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A range inventory and condition survey of part of the Western Australian Nullarbor Plain, 1974

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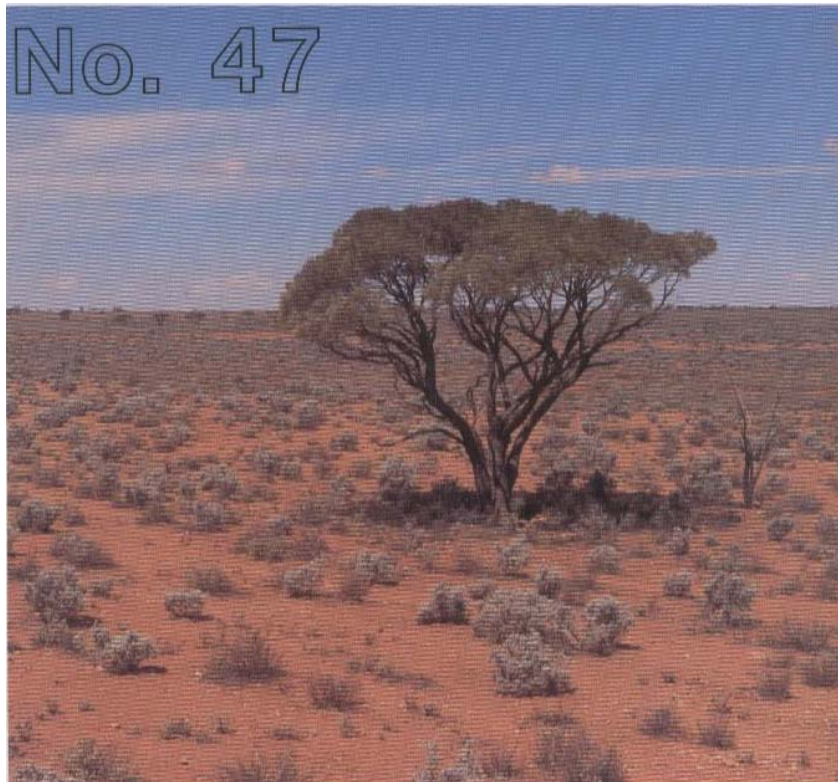
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Technical Bulletin

A range inventory and condition
survey of part of
the Western Australian
Nullarbor Plain, 1974



A.A. Mitchell
R.C. McCarthy
and R.B. Hacker
Second edition
1988

A range inventory and condition survey of part of the Western Australian Nullarbor Plain, 1974

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1988**

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SUMMARY

1. The area surveyed covers approximately 47 400 square kilometers and lies within the Eucla, Noonaera, Forrest and Loongana 1:250 000 map sheets.
 2. The area is described in terms of climate, geomorphology, soils, vegetation, land zones and land systems. Land zone and land system maps at 1:250 000 scale are presented.
 3. Condition statements are presented for each land zone, each land system and each station property within the survey area.
 4. Nineteen thousand (19 000) square kilometers of 40 per cent of the survey area is in poor condition. Shrub pastures have been degraded to annual grass and herb pastures.
 5. Areas in fair, good and excellent condition comprise 10 per cent, 11 per cent and 39 per cent respectively of the survey area.
 6. There is no active accelerated erosion within the survey area.
 7. The poor condition of parts of the area is due to the combined effects of rabbits, fire and drought. Domestic stock are absent over most of the area and have played only a minor role in pasture degradation.
 8. At present (1979) unalienated crown land occupies 77 per cent of the survey area and is considered unsuitable for pastoral use.
 9. Reasons for this include:
 - The low and erratic rainfall.
 - The degraded condition of the shrub pastures. Where these are degraded to ephemeral grasses and herbs, carrying capacity is very low and pastoral enterprises would be extremely vulnerable in times of drought; that, the pastures have no durability.
 - The lack of suitable stock waters.
 10. With the possible exception of one large lease, the other pastoral leases within the survey area are not economically viable at present and are unlikely to be viable in the future..
-

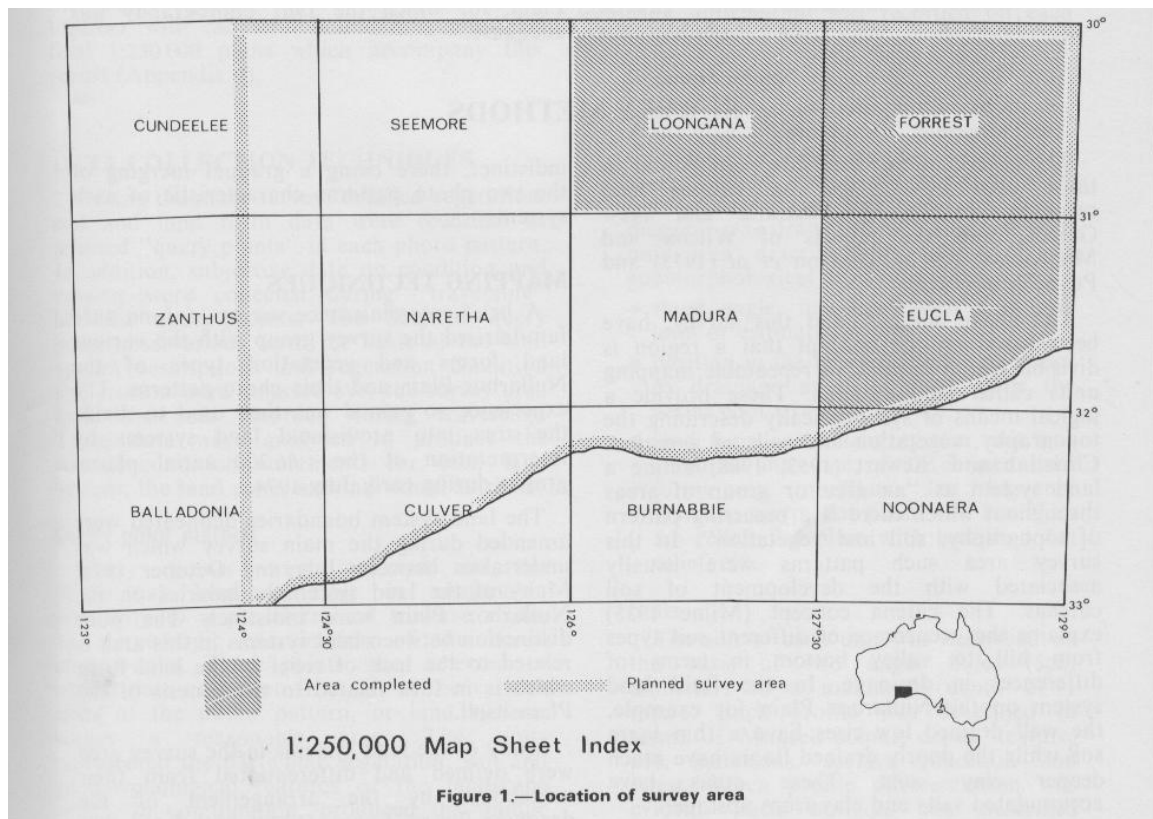
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INTRODUCTION

The Western Australian portion of the Nullarbor Plain was largely unalienated before 1955, but considerable pastoral development occurred in the 1960s. From 1969 to 1973 the region was severely affected by drought and some sheep stations suffered stock losses greater than 75 per cent. Serious soil and pasture degradation was reported on the Nullarbor Plain by field officers of the Western Australian Department of Agriculture during the drought period and the State's Pastoral Appraisal Board subsequently acted to prevent further alienation of the eastern part of the Nullarbor region.

However because interest in development of the area has continued the Board commissioned a joint survey by the Departments of Lands and Surveys, and Agriculture in early 1974.



The survey covered approximately 47 400 sq. kilometers of Western Australia (Figure 1) and included most of the land between latitudes 30°S and 32°S and longitudes 126°E and 129°E. The Eucla, Noonaera, Forrest and Loongana 1:250 000 map sheets cover the area surveyed.

The aims of the survey were:

- To map the area of interest into land systems at 1:250 000 scale.
- To determine and define the type and severity of pasture degeneration and soil erosion on a land system basis.
- To determine whether or not unalienated land should be released for pastoral purposes.

The planned survey area covered the entire Western Australian part of the Nullarbor Plain and included many recently developed stations. These are not included in this report for the following reasons:

- The 1961 aerial photography, then the only photo coverage available, was inadequate in areas developed since 1961. New tracks and fences could not be positioned accurately on the aerial photographs because of the lack of identifiable landmarks. Consequently the survey group was rarely sure of its exact position in new station country.

- Cross country navigation was extremely time consuming and inaccurate. The featureless landscape made precise location on the photographs particularly difficult. Compass bearing traverses were hazardous due to the numerous rabbit warrens present and the generally rugged nature of the limestone surface.
- Bushfires had changed the vegetation since 1961 and photo patterns often did not correspond with ground truth.
- This report is therefore restricted to the few long settled pastoral properties, and unalienated land on the eastern edge of the Western Australian part of the Nullarbor Plain, for which the 1961 photography was adequate.

SURVEY METHODS

The general survey methods were similar to those used by CSIRO on various land resource surveys of Australia and New Guinea, and the reports of Wilcox and MacKinnon (1972), Dawson *et al* (1975) and Payne *et al* (1979).

The above surveys, and this survey, have been based on the concept that a region is divisible into a number of repeatable mapping units called land systems. These provide a logical means of systematically describing the topography, vegetation and soils of a region. 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, soil and vegetation". In this survey area such patterns were usually associated with the development of soil catenas. The catena concept (Milne 1935) explains the occurrence of different soil types from hill to valley bottom in terms of differences in drainage. In the Reid land system on the Nullarbor Plain for example, the well drained low rises have a thin loam soil while the poorly drained floors have much deeper clay soils. These areas have accumulated salts and clay from upslope.

Each land system is characterized by a unique pattern on the aerial photographs. In some instances the boundaries between adjacent land systems were well defined while elsewhere the characteristic photo patterns merged gradually with no clear-cut boundaries. For example, the Loongana land system which was delineated on the presence of *Meuhlenbeckia* swamps had distinct boundaries. Conversely, the boundary between the Deakin and Oasis land systems was often indistinct, there being a gradual merging of the two photo patterns characteristic of each system.

MAPPING TECHNIQUES

A brief reconnaissance survey in June 1974 familiarised the survey group with the various land forms and vegetation types of the Nullarbor Plain and their photo patterns. The experience so gained was then used to divide the area into provisional land systems by interpretation of the 1:86 200 aerial photographs during early July 1974.

The land system boundaries delineated were amended during the main survey which was undertaken between July and October 1974. Many of the land system boundaries on the Nullarbor Plain were indistinct. The poor distinction between land systems in this area is related to the lack of relief in the land form which is in turn related to the genesis of the Plain itself.

Many of the land systems in the survey area were defined and differentiated from their neighbours by the arrangement of the drainage floors. Lowry (1970) postulated that the different patterns of drainage floor development results from different jointing patterns, arguing that the drainage floors have been formed by down weathering of these joints. In most cases where jointing pattern differentiated land systems, no distinct boundaries could be discerned. Adjacent land systems were separated by a transitional zone, up to five kilometers in width, within which characteristics of both land systems were evident.

The land systems defined in this report were grouped together using land form and vegetation criteria to form five distinct regions or "land zones". These land zones are further described under geology and soils.

The land system boundaries were transferred from the 1:86 000 ozafilm line compilations and 1:250 000 topographic maps had a common grid pattern enabling boundaries to be transferred directly. Fair drawing was then simply a matter of tracing the data required from the base sheets, together with cadastral boundaries, onto the final 1:250 000 plans which accompany this report (Appendix 3).

DATA COLLECTION TECHNIQUES

During this main survey, detailed vegetation, soil and land form data were recorded at selected "query points" in each photo pattern. In addition, subjective data on condition and erosion were collected during "traversing" between query points. The detailed query point observations form the basis of the land system descriptions and vegetation condition and erosion were assessed over the survey area from the data recorded during traversing. These data were analysed to produce the overall condition statements for each land system, the land zone, and individual stations.

Query point method

Query points were selected in the provision land systems, in reasonable proximity to a predetermined traverse route, by stereoscopic examination of the aerial photographs. These points were selected to permit data collection from all of the various units of the photo pattern, or land system, within a reasonable area. The units represented the particular vegetation, soil and geomorphological features of the landscape which, in combination, produced the unique land form, and photo pattern, characteristic of the land system. Final selection of query points was based on field examination. No point was selected within 1 km of a stock watering point or land system boundary or within 200 m of a fence line.

At each query point, data for each unit of the pattern were collected from areas precisely located on the aerial photograph, and on the ground. In some instances, the boundary between units was distinct (e.g. between donga floors and adjacent slopes) while in other situations units were not clearly defined, the photo pattern reflecting gradual changes in soil and vegetation. In these situations considerable care was necessary in defining the sampling area within each unit.

Query points located on the 1:86 200 aerial photographs were subsequently located on the 1:250 000 map sheets. During the survey 138 query points were examined.

Query point information was coded onto three data sheets, one each for Geomorphology, Soils and Vegetation. The following information was recorded on each sheet:

Geomorphology

The date, aerial photo reference, Australian Transverse Mercator co-ordinates, geology, station name, land system name and query point number, were recorded on this sheet. A block diagram was drawn of each site and each unit was described in terms of its geomorphological attributes which were:

- slope angle, measured with a dumpy level or estimated by eye.
- Position in the landscape with reference to drainage as determined from the aerial photographs.
- land form - each land system unit was classified into one of the 28 defined land forms e.g. mudflats and lagoonal systems, scarp, flat plain with less than 5m relief, flat plain with less than 1m relief, etc.

Soils

The soil of each unit was described on the basis of two auger holes (5cm diameter) to a maximum depth of 1 metre. Each profile was described in terms of Munsell colour, depth, texture, pH, inclusions, surface condition and strew. When profile differentiation was evident, each horizon was described separately. Samples were taken from many of the profiles for mechanical analysis and for determination of soluble salts and total nitrogen.

The various parameters recorded were coded for entry onto the data sheet according to the definitions of Table 1.

The soil of each land system unit was described after collation of these data from all such units sampled during the survey.

Table 1. – Nullarbor inventory and condition survey soil descriptions and codes.

<i>Surface Condition</i>		<i>Texture</i>	
Code	Description	Code	Description
01	Seasonal cracking	001	Gravel
02	Hard setting	002	Coarse sand
03	Loose	003	Sand
04	Crusting	004	Fine sand
05	Cryptogammic crusting	005	Loamy coarse sand
<i>Surface strew and profile inclusions</i>		006	Loamy sand
Code	Description	007	Loamy fine sand
06	Gravel 2-4 mm	008	Coarse sandy loam
07	Pebble 4-64 mm	009	Sandy loam
08	Cobble 64-256 mm	010	Fine sandy loam
09	Boulders 256 mm	011	Loam
10	Angular fragments of Gravel size	012	Sandy clay loam
11	Angular fragments of Pebble size	013	Clay loam
12	Angular fragments of Cobble size	014	Sandy clay
13	Angular fragments of Boulder size	015	Light clay
14	Outcropping parent rock	016	Medium clay
15	Marine shells	017	Heavy clay
<i>Distribution of Surface Strew</i>		<i>Soil Colour</i>	
Code	Description	Code	Description
01	01	01	5 R
02	02	02	7.5 R
03	03	03	10 R
04	04	04	2.5 YR
05	05	05	5 YR
06	Irregular cover - moderate	06	7.5 YR
07	Irregular cover - sparse	07	10 YR
	Clumped	08	2.5 Y
		09	5 Y

Table 2. – Structural classification of vegetation

Life form of Stratum producing Largest biomass	Projected foliage Cover %	Description	Code
Trees 10-30 m	70-100	Closed forest	001
	30-70	Open forest	002
	10-30	Woodland	003
	<10	Open Woodland	004
Trees 6-10 m	70-100	Low closed forest	005
	30-70	Low open forest	006
	10-30	Low woodland	007
	<10	Low open woodland	008
Shrubs 2-8 m	70-100	Closed scrub	009
	30-70	Open scrub	010
	10-30	Tall shrubland	011
	<10	Tall open woodland	012
Shrubs up to 2m	70-100	Closed heath	013
	30-70	Open heath	014
	10-30	Low shrubland	015
	<10	Low open shrubland	016
Herbs & Grasses	70-100	Closed hermland grassland	017
	30-70	Herbland grassland	018
	10-30	Open herbland grassland	019
Hummock grasses	10-30	Hummock grassland	020
	<10	Open hummock grassland	021

Each woody perennial species was described in terms of height, projected foliage cover (PFC) and age structure of the population

Vegetation

Classification methods

The vegetation of each land system unit was classified according to the stratum producing the largest biomass. The dominant stratum was characterized in terms of density and height after Specht (1970) using the definitions and codes detailed in Table 2.

Plant height was classified using the categories shown in Table 3, Height descriptions apply to the general level of the mature population and are not objective estimates of average plant height.

Table 3. – Plant height classification

Height (m)	Class
0-0.33	1
0.34-0.67	2
0.68-1.0	3
1.01-1.33	4
1.34-1.67	5
1.68-2.0	6
2.01-10.0	7
10.01+	8

Tree and shrub PFC was measured using the plotless method of Cooper (1963). This method is suitable for use in sparsely vegetated, arid environments such as the survey area but is inaccurate when actual cover exceeds 35 per cent. In the survey area PFC of tree or shrub species rarely exceeded this level and in such instances cover was estimated by eye.

Age structure of the various tree and shrub populations was classified according to the definitions of Table 4. Age structure of a population was considered important in relation to vegetation condition. A well structured population of desirable perennials is usually indicative of excellent condition. A population of even aged old plants may, in some cases, indicate declining condition.

Cover of ephemeral species was estimated by eye in 10 random quadrats of 0.5m² and the average cover recorded. A list of the major species present in these quadrats was compiled but only total PFC was estimated. The survey was conducted under exceptionally favourable seasonal conditions and ground cover estimates were generally high.

Table 4. – Age structure categories

Description	Code
Even aged population of old plants	01
Even aged population of young plants	02
Seedlings only, abundant	03
Seedlings only, infrequent or rare	04
Noticeable break in age structure, only old plants and seedlings present	05
Well structured population with all age/size classes present	06

The vegetation of the survey area was classified into 19 associations based on the data described above. These associations are discussed later and described in detail in Appendix 1. The vegetation and pastoral value of each land system unit is also described in terms of these associations.

Disturbance factors

Factors considered to have contributed to the disturbance or degradation of vegetation were determined for each unit of the pattern within the query point area. The following disturbance factors were defined and recorded as present or absent in each area examined:

- No disturbance
- Fire
- Rabbits
- Stock
- Drought

No severity rankings were attached to the factors since in many cases two or three disturbance factors were involved. In these instances it was impossible to point to any one factor as the major cause of vegetation disturbance.

Fire was recorded as "present" when either charcoal, or the charred remains of trees or shrubs were observed.

Rabbits were recorded as "present" when new or old warrens were observed in the immediate vicinity of a query point.

Stock were recorded as present when dung, tracks or grazing damage were observed.

The survey area had experienced severe drought conditions during the period 1969-1973. Drought effects were thus recorded as "present" when a substantial portion of the perennial vegetation had died in the absence of any other obvious disturbance factor, or when, if other disturbance factors were present, the appearance of the dead shrubs suggested that drought had contributed to the overall mortality.

The condition of each land system is discussed in relation to the various disturbance facts under "condition of the survey area".

Vegetation condition and soil erosion

The vegetation condition of each unit was assessed as excellent, good, fair or poor based on a comparison of present vegetation with the assumed climax for the site. The nature of the climax vegetation was inferred from observation of apparently undisturbed areas. As much of the surveyed area has never supported domestic livestock, the term "vegetation condition" was adopted rather than "range condition" to describe the present state of the vegetation. The definitions of Table 5 were used to determine the vegetation condition class of each area observed.

Table 5. – Vegetation condition classes

Vegetation Condition Class	Condition	Description
1	Excellent	Shrubland or grassland in original condition
2	Good	Some deterioration in the perennial component of the vegetation
3	Fair	Vegetation degraded with few climax species present
4	Poor	Absence of shrubs or perennial grasses. Annual species only.

Definitions shown in Table 6 were drawn up at the beginning of the survey to describe the type and severity of erosion at each query point. In fact, however, no substantial erosion was observed throughout the surveyed area.

Table 6. – Erosion classes

Code	Description
<i>Wind erosion</i>	
01	No visible disturbance of the soil.
02	Discontinuous scalding of soil surface, redistribution of heavier soil fractions to the margins of the scald. Minor build-up of soil material around obstacles such as plant bases or grass crowns.
03	Hummocking or drifting of the soil against obstacles – sometimes associated with large and often continuous scalding.
04	Major deflation of the soil surface – active stripping of large areas – plant cover frequently absent, major sand drift.
<i>Water erosion</i>	
10	No erosion
11	Minor erosion – rills up to 10 cm in depth. No deep gullies.
12	Surface stripping to 3 cm on even slopes.
13	Erosion gullies . 10 cm in depth. No deep gullies.
14	Severe sheeting and/or gullies on lower and upper slopes.

Query point data were transferred from the recording sheets to data recording sheets and then to punched cards. The data was analysed using two Sort-Merg programs. All analyses were conducted on the Cyber 7200 computer at the WA regional Computing Centre.

The first program analysed the various environmental parameters thought important in determining the distribution of plant species within the survey area. This material was used in formulating the descriptions of the plant associations presented in Appendix 1. The second program listed the soils and vegetation of each land system unit.

Vegetation condition and disturbance data were analysed manually.

Traverse method

Field operation

The traverse recording method consisted of visually assessing vegetation condition and shrub cover at regular intervals while motoring between query points. Assessments were made from a vehicle traveling at no more than 50 km/h at points 1.6 km apart. Two experienced observers made simultaneous assessments in order to eliminate single observer bias. Any differences were resolved by consensus.

Vegetation condition was assessed using the class rating system detailed in Table 5 and shrub cover assessed in terms of four PFC classes defined in Table 7.

Table 7. – Shrub cover classes

Class	Per cent Projected foliage cover
1	>10
2	6-10
3	2-5
4	0-1

All available tracks within the survey area were traversed and as many recordings as possible obtained. Vegetation condition and shrub cover assessments made on traverse routes are presented on 1:250 000 overlays (Appendix 4). A total of 1 273 traverse condition recordings were made during the survey.

The traverse recording method is a simple sampling technique for assessing vegetation condition. Its major disadvantage is that since traversing is necessarily confined to identifiable tracks, estimates of the condition of a land system may be seriously biased if tracks tend to be confined to particular parts of the landscape. This difficulty was apparent in some parts of the survey area in which tracks tended to follow drainage floors as far as possible, or when they followed degraded areas from which shrubs had been removed. This difficulty was apparent in some parts of the survey area in which tracks tended to follow drainage floors as far as possible, or when they followed degraded areas from which shrubs had been removed. The difficulty of cross-country traversing on the Nullarbor, however, has already been noted so that restriction of traverse recordings to established tracks was an unavoidable feature of the survey.

Lack of tracks in some parts of the survey area, together with the difficulties of cross-country traversing, resulted in rather inadequate sampling of some land systems.

Data analysis

The vegetation condition of each land zone, land system and pastoral lease was determined from the traverse data. For any particular zone, land system or lease, the vegetation condition scores obtained from the traverse record were averaged. Overall vegetation condition classes could then be assigned to each zone, system or lease based on the categories defined in Table 8. Data for particular land systems etc. were extracted by hand from the traverse record after plotting onto 1:250 000 sheet overlays.

Table 8. – Overall vegetation condition categories

Overall vegetation Condition category	Average vegetation Condition score
Excellent	1.0-1.75
Good	1.76-2.50
Fair	2.51-3.25
Poor	3.26-4.0

The vegetation condition of each land system was analysed as shown in Table 9.

Table 9. – Vegetation condition analysis for Jubilee land system

Land system	No. of condition recordings	Per cent in Condition classes				Average condition score	Overall vegetation condition
		1	2	3	4		
Jubilee	78	20	5		71	3.26	Poor

CLIMATE

The survey area falls within the semi-arid to arid region as defined by Meigs (1953) and is unsuitable for agricultural use. Its most effective rainfalls during winter (Australian Bureau of Meteorology, 1971) and the climate is controlled by the two distinct weather patterns described below.

MAJOR CLIMATIC PATTERNS

Summer patterns

The summer weather pattern is characterized by the migration of anti-cyclonic systems from west to east over southern Western Australia. These create westerly winds from the sea as they approach the coast, bringing cooler conditions. However they create hot easterly winds off the land mass as they migrate over the continent. An alternating pattern of hot and cool periods is thus associated with these anticyclones as they migrate across the continent. The remnants of northern cyclonic disturbances occasionally pass over the area as depressions, bringing heavy but unreliable rain.

