saltbush and bluebush and some tall acacia shrublands. Pastoral value is high.

Four other systems of high pastoral value occur on the station. The largest of these is Target (6.6%) which is found in the south of the station and consists of nearly flat plains with sandy banks and small but prominent drainage foci with dense vegetation. The plains support currant bush mixed shrublands and tall acacia shrublands.

The remainder of the station (16.6%) consists of land systems McLeod, Lyons and Yalbalgo which are of moderate grazing value. The McLeod system (7.2%) occurs in the central west and consists of saline plains with low shrublands of samphire and saltbush. The Lyons system occurs in the centre and north-east. It consists of sandy alluvial plains with numerous distinctive claypans surrounded by linear and reticulate dunes. Vegetation is currant bush mixed shrublands on the alluvial plains and tall shrublands of wanyu on the dunes. The Yalbalgo system consists of large linear dunes and sandy swales and vegetation is mainly a tall shrubland of wanyu.

All land systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Boologooro station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	McLeod - samphire flats and sandy plains with bare marginal mudflats, samphire and saltbush shrublands.	7.2
	Lyons - sandy alluvial plains with numerous claypans and reticulate and linear dunes; currant bush mixed shrublands and wanyu shrublands.	5.8
	Yalbalgo - sandplain with linear and reticulate dunes; tall shrublands of wanyu.	3.6
		16.6
High (5-9 ha/s.u.)	Sandal - alluvial plains with numerous low sandy rises and banks, duplex and sand soils; currant bush, acacia and bluebush mixed shrublands.	48.6
	Warroora - nearly flat, saline alluvial plains, sluggish drainage tracts and prominent drainage foci, minor limestone outcrop plains and sandy banks; low shrublands of saltbush and bluebush.	21.4
	Target - plains with sandy banks, more clayey inter-bank areas and numerous small drainage foci; currant bush mixed shrublands and acacia shrublands.	6.6
	Brown - gently undulating sand plains and occasional dunes; tall mixed Acacia shrublands.	2.5
	Sable - nearly flat saline alluvial plains minor sandy banks; low shrublands of saltbush and bluebush.	2.2
	Trealla - elevated limestone plains and plains with thin sand cover, minor steeper marginal slopes, tall mixed acacia shrublands	2.1
		83.4
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (109 recordings on 9 land systems)

Boologooro

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Brown	3	100	—	—	—	100	—	—	—	—	100	—	—
Lyons	14	100	—	—	—	7	50	29	14	—	57	29	14
MacLeod	1	—	—	—	100	—	—	—	—	100	—	—	100
Sable	2	100	—	—	—	—	50	—	50	—	50	—	50
Sandal	61	93	5	2	—	10	38	36	16	—	48	36	16
Target	2	100	—	—	—	—	50	50	—	—	50	50	—
Trealla	3	100	—	—	—	67	33	—	—	—	100	—	—
Warroora	20	90	10	—	—	40	40	15	5	0	80	15	5
Yalbalgo	3	100	—	—	—	—	—	67	33	—	—	67	33
Total over all land systems	109	93	5	1	1	18	38	29	14	1	56	29	15

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 4 sites on 2 land systems.

Range condition and recommendations

1. Sandal land system (48.6%)

The Currant Bush Mixed Shrub pastures (CBMS) on the duplex soil plains of the system are mostly in good condition although some 22% of the traverse records indicate shrub losses and poor condition. The Acacia Sandplain (ACSA) pastures of the low sandy rises of the system are in fair to very good condition. Degraded areas would respond well to spelling from grazing over a number of growing seasons.

2. Warroora land system (21.4%)

The Saltbush (SALT) and Bluebush (BLUE) pastures of this system are mostly in good or very good condition and there is very little erosion. The system is under used due to the general lack of good quality stock water supplies.

3. McLeod land system (7.2%)

Because of the highly saline nature of the Samphire (SAMP) and Saltbush (SALT) pastures the system is only of limited use for pastoral purposes. The problem of high levels of salt intake by stock are increased if stock water supplies are also saline. Condition of the pastures is good or very good.

4. Target land system (6.6%)

The system was not intensively sampled but where seen was in fair or good range condition.

5. Lyons land system (5.8%)

The Currant Bush Mixed Shrub (CBMS) pastures on this system are mostly in fair or good condition although some areas show partial degradation to poor condition. Acacia Sandplain (ACSA) pastures dominate the dunes and sandy swales of the system and are good condition.

6. Yalbalgo land system (3.6%)

The system was insufficiently sampled but from knowledge of the Acacia Sandplain pastures of the system as seen elsewhere during the survey, condition is expected to be fair or good. The system is not prone to erosion.

7. The remaining three minor land systems are in fair or good range condition.

8. The station is well subdivided into paddocks but, as is common with stations in the coastal strip north and south of Carnarvon, has some problems of insufficient or poor quality (saline) stock water supplies. High salt intake by stock resulting from a combination of saline pastures and saline waters means that grazing range around waters is often severely restricted. As a result many of the Saltbush and Bluebush pastures on the station are not fully used. The provision of more frequent, better quality stock waters is required so that these valuable pastures may be fully used.

9. The recommended sheep unit capacity for present condition is 8,800.

10. The capability sheep unit capacity if all country was in good range condition is estimated at 10,700.

Individual station report

Boologooro station - 74,117 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandal	360	CBMS	108	18	36	—	2,610	3,240
		ASCA	92	48	4	—	1,083	1,200
		BLUE	36	6	12	—	870	1,080
Warroora	158	BLUE	46	11	6	—	1,095	1,260
		SALT	44	14	5	—	1,086	1,260
		SAMP	32	—	—	—	128	128
McLeod	54	SAMP	27	—	—	—	108	108
		SALT	11	—	—	—	220	220
		No veg	16	—	—	—	—	—
Target	49	CBMS	2	9	11	—	221	440
		ACSA	7	10	3	—	133	167
		ACCR	3	3	1	—	95	140
Lyons	43	ACSA	16	4	2	—	166	183
		CBMS	4	4	1	—	136	180
		ACCR	—	3	—	—	30	60
		No veg	9	—	—	—	—	—
Yalbalgo	27	ACSA	13	10	4	—	187	255
Brown	18	ASCA	10	5	1	—	119	133
		SALT	1	1	—	—	33	40
Sable	17	SALT	5	2	1	—	131	160
		BLUE	4	2	1	—	111	140
		ACSA	1	1	—	—	15	17
Trealla	15	ACMS	9	4	1	—	226	280
		BLUE	1	—	—	—	20	20
Totals	741		497	155	89	—	8,823	10,711

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 8,800

Capability sheep unit capacity 10,700

Declared stock numbers (sheep units or equivalent) 1968-1983 (no data for 1971, 1977, 1982, 1984):

average (mean) 8,642

highest (1972) 13,250

lowest (1983) none

Brickhouse station - Carnarvon Shire

Area 2,263 km²

Location

Brickhouse station is located on the Quobba, Kennedy Range, Shark Bay and Wooramel 1:250,000 map sheet. The homestead is about 19 km east by road from Carnarvon. The station has common boundaries with Boolathana, Doorawarrah, Meeragoolia and Callagiddy stations and to the Carnarvon townsite area. Its western side extends to a long coastline north of Shark Bay.

Description

The Gascoyne River runs through the station from east to west and divides it into two sections, about one-third north of the river and two-thirds to the south.

The station consists largely of broad, saline and non-saline active floodplains and stable floodplains of the Gascoyne River delta. All of the station is accessible to livestock and nearly all of it is of high pastoral value.

The most extensive land systems are Sandal (34.9% of the station area), Delta (28.2%) and Sable (26.3%). These three systems all consist of almost flat alluvial plains with varying proportions of low sandy banks and rises. They support low shrublands of saltbush and bluebush over broad plains and patches of tall acacia shrublands on the sandy rises. The Delta system is marginally lower than the other systems and consists of active flood plains of the Gascoyne River. It is susceptible to degradation and has numerous scalded, hummocked and water scoured areas.

The remaining seven land systems on the station collectively occupy only 10.6% of the total area. Of these the Brown (3%), Littoral (2.5%) and River (2.5%) systems are the most significant.

The Brown system occurs in the west near the coast and consists of undulating sandy plains and occasional large dunes. It supports tall acacia shrublands sometimes with a ground storey of buffel grass.

The Littoral system occurs as a long strip fringing the coastal margin of the station. It consists of low, stabilized sand dunes and narrow sandy plains fronting onto highly saline samphire flats and bare tidal sandflats with mangroves on the outer margins.

The River system occurs as a narrow strip of country on either side of the Gascoyne River. It includes the river channel, banks and narrow levee zones. Vegetation on the levees is a scattered eucalypt and acacia woodland frequently with a ground storey of dense buffel grass. The river channel is lined with large river red gums.

All ten systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) are summarised in table 2. These statements were derived from traverse records.

Table 1. Land systems on Brickhouse station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Brown - gently undulating sand plains and occasional dunes; tall acacia shrublands also buffel grass.	3.0
	Littoral - low coastal foredunes, samphire and tidal flats and mangrove fringes.	2.5
		5.5
High (5-9 ha/s.u.)	Sandal - alluvial plains with numerous low sandy rises and banks, duplex and sand soils; currant bush, acacia and bluebush mixed shrublands.	34.9
	Delta - almost flat, active alluvial flood plains, low shrublands of saltbush and bluebush.	28.2
	Sable - nearly flat, saline alluvial plains, minor sandy banks; low shrublands of saltbush and bluebush.	26.3
	River - narrow active floodplains and levees with major channels; fringing woodlands and tall shrublands with tussock grasses.	2.5
	Lyons - sandy alluvial plains with numerous claypans and reticulate and linear dunes; currant bush mixed shrublands and acacia shrublands.	1.6
	Ella - short linear dunes and sandy banks with interdunal plains and drainage foci, sand dune gidgee woodlands and mixed shrublands.	0.4

Table 1 Continued...

Pastoral value	Land systems	Area %
	Target - plains with sandy banks, more clayey interbank areas and numerous small drainage foci; currant bush mixed shrublands and acacia shrublands.	< 0.1
		94.0
Very high (< 5 ha/s.u.)	Chargoo - nearly flat, saline alluvial plains with numerous drainage foci and swampy depressions, chenopod shrublands and tussock grasses	0.5
		100.0

Table 2. Condition statements derived from traverse records (427 recordings on 8 land systems)

Brickhouse

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Brown	8	100	—	—	—	—	61	39	—	—	62	38	—
Cahill	3	100	—	—	—	33	67	—	—	—	100	—	—
Delta	172	32	26	23	19	2	18	26	26	28	20	21	59
Ella	3	100	—	—	—	—	—	67	33	—	—	67	33
Littoral	14	100	—	—	—	86	7	7	—	—	93	7	—
Lyons	3	100	—	—	—	—	67	33	—	—	67	33	—
Sable	94	97	3	—	—	13	37	33	16	1	50	33	17
Sandal	130	93	5	2	—	2	33	40	24	1	34	41	25
Total over all land systems	427	70	12	10	8	7	28	31	22	12	35	30	35

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 20 sites on 5 land systems.

Range condition and recommendations

1. Sandal land system (34.9%)

This system supports valuable Currant Bush Mixed Shrub pastures (CBMS) and some Bluebush (BLUE) on the duplex soils of the alluvial plains and Acacia Sandplain pastures (ACSA) on the sandy rises. Condition of the Currant Bush Mixed Shrub pastures is mostly fair although there are also considerable areas in good and poor condition. The poorer parts show considerable loss of desirable shrubs such as currant bush, Gascoyne bluebush and tall saltbush. Condition of the Acacia Sandplain pastures varies from poor to good. A few parts of the system show minor erosion, but in general the system is stable.

The traverse data indicates that about 25% of the system is in poor range condition with depleted pastures. Some 41% and 35% are in fair and good range condition respectively. The poorer parts could be readily improved by spelling from grazing over a number of growing seasons.

2. Delta land system (28.2%)

The flood plains of this system support mixed Saltbush (SALT) and Bluebush (BLUE) pastures. Pasture condition is mostly poor or very poor with minor areas in fair or good condition. Very poor condition is indicated by severe depletion of desirable shrubs such as bladder saltbush, low bluebush and Gascoyne bluebush.

Wind and water erosion is common on the system and has resulted in extensive, bare scalded surfaces and areas with hummocking and water scouring.

About 104 km^2 (16%) of the system shows extreme pasture degradation with moderate to severe erosion. These areas should not be used for grazing and require special remedial treatments including cultivation works and seeding to facilitate rehabilitation. Less severely degraded areas could be improved by regular spelling from grazing over a number of growing seasons.

The system is subject to regular flooding from the Gascoyne River and is inherently susceptible to water erosion. Where vegetative ground cover is depleted by excessive grazing pressure the susceptibility to water erosion is markedly increased.

The largest single areas of degradation on the Delta system are north of the Gascoyne River in Neenalia, Canterbury and Neemanwarra paddocks. There are also extensive areas of degradation south of the river in parts of East Coburn, Mooloolo, Standard, East Coast and Wanargie paddocks and also in West Coast paddock in the vicinity of Argyle tank.

3. Sable land system (26.3%)

This stable floodplain system is slightly more elevated than the adjacent Delta system and is not subject to regular flooding from the Gascoyne River. It supports Saltbush (SALT) and Bluebush (BLUE) pastures which are mostly in fair or good condition. There is no erosion on the system and over all range condition is predominantly good or fair.

4. Brown land system (3%)

Acacia Sandplain (ACSA) pastures on this system are mostly in good condition with smaller areas in fair condition. There is no erosion.

5. Littoral land system (2.5%)

This system supports Coastal Dune Shrub (CDSH) pastures and highly saline Samphire (SAMP) pastures. Pasture condition is nearly all very good.

6. The remaining five minor systems on the station were not intensively sampled but, where seen, were in fair or good condition. The River system (2.5%), although small, provides useful grazing as it supports dense stands of buffel grass on the banks and narrow levees flanking the Gascoyne River.

7. Although the station is well developed with numerous paddocks and watering points there are still considerable areas that are poorly used because of their excessive distance (> 4 km) from water. In addition, many of the water supplies are quite saline which further restricts the grazing radius of stock during the hotter months.

Additional supplies and/or better distributed water points by piping from existing supplies are required. This will enable use of areas currently under-used and the reduction of stocking pressure on degraded parts.

8. Some existing water points are the focus points of large, badly degraded areas. The supplies should be closed down and remedial treatments commenced.

9. The recommended sheep unit capacity for present condition is 24,450.

10. The capability sheep unit capacity if all country was in good range condition is estimated at 37,950.

Individual station report
Brickhouse station - 226,328 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandal	789	CBMS	82	170	103	—	4,409	7,100
		ACSA	123	117	76	—	2,060	2,633
		BLUE	55	38	25		1,731	2,360
Delta	638	BLUE	52	57	126	52	2,541	5,740
		SALT	36	56	111	52	2,114	5,100
		ACSA	17	23	56	—	509	800
Sable	595	SALT	145	78	45	—	4,156	5,360
		BLUE	129	69	40	—	3,693	4,760
		ACSA	34	41	14	—	596	742
Brown	69	ACSA	39	23	—	—	469	517
		SALT	4	3	—	—	118	140
Littoral	58	CDSH	18	5	—	—	261	288
		SAMP	10	2	—	—	47	48
		No veg	23	—	—	—	—	—
River	57	ACCR	17	9	3	—	445	580
		TUGR	12	6	2	—	728	1,000
		No veg	8	—	—	—	—	—
Lyons	36	ACSA	4	9	5	—	110	150
		CBMS	—	2	6	—	63	160
		ACCR	—	3	—	—	30	60
		No veg	7	—	—	—	—	—
Chargoo	12	SALT	4	3	—	—	118	140
		TUGR	4	—	—	—	133	133
		BLUE	1	—	—	—	20	20
Ella	8	ACSA	3	3	—	—	44	50
		CBMS	—	2	—	—	25	40
		ACCR	—	—	—	—	—	—
Target	1	CBMS	—	1	—	—	13	20
		ACSA	—	—	—	—	—	—
		ACCR	—	—	—	—	—	—
Totals	2,263		827	720	612	104	24,433	37,941

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 24,450

Capability 37,950

Declared stock numbers (sheep units or equivalents) 1968-1984:

average (mean) 32,283

highest (1968) 42,452

lowest (1980) 12,172

Bullara station - West Pilbara Shire

Area 1,109 km²

Location

Bullara station is located on the Ningaloo and Yanrey 1:250,000 map sheets. The homestead is about 90 km south by road from Exmouth. The station has common boundaries with Giralia, Marrilla, Cardabia, Ningaloo and Exmouth Gulf stations and a short coastline to Exmouth Gulf in the north-east.

Description

The Minilya-Learmonth road runs in a northerly direction through the station dividing it into two sections. The western section consists almost entirely of undulating sandy plains with linear dunes and minor limestone ridges. This is the Cardabia land system (72.4% of the station area) which supports a hummock grassland of soft spinifex and some hard spinifex. Pastoral value is high.

The sandplains of the Cardabia system also extends to the east of the Minilya-Learmonth road, but further east the landscape is one of broad gently sloping outwash plains with duplex soils. This is the Donovan land system (23%) which supports tall shrublands of snakewood with a blnebush understorey or low shrublands of bluebush. Pastoral value is high.

In the far south-east of the station there is a small area of hilly limestone country of the Jubilee system (2.7%) and undulating stony uplands and plains of the Firecracker system (1.3%). The Jnbilee system supports a variable shrnbland with mixed hard and soft spinifex understorey. The Firecracker system supports a characteristic low shrubland of bluebush with occasional taller snakewood shrubs. Pastoral value is high.

Two other insignificant systems, Range and Learmonth, occur on the station. All systems are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) are shown in table 2. These statements were derived from traverse records.

Table 1. Land systems on Bullara station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Range - limestone hills, ridges and plateaux with steep stony footslopes; tall acacia shrublands with hard spinifex.	0.5
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Jubilee - limestone hills and undulating stony plains; acacia shrublands with hard and soft spinifex.	2.7
High (5-9 ha/s.u.)	Cardabia - undulating sandy plains with linear dunes and minor limestone ridges and outcrop plains; low shrublands and hummock grasslands of soft and hard spinifex.	72.4
	Donovan - gently sloping outwash plains and minor stony plains; snakewood shrublands with bluebush, some soft spinifex and buffel grass.	23.0
	Firecracker - undulating limestone uplands and stony plains; low shrublands of bluebush.	1.3
	Learmonth - sandplains, sandy outwash plains and minor limestone outcrop plains, soft spinifex grasslands with sparse shrubs.	< 0.1
		99.5
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (170 recordings on 4 land systems)

Bullara

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Cardabia	87	100	—	—	—	74	26	—	—	—	100	—	—
Donovan	80	95	5	—	—	23	41	24	9	3	64	25	11
Jubilee	2	100	—	—	—	100	—	—	—	—	100	—	—
Littoral	1	100	—	—	—	—	100	—	—	—	100	—	—
Total over all land systems	170	98	2	—	—	49	34	12	4	1	83	12	5

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 8 sites on 2 land systems.

Range condition and recommendations

1. Cardabia land system (72.4%)

Pastures on this system are mixed hummock grasslands of Soft Spinifex and Hard Spinifex (SOSP, HASP) with numerous low, almost heath like shrubs, interspersed (depending on fire history) with patches of taller shrubs. Pasture condition is excellent or good and there is no significant erosion.

The system is generally stable under grazing except for occasional localized dune crests which may become unstable due to the effects of fire or excessive grazing pressure. Fire is a natural feature of the environment and regular, controlled burning is an accepted management tool to maintain pastures in a useful condition for grazing. Some sand drift can occur after fire, but the system revegetates rapidly after rain and stabilizes.

2. Donovan land system (23%)

The low alluvial plains of the system support Bluebush (BLUE) pastures with a variable overstorey of snakewood. Slightly more elevated plains with limestone at shallow depth support Acacia Mixed Shrub pastures (ACMS). Pasture condition is largely good or very good although restricted areas show shrub depletion to fair or poor condition. A few small patches of severe depletion (about 2 km²) occur adjacent to watering points, notably near Minga and Cyclone mills in the east.

Over all, the system is in good range condition as indicated by 64% of the traverse records, with a further 25% and 11% indicating fair and poor range condition respectively. Those restricted parts in bad condition could be readily improved by spelling from grazing over a number of growing seasons. The introduced buffel grass is already very well established on parts of the system and has the ability to spread further.

3. The remaining four land systems (4.6% of the station area) were not intensively sampled. However, where seen they were in good condition.

4. Although the station is reasonably well developed with paddocks and watering points there are still considerable areas that are poorly used because of their excessive distance (> 4) from water. In addition, many of the water supplies are saline which further restricts the grazing radii of stock during the hotter months. Additional watering points, either new or by piping from existing supplies are required to enable better use of areas currently distant from waters.

5. The recommended sheep unit capacity for present condition if 17,000.

6. The capability sheep unit capacity if all country was in good range condition is estimated at 18,050.

Individual station report

Bullara station - 110,917 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Cardabia	803	SOSP	723	—	—	—	12,050	12,050
		HASP	80	—	—	—	400	400
Donovan	255	BLUE	95	28	17	—	2,356	2,800
		ACMS	41	27	7	2	1,134	1,540
		SOSP	19	19	—	—	475	633
Jubilee	30	HASP	15	2	—	—	82	85
		SOSP	10	2	—	—	183	200
		ACCR	1	—	—	—	20	20
Firecracker	15	BLUE	9	6	—	—	255	300
Range	5	HASP	5	—	—	—	25	25
Learmonth	1	SOSP	1	—	—	—	17	17
		HASP	—	—	—	—	—	—
		ACMS	—	—	—	—	—	—
Totals	1109		999	84	24	2	16,997	18,070

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 17,000

Capability sheep unit capacity 18,050

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1970):

average (mean) 12,908

highest (1974) 16,322

lowest (1968) 10,526

Callagiddy Station - Carnarvon Shire

Area 654 km²

Location

Callagiddy station is located on the Wooramel, Shark Bay and Kennedy Range 1:250,000 map sheets. The homestead is about 52 km south-east by road from Carnarvon some 28 km east of the North-West Coastal Highway. The station has common boundaries with Brickhouse, Meeragoolia, Ella Valla and Edaggee stations.

Description

All of the station is accessible to livestock and all is of high pastoral value.

About than 89% of the station consists of broad, almost flat, sandy alluvial plains of the Sandal land system supporting a tall shrubland of various *Acacia*, *Cassia* and *Eremophila* species and currant bush.

In the far west of the station the country becomes more open with a mixture of low shrublands of saltbush and bluebush and tall shrublands of acacias. These communities are on the broad, saline plains of the Sable land system (5.2% of the station area).

The only other significant system on the station is Ella (5.0%) which occurs in the centre-east and consists of linear dunes and sandy inter-dunal plains supporting tall shrublands of wanyu and sand dune gidgee.

All land systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) are summarized in table 2. These statements were derived from traverse records.

Table 1. Land systems on Callagiddy station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Brown - gently undulating sand plains and occasional dunes; tall acacia shrublands.	0.7
High (5-9 ha/s.u.)	Sandal - alluvial plains with numerous low sandy rises and banks, duplex and sand soils, mixed shrublands of acacia, currant bush and bluebush.	89.1
	Sable - nearly flat saline alluvial plains, minor sandy banks; low shrublands of saltbush and bluebush.	5.2
	Ella - short linear dunes and sandy banks with interdunal plains and drainage foci, sand dune gidgee woodlands and tall shrublands of wanyu.	5.0
		99.3
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (143 recordings on 3 land systems)

Callagiddy

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Ella	2	100	—	—	—	—	—	100	—	—	—	100	—
Sable	11	91	9	—	—	18	46	27	9	—	64	27	9
Sandal	130	99	1	—	—	1	18	53	25	3	18	54	28
Total over all land systems	143	99	1	—	—	2	20	52	23	3	22	52	26

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 10 sites on 3 land systems.

Range condition and recommendations

1. Sandal land system (89.1%)

This system supports valuable Currant Bush Mixed Shrub pastures (CBMS) and some Bluebush pastures (BLUE) and perennial mulla mulla on the duplex soils of the alluvial plains and Acacia Sandplain pastures (ACSA) on the sandy banks.

When in good condition the Currant Bush Mixed Shrub pastures are extremely productive with a wide range of desirable low shrubs such as currant bush, Gascoyne bluebush, Gascoyne mulla mulla, cotton bush and tall saltbush beneath tall shrubs such as curara, snakewood and spreading gidgee. Condition of the Currant Bush Mixed Shrub pastures as seen on survey is mostly fair but a high proportion of the traverse recordings (40%) also showed pasture degradation to poor or very poor condition. In these latter cases, although the pastures are still highly productive in terms of annuals, the desirable perennial shrubs are considerably depleted. Decline in condition is apparent in paddocks to the south of the homestead, past Jimmies bore. Along the south boundary fence with Edaggee station there is an obvious loss of tall shrubs, particularly snakewood, because of a past major fire.

In other areas, decline in condition of Currant Bush Mixed Shrub pastures is indicated by marked increases in undesirable shrub species. This is particularly seen in the vicinity of Old Callagiddy where waxy eremophila and straight leafed cassia form dense stands. Other species that tend to increase in the overgrazed situation are needle bush and bardie bush.

Condition of the Acacia Sandplain (ACSA) pastures of the sandy rises and banks of the Sandal system is somewhat better than the Currant Bush Mixed Shrub pastures. Condition is predominantly fair but more than a quarter of the traverse readings indicated good condition.

Range condition for the whole system is fair (54% of traverse records) with 18% in good range condition and the balance (28%) in poor condition. Because it does not slope the system is not prone to erosion but pasture degradation is common. However, as there is usually a reasonable residue of desirable shrubs even on degraded sites, the system has the ability to recover well if it can be spelled from grazing for a number of consecutive growing seasons.

2. Sable land system (5.2%)

Almost two-thirds of this system was assessed as being in good range condition with most of the balance in fair condition. Saltbush (SALT) and Bluebush (BLUE) pastures of the system consist of low shrublands of bladder saltbush and Gascoyne bluebush and are largely in good condition. There is negligible erosion.

3. Ella land system (5.0%)

This small sand dune system was insufficiently sampled but, where seen, was in fair range condition.

4. Parts of the station (notably paddocks to the south of the homestead and in the vicinity of Old Callagiddy) have received heavy use in the past and pastures are degraded. These areas have the potential to improve considerably in condition if they can be judiciously spelled in good seasons. More use could probably be made of the Sable land system in the far west of the station as it is highly productive and mostly in good condition.

5. The recommended sheep unit capacity for present condition is 6,550.

6. The capability sheep unit capacity if all country was in good range condition is estimated at 10,000.

Individual station report

Callagiddy station - 65,380 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandal	582	CBMS	24	134	104	—	2,805	5,240
		ACSA	61	140	32	—	1,511	1,942
		BLUE	44	29	14	—	1,330	1,740
Sable	34	SALT	12	—	3	—	259	300
		BLUE	12	—	2	—	253	280
		ACSA	2	3	—	—	35	42
Ella	33	ACSA	12	11	—	—	169	192
		CBMS	1	4	2	—	83	140
		ACCR	2	1	—	—	50	60
Brown	5	ACSA	3	1	—	—	31	33
		SALT	—	1	—	—	13	20
Totals	654		173	324	157	—	6,539	9,989

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 6,550

Capability sheep unit capacity 10,000

Declared stock numbers (sheep units or equivalent) 1969-1984 (no data for 1968, 1974):

average (mean) 9,321

highest (1976) 13,114

lowest (1980) 4,394

Callytharra Springs station - Shark Bay and Upper Gascoyne Shire

Area 673 km²

Location

Callytharra Springs station is located on the Wooramel and Glenburgh 1:250,000 map sheets. The homestead is about 110 km south by road from Gascoyne Junction. The station has common boundaries with Carey Downs, Byro, Gilroyd and Towrana stations.

Description

The station comprises mainly dune fields and broad sandy plains in western and central parts and rough hills and plateaux on crystalline rocks in the far east. The dunes and sandy plains are the Yalbalgo and Wooramel land systems (respectively 30.3% and 30.0% of the total station area) and these support tall shrublands of wanyu and other acacias. Pastoral value is moderate. The hills and plateaux are the Thomas (13.3%), Agamemnon (6.8%) and Pells (4.7%) land systems. These support scattered tall and low shrubs with a ground layer of forbs and annual grasses in season. Pastoral value is generally low.

The channel of the Wooramel River runs through the station from south-east to north-west and is flanked by the Channel (8.1%) land system. This system consists of rough plains, steep slopes (often intensely dissected to exposed hardpan) and river channels and banks. The system supports a very scattered and depauperate shrub cover on the plains and slopes and a fringing woodland of eucalypts along the channels and banks. Pastoral value is moderate.

Three other minor land systems Sandplain (5.9%), Moogooloo (0.6%) and Jimba (0.3%) occur on the station. All systems found on the station are further summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Callytharra Springs station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Moogooloo - deeply dissected plateaux, mesas and hills of sedimentary rocks, steep footslopes and narrow valleys; tall acacia shrublands.	0.6
Low (20-30 ha/s.u.)	Thomas - low lateritized mesas; hills and stony plains of granite or gneiss, scattered tall shrublands of mulga and other acacias.	13.3
	Agamemnon - rough hills and ridges of granite and gneiss; scattered tall shrublands of mulga and other acacias.	6.8
	Pells - low hills, ridges and mesas of sedimentary rocks; stony slopes and lower plains, scattered tall acacia shrublands.	4.7
		24.8
Moderate (10-19 ha/s.u.)	Yalbalgo - sandplains with linear and reticulate dunes; tall shrublands of wanyu.	30.3
	Wooramel - sandy plains and stony plains often with hardpan at shallow depth; tall shrublands of wanyu and mulga.	30.0
	Channel - major channels with narrow flood plains and dissected marginal slopes and plains; very scattered shrublands and fringing woodlands.	8.1
	Sandplain - nearly flat to gently undulating red sandplains; tall shrublands of wanyu.	5.9
	Jimba - gently sloping alluvial plains with diffuse drainage, minor pebbly plains and low ridges; scattered shrublands	0.3
		74.6
High (5-9 ha/s.u.)	—	—
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (93 recordings on 5 land system)

Callytharra Springs

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Agamemnon	2	100	—	—	—	100	—	—	—	—	100	—	—
Channel	3	100	—	—	—	—	—	100	—	—	—	100	—
Thomas	14	93	7	—	—	43	29	21	7	—	72	21	7
Wooramel	45	96	2	2	—	11	44	16	22	7	55	16	29
Yalbalgo	29	93	7	—	—	14	62	17	7	—	76	17	7
Total over all land systems	93	96	3	1	—	18	46	19	14	3	64	19	17

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 5 sites on 4 land systems.

Range condition and recommendations

1. Yalbalgo land system (30.3%)

This system supports the Acacia Sandplain (ACSA) pasture type which has a typical tall shrub layer of wanyu above very scattered low shrubs and wanderrie grass in season. Pasture condition as seen during the survey, although dry, was mostly good or excellent with only minor areas assessed as fair or poor. There is no erosion.

Because of the relatively sparse occurrence of palatable shrubs and the rather short-lived nature of the wanderrie grasses the system has only limited drought value.

Fire may be a useful management tool on this system, but its use has not been researched. Evidence seen during the survey suggests that the effects of fire are extremely long term. Where the over-storey of tall wanyu shrubs has been killed by fire the low shrub layer and the ground layer is increased in diversity of species and in density. This fire induced sub-climax appears to be considerably more productive for livestock production than the mature wanyu stand.

2. Wooramel land system (30.0%)

The sandy plains of this system frequently have hardpan at < 1 m depth and are interspersed with plains with hardpan at the surface or with a sparse stony surface mantle. The plains support the Acacia Sandplain (ACSA) and Acacia Short Grass Forb (ASGF) pasture types. These pastures have an over-storey of tall shrubs dominated by wanyu, mulga and other acacias with scattered low shrubs, grasses and forbs.

Condition of the pastures varied from very poor to excellent. Some large areas in the west of the station and north of the Wooramel River were severely drought affected with much of the wanyu being dead. Elsewhere there was a good sprinkling of desirable low shrubs such as Wilcox bush, mulga bluebush and flat leaved bluebush beneath the wanyu or mulga.

3. Thomas and Agamemnon land systems (13.3 and 6.8% respectively)

These hilly systems support Stony Short Grass Forb (SSGF) or Acacia Short Grass Forb (ASGF) pastures with sparse palatable shrubs, forbs and annual grasses interspersed with mulga and various *Eremophila* and *Cassia* species. Pasture condition was either good or excellent, but the pastures have only moderate durability in droughts. Short term opportunistic use can be made of the flush of forbs and annual grasses in good seasons.

4. The remaining minor systems were not intensively sampled but, where seen, were mostly in good range condition.

5. The station is very poorly developed in terms of paddocks and artificial watering points and, at the time of survey in 1982, was carrying very few stock due to the effects of previous droughts. Considerable areas of the station cannot be used to any extent because of the lack of stock waters.

6. The recommended sheep unit capacity for present condition and assuming full development is 3,950.

7. The capability sheep unit capacity if all country was in good range condition is estimated at 4,500.

Individual station report

Callytharra Springs station - 67,327 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Yalbalgo	204	ACSA	155	35	14	—	1,566	1,700
Wooramel	202	ACSA	65	26	30	—	824	1,008
		ASGF	49	8	24	—	332	405
Thomas	89	SSGF	64	19	6	—	331	356
Channel	55	SSGF	22	22	—	—	161	176
		ACCR	3	3	—	—	90	120
		No veg	5	—	—	—	—	—
Agamemnon	45	SSGF	45	—	—	—	180	180
Sandplain	40	ACSA	20	20	—	—	292	333
Pells	32	ASGF	32	—	—	—	160	160
Moogooloo	4	ASGF	4	—	—	—	20	20
Jimba	2	STCH	2	—	—	—	17	17
		ASGF	—	—	—	—	—	—
		ACSA	—	—	—	—	—	—
Totals	673		466	133	74	—	3,973	4,475

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 3,950

Capability 4,500

Declared stock numbers (sheep units or equivalent) 1968-1983 (no data for 1971, 1984):

average (mean) 4,123

highest (1976) 6,975

lowest (1981) 1,050

Carbla station - Shark Bay Shire

Area 957 km²

Location

Carbla station is located on the Yaringa 1:250,000 map sheet. The homestead is 10 km west of North-West Coastal Highway and is approximately 185 km south by road from Carnarvon. The station has common boundaries with Yaringa, Woodleigh and Hamelin stations and, in the west, has a coastline on Hamelin Pool.

Description

About two-thirds of the station consists of broad limestone plains of the Toolonga land system supporting acacia mixed shrub pastures of moderate pastoral value.

In central, north-eastern and south-eastern parts of the station the limestone plains have been masked by sand to form the Sandplain and Yaringa land systems (collectively 22.3% of the station area). These systems support tall shrublands of wanyu and are of moderate to high pastoral value. The Yaringa system also occurs near the coast where it is associated with isolated low limestone mesas and plateaux and low outwash plains of the Foscal land system (7%).

Four other minor land systems namely Snakewood, Salune, Littoral and Coast occur on the station. The largest and most valuable of these is Snakewood (2.5%) which consists of nearly flat plains with duplex soils and snakewood and saltbush shrublands.

All systems found on the station are summarized in table 1.

Condition statements for land systems and for the whole station (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Carbla station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Sandplain - nearly flat to gently undulating red sandplain with tall shrublands of wanyu.	12.5
	Salune - saline plains and pans with scattered low dunes; bluebush, samphire and wanyu shrublands.	0.6
	Littoral - low coastal foredunes, samphire and tidal flats and mangroves fringes	0.4
		13.5
High (5-9 ha/s.u.)	Toolonga - limestone plains with mixed acacia tall shrublands.	66.8
	Yaringa - sandy plains with sandy banks, low dunes and limestone outcrop plains; tall shrublands of wanyu.	9.8
	Foscal - gently sloping outwash plains, low limestone mesas, plateaux edges and footslopes; saltbush and bluebush shrublands.	7.0
	Snakewood - nearly flat plains with duplex soils; tall shrublands of snakewood with saltbush understorey.	2.5
	Coquina - low shelly foredunes, shell beaches and supra-tidal flats; scattered tall acacia shrublands on dunes.	0.4
		86.5
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (165 recordings on 5 land systems) Carbla

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Foscal	19	100	—	—	—	5	42	37	11	5	47	37	16
Sandplain	18	100	—	—	—	—	33	61	6	—	33	61	6
Salune	2	50	50	—	—	—	—	100	—	—	—	100	—
Toolonga	107	98	2	—	—	1	10	45	39	5	11	45	44
Yaringa	19	100	—	—	—	5	53	26	16	—	58	26	16
Total over all land systems	165	98	2	—	—	2	21	44	29	4	23	44	33

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 12 sites on 3 land systems.

Range condition and recommendations

1. Toolonga land system (66.8%)

Within the Acacia Mixed Shrub (ACMS) pasture of this system there has been considerable loss of desirable perennial shrubs. Consequently, although the system is still moderately productive in terms of cotton bush and annual grasses and forbs in season, drought reserves are seriously depleted. Range condition is mostly fair or poor.

Desirable species such as green cassia, currant bush, ragged leaf scaevola and warty leaved eremophila, although very scattered, are still present. The system has the ability to recover well if judicious spelling of paddocks can be incorporated into the management system. Erosion is not a problem on the system.

2. Sandplain land system (12.5%)

Pastures on this land system are in fair or good condition and there is no erosion. The system is not fully used as it is inadequately watered in the far north-east of the station.

3. Yaringa land system (9.8%)

The majority of this system is in good range condition with pastures in good to excellent condition and no erosion. In some restricted areas pastures are degraded to fair or poor condition.

4. Foscal land system (7%)

The Saltbush (SALT) and Bluebush (BLUE) pastures on this system are nearly all in fair or good condition. It is likely that stock are unable to use these pastures fully because of high dietary salt intake from a combination of salty vegetation and salty stock waters.

5. Other minor systems, Snakewood, Salune, Littoral and Coast, are generally in fair or good range condition.

6. The station is inadequately watered. Large areas in many paddocks are considerably in excess of 5 km from permanent water supplies. Pastures in these areas are under used and are in good condition. This is particularly the case in all paddocks down the far eastern side of the station.

Additional water points, either in the form of new sources or by piping from existing supplies, are required to enable better distribution of stock and reduction in grazing pressure on some of the paddocks in central parts of the station.

7. The recommended sheep unit capacity for present condition and assuming the whole station was adequately watered (which is not the case, see 6) is 8800.

8. The capability sheep unit capacity if all country was in good range condition is estimated at 17,100.

Individual station report

Carbla station - 95,733 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Toolonga	639	ACMS	63	259	253	—	5,431	12,780
		ACSA	—	32	—	—	200	267
		ASGF	4	8	20	—	97	160
Sandplain	120	ACSA	40	73	7	—	818	1,000
Yaringa	94	ACSA	38	19	18	—	507	625
		ACMS	16	3	—	—	350	380
Foscal	67	SALT	24	10	3	—	624	740
		BLUE	6	17	—	—	333	460
		ACMS	—	4	3	—	59	140
Snakewood	24	SALT	—	19	—	—	238	380
		ACMS	—	4	—	—	40	80
		ACSA	—	1	—	—	6	8
Salune	5	ACSA	—	2	—	—	13	17
		SAMP	2	—	—	—	8	8
		BLUE	—	1	—	—	13	20
Coquina	8	CDSH	4	—	—	—	50	50
		No veg	4	—	—	—	—	—
Totals	957		201	452	304	—	8,787	17,115

* Area of extreme degradation; severe erosion and/or pasture degradation zero carrying capacity.

Recommended sheep unit capacity 8,800

Capability 17,100

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 9,343

highest (1975) 13,631

lowest (1968) 1,550

Cardabia station - Carnarvon Shire

Area 1,998 km²

Location

Cardabia station is located on the Minilya, Winning Pool, Ningaloo and Yanrey 1:250,000 map sheets. The station homestead is about 245 km north by road from Carnarvon. The main Minilya-Exmouth road passes in a northerly direction through the western half of the station and the nearest town is Exmouth about 150 km to the north. Cardabia has common boundaries with Ningaloo, Bullara, Marilla, Winning, Mia Mia and Warroora stations. In the west, the station has about 37 km of coastline on the Indian Ocean which includes the Mauds landing site and the Coral Bay tourist establishment.

Description

All of the station, with the exception of parts of the Giralia Range in the centre, is readily accessible to livestock. About 45% of the station area is country of high pastoral value and 52.5% is of moderate pastoral value. The remaining 2.5% is of low or very low value.

The western part of the station consists largely of high, undulating sandy plains and longitudinal dunes of the Cardabia land system (27%). The vegetation is a low hummock grassland of mixed soft and hard spinifex with numerous low shrubs rarely exceeding 2 m in height and usually much less. Along the coast a narrow strip of large recent dunes and beach ridges forms the Coast land system (1%).

The Giralia Range (Jubilee land system) runs north-south through the centre of the property. This consists of rough limestone hills and undulating stony plains supporting mostly hard spinifex pastures. Relief above sea level is up to a maximum of 216 m at Remarkable Hill. Low outwash plains of the Donovan land system (17%) flank the western side of the Giralia Range. These plains support productive Gascoyne bluebush pastures.

Gently sloping plains of the Gearle and Yarcowie land systems (20% and 4% respectively) predominate in the east. These systems are based on bentonitic siltstone, shale and radiolarite and support productive pastures of bluebush, saltbush and perennial tussock grasses as well as some soft spinifex and introduced buffel grass. Cardabia Creek, an intermittent stream, drains in a north-south direction through these eastern plains.

In the far east of the station the country consists of raised calcrete plains of the Carleeda land system (7%). This country supports useful soft spinifex pastures with minor inclusions of hard spinifex.

Table 1 summarizes the land systems found on the station.

Condition statements for land systems and for the station as a whole have been prepared from data collected whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Cardabia station

Potential value	Land systems	Area %
Very low (> 30 ha/s.u.)		—
Low (20-30 ha/s.u.)	Wapet - low rises and stony plains and slopes with hard spinifex hummock grasslands.	2.0
Moderate (10-19 ha/s.u.)	Jubilee - limestone hills and undulating stony plains with hard and soft spinifex and scattered shrubs.	18.0
	O'Brien - gently sloping alluvial plains and minor stony plains, mixed acacia shrublands with vegetation often arranged in groves.	0.5
	McLeod - samphire flats and sandy plains with bare marginal mudflats; samphire and saltbush low shrublands.	0.5
		19.0
High (5-9 ha/s.u.)	Cardabia - undulating sandy plains with linear dunes, minor limestone rises; hummock grasslands soft and hard spinifex with scattered shrubs.	27.0
	Gearle - alluvial plains, more sloping marginal plains, gently sloping saline and low rises; mixed shrublands of acacias, bluebush and saltbush.	20.0
	Donovan - gently sloping outwash plains and minor stony plains, tall shrublands of snakewood with bluebush, some soft spinifex and buffel grass.	17.0
	Carleeda - undulating limestone plains, soft spinifex and some hard spinifex with scattered shrubs.	7.0
	Yarcowie - gilgai plains with clay soils; tussock grasslands and sparse shrubs.	4.0
	Firecracker - undulating limestone uplands and plains; low shrublands of Gascoyne bluebush.	3.0

Table 1 continued...

Potential value	Land systems	Area %
	Coast - large, long walled parabolic coastal dunes and narrow swales, minor limestone plains and rocky wave cut platforms; tall acacia shrublands, also soft spinifex and buffel grass	1.0
		79.0
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (278 recordings on 12 land systems)

Cardabia

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Cardabia	73	99	1	—	—	80	16	4	—	—	96	4	—
Collier	1	100	—	—	—	100	—	—	—	—	100	—	—
Carleeda	4	100	—	—	—	75	25	—	—	—	100	—	—
Coast	7	100	—	—	—	86	14	—	—	—	100	—	—
Donovan	70	100	—	—	—	37	39	24	—	—	76	24	—
Firecracker	7	71	29	—	—	—	57	43	—	—	57	43	—
Gearle	72	79	18	3	—	17	33	39	11	—	49	38	13
Jubilee	19	100	—	—	—	68	16	16	—	—	84	16	—
MacLeod	7	100	—	—	—	57	43	—	—	—	100	—	—
O'Brien	1	100	—	—	—	—	100	—	—	—	100	—	—
Wapet	7	100	—	—	—	57	43	—	—	—	100	—	—
Yarcowie	10	40	40	20	—	10	30	50	—	10	30	50	20
Total over all land systems	278	92	7	1	—	47	29	21	3	—	75	21	4

Range evaluation sites

Detailed descriptions and measurements of land form, vegetation, soils and range condition were made at 16 sites on 7 land systems.

Range condition and recommendations

1. Cardabia land system (27%)

Pastures on this system are mixed Soft Spinifex and Hard Spinifex (SOSP, HASP) with numerous low shrubs. Pasture condition is excellent or good and there is no erosion.

The system is generally stable under grazing except for occasional localized dunes and dune crests which may become unstable due to the effects of fire or excessive grazing pressure. Fire is a natural feature of the environment and regular, controlled burning is a management tool to maintain pastures in an attractive condition for livestock. Some sand drift can occur after fire, but the system revegetates rapidly after rain and stabilizes.

2. Gearle land system (20%)

This system supports valuable Saltbush (SALT) and Bluebush (BLUE) pastures which are mostly in fair or good condition. Some parts show active erosion in the form of shallow gullying, rilling and scalding.

Parts of the system with slopes in excess of about 1% and/or highly saline soils are very susceptible to erosion. Other units of the system such as stony rises and flat plains with clay soils are relatively stable. Access tracks should avoid sensitive erosion susceptible areas.

Fire should be avoided on this system. Some areas require spelling over a number of consecutive growing seasons in order to encourage shrub recovery.

3. Jubilee land system (18%)

The stony limestone hills and plains of this system support mostly Hard Spinifex (HASP) pastures with minor areas of Soft Spinifex (SOSP). Pasture condition is excellent or good and there is no erosion.

The system is stable under grazing and, due to shallow soils with dense surface mantle of stones, is not susceptible to erosion. Because of its stability, this system is suitable for access tracks which should be confined to it wherever possible. Also, where possible, watering points should be located on this system rather than on adjacent, more sensitive, systems. Burning every four or five years is a desirable management practice.

4. Donovan land system (17%)

This plain system supports Bluebush (BLUE) pastures. Pasture condition is generally good although some localized areas show considerable depletion of bluebush. Buffel grass has colonized strongly and, in some cases, has entirely replaced the bluebush.

The system is generally resistant to erosion because of its heavy soils and lack of slope. Areas that are only in fair condition would benefit from spelling over a growing period. Fire should be avoided.

5. Carleeda land system (7%)

Soft Spinifex (SOSP) pastures on this land system are in good or very good condition. The system is not susceptible to erosion and it is stable under grazing. Regular burning is an acceptable and desirable management practice.

6. Yarcowie land system (4%)

This gilgai plain system supports Tussock Grass (TUGR) pastures and various acacias and some chenopod shrubs. Condition is generally fair to good. Tracks and sheep pads on sloping margins of the system are susceptible to erosion and there are some localized areas of active gullying.

7. Firecracker land system (3%)

Bluebush pastures on this system (Gascoyne bluebush) are in fair to good condition. There are some isolated areas of minor erosion. Sloping parts of the system without stony surface strew are highly susceptible to erosion in the form of gullying and sheeting if the vegetative cover is depleted. Access tracks should avoid these parts. More stony parts are much less susceptible.

Periodic spelling from grazing is required to maintain pasture vigour. Fire should be avoided.

8. Coast land system (1%)

Pastures on this system are in good condition and there is no significant erosion.

Under conditions of very heavy grazing or excessive disturbance parts of this system can commence actively eroding with the formation of large blow-outs and unstable dune crests. Access through dune areas needs to be carefully planned and controlled. Burning is probably an undesirable practice.

9. Wapet, O'Brien and McLeod land systems (collectively 3%)

These minor systems are in fair to good condition.

10. The station is almost fully developed as a sheep station with numerous paddocks and watering points. A few sections, notably in the far north, are not adequately watered.

11. The recommended sheep unit capacity for present condition is 28,450.

12. The capability sheep unit capacity assuming all country was in good range condition is estimated at 32,900.

Individual station report

Cardabia station - 199,876 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Cardabia	546	SOSP	420	17	—	—	7,142	7,283
		HASP	105	4	—	—	538	545
Gearle	377	BLUE	111	86	29	—	3,476	4,520
		SALT	51	45	17	—	1,689	2,260
		TUGR	17	15	6	—	1,174	1,900
Donovan	366	BLUE	135	66	—	—	3,525	4,020
		ACMS	89	21	—	—	1,990	2,200
		SOSP	55	—	—	—	917	917
Jubilee	342	HASP	162	26	—	—	897	940
		SOSP	103	34	—	—	2,000	2,283
		ACCR	9	8	—	—	260	340
Carleeda	122	SOSP	86	—	—	—	1,433	1,433
		HASP	24	—	—	—	120	120
		TUGR	12	—	—	—	400	400
Firecracker	92	BLUE	52	40	—	—	1,540	1,840
Yarcowie	76	TUGR	18	31	12	—	606	1,017
		BLUE	5	7	3	—	206	300
Wapet	42	HASP	42	—	—	—	210	210
Coast	16	CDSH	16	—	—	—	200	200
O'Brien	10	ASGF	2	3	—	—	20	25
		STCH	1	2	—	—	18	25
		ACCR	—	2	—	—	20	40
McLeod	6	SAMP	3	—	—	—	12	12
		No veg	2	—	—	—	—	—
		SALT	1	—	—	—	20	20
Giralia	3	HASP	2	—	—	—	10	10
		SOSP	1	—	—	—	17	17
Totals	1,998		1,524	407	67	—	28,440	32,877

* Area of extreme degradation; severe erosion and/or pasture degradation zero carrying capacity.

Recommended sheep unit capacity 28,450

Capability 32,900

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 22,947

highest (1975) 28,100

lowest (1968) 16,650

Carey Downs station - Upper Gascoyne Shire

Area 955 km²

Location

Carey Downs station is located on the Glenburgh and Wooramel 1:250,000 map sheets. The homestead is about 85 km south by road from Gascoyne Junction. The station has common boundaries with Dairy Creek, Glenburgh, Byro, Callytharra Springs and Towrana stations.

Description

The station comprises sandy plains and dunes in the west, gently sloping stony plains in central parts and rough hills and plateaux on granite and gneiss in the east. Except for a few of the roughest ranges most of the property is accessible to livestock and about two-thirds of the country is of moderate pastoral value. The balance is of low or very low pastoral value.

The largest land system on the station is Agamemnon (28.3%) which consists of granite and gneiss hills and ridges with stony slopes and narrow drainage lines. The system occurs in the east of the station and is associated with other hill systems such as Sandiman (12.3%), Thomas (5.9%), Pells (4.9%) and Phillips (1.9%). All these systems support a scattered mixed shrubland dominated by acacias, eremophilas and cassias with forbs and annual grasses as a ground cover in season. The shrub cover becomes rather more dense and diverse along the narrow drainage floors and creek-lines. The systems provide very useful feed although carrying capacity is generally low.

The dunes and sandy plains in the west of the station consist of the Yalbalgo (7.9%), Divide (2.3%) and Wooramel (19.0%) land systems. These systems support tall shrublands of wanyu and other acacias with variable low shrubs and grasses. The Divide system frequently has a prominent ground layer of hard and soft spinifex. Pastoral value of these systems is moderate.

The Durlacher system (6.2%) found between the sandy systems to the west and the hill systems to the east consists of gently sloping plains, drainage zones and low stony rises all commonly with a sparse to moderately dense mantle of quartz and other rock fragments. The system supports a variable but usually sparse shrubland with mulga and other *Acacia*, *Eremophila* and *Cassia* species.

An additional six minor land systems are found on the station. All fifteen systems are further summarized in table 1.

Condition statements for each land system and for the station as a whole have been prepared from data collected whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Carey Downs station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Moogooloo - deeply dissected plateaux, mesas and hills of sedimentary rocks, steep footslopes and narrow valleys; sparse tall shrublands.	0.1
Low (20-30 ha/s.u.)	Agamemnon - rough hills and ridges of granite and gneiss; scattered tall shrublands of mulga and other acacias.	28.3
	Thomas - low lateritized mesas, hills and stony plains of granite or gneiss; scattered tall shrublands of mulga and other acacias.	5.9
	Pells - low hills, ridges and mesas of sedimentary rocks, stony slopes and lower plains; scattered tall acacia shrublands.	4.9
		39.1
Moderate (10-19 ha/s.u.)	Wooramel - sandy and stony plains often with hardpan at shallow depth; tall shrubland of wanyu and mulga.	19.0
	Sandiman - undulating stony uplands with low breakaways and ridges; scattered tall acacia shrublands.	12.3
	Yalbalgo - sandplains with linear and reticulate dunes; tall shrublands of wanyu.	7.9
	Sandplain - nearly flat to gently undulating red sandplains with tall shrublands of wanyu.	6.7
	Durlacher - gently sloping stony plains and low stony rises; scattered tall and low shrublands of *Acacia* and *Eremophila* species and chenopods.	6.2
	Divide - gently undulating sandplains with occasional minor dunes; shrublands and hummock grasslands mostly hard spinifex.	2.3

Table 1 continued...

Pastoral value	Land systems	Area %
	Phillips - undulating stony uplands and low hills of granite and gneiss; scattered tall acacia shrublands.	1.9
	Channel - major channels with narrow floodplains and dissected marginal slopes and plains; very scattered acacia shrublands and fringing woodlands.	1.4
	Yagina - low stony plains, soil covered plains, stony claypans and minor sandy banks and dunes; scattered tall acacia shrublands.	1.2
	Mantle - gently undulating stony plains with sluggish drainage, stony rises and low summits; scattered tall and low shrublands.	1.0
	Jimba - gently sloping alluvial plains with diffuse drainage, minor pebbly plains and low ridges; scattered tall and low shrublands.	0.9
		60.8
High (5-9 ha/s.u.)	—	—
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (140 recordings on 10 land systems)

Carey Downs

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Agamemnon	26	100	—	—	27	54	19	—	—	81	19	—	
Channel	1	—	100	—	—	—	—	100	—	—	—	100	—
Divide	4	100	—	—	—	75	25	—	—	—	100	—	—
Durlacher	13	84	8	8	—	—	—	38	47	15	—	38	62
Pells	2	50	50	—	—	—	50	—	50	—	50	—	50
Sandiman	24	83	13	4	—	—	13	54	29	4	13	54	33
Sandplain	11	100	—	—	—	9	55	27	9	—	64	27	9
Wooramel	47	89	9	2	—	6	17	36	32	9	23	36	41
Yalbalgo	11	100	—	—	—	—	27	37	27	9	27	37	36
Yagina	1	100	—	—	—	100	—	—	—	—	100	—	—
Total over all land systems	140	91	7	2	—	11	26	33	24	6	37	34	29

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 8 sites on 5 land systems.

Range condition and recommendations

1. Agamemnon land system (28.3%)

This rough low hill system in the east is not heavily used for grazing and is nearly all in good range condition. It supports Stony Short Grass Forb (SSGF) or Acacia Short Grass Forb (ASGF) pastures with some palatable low shrubs and numerous forbs and annual grasses in season. Although it only has limited drought reserves the system can provide useful quantities of feed in some seasons. Additional water supplies would be required to bring it and other hilly systems further east into production.

2. Wooramel land system (19%)

The sandy plains of this system support Acacia Sandplain (ACSA) pastures while the more stony plains or plains with hardpan at shallow depth support the Acacia Short Grass Forb (ASGF) pasture type. These pastures have an overstorey of tall shrubs of either wanyu or mulga with an understorey of scattered low shrubs, grasses and forbs.

The condition of pastures on the system varies considerably from very poor to very good depending on distance from water, intensity of past use and the effects of fire and drought. There is very little erosion, but some extensive parts of the system such as in parts of Cardilya paddock show pasture degradation with the loss of desirable perennial shrubs such as mulga, bluebush, flat leaf bluebush and Wilcox bush. However, the system has the ability to recover well if it can be protected from grazing for a number of consecutive growing seasons.

Some large areas of wanyu shrub, notably in the paddock to the south-east of Four Corner well, have died some considerable time ago probably as the result of fire and have not regenerated to wanyu. However the ground layer of low shrubs such as Wilcox bush, flat leaf bluebush, cotton bush and other desirable shrubs and wanderrie grasses has increased considerably.

Fire may be a useful management tool on the acacia sandplain pastures of the sandy parts of this system, but its use has not been researched. The remarkable increase in diversity and density of the ground layer after fire and the very long time span (50 years) for the wanyu to become dominant again has also been seen elsewhere during the survey. The fire induced sub-climax appears to be considerably more productive for livestock production than is the dense mature wanyu situation.

