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A report on the condition of the Gascoyne catchment

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A REPORT
ON THE CONDITION
OF THE
GASCOYNE CATCHMENT

by

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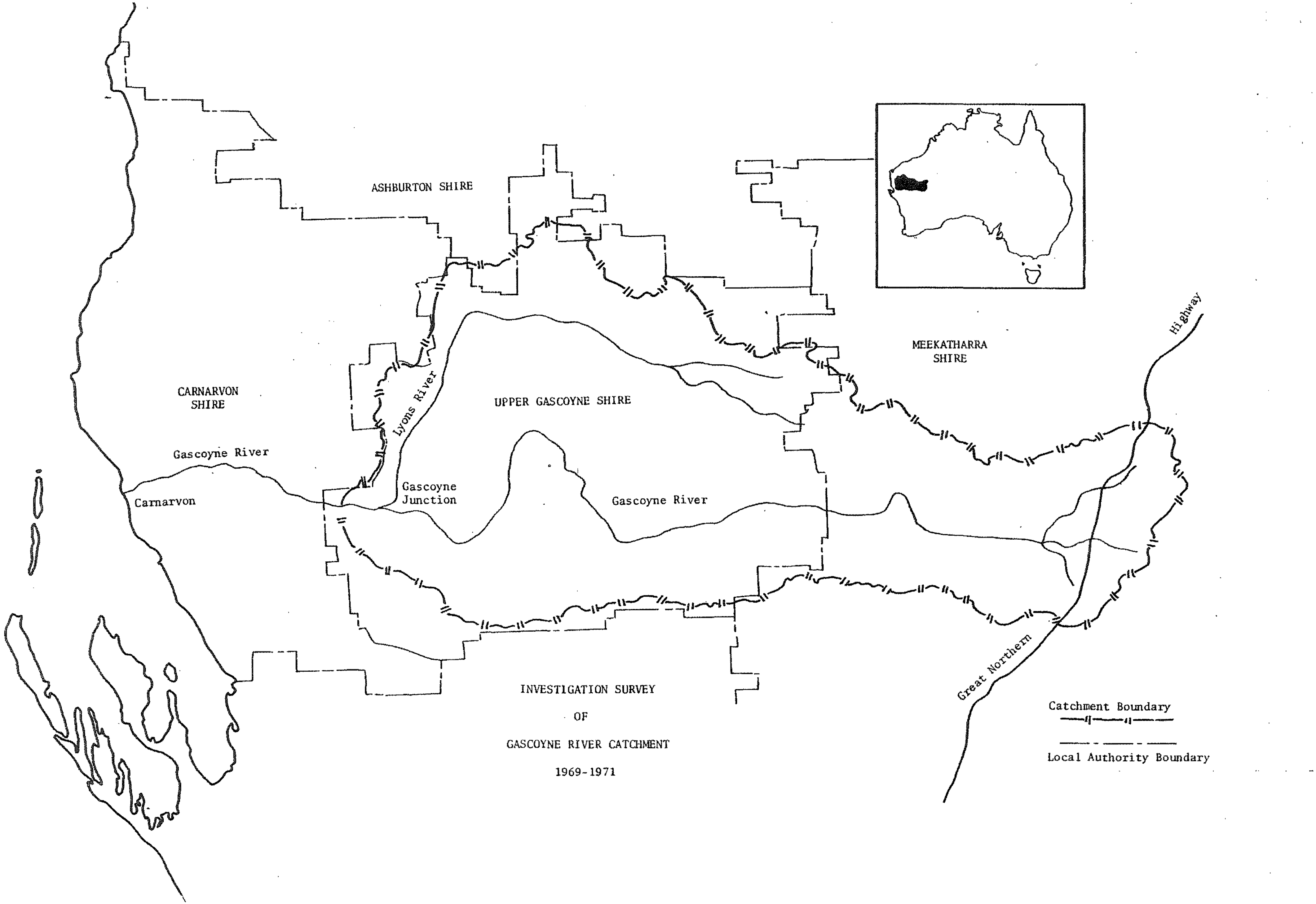
ASHBURTON SHIRE
MEEKATHARRA
SHIRE
CARNARVON
SHIRE
UPPER GASCOYNE SHIRE
Lyons River
Gascoyne River
Carnarvon
Gascoyne
Junction
Gascoyne River
Highway
Great Northern
INVESTIGATION SURVEY
OF
GASCOYNE RIVER CATCHMENT
1969-1971
Catchment Boundary
Local Authority Boundary

CONTENTS

Erratum: For Acacia holosericea read A. citrino-viridis

SECTION 1

Summary

1. Three thousand six hundred and thirty four (3 634) square miles of the Gascoyne catchment are badly eroded and will become irreversibly degraded unless they are removed from the available grazing area.

2. Twelve thousand eight hundred and three (12 803) square miles are degraded and have some erosion. They need careful use if they are not to degrade further.

3. Seven thousand nine hundred and forty-four (7 944) square miles are in an acceptable condition. This is mostly hill or stony short grass country

4. The eroded areas are those which have soils susceptible to erosion and are capable of supporting palatable and durable pastures. They receive frequent run-on water from areas upslope and they are readily accessible. These factors have led to their preferential use.

5. The above factors have combined with heavy overuse which, acting in conjunction with the undesirable effects of systems of continuous grazing, has produced the devastated areas. It is suggested that the current method of assessing Estimated Carrying Capacity (E.C.C.) does not take into account the special needs of pastures and should be modified. E.C.C's should be supported by factual information on grazing capacity. The drop in E.C.C. which has occurred in the past 25 years casts doubt on the value of these estimates if they are to be considered as real measures of the capacity of the State's rangelands to produce on a continuing basis.

6. It is suggested that a system of sheep unit capacities (S.U.C.) based on current quantitative data should be adopted to control use of supervised rangelands. Rangeland productivity under a range of conditions needs to be established for many rangeland types.

7. Continuous use of many rangelands should be avoided, particularly after severe droughts and in degraded and incipiently eroding pastures. This will require some supervision.

8. A reduction of stock numbers from 416 833 to 237 290 is recommended in order to prevent further erosion and to assist in rangeland rehabilitation.

INTRODUCTION

Severe flooding in Carnarvon followed heavy rains on the Gascoyne Catchment in February 1961. The flooding and erosion were extensive enough to suggest that run-off from the catchment was excessive. Lightfoot (1961)* reported that excess run-off was due to degradation of the catchment area. This report will describe the catchment area in terms of the degradation of its rangeland and its susceptibility to erosion.

An aerial reconnaissance was made by two officers of the Department of Agriculture in September 1961. A summary of the observations made was included in the Gascoyne River Erosion Committee report, Lightfoot *(op.cit.)*. The report suggested that steps should be taken to prevent further denudation and erosion of the catchment.

A second Gascoyne Catchment Erosion Committee appointed by the Pastoral Appraisement Board initiated a reconnaissance of the catchment by two photo-interpreters of the Department of Lands and Surveys and two Agricultural Advisers of the Department of Agriculture. Subsequent photo interpretation proved inadequate to describe the extent of nature of the erosion. The surface stripping and fine rilling common in many places could not be detected on the smallscale (1:40 000) photographs available and was in fact confused with natural run-off systems from hill slopes. It was subsequently found that erosion was frequently expressed by shallow terracing and stripping of the shallow soils of the alluvial plains. Such features of degradation are not readily visible on small scale photographs.

The Catchment Erosion Committee in June 1969, recommended that a joint survey team consisting of officers of the Departments of Agriculture and of Lands and Surveys be set up to investigate conditions on the catchment. This report is that of the joint team's work in the field in 1969 and 1970. It will describe the catchment in terms of its rangeland types and their susceptibility to erosion.

The land system or "rangeland type" approach adopted allowed a logical and sequential examination of all parts of each property. The occurrence of erosion and degradation in each rangeland type was thereby determined for each station. It was from an examination of the total records for each rangeland and for each station that the whole situation on the catchment was determined.

Recommendations on stocking rates and remedial treatments have been included for each of the rangeland types identified in the survey.

The influence of climate on erosion and on recovery is discussed The rangeland types have also been described in their respective geomorphological provinces. The pastures have been described as they fall into natural groupings. Recommendations for the grazing management of these pastures are given.

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*Lightfoot, L.C. (1961) Soil Erosion on the Gascoyne River Catchment Area. Report of the Gascoyne River Erosion Committee Mimeo W.A. Dept.Agric. pp 18 maps 2.

TECHNIQUE OF THE SURVEY

Apart from the very brief descriptions of the area in Jutson (1934), in the Maps of Australian Soils, Bettenay (1969) and in the Vegetation of Australia, Williams (1955) there was no information on the nature of the Gascoyne catchment. A number of early (1918-1922) plans of each pastoral property were available and these provided a superficial description of some of the pastures on the properties. However, the pastures on the stations covered in these reports could not be related to one another. The brief descriptions given could not adequately describe the structure of each property. As this survey was undertaken to describe erosion on the catchment, it was clear that it would be necessary to make formal descriptions of the land forms so that condition and erosion (if any) could be classified and compared in a logical way. The parts of the catchment could therefore be related to each other, and the areas of various land forms subject to erosion on each property could be designated according to size, degree of erosion, and range condition.

The procedures adopted were similar to those practised by the CSIRO Division of Land Research in surveys of land resources in Australia and New Guinea.

In this study, however, "rangeland types" replaced the concept of the land system as the base of mapping the catchment. Land systems are areas or groups of areas with a recurring pattern of land forms, soils and vegetation. Rangeland types are areas with recurring photo patterns of pastures and land forms in which the patterns caused by local geology and soil characteristics merge together and are often suppressed by the vegetation response. In rangeland types two or more distinct land systems may be united because of their similarity of vegetation expression. Or alternatively, large cohesive units of a land system may be described as separate rangeland types since they are large enough to be significant pastures on properties. As such, they are subject to distinct grazing pressures and to special conditions of erosion. In most instances, land systems and rangeland types are identical since the genetic influences of land formation impose by far the most outstanding pattern characteristics.

Photo-interpretation procedure

The initial interpretation of the aerial photograph cover using one mile scale mosaics, was made in August to October 1969 when three brief reconnaissance visits were made in order to familiarise the survey party with the catchment. At this time, a number of patterns were delineated, sufficient for the interpretation of the 1:40 000 scale photographs to be completed in the 1969-70 summer prior to the commencement of the field survey.

The survey occupied the period April to October 1970 when a team of Department of Agriculture and Lands Officers worked throughout the catchment area. During the survey, the aerial photographs were examined in the light of field experience and the boundaries of the rangeland types were altered according to the results of the field examination. The rangeland types were mapped subsequently onto the 1:40 000 photographs for later transfer to the 1:40 000 chronoflex compilation sheets which were available from previous mapping projects by the Lands Department. The finished 1:250 000 map sheets prepared by the survey team were assembled from the 1:40 000 chronoflex sheets.

The determination of ideal range condition

The rangeland types were established as reliable and repeatable mapping units by a series of precise observations at range evaluation sites ("query points"). A number of "query points" were marked on the photographs for each of the rangeland types already delineated. At each of the query points, information on landform, geology, soils, pastures, erosion and pasture condition was gathered.

The landform information notes included a brief description of the geology and of the various components of the landscape. The data included slope measurements, channel descriptions, relief and the type of strew. Soils data gathered embraced depth (to 36"), texture, pH, colour, surface conditions and strew. The vegetation data was gathered according to the method described by Christian and Perry (1953) in which three levels of trees, shrubs and ground flora are described in terms of species occurrence, with dominance indicated as well as height and density. Quantitative measurements of vegetation were made in a number of rangeland types using plotless methods developed for shrubs by Cooper (1963) and by using an adaptation of the Tidmarsh and Havenga (1955) wheeled transect marker. This detailed information was particularly valuable when it was derived from relic areas in good range condition. It allowed descriptions to be made of the optimum or climax condition. Each land system on the catchment could be ranked therefore in terms of its condition as it was encountered on each station, using the relic area as the guide to the optimum. It is not suggested here that climax conditions are always the most desirable in the range situation. However, the assumption was made that optimum range condition in an arid environment enjoying generally less than 8 inches (200 mm) of erratic annual rainfall is most commonly achieved close to the climax situation. Departures from the climax condition are, in nearly every case, associated with increased instability of landscape and lowered production. This need to aim at the climax or stable situation in management is emphasised by the approach to land use on the catchment where animals are confined in paddocks of at least 15 000 acres (6 000 ha) fenced without respect to vegetation boundaries. In this situation management of pastures in disclimax conditions is extremely difficult and mostly impossible. The measure then of deterioration or degradation of pastures on the catchment is the extent of the departure of a rangeland type from the climax, or if not climax, then the stable situation.