Winter patterns

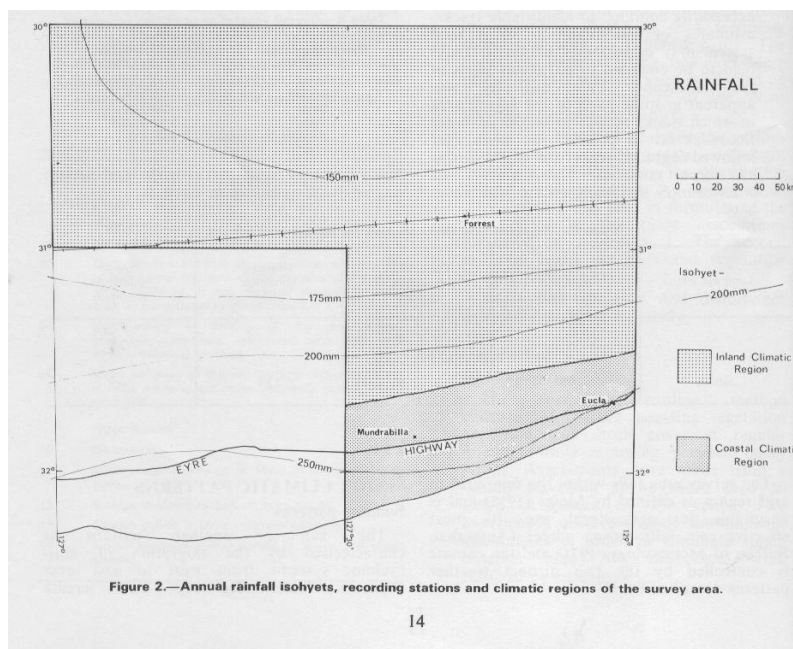
In winter the southern hemisphere's anti-cyclonic belt moves northwards allowing the low pressure systems to take a more northerly track over southern Western Australia. In most cases these low pressure, rain-bearing depressions reach the Nullarbor region devoid of rain but rain is occasionally received from particularly intense depressions and from depressions that move inland from the Bight in an east-north-easterly direction. The main source of substantial winter rainfall arises from the convergence of a depression or an anti-cyclone with a moist northerly air mass. Heavy rains are received at the interface of the two air-streams. This type of rainfall however, is unreliable.

Cold conditions may be created either by winds from the sea or a high pressure system causing cloudless nights which usually result in radiation frosts. Winds blowing off the land mass otherwise create mild winter conditions.

CLIMATIC FACTORS

continuous records of rainfall and/or temperature are available from Eucla (98 years), Mundrabilla (73 years) and Forrest (44 years). Records have been kept for shorter periods at other stations in the survey area but are often incomplete.

The survey area was divided into two climatic regions as shown in Figure 2. Eucla and Mundrabilla represent the coastal region while Forrest represents the inland region.



The coastal and inland regions exhibit marked differences in average annual rainfall, minimum winter temperatures and maximum summer temperatures. However, the boundary is diffuse and has been arbitrarily drawn 20 to 30 km north of the Hampton Range.

The inland climatic region is characterized by hot summers, cold winters and very low and erratic rainfall. In the coastal region oceanic influences have a modifying effect on the excesses of temperature and aridity.

Rainfall

Mean annual rainfall in the coastal region varies from 250 mm at Eucla to 230 mm at Mundrabilla. Forrest in the inland region, receives a mean annual rainfall of 170 mm. Mean monthly rainfall data for the three stations are presented in Figure 3. The coefficients of variation of monthly rainfall are presented in Figure 4.

Coastal Region

Winter rainfall predominates at both stations in terms of monthly averages, and is more reliable than summer rainfall. However, winter rains are still extremely variable.

The higher coefficients of variation in the January-March period compared with the September-December period reflect occasional intrusion into the area of cyclonic rain-bearing depressions in mid-late summer while the early summer period is more consistently dry.

The effect of distance from the sea on mean annual rainfall is reflected in the data for Eucla (250 mm) and Mundrabilla (230 mm). The former is located about a km from the shore line while the latter is situated 10 km inland. The coastal region may be described as semi-arid according to Meigs (1953).

Inland region

Mean monthly rainfall data for Forrest are presented in Figure 3 and coefficients of variation of monthly rainfall are detailed in Figure 4. The mean annual rainfall of 170 mm is distributed more uniformly through the year than for stations in the coastal region although the seasonal pattern of reliability, as reflected in the coefficients of variation, is similar for all three stations. The region may be described as arid according to Meigs (1953).

Temperature

Mean monthly maximum and minimum temperatures are presented for Eucla (coastal region) and Forrest (inland region) in Figure 5.

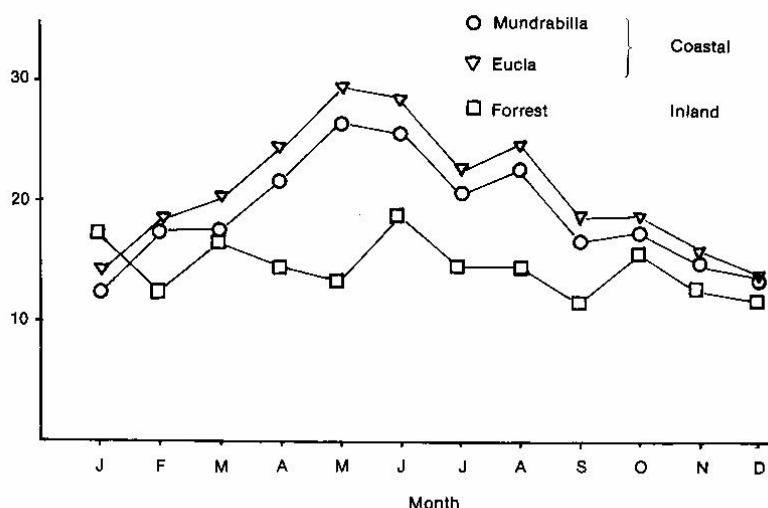


Figure 3.—Mean monthly rainfall at Eucla, Mundrabilla and Forrest.

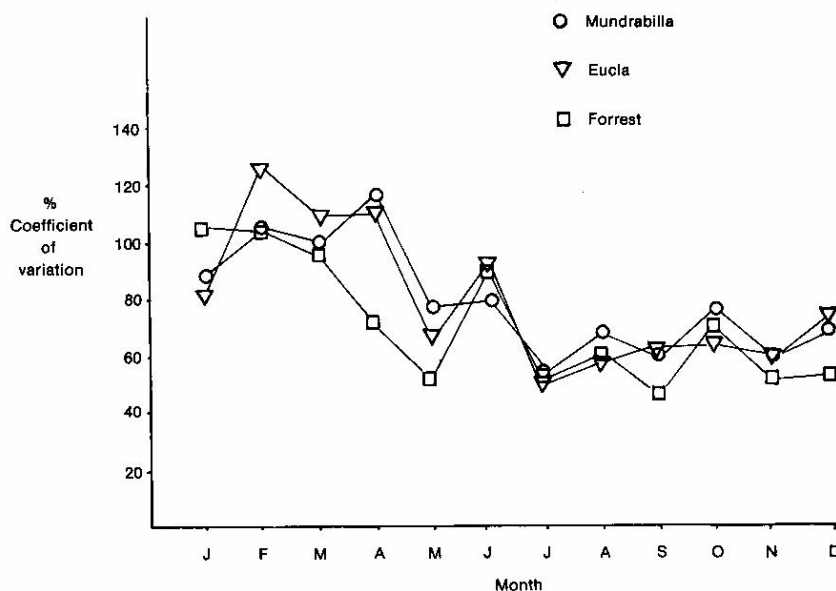


Figure 4.—Coefficient of variation of monthly rainfall at Eucla, Forrest and Mundrabilla.

At Eucla mean monthly maxima vary from 26°C in January to 18°C in July while the corresponding figures for Forrest are 33°C and 18°C. Mean monthly minima vary from 17°C (February to 7°C (July) at Eucla and from 15°C (February to 4°C (July) at Forrest.

In general, the inland region is characterised by higher maximum and lower minimum temperatures than the coastal region where sea breezes, increased cloud cover and higher relative humidity ameliorate climatic conditions throughout the year.

Evaporation

Average monthly potential evaporation data for Eucla (coastal) and Forrest (inland) are presented in Figure 6. Data are based on nine and eight years of records for Eucla and Forrest respectively.

Evaporative demand is higher in the inland region throughout the year and markedly so in summer, reflecting the higher temperatures, and lower relative humidity and cloud cover of this area compared with the coastal region.

In general, the climate of the survey area ranges from winter rainfall semi-arid adjacent to the coast to an arid climate with more uniform rainfall distribution in the north. Even in the north, however, winter rainfall tends to be more reliable although monthly averages do vary greatly. In both regions winter rainfall is generally more effective in terms of vegetation growth since evaporative demand in summer is high. Major flushes of growth, however, result from occasional heavy falls in mid-late summer associated with the movement into the area of rain bearing depressions, the remnants of tropical cyclones. While seasonal patterns of rainfall reliability can be discerned, particularly in the coastal region, rainfall overall is highly variable. Coastal influences exert a modifying effect on climate along the southern fringe of the survey area, but such effects diminish rapidly with distance from the sea.

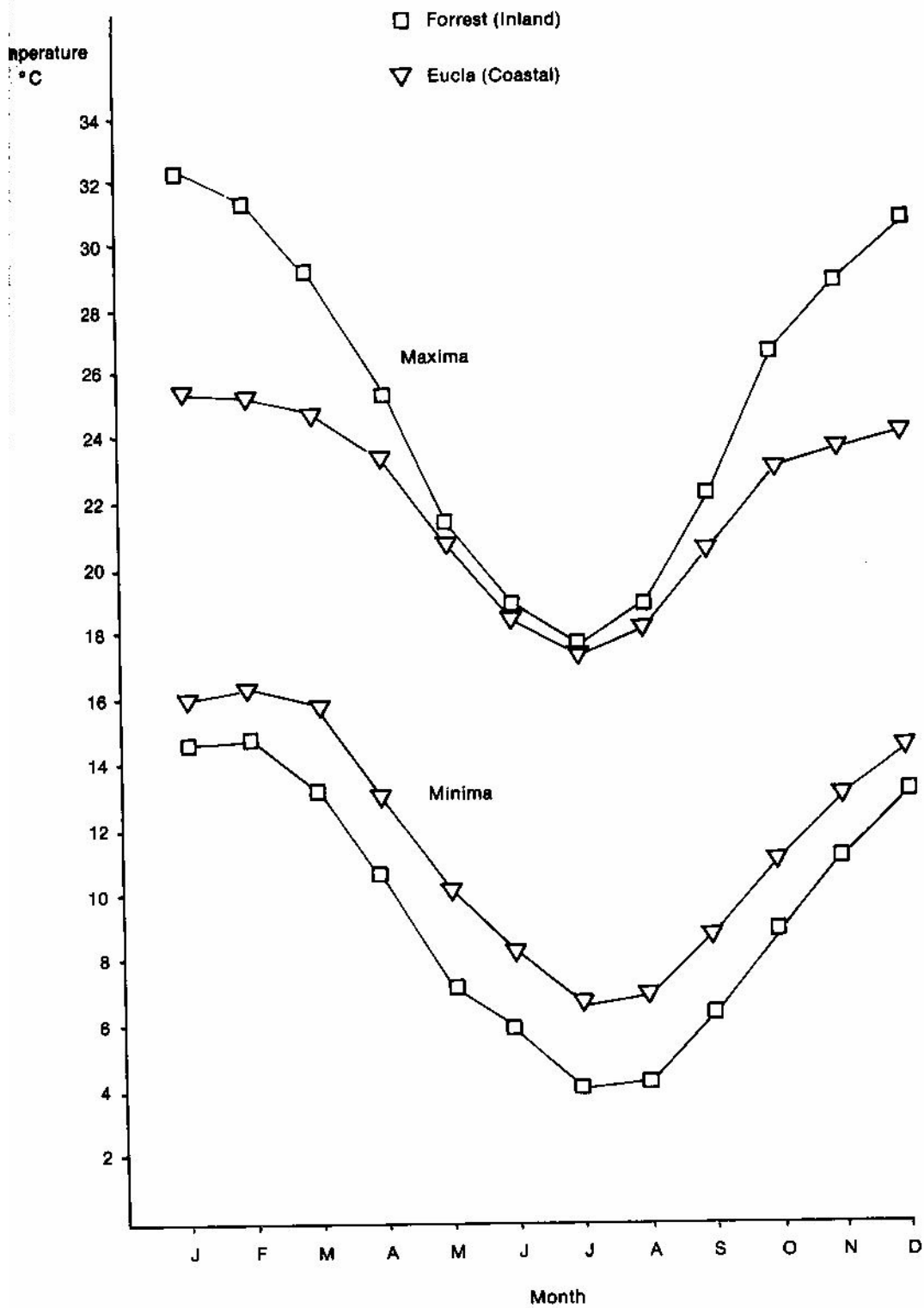


Figure 5.—Mean monthly temperatures at Eucla and Forrest.

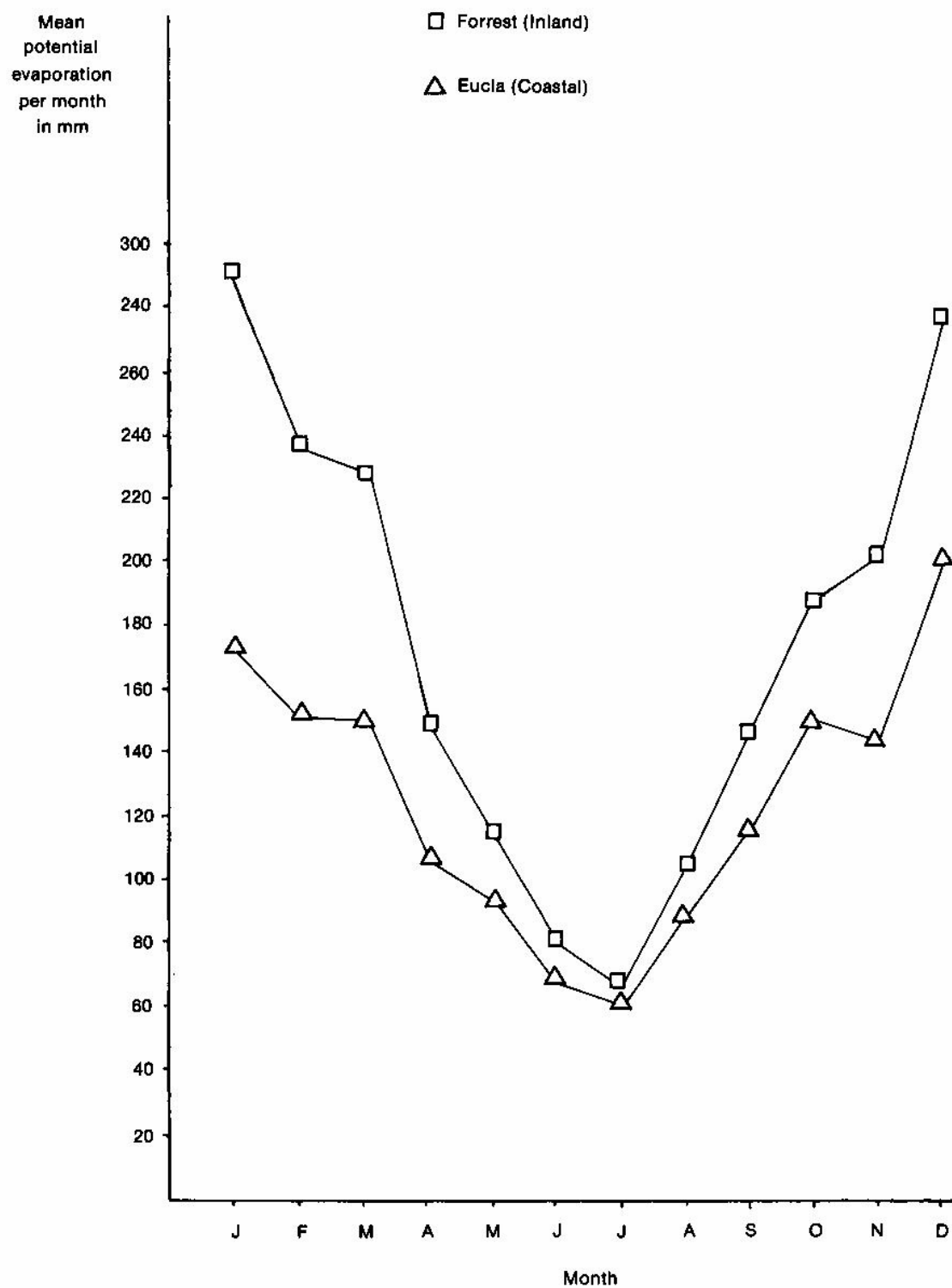


Figure 6.—Potential mean monthly evaporation at Eucla and Forrest.

GEOLOGY, GEOMORPHOLOGY AND LAND ZONES

The survey area forms part of the Eucla Basin (Jutson 1934). The geology of the Western Australian part of this basin was surveyed by Lowry (1970) whose maps provide the geological basis for the present survey.

The area may be divided into two distinct geological regions within which a number of land zones have been defined. The major geological regions are the Bunda Plateau and the Roe Plain and their boundaries, together with those of the land zones, are shown in Figure 7. Land zones are modifications of Lowry's hydrological regions.

THE BUNDA PLATEAU

Some 44 513 sq km or 94 per cent of the survey area falls within the Bunda Plateau geological region. This region contains the Nyanga, Dimer, Nullarbor and Hampton land zones and land surfaces slope very gently to the north reaching a maximum elevation of 240 m above sea level. In the south, the plateau ends at the wave-formed scarp known as the Hampton Range where the minimum height of the plateau is about 90 m above sea level.

The plateau is almost entirely covered by a thin, continuous layer of horizontal Nullarbor Limestone and constitutes one of the world's largest karst systems (Jennings 1967) although the full development of karst features has been retarded by the arid to semi-arid climate (Lowry 1970). The marine sediments of the Nullarbor Limestone were laid down in pre-Tertiary times when the entire land area of the present Eucla Basin was submerged. Uplift of the Bunda Plateau to its present position occurred during the Tertiary and was probably the result of isostatic rebound associated with a drop in sea level. Jointing patterns of the Nullarbor Limestone probably formed during the period of uplifting and the plateau has since been subjected to minimal tectonic activity.

Lowry (1970) postulates that after uplift, more or less even weathering of the Nullarbor Limestone produced a continuous layer of clay and kankar over the entire plateau. Deflation of the surface during a subsequent period of extreme aridity, however, removed most of this material. Residual areas today are restricted to the north of the survey area (Nyanga land zone) and are associated with relict river systems. The residual clay and kankar of these areas is usually raised three to four metres above the deflated surface of the Nullarbor Limestone with a gradual transition between the two levels.

Drainage throughout the plateau is endoreic and consists of a mosaic of small catchments each draining to a central focus. These foci have undergone colluvial infilling to form dongas and clay pans. The latter are often saline.

Dongas are generally circular to oval in shape and up to 1 km in width. They are described by Lowry (1970) as immature solution dolines that have been infilled with colluvial material to form a clay floor, with areas of gilgai microrelief. Gilgai formation is a distinctive characteristic of dongas and results from wetting and drying of clays with high montmorillonite contents (Hallsworth 1955). Soil heaving associated with wetting and drying cycles has brought large limestone boulders to the surface of gilgaied areas. Donga floors generally support a sparse tree cover, particularly *Pittosporum phillyraeoides* and are surrounded by an annulus of skeletal soil which supports an *Acacia tetragonophylla* community. In contrast, claypans lack gilgai development and are devoid of tree cover. Their maximum width is about 1 km.

No well defined drainage lines exist on the Bunda Plateau but there are remnants of some ancient river systems associated with the residual clay and kankar in the north of the survey area. Small centripetal drainage systems have been observed on aerial photographs of the Colville land system.

The land zones of the Bunda Plateau may be differentiated on the basis of land form, soil and vegetation characteristics. The distinguishing features of the component land zones are outlined below.

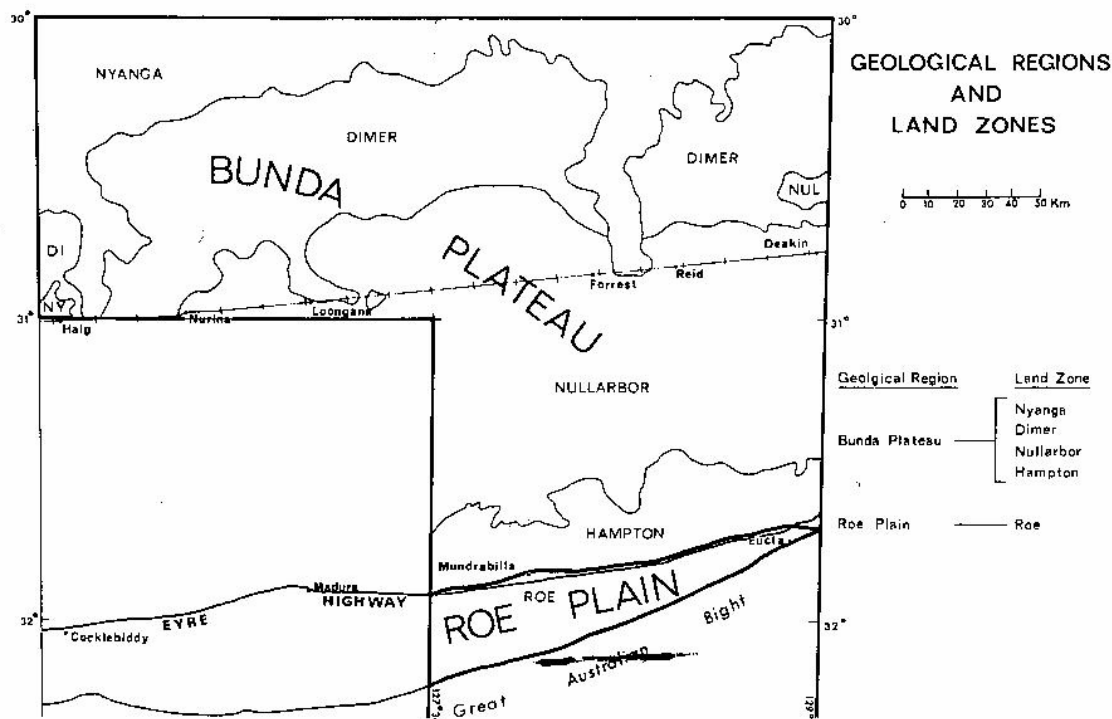


Figure 7.—Geological regions and landzones.

The Nynga land zone

This land zone is differentiated from the others by the presence of residual clay and kankar and relict river systems. The clay and kankar form broad flat plains underlain by Nullarbor Limestone.

Other features of the zone are small clay and kankar residuals above the limestone basement, low limestone rises and diffuse drainage tracts with claypans and dongas between the limestone rises.

Where exposed, the Nullarbor Limestone has been preferentially eroded down its vertical joints. This has led to the formation of drainage tracts with dongas of claypans. Soils of the dongas are silty clay loams and gilgaied clays. They are generally not saline probably because of rapid vertical drainage through the porous floor. Good quality water is sometimes found beneath the dongas.

The Dimer land zone

This land zone consists of deflated Nullarbor Limestone and is characterized by the predominance of dongas, rather than claypans, in the drainage foci. Relief is generally less than three metres and the landscape is gently undulating from the preferential down weathering of the joints to form drainage tracts leading into drainage foci.

In parts of the Dimer land zone, some of the drainage foci form swamps rather than dongas. This is probably a result of an impermeable substratum. There are also occasional dongas which accumulate salt. The surfaces that have accumulated salt are bare and produce a white signature on the aerial photography.

The Nullarbor land zone

This land zone consists of broad plains of deflated Nullarbor Limestone and is characterized by large claypans, the absence of trees, and the total absence of trees. It is this area for which the name Nullarbor was coined by Delisser in 1866. Relief is generally less than four metres except in the vicinity of rare fault lines. Preferential down weathering of the limestone joints has produced a gently undulating land surface which consists of low rises, marginal run-off areas; drainage tracts and claypans. Marginal run-off area supporting banded saltbush (*Atriplex* spp) dominate the landscape in this land zone.

The claypans have formed by infilling of drainage foci with colluvial material from the limestone rises. The claypan soils are impermeable, become water-logged after heavy rain, and do not support trees or shrubs. The centre of many claypans is scalded due to the accumulation of salts.

The Hampton land zone

This land zone consists of Nullarbor Limestone in the north and Abrakurrie Limestone in the south. Nullarbor Limestone conformably overlies Abrakurrie Limestone but has presumably been stripped from the southern sector since Tertiary times. The zone is characterized by low stony, tree covered limestone ridges forming a reticulate pattern.

The ridges have a north easterly trend and stand 3 to 15 m above the more or less parallel drainage tracts. They are often 10 km long and up to 1 km in width. The claypans forming the drainage tracts have presumably developed by down weathering and colluvial infilling of the limestone joints. Dongas and gilgai formations are characteristically absent. The local distribution of salt in some claypans is responsible for the presence or samphire (*Arthrocnemum* spp) while bluebush (*maireana sedifolia*) and saltbush (*Atriplex vesicaria*) occur on the lower slopes of the ridges and the less saline claypans. In this respect, the Hampton land zone is markedly contrasted with the Nyanga, Dimer and Nullarbor land zones in which bluebush is restricted to the low rises and is never found on the drainage floors.

An area of stabilized sand dunes is located on the southern edge of the Hampton land zone. Dunes are derived from sand advancing over the scarp of the Hampton Range from the Roe Plain (Jennings 1963).

THE ROE PLAIN

This geological region is composed of a single land zone, called the Roe land zone, which covers 2 887 sq. km and accounts for 6 per cent of the survey area.