3. Sandiman land system (12.3%)

This stony system as seen in the north-east of the station is mostly in fair range condition but some drainage floors and stony plains are degraded with pastures in poor condition. A few of the less stony drainage floors are eroded with rills and shallow gullies. Elsewhere the system is inherently resistant to erosion because of the surface mantle of rocks and cobbles.

4. Yalbalgo (7.9%) and Sandplain (6.7%) land systems

These sandy systems support Acacia Sandplain (ACSA) pastures with a tall shrub over-storey of wanyu and variable low shrubs and wanderrie grasses. Pasture condition is mostly fair or good although some areas on the Yalbalgo system were assessed as being poor.

Because palatable shrubs below the wanyu are sparse and the wanderrie grass pastures are fairly short lived the system has only limited reserves for times of drought. However, in good seasons the grasses and wanyu bean crop provide good grazing.

On these systems fire is a possible management tool (as on the Wooramel system) and useful shrubs and grasses can be expected to increase markedly after fire has killed the mature wanyu.

5. Durlacher land system (6.2%)

This stony plain system supports sparse Acacia Short Grass Forb (ASGF) pastures and Stony Chenopod (STCH) pastures. The low shrub layer includes unpalatable *Eremophila* and *Cassia* species with, when in good condition, a scattering of desirable shrubs such as cotton bush, flat leaf bluebush and tall saltbush. In small run-on areas the vegetation can be more dense with a wider range of desirable species.

Many of the desirable shrubs have been lost from the system; about 60% of the traverse records indicated poor or very poor pasture condition with the balance in fair condition. The system requires spelling to enable the desirable shrubs to recover.

6. The remaining nine land systems on the station collectively occupy 19.6% of the station area. They include the rough hill systems Thomas and Pells and the stony plains of the Phillips system. Some parts of these systems have been used for grazing but the bulk of them occur in the far east of the property and have not been developed with waters or fencing. They were not intensively sampled or not sampled at all. Where seen these systems and the other minor systems on the station were nearly all in good range condition.

7. The recommended sheep unit capacity for present condition is 4900. This figure assumes that all pastures are adequately watered which is not the case (see 6).

8. The capability sheep unit capacity if all country was in good range condition is estimated at 6,250.

Individual station report

Carey Downs station - 95,536 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Agamemnon	271	SSGF	198	46	—	—	945	976
		ACCR	27	—	—	—	540	540
Wooramel	181	ACSA	23	39	47	—	623	908
		ASGF	17	26	29	—	244	360
Sandiman	118	STCH	10	42	25	—	377	642
		SSGF	5	22	14	—	121	164
Yalbalgo	76	ACSA	21	28	27	—	458	633
Sandplain	63	ACSA	40	17	6	—	464	525
Durlacher	59	STCH	—	15	14	—	122	242
		ASGF	—	12	12	—	70	120
		ACCR	—	—	6	—	30	120
Thomas	56	SSGF	56	—	—	—	224	224
Pells	47	ASGF	10	27	10	—	165	235
Divide	22	HASP	20	—	—	—	100	100
		ACCR	2	—	—	—	40	40
Phillips	18	SSGF	14	—	—	—	56	56
		STCH	3	—	—	—	25	25
		ACCR	1	—	—	—	20	20
Channel	14	SSGF	—	7	—	—	23	28
		ACCR	—	4	—	—	40	80
		No veg	3	—	—	—	—	—
Yagina	11	ASGF	8	—	—	—	40	40
		ACSA	2	—	—	—	17	17
		ACMS	1	—	—	—	20	20
Mantle	9	STCH	6	—	—	—	50	50
		SSGF	3	—	—	—	12	12
Jimba	9	STCH	6	—	—	—	50	50
		ASGF	2	—	—	—	10	10
		ACSA	1	—	—	—	8	8
Moogooloo	1	ASGF	1	—	—	—	5	5
Totals	955		480	285	190	—	4,899	6,250

* Area of extreme degradation; severe erosion and/or pasture degradation zero grazing capacity.

Recommended sheep unit capacity 4,900

Capability 6,250

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 3,947

highest (1970) 6,033

lowest (1980) 1,500

Carrarang station - Shark Bay Shire

Area 805 km²

Location

Carrarang station is located on the Edel 1:250,000 map sheet. Access to the station is via the road between the Overlander Roadhouse, on North-West Coastal Highway, and Shark Bay and then via Tamala station on the Useless Loop road. The homestead is on the Carrarang Peninsula about 118 km west of the Overlander Roadhouse.

The station has a common boundary with Tamala station in the south. It has a long convoluted coastline with shallow tidal flats to Freycinet Estuary in the east and a coastline with steep cliffs to the Indian Ocean in the west.

Description

The two largest land systems on the station are Edel (61.2%) and Coast (36.1%). The Edel system consists of undulating and, at times, moderately elevated sandy plains (relative relief up to 70 m) with minor dunes and limestone rises. The Coast system consists of large linear and reticulate coastal dunes, including unstable blow-out areas, with minor limestone rises and steep coastal cliffs. Both systems support similar mixed shrublands and pastoral value is high.

The remaining three systems on the station, Birrida, McLeod and Littoral, collectively occupy only 2.7% of the total station area. They are all highly saline systems with low shrublands of samphire and saltbush and some bare mudflats and tidal flats. Pastoral value is moderate. All systems are summarized in table 1.

Condition statements for land systems and for the whole station (total over all land systems) were prepared from data collected whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Carrarang station

Potential value	Land systems	Area %
Very low (> 30 ha/s.u.)		—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Birrida - highly saline and gypsiferous pans and depressions; low shrublands of samphire and saltbush.	2.4
	McLeod - bare mudflats, saline plains and marginal sandy plains; sparse low shrublands of samphire and saltbush in parts.	0.2
	Littoral - low coastal foredunes, samphire flats and tidal flats with mangrove fringes; low and tall shrublands in parts.	0.1
		2.7
High (5-9 ha/s.u.)	Edel - undulating sandy plains, minor saline flats, low dunes and limestone rises, mixed low shrubs; degraded areas with exotic annual pastures.	61.2
	Coast - large long walled parabolic coastal dunes, including unstable blow out areas, narrow swales, minor limestone plains, rocky wave cut platforms and beach; mixed low shrubs, also soft spinifex and buffel grass.	36.1
		97.3
Very high (< 5 ha/s.u.)		—
		100.0

Table 2. Condition statements derived from traverse records (192 recordings on 4 land systems)

Carrarang

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Birrida	3	100	—	—	—	67	33	—	—	—	100	—	—
Coast	46	94	2	—	4	81	13	—	2	4	93	—	7
Edel	140	95	4	1	—	34	30	19	11	6	64	19	17
MacLeod	3	100	—	—	—	33	67	—	—	—	100	—	—
Total over all land systems	192	94	4	1	1	45	27	14	8	6	72	14	14

Range evaluation sites

Detailed descriptions and measurements of land form, vegetation, soils and range condition were made at 12 sites on 3 land systems.

Range condition and recommendations

1. Edel land system (61.2%)

Condition of the Coastal Dune Shrub pastures (CDSH), Saltbush pastures (SALT) and Heath (HEAT) on this system is generally good or very good. Some areas around watering points such as at Biddy Giddy outcamp and in Coolboo paddock have been profoundly altered from perennial shrublands to exotic annual grass and herb pastures but appear to be reasonably stable.

Much of the system is not used for grazing because of the lack of stock waters.

2. Coast land system (36.1%)

This system supports similar shrublands to the Edel system and these are nearly all in very good condition. Most of the system is ungrazed because of the lack of stock waters.

About 30 km² of the system consists of very large unstable blowouts and mobile dunes. The largest of these areas commences near Dulverton Bay and extends north for about 23 km on to Bellefin Prong. The general area has been used for grazing in the past (a number of abandoned watering points are present), but because of its unstable condition, it should not be brought into production again.

Much of the Coast system is extremely sensitive to any form of disturbance and is highly vulnerable to wind erosion. It is doubtful if the system should be used for pastoral purposes and, at the present time, most of it is in fact not being used. Use of the system for almost any purpose will need to be carefully planned.

3. The remaining land systems Birrida, McLeod and Littoral are mostly in good condition but, because of their relatively small areas, are of little significance for grazing.

4. The station is very poorly watered with many areas being in excess of 5km from stock water.

5. Recommended sheep unit capacity for present condition is 8,000. This figure assumes that all pastures are adequately watered which is not the case (see 4).

6. Capability sheep unit capacity if all country was in good range condition is estimated at 9,680.

Individual station report

Carrarang station - 80,515 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Edel	493	CDSH	264	71	84	—	4,143	5,238
		HEAT	30	10	9	—	143	163
		SALT	16	5	4	—	408	500
Coast	291	CDSH	255	—	—	36	3,188	3,638
Birrida	19	SAMP	16	—	—	—	64	64
		SALT	3	—	—	—	60	60
McLeod	1	SAMP	1	—	—	—	4	4
		No veg	—	—	—	—	—	—
		SALT	—	—	—	—	—	—
Littoral	1	CDSH	1	—	—	—	13	13
		No veg	—	—	—	—	—	—
		SAMP	—	—	—	—	—	—
Totals	805		586	86	97	36	8,023	9,680

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 8,000

Capability 9,700

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 9,321

highest (1971) 15,834

lowest (1979) 420

Coburn station - Shark Bay Shire

Area 1,005 km²

Location

Coburn station is located on the Yaringa 1:250,000 map sheet. The homestead is 25 km west of North-West Coastal Highway and is about 260 km south by road from Carnarvon. The station has common boundaries with Hamelin, Meadow, Nerren Nerren and Nanga stations and with the Cooloomia Nature Reserve.

Description

More than 85% of the station consists of gently undulating sandplain of the Nerren, Nanga and Sandplain land systems.

The Nerren system occupies about 34.6% of the station area and occurs in the central and southern parts. It supports a tall shrubland dominated by wanyu with a patchy over-storey of various eucalypts. Pastoral value is moderate.

The Sandplain system (15.6%) which occurs in the eastern half of the station is very similar to the Nerren system but lacks the eucalypt over-storey.

The Nanga sandplain system (35.4%) occurs in the far west of the station. It is rather more undulating than the Nerren system and the vegetation is quite different in that it consists of scrubby heath and tree heath with a wide variety of species typical of sandplains south of the survey area. Pastoral value is very low.

Two land systems, Yaringa (8.2%) and Snakewood (5.3%), occur in the north of the station. The Yaringa system consists of sandy plains with tall shrublands of wanyu and minor limestone plains supporting tall shrublands of Hamelin wattle and other acacias. Pastoral value is moderate. The Snakewood system is characterized by snakewood and saltbush shrublands on nearly flat plains with duplex soils. Pastoral value is high.

There are small areas of three other systems on the station, but these are of little significance.

All systems are summarized and their pastoral value shown in table 1.

Condition statements for land systems and for the whole station (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Coburn station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Nanga - undulating sand plain and occasional dunes with tree heath	35.4
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Nerren - nearly flat to gently undulating red sandplains; tall shrublands of wanyu with scattered trees and mallee eucalypts	34.6
	Sandplain - nearly flat to gently undulating red sandplains; tall wanyu shrublands	15.6
	Cooloomia - undulating sandplain and minor limestone outcrop plains; tall and low shrublands with mallee eucalypts; also scrubby heath	0.8
		51.0
High (5-9 ha/s.u.)	Yaringa - sandy plains with sandy banks, low dunes and limestone outcrop plains; tall shrublands of wanyu and other acacias	8.2
	Snakewood - nearly flat plains with duplex soils; tall shrublands of snakewood with understorey of saltbush	5.3
	Toolonga - limestone plains with tall shrublands of Hamelin wattle and other acacias	< 0.1
	Tarcumba - nearly flat plains with gradational soils overlying calcrete; tall shrublands of acacias	< 0.1
		13.6
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (156 recordings on 6 land systems)

Coburn

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Nanga	22	100	—	—	—	91	9	—	—	—	100	—	—
Nerren	69	100	—	—	—	1	12	51	35	1	13	51	36
Sandplain	37	100	—	—	—	—	14	67	19	—	14	67	19
Snakewood	8	100	—	—	—	—	13	49	25	13	13	49	38
Toolonga	1	100	—	—	—	—	—	100	—	—	—	100	—
Yaringa	19	100	—	—	—	—	16	42	42	—	16	42	42
Total over all land systems	156	100	—	—	—	13	12	48	26	1	26	46	28

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 6 sites on 4 land systems.

Range condition and recommendations

1. Nanga land system (35.4%)

Condition of the Heath (HEAT) pastures on this system is good or excellent but they are of little use for pastoral purposes being rated at only 1s.u./30ha. Most of the system is not developed and is not used by the station for grazing.

2. Nerren land system (34.6%)

Most of the Acacia and Eucalyptus Short Grass Forb (AESG) pastures on this system are in fair or poor condition. In parts there has been considerable loss of useful low shrubs and the pastures are now only annual grasses and forbs in season. There is no erosion.

When in good condition a small range of desirable shrubs such as ruby saltbush, cotton bush and flat leaf bluebush occur clumped beneath the eucalypt trees and larger wattles. These species confer limited drought durability to the pastures and management needs to aim at maintaining them in the stand.

3. Sandplain land system (15.6%)

About two-thirds of the Acacia Sandplain (ACSA) pastures on this system are in fair condition with the remainder about evenly distributed between good and poor. The pasture type is very similar to that on the Nerren system with, when in good condition, a small range of desirable low shrubs as well as annuals in season.

4. Yaringa land system (8.2%)

Acacia Sandplain (ACSA) and Acacia Mixed Shrub (ACMS) pastures on the Yaringa land system all show more or less depletion to fair or poor condition. The system has little durability in times of drought.

5. Snakewood land system (5.3%)

This valuable system with Saltbush (SALT) pastures is mostly in fair or bad range condition. Pastures are mostly degraded with almost half assessed as being poor or very poor. However, despite its depletion the pastures still have the potential to recover if strategic spelling over a number of growing seasons can be incorporated into the management system.

6. A major problem on the station is that it has an inadequate number of stock watering points. As a result, stock are poorly distributed over the property and grazing pressure has been excessive in some areas. This is reflected in the poor condition of much of the pasture. Attempts in the past to obtain additional supplies have been unsuccessful with drill holes being dry or containing very salty water. Until additional supplies are established it will be impossible to bring all parts of the property into use and to relieve grazing pressure on degraded areas.

7. The recommended sheep unit capacity for present condition and assuming the station was adequately watered (which is not the case, see 6 above) is 5150.

8. The capability sheep unit capacity if all country was in good range condition is estimated at 7,050.

Individual station report

Coburn station - 100,483 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Nanga	356	HEAT	320	—	—	—	1,067	1,067
		HASP	36	—	—	—	180	180
Nerren	348	AEGF	45	178	125	—	1,810	2,486
Sandplain	157	ACSA	22	105	30	—	960	1,308
Yaringa	83	ACSA	14	14	38	—	356	550
		ACMS	—	17	—	—	170	340
Snakewood	53	SALT	6	18	18	—	458	840
		ACMS	—	8	—	—	80	160
		ACSA	—	3	—	—	19	25
Cooloomia	8	AEGF	3	2	1	—	37	43
		ACMS	1	—	—	—	20	20
		HEAT	1	—	—	—	3	3
Toolonga	0.4	ACMS	—	0.4	—	—	4	8
		ACSA	—	—	—	—	—	—
		ASGF	—	—	—	—	—	—
Tarcumba	0.2	ACMS	—	0.2	—	—	2	4
Totals	1,005		448	345	212	—	5,166	7,034

* Area of extreme degradation; severe erosion and/or pasture degradation, zero grazing capacity.

Recommended sheep unit capacity 5,150

Capability sheep unit capacity 7,050

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 7,167

highest (1974) 10,103

lowest (1981) 3,200

Cooralya station - Carnarvon Shire

Area 1,619 km²

Location

Cooralya station is located on the Quobba and Kennedy Range 1:250,000 map sheets. The homestead is 8 km east of the North-West Coastal Highway and about 75 km north-east of Carnarvon by road. The station has common boundaries with Manberry, Hill Springs, Mardathuna, Doorawarrah, Boolathana, Boologooro and Minilya stations.

Description

All of the station is accessible to livestock. About half the country has been classified as being of high pastoral value and the remainder is of moderate value.

The two largest land systems on the station, Yalbalgo and Sandal, collectively occupy about 87% of the station area. The Yalbalgo system occurs in the northern half of the station and also in the east. It consists of sandplain with numerous linear and reticulate dunes and supports a moderately close tall shrubland of wanyu. The Sandal system occupies most of the southern half of the station and consists of alluvial plains with duplex soils and numerous low sandy rises and banks. Vegetation consists of mixed tall shrublands of various acacias with numerous low shrubs such as currant bush and cassias.

Six other land systems make up the rest of the station (13.4%) and although these systems are all relatively small they are important as they are of high or moderate pastoral value. The largest of these are Lyons (8.8%) and Sable (2.4%).

The Lyons system is found as inclusions in the Yalbalgo system in central and eastern parts of the station. It consists of sandy plains with numerous large, distinctive claypans surrounded by linear and reticulate dunes. The vegetation is a tall mixed shrubland, with wanyu dominating on the sand dunes. The Sable system occurs in the far south-west of the station and consists of almost flat saline alluvial plains with minor areas of sandy banks. Vegetation on the plains is mostly a low shrubland of Gascoyne bluebush and saltbush. The sandy banks support taller acacia shrublands.

All land systems found on the station are further summarized in table 1.

Condition statements for each land system for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Cooralya station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	-	—
Low (20-30 ha/s.u.)	-	—
Moderate (10-19 ha/s.u.)	Yalbalgo - sandplain with linear and reticulate dunes; tall shrublands of wanyu	49.2
	Lyons - sandy alluvial plains with numerous claypans and reticulate and linear dunes; tall mixed shrublands of acacias and currant bush	8.8
		58.0
High (5-9 ha/s.u.)	Sandal - alluvial plains with numerous low sandy rises and banks, duplex and sand soils; tall mixed shrublands of acacias and currant bush	37.4
	Sable - nearly flat saline alluvial plains, minor sandy banks; low shrublands of saltbush and bluebush and some tall acacia shrublands	2.4
	Target - plains with sandy banks, more clayey interbank areas and numerous small drainage foci; tall shrublands of acacias and currant bush	0.8
	Ella - short linear dunes and sandy banks with inter-dunal plains and drainage foci, tall acacia shrublands	0.7
	Gearle - gently sloping plains, minor stony rises with more sloping marginal plains, low shrublands of bluebush	0.4
	Mary - gently sloping plains with calcrete at shallow depth; mixed tall shrublands of acacias and cassias	0.3
		42.0
Very high (< 5 ha/s.u.)	-	—
		100.0

Table 2. Condition statements derived from traverse records (218 recordings on 4 land systems)

Cooralya

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Lyons	31	100	—	—	—	23	6	52	19	—	29	52	19
Sandal	115	99	1	—	—	1	17	55	25	2	18	55	27
Target	1	100	—	—	—	—	—	—	100	—	—	—	100
Yalbalgo	71	99	—	1	—	14	39	38	8	1	52	38	10
Total over all land systems	218	99	—	—	—	8	22	50	19	1	31	48	21

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 12 sites on 4 land systems.

Range condition and recommendations

1. Yalbalgo land system (49.2%)

This system supports the Acacia Sandplain (ACSA) pasture type. The pastures consist of scattered low shrubs such as cotton bush, flannel bush and Wilcox bush and wandarrie grass beneath tall shrubs such as wanyu and other acacias. Pasture condition as seen during survey was nearly all fair to very good. There is no erosion and over all range condition was fair or good.

Fire may be a useful management tool on this system, but its use has not been researched. Evidence seen elsewhere during survey suggests that the effects of fire are long term. Wanyu may take decades to regenerate after fire although other acacias in the stand recover much more rapidly. When the over-storey of tall shrubs is killed by fire the low shrub layer and the ground layer often increases markedly both in diversity of species and in density. This fire induced sub-climax appears to be considerably more productive for livestock production than is the climax situation.

2. Sandal land system (37.4%)

This system supports valuable Currant Bush Mixed Shrub pastures (CBMS) on the duplex soils of the alluvial plains and Acacia Sandplain pastures (ACSA) on the sandy banks. Both pasture types are largely in fair condition although some areas are poor and show considerable loss of desirable shrubs such as currant bush and tall saltbush and an increase in undesirables such as needle bush. Areas in poor condition are still highly productive in terms of annual herbage in season, but have limited drought reserves compared to areas in good condition. Strategic spelling over a number of growing seasons will enable the recovery of desirable low shrubs. Techniques to reduce thickets of needle bush on a wide scale have yet to be developed.

Buffel grass has colonized many of the sandy areas of this system and compliments native pastures on these sites. It is continuing to spread and its spread on to duplex soils and more clayey soil sites where it may compete with desirable low shrubs needs to be monitored.

3. Lyons land system (8.8%)

This system also supports Currant Bush Mixed Shrub pastures (CBMS) and Acacia Sandplain pastures (ACSA). Pasture condition is very similar to that of the Sandal system. Condition is predominantly fair although significant areas (about 20% of the traverse recordings) were in poor condition with depleted shrub pastures. These pastures have the potential to recover well if they can be occasionally spelled from grazing.

4. The remaining minor land systems on the station were not intensively sampled but, where seen, were generally in fair condition with no erosion. Their overall condition is expected to be similar to that of the Sandal system.

5. The recommended sheep unit capacity for present condition is 13,350.

6. The capability sheep unit capacity if all country was in good range condition is estimated at 18,650.

Individual station report

Cooralya station - 161,886 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Yalbalgo	797	ACSA	414	303	80	—	5,665	6,642
Sandal	606	CBMS	41	156	76	—	3,245	5,460
		ACSA	44	140	58	—	1,474	2,017
		BLUE	14	52	25	—	1,086	1,820
Lyons	143	ACSA	5	52	15	—	427	600
		CBMS	—	23	8	—	338	620
		ACCR	—	11	—	—	110	220
		No veg	29	—	—	—	—	—
Sable	39	SALT	11	4	3	—	289	360
		BLUE	10	4	2	—	263	320
		ACSA	2	2	1	—	33	42
Target	12	CBMS	—	2	3	—	44	100
		ACSA	2	3	—	—	35	42
		ACCR	1	1	—	—	30	40
Ella	11	ACSA	4	4	—	—	58	67
		CBMS	—	2	—	—	25	40
		ACCR	1	—	—	—	20	20
Gearle	6	BLUE	4	—	—	—	80	80
		SALT	2	—	—	—	40	40
		TUGR	—	—	—	—	—	—
Mary	5	ACMS	2	3	—	—	70	100
		BLUE	—	—	—	—	—	—
Totals	1,619		586	762	271	—	13,331	18,630

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 13,350

Capability sheep unit capacity 18,650

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1969):

average (mean) 20,583

highest (1972) 27,700

lowest (1984) 15,655

Dirk Hartog Station - Shark Bay Shire

Area 617 km²

Location

Dirk Hartog station (Dirk Hartog Island) is located on the Edel and Shark Bay 1:250,000 map sheet. The nearest point of the island lies about 35 km in a westerly direction from Denham across Denham Sound. The island is almost 80km long by about 10 km wide and lies at the western side of Shark Bay with its long axis in a south-east to north-west direction.

Description

Five land systems occur on the station, three of which (Coast, Edel and Inscription) collectively make up about 99% of the total station area.

The Coast land system (41.9%) occurs along the entire western side of the island and consists of large long-walled parabolic dunes and narrow swales, unstable blow-out areas and bare mobile dunes, minor limestone hills and rises and steep sea cliffs. Vegetation is tall open heath or tall shrubland usually dominated by *Acacia ligulata* and with numerous low shrubs. There are some localized areas of spinifex hummock grassland *Triodia plurinervata* notably on the hills near Herald Heights. Pastoral value is high.

The Edel land system (32.5%) occurs in eastern and south-eastern parts of the island and consists of undulating sandy plains with minor low dunes, limestone rises and saline flats. Vegetation is a tall or low open heath or low shrubland and pastoral value is high.

The Inscription land system (24.3%) is found in the north-east and central-east of the island. It consists of gently undulating sandy plains over limestone usually at shallow depth. Vegetation is low heath with a variable admixture of spinifex. Pastoral value is low or very low.

The remaining land systems Birrida (0.7%) and Littoral (0.6%) are of little significance. All systems on the island are summarized in table1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from information recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Dirk Hartog station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	Inscription - gently undulating sandy plains over limestone at variable depth; low heath with some spinifex	24.3
Moderate (10-19 ha/s.u.)	Birrida - highly saline and gypsiferous pans and depressions, low shrublands of samphire and saltbush	0.7
	Littoral - low coastal foredunes, samphire flats and tidal flats; tall and low shrublands in parts	0.6
		1.3
High (5-9 ha/s.u.)	Coast - large, long walled parabolic coastal dunes and narrow swales, unstable blowout areas and mobile dunes, minor limestone hills and rises, steep sea cliffs; tall open heath or tall acacia shrublands	41.9
	Edel - undulating sandy plains with minor low dunes, limestone rises and saline flats, low sea cliffs, tall or low heath	32.5
		74.4
Very high (< 5 ha/s.u.)	-	—
		100.0

Table 2. Condition statements derived from traverse records (129 recordings on 3 land systems)

Dick Hartog

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Coast	37	92	5	—	3	59	30	8	—	3	89	8	3
Edel	43	93	5	2	—	9	51	33	5	2	60	33	7
Inscription	49	100	—	—	—	74	14	12	—	—	88	12	—
Total over all land systems	129	95	3	1	1	47	31	18	2	2	79	18	3

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 8 sites on 3 land systems.

Range condition and recommendations

1. Coast land system (41.9%)

This system supports Coastal Dune Shrub pastures (CDSH) which consist of a large number of palatable low shrubs mixed with less palatable types beneath taller shrubs such as *Acacia ligulata* and coastal jam. Desirable shrubs include silver saltbush, cotton bush, green cassia and rhagodias. Pasture condition is mostly good or very good.

About 16 km² of the system consists of unvegetated blowout areas or large mobile sand dunes. These unstable zones are particularly numerous in the south-west of the island where they originate on the coast facing the Indian Ocean and have migrated northwards. One blowout has migrated right across the island and enters the sea on the eastern side of the island at Tetrodon Loop. Also a number of very large mobile dunes occur in the north-west of the station near Mystery bore.

Although the system supports useful pastures it is highly susceptible to wind erosion if the vegetation is removed by fire, overgrazing or other agencies.

Elsewhere in the survey area there is clear cut evidence that some blowouts on the Coast land system have originated near man-made stock watering points. The system should not be further developed for grazing unless extreme care is taken about the siting of watering points, fences and access tracks.

2. Edel land system (32.5%)

This system supports the Coastal Dune Shrub (CDSH) pasture type and the Heath (HEAT) pasture type. Pasture condition is mostly good or fair and there is little erosion. Over all range condition is good or fair except in the vicinity of some mills where the indigenous vegetation is almost completely lost. Such areas have lost their surface sand due to wind erosion and the underlying limestone is exposed. Vegetative cover, in the form of introduced annual species, is present only during periods after rain.

3. Inscription land system (24.3%)

This system supports Heath pastures (HEAT) which are generally of very low grazing value. Many of the low shrub components are unattractive to stock although small annual species provide some useful grazing after rain. Pasture condition is mostly good or very good.

4. Much of the station, particularly in the northern half, is not being used for grazing because of the lack of permanent water supplies.

5. The recommended sheep unit capacity for present condition assuming the station was fully watered (which is not the case, see 4) is estimated at 5,450.

6. The capability sheep unit capacity if all country was in good range condition is estimated at 6,300.

Individual station report

Dirk Hartog station - 61,674 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Coast	258	CDSH	216	19	7	16	2,863	3,225
Edel	200	CDSH	101	56	11.5	1.5	1,709	2,125
		HEAT	12	7	1	—	60	67
		SALT	6	3	1	—	164	200
Inscription	150	HEAT	66	9	—	—	243	250
		HASP	66	9	—	—	360	375
Birrida	4	SAMP	3	—	—	—	12	12
		SALT	1	—	—	—	20	20
Littoral	4	CDSH	2	—	—	—	25	25
		No veg	1	—	—	—	—	—
		SAMP	1	—	—	—	4	4
Totals	616		475	103	20.5	17.5	5,460	6,303

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 5,450

Capability sheep unit capacity 6,300

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 5,956

highest (1969) 12,500

lowest (1981) 2,500

Doorawarrah station - Carnarvon Shire

Area 2,193 km²

Location

Doorawarrah station is located on the Kennedy Range and Wooramel 1:250,000 map sheets. The homestead is about 78 km east of Carnarvon on the Carnarvon-Gascoyne Junction road. The station has common boundaries with Cooralya, Mardathuna, Mooka, Jimba Jimba, Yalbalgo, Ella Valla, Meeragoolia, Brickhouse and Boolathana stations.

Description

The station largely comprises sandy alluvial plains, sandplains and sand dunes and all of it is accessible to livestock. The Ella land system is the largest and occupies about 32.5% of the total area of the station. The system occurs in the west, south and north-east and consists of short, linear sand dunes and narrow inter-dunal plains. The inter-dunal plains frequently have central run on areas or drainage foci which support somewhat more dense vegetation than the surrounding plains. Vegetation is predominantly wanyu shrubland or sand ridge gidgee woodland and pastoral value is moderate.

The Target land system (25.1%), which occurs over most of the station, has affinities with the Ella system except that it has very low sandy banks rather than dunes or ridges and has more pronounced drainage foci. Vegetation is a tall shrubland of wanyu on sandy parts and tall mixed shrublands of acacias and currant bush on the more clayey plains and drainage foci. Pastoral value is high.

The Sandal land system (13.6%) occurs in the north and west of the station and consists of alluvial plains with duplex soils and numerous low sandy banks and rises with sandy soils. It supports a mixed tall shrubland of acacias and numerous other shrubs. Pastoral value is high.

Two sand dune systems, Yalbalgo (13.0%) and Lyons (11.7%) make up most of the rest of the station. The Yalbalgo system consists of sandplains with large linear and reticulate dunes with relief up to 25 m. It supports moderately dense tall shrublands of wanyu and pastoral value is moderate. The Lyons system also consists of large dunes, but also has more clayey inter-dunal plains and large, prominent claypans. It supports shrublands of wanyu, other acacias and currant bush. Pastoral value is moderate.

Three other minor land systems (collectively 4.1%) occur on the station but are of little significance.

All systems are summarized in table1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Doorawarrah station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Yalbalgo - sandplains with linear and reticulate dunes, tall shrublands of wanyu or woodlands of sand dune gidgee	13.0
	Lyons - sandy alluvial plains with numerous claypans and reticulate and linear dunes; tall shrublands of acacias and currant bush	11.7
	Channel - major channels with narrow flood plains and dissected marginal slopes, tall acacia shrublands	3.6
		28.3
High (5-9 ha/s.u.)	Ella - short linear dunes and sandy banks with inter-dunal plains and drainage foci; sand dune gidgee woodlands and mixed tall shrublands of acacias	32.5
	Target - plains with sandy banks, more clayey interbank areas and numerous small drainage foci; tall mixed shrublands of acacias	25.1
	Sandal - alluvial plains with numerous low sandy rises and banks, duplex and sand soils; tall mixed shrublands and some low shrublands of bluebush	13.5
	River - narrow active flood plains and major channels, fringing woodlands and tall acacia shrublands	0.3
	Mary - gently sloping plains with calcrete at shallow depth, tall shrublands of acacia and cassia	0.2
		71.7
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (311 recordings on 8 land systems)

Doorawarrah

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Ella	88	96	3	1	—	5	20	48	26	1	25	48	27
Lyons	26	92	8	—	—	23	4	46	23	4	27	46	27
Mary	2	100	—	—	—	—	—	100	—	—	—	100	—
River	7	42	—	29	29	—	43	14	14	29	43	—	57
Sandal	49	90	6	4	—	2	39	45	14	—	41	45	14
Target	132	83	15	2	—	2	9	47	39	3	11	47	42
Yalbalgo	7	100	—	—	—	—	14	29	57	—	14	29	57
Total over all land systems	311	88	9	2	1	5	17	45	30	3	22	45	33

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 17 sites on 4 land systems.

Range condition and recommendations

1. Ella land system (32.5%)

About half the traverse records indicate fair range condition for this system with the remainder being about evenly distributed between good and bad condition. Condition of the Acacia Sandplain (ACSA) pastures on the sandy units of the system is nearly all fair or good. However, the Currant Bush Mixed Shrub (CBMS) pastures which occur on the more clayey inter-dunal plains are more or less degraded with considerable loss of desirable low shrubs in some parts. There is very little erosion on the system and it has the ability to recover well if spelled over a number of growing seasons.

2. Target land system (25.1%)

Acacia Sandplain (ACSA) pastures on the sandy banks of the system are mostly in fair condition and there is no erosion on this unit. Currant Bush Mixed Shrub (CBMS) pastures are in fair or poor condition with considerable depletion of desirable shrubs such as tall saltbush, ruby saltbush and green cassia. Minor wind and water erosion in the form of localized surface deflation, thin sheeting and surface scalding is common on the duplex soils associated with this pasture type. The most badly degraded areas require a programme of strategic spelling from grazing over a number of growing seasons to enable recovery of desirable shrubs.

3. Sandal land system (13.6%)

The Acacia Sandplain (ACSA) and Currant Bush Mixed Shrub (CBMS) pastures on this system are largely in fair or good condition with only some minor areas showing vegetation degradation to poor condition. There are a few localized areas of minor wind and water erosion, but generally the system is relatively stable under grazing. A system of occasional spelling of paddocks over a growing season would be beneficial.

4. Yalbalgo land system (13.0%)

The system was inadequately sampled. However, where seen, there was no erosion but the acacia sandplain pastures were depleted. Generally the system is stable under grazing and not highly susceptible to degradation.

5. Lyons land system (11.7%)

Condition of the Acacia Sandplain (ACSA) and Currant Bush Mixed Shrub (CBMS) pastures seen on this system was predominantly fair or good with some localized parts for example in the vicinity of watering points, in poor condition. There is occasional minor wind and water erosion but this is not a significant problem.

6. The remaining land systems Channel (3.6%), River (0.3%) and Mary (0.2%) were not intensively sampled. However, some moderate and severe water erosion in the form of active rills and gullies was seen on slopes marginal to the main river channel of the Gascoyne River. Because of the proximity to water these sites are likely to be overgrazed and the erosion problem may need further attention.

7. The station has been well developed in terms of paddocks and stock water in the past. Many of the more outlying paddocks did not appear to be in use. Stock should be more equitably distributed over the property so that regular spelling can be commenced on more heavily grazed parts of the station.

8. The recommended sheep unit capacity for present condition is 16,900.

9. The capability sheep unit capacity if all country was in good condition is estimated at 27,350.

Individual station report

Doorawarrah station - 219,301 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Ella	714	ACSA	175	260	65	—	3,343	4,167
		CBMS	9	63	71	—	1,411	2,860
		ACCR	18	36	17	—	805	1,420
Target	551	CBMS	10	104	134	—	2,338	4,960
		ACSA	35	128	57	—	1,320	1,833
		ACCR	21	42	20	—	940	1,660
Sandal	299	CBMS	32	81	22	—	1,790	2,700
		ACSA	73	31	16	—	866	1,000
		BLUE	11	26	7	—	589	880
Yalbalgo	284	ACSA	20	41	81	—	747	1,183
		HASP	28	57	57	—	473	710
Lyons	255	ACSA	12	82	34	—	749	1,067
		CBMS	—	56	—	—	700	1,120
		ACCR	—	8	12	—	140	400
		No veg	51	—	—	—	—	—
Channel	79	BLUE	2	17	21	—	384	800
		ACCR	4	8	4	—	180	320
		No veg	23	—	—	—	—	—
River	7	ACCR	—	4	—	—	40	80
		TUGR	—	2	—	—	40	100
		No veg	1	—	—	—	—	—
Mary	4	ACMS	—	4	—	—	40	80
Totals	2,193		525	1,050	618	—	16,895	27,340

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 16,900

Capability sheep unit capacity 27,350

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 19,391

highest (1976) 25,272

lowest (1981) 9,050

Edaggee station - Carnarvon Shire

Area 679 km²

Location

Edaggee station is located on the Wooramel 1:250 000 map sheet. The homestead is about 22 km east of the North-West Coastal Highway with the road turn-off about 77 km south of Carnarvon. Edaggee has common boundaries with Brickhouse, Callagiddy, Ella Valla, Marron, Wahroonga and Wooramel stations. In the south-west it has a coastline of about 12 km on Shark Bay.

Description

The station consists of broad, almost flat plains with numerous low sandy rises and minor areas of sandplain and sand dunes. All of the station is accessible to livestock and is classified as being of high pastoral value.

Five land systems occur on the station; the largest of these is the Sandal system which occupies about 75% of the total station area. It consist of low plains with numerous low sandy rises and banks supporting tall acacia shrublands.

The Sable land system (15.6%) occurs in the west of the station. It consists of saline alluvial plains with occasional sandy rises and supports low shrublands of saltbush and bluebush on the plains and tall shrublands of silver bark wattle and other acacias on the sandy rises.

Two other minor systems Ella (9.3%), and Brown (0.6%) occur on the station. All systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Edaggee station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Brown - gently undulating sandplains and occasional dunes; tall acacia shrublands	0.6
High (5-9 ha/s.u.)	Sandal - alluvial plains with numerous low sandy rises and banks, duplex and sand soils; tall shrublands of acacias and currant bush, minor low shrublands of bluebush	74.5
	Sable - nearly flat saline alluvial plains, minor sandy banks; low shrublands of saltbush and bluebush, some tall acacia shrublands	15.6
	Ella - short linear dunes and sandy banks with inter-dunal plains and drainage foci, sand dune gidgee woodlands and acacia shrublands	9.3
		99.4
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (147 recordings on 5 land systems)

Edaggee

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Brown	2	100	—	—	—	—	—	100	—	—	—	100	—
Ella	11	100	—	—	—	—	—	45	55	—	—	45	55
Littoral	4	100	—	—	—	75	25	—	—	—	100	—	—
Sable	27	100	—	—	—	45	33	22	—	—	78	22	—
Sandal	103	99	1	—	—	1	17	47	26	9	18	47	35
Total over all land systems	147	99	1	—	—	11	19	42	22	6	30	41	29

Range evaluation sites

Detailed descriptions of landform, vegetation, soils and range condition were made at 9 sites on 2 land systems.

Range condition and recommendation

1. Sandal land system (74.5%)

This system supports valuable Currant Bush Mixed Shrub pastures (CBMS) and some Bluebush (BLUE) on the duplex soils of the alluvial plains and interbank areas and Acacia Sandplain pastures (ACSA) on the sandy banks. Condition of the Currant Bush Mixed Shrub pastures is predominantly fair or poor although some areas are in good condition. The poorer parts, which are concentrated in paddocks near the homestead, show considerable loss of desirable shrubs such as currant bush and tall saltbush. Undesirable species such as needle bush, bardie bush and waxy leaved eremophila have increased at the expense of the desirables. Condition of the Acacia Sandplain pastures on the sandy rises is rather better being mostly fair or good. There is no erosion on the system.

About 29% of the traverse observations indicated bad range condition with depleted pastures. These areas still produce abundant annual herbage in season, but their reserves of palatable shrubs for dry periods are much reduced. Some 41% and 30% of the observations indicated fair and good range condition respectively.

Degraded parts, where undesirable species have not increased substantially, could be readily improved by spelling from grazing. However, where dense stands of undesirable shrubs have become established, practical methods for their removal are not known.

2. Sable land system (15.6%)

This system supports mixed Bluebush and Saltbush pastures (BLUE, SALT) with smaller areas of Acacia Sandplain pastures (ACSA). Pasture condition is mostly good or very good with a wide range of desirable shrubs such as Gascoyne bluebush, low bluebush, Gascoyne mulla mulla, bladder saltbush and silver saltbush. There is no erosion. The system is not fully used for grazing because many parts are distant from stock water supplies.

3. Ella land system (9.3%)

This sandy system supports Acacia Sandplain pastures (ACSA) with minor areas of Currant Bush Mixed Shrub pastures (CBMS) on the inter-dunal corridors. The system is restricted to the north-east of the station. Only part of the system was sampled but, where seen, the pastures were degraded with loss of desirable shrubs. There is no erosion.

4. Brown land system (0.6%)

Pastures on this minor system are in fair condition and there is no erosion.

5. The station is inadequately watered. More than half the pastures on the station are further than 5 km from permanent stock water. Consequently pastures distant from water are in good condition and are little used while those close to the watering points have been over-used and are now degraded. Additional watering points, possibly by piping from existing artesian supplies, are required to enable better distribution of livestock.

6. The recommended sheep unit capacity for present condition (assuming the station is adequately watered which is not the case, see 5) is 6,700.

7. The capability sheep unit capacity if all country was in good range condition is estimated at 10,450.

Individual station report

Edaggee station - 67,878 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandal	505	CBMS	34	75	118	—	2,356	4,540
		ACSA	45	121	36	—	1,275	1,683
		BLUE	13	38	25	—	891	1,520
Sable	106	SALT	34	14	—	—	855	960
		BLUE	30	12	—	—	750	840
		ACSA	11	5	—	—	123	133
Ella	64	ACSA	—	34	11	—	257	375
		CBMS	—	2	11	—	94	260
		ACCR	—	6	—	—	60	120
Brown	4	ACSA	—	4	—	—	25	33
		SALT	—	—	—	—	—	—
Totals	679		167	311	201	—	6,686	10,464

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 6,700

Capability sheep unit capacity 10,450

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 9,773

highest (1976) 15,300

lowest (1980) 1,000

Ella Valla station - Carnarvon Shire

Area 7,614 km²

Location

Ella Valla station is located on the Wooramel 1:250 000 map sheet. The homestead is about 68 km east of the North-West Coastal Highway with the road turn-off about 22 km south of Carnarvon. Common boundaries are shared with Meeragoolia, Doorawarrah, Yalbalgo, Marron, Edaggee and Callagiddy stations.

Description

The eastern two-thirds of the station consists of short, linear sand dunes and narrow inter-dunal plains of the Ella land system. Relief of the dunes is up to 15 m. The inter-dunal plains frequently have central run-on areas or drainage foci which support more dense vegetation than the surrounding plains. Vegetation on the sandy units of the system is sand dune gidgee woodland or wanyu shrubland and elsewhere is mixed shrubland. Pastoral value is high.

Most of the remainder of the station consists of alluvial plains with numerous low sandy banks and rises. This is the Sandal land system (28.2%) which supports mixed shrubland, wanyu shrubland and some Gascoyne bluebush. Pastoral value is high.

Only one other land system, Brown (7%) occurs on the station. It is found in the south-west and consists of sandplain with tall shrublands of wanyu and other acacias.

The three systems found on the station are summarized and their pastoral value shown in table 1.

Condition statements for each land system and for the whole station (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Ella Valla station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Ella - short linear dunes and sandy banks with inter-dunal plains and drainage foci, sand dune gidgee woodlands and mixed shrublands	64.8
	Brown - gently undulating sandplains and occasional dunes; tall shrublands of wanyu	7.0
		71.8
High (5-9 ha/s.u.)	Sandal - alluvial plains with numerous low sandy rises and banks, duplex and sand soils; tall shrublands of acacias and currant bush, minor low shrublands of bluebush	28.2
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (165 recordings on 3 land systems)

Ella valla

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Brown	2	100	—	—	—	—	50	50	—	—	50	50	—
Ella	95	100	—	—	—	5	41	41	12	1	46	41	13
Sandal	68	100	—	—	—	3	28	46	22	1	31	45	24
Total over all land systems	165	100	—	—	—	4	36	43	16	1	40	43	17

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 11 sites on 2 land systems.

Range condition and recommendations

1. Ella land system (64.8%)

Most of this system is in fair or good range condition. Condition of the Acacia Sandplain (ACSA) pastures on the sandy units of the system is fair to good. The Currant Bush Mixed Shrub (CBMS) pastures of the inter-dunal plains are rather more degraded with almost 50% classified as being in poor condition. There is no erosion on the system and it has the ability to recover well if spelled over growing seasons.

2. Sandal land system (28.2%)

This system is mostly in fair or good range condition although some Currant Bush Mixed Shrub (CBMS) pastures are degraded to poor condition.

This pasture type occurs on the small flat plains with duplex soils which lie between the sandy banks and rises of the system. When in good condition the pasture is very productive with numerous desirable shrubs such as currant bush and tall saltbush. Decline in condition is often indicated by a relative increase in undesirable species such as waxy leaf eremophila and straight leaf cassia.

3. Brown land system (7%)

This minor system was not intensively sampled but, where seen, was in fair or good range condition.

4. The station is generally well watered. Only small areas in the far east and south-west are more than 5 km from a watering point. Stock can be well distributed over the property.

5. The recommended sheep unit capacity for present condition is 7,000.

6. The capability sheep unit capacity if all country was in good range condition is estimated at 9,650.

Individual station report

Ella Valla station - 76,135 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Ella	493	ACSA	176	145	24	—	2,469	2,875
		CBMS	13	40	46	—	1,048	1,980
		ACCR	39	10	—	—	880	980
Sandal	215	CBMS	10	58	29	—	1,106	1,940
		ACSA	43	28	15	—	593	717
		BLUE	13	13	6	—	460	640
Brown	53	ACSA	24	24	—	—	350	400
		SALT	3	2	—	—	85	100
Totals	761		321	320	120	—	6,991	9,632

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 7,000

Capability 9,650

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 10,701

highest (1969) 15,723

lowest (1980) 4,500

Exmouth Gulf station - Exmouth Shire

Area 930 km²

Location

Exmouth Gulf station is located on the Yanrey and Ningaloo 1:250 000 map sheets. The homestead is 5 km east of the Exmouth road and about 53km south by road from Exmouth. The station has common boundaries with Bullara station, Cape Range National Park and in the east with the coastline of Exmouth Gulf.

Description

Only four land systems occur on the station. Nearly 60% of the station comprises rugged limestone hills, ridges and plateaux of the Range land system (Cape Range). Most of this system is unsuitable for grazing and is not used by the station. Most of the remainder of the station consists of undulating sandy plains of the Cardabia land system and sandplains, minor outwash plains and stony plains of the Learmonth system. Both these systems support hummock grasslands, predominantly of soft spinifex, with a patchy over-storey of tall shrubs. Pastoral value is high.

Small areas of the Littoral system with low coastal dunes with soft spinifex and buffel grass, samphire flats, bare mudflats and mangroves occur along the shoreline to Exmouth Gulf. All systems are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Exmouth Gulf station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Range - limestone hills, ridges and plateaux with steep stony footslopes; tall shrublands with hard spinifex	57.2
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Littoral - low coastal foredunes, samphire and tidal flats and mangrove fringes; hummock grasslands, soft spinifex and buffel grass and scattered shrubs, also low shrublands of samphire	2.7
High (5-9 ha/s.u.)	Cardabia - undulating sandy plains with linear dunes and minor limestone ridges and outcrop plains; low shrublands and hummock grasslands of soft and hard spinifex	26.3
	Learmonth - sandplains, sandy outwash plains and minor limestone outcrop plains; soft spinifex hummock grasslands with scattered shrubs	13.8
		40.1
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (105 recordings on 4 land systems)

Exmouth

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Cardabia	55	98	2	—	—	71	27	2	—	—	98	2	—
Learmonth	39	97	3	—	—	81	8	8	—	3	89	8	3
Littoral	5	100	—	—	—	40	60	—	—	—	100	—	—
Range	6	100	—	—	—	83	17	—	—	—	100	—	—
Total over all land systems	105	98	2	—	—	74	21	4	—	1	95	4	1

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 5 sites on 3 land systems.

Range condition and recommendations

1. Cardabia land system (26.3%)

Pastures are mostly Soft Spinifex (SOSP), but also with some Hard Spinifex (HASP). Pasture condition is very good or good and there is no erosion.

The system is generally stable under grazing except for occasional localized dunes and dune crests which may become unstable due to the effects of fire or excessive grazing pressure. Fire is a natural feature of the environment and regular, controlled burning is an accepted management tool to maintain pastures in a useful condition for grazing. Some sand drift can occur after fire, but the system revegetates rapidly after rain and stabilizes.

2. Learmonth land system (13.8%)

This system supports Soft Spinifex pastures (SOSP) on the sandy parts with minor areas of Acacia Mixed Shrub pastures (ACMS) on small outwash plains over limestone. Buffel grass is well established on some sandy areas especially in paddocks close to the homestead. Over all, the pastures are in very good or good condition and there is no erosion. An exception is in the eastern half of Wogalti paddock where pastures are depleted to poor or very poor condition and there are small patches of minor wind and water erosion.

3. Littoral land system (2.7%)

This minor system was not sampled intensively. However, where the soft spinifex, buffel grass, samphire and saltbush pastures of the system were seen they were in good or very good condition.

4. The recommended sheep unit capacity for present condition is 8,050.

5. The capability sheep unit capacity if all country was in good range condition is estimated at 8,250.

Individual station report

Exmouth Gulf station - 92,986 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Range	532	HASP	484	48	—	—	2,580	2,660
Cardabia	245	SOSP	192	4	—	—	3,233	3,267
		HASP	48	1	—	—	243	245
Learmonth	128	SOSP	69	8	—	—	1,217	1,283
		HASP	23	3	—	—	125	130
		ACMS	23	2	—	—	480	500
Littoral	25	SOSP	10	—	—	—	167	167
		SAMP	5	—	—	—	20	20
		No veg	10	—	—	—	—	—
Totals	930		864	66	—	—	8,065	8,272

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 8,050

Capability 8,250

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1974):

average (mean 9,468

highest (1975) 11,503

lowest (1980) 7,498

Faure station - Shark Bay Shire

Area 58 km²

Location

The station consists of Faure Island in Shark Bay at the head of the Hamelin Pool embayment. The island lies about 18 km east of the Peron Peninsula from Monkey Mia.

Description

Three land systems, Sandplain, Birrida and Littoral, occur on the station. The Sandplain system is by far the largest (82.1% of total station area) and consists of undulating red sandplain supporting a moderately close wanyu shrubland about 1.5-2 m high. Under-shrubs are considerably more prolific than is usual for this system and this, coupled with the widespread occurrence of buffel grass means that pastoral value is very high.

The Birrida system (11%) occurs in the north and west as a series of salt pans and depressions with sandy margins. The system supports low shrublands of saltbush and samphire.

The Littoral system occurs as a narrow coastal fringe in the north, north-east and south-west. It consists of low coastal foredunes and samphire and tidal flats with mangrove fringes. The foredunes support a mixed shrubland of stunted wanyu and curara 1-2 m high with numerous under-shrubs and coastal spinifex.

The three land systems on the station are summarized in table 1.

Condition statements for land systems and for the whole station (taken over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Faure station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Birrida - highly saline pans and depressions with sandy margins; low shrublands of samphire and saltbush	11.2
	Littoral - low coastal foredunes, samphire and tidal flats with mangrove fringes, low shrublands of wanyu and curara, also coastal spinifex and samphire	6.7
		17.9
High (5-9 ha/s.u.)	—	—
Very high (< 5 ha/s.u.)	Sandplain - nearly flat to gently undulating red sandplain with wanyu shrublands and buffel grass	82.1
		100.0

Table 2. Condition statements derived from traverse records (22 recordings on 2 land systems)

Faure

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Birrida	3	100	—	—	—	33	67	—	—	—	100	—	—
Sandplain	19	79	21	—	—	21	42	21	5	11	63	21	16
Total over all land systems	22	82	18	—	—	23	45	18	5	9	68	18	14

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 3 sites on 2 land systems.

Range condition and recommendations

1. Sandplain land system (82%)

This system usually supports the Acacia Sandplain pasture type (ACSA) but on Faure the pastures are more productive and are closer in composition (in terms of desirable low shrubs) to the Coastal Dune Shrub pasture type (CDSH). The over-storey consists of somewhat wind pruned wanyu and curara to about 2 m. Useful low shrubs such as silver saltbush, tall saltbush and ruby saltbush are numerous and buffel grass is widely established especially in the paddocks at the southern end of the island.

Over 60% of the traverse recordings indicated good or very good pasture condition with most of the remainder indicating fair condition. In the southern paddocks the pastures have been degraded with considerable loss of desirable low shrubs but buffel grass is now well established.

Near the south-eastern coast there is some minor wind erosion with disturbed sandy surfaces. However, these areas are becoming stabilized by buffel grass. In the south-west there are some old, small coastal blowouts which are now stabilized by buffel grass and coastal spinifex. They are not likely to become a problem except under extreme conditions of overgrazing or drought.

2. Birrida land system (11%)

Saltbush (SALT) and Samphire (SAMP) pastures of this system were all in good or very good condition. The former pastures are very productive with many desirable shrubs such as bladder saltbush, felty bluebush, cotton bush and rhagodias.

3. Littoral land system (7%)

This system was not traversed. However, it was seen at a number of points and at these was in good condition.

4. The recommended sheep unit capacity for present condition is 1,230.

5. The capability sheep unit capacity if all country was in good range condition is estimated at 1,350.

Individual station report

Faure station - 5,816 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandplain	48	CDSH	24	8	6	—	618	760
		TUGR	10	—	—	—	500	500
Birrida	6	SAMP	3	—	—	—	12	12
		SALT	3	—	—	—	60	60
Littoral	4	CDSH	2	—	—	—	40	40
		No veg	2	—	—	—	—	—
		SAMP	—	—	—	—	—	—
Totals	58		44	8	6	—	1,230	1,372

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 1,250

Capability 1,350

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 1,753

highest (1974) 2,734

lowest (1981) 798

Gilroyd station - Carnarvon & Shark Bay Shires

Area 8,094 km²

Location

Gilroyd station is located in the south-east of the Wooramel 1:250,000 map sheet. The homestead is about 230 km by road south-east from Carnarvon via Pimbee, Wahroonga and Edaggee stations. The station has common boundaries with Towrana, Callytharra Springs, Byro, Yalardy, Woodleigh and Meedo stations.

Description

More than 80% of the station consists of gently undulating red sandplain of moderate pastoral value. This is the Sandplain land system which supports tall shrublands of wanyu or open woodlands of sand dune gidgee.

The Yalbalgo system (17.2% of the station area) occurs in north-eastern and central eastern parts of the station. It consists of well-defined linear sand dunes with relief up to 20 m and sandy swales and supports virtually the same vegetation as the Sandplain system.

Three other land systems, Wooramel, Target and Channel occur on the station but collectively occupy only about 1.2% of the total station area. A large bare claypan about 500 ha in area (0.6%) occurs in the south on the boundary with Yalardy station.

All land systems on the station are summarized in table 1.

Condition statements for land systems and for the whole station (total overall land systems) are shown in table 2.

Table 1. Land systems on Gilroyd station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Sandplain - nearly flat to gently undulating red sandplain with tall shrublands of wanyu and woodlands of sand dune gidgee	81.0
	Yalbalgo - sandplain with linear and reticulate dunes; tall shrublands of wanyu and woodlands of sand dune gidgee	17.2
	Wooramel - sandy plains and stony plains with hardpan at shallow depth; tall shrublands of wanyu and mulga	1.0
	Channel - major channels with highly dissected marginal slopes and plains, very scattered low shrublands and fringing woodlands	0.1
		99.3
High (5-9 ha/s.u.)	Target - plains with sandy banks, more clayey interbank areas and numerous small drainage foci; tall mixed shrublands of acacia, currant bush and others	0.1
Very high (< 5 ha/s.u.)	—	—
	Bare claypan	0.6
		100.0

Table 2. Condition statements derived from traverse records (164 recordings on 3 land systems)

Gilroyd

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Sandplain	114	100	—	—	—	12	34	48	6	—	46	48	6
Target	1	100	—	—	—	—	100	—	—	—	100	—	—
Yalbalgo	49	98	2	—	—	—	31	47	22	—	31	47	22
Total over all land systems	164	99	1	—	—	9	34	46	11	—	42	47	11

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 8 sites on 2 land systems.

Range condition and recommendations

1. Sandplain land system (81%)

This system supports the Acacia Sandplain (ACSA) pasture type. Typically, this pasture has a tree layer of sand dune gidgee or, less frequently, a tall shrub layer of wanyu. The lower layers consist of very scattered low shrubs including a few desirable species such as Wilcox bush and cotton bush. In season there is a prominent ground layer dominated by wanderrie grass or forbs. Pasture condition as seen during survey was mostly fair or good. There is no erosion present and over all range condition is fair or good.

Because of the general lack of palatable shrubs and the rather ephemeral nature of the wanderrie grass pastures the system has limited drought value. Opportunistic use on a flexible basis can be made on the grass pastures in good seasons.