The above information provided the base for the decription and the mapping of the catchment into rangeland types. Later the total area of each rangeland was determined for the catchment and for each property. It then became possible from traverse data obtained on each station to define areas subject or resistant to erosion with accuracy as to location and to size.

Classification of range condition

The pasture and soils information gathered enabled the rangeland types to be placed into logical pasture groupings. These are described in the section of this report under pastures. It will be seen that the allocation into pasture groups was based upon concepts of durability or ephemerality, quantity of pasture available, palatability and frequency of availability. Studies on a great number of different pasture types have been undertaken by the Department of Agriculture. These studies, conducted for over 20 years, have embraced pastures in the stony short

short grass-forb, stony chenopod, mulga short grass-forb, chenopod, and wandarrie groups into which the pastures of the catchment fall. During the course of these studies it has been possible to define the various levels of pasture condition in terms of species frequency and distribution for each pasture group. In this survey, five levels of condition were established, each being large enough and sufficiently well defined to permit a particular pasture condition to be allocated to every rangeland evaluation site and traverse record site. The levels are shown in Table 1.

TABLE 1. PASTURE CONDITION CLASSES

Condition class	Pasture description
1	Pristine or original condition
2	Good condition, partly used, loss of some rare species
3	Vegetation degradation obvious, often reduction to unpalatable species or to ephemeral species - no erosion or very minor erosion
4	Vegetation degraded, with obvious wind and water erosion in parts
5	Vegetation degraded with major erosion, gullies and surface stripping over most of the area

Using this classification it was possible therefore to define areas of erosion hazard. While pastures in condition 3 are undesirable, these currently stable situations were not considered in the assessment of erosion on the catchment. Pastures in conditions 4 and 5 were eroded.

The potential of rangeland types

The potential of the rangeland was also assessed at each query point. The criteria of accessibility, durability, palatability and availability were used. Five site potential recording levels were described for the catchment. They are shown in Table 2.

TABLE 2. Rangeland potential

Potential class	
1	Palatable durable pastures, principally shrubby types with associated ephemeral species, e.g. saltbush plains
2	Palatable, partly durable pastures, with some drought evading perennials, associated valuable ephemerals, e.g. wandarrie grass pastures
3	Shrubby pastures of mixed acceptability and palatability, with abundant ephemeral ground species in season, e.g. non saline alluvial plains.
4	Scattered shrubby pastures of mixed acceptability and palatability, sparse ephemeral ground species, e.g. rocky slopes.
5	Pastures of low palatability, inaccessible and of low productivity, e.g. spinifex (*Triodia basedowii*) or mountain summits

Pasture condition and potential values were assigned to each of the rangeland evaluation sites visited.

The classification of erosion

Erosion was described at each evaluation or query site in terms of the amount of wind and water erosion present. The classifications for each site are shown in Table 3. The descriptions were clear enough to allow erosion, if any was present, to be assigned with confidence to the particular class.

TABLE 3. Classification of wind and water erosion

Erosion class	Description of site conditions	Erosion class	Description of site conditions
0	None	0	None
1	Slight surface sheeting or minor scalding	1	Sealing of the surface
2	Minor surface redistribution, small accumulations	2	Minor rilling of the soil surface in places but no deep gullies
3	Hummocking of sand beneath shrubs or into small banks	3	Surface stripping on even slopes in a terrace-like fashion
4	Major drift, and dune activation	4	Erosion gullies, on the lower slopes only
		5	Erosion gullies, on lower and upper slopes

The statements for each query site thus recorded the landform, soils, vegetation present, erosion, condition and potential. Over the whole catchment they provided a picture of the range of conditions found in every rangeland type.

The precise position of each of the query points was marked on the 1:40 000 aerial photographs and at many of these ground photographs were taken. A number of them are shown in the accompanying plates. The ground data and photographs taken at these precisely located query points could provide a most useful base for evaluating future trends in condition on the catchment.

Traverse information

The query point data assembled, together with the prior knowledge of the ideal condition of each rangeland accumulated from the ecological information available, provided the base data for the evaluation of range condition and erosion in each of the rangelands on each station. This precise information was gathered at the 280 range evaluation sites.

Information on erosion and range condition was also obtained on over 3 000 miles of vehicle traverse on the catchment. Traverse routes were plotted on the marked 1:40 000 aerial photographs. On each station traverses were made over all rangeland types and in as many

distinct locations on each station as possible. Recordings of wind and water erosion, condition and capability were made of each rangeland type traversed, as it was entered, and left, and at each mile within the type. In this way, 2426 recordings of catchment condition were made on 51 rangeland types. The standards used were those adopted for the rangeland evaluation sites. The field traverse record is shown on the accompanying maps.

The recordings were always made by two experienced observers to eliminate bias. This role was always assumed by those concerned with research into the pastures of the area.

The information was coded for a computer programme devised by Miss H. Nicol of the Department of Agriculture for the PDP-6 computer at the University of Western Australia.

The computer programme print out provided a breakdown of the traverse record in terms of:-

(a) the condition of each rangeland on each station

(b) the condition of each rangeland on the catchment

(c) the condition of the catchment as a whole

and

(d) the relationship of condition and potential (capability) to wind and water erosion in a series of two by two tables for each station and for the whole catchment

Station erosion assessment

The traverse information together with the query point data and field notes enabled a picture of erosion conditions on stations and on the whole catchment to be assembled. For each station information on the condition of each rangeland type was available from the print out of the computer programme. Rach rangeland type therefore was able to be ranked according to its erosion status and its condition. These statements were later modified on the plan of each station where the traverse data indicated a departure from the general view. Examples of the print out are shown in Table 4 where part of the results for a particular station on the catchment are shown.

TABLE 4. Typical station computer print out

Land system Three Rivers

Rating	Wind No.	Per cent	Rating	Water No.	Per cent	Rating	Condition No.	Per cent	Rating	Capability No.	Per cent
LE 0	4	12.9	LE 0	2	6.5	LE 1	0	0	1	0	0
1	12	38.7	1	25	80.6	2	7	22.6	2	4	12.7
2	13	41.9	2	1	3.2	3	16	51.6	3	25	80.6
3	2	6.5	3	2	6.5	4	7	22.6	4	2	6.5
4	0	0	4	1	3.2	5	1	3.2	5	0	0
			5	0	0.0						
Total	31			31			31			31	

Land system - Warrie

0	2	12.5	0	4	25.0	1	0	0	1	0	0
1	7	43.8	1	6	37.5	2	0	0	2	10	62.5
2	6	37.5	2	3	18.8	3	5	31.3	3	6	37.5
3	1	6.3	3	1	6.3	4	9	58.3	4	0	0
4	0	0	4	2	12.5	5	2	12.5	5	0	0
			5	0	0						
Total	16			16			16			16	

TABLE 4 (Cont'd)
Land system - Jingle

Rating	Wind No.	Per cent	Rating	Water No.	Per cent	Rating	Condition No.	Per cent	Rating	Capability No.	Per cent
0	0	0	0	0	0	1	0	0	1	0	0
1	1	50	1	2	100	2	0	0	2	0	0
2	1	50	2	0	0	3	1	50	3	2	100
3	0	0	3	0	0	4	1	50	4	0	0
4	0	0	4	0	0	5	0	0	5	0	0
			5	0	0						
Total	2			2			2			2	

Land system - Landor

0	0	0	0	1	0	1	0	0	1	0	0
1	0	0	1	1	100	2	0	0	2	1	100
2	1	100	2	0	0	3	0	0	3	0	0
3	0	0	3	0	0	4	1	100	4	0	0
4	0	0	4	0	0	5	0	0	5	0	0
	1		5	0	0		1				
Total	1			2			1			1	

Land system - Gascoyne

Rating	Wind No.	Per cent	Rating	Water No.	Per cent	Rating	Condition No.	Per cent	Rating	Capability	Per cent
0	1	33	0	1	33	1	0	0	1	0	0
1	0	0	1	1	33	2	1	25	2	2	50
2	2	66	2	1	33	3	3	75	3	2	50
3	0	0	3	0	0	4	0	0	4	0	0
4	0	0	4	0	0	5	0	0	5	0	0
			5	0	0						
Total	3			3			4			4	

Land system - Divide

0	0	0	0	1	50	1	0	0	1	0	0
1	1	50	1	1	50	2	0	0	2	1	50
2	1	50	2	0	0	3	1	50	3	1	50
3	0	0	3	0	0	4	1	50	4	0	0
4	0	0	4	0	0	5	0	0	5	0	0
			5	0	0						
Total	2			2			2			2	

TABLE 4 (Cont'd)

Land system - Augustus

Rating	Wind No.	Per cent	Rating	Water No.	Per cent	Rating	Condition No.	Per cent	Rating	Capability No.	Per cent
0	2	100	0	2	100	1	0	0	1	0	0
1	0	0	1	0	0	2	1	50	2	0	0
2	0	0	2	0	0	3	1	50	3	1	50
3	0	0	3	0	0	4	0	0	4	1	50
4	0	0	4	0	0	5	0	0	5	0	0
			5	0	0						
Total	2			2			2			2	

Land system - Sugarloaf

0	6	27.3	0	8	36.4	1	0	0	1	1	4.5
1	5	22.7	1	10	45.5	2	3	13.6	2	13	59.1
2	11	50.0	2	0	0	3	6	27.3	3	5	22.7
3	0	0	3	2	9.1	4	13	59.1	4	3	13.6
4	0	0	4	2	9.1	5	0	0	5	0	0
			5	0	0						
Total	22			22			22			22	

The survey team attempted to traverse every part of the catchment that was in any way accessible. The traverse routes can be seen on the accompanying maps as these are identified by the traverse record symbols, but some of the hill or stony short grass-forb pasture groups were omitted since they could not be visited by vehicle. However, the records clearly show that these pasture groups are not subject to erosion and could not have contributed to the statement of erosion, whereas the lower rangelands are eroded and degraded and are of concern.

A number of conventions were used to partition the erosion data recorded into three categories of condition, viz. acceptable, supervised and remedial condition.

1. Acceptable rangeland condition falls into those erosion classes of (a) neither wind nor water erosion, or (b) erosion to sealing or sheeting with vegetation deterioration to the unpalatable or ephemeral state. The hill pasture group and stony, short grass-forb pasture group are nearly always in the acceptable condition.

2. Supervised rangeland condition is that in which vegetation deterioration to ephemerals or to unpalatable species is associated with minor surface redistribution by wind or with minor guttering of the surface. Wandarrie pasture groups frequently fall into this category.

3. Remedial rangeland condition is that in which there is pasture deterioration often associated with a major reduction in total plant cover, particularly of perennial shrubs, and with hummocking or drift, guttering, surface stripping or terracing, or with gullying on the slopes. Rangelands in this condition are frequently found in the stony chenopod, chenopod and mulga short grass-forb groupings.

These three classes of range condition were broad enough to be readily distinguishable from the data. The "remedial condition" rangelands had extensive areas of erosion and were thus easily classified into this category. The two former classifications covered a much wider range of expressions of range condition.

Traverse records, range evaluation site information and field notes show that on the property given in Table 4 Sugarloaf and Warrie rangelands were degraded and eroded. The traverse record indicated that an area of Warrie in the east was not badly affected by erosion. Twenty square miles were therefore placed in the supervised use category. No such partition was made of Sugarloaf since the record showed a complex mosaic of erosion and non-eroded areas on this rangeland. It was therefore all placed in the remedial use category.

Augustus, Mulgul, Diorite, George and Collier rangelands were in an acceptable condition. These resistant rangelands with the predominately rocky surfaces of bare rock on heavy cobble and pebble screes and mantles are infrequently grazed by stock and have an inherent resistance to erosion. The remaining rangelands were placed in a supervised use category indicating the presence of patches of slightly eroded country associated with vegetation degradation. These rangelands are accessible to grazing animals and are prone to erosion with overuse. Care in the management of these is essential if they are to remain stable.