The Roe land zone consists of a plain of Pleistocene Roe Calcarene underlain by Wilson Bluff and Abrakurrie Limestone. The plain emerged as a result of sea level changes. It is bounded to the north by the wave cut scarp of the Hampton Range and in the south by the Great Australian Bight. Jointing patterns are absent in the Roe Calcarene. Martin (1973) suggests that the sea level has been much lower, and the Roe Plain correspondingly larger, than at the present. She dates the final increase in sea level to 5 000-9 000 B.P. The land surface is extremely flat except where the Roe Calcarene is overlain by colluvium, wind deposited sand or lagoonal mud. Highly saline drainage foci, 10 m or more in diameter, form a dense stipple pattern over much of the plain particularly in the northern parts below the Hampton Range. Colluvium from the Hampton Range overlies the Roe Calcarene at the base of the scarp. At Eucla, stabilized Pleistocene sand dunes overlie the calcarene and kankar has been formed beneath the surface of these old dunes. Saline Pleistocene lagoonal muds have been deposited in low areas of the plain.

Saline lagoonal muds of recent age are found near the coast running parallel to and just behind the present foreshore. The coastline itself is fringed by stabilised sand dunes of Recent origin.

SOILS

Little information was available concerning the soils of the survey area before the present study. Lowry (1970) described the geology and some of the prominent soil features while Northcote *et al* (1968) broadly mapped the soils of the region at a scale of 1:2 000 000.

Geological and climatic constraints have severely limited soil development throughout the survey area. Geologically, the region is relatively uniform, the Bunda Plateau being mostly underlain by horizontal Nullarbor Limestone and the Roe Plain by Roe Calcarene. The uniformity of the underlying parent material has resulted in soils which display little variation in such properties as pH, texture and colour while the arid to semi-arid climate has limited profile development and, indeed, the development of landscape features generally. Stephens (1956) described the soils of the Nullarbor as "simple calcareous residues of the mineral matter left from the weathering of the parent limestone. The low rainfall of the area precludes any significant profile formation other than partial removal of lime from the soil".

SOIL CLASSIFICATION

Soils of the various land system units were sampled and analysed as described previously. Only five of the Great Soil Groups (Stace *et al* 1968) are represented in the survey area. The 7th Approximation method (U.S. Soil Survey Staff, 1960) classifies the soils into three Orders. These alternative classifications are detailed in Table 11. Soil descriptions and their relationship to the vegetation associations and land zones of the survey area are presented in Table 10.

Table 10. – Description of soils in the survey area

Great soil group	Brief soil description	Position	Vegetation	Land zones
Grey-brown and red calcareous desert soils	Dense pebble or cobble strew with out-cropping limestone parent material (p.m.). Vesicular crusting surface over a uniform yellowish red silty loam, 0.1-0.2m deep	Low rises and marginal slopes to dongas	<i>Maireana sedifolia</i> shrubland. Assoc. No. 9. <i>Eucalyptus socialis</i> low woodland. Assoc. No. 3. <i>Acacia tetragonophylla</i> tall shrubland. Assoc. No. 8.	Nyanga, Dimer, Nullarbor and Hampton
	Sparse pebble strew or strewless. Vesicular crusting surface over a uniform yellowish red silty loam, 0.4-1.0 m + deep. Sometimes underlain with kankar.*	Drainage floors, claypans and clay floors of dongas.	<i>Stipa</i> spp. and <i>Danthonia caespitosa</i> short grass land. Assoc. No. 18 <i>Maireana sedifolia</i> shrubland. Assoc. No. 9 <i>Pittosporum phillyraeoides</i> grassy woodland. Assoc. No. 7	Nyanga, Dimer, Nullarbor and Hampton
	Sparse pebble strew with loose surface over a uniform yellowish red silty loam, 0.2 m deep and underlain by kankar.*	Flat plains	<i>Nitraria schroberi</i> shrubland Assoc. No. 15. <i>Eucalyptus gracilis</i> low woodland. Assoc. No. 1. <i>Selenothamnus squamatus</i> shrubland. Assoc. No.13	Roe
Solonchak	Sparse cobble strew with occasional out-cropping p.m. Localised banding of surface salt to form an alternating system of scalds and saltbush interbands. 1.0 m + deep.	Marginal slopes to drainage.	<i>Atriplex vesicaria</i> shrubland. Assoc. No. 11	All and zones.
	Crusting of loose surface with sparse pebble strew. Depp (1.0 m +) saline yellowish red silty loam or loam.*	Drainage floors and claypans.	<i>Arthrocnemum</i> spp. shrubland Assoc. No. 10. <i>Maireana oppositifolia</i> shrubland. Assoc. No. 14	Hampton and Roe
	Vesicular crusting surface with considerable micro relief 0.3-2.0 m deep above kankar.*	Large scalds in claypans and swamps.	Sparse halophytic annuals. <i>Muehlenbeckia cunninhamii</i> Assoc. No. 16	Nullarbor and Dimer.
Gilgai	Loose cracking surface with considerable micro relief 0.3-2.0 m, with boulder strew of limestone parent material. Deep (1.0 m +) profile of dark red clay or silty clay.*	Donga floors.	<i>Pittosporum phillyraeoides</i> grassy woodland. Assoc. No. 7. <i>Eragrostis setifolia</i> grassland. Assoc. No. 19. <i>Atriplex vesicaria</i> shrub land. Assoc. No. 12.	Nyanga and Dimer.
Solonized brown soils	Sparse pebble strew with a loose surface over a uniform yellowish red silty loam or sandy loam. 0.2-1.0 m + deep above massive clay and kankar.*	Flat plateaux.	<i>Acacia sowdenii</i> low woodland with dense shrub understorey. Assoc. No. 4, 5 and 6.	Nyanga
	Loose surfaced brown loamy sand 1 m + deep underlain by sand and kankar.*	Stabilised sand dunes.	<i>Eucalyptus gracilis</i> woodland. Assoc. No. 1	Roe
	Pebble strew with loose surface over a uniform reddish brown sandy loam. 0.3 m deep over kankar.*		<i>Eucalyptus gracilis</i> woodland. Assoc. No. 1. <i>Cratystylis conocephala</i> shrubland. Assoc. No. 17	Hampton and Roe.
Skeletal soils	Shallow soil without profile development and with dense angular limestone strew and inclusions.*	Scree slopes.	<i>Eucalyptus diversifolia</i> woodland. Assoc. No. 2.	Roe.

Table 11. – Soil Groups and Orders within the survey area

Great Soil Groups	7 th Approximation Orders
Grey, brown and red calcareous desert soils Solonized brown soils Solonchak soils	Aridisols
Gilgaied soils Skeletal soils	Vertisols Lithosols

SOIL EROSION

No significant accelerated erosion was observed within the survey area despite the widespread removal of perennial shrubs.

The survey area for the most part has no previous grazing history and no conclusions can therefore be drawn regarding the susceptibility of the soils to erosion in the presence of stock. Some soil types, however, are likely to be susceptible to wind erosion following grazing disturbance. These include the solonchak soils which dominate marginal run-off areas in all land zones and which, when dry, form a powdery surface.

Drainage floors and claypans are also considered susceptible to wind erosion following grazing disturbance. In the case of solonchak soils occurring in these situations in the Hampton and Roe land zones, grazing activity has been severely limited by the saline nature of the vegetation and the lack of adequate water supplies. The same applies to the group of grey-brown and red calcareous desert soils occurring as flat plains in the Roe land zone (see Table 10). Loose surfaced solonized brown soils, which occur extensively over massive clay and kankar in the Nyanga land zone, are also considered susceptible to wind erosion following disturbance.

The skeletal soils of the scree slopes (Roe land zone) and the gilgai soils of the donga floors (Nyanga and Dimer land zones) are not considered susceptible to erosion but are very limited in extent. The shallow grey-brown and red calcareous desert soils which occur extensively on low rises and marginal slopes in the Nyanga, Dimer, Nullarbor and Hampton land zones (Table 10) generally possess a strong vesicular crypto-crust and a heavy stone mantle and are thus resistant to soil removal by either wind or water action.

Rabbit activity does not generally appear to be associated with erosion in the survey area. One instance was observed, however, in the Oasis land system, where disturbance of a claypan by rabbits was associated with wind hummocking.

VEGETATION AND PASTURES

The survey area falls within the Eucla district of the Ereman botanical province of Gardner (1942). The major vegetation characteristics of its land zones are outlined below.

Nyanga land zone

The vegetation consists of thickly wooded succulent steppe (Beard, 1975). *Acacia sowdenii* (myall) dominates the tree layer beneath which is usually found a well developed chenopodiaceous shrub layer.

Dimer land zone

A chenopodiaceous shrub steppe dominated by either *Maireana sedifolia* (bluebush) or *Atriplex vesicaria* (saltbush) covers most of this land zone. Dongas support a low open grassy woodland dominated by *Acacia tetragonophylla* (curare), *Pittosporum phillyraeoides* (desert willow) and *Grevillea* spp. while claypans support grasslands dominated by *Stipa* spp. (spear grass) and *Danthonia caespitosa* (wallaby grass).

Nullarbor land zone

The vegetation of this land zone consists of a chenopodiaceous shrub steppe dominated by either *Maereana sedifolia* or *Atriplex vesicaria*. Claypans support a grassland dominated by *Stipa* spp. and *Danthonia caespitosa*. There are no trees in this land zone.

Hampton land zone

The vegetation consists of woodland dominated by either *Acacia sowdenii* or *Eucalyptus socialis* with a sparse shrub understory on the low limestone ridges, while the intervening drainage areas support a complex mosaic of grassland and shrubland. The shrubland is dominated by either *Maireana sedifolia*, *Atriplex vesicaria* or *Arthrocnemum* spp. (samphire), while *Stipa* spp. and *Danthonia caespitosa* dominate grassland areas.

Roe land zone

The vegetation consists of a mosaic of mallee woodland dominated by *Eucalyptus gracilis*, *E. socialis* and *Melaleuca* spp. Shrub steppe dominated by *Arthrocnemum* spp. is restricted to areas of lagoonal mud near the coast.

PLANTS AND THE ENVIRONMENT

Climate

The two climatic regions of the survey area are the semi-arid coastal region and the arid inland region. The Roe and Hampton land zones occur within the coastal region while most of the Nullarbor, and all of the Dimer and Nyanga land zones are in the inland region.

Water is the major constraint on plant distribution and productivity in this semi-arid environment.

Many species are specific to either the inland or the coastal climatic region. Species restricted to the coastal region include *Eucalyptus oleosa*, *E. gracilis*, *E. socialis*, *Geijera linearifolia* and *Melaleuca* spp. while *Acacia tetragonaphuylla*, *Teurinum racemosum*, *Grevillea* spp., and *Eremophila longifolia* are exclusive to the inland region. Some species, especially annuals such as *Stipa variabilis*, *Zygophyllum* spp., and *Bassia* spp. are ubiquitous throughout the survey area.

A sharp northerly rainfall gradient exists across the coastal climatic region. *Eucalyptus socialis* is the most northerly occurring eucalypt in the region and has the lowest rainfall requirement of any eucalypt in the area (Parsons, 1970). It dominates the southern limestone ridges of the Thampanna land system, (Hampton land zone) but its abundance declines with increasing distance from the coast in response to decreasing rainfall. It is finally found in small isolated clumps on the very tops of the limestone ridges in the north of the Thampanna land system. It is finally found in small isolated clumps on the very tops of the limestone ridges in the north of the Thampanna land system.

Acacia sowdenii tolerates more xeric conditions than *E. socialis*. It occurs throughout the Roe and Hampton land zones and becomes the dominant tree when *E. socialis* reaches the northern limit of its distribution. Further north, as rainfall declines, *A. sowdenii* is restricted to the crests of the limestone rises at the edge of the treeless Nullarbor land zone. It reappears, however, in the drier Nyanga land zone, in the north of the survey area, in response to deeper soils.

Edaphic factors

While rainfall exerts the primary control on species distribution within the survey area generally, soil type influences distribution within the landscape. Water availability varies greatly between soil types due to differences in clay content, infiltration rates and runoff-runon relationships (Gunn 1967, 1974). Such differences profoundly influence vegetation in an arid environment. They are manifested particularly in the contrasting species assemblages of the dongas and drainage floors and the intervening rises and slopes. In the Dimer and Nyanga land zones, for example, *Eragrostis setifolia* (Neverfail grass), *Eremophila longifolia* and *Grevillea* spp. are entirely restricted to the deep gilgaid clays of the dongas while a depauperate, almost unispecific stand of *Maireana sedifolia* frequently occurs on the shallow soils of the low rises and stony plains (e.g. Oasis land system).

Slopes receiving run off in the Nyanga, Dimer and Nullarbor land zones have frequently accumulated salts from upslope resulting in the formation of solonchak soils. Saltbush (*Atriplex vesicaria*) forms a characteristic community in these situations consisting of bands of dense vegetation, roughly on the contour, separated by bare, scalded interbands.

Fire

Bushfires are a natural feature of the Nullarbor environment following seasonal conditions which promote abundant ephemeral growth. Annual species such as *Stipa* and *Helipterum* may produce in total up to 1 500

kg/ha of dry matter in years of above average winter rainfall. This growth readily carries a fire the following summer.

Fires occur spontaneously as a result of lightning strikes during summer thunderstorms. The extent to which Aborigines burnt the area is unknown but some degree of burning was almost certainly initiated, particularly near the coast (Wright, 1971). The frequency of fires, however is thought to have increased in the last 70 years. Steam trains on the transcontinental railway were undoubtedly responsible for many fires prior to the introduction of effective spark arresters while rabbit trappers sometimes burnt areas to attract rabbits to succulent regrowth.

Beard (1975) maintains that "the Nullarbor Plain seems always to have been substantially fire free since a fire would only travel following a good season, when there is a dense growth of tall grass. Occurrence of old trees of fire-tender species of *Acacia* on the Plain (*A. Sowdenii*, *A. aneura*) indicates freedom from fire". While fires in the present survey area are undoubtedly sporadic rather than regular, their role in shaping the original vegetation was probably more important than Beard implies, particularly on the Bunda Plateau. At the same time, however, the irregularity of fire has apparently precluded, or at least not fostered, the development of fire resistant or fire tolerant species since many of the dominant species of the region (e.g. *Atriplex vesicaria*, *A. nummularia*, *Acacia aneura*, *A. sowdenii* and *A. tetragonophylla*) are fire sensitive. A large proportion of *Danthonia cespitosa* tussocks is also killed by fire but Bluebush (*Maireana sedifolia*) is capable of regeneration from old wood following burns of low to moderate intensity if it is not severely grazed on droughted in the post-burn period (Mitchell unpublished data).

Our observations of burnt shrub crowns and of the pattern of burning (observed during aerial reconnaissance of the Nullarbor during the severe bush fires of the 1974/75 summer) leads us to suggest that fire has always exerted an influence on the vegetation of the survey area, particularly in the Nullarbor and Dimer land zones. Prior to European settlement, and the introduction of rabbits, the vegetation of these zones is thought to have been in a state of cyclic equilibrium in which shrub dominant and grass dominant phases occurred in a mosaic pattern over the landscape, while at any point the two phases alternated with each other, probably on a fairly long time scale. This suggestion of a cyclic climax derives from the belief that intermittent fires have always been a feature of the area and from the observation that fires do not burn uniformly but rather in a mosaic pattern resulting in a patchwork of burnt and unburnt areas. Fires following abnormally high rainfall years could thus be expected to eliminate shrubs from some areas while leaving others intact to act as seed sources for the eventual re-establishment of the shrub phase on burnt patches. The time period required for re-establishment is unknown but was probably lengthy since elimination of shrubs results in enhanced grass growth and renders burnt areas more susceptible to subsequent burning. Thus the grass phase tends to be maintained once established. If maintenance of the grass phase were permanent, however, successive fires would eventually have eliminated shrubs entirely, resulting in extensive sub-climax grasslands. Since this is obviously not the case, the conclusion is that shrub recolonisation of burnt areas eventually occurs at a time scale determined by the seasonal conditions and burning history of the area. Intermittent fires, burning in a mosaic pattern, could thus create a vegetation mosaic consisting of grass phases and shrub phases in various stages of regeneration.

Rabbits

The rabbit (*Oryctolagus cuniculus*) was introduced into Australia in 1859 and is still one of our major agrarian and pasture pests, despite the decimation of its numbers by myxomatosis in the 1950's (Fenner and Radcliffe, 1965). The delicate equilibrium of the vegetation in parts of the arid Dimer, Nyanga and Nullarbor land zones has been shattered by rabbits. Beard (1975) observed that rabbits were responsible for the declining condition of the vegetation on the Nullarbor Plain.

Rabbits are well adapted to this environment. They conserve water by living underground and only eat the most succulent parts of the plants from which they obtain sufficient water to survive (Cooke, 1975). Their populations react rapidly to increases of available forage and often reach plague proportions, e.g. in pastoral areas of South Australia rabbit numbers have been estimated to be as high as 2 300 per sq. km.

Before a rabbit population of plague proportions declines, shrub and tree seedlings are decimated and the vigour of the mature plants reduced. The recovery of a tree or shrub population after a fire or drought may be severely retarded by rabbits. Damage to perennial shrub vegetation results in an increase in the annual component which invariably results in increased fire frequency.

The interrelationship of climate, rabbits and fire on shrub population dynamics has been depicted diagrammatically in Figure 8.

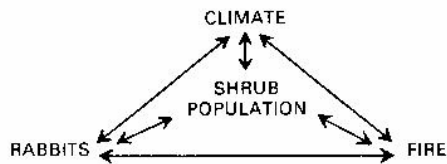


Figure 8.—Interrelationship of fire, rabbits and climate on shrub population dynamics.

The interactions of climate, rabbits and fire have eliminated *Maireana sedifolia* and *Atriplex vesicaria* from large areas of the Nullarbor, Dimer and Nyanga land zones. In some areas such as the Rabbit and land system (Figure 9) permanent degradation of the range has occurred. Here, *M. sedifolia* has been entirely eliminated and, as its seed has limited longevity (Burbridge 1946), there are no seed sources for regeneration. These degraded areas are unlikely to regenerate in the near future (Beard 1975) even if there were a permanent decrease in the rabbit population.



Figure 9.—Rabbit land system in very poor condition; *Maireana sedifolia* has been replaced by annuals.

CLASSIFICATION AND FLORISTICS

The vegetation of the survey area was classified into the 19 distinct communities or associations, summarized in Table 12 and described in detail in Appendix 1. The vegetation was divided into associations on the following criteria:

- species present
- spatial distribution
- life form

Perennial species were chosen to characterize associations. Annual species were not usually used for this purpose because many are ubiquitous throughout the survey area and their composition and density fluctuates considerable from year to year in response to the vagaries of climate. Perennials do not reflect minor seasonal variations.

Some association varied appreciably, whilst others were uniform. For example, Association No. 7 was usually dominated by *Grevillia* spp. and *Pittosporum phillyaeoides* but species composition and projected foliage cover often showed considerable variation. In contrast, Association No. 11 which was dominated by *Atriplex vesicaria* and *Maireana georgei* was remarkably uniform throughout the survey area.

A total of 155 species was recorded within the survey area, a very low number considering the large area covered in this survey. The major factors responsible for the depauperate nature of the vegetation are low rainfall and shallow, highly calcareous soils. Species found in the area are either calciphiles or those tolerant of saline soils.

The Roe and Hampton land zones support a more diverse flora than other land zones in direct consequence of the more mesic climate they receive.

PASTURE CHARACTERISTICS AND CARRYING CAPACITY ESTIMATIONS

The 19 plant associations found in the survey area and summarized in this Chapter (Table 12) fall naturally into two broad pasture types:-

- Drought resistant perennials (17 associations)
- Drought evading perennials (two associations)

Descriptions of the plant associations which follow include estimates of palatability based on field observations and Jessup's (1951) work in north western South Australia. Species were ranked into one of six palatability categories, giving an indication of the pastoral value of the various species within each association. The six palatability categories were very palatable, quite palatable, moderately palatable, slightly palatable, unpalatable and unknown. The descriptions also indicate carrying capacity in hectares/sheep unit and the sensitivity of the associations to grazing and disturbance.

Table 12. – Summary of Floristic Associations

Predominant species		Characteristics	Habitat
Eucalypt Woodland			
No. 1	<i>Eucalyptus gracilis</i> <i>Melaleuca</i> spp.	Open to closed eucalypt Woodland characterized by <i>E. gracilis</i> and <i>Melaleuca</i> spp. Dense shrub layer dominated by <i>Cratystylis conocephala</i> . (false bluebush).	High rainfall areas of the Roe and Hampton land zones
No. 2	<i>Eucalyptus diversifolia</i>	Open eucalypt woodland with sparse shrubs and ground cover.	Scree slopes of Hampton Range
No. 3	<i>Eucalyptus socialis</i> <i>Acacia sowdenii</i>	Open – low open woodland dominated by <i>E. socialis</i> supporting a sparse shrub layer.	Low limestone ridges in the Hampton land zone
Acacia Woodlands			
No. 4	<i>Acacia sowdenii</i> <i>Cratystylis conocephala</i>	Low open <i>A. sowdenii</i> (myall) woodland with dense shrub understorey of <i>C. conocephala</i> (false saltbush).	Residual clay and kankar in the Nyanga land zone
No. 5	<i>Acacia sowdenii</i> <i>Atriplex vesicaria</i>	Low open <i>A. sowdenii</i> (myall) woodland with a dense shrub understorey of <i>A. vesicaria</i> (bluebush).	Residual clay and kankar in the Nyanga land zone
No. 6	<i>Acacia sowdenii</i> <i>Maireana sedifolia</i>	Low open <i>A. sowdenii</i> (myall) woodland with an open shrub understorey of <i>M. sedifolia</i> (bluebush).	Residual clay and kankar in the Nyanga land zone.
No. 7	<i>Pittosporum phillyraeoides</i>	Open grassy woodland characterized by <i>P. phillyraeoides</i> (desert willow). <i>Grevillea</i> spp. and <i>A tetragonophylla</i> (curare). <i>Eragrostis setifolia</i> (neverfail) characterizes the ground layer.	Dongas in the Nyanga and Dimer land zones
No. 8	<i>Acacia tetragonophylla</i> <i>Pittosporum phillyraeoides</i>	Tall open shrubland characterized by <i>A.tetragonophylla</i> (curare).	Skeletal soils forming aprons around dongas in Dimer and Nyanga land zones.
Chenopod Shrublands			
No. 9	<i>Maireana sedifolia</i>	Low open grassy shrubland dominated by <i>M. sedifolia</i> (bluebush).	Stony rises throughout the area and claypans of the Hampton land zone

No. 10	<i>Arthrocnemum</i> spp. <i>Atriplex vesicaria</i>	Halophytic, low open shrubland characterized by <i>Arthrocnemum</i> spp (samphire) with sparse ground cover.	Saline run-off areas in the Hampton land zone and the Morris land system
No. 11	<i>Atriplex vesicaria</i> <i>Maireana georgei</i>	Halophytic, contour branded low shrubland dominated by <i>A vesicaria</i> (saltbush) with scalded interbands.	Saline marginal slopes to drainage floors. Occurs throughout the area
No. 12	<i>Atriplex vesicaria</i>	Halophytic, low open shrubland dominated by <i>A. vesicaria</i> (saltbush).	Gilgaied relict river beds in the Nyanga land zone
No. 13	<i>Selenothamnus squamatus</i>	Low open shrubland dominated by <i>S. squamatus</i> .	Stony rises in Chowilla land system
No. 14.			

Pastures characterized by drought resistant perennial shrubs

Association No. 1 Woodland characterized by *Eucalyptus gracilis* *Melaleuca* spp. and *Cratystylis conocephala* 7.5 ha per S.U.

This pasture is restricted to the highest rainfall areas within the region. It is a highly productive woodland pasture, especially where it has not reached its climax and developed into a dense woodland. It is found on loose surfaced calcareous loams which are easily disturbed and should be carefully managed.

TOP FEED: Slightly palatable myall (*A. sowdenii*). The eucalypts and *Melaleuca* spp. are unpalatable.

SHRUBS: Large variety of edible shrubs such as *A. vesicaria* which is quite palatable. *Eremophila weldii*, and *E. glabra* are moderately palatable. *Cratystylis conocephala* is of unknown palatability.

GROUND LAYER: Very variable. Consists mainly of *Stipa* spp, which are unpalatable. Small component of palatable species such as *Bassia* spp.

Association No. 2 Woodland characterized by *Eucalyptus diversifolia*. 25 ha per S.U.

This pasture is restricted to the scarp face of the Hampton Range. It is virtually inaccessible and is of little pastoral value. Soils consist of a skeletal limestone scree slope.

TOP FEED: No palatable top feed is available.

SHRUBS: Very sparsely distributed *Cassia nemophila*, *Eremophila glabra* and *Maireana* spp. These species are moderately palatable.

GROUND LAYER: Production is very variable and is restricted to small pockets of deep soils where *Poa drummondii* is found.

Association No. 3 Low woodland characterized by *Eucalyptus socialis* and *Acacia sowdenii*. 12.5 ha per S.U.

This pasture is restricted to the low limestone ridges of the Hampton land zone. It is moderately productive pasture on shallow erosion resistant sandy loam covered with cobbles. It receives around 200 mm average rainfall.