Fire may be a useful management tool on this land system, but its use has not been researched. Evidence seen on this system during survey suggests that the effects of fire are very long term. Where the over-storey of tall wanyu shrubs has been killed by fire the low shrub layer and the ground layer is remarkably increased both in diversity of species and in density. This fire induced sub.climax appears to be considerably more productive for livestock production than is the mature wanyu or sand dune gidgee situation.

2. Yalbalgo land system (17.2%)

This system supports the same Acacia Sandplain (ACSA) pasture as found on the Sandplain system. Pasture condition is mostly fair although it varies from good to poor depending largely on distance from water.

3. The station has been developed relatively recently having been taken up in the mid 1950s. Some of the paddocks are very large, and eleven watering points have been established. However, the station is still not adequately watered with considerable areas in the north-west, south-west, south and south-east being further than 5 km from water. Pastures distant from water are in good or very good condition and are currently under-used. Conversely, over-use has occurred around some existing waters and pasture condition has declined.

4. The recommended sheep unit capacity for present condition is 5,600.

5. The capability sheep unit capacity if all country was in good range condition is estimated at 6,700.

Individual station report

Gilroyd station - 80,937 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandplain	653	ACSA	300	314	39	—	4,619	5,442
Yalbalgo	140	ACSA	43	66	31	—	895	1,167
Wooramel	9	ACSA	3	2	—	—	38	42
		ASGF	2	2	—	—	17	20
Target	1	CBMS	—	1	—	—	13	20
		ACSA	—	—	—	—	—	—
		ACCR	—	—	—	—	—	—
Channel	1	SSGF	—	1	—	—	3	4
		ACCR	—	—	—	—	—	—
large clay pans	5	No veg	5	—	—	—	—	—
Totals	809		353	386	70	—	5,585	6,695

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 5,600

Capability 6,700

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 7,527

highest (1974) 11,000

lowest (1981) 2,850

Gnaraloo station - Carnarvon Shire

Area 913 km²

Location

Gnaraloo station is located on the Minilya 1:250,000 map sheet. The homestead is about 155 km north by road from Carnarvon via Quobba station. Boundaries are shared with Warroora, Minilya and Quobba stations and with Lake McLeod in the east. The western boundary is the coastline of the Indian Ocean.

Description

Nearly two-thirds of the station consists of undulating sandy plains and linear dunes of the Mallee, Cardabia and Coast land systems. Most of the remainder of the station consists of elevated limestone plains or plains with thin sand cover over limestone of the Trealla land system.

The Mallee system (47.5% of the station area) is the largest and occurs throughout the centre of the station. It supports a moderately close tall shrubland or low woodland with numerous *Acacia* species and patchy stands of eucalypts in both mallee and tree form. The ground layer is a mixture of soft and hard spinifex. Pastoral value is moderate or high depending on the proportion of soft and hard spinifex and the time since last burning.

The Cardabia system (11.5%) is very similar in landform to the Mallee system. Near the coast it supports a hummock grassland of hard and soft spinifex with patchy shrubs. Further inland the shrubs become taller and more numerous and, except for the lack of eucalypts, the vegetation is similar to the Mallee system. Pastoral value is generally moderate.

The Coast system (4.9%) consists of large parabolic coastal dunes and sandy swales with minor limestone plains, low sea cliffs and rocky wave cut platforms. The system supports patchy tall shrublands with coastal jam, curara and silver bark wattle and hummock grasslands of soft and hard spinifex.

The limestone based Trealla land system (29.2%) occurs on the north of the station. It supports a moderately close tall shrubland dominated by silver bark wattle, but with various other *Acacia* species such as wanyu, curara and snakewood. Numerous useful low shrubs occur in the understorey and pastoral value is high.

Two other minor land systems, Warroora (4%) and McLeod (2.9%) occur in the south-east adjacent to Lake McLeod. Although they are small in area these saline plain systems support very useful shrublands of saltbush and bluebush and pastoral value is high.

All land systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Gnaraloo station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	McLeod - samphire flats and sandy plains with bare marginal mudflats; low shrublands of samphire and saltbush	2.9
	Mallee - undulating sandy plains with limestone at shallow depth, linear dunes and minor limestone outcrop plains; mallee shrublands with soft and hard spinifex	47.5
		50.4
High (5-9 ha/s.u.)	Trealla - elevated limestone plains and plains with thin sand cover, minor steeper marginal slopes; tall shrublands of various acacias	29.2
	Cardabia - undulating sandy plains with linear dunes, minor limestone rises; hummock grasslands of soft and hard spinifex with scattered shrubs	11.5
	Coast - large, long-walled parabolic coastal dunes and narrow swales, unstable blowout areas, low sea cliffs, rocky wave cut platforms and beach; patchy acacia shrublands and hummock grasslands of soft and hard spinifex	4.9
	Warroora - nearly flat, saline alluvial plains, sluggish drainage tracts and prominent drainage foci, minor limestone outcrop plains and sandy banks; low shrublands of saltbush and bluebush	4.0
		49.6
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (194 recordings on 6 land systems)

Gnaraloo

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Cardabia	39	81	13	3	3	18	46	31	5	—	64	28	8
Coast	15	60	13	20	7	—	33	60	—	7	33	40	27
MacLeod	10	100	—	—	—	100	—	—	—	—	100	—	—
Mallee	61	85	13	2	—	23	47	23	5	2	70	23	7
Trealla	46	100	—	—	—	30	38	28	4	—	68	28	4
Warroora	23	100	—	—	—	83	17	—	—	—	100	—	—
Total over all land systems	194	88	8	3	1	33	37	25	4	1	70	23	7

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 8 sites on 4 land systems.

Range condition and recommendations

1. Mallee land system (47.5%)

The system supports mixed Hard Spinifex and Soft Spinifex pastures (HASP, SOSP) with variable inclusions of useful low shrubs. Pasture condition is mostly good or very good with some areas in fair condition. There is localized minor wind erosion on a few dunes and dune crests, but this is not a serious problem.

The value of the pastures for grazing depends largely on burning history and the length of time elapsed since the last fire. Fire is a natural feature of the environment and occasional controlled burning is an accepted management tool to maintain pastures in a useful condition for grazing. Pasture composition is considerably altered for a few years after burning with rapid growing species such as native poplar and fire bush becoming temporarily dominant. Numerous low shrubs, herbs and grasses, some of which are valuable to stock, are also promoted for a few years following fire.

2. Trealla land system (29.2%)

This system supports valuable Acacia Mixed Shrub pastures (ACMS) with numerous desirable shrubs such as Wilcox bush, warty leaf eremophila, felty bluebush and currant bush. Pasture condition varies from fair to very good. There is no erosion. Considerable parts of the system are further than 5 km from stock water and are not fully used for grazing.

3. Cardabia land system (11.5%)

Pastures on this system are hummock grasslands of Soft Spinifex and Hard Spinifex (SOSP, HASP) with numerous low shrubs. Pasture condition is predominantly good with smaller proportions in very good and fair condition. There are a few areas near the coast showing wind erosion in the form of soil hummocking and stripping to expose the underlying limestone.

The system is generally stable under grazing except for occasional dunes and dune crests which may become unstable due to the effects of fire or excessive grazing pressure. Periodic controlled burning is desirable to maintain pastures in an attractive condition for stock. Some sand drift can occur after fire but the system revegetates rapidly after rain and stabilizes.

4. Coast land system (4.9%)

This system supports Coastal Dune Shrub pastures (CDSH) and Soft Spinifex pastures (SOSP). Pasture condition is variable but generally somewhat degraded. There has been a marked loss of desirable shrubs and a suggestion of an increase in hard spinifex in some areas especially within a few kilometres of watering points.

The system is highly susceptible to wind erosion once vegetation is depleted and there are patches of severe wind erosion in the form of sand hummocking and stripping to the underlying limestone pavement in Monument paddock. There are active dune blowouts, with a total area of about 12 km^2, near Monument mill and 17 Mile mill.

The large degraded section of this system in the vicinity of Monument mill should not be used for grazing. About 10 km of fencing would be required to exclude the area from use.

5. Warroora land system (4%)

The Saltbush and Bluebush pastures (SALT, BLUE) on this system are all in very good or good condition and there is no erosion. Much of the system has only recently been brought into full use by the provision of additional watering points.

6. McLeod land system (2.9%)

Samphire and Saltbush pastures (SAMP, SALT) on this system are in very good condition.

7. About 20% of the station, notably in the central east and north-east, cannot be fully used for grazing because of the distance (5km or more) from permanent stock water supplies.

8. The recommended sheep unit capacity for present condition assuming the whole station was fully watered (which is not the case, see 7) is 10,350.

9. The capability sheep unit capacity if all country was in good range condition is estimated at 12,550.

Individual station report

Gnaraloo station - 91,328 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Mallee	434	HASP	182	60	18	—	1,155	1,300
		SOSP	122	40	12	—	2,415	2,900
Trealla	267	ACMS	170	79	5	—	4,221	5,080
		BLUE	11	2	—	—	245	260
Cardabia	105	SOSP	54	24	6	—	1,124	1,400
		HASP	13	6	2	—	90	105
Coast	45	CDSH	6	7	4	6	141	440
		SOSP	5	7	4	6	174	288
Warroora	36	BLUE	16	—	—	—	320	320
		SALT	15	—	—	—	300	300
		SAMP	5	—	—	—	20	20
McLeod	26	SAMP	13	—	—	—	52	52
		SALT	5	—	—	—	100	100
		No veg	8	—	—	—	—	—
Totals	913		625	225	51	12	10,357	12,565

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 10,350

Capability sheep unit capacity 12,550

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 7,110

highest (1969) 9,663

lowest (1981) 4,248

Hamelin station - Shark Bay Shire

Area 2,028 km²

Location

Hamelin station is located on the Yaringa 1:250,000 map sheet. The homestead is about 27 km west of North-West Coastal Highway on the access road from the Highway to Denham. The station has common boundaries with Carbla, Woodleigh, Talisker, Meadow, Coburn and Nanga stations and a coastline to the Hamelin Pool embayment.

Description

Nine land systems occur on the station and all are accessible to livestock. Over 70% of the station is assessed as being of high pastoral value (carrying capacity 5-9 ha/s.u.) with the remainder being of moderate or very low value.

The largest land system on the station is the Snakewood system which occupies about 34% of the total station area. It occurs scattered throughout the station with the largest single expanse in north-central parts. It supports a characteristic tall shrubland dominated by snakewood. Pastoral value is high.

Extensive limestone outcrop plains of the Toolonga system (24.6%) occur in the central west of the station with smaller areas in the north-west close to the coastline. The system supports a moderately close tall shrubland dominated by Hamelin wattle and with numerous other acacias. Pastoral value is high.

The Sandplain land system (16.5%) occurs as large expanses in the far north-east and east of the station and also as numerous smaller patches overlying Toolonga limestone in the centre of the station. It consists of nearly flat or gently undulating red sandplain and supports a moderately close tall shrubland of wanyu. The Yaringa system (11%) is closely associated with the Sandplain system and consists of small patches of sandplain and limestone plains. It supports tall shrublands of wanyu on the sand and Hamelin wattle, curara and other acacias on the limestone.

The Nanga system (5.9%) is found in the far south-west of the station. It consists of undulating sandplain and occasional dunes supporting tree heaths and other South-West Botanical Province vegetation. Pastoral value is very low.

The Nerren system (5.6%) occurs in the central west and the south-eastern corner of the station. It is very similar in landform to the Sandplain system being nearly flat to gently undulating red sandplain. It mainly supports a moderately close tall shrubland of wanyu with a scattered tree over-storey of various eucalypts. About 25 per cent of the system, in central western parts, consists of flat plains with calcareous soils and tree steepe vegetation of Dongara mallee over hard spinifex. Pastoral value is moderate to low.

Low limestone breakaways and gently sloping outwash plains of the Foscal land system (1.9%) occur in the north-east and north-west. It supports tall shrublands of acacias and low shrublands of saltbush and bluebush. Pastoral value is high.

The remaining two very small systems Coquina and McLeod support halophytic shrublands close to the shore line of Hamelin Pool. They are of little significance for grazing.

All land systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Hamelin station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Nanga - undulating sandplains and occasional dunes, tree heath vegetation	5.9
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Sandplain - nearly flat to gently undulating red sandplain with tall shrublands of wanyu	16.5
	Nerren - nearly flat to gently undulating red sandplain; tall shrublands of wanyu with patchy eucalypt trees and hard spinifex	5.6
	Coquina - low shelly foredunes, shell beaches and supra-tidal flats; scattered tall acacia shrublands on dunes	0.4
	McLeod - samphire flats and sandy plains with bare marginal mudflats; samphire and saltbush low shrublands	0.2
		22.7
High (5-9 ha/s.u.)	Snakewood - nearly flat plains with duplex soils; tall shrublands of snakewood	33.9
	Toolonga - limestone outcrop plains with tall shrublands of Hamelin wattle and other acacias	24.6
	Yaringa - sandy plains with sandy banks, occasional low dunes and limestone outcrop plains, tall shrublands of wanyu	11.0
	Foscal - gently sloping outwash plains, low limestone mesas and plateaux edges and footslopes; low shrublands of saltbush and bluebush	1.9
		71.4
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (290 recordings on 9 land systems)

Hamelin

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Coquina	7	86	14	—	—	—	71	29	—	—	71	29	—
Foscal	8	100	—	—	—	—	38	50	13	—	38	49	13
MacLeod	1	100	—	—	—	100	—	—	—	—	100	—	—
Nanga	5	100	—	—	—	100	—	—	—	—	100	—	—
Nerren	29	100	—	—	—	17	24	45	14	—	41	45	14
Sandplain	52	100	—	—	—	17	29	23	23	8	46	23	31
Snakewood	49	94	6	—	—	4	18	16	33	6	10	48	42
Toolonga	111	99	1	—	—	1	9	48	36	6	10	48	42
Yaringa	28	100	—	—	—	11	7	53	29	—	18	53	29
Total over all land systems	290	98	2	—	—	9	18	36	28	9	27	37	36

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 17 sites on 4 land systems.

Range condition and recommendations

1. Snakewood land system (33.9% of total station area)

This system supports highly productive saltbush pastures (SALT) beneath an overstorey of snakewood with smaller areas of acacia mixed shrub pastures (ACMS) which also support numerous useful low shrubs when in good condition.

Pasture condition is variable, but substantial areas are seriously degraded with considerable loss of desirable shrubs. Some 62% of the traverse recordings indicated poor or very poor pasture conditions. The degraded pastures are still productive in terms of annual herbs and forbs in season, but their reserves of palatable shrubs for dry periods are well below potential. Degraded areas of the system occur in central northern paddocks such as Five Mile, Milkbush and Coolglya. The system still has the ability to respond well if fully protected from over grazing; a spelling programme needs to be implemented in one or two of the most degraded paddocks.

Some saltbush pastures on the Snakewood system are in excellent condition, for example those in North and South Hanlins paddocks to the east of North-West Coastal Highway. This area and others in good condition appear to have had little use due to problems associated with a lack of good quality stock water supplies or long distances from supplies.

2. Toolonga land system (24.6%)

The most important pasture type on this system is Acacia Mixed Shrub (ACMS). When in good condition the pastures have numerous desirable low shrubs including ragged leaf scaevola, tall saltbush, tall cassia, warty leaf eremophila and ruby saltbush beneath tall shrubs of Hamelin wattle, silver bark wattle and other acacias.

Pastures are nearly all degraded to some extent with the majority being in fair range condition. Extensive areas show serious depletion of desirable shrubs to poor or very poor condition, but some areas are in good condition. Degraded areas are still productive in that they often support the intermediate value cotton bush and numerous forbs and annual grasses in season. However, their reserves of palatable shrubs for dry seasons are much reduced. Degraded parts have the capacity to recover if spelled for a number of consecutive growing seasons and conservatively stocked at other times.

3. Sandplain land system (16.5%)

Condition of the Acacia Sandplain (ACSA) pastures of this system are variable. About 46% of traverse observations indicated good or very good condition, 22% indicated fair and 32% indicated poor or very poor condition. There is no erosion.

Areas in good or very good condition occur in the far north-east and south-west of the station. They appear to receive little grazing because of the lack of water supplies. There are also some areas of the Snakewood system in good condition in the same general locality. Consideration needs to be given to developing water supplies to these areas so that stock can be more equitably distributed over the station.

4. Yaringa land system (11%)

The system supports Acacia Sandplain pastures (ACSA) on sandplains and Acacia Mixed Shrub pastures (ACMS) on limestone plains. Pastures are predominantly in fair range condition although condition varies from very good to poor. There is no erosion and the system is stable under grazing. No special grazing management, other than occasional spelling to maintain desirable low shrubs in the stand, is required.

5. Nanga land system (5.9%)

The system supports Heath (HEAT) pastures but is little used due to its lack of water and poor potential for grazing. Pastures are in very good condition but it is doubtful if they can be economically developed for grazing.

6. Nerren land system (5.6%)

Pastures on this sandplain system are Acacia and Eucalypt Short Grass Forb (AEGF) which are similar to the Acacia Sandplain (ACSA) types. There are also some Hard Spinifex (HASP) pastures as the ground storey to eucalypt woodland. Pasture condition is mostly fair, good or very good and there is no erosion.

7. Foscal land system (1.9%)

This system supports productive Saltbush and Bluebush (SALT, BLUE) pastures and Acacia Mixed Shrub (ACMS) pastures. Pasture condition is mostly fair or good and there is no erosion. High dietary salt intakes by sheep can occur on this system as a result of a combination of saline feed and brackish stock water supplies. This will restrict the use that can be made of the pastures. It is important to ensure that stock water supplies are of good quality.

8. The station is well developed in terms of paddocks but parts, as previously mentioned, are inadequately watered. Also, some existing water supplies are rather saline which will restrict the grazing radii of stock watering on them especially if pastures commanded by the particular water are saline.

9. The recommended sheep unit capacity for present condition assuming the station is fully watered (which is not the case, see 8) is 16,650.

10. The capability sheep unit capacity if all country was in good range condition is estimated at 29,900.

Individual station report

Hamelin station - 202,821 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Snakewood	686	SALT	93	61	395	—	5,091	10,980
		ACMS	18	34	51	—	1,019	2,060
		ACSA	27	—	7	—	253	283
Toolonga	500	ACMS	54	275	121	—	4,586	9,000
		ACSA	—	13	12	—	129	208
		ASGF	—	5	20	—	67	125
Sandplain	335	ACSA	154	74	107	—	2,174	2,792
Yaringa	224	ACSA	25	95	59	—	1,038	1,492
		ACMS	15	23	7	—	573	900
Nanga	120	HEAT	108	—	—	—	360	360
		HASP	12	—	—	—	60	60
Nerren	113	AEGF	52	25	36	—	654	807
Foscal	38	SALT	8	10	3	—	304	420
		BLUE	5	6	2	—	188	260
		ACMS	2	2	—	—	60	80
Coquina	8	CDSH	3	1	—	—	45	50
		No veg	4	—	—	—	—	—
McLeod	4	SAMP	2	—	—	—	8	8
		No veg	1	—	—	—	—	—
		SALT	1	—	—	—	20	20
Totals	2,028		584	624	820	—	16,629	29,905

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 16,650

Capability sheep unit capacity 29,900

Declared stock numbers (sheep units or equivalent) 1968-84 (no data for 1973-1974):

average (mean) 12,462

highest (1976) 18,100

lowest (1981) 6,092

Hill Springs station - Carnarvon Shire

Area 1,232 km²

Location

Hill Springs station is located on the Kennedy Range and Winning Pool 1:250,000 map sheets. The homestead is about 90 km north-east of the North-West Coastal Highway via Mardathuna station and about 145 km north-east by road from Carnarvon. The station shares boundaries with Middalya, Mardathuna, Cooralya, Manberry and Wandagee stations.

Description

The largest land system on the station is Yalbalgo which consists of sandplain and linear dunes supporting moderately close tall shrublands of acacias, mainly wanyu, silver bark wattle and spreading gidgee. It occupies most of the southern half of the station and pastoral value is moderate.

The Windalia land system (15% of the total station area) and the O'Brien system (16%) occur in the north of the station. The Windalia system lies above O'Brien and consists of gently sloping stony plains and narrow upper interfluves on radiolarite. It supports very scattered to moderately close tall shrublands dominated by spreading gidgee. Pastoral value is moderate. The O'Brien system consists of broad alluvial plains and slightly more elevated upper plains and interfluves. It supports tall shrublands of spreading gidgee and snakewood which are frequently arranged in a groved pattern with dense vegetation in the groves and much sparser vegetation in the broader intergrove areas. Pastoral value is moderate.

The Mary system (11.9%) occurs in the centre of the station. It consists of gently sloping plains with calcrete at shallow depth and low stony calcrete rises. It supports a tall shrubland of spreading gidgee and silver bark wattle frequently with relatively dense under-shrubs dominated by cassias. Pastoral value is high.

Four other small land systems namely Gearle, Cahill, Lyons and Jimba also occur on the station. The Gearle system (4.9%) consists of very gently sloping alluvial plains supporting low shrublands of bluebush. When in good condition the pastoral value of the system is high. The Cahill system (2.4%) consists of sandy outwash plains and channelled flow zones. It supports tall shrublands with scattered eucalypts. In some parts buffel grass is well established in the ground layer. Pastoral value is high.

The Lyons and Jimba systems (0.2% and < 0.1% respectively) are of negligible significance to the station.

All land systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Hill Springs station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Yalbalgo - sandplains with linear and reticulate dunes, tall shrublands of wanyu and spreading gidgee	49.5
	O'Brien - tributary alluvial plains and slightly more elevated upper plains and interfluves; tall acacia shrublands often groved	16.0
	Windalia - stony plains and narrow dissected upper interfluves on radiolarite; tall shrublands of spreading gidgee	15.0
	Lyons - sandy alluvial plains with numerous claypans and reticulate and linear dunes; currant bush mixed shrublands and tall acacia shrublands	0.2
	Jimba - gently sloping alluvial plains with diffuse drainage, minor pebbly plains and low ridges, scattered tall and low shrublands, acacias and some chenopods	0.1
		80.8
High (5-9 ha/s.u.)	Mary - gently sloping plains with calcrete at shallow depth and low calcrete rises; tall shrublands of acacia and cassia	11.9
	Gearle - gently sloping alluvial plains, minor low rises with more sloping marginal plains; low shrublands of saltbush and bluebush	4.9
	Cahill - sandy outwash plains and channelled flow zones; tall acacia shrubland or open woodlands, some buffel grass	2.4
		19.2
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (171 recordings on 6 land systems)

Hill Springs

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Cahill	9	100	—	—	—	11	45	33	11	—	56	33	11
Gearle	32	97	—	—	3	—	—	25	44	31	—	25	75
Mary	22	100	—	—	—	5	41	54	—	—	45	55	—
O'Brien	43	95	5	—	—	2	30	40	26	2	33	39	28
Windalia	3	100	—	—	—	—	—	100	—	—	—	100	—
Yalbalgo	62	98	2	—	—	35	26	29	10	—	61	29	10
Total over all land systems	171	98	2	—	1	15	25	35	19	6	39	36	25

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 10 sites on 6 land systems.

Range condition and recommendations

1. Yalbalgo land system (49.5%)

This system supports the Acacia Sandplain pasture type (ACSA) with scattered desirable low shrubs such as Wilcox bush, cotton bush and flannel bush below the tall shrub layer. The ground storey supports wandarrie grass and various herbs in season and, in some areas, soft and hard spinifex. Pasture condition as seen during survey was about evenly distributed between fair, good and very good with only minor areas assessed as poor. There was no erosion.

Because of the relatively sparse occurrence of palatable shrubs and the rather short lived nature of the wandarrie grasses the system has only limited drought value.

Fire may be a useful management tool on this system, but its use has not been researched. Evidence seen during the survey suggests that the effects of fire are extremely long term. Where the over-storey of tall shrubs has been killed by fire the low shrub layer and the ground layer is increased in diversity of species and in density. This fire induced sub-climax vegetation appears to be considerably more useful for livestock production than the mature shrub stand.

2. O'Brien land system (16%)

Pastures on this system are predominantly Acacia Short Grass Forb (ASGF) with smaller inclusions of Stony Chenopod (STCH) and Acacia Creek-line (ACCR) types. The latter type occurs as dense stands of vegetation in groves and along drainage floors. Pasture condition is mostly fair, although there are substantial parts in poor and good condition. There is no erosion on the system.

The system supports a wide range of desirable low shrubs and grazing management needs to be aimed at ensuring the maintenance of these in the stand. Desirable species include Wilcox bush, flat leaf bluebush, and ruellia on the grooved plains and Gascoyne mulla mulla, ruby saltbush and sago bush on more saline parts.

3. Windalia land system (15%)

This system supports the same pastures as the O'Brien system but with rather less of the more productive inclusions of Stony Chenopod (STCH) and Acacia Creek-line types.

The system was inadequately traversed but, because of its distance from water and on the evidence seen at one range evaluation site, is expected to be in good range condition. There is one localized area of about 0.5km² of severe pasture degradation in the vicinity of End tank. This is part of a much larger area of severe degradation occurring on the adjacent Gearle land system.

4. Mary land system (11.9%)

This system supports productive Acacia Mixed Shrub (ACMS) pastures. Pasture condition is about evenly distributed between fair and good. There is no erosion and the system is relatively stable under grazing.

5. Gearle land system (4.9%)

This system supports bluebush (BLUE) pastures which are mostly seriously degraded to poor or very poor condition. The pastures are attractive to livestock, are well-watered and have been over grazed in the past.

About 11 km² of the system is severely degraded with gross loss of desirable shrubs accompanied in some instances by minor to severe water erosion. These degraded areas are centred on Whitby dam, McDonald dam and End tank. Watkins paddock which contains the largest areas of severe degradation should be closed to grazing until pastures recover.

6. Cahill land system (2.4%)

Pasture types on this system are Acacia Sandplain (ACSA) and some buffel grass (Tussock Grass TUGR). Pasture condition is mostly fair or good and there is no erosion.

7. The northern most parts of the station (Windalia land system) are very little used for grazing as they are in excess of 5 km from permanent stock water. Additional water points need to be developed to bring this country into use and to allow destocking of severely degraded sections elsewhere (e.g. Watkins paddock, see 5).

8. The recommended sheep unit capacity for present condition is 10,600.

9. The capability sheep unit capacity if all country was in good range condition is estimated at 13,900.

Individual station report

Hill Springs station - 123,191 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Yalbalgo	610	ACSA	335	159	55	—	4,005	4,575
		SOSP	37	18	6	—	791	1,017
O'Brien	198	ASGF	29	42	28	—	355	495
		STCH	8	27	15	—	252	417
		ACCR	41	—	8	—	860	980
Windalia	185	ASGF	118	15	14.5	0.5	676	740
		ACCR	15	4	—	—	340	380
		STCH	14	4	—	—	137	150
Mary	146	ACMS	63	76	—	—	2,020	2,780
		BLUE	3	4	—	—	110	140
Gearle	60	BLUE	—	14	29	11	356	1,080
		TUGR	—	2	4	—	56	300
Cahill	29	ACSA	8	5	2	—	106	125
		TUGR	8	5	1	—	504	700
Lyons	3	ACSA	1	1	—		15	17
		CBMS	1	—	—	—	20	20
		ACCR	—	—	—	—	—	—
Jimba	1	STCH	1	—	—	—	8	8
Totals	1,232		682	376	162.5	11.5	10,611	13,924

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 10,600

Capability sheep unit capacity 13,900

Declared stock numbers (sheep units or equivalent) 1971-1984 (no data for 1968-1970):

average (mean) 12,542

highest (1973) 18,000

lowest (1981) 9,000

Lyndon station - Carnarvon Shire

Area 2,482 km²

Location

Lyndon station is located on the Winning Pool and Edmund 1:250,000 map sheets. The homestead is about 148 km east of the Minilya River bridge on the North-West Coastal Highway via Middalya and Williambury stations. Boundaries are shared with Towera, Maroonah, Williambury, Middalya and Mia Mia stations.

Description

Landforms on the station are many and varied with 21 land systems being represented. The two largest systems are Durlacher (21.5% of total station area) and Yinnietharra (16.3%). The Durlacher system which is scattered throughout the station, consists of gently sloping plains and low stony rises with a characteristic mantle of white quartz pebbles and rocks. It supports scattered tall and low shrubs and pastoral value is moderate.

The Yinnietharra system is similar to Durlacher, but is more sandy with gently sloping sandy plains, broad drainage tracts, minor stony plains and low granite hills. It supports tall shrublands usually dominated by mulga and pastoral value is moderate.

In the eastern half of the station there are a number of rugged hilly land systems based on granite, gneiss and schist. These are the Agamemnon and James systems (13.4 and 1.3%) with associated stony uplands and lower plains of the Phillips system (10.1%). They support sparse tall shrublands of mulga and other acacias and pastoral value is low or moderate.

In the far east rugged mountain ridges of the Augustus system (5.3%) dominate the landscape. The system is based on quartzite, sandstone and dolomite and is too rugged to be of much pastoral use.

In the western half of the station a number of sandy low relief systems occur. These are the sandy plains of the Uaroo system (6.5%), sandplain and dunes of the Giralia system (5.8%) and sandy alluvial plains and broad drainage zones of the Wash system (8.7%) associated with the Lyndon River. The former two systems support hard and soft spinifex hummock grasses with variable tall shrubs. The Wash system is more productive with tall shrublands of spreading gidgee and other acacias with many useful low shrubs and perennial grasses.

Numerous other small land systems occur on the station. Of these the River system (1.9%) along the Lyndon River, the Gneudna system (1.3%) in the south and south-west and the Winning system (0.9%) in the west of the station are the most valuable for pastoral use.

All land systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Lyndon station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Augustus - rugged mountains, hills and ridges of sedimentary rocks; tall shrublands of mulga and other acacias	5.2
Low (20-30 ha/s.u.)	Agamemnon - rough hills and ridges of granite and gneiss; scattered tall shrublands	13.4
	Collier - low hills of sandstone and quartzite and stony undulating uplands; tall shrublands of mulga	3.1
	James - low granite hills and ridges, undulatingstony plains and lower plains; scattered tall acacia shrublands	1.3
	Billy - low plateaux, mesas and buttes with stony footslopes and narrow drainage floors; scattered tall acacia shrublands	1.0
	Two Hills - hills and stony footslopes of sedimentary rocks; scattered tall acacia shrublands	0.5
	Glenburgh - rugged granite hills, stony uplands and lower plains; scattered tall acacia shrublands	0.2
		19.5

Table 1 continued...

Pastoral value	Land systems	Area %
Moderate (10-19 ha/s.u.)	Durlacher - gently sloping stony plains, with broad drainage tracts, low stony rises and occasional ridges; scattered tall and low shrublands of *Acacia* and *Eremophila* species and chenopods	21.5
	Yinnietharra - gently sloping sandy plains and broad drainage tracts, minor stony plains and low granite hills; tall acacia shrublands	16.3
	Phillips - low undulating stony uplands and low hills of crystalline rocks; scattered tall acacia shrublands	10.1
	Uaroo - nearly flat sandy plains and minor pebbly plains; spinifex hummock grasslands with scattered shrubs	6.5
	Giralia - sandy plains with large linear dunes; spinifex hummock grasslands and scattered shrubs	5.8
	Windalia - stony plains and narrow dissected upper interfluves on radiolarite; tall acacia shrublands	2.1
	Mantle - gently undulating stony plains with sluggish drainage tracts, stony rises and low summits; scattered tall and low shrublands acacias and some chenopods	0.2
	Jimba - gently sloping alluvial plains with diffuse drainage, minor pebbly plains and low ridges; scattered tall and low shrublands acacias and some chenopods	< 0.1
	Divide - gently undulating sandplain with occasional dunes; spinifex hummock grasslands with scattered shrubs	< 0.1
	Duffy - gently undulating sandy and stony plains, minor stony rises and low granite hills; spinifex hummock grasslands and scattered shrubs	< 0.1
		62.5
High (5-9 ha/s.u.)	Wash - sandy alluvial plains and broad drainage zones receiving more concentrated sheet flow; tall acacia shrublands and grassy woodlands	8.7
	River - narrow sandy flood plains and major channels; tall shrublands and grassy woodlands	1.9
	Gneudna - almost flat plains with calcareous soils and parallel bands of siltstone and limestone outcrop; tall acacia shrublands	1.3
	Winning - low rises, extensive lower plains and broad drainage tracts; scattered tall and low shrublands	0.9
		12.8
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (300 recordings on 12 land systems)

Lyndon

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Agamemnon	16	100	—	—	—	13	74	13	—	—	87	13	—
Collier	4	100	—	—	—	—	75	25	—	—	75	25	—
Durlacher	92	90	10	—	—	—	15	52	28	5	15	51	34
Giralia	5	100	—	—	—	60	40	—	—	—	100	—	—
Gneudna	2	100	—	—	—	—	50	50	—	—	50	50	—
James	2	100	—	—	—	—	50	50	—	—	50	50	—
Phillips	35	94	6	—	—	6	17	71	6	—	23	71	6
River	11	100	—	—	—	18	27	46	9	—	46	45	9
Thomas	1	100	—	—	—	—	—	100	—	—	—	100	—
Uaroo	19	100	—	—	—	37	58	5	—	—	95	5	—
Wash	38	78	11	11	—	5	26	46	18	5	32	44	24
Yinnietharra	75	74	23	3	—	1	5	44	39	11	7	44	49
Total over all land systems	300	87	11	2	—	6	22	45	22	5	29	44	27

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 23 sites on 5 land systems.

Range condition and recommendations

1. Durlacher land system (21.5%)

The broad stony plains of this system support Stony Chenopod (STCH) and Acacia Short Grass Forb (ASGF) pastures. When in good condition these pastures have a good range of desirable low shrubs such as tall cassia, warty leaf eremophila and cotton bush on the non saline sites and silver saltbush, tall saltbush, ruby saltbush and sago bush on more saline sites.

The traverse data show that, in general, the pastures are degraded with the bulk being in fair or poor condition. Desirable species are depleted in many areas, but the system has the capacity to recover under strategic spelling. There is some minor water erosion in some parts, but this is not a significant problem.

2. Yinnietharra land system (16.3%)

The system supports Stony Chenopod (STCH) and Acacia Short Grass Forb (ASGF) pastures on the broad plains with denser Acacia Creek-line (ACCR) pastures on drainage floors and flow zones. Desirable shrub species are similar to those listed for the Durlacher system.

Pasture condition is predominantly fair, but substantial parts are degraded to poor or very poor condition. Minor and sometimes moderate water erosion in the form of shallow rilling and guttering is common on broad drainage floors and flow zones.

About 8 km^2 of the system shows severe degradation with almost complete loss of perennial vegetation and severe soil erosion. These areas are in Beroi paddock near Beroi dam, in North Quaille paddock and in Ram paddock. A rehabilitation programme involving complete protection from grazing with additional fencing to effect this is required and possibly some cultivation and seeding work needs to be commenced.

3. Agamemnon land system (13.4%)

This rough hilly system which supports Stony Short Grass Forb (SSGF) pastures with minor areas of Acacia Creek-line (ACCR) pastures is nearly all in good range condition. Pasture condition is mostly good and there is no erosion.

4. Phillips land system (10.1%)

The stony plains of this system support Stony Short Grass Forb (SSGF) pastures with small inclusions of better quality Stony Chenopod (STCH) pastures and Acacia Creek-line (ACCR) pastures along the water courses. Pasture condition is variable but mostly fair or good with only minor depletion of desirable shrubs. The stony nature of the system means that it is inherently resistant to erosion except for occasional minor rilling along narrow drainage floors.

5. Wash land system (8.7%)

Pastures found on this productive system are Acacia Short Grass Forb (ASGF), Acacia Creek-line (ACCR) and Tussock Grasses (TUGR). When in good condition many desirable shrubs and grasses occur especially where the system is subject to flood out from the Lyndon River. Desirables include tall saltbush, currant bush, ruby saltbush and the tussock grasses silky brown top and ribbon grass.

Pasture condition varies from very good to very poor. Taken over all about 30% of the traverse recordings indicated good or very good condition, about 50% indicated fair condition and 20% indicated poor or very poor condition.

About 6.5 km^2 of the system in Bumbarry paddock is severely degraded. Duplex soils have lost sandy surface horizons to form numerous scalds between residual sandy surfaces. Water erosion in the form of rills and scour lines is common and perennial vegetation is extremely sparse. In order to encourage recovery the paddock should be spelled for a number of consecutive growing seasons and grazed at conservative rates during other times of the year.

6. Uaroo and Giralia land systems (6.5 & 5.8% respectively)

These sandy systems support a mixture of Hard Spinifex and Soft Spinifex pastures (HASP, SOSP). Pasture condition is nearly all good or very good and there is no erosion. Occasional burning is a management requirement on these systems in order to maintain pastures in a useful condition for stock.

The Giralia system in the south-west of the station is little used. To bring it into production additional boundary fencing and the upgrading of water supplies such as Tarn bore would be required.

7. Condition of pastures on the other five land systems traversed on the station (Collier, Gneudna, James, River and Two Hills) are nearly all in fair to very good condition and there is no erosion. Buffel grass is well established on parts of the River system.

8. Although much of the station is well developed in terms of stock water points there are still some substantial areas that are > 5 km from permanent waters. The largest single area is in the north-west where parts of the Windalia, Billy and Giralia systems are under-used. Also, in southern parts of Beroi and Willaraddie paddocks the Durlacher and Phillips systems are distant from water supplies. Consideration needs to be given to piping water or providing other water supplies to these areas.

9. The recommended sheep unit capacity for present condition is 14,950.

10. The capability sheep unit capacity if all country was in good range condition is estimated at 20,700.

Individual station report

Lyndon station - 248,208 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Durlacher	534	STCH	21	147	99	—	1,240	2,225
		ASGF	15	131	68	—	682	1,070
		ACCR	30	15	8	—	790	1,060
Yinnietharra	405	ASGF	—	82	100	—	523	910
		STCH	4	64	66	8	573	1,183
		ACCR	22	45	14	—	978	1,620
Agamemnon	332	SSGF	254	45	—	—	1,166	1,196
		ACCR	33	—	—	—	660	660
Phillips	250	SSGF	22	164	14	—	663	800
		STCH	—	34	4	—	183	317
		ACCR	6	6	—	—	180	240
Wash	215	ASGF	49	49	31	—	486	645
		ACCR	23	30	6	6	790	1,300
		TUGR	—	11	10	—	178	700
Uaroo	163	HASP	114	—	—	—	570	570
		SOSP	49	—	—	—	817	817
Giralia	144	HASP	86	—	—	—	430	430
		SOSP	58	—	—	—	967	967
Augustus	129	ASGF	123	—	—	—	615	615
		ACCR	6	—	—	—	120	120
Collier	76	ASGF	42	—	—	—	210	210
		SSGF	19	—	—	—	76	76
		STCH	11	4	—	—	112	125
Windalia	52	ASGF	21	21	—	—	175	210
		ACCR	4	1	—	—	90	100
		STCH	3	2	—	—	35	42
River	46	ACCR	10	10	3	—	319	460
		TUGR	7	7	2	—	498	800
		No veg	7	—	—	—	—	—
James	32	SSGF	27	—	—	—	108	108
		STCH	3	2	—	—	35	42
Gneudna	32	BLUE	—	16	—	—	200	320
		STCH	—	16	—	—	80	133
Billy	26	SSGF	16	—	—	—	64	64
		ASGF	5	5	—	—	42	50
Winning	23	BLUE	1	5	10	—	145	320
		SOSP	4	—	—	—	50	50
		STCH	—	1	2	—	12	25
Two Hills	12	SSGF	12	—	—	—	48	48
Glenburgh	6	SSGF	6	—	—	—	24	24
Mantle	4	STCH	1	2	—	—	18	25
		SSGF	1	—	—	—	8	8
Jimba	0.4	STCH	0.4	—	—	—	3	3
		ASGF	—	—	—	—	—	—
		ACSA	—	—	—	—	—	—
Divide	0.3	HASP	0.3	—	—	—	2	2
		ACCR	—	—	—	—	—	—
Duffy	0.2	HASP	0.2	—	—	—	1	1
		SOSP	—	—	—	—	—	—
Totals	2,482		1,116	913	439	14	14,966	20,691

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 14,950

Capability sheep unit capacity 20,700

Declared stock numbers (sheep units or equivalents) 1969-1984 (no data for 1968):

average (mean) 26,496

highest (1971) 40,949

lowest (1979) 6,772

Manberry station - Carnarvon Shire

Area 854 km²

Location

Manberry station is located on the Winning Pool and Kennedy Range 1:250,000 map sheets. The homestead is about 17 km east of the North-West Coastal Highway and 124 km north of Carnarvon. The station has common boundaries with Wandagee, Hill Springs, Cooralya and Minilya stations.

Description

Six land systems occur on the station and all of these are accessible to stock. The largest system is Yalbalgo (about 70% of the total station area) which is found in northern, western and southern parts. It consists of long linear sand dunes oriented in a north-westerly direction and with up to 15 m relief and sandy inter-dunal corridors. It supports a moderately close tall shrubland dominated by wanyu and spreading gidgee with numerous low shrubs and occasionally hard spinifex in the ground layer. Pastoral value is moderate.

The O'Brien land system (22.9%) is found in the north-west of the station. It consists of nearly flat or gently sloping alluvial plains and slightly more elevated upper plains and interfluves. It supports tall shrublands of spreading gidgee which is frequently arranged in a groved pattern with dense stands in the groves and sparser stands in the broader intergrove areas. Pastoral value is moderate.

The Mary system (3.8%) is found in the north-east and south-east. It consists of gently sloping sandy plains with calcrete at shallow depth or outcropping at the surface. It supports a tall shrubland of silver barked wattle and other acacias with a low shrub layer usually dominated by cassias. Pastoral value is high.

The Cahill land system (2.6%) consists of sandy outwash plains associated with the Hutton Creek which flows through the centre of the station. The system supports a sparse to moderately close tall shrubland of silver barked wattle and spreading gidgee with occasional coolibah trees. Buffel grass has established in some areas and pastoral value is high.

Two other minor systems, Brown and Sandal, occur on the station (collectively 1.0%) but are of little significance. All the systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Manberry station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Yalbalgo - sandplains with linear and reticulate dunes; tall shrublands of wanyu and spreading gidgee	69.7
	O'Brien - tributary alluvial plains and slightly more elevated upper plains and interfluves; tall acacia shrublands often arranged in groves	22.9
	Brown - gently undulating sandplains and occasional longitudinal dunes; tall shrublands of wanyu and silver bark wattle	0.8
		93.4
High (5-9 ha/s.u.)	Mary - gently sloping plains and low rises with calcrete at shallow depth at surface; tall shrublands of acacias and cassias	3.8
	Cahill - sandy outwash plains with channels; tall shrublands of silver bark wattle and other acacias	2.6
	Sandal - alluvial plains with numerous sandy banks and rises, duplex and sand soils; tall acacia shrublands	0.2
		6.6
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (128 recordings on 4 land systems)

Manberry

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Cahill	8	100	—	—	—	—	25	75	—	—	25	75	—
Mary	2	100	—	—	—	—	—	100	—	—	—	100	—
O'Brien	44	100	—	—	—	—	9	48	32	11	9	48	43
Yalbalgo	74	99	1	—	—	5	19	49	26	1	24	49	27
Total over all land systems	128	99	1	—	—	3	16	50	26	5	19	51	30

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 8 sites on 3 land systems.

Range condition and recommendations

1. Yalbalgo land system (69.7%)

The system supports Acacia Sandplain (ACSA) pastures with scattered desirable low shrubs such as Wilcox bush, cotton bush and flat leaf bluebush below the tall shrub layer. The ground layer supports wandarrie grass and numerous herbs in season and, in some areas, soft and hard spinifex. Pasture condition is predominantly fair. However some considerable areas such as in Meeraji paddock are in poor condition with depletion of desirable low shrubs. Elsewhere in areas which have not been used for some time or which are distant from water, such as South Bore paddock, pasture condition is good or very good. There is no erosion on the system.

Because of the relatively sparse occurrence of palatable shrubs and the apparently short lived nature of wandarrie grasses here, the system only has limited durability in drought times.

Fire may be a useful management tool on this system, but its use has not been researched. Evidence seen elsewhere during the survey suggests that the effects of fire are extremely long term. Where the over-storey of tall shrubs has been killed by fire the low shrub layer and the ground layer is increased in diversity of species and in density. The fire-induced sub-climax vegetation appears to be considerably more useful for livestock production than the mature shrub stand.

2. O'Brien land system (22.9%)

Pastures are predominantly Acacia Short Grass Forb (ASGF) with smaller inclusions of Stony Chenopod (STCH) and Acacia Creek-line (ACCR) types. The latter type occurs as dense stands of vegetation in groves and along drainage floors. Nearly all of these pastures show some degree of loss of desirable shrubs. None of the traverse recordings indicated very good pasture condition and good, fair, poor and very poor condition were indicated by 9%, 48%, 32% and 11% respectively of the recordings. There is no erosion on the system. The O'Brien land system in Manarrah paddock in the north is in poor condition, but has the ability to recover if it could be spelled for a number of consecutive growing seasons and grazed at very conservative levels during other times of the year.

3. Mary land system (3.8%)

The system was not intensively sampled but, where seen, its pastures were in fair condition and there was no erosion.

4. Cahill land system (2.6%)

This system supports Acacia Sandplain (ACSA) pastures with some areas of Tussock Grass (TUGR) pastures of introduced buffel grass. Pasture condition is fair or good and there is no erosion.

5. The small areas of the Brown and Sandal systems were not sampled, but are likely to be in fair or good condition.

6. Some areas of the station such as parts of Paddy's and South Bore paddocks and all of Colvins paddock are not used because of the lack of water supplies. At the time of survey, Jone's bore in Paddy's paddock and Colvin well in Colvin's paddock were not operational. There is a need to refurbish these water sources or develop alternate sources so that this country which is in good condition can be brought into use. This will enable the grazing pressure on other parts of the station, notably the O'Brien land system, to be reduced.

7. The estimated recommended sheep unit capacity for present condition is 5,650.

8. The estimated capability sheep unit capacity if all country was in good range condition is estimated at 8,350.

Individual station report

Manberry station - 85,408 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Yalbalgo	595	ACSA	125	291	179	—	3,576	4,958
O'Brien	196	ASGF	3	43	52	—	288	490
		STCH	—	49	—	—	245	408
		ACCR	14	35	—	—	630	980
Mary	32	ACMS	12	15	3	—	409	600
		BLUE	—	2	—	—	25	40
Cahill	23	TUGR	4	7	3	—	352	700
		ACSA	3	4	2	—	58	75
Brown	7	ACSA	4	2	—	—	46	50
		SALT	—	1	—	—	13	20
Sandal	1	CBMS	—	1	—	—	13	20
		ACSA	—	—	—	—	—	—
		BLUE	—	—	—	—	—	—
Totals	854		165	450	239	—	5,655	8,341

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 5,650

Capability sheep unit capacity 8,350

Declared stock numbers (sheep units or equivalent) 1968-1983 (no data for 1972, 1984):

average (mean) 10,287

highest (1976) 13,550

lowest (1982) 7,211

Mardathuna station - Carnarvon Shire

Area 2,433 km²

Location

Mardathuna station is located on the Kennedy Range 1:250,000 map sheet. The homestead is about 132 km north east by road from Carnarvon via the North-West Coastal Highway and station access road. The station has common boundaries with Cooralya, Hill Springs, Middalya, Williambury, Mooka and Doorawarrah stations and with the Kennedy Range National Park.

Description

Eleven land systems are found on the station and most of these, with the exception of the rugged hill system Moogooloo, are accessible to livestock.

The largest system is Yalbalgo which occupies about 34% of the total station area and is found in south-western and south central parts. The system consists of linear sand dunes, sandy inter-dunal corridors and sandplain. The dunes are generally orientated in a north-west to south-east direction and relief is up to about 12 m. It supports a moderately close tall shrubland dominated by wanyu and spreading gidgee with numerous low shrubs and occasionally spinifex in the ground layer. Pastoral value is moderate.

Plains of the Windalia system (12.4%) occur in the north and east of the station associated with the O'Brien system (8.3%) and low flat-topped hills of the Billy system (5.6%). The Windalia system consists of gently sloping stony plains on radiolarite and narrow stony upper interfluves with intensely dendritic drainage patterns. It supports very scattered to moderately close tall shrublands dominated by spreading gidgee. Pastoral value is moderate.

The O'Brien system lies below the Windalia system and consists of broad, alluvial plains and slightly more elevated upper plains. It supports tall shrublands of spreading gidgee and snakewood which are frequently arranged in a groved pattern with dense vegetation in the groves and much more sparse vegetation in the broader intergrove areas. Pastoral value is moderate.

The Billy system consists of low plateaux, mesas and buttes of duricrust over radiolarite, with short stony footslopes and narrow drainage floors. It supports very sparse short or tall shrublands of various acacias and pastoral value is low.

The Moogooloo system (11.8%) occurs in the north-east of the station and consists of deeply dissected plateaux, mesas and hills of sedimentary rocks with steep footslopes and narrow valleys. The hills and plateaux crests rise up to 150 m or more above the plains of other systems to the west. A few valleys and footslopes are accessible to cattle but most of the system is too rugged and inaccessible to be of any use for pastoral purposes. The Kennedy system (3.0%) of large linear sand dunes lies on top of the Moogooloo plateaux surface. It supports hummock grasslands of spinifex with numerous shrubs and, because of its isolated position and difficulty of access, is of no pastoral value to the station.

The Cahill land system (9.7%) occurs mainly in the centre of the station as broad sandy outwash plains flanking Watermelon Creek and Irybaroo Creek. It supports moderately close tall shrublands of silver bark wattle and spreading gidgee and numerous low shrubs. Pastoral value is high.

Gently sloping plains and low rises with calcrete at shallow depth or at the surface of the Mary system (8.4%) occur in the south-central part of the station. It supports a moderately close tall shrubland of silver bark wattle and other acacias with a prominent low shrub layer dominated by cassias. Pastoral value is high.

Three other systems namely Lyons (2.6%), Mantle (2.1%) and Gearle (2.1%) are found on the station. Although restricted in area they are of moderate or high pastoral value.

All systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Mardathuna station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Moogooloo - deeply dissected plateaux, mesas and hills of sedimentary rocks with steep footslopes and narrow valleys; tall shrublands of mulga and other acacias	11.8
Low (20-30 ha/s.u.)	Billy - low plateaux, mesas and buttes with stony footslopes and narrow drainage floors, sparse mulga shrublands	5.6
	Kennedy - elevated sandy plains with large linear and reticulate dunes; hummock grasslands of hard spinifex with scattered shrubs	3.0
		8.6

Table 1 continued...

Pastoral value	Land systems	Area %
Moderate (10-19 ha/s.u.)	Yalbalgo - sandplains with linear and reticulate dunes; tall shrublands of wanyu and spreading gidgee	34.0
	Windalia - stony plains and narrow dissected upper interfluves on radiolarite; tall shrublands of spreading gidgee	12.4
	O'Brien - tributary alluvial plains and slightly more elevated upper plains and interfluves; tall acacia shrublands often arranged in groves	8.3
	Lyons - sandy alluvial plains with numerous claypans and reticulate and linear dunes; tall mixed shrublands of acacias and numerous low shrubs	2.6
	Mantle - gently undulating stony plains with sluggish drainage tracts, stony rises and low summits; sparse tall and low shrublands of acacias and some chenopods	2.1
		59.4
High (5-9 ha/s.u.)	Cahill - sandy outwash plains with channels; tall shrublands of silver bark wattle and other acacias	9.7
	Mary - gently sloping plains and low rises with calcrete at shallow depth or at surface; tall shrublands of acacias and cassias	8.4
	Gearle - gently sloping alluvial plains with duplex soils, minor low rises with more sloping marginal plains; low shrublands of bluebush	2.1
		20.2
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (334 recordings on 10 land systems)

Mardathuna

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Billy	7	71	29	—	—	14	—	72	14	—	14	72	14
Cahill	45	85	11	—	4	11	33	42	7	7	45	42	13
Gearle	27	51	26	19	4	—	4	7	48	41	4	7	89
Lyons	15	93	7	—	—	13	27	33	27	—	40	33	27
Moogoolo	1	100	—	—	—	—	—	100	—	—	—	100	—
Mantle	16	100	—	—	—	—	—	31	63	6	—	31	69
Mary	36	100	—	—	—	3	44	42	11	—	47	42	11
O'Brien	46	93	7	—	—	2	33	41	17	7	35	41	24
Windalia	49	88	12	—	—	2	37	43	14	4	39	43	18
Yalbalgo	92	97	2	1	—	34	41	18	5	2	74	18	8
Total over all land systems	334	89	8	2	1	13	32	32	16	7	44	33	23

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 18 sites on 8 land systems.

Range condition and recommendations

1. Yalbalgo land system (34.0%)

The system supports Acacia Sandplain pastures (ACSA) with scattered desirable low shrubs such as Wilcox bush, cotton bush and flat leaf bluebush below the tall shrub layer. The ground layer supports wanderrie grass and numerous herbs in season and, in some areas, soft and hard spinifex. Pasture condition is mostly good or very good with minor localised areas showing loss of desirable shrubs to fair or poor condition. There is no significant erosion on the system.

Because of the relatively sparse occurrence of palatable shrubs and the rather short lived nature of wanderrie grass the system only has limited durability in times of drought.

Controlled burning may be a desirable management practice on this system, but this has not been researched. Evidence seen elsewhere during the survey suggests that the effects of fire are extremely long term. Where the over-storey of tall shrubs has been killed by fire the low shrub layer and the ground layer is increased in both diversity of species and density. The fire-induced sub-climax vegetation appears to be considerably more useful for livestock production than the mature shrub stand.

2. Windalia land system (12.4%)

This system supports Acacia Short Grass Forb pastures (ASGF) with smaller inclusions of Stony Chenopod (STCH) and Acacia Creek-line (ACCR) types. When in good condition there is a wide range of desirable low shrubs below the upper storey of spreading gidgee and other acacias. Desirables include Wilcox bush, flat leaf bluebush, *Phyllanthus* species, corky barked kallstroemia and ruby saltbush.

Pasture condition is mostly good or fair although some restricted areas have lost desirable shrubs and are in poor condition. There is some minor water erosion on some lower plains but generally the system is not susceptible to erosion.

3. Moogooloo land system (11.8%)

Little of this rugged and poorly accessible system was seen on this station. However, most of it is not suitable for grazing and condition of the vegetation is expected to be good.

4. Cahill land system (9.7%)

This system supports the Acacia Sandplain (ACSA) pasture type with some buffel grass and Soft Spinifex (SOSP) pastures in parts. Pasture condition is rather variable but the bulk of traverse recordings indicated fair or good condition. There is one localized area of about 0.5 km^2 of severe degradation near Donovan dam but, over all, the system is in fair or good range condition and there is no erosion.

5. Mary land system (8.4%)

Pasture type is Acacia Mixed Shrub (ACMS) which includes a good range of desirable low shrubs such as warty leaf eremophila, felty bluebush, ruby saltbush and tall saltbush beneath various cassias and acacias. Pasture condition is mostly fair or good and there is no erosion.

6. O'Brien land system (8.3%)

Pastures on this productive system are predominantly Acacia Short Grass Forb (ASGF) with smaller inclusions of Stony Chenopod (STCH) and Acacia Creek-line (ACCR) types. When in good condition there is a wide range of desirable low shrubs including Wilcox bush, flat leaf bluebush and ruellia on the groved plains and Gascoyne mulla mulla, ruby saltbush and sago bush on the more saline parts. Traverse data indicated that most pastures were in fair or good condition although some areas close to water points such as Mansfield dam are degraded to poor or very poor condition. There is occasional minor water erosion in the form of shallow rills, but generally the system shows no erosion.

7. Mantle land system (2.1%)

The system supports sparse Stony Short Grass Forb (SSGF) and Stony Chenopod pastures (STCH) most of which are degraded to poor condition. Nearly all of the system is located in West Wandinuie paddock where it is associated with an area of severely degraded Gearle land system. A programme of spelling over a number of consecutive wet seasons and conservative use at other times of the year is required in the paddock in order to encourage pasture recovery.

8. Gearle land system (2.1%)

This system supports valuable Gascoyne Bluebush (BLUE) pastures which are attractive to stock and appear to have received heavy preferential use. In most cases pastures are now profoundly altered with considerable loss of Gascoyne bluebush and other desirable halophytic shrubs. Some 48% of traverse recordings indicated poor pasture condition and 41% indicated very poor condition. Active wind and water erosion in the form of rills, small gullies and surface hummocking of the duplex soils is common.

About 3 km^2 near Bottom dam in west Wandinuie paddock is severely degraded and needs protection from grazing. A programme of rehabilitation as outlined in 7 is required and additional fencing to subdivide the paddock should be considered.