Summaries of range condition and erosion status are given for each station in this report. These summaries also show the recommended stocking rate for each station where the areas of remedial condition rangeland are withdrawn from use.

Rangeland type erosion status

The computer sorting of the data also allowed estimates of erosion status and range condition to be established for each of the rangeland types. Tables for these and the discussion are included in the section of the report which deals with rangeland type descriptions.

The determination of sheep unit capacity for stations on the catchment

The widely fluctuating stock numbers (Table 1 Section 4) and the gross deterioration of the catchment indicate that the pastures are being used beyond their capability to produce on a continuous basis and that the condition of the resource base is being lowered, rather than maintained. Estimates of carrying capacity which have been made in the past are clearly inadequate and should be replaced by values appropriate to the potential of the pasture to produce.

Survey procedures delineated the areas on each property which were eroded and which should not be stocked. It was then possible to measure the remaining rangelands and to allot them to their respective pasture groupings. Using information from investigations being undertaken in the area it was possible to propose certain productivity levels for each class of pasture on the catchment. Table 5 summarises the results of a number of production measurements made in various pasture groups.

TABLE 5. Dry matter production (lbs-per acre) in various pasture types in successive years

	Shrub component	Ground production	Total
Chenopod pastures (Yalgoo Western Australia)	500	10	510
	275	7.5	282.5
	102	* 0.5	102.5
	127	0.4	127.4
	35	Nil	35.0
	84	Nil	84.0
	209	n.a	209+
Mulga short grass-forb (Wiluna Western Australia)	*Acacia aneura*	70	70
	A. terragonophylla	30	30
	and		
	A. craspedocarpa	20	20
	inaccessible and	750	750
	unpalatable	Nil	-
		* 100	100
Stony chenopod Gascoyne Catchment		* 100	
		20	
		203	
Stony short grass-forb Meekatharra Western Australia	Pasture reduced	10	10
	to unpalatable		
	Eremophila spp.	120	120
	to acceptable shrubs	20	20
		* 25	25
		90	90
Perennial grass (wandarrie) Meekatharra	6.7	* 96.0	102.7
	28.5	16.5	45.0
Stony chenopod Meekatharra	6.0	14.3	20.3
	40.6	8.0	48.6
	(poor pastures)		
Mulga short grass-forb Meekatharra	9.9	Nil	9.9
	31.4	* 4.8	36.2
	(poor pastures)		

* Most commonly expected rainfall year.

These levels of production take account of all the material available. In U.S.A, W.R. Chapline (priv. comm.) reports that use of 50 per cent of the annual production is permitted on most rangelands. More sophisticated systems of use have been developed in some instances, but the guide line of fifty per cent use usually ensures the maintenance of productivity levels.

Adopting this level of use Table 6 shows stocking rates and production relationships used to determine sheep unit capacities. The table is based on an annual requirement by adult sheep for 1 000 pounds of dry matter per annum.

TABLE 6. Relationships between production and sheep stocking rates

Production pounds per acre	Stocking rate at 50 per cent usage acres per sheep
10	200
20	100
30	60
50	40
100	20

The modal or most commonly expected rainfall year is indicated in Table 5. Using the production thus shown as the most commonly expected, Table 7 shows the acceptable stocking rates for each rangeland type on the catchment in terms of sheep per square mile and acres per sheep. Cattle maybe converted at the rate of one beast being equivalent to five sheep. Although such conversions do not agree with feeding trials, the legal conversion in the Land Act is at this rate. Information from the rangeland type descriptions was used to vary some rangelands potential away from the bulk of those in any particular group.

The planimetered areas of each rangeland on each station, not including the eroded areas, were used in combination with the appropriate stocking rate in Table 7 to determine the recommended rate for each property. This is the sheep unit capacity for that property and is given in the station descriptions in Section 5 and in the summary table attached to Section 4.

TABLE 7. Showing stocking rates for specific pastures groups and rangeland types

Pasture group	Rangeland type	Sheep per square mile	Acres per sheep
Hills	Peak Hill	6	100
	Agamemnon	6	100
	Augustus	6	100
	Glenburgh	6	100
	Diorite	6	100
	Mulgul	6	100
	Pells	10	60
	Moogooloo	10	60
	Fossil	12	50
Stony short grass-forb	Beasley	10	60
	Phillips	10	60
	Collier	10	60
	George	10	60
	James	10	60
	Two Hills	10	60
	Thomas	10	60
	Jamindie	6	100
	Mabbutt	6	100
Stony chenopod	Woodlands	16	40
	Sandiman	16	40
	Horseshoe	16	40
	Durlacher	16	40
	Bryah	16	40
	Yinnietharra	16	40
	Sugarloaf	16	40
	Kurubuka	16	40
	Nadarra	16	40
	Mantle	16	40
	Jimba	32	20
	Wooramel	32	20
Chenopod	Warri	16	40
	Peedawarra	21	30
	Jingle	21	30
	Biblingunna	32	20
Wandarrie	All types	16	40
Mulga short grass-forbs	All except	10	60
	Macadam	6	100
Sanddune halophyte	Bidgemia	32	20
	Lyons	16	40
Sandplain	Divide	6	100
	Yalbalgo	16	40
River	Gascoyne	16	40

BIBLIOGRAPHY

Bettenay E. *et. al.* 1969. Atlas of Australian Soils. CSIRO Canberra.

Christian C.S. and Perry R.A. 1953. The systematic description of plant communities by the use of symbols. J.Ecol. 41.1.

Cooper C.F. 1963. An evaluation of variable plot sampling in shrub and herbaceous vegetation. Ecol. 44 : 565-9.

Jutson J.T. 1934. The Physiography (geomorphology) of Western Australia. 2nd. Ed. Geol.Surv. W.Aust. Bull.No.95.

Tidmarsh C.E.M. and Havenga C.M. 1955. The wheel point method of survey and measurement of semi-open grasslands and Karoo vegetation in South Africa. Mem.29 Bot. Surv. S.Afr. pp 53. bibl.11, illus.18 graphs.

Williams R. 1955. Vegetation Regions. Atlas of Australian Resources. Dept. of Nat. Dev. Canberra.

EROSION ON THE GASCOYNE CATCHMENT

Erosion and degradation has accompanied the use of the semi-arid and arid areas of the world. The Imperial Agricultural Bureau (1947) reported as follows:- the picture over a greater part of these very large areas, particularly in a semi-arid climate is generally one of gross overstocking with a resultant deterioration in the vegetation cover and a serious reduction in the capacity of the vegetation to play its primary role, the conservation of soil against water and wind erosion.

The situation in Australia is, in general terms, little different from that expressed for arid areas everywhere. The Royal Commission into the Pastoral Areas of New South Wales of 1901 showed that erosion and pasture deterioration had occurred due in part to overstocking, spread of non-edible shrubs, low rainfall and vegetation destruction in drought areas. The Royal Commission demonstrated a decline in stock numbers since settlement attributable to the deterioration of the base resource. Heathcote (1964) has also referred to the decline in the total pastoral resource since the settlement of Australia's semi-arid and arid land. He makes the point that while the problem of stock water supplies have been solved, the fluctuations of stock feed have not been met by an industry which still relies entirely upon natural vegetation. Thus, while more land has been made available to grazing by stock through the provision of more water supplies, fewer sheep are in fact being carried and productivity per unit area has declined due to the inability of the native pasture to continue production at the levels demanded of it.

Ratcliffe (1937) working in the north-east of South Australia noted that "stocking as practised in Australia must inevitably result in the progressive reduction of the slow-growing ever-green fodder plants". Chippendale (1965) reports similar situations following stocking in the Northern Territory where he notes that explorers plant collections reflect country in much better condition in the past than it is today. Chippendale (*ibid*) also points out that the desirable species in pastures in Central Australia have been reduced under stocking.

In Western Australia, Brockway (1959) has drawn attention to the serious deterioration in mulga (*Acacia aneura*) stands which took place during his 33 years of observation, a process which was still continuing. He demonstrated a progressive site deterioration under stocking caused by a loss of root material from annual species which are reduced, a loss of litter, loss of prime surface soil conditions leading to scalding and a destruction of the seed bed and eventually to a lack of volunteer species. Brockway also pointed out that the lack of regeneration which accompanied the deterioration of soil conditions could be attributed to a failure in germination and establishment. Thus any degradation in seed bed conditions will be associated eventually with a reduction in surface cover and eventually with increased erosion.

Although Fyfe (1940) had the impression (*sic.*) that in only a few localities had soil erosion permanently reduced the carrying capacity over extensive areas, he did report on the shifting of the surface soil on many stations, the increase in the size of scalds and the ridges of sand created by wind. These would be signs of erosion which were current but which could be remedied by the application of proper grazing

TABLE 1. Showing sheep numbers and sheep units on a station and on the Catchment respectively.

Station Year	Sheep numbers	Catchment Total sheep units	
1934	92 000	625 440	
1935	79 000	615 663	
1936	20 000	331 771	*
1937	33 312	168 934	*
1938	19 000	215 637	
1939	17 000	206 354	*
1940	12 000	160 429	*
1941	10 606	137 159	*
1942	No shearing	155 108	
1943	15 546	189 042	
1944	12 351	221 634	*
1945	12 395	193 528	*
1946	n.a	231 269	
1947	16 000	272 942	
1948	21 000	278 053	
1949	21 500	383 321	
1950	30 000	437 038	
1951	30 000	384 358	
1952	35 000	347 629	
1953	40 765	361 151	
1954	41 891	361 791	
1955	39 796	336 794	
1956	35 909	298 256	*
1957	20 906	219 606	*
1958	18 912	205 316	
1959	24 800	241 123	
1960	31 852	263 813	
1961	29 998	277 559	
1962	33 334	312 745	
1963	41 650	330 025	
1964	38 793	362 042	
1965	40 712	370 749	
1966	45 193	387 744	
1967	42 332	397 096	
1968	39 707	397 111	
1969	44 044	429 308	

* = low rainfall years.

practises. Fyfe also reported that overstocking was common in the pastoral areas with consequent heavy damage and stock losses.

The evidence therefore shows that rangeland deterioration is common and that Western Australia is in no way different to the rest of Australia in that its pastoral resources have been gravely depleted. The measure of the effect of depletion is the change in carrying capacity which has taken place during the period in which the area has been settled. Table 1 shows the pattern in sheep units on the Gascoyne Catchment and the sheep numbers on a particular station on the Catchment.

Earlier records show a climb to the high numbers of 1934 and that these were maintained for a number of years prior to this date. It should be noted that in this period there were fewer water supplies than now on leases and that many properties have been fully developed in this respect since World War 2.

Table 1 shows the fluctuations in numbers at both the station and the catchment level notwithstanding the increased grazing range. Climatic crises in the years indicated caused marked drops in the numbers of animals supported thus emphasising the dependence of the area upon annual feed and suggesting a loss of perennial components in the pasture. The generally wet sixties were associated with increases in stock numbers similar to those found in the Eastern Goldfields and in other parts of the pastoral areas.

These great fluctuations in stock numbers show that the catchment rangelands are being exploited for maximum production since variations in rainfall have an immediate effect on stock carried.

A stable industry has not developed since use patterns have been without reference to the conservation of vegetation and soil and have instead led to the deterioration of both these assets. The present and past systems of use have demanded the utilisation of all available vegetation to the exclusion of the needs of the pastures for maintenance or of the landscape for stability.

Various estimates have of course been made of the capacity of stations on the Gascoyne to support stock. Table 2 shows the estimates of carrying capacity made for six stations on the catchment in 1920 and 1965 and the sheep unit capacity derived for the station on the basis of information available from experimental work and described elsewhere.

TABLE 2. Changes in estimated carrying capacity for six stations (acres per sheep)

Station	1920	1965	S.U.C
A	20	40	75
B	23	33	61
C	15	30	50
D	14	40	52
E	20	35	56
F	16	33	54

(S.U.C. - sheep unit capacity)

In five cases the estimates of carrying capacity used in 1965 are about half or less than those made in 1920. Changes in the estimates show that the original levels were set too high and must have involved overuse in the earlier years of settlement. The sheep unit capacity levels show further departures so that the expected productivity of these leases is in fact only one-third of that originally estimated using subjective judgment. Grazing at the higher levels has resulted in overuse of pasture and a deterioration in their condition.