TOP FEED: Slightly palatable *A. sowdenii* and moderately palatable *A. oswaldii*. *E. socialis* is unpalatable; plus numerous other palatable species.

SHRUBS: Quite palatable *Eremophila weldii*, *Atriplex vesicaria* *Ptilotus obovatus* and *Maireana sedifolia*. *Danthonia caespitosa* and unpalatable *Stipa* spp.

GROUND LAYER: Palatable

Association No. 4 Low myall woodland (*Acacia sowdenii*) characterised by a false bluebush understorey (*Cratystylis conocephala*). 17.5 ha per S.U.

This pasture is of very limited distribution and is restricted to the Gunnadorah land system. It is found on the easily disturbed solonised brown soils (clay and kankar) of the above land system and received around 150 mm rainfall. It is not very productive because of the arid climate. This pasture is probably very sensitive to grazing and requires careful management.

TOP FEED: Slightly palatable *A. sowdenii* and *Myoporum desertii*.

SHRUB: *C. conocephala* of unknown palatability.

GROUND LAYER: Very variable, depending on seasonal conditions. Mainly unpalatable *Stip variabilis* and *Helipterum floribundum*. Contains a small component of very palatable *Tetragonia eremea*.

Association No. 5 Low myall (*Acacia sowdenii*) woodland with a saltbush (*Atriplex vesicaria*) understorey. 17.5 ha per S.U.

This pasture is restricted to the loose, easily disturbed solonised brown soils (clay and kankar) of the Nyanga land zone and receives around 150 mm rainfall. If grazed, it requires careful management.

TOP FEED: Slightly palatable *A. sowdenii* and *Myoporum desertii*.

SHRUBS: Quite palatable. *A. vesicaria* and slightly palatable *Maireana georgei*.

GROUND LAYER: Mainly unpalatable *Stipa* variability. Some very palatable *Tetragonia eremea*.

Association No. 6 Low myall (*Acacia sowdenii*) woodland with a bluebush (*Maireana sedifolia*) understorey. Estimated carrying capacity varies from 7.5 to 17.5 ha/S.U. depending on rainfall.

This pasture is found on the loose, easily disturbed solonised brown soils (clay and kankar) of the Nyanga land zone and in the Roe land zone. It is amongst the most sensitive country in the area and should be managed accordingly. Large areas have already been downgraded by fire and rabbits to a *Stipa variabilis* grassland of a very low carrying capacity.

TOP FEED: Slightly palatable *A. sowdenii* and *A. oswaldii*. *Heterodendrum oleifolium* is very palatable but sporadic in occurrence.

SHRUBS: *M. sedifolia* is common and moderately palatable whilst *Rhagodia gaudichaudiana* occurs occasionally and is slightly palatable.

GROUND LAYER: Sparse cover of herbs and grasses of which *Erodium cygnorum* and *Bassia* spp. are palatable.

Association No. 7 Low grassy woodland characterised by *Pittosporum phillyraeoides* and *Grevillea* spp. 5 ha per S.U.

This pasture is found on deep clay soils in the dongas of the Nyanga and Dimer land zones. It is one of the most productive pastures in the survey area, is preferentially grazed and is relatively resistant to erosion.

TOP FEED: *Grevillea* spp. is slightly palatable whilst *P. phillyraeoids* is quite palatable.

SHRUBS: *Lycium australe*, *R. gaudichaudiana* and *Enchylaena tomentosa* are moderately palatable while *Eremophila longifolia* is slightly palatable.

GROUND LAYER: Highly productive and supports the very palatable *Trigonella suavissima* and *Erodium crinitum* and the quite palatable grasses *Eragrostis setifolia* and tall *Stipa* (*Stipa* spp.).

Association No. 8 Tall shrubland characterized by *Acacia tetragonophylla*. 20 ha per S.U.

This pasture is found on thin soils surrounding the dongas of the Nyanga and Dimer land zones. It is one of the least productive pastures and receives about 150 mm rainfall. In terms of pastoral value it is insignificant because it is unproductive and constitutes less than 1% of any land system.

TOP FEED: Slightly palatable *A. tetragonophylla* and occasional quite palatable *P. phillyraeoides* and *Acacia aneura*.

SHRUBS: Nil.

GROUND LAYER: Production very variable depending on seasonal conditions. Very palatable *Tetragonia eremea* and moderately palatable *Danthonia caespitosa* and *Teucrium racemosum*.

Association No. 9 Shrub steppe characterized by *Maireana sedifolia*. This pasture is common through the survey area with an estimated carrying capacity varying from 7.5 to 20 ha per S.U. depending on rainfall and topographic location.

This pasture is found on the low rises of the Nyanga and Dimer land zones where it receives an average rainfall of 150 mm. Here, it is not very productive and much more sensitive to the degrading effects of rabbits and fire than in the more mesic areas of the Nullarbor. It has been rated at 20 ha per S.U. This association is also found on the low rises of the Nullarbor land zone which receive slightly more rain (175 mm) and is thus slightly more productive and much more sensitive to the degrading effects of rabbits and fire than in the more mesic areas of the Nullarbor. It has been rated at 20 ha per S.U. This association is also found on the low rises of the Nullarbor land zone which receive slightly more rain (175 mm) and is thus slightly more productive (17.5 ha per S.U.).

Where this pasture occurs on the low rises of the Nyanga, Dimer and Nullarbor land zone it is very susceptible to degradation but not the erosion because the soil is very thin and is covered by a dense stone mantle.

The clay pans of the Hampton land zone support this pasture, are highly productive (7.5 ha per S.U.) and are more resistant to degradation because they receive run off and have deeper soils.

TOP FEED: Nil.

SHRUB: Moderately palatable *M. sedifolia* with small but quite palatable *A. vesicaria* component.

GROUND LAYER: Very variable production. Unpalatable *Stipa variabilis*.

Association No. 10 Shrub steppe characterized by *Arthrocnemum* spp. and *Atriplex vesicaria*. 7.5 ha per S.U.

This pasture is restricted to the marginal slopes, to drainage floors and the claypans in the Hampton land zone and the Morris land system (Nullarbor land zone and the Morris land system (Nullarbor land zone). It is found on solonchak soils and is a high salt content pasture. Although the shrub species have a high protein content, their high salt content restricts their utilisation unless excellent quality waters are provided.

TOP FEED: Nil.

SHRUBS: Quite palatable, high salt content *Arthrocnemum* spp. and *A. vesicaria*.

GROUND LAYER: Few palatable species.

Association No. 11 Shrub steppe characterized by *Atriplex vesicaria* and *Maireana georgei*. 7.5 ha per S.U.

This pasture is common to most land systems in the Nyanga, Dimer, nullarbor and Hampton land zones. It occupies the solonchak soils on the margins of the drainage floors and receives run-on. It is a highly productive pasture but its grazing must be carefully managed because its saline soil surface is easily disturbed. The pasture is highly saline and requires good quality water to fully utilize the highly nutritious fodder that it provides.

TOP FEED: Nil.

SHRUBS: Quite palatable *A. vesicaria* and infrequent, slightly palatable *Maireana georgei*.

GROUND LAYER: Variable density. None of the species are very palatable.

Association No. 12 Shrub steppe characterized by *A. vesicaria* 12.5 ha per S.U.

This pasture is restricted to the saline gilgaied clays in the ancient river beds of the Nyanga land zone and is of little importance. It is a moderately productive pasture but highly saline, requiring good quality water for its use.

TOP FEED: Nil.

SHRUBS: Quite palatable *A. vesicaria* and sparse, moderately palatable *Lycium australe*.

GROUND LAYER: Consists of sparse unpalatable forbs.

Association No. 13 Shrub steppe characterized by *Selenothamnus squamatus*. 17.5 ha per S.U.

This pasture is restricted to the low limestone rises in the Chowilla land system and is of little importance. It grows on thin soils and is unproductive and probably susceptible to degradation.

TOP FEED: Nil

SHRUBS: *S. squamatus* is of unknown palatability and infrequent but quite palatable *A. vesicaria*.

GROUND LAYER: Variable density of unpalatable annuals.

Association No. 14 Shrub steppe characterized by *Maireana oppositifolia* and *Arthrocnemum* spp. 25 ha per S.U.

This pasture is restricted to the lagoonal muds of the Roe land zone. It is moderately productive but is highly saline and because of the lack of any good quality water is unavailable to stock.

TOP FEED: Nil.

SHRUBS: Quite palatable, high salt content *Arthrocnemum* spp. and *Maireana oppositifolia* of unknown palatability.

GROUND LAYER: Very sparse halohytic forbs.

Association No. 15 Shrub steppe characterized by *Nitraria schoberi*. 5 ha per S.U.

This pasture is restricted to the lower rainfall areas of the Roe land zone. It is a highly productive pasture and is not extremely saline. The soil is a calcareous desert loam with a loose surface which is easily disturbed and requires careful management.

TOP FEED: Nil.

SHRUBS: *Nitraria schoberi* of unknown palatability, *Atriplex vesicaria* and numerous other moderately palatable shrubs.

GROUND LAYER: Variable density depending on season. Contains a small component of moderately palatable species such as *Danthonia caespitosa* and *Bassia* spp.

Association 16 Shrubland characterized by *Muehlenbeckia cunninghamii*. 45 ha per S.U.

The pasture is restricted to the swamps in the Loongana and Bullseye land systems, is very unproductive and worthless for grazing.

TOP FEED: Nil.

SHRUBS: *M. cunninghamii* which is unpalatable.

GROUND LAYER: Nil

Association no. 17 Open shrubland characterized by *Cratystylis conocephala*. 7.5 ha per S.U.

This pasture is restricted to the reddish brown calcareous silty loam soils of the higher rainfall areas of the Roe and Hampton land zones. Although highly productive pasture it needs careful management to maintain it in good condition.

TOP FEED: Nil.

SHRUBS: *C. conocephala* of unknown palatability; *A. vesicaria* and *Eremophila weldii* are quite palatable, and many other palatable species are present.

GROUND LAYER: Sparse and unpalatable *Stipa trichophylla*.

Pastures characterized by drought evading perennial grasses.

Association No. 18 Short grassland characterized by *Stipa* spp. and *Danthonia caespitosa*.

This association is found throughout the survey area but is especially prominent in the claypans. It is quite productive and non saline but has no drought resistance. This association tends to dominate degraded *Maireana sedifolia* sites.

TOP FEED: Nil.

SHRUBS: Nil.

GROUND LAYER: Palatable *D. caespitosa*, *Tetragonia eremea* and many species of unknown palatability. *Stipa* spp. are generally unpalatable.

Association 19 Short grassland characterized by *Eragrostis setifolia*. 5 ha per S.U.

This pasture is restricted to the gilgaied depression in the Nyanga and Dimer land systems and is highly productive. However, it has no reserves in time of drought and is preferentially grazed by stock.

TOP FEED: Nil.

SHRUBS: Nil

GROUND LAYER: Palatable *Eragrostis setifolia*, *Trigonella suavissima* and *Erodium crinitum* and many other species of unknown palatability.

In the arid to semi-arid environment of the survey area, low and erratic rainfall determines pasture production which is usually restricted to winter months. Pastures consequently consist of drought resistant perennials, drought evading perennials and ephemerals.

Forage quality is usually high in winter. In summer, the ephemerals and drought evaders hay off, producing forage of low nutrient value, while the drought resistant perennials maintain their forage values throughout periods of moisture stress (Wilson 1966). Edible perennial shrubs and trees form valuable forage reserves in summer and during droughts. These stable and durable perennials, which have been used to characterize associations, are the most valuable fodder plants in the area. Any degradation of these perennial communities in this environment results in reduced stocking capacity, especially during droughts.

Very little quantitative productivity data is available for the various associations in the survey area itself, but productivity figures for some associations are known from areas with similar climatic and edaphic conditions. Figures for an *Acacia sowdenii*-*Maireana sedifolia* community (Association No. 6) on Kanandah Station and for a *Maireana sedifolia* community (Association No. 9) in the Goldfields are shown in Table 13. The former is one of the least productive associations whilst the latter is one of the most productive.

Table 13 – Productivity of two plant associations

	Shrub component kg/ha	Ground component kg/ha	Total kg/ha
<i>A. sowdenii</i> – <i>M sedifolia</i> (Association No. 6)	50	85	135
<i>M. sedifolia</i> (Association No. 9)	300	120	420

By ranking the other associations in relation to those in Table 13 and from field observations the forage production for each plant association in excellent condition was estimated.

Carrying capacity estimations were made assuming 10 per cent safe use level on the shrub components and 25 per cent use level for the ground component. A sheep unit (adult) was assumed to require 450 kg of dry matter per annum.

Carrying capacity estimates were not solely determined from productivity data and estimates were also influenced by climate, palatability and durability of the vegetation. Carrying capacities are expressed as hectares per sheep unit on a year long basis and are shown for each association in Table 14.

Carrying capacity estimates for each land system taking into account the capacities of the system's component vegetation associations are presented in Table 15. The estimates are made assuming excellent condition of the vegetation.

Table 14. – Estimated carrying capacity of Nullarbor plant associations assuming excellent (near pristine) condition

Association No.	Predominant species	ha/sheep unit
1	<i>Eucalyptus gracilis</i> – <i>Melaleuca</i> spp	7.5
2	<i>Eucalyptus diversifolia</i>	25.0
3	<i>Eucalyptus socialis</i> – <i>Acacia sowdenii</i>	12.5
4	<i>Acacia sowdenii</i> – <i>Cratystylis conocephala</i>	17.5
5	<i>Acacia sowdenii</i> - <i>Atriplex vesicaria</i>	17.5
6	<i>Acacia Sowdenii</i> – <i>Maireana sedifolia</i> Inland climatic region	17.5
7	<i>Pittosporum phylliraeoides</i> – <i>Grevillea</i> spp	5.0
8	<i>Acacia tetragonophylla</i>	20.0
9	<i>Maireana sedifolia</i> 150 mm rainfall	20.0
10	<i>Arthrocnemum</i> spp – <i>Atriplex vesicaria</i>	7.5
11	<i>Atriplex vesicaria</i> – <i>Maireana georgei</i>	7.5
12	<i>Atriplex vesicaria</i>	12.5
13	<i>Selenothamnus squamatus</i>	17.5
14	<i>Maireana oppositifolia</i> – <i>Arthrocnemum</i> spp	25.0
15	<i>Nitraria schoberi</i>	5.0
16	<i>Muehlenbeckia cunninghamii</i>	45.0
17	<i>Cratystylis conocephala</i>	7.5
18	<i>Stipa</i> spp – <i>Danthonia caespitosa</i>	15.0
19	<i>Eragostis setifolia</i>	5.0

A sigmoidal relationship between carrying capacity and range condition was assumed and station carrying capacity estimates for condition was assumed and station carrying capacity estimates for condition levels other than excellent were calculated as follows:

Condition Level	Carrying capacity
Good	80% of capacity for excellent condition
Fair	50% of capacity for excellent condition
Poor	30% of capacity for excellent condition

Table 15 – Estimated carrying capacity of land systems assuming excellent vegetation condition

Land zone	Land System	ha/sheep unit
Nyanga	Carlisle	18
	Colville	16
	Gunnadorah	16
	Jubilee	18
	Kyarra	19
	Rabbit	20
Dimer	Bullseye	15
	Deakin	15
	Loongana	18
	Nurina	16
	Oasis	19
Nullarbor	Gafa	14
	Kybo	14
	Morris	16
	Reid	15
	Shake Hole	14
	Skink	16
Hampton	Chowilla	14
	Moopina	11
	Thampanna	10
	Weebubbie	13
Roe	Eucla	11
	Mundrabilla	7

PASTORAL POTENTIAL

The vegetation that is in good or excellent condition within the survey area is generally of moderate pastoral value. However, only about 50% of the pastures are in good or excellent condition and these are situated in the southern areas. The carrying capacity of the remaining degraded pastures is very low, probably less than 30 per cent of the figures quoted for excellent condition.

Little of the survey area is used for pastoral purposes as, in most areas, poor quality water, low rainfall and saline fodder interact to make pastoral development a doubtful economic proposition. When sheep or cattle graze these chenopodiaceous shrublands, the combination of high salt intake from pastures and waters increases the need for water by 2-3 times the normal level (Wilson 1966). Therefore, more frequent trips are made to a watering point, reducing an animal's foraging radius. During droughts, sheep or saline shrub pastures and salty water may die from acute salt accumulation (Wilson 1975) or starve because their foraging radius is restricted by the salt situation.

The lack of good quality water and the generally poor condition of pastures are the major limitations to pastoral development in this area. Ground water is generally deep and highly saline (5 000 -12 000 ppm sodium chloride) (Lowry 1970). Lowry's No. 2 hydrological region is equivalent to the Dimer land zone. In this land zone some adequate quality stock water (1 000 ppm sodium chloride) has been obtained by drilling in dongas. Yield from these bores decreases in times of drought. In the Hampton land zone Mundrabilla station has a limited number of earth dams and some new bores.

It seems unlikely that acceptable quality bore water could be found over much of the survey area. It may be technically feasible to construct dams in some instances but much of the country is unsuitable for dams.

It must be concluded that unalienated parts of the survey area have negligible potential for pastoral production. The reasons for this can be summarized as:-

- The poor condition of the shrub pasture and their consequent very low carrying capacities, especially during drought.
- The low and erratic rainfall.

- The difficulties of obtaining good quality stock waters.
- The present depressed economic state of the pastoral industry.

CONDITION OF THE SURVEY AREA

This survey and previous ones of this nature (Wilcox and McKinnon 1972 and Payne *et al*, 1979) used the benchmark or inferential vegetation condition assessment technique. This method consists of finding pasture benchmarks which are sites in pristine or excellent condition assessment technique. This method consists of finding pasture benchmarks which are sites in pristine or excellent condition. The benchmark sites are then compared with sites of similar potential. Similar sites are ranked into vegetation condition classes depending how far each site has departed from the benchmark. Concepts of condition and criteria used to define condition were discussed under survey methods.

Virtually no accelerated erosion was observed during the survey and condition of the range was assessed from vegetation parameters.

The condition of each of the land systems in the survey area is summarized in Table 16.

NYANGA LAND ZONE – 9 800 sq km (20.7%)

The Nyanga land zone is comprised of the Gunnadorah, Carlisle, Jubilee, Kyarra, Rabbit and Colville land systems. The zone is characterized by a myall woodland on clay and kankar in various stages of dissection and is found in the very north of the survey area on the Loongana and Forrest 1:250 000 map sheets. The climate is arid and mean annual rainfall is approximately 160 mm. This is the driest land zone in the survey area.

Analysis of the traverse condition data shows a bimodal distribution of the data. Taken overall, this land zone was in fair, tending towards poor, condition. Areas in the various condition classes throughout the land zone are presented below:

	Condition class			
	1 (Excellent)	2 (Good)	3 (Fair)	4 (Poor)
Area (sq. km)	1 628	663	1 717	5 792
%	17	7	17	59

Because this land zone has not been stocked, all degradation is a result of the interaction of rabbits, fire and drought. Its condition and component land systems is summarized in Table 17.

Table 16 – Analysis of traverse condition data by land systems

	Number of recordings within each vegetation condition class				Average condition class	Overall condition statement
	(Excellent)	(Good)	(Fair)	(Poor)		
	1	2	3	4		
NYANGA LAND						
ZONE						
Carlise	20	8	12	66	3.17	Fair
Colville	1	0	0	2	3.00*	Probably Fair
Gunnadorah	7	6	13	24	3.08	Fair
Jubilee	16	4	3	55	3.26	Poor
Kyarra	1	0	6	3	3.10	Fair
Rabbit	0	0	0	19	4.00	Very Poor

Table 16 – Analysis of traverse condition data by land systems - *continued*

	Number of recordings within each vegetation condition class				Average condition class	Overall condition statement
	(Excellent) 1	(Good) 2	(Fair) 3	(Poor) 4		
DIMER LAND ZONE						
Bullseye	9	12	2	9	241	Good
Deakin	4	0	1	7	2.92	Fair
Loongana	18	6	4	19	2.51	Fair
Nurina	13	2	14	28	2.94	Fair
Oasis	24	0	8	80	3.29	Poor
NULLARBOR LAND ZONE						
Gafa	56	10	10	46	2.39	Good
Kybo	5	0	0	2	1.86*	Good
Morris	24	2	0	0	1.08	Excellent
Reid	42	7	4	27	2.20	Good
Shake Hole	15	2	7	26	2.88	Fair
Skink	86	13	6	42	2.03	Good
HAMPTON LAND ZONE						
Chowilla	10	4	8	28	3.08	Fair
Moopina	9	0	0	0	1.00	Excellent
Thampanna	41	13	21	24	2.28	Good
Weebubbie	3	1	0	3	2.43*	Probably Good
ROE LAND ZONE						
Eucla	49	9	1	0	1.19	Excellent
Mundrabilla	78	11	3	5	1.30	Excellent

*Insufficient samples

Table 17 – Vegetation condition class data from the traverse record of the Nyanga land zone

Land system	Area (sq km)	No. of recordings	% in condition classes				Condition value	Overall condition statement
			1	2	3	4		
Gunnadorah	2 963	50	14	12	26	48	3.08	Fair
Carlisle	2 556	106	19	8	11	62	3.17	Fair
Jubilee	2 281	78	20	5	4	71	3.26	Poor
Kyarra	950	10	10	0	60	30	3.10	Fair
Rabbit	550	19	0	0	0	100	4.00	Poor
Colville	500	3	Insufficiently sampled					Probably Fair
TOTAL	00	267					3.22	Fair to Poor

Gunnadorah land system

The Gunnadorah land system covers 2 963 sq km in the north of the Forrest and in the west of the Loongana 1:250 000 map sheets. It is characterized by flat, undissected, clay and kankar plains covered by myall woodland. This unit constitutes 85 per cent of the land system's area and was usually in poor condition due to the combined influence of rabbits, fire and drought. Other units of this land system are relatively resistant to degradation and were in good to excellent condition.

Taken overall, this system was in fair condition and it is likely that the overall condition of the system is marginally better than indicated by traverse records. For ease of traveling, most tracks traversed followed perimeters of the system which, in many cases, had been badly degraded by fire and rabbits.

Picture goes here

Gunnadorah land system. Query No. 123 clay and kankar plain supporting a myall woodland. This area is in fair condition. Note the absence of shrubs in the foreground.

Carlisle land system

The Carlisle land system covers 2 556 sq km along the northern boundaries of the Loongana and Forrest 1:250 000 map sheets.

Clay and kankar plains supporting a myall woodland and stony plains supporting a bluebush shrubland constitute 85 percent of this land system's area. They were usually in poor condition, probably due to the effects of rabbits, fire and drought. Other units of this land system constitute only 15 per cent of the area and are relatively resistant to degradation and were in good condition.

Traverse data indicated that, taken overall, this system was in fair condition but, due to the lack of vehicle accessibility discussed previously the condition recordings collected may not be representative. The system was probably in marginally better condition than depicted by traverse information.

Picture goes here

Carlisle land system. Query No. 121. The shrubs have been eliminated from this clay and kankar plain and this area is in poor condition.

Jubilee land system

THE Jubilee land system covers 2 281 sq km and stretches in a north western arc from the bottom centre of the Forrest 1:250 000 map sheet to the top of the Loongana 1:250 000 map sheet. It is characterized by dissected clay and kankar residuals supporting myall woodland, numerous claypans and infrequent large dongas.

Residuals and lower plains supporting bluebush constitute 80 per cent of the land system. They were usually found in poor condition due to the influence of rabbits, fire and drought. The remaining 20 per cent of the system includes dongas and marginal slopes to drainage floors.

As a result of the more favoured position of the dongas and drainage floors in the landscape, these units were invariably in good condition. Because of their restricted area however they cannot markedly influence the poor overall condition of the system.

Picture goes here

Jubilee land system. Query No. 127. The donga in the foreground in excellent condition whilst the low rise in the background is in poor condition.

Kyarra land system

The Kyarra land system covers 950 sq km in the north west of the Loongana 1:250 000 map sheet and is characterized by poorly dissected clay and kankar plains with infrequent small dongas. Plains supporting myall and lower slopes supporting bluebush constitute 90 per cent of this land system and have been degraded by rabbits, fire and drought. The dongas are usually in good condition and taken overall traverse data indicates this system to be in fair condition.

Picture goes here

Kyarra land system. Query No. 174. Clay and kankar supporting myall and bluebush in good condition.

Rabbit land system

The Rabbit land system covers 550 sq km in the centre of the Forrest 1:250 000 map sheet. It is characterized by flat clay and kankar plains with very small claypans.

The plain unit occupies 95 per cent of the system and is in poor condition. The plains presumably supported myall and bluebush but are now degraded to a herbland dominated by wardsweed (*Carracthea* annual) and *Bassia* spp. It is riddled with rabbit warrens and has been burnt frequently.

Colville land system

The Colville land system covers 500 sq km on the northern edge of the Forrest map sheet. Its condition was assessed as being probably fair but it was insufficiently sampled.

DIMER LAND ZONE – 14 162 sq km (29.9%)

THE Dimer land zone includes the Bullseye, Oasis, Nurina, Deakin and Loongana land systems, characterized by deflated Nullarbor limestone forming regularly spaced, circular drainage foci or dongas supporting woodland. This land zone is in the inland climatic region and receives marginally more rainfall (180 mm mean annual) than the Nyanga land zone (160 mm mean annual). It is found to the south of the Nyanga land zone on the Forrest and Loongana 1:250 000 map sheets.