Although the Gearle system is small it is important to the station as it still supplies good quality annual feed in season. However, the general loss of durable shrubs has greatly reduced its usefulness in drought times. The system has the potential to recover if a system of strategic spelling could be implemented on the paddocks in which the system occurs, namely Soak Creek, North Cahill, South Cahill and West Wandinuie. Buffel grass has already colonized in some parts and probably has the capacity to spread further.

9. The remaining land systems, Billy, Kennedy and Lyons, were not intensively sampled but are likely to be in fair or good condition.

10. The recommended sheep unit capacity for present condition is 18,600.

11. The capability sheep unit capacity if all country was in good range condition is estimated at 23,900.

Individual station report

Mardathuna station - 243,368 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Yalbalgo	828	ACSA	490	119	53	—	5,039	5,517
		SOSP	123	30	13	—	2,352	2,767
Windalia	301	ASGF	99	101	41	—	934	1,205
		ACCR	24	6	—	—	540	600
		STCH	—	18	12	—	130	250
Moogooloo	288	ASGF	288	—	—	—	1,440	1,440
Cahill	236	ACSA	95	89	27.5	0.5	1,458	1,767
		TUGR	11	10	3	—	762	1,200
Mary	204	ACMS	91	82	21	—	2,771	3,880
		BLUE	5	4	1	—	156	200
O'Brien	203	ASGF	35	45	22	—	380	510
		STCH	17	23	11	—	293	425
		ACCR	25	13	12	—	690	1,000
Billy	136	SSGF	12	59	11	—	267	328
		ASGF	8	39	7	—	188	270
Kennedy	72	HASP	72	—	—	—	360	360
Lyons	63	ACSA	13	8	11	—	202	267
		CBMS	—	4	10	—	113	280
		ACCR	—	5	—	—	50	100
		No veg	12	—	—	—	—	—
Mantle	52	STCH	—	5	29	—	122	283
		SSGF	—	7	11	—	45	72
Gearle	50	BLUE	2	3	37	3	309	900
		TUGR	—	—	5	—	20	250
Totals	2,433		1,422	670	337.5	3.5	18,621	23,871

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 18,600

Capability sheep unit capacity 23,900

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 23,676

highest (1969) 36,250

lowest (1980) 14,500

Marron station - Carnarvon Shire

Area 8,057 km²

Location

Marron station in located on the Wooramel 1:250,000 map sheet. The homestead is about 37 km west of North-West Coastal Highway and is about 115 km by road from Carnarvon. The station has common boundaries with Ella Valla, Yalbalgo, Wahroonga and Edaggee stations.

Description

The largest land system on the station is Sandal (44.9% of the station area) which predominates in central and south-western parts. It consists of alluvial plains with duplex soils and numerous low sandy rises and banks. Vegetation is a mixture of tall shrublands of various acacias and low shrublands of bluebush and Gascoyne mulla mulla. Pastoral value is high.

The remainder of the station is made up of the sand dune systems Ella (35.2%) and Yalbalgo (9.9%).

The Ella system occurs in northern and central parts and consists of short linear dunes with relief up to 15 m and narrow interdunal plains with more clayey soil and characteristic drainage foci. The vegetation on the sandy units is sand dune gidgee woodland or wanyu shrubland and elsewhere is mixed shrubland. Pastoral value is moderate.

The Yalbalgo land system occurs in the east of the station. It consists of large linear dunes and sandy swales and lacks the drainage foci unit of the Ella system. Vegetation is mainly a tall shrubland of wanyu with some trees of sand dune gidgee. Pastoral value is moderate.

Table 1 summarizes the land systems found on the station.

Condition statements for land systems and for the whole station (total over all land systems) are shown in table 2. These statements were derived from traverse records.

Table 1. Land systems on Marron station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Ella - short linear dunes and sandy banks with inter-dunal plains and drainage foci, sand dune gidgee woodlands and mixed acacia shrublands	35.2
	Yalbalgo - sandplain with linear and reticulate dunes, tall shrublands of wanyu and sand dune gidgee woodlands	19.9
		55.1
High (5-9 ha/s.u.)	Sandal - alluvial plains with numerous low sandy rises and banks, duplex and sand soils; tall mixed shrublands of acacias and numerous low shrubs	44.9
Very high (< 5 ha/s.u.)		—
		100.0

Table 2. Condition statements derived from traverse records (159 recordings on 3 land systems)

Marron

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Ella	50	100	—	—	—	12	56	24	8	—	68	24	8
Sandal	91	100	—	—	—	3	22	42	29	4	25	42	33
Yalbalgo	18	100	—	—	—	11	61	28	—	—	72	28	—
Total over all land systems	159	100	—	—	—	7	36	35	19	3	44	35	21

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 12 sites on 3 land systems.

Range condition and recommendations

1. Sandal land system (44.9%)

There is no erosion on this system, but some pastures are degraded. In particular the Currant Bush Mixed Shrublands (CBMS) on the duplex soil plains of the system are nearly all more or less degraded. Although this pasture type is still moderately productive there has been a loss of desirable shrubs and, in some of the south-west and western paddocks, a marked increase in undesirable species such as waxy leafed eremophila and needle bush.

2. Ella land system (35.2%)

Most of this system is in good range condition. The predominant Acacia Sandplain (ACSA) pasture type is mostly in good condition and there is no erosion. The minor Currant Bush Mixed Shrub (CBMS) pasture type is rather more variable with condition about equally distributed between good, fair and poor.

3. Yalbalgo land system (19.9%)

This system is nearly all in good range condition. Some parts of the system in the far east are probably not fully used because of the considerable distance from water.

4. The station is not particularly well watered with at least a quarter of its country being > 5 km from water. The reduced condition of paddocks in the vicinity of the homestead and to the west suggests that they have carried excessive numbers of stock in the past. Piping of water to new distribution points should be considered as a means of ensuring more equitable use of pastures over the property.

5. The recommended sheep unit capacity for present condition is 7,500.

6. The capability sheep unit capacity if all country was in good range condition is estimated at 10,250.

Individual station report

Marron station - 80,569 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandal	362	CBMS	26	69	68	—	1,808	3,260
		ACSA	48	59	38	—	921	1,208
		BLUE	27	27	—	—	878	1,080
Ella	283	ACSA	153	45	—	—	1,556	1,650
		CBMS	17	17	23	—	696	1,140
		ACCR	14	14	—	—	420	560
Yalbalgo	160	ACSA	115	45	—	—	1,240	1,333
Totals	805		400	276	129	—	7,519	10,231

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 7,500

Capability sheep unit capacity 10,250

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1974):

average (mean) 10,580

highest (1976) 15,700

lowest (1980) 1,200

Meadow station - Shark Bay Shire

Area 832 km²

Location

Meadow station is located on the Yaringa 1:250,000 map sheet. The homestead is 5 km east of the North-West Coastal Highway and is about 240 km south by road from Carnarvon. The station has common boundaries with Woodleigh, Hamelin, Coburn and Nerren Nerren stations and vacant crown land.

Description

About 75% of the station consists of gently undulating sandplain of the Nerren, Sandplain and Nanga land systems.

The Nerren system (44.4% of the station area) occurs throughout the station except in central parts. It supports a tall shrubland dominated by wanyu with a patchy over-storey of various eucalypts. Pastoral value is moderate.

The Sandplain system (22.5%), which occurs mainly in the north-east and east, is very similar to the Nerren system, but lacks the eucalypt over-storey.

The Nanga sandplain system (7.9%) is found in the south-west of the station. It is more undulating than the Nerren and Sandplain systems with occasional steep dunes and sandy ridges. The vegetation is very different from that found on the other two systems and consists of scrubby heath and tree heath with a wide variety of species typical of sandplains south of the survey area. Pastoral value is very low.

The Tarcumba system (21.9%) occurs in the centre of the station. It consists of nearly flat plains with gradational soils overlying calcrete and supports acacia mixed shrublands. Pastoral value is high.

Three other minor land systems, giving a total of seven systems, occur on the station. All systems are briefly described in table 1.

Condition statements for land systems and for the whole station (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Meadow station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Nanga - undulating sand plain and occasional dunes with tree heath	7.9
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Nerren - nearly flat to gently undulating red sandplain; tall shrublands of wanyu with scattered trees various eucalypts	44.4
	Sandplain - nearly flat to gently undulating red sandplain; tall shrublands of wanyu	22.5
	Yaringa - sandy plains with sandy banks, low dunes and limestone outcrop plains; tall shrublands of wanyu and other acacias	1.9
		68.8
High (5-9 ha/s.u.)	Tarcumba - nearly flat plains with gradational soils overlying calcrete; tall shrublands numerous acacias	21.9
	Snakewood - nearly flat plains with duplex soils; tall shrublands of snakewood with saltbush understorey	1.3
	York - nearly flat low lying alluvial plains with weakly gilgaied clay soils; woodlands of York gum and other eucalypts also tall acacia shrublands	0.1
		23.3
Very high (< 5 ha/s.u.)		
		100.0

Table 2. Condition statements derived from traverse records (168 recordings on 6 land systems)

Meadow

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Nanga	17	100	—	—	—	65	29	6	—	—	94	6	—
Nerren	52	100	—	—	—	6	44	42	8	—	50	42	8
Sandplain	62	100	—	—	—	48	18	26	5	3	66	28	8
Snakewood	4	75	25	—	—	—	—	25	25	50	—	25	75
Tarcumba	29	100	—	—	—	—	7	62	31	—	7	62	31
Yaringa	4	100	—	—	—	—	25	50	25	—	25	50	25
Total over all land systems	168	99	1	—	—	26	25	36	11	2	51	36	13

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 11 sites on 6 land systems.

Range condition and recommendations

1. Nerren land system (44.4%)

This system with Acacia and Eucalyptus Short Grass Forb (AEGF) pastures is nearly all in fair or good range condition. When in good condition a small range of desirable shrubs such as ruby saltbush, cotton bush and flat leafed bluebush occur clumped beneath the eucalypt trees and larger wattles. These species confer limited drought durability to the pastures while numerous annual forbs and grasses provide ephemeral feed in season.

Much of the Nerren land system in the south-east of the station is not used for grazing as there are no permanent stock waters.

2. Sandplain land system (22.5%)

About two-thirds of this system is in good range condition and most of the remainder is in fair condition. Pasture is the Acacia Sandplain (ACSA) type which is very similar to the Acacia and Eucalypt Short Grass Forb (AEGF) pastures of the Nerren land system. The pastures are essentially ephemeral with numerous forbs and annual grasses in season but only small numbers of useful low shrubs for times of drought.

3. Tarcumba land system (21.9%)

This system (with the minor Snakewood system) is the most valuable on the station and has been fully used in the past. More than half of the system is in fair range condition with the remainder being about equally distributed between good and poor condition.

Pastures are productive Acacia Mixed Shrub (ACMS) with an over-storey of numerous wattles such as silver bark wattle, minnirichi, curara and *Acacia galeata* and, when in good condition, a wide range of desirable low shrubs. Desirable species include green cassia, tall saltbush, flat leafed bluebush, woolly bluebush and ruby saltbush. In some parts these species have been depleted but the system has the potential to recover well if spelled from grazing over a number of growing seasons.

4. Nanga land system (7.9%)

This system with its very low grazing value Heath (HEAT) pastures is largely unused due to the lack of stock waters. Range condition is good.

5. Yaringa land system (1.9%)

Condition of the Acacia Sandplain (ACSA) and Acacia Mixed Shrub (ACMS) pastures on this minor system varies from good to poor depending on distance from water.

6. Snakewood land system (1.3%)

Condition of the Saltbush (SALT) pastures beneath the snakewood shrubs on this system vary from good to very poor depending on the level of past use. Because of its small area the system is of little significance on the station.

7. The station is inadequately watered especially in the south but also in other parts. Additional water points are required so that the country can be more fully used and stock better distributed. Dams have been successfully introduced on suitable sites with clay subsoils and may have the potential to bring stock to other areas where underground water supplies are lacking.

8. The recommended sheep unit capacity for present condition and assuming the station was adequately watered (which is not the case, see 7 above) is 6,100.

9. The capability sheep unit capacity if all country was in good range condition is estimated at 8,500.

Individual station report

Meadow station - 83,244 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Nerren	369	AEGF	185	155	29	—	2,299	2,636
Sandplain	187	ACSA	123	49	15	—	1,391	1,558
Tarcumba	182	ACMS	33	100	49	—	1,966	3,640
Nanga	66	HEAT	55	4	—	—	193	197
		HASP	6	1	—	—	33	35
Yaringa	16	ACSA	—	9	4	—	72	133
		ACMS	3	—	—	—	60	60
Snakewood	11	SALT	—	2	7	—	69	180
		ACMS	—	2	—	—	20	40
		ACSA	—	—	—	—	—	—
York	1	SALT	—	1	—	—	13	20
		ACMS	—	—	—	—	—	—
Totals	832		405	323	104	—	6,116	8,499

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 6,100

Capability sheep unit capacity 8,500

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1971):

average (mean) 5,840

highest (1970) 8,976

lowest (1984) 1,022

Meedo station - Carnarvon Shire

Area 1,465 km²

Location

Meedo station is located on the Wooramel 1:250,000 map sheet. The homestead is close to the Wooramel River and is about 39 km east by road from North-West Coastal Highway. Total distance to Carnarvon by road is about 160 km. The station has common boundaries with Wahroonga, Pimbec, Towrana, Gilroyd, Woodleigh, Yaringa and Wooramel stations.

Description

Nearly all of the station consists of red sandy country of the Sandplain, Lyons and Yalbalgo land systems. These systems are all accessible to livestock and are of moderate pastoral value.

The intermittent Wooramel River runs east-west through the centre of the station and is flanked on either side by the Lyons land system. The Lyons system (24.5% of the station area) consists of sandy alluvial plains with numerous distinctive clay pans surrounded by reticulate and linear sand dunes. Vegetation is mainly rather thin mixed shrublands on the alluvial plains and denser tall wanyu shrublands or sand dune gidgee woodlands on the dunes.

The Sandplain land system (48.7%) is the largest on the station. It occurs in north central parts of the station and also on the south-west and south-east. It consists of gently undulating red sandplain with either wanyu shrublands or sand dune gidgee woodlands.

The Yalbalgo system (24%) occurs in the north-east, north-west and other parts of the station. It consists of well defined linear sand dunes with relief up to 20 m and sandy swales and supports the same vegetation as the Sandplain system.

Four other land systems, Target, Foscal, Yaringa and Delta occur but collectively only occupy 1.4% of the station area and are of little significance. Some very large clay pans (up to 5 km in extent) are found on the station. The larger of these occupy about 1.4% of the total station area. They are unvegetated and are of no use for pastoral purposes. All land systems on the station are summarized in table 1.

Condition statements for land systems and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Meedo station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Sandplain - nearly flat to gently undulating red sandplain; tall shrub lands of wanyu and woodlands of sand dune gidgee.	48.7
	Lyons - sandy alluvial plains witH numerous claypans and reticulate and linear dunes; tall shrublands of acacias with numerous low shrubs and woodlands of sand dune gidgee.	24.5
	Yalbalgo - sandplain with linear and reticulate dunes; tall wanyu shrublands and sand dune gidgee woodlands.	24.0
	Yaringa - sandy plains with sandy banks, low dunes and limestone outcrop plains; tall shrublands of wanyu and other acacias.	0.3
		97.5
High (5-9 ha/s.u.)	Target - plains with sandy banks, more clayey inter-bank areas and numerous small drainage foci; tall acacia species mixed shrubland.	0.5
	Foscal - gently sloping outwash plains, low limestone mesas, plateaux edges and footslopes; low shrublands of saltbush and bluebush	0.4
	Delta - almost flat, active alluvial floodplains with low shrublands of saltbush and bluebush.	0.2
		1.1
Very high (< 5 ha/s.u.)		
	Large bare claypans	1.4
		100.0

Table 2. Condition statements derived from traverse records (216 recordings on 5 land systems)

Meedo

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Foscal	1	100	—	—	—	—	—	100	—	—	—	100	—
Lyons	89	68	25	6	1	—	2	34	48	16	2	34	64
Sandplain	85	100	—	—	—	—	40	44	16	—	40	44	16
Yalbalgo	40	100	—	—	—	8	40	39	13	—	47	40	13
Yaringa	1	100	—	—	—	—	—	100	—	—	—	100	—
Total over all land systems	216	88	10	2	—	1	24	40	29	6	25	40	35

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 9 sites on 2 land systems.

Range condition and recommendations

1. Sandplain land system (48.7%)

This system supports the Acacia Sandplain (ACSA) pasture type. This pasture has a typical tall shrub layer of wanyu or a scattered tree layer of sand dune gidgee . The lower layers consist of very scattered low shrubs including a few palatable species and a prominent grass layer dominated by wanderrie grass. Pasture condition as seen during survey was mostly fair or good. There is no erosion present and over all range condition is fair or good.

Because of the general scarcity of palatable shrubs and the rather ephemeral nature of the wanderrie grass pastures the system has limited drought value. Opportunistic use on a flexible basis can be made on the grass pastures in good seasons.

Controlled burning may be a useful management tool on this land system, but its use has not been researched. Evidence seen on this system during survey suggests that the effects of fire are very long term. Where the over-storey of tall wanyu shrubs has been killed by fire the low shrub layer and the ground layer can be remarkably increased both in diversity of species and in density. This fire-induced sub-climax appears to be considerably more productive for livestock production than is the wanyu climax situation.

2. Lyons land system (24.5%)

Currant Bush Mixed Shrub (CBMS) pastures on the small interdunal plains of this land system are mostly degraded to poor or very poor condition. The system still produces useful annual feed in good seasons, but its durability in drought times is considerably reduced due to the loss of many desirable perennial shrubs. In some parts there have been marked increases in the undesirable needle bush. The dunes and sandy banks of the system are relatively resistant to erosion but the small inter-dunal plains with duplex soils are susceptible. More than one-third of the traverse recordings showed minor erosion and 11% indicated moderate erosion.

Management programmes involving regular spelling over growing seasons and conservative stocking at other times of the year are required in order to encourage pasture recovery.

3. Yalbalgo land system (24%)

This system supports the same Acacia Sandplain pasture as described for the Sandplain system. Pasture condition is fair to good and there is no erosion. As for the Sandplain system the wanderrie grass pastures have limited drought value and fire is a potential management tool.

4. The remaining four land systems collectively occupy 1.4% of the station area. They were not intensively sampled but, where seen, were in fair range condition.

5. The station is well developed in terms of paddocks and is adequately watered except in the south-eastern corner. Pastures in this area are in good condition and should be brought into more use so that grazing pressure can be reduced in some other paddocks along the Wooramel River frontage.

6. The recommended sheep unit capacity for present condition is 9,250.

7. The capability sheep unit capacity if all country was in good range condition is estimated at 12,850.

Individual station report

Meedo station - 146,492 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandplain	713	ACSA	285	314	114	—	4,794	5,942
Lyons	360	ACSA	9	106	65	—	998	1,500
		CBMS	—	9	70	—	550	1,580
		ACCR	—	29	—	—	290	580
		No veg	72	—	—	—	—	—
Yalbalgo	352	ACSA	162	144	46	—	2,434	2,933
Target	7	CBMS	—	1	2	—	25	60
		ACSA	1	2	—	—	21	25
		ACCR	—	1	—	—	10	20
Foscal	6	SALT	—	3	—	—	38	60
		BLUE	—	2	—	—	25	40
		ACMS	—	1	—	—	10	20
Yaringa	4	ACSA	—	3	—	—	19	25
		ACMS	—	1	—	—	10	20
Delta	3	BLUE	—	2	—	—	25	40
		SALT	—	1	—	—	13	20
		ACSA	—	—	—	—	—	—
Large clay pans	20	No veg	20	—	—	—	—	—
Totals	1,465		549	619	297	—	9,262	12,865

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 9,250

Capability sheep unit capacity 12,850

Declared stock numbers (sheep units or equivalent) 1968-1974 (no data for 1969):

average (mean) 12,196

highest (1970) 18,661

lowest (1980) 2,684

Meeragoolia station - Carnarvon Shire

Area 260 km²

Location

Meeragoolia station is located on the Kennedy Range and Wooramel 1:250,000 map sheets. The homestead is situated about 68 km due east by road from Carnarvon along the Carnarvon - Gascoyne Junction road and then south by station access road. The station has common boundaries with Brickhouse, Doorawarrah, Ella Valla and Callagiddy stations.

Description

Only four land systems occur on the station and three of these, Sandal, Target and Lyons, collectively occupy over 98% of the total station area. All systems are accessible to livestock and pastoral value is high.

The largest system is Sandal (56.6%) which occurs throughout the southern parts of the station. It consists of almost flat or very gently sloping alluvial plains with numerous low sandy banks and rises. Soils are duplex types and sands. Vegetation consists of scattered to moderately close tall shrublands of various acacias and currant bush on the plains and tall shrublands of silver bark wattle and wanyu on the sandy banks.

The Target system occupies about 36% of the station area in the north and as inclusions in the Sandal system. It consists of nearly flat plains with numerous sandy banks, more clayey interbank areas and small but prominent drainage foci with denser vegetation than on the surrounding country. The system supports the same tall acacia shrublands as found on the Sandal system.

The Lyons system (6.1%) occurs along the northern boundary of the station. It consists of sandy plains with numerous large, distinctive claypans surrounded by linear and reticulate sand dunes. Vegetation is the same as found on the other two systems but with a higher proportion of the wanyu and silver bark wattle tall shrubland associated with the large sandy units of the system.

The Ella system (1.6%) occurs in the far south and west of the station. It is similar to the Target system except that it has prominent short linear dunes as well as sandy banks, inter-dunal plains with more clayey soil and drainage foci with rather more dense vegetation. Vegetation structure and composition is the same as the other three systems.

All systems on the station are summarized in table 1.

Condition statements for each land system for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Meeragoolia station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Lyons - sandy alluvial plains with numerous claypans and reticulate and linear dunes; tall shrublands of acacias and numerous others	6.1
High (5-9 ha/s.u.)	Sandal - alluvial plains with numerous low sandy rises and banks, duplex and sand soils; tall shrublands of acacias with numerous low shrubs	56.6
	Target - plains with sandy banks, more clayey interbank areas and numerous small drainage foci; tall shrublands of acacias with numerous low shrubs	35.7
	Ella - short linear dunes and sandy banks with more clay inter-dunal plains and drainage foci; tall shrublands of acacias and numerous others	1.6
		93.9
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2: Condition statements derived from traverse records (95 recordings on 4 land systems)

Meeragoolia

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Ella	3	100	—	—	—	—	—	67	33	—	—	67	33
Lyons	9	100	—	—	—	11	11	45	22	11	22	45	33
Sandal	46	96	4	—	—	—	20	47	33	—	20	47	33
Target	IR837	89	11	—	—	—	8	30	46	16	8	30	62
Total over all land systems	95	94	6	—	—	1	14	41	37	7	15	41	44

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 5 sites on 3 land systems.

Range condition and recommendation

1. Sandal land system (56.6%)

This system supports valuable Currant Bush Mixed Shrub (CBMS) and some Bluebush (BLUE) pastures on the duplex soils of the alluvial plains and Acacia Sandplain pastures (ACSA) on the sandy banks. Condition of the currant bush and bluebush pastures is mostly poor with considerable loss of desirable shrubs such as currant bush, Gascoyne bluebush and tall saltbush. The desirables have largely been replaced by serious increases or invasions of undesirable shrubs, mainly crinkled and grey cassias and waxy leaf eremophila, which have formed close stands on some of the most productive areas. The Acacia Sandplain pastures are in fair or good condition. There is no erosion on the system but, because of the depleted currant bush pastures, the over all assessment for the system is about one-third in poor range condition, half in fair condition and the balance in good condition.

Areas in poor or fair condition are still highly productive in terms of annual herbage in season, but have limited drought reserves compared to areas in good condition. In order to enable recovery of desirable shrubs one or two of the most degraded paddocks should be spelled over a number of consecutive growing seasons and stocked at very conservative levels during other times of the year.

2. Target land system (35.7%)

This system supports the same pasture types, except for bluebush, as the Sandal system. As is the case with the Sandal system the Currant Bush Mixed Shrub (CBMS) pastures are considerably depleted to poor or very poor condition. Acacia Sandplain (ACSA) pastures on the sandy units of the system are also depleted, but less so with the bulk being in fair or poor condition. There is some minor water erosion in the form of patchy thin sheeting on some duplex soil sites but this is not a significant problem.

A programme of regular spelling of selected paddocks needs to be developed in order to promote pasture recovery.

3. Lyons land system (6.1%)

Condition of this system is very similar to the others in that pastures are generally degraded with Currant Bush Mixed Shrub (CBMS) pastures more so than the Acacia Sandplain (ACSA) pastures. There is no erosion on the system.

4. Ella land system (1.6%)

This system is of very limited extent on the station and is of little importance. Where seen its pastures were in fair or poor condition.

5. This small station is very well developed in terms of paddocks and water supplies. A system of progressive spelling of the most degraded paddocks could be readily implemented. Invasion by inedible shrubs is a serious problem on parts of the Sandal and Target land systems. Although there is no economically viable means of shrub eradication that can be recommended as yet, undesirable shrub reduction should remain a long-term objective.

6. The recommended sheep unit capacity for present condition is 2,050.

7. The capability sheep unit capacity if all country was in good range condition is estimated at 3,900.

Individual station report

Meeragoolia station - 26,040 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandal	147	CBMS	—	26	40	—	575	1,320
		ACSA	23	34	2	—	412	492
		BLUE	—	9	13	—	194	440
Target	93	CBMS	—	8	34	—	313	840
		ACSA	6	17	14	—	212	308
		ACCR	7	7	—	—	210	280
Lyons	16	ACSA	3	3	2	—	52	67
		CBMS	—	3	1	—	44	80
		ACCR	—	1	—	—	10	20
		No veg	3	—	—	—	—	—
Ella	4	ACSA	—	2	1	—	17	25
		CBMS	—	1	—	—	13	20
		ACCR	—	—	—	—	—	—
Totals	260		42	111	107	—	2,052	3,892

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 2,050

Capability sheep unit capacity 3,900

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 4,998

highest (1969) 7,031

lowest (1980) 570

Mia Mia station - Carnarvon Shire

Area 2,089 km²

Location

Mia Mia station is located on the Winning Pool 1:250,000 map sheet. The homestead is 10 km east of the North-West Coastal Highway and is about 216 km north by road from Carnarvon. The station has common boundaries with Winning, Lyndon, Middalya, Wandagee, Minilya, Warroora, Cardabia and Marrilla stations.

Description

The North West Coastal Highway passes through the station separating it into a western third and an eastern two-thirds. The Lyndon River runs through the centre and western parts and, in the far west, Cardabia Creek runs north to south through the property.

Landforms on the station are many and varied with 21 land systems being represented. The largest system is Giralia (22.5% of total station area) which is found mostly in eastern and south-eastern parts. The system consists of sandplains with large linear dunes up to 15 m in height and supports spinifex hummock grasslands with numerous shrubs. Pastoral value is high or moderate depending on the relative proportions of soft and hard spinifex.

The Uaroo system (16.3%) occurs in the central west. It consists of broad, almost flat or gently sloping sandy plains with calcrete at shallow depth. Vegetation is a hummock grassland of hard and soft spinifex with numerous shrubs. Pastoral value is moderate.

The Spot system (10.4%) is associated with the Uaroo system and consists of flat to gently sloping plains with numerous sandy banks and more clayey interbank areas and alluvial plains. Soils are sands and duplex types. Vegetation consists of tall shrublands dominated by acacias and cassias and pastoral value is high.

A large area of the Winning land system (9.5%) is found in the centre of the station to the east and north-east from the homestead. The system consists of a few low rises and hills with extensive lower plains and broad drainage tracts. It supports scattered to moderately close tall and low shrublands often dominated by snakewood in the upper-storey. Pastoral value is high.

The productive Gearle land system (7.5%) occurs in the north-west and west of the station. It consists of gently sloping plains with minor low limestone rises and restricted more sloping marginal plains. Vegetation is variable consisting of scattered low shrublands of Gascoyne bluebush or tall acacia shrublands frequently with denser patches arranged in groves or bands on the plains.

The Wandagee land system (7.1%) is found in centre and east of the station and is based on sedimentary rocks of Permian age. It consists of nearly flat stony and clayey plains with broad drainage zones and low, often parallel, rises with rock outcrop. Vegetation varies from a very scattered to moderately close tall shrubland of snakewood, bardie bush and other acacias and numerous low shrubs. Pastoral value is high.

Sandy alluvial plains and broad drainage zones of the Wash land system (5.6%) occur in the centre and far east of the station. It supports tall shrublands of spreading gidgee and other acacias which are often arranged in a groved pattern with dense stands in the groves and sparser stands in the broader intergrove areas. Pastoral value is high.

The hill system Fossil (5.1%) occurs in the far south-east of the station where it represents the Gooch ranges which rise up to about 170 m above the surrounding sandplain country. The system is based on Permian age sedimentary rocks and consists of rounded summits and plateaux remnants with steep rocky, often benched footslopes. The system is poorly accessible to livestock and pastoral value is low.

Other important land systems found on the station are Marloo (5.1%), Donovan (4.3 per cent), River (2.9%) and O'Brien (1.4%). These systems are of high or moderate pastoral value.

The Marloo system is found in the south-west of the station where it forms almost flat alluvial plains with very sluggish through drainage and meandering channels associated with Carbabia Creek. Soils are gilgaied clays and the vegetation is a tussock grassland with occasional shrubs.

The Donovan system in the west and north-west of the station consists of gently sloping outwash plains and minor limestone plains and rises. It supports scattered low shrublands of Gascoyne bluebush and moderately close to close tall shrublands of silver bark wattle and other acacias.

The River system flanks the Lyndon River in parts and consists of narrow active floodplains and major channels. Vegetation is a tall acacia shrubland or open woodland of coolibah, often with a dense lower layer of smaller shrubs or buffel grass.

The O'Brien system is found in the south-east of the station as tributary alluvial plains and slightly more elevated upper plains and interfluves. It supports scattered tall shrublands of spreading gidgee and snakewood which may be arranged in a groved pattern with dense vegetation in the groves and much sparser vegetation in the broader intergrove areas.

Another nine systems occur on the station but these collectively only occupy 2.2% of the total area. All systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Mia Mia station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	Fossil - rugged hills, ridges and plateaux of sedimentary rocks, steep benched footslopes; scattered tall acacia shrublands	5.1
	Billy - low plateaux, mesas and buttes with stony footslopes and narrow drainage floors; scattered tall acacia shrublands	< 0.1
		5.2
Moderate (10-19 ha/s.u.)	Giralia - sandy plains with large linear dunes;spinifex hummock grasslands and scattered shrubs	22.5
	Uaroo - nearly flat sandy plains and minor pebbly plains; spinifex hummock grasslands with scattered shrubs	16.3
	O'Brien - tributary alluvial plains and slightly more elevated upper plains and interfluves; tall acacia shrublands often arranged in groves	1.4
	Windalia - stony plains and narrow dissected upper interfluves on radiolarite; tall shrublands of spreading gidgee	0.9
	Jubilee - limestone hills and undulating stony plains; tall shrublands with soft and hard spinifex	0.1
	Jimba - gently sloping alluvial plains with diffuse drainage, minor pebbly plains and low ridges; scattered tall and low shrublands	< 0.1
		41.2
High (5-9 ha/s.u.)	Spot - alluvial plains and plains with sandy banks and more clayey interbank areas; tall shrublands of acacias and currant bush, also bluebush and some spinifex grasslands	10.4
	Winning - low rises, extensive lower plains and broad drainage tracts; scattered tall and low shrublands of snakewood and bluebush	9.5
	Gearle - gently sloping alluvial plains, minor low rises with more sloping marginal plains; tall and low shrublands of acacias,saltbush and bluebush	7.5
	Wandagee - nearly flat stony and clayey plains with broad drainage zones and outcrop rises of sedimentary rocks; scattered tall acacia shrublands with numerous low shrubs including saltbush	7.1
	Wash - sandy alluvial plains and broad drainage zones receiving more concentrated sheet flow; tall acacia shrublands	5.6
	Marloo - gilgai alluvial plains with clay soils; tussock grasslands	5.1
	Donovan - gently sloping outwash plains and minor stony plains; tall shrublands of snakewood and other acacias, also bluebush and buffel grass	4.3
	River - narrow active flood plains and major channels, tall acacia shrublands or open coolibah woodlands with numerous low shrubs and buffel grass	2.9
	Yalkalya - saline alluvial plains and low calcrete rises; mixed tall and low shrublands of acacias, bluebush and saltbush, some hard spinifex	0.2
	Firecracker - undulating limestone uplands and stony plains, low shrublands of bluebush	0.2
	Trealla - elevated limestone plains and plains with thin sand cover, minor steeper marginal slopes; tall acacia shrublands	0.1
	Sandal - alluvial plains with numerous low sandy banks and rises, duplex and sand soils; tall mixed shrublands with acacias and numerous low shrubs	< 0.1
		53.0
Very high (< 5 ha/s.u.)	Barrabiddy - active flood plains and broad drainage zones with numerous channels; moderately close tall shrublands of acacias, numerous low shrubs and buffel grass	0.6
		100.0

Table 2: Condition statements derived from traverse records (280 recordings on 14 land systems)

Mia Mia

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Barrabiddy	1	—	100	—	—	—	—	—	100	—	—	—	100
Donovan	31	100	—	—	—	23	23	38	16	—	45	39	16
Fossil	3	100	—	—	—	—	100	—	—	—	100	—	—
Gearle	12	67	33	—	—	8	8	51	25	8	17	50	33
Giralia	27	100	—	—	—	89	7	4	—	—	96	4	—
Marloo	11	100	—	—	—	27	27	37	9	—	55	36	9
O'Brien	7	100	—	—	—	—	29	43	14	14	29	42	29
River	15	80	13	7	—	33	20	27	7	13	53	27	20
Spot	49	80	20	—	—	6	22	41	31	—	49	40	31
Trealla	2	100	—	—	—	—	50	50	—	—	50	50	—
Uaroo	38	100	—	—	—	86	11	—	3	—	97	—	3
Wandagee	40	94	3	3	—	18	28	33	18	3	45	35	20
Winning	35	63	31	6	—	—	9	48	17	26	9	48	43
Wash	9	100	—	—	—	—	78	22	—	—	78	22	—
Total over all land systems	280	89	10	1	—	30	21	29	15	5	50	30	20

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 13 sites on 6 land systems.

Range condition and recommendation

1. Giralia and Uaroo land systems (collectively 38.8%)

Both these sandy systems support mixed Hard Spinifex (HASP) and Soft Spinifex (SOSP) pastures which are nearly all in very good or good condition. No erosion was observed on either system.

Old, mature spinifex stands are useless for grazing and management must be aimed at maintaining the pastures in as attractive condition to stock as possible. Spinifex should be burnt on a fairly regular basis about every four or five years. Burnt areas should not be grazed for about 8-10 weeks over the growing season following the fire in order to encourage establishment of durable grasses, shrubs and spinifex seedlings.

The spinifex-based land systems are generally resistant to degradation, although some wind erosion may result if a prolonged dry spell occurs after burning. However, there is rapid re-establishment of vegetation and return to stability after rain.

2. Spot land system (10.4%)

The Currant Bush Mixed Shrub (CBMS) and Bluebush (BLUE) pastures of the alluvial plains and interbank plains of the system are all somewhat degraded to fair or poor condition. Soils are duplex types and minor wind and water erosion is common. Acacia Sandplain (ACSA) and Hard Spinifex (HASP) pastures of the sandy banks of the system are largely in good condition.

3. Winning land system (9.5%)

The broad alluvial plains and drainage tracts of the system support Bluebush (BLUE) pastures characterised by desirable low shrubs such as Gascoyne bluebush, silver saltbush, ruby saltbush and Gascoyne mulla mulla beneath scattered tall shrubs of snakewood. In some areas there has been considerable loss of desirable shrubs and pastures are degraded to fair, poor or very poor condition. Pasture decline is often accompanied by minor and moderate erosion in the form of rilling, thin sheeting and wind hummocking.

The worst affected area lies just to the east of the homestead in 5 Mile paddock where about 9 km^2 is severely degraded. A scattering of desirable shrubs remain and thus the area has the potential to recover, but will require full protection from grazing for a number of years to enable new plants to become established. A minimal amount of soil works to trap water and provide a seedbed may hasten the recovery process. A rehabilitation programme needs to be planned and implemented as a matter of some priority. Elsewhere in other paddocks the system is mostly in fair condition and there is no erosion.

4. Gearle land system (7.5%)

The system supports highly productive Bluebush and Saltbush pastures (BLUE, SALT). Desirable low shrubs include bladder saltbush, silver saltbush, ruby saltbush and Gascoyne bluebush. Buffel grass is well established in restricted parts. Pasture condition is predominantly fair although all levels of condition from very good to very poor are present. There is some patchy minor erosion.

The system is one of the most useful and productive on the station. Generally the almost flat parts of the system are stable under grazing but more sloping parts with duplex soils are susceptible to erosion if the vegetation is depleted. Areas in fair or poor condition should be spelled from grazing for a number of consecutive growing seasons and stocked at conservative rates at other times of the year.

5. Wandagee land system (7.1%)

This complex system supports Saltbush (SALT), Stony Chenopod (STCH), Acacia Creek-line (ACCR) and some Hard Spinifex (HASP) pastures. Pasture condition is mostly good or fair with some localized areas degraded to poor condition. There is occasional minor erosion on the softer drainage floors and plains but this is not a significant problem.

6. Wash land system (5.6%)

Condition of the Acacia Short Grass Forb (ASGF) and Acacia Creek-line (ACCR) pastures of the system as seen in Pleiades paddock is mostly good. There is no erosion. Desirable low shrubs beneath the upper layer of spreading gidgee include flat leaf bluebush, Wilcox bush, currant bush and tall cassia. Parts of the system in Pleiades and Jillillia paddocks are not fully used because of the considerable distance from stock water.

7. Marloo land system (5.1%)

This alluvial plains system supports mixed Tussock Grass (TUGR) pastures dominated by Roebourne plains grass but with others such as neverfail grass, silky browntop, barley mitchell grass and weeping mitchell grass. Pasture condition varies from fair to very good. With its clay soils and almost flat topography the system is inherently resistant to erosion. It is regularly flooded by Cardabia Creek and the Lyndon River and provides valuable grazing.

8. Donovan land system (4.3%)

Pastures are Bluebush (BLUE) and Acacia Mixed Shrub (ACMS). Condition is predominantly fair although there are also substantial parts in good or very good condition with a wide range of desirable low shrubs beneath the taller snakewood or silver bark wattle. Buffel grass has successfully established on the system in Collie paddock and on adjacent more sandy systems such as Giralia in the vicinity of the shearing shed.

9. River land system (2.9%)

Much of the system receives regular flooding from the Lyndon River. It supports Acacia Creek-line (ACCR) pastures and dense buffel grass Tussock Grass (TUGR) pastures. Pasture condition is largely fair to very good although localised areas show loss of desirable shrubs to poor or very poor condition. However, the system generally has good vegetative cover and is stable under grazing.

10. The remaining minor land systems on the station are all in fair or good range condition.

11. The recommended sheep unit capacity for present condition is 21,450.

12. The capability sheep unit capacity if all country was in good range condition is estimated at 29,400.

Individual station report

Mia Mia station - 208,963 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Giralia	470	HASP	271	11	—	—	1,392	1,410
		SOSP	180	8	—	—	3,067	3,133
Uaroo	341	HASP	232	—	7	—	1,178	1,195
		SOSP	99	—	3	—	1,662	1,700
Spot	217	CBMS	20	29	60	—	1,138	2,180
		BLUE	—	30	24	—	525	1,080
		ACSA	30	21	3	—	393	450
Winning	199	BLUE	6	66	58	9	1,308	2,780
		SOSP	15	15	—	—	375	500
		STCH	3	20	7	—	148	250
Gearle	156	BLUE	19	47	28	—	1,143	1,880
		SALT	9	24	14	—	568	940
		TUGR	—	15	—	—	300	750
Wandagee	147	SALT	13	41	20	—	898	1,480
		STCH	4	16	10	—	147	250
		ACCR	13	9	—	—	350	440
		HASP	19	—	2	—	100	105
Wash	117	ASGF	55	15	—	—	325	350
		ACCR	27	8	—	—	603	700
		TUGR	9	3	—	—	510	600
Fossil	107	ASGF	107	—	—	—	535	535
Marloo	106	TUGR	58	38	10	—	1,622	2,208
Donovan	91	BLUE	22	17	11	—	721	1,000
		ACMS	11	14	2	—	373	540
		SOSP	14	—	—	—	233	233
River	61	ACCR	15	9	7	—	425	620
		TUGR	11	6	4	—	686	1,050
		No veg	9	—	—	—	—	—
O'Brien	29	ASGF	4	7	4	—	53	75
		STCH	2	3	2	—	38	58
		ACCR	2	3	2	—	80	140
Windalia	18	ASGF	6	5	3	—	54	70
		STCH	—	2	—	—	10	17
		ACCR	2	—	—	—	40	40
Barrabiddy	13	SALT	—	3	6	—	75	180
		TUGR	2	2	—	—	140	200
Yalkalya	5	BLUE	1	1	—	—	33	40
		SALT	1	1	—	—	33	40
		HASP	1	—	—	—	5	5

Mia Mia station continued

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Firecracker	4	BLUE	2	2	—	—	65	80
Trealla	3	ACMS	2	1	—	—	50	60
		BLUE	—	—	—	—	—	—
Jubilee	3	HASP	2	—	—	—	10	10
		SOSP	1	—	—	—	17	17
		ACCR	—	—	—	—	—	—
Billy	2	SSGF	1	—	—	—	4	4
		ASGF	1	—	—	—	5	5
Sandal	0.4	CBMS	0.4	—	—	—	8	8
Jimba	0.2	STCH	0.2	—	—	—	2	2
Totals	2,089		1,301	492	287	9	21,447	29,410

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 21,450

Capability sheep unit capacity 29,400

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 26,840

highest (1971) 32,910

lowest (1981) 22,036

Middalya station - Carnarvon Shire

Area 1,997 km²

Location

Middalya station is located on the Winning Pool and Kennedy Range 1:250,000 map sheets. The homestead is about 80 km east of the North-West Coastal Highway from the bridge on the Minilya River 216 km north-east of Carnarvon. Middalya has common boundaries with Mia Mia, Lyndon, Williambury, Mardathuna, Hill Springs and Wandagee stations.

Description

The Minilya River runs through the centre of the property from the south-east to the north-west and many different landforms (20 land systems) occur.

In the north of the station the most widespread landforms are sandplains with large linear dunes of the Giralia land system (27.7% of the total station area) and rough hills with steep benched slopes of the Gooch Range (Fossil land system, 7.0%). The Giralia system supports hummock grasslands of soft and hard spinifex with numerous shrubs. Pastoral value is either moderate or high depending on the relative proportions of soft and hard spinifex. The Fossil system supports sparse acacia shrublands and, because of its rugged nature, is of very little use for pastoral purposes.

The second largest land system is Jimba (23.0%) which is scattered throughout central and southern parts of the station. It consists of gently sloping alluvial plains, minor pebbly plains and low ridges derived from Permian age sedimentary rocks and supports variable, very scattered to moderately close tall and low shrublands. The Mantle system (4.1%) is associated with and has affinities with the Jimba system in that it is also derived from Permian sediments. It is a plain system, but is more undulating and stony than Jimba. It supports very scattered or scattered tall and low shrublands. Pastoral value of both systems is moderate.

The Wash land system (9.0%) occurs in central eastern parts and consists of sandy alluvial plains and broad drainage zones. It supports tall shrublands of spreading gidgee and other acacias with many low shrubs and some perennial grasses. The vegetation is frequently arranged in dense clumps or groves alternating with less dense patches over the plains. Pastoral value is high.

The rugged hill system Moogooloo (7.2%) occurs in the far south-east of the station as part of the Kennedy Range rising about 100 m above the adjacent plains. The system is of very little use for pastoral purposes.

The Windalia land system (4.3%) is restricted to the south-west of the station. It consists of gently sloping stony plains on radiolarite and narrow, stony upper interfluves with intensely dendritic drainage patterns. It supports very scattered to moderately close tall shrublands dominated by spreading gidgee. Pastoral value is moderate.

The Yalbalgo system (3.4%) in the south-west of the station is similar in landform to Giralia in that it consists of sandplain and linear dunes. However, it supports tall acacia shrublands of wanyu and silver bark wattle instead of hummock grasslands of spinifex. Pastoral value is moderate.

Another ten land systems are found on the station but many are restricted in extent. The most important are Target (2.6%), River (1.9%), Lyons (1.5%) and Bidgemia (1.4%) all of which are of high pastoral value.

All systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Middalya station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Moogooloo - deeply dissected plateaux, mesas and hills of sedimentary rocks with steep footslopes and narrow valleys; tall shrublands of mulga and other acacias	7.2
Low (20-30 ha/s.u.)	Fossil - rugged hills, ridges and plateaux of sedimentary rocks, steep benched footslopes; scattered tall shrublands of mulga and other acacias	7.0
	Billy - low plateaux, mesas and buttes with stony footslopes and narrow drainage floors; scattered tall shrublands of mulga and other acacias	0.3
		7.3
Moderate (10-19 ha/s.u.)	Giralia - sandy plains with large linear dunes; spinifex hummock grasslands and scattered shrubs	27.7
	Jimba - gently sloping alluvial plains with diffuse drainage tracts, minor pebbly plains and low ridges; scattered tall and low shrublands of *Acacia* and *Eremophila* species and chenopods	23.0
	Uaroo - nearly flat sandy plains and minor pebbly plains; spinifex hummock grasslands and scattered shrubs	4.9

Table 1 continued...

Pastoral value	Land systems	Area %
	Windalia - stony plains and narrow dissected upper interfluves on radiolarite; tall shrublands of spreading gidgee	4.3
	Mantle - gently undulating stony plains with sluggish drainage tracts, stony rises and low summits; scattered tall and low shrublands of *Acacia* and *Eremophila* species and chenopods	4.1
	Yalbalgo - sandplains with linear and reticulate dunes; tall shrublands of wanyu and other acacias	3.4
	Channel - major channels with narrow flood plains and dissected marginal slopes and plains; scattered tall acacia shrublands	0.9
	Divide - gently undulating sandplains with occasional minor dunes; hummock grasslands of spinifex and scattered shrubs	0.2
	O'Brien - tributary alluvial plains and slightly more elevated upper plains and interfluves; tall acacia shrublands often arranged in groves	< 0.1
		68.5
High (5-9 ha/s.u.)	Wash - sandy alluvial plains and broad drainage zones receiving more concentrated sheet flow; tall shrublands of spreading gidgee and other acacias	9.0
	Target - plains with sandy banks, more clayey interbank areas and numerous small drainage foci; mixed tall shrublands *Acacia* species with numerous low shrubs	2.6
	River - narrow active flood plains and major channels; fringing woodlands of river gum and tall acacia shrublands	1.9
	Lyons - sandy alluvial plains with numerous claypans and reticulate and linear dunes; tall shrublands of wanyu, also other acacias and numerous low shrubs	1.5
	Bidgemia - tributary alluvial plains with sandy banks and minor dunes; tall shrublands of acacias and some chenopods	1.4
	Spot - alluvial plains and plains with sandy banks and more clayey interbank areas; tall shrublands of acacias and currant bush, also bluebush and some spinifex grasslands	0.6
	Yalkalya - saline alluvial plains and low calcrete rises; tall acacia shrublands and low shrublands of saltbush and bluebush	< 0.1
	Winning - low rises, lower plains and broad drainage tracts; scattered tall and low shrublands of snakewood and bluebush	< 0.1
		17.0
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2: Condition statements derived from traverse records (244 recordings on 13 land systems)

Middalya

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Bidgemia	8	49	38	13	—	—	—	62	38	—	—	62	38
Channel	4	50	50	—	—	—	50	25	25	—	50	25	25
Fossil	3	67	—	—	33	—	67	—	33	—	67	—	33
Giralia	36	97	3	—	—	55	42	3	—	—	97	3	—
Jimba	90	71	26	3	—	1	16	46	29	8	17	45	38
Lyons	1	100	—	—	—	—	100	—	—	—	100	—	—
Mantle	15	87	13	—	—	—	—	66	27	7	—	67	33
River	2	100	—	—	—	50	—	50	—	—	50	50	—
Target	25	72	24	4	—	8	24	44	24	—	28	48	24
Uaroo	23	96	4	—	—	48	48	4	—	—	96	4	—
Windalia	2	50	—	50	—	—	—	—	50	50	—	—	100
Wash	32	78	13	6	3	3	13	31	31	22	16	31	53
Yalbalgo	3	100	—	—	—	—	—	—	33	67	—	—	100
Total over all land systems	244	79	17	3	1	15	23	33	22	7	36	34	30

Range evaluation sites

Detailed descriptions and measurement of landform, vegetation, soils and range condition were made at 17 sites on 7 land systems.

Range condition and recommendations

1. Giralia land system (27.7%)

This sandplain and dune system supports mixed Hard Spinifex (HASP) and Soft Spinifex (SOSP) pastures which are in good or very good condition. There is no erosion. Much of the system in the far north-east and north-west of the station is not used for grazing due to the lack of stock water supplies.

Old, mature spinifex stands are of little use for grazing, but young stands supply useful grazing. Spinifex communities should be burnt on a fairly regular basis about every four or five years. Burnt areas should not be grazed for 8-10 weeks over the growing season following the fire to encourage establishment of durable grasses, shrubs and spinifex seedlings.

Spinifex based land systems are generally resistant to degradation although some minor wind erosion may result if a prolonged dry spell occurs after burning. However, there is a rapid re-establishment of vegetation and return to stability after rain.

2. Jimba land system (23.0%)

The system supports Bluebush (BLUE), Stony Chenopod (STCH), Acacia Short Grass Forb (ASGF) and Acacia Sandplain (ACSA) pastures. Pasture condition varies from good to very poor. Areas distant from stock water such as in the west of Cooraling paddock are in good condition with numerous desirable shrubs such as Gascoyne bluebush, Gascoyne mulla mulla, currant bush and ruby saltbush. Elsewhere pasture condition ranges from fair to very poor. More than 25% of the traverse recordings indicated minor water erosion as isolated rilling and sheeting on lower plains. Other parts of the system such as gently undulating pebbly and stony plains are inherently resistant to erosive forces and are not eroded.

About 14 km^2 of the system in Aerodrome paddock and in the vicinity of Naniago dam and at Blair camp is severely degraded with severe depletion of desirable low shrubs and bare scalded surfaces. Aerodrome paddock should be closed to grazing until pasture recovery is effected. Some strip cultivation and seeding should be considered as a means of hastening the recovery process.

3. Wash land system (9.0%)

Pastures found on this productive system are the Acacia Short Grass Forb (ASGF) and Acacia Creek-line (ACCR) types. The latter pasture frequently occurs as dense stands in small drainage foci or groves on the broad plains and along watercourses and drainage tracts. When in good condition, numerous desirable low shrubs such as tall saltbush, Wilcox bush, ruby saltbush, flat leaf bluebush and cotton bush are found beneath the taller shrubs.

Most pastures are degraded to fair, poor or very poor condition. An exception to this is in northern parts of Windelbalia paddock where pasture condition is good or very good. Poor sections are in Mundarie ram paddock and between Karilla and Mundarie water points.

A broad drainage plain of about 7 km^2 in Blair camp paddock is severely degraded. Vegetation is restricted to annuals in season and occasional shrubs of wait-a-while. Severe soil erosion as water scouring, rilling, sheeting and wind piling is widespread. The area should be protected from grazing.

4. Fossil and Moogooloo land systems (collectively 14.2%)

These rugged systems are of negligible use for grazing and were little sampled.

5. Uaroo land system (4.9%)

This sandy plain system which supports Hard Spinifex (HASP) and some Soft Spinifex (SOSP) is all in good range condition.

6. Windalia land system (4.3%)

This system, which is mostly in West Paddy's Tank paddock was not intensively sampled. However, where it was inspected the pastures were in good condition and there was no erosion.

7. Mantle land system (4.1%)

This system supports Stony Chenopod (STCH) and Stony Short Grass Forb (SSGF) pastures. Pastures are degraded, but there is no significant erosion on the system.

8. Yalbalgo land system (3.4%)

This minor system was not intensively sampled, but as seen elsewhere on the survey is expected to be in good or fair condition.

9. Target land system (2.6%)

This system supports Acacia Sandplain (ACSA) pastures on sandy banks and Currant Bush Mixed Shrub (CBMS) and minor chenopod pastures on the small inter-bank plains. The acacia sandplain pastures are in fair or good condition, but the other pastures are more or less depleted to fair or poor condition. Some minor erosion occurs on duplex soils of the inter-bank areas.

10. The remaining ten land systems collectively occupy 6.8% of the station area and are of little over all significance to the station. They were insufficiently sampled but are expected to be in fair condition.

11. The station is not particularly well developed in terms of stock watering points. Some extensive areas of useable country are > 5km from water and have not been developed.

The largest single area as yet undeveloped is part of the Giralia land system to the west of the Gooch Range. There are also large areas of unwatered Giralia system in the far north-west and north-east of the station. Other areas which are in good condition and require additional waters for full use are in the west of Cooraling paddock, the west of West Moogoo paddock and the north-west of West Paddy's Tank paddock. There is a need to bring these and other areas into production so that the grazing pressure on degraded parts of the station can be reduced.

12. The recommended sheep unit capacity for present condition and assuming full development (which is not the case, see 11) is 15,200.

13. The capability sheep unit capacity if all country was in good range condition is estimated at 19,350.

Individual station report

Middalya station - 199,720 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Giralia	552	SOSP	321	10	—	—	5,433	5,517
		HASP	214	7	—	—	1,093	1,105
Jimba	459	STCH	42	125	117	14	1,365	2,483
		ASGF	28	75	12	—	420	575
		ACSA	15	16	15	—	285	383
Wash	180	ASGF	5	39	64	—	315	540
		ACCR	18	18	11	7	595	1,080
		TUGR	—	5	13	—	135	600
Moogooloo	143	ASGF	143	—	—	—	715	715
Fossil	140	ASGF	140	—	—	—	700	700
Uaroo	99	HASP	66	3	—	—	340	345
		SOSP	29	1	—	—	492	500
Windalia	87	ASGF	33	23	14	—	277	350
		ACCR	7	2	—	—	160	180
		STCH	—	4	4	—	33	67
Mantle	82	STCH	—	29	24	—	225	442
		SSGF	—	19	10	—	83	116
Yalbalgo	68	ACSA	26	19	9	—	371	450
		SOSP	7	5	2	—	166	233
Target	51	CBMS	4	8	11	—	249	460
		ACSA	7	13	—	—	140	167
		ACCR	—	8	—	—	80	160
River	38	ACCR	10	9	—	—	290	380
		TUGR	7	6	—	—	470	650
		No veg	6	—	—	—	—	—
Lyons	30	ACSA	4	7	4	—	93	125
		CBMS	—	2	5	—	56	140
		ACCR	—	2	—	—	20	40
		No veg	6	—	—	—	—	—
Bidgemia	28	ACSA	—	18	—	—	113	150
		CBMS	—	4	3	—	69	140
		SALT	—	2	1	—	31	60
Channel	17	ACCR	7	6	—	—	200	260
		HASP	2	—	—	—	10	10
		No veg	2	—	—	—	—	—
Spot	11	CBMS	1	3	3	—	76	140
		HASP	3	—	—	—	15	15
		ACSA	1	—	—	—	8	8
Billy	7	SSGF	4	—	—	—	16	16
		ASGF	2	1	—	—	13	15
Divide	3	HASP	3	—	—	—	15	15
		ACCR	—	—	—	—	—	—
Yalkalya	1	BLUE	—	1	—	—	13	20
		SALT	—	—	—	—	—	—
		HASP	—	—	—	—	—	—
Winning	0.8	BLUE	—	0.8	—	—	10	16
		SOSP	—	—	—	—	—	—
		STCH	—	—	—	—	—	—
O'Brien	0.6	ASGF	—	0.6	—	—	2	3
		STCH	—	—	—	—	—	—
		ACCR	—	—	—	—	—	—
Totals	1,997		1,163	491	322	21	15,192	19,371

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 15,200

Capability sheep unit capacity 19,350

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 15,773

highest (1970) 22,963

lowest (1978-79) 11,500

Minilya station - Carnarvon Shire

Area 2,733 km²

Location

Minilya station is located on the Minilya, Winning Pool, Quobba and Kennedy Range 1:250,000 map sheets. The homestead is 5 km west of the North-West Coastal Highway near the Minilya River and about 143 km north from Carnarvon. The station has common boundaries with Warroora, Mia Mia, Wandagee, Manberry, Cooralya, and Boologooro stations and Lake McLeod.