Marshall (1970) has emphasised the importance of maintaining adequate shrub cover in the arid environment since it is these that reduce the erosive effects of wind which is the principal eroding force. Unchecked wind continually causes landscape deterioration since it results in surface deflation, abrasion of the surface and destruction of existing vegetation through sandblasting. The erosive effects of water and the importance of maintaining a protective cover are known in almost every environment. Any consideration of erosion on the catchment must therefore include not only a description of the obvious signs of erosion such as hummocking or gullying, but it should include an appreciation of the extent of pasture retrogression since in some cases this is the associate and precursor of the overt signs of soil erosion.

Location of erosion on the catchment

Table 3 lists the eroded rangeland types as found on the survey according to their pasture groupings.

TABLE 3. Eroded Pasture groups and rangeland types

Pasture group	Rangeland type	Total area sq.m	Area eroded sq.m	Percentage area eroded
Hill	Moogooloo	196	13	6
Stony S.G.F	Thomas	1 036	30	3
	Phillips	3 000	104	3
	James	651	116	18
Stony chenopod	Sugarloaf	121	53	44
	Wooramel	196	40	20
	Jimba	718	461	64
	Sandiman	479	77	16
	Durlacher	1 937	617	33
	Yinnietharra	306	147	48
	Bryah	290	75	24
	Nadarra	362	27	7
Chenopod	Jingle	81	49	60
	Warri	587	237	40
	Peedawarra	67	40	60
Wandarrie	Doolgunna	36	6	16
	Winmar	351	36	10
	Blech	44	42	95
Mulga S.G.F	Three Rivers	1 739	1 076	62
	Frederick	554	76	14
	Clere	46	30	65
Sanddune halophyte	Bidgemia	438	235	53
	Lyons	200	47	23

The total area of each eroded rangeland type is shown and the percentage of this eroded is also shown for each type. Gascoyne rangeland type is included in the uneroded systems since it was difficult to determine whether the changes in condition were merely temporal ones caused by flash flooding or long term changes caused by overuse and degradation.

Table 4 shows the wind and water erosion and condition statement gained from all the traverse information.

TABLE 4. Summary table of erosion and range condition

Wind erosion		Water erosion		Condition	
Rating	Percent	Rating	Percent	Rating	Percent
0	27.0	0	35.7	1	0.5
1	26.4	1	30.7	2	5.8
2	38.5	2	12.6	3	65.0
3	7.7	3	11.4	4	26.8
4	0.4	4	9.4	5	1.9
		5	0.2		

Serious wind erosion occurred on 8.1 percent of locations and a serious water erosion problem existed on 21 percent of the locations. Range degradation associated with serious erosion problems existed on 28.7 percent of the sites visited on the survey.

Over three quarters of the erosion on the catchment can be ascribed to six rangeland types. These are Three Rivers, 30 percent of the eroded area, Durlacher and Yinnietharra, 21 percent, Jimba 13 percent, Bidgemia 7 percent and Warri 6 percent of the eroded area. The remaining rangelands contribute only marginally and on specific stations only to the erosional problem.

All twenty three rangelands are readily accessible, have palatable pastures and in most instances receive run-on water from areas up slope. They would be therefore preferentially grazed by stock and at heavy rates particularly where they are surounded by less attractive rangelands.

A substantial proportion of Jimba and Bidgemia rangeland types are eroded and degraded, indicating both overuse and a susceptibility to erosion. Mantle rangeland type is the sole accessible Permian Basin rangeland with little or no erosion thus illustrating the susceptibility of this province to the effects of overuse. The rangeland type descriptions in section 9 show how the characteristics of the component types of the province have assisted in the development of erosion. Plate 29 shows the type of erosional pattern found in Jimba rangeland type where guttering and gully head movement up slope is unimpeded by vegetation and aided by the high'· alkaline clay soils common in this rangeland.

Some of the more spectacular forms of erosion on the catchment are found in Three Rivers rangeland where 62 percent is indicated as being eroded. Plate 29 shows a typical erosional pattern developed on the alluvial tributary drainage. The trunk drainage may be seen on the upper right of the photograph. The gully head systems can be seen advancing on a wide front up the alluvial drainage plain which forms

the major component of these rangelands. These flat accessible areas have been overused to the extent that the vegetation has been removed and water flow increased. These unprotected surfaces carrying broad diffuse flow should have cover similar to that found on Plate 9 where no erosion was found.

Erosion is a current process on the catchment as the twin photographs in Plate 30 demonstrate. This area on the Wooramel 4-mile sheet was photographed in 1952 and again in 1964. The gully heads have advanced markedly up slope, whole new series of gullies have been formed, the creekline shows greater incision, has a wider bed and there is more vegetation on its margins. This is an area of Permian based Jimba land system and emphasises once more the vulnerability of these areas to erosion. Similar paired photographs showing current erosion can be found in the Three Rivers rangeland types on the eastern part of the catchment.

Treatment of erosion on the catchment

Three classes of country have been described in this report. The acceptable rangelands present no problem as has been described. The supervised use rangelands and remedial use rangelands described in Section 3 and delineated with respect to stations in Section 5 require special explanation.

(a) Supervised use rangelands

The figures quoted in Table 1 show that maximum stocking levels have always been maintained on the catchment and Table 2 shows that these figures have been constantly declining as the rangeland condition deteriorates. Supervised use rangelands are those in which some erosion exists, but in general have only degraded pastures. A potential erosion problem does exist, however, unless grazing management schemes commensurate with the maintenance of the resource are adopted.

Dyksterhuis (1949) has defined proper use as the degree of grazing which will allow the more desirable forage plants to maintain their stand and vigour and thereby prevent undue run off and erosion. He suggests that there are four factors entailed in the harmonious manipulation of rangelands for grazing use. These are:-

1. Proper numbers of livestock
2. Proper class and kind of livestock
3. Proper season and sequence of use
4. Proper distribution of livestock.

On the Gascoyne Catchment with the level of development available and with the extensive system of grazing practised, it is possible only to attend to the numbers as the major method of maintaining the resource base.

The recommendations for stocking rates calculated according to the method outlined in Section 3 and apportioned according to individual stations in Section 5 apply to those areas of acceptable and supervised use rangelands and should allow for continued use of these pastures. But it will be necessary for management to adopt the rangeland management practices recommended by the Department of Agriculture involving spelling for the rejuvenation of the stand if the resource is not to deteriorate. Such treatments are of special significance after droughts.

It is not possible to graze any pasture at a level which will minimise disturbance to all the component species. The aim is rather to adjust numbers to a level at which the stability of the pasture can be maintained. It is worth noting that the reduction of numbers to 237 290 is not substantially different from the carrying capacity of the catchment from 1936 to 1969 which was 290 000.

(b) Remedial use rangelands

The 3 634 square miles of eroded and degraded rangelands occur as a mosaic across the catchment. Clearly though they are concentrated in the Permian Basin and on the Eastern Tributary plains. The destruction of the soil surface conditions, the removal of vegetation and the current active erosion makes these areas highly unstable and of high erosion hazard. The complete exclusion of stock from these areas is recommended as the only effective means of achieving recovery. The process will in many cases be extremely slow since it will proceed through a number of seral stages. Grazing in the early seral stages of recovery is likely to impede regeneration and should not be attempted. When recovery is sufficiently advanced so that stability is guaranteed then grazing could be permitted provided that the pastoralist uses discretion and does not remove all available feed. Young volunteer plants are particularly vulnerable in the early stages of growth and could easily be removed by stock.

Recovery of active gully head and terrace erosion will be an extremely slow process in this environment unless aided by a sequence of above rainfall years. Under a normal rainfall pattern recovery towards stability will be a gradual and fitful process.

Fencing of eroded rangelands may be feasible in some instances. In others, however, the existing fencing for sheep will be adequate. On the cattle stations fencing is required with extra water supply points. Active erosion along the tributary plains of the trunk drainages on the cattle stations can only be arrested if this fencing is erected.

A programme of reduced numbers and exclusion of stock from specified areas will halt the erosion process and restore the productivity of the Catchment. In particular it should reduce the violent fluctuations in stock numbers so common on the Catchment. Haskell (1945) reports the recovery of arid American range through stock reductions following its heavy use. Similar improvements should occur in the Gascoyne Catchment.

BIBLIOGRAPHY

Brockway G.E. 1959. Grazing effects on shrub and tree growth of arid and semi-arid regions of Western Australia. A.N.Z.A.A.S Proc. 34th meeting Perth. 1959.

Chippendale G.M. 1963. Pasture deterioration in Central Australia. J. Aust. Inst. Agric. Sci. 29 : 84-89.

Chippendale G.M. 1965. Problems of pastoral land use in Central Australia Agros 1965. pp4.

Dyksterhuis F.J. 1949. Condition and management of rangeland based on quantitative ecology. J. Range Managt. 2(3) : 104-105.

Fyfe W.V. 1940. Report of the Royal Commission to inquire into and report upon the Financial and Economic Position of the Pastoral Industry in the Leasehold Areas in Western Australia. Govt. Printer. Perth; 1940.

Haskell Horace S. 1945. Successional trends on a conservatively grazed desert grassland range. J. Amer. Soc. Agron. 37 : 978-90.

Heathcote R.L. 1964. Assessment of Pastoral Resources in semi-arid Australia in "Advancement in Science". May 1964 pp47-60.

Imperial Agricultural Bureau Joint Publication No.10. 1947 - The use and misuse of shrubs and trees as fodder.

Marshall J.K. 1970. Assessing the protective role of shrub - dominated rangeland vegetation against soil erosion by wind. Int. Grass. Conf. Proc. 1970. Surfers Paradise Australia pp19-23.

Ratcliffe F. 1937. Further observations on Soil Erosion and Sand Drift. CSIR Australia Pamph. 79.

SUMMARY OF MAJOR PROPERTIES

NAME	AREA SQUARE MILES	PRESENT E.C.C.	CURRENT STOCK NUMBERS (SHEEP UNITS) 1972	RECOMMENDED AREA FOR GRAZING SQUARE MILES	S.U.C	AREA RECOMMENDED FOR EXCLUSION SQUARE MILES	COMMENTS
Bidgemia	1 625 976 210 ac.	60 013 1:16	46 150	1 201	19 965	423	(a) Gross erosion and degradation on south and west (b) Great increase in invading shrubs (c) Recommend change in E.C.C.
Bryah	531 332 411 ac.	8 523 1:39	5 125	359	4 350	172	
Cobra	487 295 898 ac.	7 397 1:40	4 112	487	5 000	Nil	
Coordewandy	236 149 929 ac.	6 519 1:23	5 525	196	2 270	40	Very large gullies.
Dairy Creek	679 408 434 ac.	12 377 1:33	11 100	570	10 100	109	Very heavy past use.
Dalgety Downs	930 572 897 ac.	26 040 1:22	18 920	873	8 720	57	Over-use of better pastures has led to severe erosion on 57 square miles.
Doolgunna	718 467 708 ac	8 504 1:55	4 749	262 on catchment	3 260 on catchment	66 on catchment	Not all on catchment.

NAME	AREA SQUARE MILES	PRESENT E.C.C.	CURRENT STOCK NUMBERS (SHEEP UNITS) 1972	RECOMMENDED AREA FOR GRAZING SQUARE MILES	S.U.C	AREA RECOMMENDED FOR EXCLUSION SQUARE MILES	COMMENTS
Edmund	344 220 000 ac.	7 857 1:28	4 225	330 on catchment	3 000 on catchment	Nil	Recommend change in E.C.C. Very little erosion.
Errabiddy	304 194 301 ac.	5 113 1:38	7 149	202 on catchment	2 600 on catchment	25	
Eudamullah	1 011 642 050 ac.	26 752 1:24	15 588	914	9 900	97	
Gifford Creek	946 598 901 ac.	18 148 1:33	12 620	829	9 162	117	Fence northern half.
Glenburgh	374 239 114 ac.	7 970 1:30	8 471	312	3 050	62	Run in conjunction with Coordewandy .
Jimba Jimba	620 372 475 ac.	12 845 1:29	17 620	444	8 435	176	Overstocked at present.
Kumarina	814 520 960 ac.	16 280 1:32	1 350	715 on catchment	4 518 on catchment	Nil	Partly used at present. Should be fenced.
Landor	1 413 855 203 ac.	31 674	31 928	1 288	18 650	125	Eroded mostly on south. Overstocked at present.
Lyons River	584 360 300 ac.	15 665 1:23	14 300	526	8 850	58	Very bad erosion.