Taken overall this land zone was in fair condition with the traverse condition data exhibiting bimodal distribution as shown below.

	Condition class			
	1 (Excellent)	2 (Good)	3 (Fair)	4 (Poor)
Area (sq km)	3 720	2 608	1 198	6 636
%	26	18	9	47

There have been some recent stock introductions to this land zone but these cannot be blamed for the badly degraded areas for which a combination of rabbits, fire and drought are responsible. The condition of this land zone and component land systems is summarized in Table 18.

Table 18 – Vegetation condition class data from the traverse record of the Dimer land zone

Land system	Area (sq km)	No. of recordings	% in condition classes				Condition value	Overall condition statement
			1	2	3	4		
Bullseye	6 606	32	28	38	6	28	2/41	Good
Oasis	4 663	112	22	0	7	71	3.29	Poor
Nurina	1 256	57	23	3	25	49	2.96	Fair
Deakin	956	12	34	0	8	58	2.92	Fair
Loongana	681	47	38	12	9	40	2.51	Fair to Good
TOTAL	14 162	260					2.83	Fair

Bullseye land system

The Bullseye land system covers 6 606 sq km in the west of the Forrest and in the centre of the Loongana 1:250 000 map sheets. It is characterised by dongas with prominent white annuli, which are sometimes scalded or support a lignum swamp.

Stony plains supporting fair condition bluebush comprise 65 per cent of this system. The remaining 25 per cent includes run ff areas marginal to drainage floors, drainage floors and dongas. These were in good to excellent condition.

The traverse data indicates that, taken overall the land system was in good condition.

Picture goes here

Bullseye land system. Query No. 111. Stony plains in poor condition. This once supported a bluebush shrubland. Note the rabbit piosphere in the foreground.

Oasis land system

The Oasis land system covers 4 663 sq km in the centre of the Forrest 1:250 000 map sheet and is characterized by many small dongas.

This system was in poor condition including 92 per cent of its area composed of stony plains supporting bluebush pastures. Although the other units were in good to excellent condition, they do not contribute significantly to the area.

Nurina land system

The Nurina land system covers 1 256 sq km in the south west corner of the Loongana 1:250 000 map sheet and is characterized by rectilinear orientation of the drainage floors and large oval claypans. Stony plains supporting bluebush comprise 50 per cent of this land system's area and were in fair to poor condition due to the effects of fire, rabbits and drought. The remaining units including dongas, claypans and marginal slopes were in good condition.

Taken overall the condition of the Nurina system is fair.

Picture goes here

Nurina land system. Query No. 163. Stony plain in poor condition. Note that there are few bluebushes remaining on this site.

Deakin land system

The Deakin land system covers 956 sq km along the southern boundary of the Dimer land zone at the eastern edge of the Forrest 1:250 000 map sheet. The system has characteristics of land systems found in the Nullarbor land zone, possessing such common features as dongas and large areas of marginal slopes to drainage. Stony plains supporting bluebush comprise 40 per cent of the system and were in poor condition thought to be due to the combined effects of rabbits, fire and drought. Marginal slopes to drainage floors supporting saltbush comprised 50 per cent of the system, and were usually in good condition.

The traverse data indicated that, taken overall the system was in fair condition.

Picture goes here

Deakin land system. Query No. 106. Stony plains in good condition with 5 per cent bluebush PFC (projected foliage cover).

Loongana land system

The Loongana land system covers 681 sq km in the centre of the Loongana 1:250 000 map sheet. It is characterized by the presence of frequent lignum swamps.

Stony plains supporting bluebush constitute 70 per cent of this system's area with individual sites either in excellent or poor condition. Poor condition resulted from the effects of fire and rabbits.

Remaining units of the system were in good condition.

Take overall traverse data indicated that the Loongana system was in fair to good condition.

NULLARBOR LAND ZONE – 16 820 sq km (35.5%)

The Nullarbor land zone is comprised of the Skink, Gafa, Reid, Morris, Shake Hole and Kybo land systems, characterized by deflated Nullarbor limestone forming large claypans, the drainage foci and the complete lack of trees. This land zone is in the inland climate region but may receive marginally more rain than either the Dimer or the Nyanga land zones to the north. This zone is found on the southern edges of the Loongana and Forrest 1:250 000 map sheets and occupies the northern portion of the Eucla map sheet.

Taken overall the zone was in good condition as shown by the various condition classes listed below:

	Condition class			
	1 (Excellent)	2 (Good)	3 (Fair)	4 (Poor)
				5 026
Area (sq km)	9 518	1 319	957	
%	57	8	6	29

The zone is stocked only along its southern edge and present condition and that of component land systems is summarized in Table 19.

Table 19 – Vegetation condition class data from the traverse record of the Nullarbor land zone

Land system	Area (sq km)	No. of recordings	% in condition classes				Condition value	Overall condition statement
			1	2	3	4		
Skink	4 850	147	58	9	4	29	2.03	Good
Gafa	3 669	122	46	8	8	38	2.39	Good
Reid	3 419	80	52	9	5	34	2.20	Good
Morris	2 738	26	92	8	0	0	1.08	Excellent
Shake Hole	2 069	50	30	4	14	52	2.88	Fair
Kybo	75	7	72	0	0	28	2.14	Good
TOTAL	16 820	432					2.20	Good

Skink land system

The Skink land system covers 4 850 sq km in the south of the Forrest and the north of the Eucla 1:250 000 map sheets. It is characterized by large oval claypans.

Stony plains supporting bluebush comprise 60 per cent of this land system and were in fair condition but with some degradation caused by rabbits, fire and drought. The remaining units such as claypans and drainage floors were in good to excellent condition. Taken overall the system was in good condition.

Picture goes here.

Skink land system. Query No. 92. Stony plains supporting bluebush in excellent condition.

Gafa land system

The Gafa land system covers 3 669 sq km in the south east corner of the loongana and the south west corner of the Forrest 1:250 000 map sheets. It is characterized by wide drainage floors with infrequent claypans which are usually scalded.

Low rises supporting blue bush comprise 30 per cent of the area of this system and were in fair condition. The remaining units such as claypans were in good to excellent condition.

Taken overall, this land system was in good condition but some specific areas, especially adjacent to the railway line, were in very poor condition.

Picture goes here

Gafa land system. Query no. 156. Low rises in poor condition with the railway line on the right.

Reid land system

The Reid land system covers 3 419 sq km in the north east of the Eucla and the south east of the Forrest 1:250 000 map sheets. It is characterized by round claypans occurring in chains.

Very low stony rises supporting bluebush constitute about 40 per cent of the system's area and were generally in fair condition but rabbits, fire and drought have caused some degradation on this unit.

The remaining units – marginal slopes, drainage floors and claypans constitute about 60 per cent of the system's area and were in good condition.

Overall, the Reid land system was classified as being in good condition.

Picture goes here

Reid land system. Query No. 104. Stony low rise in excellent condition.

Morris land system

The Morris land system covers 2 738 sq k in the centre of the Eucla 1:250 000 map sheet and is characterized by discrete sinuous claypans. The system was in excellent condition.

Picture goes here

Morris land system. Query No. 104. Stony low rise in excellent condition.

Shake Hole land system

The Shake Hole land system covers 2 069 sq km in the centre of the Eucla 1:250 000 map sheet. It is characterized by long parallel drainage floors and crests which occasionally support myall, with stony plains and crests supporting bluebush occupying about 55 per cent of the area. Due to the effects of fire, rabbits and drought they were in poor condition but the remainder of the system (45 per cent) including the claypans, marginal slopes to drainage floors and drainage floors were usually in fair condition.

Taken overall, the Shake Hole land system was in fair condition.

Picture goes here

Shake Hole land system. Query No. 78. Low rise in fair condition.

Kybo land system

The Kybo land system covers only 75 sq km on the southern edge of the Loongana 1:250 000 map sheet near Nurina. It is characterized by very long broad drainage floors and was generally in good condition.

HAMPTON LAND ZONE – 3718 sq km (7.8%)

The Hampton land zone is comprised of the Thampanna, Chowilla, Weebubbie and Moopina land systems characterized by low woodland on low limestone ridges. This land zone is part of the coastal climatic region and receives approximately 200-230 mm mean annual rainfall. It is therefore, somewhat less arid than the Dimer, Nullarbor and Nyanga zones.

Taken overall, this zone was in good tending to fair condition with the areas in various condition classes in the zone shown below:

	Condition class			
	1 (Excellent)	2 (Good)	3 (Fair)	4 (Poor)
Area (sq km)	1 318	400	591	1 409
%	35	11	16	38

Most of the Hampton land zone has carried stock although, because of the recent drought, few animals were present during the survey. Parts of the zone have deteriorated as a result of rabbits, fire, drought and stock. The condition of the zone and its component land systems is summarized in Table 20.

Table 20 – Vegetation condition class data from the traverse record of the Hampton land zone

Land system	Area (sq km)	No. of recordings	% in condition classes				Condition value	Overall condition statement
			1	2	3	4		
Thampanna	1 706	99	42	13	21	24	2.28	Good
Chowilla	1 456	50	20	8	16	56	3.08	Fair
Weebubbie	431	7	43	14	0	43	2.43	Good
Moopina	125	9	100	0	0	0	1.00	Excellent
TOTAL	3 718	165					2.46	Good to Fair

Thampanna land system

The Thampanna land system covers 1 706 sq. km in an east-west band across the Eucla 1:250 000 map sheet. It is characterized by anastomosing drainage floors separated by low limestone ridges supporting eucalypt and/or myall woodland. These constitute 55 per cent of the system's area, and were in good condition. However, the more productive drainage floors support a chenopod shrubland which was generally in poor to fair condition due to grazing by rabbits and stock and the effects of fire and drought.

Picture goes here.

Thampanna land system: Query No. 5. The drainage floor in the foreground is in poor condition whilst the low rise in the background is in good condition.

The Thampanna system supports most of Mundrabilla station's stock. Although areas around watering points have been degraded by stock, taken overall the system was in good condition.

Chowilla land system

The Chowilla land system covers 1 456 sq km of the northern edge of the Hampton land zone on the Eucla 1:250 000 map sheet. It is characterized by sinuous drainage floors and claypans with scattered myall on the higher rises.

Low rises supporting bluebush cover 55 per cent of this system's area and were in poor condition because of the effects of rabbits, stock, fire and drought. Remaining units of the system such as claypans were in good condition. This system falls within the boundaries of Mundrabilla, Wanteen and Moopina stations and taken overall was in fair condition.

Picture goes here

Chowilla land system. Query No. 55. Low rise in poor condition.

Weebubbie land system

The Weebubbie land system covers 431 sq km on top of the eastern end of the Hampton Range on the Eucla 1:250 000 map sheet. It is characterized by discrete circular drainage floors and falls almost wholly within Moopina Station. While more productive units such as the drainage floors (25 per cent) have been partly degraded by the combined effects of rabbits, stock, fire and drought, other units of the system are generally in good condition. On the overall basis the Weebubbie land system is in good condition.

Moopina land system

The Moopina land system covers 125 sq. km on the top if the eastern end of the Hampton Range on the Eucla 1:250 000 map sheet. It is characterized by flat clay and kankar plains underlain by limestone and in excellent condition.

ROE LAND ZONE 0 2887 sq. km (6.1%)

The Roe land zone is comprised of the Mundrabilla and Eucla land systems. It is characterized by a flat coastal plain which is abruptly defined on its northern boundary by the Hampton Range and in the south by

the sea. The land zone is part of the coastal climatic region and although the most mesic area within the survey is still classified as semi-arid.

The area is leased to Mundrabilla, Moopina and Wanteen stations and was in excellent condition. It has never been heavily stocked because of the lack of suitable stock water. Areas in the various condition classes are presented below.

	Condition class			
	1 (Excellent)	2 (Good)	3 (Fair)	4 (Poor)
Area (sq km)	2 338	375	87	87
%	81	13	3	3

Table 21 – Vegetation condition class data from the traverse record of the Roe land zone

Land system	Area (sq km)	No. of recordings	% in condition classes				Condition value	Overall condition statement
			1	2	3	4		
Mundrabilla	2 156	97	81	11	3	5	1.30	Excellent
Eucla	731	59	83	15	2	0	1.19	Excellent
TOTAL	2 887	156					1.28	Excellent

Mundrabilla land system

The Mundrabilla land system covers 2 156 sq. km of the south west corner of the Eucla 1:250 000 map sheet. It is characterized by a flat coastal plain of Roe Calcarene overlain by recent sand dunes near the coast. The system was in excellent condition.

Picture goes here.

Mundrabilla land system. Query No. 16. *Nitraria schoberi* shrubland in excellent condition.

Eucla land system

The Eucla land system covers 731 sq km of the south eastern corner of the Eucla 1:250 000 map sheet. It is characterised by residual sand and kankar plains, lagoonal mud flats and recent sand dunes partly overlying Roe Calcarene. Although the system has been stocked and rabbits are present it is in almost pristine condition throughout. Because stock cannot be maintained on a year round basis because of the lack of good stock waters and the halophytic vegetation, taken overall the system was in excellent condition.

Picture goes here.

Eucla land system. Query No. 23. *Eucalyptus socialis* Association (No. 3) in good condition in background with a *Stipa* ssp grassland Association (No. 18) in the foreground.

LAND SYSTEM DESCRIPTIONS

Land systems have been described after Mabbutt *et al* (1963) and Dawson *et al* (1974), with most being depicted in plan form because of their lack of relief. Block diagrams were drawn for the Eucla and Mundrabilla land systems where there is considerable relief.

A representative cross section has been included for those land systems described in plan form and horizontal relief has been exaggerated. Vegetation has been represented on these cross sections using symbols after Dansereau (1951) and Dawson *et al* (1974). Table 22 lists the symbols and the species they represent.

The description of each land system includes a carrying capacity estimation for the system as a whole and for each unit of the system. Carrying capacity estimates for the whole system are shown (1) *for excellent condition* and (2) *for the condition as seen at the time (1974) of survey*. Estimates for the individual units of each system are shown only for excellent condition.

Table 22. – Vegetation symbols used in the land system cross sections.

<i>Acacia aneura</i>	▽
<i>Acacia sowdenii</i>	▽
<i>Acacia tetragonophylla</i>	▽
<i>Arthrocnemum</i> spp.	▽
<i>Atriplex nummularia</i>	●
<i>Atriplex vesicaria</i>	●
<i>Cratystylis conocephala</i>	●
<i>Eucalyptus gracilis</i>	●
<i>Eucalyptus oleosa</i>	●
<i>Eucalyptus socialis</i>	●
Grassland	✕
<i>Grevillea</i> spp.	✕
<i>Maireana sedifolia</i>	▽
<i>Melaleuca</i> spp.	●
<i>Muehlenbeckia cunninghamii</i>	●
<i>Pittosporum phillyraeoides</i>	●
<i>Rhagodia gaudichaudiana</i>	◇

Dimer Land Zone

BULLSEYE LAND SYSTEM - (6 606 sq km)

General description

Gently undulating stony plains supporting *Maireana sedifolia* on the rises and *Atriplex vesicaria* and grassland in the drainage floors and on their marginal slopes.

The drainage floors run into either small claypans or large dongas with prominent white scalded annuli.

Position

Found on the Forrest and Loongana 1:250:000 map sheets in the Dimer land zone and associated with the Nurina, Carlisle, Jubilee, Gafa and Loongana land systems.

Geology

Deflated Nullarbor Limestone.

Landform

Differential erosion of the deflated limestone has formed large circular drainage foci (dongas) and drainage floors arranged in a rectilinear to irregular pattern.

Traverse data and condition

Condition class	No. of traverse records	%
1. (excellent)	9	28
2. (good)	12	38
3. (fair)	2	6
4. (poor)	9	28
TOTAL	32	

Overall condition = GOOD

No. of query points = 3

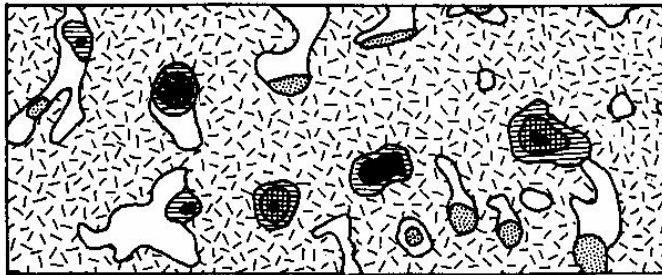
Hectares per s.u. excellent condition = 18. present condition = 46.5

Picture here

Bullseye land system. Query No. 10. Degraded low rise in foreground with sparse *A. Tetragonophylla*. Donga in background is in good condition.

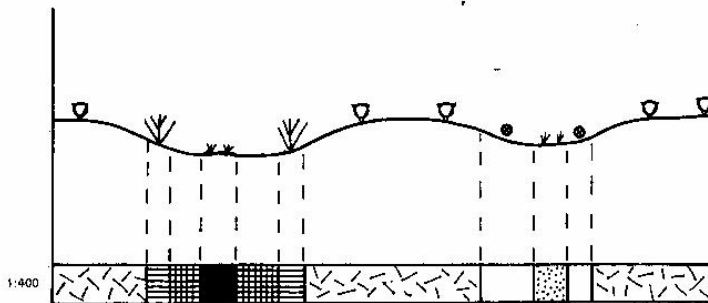
BULLSEYE LAND SYSTEM

Plan view



1:85 200

Cross section



1:40 000

BULLSEYE LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
62		Stony plains relief up to 4m.	Dense cobble strew with outcropping parent material. Yellowish red silty loam \pm 0.2 m deep.	<i>M. sedifolia</i> shrubland Assoc. No. 9.	17.5
3		Marginal slopes to dongas up to 0.2km wide.		<i>A. tetragonaphylla</i> tall shrubland Assoc. No. 8.	20
15		Margins to drainage floors.	Probably sparse cobble strew with outcropping parent material. Localised banding of surface salt. Yellowish red silty loam 0.9m deep.	Probably <i>A. vesicaria</i> association. Assoc. No. 11.	7.5
8		Clay floor of donga up to 1.6km diam.	Strewless. Yellowish red silty loam, 1m+ deep.	<i>P. phillyraeoides</i> grassy woodland. Assoc. No. 7.	5
		Gilgai in donga floor.	Sparse boulder strew. Dark red silty clay 1m+ deep.	<i>E. setifolia</i> grassy woodland. Assoc. No. 19.	
1		Swamp 0.4km diam.	Strewless. Yellowish red silty loam 1m+ deep.	<i>M. cunninghamii</i> tall shrubland Assoc. No. 16.	25
1		Scald up to 0.4km diam.	Probably strewless with yellowish red silty loam 0.75m deep overlying kankar. Low salt.	-	50
10		Drainage floors up to 0.3km wide and 0.9km long.	Probably sparse cobble strew. Yellowish red silty loam, 0.8m deep. Salt increases with depth.	Probably <i>Stipa</i> spp. and <i>D. caespitosa</i> short grass land. Assoc. No. 18.	15

Nyanga Land Zone

CARLISLE LAND SYSTEM – 2 556 sq km)

General description

Gently undulating stony plains with *Acacia sowdenii* on the crests, *Masireana sedifolia* on the lower plains and slopes. Large to small dongas support *Accacia aneura*, *Pittosporum phillyraeoides* and *Grevillea* spp. Small depressions covered with *Atriplex vesicaria* characterize this land system.

Position

Found on the Forrest and Loongana 1:250 000 map sheets in the Nyanga land zone and is associated with the Gunnadorah, Oasis, Bullseye and Jubilee land systems.

Geology

Nullarbor Limestone overlain by partially deflated clay and kankar.

Landform

The land surface is composed of residual clay and kankar plateau which has been dissected to expose Nullarbor Limestone. The latter has been differentially weathered to form large dongas whilst very small dongas occur on the clay and kankar. There is no dominant jointing pattern.

Traverse record and condition

Condition class	No. of traverse recordings	%
1. (excellent)	20	19
2. (good)	8	8
3. (fair)	12	11
4. (poor)	66	62
TOTAL	106	

Overall condition = FAIR

No. of query points = 10

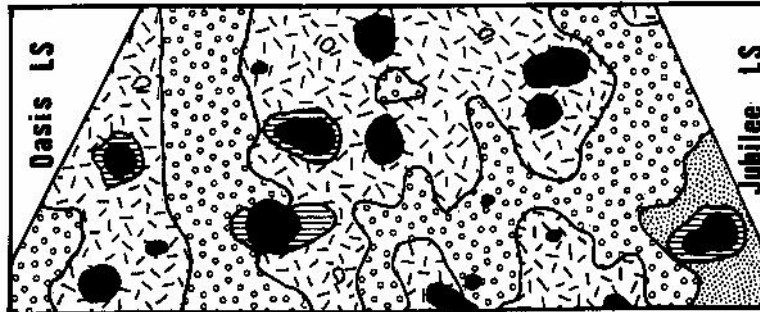
Hectares per s.u. excellent condition = 18. present condition = 46.5

[Picture here](#)

Carlisle land system Query No. 128. Residual clay and kankar crest supporting *A sowdenii* in foreground, lower slopes supporting *M. sedifolia* in middle distance and a donga in the background. All units in excellent condition.

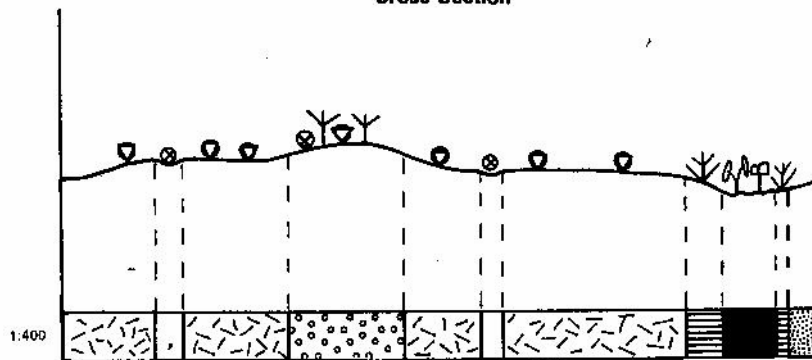
CARLISLE LAND SYSTEM

Plan view









1:85 200

Cross Section



1:1 40 000

CARLISLE LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
	20	Crests up to 4m relief.	Moderate pebble strew. Yellowish red silty loam of variable depth 0.2 - 1m+ deep. Underlain by clay and kankar.	<i>A. sowdenii</i> woodland with an understorey of either <i>A. vesicaria</i> or <i>M. sedifolia</i> . Assoc. No. 5 and 6.	17.5
	65	Stony plains less than 4m relief.	Moderate cobble strew. Yellowish red silty loam, up to 0.2m deep.	<i>M. sedifolia</i> shrubland. Assoc. No. 9.	20
	1	Marginal slopes to donga about 0.1km diam.	Moderate pebble strew. with outcropping parent material. Yellowish red silty loam, ± 0.5m deep.	<i>A. tetragonophylla</i> tall shrubland. Assoc. No. 8.	25
	5	Drainage floors.	Moderate pebble strew. Yellowish red silty loam + 1m deep.	<i>Stipa</i> spp and <i>D. caespitosa</i> grassland. Assoc. No. 18.	15
	8	Clay floor of dongas 0.4km diam.		<i>P. phillyraeoides</i> grassy woodland. Assoc. No. 7.	
		Gilgaiéd donga floors.	Loose surface with boulder strew. Dark red silty clay.	<i>E. setifolia</i> grassland. Assoc. No. 19.	5
	1	Small discrete drainage depressions.	Sparse pebble strew. Localised banding of salt on surface. Yellowish red silty loam 1m+ deep.	<i>A. vesicaria</i> shrubland Assoc. No. 11.	7.5

Hampton Land Zone

CHOWILLA LAND SYSTEM – (1 456 sq km)

General Description

Gently undulating stony plains with scattered *Acacia sowdenii* on the highest crests. The stony plains support *Maireana sedifolia* whilst the marginal slopes to drainage floors, drainage floors and claypans carry *Atriplex vesicaria*, *Arthrocnemum* spp. and grassland.

Position

Found on the Eucla 1:250 000 map sheet in the Hampton land zone sandwiched between the Thampanna to the south and Morris land systems to the north.

Geology

Deflated Nullarbor Limestone.

Landform

Land surfaces formed by differential erosion down the joints of the deflated nullarbor Limestone. The low crests and plains are separated by drainage depressions which terminate in oval claypans. Relief seldom exceeds 5m.

Traverse data and condition

Condition class	No. of condition recordings	%
1. (excellent)	10	20
2. (good)	4	8
3. (fair)	8	16
4. (poor)	28	56
TOTAL	106	

Overall condition = FAIR

No. of query points = 5

Hectares per s.u. excellent condition = 14. present condition = 25

[Picture here](#)

Chowilla land system. Query No. 57. *M. Sedifolia* in claypan in middle distance and *A. sowdenii* on the crests of the limestone ridges. Units in fair condition.