Description

A total of 23 land systems are found on the station. The most important of these are alluvial plain systems associated with the Minilya River and Barrabiddy Creek which run from east to west through the centre of the station and then into Lake McLeod.

Three of the most extensive alluvial plain systems are Sandal (23.4% of total station area), Delta (23 per cent) and Warroora (6.5%). These systems all consist of almost flat saline and non-saline alluvial plains with varying proportions of low sandy banks and rises. They support extensive low shrublands of saltbush and bluebush and patches of tall acacia shrubland on the sandy rises. The Delta system is marginally lower than the other systems and consists of active floodplains with numerous scalds and scoured areas associated with flooding from the Minilya River. Pastoral value of each system is high.

Another alluvial plain system Barrabiddy (3.3%) flanks the Barrabiddy Creek in south-central parts of the station. It consists of active floodplains and broad drainage zones with numerous braided channels. It supports a tall shrubland of various acacias, notably snakewood and bardie bush, with numerous low shrubs and some perennial grasses. When in good condition pastoral value is very high.

The second largest land system is Giralia (23.4%) which predominates in the north-east of the station. The system consists of sandplain and large linear dunes supporting a mixture of hard and soft spinifex hummock grasslands and numerous shrubs. Pastoral value is moderate or high depending on the relative proportions of soft and hard spinifex. The Giralia system is closely associated with the Uaroo system (2.1%) which consists of almost flat sandy plains with calcrete at shallow depth supporting mostly hard spinifex.

Another sand dune system Yalbalgo (5.0%) occurs in the centre and south of the station. It is very similar in landform to Giralia but supports tall acacia shrublands rather than spinifex hummock grasslands. Pastoral value is moderate.

An important system found in the west of the station is Trealla (8.8%). It consists of elevated limestone plains and low rises and in the north-west forms the Gnargoo Range rising up to 70 m above the surrounding plains. It supports a moderately close tall shrubland of various acacias and pastoral value is high.

The Chargoo system (3.9%) occurs in the north-west of the station as almost flat, saline alluvial plains with numerous drainage foci and swampy depressions. It is regularly flooded by overflow from the Lyndon River and supports low shrublands of various saltbush and bluebush types and patches of tussock grasses. Pastoral value is very high.

In the north of the station the Target system (3.2%) lies between the alluvial plains of the Sandal system and the sand dunes of the Giralia system. Target consists of almost flat plains with numerous low sandy banks, inter-bank areas with more clayey soils and small prominent drainage foci. It supports tall acacia shrublands with numerous under-shrubs and pastoral value is high.

Another 13 land systems occur on the station. Although individually restricted in extent they collectively occupy 9.1% and are nearly all of high pastoral value.

All systems found on the station are summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Minilya station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.),	Fossil - rugged hills, ridges and plateaux of sedimentary rocks, steep benched footslopes; scattered tall acacia shrublands	< 0.1
Moderate (10-19 ha/s.u.)	Giralia - sandy plains with large linear dunes; spinifex hummock grasslands and numerous shrubs	23.0
	Yalbalgo - sandplains with linear and reticulate dunes; tall shrublands of wanyu and other acacias	5.0
	Brown - gently undulating sandplains and occasional dunes; tall shrublands of Wanyu and silver bark wattle; also buffel grass	2.1

Table 1 continued...

Pastoral value	Land systems	Area %
	Uaroo - nearly flat sandy plains and minor pebbly plains; hummock grasslands of hard and soft spinifex with numerous shrubs	2.1
	McLeod - samphire flats and sandy plains with bare marginal mudflats; low shrublands of samphire and saltbush	2.0
	Lyons - sandy alluvial plains with numerous claypans and reticulate and linear dunes; tall shrublands of wanyu, other acacias and numerous low shrubs	0.2
	O'Brien - tributary alluvial plains and slightly more elevated upper plains and interfluves; tall acacia shrublands often arranged in groves	0.1
		34.5
High (5-9 ha/s.u.)	Sandal - alluvial plains with numerous low sandy rises and banks, duplex and sandy soils; tall shrublands of acacias, currant bush and some bluebush	23.4
	Delta - almost flat, active alluvial flood plains; low shrublands of saltbush and bluebush	11.7
	Trealla - elevated limestone plains and plains with thin sand cover, minor steeper marginal slopes; moderately close tall shrublands of silver bark wattle, snakewood and other acacias	8.8
	Warroora - nearly flat, saline alluvial plains, sluggish drainage tracts and prominent drainage foci, minor limestone outcrop plains and sandy banks; low shrublands of saltbush and bluebush, some tall acacia shrublands.	6.5
	Target - plains with sandy banks, more clayey interbank areas and numerous small drainage foci; tall shrublands of acacias with numerous low shrubs	3.2
	Spot - alluvial plains and plains with sandy banks and more clayey interbank areas; tall shrublands of acacias, also bluebush and some spinifex grasslands	1.8
	Yalkalya - saline alluvial plains and low calcrete rises; mixed tall and low shrublands of acacias, bluebush and saltbush, some hard spinifex	0.9
	Gearle - gently sloping alluvial plains, minor low rises with more sloping marginal plains, tall and low shrublands of acacias, saltbush and bluebush	0.7
	River - narrow, active flood plains and major channels; tall acacia shrublands or open coolibah woodland with numerous low shrubs and buffel grass	0.5
	Donovan - gently sloping outwash plains and minor stony plains; tall shrublands of snakewood and other acacias, also bluebush and buffel grass	0.3
	Wash - sandy alluvial plains and broad drainage zones receiving more concentrated sheet flow; tall acacia shrublands	0.3
	Marloo - gilgai alluvial plains with clay soils; tussock gassslands	0.1
	Cardabia - undulating sandy plains with linear dunes and minor limestone ridges and outcrop plains; low shrublands and hummock grasslands of soft and hard spinifex	0.1
		58.3
Very high (< 5 ha/s.u.)	Chargoo - nearly flat, saline alluvial plains with numerous drainage foci and swampy depressions; low shrublands of saltbush and bluebush, also tussock grasses	3.9
	Barrabiddy - active flood plains and broad drainage zones with numerous channels; tall shrublands of numerous acacias with saltbush and buffel grass	3.3
		7.2
		100.0

Table 2. Condition statements derived from traverse records (393 recordings on 17 land systems)

Minilya

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Barrabiddy	10	60	20	20	—	—	20	30	50	—	20	30	50
Brown	4	100	—	—	—	—	25	25	50	—	25	25	50
Chargoo	22	81	14	5	—	5	41	40	14	—	45	41	14
Delta	116	47	28	16	9	3	28	27	26	16	31	27	42
Gearle	1	100	—	—	—	—	100	—	—	—	100	—	—
Giralia	31	100	—	—	—	84	13	3	—	—	97	3	—
Lyons	5	100	—	—	—	20	20	20	40	—	40	20	40
MacLeod	1	100	—	—	—	—	100	—	—	—	100	—	—
River	2	100	—	—	—	—	100	—	—	—	100	—	—
Sandal	105	85	15	—	—	16	31	44	9	—	47	44	9
Spot	1	100	—	—	—	—	—	100	—	—	—	100	—
Target	21	100	—	—	—	19	48	33	—	—	67	33	—
Trealla	24	92	4	—	4	8	55	29	4	4	63	29	8
Uaroo	10	100	—	—	—	80	20	—	—	—	100	—	—
Wandagee	3	100	—	—	—	100	—	—	—	—	100	—	—
Warroora	27	100	—	—	—	15	70	15	—	—	85	15	—
Yalbalgo	10	100	—	—	—	50	30	20	—	—	80	20	—
Total over all land systems	393	78	14	5	3	19	34	29	13	5	53	29	18

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 26 sites on 7 land systems.

Range condition and recommendations

1. Sandal land system (23.4%)

This productive system supports Currant Bush Mixed Shrub (CBMS) pastures and some Bluebush (BLUE) on the broad plains with duplex soils and Acacia Sandplain (ACSA) pastures on the sandy rises. The currant bush mixed shrub pastures are somewhat degraded with the majority in fair condition and the balance in poor condition. The other pastures are mostly in fair condition although substantial parts are also in good or very good condition. Buffel grass is well established on the more sandy parts of the system especially near the Minilya River and Barrabiddy Creek in such paddocks as Geeberri and Minnaberri.

There is occasional minor erosion on duplex soil sites, but this is not a significant problem and most parts of the system can be grazed on a year long basis. Degraded section will respond well to spelling over a number of consecutive growing seasons and conservative stocking at other times.

2. Giralia land system (23%)

Hard Spinifex (HASP) and Soft Spinifex (SOSP) pastures on this system are nearly all in very good condition. There is no erosion. At the time of survey much of the system was not being used for grazing as a number of stock water points were not in use.

Old, mature spinifex stands are of little use for grazing but young stands provide useful grazing. Spinifex communities should be burnt on a fairly regular basis about every four or five years. In order to encourage establishment of durable grasses, shrubs and spinifex seedlings the burnt areas should not be grazed for 8-10 weeks over the grazing season following the fire.

Spinifex based land systems are generally resistant to degradation although some minor wind erosion may result if a prolonged dry spell occurs after burning. However, there is a rapid re-establishment of vegetation and return to stability after rain.

There is a need to bring the Giralia system in the north-eastern part of the station into production so that grazing pressure on degraded parts of the station can be reduced. The unused north-eastern part of the station also includes some fairly extensive areas of the high pastoral value systems Yalkalya and Spot as well as Giralia.

3. Delta land system

This complex system supports Bluebush (BLUE) and Saltbush (SALT) pastures of various types on the broad flood plains and drainage tracts with minor areas of Acacia Sandplain (ACSA) on sandy rises.

Although parts of the system are still highly productive in terms of perennial shrubs and annuals in season the general condition of the bluebush and saltbush pastures is degraded to fair, poor or very poor condition. The acacia sandplain pastures which often contain dense stands of introduced buffel grass are in good condition.

Minor to severe erosion in the form of surface scalding, wind piling, rilling and scouring is widespread on the flood plain. Over the whole land system 42%, 27% and 31% of the traverse recordings indicated bad, fair and good range condition respectively.

More than 36 km^2 of the system (11%) is severely degraded with almost complete loss of vegetative cover and severe erosion. These areas are mostly in Shed, Nalyatharra and Booladan paddocks. These paddocks or parts of them should be closed to grazing until recovery is effected. Strip cultivation and seeding with buffel grass and native shrub species should be considered as a means of hastening recovery.

4. Trealla land system (8.8%)

This system supports moderately close Acacia Mixed Shrub (ACMS) pastures with numerous desirable low shrubs such as Wilcox bush, currant bush, ruby saltbush and flat leaf bluebush beneath the taller acacia shrubs. There are also smaller areas of Gascoyne bluebush associated with snakewood.

Condition of the pastures in predominantly good and generally there is no erosion on the system. An exception to this is north and west of Neemarabada bore where there are patches of severe active gully erosion.

Most of the system is stable and can be grazed year long provided stocking rates are conservative. However, a minor unit of the system, namely steeper slopes marginal to extensive more gently sloping plains and supporting Gascoyne bluebush, is more sensitive to degradation and erosion and needs to be carefully monitored.

5. Warroora land system (6.5%)

This saline plain system supports productive Saltbush (SALT) and Bluebush (BLUE) pastures with minor areas of Samphire (SAMP). Pasture condition is nearly all good or very good and there is no erosion. The pastures cannot be fully used by livestock due to high dietary salt intake from the vegetation and poor quality (salty) water supplies or lack of water supplies.

6. Yalbalgo land system (5%)

The Acacia Sandplain (ACSA) pastures of this system are nearly all in good or very good condition and there is no erosion. The system is stable under grazing and provides useful feed in the form of wandarrie grasses, forbs and some useful shrubs in season. Wanyu beans (seeds) also provide feed after favourable seasons but, in general, the durability of pastures for drought times is only moderate or low.

7. Chargoo land system (3.9%)

This system supports a complex mosaic of saline and none-saline pastures notably various types of saltbush and bluebush and Tussock Grasses (TUGR). Small depressions and larger drainage foci and swamps support dense stands of vegetation including perennial tussock grasses, low shrubs such as spiny bluebush and swamp bluebush and tall shrubs such as curara and mimosa bush. Slightly more elevated margins and alluvial plains support sparser growth.

Pasture condition is mostly fair or good although restricted areas are degraded to poor condition and have minor wind and water erosion.

8. Barrabiddy land system (3.3%)

This alluvial system is subject to regular flooding as sheet flow and channelled flow from Barrabiddy Creek. It supports a mixture of pastures such as Acacia Creek-line (ACCR), Saltbush (SALT) and Tussock Grasses (TUGR). Pasture condition varies from good to poor, but is predominantly poor. As a result of flooding there is frequent redistribution of soil material over the flood plains and, where vegetation is depleted, accelerated erosion as scouring, rilling, sheeting and hummocking is common. Degraded parts of the system occur in Barrabiddy paddock and, to a lesser extent, in Minnaberri paddock both of which would benefit from occasional spelling. Buffel grass is well established on sandy parts of the system and its further spread should be encouraged.

9. Target land system (3.2%)

The system supports useful Currant Bush Mixed Shrub (CBMS), Acacia Creek-line (ACCR) and Acacia Sandplain (ACSA) pastures. The current bush mixed shrub pastures are preferentially grazed and are in fair or good condition; the other pastures are in good or very good condition. There is no erosion and over all range condition is mostly good.

10. An additional eight minor land systems were traversed on the station. Some were not sampled in detail but, in general, range condition was fair or good. There were no severe limitations to pastoral use or special management programmes required on these systems.

11. The station is well developed in terms of paddocks. Much of it is well supplied with stock waters (often by long pipelines from reliable good quality supplies near the Minilya River). An exception is the north-eastern part of the station (see 2) which is very poorly watered and mostly not in use. This area needs to be brought into production in order to relieve grazing pressure elsewhere.

Because of the many paddocks a system of strategic pasture spelling and regeneration work could be readily implemented in those paddocks that are in poor range condition. Paddocks requiring priority treatment are Shed, Nalyatharra and Booladan (see 3).

12. The recommended sheep unit capacity for present condition assuming the whole station is adequately watered (which is not the case, see 11) is 31,050.

13. The capability sheep unit capacity if all country was in good range condition is estimated at 40,700.

Individual station report

Minilya station - 273,313 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandal	638	CBMS	—	212	75	—	3,119	5,740
		ACSA	166	77	12	—	1,913	2,125
		BLUE	22	74	—	—	1,365	1,920
Giralia	629	HASP	366	11	—	—	1,867	1,885
		SOSP	244	8	—	—	4,133	4,200
Delta	318	BLUE	19	44	62	18	1,318	2,860
		SALT	17	39	53	18	1,159	2,540
		ACSA	38	10	—	—	379	400
Trealla	241	ACMS	127	75	25	2	3,446	4,580
		BLUE	9	3	—	—	218	240
Warroora	178	BLUE	65	15	—	—	1,488	1,600
		SALT	58	13	—	—	1,323	1,420
		SAMP	27	—	—	—	108	108
Yalbalgo	136	ACSA	109	27	—	—	1,077	1,133
Chargoo	108	SALT	19	30	11	—	824	1,200
		TUGR	17	5	—	—	983	1,067
		BLUE	13	3	—	—	298	320
Barrabiddy	89	SALT	—	24	38	—	538	1,240
		TUGR	27	—	—	—	900	900
Target	86	CBMS	16	23	—	—	608	780
		ACSA	30	4	—	—	275	283
		ACCR	13	—	—	—	260	260
Brown	59	ACSA	13	13	27	—	298	442
		SALT	2	1	3	—	71	120
Uaroo	56	HASP	39	—	—	—	195	195
		SOSP	17	—	—	—	283	283
McLeod	55	SAMP	28	—	—	—	112	112
		SALT	11	—	—	—	220	220
		No veg	16	—	—	—	—	—
Spot	49	CBMS	—	29	—	—	363	580
		HASP	15	—	—	—	75	75
		ACSA	—	5	—	—	31	42
Yalkalya	25	BLUE	11	—	—	—	220	220
		SALT	11	—	—	—	220	220
		HASP	3	—	—	—	15	15
Gearle	20	BLUE	12	—	—	—	240	240
		SALT	6	—	—	—	120	120
		TUGR	2	—	—	—	100	100
River	15	ACCR	8	—	—	—	160	160
		TUGR	5	—	—	—	250	250
		No veg	2	—	—	—	—	—
Donovan	9	BLUE	5	—	—	—	100	100
		ACMS	3	—	—	—	60	60
		SOSP	1	—	—	—	17	17
Wash	7	ASGF	4	—	—	—	20	20
		ACCR	2	—	—	—	40	40
		TUGR	1	—	—	—	33	33
Lyons	6	ACSA	1	1	1	—	19	25
		CBMS	—	2	—	—	25	40
		No veg	1	—	—	—	—	—
Marloo	3	TUGR	3	—	—	—	100	100
O'Brien	3	ASGF	1	—	—	—	5	5
		STCH	1	—	—	—	8	8
		ACCR	1	—	—	—	20	20
Cardabia	2	SOSP	2	—	—	—	33	33
Fossil	1	ASGF	1	—	—	—	5	5
Totals	2733		1640	748	307	38	31,057	40,701

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 31,050

Capability sheep unit capacity 40,700

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1974):

average (mean) 35,836

highest (1977) 48,000

lowest (1980) 25,875

Mooka station - Carnarvon Shire

Area 458 km²

Location

Mooka station is located on the Kennedy Range 1:250,000 map sheet. The homestead is situated 5 km north of the Carnarvon-Gascoyne Junction road and is about 144 km east of Carnarvon. The station has common boundaries with Mardathuna, Doorawarrah, Jimba Jimba, and Bidgemia stations and with the Kennedy Range National Park.

Description

Eleven land systems are found on the station. By far the largest is Yalbalgo (60.2% of the total area) which occurs in western central and southern parts of the station. It consists of large linear and reticulate sand dunes up to 12 m high and sandy swales. The system supports tall shrublands of various acacias with occasional patches of eucalypts in both tree and mallee forms. Numerous low shrubs and patchy spinifex make up the understorey. Pastoral value is low or moderate.

The northern part of the station comprises mainly of three land systems namely Billy (13.7%), Windalia (8.3%) and Cahill (10.1%). The Cahill system also occurs along the eastern boundary of the station at the foot of the Kennedy Ranges. The Billy system consists of low plateaux, mesas and buttes with stony footslopes and narrow drainage floors. It supports sparse tall shrublands of mulga and other acacias and pastoral value is low.

The Windalia system lies below Billy and consists of stony plains and narrow, dissected upper interfluves on radiolarite. It supports sparse tall shrublands of mulga and other acacias on the plains with more dense and productive tall shrublands along narrow drainage floors and flow lines. Pastoral value is moderate.

The Cahill system consists of sandy outwash plains and sandy channels. It supports moderately close tall shrublands of silver bark wattle, wanyu and other acacias with numerous low shrubs and various grasses. Pastoral value is high.

Seven other minor systems occur on the station.

All systems are briefly described and their pastoral value for good range condition status indicated in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Mooka station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Moogooloo - deeply dissected plateaux, mesas and hills of sedimentary rocks, steep footslopes and narrow valleys; scattered tall shrublands of mulga and other acacias	3.6
Low (20-30 ha/s.u.)	Billy - low plateaux, mesas and buttes with stony footslopes and narrow drainage floors; scattered tall and low shrublands of mulga and other acacias.	13.7
	Kennedy - elevated sandy plains with large linear and reticulate dunes; hummock grasslands of hard spinifex and numerous shrubs	0.4
		14.1
Moderate (10-19 ha/s.u.)	Yalbalgo - sandplains with linear and reticulate dunes; tall shrublands of wanyu and other acacias, occasional eucalypts and some spinifex	60.2
	Windalia - stony plains and narrow dissected upper interfluves on radiolarite; tall shrublands of mulga and other acacias.	8.3
	Channel - major channels with dissected marginal slopes and narrow flood plains; tall acacia shrublands	2.0
		70.5
High (5-9 ha/s.u.)	Cahill - sandy outwash plains with sandy channels; tall shrublands of silver bark wattle and other acacias	10.1
	O'Brien - tributary alluvial plains and slightly more elevated upper plains and interfluves; tall shrublands of acacias	0.9
	Target - plains with sandy banks, more clayey interbank areas and numerous small drainage foci; tall shrublands of acacias with numerous low shrubs	0.5
	Ella - linear dunes and sandy banks, inter-dunal plains with more clayey soils and drainage foci; tall shrublands of acacias with numerous low shrubs	0.2
	Mary - gently sloping plains with calcrete at shallow depth; tall shrublands of acacias and cassias.	0.1
		11.8
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (131 recordings on 10 land systems).

Mooka

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Billy	12	100	—	—	—	—	67	33	—	—	67	33	—
Cahill	29	97	3	—	—	17	28	48	7	—	45	48	7
Ella	6	83	17	—	—	—	—	—	100	—	—	—	100
Moogoolo	13	100	—	—	—	8	46	46	—	—	54	46	—
Mary	1	100	—	—	—	100	—	—	—	—	100	—	—
O'Brien	5	100	—	—	—	80	20	—	—	—	100	—	—
River	2	50	50	—	—	—	—	50	50	—	—	50	50
Target	1	100	—	—	—	—	—	100	—	—	—	100	—
Windalia	15	100	—	—	—	13	60	7	20	—	73	7	20
Yalbalgo	47	98	2	—	—	34	40	15	11	—	74	15	11
Total over all land systems	131	97	3	—	—	22	39	26	13	—	61	26	13

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 8 sites on 5 land systems.

Range condition and recommendations

1. Yalbalgo land system (60.2%)

The dunes and sandy swales of the system support Acacia Sandplain pastures and Hard Spinifex pastures (ACSA, HASP) which are mostly in good or very good condition. Restricted areas close to watering points show depletion of palatable species to fair or poor condition.

The system is stable under grazing and provides useful feed in the form of wanderrie grasses and forbs in season and some palatable shrubs. However, many of the shrubs and the hard spinifex are of little use for grazing and the pastures supply only low or moderate reserves for drought periods.

Burning should be used on the spinifex communities as a management tool for keeping the pastures in as attractive condition as possible for livestock. Burning can probably be carried out every five or six years and, in order to encourage the establishment of palatable grasses, herbs and young shrubs, burnt areas should not be grazed for 8-10 weeks over the growing season following the fire

At least 50% of the system is not grazed as there are no permanent stock waters.

2. Billy land system (13.7%)

The sparse Stony Short Grass Forb and Acacia Short Grass Forb pastures (SSGF, ASGF) of this system are mostly in good condition. Because of its stony nature the system is inherently resistant to erosion.

3. Cahill land system (10.1%)

The Acacia Sandplain pastures (ACSA) of this flood out system support a reasonable range of desirable low shrubs and scattered perennial grasses. Pasture condition is predominantly fair although substantial numbers of the traverse records (45%) also indicated good or very good condition. Flooding causes re-distribution of sand within the system and surfaces are often uneven and moundy but no accelerated erosion was observed.

4. Windalia land system (8.3%)

The system supports Acacia Short Grass Forb pastures (ASGF) on stony interfluves and slopes wih somewhat denser Acacia Creek-line pastures (ACCR) along narrow creek-lines and in small patches or groves on the stony interfluves. Most of the pastures are in good condition except for those close to the old Binthalya shearing shed which are in poor condition. There is no erosion.

5. All the remaining systems on the station, with the exception of Ella, are in good range condition. The Ella system is restricted to a small piece of country immediately north of the homestead. Between No. 1 and No. 2 Bores the pastures are degraded to poor condition.

6. The southern and south-eastern parts of the station are reasonably well developed with paddocks and water points. However, all of the western part of the station (Yalbalgo land system, see 1) is undeveloped and not used. The feasibility of development should be considered.

In the north the station has recently acquired additional country from the old Binthalya station lease. A number of old watering points and paddocks in this area could be upgraded and brought into use fairly readily and this should be undertaken.

7. The recommended sheep unit capacity for present condition assuming that the whole station is adequately watered (which is not the case, see 6) is 4,700.

8. The capability sheep unit capacity if all country was in good range condition is estimated at 5,450.

Individual station report

Mooka station - 80,931 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Yalbalgo	487	HASP	216	44	32	—	1,307	1,460
		ACSA	144	29	22	—	1,469	1,625
Billy	111	SSGF	45	22	—	—	253	268
		ASGF	29	15	—	—	195	220
Cahill	82	ACSA	33	36	5	—	520	617
		TUGR	4	4	—	—	200	267
Windalia	67	ASGF	48	—	6	—	255	270
		ACCR	—	7	—	—	70	140
		STCH	4	—	2	—	40	50
Moogooloo	29	ASGF	16	13	—	—	123	145
Channel	16	STCH	2	3	2	—	38	58
		ACCR	—	7	—	—	70	140
		No veg	2	—	—	—	—	—
O'Brien	8	ASGF	4	—	—	—	20	20
		STCH	2	—	—	—	17	17
		ACCR	2	—	—	—	40	40
Target	4	CBMS*	1	1	—	—	33	40
		ACSA	2	—	—	—	17	17
Kennedy	3	HASP	3	—	—	—	15	15
Ella	1	ACSA	1	—	—	—	8	8
Mary	1	ACMS	1	—	—	—	20	20
Totals	809		559	181	69	—	4,710	5,437

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 4,700

Capability sheep unit capacity 5,450

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 3,258

highest (1980) 4,666

lowest (1969) 545

Nanga station - Shark Bay Shire

Area 1,750 km²

Location

Nanga station is located on the Yaringa and Edel 1:250,000 map sheets. The homestead is situated about 84 km west from North-West Coastal Highway along the access road between the highway and Denham township. The station has common boundaries with Hamelin, Coburn, Tamala and Peron stations and the Cooloomia Nature Reserve. The station also has an extensive shoreline boundary to Hamelin Pool and Freycinet Estuary.

Description

Nearly all of the station consists of gently undulating or hummocky red or yellow sandplains of the Nanga, Sandplain, Nerren and Peron land systems. The Nanga system is by far the largest occupying about 76% of the total station area and occurring throughout southern and central parts. It supports a complex vegetation of tree heath and scrub heath and pastoral value is very low.

The other three sandplain systems Sandplain (14.9%), Nerren (3.5%) and Peron (0.8%) occur in the north of the station. The Sandplain system supports a close tall shrubland of wanyu and other acacias, the Nerren system supports similar vegetation, but with scattered eucalypts and the Peron system supports mixed low and tall shrubland usually dominated by *Acacia ligulata*. Pastoral value of the Sandplain and Peron systems is high and the Nerren system is of moderate value.

The Birrida system (1.9%) occurs mainly in the north of the station as a series of small inclusions within the Sandplain system. It consists of highly saline and gypsiferous pans and depressions supporting low shrubland of samphire, saltbush and other halopytic plants. Pastoral value is moderate.

The Coquina system (1.3%) occupies the north-eastern edge of the station flanking Hamelin Pool. It consists of low shelly foredunes with scattered tall and low shrubs, occasional samphire flats and shell beaches and supra-tidal flats without vegetation. Pastoral value of the vegetated units of the system is moderate.

Three other minor land systems occur on the station. All systems are briefly described and their pastoral value for good range condition status indicated in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Nanga station

Pastoral value	Land systems	Area %
Very low (> 30ha/s.u.)	Nanga - undulating sandplains and occasional dunes; tree heath and scrub heath	75.7
	Zuytdorp - elevated undulating limestone plains with thin sand cover, sandy coastal slopes and sea cliffs; heath and scrub heath.	1.3
		77.0
Low (20-30ha/s.u.)	—	—
Moderate (10-19ha/s.u.)	Nerren - nearly flat to gently undulating red sandplains; tall wanyu shrublands with scattered trees, mainly eucalypts.	3.5
	Birrida - highly saline and gypsiferous pans and depressions; low shrublands of samphire and saltbush.	1.9
	Coquina - low shelly foredunes, shell beaches and supra-tidal flats; vegetated parts support tall and low shrublands.	1.3
	McLeod - samphire flats and sandy plains with bare marginal mudflats; low shrublands of samphire and saltbush	0.2
		6.9
High (5-9ha/s.u.)	Sandplain - nearly flat to gently undulating red sandplains; tall wanyu shrublands	14.9
	Peron - undulating plains of calcareous sands; tall and low shrublands of *Acacia ligulata*	0.8
	Edel - undulating sandy plains with minor low dunes, limestone rises and saline flats; mixed shrublands of acacias and saltbush, also heath	0.4
		16.1
Very high (<5 ha/s.u.)	—	—
		100.0

Table 2 Condition statements derived from traverse records (206 recordings on 9 land systems)

Nanga

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Birrida	14	100	—	—	—	36	50	14	—	—	86	14	—
Coquina	4	100	—	—	—	—	50	50	—	—	50	50	—
Edel	4	50	50	—	—	—	—	—	100	—	—	—	100
MacLeod	1	100	—	—	—	100	—	—	—	—	100	—	—
Nanga	100	100	—	—	—	85	13	2	—	—	98	2	—
Nerren	22	100	—	—	—	—	59	41	—	—	59	41	—
Peron	14	93	7	—	—	—	14	58	21	7	14	57	29
Sandplain	38	100	—	—	—	5	32	42	21	—	37	42	21
Zuytdorp	9	100	—	—	—	100	—	—	—	—	100	—	—
Total over all land systems	206	99	1	—	—	50	24	19	7	—	73	19	8

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 14 sites on 7 land systems.

Range condition and recommendations

1. Nanga land system (75.7%)

This extensive system of hummocky sand plain supports Heath pastures (HEAT) in the form of tree heath and scrub heath. Condition of the vegetation is good or very good, but the potential for pastoral use is very low and it is doubtful if the system can be developed economically. Most of the system is not being grazed as there are no stock waters.

2. Sandplain land system (14.9%)

The Acacia Sandplain (ACSA) pastures of the system support scattered desirable low shrubs such as cotton bush, tall saltbush, currant bush and *Chenopodium gaudichaudianum* below the taller wanyu and silver bark wattle. There are also sparse wanderrie grasses and forbs in season.

Pasture condition is mostly fair but varies from good to poor depending largely on the distance from water. There is no erosion and the system is stable under grazing.

Controlled burning may be a useful management tool on this system, but its use has not been researched. Evidence seen elsewhere on this system suggests that the effects of fire are very long term. Where the overstorey of tall shrubs has been killed by fire the low shrub layer and the ground layer is increased in diversity of species and in density. This fire-induced sub-climax appears to be more useful for livestock production than is the climax situation of dense tall shrubland of wanyu.

3. Nerren land system (3.5%)

The system supports the Acacia and Eucalyptus Short Grass Forb (AEGF) pasture type which is similar to the Acacia Sandplain pasture of the Sandplain system. Useful low shrubs are scattered or clumped beneath the larger trees and there are sparse grasses and forbs in season. Pasture condition is good or fair and there is no erosion.

4. Birrida land system (1.9%)

The Samphire (SAMP) and Saltbush (SALT) pastures of the system are mostly in good or very good condition. The samphire pastures are probably too saline to be of much use for sheep.

5. Zuytdorp land system (1.3%)

The small section of this system in the far south-west of the station supports Heath pastures (HEAT) in very good condition. The system is of very low inherent productivity for grazing and is unsuitable for pastoral development.

6. Peron and Edel land systems (0.8% and 0.4% respectively)

These systems occur near the homestead and appear to have received heavy use in the past. Condition of the Acacia Sandplain (ACSA) and Heath (HEAT) pastures is variable but mostly poor with death of many low shrubs. There is some minor wind erosion as hummocking and piling around plants. The small paddock immediately to the north-west of the homestead up to the boundary with Peron station needs to be spelled.

7. The station is very poorly developed in terms of stock waters and paddocks. Development is confined to the north on about one-quarter of the total station area. Because of its inherently very poor pastures it is doubtful if the very large Nanga land system can be developed economically. Basically the system is not suitable for pastoral use.

8. The recommended sheep unit capacity for present condition and assuming the station is fully developed (which is not the case, see 7) is 7,700.

9. The capability sheep unit capacity if all country was in good range condition is estimated at 8,850.

Individual Station Report

Nanga Station - 175,066 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Nanga	1,326	HEAT	1,299	27	—	—	4,398	4,420
Sandplain	261	ACSA	97	110	54	—	2,346	3,263
Nerren	61	AEGF	36	25	—	—	396	436
Birrida	33	SAMP	24	4	—	—	109	112
		SALT	4	1	—	—	93	100
Coquina	23	CDSH	7	6	—	—	130	163
		No veg	10	—	—	—	—	—
Zuytdorp	22	HEAT	22	—	—	—	73	73
Peron	14	ACSA	2	8	1	—	96	138
		HEAT	—	2	—	—	5	7
		HASP	—	1	—	—	3	5
Edel	8	CDSH	—	—	4	—	16	50
		SALT	—	—	3	—	19	60
		HEAT	—	—	1	—	2	3
McLeod	3	SAMP	2	—	—	—	8	8
		No veg	1	—	—	—	—	—
		SALT	—	—	—	—	—	—
Totals	1,751		1,504	184	63	—	7,694	8,838

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 7,700

Capability sheep unit capacity 8,850

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1969, 1979-80):

average (mean) 4,443

highest (1970) 6,370

lowest (1983) 1,920

Nerren Nerren Station - Shark Bay and Northampton Shires

Area 1,775 km²

Location

Nerren Nerren station is located on the Ajana and Yaringa 1:250,000 map sheets. The homestead is on the North-West Coastal Highway about 148 km north of Northampton. The station has common boundaries with Coburn, Meadow, and Murchison House stations, the Cooloomia Nature Reserve and vacant crown land.

Description

Only four land systems occur on the station and three of these are sandplain types.

The Nanga system (38.4% of total station area) occurs in the west and central parts. It consists of gently undulating red to yellow sandplain with confused sand ridges and hummocks up to 6m high. It supports a scrubby heath vegetation and pastoral value is very low.

The Nerren system is found in the south-east and north-east of the station and consists of gently sloping red sandplains. It supports a moderately close tall shrubland dominated by wanyu with frequent patches of emergent trees of various eucalypts. Pastoral value is moderate.

The Cooloomia system (25.6%) occurs in the central west as a broad strip of country running from north to south for the full length of the station. It consists of undulating red sandplain and minor limestone plains. It supports tall shrublands with patchy eucalypts interspersed with more open areas and scrubby heath. Pastoral value is moderate.

The York system (3.4%) occurs in the centre and east of the station as nearly flat alluvial plains and unchannelled drainage zones sometimes with calcareous gradational or weakly gilgaied clay soils. It supports woodlands dominated by York gum and tall shrublands of curara, wanyu and other acacias. Pastoral value is high.

All land systems on the station are further described and their pastoral value for good range condition status indicated in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Nerren Nerren station

Pastoral value	Land systems	Area %
Very low (> 30ha/s.u.)	Nanga - undulating sand plains with confused sand ridges; scrub heath	38.4
Low (21-30ha/s.u.)	—	—
Moderate (10-20ha/s.u.)	Nerren - nearly flat to gently undulating red sandplains; wanyu shrublands with scattered trees of various eucalypts	32.6
	Cooloomia - undulating sandplains and minor limestone outcrop plains; tall and low shrublands with mallee form eucalypts, also scrubby heath	25.6
		58.2
High (5-9ha/s.u.)	York - nearly flat low lying alluvial plains sometimes with weakly gilgaied clay soils; eucalypt woodlands and tall acacia shrublands	3.4
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (248 recordings on 5 land systems)

Nerren Nerren

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Cooloomia	41	100	—	—	—	7	49	37	5	2	56	37	7
Nanga	84	100	—	—	—	73	21	5	1	—	94	5	1
Nerren	109	100	—	—	—	9	34	30	25	2	43	30	27
Tarcumba	2	100	—	—	—	—	50	50	—	—	50	50	—
York	12	100	—	—	—	—	17	58	25	—	17	58	25
Total over all land systems	248	100	—	—	—	30	32	24	13	1	61	24	15

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 13 sites on 4 land systems.

Range condition and recommendations

1. Nanga land system (38.4%)

The Heath (HEAT) pastures of this system are almost all in very good or good condition and there is no erosion present. Pastures are of very low grazing value and it is unlikely that the system can be developed economically.

2. Nerren land system (32.6%)

Condition of the Acacia Eucalypt Short Grass Forb (AEGF) pastures is variable, but mostly fair or good although some restricted areas close to watering points have lost most desirable low shrubs and are degraded to poor condition.

When unburnt for many years the system supports a moderately dense tall shrubland dominated by wanyu and needle myall with numerous tree eucalypts. When in good condition desirable low shrubs such as cotton bush, tall saltbush and ruby saltbush are found scattered sparsely or clumped beneath the larger trees and tall shrubs. The system also supports sparse wanderrie grasses and forbs in season. It provides useful grazing, but pastures have only limited durability in dry times.

Controlled burning may be a useful management tool on the system but its use has not been researched. The effects of fire appear to be long term. Where the over-storey of tall shrubs has been killed by burning the low shrub layer and the ground layer is increased in diversity of species and in density. The fire-induced sub-climax vegetation appears to be more useful for livestock production than is the climax situation of dense tall shrubs and eucalypt trees.

3. Cooloomia land system (25.6%)

This system supports Acacia Eucalypt Short Grass Forb (AEGF) pastures and some Heath (HEAT) on the undulating sandy plains and useful Acacia Mixed Shrub (ACMS) pastures on restricted limestone plains or plains with thin sand cover over limestone. Pasture condition is predominantly good although some substantial areas are in fair condition. Much of the system, especially in the north-west of the station, is not fully used for grazing because of the lack of stock water supplies.

4. York land system (3.4%)

This system supports Saltbush (SALT) and Acacia Mixed Shrub (ACMS) pastures and is a preferred grazing area. Pastures are still moderately productive, but loss of desirable saltbush has occurred in parts. Some 25%, 58% and 17% of traverse records indicated poor, fair and good pasture condition respectively. The system has the potential to improve in condition if spelled over a number of consecutive growing seasons and conservatively stocked at other times.

5. The eastern half of the station is well devloped in terms of paddocks, laneways and water points. The central western part is also developed with a number of large paddocks and water points. Other parts, notably in the far north-west and in the south-west, cannot be used for grazing because of the lack of permanent stock waters. The Cooloomia land system in the north-west of the stationin the vicinity of the old Cooloomia homestead is in good condition and the provision of additional watering points to bring this country into production should be considered.

6. The recommended sheep unit capacity for present condition and assuming that the whole station was developed (which is not the case, see 5) is 9,650.

7. The capability sheep unit capacity if all country was in good range condition is estimated at 11,400.

Individual station report

Nerren Nerren station - 177,541 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Nanga	681	HEAT	576	31	6	—	2,010	2,043
		HASP	64	3	1	—	333	340
Nerren	579	AEGF	249	174	156	—	3,369	4,136
Cooloomia	454	AEGF	171	160	32	—	2,238	2,593
		ACMS	38	8	—	—	840	920
		HEAT	45	—	—	—	150	150
York	61	SALT	8	29	12	—	598	980
		ACMS	2	7	3	—	129	240
Totals	1,775		1,153	412	210	—	9,667	11,402

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 9,650

Capability sheep unit capacity 11,400

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 5,374

highest (1972) 8,093

lowest (1984) 3,773

Ningaloo station - Carnarvon and Exmouth Shires

Area 497 km²

Location

Ningaloo station is located on the Ningaloo-Yanrey 1:250,000 map sheet. The homestead is situated about 32 km west of the Carnarvon-Exmouth road by access road which leaves the main road at a point about 95 km south of Exmouth. The station has common boundaries with Bullara and Cardabia stations and to Location 97 in the north. In the west it has a long coastline to the Indian Ocean.

Description

Five land systems occur on the station. The largest of these is Cardabia which occupies about 80% of the total station area. It consists of gently to strongly undulating sandy plains with linear dunes and occasional limestone rises and minor limestone plains. Vegetation is a hummock grassland of soft and hard spinifex with numerous patchy low shrubs including *Banksia ashbyi*. Buffel grass has colonized considerable areas and forms dense stands in some parts. Pastoral value is high where the vegetation is dominated by soft spinifex and buffel grass.

The Coast system (11.4%) extends as a narrow strip along the western edge of the station flanking the Indian Ocean. It consists of large, long walled parabolic dunes and narrow swales, unstable blow-out areas and coastal fore-dunes and beaches. It supports moderately dense shrublands with coastal jam, minga bush, numerous low shrubs and grasses including introduced buffel grass. Pastoral value is high.

The Learmonth system (6.8%) occurs in the north-west as a strip between the Coast system to the west and the low limestone hills of the Range system to the east. It consists of sandy outwash plains with some stony limestone plains. Vegetation is a patchy shrubland of *Acacia ligulata*, *A.bivenosa* and numerous other shrubs, hard and soft spinifex and some buffel grass. Pastoral value is generally high.

The Range system (4.3%) of rough limestone ranges runs north to south as a narrow strip of country through the north-west of the station. Relief is generally 60-100 m but occasionally up to 150 m. Vegetation is very sparse shrubs and hard spinifex and there is much bare rock. Pastoral value is very low.

A small area of the McLeod land system (0.5%) occurs just north-west of the homestead. It consists of saline clay flats and marginal sandy plains. Vegetation is samphire, some saltbush, salt water couch and soft spinifex. Pastoral value is moderate.

All systems on the station are further summarized in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Ningaloo Station.

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Range - rough limestone ridges and hills with steep stony footslopes; scattered shrubs and hard spinifex	4.3
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	McLeod - saline clay flats with narrow marginal sandy plains; low shrublands of samphire and saltbush, also salt water couch	0.5
High (5-9 ha/s.u.)	Cardabia - gently to strongly undulating sandy plains with linear dunes and minor limestone rises and outcrop plains; hummock grasslands of soft and hard spinifex with numerous shrubs, also buffel grass	76.9
	Coast - large, long walled parabolic dunes and narrow swales, unstable blow out areas, coastal fore dunes and beach; shrublands with coastal jam, numerous low shrubs and grasses including buffel grass	11.5
	Learmonth - sandy outwash plains and limestone outcrop plains; shrublands of acacias and numerous other shrubs with hard spinifex, and some buffel grass	6.8
		95.2
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (83 recordings on 5 land systems)

Ningaloo

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Cardabia	51	100	—	—	—	47	31	22	—	—	78	22	—
Coast	2	100	—	—	—	50	50	—	—	—	100	—	—
Learmonth	23	100	—	—	—	9	60	22	9	—	69	22	9
MacLeod	6	100	—	—	—	17	83	—	—	—	100	—	—
Range	1	100	—	—	—	—	—	100	—	—	—	100	—
Total over all land systems	83	100	—	—	—	34	44	20	2	—	78	20	2

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 5 sites on 3 land systems.

Range condition and recommendations

1. Cardabia land system (76.9%)

Pastures are Soft Spinifex and Hard Spinifex (SOSP, HASP) with some significant areas of introduced buffel grass. Pasture condition is predominantly good or very good and there is no erosion. Pasture condition in some heavily used paddocks near the homestead is reduced somewhat to fair condition this being indicated by an apparent increase in the proportion of hard spinifex to soft spinifex in the stand and an increase in the undesirable shrub coastal daisy bush.

Old, mature stands of spinifex are of little use for grazing and fairly regular controlled burning is required in order to maintain the pastures in an attractive condition for stock. To encourage establishment of grasses, shrubs and spinifex seedlings burnt areas should not be grazed for about 8-10 weeks over the growing season following the fire.

Much of the Cardabia system in the south is little grazed or not grazed as there are no permanent stock water supplies. Pastures are soft spinifex and buffel grass in very good condition. New attempts to provide good quality stock water points are required in order to bring the area into production.

2. Coast land system (11.5%)

The system is inherently highly susceptible to wind erosion if the vegetation is depleted or lost as a result of any disturbance. About 16 km^2 of the system (28%) consists of beach blowouts and large mobile dunes devoid of vegetation. Elsewhere, the system supports Coastal Dune Shrub pastures (CDSH) which contain palatable low shrubs such as *Rhagodia* species and ragged leaf scaevola below taller shrubs such as coastal jam and minga. Grasses include buffel grass, *Paspalidium tabulatum* and beach spinifex.

Because of its fragility, the system (despite carrying some useful pastures) is not suitable for pastoral use. It is currently used and great care needs to be taken with control of stock numbers and the positioning of access tracks and water points. To be able to exercise proper stock management the system should be fenced off from adjacent systems. This applies for the northern half of the station.

Fire should be avoided on the system.

3. Learmonth land system (6.8%)

Hard Spinifex and Soft Spinifex pastures of the system also contain some buffel grass and some useful low shrubs. Pasture condition is nearly all good with restricted areas in fair condition. There is no erosion.

4. Condition of the two minor systems Range (4.3%) and McLeod (0.5%) is generally good.

5. The station is not adequately watered as about 50% of its pastures are 5 km or more from stock waters. Much pasture is under-used. Additional waters are required especially in the south (see 1) and also in the north-east of the station.

6. The recommended sheep unit capacity for present condition and assuming that the station is fully watered (which is not the case, see 5) is 5,950.

7. The capability sheep unit capacity if all country was in good range condition and was fully watered is estimated at 6,800.

Individual station report

Ningaloo station - 49,731 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Cardabia	382	SOSP	239	67	—	—	4,542	5,100
		HASP	59	17	—	—	352	380
Coast	57	CDSH	41	—	—	16	513	713
Learmonth	34	SOSP	13	5	2	—	266	333
		HASP	5	2	—	—	32	35
		ACMS	7	—	—	—	140	140
Range	22	HASP	22	—	—	—	110	110
McLeod	2	SAMP	1	—	—	—	4	4
		SALT	—	—	—	—	—	—
		No veg	1	—	—	—	—	—
Totals	497		388	91	2	16	5,959	6,815

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 5,950

Capability sheep unit capacity 6,800

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 6,013

highest (1970-1972) 7,000

lowest (1979) 4,670

Peron station - Shark Bay Shire

Area 1,052 km²

Location

Peron station is located on the Shark Bay and Edel 1:250,000 map sheets. It occupies nearly all of the Peron Peninsular which protrudes into Shark Bay. In the south the station has a short boundary across the Taillefer Isthmus with Nanga station. The homestead is situated about 10 km north of the Denham township.

Description

About three-quarters of the station consists of gently undulating red sandplain and low sandhills of the Sandplain and Peron land systems. The Sandplain system (47.7% of total station area) extends from the north-east down to the central eastern part of the station. It supports a moderately close or close tall shrubland dominated by wanyu. The Peron system (27.7%) occurs in the north-west. It supports close shrublands and patchy thickets usually less than 2 m high and dominated by *Acacia ligulata* and *Lamarchea hakeifolia*. Pastoral value of both systems is high.

The Taillefer system (17.8%) is the third largest on the sation and is found in the south. It consists of undulating sandplain with calcareous soils with some limestone ridges and outcrop and coastal dunes. It supports hummock grasslands of spinifex *Trodia plurinervata* with numerous low shrubs especially *Acacia ligulata*. Pastoral value is moderate.

The only other system of importance is the Birrida system (5.4%) which occurs as low lying salt pans and depressions (up to 7 km in extent, but usually much less) amongst the sandplains of the Peron and Sandplain systems. Soils are highly saline and gypsiferous and vegetation is a low shrubland of samphire and saltbush. Pastoral value is moderate.

An additional four minor land systems occur on the station. All systems are briefly described and their pastoral value for good range condition status indicated in table 1.

Condition statement for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Peron station

Pastoral value	Land systems	Area %
Very low (>30 ha/s.u.)	—	—
Low (21-30 ha/s.u.)	—	—
Moderate (10-20 ha/s.u.)	Taillefer - undulating sandy plains over limestone, minor limestone ridges and coastal dunes; hummock grasslands of *Triodia plurinervata* and patchy shrubs	17.8
	Birrida - highly saline and gypsiferous pans and depressions; low shrublands of samphire and saltbush	5.4
	Coquina - low shelly foredunes, shell beaches and supra-tidal flats; vegetated parts support tall and low shrublands	0.3
	Littoral - low coastal foredunes, samphire flats and tidal flats with mangrove fringes; tall and low shrublands in parts	0.2
	McLeod - samphire flats and sandy plains with bare marginal mudflats, low shrublands of samphire and saltbush in parts.	0.2
		23.9
High (5-9 ha/s.u.)	Sandplain - gently undulating red sandplains and sand ridges; tall shrublands of wanyu	47.7
	Peron - undulating sandplains often with calcareous soils, minor coastal dunes; low shrublands and thickets of acacia and *Lamarchea hakeifolia*	27.7
	Edel - undulating sandy plains with minor low dunes, limestone rises and saline flats, low shrublands of acacia, saltbush, also some heath	0.7
		76.1
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (176 recordings on 7 land systems)

Peron

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Birrida	11	100	—	—	—	36	64	—	—	—	100	—	—
Edel	4	75	25	—	—	—	—	75	25	—	—	75	25
Littoral	1	100	—	—	—	—	—	100	—	—	—	100	—
MacLeod	5	100	—	—	—	40	60	—	—	—	100	—	—
Peron	59	100	—	—	—	5	49	31	12	3	54	31	15
Sandplain	61	100	—	—	—	18	15	39	25	3	33	39	28
Taillefer	35	68	23	6	3	—	17	43	29	11	17	43	40
Total over all land systems	176	93	5	1	1	11	31	34	19	5	43	34	23

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 16 sites on 4 land systems.

Range condition and recommendations

1. Sandplain land system (47.7%)

The Acacia Sandplain pastures (ACSA) of the system support scattered desirable low shrubs such as cotton bush, ruby saltbush, currant bush, *Rhagodia* species and *Chenopodium gaudichaudianum* below the taller wanyu and silver bark wattle. There are also numerous annual grasses and forbs in season. In terms of useful low shrubs the pasture is considerably more productive than the same type found further inland and has been assessed as having a higher potential carrying capacity.

Pasture condition varies considerably with 28% of traverse recordings indicating poor or very poor condition, 39% indicating fair condition and 33% indicating good or very good condition. There is no erosion on the system. Areas of pasture degradation are nearly always confined to within a few kilometres of major watering points or to small paddocks close to shearing facilities.

2. Peron land system (27.7%)

This system also supports the Acacia Sandplain pasture type although the taller shrub species differ somewhat from those found on the Sandplain system. Close to the west coast the shrubs become shorter and more stunted as a result of the wind effect and the pasture type becomes Heath (HEAT).

Pasture condition is mostly good or fair although some restricted areas around watering points are degraded to poor conditon. There is no erosion on the system.

3. Taillefer land system (17.8%)

This system supports Hard Spinfex (HASP) pastures with minor areas of Coastal Dune Shrub (CDSH) and Saltbush (SALT) pastures. When in good condition the hard spinifex pastures have a good number of desirable small shrubs and herbaceous species such as cotton bush, ragged leaf scaevola, ruby saltbush, *Rhagodia latifolia* and others between the spinifex.

Pastures on the system are mostly more or less degraded to fair, poor or very poor condition. About 15 km^2 of the system in the south of the station near the new shearing shed is severely degraded with depleted pastures and serious wind erosion. The area has been burnt and subjected to excessive grazing pressure. In these circumstances the system is highly susceptible to wind erosion. The area should be spelled from grazing for at least one full year by which time reasonable recovery could be expected. Buffel grass is becoming established in some areas and has potential as a stabilising coloniser. Its spread should be encouraged.

Strategic burning may be a useful method of maintaining desirable palatable shrubs, herbs and grasses in the system but it must be accompanied by spelling until six or eight weeks after commencement of the growing season and conservative stocking for the remainder of the year. When in good conditon the recommended stocking rate on a year long basis is about 1 sheep unit/11ha. This represents about 1,700 total sheep units for the whole system.

4. Birrida land system (5.4%)

The Samphire (SAMP) and Saltbush pastures of this system are all in good or very good condition, and there is no erosion.

5. The minor systems Edel, Littoral and McLeod were not intensively sampled but, where seen, were mostly in good or fair condition.

6. Central part of the station are reasonably well developed with water points and paddocks but some extensive areas in the north, far south and east cannot be fully used for grazing because of the lack of permanent water supplies. The provision of water supplies to these areas needs to be considered.

7. The recommended sheep unit capacity for present conditon and assuming that the station is fully developed (which is not the case, see 6) is 8,350.

8. The capability sheep unit capacity if all country was in good range condition is estimated at 11,650.

Individual station report

Peron station - 105,200 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandplain	502	ACSA	166	196	140	—	4,268	6,275
Peron	291	ACSA	126	72	35		2,315	2,913
	—	HEAT	24	14	6	—	127	147
	—	HASP	8	4	2	—	100	117
Taillefer	187	HASP	32	66	55	15	900	1,400
	—	CDSH	—	5	5	—	56	125
	—	SALT	—	9	—	—	113	180
Birrida	57	SAMP	48	—	—	—	192	192
	—	SALT	9	—	—	—	180	180
Edel	7	CDSH	—	3		—	25	50
	—	SALT	—	2	—	—	25	40
	—	HEAT	—	1	—	—	3	3
Coquina	3	CDSH	2	—	—	—	25	25
	—	No veg	1	—	—	—	—	—
Littoral	3	CDSH	1	—	—	—	13	13
	—	No veg	1	—	—	—	—	—
	—	SAMP	1	—	—	—	4	4
McLeod	2	SAMP	1	—	—	—	4	4
	—	No veg	1	—	—	—	—	—
	—	SALT	—	—	—	—	—	—
Totals	1,052		421	372	244	15	8,350	11,668

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 8,350

Capability sheep unit capacity 11,650

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1972):

average (mean) 11,525

highest (1975) 20,000

lowest (1981) 5,045

Pimbee station - Carnarvon Shire

Area 565 km²

Location

Pimbee station is located on the Wooramel 1:250,000 map sheet. Access to the station is through Gascoyne Junction to the north-east or via Wahroonga and Edaggee stations to the North-West Coastal Highway in the west. The station has common boundaries with Yalbalgo, Winderie, Towrana, Meedo and Wahroonga stations.

Description

Nearly 90% of the station consists of sand dunes and sandy swales of the Yalbalgo land system. The system supports a woodland of sand dune gidgee or, less frequently, a tall shrubland of wanyu with a ground layer of wanderrie grasses. Pastoral value is moderate.

Gently undulating sandplain of the Sandplain system occupies about 7.5% of the station area and occurs in the south. Vegetation is similar to the Yalbalgo system.

The Target land system (3.4%) occurs in the south-east of the station. It consists of plains with low sandy banks, more clayey inter-bank areas and small but prominent drainage foci with denser vegetation than that surrounding. It supports tall shrublands with wanyu, other acacias and currant bush. Pastoral value is high.

A minor but very distinctive land system occurs in the east of the station. This is the Yagina system (1.3%) which consists of stony plains and low stony rises with stony claypans and minor sandy banks. Vegetation is a sparse shrubland of mulga, with other *Acacia*, *Cassia* and *Eremophila* species.

All land systems on the station are summarized in table 1. Condition statements for land systems and for the whole station (total over all land systems) are shown in table 2.

Table 1. Land systems on Pimbee station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Yalbalgo - sandplain with linear and reticulate dunes; tall shrublands of wanyu and woodlands of sand dune gidgee	87.0
	Sandplain - nearly flat to gently undulating red sandplain with wanyu shrublands and sand dune gidgee woodlands.	7.5
	Yagina - low stony plains, soil covered plains, stony claypans and minor sandy banks and dunes, sparse tall shrublands of mulga and wanyu	1.3
	Yaringa - sandy plains and limestone outcrop plains with occasional low dunes, tall acacia shrublands	0.4
		96.2
High (5-9 ha/s.u.)	Target - plains with sandy banks, more clayey inter-bank areas and numerous small drainage foci; mixed shrublands and acacia shrublands	3.4
Very high (< 5 ha/s.u.)	—	—
	Bare claypans	0.4
		100.0

Table 2. Condition statements derived from traverse records (72 recordings on 3 land systems)

Pimbee

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Sandplain	4	100	—	—	—	—	—	25	50	25	—	25	75
Yalbalgo	65	100	—	—	—	—	25	50	22	3	25	50	25
Yagina	3	100	—	—	—	—	—	33	67	—	—	33	67
Total over all land systems	72	100	—	—	—	—	22	49	25	4	22	49	29

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 5 sites on 2 land systems.

Range condition and recommendations

1. Yalbalgo land system (87%)

This system supports the Acacia Sandplain (ACSA) pasture type which has an upper layer of trees characterized by sand dune gidgee or, less frequently, a tall shrub layer of wanyu. The lower layers consist of very scattered low shrubs including a few palatable species and a prominent grass layer dominated by wanderrie grasses. About half of the pastures as seen on survey were in fair condition with the remainder being evenly distributed between good and poor. Poor condition was indicated by an almost complete lack of desirable low shrubs such as Wilcox bush, flat leaf bluebush and corky bark kallstroemia.