NAME	AREA SQUARE MILES	PRESENT E.C.C.	CURRENT STOCK NUMBERS (SHEEP UNITS) 1972	RECOMMENDED AREA FOR GRAZING SQUARE MILES	S.U.C.	AREA RECOMMENDED FOR EXCLUSION SQUARE MILES	COMMENTS
Mangaroon	389 249 075 ac.	11 321 1:22	11 978	237 on catchment	2 500 on catchment	56	Overstocked at present
Milgun	1 164 744 855 ac.	21 281 1:35	21 200	707	7 660	497	Great degradation on plains. Area includes stock routes
Mingah Springs	791 506 167 ac.	13 680 1:37	2 615	736 on catchment	5 600 on catchment	5	Recommend change in E.C.C. Property only partly used. Stock should be better distributed
Minnie Creek	833 509 330 ac.	17 666	24 835	363	4 820	470	Extreme erosion and degradation on all but hill pastures. Overstocked at present.
Mooloo Downs	493 325 476 ac.	14 151 1:23	15 800	475	4 500	18	Overstock at present Heavy use makes this station very prone to drought.
Mt. Augustus	1 598 995 813 ac.	30 176 1:33	29 158	1 453	14 600	145	Recommended fencing of cattle country.
Mt. Clere	1 238 765,562 ac.	23 200 1:33	13 575	1 022	11 600	216	Over-use of grassy pastures and of flood plains by cattle.
Mt. James	777 381 323 ac.	12 300 1:31	6 550	777	8 100	Nil	
Mt. Phillips	896 566 466 ac.	26 974 1:21	10 050	851	7 700	45	

NAME	AREA SQUARE MILES	PRESENT E.C.C.	CURRENT STOCK NUMBERS (SHEEP UNITS) 1972	RECOMMENDED AREA FOR GRAZING SQUARE MILES	S.U.C.	AREA RECOMMENDED FOR EXCLUSION SQUARE MILES	COMMENTS
Mulgul	975 692 757 ac.	23 092 1:30	7 525	845 on catchment	6 600 on catchment	Nil	
Three Rivers	1 547 933 767 ac.	23 344 1:40	9 610	1 138	14 000	409	Tributary plains are extremely degraded and eroded - 409 sq.miles
Waldburg	512 317 313 ac.	9 000 1:35	2 625	512	3 980	Nil	
Wanna	1 019 652 318 ac.	21 700 1:30	7 725	506	4 000	Nil	Recommended change in E.C.C.
Woodlands	835 529 525 ac.	13 238 1:40	8 905	757	6 000	78	Most pastures poor producers. Plains types badly degraded.
Yarlarweelor	1 088 696 455 ac.	15 477 1:45	23 500	500 on catchment	6 200 on catchment	Nil	Overstocked at present
Yinnietharra	789 504 932 ac.	29 702 1:17	12 250	657	7 600	168	Over-use of stony chenopod pastures in past has led to severe erosion. Area available includes reserves
TOTALS			416 833		237 290	3 634	

INDIVIDUAL STATION REPORTS

In the section which follows each of the stations on the catchment is dealt with in detail. The areas of each type of rangeland and the condition of each on the station are given.

Rangelands were placed into three categories for the purpose of station assessment. These were acceptable (A) supervised (S) and remedial (R).

<u>Acceptable rangelands</u> were those which showed no signs of erosion although they could have deteriorated in respect of their pastures.

<u>Supervised rangelands</u> were those which showed some signs of erosion in parts though the record from traverse observations showed that this was not general. Pastures were degraded and the rangelands were in danger of deteriorating to an unacceptable condition if grazing pressure was continued. It will be seen that on different stations the same rangeland may be in supervised condition, or acceptable or even in remedial condition.

<u>Remedial rangelands</u> were those which showed areas of major erosion and pasture degradation. Their condition was such that further use was unadvisable since deterioration could only continue and reduce the rangelands even lower in condition. Some of these remedial rangelands were so badly degraded that recovery in even 25 years was considered to be unlikely. Some grassy rangelands such as Landor type were also profoundly degraded and should ideally have been placed in the restricted classification. However, since they are not prone to water erosion and tend to resist wind erosion to some extent they were excluded from this category and placed in the supervised use group.

The allocation to these classes of condition was made on the basis of the sorting made of the traverse record, from field notes taken on the survey and from the query point data sheets. A summary of the condition of all rangelands is given as a short table in each station report.

The areas which should be removed from use are designated in respect of the rangelands in the table for each station and their general location on the station is also described. The suggested sheep unit capacity for each station is also given. These stocking rates should apply until recovery is achieved.

Bidgemia station falls entirely within the catchment and is found on Kennedy Range, Wooramel, Mt. Phillips and Glenburgh four-mile sheets.

Two hundred and forty-two traverse records were made and twenty-two query points were selected on the property

This extremely large property of 1626 square miles has extensive areas of degraded and eroded rangeland particularly in the stony chenopod, chenopod and sand-dune halophyte groups. Four hundred and twenty three square miles should be removed from use. These represent most of the lower parts of the property. Only the hills are in acceptable condition.

An alarming increase, to almost total dominance, in parts, of *Hakea priessii* (needlebush) is a feature of the degradation process on Bidgemia. It is particularly prevalent on the stony chenopod, and chenopod pasture groups. Where it is dominant the pastures are virtually useless and likely in economic time to remain so. The spread of needlebush can be expected to continue unless management practises are adopted, which will promote more attractive competitors.

The estimate of carrying capacity made in 1946 was 1 in 100, but the current rate is 1 to 16. It is difficult to understand how this change was effected in view of the obvious and gross deterioration which has occurred.

The sheep unit capacity recommended here is 19 965 on the acceptable and supervised rangelands. The areas to be removed from use are found on the western side and on the southern half. The north eastern section would be capable of carrying sheep as would some of the areas of Mantle rangeland type. However, unless paddocking changes are made, it is unlikely that these supervised areas could be grazed as they are so intermingled with degraded pastures.

Traverse Summary - 242 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	8	None	14	Pristine	0
Sheeting	27	Sealing	31	Good	6
Surface redistribution	50	Minor rilling	22	Vegetation degraded	68
Hummocking	15	Stripping	17	Vegetation degraded; some erosion	26
Major drift	0	Lower slope gullies	16	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION BIDGEMIA 1625 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Agamemnon	72	+		
	Pells	84	+		
	Augustus	7	+		
	Fossil	30	+		
	Glenburgh	9	+		
	Moogooloo	54	+		
Stony S.G.F.	Phillips	178		178	
	Thomas	16		16	
	James	22	+		
Stony Chenopod	Wooramel	45		+	
	Jimba	249		70	179
	Sandiman	87		37	50
	Mantle	192		192	
	Durlacher	112		96	16
	Yinnietharra	31		31	
	Nadarra	2		2	
Chenopod	Jingle	26		15	11
Wandarrie	Winmar	1		+	
Mulga S.G.F.	Frederick	8		+	
Sand dune Halophyte	Bidgemia	150		30	120
	Lyons	94		47	47
Sandplain	Divide	1		+	
River	Gascoyne	155		+	
Total area on Catchment		1625	278	924	423

Area to be removed from use 423 Sq Miles

Area available for grazing 1201 Sq Miles

Sheep Unit Capacity (S.U.C.) 19 965

BRYAH STATION MEEKATHARRA SHIRE

Bryah Station lies entirely within the catchment extending to the divide on the south eastern side.

It is found on the Peak Hill and Collier four mile sheets.

Much of the property is hill and stony short grass-forb country, and this has resulted in over-use of the more accessible and productive parts.

Forty six traverse recordings were made on eight rangelands and seven query points were selected on the property.

Bryah and Three Rivers rangelands are severely over-used and degraded. They should be removed from the stocked area. They occur on the lowest parts of the property. A small area of Three Rivers rangeland is not adversely affected.

The remainder of the property, 359 square miles can be grazed under supervision in order to prevent further deterioration of susceptible rangelands such as Clere and Durlacher. A sheep unit capacity of 4350 is recommended.

The area which should be removed from use lies north of Bryah homestead on either side of Yandthangunna Creek and its tributaries, and also north of River Well on the north bank of the Gascoyne River.

Traverse Summary - 46 Observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	21	None	23	Pristine	4
Sheeting	32	Sealing	39	Good	13
Surface redistribution	26	Minor rilling	14	Vegetation degraded	48
Hummocking	15	Stripping	18	Vegetation degraded; some erosion	28
Major drift	6	Lower slope gullies	6	Vegetation degraded; major erosion	7
		Upper & lower slope gullies	0		

STATION BRYAH 531 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	44	+		
	Peak Hill	6	+		
Stony S.G.F.	Jamindie	123		+	
	Collier	34	+		
	Beasley	29	+		
	George	3	+		
Stony Chenopod	Bryah	72			+
	Horseshoe	22		+	
	Durlacher	12		+	
Chenopod	Warri	7		+	
	Bibbingunna	3	+		
Wandarrie					
Mulga S.G.F.	Frederick	52		+	
	Three Rivers	102		2	100
	Clere	2		+	
Sand dune Halophyte					
Sandplain					
River	Gascoyne	20		+	
Total area on Catchment		531	119	240	172

Area to be removed from use 172 Sq Miles

Area available for grazing 359 Sq Miles

Sheep Unit Capacity (S.U.C.) 4 350

COBRA STATION — UPPER GASCOYNE SHIRE

Cobra Station lies entirely within the Gascoyne catchment. It is found on the Mt. Phillips and Mt. Egerton four-mile sheets.

The property consists of stony and hill pastures not prone to degradation or to erosion. The hill pastures, stony short grass-forb and sandplain pastures are in an acceptable condition and the remainder are in need of supervised use.

There are no areas which need to be taken out of use. Fourteen traverse records were made and three query points were selected on the property.

A reduction in estimated carry capacity is recommended. While the current E.C.C. of one sheep to 40 acres is a reasonable figure for the Wandarrie and stony chenopod pastures, it is quite unacceptable for the hill and stony short grass-forb pastures which comprise most of the property.

Traverse Summary - 14 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	86	None	86	Pristine	0
Sheeting	7	Sealing	7	Good	14
Surface redistribution	7	Minor rilling	7	Vegetation degraded	86
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	0
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION COBRA 487 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	146	+		
Stony S.G.F.	Phillips	41	+		
	Collier	18	+		
	Jamindie	80	+		
	George	24	+		
Stony Chenopod	Durlacher	15	+		
	Sugarloaf	4		+	
Chenopod					
Wandarrie	Landor	12		+	
	Winmar	38		+	
	Flood	5		+	
	Doolgunna	6		+	
	Outwash	2		+	
Mulga S.G.F.	Three Rivers	9		+	
	Frederick	2		+	
Sand dune Halophyte					
Sandplain	Divide	85	+		
River					
Total area on Catchment		487	409	78	

Area to be removed from use Nil Sq Miles

Area available for grazing 487 Sq Miles

Sheep Unit Capacity (S.U.C.) 5 000

COORDEWANDY STATION | UPPER GASCOYNE SHIRE

Coordewandy station is virtually all on the catchment and is found on the Glenburgh four-mile sheet. It is run in conjunction with Glenburgh station and comments on that station should therefore be read in conjunction with these.

Seventeen traverse recordings were made on four rangeland types and three query points were selected on the property.

Serious erosion problems exist on Sandiman rangeland. Some of the deepest and most extensive gully systems on the catchment were found on Coordewandy station. Moogooloo rangeland is also seriously degraded. These two rangelands comprising 40 square miles should be removed from use. The Pastoral Inspector's report of 1920 refers to extensive areas of saltbush and bluebush on the property none of which exist today.