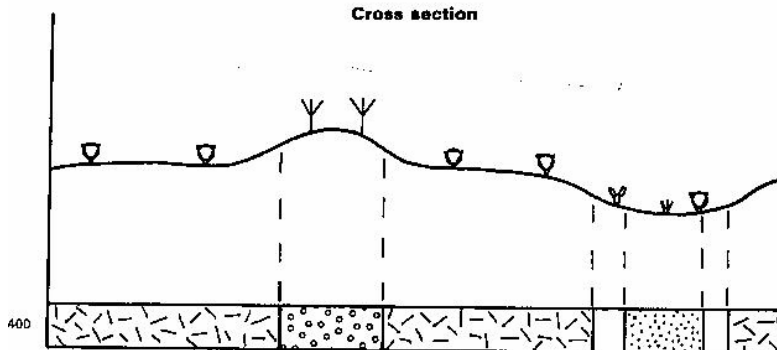
CHOWILLA LAND SYSTEM

Plan view



1 86 200

Cross section



1 40 000

CHOWILLA LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
5		Crests 4m relief.	Moderate pebble strew with outcropping parent material. Yellowish red silty loam 0.1m deep.	<i>A. sowdenii</i> low woodland. Assoc. No. 5. or <i>E. socialis</i> woodland. Assoc. No. 3	12.5
55		Stony plains and lower slopes.		<i>M. sedifolia</i> shrubland. Assoc. No. 9. or <i>S. squamatus</i> shrubland. Assoc. No. 13.	17
25		Marginal slopes to drainage floors.	Sparse pebble strew. Yellowish red silty loam of variable depth 0.25-0.5m. Highly saline.	<i>Arthrocnemum</i> spp. and <i>A. vesicaria</i> shrubland. Assoc. No. 10.	
		Long narrow drainage floors up to 0.2km wide 1.5km long.	Strewless. Yellowish red silty loam 1m + deep.	<i>M. sedifolia</i> shrubland. Assoc. No. 9. and <i>Stipa</i> spp and <i>D. caespitosa</i> short grass land. Assoc. No. 18.	8.5
15		Claypans up to 0.5km diam.			10

Nyanga Land Zone

COLVILLE LAND SYSTEM – (500 sq km)

General Description

Very gently undulating smooth plain underlain by sand and kankar and supports and *Accacia sowdenii* woodland with a chenopod shrub understorey. *Acacia aneura* grows in the dongas and claypans. Termite mounds are unique to this land system.

Position

Found on the Forrest 1:250 000 map sheet in the Nyanga land zone and associated with Gunnadorah and Oasis land systems.

Geology

Nullarbor Limestone overlain by residual sand and kankar.

Landform

The land surface is a flat plain of undissected sand and kankar. Some dongas and claypans exhibit centripetal drainage. Relict river systems and dongas are about 3 m and 2m respectively below the plateau.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	1	33
2. (good)	0	
3. (fair)	0	
4. (poor)	2	67
TOTAL	3	

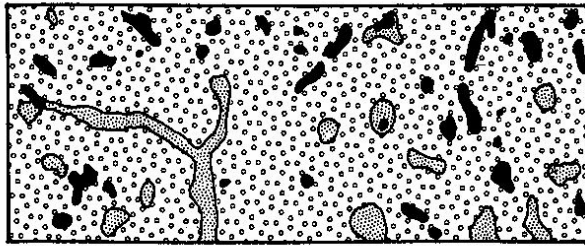
Overall condition = Insufficient samples, probably fair to poor
No. of query points = 1
Hectares per s.u. excellent condition = 16. present condition = 32

Picture goes here

Colville land system. Query No. 124. Claypan supporting sparse *A. aneura* above grassland in centre with an *A. sowdenii*-*M. sedifolia* low woodland on margins. Both in good condition.

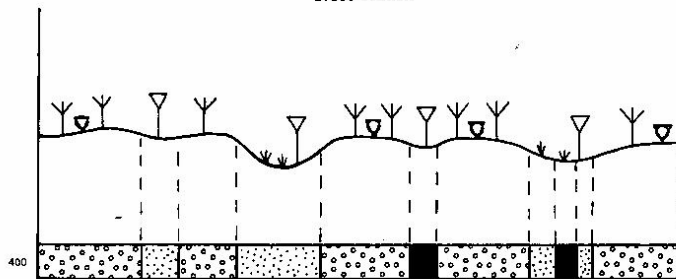
COLVILLE LAND SYSTEM

Plan view



1:86 200

Cross section



1:40 000

COLVILLE LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
83		Smooth plain underlain by sand and kankar up to 2m relief.	Dense pebble strew. Yellowish red sandy loam 0.25m deep over sand and kankar.	<i>A. bowdenii</i> woodland with a <i>M. sedifolia</i> understorey. Assoc. No. 6.	17.5
10		Claypans up to 0.3km diam.	Sparse pebble strew. Yellowish red silty loam 1m+ deep.	Sparse <i>A. aneura</i> above a dense <i>Stipa</i> spp. and <i>D. caespitosa</i> grassland. Assoc. No. 18.	15
7		Clay floors of dongas.	Probably sparse strew. Yellowish red silty loam 1m+ deep.	Probably <i>A. aneura</i> above <i>E. setifolia</i> grassland. Assoc. No. 19.	5
		Gilgaied donga floors.	Probably loose surface with sparse boulders. Dark red clay 1m+ deep.		

Dimer Land Zone

DEAKIN LAND SYSTEM – (956 sq km)

General description

Gently undulating stony plains which support *Maireana sedifolia*, *Atriplex vesicaria* on the marginal slopes to drainage floors and *Pittosporum phillyraeoides* and *Grevillea* spp.

Position

Found on the Forrest 1:250 000 map sheet in the Dimer land zone, wedged between the Oasis and Reid land systems.

Geology

Deflated Nullarbor Limestone.

Land form

Differential erosion of the deflated limestone surface has formed narrow drainage floors (0.5 km wide) with small dongas which follow a north-west trend. Relief seldom exceeds 4 m.

This land system is intermediate between the Oasis system which has numerous small dongas and the Reid land system which has large claypans but no dongas.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	4	34
2. (good)	0	0
3. (fair)	1	8
4. (poor)	7	58
TOTAL	12	

Overall condition = FAIR

No. of query points = 2

Hectares per s.u. excellent condition = 15. present condition = 36.5

Picture goes here

Deakin land system. Query No. 135. Low rise supporting *M. sedifolia* and a donga in the background. Note the rabbit piosphere in the foreground. All units in good condition.

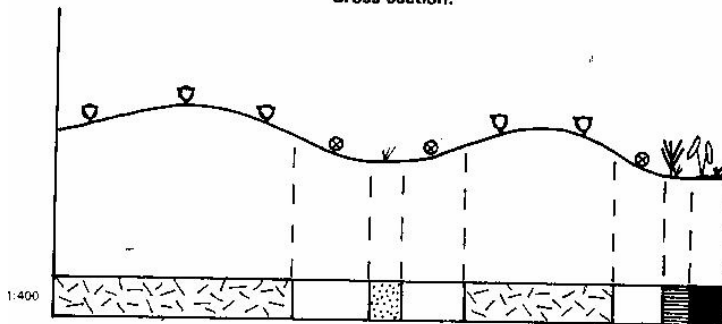
DEAKIN LAND SYSTEM

Plan view



1:86 200






Cross section.



1:400

1:40 000

DEAKIN LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
	40	Low rises up to 4m relief 0.6km wide and 6km long.	Dense pebble strew with outcropping parent material. Yellowish-red silty loam 0.2m deep.	<i>M. sedifolia</i> shrubland. Assoc. No. 9.	17.5
	< 1	Marginal slopes to dongas 0.1km wide.		<i>A. tetragonophylla</i> tall shrubland. Assoc. No. 8.	20
	50	Marginal run off areas.	Dense cobble strew out cropping parent material. Localised banding of surface salt. Yellowish-red silty loam 0.6m deep.	<i>A. vesicaria</i> shrubland. Assoc. No. 11.	
		Drainage floors up to 0.5km wide, 10km long.	Strewless surface. Yellowish red silty loam 1m+ deep.	<i>Stipa</i> spp. and <i>D. caespitosa</i> short grass land. Assoc. No. 18.	12.5
	10	Claypans.			15
	< 1	Clay floors of dongas.		<i>P. phillyraeoides</i> grassy woodland. Assoc. No. 7.	5
		Gilgaied donga floors.	Sparse boulder strew. Dark red silty clay 1m+ deep.	<i>E. setifolia</i> grassland. Assoc. No. 19.	

Roe Land Zone

EUCLA LAND SYSTEM – (731 sq km)

General description

Consists of a coastal plain which abuts onto the Hampton Range. The Range carries a sparse *Eucalyptus diversifolia* woodland whilst the plain carries a mosaic of dense shrubland and woodland dominated by *Arthrocnemum* spp., *Eucalyptus gracilis* and *Melaleuca* spp.

Position

Found at the south eastern edge of the Eucla 1:250 000 map sheet in the Roe land zone. It is associated with the Weebubbie and Moopina land systems to the north and is bordered by the Great Australian Bight in the south.

Geology

Wilson Bluff Limestone overlain by Roe Calcarenite which is itself overlain in parts by clay and kankar, stabilized Pleistocene sand dunes, Pleistocene and Recent lagoonal mud and Recent unconsolidated sand dunes.

Landform

Surfaces consist of a high wave formed scarp up to 50 m high with a band of colluvium (0.5 ± 0.2 km wide) at its base. A flat limestone plain (0 to 13 km wide) extends from the base of the scarp to the shore. It is covered in parts by a narrow band of residual sand and kankar which runs parallel to the scarp face. Pleistocene lagoonal mud covers a shallow depression in the centre of the plain and Recent lagoonal mud has been deposited in a narrow band adjacent to the coast. Low stabilized Pleistocene sand dunes occur north of the Recent lagoonal mud flats which also abut the unconsolidated dunes of the foreshore in the south.

Traverse record and condition

Condition class	No. of traverse records	%
1. (excellent)	49	83
2. (good)	9	15
3. (fair)	1	2
4. (poor)	0	0
TOTAL	59	

Overall condition = EXCELLENT

No. of query points = 17

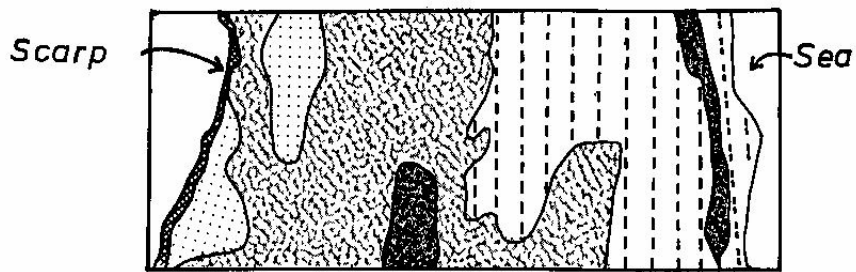
Hectares per s.u. excellent condition = 11. present condition = 11.5

Picture goes here.

Eucla land system. Query No. 67. Lagoonal muds supporting *Arthrocnemum* spp. in excellent condition. Hampton Rand in the background.

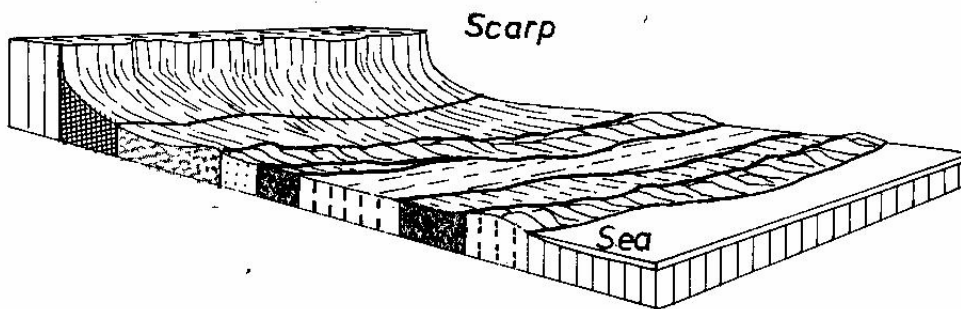
EUCLA LAND SYSTEM

Plan view



1:86 200

Block diagram



EUCLA LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
	1	Wave formed scarp face height up to 90 m.	Skeletal loamy soil	Probably supports <i>E. diversifolia</i> . Assoc. No. 2.	25
	45	Flat plains.	Loose surface without strew. Yellowish red silty clay, salinity increases with depth. Underlain by kankar.	Complex mosaic of <i>E. gracilis</i> , <i>Melaleuca</i> spp. Assoc. No. 1 and No. 13. and <i>N. schoberti</i> shrubland.	7.5
	15	Undulating plains.	Loose surface with pebble strew. Brown loamy sand 1m+ deep, underlain by sand and kankar.	Mosaic of <i>E. gracilis</i> spp. Assoc. No. 1 and very dense <i>Melaleuca</i> spp.	7.5
	20	Pleistocene and recent lagoonal mud flats.	Sparse pebble strew. Highly saline yellowish red loam with inclusions. A gypsum layer is sometimes present.	<i>Arthrocnemum</i> spp. shrubland. Assoc. No. 14.	25
	15	Stabilised recent sand dunes. Rises.	Loose surface with moderate pebble strew. Reddish brown sandy loam 0.3m deep over kankar.	<i>E. gracilis</i> , <i>Melaleuca</i> spp. woodland. Assoc. No. 1.	7.5
		Swales.	Sparse pebble strew, reddish brown loam 0.75 m deep over kankar.	sand. <i>C. conocephala</i> shrubland. Assoc. No. 17.	
	4	Unconsolidated sand dunes and beach.	Deep calcareous sand.	<i>Salsola</i> spp. <i>Aizoon</i> spp.	0

Nullarbor Land Zone

GAFA LAND SYSTEM – (3 669 sq km)

General description

Very gently undulating stony plains supporting *Maireana sedifolia* and *Atriplex vesicaria* on the rises and a mosaic of grassland and *Atriplex vesicaria* in the drainage floors and claypans.

Position

Found on the Forrest and Loongana 1:250 000 map sheets in the Nullarbor land zone and associated with the Bullseye, Skink and Loongana land systems.

Geology

Deflated Nullarbor Limestone.

Landform

Differential erosion of the deflated limestone surface down the joints has formed narrow stony rises separated by wide drainage floors with infrequent large scalded claypans and dongas.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	56	46
2. (good)	10	8
3. (fair)	10	8
4. (poor)	46	38
TOTAL	122	

Overall condition = GOOD

No. of query points = 6

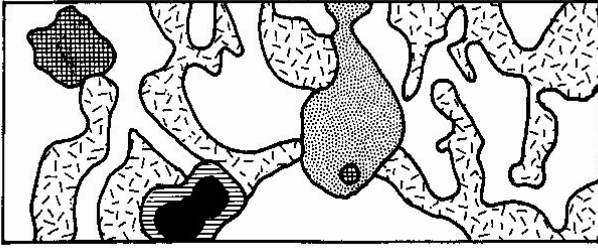
Hectares per s.u. excellent condition = 14. present condition = 28

Picture goes here.

Gafa land system. Query No. 145. Low rise supporting *M. sedifolia* in good condition.

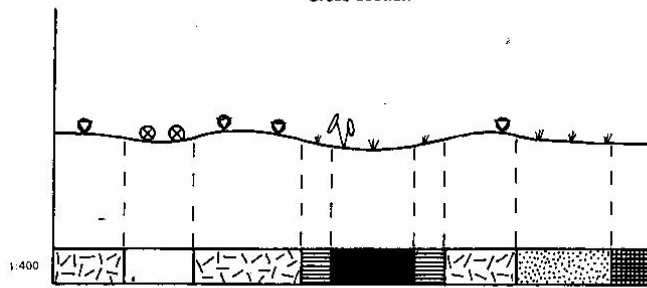
GAFA LAND SYSTEM

Plan view








1:88 000

Cross section



1:40 000

GAFA LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
	30	Low rises 1m relief. Up to 0.6 km wide and 2km long.	Dense pebble strew with outcropping parent material. Yellowish red silty loam, 0.1m deep.	<i>M. sedifolia</i> shrubland. Assoc. No. 9.	17.5
		Marginal slopes to drainage floors.	Sparse cobble strew with outcropping parent material. Localised banding of surface salt. Yellowish red silty loam 0.8m deep.	<i>A. vesicaria</i> shrubland. Assoc. No. 11.	
	55	Wide drainage floors up to 1.25km wide.	Sparse pebble strew. Yellowish red silty loam, 0.75m deep.	<i>Stipa</i> spp. and <i>D. caespitosa</i> short grassland. Assoc. No. 18.	12.5
	10	Large oval claypans up to 1.3km wide 2.5km long.			15
	5	Large scalded claypans up to 1km diam.	Strewless. Yellowish red silty loam about 0.5m deep. Low salt.	Nil	0
	<1	Marginal slopes to juvenile dongas.	Dense cobble strew with outcropping parent material. Yellowish red silty loam 0.1m deep.	<i>Stipa</i> spp and <i>D. caespitosa</i> short grassland. Assoc. No. 18.	15
	< 1	Juvenile dongas.	Strewless. Yellowish red silty loam 1m+ deep.	Depauperate <i>P. phillyraeoides</i> grassy woodland. Assoc. No. 7.	

Nyanga Land Zone

GUNNADORAH LAND SYSTEM – (2 963 sq km)

General description

Flat smooth plains underlain by clay and kankar supporting *Acacia sowdenii* woodland with a chenopod understorey. *Acacia aneura* occupies the small dongas while *Atriplex vesicaria* grows in the gilgai soils of the relict river systems.

Position

Found on the Forrest and Loongana 1:250 000 map sheets in the Nyanga land zone and associated with the Kyarra, Nurina, Carlisle and Colville land systems. A very small anomalous residual (9sq km) is found in the centre of the Hampton land zone.

Geology

Residual clay and kankar overlying Nullarbor Limestone.

Landform

The land surface is composed of a flat plain of undissected clay and kankar with a maximum of 1 m local relief. Claypans and dongas are of infrequent occurrence. Relict rivers are now a series of anastomosing valleys (\pm 3 m relief) with gilgaied claypans along their length.

Traverse record and condition

Condition class	No. of traverse recordings	%
1. (excellent)	7	14
2. (good)	6	12
3. (fair)	13	26
4. (poor)	24	48
TOTAL	50	

Overall condition = FAIR

No. of query points = 6

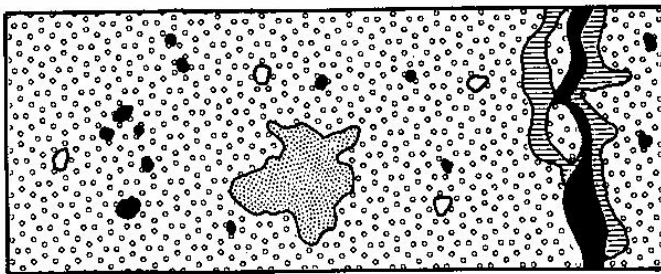
Hectares per s.u. excellent condition = 16. present condition = 30

Picture goes here.

Gunnadorah land system. Query No. 108. Flat clay and kankar plain supporting an *A. sowdenii* and *A. vesicaria* low woodland in excellent condition.

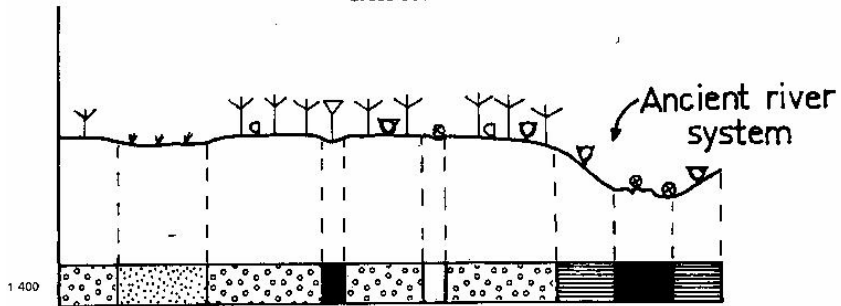
GUNNADORAH LAND SYSTEM

Plan view









1:86 200

Cross section



1 40 000

GUNNADORAH LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
	85	Flat plain up to 1m relief.	1m Loose surface with moderate pebble strew. Yellowish red sandy loam 0.15 - 1m+ deep, underlain by massive clay and kankar.	<i>A. sowdenii</i> low woodland with a shrub understorey of either <i>M. sedifolia</i> or <i>C. conocephala</i> . Assoc. No. 4,5,6.	17.5
	1	Margins to relict river beds 0.2km wide.	Loose surface with sparse pebble strew. Yellowish red silty loam about 0.6m deep.	<i>M. sedifolia</i> shrubland with sparse <i>A. sowdenii</i> Assoc. No. 9.	20
	1	Small drainage foci up to 0.1 km diam.	Strewless. Localised banding of surface salt. Yellowish red silty loam <1m deep.	<i>A. vesicaria</i> shrubland Assoc. No. 11.	7.5
	3	Ancient river bed up to 0.2km wide.	Sparse cobble strew. Gilgaied yellowish red silty clay 1m+ deep.	<i>A. vesicaria</i> shrublands Assoc. No. 11 and 12.	7.5
	7	Small dongas 0.1km diam.	Strewless. Yellowish red silty loam 1m+ deep.	<i>P. phillyraeoides</i> grassy woodland with <i>A. aneura</i> Assoc. No. 7.	5
	4	Claypans up to 0.6 km diam.	Strewless. Yellowish red silty loam, 1m+ deep.	<i>Stipa</i> spp. and <i>D. caespitosa</i> short grass land Assoc. No. 18.	15

Nyanga Land Zone

JUBILEE LAND SYSTEM – (2 281 sq km)

General description

Undulating plains; the higher, smooth clay and kankar crests support *Acacia sowdenii* whilst the lower stony plains and slopes support *Maireana sedifolia*. The drainage floors and margins to drainage floors support a mosaic of *Atriplex vesicaria* and grassland, whilst large infrequent dongas support *Grevillea* spp. and *Acacia tetragonophylla*.

Position

Found on the Forrest and Loongana 1:250 000 sheets in the Nyanga land zone and associated with the Gunnadorah, Rabbit and Bullseye land systems.

Geology

Dissected residual clay and kankar overlying Nullarbor Limestone.

Landform

The land surface is composed of a residual clay and kankar plateau which has been dissected to expose Nullarbor Limestone on the lower slopes. The latter has been differentially weathered down the joints and infilled with colluvium to form long, narrow, sub parallel drainage floors up to 8 km long with infrequent dongas in the drainage foci. The trend of the dominant jointing pattern varies from NE-SW around Forrest to NW-SE north of Nurina. The area is intermediate in form between the intact residual clay and kankar of the Gunnadorah and Rabbit land systems and the completely deflated Bullseye land system.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	16	20
2. (good)	4	5
3. (fair)	3	4
4. (poor)	55	71
TOTAL	78	

Overall condition = POOR

No. of query points = 11

Hectares per s.u. excellent condition = 18. present condition = 49

Picture goes here.

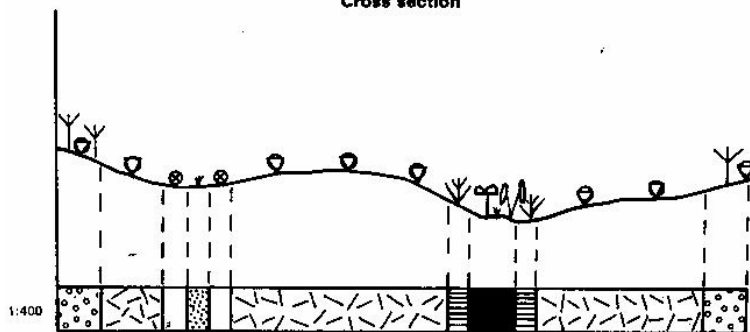
JUBILEE LAND SYSTEM

Plan view



1:86 200

Cross section



1:40 000

JUBILEE LAND SYSTEM

Key	Area %	Landform	Soils	Vegetation	Ha per S.U.
	10	Crests 4m relief underlain by massive clay and kankar.	Loose surface with moderate pebble strew. Yellowish red loamy sand 0.2m deep, overlying massive calcrete (kankar).	<i>A. scowdenii</i> woodland with <i>M. sedifolia</i> understorey. Assoc. No. 6.	17.5
	70	Lower plains and slopes less than 4m relief.	Moderate pebble strew. Yellowish red silty loam of variable depth 0.1 - 1m.	<i>M. sedifolia</i> shrubland. Assoc. No. 9.	20
	15	Margins to drainage floors.	Moderate pebble strew. Localised banding of surface salt. Yellowish red silty loam 1m+ deep.	<i>A. vesicaria</i> shrubland. Assoc. No. 11.	
		Drainage floors.	Strewless. Yellowish red silty loam 1m+ deep.	<i>Stipa</i> spp <i>D. caespitosa</i> short grass land. Assoc. No. 18.	12.5
	<1	Small claypans with scalds about 0.4km diam.			15
	<1	Marginal slopes to donga.	Cobble strew with outcropping parent material. Yellowish red silty loam 0.1m deep.	<i>A. tetragonophylla</i> tall shrubland. Assoc. No. 8.	20
	3	Clay floors of dongas.	Strewless. Yellowish red silty loam 0.15-1m+ deep,	<i>P. phillyraeoides</i> grassy woodland. Assoc. No. 7.	5
		Gilgaied donga floors.	Loose surface with boulder strew. Dark red, silty clay 1m+ deep.	<i>E. sedifolia</i> grassland. Assoc. No. 19.	