Because of the general sparsity of palatable shrubs, even when in good condition, and the rather short-lived nature of wanderrie grasses, the system has limited drought value. Opportunitistic use can be made of the grass pastures in good seasons, but management needs to be flexible in times of drought.

Fire may be a useful management tool on this land system, but its use has not been researched.

2. Sandplain land system (7.5%)

The Acacia Sandplain pastures on this system were in very poor to fair condition. However, the system was not adequately sampled and the few recordings made were close to a watering point. More distant from water and in line with the system as seen in other parts of the survey area, over all condition is likely to be fair to good. As with the Yalbalgo system the wanderrie grass pastures have limited drought value and fire is a potential management tool. Evidence seen on this system during survey suggests that the effects of fire are very long term. Where the over-storey of trees and tall shrubs has been killed by fire the low shrub layer and the ground layer is remarkably increased both in diversity of species and in density. This fire induced sub-climax appears to be considerably more useful for livestock production than is the mature sand dune gidgee or wanyu situation.

3. Target land system (3.4%)

This minor system was not sampled. However, its condition was expected to be similar to that seen on the system elsewhere in the survey area. Currant Bush Mixed Shrub pastures (CBMS) of the narrow plains between the sandy banks of the system are likely to show some degradation with loss of desirable shrubs. The other pastures of the system are expected to be in fair to good condition.

4. Yagina land system (1.3%)

Condition of the Acacia Short Grass Forb (ASGF) pastures on this stony rather unproductive system was fair to poor. The system produces useful forbs and annual grasses in season, but desirable low shrubs are very sparse and consequently the system has little drought durability.

5. The station is well watered except in northern parts of the north paddocks where some considerable areas are > 5 km from water and are probably under-used.

6. The recommended sheep unit capacity for present condition is 3,600.

7. The capability sheep unit capacity if all country was in good range condition is estimated at 4,850.

Individual station report

Pimbee station - 56,509 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Yalbalgo	490	ACSA	123	245	122	—	3,044	4,083
Sandplain	43	ACSA	22	16	5	—	303	358
Target	20	CBMS	1	4	4	—	95	180
		ACSA	3	4	1	—	54	67
		ACCR	1	2	—	—	40	60
Yagina	8	ASGF	1	3	1	—	18	25
		ACSA	—	2	—	—	13	17
		ACMS	—	1	—	—	10	20
Yaringa	2	ACSA	—	2	—	—	13	17
		ACMS	—	—	—	—	—	—
large clay pans	2	No veg	2	—	—	—	—	—
Totals	565		153	279	133	—	3,590	4,827

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 3,600

Capability sheep unit capacity 4,850

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1970):

average (mean) 5,951

highest (1975) 8,400

lowest (1980) 1,200

Quobba station - Carnarvon Shire

Area 750 km²

Location

Quobba station is located on the Quobba and Minilya 1:250,000 map sheets. The homestead is situated close to the coast about 82 km north by road from Carnarvon. The station has common boundaries with Boolathana and Gnaraloo stations and fronts onto Lake McLeod in the east and the coastline of the Indian Ocean in the west.

Description

Nearly two-thirds of the station consists of undulating sandy plains, linear dunes and minor limestone ridges of the Cardabia land system. This system occurs as a continuous belt of country running down the centre of the property from north to south. It supports patchy shrublands usually under 2 m high with soft and hard spinifex understorey. Pastoral value is high.

The Warroora system (12.7% of total station area) occurs along the eastern edge of the station associated with the McLeod system (5.6%). It consists of almost flat or gently sloping saline alluvial plains, sluggish drainage tracts, limestone outcrop plains and minor sandy banks. The saline plains support low shublands of saltbush and bluebush and the more sandy areas scattered tall acacia shrublands. Pastoral value is high. The McLeod system consists of saline flats and sandy plains with bare marginal mudflats. The vegetated areas support low shrublands of samphire and saltbush. Taken over all, pastoral value is moderate.

The Coast land system (9.4%) occurs as a narrow strip along the western edge of the station. It consists of large, long-walled parabolic coastal dunes and narrow swales, unstable blow-out areas, minor limestone plains, rocky wave-cut platforms and sea cliffs. The system supports various low shrub communities which are sparse and wind pruned close to the coast and somewhat taller and more diverse on the more inland dunes. Pastoral value is high.

Two other sandy systems, Mallee (4.5%) and Brown (1.2%) are found on the station. The Mallee system is in the north-east and consists of undulating sandy plains with limestone at shallow depth and linear dunes similar to those of the Cardabia system. It supports a tall shrubland of acacias and mallee form eucalypts. The Brown system (which is in the south) consists of gently undulating sandy plains with moderately close tall shrublands of silver bark wattle and other acacias and numerous low shrubs. Pastoral value of both systems is moderate.

One other minor land system, Trealla, occurs on the station but is of little significance. All systems are summarized and their pastoral value for good range condition status indicated in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Quobba station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	McLeod - samphire flats and sandy plains with bare marginal mudflats; low shrublands of samphire and saltbush	5.6
	Mallee - undulating sandy plains with limestone at shallow depth, linear dunes and minor limestone outcrop plains; tall shrublands, acacias and mallee eucalypts, with spinifex	4.5
	Brown - gently undulating sandplains and occasional dunes; tall acacia shrublands	1.2
		11.3
High (5-9 ha/s.u.)	Cardabia - undulating sandy plains with linear dunes and minor limestone ridges and outcrop plains, low acacia shrublands with soft and hard spinifex	65.7
	Warroora - nearly flat, saline alluvial plains, sluggish drainage tracts and prominent drainage foci, limestone outcrop plains and sandy banks; low shrublands of bluebush and saltbush	12.7
	Coast - large, long-walled parabolic coastal dunes and narrow swales, unstable blow-out areas, minor limestone plains, rocky wave cut platforms and sea cliffs; low mixed shrublands and some spinifex	9.4
	Trealla - elevated limestone plains and plains with thin sand cover, minor steeper marginal slopes; tall acacia shrublands	0.2
		88.0
Very high (< 5 ha/s.u.)	—	—
	Bare surfaces of Lake McLeod	0.7
		100.0

Table 2. Condition statements derived from traverse records (217 recordings on 6 land systems)

Quobba

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Brown	18	100	—	—	—	17	44	39	—	—	61	39	—
Cardabia	103	100	—	—	—	17	57	26	—	—	74	26	—
Coast	26	73	11	8	8	—	46	39	15	—	46	39	15
MacLeod	31	100	—	—	—	97	3	—	—	—	100	—	—
Mallee	4	100	—	—	—	—	25	50	25	—	25	50	25
Warroora	35	100	—	—	—	83	14	3	—	—	97	3	—
Total over all land systems	217	97	1	1	1	36	40	22	2	—	76	22	2

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 14 sites on 6 land systems.

Range condition and recommendations

1. Cardabia land system (65.7%)

This system supports Soft Spinifex and Hard Spinifex (SOSP, HASP) pastures with an admixture of numerous low shrubs, some of which are useful types such as ruby saltbush, cotton bush and *Rhagodia* species. Pasture condition is predominantly good with the balance being in very good or fair condition. There is generally no erosion on the system although areas such as dune crests which may occasionally be bared by fire or excessive use near watering points are susceptible to wind erosion. However, the system revegetates rapidly after rain and stabilizes.

Old mature stands of spinifex are unattractive to livestock and fire is likely to be a useful management tool on this system although its use has not been researched in this environment. Periodic, controlled burning removes old spinifex tussocks and stimulates the growth of shrubs, herbs and grasses some of which are desirable palatable types. Burning on a rotational system would decrease the risk of wild fires over large areas. Burnt areas should not be stocked for about eight weeks over the growing season following the fire in order that seedlings of desirable plants can become established.

2. Warroora land system (12.7%)

The Bluebush and Saltbush (BLUE, SALT) pastures on this productive system are nearly all in very good condition and there is no erosion. Much of the system in the north-east is little used by livestock because of the excessive distance from stock water. Consideration needs to be given to supplying waters to bring this area into production. Ideally, water supplies need to be of low salinity as the dietary salt intake of sheep on bluebush and saltbush pastures is already high and excessive salt intake resulting from a combination of salty feed and salty water will severely reduce animal productivity and restrict grazing radii.

3. Coast land system (9.4%)

Traverse observations indicate that about half of the Coastal Dune Shrub (CDSH) pastures of the system are in good condition. Some considerable parts show minor pasture degradation to fair condition and restricted areas, mostly in the vicinity of water points, are degraded further to poor condition.

Some isolated parts of the system show moderate and severe wind erosion with deflation of the sandy surface to expose the underlying limestone pavement. About 5 km² of the system is severely degraded and consists of unvegetated sand blowouts and mobile dunes commencing at the coast and extending northwards. These areas are adjacent to 9 Mile well and 17 Mile well.

The Coast land system is inherently susceptible to wind erosion once the vegetative cover is depleted or removed by any agency such as fire, roadbuilding or overstocking. Its use for any purpose needs to be carefully planned and managed to minimize the risk of erosion. Burning should be avoided and ideally the system needs to be separately fenced so that complete control of intensity of grazing and season of use is possible.

4. McLeod land system (5.6%)

The Samphire (SAMP) and Saltbush (SALT) pastures on this system are in very good condition and there is no erosion. The pastures are highly saline and this, coupled with long distances from water or brackish water supplies, means that they are in general, only lightly used.

5. Mallee land system (4.5%)

This system was not intensively sampled but the pastures, where seen, were mostly in fair condition. As with the Cardabia system fire is a potential management tool.

6. Brown land system (1.2%)

This system supports Acacia Sandplain pastures (ACSA) and some saltbush (SALT) pastures. Condition varies from fair to very good, but is predominantly good. There is no erosion.

When in good condition numerous desirable low shrubs such as silver saltbush, cottonbush, ruby saltbush and *Rhagodia preissii* occur beneath taller acacias. Management should aim at maintaining these desirables in the stand.

7. The southern half of the station is well developed with paddocks and water supplies but elsewhere the station is not well watered. Considerable areas in the centre and north-east are > 5 km from stock water supplies. Consideration needs to be given to supplying water to bring these areas into use.

8. The recommended sheep unit capacity for present condition and assuming that the station is fully watered (which is not the case see 2, 7) is 9,050.

9. The capability sheep unit capacity if all country was in good range condition is estimated at 10,350.

Individual station report

Quobba station - 74,973 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Cardabia	492	SOSP	292	102	—	—	5,717	6,567
		HASP	73	25	—	—	448	490
Warroora	96	BLUE	43	—	—	—	860	860
		SALT	39	—	—	—	780	780
		SAMP	14	—	—	—	56	56
Coast	70	CDSH	30	25	10	5	594	875
McLeod	42	SAMP	21	—	—	—	84	84
		SALT	8	—	—	—	160	160
		No veg	13	—	—	—	—	—
Mallee	34	HASP	5	10	5	—	71	100
		SOSP	4	7	3	—	137	233
Brown	9	ACSA	5	3	—	—	60	67
		SALT	1	—	—	—	20	20
Trealla	2	ACMS	2	—	—	—	40	40
		BLUE	—	—	—	—	—	—
Lake McLeod	5	No veg	5	—	—	—	—	—
Totals	750		555	172	18	5	9,027	10,332

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 9,050

Capability sheep unit capacity 10,350

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1970):

average (mean) 6,610

highest (1971) 8,270

lowest (1982) 4,737

Talisker station - Shark Bay Shire

Area 2,873 km²

Location

Talisker station is located on the Yaringa 1:250,000 map sheet. The homestead is about 90 km east by road from the North-West Coastal Highway through Woodleigh station. The station has common boundaries with Yalardy, Muggon, Meadow, Hamelin and Woodleigh stations and, in the south, to vacant crown land.

Description

About 95% of the station consists of almost flat to gently undulating red sandplain of the Sandplain land system. This system supports a moderately close tall shrubland dominated by wanyu but also with numerous other tall and low shrubs. Pastoral value is moderate.

Four other systems Nerren (2.7%), Snakewood (1.3%), Yalbalgo (0.5%) and Garry (0.3%) occur on the station.

The Nerren system is found in the centre of the station close to the homestead and in the far south-west. It consists of red sandplain very similar to the Sandplain system except that the vegetation includes prominent patches of eucalypt trees emergent from the tall shrubland of wanyu. Pastoral value is moderate.

The Snakewood system occurs only in the south-west of the station. It consists of nearly flat plains with duplex soils and supports tall shrublands of snakewood with a saltbush understorey. Pastoral value is high.

The Yalbalgo system, which consists of longitudinal sand dunes and sandy inter-dunal plains, occurs in the north-east of the station. It supports the same vegetation as the Sandplain system, that is a moderately close tall shrubland of wanyu and other acacias. Pastoral value is moderate.

In the centre of the station and in the north-east there are a number of small patches of the Garry land system. It consists of gently sloping stony plains, minor alluvial plains and drainage floors and low limestone rises. It supports scattered tall shrublands of mulga and other acacias with low shrubs of *Eremophila* and *Cassia* species and some low shrublands of sago bush. Pastoral value is moderate.

All the systems on the station are further summarized in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Talisker station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Sandplain - nearly flat to gently undulating red sandplains; moderately close to close tall shrublands of wanyu	95.2
	Nerren - nearly flat to gently undulating red sandplains; moderately close tall shrublands of wanyu with patches of emergent eucalypt trees.	2.7
	Snakewood - nearly flat plains with duplex soils; tall shrublands of snakewood with saltbush understorey	1.3
	Yalbalgo - sandplains with linear and reticular dunes; moderately close tall shrublands of wanyu	0.5
	Garry - gently sloping stony plains, minor alluvial plains and drainage floors and low limestone rises; scattered tall shrublands of mulga and other acacias also low shrublands of sago bush	0.3
		100.0
High (5-9 ha/s.u.)	—	—
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (185 recordings on 3 land systems)

Talisker

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Garry	2	100	—	—	—	—	—	100	—	—	—	100	—
Nerren	7	100	—	—	—	—	43	57	—	—	43	57	—
Sandplain	176	100	—	—	—	24	27	39	9	1	51	40	9
Total over all land systems	185	100	—	—	—	23	27	41	8	1	49	42	9

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 7 sites on 3 land systems.

Range condition and recommendations

1. Sandplain land system (95.2%)

The Acacia Sandplain (ACSA) pastures on this sytem are mostly in fair, good or very good conditon. Good condition is indicated by scattered desirable shrubs such as warty leaf eremophila, Wilcox bush, cotton bush, tall saltbush, *Chenopodium gaudichaudianum* and sparse wanderrie grasses beneath the taller wanyu shrubs. Some restricted areas in existing paddocks show loss of desirable shrubs and are degraded to poor condition but elsewhere within paddocks the pasture condition is fair or good.

Desirable shrubs are only sparsely scattered even when the pastures are in good condition. For this reason, and also because of the relatively short-lived nature of wanderrie grasses, the pastures have only limited value in times of drought.

Fire may be a useful management tool on this land system, but its use has not been researched. Evidence seen elsewhere on this system suggests that the effects of fire are very long term. Where the overstorey of wanyu is killed by fire the low shrub layer and ground layer is considerably increased in diversity of species and in density. This fire-induced sub-climax vegetation appears to be considerably more productive for livestock production than are stands of mature wanyu.

At least 80% of this system is unused for grazing or is little used being >5 km from permanent stock water supplies. In the south and south-west the system is entirely unwatered being 30-60 km from the nearest supply.

2. Nerren land system (2.7%)

This system supports Acacia and Eucalypt Short Grass Forb (AEGF) pastures which are very similar to the Acacia Sandplain pastures of the Sandplain system. Condition of the pastures on the system near the homestead is all fair or good. The section of the system in the far south-west of the station was not inspected but, because it is unused for grazing, is expected to be in very good condition.

3. Snakewood land system (1.3%)

This small system in the far south-west was not inspected. The area is not grazed and Saltbush (SALT) pastures are expected to be in very good condition.

4. Yalbalgo and Garry land systems (0.5, 0.3% respectively)

The Yalbalgo system was not inspected, but is likely to be in good condition. The Garry system supports Acacia Short Grass Forb (ASGF) pastures on stony plains and Bluebush (BLUE) pastures on small alluvial plains. The Acacia Short Grass Forb pastures are in fair condition but the small inclusions of Bluebush pastures have been preferentially over-grazed and are in poor condition. Desirable low shrubs such as sago bush, silver saltbush and low bluebush are still present but at numbers well below potential. The pastures have the ability to recover if they can be spelled over a number of growing seasons and stocked conservatively at other times.

5. The southern and south-western parts of the station are undeveloped with no permanent stock water supplies or fences. Less that 20% of the pastures on the station are within 5 km of permanent water supplies.

6. The recommended sheep unit capacity for present condition and assuming that the station is fully developed (which is not the case see 1, 5) is 20,800.

7. The area commanded by the eight watering points in use at the time of survey can safely carry about 4,000 sheep units.

8. The capability sheep unit capacity if all country was in good range condition is estimated at 24,300.

Individual station report

Talisker station - 287,284 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandplain	2735	ACSA	1,395	1,094	246	—	19,447	22,792
Nerren	78	AEGF	34	44	—	—	487	557
Snakewood	37	SALT	30	—	—	—	600	600
		ACMS	6	—	—	—	120	120
		ACSA	1	—	—	—	8	8
Yalbalgo	13	ACSA	13	—	—	—	108	108
Garry	10	ASGF	—	8	—	—	27	40
		BLUE	—	2	—	—	25	40
Totals	2,873		1,479	1,148	246	—	20,822	24,265

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 20,800

Capability sheep unit capacity 24,300

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 7,224

highest (1977) 12,677

lowest (1984) 4,413

Tamala station - Shark Bay Shire

Area 1,298 km²

Location

Tamala station is located on the Edel, Yaringa and Ajana 1:250,000 map sheets. The homestead is about 90 km west of the North-West Coastal Highway via the access road to Denham and Useless Loop. The station has common boundaries with Carrarang, Nanga and Murchison House stations and to the Cooloomia Nature Reserve. In the north the station has a boundary to the convoluted shoreline of Freycinet Estuary and in the west ends at the spectacular Zuytdorp cliffs overlooking the Indian Ocean.

Description

The largest land system on the station is Nanga (33.2%) which consists of undulating sandplains and occasional confused dunes. It occurs in the north-east and south-east of the station. It supports tree heath and scrub heath vegetation and pastoral value is very low. The south-eastern section is undeveloped and is not used for grazing.

The Zuytdorp system (22.3%) is restricted to the southern half of the station. It consists of elevated, undulating limestone plains with thin sand cover, sandy coastal slopes and sea cliffs up to 100 m above sea level. It supports scrub heath vegetation with some low halophytic components on the coastal slopes and cliffs. Pastoral value is very low. Nearly all of the system is undeveloped and is not used for grazing.

The Coast system (17.8%) is found in the north-west directly above the Zuytdorp cliffs. It consists of large, long-walled parabolic coastal dunes and narrow swales with minor limestone plains. There are a number of unstable blowout areas and unvegetated mobile dunes. The system supports moderately close or close shrublands usually < 2 m high and often with useful halophytic low shrubs amongst the more heath like types. Pastoral value is high.

The Tamala land system (10.5%) is an important system found in the centre of the station and near the homestead. It consists of undulating sandy plains and plains with thin sand cover over limestone and prominent limestone rises. It supports moderately close tall shrublands of various acacias and extensive areas of annual grasslands and herb-fields which have replaced much of the original perennial vegetation. Much of the new vegetation is made up of introduced annual species of grasses, forbs and medics. Its pastoral value, as an annual pasture at a site of high expectancy for winter rainfall, is very high.

The Edel system (8.6%) in the north of the station is similar to Coast but with less relief. It consists of undulating sandy plains with minor low dunes, limestone rises and saline flats. It supports moderately close low shrublands with many useful shrub species and annual grasses and forbs. Pastoral value is high.

The Cullawarra system (6.6%) in the centre of the station consists of rough, undulating limestone plains and low hills and steep sea cliffs. It supports low shrublands of saltbush with patches of tall shrublands frequently with many exotic annual species in the ground layer. Pastoral value is very high.

One other minor land system (Birrida 1.0%), occurs on the station. It consists of saline flats and pans with low shrublands of saltbush and samphire.

All systems on the station are further summarized in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Tamala station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Nanga - undulating sandplains and occasional dunes; tree heath and scrub heath	33.2
	Zuytdorp - elevated, undulating limestone plains with thin sand cover, sandy coastal slopes and sea cliffs; heath and scrub heath	22.3
		55.5
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Birrida - highly saline and gypsiferous pans and depressions; low shrublands of samphire and saltbush	1.0
High (5-9 ha/s.u.)	Coast - large, long-walled parabolic coastal dunes and narrow swales, minor limestone plains, unstable blowout areas and mobile dunes; close low shrublands of acacias, saltbush, some scrub heath	17.8
	Edel - undulating sandy plains with minor low dunes, limestone rises and saline flats; low shrublands of acacias, saltbush, also some heath	8.6
		26.4
Very high (< 5 ha/s.u.)	Tamala - undulating sandy plains and plains with thin sand cover over limestone, minor limestone ridges; annual grasslands and herb-fields and tall acacia shrublands	10.5
	Cullawarra - undulating limestone plains and low hills, steep sea cliffs, low shrublands of saltbush, patches tall acacia shrublands and annual herb-fields	6.6
		17.1
		100.0

Table 2. Condition statements derived from traverse records (238 recordings on 7 land systems)

Tamala

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Birrida	6	83	17	—	—	17	32	17	17	17	50	17	33
Coast	61	79	8	3	10	25	32	23	7	13	57	23	20
Cullawarra	9	100	—	—	—	11	45	11	11	22	56	11	33
Edel	44	96	2	—	2	34	39	20	7	—	73	20	7
Nanga	31	100	—	—	—	45	52	3	—	—	97	3	—
Tamala	60	77	13	10	—	—	13	30	27	30	13	30	57
Zuytdorp	27	100	—	—	—	81	4	15	—	—	85	15	—
Total over all land systems	238	88	6	3	3	29	28	20	11	12	57	20	23

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 21 sites on 6 land systems.

Range condition and recommendations

1. Nanga land system (33.2%)

Heath (HEAT) pastures on this system are in good or very good condition. However, potential for pastoral use is very low and it is doubtful if the system can be economically developed. Most of the system is not used for grazing.

2. Zuytdorp land system (22.3%)

The Heath pastures on this system are predominantly in very good condition. Sandy coastal slopes and the tops of coastal cliffs carry a few useful halophytic shrubs, but most of the heath vegetation is of little use for grazing. Over all pastoral value is very low and the system does not warrant development for pastoral use. It is currently unused.

3. Coast land system (17.8%)

Condition of the Coastal Dune Shrub (CDSH) pastures of this system are extremely variable. Large areas are in good or very good condition but some considerable parts are degraded to fair, poor or very poor condition.

At least 9 km^2 of the system consists of wind eroded blowout areas with large unvegetated, mobile sand dunes. The largest single area of blowout and dunes is in West Beethan paddock and Whale paddock between Beethan outcamp and Whale well. The deflated areas of the blowouts where the sand has been removed to expose the undersurface of limestone rubble need to be fully protected from grazing. This will enable primary colonization to commence. Additional fencing will be required to enable the areas to be excluded from grazing.

Much of the system is poorly watered being at least 5 km or more from permanent stock water supplies. Consequently, much pasture is under used or not used at all.

The system can provide good quality grazing, but it is inherently sensitive to wind erosion if the vegetative cover becomes depleted. It is essential that control of intensity of use and season of use by livestock is done and this automatically requires adequate paddocking and sufficient, well distributed watering points.

4. Tamala land system (10.5%)

The system supports Exotic Annual (EXAN) pastures and Acacia Mixed Shrub (ACMS) pastures. The introduced annual species consist of wild oats, barley grass, lupins, wild turnip, medics and others and have almost completely replaced the original shrub vegetation. It appears that the original vegetation was partly cleared from some areas many years ago. Additional pressures on the vegetation from rabbits, goats and fires have also contributed to shrub loss. The annuals are productive under a regular pattern of winter rainfall and bind the soil surface. However, if over-grazed there is a high susceptibility to wind erosion and/or invasion by undesirable shrubs such as tomato bush.

The acacia mixed shrub pastures which occur elsewhere on the system vary in condition from good to very poor but are predominantly poor to very poor with depletion of desirable low shrubs. There is no erosion.

5. Edel land system (8.6%)

The system supports productive Coastal Dune Shrub (CDSH) pastures and minor areas of Saltbush (SALT) pastures. The coastal dune shrub pastures are almost all in good or very good condition with only very localized areas close to a few water points showing loss of desirable shrubs. The saltbush pastures are in fair to good condition.

Some of the system is little used because it is well in excess of 5 km from permanent stock water. For example, Talga paddock in the north-west of the station is not watered. Pasture condition is very good and the area needs to be brought into production so that stock can be more equitably spread over the station.

6. Cullawarra land system (6.6%)

The system supports Saltbush and Exotic Annual pastures. Condition of the saltbush pastures varies from very poor to very good depending largely on the distance from stock water. In some places the native shrub pastures have been more or less replaced by introduced annual pastures which supply good quality feed in season.

About half the system is little grazed as it is 5 km or more from permanent stock water.

7. The station is not adequately watered in that sizeable areas of the productive Edel and Cullawarra land systems (see 5 and 6) are well over 5 km from permanent supplies. Pastures in these areas are in good condition and consideration should be given to providing water supplies.

8. Over 50% of the station (the Nanga and Zuytdorp systems) is of very low pastoral value and is currently little used or unused because of the lack of water supplies and, in all probability, cannot be economically developed. The systems are unsuitable for pastoral purposes.

9. The recommended sheep unit capacity for present condition and assuming that the station is fully watered (which is not the case see 7, 8) is 11,500.

10. The watered area of the station is capable of safely carrying about 7,500 sheep units.

11. The capability sheep unit capacity if all country was in good range condition and was fully watered is estimated at 13,350.

Individual station report

Tamala station - 129,766 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Nanga	431	HEAT	376	12	—	—	1,283	1,293
		HASP	42	1	—	—	213	215
Zuytdorp	289	HEAT	246	43	—	—	928	963
Coast	231	CDSH	131	53	37	9	2,165	2,875
		EXAN	1	—	—	—	45	45
Tamala	136	EXAN	68	—	—	—	3,091	3,091
		ACMS	11	15	35	—	589	1,220
		SAMP	—	5	2	—	21	28
Edel	111	CDSH	83	7	4	—	1,104	1,175
		HEAT	10	1	—	—	36	44
		SALT	3	2	1	—	91	120
Cullawarra	86	SALT	38	7	22	—	985	1,340
		EXAN	19	—	—	—	864	864
Birrida	13	SAMP	6	2	3	—	37	44
		SALT	1	1	—	—	33	40
Totals	1,297		1,035	149	104	9	11,485	13,357

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 11,500

Capability sheep unit capacity 13,350

Declared stock numbers (sheep units or equivalent) 1969-1984 (no data for 1968, 1970-71):

average (mean) 11,831

highest (1974) 19,000

lowest (1984) 5,031

Towera station - West Pilbara Shire

Area 2,061 km²

Location

Towera station is located on the Winning Pool and Edmund 1:250,000 map sheets. The homestead is about 40 km south of the North-West Coastal Highway from the turn-off at Barradale Roadhouse. The station shares boundaries with Uaroo, Maroonah, Lyndon, Winning and Nyang stations.

Description

Eighteen different land systems occur on the station. Most of these are sandy or stony plain systems although a number of low granitic hill systems occur in the east of the station. The channel of the Yannarie River runs through the property in a south-east to north-west direction and the Lyndon River passes through the south-west corner.

The largest land system is Durlacher (28% of total station area) which is common in the eastern half of the station. It consists of almost flat or gently undulating stony plains and interfluves usually with a mantle of white quartz pebbles and rock fragments. There are also almost flat drainage floors and a few low stony ridges. The system supports scattered tall shrublands of mulga, snakewood and other acacias with various low shrubs including useful chenopod types. Pastoral value is moderate.

In the western half of the station a number of sandplain systems predominate. These are Uaroo (21.1%), Duffy (17.4%) and Giralia (5.1%).

The Uaroo system consists of nearly flat sand plains and minor pebbly plains often with calcrete at shallow depth. It supports hummock grasslands of hard and soft spinifex with numerous patchy shrubs. The Duffy system consists of gently undulating sandy plains, minor stony plains and rises and low granitic hills. It supports hummock grasslands of spinifex and scattered tall shrublands. The Giralia system consists of sandplains with large linear dunes. It supports hummock grasslands of hard and soft spinifex with numerous shrubs. Pastoral value of the three systems is generally moderate, but declines as the proportion of hard spininfex increases.

The Yinnietharra system (7.9%) in the east consists of gently sloping sandy plains and broad drainage tracts receiving sheet and channelled flow, minor stony plains and low granitic hills. Vegetation is very scattered to moderately close tall shrublands of mulga and spreading gidgee. Pastoral value is moderate.

In the south-west of the station, an important system, Wash, is associated with flood out from the Lyndon River which at this point has no well defined channel. The system consists of sandy alluvial plains and broad drainage zones receiving concentrated sheet flow. The sandy plains support tall shrublands of spreading gidgee and numerous other acacias frequently arranged in patches of groves. Drainage tracts and floodplains support low woodlands of coolibah or tall shrublands with many low shrubs and scattered perennial grasses in the understorey. Pastoral value is high.

The Channel system (2.9%) occurs as a narrow strip flanking the Yannarie River in the centre and north-west of the station. It consists of the river channel, banks, narrow flood plains and steeper marginal slopes to the adjoining systems. Vegetation consists of fringing woodlands of coolibah and river gum along the channels and banks and sparse tall acacia shrublands on the marginal slopes. Pastoral value is moderate.

Eleven additional land systems (totalling 10.2%) occur on the station. Of these James (2.3%), Agamemnon (0.6%), Capricorn (0.3%), Billy (0.2%), Prairie (0.1%) and Augustus (0.1%) are hill systems of low pastoral value.

All systems on the station are further summarized in table 1.

Condition statements for land systems and for the station as a whole are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Towera station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Augustus - rugged mountains, hills and ridges of sedimentary rocks; tall shrublands of mulga and other acacias	0.1
Low (20-30 ha/s.u.)	James - low granite hills and ridges, undulating stony plains and lower plains; scattered tall acacia shrublands	2.3
	Agamemnon - rough hills and ridges of granite and gneiss; scattered tall acacia shrublands	0.6
	Capricorn - rugged sandstone hills, ridges, stony footslopes and stony interfluves; scattered tall acacia shrublands, some spinifex	0.3
	Billy - low plateaux, mesas and buttes with stony footslopes and narrow drainage floors; scattered tall acacia shrublands	0.2
		3.4

Table 1 continued...

Pastoral value	Land systems	Area %
Moderate (10-19 ha/s.u.)	Durlacher - gently sloping stony plains and drainage floors, minor stony ridges; scattered tall and low shrublands	28.0
	Uaroo - nearly flat sandy plains and minor pebbly plains with calcrete at shallow depth; hummock grasslands of hard and soft spinifex with numerous shrubs	21.1
	Duffy - gently undulating sandy and stony plains and drainage tracts, minor stony rises and low granitic hills; hummock grasslands of hard and soft spinifex, also tall shrublands	17.4
	Yinnietharra - gently sloping sandy plains and broad drainage tracts, minor stony plains and low granite hills; scattered tall shrublands of mulga and other acacias	7.9
	Giralia - sandy plains with large linear dunes; hummock grasslands of hard and soft spinifex with numerous shrubs	5.1
	Channel - major river channels, banks, narrow flood plains and dissected marginal slopes; fringing woodlands and scattered tall shrublands	2.9
	Windalia - stony plains and narrow dissected upper interfluves on radiolarite; tall shrublands of spreading gidgee and other acacias sometimes groved	2.8
	Collier - low hills of sandstone and quartzite and stony undulating uplands; tall shrublands of mulga and other acacias	1.8
	Phillips - undulating stony uplands and low hills of crystalline rocks; scattered tall shrublands of mulga and other acacias	0.3
	Prairie - granite hills and undulating stony plains; scattered tall shrublands of mulga and other acacias	0.1
		87.4
High (5-9 ha/s.u.)	Wash - sandy alluvial plains and broad drainage tracts receiving concentrated sheet flow; tall, moderately close shrublands of spreading gidgee and other Acacia species sometimes groved, also scattered low woodland of coolibah and acacias with numerous other shrubs and perennial grasses	7.4
	River - Narrow active floodplains, channels and banks; fringing woodlands of river gum, coolibah and acacias	0.9
	Winning - low plains and broad drainage tracts, scattered tall shrublands of snakewood	0.8
		9.1
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (314 recordings on 14 land systems)

Towera

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Agamemnon	4	100	—	—	—	—	—	100	—	—	—	100	—
Billy	1	100	—	—	—	—	100	—	—	—	100	—	—
Channel	5	100	—	—	—	20	40	40	—	—	60	40	—
Collier	5	100	—	—	—	20	60	20	—	—	80	20	—
Duffy	86	86	12	2	—	13	31	30	16	10	43	30	27
Durlacher	85	94	4	2	—	7	19	50	22	2	26	49	25
Glenburgh	1	100	—	—	—	—	100	—	—	—	100	—	—
James	3	100	—	—	—	34	33	33	—	—	67	33	—
Phillips	2	100	—	—	—	—	—	100	—	—	—	100	—
River	2	100	—	—	—	—	100	—	—	—	100	—	—
Uaroo	45	100	—	—	—	44	47	9	—	—	91	9	—
Windalia	19	95	5	—	—	11	47	26	16	—	58	26	26
Wash	22	100	—	—	—	—	18	68	14	—	18	68	14
Yinnitharra	34	100	—	—	—	18	44	26	9	3	62	26	12
Total over all land systems	314	95	4	1	—	15	32	36	13	4	48	35	17

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range conditon were made at 19 sites on 9 land systems.

Range condition and recommendations

1. Durlacher land system (28%

The broad stony plains and upper parts of the system support Acacia Short Grass Forb (ASGF) pastures whercas the drainage tracts and lower plains support more productive Stony Chenopod (STCH) pastures. Pasture condition is predominantly fair, however, all levels of condition from very good to very poor were encountered. About one-quarter of the traverse records indicated pasture degradation to poor or very poor condition. There is occasional erosion as water stripping and rilling on drainage tracts, but the major parts of the system are inherently resistant to erosive processes due to their stony mantle.

Degraded condition on the acacia short grass forb pastures is indicated by the general loss of desirable low shrubs such as ruby saltbush, cotton bush, flat leaf bluebush and green cassia from below the mulga. On drainage tracts which may be weakly gilgaied the pastures become the stony chenopod type usually beneath snakewood. Desirable low shrubs include sago bush. ruby saltbush, currant bush, tall saltbush and *Cassia hamersleyensis*. Patchy stands of never fail grass and Roebourne plains grass occur in the stony gilgais.

Degraded parts of the system have the potential to recover well if they are spelled for a number of consecutive growing seasons and stocked conservatively at other times.

2. Uaroo land system (21.1%)

Hard Spinifex (HASP) and Soft Spinifex (SOSP) pastures on this system are all in good or very good condition and there is no erosion.

Old mature stands of spinifex are of little use for grazing and fire is a recommended management tool to maintain the pastures in attractive condition for livestock. Periodic controlled burning removes old spinifex tussocks and stimulates the growth of shrubs, herbs and grasses some of which are desirable palatable types. Burning on a rotational system decreases the risk of wild fires over large areas. Burnt areas should not be stocked for about eight weeks over the growing season following the fire in order that seedlings of desirable plants can become established.

3. Duffy land system (17.4%)

This system supports Hard Spinifex and Soft Spinifex pastures on sandy and stony plains and Acacia Short Grass Forb on drainage tracts and some stony plains.

Condition of the spinifex pastures is mostly good or very good although localized areas are somewhat degraded to fair or poor condition. The Acacia Short Grass Forb pastures are in much poorer condition. Condition is mostly fair, but substantial areas are in poor or very poor condition with loss of desirable shrubs such as cotton bush, tall saltbush and currant bush.

About 10 km^2 of the system is severely degraded with much depleted pastures and some erosion. These areas are in the south-east of Woolkarra paddock and south-west of Chearie paddock near Chearie mill and in Three Mile paddock. Woolkarra and Three Mile paddocks would benefit from spelling over a number of seasons to encourage pasture recovery.

4. Yinnietharra land system (7.9%)

Acacia Short Grass Forb and Stony Chenopod pastures are generally in fair, good or very good condition. There is no erosion and over all range condition is predominantly good.

5. Wash land system (7.4%)

Productive Acacia Creek-line (ACCR), Tussock Grass (TUGR) and Acacia Short Grass Forb (ASGF) pastures on this system are largely in fair condition with much lesser areas in good and poor condition. There is no erosion.

6. Giralia land system (5.1%)

This system was not traversed but, as it is a spinifex based system, pasture condition is likely to be good and there would be no erosion.

Periodic burning (as for the Uaroo system, see 2) is a recommended management procedure.

7. Channel land system (2.9%)

This system and the similar River system (0.9%) were not intensively sampled but, where seen, were in good or fair range condition. Buffel grass is well established along the banks and narrow flood out zones associated with the system.

8. Windalia land system (2.8%)

The Acacia Short Grass Forb, Acacia Creek-line and Stony Chenopod pastures of the system are mostly in fair, good or very good condition.

9. The many other small land systems on the station were not intensively sampled but, where seen, were in fair or good range condition without any erosion problems.

10. Although a number of mills were not in use at the time of survey the station is reasonably well developed with waters and paddocks. However a number of additional watering points, either by upgrading existing supplies or providing new supplies, are required in order to make full use of available pastures. For example considerable areas in North Pindarra paddock and the north of Pongo paddock are > 5 km from permanent stock water supplies.

11. The recommended sheep unit capacity for present condition assuming that the station is fully watered is 13,950.

12. The capability sheep unit capacity if all country was in good range condition is estimated at 17,550.

Individual station report

Towera station - 206,114 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Durlacher	577	STCH	46	162	81	—	1,463	2,408
		ASGF	42	132	57	—	793	1,155
		ACCR	29	28	—	—	860	1,140
Uaroo	436	HASP	278	27	—	—	1,480	1,525
		SOSP	119	12	—	—	2,083	2,183
Duffy	358	HASP	82	56	41	—	699	895
		ASGF	—	47	50	10	282	535
		SOSP	40	19	13	—	877	1,200
Yinnietharra	163	ASGF	43	21	9	—	308	365
		STCH	34	16	7	—	387	475
		ACCR	33	—	—	—	660	660
Wash	152	ASGF	16	62	13	—	319	455
		ACCR	8	31	7	—	505	920
		TUGR	3	10	2	—	275	500
Giralia	106	HASP	61	3	—	—	315	320
		SOSP	40	2	—	—	683	700
Channel	59	HASP	45	2	—	—	232	235
		ACCR	5	1	—	—	110	120
		No veg	6	—	—	—	—	—
Windalia	57	ASGF	26	14	6	—	192	230
		ACCR	5	1	—	—	110	120
		STCH	—	3	2	—	22	42
James	47	SSGF	27	13	—	—	151	160
		STCH	5	2	—	—	52	58
Collier	38	ASGF	17	4	—	—	98	105
		SSGF	8	2	—	—	39	40
		STCH	6	1	—	—	55	58
River	18	ACCR	9	—	—	—	180	180
		TUGR	6	—	—	—	300	300
		No veg	3	—	—	—	—	—
Winning	17	BLUE	10	2	—	—	225	240
		SOSP	3	—	—	—	50	50
		STCH	2	—	—	—	17	17
Agamemnon	12	SSGF	11	—	—	—	44	44
		ACCR	—	1	—	—	10	20
Phillips	6	SSGF	5	—	—	—	20	20
		STCH	1	—	—	—	8	8
		ACCR	—	—	—	—	—	—
Capricorn	6	HASP	4	—	—	—	20	20
		SSGF	2	—	—	—	8	8
		ACCR	—	—	—	—	—	—
Billy	5	SSGF	3	—	—	—	12	12
		ASGF	2	—	—	—	10	10
Prairie	2	ASGF	2	—	—	—	10	10
		SSGF	—	—	—	—	—	—
		ACCR	—	—	—	—	—	—
Augustus	2	ASGF	2	—	—	—	10	10
		ACCR	—	—	—	—	—	—
Totals	2,061		1,089	674	288	10	13,974	17,553

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 13,950

Capability sheep unit capacity 17,550

Declared stock numbers (sheep units or equivalent) 1974-1984 (no data for 1968-73):

average (mean) 8,786

highest (1976) 22,656

lowest (1980) 570

Towrana station - Upper Gascoyne Shire

Area 1,627 km²

Location

Towrana station is located wholly on the Wooramel 1:250,000 map sheet. The homestead is about 50 km due south by road from Gascoyne Junction. The station has common boundaries with Winderie, Dairy Creek, Carey Downs, Callytharra Springs, Gilroyd, Meedo and Pimbee stations.

Description

Nearly 60% of the station consists of sandplains with many linear and reticulate dunes up to about 12 m in height. This is the Yalbalgo land system which supports a moderately close or close tall shrubland dominated by wanyu or a woodland of sand dune gidgee. Pastoral value is moderate.

The second largest system on the station is Sandplain (17.8%) which is found mainly in the central west and south of the station. It consists of almost flat or gently undulating red sandplain and supports a close tall shrubland of wanyu with some minor areas of sand dune gidgee woodland. Pastoral value is moderate.

The Yagina land system (6.1%) occurs as isolated patches in north central and north-western parts of the station. It consists of stony plains and stony claypans with small areas of soil covered plains and sandy banks and dunes. It supports scattered tall shrublands of mulga and other acacias and pastoral value is moderate.

The Wooramel system (5.7%) in the east consists of sandy plains and stony plains often with hardpan at shallow depth. It supports tall shrublands of wanyu on the sandy sections and sparse tall shrublands of mulga and other acacias on the more stony plains. Pastoral value is moderate.

The Target system (5.7%) occurs in the south-west of the station. It consists of plains with sandy banks, more clayey inter-bank areas and numerous small drainage foci. It supports tall shrublands of wanyu, silver bark wattle, curara and prickly acacia with numerous low shrubs. The vegetation in the drainage foci is much denser than on the surrounding plains. Pastoral value is high.

The channel of the Wooramel River passes through the southern part of the station and is flanked by the Channel land system (3.6%). The system includes the river channel and banks and adjacent dissected marginal slopes and low breakaways with hardpan exposure. The channels and banks support narrow fringing woodland communities and the dissected slopes support very scattered tall acacia shrublands. Overall pastoral value is low.

A minor system, Sandiman (1.7%) occurs in the north-east of the station. It consists of undulating stony uplands with low breakaways and ridges. It supports scattered tall shrublands of mulga and other acacias with *Cassia* and *Eremophila* species in the low shrub layer. Pastoral value is moderate.

All the land systems on the station are further summarized in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Towrana station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	Channel - major channels and banks with dissected marginal slopes and plains with low breakaways; very scattered tall shrublands	3.6
Moderate (10-19 ha/s.u.)	Yalbalgo - sandplains with large linear and reticulate dunes; close tall shrublands of wanyu or woodlands of sand dune gidgee.	59.4
	Sandplain - nearly flat to gently undulating red sandplains; close tall shrublands of wanyu	17.8
	Yagina - low stony plains, soil covered plains, stony claypans and minor sandy banks and dunes; scattered tall shrublands of mulga, wanyu and other acacias	6.1
	Wooramel - sandy plains and stony plains with hardpan at shallow depth; scattered tall shrublands of wanyu and mulga	5.7
	Sandiman - undulating stony uplands with low breakaways and ridges; scattered tall shrublands of mulga and other acacias	1.7
		90.7
High (5-9 ha/s.u.)	Target - plains with sandy banks, more clayey inter-bank areas and numerous small drainage foci; scattered to moderately close tall shrublands of wanyu, silver bark wattle and other acacias	5.7
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (234 recordings on 7 land systems)

Towrana

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Channel	2	50	—	50	—	—	—	—	100	—	—	—	100
Sandiman	7	100	—	—	—	—	—	86	14	—	—	86	14
Sandplain	26	100	—	—	—	—	46	54	—	—	46	54	—
Target	28	100	—	—	—	7	36	50	7	—	43	50	7
Wooramel	32	97	3	—	—	3	16	43	38	—	19	43	38
Yalbalgo	123	99	1	—	—	—	25	45	29	1	25	45	30
Yagina	16	100	—	—	—	—	19	62	13	6	19	62	19
Total over all land systems	234	99	1	—	—	1	26	48	24	1	27	49	24

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 15 sites on 6 land systems.

Range condition and recommendations

1. Yalbalgo land system (59.4%)

Condition of the Acacia Sandplain (ACSA) pastures of this system is predominantly fair although substantial parts are also in good and poor condition. There is no erosion on the system.

Good condition is indicated by a sparse scattering of useful low shrubs such as tall saltbush, Wilcox bush, flat leaf bluebush and corky bark kallstroemia below the taller wanyu shrubs. In paddocks close to the homestead the pastures show varying degrees of loss of desirable shrubs to fair or poor condition. Wanderrie grasses provide valuable feed in season as do wanyu beans in good seasons. Even when in good conditon the pastures have only limited value in times of drought.

2. Sandplain land system (17.8%)

The system supports the same Acacia Sandplain pasture type as the Yalbalgo system. Pasture condition is about evenly distributed between fair and good and there is no erosion. Fire may be a useful management tool on this system, but its use has not been researched. Evidence seen elsewhere on this system suggests that the effects of fire are very long term. Where the over-storey of wanyu is killed by fire the low shrub layer and ground layer is considerably increased in diversity of species and in density. The fire induced sub-climax vegetation appears to be more productive for livestock production than old stands of mature wanyu.

3. Yagina land system (6.1%)

The system supports Acacia Short Grass Forb (ASGF) pastures on the stony plains and Acacia Sandplain on the sandy units. Pasture condition is mostly fair but varies from poor to good. There is no erosion.

4. Wooramel land system (5.7%)

Condition of the Acacia Sandplain and Acacia Short Grass Forb pastures on the system is mostly fair or poor. Durable low shrubs have been moderately depleted in most areas where the system was assessed. The system should be occasionally spelled from grazing over a growing season to enable the recovery of desirable shrubs.

5. Target land system (5.7%)

The system supports Acacia Sandplain pastures on the sandy banks and Currant Bush Mixed Shrub (CBMS) pastures on the more clayey inter-bank areas. The acacia sandplain pastures are in fair or good condition. Condition of the Currant Bush Mixed Shrub pastures is predominantly fair, but varies from good to poor.

6. Channel land system (3.6%)

The system was insufficiently sampled to be able to make any definite statements about condition.

7. Sandiman land system (1.7%)

Stony Chenopod (STCH) and Stony Short Grass Forb (SSGF) pastures are in fair condition and there is no erosion on the system.

8. Central, northern and eastern parts of the station are well developed in terms of paddocks and watering points. In the south and west the station is only partly developed and some areas are inadequately watered. At the time of survey these latter areas were being run by the adjoining stations Gilroyd and Pimbee by arrangement with the lessee of Towrana.

9. The recommended sheep unit capacity for present condition and assuming that the station is fully developed is 10,200.

10. The capability sheep unit capacity if all country was in good range condition is estimated at 13,700.

Individual station report

Towrana station - 162,735 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Yalbalgo	966	ACSA	241	435	290	—	5,887	8,050
Sandplain	290	ACSA	133	157	—	—	2,090	2,417
Yagina	99	ASGF	14	41	14	—	242	345
		ACSA	5	15	—	—	135	167
		ACMS	2	8	—	—	120	200
Wooramel	93	ACSA	10	23	23	—	319	467
		ASGF	5	13	19	—	116	185
Target	93	CBMS	12	18	12	—	540	840
		ACSA	19	18	—	—	271	308
		ACCR	—	14	—	—	140	280
Channel	58	SSGF	25	24	—	—	180	196
		ACCR	2	1	—	—	50	60
		No Veg	6	—	—	—	—	—
Sandiman	28	STCH	—	15	3	—	85	150
		SSGF	—	9	1	—	32	40
Totals	1,627		474	791	362		10,207	13,705

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 10,200

Capability sheep unit capacity 13,700

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1972):

average (mean) 8,198

highest (1970) 14,991

lowest (1980) none

Wahroonga station - Carnarvon Shire

Area 831 km²

Location

Wahroonga station is located on the Wooramel 1:250,000 map sheet. The homestead is about 120 km south-east from Carnarvon via the North-West Coastal Highway and station access road. The station has common boundaries with Marron, Yalbalgo, Pimbee, Mcedo, Wooramel and Edaggee stations.

Description

Only four land systems namely Yalbalgo, Sandal, Ella and Lyons occur on the station and two of these (Yalbalgo and Sandal) collectively occupy about 96% of the total station area.

The Yalbalgo system occupies the whole of the eastern half of the station. It consists of linear sand dunes with up to 15 m relief above sandy swales and supports a moderately close tall shrubland of wanyu or woodland or sand dune gidgee. Pastoral value is moderate.

The Sandal system is found in the west and consists of nearly flat alluvial plains with numerous low sandy banks and rises. The plains support tall shrublands of various acacias and numerous low shrubs and the sandy banks support tall shrublands of wanyu or silver bark wattle. Pastoral value is high.

The minor systems Ella and Lyons occur in central parts of the station. All systems are further summarized in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Wahroonga station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (21-30 ha/s.u.)	—	—
Moderate (10-20 ha/s.u.)	Yalbalgo - sandplains with linear and reticulate dunes and sandy swales; tall shrublands of wanyu or woodlands of sand dune gidgee	57.0
High (5-9 ha/s.u.)	Sandal - alluvial plains with numerous low sandy banks and rises, duplex and sand soils; mixed tall shrublands of various acacias and numerous low shrubs	38.7
	Ella - short linear dunes and sandy banks, inter-dunal plains with more clayey soils and drainage foci; tall shrublands of wanyu and other acacias	3.5
	Lyons - sandy alluvial plains with numerous large claypans and reticulate and linear dunes; tall shrublands of wanyu and other acacias	0.8
		43.0
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2 Condition statements derived from traverse records (157 recordings on 3 land systems)

Wahroonga

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Ella	1	100	—	—	—	—	100	—	—	—	100	—	—
Sandal	73	100	—	—	—	—	8	39	37	16	8	38	54
Yalbalgo	83	100	—	—	—	17	52	29	2	—	69	29	2
Total over all land systems	157	100	—	—	—	9	32	33	18	8	41	33	26

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at ten sites on two land systems.

Range condition and recommendations

1. Yalbalgo land system (57%)

The Acacia Sandplain (ACSA) pastures of the system are mostly in good or very good condition with only minor parts reduced to fair condition. There is no erosion.

When in good condition the pasture supports very scattered desirable low shrubs such as Wileox bush, corky bark kallstroemia, warty leaf eremophila and cotton bush and wanderrie grasses beneath the taller wanyu shrubs. Because of the general scarcity of palatable shrubs and the rather short lived nature of wanderrie grasses the pastures have limited durability in times of drought. However, they provide good feed in reasonable seasons and should be used on a flexible basis. In general more use could be made of these pastures.

Controlled burning may be a useful management tool on these pastures but its use has not been researched.

2. Sandal land system (38.7%)

The system supports Currant Bush Mixed Shrub (CBMS) pastures on the interbanks and plains with duplex soils and Acacia Sandplain pastures on the sandy banks and rises.

The Currant Bush Mixed Shrub pastures are considerably degraded with marked loss of desirable low shrubs and, in many cases, marked increases in undesirable types such as needle bush, waxy leaf poverty bush and bardie bush. There is no erosion. The pasture is still quite productive in terms of annuals and some useful perennial shrubs, but it is producing at well below potential and its usefulness for drought times is considerably reduced. As on the same system in other parts of the survey area the invasion by undesirable shrubs is a matter of concern. Practical methods of reducing undesirable species and replacing with better species are not known. The Acacia Sandplain pastures of the system are not as badly degraded as the Currant Bush Mixed Shrub pastures being predominantly in fair condition.

3. Ella (3.5%) and Lyons (0.8%) land systems

These small systems were not intensely sampled. They both support Currant Bush Mixed Shrub and Acacia Sandplain pastures as for the Sandal system. The former pastures are likely to be degraded to poor condition and the latter are most likely in fair condition.

4. The station is well developed in terms of paddocks, but is inadequately watered. About half the pastures on the station are > 5 km from permanent stock water supplies. The provision of additional water supplies needs to be considered so that stock can be more equitably distributed and grazing pressure reduced on parts of the Sandal land system.

5. The recommended sheep unit capacity for present condition is 6,150.

6. The capability sheep unit capacity if all country was in good range condition is estimated at 9,300.

Individual station report

Wahroonga station - 83,074 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Yalbalgo	474	ACSA	327	138	9	—	3,624	3,950
Sandal	321	CBMS	—	32	113	—	1,106	2,900
		ACSA	21	69	38	—	758	1,067
		BLUE	—	11	37	—	369	960
Ella	29	ACSA	9	9	2	—	139	167
		CBMS	1	2	3	—	64	120
		ACCR	2	1	—	—	50	60
Lyons	6	ACSA	1	2	—	—	21	25
		CBMS	—	1	1	—	19	40
		ACCR	—	—	—	—	—	—
		No veg	1	—	—	—	—	—
Totals	830		362	265	203	—	6,150	9,289

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 6,150

Capability sheep unit capacity 9,300

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 7,639

highest (1969) 10,987

lowest (1980) 2,637

Wandagee station - Carnarvon Shire

Area 1,924 km²

Location

Wandagee station is located on the Winning Pool and Kennedy Range 1:250,000 map sheets. The homestead is close to the Minilya River, 60 km east of the Minilya bridge which is about 135 km north of Carnarvon on the North-West Coastal Highway. The station has common boundaries with Minilya, Mia Mia, Middalya, Hill Springs and Manberry stations.

Description

The Minilya River passes from east to west through the centre of the station. Barrabiddy Creek, a large tributary of the Minilya River, passes through the southern part.

Eighteen land systems occur on the station and ten of these (about 44% of the total station area) are of high pastoral value. One system, Barrabiddy (7.2%), is of very high pastoral value when in good range condition.

The largest system on the station is Jimba (26.3%). It occurs in the eastern half and consists of gently sloping alluvial plains with diffuse drainage zones, minor pebbly plains and low ridges. It supports tall and low shrublands with snakewood and other acacias and numerous low shrubs including various bluebush types and cassias.

The Giralia system (13%) is the second largest. It occurs mostly in the north-west and north-east and is little grazed. It supports spinifex hummock grasslands on sandplain with large linear dunes.

A number of important alluvial plain systems associated with the Minilya River and Barrabiddy Creek occur in the centre and south of the station. These include Target (9.5%), Barrabiddy (7.2%), Sandal (6.7%) and River (2.3%). All these systems support scattered to moderately close tall shrublands dominated by acacias such as snakewood, curara, silver bark wattle and wanyu, with numerous low shrubs.

Spot (5.8%) is a productive system lying to the north of the Minilya River between the low plains of the Jimba and Target systems and the spinifex sandplain of the Giralia system. It consists of alluvial plains with numerous low sandy banks and rises supporting tall acacia shrublands and some spinifex.

The Wandagee system (5.4%) in the centre of the station, is a distinctive nearly flat stony and clayey plain system based on sedimentary rocks of Permian age. It supports scattered tall shrublands of acacias with variable low shrubs including useful bluebush and saltbush.

In the south-west the predominant systems are O'Brien (4.5%) and Mary (4.3%). O'Brien consists of tributary alluvial plains and slightly more elevated upper plains and interfluves. It supports tall shrublands dominated by spreading gidgee and the vegetation is frequently arranged in dense groves interspersed with less dense inter-grove areas across the plains. The Mary system consists of gently sloping plains with calcrete at the surface or at shallow depth. It supports scattered to moderately close tall shrublands with silver bark wattle and spreading gidgee and a prominent and characteristic low shrub layer of cassias.

Saline plains and low calcrete rises of the Yalkalya (5.1%) occur in the far north. The system supports scattered tall and low shrublands with snakewood, bluebush and saltbush.

Seven other small systems occur on the station. All systems are further summarized and their pastoral value for good range condition status indicated in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Wandagee station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (21-30 ha/s.u.)	Fossil - rugged hills and ridges of sedimentary rocks; sparse tall acacia shrublands	0.3
Moderate (10-20 ha/s.u.)	Jimba - gently sloping alluvial plains with diffuse drainage zones, minor pebbly plains and low ridges; scattered tall and low shrublands of *Acacia* and *Eremophila* species and chenopods	26.3
	Giralia - sandy plains with large linear dunes; hummock grasslands of hard and soft spinifex with numerous shrubs	13.0
	O'Brien - tributary alluvial plains and slightly more elevated upper plains and interfluves; tall acacia shrublands often with vegetation banded in groves	4.5
	Yalbalgo - sandplains with linear and reticulate dunes and sandy swales; tall shrublands of wanyu	3.5
	Windalia - stony plains and narrow dissected upper interfluves on radiolarite; very scattered tall shrublands of spreading gidgee	1.3
	Uaroo - nearly flat sandy plains and minor pebbly plains; hummock grasslands of hard spinifex with numerous shrubs	0.3
		48.9

Table 1 continued...