The remaining 196 square miles can be grazed under supervision and at reduced carrying capacity. The recommended sheep unit capacity for the grazable land is 1552. When recovery is achieved about 3200 sheep could be carried, a stocking rate not much different to the present E.C.C.

The area to be removed from use lies generally south of Congo Creek.

Traverse Summary - 17 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	47	None	47	Pristine	0
Sheeting	12	Sealing	6	Good	0
Surface redistribution	41	Minor rilling	12	Vegetation degraded	65
Hummocking	0	Stripping	6	Vegetation degraded; some erosion	35
Major drift	0	Lower slope gullies	17	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	12		

STATION COORDEWANDY 236 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Agememnon	17	+		
	Moogooloo	13			13
	Pells	59	+	59	
Stony S.G.F.	Thomas	30	+		
	Phillips	8	+		
Stony Chenopod	Sandiman	72		45	27
	Wooramel	18		+	
Chenopod					
Wandarrie	Bubbagundy	3		+	
Mulga S.G.F.					
Sand dune Halophyte	Divide.	16	+		
Sandplain					
River					
Total area on Catchment		236	130	66	40

Area to be removed from use 40 Sq Miles

Area available for grazing 196 Sq Miles

Sheep Unit Capacity (S.U.C.) 2 270

DAIRY CREEK STATION UPPER GASCOYNE SHIRE

Dairy Creek station is wholly on the catchment and is found on the Glenburgh and Wooramel four-mile sheets.

Fifty seven traverse recordings were made on eleven rangeland types and twelve query points were selected on the property. The lease has been subjected to very heavy stocking rates in the past and this is reflected in its present condition. As Permian basin pastures form a large part of the area it is extremely degraded.

One hundred and nine square miles should be withdrawn from use. These include parts of the Wooramel, Jimba and Jingle in the Permian Province and Thomas in the Archean block. All have suffered from surface stripping, gullying and gross changes in pastoral condition.

The remaining 570 square miles could be used under supervised used, but at much lower rates than the current E.C.C. of 1:25 acres. A rate of about 1:36 is recommended to give a sheep unit capacity of 10 100 provided all the 570 square miles of available land is used. It should be noted that the property was supporting more sheep units than its E.C.C.

Pastoral Inspectors reports on previous occasions refer to the erosion on the property.

The area to be excluded from use extends from Pells Creek to Geeranoo Creek.

Traverse Summary - 57 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	17	None	30	Pristine	0
Sheeting	21	Sealing	17	Good	2
Surface redistribution	39	Minor rilling	19	Vegetation degraded	56
Hummocking	23	Stripping	18	Vegetation degraded; some erosion	42
Major drift	0	Lower slope gullies	16	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION DAIRY CREEK 679 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Moogooloo	46		+	
	Pells	63	+		
	Agamemnon	39	+		
	Fossil	24	+		
	Augustus	1	+		
Stony S.G.F.	Thomas	14		+	
Stony Chenopod	Wooramel	90		50	40
	Sandiman	107		+	
	Mantle	68		+	
	Nadarra	7		+	
	Durlacher	7		+	
	Jimba	134		73	61
Chenopod	Jingle	8			+
Wandarrie					
Mulga S.G.F.					
Sand dune Halophyte	Bidgemia	17		+	
	Lyons	3		+	
Sandplain	Yalbalgo	26	+		
River	Gascoyne	25	+		
Total area on Catchment		679	178	392	109

Area to be removed from use 109 Sq Miles

Area available for grazing 570 Sq Miles

Sheep Unit Capacity (S.U.C.) 10 100

DALGETY DOWNS STATION — UPPER GASCOYNE SHIRE

Dalgety Downs station is wholly on the catchment and is found on the Glenburgh and Mt. Phillips four-mile sheets.

Sixty three traverse recordings were made on nine rangeland types and eleven query points were selected on the property.

Two-thirds of the property consists of hill and stony short grass-forb pastures. As very large numbers of sheep have been carried this has led to over-use of some of the lower slope pasture groups with consequent erosion of parts of the Durlacher rangeland. Fifty seven square miles of this rangeland should be excluded from use.

The remaining 873 square miles could be grazed under supervision, but at much lower stocking rates than the unrealistic 1:22 estimated at present. With so much poor pasture on the property it is difficult to see how this carrying capacity was estimated.

The recommended sheep unit capacity is 8 720 sheep. When Durlacher is included in the available grazing land a total carrying capacity of 9 600 is suggested.

Durlacher rangeland pastures to be removed from the available rangelands are located south of the Carnarvon-Meekatharra road.

Traverse Summary - 63 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	30	None	32	Pristine	0
Sheeting	22	Sealing	27	Good	3
Surface redistribution	37	Minor rilling	8	Vegetation degraded	59
Hummocking	11	Stripping	16	Vegetation degraded; some erosion	38
Major drift	0	Lower slope gullies	17	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

DOOLGUNNA STATION | MEEKATHARRA SHIRE

Doolgunna Station forms part of the divide in the south-east and consequently not all of it lies on the catchment. It is found on the Peak Hill four-mile sheet.

Twenty five traverse recordings were made on nine rangeland types and twelve query points were selected on the property.

The tributary plain rangeland types are extremely degraded and have become eroded. The fine sandy banks of Doolgunna type have been extensively deflated. The Pastoral inspection report of 1961 also refers to extensive erosion. Warri, Doolgunna, Three Rivers and Frederick rangelands should be excluded from use. These are found on the tributary plains of the south branch of the Gascoyne from its source to the boundary. The total area involved is 66 square miles.

The remaining 262 square miles on the catchment can be grazed but at a rate lower than the current E.C.C. since the formerly higher producing rangelands have been removed from use. The lessee should make more use of the pastures towards Peak Hill.

The recommended sheep unit capacity for the area on the catchment is 3 260, approximately three quarters of the current E.C.C.

Traverse Summary - 25 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	28	None	44	Pristine	4
Sheeting	28	Sealing	40	Good	4
Surface redistribution	20	Minor rilling	8	Vegetation degraded	50
Hummocking	20	Stripping	8	Vegetation degraded; some erosion	38
Major drift	4	Lower slope gullies	0	Vegetation degraded; major erosion	4
		Upper & lower slope gullies	0		

STATION DALGETY DOWNS 930 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Agamemon	133		+	
	Glenburgh	2	+		
	Augustus	74	+		
Stony S.G.F.	Phillips	317	+		
	Thomas	144	+		
	Mabbutt	4	+		
	Jamindle	9	+		
Stony Chenopod	Durlacher	138		81	57
	Nadarra	8			
Chenopod	Warri	13		+	
Wandarrie	Winmar	11		+	
	Landor	4		+	
Mulga S.G.F.	Macadam	13	+		
	Three Rivers	11		+	
Sand dune Halophyte					
Sandplain	Divide	7	+		
River	Gascoyne	42		+	
Total area on Catchment		930	253	620	57

Area to be removed from use 57 Sq Miles

Area available for grazing 873 Sq Miles

Sheep Unit Capacity (S.U.C.) 8 720

STATION DOOLGUNNA 718 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Peak Hill	20	+		
Stony S.G.F.	Beasley	85	+		
	Phillips	33	+		
Stony Chenopod	Horseshoe	69	+		
	Durlacher	52		+	
Chenopod	Warri	9			+
Wandarrie	Doolgunna	6			+
Mulga S.G.F.	Three Rivers	40		2	38
	Frederick	13			+
Sand dune Halophyte					
Sandplain	Divide	1	+		
River					
Total area on Catchment		328	208	54	66

Area to be removed from use 66 Sq Miles

Area available for grazing 262 Sq Miles

Sheep Unit Capacity (S.U.C.) 3 260

EDMUND STATION — UPPER GASCOYNE SHIRE

Nearly all of Edmund falls on the catchment and it is found on the Edmund four-mile sheet.

Thirteen traverse recordings were made on a single rangeland (Jamindie) and one query point was selected on the property.

The rangelands with the exception of the stony chenopod group, are very depauperate and are poor producers. They are not capable of supporting large numbers of sheep.

The major part of the station is resistant to erosion even though it is degraded. There was no evidence of stripping or gullying, but abundant evidence of pasture degradation. This decline in pasture productivity is reflected by the fluctuations in numbers of sheep carried and the low capacity of the property.

The current E.C.C. is too optimistic and should be reviewed. The recommended sheep unit capacity is 3 000 for the area on the catchment. This grazing level will permit recovery of the pasture and increased durability.

Traverse Summary - 13 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	15	None	15	Pristine	0
Sheeting	85	Sealing	69	Good	8
Surface redistribution	0	Minor rilling	16	Vegetation degraded	92
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	0
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION EDMUND 344 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	91	+		
Stony S.G.F.	Jamindie	134	+		
	Phillips	23		+	
	Collier	4	+		
	James	17	+		
	George	1	+		
Stony Chenopod	Naderra	32		+	
	Durlacher	11		+	
	Yinnietharra	6		+	
Chenopod					
Wandarrie					
Mulga S.G.F.					
Sand dune Halophyte					
Sandplain					
River	Gascoyne	11	+		
Total area on Catchment		330	258	72	

Area to be removed from use Nil Sq Miles

Area available for grazing 330 Sq Miles

Sheep Unit Capacity (S.U.C.) 3 000

ERRABIDDY STATION — UPPER GASCOYNE SHIRE

About two-thirds of Errabiddy Station occurs on the Gascoyne catchment. It is found on the Robinson Range and Glenburgh four-mile sheets. It forms part of the divide on the southern half of the catchment.

Thirty seven traverse recordings were made on six rangeland types and five query points were selected.

Only Three Rivers rangeland is in need of remedial treatment and 25 square miles of it should be removed from the available grazing area.

A sheep unit capacity of 2 600 is recommended for the area on the catchment. Once rehabilitation has occurred a rate of 2 850 could be permitted for that area on the catchment. The current E.C.C. of 6 500 is an over estimate in view of the rocky nature of most of the rangelands on the property.

Traverse Summary - 37 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	19	None	51	Pristine	0
Sheeting	35	Sealing	32	Good	3
Surface redistribution	43	Minor rilling	0	Vegetation degraded	65
Hummocking	3	Stripping	9	Vegetation degraded; some erosion	32
Major drift		Lower slope gullies	8	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION ERRABIDDY 304 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Agamemnon	11	+		
	Augustus	1	+		
Stony S.G.F.	Phillips	46		+	
	Beasley	23		+	
Stony Chenopod	Durlacher	81		+	
Chenopod					
Wandarrie	Flood	8		+	
	Winmar	6		+	
Mulga S.G.F.	Three Rivers	43		18	25
	Frederick	1		+	
Sand dune Halophyte					
Sandplain					
River	Gascoyne	7	+		
Total area on Catchment		227	19	183	25

Area to be removed from use 25 Sq Miles

Area available for grazing 202 Sq Miles

Sheep Unit Capacity (S.U.C.) 2 600

EUDAMULLAH STATION

UPPER GASCOYNE SHIRE

Eudamullah Station occurs entirely on the catchment and is found on the Mt. Phillips four-mile sheet.

Ninety two traverse recordings were made on nine rangelands and eight query points were selected on the property.

Eudamullah resembles Mt. Phillips in that it has predominately hill and short grass-forb pastures. Heavy past use in the south and near the homestead has resulted in grave overuse of Durlacher and Jimba rangelands and parts of these should be removed from use. The remainder could be grazed under supervision.

The recommended S.U.C. is 9 900, a much lower figure than the current E.C.C. which is too high and would continue to lead to degradation if adopted.