Nyanga Land Zone

KYARRA LAND SYSTEM - (950 sq km)

General description

Very gently undulating plain carrying *Accacia sowdenii* on the higher rises, *Maireana sedifolia* on the lower plains and slopes and *Pittosporum phillyraeoides* and *Grevillea* spp in the dongas.

Position

Found on the Loongana 1:250 000 map sheet in the Nyanga land zone and is associated with the Gunnadorah and Carlisle land systems.

Geology

Nullarbor Limestone overlain by partially dissected residual clay and kankar.

Landform

The land surface has been formed by partial erosion of the clay and kankar plateau to expose Nullarbor Limestone on the lower slopes where differential weathering has resulted in the formation of dongas and drainage floors. This land system differs from the Carlisle land system because it contains a larger area of clay and kankar.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	1	10
2. (good)	0	0
3. (fair)	6	60
4. (poor)	3	30
TOTAL	10	

Overall condition = FAIR

No. of query points = 3

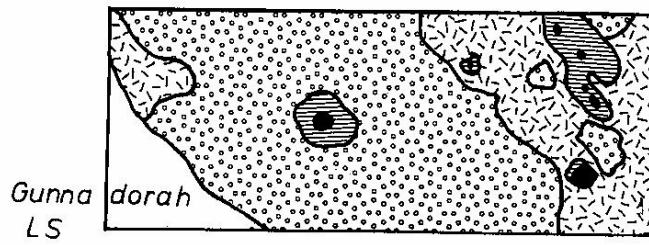
Hectares per s.u. excellent condition = 19. present condition = 43.5

Picture goes here.

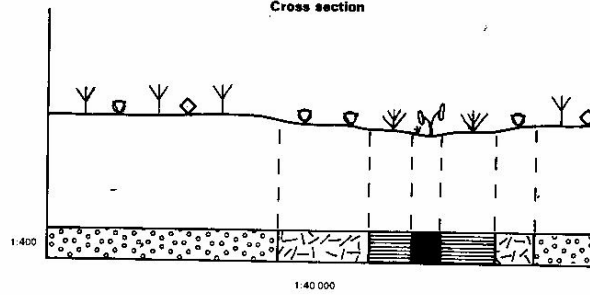
Kyarra land system. Query No. 175. Low open woodland of *A. sowdenii* with *M. sedifolia* understorey in good condition on clay and kankar plain.

KYARRA LAND SYSTEM





Plan view



Cross section



KYARRA LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
	60	Flat plains.	Moderate pebble strew. Yellowish red silty loam variable depth from 0.1-1m deep.	<i>A. scowdenii</i> low woodland with a <i>M. sedifolia</i> understorey. Assoc. No. 6.	17.5
	30	Lower slopes.	Moderate pebble strew. with outcropping parent material. Yellowish red silty loam, 0.6m deep.	<i>M. sedifolia</i> shrubland. Assoc. No. 8.	20
	7	Marginal slopes to dongas.	Sparse cobble strew with outcropping parent material. Yellowish red silty loam up to 0.4m deep.	<i>A. tetragonophylla</i> tall shrubland. Assoc. No. 8.	25
	3	Clay floor of dongas.	Sparse pebble strew. Yellowish red silty loam 0.9m deep.	<i>P. phillyraeoides</i> grassy woodland. Assoc. No. 7.	
		Gilgaied donga floors.	Boulder strew with loose surface. Yellowish red silty loam, 1m+ deep.	<i>E. setifolia</i> grassland. Assoc. No. 19.	5

Nullarbor Land Zone

KYBO LAND SYSTEM

This land system covers only 75 sq km of the survey area but is a major feature of the Madura 1:250 000 map sheet. No query points were selected from this area. The lack of this information and its small area has prohibited the formulation of a full land system description.

General description

Undulating stony plains supporting *Maireana sedifolia* on the low rises and *Atriplex vesicaria* and grassland on the marginal slopes and wide drainage floors. Grassland occurs in the claypans.

Position

Found in the south of the Loongana 1:250 000 map sheet in the Nullarbor land zone and is associated with the Nurina and Gafa land systems.

Geology

Deflated Nullarbor Limestone.

Landform

Differential erosion of the deflated limestone surface has formed stony plains and wide drainage floors trending N-S along jointing fractures.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	5	72
2. (good)	0	0
3. (fair)	0	0
4. (poor)	2	28
TOTAL	7	

Overall condition = Insufficient samples, probably good

No. of query points = 0

Hectares per s.u. excellent condition = 14. present condition = 17.5

Dimer Land Zone

LOONGANA LAND SYSTEM – (781 sq km)

General description

Very gently undulating stony plains supporting *Maireana sedifolia*. Shallow drainage floors and their marginal slopes carrying *Atriplex vesicaria* and grassland. Swamps supporting *Muehlenbeckia cunninghamii* OR DONGAS SUPPORTING *Pittosporum phillyraeoides* are found in the drainage foci.

Position

Found on the Loongana 1:250 000 map sheet in the Dimer land zone and is associated with the Bullseye and Gafa land systems.

Geology

Deflated Nullarbor Limestone.

Landform

The deflated limestone surface has been differentially eroded to form shallow subcircular drainage foci. Swamp formation is thought to be due to an impervious substrata, whilst dongas are thought to have porous substrata. Swamps are better develop din this land system than in any other.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	18	38
2. (good)	13	6
3. (fair)	9	4
4. (poor)	40	19
TOTAL	47	

Overall condition = FAIR

No. of query points = 4

Hectares per s.u. excellent condition = 18. present condition = 37

Picture goes here.

Loongana land system. Query No. 133. Stony plain in poor condition. Marginal slope to donga supporting *A tetragonophylla* on middle left in good condition.

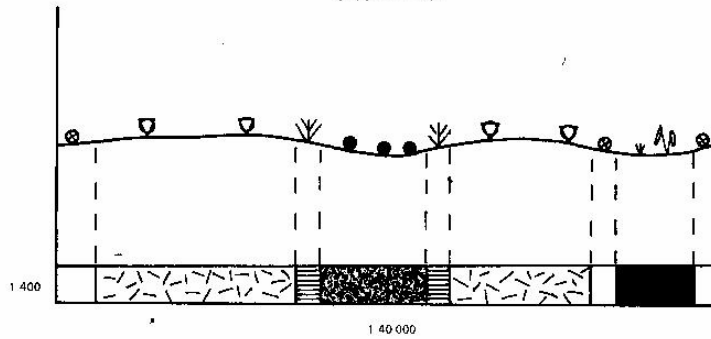
LOONGANA LAND SYSTEM

Plan view



1:86 200

Cross section



LOONGANA LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
70		Stony plains about 1m relief.	Moderate pebble strew with outcropping parent material. Yellowish red silty loam, ± 0.1 m deep.	<i>M. sedifolia</i> shrubland. Assoc. No. 9.	17.5
22		Marginal slopes to drainage floors.	Moderate cobble strew with outcropping parent material. Localised banding of salt on surface. Yellowish red silty loam about 0.25m deep.	<i>A. vesticaria</i> shrubland. Assoc. No. 11.	
		Sinuuous drainage floors up to 2km long.	Sparse pebble strew. Yellowish red silty loam about 0.7m deep.	<i>Stipa</i> spp. <i>D. caespitosa</i> grassland. Assoc. No. 18.	12.5
1		Marginal slope to drainage foci.	Moderate cobble strew with outcropping parent material.	<i>A. tetragonophylla</i> tall shrubland. Assoc. No. 8.	25
2		Gilgaied floors of dongas.	Probably dark red clay with boulder strew.	<i>E. setifolia</i> grassland. Assoc. No. 19.	5
5		Swamps up to 0.4km diam.	Sparse cobble strew. Yellowish red silty loam about 0.25m deep.	<i>M. cunninghami</i> shrubland. No annual cover. Assoc. No. 16.	50

Hampton Land Zone

MOOPINA LAND SYSTEM – (125 sq km)

General description

Nearly flat smooth plains supporting dense *Eucalyptus gracilis* and *Melaleuca* spp. on the higher ground. The shallow depressions support fewer trees and a greater number of shrubs, especially *Cratystylis conocephala*.

Position

Found on the Eucla 1:250 000 map sheet in the Hampton land zone and associated with the Weebubbie land system to the north and the Eucla land system to the south.

Geology

Nullarbor Limestone overlain by residual sand and kankar.

Landform

The land system is a flat plain of undissected Pleistocene sand and kankar with small drainage foci. Relief seldom exceeds 1 m.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	9	100
2. (good)	0	0
3. (fair)	0	0
4. (poor)	0	0
TOTAL	9	

Overall condition = EXCELLENT

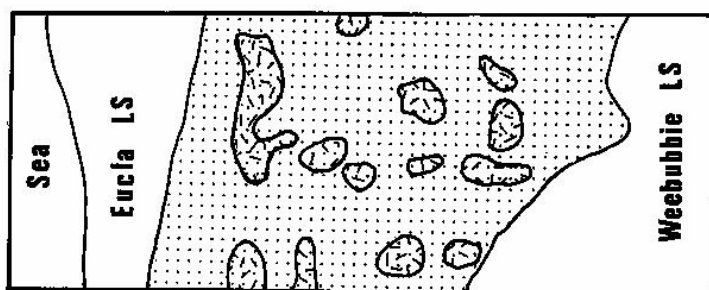
No. of query points = 1

Hectares per s.u. excellent condition = 11. present condition = 11

Picture goes here

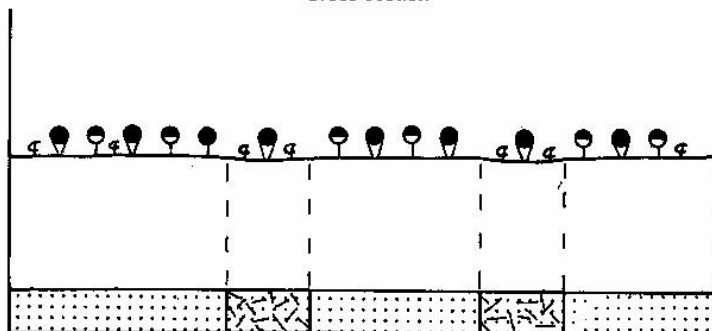
Moopina land system. Query No. 63. Claypan supporting *Cratystylis conocephala* in foreground with an *E. gracilis*, *Melaleuca* spp, low woodland. All units in excellent condition.

Plan view



1:88 200

Cross section



1:400 000

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
75	75	Flat plains up to 1m relief.	Loose surface with sparse gravel strewn. Dark reddish brown sandy loam about 0.3m deep underlain by kankar.	<i>E. gracilis</i> - <i>Melaleuca</i> spp. woodland with an <i>Eremophila weldii</i> understorey. Assoc. No. 1.	12.5
25	25	Drainage floors and claypans.	Loose surface without strewn. Yellowish red silty loam 1m+ deep.	Sparse <i>E. gracilis</i> - <i>Melaleuca</i> spp. woodland with a dense <i>C. conocephala</i> understorey. Assoc. No. 1.	7.5

Nullarbor Land Zone

MORRIS LAND SYSTEM – (2 738 sq km)

General description

Very gently undulating plains with *Maireana sedifolia* on the higher parts and *Atriplex vesicaria*, *Arthrocnemum* spp. and grassland in the drainage floors and on their marginal slopes. The claypans support grassland.

Position

Found on the Eucla 1:250 000 map sheet in the Nullarbor land zone and associated with the Reid and Skink land systems to the north and the Chowilla land system in the south.

Geology

Deflated Nullarbor Limestone.

Landform

Differential weathering along the irregular jointing patterns of the nullarbor Limestone has formed low stony plains with up to 2m relief separated by sinuous drainage floors and claypans.

Traverse record and condition

Condition class	No. of traverse recordings	%
1. (excellent)	24	92
2. (good)	2	8
3. (fair)	0	0
4. (poor)	0	0
TOTAL	26	

Overall condition = EXCELLENT

No. of query points = 3

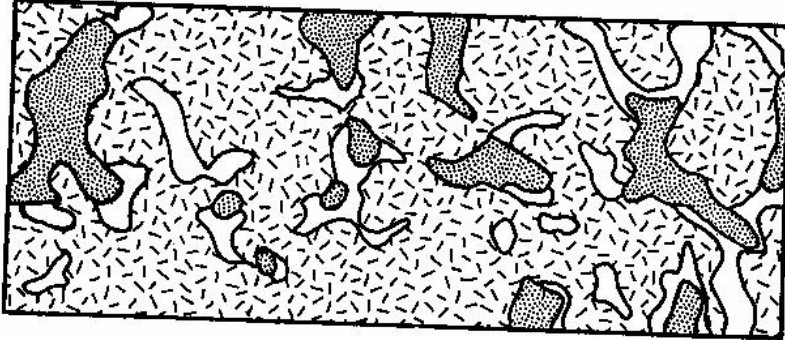
Hectares per s.u. excellent condition = 16. present condition = 16.5

Picture goes here

Morris land system. Query No. 59. Low rises supporting *M. sedifolia* in foreground and a banded *A. vesicaria* community on the marginal slopes in the middle distance.

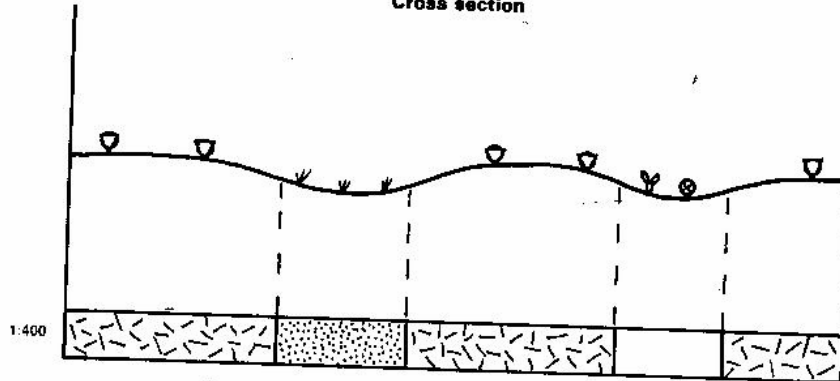
MORRIS LAND SYSTEM

Plan view



1:86 200

Cross section



MORRIS LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Haper S.U.
	66	Stony plains up to 2m relief.	Dense pebble strew with outcropping parent material. Yellowish red silty loam less than 0.2m deep.	<i>M. sedifolia</i> shrubland Assoc. No. 9.	17.5
	20	Marginal slopes to drainage floors.	Sparse cobble strew with outcropping parent material. localised banding of surface salt. Yellowish red silty loam about 0.5m deep.	<i>A. vesicaria</i> shrubland. Assoc. No. 11.	12.5
		Drainage floors up to 0.25km wide 1.0km long.	Strewless yellowish red silty loam, 1m+ deep.	<i>Stipa</i> spp and <i>D. caespitosa</i> short grassland Assoc. No. 18.	
	14	Large sinuous claypans 1.7km long up to 5km wide.			15

Roe Land Zone

MUNDRABILLA LAND SYSTEM – (2 156 sq km)

General description

Consists of a coastal plain which abuts onto the Hampton Range (scarp). The Range supports a sparse *Eucalyptus diversifolia* woodland on its scree slope. The coastal plain supports a sparse woodland above a dense shrubland which is dominated by *Nitraria schoberi* and *Maireana sedifolia*.

Position

Found in the south-western section of the Eucla and Noonaera 1:250 000 map sheet in the Roe land zone. It is sandwiched between the Hampton tableland to the north and the Great Australian Bight to the south.

Geology

Wilson Bluff Limestone overlain by Roe Calcarene which is itself overlain in parts by stabilized Pleistocene sand dunes, Recent sand dunes and Recent lagoonal mud.

Landform

Land surfaces consist of a wave formed scarp face (50 m) with a narrow band of colluvium at its base. A flat limestone plain 20 km wide extends from the base of the scarp to the shore. In its southern parts, it is covered by stabilised sand dunes, lagoonal mud and unconsolidated sand dunes.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	78	81
2. (good)	11	11
3. (fair)	3	3
4. (poor)	5	5
TOTAL	97	

Overall condition = EXCELLENT

No. of query points = 16

Hectares per s.u. excellent condition = 7. present condition = 8

Picture goes here

Mundrabilla land system Query No. 7. *Nitraria schoberi* shrubland with sparse *A. sowdenii* in excellent condition. Hampton Range in the background.

Dimer Land Zone

NURINA LAND SYSTEM (1 256 sq km)

General description

Very gently undulating stony plains supporting *Maireana sedifolia* on the rises, *Atriplex vesicaria* and grassland in the drainage floors and their marginal slopes and *Grevillea* spp. and *Pittosporum phillyraeoides* in the dongas. Infrequent large scalded dongas occur in this land system.

Position

Found on the Loongana 1:250 000 map sheet in the Dimer land zone and associated with the Bullseye and Gunnadorah land systems.

Geology

Deflated Nullarbor Limestone.

Landform

Differential erosion of the deflated Nullarbor Limestone surface has formed shallow depressions which have undergone colluvial infilling. The strongly rectilinear jointing pattern trends N-S, E-W. Claypans, dongas and scalds have formed in the drainage foci. Relief seldom exceeds 1.5 m.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	13	23
2. (good)	2	3
3. (fair)	14	25
4. (poor)	28	49
TOTAL	57	

Overall condition = FAIR

No. of query points = 5

Hectares per s.u. excellent condition = 16. present condition = 38.5

Picture goes here

Nurina land system. Query No. 162. Claypan supporting a *Stipa* spp., *D. caespitosa* community in excellent condition with a degraded low rise in background.

Dimer Land Zone**OASIS LAND SYSTEM** (4 663 sq km)*General description*

Flat stony plains supporting *Maireana sedifolia* and small circular dongas with *Pittosporum phillyraeoides* and *Acacia tetragonophylla*.

Position

Found on the Forrest and Loongana 1:250 000 map sheets in the Dimer land zone and associated with the Deakin, Gunnadorah and Bullseye land systems.

Geology

Deflated Nullarbor Limestone.

Landform

The deflated limestone surface has been differentially eroded to form numerous small, shallow, circular drainage foci about 2 m below the plain. A jointing pattern is not evident. The drainage foci (dongas) are randomly distributed.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	24	22
2. (good)	0	0
3. (fair)	8	7
4. (poor)	80	71
TOTAL	112	

Overall condition = POOR

No. of query points = 10

Hectares per s.u. excellent condition = 19. present condition = 52

Picture goes here

Oasis land system. Query No. 107. Clay floor of donga in foreground and *M. sedifolia* on stony plains in background. Both in excellent condition.

Nyanga Land Zone

RABBIT LAND SYSTEM (550 sq km)

General description

Flat smooth undissected clay and kankar plain that no longer supports any woody perennials.

Position

Found on the Forrest 1:250 000 map sheet in the Nyanga land zone and is associated with the Jubilee and Gunnadorah land systems.

Geology

Nullarbor Limestone overlain by residual clay and kankar.

Landform

Residual land surface forming a flat plain with very small, shallow, claypans.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	0	0
2. (good)	0	0
3. (fair)	0	0
4. (poor)	19	100
TOTAL	19	

Overall condition = POOR

No. of query points = 3

Hectares per s.u. excellent condition = 20. present condition = 67

Picture goes here

Rabbit land system. Query No. 81. Clay and kankar plain in poor condition. Now supports a short grass community.

Nullarbor Land Zone

REID LAND SYSTEM (3 419 sq km)

General description

Gently undulating stony plains supporting *Maireana sedifolia* on the low rises, *Atriplex vesicaria* and grassland in the drainage floors and on their marginal slopes. Grassland occurs in the claypans.

Position

Found on the Forrest and Eucla 1:250 000 map sheets in the Nullarbor land zone and associated with the Deakin and Morris land systems.

Geology

Deflated Nullarbor Limestone.

Landform

Differential erosion of the deflated limestone surface has formed drainage floors along the joints which trend NW-SE. Low rises run parallel to the drainage floors, where circular drainage foci are found. Relief seldom exceeds 2m.

Traverse record and condition

Condition class	No. of traverse recordings	%
1. (excellent)	42	52
2. (good)	7	9
3. (fair)	4	5
4. (poor)	27	34
TOTAL	80	

Overall condition = GOOD

No. of query points = 10

Hectares per s.u. excellent condition = 15. present condition = 30

Picture goes here

Reid land system. Query No. 93. Marginal slopes supporting banded *A. vesicaria* in excellent condition. A low rise supporting *M. sedifolia* in good condition in background.

SHAKEHOLE LAND SYSTEM

Plain View

Insert graphic here

Cross section

Insert graphic here

SHAKEHOLE LAND SYSTEM

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
5		Crests 3m relief	Dense cobble strew. Yellowish red silty loam ± 0.1 m deep.	Sparse <i>A. sowdenii</i> and <i>P. phillyraeoides</i> without a shrub understorey.	20
50		Stony plains and slopes		<i>M. Sedifolia</i> shrubland. Assoc. No. 9.	17.5
35		Marginal slopes to drainage floors	Sparse cobble strew. Localised banding of surface salt. Yellowish red silty loam, 0.7m+ deep.	<i>A. vesicaria</i> shrubland. Assoc. No. 11.	
		Long, narrow drainage floors up to 10km long, 0.2 km wide.	Strewless. Yellowish red silty loam, 1m+ deep.	<i>M. Sedifolia</i> shrubland. Assoc. No. 9 and <i>Stipa</i> spp and <i>D. caespitosa</i> short grassland and <i>Arthrocnemum</i> spp. Shrubland Assoc. No. 10.	9
10		Claypans about 0.4 km diam			15

Nullarbor Land Zone

SKINK LAND SYSTEM (4 850 sq km)

General description

Very gently undulating stony plains supporting *Maireana sedifolia*, marginal slopes to drainage floors and drainage floors supporting *Atriplex vesicaria* and claypans supporting grassland.

Position

Found on the Eucla and Forrest 1:250 000 map sheets in the Nullarbor land zone. It is associated with the Shake Hole and Morris land systems in the south and the Reid, Gafa and Jubilee land systems in the north.

Geology

Deflated Nullarbor Limestone.

Landform

The predominantly NE-SW trending joints have been differentially eroded to form long narrow drainage floors with large oval claypans in the drainage foci. Dongas are occasionally found in the northern areas.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	86	58
2. (good)	13	9
3. (fair)	6	4
4. (poor)	42	29
TOTAL	147	

Overall condition = GOOD

No of query points = 9

Hectares per s.u. excellent condition = 16. Present condition = 28

Insert picture

Skink land system. Query No. 61. Marginal slopes supporting banded *A. vesicaria* in excellent condition.

SKINK LAND SYSTEM

Plan view

Insert graphic

Cross section

Insert graphic

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
	60	Stony plains up to 3m relief.	Dense cobble strew, and outcropping parent material. Yellowish-red silty loam 0.1 – 0.2 m deep.	<i>M. sedifolia</i> Assoc. No. 9	17.5
	<1	Marginal slopes to dongas		<i>A. tetragonophylla</i> Assoc. No. 8.	20
	30	Marginal slopes to drainage floors.	Sparse cobble strew with outcropping parent material. Localised banding of surface salt. Yellowish-red silty clay \pm 0.5m deep.	<i>A. vesicaria</i> Assoc. No. 11.	12.5
		Drainage floors up to 13km long and 0.4km wide	Sparse cobble strew. Yellowish-red silty loam \pm 0.9m deep.	<i>Stipa</i> spp – <i>D. caespitosa</i> Assoc. No. 18.	
	7	Large round to oval claypans up to 0.9km diameter.			15
	<1	Large scalds in claypans \pm 0.3 km diameter.	Surface without crypto crust and sparse cobble strew. Saline yellowish-red silty	Sparse halophytic annuals. <i>Frankenia</i> spp.	50

		loam, 0.1 – 0.25m deep underlain by kankar.	
<1	Clayfloor of large dongas ± 0.3km diameter.	Strewless surface. Yellowish-red silty loam 1m+ deep.	<i>P. phillyraeoides</i> grassy woodland. Assoc. No. 7.
	Gilgaed floors of dongas.	Loose surface with boulder strew. Red silty clay 1m+ deep.	<i>E. setifolia</i> grassland Assoc No. 19 5

Hampton Land Zone

THAMPANNA LAND SYSTEM (1 706 sq km)

General description

Eucalyptus socialis, *Eucalyptus oleosa* and *Acacia sowdenii* dominate a low open woodland on the low joint controlled limestone ridges. These are separated by drainage floors and claypans which support a mosaic of grassland and chenopod shrubland.

Position

Found on the Eucla 1:250 000 map sheet in the Hampton land zone. Its southern boundary is defined by the Hampton Range and its northern boundary by the Chowilla and Shake Hole land systems.

Geology

Deflated Abrakurrie and Nullarbor Limestone.

Landform

Land surfaces formed by differential erosion of the deflated Nullarbor and Abrakurrie Limestone. The low ridges show more relief in the south (7m) than in the north (3m). Colluvial infilling of the weathered joints has formed irregularly shaped drainage floors following a NE-SW trend.

Traverse data and condition

Condition class	No. of traverse recordings	%
1. (excellent)	41	42
2. (good)	13	13
3. (fair)	21	21
4. (poor)	24	24
TOTAL	147	42

Overall condition = GOOD

No of query points = 12

Hectares per s.u. excellent condition = 10. Present condition = 18.