Pastoral value	Land systems	Area %
High (5-9 ha/s.u.)	Target - plains with sandy banks and more clayey inter-bank areas with numerous small drainage foci; scattered tall acacia shrublands with numerous low shrubs	9.5
	Sandal - alluvial plains with numerous low sandy banks and rises, duplex and sand soils; mixed tall shrublands various acacias and numerous low shrubs	6.7
	Spot - alluvial plains and plains with reticulate sandy banks and more clayey inter-bank areas; mixed tall shrublands of snakewood and other acacias some hard spinifex	5.8
	Wandagee - nearly flat stony plains and clayey plains with broad drainage zones and outcrop rises on sedimentary rocks; scattered tall shrublands of snakewood and other acacias with bluebush and saltbush	5.4
	Yalkalya - saline alluvial plains and low calcrete rises, scattered tall and low shrublands with snakewood, bluebush and saltbush	5.1
	Mary - gently sloping plains with calcrete at surface or at shallow depth, minor calcrete rises; tall shrublands of spreading gidgee and silver bark wattle with numerous cassias low shrubs	4.3
	Channel - major channels with narrow floodplains and dissected marginal slopes; fringing woodlands along channels, scattered shrublands of snakewood and bluebush	2.9
	River - narrow, active floodplains and major channels, fringing woodlands and tall acacia shrublands	2.3
	Gearle - gently sloping alluvial plains, minor low rises with more sloping marginal plains; scattered tall acacia shrublands and low shrublands of bluebush	0.9
	Winning - low rises, extensive lower plains and broad drainage tracts; scattered tall shrublands of snakewood with bluebush and saltbush	0.7
		43.6
Very high (< 5 ha/s.u.)	Barrabiddy - active flood plains and broad drainage zones with numerous channels; tall shrublands of snakewood and other acacias with bluebush and saltbush	7.2
		100.0

Table 2 Condition statements derived from traverse records (300 recordings on 16 land systems)

Wandagee

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Barrabiddy	39	43	36	13	8	3	5	33	36	23	8	33	59
Channel	6	50	33	17	—	17	—	66	17	—	17	50	33
Fossil	1	100	—	—	—	—	—	100	—	—	—	100	—
Gearle	10	90	—	10	—	20	20	30	30	—	40	20	40
Giralia	5	100	—	—	—	20	80	—	—	—	100	—	—
Jimba	83	68	24	7	1	—	12	37	35	16	12	37	51
Mary	13	100	—	—	—	8	38	54	—	—	46	54	—
O'Brien	10	100	—	—	—	—	30	40	30	—	30	40	30
River	6	67	33	—	—	17	33	33	17	—	50	33	17
Sandal	8	100	—	—	—	—	87	13	—	—	87	13	—
Spot	12	100	—	—	—	8	51	33	8	—	59	33	8
Target	38	97	3	—	—	13	24	47	16	—	37	47	16
Wandagee	49	69	31	—	—	—	—	18	41	41	—	18	82
Windalia	5	80	20	—	—	—	—	60	40	—	—	60	40
Yalbalgo	3	100	—	—	—	—	100	—	—	—	100	—	—
Yalkalya	12	50	25	8	17	17	41	17	8	17	58	17	25
Total over all land systems	300	74	19	5	2	5	19	34	27	15	24	33	43

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 28 sites on 11 land systems.

Range condition and recommendations

1. Jimba land system (26.3%)

The system supports Acacia Short Grass Forb (ASGF) and Stony Chenopod (STCH) pastures. In general both types have lost desirable shrub species and are degraded to fair, poor or very poor condition. Minor and moderate erosion in the form of rilling, hummocking and thin sheeting is common on drainage plains and other parts not protected by a stony surface mantle. Some 50% of traverse records indicated poor range condition. In particular parts of Nalbia paddock are severely degraded. The paddock requires spelling over a number of consecutive growing seasons and conservative stocking at other times. Regeneration treatments involving soil cultivation and seeding should be considered.

2. Giralia land system (13%)

Hard Spinifex (HASP) and Soft Spinifex (SOSP) pastures are in good condition. Much of the system in the north of the station is not grazed because of the lack of stock waters. The provision of additional water supplies needs to be considered to enable use of this system and other systems in the north.

3. Target land system (9.5%)

The system supports productive Currant Bush Mixed Shrub (CBMS) pastures on inter-bank alluvial plain parts and less productive Acacia Sandplain (ACSA) pastures on sandy banks and rises. The former pastures are moderately degraded to fair range condition and the latter pastures are mostly in fair or good condition. There is no significant erosion.

4. Barrabiddy land system (7.2%)

This floodplain system supports Saltbush (SALT) and Tussock Grass (TUGR) pastures beneath snakewood and bardie bush and numerous other tall and low shrubs. Although the system is still moderately productive the pastures are often seriously degraded with extensive areas in very poor condition. Erosion in the form of rilling, guttering, sheeting and hummocking is common.

About 24 km^2 (18%) of the system is severely degraded with gross loss of desirable shrubs and active erosion. The worst affected areas are in parts of Mokine, Mungadan, Nalbia and Koolkilya paddocks and in the small paddocks near the shearing shed. A long term regeneration programme, involving complete destocking and soil cultivation and seeding where applicable, needs to be commenced in one or other of these paddocks and progressively carried through to the other paddocks.

5. Sandal land system (6.7%)

This system was not intensively sampled but where seen the Acacia Sandplain pastures were in good condition. Currant Bush Mixed Shrub pastures are likely to be somewhat degraded.

6. Spot land system (5.8%)

The most important pasture on the system is the Currant Bush Mixed Shrub type which is somewhat degraded to fair condition. It is likely that parts more distant from water are in better condition. There is no erosion on the system.

7. Wandagee land system (5.4%)

Saltbush and Stony Chenopod pastures are nearly all degraded to poor or very poor condition with large areas supporting only a very scattered cover of low shrubs. There is little erosion on the system, but productivity and drought durability are well below potential and over all range condition is poor.

The pastures have the potential to recover, but will require protection from use for a number of years and conservative grazing at other times. Strip cultivation and seeding works in the past have promoted the establishment of desirable saltbush shrubs but unless grazing pressure is carefully controlled the beneficial results of such treatments can be quickly nullified.

Most of the system falls within Mungadan, Nalbia and Koolkilya paddocks all of which have been previously mentioned (see 4) as requiring regeneration. One or other of these paddocks should be closed to grazing for a number of years and remedial works commenced. Such a programme should then be progressively extended to the other paddocks in the future.

8. Yalkalya land system (5.1%)

The system supports a mixture of Saltbush and Bluebush pastures and also some Hard Spinifex. Pasture condition varies from good to very poor largely depending on distance from water. Some parts of the system probably receive very little use because of the excessive distance from permanent water. Pastures near Quailing dam are over used and show minor to severe water erosion.

9. Condition of the remaining land systems on the station are summarized in table 2. Generally there is little erosion although parts of the Gearle system are inherently susceptible. Pasture condition is variable ranging from good to poor.

10. In some outlying parts, for example North Coolanberry and South Coolanberry paddocks in the north-west, the station is inadequately watered. Watered areas in central paddocks have carried excessive stock numbers in the past and as a consequence many pastures are significantly degraded. Additional water points are required so that a spelling programme can be commenced on degraded saltbush and bluebush pastures. Because of the general absence of good ground water these additional points may need to be provided by pipeline from existing supplies or as new dams.

11. The recommended sheep unit capacity for present condition and assuming the station is fully watered is 16,500.

12. The capability sheep unit capacity if all country was in good range condition is estimated at 24,800.

Individual station report

Wandagee station - 192,376 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Jimba	507	STCH	43	112	175	—	1,502	2,750
		ASGF	—	60	67	—	368	635
		ACSA	—	50	—	—	313	417
Giralia	250	HASP	150	—	—	—	750	750
		SOSP	100	—	—	—	1,667	1,667
Target	184	CBMS	12	52	19	—	1,009	1,660
		ACSA	39	31	4	—	535	617
		ACCR	—	27	—	—	270	540
Barrabiddy	139	SALT	—	38	35	24	694	1,940
		TUGR	8	8	26	—	504	1,400
Sandal	128	CBMS	50	8	—	—	1,100	1,160
		ACSA	44	7	—	—	410	425
		BLUE	17	2	—	—	365	380
Spot	112	CBMS	—	54	13	—	756	1,340
		HASP	34	—	—	—	170	170
		ACSA	11	—	—	—	92	92
Wandagee	104	SALT	—	9	39	4	357	1,040
		STCH	—	4	17	—	77	175
		ACCR	—	16	—	—	160	320
		HASP	15	—	—	—	75	75
Yalkalya	99	SALT	23	6	16	—	635	900
		BLUE	22	6	16	—	615	880
		HASP	8	2	—	—	47	50
O'Brien	87	ASGF	13	18	13	—	158	220
		STCH	7	8	7	—	122	183
		ACCR	7	8	6	—	250	420
Mary	83	ACMS	36	43	—	—	1,150	1,580
		BLUE	2	2	—	—	65	80
Yalbalgo	66	ACSA	33	—	—	—	275	275
		HASP	33	—	—	—	165	165
Channel	56	BLUE	5	14	9	—	331	560
		ACCR	3	9	5	—	175	340
		No veg	11	—	—	—	—	—
River	45	ACCR	11	8	4	—	320	460
		TUGR	8	5	3	—	512	800
		No veg	6	—	—	—	—	—
Windalia	25	ASGF	—	12	8	—	60	100
		ACCR	—	2	1	—	25	60
		STCH	—	1	1	—	8	17
Gearle	16	BLUE	4	2	4	—	130	200
		SALT	2	1	2	—	65	100
		TUGR	—	1	—	—	20	50
Winning	12	BLUE	4	4	—	—	130	160
		SOSP	2	—	—	—	33	33
		STCH	2	—	—	—	17	17
Uaroo	6	HASP	4	—	—	—	20	20
		SOSP	2	—	—	—	33	33
Fossil	5	ASGF	5	—	—	—	25	25
Totals	1,924		776	630	490	28	16,560	24,781

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 16,550

Capability sheep unit capacity 24,800

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 20,408

highest (1976) 27,465

lowest (1979) 14,430

Warroora station - Carnarvon Shire

Area 1,077 km²

Location

Warroora station is located on the Minilya and Winning Pool 1:250,000 map sheets. The homestead is about 163 km north from Carnarvon via the North-West Coastal Highway and the Minilya-Exmouth road. The station has common boundaries with Cardabia, Mia Mia and Minilya stations and a coastline along the Indian Ocean in the west.

Description

Ten land systems occur on the station. All are accessible to livestock and most are of high pastoral value.

The largest system is Cardabia (30.5% of the total station area) which occurs as a large single area in the west and north-west. It consists of undulating sandy plains with linear dunes and minor limestone ridges and supports hummock grasslands of soft and hard spinifex with numerous shrubs. Near the homestead the spinifex has been replaced by introduced buffel grass.

The Coast land system (2.4%) occurs as a narrow strip along the coastline to the immediate west of the Cardabia system. It is comprized of large, long walled parabolic coastal dunes and narrow swales with beaches and minor areas of limestone exposure. It supports a wide range of tall and low shrubs with some soft spinifex and buffel grass.

Gently sloping outwash plains and more elevated stony limestone plains of the Donovan system (28.7%) occur as a strip running the full length of the eastern side of the station. The outwash plains support low shrublands of Gascoyne bluebush with scattered tall shrubs of snakewood. Slightly more elevated plains support moderately close tall shrublands dominated by silver bark wattle with numerous low shrubs.

The Warroora system (13.5%) occurs in the centre of the station and consists of nearly flat, saline alluvial plains with sluggish drainage tracts and prominent drainage foci and minor sandy banks. It supports low shrublands of samphire, bluebush and saltbush on the plains and tall shrublands mainly of silver bark wattle on the sandy banks.

Elevated limestone plains of the Trealla land system (13.1%) occur in the south-west of the station and also as smaller outliers in the Warroora system in central parts. The system supports moderately close to close tall shrublands dominated by silver bark wattle, curara and snakewood with numerous useful low shrubs.

The Chargoo system (5.9%) is a productive system found in the south central part of the station immediately at the head of Lake McLeod. It consists of nearly flat, highly saline alluvial plains with numerous large drainage foci and swampy depressions supporting low shrublands of various saltbush types, frankenia and samphire.

The Jubilee (3.4%) and Firecracker (2.3%) systems occur in the north-east of the station as low hills and elevated limestone uplands. The Jubilee system supports hummock grasslands of hard and soft spinifex with scattered shrubs and the Firecracker system supports low shrublands of Gascoyne bluebush with very scattered tall shrubs, mainly snakewood.

Two other very small systems Marloo and Gearle occur on the station but are of little significance. All systems are further summarized and their pastoral value for good condition status indicated in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Warroora station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Jubilee - limestone hills and undulating stony plains, hummock grasslands of hard and soft spinifex with numerous shrubs	3.4
High (5-9 ha/s.u.)	Cardabia - undulating sandy plains with linear dunes, minor limestone ridges and outcrop plains, hummock grasslands of soft and hard spinifex with numerous shrubs	30.5
	Donovan - gently sloping outwash plains and minor limestone plains; low shrublands of Gascoyne bluebush and snakewood, also moderately close tall shrublands of silver bark wattle and other acacias	28.7
	Warroora - nearly flat saline alluvial plains, sluggish drainage tracts and prominent drainage foci, minor limestone outcrop plains and sandy banks; low shrublands of samphire, Gascoyne bluebush and saltbush, also tall shrublands of silver bark wattle	13.5
	Trealla - elevated limestone plains and plains with thin sand cover, minor steeper marginal slopes; moderately close tall shrublands of silver bark wattle and snakewood, also some low shrublands of Gascoyne bluebush	13.1
	Chargoo - nearly flat, saline alluvial plains with numerous large drainage foci and swampy depressions; low shrublands of saltbush, frankenia and samphire	5.9

Table 1 continued...

Pastoral value	Land systems	Area %
	Coast - large parabolic coastal dunes and narrow swales, unstable blow-out areas, minor limestone plains and beaches; low shrublands of acacias and numerous other shrubs, some soft spinifex	2.4
	Firecracker - undulating limestone uplands and plains; low shrublands of Gascoyne bluebush with scattered snakewood	2.3
	Marloo - gilgai alluvial plains with clay soils; tussock grasslands of Roebourne plains grass and other perennial grasses	0.1
	Gearle - gently sloping alluvial plains, minor low rises with more sloping marginal plains; scattered tall shrublands with snakewood and wait-a-while with saltbush and bluebush	0.1
		96.6
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (132 recordings on 6 land systems)

Warroora

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Cardabia	57	100	—	—	—	70	23	7	—	—	93	7	—
Chargoo	18	94	6	—	—	6	39	44	11	—	44	45	11
Coast	2	100	—	—	—	100	—	—	—	—	100	—	—
Donovan	18	100	—	—	—	33	45	22	—	—	78	22	—
Trealla	7	100	—	—	—	14	43	43	—	—	57	43	—
Warroora	30	100	—	—	—	23	60	17	—	—	83	17	—
Total over all land systems	132	99	1	—	—	43	37	18	2	—	80	18	2

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 13 sites on 5 land systems.

Range condition and recommendations

1. Cardabia land system (30.5%)

Soft Spinifex (SOSP) and Hard Spinifex (HASP) pastures are in good or very good condition and there is no erosion. Near the homestead and elsewhere introduced buffel grass has replaced the spinifex.

The system is generally stable under grazing except for occasional localized dunes and dune crests which may become unstable due to the effects of fire or excessive grazing pressure. Fire is a natural feature of the environment and regular, controlled burning is a managment tool to maintain pastures in an attractive condition for livestock. Some sand drift can occur after fire, but the system revegetates rapidly after rain and stabilizes.

2. Donovan land system (28.7%)

The system supports productive Bluebush (BLUE) and Acacia Mixed Shrub (ACMS) pastures. Pasture condition is predominantly good or very good and there is no erosion.

Much of this system in the north-east and east of the station is little grazed as it is well in excess of 5 km from stock water supplies. The pastures are durable and productive and additional waters are required to bring the system into full use. The use of dams needs to be considered as underground supplies are known to be difficult to obtain.

3. Warroora land system (13.5%)

Pastures are Saltbush (SALT) and Bluebush with some areas of Samphire (SAMP). Pasture condition is predominantly good but ranges from fair to very good. A wide range of desirable low shrubs such as Gascoyne bluebush, low bluebush, sage, bladder saltbush and silver saltbush are present. These provide nutritious and durable feed, but have a high salt content. Salt intake by sheep grazing these pastures may be excessive especially if water supplies are also salty as is frequently the case. High salt intake restricts the grazing radii of sheep and limits the use that can be made of the available pastures.

Some extensive areas of the Warroora system (e.g. in Home Tank paddock and East Bore paddock) are little used due to the excessive distance from stock waters. Additional good quality supplies are required so that pastures can be fully used.

4. Trealla land system (13.1%)

Acacia Mixed Shrub pastures and Bluebush pastures are in fair or good condition. Areas in fair condition such as Bulbarli paddock would benefit from spelling over a number of growing seasons.

5. Chargoo land system (5.9%)

Saltbush, Bluebush and Samphire pastures are nearly all in fair or good condition. Good quality waters are needed in order to make maximum use of the saline pastures.

6. Coast land system (2.4%)

This system was not intensively sampled. Where seen south of the homestead it supported buffel grass pastures which were in good condition. Pasture condition elsewhere is expected to be good as much to the system is distant from water supplies. However, the system is inherently susceptible to wind erosion if the vegetation is depleted and thus, if it is to be brought into full use, very careful control of stocking intensity would be essential. About 1 sq km of bare sandy blowout occurs on the coast close to Upper Bulbarli well and, ideally, this area should be fenced out.

7. Jubilee (3.4%), Firecracker (2.3%), Marloo (0.1%) and Gearle (0.1%) systems

These isolated systems were not examined. They are all distant from water and very little used and are expected to be in good range condition.

8. The station is inadequately watered and many of the existing waters are fairly saline which restricts the use that can be made of the available pastures in particular the saline pasture types. As mentioned under 2, 3 and 5 additional good quality waters (probably from dams) are required.

9. The recommended sheep unit capacity for present condion and assuming the station is fully watered (which is not the case, see 8) is 16,350.

10. The capability sheep unit capacity if all country was in good range condition is estimated at 18,500.

Individual station report

Warroora station - 107,653 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Cardabia	329	SOSP	245	18	—	—	4,233	4,383
		HASP	61	5	—	—	322	330
Donovan	309	BLUE	105	65	—	—	2,913	3,400
		ACMS	84	9	—	—	1,770	1,860
		SOSP	40	6	—	—	717	767
Warroora	145	BLUE	54	11	—	—	1,218	1,300
		SALT	48	10	—	—	1,085	1,160
		SAMP	18	4	—	—	85	88
Trealla	140	ACMS	44	89	—	—	1,770	2,660
		BLUE	5	2	—	—	125	140
Chargoo	64	SALT	15	16	4	—	525	700
		SAMP	10	9	—	—	70	76
		BLUE	4	5	1	—	149	200
Jubilee	37	HASP	17	3	—	—	95	100
		SOSP	13	2	—	—	233	250
		ACCR	2	—	—	—	40	40
Coast	26	CDSH	15	5	—	1	223	263
		TUGR	5	—	—	—	250	250
Firecracker	25	BLUE	25	—	—	—	500	500
Marloo	1	TUGR	1	—	—	—	18	18
Gearle	1	BLUE	1	—	—	—	20	20
Totals	1,077		812	259	5	1	16,361	18,505

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 16,350

Capability sheep unit capacity 18,500

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 13,329

highest (1974) 17,853

lowest (1981,83) 8,669

Williambury station - Carnarvon and Upper Gascoyne Shires

Area 2,728 km²

Location

Williambury station is located on the Winning Pool and Kennedy Range 1:250,000 map sheets. The homestead is about 135 km east of the Minilya River bridge which is on the North-West Coastal Highway about 135 km north of Carnarvon. The station shares common boundaries with Lyndon, Mangaroon, Minnie Creek, Mardathuna and Middalya stations and the Kennedy Range National Park.

Description

Twenty-five different land systems occur on the station and landforms are complex and variable. The Minilya River and the Minilya River south branch run through northern and central parts.

The eastern part of the station is comprised of rugged hills and ridges of the Agamemnon (9.8%) and James (3.5%) systems and stony uplands and plains of the Phillips (7.9%) and Durlacher (9.9%) systems. These systems are all based on or derived from Proterozoic age granitic and gneissic rocks and frequently have a surface mantle of white quartz fragments. They support scattered tall shrublands of mulga and other acacias. Pastoral value varies from very low to moderate depending on the accessibility to stock.

The Two Hills (4.0%), Pells (3.7%) and Fossil (2.8%) systems occur as lines of hills, mesas and ridges running from the north to the south-east through the station. They are based on sedimentary rocks of Permian age. Parts of these systems are poorly accessible and pastoral value is generally low.

Two important plain systems derived from Permian age sediments, namely Jimba (19.9%) and Mantle (5.8%) occur in the western half of the station. The Jimba system consists of gently sloping alluvial plains with broad drainage tracts and minor pebbly plains. It supports scattered shrublands with numerous palatable low shrubs. Pastoral value is moderate to high, but the system is prone to degradation and erosion. The Mantle system is more stable in that most of its undulating plains are protected by a surface mantle of stones and pebbles.

A number of sandplain and sand dune systems are found in the north-west and south-west. These are the systems Divide (4.5%), Yalbalgo (1.2%), Giralia (1.0%) and Kennedy (4.9%). Kennedy occurs as a remarkable elevated red sand dune system perched on the high plateaux surface of the Kennedy Range. It supports spinifex hummock grasslands with numerous shrubs and is of very little use for grazing.

Numerous other small systems occur and of these River (2.7%), Wash (2.3%), Gneudna (1.8%) and Bidgemia (1.1%) are of high pastoral value.

All systems on the station are further summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from data recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Williambury station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Moogooloo - deeply dissected plateaux, mesas and hills of sedimentary rocks, steep footslopes and narrow valleys; scattered tall shrublands of mulga and other acacias	8.0
Low (20-30 ha/s.u.)	Agamemnon - rough hills and ridges of crystalline rocks; scattered tall shrublands of mulga and other acacias	9.8
	Kennedy - elevated sandy plains with large linear and reticulate dunes; hard spinifex hummock grasslands with numerous shrubs	4.9
	Two Hills - Hills and stony footslopes of sedimentary rocks; scattered tall shrublands of mulga and other acacias	4.0
	Pells - low hills, ridges and mesas of sedimentary rocks, stony slopes and lower plains; scattered tall shrublands of mulga and other acacias	3.7
	James - low granite hills and ridges, undulating stony plains and lower plains; scattered tall shrublands of mulga and other acacias	3.5
	Fossil - rugged hills, ridges and plateaux of sedimentary rocks; scattered tall shrublands of mulga and other acacias	2.8
	Glenburgh - rugged granite hills, stony uplands and lower plains; scattered tall shrublands of mulga and other acacias	1.1
	Billy - low plateaux, mesas and buttes with stony footslopes and narrow drainage floors; very scattered tall shrublands of mulga and other acacias	< 0.1
		29.8

Table 1 continued...

Pastoral value	Land systems	Area %
Moderate (10-19 ha/s.u.)	Jimba - gently sloping alluvial plains with diffuse drainage tracts, minor pebbly plains and low ridges; scattered tall and low shrublands of *Acacia* and *Eremophila* species and chenopods	19.9
	Durlacher - gently sloping stony plains with broad drainage tracts and low stony rises; scattered tall and low shrublands of *Acacia* and *Eremophila* species and chenopods	9.9
	Phillips - undulating stony uplands and low hills of crystalline rocks; scattered tall shrublands of mulga and other acacias	7.9
	Mantle - gently undulating stony plains with sluggish drainage tracts, stony rises and low summits, scattered tall and low shrublands of *Acacia* and *Eremophila* species and chenopods	5.8
	Divide - gently undulating sandplains with occasional low dunes; hard spinifex tussock grassland with numerous shrubs	4.5
	Lyons - sandy alluvial plains with numerous large claypans and reticulate and linear dunes; tall shrublands of numerous acacias	1.6
	Yinnietharra - gently sloping sandy plains and broad drainage tracts, minor stony plains and low granite hills; scattered tall shrublands of mulga and other acacias	1.4
	Yalbalgo - sandplains with linear and reticulate dunes; moderately close tall shrublands of wanyu	1.2
	Giralia - sandy plains with large linear dunes; hummock grasslands of soft and hard spinifex with numerous shrubs	1.0
	Wooramel - sandy plains and stony plains often with hardpan at shallow depth; tall shrublands of mulga and other acacias	0.5
		53.7
High (5-9 ha/s.u.)	River - narrow active floodplains and major channels; fringing woodlands of river gum and tall shrublands	2.7
	Wash - sandy alluvial plains and broad drainage zones receiving more concentrated sheet flow; moderately close tall shrublands of spreading gidgee and other acacias	2.3
	Gneudna - almost flat plains with calcareous soils and parallel bands of siltstone and limestone outcrop, tall shrublands of acacias and chenopods	1.8
	Bidgemia - tributary alluvial plains with sandy banks and minor dunes; tall shrublands of acacias and some chenopods	1.1
	Cahill - sandy outwash plains with channels; moderately close tall shrublands of acacias	0.4
	Wandagee - nearly flat stony and clayey plains with broad drainage zones and outcrop rises of sedimentary rocks; scattered tall shrublands of snakewood and other acacias	0.2
		8.5
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (334 recordings on 18 land systems)

Williambury

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Agamemnon	6	100	—	—	—	—	—	50	50	—	—	50	50
Divide	21	95	5	—	—	62	24	—	14	—	86	—	14
Durlacher	56	87	13	—	—	—	5	30	51	14	5	30	65
Fossil	4	75	25	—	—	—	—	100	—	—	—	100	—
Gneudna	20	80	10	10	—	—	—	35	30	30	—	35	65
Jimba	107	55	23	15	7	1	25	37	25	12	26	36	38
James	1	100	—	—	—	—	—	—	100	—	—	—	100
Kennedy	11	100	—	—	—	100	—	—	—	—	100	—	—
Lyons	7	100	—	—	—	86	14	—	—	—	100	—	—
Moogooloo	5	80	—	20	—	60	20	—	20	—	80	—	20
Mantle	34	88	9	3	—	—	9	41	38	12	9	38	53
Pells	7	57	29	14	—	—	14	72	14	—	14	72	14
Phillips	26	92	8	—	—	—	27	57	4	12	27	58	15
River	9	89	11	—	—	34	33	22	11	—	67	22	11
Thomas	2	100	—	—	—	—	—	100	—	—	—	100	—
Two Hills	8	74	13	13	—	13	25	49	13	—	38	49	13
Wash	6	67	33	—	—	—	—	83	17	—	—	83	17
Yalbalgo	4	100	—	—	—	—	50	50	—	—	50	50	—
Total over all land systems	334	77	14	7	2	11	16	37	26	10	28	35	37

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 21 sites on 10 land systems.

Range condition and recommendations

1. Jimba land system (19.9%)

The Jimba system is derived from soft sediments of Permian age with much less stony surface mantle than some other Permian systems such as Mantle. It is inherently highly susceptible to erosion if the vegetative cover is depleted.

Stony Chenopod (STCH) and Acacia Short Grass Forb (ASGF) pastures vary in condition from good to very poor. In many instances desirable low shrubs such as sago bush, ruby saltbush and Gascoyne mulla mulla are seriously depleted. (Some 37% of traverse records indicated poor or very poor pasture condition).

Water erosion in the form of rills, shallow gullies and surface sheeting and ranging in severity from minor to severe is common on unprotected plains.

At least 24 km^2 of the system is extremely degraded with severe erosion and pasture depletion and should not be used for grazing. The areas of concern are concentrated in West Gneudna paddock (southern end), Shearing paddock and South Branch paddock. A programme of regeneration involving protection from grazing and possibly soil cultivation and seeding needs to be undertaken.

Other parts of the Jimba system such as in Norton's paddock and Kimber's paddock have not received as heavy use and are in better condition. However, even here the inherent fragility of the system is evidenced by active erosion near Kimber well. The Jimba system in these two paddocks is not well watered and additional supplies are required so that more use can be made of the available pastures. However, very careful control of grazing intensity and season of use will be needed in order to ensure that soil stability is maintained.

2. Durlacher land system (9.9%)

Stony Chenopod and Acacia Short Grass Forb pastures are all more or less degraded. Almost two-thirds of the traverse records indicated poor or very poor pasture condition. There is very little erosion as most of the system has a stony surface mantle which protects the soil.

3. Agamemnon land system (9.8%)

This rough hill system was not intensively sampled, but where seen the Stony Short Grass Forb (SSGF) pastures were in fair or poor condition. Much of the system is little used because of lack of permanent water supplies and some difficulty of access. Over all pasture condition is likely to be good. The pastures provide little in the way of durable shrubs for drought times, but opportunistic use of annuals can be made after good seasons.

4. Moogooloo land system (8%)

This rugged system is difficult of access and provides only very limited rough grazing. Pasture condition is mostly good.

5. Phillips land system (7.9%)

This stony system supports Stony Short Grass Forb pastures with minor areas of better quality Acacia Creek-line (ACCR) and Stony Chenopod pastures. Pasture condition is mostly fair and there is negligible erosion.

6. Mantle land system (5.8%)

This accessible system supports useful Stony Chenopod pastures with some areas of less productive Stony Short Grass Forb pastures. Much of the system occurs in paddocks close to the old Moogooree homestead and pastures are degraded to poor or very poor condition, but there is little erosion. Further afield the system is mostly in fair condition.

7. Kennedy land system (4.9%)

This sand dune system lies on top of the Kennedy Range. Vegetation is predominantly Hard Spinifex (HASP) and the area is not used for grazing.

8. Divide land system (4.5%)

This system supports predominantly Hard Spinifex pastures with some areas of more useful shrubs. Pasture condition is good or very good and there is no erosion.

9. Two Hills (4%), Pells (3.7%), James (3.5%), and Fossil (2.8%) land systems

Parts of these hill systems are almost inaccessible to stock. Elsewhere they provide only limited rough grazing. They were not intensively sampled but where seen the pastures were in fair or good condition.

10. River land system (2.7%)

The banks and narrow floodplains of this system flank the Minilya River and support Acacia Creek-line pastures and buffel grass Tussock Grass pastures (TUGR). Pasture condition is mostly good or very good.

11. Gneudna land system (1.8%)

This small, but potentially productive system supports Bluebush (BLUE) pastures and Stony Chenopod pastures. The system is attractive to stock and appears to have been preferentially grazed in the past. Pasture condition is about evenly distributed between fair, poor and very poor and there are localized areas of erosion. Degraded areas occur near Gneudna bore and Mymabalya tank and these areas require spelling for a number of growing seasons.

12. The remaining 11 land systems collectively occupy less than 11% of the total station area. They were not intensively sampled, but where seen were generally in reasonable condition.

13. Williambury is a very large station with many diverse landforms and pasture types making management difficult. Many land systems are rugged and stony and provide only poor to fair grazing. However, these systems are resistant to erosion and are in better condition than the softer plain systems. If possible, more use should be made of the stony systems in the east and south-east so that grazing pressure on degraded systems elsewhere can be reduced.

14. Some of the most productive systems on the station are those plain systems derived from Permian and Devonian age sediments (Jimba, Mantle and Gneudna) and also the Durlacher system and the flood plain River system. Unfortunately some of these (especially Jimba) are highly susceptible to erosion, are degraded and are currently producing at well below their potential. Special treatments including complete protection from grazing, protection at strategic times during growing seasons and conservative use at other times are needed in order to improve condition. Some areas may require soil cultivation and seeding to hasten recovery.

15. In general the station is well developed in terms of paddocks and water supplies.

16. The recommended sheep unit capacity for present condition is 14,050.

17. The capability sheep unit capacity if all country was in good range condition is estimated at 20,150.

Individual station report

Williambury station - 272,756 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Jimba	543	STCH	95	113	121	24	1,760	2,942
		ASGF	30	76	30	—	478	680
		ACSA	12	24	18	—	322	450
Durlacher	269	STCH	8	30	96	—	537	1,117
		ASGF	3	37	68	—	308	540
		ACCR	—	14	13	—	205	540
Agamemnon	268	SSGF	164	63	14	—	894	964
		ACCR	18	7	2	—	440	540
Moogooloo	218	ASGF	126	81	11	—	928	1,090
Phillips	214	SSGF	50	106	15	—	587	688
		STCH	—	16	16	—	133	267
		ACCR	—	6	5	—	85	220
Mantle	159	STCH	4	37	62	—	425	858
		SSGF	3	23	30	—	149	224
Kennedy	132	HASP	132	—	—	—	665	665
Divide	123	HASP	95	—	16	—	515	555
		ACCR	10	—	2	—	210	240
Two Hills	111	SSGF	42	55	14	—	379	444
Pells	103	ASGF	7	33	6	—	160	230
		SSGF	6	30	5	—	134	164
		ACCR	2	12	2	—	170	320
James	95	SSGF	41	27	13	—	280	324
		STCH	7	5	2	—	90	117
Fossil	76	ASGF	24	43	9	—	286	380
River	73	ACCR	25	8	4	—	600	740
		TUGR	17	6	3	—	982	1,300
		No veg	10	—	—	—	—	—
Wash	62	ASGF	—	37	—	—	123	185
		ACCR	—	19	—	—	190	380
		TUGR	—	3	3	—	62	200
Gneudna	49	BLUE	—	9	16	—	213	500
		STCH	—	8	16	—	93	200
Lyons	43	ACSA	22	—	—	—	183	183
		CBMS	5	4	—	—	150	180
		ACCR	3	—	—	—	60	60
		No veg	9	—	—	—	—	—
Yinnietharra	37	ASGF	4	6	7	—	58	85
		STCH	2	6	5	—	63	108
		ACCR	3	3	1	—	95	140
Yalbalgo	32	ACSA	8	8	—	—	117	133
		HASP	8	8	—	—	67	80
Bidgemia	30	ACSA	—	5	15	—	100	167
		CBMS	—	2	5	—	90	140
		SALT	—	1	2	—	30	60
Glenburgh	29	SSGF	29	—	—	—	116	116
Giralia	28	HASP	16	1	—	—	85	85
		SOSP	10	1	—	—	183	183
Wooramel	14	ACSA	3	2	3	—	40	67
		ASGF	2	2	2	—	20	30
Cahill	12	ACSA	5	5	—	—	50	83
		TUGR	1	1	—	—	75	100
Wandagee	6	SALT	1	1	1	—	40	60
		STCH	—	1	—	—	5	8
		ACCR	—	1	—	—	10	20
		HASP	1	—	—	—	5	5
Billy	2	SSGF	1	—	—	—	4	4
		ASGF	1	—	—	—	5	5
Totals	2728		1125	1028	551	24	14,054	20,166

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 14,050

Capability sheep unit capacity 20,150

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 11,651

highest (1975) 16,125

lowest (1980) 4,412

Winderie station - Upper Gascoyne Shire

Area 692 km²

Location

Winderie station is located on the Wooramel 1:250,000 map sheet. The homestead is about 36 km south of Gascoyne Junction and the station has common boundaries with Jimba Jimba, Bidgemia, Dairy Creek, Towrana, Pimbee and Yalbalgo stations.

Description

Nearly 60% of the station consists of sandplain and linear dunes of the Yalbalgo land system. The system supports a moderately close tall shrubland of wanyu or woodland of sand dune gidgee with a ground layer of wanderrie grasses. Pastoral value is moderate.

The Bidgemia system (11.4%) occurs, closely associated with the Jimba system (7.6%), in the north-east of the station. Bidgemia consists of tributary alluvial plains with sandy banks and minor dunes; Jimba consists of gently sloping plains with diffuse drainage tracts, minor pebbly plains and low rises on Permian sediments. Both systems support scattered tall acacia shrublands with numerous palatable low shrubs. Pastoral value is high or moderate, but the systems are highly susceptible to erosion if the pastures are degraded.

The Sandiman land system (9.0%) occurs scattered through the central and eastern parts of the station. It consists of undulating stony uplands with low breakaways and ridges. It supports tall shrublands with mulga and other acacias and scattered palatable low shrubs. Pastoral value is moderate.

The Wooramel system (6.7%) occurs in the east as sandy plains and stony plains often with hardpan at shallow depth. It supports moderately close tall shrublands of wanyu on the sandy parts with sparser tall shrublands of mulga and other acacias on the stony plains. Pastoral value is moderate.

The Fossil system (4.5%) occurs as low hills and ridges in the centre of the station and also as isolated hills and mesas such as Round Hill. It supports tall acacia shrublands and pastoral value is low.

Two other minor systems Sandplain (2.4%) and Yagina (0.2%) occur but are of little significance. All systems on the station are further summarized in table 1.

Condition statements for each land system and for the whole station (total over all land systems) have been prepared from information recorded whilst traversing on the station and are presented in table 2.

Table 1. Land systems on Winderie station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	Fossil - hills, ridges and mesas of sedimentary rocks; scattered tall shrublands of mulga and other acacias	4.5
Moderate (10-19 ha/s.u.)	Yalbalgo - sandplains with linear and reticulate dunes; moderately close tall shrublands of wanyu or woodlands of sand dune gidgee	58.2
	Sandiman - undulating stony uplands with low breakaways and ridges, scattered tall shrublands of mulga and other acacias	9.0
	Jimba - gently sloping alluvial plains with diffuse drainage tracts, minor pebbly plains; scattered tall and low shrublands of *Acacia* and *Eremophila* species and chenopods	7.6
	Wooramel - sandy plains and stony plains often with hardpan at shallow depth; tall shrublands of wanyu or mulga and other acacias	6.7
	Sandplain - nearly flat to gently undulating red sandplains; moderately close tall shrublands of wanyu or woodlands of sand dune gidgee	2.4
	Yagina - low stony plains, soil covered plains, stony claypans and minor sandy banks and dunes; tall acacia shrublands	0.2
		84.1
High (5-9 ha/s.u.)	Bidgemia - tributary alluvial plains with sandy banks and minor dunes; scattered tall and low shrublands of wanyu and other acacias, also chenopods	11.4
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (128 recordings on 7 land systems)

Winderie

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Bidgemia	14	44	21	21	14	—	—	7	57	36	—	7	93
Fossil	5	100	—	—	—	—	—	80	20	—	—	80	20
Jimba	19	47	21	32	—	—	—	32	42	26	—	32	68
Sandiman	15	100	—	—	—	—	—	80	20	—	—	80	20
Sandplain	4	100	—	—	—	—	50	50	—	—	50	50	—
Wooramel	10	100	—	—	—	—	60	40	—	—	60	40	—
Yalbalgo	61	98	—	2	—	3	28	52	15	2	31	53	16
Total over all land systems	128	85	5	8	2	2	20	46	23	9	21	48	31

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 11 sites on 5 land systems.

Range condition and recommendations

1. Yalbalgo land system (58.2%)

This system supports the Acacia Sandplain (ACSA) pasture type which has an upper layer of trees characterized by sand dune gidgee or of tall shrubs of wanyu. The lower layers consist of very scattered low shrubs including a few palatable species and a prominent grass layer of various wanderrie grasses. Pasture condition was predominantly fair although some considerable areas were also in good condition. Restricted areas, usually in the vicinity of water points, show loss of desirable low shrubs and were in poor condition. There is no erosion.

Because of the general sparsity of palatable shrubs, even when in good condition, and the rather short lived nature of wanderrie grass, the system has limited drought value. Opportunistic use can be made of the grass pastures and wanyu beans provide useful feed in favourable seasons, but management needs to be flexible in times of drought.

Fire may be a useful management tool on this system, but its use has not been researched.

2. Bidgemia land system (11.4%)

Pastures are Acacia Sandplain on the sandy units of the system and Currant Bush Mixed Shrub (CBMS) and some Saltbush (SALT) on the more clayey alluvial plains and inter-bank areas. In general the pastures (particularly the Currant Bush Mixed Shrub and Saltbush types) are degraded to poor or very poor condition. Wind and water erosion in the form of hummocking, surface stripping, rilling and guttering is widespread on the duplex soils of the interbank areas. About 13km^2 (16%) of the system is severely degraded. In order to encourage the recovery of desirable shrubs these areas, which are mostly in Secret paddock, should be fully protected from grazing for a number of years. Special remedial treatments including soil cultivation works and seeding need to be considered as a means of hastening rehabilitation.

3. Sandiman land system (9.0%)

Pastures are useful Stony Chenopod (STCH) on the lower units of the system and Stony Short Grass Forb (SSGF) on the ridges and breakaways. Pasture condition is nearly all fair although minor areas are poor. There is no erosion.

4. Jimba land system (7.6%)

The system is derived from soft Permian sediments and, except for minor stony and cobbly plains, is inherently highly susceptible to erosion if the vegetative cover is depleted.

Stony chenopod and Acacia Short Grass Forb (ASGF) pastures vary in condition from fair to very poor. In many instances desirable low shrubs such as sago bush, ruby saltbush, Gascoyne bluebush and Gascoyne mulla mulla are seriously depleted and the pastures are producing at well below their potential. Elsewhere pasture degradation takes effect as changes in botanical composition and dramatic increases in undesirable woody shrubs. This is the case in parts of Ram paddock where there has been a remarkable increase in grey cassia and crinkled cassia at the expense of more desirable shrubs. Water erosion in the form of thin sheeting, rilling and guttering is common.

At least 14 km^2 (26%) of the system in Secret paddock is very severely degraded and should not be grazed. A programme of regeneration involving protection from grazing and possibly cultivation works and seeding needs to be undertaken. Such a programme would include areas of the Bidgemia system (see 2). Subdivisional fencing of Secret paddock needs to be considered so that the affected areas can be protected from grazing while other parts can still be grazed.

5. Wooramel land system (6.7%)

The system supports Acacia Sandplain and Acacia Short Grass Forb pastures which are in good or fair condition. There is no erosion and the system is relatively stable under grazing.

6. Fossil (4.5%) and Sandplain (2.4%) land systems

These systems were not intensively sampled but, where seen, were generally in fair or good range condition. They are not prone to erosion.

7. Although the station is quite well developed in terms of paddocks and water points there are a number of areas that are not in use or are not fully used in that they are > 5 km from permanent stock water supplies. Areas in this category include parts of Bibra and West Bore paddocks. Consideration needs to be given to bringing these areas into use so that grazing pressure on degraded parts of the station can be reduced.

8. The recommended sheep unit capacity for present condition is 3,900.

9. The capability sheep unit capacity if all country was in good range condition is estimated at 5,800.

Individual station report

Winderie station - 69,230 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Yalbalgo	403	ACSA	125	214	64	—	2,635	3,358
Bidgemia	79	ACSA	—	26	25	—	263	425
		CBMS	—	—	7	13	44	400
		SALT	—	—	8	—	50	160
Sandiman	62	STCH	—	28	12	—	180	333
		SSGF	—	22	—	—	73	88
Jimba	53	STCH	—	11	10	14	88	292
		ASGF	—	4	9	—	36	65
		ACSA	—	5	—	—	31	42
Wooramel	46	ACSA	19	9	—	—	215	233
		ASGF	—	18	—	—	60	90
Fossil	31	ASGF	—	25	6	—	98	155
Sandplain	16	ACSA	8	8	—	—	117	133
Yagina	2	ASGF	—	2	—	—	7	10
Totals	692		152	372	141	27	3,897	5,784

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 3,900

Capability sheep unit capacity 5,800

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1971):

average (mean) 8,480

highest (1969) 13,237

lowest (1980) 2,145

Winning station - West Pilbara and Carnarvon Shires

Area 1,585 km²

Location

Winning station is located on the Winning Pool 1:250,000 map sheet. The homestead is about 240 km north of Carnarvon on the North-West Coastal Highway and the station has common boundaries with Marrilla, Giralia, Nyang, Towera, Lyndon, Mia Mia and Cardabia stations.

Description

Many varied landforms occur on the station with a total of 17 land systems being represented.

The largest system is Winning (29.3% of total station area) which occurs throughout the station except in the far west. It consists of extensive low plains and broad drainage tracts with occasional low hills and ridges. It supports scattered tall shrublands usually dominated by snakewood and pastoral value is high.

The Spot system (15.1%) covers extensive areas in the centre of the station. It consists of alluvial plains and plains with low reticulate sandy banks interspersed with circular and elongated inter-bank areas with more clayey soils. It supports scattered tall shrublands of acacias such as bardie bush, silver bark wattle and snakewood with numerous low shrubs and some spinifex. Pastoral value is high.

Broad, almost flat sandy plains of the Uaroo system (10.4%) occur in the north and south-east. These plains frequently have calcrete at shallow depth and they support hummock grasslands of hard spinifex and some soft spinifex with numerous shrubs. Pastoral value is moderate.

The O'Brien system (8.9%) which occurs in the centre of the station consists of tributary alluvial plains and slightly more elevated upper plains and interfluves. It supports patchy tall and low shrublands with spreading gidgee, snakewood, *Cassia* and *Eremophila* species and some chenopods. The vegetation is often arranged in dense clumps or groves with sparser cover between and the soil frequently has a mantle of pebbles and radiolarite rock fragments. Pastoral value is moderate.

An important system in the west is Gearle (7.6%) which consists of gently sloping alluvial plains, minor low rises and more sloping plains marginal to the slightly more elevated Carleeda (5.9%) system. The Gearle system supports patchy tall shrublands with wait-a-while and snakewood above Gascoyne bluebush and other chenopods. Pastoral value is high. The Carleeda system consists of undulating limestone plains and platforms with short marginal slopes to narrow lower plains and drainage floors. It supports soft spinifex hummock grasslands with numerous shrubs and pastoral is high.

Other smaller high pastoral value systems of local importance are Wash (4.0%), Wandagee (2.4%) and Donovan (0.7%). Other useful systems of moderate pastoral value include Giralia (3.6%), Windalia (2.4%) and Jimba (2%). All systems on the station are further summarized in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Winning station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	Lake - large, mostly bare pans and lake beds with narrow marginal sandy banks supporting spinifex	3.9
Low (20-30 ha/s.u.)	Billy - low plateaux, mesas and buttes with stony footslopes and narrow drainage floors; scattered tall acacia shrublands	2.0
	Fossil - rough hills, ridges and plateaux of sedimentary rocks; scattered tall acacia shrublands	0.3
		2.3
Moderate (10-19 ha/s.u.)	Uaroo - nearly flat sandy plains and minor pebbly plains with calcrete at shallow depth; hummock grasslands of hard and soft spinifex with numerous shrubs	10.4
	O'Brien - Tributary alluvial plains and slightly more elevated upper plains and interfluves; patchy tall and low shrublands of spreading gidgee, snakewood, *Cassia* and *Eremophila* species and some chenopods often arranged in groves	8.9
	Giralia - sandy plains with large linear dunes; hummock grasslands of hard and soft spinifex with numerous shrubs	3.6
	Windalia - stony plains and narrow dissected upper interfluves on radiolarite; scattered tall shrublands of spreading gidgee and other acacias often arranged in groves	2.4
	Jimba - gently sloping alluvial plains with diffuse drainage tracts, minor pebbly plains and low ridges; scattered tall and low shrublands of *Acacia* and *Eremophila* species and chenopods	2.0
	Channel - major channels with narrow flood plains and dissected marginal slopes; scattered tall acacia shrublands	1.1
		28.4

Table 1 continued...

Pastoral value	Land systems	Area %
High (5-9 ha/s.u.)	Winning - extensive low plains and broad drainage tracts with low ridges and narrow footslopes; scattered tall shrublands of snakewood	29.3
	Spot - alluvial plains with sandy banks and more clayey inter-bank areas; tall shrublands of acacia and cassia also bluebush and some spinifex	15.1
	Gearle - gently sloping alluvial plains, minor low rises with more sloping marginal plains; scattered tall and low shrublands of wait-a-while, snakewood and chenopods	7.6
	Carleeda - undulating limestone plains and platforms with short marginal slopes to narrow lower plains and drainage floors; soft spinifex hummock grasslands with numerous shrubs	5.9
	Wash - sandy alluvial plains and broad drainage zones receiving more concentrated sheet flow; scattered to moderately close tall shrublands of spreading gidgee and other acacias	4.0
	Wandagee - nearly flat stony and clayey plains with broad drainage zones and outcrop rises of sedimentary rocks; scattered tall acacia shrublands with numerous low shrubs including chenopods	2.5
	Donovan - gently sloping outwash plains and minor limestone plains; tall shrublands of snakewood and other acacias	0.8
	River - narrow, active flood plains and major channels; fringing woodlands of river red gum and tall acacia shrublands	0.2
		65.4
Very High (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (227 recordings on 12 land systems)

Winning

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Carleeda	10	100	—	—	—	50	40	—	10	—	90	—	10
Gearle	22	90	5	5	—	9	36	27	23	5	45	23	32
Giralia	4	100	—	—	—	25	50	25	—	—	75	25	—
Jimba	9	89	11	—	—	—	33	45	22	—	33	45	22
Lake	9	67	33	—	—	33	45	11	11	—	78	11	11
O'Brien	27	89	7	4	—	—	11	22	41	26	11	26	67
River	1	100	—	—	—	—	100	—	—	—	100	—	—
Spot	29	93	7	—	—	17	21	14	31	17	38	14	48
Uaroo	14	100	—	—	—	100	—	—	—	—	100	—	—
Wandagee	11	100	—	—	—	—	9	73	18	—	9	73	18
Winning	71	67	27	6	—	—	14	20	41	25	14	20	66
Wash	20	100	—	—	—	15	40	40	5	—	55	40	5
Total over all land systems	227	85	12	3	—	15	22	23	26	14	37	22	41

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 13 sites on 8 land systems.

Range condition and recommendations

1. Winning land system (29.3%)

This system supports Bluebush (BLUE) pastures beneath snakewood with some minor areas of Stony Chenopod (STCH) and Soft Spinifex (SOSP) pastures. In general the pastures are considerably degraded to poor or very poor condition with only minor areas being in fair or good condition. Soil erosion, mostly minor, but some of moderate severity, was recorded at more than 30% of the traverse points.

About 19 km² of the system in Post Office - MRD paddock and Kiligidri paddock near 4 mile bore shows severe degradation with almost total loss of desirable perennial shrubs and some erosion. To encourage recovery this area needs to be fully protected from grazing for a number of years and cultivation and seeding treatments considered.

Elsewhere the system, although degraded, is still productive in terms of annual forage and remaining desirable shrubs. However, it is producing at well below potential and its durability in drought times is considerably reduced. The system has the capability to recover well if a programme of strategic spelling over a number of growing seasons and conservative use at other times can be commenced in paddocks such as Querie No. 5, Tripod and Silent.

2. Spot land system (15.1%)

This system supports useful Currant Bush Mixed Shrub (CBMS) pastures with some Bluebush and Hard Spinifex (HASP). Pasture condition varies from good to very poor but is predominantly poor. There is no erosion. About 3 km² in the vicinity of 4 Mile bore is severely degraded.

3. Uaroo (10.4%) and Giralia (3.6%) land systems

These spinifex based systems are all in good range condition. Pastures are Hard Spinifex and Soft Spinifex which are relatively stable under grazing.

Hard spinifex is rarely grazed, but soft spinifex has moderate value with good drought durability. Old spinifex stands are useless for grazing and management must be aimed at being able to present some areas in an attractive condition to stock at all times. Spinifex should be burnt on a fairly regular basis every 4-5 years and burning should be late in the year. Burnt areas should not be grazed for about 8-10 weeks over the growing season following the fire to encourage establishment of durable grasses, shrubs and spinifex seedlings.

The spinifex land systems are generally resistant to degradation, although some wind erosion results if a prolonged dry spell occurs after burning. However, there is a rapid re-establishment of vegetation and return to stability after rain.

4. O'Brien land system (8.9%)

The system supports mixed Stony Chenopod (STCH) and Acacia Short Grass Forb (ASGF) pasture and, on the groves and creek-lines, denser Acacia Creek-line (ACCR) pastures. When in good condition the Stony Chenopod pastures carry a range of desirable low shrubs such as sago bush, Gascoyne bluebush, ruby saltbush and Gascoyne mulla mulla beneath the taller snakewood. Elsewhere the pastures consist of non-saline types such as Wilcox bush and cotton bush beneath spreading gidgee. In many areas desirable shrubs are considerably depleted and pasture condition is largely poor or very poor. There is some minor soil erosion on the system but this is not a significant problem. A programme of spelling from grazing over a number of growing seasons is required to encourage recovery of desirable shrubs.

5. Gearle land system (7.6%)

This system supports productive Bluebush and Saltbush (SALT) pastures which are predominantly in good or fair condition with restricted parts showing shrub depletion to poor condition. Buffel grass has successfully colonized disturbed sites adjacent to watering points and elsewhere.

6. Carleeda land system (5.9%)

This limestone based system supports Soft Spinifex and Hard Spinifex pastures with some Tussock Grass pastures (TUGR) on narrow drainage floors and alluvial plains. Pasture condition is almost all good or very good and the system is not prone to erosion. Nearly all of the system in Carleeda paddock is well in excess of 5 km from permanent stock waters. Additional water supplies are required so that pastures can be fully used and stock numbers reduced on degraded parts of the station.

7. Wash land system (4.0%)

The system supports Acacia Short Grass Forb pastures on the broad plains with denser Acacia Creek-line pastures in drainage tracts and groves. Pasture condition is mostly good, but varies from fair to very good. There is no erosion. In the far south of the station in Kiolowibri West paddock the system is in very good condition with numerous desirable low shrubs such as flat leaf bluebush, Wilcox bush, currant bush, tall cassia and cotton bush beneath spreading gidgee.

8. Wandagee (2.5%) and Jimba (2.0%) land systems

These complex plain systems derived from Permian age sediments in the south-east of the station support a mosaic of useful pasture types including Stony Chenopod, Saltbush, Acacia Short Grass Forb and Acacia Creek-line. Pasture condition is predominantly fair with lesser areas in good or poor condition. There is no erosion on the Wandagee system, but occasional minor erosion occurs on the Jimba system which is inherently susceptible to erosion if the vegetation is depleted.

9. The remaining minor land systems on the station were not extensively sampled but, where seen, were in fair range condition. They are not expected to show any problems of severe degradation.

10. The recommended sheep unit capacity for present condition is 13,450.

11. The capability sheep unit capacity if all country was in good range condition is estimated at 22,300.

Individual station report

Winning station - 158,507 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Winning	465	BLUE	39	52	216	19	2,780	6,520
		SOSP	47	23	—	—	975	1,167
		STCH	5	26	38	—	298	575
Spot	240	CBMS	7	30	104	3	1,165	2,880
		BLUE	2	10	36	—	390	960
		HASP	48	—	—	—	240	240
Uaroo	165	HASP	116	—	—	—	580	580
		SOSP	49	—	—	—	817	817
O'Brien	142	ASGF	28	—	43	—	248	355
		STCH	—	8	28	—	133	300
		ACCR	—	35	—	—	350	700
Gearle	120	BLUE	18	22	32	—	835	1,440
		SALT	11	14	11	—	464	720
		TUGR	12	—	—	—	400	400
Carleeda	93	SOSP	59	—	6	—	1,007	1,083
		HASP	17	—	2	—	90	95
		TUGR	8	—	1	—	271	300
Wash	64	ASGF	22	14	2	—	162	190
		ACCR	11	7	1	—	295	380
		TUGR	4	2	1	—	37	200
Lake	62	SOSP	6	—	—	—	100	100
		No veg	56	—	—	—	—	—
Giralia	58	HASP	26	9	—	—	160	175
		SOSP	17	6	—	—	333	383
Wandagee	39	SALT	2	15	3	—	246	400
		STCH	1	6	1	—	42	67
		ACCR	1	4	1	—	65	120
		HASP	5	—	—	—	25	25
Windalia	38	ASGF	14	10	6	—	203	150
		ACCR	3	1	—	—	70	80
		STCH	—	2	2	—	17	33
Jimba	32	STCH	7	9	5	—	120	175
		ASGF	3	4	1	—	31	40
		ACSA	1	1	1	—	19	25
Billy	31	SSGF	10	9	—	—	70	76
		ASGF	6	6	—	—	50	60
Channel	17	STCH	3	4	2	—	52	75
		ACCR	2	2	1	—	65	100
		No veg	3	—	—	—	—	—
Donovan	12	BLUE	5	2	—	—	125	140
		ACMS	2	2	—	—	60	80
		SOSP	1	—	—	—	17	17
Fossil	5	ASGF	5	—	—	—	25	25
River	2	ACCR	—	2	—	—	20	40
Totals	1,585		682	337	544	22	13,452	22,288

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 13,450

Capability sheep unit capacity 22,300

Declared stock numbers (sheep units or equivalent) 1968-1984 (no data for 1972):

average (mean) 19,912

highest (1971) 40,795

lowest (1973) 6,575

Woodleigh station - Shark Bay Shire

Area 2,331 km²

Location

The station is located on the Yaringa and Wooramel 1:250,000 map sheets. The homestead is about 44 km east of the North-West Coastal Highway with the turn-off from the highway at about 177 km south from Carnarvon. The station has common boundaries with Meedo, Gilroyd, Yalardy, Talisker, Hamelin, Carbla and Yaringa stations.