Traverse Summary - 92 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	20	None	40	Pristine	0
Sheeting	35	Sealing	28	Good	6
Surface redistribution	45	Minor rilling	14	Vegetation degraded	81
Hummocking	0	Stripping	12	Vegetation degraded; some erosion	13
Major drift	0	Lower slope gullies	6	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION EUDAMULLAH 1011 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Agamemnon	115	+		
	Fossil	14	+		
	Glenburgh	90	+		
	Moogooloo	5	+		
	Augustus	1	+		
Stony S.G.F.	Phillips	233		+	
	Thomas	80	+		
	James	129	+		
Stony Chenopod	Sandiman	48		+	
	Durlacher	105		23	82
	Mantle	39		+	
	Yinnietharra	33		+	
	Jimba	15			15
	Wooramel	1		+	
Chenopod					
Wandarrie	Winmar	72		+	
Mulga S.G.F.					
Sand dune Halophyte					
Sandplain					
River	Gascoyne	31		+	
Total area on Catchment as amended 23/7/73			434	480	97

Area to be removed from use 97 Sq Miles

Area available for grazing 914 Sq Miles

Sheep Unit Capacity (S.U.C.) 9 900

GIFFORD CREEK STATION — UPPER GASCOYNE SHIRE

Gifford Creek Station lies wholly within the Gascoyne catchment and is found on the Mt. Phillips and Edmund four-mile sheets.

One hundred and fourteen traverse recordings on twelve rangelands were made and 12 query points were selected on the property.

Over sixty per cent of the property consists of hill and stony short grass-forb pastures of inherently low productivity and reduced accessibility. The attractive inclusions within these, and the other accessible pastures have been subjected to heavy use particularly on the south of the Lyons River which has been developed for sheep. The bulk of the Durlacher, Winmar and Thomas rangelands occur on this part of the lease and all are very seriously degraded and eroded. Most of them should be excluded from the available grazing land. The area involved is 117 square miles.

The remaining 829 square miles can be used and this lies essentially north of the Lyons River. Of particular interest is the area of Nadarra rangeland which is in good condition. This is due to lack of watering points and its use by cattle which have tended not to destroy the shrubs.

A sheep unit capacity of 9 162 is recommended.

Most of the northern side of the property is unfenced but should be if proper pasture management is to be effected. Consideration should also be given to upgrading many of the existing fences in the sheep area.

Traverse Summary - 114 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	39	None	49	Pristine	0
Sheeting	26	Sealing	17	Good	10
Surface redistribution	34	Minor rilling	11	Vegetation degraded	69
Hummocking	1	Stripping	14	Vegetation degraded; some erosion	21
Major drift	0	Lower slope gullies	9	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION GIFFORD CREEK 946 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Agamemnon	66	+		
	Glenburgh	45		+	
	Augustus	50	+		
Stony S.G.F.	Phillips	225		+	
	James	97	+		
	Thomas	38		8	30
	George	29	+		
	~~Jamindie~~	41	+		
	~~Collier~~	5	+		
Stony Chenopod	Durlacher	59		8	51
	Nadarra	185		+	
	Kurubuka	8		+	
	Sugarloaf	1		+	
Chenopod	Peedawarra	8		+	
	Warri	3		+	
	Bibbingunna	2		+	
Wandarrie	Winmar	44		8	36
Mulga S.G.F.	Three Rivers	3		+	
Sand dune Halophyte					
Sandplain					
River	Gascoyne	38	+		
Total area on Catchment		946	326	479	117

Area to be removed from use 117 Sq Miles

Area available for grazing 829 Sq Miles

Sheep Unit Capacity (S.U.C.) 9 162

GLENBURGH STATION — UPPER GASCOYNE SHIRE

Glenburgh Station lies entirely within the catchment and is found on the Glenburgh four-mile sheet. It is run in conjunction with Coordewandy Station and these comments should be read with those made for that property.

Thirty six traverse recordings were made on six rangelands and four query points were selected on the property.

Almost all of the property consists of hill or stony short grass-forb pastures. Very large numbers of stock have been carried and this has led to the deterioration of saline inclusion areas and non-saline valley plains particularly in Phillips and Durlacher rangelands. The Pastoral inspectors report of 1 920 refers to saltbush plains which have now disappeared.

Phillips and Durlacher rangelands totalling 62 square miles should be withdrawn from use. The remainder could be grazed but at markedly different rates to the E.C.C. of 1 to 30.

The recommended sheep unit capacity is 3 050 rising to 3 700 once the protected areas have recovered.

The areas in need of prolonged protection lie north and east of the homestead in the valley of the Geeranoo Creek and its tributaries.

Traverse Summary - 36 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	28	None	28	Pristine	0
Sheeting	19	Sealing	19	Good	0
Surface redistribution	39	Minor rilling	22	Vegetation degraded	69
Hummocking	14	Stripping	14	Vegetation degraded; some erosion	31
Major drift	0	Lower slope gullies	17	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION GLENBURGH 374 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Agamemnon	98	+		
	Pells	29	+		
	Glenburgh	25		+	
	Moogooloo	1	+		
Stony S.G.F.	Phillips	90		35	55
	James	27		+	
	Thomas	52	+		
Stony Chenopod	Durlacher	22		15	7
	Jimba	9	+		
	Wooramel	4		+	
	Sandiman	7		+	
Chenopod					
Wandarrie					
Mulga S.G.F.	Macadam	5	+		
	Three Rivers	1	+		
Sand dune Halophyte					
Sandplain					
River	Gascoyne	4	+		
Total area on Catchment		374	199	113	62

Area to be removed from use 62 Sq Miles

Area available for grazing 312 Sq Miles

Sheep Unit Capacity (S.U.C.) 3 050

JIMBA JIMBA STATION UPPER GASCOYNE SHIRE

Jimba Jimba Station occurs on the south west corner of the catchment area and is found on the Wooramel and Kennedy Range four-mile sheets.

Forty four traverse recordings were made on six rangelands and eight query points were selected on the station.

Degradation with erosion is commonplace on this property and particularly on the susceptible rangelands of Jimba and Bidgemia. The eroded parts of these rangelands comprise 176 square miles and their protection from use is recommended. The Permian based Jimba rangeland is particularly eroded in parts and should be grazed with great care once recovery has been achieved.

The remainder of the property can be grazed under supervision. Care should be taken to ensure that the potentially erodible rangelands in the Permian basin are grazed correctly. A sheep unit capacity of 8 435 is recommended.

The area to be free from stock lies east and south of the Yalbalgo rangeland south of the Gascoyne River and extends north of river near the homestead.

Traverse Summary - 44 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	0	None	2	Pristine	0
Sheeting	25	Sealing	36	Good	2
Surface redistribution	45	Minor rilling	32	Vegetation degraded	79
Hummocking	30	Stripping	9	Vegetation degraded; some erosion	19
Major drift	0	Lower slope gullies	18	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	3		

STATION JIMBA JIMBA 620 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Fossil	6	+		
	Moogooloo	33	+		
Stony S.G.F.					
Stony Chenopod	Jimba	78		17	61
	Sandiman	71		+	
	Mantle	24		+	
	Wooramel	5		+	
Chenopod	Jingle	1		+	
Wandarrie					
Mulga S.G.F.					
Sand dune Halophyte	Bidgemia	191		76	115
	Lyons	31		+	
Sandplain	Yalbalgo	170		+	
	Divide	2	+		
River	Gascoyne	8		+	
Total area on Catchment		620	41	403	176

Area to be removed from use 176 Sq Miles

Area available for grazing 444 Sq Miles

Sheep Unit Capacity (S.U.C.) 8 435

KUMARINA STATION | MEEKATHARRA SHIRE

Kumarina Station lies almost wholly within the catchment and is found on the Collier four-mile sheet. The property is only partly used and is in good range condition.

Eleven traverse recordings were made on three rangelands and two query points were selected on the lease.

Most of the property consists of hill and stony short grass-forb pastures of low durability and carrying capacity. The current E.C.C. of 1:32 is too high and could lead to degradation of the lower, more accessible parts particularly if cattle are grazed at these rates. At present no part of the property on the catchment is degraded.

The recommended sheep unit capacity is 4 500 on the 715 square miles within the catchment. As there are no fences at present, these should be erected in order to contain stock for better pasture management.

Traverse Summary - 11 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	55	None	64	Pristine	18
Sheeting	45	Sealing	36	Good	54
Surface redistribution	0	Minor rilling	0	Vegetation degraded	28
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	0
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION KUMARINA 814 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	199	+		
Stony S.G.F.	Jamindie	207	+		
	George	8	+		
	Collier	67	+		
Stony Chenopod	Bryah	6	+		
Chenopod	Peedawarra	4	+		
	Warri	4	+		
Wandarrie					
Mulga S.G.F.	Three Rivers	62	+		
	Frederick	96	+		
Sand dune Halophyte					
Sandplain	Divide	62	+		
River					
Total area on Catchment		715	715		

Area to be removed from use Nil Sq Miles

Area available for grazing 715 Sq Miles

Sheep Unit Capacity (S.U.C.) 4 500

LANDOR STATION   UPPER GASCOYNE SHIRE

Landor Station occurs wholly on the catchment and is found on the Robinson Range, Glenburgh and Mt. Phillips four-mile sheets.

One hundred and ninety-eight traverse recordings were made and 20 query points were selected.

The hill and stony short grass-forb pastures are in acceptable condition. Parts of the Durlacher, Jingle and Peedawarra in the stony chenopod and chenopod groups are severely degraded and eroded and these areas should not be grazed. The remaining areas of these rangelands and the other pasture groups require supervised use. Over forty per cent of Landor Station consists of wandarrie pastures which are resistant to wind erosion. At the same time they have, however, deteriorated due to suppression of the perennial palatable grasses. Supervised use of these pastures will facilitate their recovery.

The E.C.C. of the property is 31 674. It carried 30 600 at the time of survey. The recommended sheep unit capacity is 18 650.

The area to be removed from use lies to the south of the Gascoyne River and to the west of the Mt. Augustus - Meekatharra road. The Pastoral inspectors report of 1920 refers to saltbush in this area, none of which is present today.

Traverse Summary - 198 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	16	None	42	Pristine	0
Sheeting	39	Sealing	41	Good	4
Surface redistribution	38	Minor rilling	9	Vegetation degraded	78
Hummocking	6	Stripping	4	Vegetation degraded; some erosion	18
Major drift	1	Lower slope gullies	4	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION LANDOR 1413 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Agamemnon	10	+		
	Augustus	29	+		
Stony S.G.F.	Thomas	15	+		
	Mabbutt	13	+		
	Jamindie	6	+		
	George	3	+		
	Phillips	78			
Stony Chenopod	Durlacher	227		135	92
	Horseshoe	31	+		
	Nadarra	2	+		
Chenopod	Warri	81		+	+
	Jingle	26			26
	Peedawarra	7			7
Wandarrie	Landor	204		+	
	Bubbagundy	83		+	
	Winmar	29		+	
	Flood	286		+	
Mulga S.G.F.	Three Rivers	106		+	
	Macadam	20	+		
	Clere	11		+	
	Stonehut	3	+		
	Frederick	24		+	
Sand dune Halophyte					
Sandplain	Divide	13	+		
River	Gascoyne	106		+	
Total area on Catchment		1413	223	1065	125

Area to be removed from use 125 Sq Miles

Area available for grazing 1288 Sq Miles

Sheep Unit Capacity (S.U.C.) 18 650

LYONS RIVER STATION | UPPER GASCOYNE SHIRE

Lyons River Station is totally on the catchment and is found on the Kennedy Range and Mt. Phillips four-mile sheets.

Fifty seven traverse recordings were made on seven rangelands and eight query points were selected on this property.

The rangelands are principally those of the Permian basin, and only minor parts of the Archean province rangelands are found on the property. The alluvial plain Permian rangelands are extremely degraded and eroded particularly between the Lyons River and the Kennedy Range escarpment. This area of 58 square miles of Jimba rangeland should be removed from use. The remainder of the property, 526 square miles, could be grazed under supervision, but at a grazing level of about 1 to 40 and not 1 to 23 acres as indicated by the current E.C.C. A sheep unit capacity of 8 850 sheep is recommended.

The area to be free of stock lies west of the Lyons River. The Pastoral inspection report of 1920 refers to light sandy flats which have now been stripped of their sand mantle, and to saltbush which does not now exist in this area. Protection for very long periods up to 25 years is suggested for the degraded land.