Insert graphic

Thampanna land system. Query No. 13. Limestone ridge supporting *A. sowdenii* and *A. nummularia* in foreground and background. Claypan in middle distance supporting *M. sedifolia* and *Arthrocnemum* spp. Units in good condition.

THAMPANNA LAND SYSTEM

Plan view

Insert graphic

Cross section

Insert graphic

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
	55	Low ridges up to 7m relief.	Moderate cobble strew with outcropping parent material. Yellowish-red sandy loam \pm 0.1m deep.	<i>E. socialis</i> low woodland. Assoc. No. 3 or <i>A. sowdenii</i> low woodland with <i>A. nummularia</i> . Assoc. No. 5.	12.5
		Lower slopes	Moderate pebble strew. Yellowish-red silty loam 0.1 – 0.4 m deep.	Sparse <i>A. oswaldii</i> above a <i>Stipa</i> spp. and <i>D. caespitosa</i> short grassland. Assoc. No. 18.	
	45	Long irregular drainage floors up to 4km long and 0.5km wide.	Sparse pebble strew. Saline yellowish-red silty loam 1m+ deep.	Complex mosaic of <i>M. Sedifolia</i> shrubland Assoc. No. 9, and <i>Athrocneum</i> spp. shrubland. Assoc. No. 10, and <i>Stipa</i> spp. and <i>D. caespitosa</i> short grassland. Assoc. No. 18.	7.5

Hampton Land Zone

WEEBUBBIE LAND SYSTEM (431 sq km)

General Description

Gently undulating stony plains supporting a *Melaleuca* spp. and *Eucalyptus gracilis* woodland on the rises. The lower slopes, drainage floors and claypans support a mosaic of grassland and chenopod shrubland.

Position

Found on the Eucla 1:250 000 map sheet in the Hampton land zone and associated with the Chowilla land system in the north and the Moopina and Eucla land systems in the south.

Geology

Deflated Nullarbor Limestone.

Landform

Differential erosion of the deflated limestone surface has formed numerous small oval to circular drainage foci separated by stony plains and low ridges (3m relief).

Traverse record and condition

Condition class	No. of traverse recordings	%
1. (excellent)	3	43
2. (good)	1	14
3. (fair)	0	0
4. (poor)	3	43
TOTAL	7	43

Overall condition = Insufficient samples, probably fair

No of query points = 2

Hectares per s.u. excellent condition = 13. Present condition = 26.

Insert picture

Weebubbie land system. Query No. 56. Claypan supporting *M. sedifolia* in the foreground and *E. gracilis* in background on limestone ridges. All units are in good condition.

WEEBUBBIE LAND SYSTEM

Plan View

Insert graphic

Cross section

Insert graphic

Key	Area %	Landform	Soil	Vegetation	Ha per S.U.
	75	Low ridges up to 3m relief.	Dense pebble strew. Reddish-brown silty loam, 0.1m deep.	<i>E. gracilis</i> – <i>Melaleuca</i> spp. woodland Assoc. No. 1.	12.5
		Stony plains and slopes.		<i>S. squamatus</i> shrubland and Assoc. No. 13.	
	20	Closed drainage floors	Strewless surface. Yellowish-red silty loam of variable depth. 0.5m – 1m+ deep, underlain by kankar.	<i>Stipa</i> spp., <i>Danthonia caespitosa</i> grassland. Assoc. No. 18.	15
	5	Circular to oval claypans up to 0.25km in diameter.		<i>M. sedifolia</i> shrubland. Assoc. No. 9.	7.5

APPENDIX 1

FLORISTIC ASSOCIATIONS

No. 1 *Eucalyptus gracilis*, *Melaleuca* spp. and *Cratystylis conocephala* association.

Consists of a low woodland – low open woodland with a dense diverse shrub understorey. Where it occurs on stabilised sand dunes, shrub cover is dense and tree cover sparse in the swales, whilst the situation is reversed on the ridges.

This association occurs on flat Roe Calcarenite and stabilised sand dunes on the Eucla and Mundrabilla land systems; on the sand and kankar in the Moopina and Eucla land systems and on Nullarbor Limestone in Weebubbie land system.

It is found only in the higher rainfall areas.

STRUCTURAL FORM:	Low woodland – low open woodland Ht 8 ± 3 m, PFC $15 \pm 10\%$.
TREE LAYER:	Ht 8 ± 3 m, PFC $13 \pm 9\%$.
Predominant spp:	<i>Eucalyptus gracilis</i> , <i>Melaleuca</i> spp.
Frequent spp:	<i>Eucalyptus oleosa</i> , <i>Acacia sowdenii</i> , <i>Eucalyptus socialis</i> .
SHRUB LAYER:	Ht 1.2 ± 0.3 m, PFC $15 \pm 10\%$
Predominant spp:	<i>Cratystylis conocephala</i> , Ht 1.2 ± 0.3 m, PFC $11 \pm 9\%$
Frequent spp:	<i>Eremophila weldii</i> , <i>Eremophila glabra</i> , <i>Geijera linearifolia</i> , <i>Marieana excavata</i> , <i>Westringia ridgida</i> , <i>Atriplex vesicaria</i> , <i>Maireana sedifolia</i> , <i>Nitraria schoberi</i> .
GROUND LAYER:	Sparse
FORBS:	<i>Zygophyllum</i> spp., <i>Bassia</i> spp., <i>Frankenia</i> spp.
GRAMINEAE:	<i>Stipa</i> spp.

No. 2 *Eucalyptus diversifolia* association.

Consists of a low open woodland restricted to the scree slopes of the Hampton scarp.

STRUCTURAL FORM:	Low open woodland. Ht 7 ± 2 m, PFC $7 \pm 3\%$.
TREE LAYER:	Ht 7 ± 2 m, PFC $\pm 3\%$.
Predominant spp:	<i>Eucalyptus diversifolia</i> .
SHRUB LAYER:	Ht 1.0 ± 0.6 m, PFC $2 \pm 1\%$.
Frequent spp:	<i>Atriplex nummularia</i> , <i>Eremophila glabra</i> , <i>Cassia nemophila</i> , <i>Maireana radiata</i> .
GROUND LAYER:	Sparse.
FORBS:	<i>Helipterum</i> spp., <i>Goodenia pinnatifida</i>
GRAMINEAE:	<i>Poa drummondii</i> , <i>Stipa</i> spp.

No. 3 *Eucalyptus socialis* – *Acacia sowdenii* association.

This consists of a low woodland with a diverse open shrub understorey. Found on limestone ridges in the Hampton land zone and has a restricted distribution in the Roe land zone.

In the southern part of the Hampton land zone, rainfall averages 200mm per annum. *Eucalyptus socialis* and *Eucalyptus oleosa* dominate the ridges in this area. Rainfall decreases northwards and *E. oleosa* is limited to the wetter parts. Further north, *Eucalyptus socialis* decreases in size and importance and is replaced by myall, *Acacia sowdenii*.

The distribution of the eucalypts on the ridges is peculiar; eucalypts dominate the crests but thin out down slope and grade into myall which becomes dominant on the lower slopes.

Eremophila weldii and *Atriplex vesicaria* may be found in bands running along these ridges.

STRUCTURAL FORM:	Low woodland – low open woodland Ht 7 ± 3 m, PFC $8 \pm 5\%$.
TREE LAYER:	Ht 7 ± 3 m, PFC $6 \pm 4\%$.
Predominant spp:	<i>Eucalyptus socialis</i> and <i>Acacia sowdenii</i> .

Frequent spp: *Eucalyptus oleosa*, *Santalum acuminatum*, *Pittosporum phillyraeoides*,
Acacia oswaldii, *Myoporum desertii*.
 SHRUB LAYER: Ht 1.3 ± 0.6 m, PFC 5 ± 4%.
 Frequent spp: *Eremophila weldii*, *Ptilotus obovatus*, *Ptilotus symoni*, *Atriplex*
nummularia, *Atriplex vesicaria*, *Enchylaena tomentosa*, *Maireana*
sedifolia, *Maireana* spp., *Rhagodia gaudichaudiana*.
 GROUND COVER: Sparse.
 FORBS: *Zygophyllum* spp.
 GRAMINIEAE: *Stipa variabilis* and *Danthonia caespitosa*.

No. 4 *Acacia sowdenii* – *Cratystylis conocephala* association.

Consists of low open woodland with an open shrub understorey growing on clay and kankar in the Nyanga land zone. Land surface is usually flat with sparse annual cover.

STRUCTURAL FORM: Low open woodland. Ht 4 ± 1 m, PFC 5 ± 2%.
 TREE LAYER: Ht 4 ± 1m, PFC 4 ± 2%.
 Predominant spp: *Acacia sowdenii*
 Frequent spp: *Myoporum desertii*, *Heterodendrum oleifolium*, *Santalum acuminatum*.
 SHRUB LAYER: Ht 1.0 ± 0.3 m, PFC 10 ± 8.5%.
 Predominant spp: *Cratystylis conocephala*, Ht 1.0 ± 0.3 m, PFC 9 ± 4%
 Frequent spp: *Maireana sedifolia*, *Atriplex vesicaria*.
 GROUND LAYER: Sparse.
 FORBS: *Helipterum* spp., *Zygophyllum* spp., *Anagallis brachypappus*, *Tetragonia*
eremaea, *Erodium crinitum*, *Senecio laetus*.
 GRAMINIEAE: *Stipa variabilis*.

No 5 *Acacia Sowdenii* – *Atriplex vesicaria* association.

Consists of a low open woodland with a saltbush understorey and is found exclusively on the Gunnadorah land system growing in deep residual clay and kankar.

STRUCTURAL FORM: Low open woodland. Ht 4 ± 1 m, PFC 5 ± 2 per cent.
 TREE LAYER: Ht 4 ± 1 m, PFC 4 ± 2 per cent.
 Predominant spp: *Acacia sowdenii*.
 Frequent spp: *Myoporum desertii* and *Heterodendrum oleifolium*
 SHRUB LAYER: Ht 0.5 ± 0.2 m, PFC 12 ± 5 per cent.
 Predominant spp: *Atriplex vesicaria*, Ht 0.5 ± 0.2m, PFC 11 ± 6 per cent.
 Frequent spp: *Atriplex nummularia* and *Maireana sedifolia*.
 GROUND LAYER: Sparse.
 FORBS: *Senecio laetus*, *Helipterum* spp., *Zygophyllum* spp.
 GRAMINIEAE: *Stipa variabilis*

No. 6 *Acacia sowdenii* – *Maireana sedifolia* association.

Consists of a low open woodland with a low open shrub understorey growing on clay and kankar and dominates large areas of the Nyanga land zone.

STRUCTURAL FORM: Low open woodland, Ht 4 ± 1 m, PFC 5 ± 2 per cent.
 TREE LAYER: Ht 4 ± 1 m, PFC 4 ± 2 per cent.
 Predominant spp: *Acacia sowdenii*.
 Frequent spp: *Heterodendrum oleifolium*, *Myoporum desertii* and *Acacia oswaldii*.
 SHRUB LAYER: Ht 0.6 ± 0.2 m, PFC 5 ± 3 per cent.
 Predominant spp: *Maireana sedifolia*, Ht 0.6 ± 0.2 m, PFC 5 ± 3 per cent.
 Frequent spp: *Rhagodia gaudichaudiana* and *Atriplex vesicaria*.
 GROUND COVER: Very sparse.
 FORBS: *Goodenia pinnatifida*, *Erodium cygnorum*, *Helipterum floribundum*,
Gnaphosis skirrophora, *Angianthus brachypappus* and *Bassia* spp.
 GRAMINIEAE: *Stipa variabilis*.

No. 7 *Pittosporum phillyraeoides*, *Grevillea* spp., *Acacia tetragonophylla* and *Eragrostis setifolia* association.

Consists of a low open grassy woodland and occurs in circular gilgaied drainage foci, locally known as dongas (Lowry, 1970). Dongas are found in the land systems of the Dimer and Nyanga land zones. The gilgaied areas generally support a diverse and dense community of grasses characterised by *eragrostis*

setifolia and Tall Stipa (*Stipa* spp.). Gilgais vary in form from almost flat to 2 m relief between the puffs and depressions.

STRUCTURAL FORM: Low open grassy woodland – open tall shrubland. Ht 6 ± 3 m, PFC 5 ± 4 per cent.
 TREE LAYER: Ht 7 ± 2 m, PFC 2 ± 1 per cent.
 Predominant spp: *Grevillea* spp., *Pittosporum phillyraeoides*.
 TALL SHRUBS: Ht 3 ± 2 m, PFC 2 ± 1 per cent.
 Predominant spp: *Acacia tetragonophylla*.
 Frequent spp: *Acacia aneura*, *Eremophila longifolia*, *Eremophila latifolia*.
 SHRUB LAYER: Ht 0.6 ± 0.3 m, PFC 1 ± 1 per cent.
 Frequent spp: *Lycium australe*, *Rhagodia gaudichaudiana*, *Enchylaena tomentose*.
 GROUND COVER: Dense.
 FORBS: *Trigonella sauvissima*, *Lotus australis*, *Goodenia pinnatifida*, *Helipterum haigii*, *Erodium crinitum*, *Clanthus formosus*, *Senecio lautus*, *Malva parviflora*, *Bassia* spp, *Teucrium racemosum* and *Oxalis* spp.
 GRAMINIEAE: *Eragrostis setifolia* and Tall Stipa (*Stipa* spp.)

No. 8 *Acacia tetragonophylla* – *Pittosporum phillyraeoides* association.

Consists of a tall open shrubland that grows in a narrow annular ring surrounding each donga. This association is restricted to the Dimer and Nyanga land zones.

STRUCTURAL FORM: Tall open shrubland. Ht 3 ± 1 m, PFC 3 ± 2 per cent.
 TALL OPEN SHRUBLAND: Ht 3 ± 1 m, PFC 3 ± 2 per cent.
 Predominant spp: *Pittosporum phillyraeoides*, *Acacia tetragonophylla*.
 Frequent spp: *Acacia oswaldii*, *Acacia aneura*.
 SHRUB LAYER: Ht 0.6 ± 0.3 m, PFC 2 ± 1 per cent.
 Frequent spp: *Rhagodia gaudichaudiana*
 GROUND COVER: Very sparse.
 FORBS: *Tetragonia eremaea*, *Carracthea annua*, *Swainsona kingii*, *Helipterum floribundum*, *Malva parviflora*, *Senecio lautus* and *Teucrium racemosum*.
 GRAMINIEAE: *Stipas scabra*, *stipa variabilis* and *Danthonia caespitose*.
 CHENOPOD
 SHRUBLANDS

No. 9 *Maireana sedifolia* association.

Consists of a low open shrubland dominated by bluebush growing on skeletal limestone soils throughout the survey area. When in good condition a small saltbush (*Atriplex vesicaria*) component is usually present.

This association is susceptible to degradation by fire and rabbits. Large areas previously supporting this association have been degraded to grassland or herbland.

STRUCTURAL FORM: Low open shrubland. Ht 0.8 ± 0.3 m, PFC $5 \pm 4\%$.
 SHRUB LAYER: Ht 0.8 ± 0.3 m, PFC $5 \pm 3\%$.
 Predominant spp: *Maireana sedifolia*.
 Frequent spp: *Atriplex vesicaria*, *Selenothamnus squamatus*.
 GROUND LAYER: Sparse.
 FORBS: *Plantago varia*, *Carracthea annua*, *Swainsona olerii*.
 GRAMINIEAE: *Stipa platychaeta*, *Stipa* spp, *Stipa scabra* and *Stipa variabilis*.

No. 10 *Arthrocnemum* spp – *Atriplex vesicaria* association.

Consists of a low shrubland – low open shrubland growing in the claypans on the margins of the drainage floors of the Hampton land zone and the Morris land system.

STRUCTURAL FORM: Low shrubland – low open shrubland.
 Ht 1.1 ± 0.3 m, PFC $10 \pm 8\%$.
 SHRUB LAYER: Ht 1.1 ± 0.3 m, PFC $10 \pm 8\%$.
 Predominant spp: *Arthrocnemum* spp and *Atriplex vesicaria*.
 Frequent spp: *Lycium australe* and *Atriplex vesicaria*.
 GROUND LAYER: Moderately dense.
 FORBS: *Zygophyllum* spp., *Senecio lautus*, *Bassia* spp. and *Aizoon quadrifidum*.

GRAMINIEAE: *Stipa* spp.

No 11 *Atriplex vesicaria* – *Maireana georgei* association.

This association is common throughout the survey area on medium depth soils. It consists of a low shrubland characterised by parallel banding of the vegetation. Bare scalded saline earth separates dense bands of saltbush (*Atriplex vesicaria*) (30% PFC)

Although saltbush is very fire sensitive (Mitchell – unpublished data) this association is resistant to burning because the scalds from natural fire breaks between bands of saltbush. If saltbushes are lost through burning or are eaten out by sheep or rabbits, they are rapidly replaced from seed. However, if subjected to heavy continuous use the association degrades rapidly.

STRUCTURAL FORM: Low shrubland. Ht 0.5 ± 0.2 m, PFC $14 \pm 8\%$.
SHRUB LAYER: Ht 0.5 ± 0.2 m, PFC $14 \pm 8\%$.
Predominant spp: *Atriplex vesicaria*.
Frequent spp: *Maireana georgei*, *Maireana turbinata*.
GROUND LAYER: Nil on scalds and dense on interscald bands.
FORBS: *Lotus australis*, *Calotis hispidula*, *Frankenia* spp. and *Zygophyllum* spp.
GRAMINIEAE: *Stipa eremophila*.

No. 12 *Atriplex vesicaria* association.

Consists of a low open halophytic shrubland dominated by an evenly distributed cover of saltbush growing on deep gilgaed soil in the relict river beds of the Gunnadorah land system.

STRUCTURAL FORM: Low open shrubland. Ht 0.4 ± 0.1 m, PFC 6%.
SHRUB LAYER:
Predominant spp: *Atriplex vesicaria*.
Frequent spp: *Lycium australe*.
GROUND LAYER: Very sparse.
FORBS: *Bassia sclerolaenoides*, *Helipterum* spp., *Bassia patenticurpis*, *Atriplex acutibractea*.
GRAMINIEAE: Nil.

No. 13 *Selenothamnus squamatus* association.

Consists of a low open shrubland growing on stony rises in the Chowilla land system.

STRUCTURAL FORM: Low open shrubland. Ht 0.6 ± 0.2 m, PFC 6%.
SHRUB LAYER: Ht 0.6 ± 0.2 m, PFC 6%.
Predominant spp: *Selenothamnus squamatus*.
Frequent spp: *Atriplex vesicaria*.
GROUND LAYER: Sparse.
FORBS: *Helipterum* spp., *Bassia* spp.
GRAMINIEAE: *Stipa* spp.

No. 14 *Maireana oppositifolia*, *Arthrocnemum* spp. and *Selenothamnus squamatus* association.

Consists of a low shrubland growing on deep, saline, lagoonal mud with a very sparse cover of halophytic forbs and grasses. This association only occurs in the Roe land zone.

STRUCTURAL FORM: Low shrubland – low open shrubland
SHRUB LAYER: Ht 0.6 ± 0.3 m, PFC 11 ± 3 per cent.
Predominant spp: *Maireana oppositifolia*, *Arthrocnemum* spp. and *Selenothamnus squamatus*.
Frequent spp: *Atriplex vesicaria*.
GROUND LAYER: Very sparse.
FORBS: *Frankenia* spp., *Aizoon quadrifidum*.
GRAMINIEAE: *Stipa* spp.

No. 15 *Nitraria schoberi* association.

Consists of a diverse low – tall shrubland and is restricted to the flat areas of the Roe land zone. Saline microdrainage foci (15 cm deep) are interspersed by raised, less saline, ground. Consequently the

vegetation varies in species composition and cover values in response to salinity. Higher cover values of saltbush (*Atriplex vesicaria*) are found in the drainage foci.

STRUCTURAL FORM: Low – tall shrubland. Ht 1.7 ± 0.4 m, PFC 11 ± 5 per cent.
 SHRUB LAYER: Ht. 1.7 ± 0.4 m, PFC 6 ± 3 per cent.
 Predominant spp: *Nitraria schoberi*.
 Frequent spp: *Atriplex vesicaria*, *Maireana sedifolia*, *Atriplex nummularia*, *Lycium australe*.
 GROUND LAYER: Sparse and variable.
 FORBS: *Senecio lautus*, *Bassia* spp., *Zygophyllum* spp.
 GRAMINIEAE: *Stipa* spp., *Stipa variabilis*, *Danthonia caespitosa*, *Stipa scabra*.

No. 16 *Muehlenbeckia cunninghamii* association.

Consists of low open shrubland and is restricted to the drainage foci of the Loongana and Bullseye land systems.

STRUCTURAL FORM: Low open shrubland. Ht 1.3 ± 0.4 m, PFC 5 ± 4 per cent.
 SHRUB LAYER:
 Predominant spp: *Muehlenbeckia cunninghamii*
 GROUND LAYER: Very sparse.
 FORBS: *Teucrium racemosum*, *Atriplex criptocarpa*
 GRAMINIEAE: Nil.

No. 17 *Cratystylis conocephala* association.

Consists of a diverse low open shrubland which is restricted to the following areas of the Roe land zone – interdune swales, colluvial deposits at the base of the Hampton Range and parts of the Roe calcarenite.

STRUCTURAL FORM: Low open shrubland. Ht 1.1 ± 0.3 m, PFC 6 ± 5 per cent.
 SHRUB LAYER: Ht 1.2 ± 0.2 m, PFC 6 ± 3 per cent.
 Predominant spp: *Cratystylis conocephala*
 Frequent spp: *Eremophila weldii*, *Lycium australe*, *Geijera linearifolia*, *Atriplex vesicaria*, *Westringia ridgida*.
 GROUND LAYER: Sparse.
 FORBS: *Zygophyllum* spp.
 GRAMINIEAE: *Stipa* spp., *Stipa trichophylla*.

No. 18 *Stipa scabra*, *Stipa variabilis* and *Danthonia caespitosa* association.

Consists of a short grassland which grows in claypans and degraded shrublands throughout the survey area.

STRUCTURAL FORM: Sparse – dense grassland
 GROUND LAYER:
 Predominant spp: *Stipa scabra*, *Stipa variabilis* and *Danthonia caespitosa*
 FORBS: *Swainsona oliveri*, *Swainsona kingii*, *Carracthea annua*, *Sonchus oleraceae*, *Senecio lautus*, *Tetragonia eremaea*, *Bassia* spp., *Atriplex acutibractea*, *Helipterum floribundum*, *Helipterum haigii*.
 GRAMINIEAE: *Stipa* spp, *Stipa trichophylla*, *Stipa juncifolia*.

No. 19 *Eragrostis setifolia* association.

Consists of a short grassland that grows in deep gilgaied clay soils of the drainage foci in the Dimer and Nyanga land zones.

STRUCTURAL FORM: Dense short grassland.
 Ht 0.4 ± 0.2 m, PFC 40 ± 30 per cent.
 GROUND LAYER:
 Predominant spp: *Eragrostis setifolia*
 FORBS: *Trigonella suavissima*, *Lotus australis*, *erodium crinitum*, *Oxalis* spp.
 GRAMINIEAE: *Danthonia caespitosa*, Tall *stipa*, *Stipa juncifolia* and *Eragrostis setifolia*.

APPENDIX 2

COMMUNICATION LINES AND POPULATION

The population centres within the survey area are found along the communication lines which consist of the Transcontinental Railway Line and the Eyre Highway.

Transcontinental Railway Line

Within the survey area there are five settlements along the railway line at Loongana, Mundrabilla, Reid, Deakin and Forrest. Their average population is about 20 persons. Forrest is the biggest settlement and has a large airfield plus hangars, a post office, a meteorological station and a railway rest house. It is also the centre of a rabbit trapping enterprise.

These settlements are victualled by the 'tea and sugar' train which runs weekly from Port Augusta to Kalgoorlie. The roads between the settlements and the Eyre Highway are extremely rough and usually require a four wheel drive vehicle.

The railway maintenance men or fettlers are the largest occupation group in the survey area. They are also extremely transient.

Eyre Highway

Within the survey area, there are two roadhouses on the Eyre Highway at Mundrabilla and Eucla. These offer fuel, repairs and overnight accommodation. The West Australian portion of the Eyre Highway has been sealed for some years, whilst the South Australian portion was completed in 1977. Traffic should increase considerably once there is a complete strip of bitumen between Perth and the eastern cities.

Communications other than along the Eyre Highway and the railway line are difficult. The best tracks are on the stations while the remainder have never been graded and are extremely rough and only accessible by four wheel drive. Dense scrub also limits access to the Nyanga and Roe land zones. Cross country traversing is not recommended because of abrupt swallow holes and rabbit warrens.

The area is underdeveloped in the pastoral context. Gunnadorah and Mundrabilla stations are the only properties of any consequence, and not more than 10 people earn a living from pastoral pursuits over the entire area.

A rabbit trapping concern operates out of Forrest. The rabbit population was much larger 10 years ago than at present (Beard 1975). The country around Forrest once supported 23 commercial rabbit trappers and the number is now about a third of this. The rabbits are railed to Perth in freezer trucks.

Two small scale shark fishing operations are run from the coast near Mundrabilla.

There is no mining of any sort in the area.

APPENDIX 3

LAND SYSTEM MAPS

1:250 000 SCALE.

Eucla and Noonaera

Forrest

Loongana

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