Description

Only four land systems, Sandplain, Yaringa, Yalbalgo and Snakewood occur on the station. By far the largest of these is Sandplain (97.8% of the total station area) which consists of almost flat to gently undulating red sandplain supporting moderately close tall shrublands usually dominated by wanyu. Pastoral value is moderate.

The Yaringa system (0.8%) in the far west of the station consists of sandy plains overlying calcrete at shallow depth and minor calcrete outcrop plains. Vegetation is a tall shrubland of wanyu and other acacias. Pastoral value is high.

The Yalbalgo system (0.7%) is restricted to one isolated area in the north-west of the station. It consists of sandplains with well developed linear dunes. Vegetation is sand dune gidgee woodland with wanyu shrubland and pastoral value is moderate.

The Snakewood (0.7%) system is found as a small area in the south-west of the station. It consists of almost flat plains with duplex soils supporting a distinctive tall shrubland of snakewood with a saltbush understorey. Pastoral value is high. All systems on the station are further summarized in table 1.

Condition statements for land systems and for the station as a whole (total over all land system) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Woodleigh station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate 10-19 ha/s.u.)	Sandplain - nearly flat to gently undulating red sandplains; moderately close to close tall shrublands of wanyu	97.8
	Yalbalgo - sandplains with linear and reticulate dunes; gidgee woodlands and moderately close tall shrublands of wanyu	0.8
		98.6
High (5-9 ha/s.u.)	Yaringa - sandy plains and limestone plains with occasional low dunes; tall shrublands of wanyu and other acacias	0.7
	Snakewood - nearly flat plains with duplex soils, tall shrublands of snakewood with saltbush understorey	0.7
		1.4
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (316 recordings on 3 land systems)

Woodleigh

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Sandplain	307	100	—	—	—	16	41	34	8	1	57	34	9
Yalbalgo	2	100	—	—	—	—	100	—	—	—	100	—	—
Yaringa	7	100	—	—	—	—	29	42	29	—	29	42	29
Total over all land systems	316	100	—	—	—	16	40	34	9	1	57	34	9

Range evaluation sites

Detailed description and measurements of landform, vegetation, soils and range condition were made at 10 sites on 1 land system.

Range condition and recommendations

1. Sandplain land system (97.8%)

The Acacia Sandplain (ACSA) pastures of the system are mostly in fair, good or very good condition. Good condition is indicated by the presence of desirable low shrubs such as warty leaf eremophila, Wilcox bush, cotton bush, flat leaf bluebush, tall saltbush and wanderrie grasses beneath the taller acacia shrubs.

Desirables are very scattered below dense stands of tall shrubs but increase markedly in density and species diversity if the tall shrub layer thins or is lost. In this respect past fires on parts of the Sandplain system on Woodleigh have improved the pastures for livestock production. Strategic burning is likely to be a useful management tool on the system but its use has not been researched. Evidence seen during the survey suggests that the effects of fire are extremely long-term in that wanyu may take more than 50 years to reach its pre-fire density.

2. Yaringa land system (0.8%)

The system supports Acacia Sandplain pastures on the sandplain unit and Acacia Mixed Shrub (ACMS) pastures on the stony limestone plain unit. Pasture condition is predominantly fair with restricted parts in good and poor condition. There is no erosion on the system.

3. Yalbalgo land system (0.7%)

This minor system was not intensively sampled but, where seen, the Acacia Sandplain pastures were in good condition. The system as a whole is expected to be in good condition.

4. Snakewood land system (0.7%)

This small system was not inspected. It supports Saltbush (SALT) pastures which frequently receive preferential grazing. However, because the system is some distance from permanent water supplies, pasture condition is expected to be fair to good.

5. Parts of the station are well developed in terms of paddocks and water supplies. However, about 40% of the total station area is poorly used or not used as it is > 5 km from permanent waters. These under used areas are largely in the north-east, east and south. Consideration needs to be given to the provision of additional water supplies.

6. The recommended sheep unit capacity for present condition and assuming that the station is fully watered (which is not the case, see 5) is 17,050.

7. The area currently commanded by water is capable of carrying about 10,250 sheep units.

8. The capability sheep unit capacity if all country was in good range condition (and fully watered) is estimated at 19,650.

Individual station report

Woodleigh station - 233,136 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandplain	2,280	ACSA	1,300	775	205	—	16,497	19,000
Yaringa	19	ACSA	—	9	6	—	80	125
		ACMS	4	—	—	—	80	80
Yalbalgo	17	ACSA	17	—	—	—	142	142
Snakewood	15	SALT	6	6	—	—	195	240
		ACMS	2	—	—	—	40	40
		ACSA	1	—	—	—	8	8
Totals	2,331		1,330	790	211	—	17,042	19,635

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 17,050

Capability sheep unit capacity 19,650

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 17,641

highest (1974) 22,575

lowest (1981) 9,200

Wooramel station - Carnarvon Shire

Area 1,414 km²

Location

Wooramel station is located on the Wooramel 1:250,000 map sheet. The homestead is about 120 km south of Carnarvon via the North-West Coastal Highway. The station has common boundaries with Edaggee, Wahroonga, Meedo and Yaringa stations and with the coast line of Shark Bay in the west.

Description

The unpredictable and highly intermittent Wooramel River runs through the station from the east to the south-west where it discharges into Shark Bay just north of Gladstone. Much of the station consists of broad, more or less saline alluvial plains of the Sable (28.2% of total station area), Sandal (22.8%) and Delta (18.7%) land systems.

The Sable system occurs as a wide strip along the north-western edge of the station. It consists of almost flat, saline plains with duplex soils and minor sandy banks. It supports a characteristic moderately close low shrubland of bluebush and saltbush interspersed with tall acacia shrublands on the sandy rises. Pastoral value is high.

The Sandal system occurs in the north-west adjacent to and inland from the Sable system. It consists of alluvial plains with numerous low sandy banks and rises. It supports tall acacia shrublands with numerous useful low shrubs and pastoral value is high.

The Delta system occurs in the centre of the station as almost flat, active alluvial flood plains associated with the Wooramel River. It supports degraded tall and low shrublands with various acacias and remnant chenopod shrubs. Pastoral value is variable depending on the degree of degradation. Potential pastoral value when in good condition is high.

An important system in the south and centre of the station is Foscal (9.3%) which consists of gently sloping outwash plains below low limestone plateaux and mesas. It supports mixed tall and low shrublands of saltbush, bluebush, other useful low shrubs and acacias. Pastoral value is high. The Yaringa land system (8.7 per cent) occurs as sandy plains and limestone plains in central, northern and south eastern parts. It supports moderately close tall shrublands of wanyu and other acacias. Pastoral value is high.

Two sandplain and dune systems, Lyons (7.0%) and Yalbalgo (3.9%) occur in the east. The Lyons system is characterized by numerous large claypans on sandy alluvial plains with numerous reticulate and linear dunes. The Yalbalgo system consists of sand plains with linear dunes and sandy swales. Both systems support scattered to moderately close tall shrublands of wanyu and other acacias.

The Salune system (0.9%) occurs as an isolated area in the east. It consists of distinctive highly saline plains and pans with scattered low dunes. Vegetation consists of low shrublands of bluebush, saltbush and samphire and some tall acacia shrublands. Pastoral value is moderate.

Two other minor systems, Littoral (0.5%) and Sandplain (< 0.1%) are found on the station. All systems are further summarised in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Wooramel station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Lyons - sandy alluvial plains with numerous large claypans and reticulate and linear dunes; scattered to moderately close tall shrublands of acacias	7.0
	Yalbalgo - sandplains with linear and reticulate dunes; moderately close tall shrublands of wanyu	3.9
	Salune - saline plains and pans with scattered low dunes; low shrublands of bluebush, saltbush and samphire and tall acacia shrublands	0.9
	Littoral - low coastal foredunes, samphire flats and tidal flats and mangrove fringes; low shrublands of samphire and tall shrublands of acacias	0.5
	Sandplain - nearly flat to gently undulating red sandplains; moderately close tall shrublands of wanyu	< 0.1
		12.3
High (5-9 ha/s.u.)	Sable - nearly flat, saline alluvial plains with minor sandy banks; low shrublands of bluebush and saltbush, also tall acacia shrublands	28.2
	Sandal - alluvial plains with numerous low sandy banks and rises, duplex and sand soils; tall shrubland of acacias and currant bush	22.8
	Delta - almost flat, active alluvial floodplains; degraded tall and low shrublands of acacias, saltbush and bluebush	18.7

Table 1 continued...

Pastoral value	Land systems	Area %
	Foscal - gently sloping outwash plains beneath low limestone plateaux and mesas; tall acacia shrublands and low shrublands of saltbush and bluebush	9.3
	Yaringa - sandy plains and limestone plains with occasional low dunes; tall shrublands of wanyu and other acacias	8.7
		87.7
Very high < 5 ha/s.u.	—	—
		100.0

Table 2. Condition statements derived from traverse records (310 recordings on 10 land systems)

Wooramel

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Delta	88	11	20	43	26	—	3	18	33	46	3	15	82
Foscal	32	78	13	9	—	—	28	19	37	16	28	19	53
Littoral	6	83	17	—	—	50	50	—	—	—	100	—	—
Lyons	14	65	21	14	—	—	14	43	29	14	14	43	43
Sable	70	77	17	6	—	24	35	27	11	3	59	27	14
Sandal	68	97	3	—	—	—	9	38	47	6	9	38	53
Sandplain	1	100	—	—	—	—	100	—	—	—	100	—	—
Salune	4	100	—	—	—	—	25	75	—	—	27	75	—
Yalbalgo	15	93	—	7	—	27	40	20	13	—	67	20	13
Yaringa	12	83	17	—	—	8	50	25	17	—	28	25	17
Total over all land systems	310	64	14	15	7	8	20	26	29	17	28	25	47

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 23 sites on 7 land systems.

Range condition and recommendations

1. Sable land system (28.2%)

This system supports productive Bluebush and Saltbush (BLUE, SALT) pastures on the broad plains and Acacia Sandplain (ACSA) pastures on the restricted sandy rises. Pasture condition is mostly good or very good with localized areas in the vicinity of watering points showing loss of desirable shrubs to poor or very poor condition. There is some minor erosion in the form of wind piling around shrubs and breaking of the surface crust on parts of the system, but generally erosion is not a problem. An exception to this is in 5 Mile paddock and the southern end of Coolbara paddock where about 5 km^2 of the system is severely degraded with almost complete loss of desirable shrubs and active erosion.

Much of the system is considerably > 5 km from permanent water supplies and is little used by stock. Additional good quality water supplies need to be provided so that the pastures can be brought into full production and the stocking pressure reduced on other degraded parts of the station.

2. Sandal land system (22.8%)

The system supports Currant Bush Mixed Shrub (CBMS) and Acacia Sandplain pastures with some minor areas of Bluebush. The pastures are still quite productive but the Currant Bush Mixed Shrub pastures in particular are largely degraded to fair or poor condition. There is no significant erosion on the system. Over all, about 10%, 40% and 50% of the traverse observations indicated good, fair and poor range condition respectively. The poorer parts of the system could be readily improved by spelling from grazing over a number of growing seasons.

3. Delta land system (18.7%)

When in good condition the floodplains of this system support mixed Saltbush and Bluebush pastures. Pasture condition is predominantly very poor or poor with marked loss of desirable low shrubs and, in some areas dramatic increases in undesirables such as needle bush. Moderate to severe soil erosion is common.

The system has lost much of its drought durability although it still supplies useful annual feed in season. Buffel grass is well established along the levees and banks of the Wooramel River, but has not spread significantly to adjacent degraded areas.

About 155 km^2 (58%) of the system shows extreme pasture degradation with moderate to severe erosion. These areas should not be used for grazing and require special remedial treatments including cultivation works and seeding to facilitate rehabilitation. Less severely degraded areas could be improved by regular spelling from grazing over a number of growing seasons. The major areas of concern are located in Home, Mongers, Coondoo, 5 Mile and Yaldbiddy paddocks.

4. Foscal land system (9.3%)

Pastures are Saltbush, Bluebush and Acacia Mixed Shrub (ACMS). Pasture condition is predominantly poor, but is extrememly variable ranging from good in Wooly paddock to very poor in southern parts of Big Woora paddock. Erosion in the form of windpiling, sheeting and guttering is common in the latter area, but elsewhere the system is relatively stable.

5. Yaringa land system (8.7%)

The system supports Acacia Sandplain pastures dominated by wanyu on the sandy units and Acacia Mixed Shrub pastures on plains with limestone at shallow depth. Pasture condition is predominantly good or fair and there is no significant erosion.

6. The remaining three minor systems, Salune, Littoral and Sandplain, were not intensively sampled but, where seen, were in fair or good range condition.

7. The lease is inadequately watered. Large areas of Bluebush and Saltbush pastures on the Sable land system (see 1) are poorly watered and under used. Elsewhere pastures on land systems flanking the Wooramel River have been heavily over used and are severely degraded.

8. A programme of rehabilitation involving additional fencing, destocking in some paddocks, cultivation and seeding works and the provision of extra water points is urgently required on the severely degraded sections.

9. The recommended sheep unit capacity for present condition and assuming the station is fully watered (which is not the case, see 7) is 13,000.

10. The capability sheep unit capacity if all country was in good range condition is estimated at 22,550.

Individual station report

Wooramel station - 141,395 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sable	398	SALT	115	38	21	5	2,906	3,580
		BLUE	102	33	24	—	2,603	3,180
		ACSA	29	26	5	—	424	500
Sandal	322	CBMS	4	41	100	—	1,218	2,900
		ACSA	16	59	54	—	718	1,075
		BLUE	8	24	16	—	560	960
Delta	265	BLUE	2	16	23	78	384	2,380
		SALT	2	14	13	77	296	2,120
		ACSA	14	13	13	—	250	333
Foscal	131	SALT	36	6	28	2	970	1,440
		BLUE	5	4	37	—	381	920
		ACMS	2	4	7	—	124	260
Yaringa	123	ACSA	81	17	—	—	781	817
		ACMS	8	9	8	—	300	500
Lyons	99	ACSA	7	37	6	—	314	417
		CBMS	6	—	10	6	183	440
		ACCR	2	—	6	—	70	160
		No veg	19	—	—	—	—	—
Yalbalgo	55	ACSA	37	11	7	—	405	458
Salune	13	ACSA	—	6	—	—	38	50
		SAMP	5	—	—	—	20	20
		BLUE	—	2	—	—	25	40
Littoral	7	No veg	6	—	—	—	—	—
		SAMP	1	—	—	—	4	4
		CDSH	—	—	—	—	—	—
Sandplain	1	ACSA	1	—	—	—	8	8
Totals	1,414		508	360	378	168	12,982	22,562

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 13,000

Capability sheep unit capacity 22,550

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 17,103

highest (1968) 27,675

lowest (1980) 2,023

Yalardy station - Shark Bay Shire

Area 1,012 km²

Location

Yalardy station is located on the Yaringa 1:250,000 map sheet. The access road to the station joins the North-West Coastal Highway at a point about 25 km north of the Overlander Roadhouse and the homestead is about 92 km east by road from the highway. The station has common boundaries with Gilroyd, Byro, Talisker and Woodleigh stations.

Description

More than 82% of the station consists of almost flat to gently undulating red sandplain of the Sandplain land system supporting a moderately close to close tall shrubland of wanyu. Pastoral value is moderate.

The Yalbalgo land system (9.6%) occurs in the north and north-east of the station. It consists of longitudinal dunes of red sand with sandy swales and inter-dunal plains. It supports tall shrublands of wanyu and some sugarbrother and pastoral value is moderate.

The Wooramel system (7.6%) runs from the eastern boundary of the station westward to the centre of the station near the homestead. It consists of sandy plains and hardpan plains with a broad diffuse drainage zone running from east to west through the system. Vegetation is moderately close tall shrublands with wanyu, minnie ritchi and scattered mulga and gidgee. Pastoral value is moderate.

Only one other land system (Lyons 0.6%) occurs on the station and this is of little significance. All systems are summarized in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Yalardy station

Pastoral value	Land systems	Area %
Very low— (> 30 ha/s.u.)	—	
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Sandplain - nearly flat to gently undulating red sandplains; moderately close tall shrublands of wanyu	82.1
	Yalbalgo - sandplains with linear and reticulate dunes; moderately close tall shrublands of wanyu	9.6
	Wooramel - sandy plains and plains with hardpan at shallow depth, moderately close tall shrublands of wanyu, mulga and other acacias	7.6
	Lyons - sandy alluvial plains with numerous claypans and reticulate and linear dunes; scattered to moderately close tall shrublands of acacias	0.6
		99.9
High (5-9 ha/s.u.)	—	—
Very high (< 5 ha/s.u.)	—	—
	Bare claypans	0.1
		100.0

Table 2. Condition statements derived from traverse records (189 recordings on 4 land systems)

Yalardy

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Lyons	3	100	—	—	—	—	—	67	33	—	—	67	33
Sandplain	154	100	—	—	—	22	51	21	6	—	73	21	6
Wooramel	20	85	15	—	—	5	35	5	35	20	40	5	55
Yalbalgo	12	100	—	—	—	17	58	25	—	—	75	25	—
Total over all land systems	189	98	2	—	—	20	48	20	10	2	68	20	12

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 8 sites on 2 land systems.

Range condition and recommendations

1. Sandplain land system (82.1%)

This system supports the Acacia Sandplain (ACSA) pasture type which has a characteristic, moderately dense, tall shrub layer of wanyu. The lower layer consists of very scattered low shrubs including some palatable species and a prominent grass layer dominated by wanderrie grasses.

About half of the pastures seen were in good condition with the remainder being about evenly distributed between fair and very good condition. There is no erosion. Good condition is indicated by the presence of some desirable low shrubs such as warty leaf poverty bush, Wilcox bush, cotton bush and flat leaf bluebush and wanderrie grasses. Because of the general sparsity of desirable shrubs, even when in good condition, and the rather short-lived nature of wanderrie grasses, the system has only limited drought value.

Desirable low shrubs and grasses increase markedly if the tall shrub layer thins or is lost. In this respect past fires on parts of the Sandplain system have improved the pastures for livestock production. Strategic burning is likely to be a useful management tool on the system, but its use has not been researched. Evidence seen during survey suggests that the effects of fire are extremely long term in that wanyu may take 50 years or more to reach its pre-fire density.

Much of the Sandplain system in the east and also in the south-west is little used for grazing as it is well in excess of 5 km from stock water supplies.

2. Yalbalgo land system (9.6%)

The system supports the same Acacia Sandplain pastures as found on the Sandplain system. Condition is predominantly good but varies from fair to very good. Considerable parts of the system in the east are little grazed due to their excessive distance from water supplies.

3. Wooramel land system (7.6%)

This system supports Acacia Sandplain pastures on the more sandy parts and Acacia Short Grass Forb (ASGF) pastures on the areas with shallow soils over hardpan. Pasture condition varies from very poor to very good, largely dependent on distance from water and history of past use. Areas in the vicinity of the homestead show loss of desirable shrub species and are degraded to poor condition. There is occasional minor erosion on parts of the system but this is not a significant problem.

4. Lyons land system (0.6%)

This very small system was not intensively sampled but where seen its pastures were in fair or poor condition.

5. The station has been developed only relatively recently and, as yet, is inadequately watered. Because of this some parts, especially in the east, are little or not used for grazing. At the time of survey about 45% of the pastures on the station were > 5 km from permanent stock waters. Additional water supplies are required so that pastures can be better used and stock distributed more equitably.

6. The recommended sheep unit capacity for present condition and assuming that the station is fully watered (which is not the case, see 5) is 7,550.

7. The capability sheep unit capacity if all country was in good range condition and was fully watered is estimated at 8,350.

Individual station report

Yalardy station - 101,171 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandplain	831	ACSA	607	175	49	—	6,348	6,925
Yalbalgo	97	ACSA	73	24	—	—	758	808
Wooramel	77	ACSA	17	—	29	—	258	383
		ASGF	16	5	10	—	122	155
Lyons	6	ACSA	3	—	—	—	25	25
		CBMS	—	1	—	—	13	20
		ACCR	1	—	—	—	20	20
		No veg	1	—	—	—	—	—
Large clay pans	1	No veg	1	—	—	—	—	—
Totals	1,012		719	205	88	—	7,544	8,336

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 7,550

Capability sheep unit capacity 8,350

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 4,963

highest (1976) 7,062

lowest (1981) 2,800

Yalbalgo station - Carnarvon Shire

Area 865 km²

Location

Yalbalgo station is located on the Wooramel 1:250,000 map sheet. The homestead is about 125 km east south-east from Carnarvon via the North-West Coastal Highway and access road through Callagiddy and Ella Valla stations. The station has common boundaries with Jimba Jimba, Winderie, Pimbee, Wahroonga, Marron, Ella Valla and Doorawarrah stations.

Description

Nearly 90% of the station consists of red sandy plains and dunes of the Yalbalgo (49.5%) and Ella (40%) land systems.

The Yalbalgo system occurs throughout the south-east and consists of longitudinal and reticulate sand dunes with relief up to 15 m and sandy swales. The system supports a moderately close tall shrubland of wanyu and pastoral value is moderate.

The Ella system is found in the north and west of the station. It consists of short, linear sand dunes and narrow inter-dunal plains. The inter-dunal plains frequently have central run-on areas or drainage foci which support denser vegetation that the surrounding plains. Vegetation on the sandy units of the system is a moderately close tall shrubland of wanyu and some woodlands of sand dune gidgee. On the lower parts of the system the vegetation is more patchy tall shrubland with spreading gidgee and other acacias and scattered gidgee trees. Pastoral value is high.

The Target system (4.5%) occurs in the centre of the station and consists of plains with sandy banks, more clayey inter-bank areas and prominent small drainage foci. Vegetation is a tall shrubland of wanyu on sandy parts amd a tall mixed shrubland elsewhere becoming moderately close or close in the drainage foci. Pastoral value is high.

A number of patches of the Mary land system (3.7%) occur on the centre of the station. The system consists of gently sloping plains with calcrete at shallow depth and a few low calcrete rises. It supports moderately close tall shrublands with silver bark wattle, spreading gidgee and snakewood with a prominent low shrub layer of cassias. Pastoral value is high.

Wooramel land system is a minor system found in the centre of the station (2.3%). It consists of sandy plains and plains with some stony surface strew and hardpan at shallow depth. It supports patchy tall shrublands with mulga, wanyu and gidgee. Pastoral value is moderate.

All land systems are further summarized in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Yalbalgo station

Pastoral value	Land systems	Area %
Very low (> 30 ha/s.u.)	—	—
Low (20-30 ha/s.u.)	—	—
Moderate (10-19 ha/s.u.)	Yalbalgo - sandplains with linear and reticulate dunes; moderately close tall shrublands of wanyu and some woodlands of sand dune gidgee	49.5
	Wooramel - sandy plains and plains with hardpan at shallow depth; scattered tall shrublands of wanyu, mulga and gidgee	2.3
		51.8
High (5-9 ha/s.u.)	Ella - plains with short linear dunes and sandy banks, inter-dunal plains with more clayey soils and drainage foci; tall shrublands of wanyu and some woodlands of sand dune gidgee, other shrublands of acacias	40.0
	Target - plains with sandy banks, more clayey inter-bank areas and numerous small prominent drainage foci; tall shrublands of wanyu and other acacias	4.5
	Mary - gently sloping plains with calcrete at shallow depth, occasional low rises of calcrete; tall shrublands silver bark wattle, spreading gidgee and cassias	3.7
		48.2
Very high (< 5 ha/s.u.)	—	—
		100.0

Table 2. Condition statements derived from traverse records (137 recordings on 5 land systems)

Yalbalgo

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Ella	62	97	3	—	—	2	23	49	24	2	24	50	26
Mary	13	85	15	—	—	—	—	46	46	8	—	46	54
Target	10	80	20	—	—	—	—	30	50	20	—	30	70
Wooramel	6	66	17	17	—	—	17	33	17	33	17	33	50
Yalbalgo	46	100	—	—	—	9	22	56	13	—	30	57	13
Total over all land systems	137	94	5	1	—	4	18	50	24	4	22	50	28

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 9 sites on 4 land systems.

Range condition and recommendations

1. Yalbalgo land system (49.5%)

The system supports Acacia Sandplain (ACSA) pastures which consist of very scattered palatable low shrubs and wanderrie grasses beneath a moderately close tall shrub layer of wanyu. Because of the general sparsity of useful low shrubs, even when in good condition, and the rather short lived nature of wanderrie grasses the system has only limited value in times of drought.

Pasture condition is predominantly fair with other areas, particularly those distant from water supplies, being in good or very good condition. Restricted parts show loss of desirable shrubs and are partly degraded to poor condition. There is no erosion and the system is stable under grazing.

Controlled burning may be a useful management tool on this land system, but its use has not been researched.

2. Ella land system (40%)

Pastures on this system are Acacia Sandplain (ACSA) on the sandy banks and dunes and Currant Bush Mixed Shrub (CBMS) on the more clayey inter-dunal plains.

Condition of the Acacia Sandplain pastures is mostly fair or good but the Currant Bush Mixed Shrub pastures have been preferentially overgrazed. Condition is now partly degraded to fair or poor. Desirable shrubs such as climbing saltbush, currant bush, Wilcox bush and flat leaf bluebush have been reduced in density and, in some cases, replaced by undersirable cassias and waxy leaf eremophila. Although the Currant Bush Mixed Shrub pastures are still moderately productive in terms of annuals and remaining perennials they have lost considerable drought durability. Strategic spelling over a number of consecutive growing seasons and conservative stocking at other times will improve pasture condition.

The condition of pastures on the Ella system in the far north of the station is better than elsewhere. The paddock to the north of East Jimalgo paddock was unwatered at the time of survey. It should be brought into use in order to relieve grazing pressure elsewhere.

3. Target land system (4.5%)

This productive system is concentrated in Moogly and West Bald Hill paddocks to the north of the homestead. It supports Acacia Sandplain pastures on the sandy banks, Currant Bush Mixed Shrub pastures on the inter-bank plains and denser Acacia Creek-line (ACCR) pastures on the drainage foci. Condition of the Acacia Sandplain and Acacia Creek-line pastures is fair or good but the Currant Bush Mixed Shrub pastures are mostly degraded to poor condition. There is some minor water erosion in the form of patchy sheeting, rilling and wind hummocking. The two paddocks require strategic spelling to encourage pasture recovery.

4. Mary land system (3.7%)

The system supports Acacia Mixed Shrub (ACMS) pastures and minor areas of Bluebush (BLUE) pastures. When in good condition Acacia Mixed Shrub pastures have many useful low shrubs such as ruby saltbush, climbing saltbush, warty leaf eremophila and felty bluebush beneath the taller cassias and acacias. Bluebush pastures carry Gascoyne bluebush and other bluebush types below snakewood. Pasture condition on this system is about evenly distributed between fair and poor meaning that many of the desirable species have been depleted.

5. Wooramel land system (2.3%)

Although this small system was not intensively sampled the indications are that pastures are generally degraded and there is some patchy erosion.

6. The station is not fully watered. About 35% of the station's pastures are >5 km from permanent stock water supplies. This applies especially to the Ella land system in the west and north and to parts of the Yalbalgo system in the north-east and south of the station. Consideration needs to be given to providing additional water supplies to some of these areas at least (e.g. northern parts as mentioned in 3) so that pastures can be better utilized and stock distributed more equitably.

7. The recommended sheep unit capacity for present condition and assuming that the station is fully watered (which is not the case, see 6) is 6,300.

8. The capability sheep unit capacity if all country was in good range condition and was fully watered is estimated at 9,050.

Individual station report

Yalbalgo station - 86,517 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Yalbalgo	428	ACSA	128	244	56	—	2,816	3,567
Ella	346	ACSA	75	150	17	—	1,631	2,017
		CBMS	—	22	47	—	569	1,380
		ACCR	26	9	—	—	610	700
Target	39	CBMS	—	2	16	—	125	360
		ACSA	6	10	—	—	113	133
		ACCR	4	1	—	—	90	100
Mary	32	ACMS	—	14	16	—	240	600
		BLUE	—	1	1	—	19	40
Wooramel	20	ACSA	2	4	6	—	66	100
		ASGF	1	3	4	—	25	40
Totals	865		242	460	163	—	6,304	9,037

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 6,300

Capability sheep unit capacity 9,050

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 8,325

highest (1968) 12,200

lowest (1980) 815

Yaringa station - Carnarvon and Shark Bay Shire

Area 1,228 km²

Location

Yaringa station is located on the Wooramel and Yaringa 1:250,000 map sheets. The homestead is about 150 km south of Carnarvon on the North-West Coastal Highway. The station has common boundaries with Wooramel, Meedo, Woodleigh and Carbla station and has a coastline to Shark Bay in the west.

Description

The largest land system is Sandplain (47.6%) which occupies the whole of the eastern part of the station. It consists of almost flat to gently undulating red sandplain supporting a moderately close tall shrubland of wanyu. Pastoral value is moderate.

The Yaringa system (24.8%) occurs in the north-west and central parts of the station. It consists of residual sandplain overlying limestone, occasional low sand dunes and minor areas of limestone plains. The sandy parts support the same tall shrublands of wanyu as for the Sandplain system and the limestone plains support tall shrublands of Hamelin wattle and other acacias. Pastoral value is high.

The Foscal system (15.4%) consisting of low limestone mesas and plateaux and broad, gently sloping outwash plains occurs in the north and west of the station. It supports tall shrublands of various *Acacia* species and low shrublands of bladder saltbush, silver saltbush and Gascoyne saltbush. Pastoral value is high.

The Salune system (4.3%) in the north of the station consists of low lying saline plains and pans with scattered low dunes. Vegetation consists of low shrublands of bladder saltbush, Gascoyne bluebush and samphire and tall shrublands of wanyu. Pastoral value is moderate.

Other land systems on the station are Yalbalgo (3.4%), Tooloonga (3.3%), Littoral (1.0%) and Sable (0.2%). Yalbalgo consists of longitudinal and reticulate sand dunes and swales supporting moderately close tall shrublands of wanyu. Pastoral value is moderate. Tooloonga consists of stony limestone plains supporting tall shrublands of Hamelin wattle, silver bark wattle and other acacias. Pastoral value is high.

All land systems are further summarized in table 1.

Condition statements for land systems and for the station as a whole (total over all land systems) are presented in table 2. These statements were derived from traverse records.

Table 1. Land systems on Yaringa station

Pastoral value	Land systems	Area %
Very low (> 30 ha/su)	—	—
Low 20-30 ha/su	—	—
Moderate (10-19 ha/su)	Sandplain - nearly flat to gently undulating red sandplain; moderately close to close tall shrublands of wanyu	47.6
	Salune - saline plains with scattered low dunes; low shrublands of saltbush, bluebush and samphire and tall shrublands of wanyu	4.3
	Yalbalgo - sandplains with linear and reticulate dunes; tall shrublands of wanyu	3.4
	Littoral - low coastal fore-dunes with acacia shrublands, samphire and tidal flats and mangrove fringes	1.0
		56.3
High (5-9 ha/su)	Yaringa - sandy plains and limestone plains with occasional low dunes, tall shrublands of wanyu, Hamelin wattle and other acacias	24.8
	Foscal - low limestone mesas and plateaux and broad, gently sloping outwash plains; tall acacia shrublands and low shrublands of saltbush and bluebush	15.4
	Tooloonga - stony limestone plains; tall shrublands of Hamelin wattle, silver bark wattle and other acacias	3.3
	Sable - nearly flat, saline alluvial plains and minor sandy banks; low shrublands of saltbush and bluebush, some tall acacia shrublands	0.2
		43.7
Very high (< 5 ha/su)	—	—
		100.0

Table 2. Condition statements derived from traverse records (169 recordings on 7 land systems)

Yaringa

Land system	No. of recordings	Total erosion (%)				Pasture condition (%)					Range condition (%)		
		nil	minor	mod.	severe	exc.	good	fair	poor	v.poor	good	fair	poor
Foscal	55	96	4	—	—	18	31	36	11	4	49	36	15
Sable	1	100	—	—	—	—	100	—	—	—	100	—	—
Sandplain	62	100	—	—	—	2	31	38	23	6	32	39	29
Salune	7	86	14	—	—	—	43	14	43	—	43	14	43
Toolonga	10	100	—	—	—	—	20	50	20	10	20	50	30
Yalbalgo	4	100	—	—	—	—	25	25	50	—	25	25	50
Yaringa	30	97	3	—	—	—	33	43	17	7	33	44	23
Total over all land systems	169	98	2	—	—	7	31	38	19	5	38	38	24

Range evaluation sites

Detailed descriptions and measurements of landform, vegetation, soils and range condition were made at 8 sites on 4 land systems.

Range condition and recommendations

1. Sandplain land system (47.6%)

The system supports Acacia Sandplain (ACSA) pastures which consist of very scattered palatable low shrubs and wanderrie grasses beneath a moderately close tall shrub layer of wanyu. Because of the general sparsity of useful low shrubs, even when in good condition, and the rather short lived nature of wanderrie grasses the system has only limited value in drought times.

Pasture condition is mostly fair although some extensive areas are in good condition and lesser parts, particularly near water supplies, are partly degraded to poor condition. There is no erosion and the system is stable under grazing.

Controlled burning may be a useful management tool on this pasture type, but its use has not been researched. Evidence seen during survey suggests that the effects of fire may be extremely long term in that wanyu stands may take 50 years or more to reach their pre-fire height and density. Where the wanyu over-storey has been killed by fire the low shrub layer and the ground layer increases considerably in diversity of species and in density. This fire-induced sub-climax appears to be considerably more productive for livestock production than is the mature wanyu situation.

Much of this system in the far east is little used or not used for grazing as it is considerably > 5 km from stock water supplies.

2. Yaringa land system (24.8%)

The system supports Acacia Sandplain pastures on the sandy units and Acacia Mixed Shrub (ACMS) pastures on the small limestone plains. Pasture condition is largely fair or good; some localized areas near waters show loss of desirable shrubs and are in poor condition. There is no significant erosion on the system.

3. Foscal land system (15.4%)

Pastures are Acacia Mixed Shrub and Saltbush (SALT) and Bluebush (BLUE). When in good condition a wide range of desirable low shrubs such as Wilcox bush and ragged leaf scaevola occur on the non saline sites and bladder saltbush, silver saltbush, Gascoyne bluebush, tall saltbush and ruby saltbush are found on the saline sites. Management should be aimed at maintaining these species in the stand.

Pasture condition varies widely from very poor to very good, but is predominantly fair or good. In particular pasture condition in No 3 and No 4 paddocks in the south-west of the station is nearly all good or very good. Pastures here are highly saline and high salt intakes by livestock may be restricting pasture use and grazing radius. It is essential that stock water supplies are well-distributed throughout these pastures.

4. Salune land system (4.3%)

Condition of the Saltbush and Bluebush pastures on the system ranges from good to partly degraded to poor condition. The Acacia Sandplain pastures of the sandy rises and low dunes on the system were not intensively sampled but where seen were in fair condition.

5. Yalbalgo land system (3.4%)

This sand dune system supporting Acacia Sandplain pastures was not intensively sampled. However it is stable under grazing and is mostly in fair condition.

6. Tooloonga land system (3.3%)

The system supports Acacia Mixed Shrub pastures which, when in good condition, have numerous desirable low shrubs such as ragged leaf scaevola, ruby saltbush, green cassia and cotton bush beneath the taller shrubs of Hamelin wattle, minni ritchi and silver bark wattle. Pasture condition is predominantly fair and there is no erosion.

7. The station is not fully watered, particularly in the east (see 1) and also in the north, north-east, and far north-west of No 3 paddock. About 50% of pastures on the station are > 5 km from permanent stock water supplies.

8. The recommended sheep unit capacity for present condition and assuming that the station is fully watered (which is not the case, see 7) is 10,000.

9. The capability sheep unit capacity if all country was in good range condition and was fully watered is estimated at 13,550.

Individual station report

Yaringa station - 122,757 ha

Land system	Area km²	Pasture lands	Range condition (km²) Good	Fair	Poor	E.d.*	Recommended sheep unit capacity	Capability sheep unit capacity
Sandplain	585	ACSA	187	228	170	—	3,663	4,875
Yaringa	305	ACSA	71	122	51	—	1,558	2,033
		ACMS	31	10	20	—	845	1,220
Foscal	190	SALT	68	28	8	—	1,760	2,080
		BLUE	25	21	21	—	894	1,340
		ACMS	5	11	3	—	229	380
Salune	53	ACSA	—	24	—	—	150	200
		SAMP	18	—	—	—	72	72
		BLUE	5	2	4	—	150	220
Yalbalgo	42	ACSA	11	11	20	—	240	350
Toolonga	40	ACMS	7	18	11	—	389	720
		ACSA	—	2	—	—	13	17
		ASGF	—	2	—	—	7	10
Littoral	12	No veg	10	—	—	—	—	—
		SAMP	1	—	—	—	4	4
		CDSH	1	—	—	—	13	13
Totals	1,227		440	479	308	—	9,987	13,534

* Area of extreme degradation; severe erosion and/or pasture degradation, zero carrying capacity.

Recommended sheep unit capacity 10,000

Capability sheep unit capacity 13,550

Declared stock numbers (sheep units or equivalent) 1968-1984:

average (mean) 9,434

highest (1976) 15,385

lowest (1980) 159

APPENDIX 2
List of Common Perennial Plant Species

Abutilon geranioides	
Abutilon otocarpum	oval leaf
Abutilon species	lantern bush
Acacia acuminata	jam
Acacia aff.coolgardiensis	sugar brother
Acacia amblyophylla	
Acacia anastema	sand dune gidgee
Acacia ancistrocarpa	Fitzroy wattle
Acacia andrewsii	
Acacia aneura	mulga
Acacia aphylla	
Acacia arida	
Acacia bivenosa	marpoo
Acacia blakelyi	
Acacia brachystachya	turpentine mulga
Acacia citrinoviridis	golden wattle or black mulga
Acacia colletoides	
Acacia coolgardiensis	sugar brother
Acacia coriacea	weeping acacia
Acacia craspedocarpa	hop mulga
Acacia cuspidifolia	wait-a-while
Acacia cuthbertsonii	
Acacia drepanophylla	Hamelin wattle
Acacia eremaea	snakewood
Acacia farnesiana	false mesquite
Acacia galeata	
Acacia grasbyi	minni ritchi
Acacia gregorii	
Acacia idiomorpha	
Acacia inaequilatera	kanji
Acacia kempeana	sandplain wattle or witchetty bush
Acacia leptospermoides	
Acacia ligulata	umbrella wattle
Acacia linophylla	bowgada
Acacia microcalyx	
Acacia murrayana	fire wattle
Acacia oswaldii	nelia or miljee
Acacia pruinocarpa	gidgee or yalardy
Acacia pyrifolia	kanji
Acacia ramulosa	wanyu
Acacia rhodophloia	flat leafed minni ritchi
Acacia rostellifera	
Acacia roycei	needle myall
Acacia sclerosperma	silver bark wattle
Acacia sibilans	Gascoyne or flannel myall
Acacia spathulifolia	
Acacia subtessarogona	spreading gidgee
Acacia tetragonophylla	curara
Acacia translucens	poverty wattle
Acacia victoriae	prickly acacia or bardie bush
Acacia wiseana	kerosine bush
Acacia xanthina	
Acacia xiphophylla	snakewood
Acanthocarpus preissii	
Adenanthos acanthophyllus	
Adriana tomentosa	bitter bush
Allocasuarina campestris	dwarf sheok
Alyogyne cuneiformis	native hibiscus
Alyogyne huegelii	
Alyogyne pinoniana	sand plain hibiscus
Alyxia buxifolia	dysentery bush
Angianthus cunninghamii	coast angianthus
Angianthus microcephalus	
Anigozanthos species	kangaroo paw
Anthobolus foveolatus	
Anthocercis littorea	
Aristida browniana	erect kerosene grass
Astrebla elymoides	weeping Mitchell grass
Astrebla pectinata	barley Mitchell grass
Astrebla squarrosa	bull Mitchell grass
Atriplex amnicola	swamp or river saltbush
Atriplex bunburyana	silver salt bush
Atriplex nummularia	old man saltbush
Atriplex paludosa	marsh saltbush
Atriplex vesicaria	bladder saltbush
Atylosia species	
Avicennia marina	mangrove
Baeckia species	
Banksia ashbyi	Ashby's banksia
Banksia lindleyana	Lindley's banksia
Banksia sceptrum	
Beaufortia dampieri	
Boerhavia diffusa	tar vine
Bonamia species	
Bossiaea rufa	
Brachychiton gregorii	kurrajong
Brachycome latisquamea	
Bursaria occidentialis	
Bursaria spinosa	Australian blackthorn
Callitris columellaris	native pine
Calothamnus chrysantherus	one sided bottle brush
Calothamnus formosus	one sided bottle brush
Calothamnus glaber	
Calothamnus kalbarriensis	Kalbarri bottlebrush
Calytrix longiflora	star flower
Calytrix muricata	star flower
Canthium latifolium	native orange
Canthium lineare	native currant
Capparis spinosa	coastal caper
Carpobrotus species	pig face
Cassia artemisioides	silver cassia
Cassia charlesiana	
Cassia chatelainiana	tall cassia
Cassia desolata	grey cassia
Cassia hamersleyensis	
Cassia helmsii	crinkled cassia
Cassia luerssenii	
Cassia nemophila	desert cassia
Cassia notabilis	cockroach bush
Cassia oligophylla	blood bush
Cassia phyllodinea	silver cassia
Cassia pruinosa	silver cassia
Cassia sturtii	green or straight leaf cassia
Cassia venusta	
Cassytha aurea	dodder laurel
Cenchrus ciliaris	buffel grass
Cenchrus setigerus	Birdwood grass
Chamelaucium species	
Chenopodium auricomum	swamp bluebush
Chenopodium gaudichaudianum	earlobe saltbush
Chorizema ericifolium	
Chrysopogon fallax	ribbon or weeping grass
Chthonocephalus tomentellus	
Clematis microphylla	small leaf clematis
Cleome viscosa	tick weed
Codonocarpus cotinifolius	fire bush or native poplar
Commicarpus australis	tar vine
Conospermum species	smoke bush
Conostylis species	cats paw
Corchorus sidoides	flannel weed
Corchorus walcottii	wooly corchorus
Corynotheca lateriflora	
Cratystylis subspinescens	sage
Crotalaria cunninghamii	green bird flower
Cymbopogon ambiguus	lemon scented grass
Cynanchum floribundum	native pear
Cyperus bifax	downs nut grass
Dampiera incana	hoary dampiera
Dampiera spicigera	spiked dampiera
Danthonia caespitosa	ringed wallaby grass
Daviesia benthamii	
Daviesia species	bacon and eggs
Dianella revoluta	native lily
Dichrostachys spicata	pied piper bush
Dicrastylis costelloi	
Dicrastylis linearifolia	cabbage bush
Digitaria aff brownii	cotton panic grass
Diplolaena dampieri	
Diplolaena grandiflora	
Diplopeltis eriocarpa	caper bush
Dissocarpus paradoxus	cannonball
Dodonaea inaequifolia	hop bush
Dodonaea pachyneura	hop bush
Dodonaea viscosa	sticky hop bush
Duboisia hopwoodii	pituri
Ecdeiocolea monostachya	
Enchylaena tomentosa	ruby saltbush
Enneapogon polyphyllus	limestone grass
Enneapogon species	nigger heads
Enteropogon acicularis	curly windmill grass
Eragrostis australasica	swamp or cane grass
Eragrostis dielsii	Murchison or red grass
Eragrostis eriopoda	woolly butt
Eragrostis japonica	fairy grass
Eragrostis lanipes	creeping wanderrie
Eragrostis oldfieldii	
Eragrostis setifolia	never fail grass
Eragrostis xerophila	Roebourne plains grass
Eremaea ebractea	
Eremaea species	

Eremophea aggregata	
Eremophila aff. gibsonii	
Eremophila clarkei	turpentine bush
Eremophila cordata	
Eremophila crenulata	waxy leafed eremophila
Eremophila cuneifolia	royal poverty bush
Eremophila exilifolia	poverty bush
Eremophila foliosissima	poverty bush
Eremophila fraseri	turpentine bush
Eremophila freelingii	limestone fuchsia
Eremophila gibsonii	poverty bush
Eremophila gilesii	turkeybush
Eremophila glabra	
Eremophila glutinosa	poverty bush
Eremophila latrobei	warty leaf poverty bush
Eremophila leucophylla	Wilcox bush
Eremophila longifolia	poverty bush
Eremophila mackinlayi	poverty bush
Eremophila maculata	native fuchsia or travel bush
Eremophila maitlandii	sandplain poverty bush
Eremophila oldfieldii	poverty bush
Eremophila oppositifolia	twin leaf eremophila
Eremophila pantonii	limestone poverty bush
Eremophila platycalyx	granite poverty bush
Eremophila pterocarpa	silver poverty bush
Eremophila spathulata	spoon leaf eremophila
Eremophila spectabilis	showy eremophila
Eremophila youngii	poverty bush
Eriachne aff. *obtusa*	northern wanderrie grass
Eriachne aff. *sulcata*	
Eriachne aristidea	false broad leaf wanderrie grass
Eriachne benthamii	swamp wanderrie grass
Eriachne flaccida	crab hole grass
Eriachne helmsii	buck wanderrie grass
Eriachne mucronata	stony wanderrie grass
Eriochloa pseudoacrotricha	soring or cup grass
Eriostemon sericeus	
Eucalyptus camaldulensis	river red gum
Eucalyptus coolabah	coolibah
Eucalyptus decipiens	
Eucalyptus dichromophloia	variable barked blood wood
Eucalyptus erythrocorys	illyarrie
Eucalyptus eudesmioides	mallalie
Eucalyptus foecunda	narrow leaved red mallee
Eucalyptus fruiticosa	
Eucalyptus jucunda	
Eucalyptus jutsonii	
Eucalyptus loxophleba	York gum
Eucalyptus mannensis	
Eucalyptus microtheca	coolibah
Eucalyptus obtusiflora	
Eucalyptus oldfieldii	Oldfields mallee
Eucalyptus oraria	
Eucalyptus prominens	
Eucalyptus roycei	Royce's mallee
Eucalyptus socialis	
Eulalia fulva	silky brown top
Euphorbia boophthona	Gascoyne spurge
Euphorbia drummondii	balsam or caustic weed
Exocarpus aphyllus	broom bush
Exocarpus sparteus	
Ficus platypoda	native fig
Frankenia pauciflora	
Geleznowia verrucosa	
Glycine canescens	native soya bean
Grevillea annulifera	
Grevillea eriostachya	orange grevillea
Grevillea gordoniana	
Grevillea rogersoniana	Rogersons grevillea
Grevillea stenobotrya	rattle bush
Grevillea variifolia	Cape Range grevillea
Hakea arida	
Hakea lorea	cork wood
Hakea preissii	needle bush
Hakea stenophylla	
Hakea suberea	cork bark tree
Halgania littoralis	
Halosarcia halocnemoides	samphire
Halosarcia indica	samphire
Halosarcia pergranulata	samphire
Halosarcia pruinosa	samphire
Halosarcia pterygosperma	samphire
Hannafordia quadrivalvis	
Hemiandra species	
Heterodendrum oleaefolium	minga or rosewood
Hibiscus species	
Hybanthus enneaspermus	
Indigofera brevidens	
Indigofera monophylla	
Ipomoea muelleri	poison morning glory
Ipomoea yardiensis	Yardie Creek morning glory
Isotropis atropurpurea	
Jacksonia velutina	stinkwood
Jasminum lineare	native jasmine
Keraudrenia hermanniifolia	crinkle leaf fire bush
Labichea cassioides	
Labichea lanceolata	
Lachnostachys eriobotria	
Lamarchea hakeifolia	false paperbark
Lawrencia chrysoderma	
Lawrencia densiflora	
Lechenaultia linarioides	yellow lechenaultia
Lechenaultia subsymosa	
Leichardtia australis	cogla
Lepidium platypetalum (formerly *L. leptopetalum*)	peppercress
Lepidium linifolium	
Limonium salicorniaceum	
Lycium australe	water bush or boxthorn
Macarthia intrica	
Maireana amoena	
Maireana aphylla	spiny bluebush
Maireana atkinsiana	bronze bluebush
Maireana convexa	mulga bluebush
Maireana georgei	golden or George's bluebush
Maireana glomerifolia	ball-leaf bluebush
Maireana lanosa	bluebush
Maireana melanocoma	pussy bluebush
Maireana oppositifolia	
Maireana planifolia	flat leafed bluebush
Maireana platycarpa	low or shy bluebush
Maireana polypterygia	Gascoyne bluebush
Maireana pyramidata	sago bush
Maireana stipitata	bluebush
Maireana suaedifolia	lax bluebush
Maireana tomentosa	felty leafed bluebush
Maireana triptera	black or three winged bluebush
Maireana villosa	bluebush
Melaleuca cardiophylla	paper bark
Melaleuca eleuterostachya	
Melaleuca leiocarpa	
Melaleuca oldfieldii	paper bark
Melaleuca psammophila	
Melaleuca uncinata	broom honey myrtle
Minuria cunninghamii	
Mirbelia microphylla	
Mirbelia ramulosa	
Mirbelia spinosa	
Mirbelia viminalis	
Monachather paradoxa	broad leafed wanderrie
Muehlenbeckia cunninghamii	swamp bush or lignum
Murchisonia fragrans	
Myoporum insulare	
Newcastelia chrysophylla	
Nitraria billardierei	
Olax species	
Olearia axillaris	coast daisy bush
Osteocarpum acropterum	
Paraneurachne muelleri	
Paspalidium aff *clementii*	
Paspalidium gracile	
Paspalidium tabulatum	
Petalostylis labicheoides	
Petrophile conifera	
Phyllanthus fuernrohrii	
Phyllanthus species (RJC. 1948)	
Phymatocarpus porphyrocephalus	
Pileanthus limacis	
Pileanthus peduncularis	coppercups
Pimelea microcephala	mallee riceflower
Pittosporum phylliraeoides	desert willow
Pityrodia cuneata	
Pityrodia oldfieldii	
Pityrodia paniculata	
Pityrodia species	
Plectrachne danthonioides	
Plectrachne pungens	gummy spinifex
Plectrachne schinzii	feathertop or oat eared spinifex
Podolepis microcephala	
Porana sericea	
Prostanthera wilkieana	
Psoralea species	scurtped
Pterigeron species	smelly bush
Ptilotus aff *drummondii*	narrow leaf mulla mulla
Ptilotus divaricatus	climbing mulla mulla
Ptilotus obovatus	cotton bush
Ptilotus polakii	Gascoyne mulla mulla
Ptilotus schwartzii	horse mulla mulla

Rhagodia drummondii	
Rhagodia eremaea	tall or climbing saltbush
Rhagodia latifolia	
Rhagodia preissii	
Ruellia primulacea	
Rulingia loxophylla	
Salsola kali	roly poly
Santalum acuminatum	quondong
Santalum lanceolatum	bitter quondong
Santalum spicatum	sandalwood
Sarcostemma australe	caustic bush
Scaevola crassifolia	
Scaevola spinescens	currant bush
Scaevola tomentosa	ragged leaf scaevola
Scholtzia leptanthia	
Sclerolaena diacantha	bindii
Sclerolaena divaricata	bindii
Sclerolaena species	bindii
Sclerolaena tridens	
Sclerolaena uniflora	
Sclerostegia disarticulata	samphire
Setaria dielsii	chinterbii
Sida aff *virgata*	
Sida calyxhymenia	tall sida
Sida echinocarpa	
Sida kingii	
Sida physocalyx	
Sida rohlenae	
Sida virgata	
Solanum esuriale	quena or devils apple
Solanum lasiophyllum	flannel bush
Solanum orbiculatum	tomato bush
Spartothamnella teucriiflora	
Spinifex longifolius	beach spinifex
Sporobolus mitchellii	rats tail couch
Spyridium complicatum	
Spyridium divaricatum	
Stipa crinita	
Stipa elegantissima	feather spear-grass
Stylobasium spathulatum	pebble bush
Swainsona ecallosa	
Swainsona pterostylis	
Tecticornia verrocosa	claypan samphire
Templetonia retusa	cockies tongues
Tephrosia bidwillii	
Tephrosia flammea	
Themeda australis	kangaroo grass
Threlkeldia diffusa	
Thryptomene baeckeacea	
Thryptomene decussata	
Thryptomene stronglophylla	
Tribulus platypterus	corky bark kallstroemia
Trichodesma zeylanicum	native blue bell
Tricoryne species	
Triodia angusta	spinifex
Triodia basedowii	buck or hard spinifex
Triodia lanigera	spinifex
Triodia plurinervata	spinifex
Triodia pungens	soft spinifex
Triodia wiseana	limestone or hard spinifex
Triumfetta chaetocarpa	
Verticordia forrestii	feather flower
Waitzia podolepis	
Westringia species	
Wurmbea odorata	
Zygophyllum aurantiacum	shrubby twin leaf
Zygophyllum fruticulosum	shrubby twin leaf
Zygophyllum species	shrubby twin leaf

APPENDIX 3

List of endemic and near-endemic plants found in the Carnarvon Basin survey area

This list is based on specimens lodged at the Western Australian Herbarium as of February 1983 and in a few cases complemented by literature records.

For unnamed species a voucher specimen is cited in parentheses following the generic name. Species not entirely confined to the area are indicated with an asterisk (*).

Forty-two true endemics and 8 near-endemics are listed below. However, as more material becomes available this number may vary.

Abutilon geranoides (DC.) Benth.
Acacia anastema Maslin
Acacia drepanophylla Maslin
Acacia galeata Maslin
Acacia roycei Maslin
* *Acacia subtessarogona* Tindale & Maslin
Acanthocarpus sp. (Wittwer W1772)
Adenanthos acanthophyllus George
Angianthus microcephalus (F. Muell.) Benth.
Atriplex paludosa subsp. *graciflora*

* *Banksia ashbyi* E.G. Baker
Beaufortia dampierii A. Cunn.
Brachycome latisquamea F. Muell.
Brachysema macrocarpum Benth.

Calothamnus sp. (S.D. Hopper 1341)
* *Chamelaucium sp.* (R.J. Cranfield 2578)
Chthonocephalus tomentellus (F. Muell.) Benth.

Dampiera incana R.Br. var. *incana*

Eragrostis oldfieldii Domin
Eremaea sp. (A.S. George 04102)
Eremophea aggregata P.G. Wilson
Eriachne gardneri Hartley
Eucalyptus beardiana Brooker & Blaxell
Eucalyptus fruticosa Brooker
Eucalyptus prominens Brooker
Eucalyptus roycei S.G.M. Carr

Grevillea rogersoniana C.A. Gardner

Ipomoea yardiensis George

* *Labichea cassioides* Gaud.
Lamarchea hakeifolia Gaud. var. *hakeifolia*

Leschenaultia subsymosa C.A. Gardner & George
Lepidium linifolium (Desvaux) Steud.

Macarthuria intrica G.J. Keighery
Maireana stipitata P.G. Wilson
Murchisonia fragrans N.H. Brittan

Newcastelia chrysophylla C.A. Gardner

Pileanthus sp. (A.S. George 10365)
Pityrodia cuneata (Gaud.) Benth.
* *Pityrodia paniculata* (F. Muell.) Benth.
Psammagrostis wiseana C.A. Gardner & C.E. Hubbard

* *Sclerolaena tridens* (F. Muell.) Domin
Spyridium divaricatum Benth.
Stipa crinata Gaud.
Swainsona ecallosa Sprague

Tricoryne sp. (G.J. Keighery 814)
* *Triodia plurinervata* N.T. Burbidge
Tetragonia diptera F. Muell.

Waitzia podolepsis (Gaud.) Steetz
* *Wurmbea odorata* T.D. Macfarlane

Verticordia sp. (A. Payne 424)

56037/8/87-2M.-L/4339

GARRY L. DUFFIELD, Government Printer, Western Australia

Western Australian
Department of
Agriculture