Traverse Summary - 57 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	3	None	33	Pristine	0
Sheeting	46	Sealing	54	Good	0
Surface redistribution	47	Minor rilling	2	Vegetation degraded	95
Hummocking	4	Stripping	9	Vegetation degraded; some erosion	5
Major drift	0	Lower slope gullies	2	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION LYONS RIVER 584 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Fossil	39	+		
	Agamemnon	28	+		
	Moogooloo	28	+		
	Pells	6	+		
Stony S.G.F.	Phillips	13		+	
Stony Chenopod	Jimba	110		52	58
	Mantle	218		+	
	Sandiman	23		+	
	Wooramel	4		+	
Chenopod					
Wandarrie	Winmar	1		+	
Mulga S.G.F.					
Sand dune Halophyte	Lyons	65		+	
	Bidgemia	16		+	
Sandplain	Yalbalgo	8		+	
River	Gascoyne	25	+		
Total area on Catchment		584	126	400	58

Area to be removed from use 58 Sq Miles

Area available for grazing 526 Sq Miles

Sheep Unit Capacity (S.U.C.) 8 850

MANGAROON STATION

UPPER GASCOYNE SHIRE

Only part of Mangaroon, 293 square miles occurs on the catchment. It is found on the Edmund four-mile sheet.

Twenty seven traverse recordings were made on four rangeland types and two query points were selected on the property.

Durlacher and Nadarra rangeland types were found to be seriously degraded and eroded in parts and 56 square miles should be removed from the available grazing area. Phillips, James, Gascoyne and Yinnietharra will require supervised use since they are prone to degradation.

The Hill types are in acceptable condition.

Stock to be carried on the catchment area should not exceed 2 500.

The area which should be removed from grazing lies north of the homestead along Russell and Pritchards Creeks and east to the Star of Mangaroon mine.

Traverse Summary 27 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	7	None	26	Pristine	0
Sheeting	86	Sealing	18	Good	0
Surface redistribution	7	Minor rilling	11	Vegetation degraded	74
Hummocking	0	Stripping	22	Vegetation degraded; some erosion	26
Major drift	0	Lower slope gullies	23	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION MANGAROON 389 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Glenburgh	3	+		
	Agamemnon	1	+		
	Augustus	10	+		
Stony S.G.F.	Phillips	114		+	
	James	74		+	
	Jamindie	2	+		
	Collier	4	+		
Stony Chenopod	Durlacher	45			+
	Nadarra	32		21	11
	Yinnietharra	1		+	
Chenopod					
Wandarrie					
Mulga S.G.F.					
Sand dune Halophyte					
Sandplain					
River	Gascoyne	7		+	
Total area on Catchment		293	20	217	56

Area to be removed from use 56 Sq Miles

Area available for grazing 237 Sq Miles

Sheep Unit Capacity (S.U.C.) 2 500

MILGUN STATION — MEEKATHARRA SHIRE

Milgun Station lies entirely within the Gascoyne catchment. It occurs on the Robinson Range, Mt. Egerton and Peak Hill four-mile sheets.

One hundred and sixty seven traverse records were made and 19 query points were selected on this property. It occurs on the Eastern Tributary plains so a large proportion of its area consists of tributary alluvial plains and wandarrie pastures.

Large areas of the chenopod, wandarrie and mulga short grass-forb pasture groups should not be grazed. Four hundred and ninety-seven square miles out of 1204 square miles available to the lessee should be freed from use. This may appear very high. However, it should be noted that this property has carried very high numbers of sheep and cattle in the past. Some of the rangelands, notably Blech, Three Rivers and Peedawarra are very susceptible to over-use and are so readily accessible that they would be preferentially used at all times thus leading to pronounced deterioration. The station also has a substantial area of Jamindie rangeland and some hill pastures which are inherently unproductive. These would be little used, and this alone would cause a significant increase in stocking rate on the more favoured areas.

It is recommended that 7 660 sheep should be carried on the 707 square miles still available but mostly under supervised use.

Traverse Summary - 197 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	19	None	22	Pristine	1
Sheeting	16	Sealing	45	Good	3
Surface redistribution	43	Minor rilling	17	Vegetation degraded	45
Hummocking	22	Stripping	22	Vegetation degraded; some erosion	39
Major drift	0	Lower slope gullies	4	Vegetation degraded; major erosion	12
		Upper & lower slope gullies	0		

STATION MILGUN 1164* Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	87			
	Mulgul	8	+		
	Peak Hill	5	+		
	Agamemnon	1	+		
Stony S.G.F.	Jamindie	142		+	
	George	76	+		
	Beasley	8	+		
	Collier	21	+		
	Phillips	1	+		
Stony Chenopod	Yinnietharra	6		+	
	Durlacher	15		+	
	Horseshoe	52		+	
	Bryah	22		+	
Chenopod	Warri	102			+
	Peedawarra	27			+
Wandarrie	Winmar	4		+	
	Landor	69		+	
	Flood	30		+	
	Blech	18			+
	Bubbagundy	3		+	
Mulga S.G.F.	Three Rivers	332		12	320
	Clere	33		3	30
	Frederick	31		+	
Sand dune Halophyte					
Sandplain					
River	Gascoyne	111		+	
Total area on Catchment		1204	207	500	497

Area to be removed from use 497 Sq Miles

Area available for grazing 707 Sq Miles

Sheep Unit Capacity (S.U.C.) 7 660

* Area on catchment exceeds total area of lease because of stock routes included. Note: over-use at present E.C.C.

MINGAH SPRINGS MEEKATHARRA SHIRE

Mingah Springs lies wholly on the Gascoyne catchment and is found on the Collier and Peak Hill four-mile sheets. As Jamindie is run in conjunction with it the two are here considered as the one property.

Thirty two traverse recordings were made on seven rangelands and six query points were selected on the property.

Three quarters of the area consists of short grass-forb and hill pastures of low carrying capacity and low durability. Only small areas of easily accessible pastures occur.

Warri rangeland, some five square miles ideally should be removed from use. However, the area is very small and would recover if stock numbers on the property were reduced to acceptable levels.

A sheep unit capacity of 5 600 is recommended under supervised use.

Traverse Summary - 32 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	37	None	41	Pristine	0
Sheeting	41	Sealing	41	Good	3
Surface redistribution	19	Minor rilling	9	Vegetation degraded	55
Hummocking	3	Stripping	9	Vegetation degraded; some erosion	42
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION MINGAH SPRINGS 791 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	P
Hill	Augustus	235	+		
	Diorite	9	+		
Stony S.G.F.	Jamindie	262		+	
	George	40	+		
	Collier	59	+		
Stony Chenopod	Bryah	38		+	
Chenopod	Warri	5			+
Wandarrie					
Mulga S.G.F.	Three Rivers	48		+	
	Frederick	24		+	
Sand dune Halophyte					
Sandplain	Divide	9	+		
River	Gascoyne	12		+	
Total area on Catchment		741	352	384	5

Area to be removed from use 5 Sq Miles

Area available for grazing 736 Sq Miles

Sheep Unit Capacity (S.U.C.) 5 600

MINNIE CREEK STATION UPPER GASCOYNE SHIRE

(now united with Mr. Sandiman)

Minnie Creek lies entirely within the Gascoyne catchment. It occurs on Edmund, Mt. Phillips and Kennedy Range four-mile sheets.

One hundred and two traverse observations were made and eight query points selected on the property.

The pastoral inspectors map of 1920 shows areas of saltbush pasture on what are now described as Nadarra, Jingle and Durlacher rangelands. Saltbush has been removed from these pastures and its place taken by annuals. The surface conditions have been violently altered by gullying and scalding.

The hill pasture group alone is recommended for continued use and is in acceptable condition. This is barely ten per cent of the property. A further twenty per cent, river and wandarrie pastures, could be grazed under supervision. The remaining 383 square miles should be removed from use. These are principally stony chenopod pastures or pastures with highly erodible duplex soils. These form the main pastures on the property and have always been subjected to severe over-use.

About 2 000 sheep could be carried on the acceptable and supervised use pastures.

Traverse Summary - 102 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	6	None	14	Pristine	0
Sheeting	32	Sealing	23	Good	0
Surface redistribution	49	Minor rilling	26	Vegetation degraded	75
Hummocking	13	Stripping	21	Vegetation degraded; some erosion	25
Major drift	0	Lower slope gullies	16	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION MINNIE CREEK 539 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Glenburgh	24	+		
	Agamemnon	23	+		
	Augustus	3	+		
Stony S.G.F.	James	116			+
	Phillips	49			+
Stony Chenopod	Yinnietharra	104			+
	Durlacher	79			+
	Nadarra	16			+
Chenopod	Jingle	4			+
Wandarrie	Winmar	42		+	
Mulga S.G.F.	Frederick	15			+
Sand dune Halophyte					
Sandplain					
River	Gascoyne	64		+	
Total area on Catchment		535	50	106	383

Area to be removed from use 383 Sq Miles

Area available for grazing 156 Sq Miles

Sheep Unit Capacity (S.U.C.) 2 000

Mooloo Downs lies wholly within the catchment and is found on the Mt. Phillips and Glenburgh four-mile sheets.

Thirty eight recordings were made on four rangeland types and three query points were selected on this property.

The lease consists of hill and stony short grass-forb pastures with only a minor amount, 19 square miles, of stony chenopod pasture. This small area has been grossly over-used, about one-third is gullied and stripped and should be excluded from the available grazing land.

The remainder of the lease can continue to be grazed. The current E.C.C. of 1:23 appears to be very high for this class of country.

The pastoral inspection reports refer to considerable stock losses and this is a reflection of over-use of the stony pastures of this lease which have been reduced to an ephemeral condition due to the removal of palatable and durable species. The creeklines in the hill and stony short grass-frob pastures have been stripped of their cover of *Chrysopogon fallax* and *Eragrostis setifolia*, but their place has been taken by Buffel grass in the lower parts where water is less limiting. A sheep unit capacity of 4 500 is recommended for the property. This is much less than the E.C.C. of 14 151 and very much below the current stocking of 16 500. However, if stock losses are to be minimised a carrying capacity approaching the S.U.C. is recommended. As the pastures improve an increase in S.U.C. should be feasible.

Traverse Summary - 38 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	47	None	45	Pristine	0
Sheeting	29	Sealing	18	Good	18
Surface redistribution	21	Minor rilling	16	Vegetation degraded	63
Hummocking	0	Stripping	5	Vegetation degraded; some erosion	19
Major drift	3	Lower slope gullies	16	Vegetation degraded; major erosion	C
		Upper & lower slope gullies	0		

STATION MOOLOO DOWNS 493 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Agamemnon	274		+	
	Augustus	17	+		
	Glenburgh	4	+		
Stony S.G.F.	Thomas	71		+	
	Phillips	89	+		
	Collier	3	+		
	James	14	+		
Stony Chenopod	Durlacher	19		1	18
Chenopod					
Wandarrie					
Mulga S.G.F.					
Sand dune Halophyte					
Sandplain					
River	Gascoyne	2	+		
Total area on Catchment		493	129	346	18

Area to be removed from use 18 Sq Miles

Area available for grazing 475 Sq Miles

Sheep Unit Capacity (S.U.C.) 4 500

MOUNT AUGUSTUS STATION — UPPER GASCOYNE SHIRE

Mt. Augustus Station lies wholly within the catchment and is found on the Mt. Egerton, Mt. Phillips and Edmund four-mile sheets.

One hundred and eighty five traverse recordings were made on fifteen rangeland types and nineteen query points were selected on the property.

About half the property consists of hill and stony short grass-forb pastures of low productivity. The grazing pressure on the remainder has therefore been severe, but only sufficient to affect adversely Warri and Sugarloaf rangeland types which should have stock excluded. One hundred and forty five square miles of country are involved.

The remaining 1 453 square miles can be grazed under supervision. The recommended sheep unit capacity is 14 660 on this area

The cattle country on Mt. Augustus is not fenced but it should be in order to control animals and to ensure that excluded areas are not grazed. The area to be excluded occurs to the east of the homestead along the Lyons and North Lyons Rivers.

Traverse Summary - 185 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	45	None	42	Pristine	0
Sheeting	25	Sealing	43	Good	11
Surface redistribution	28	Minor rilling	6	Vegetation degraded	49
Hummocking	2	Stripping	4	Vegetation degraded; some erosion	34
Major drift	0	Lower slope gullies	5	Vegetation degraded; major erosion	6
		Upper & lower slope gullies	0		

STATION MT. AUGUSTUS 1598 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	237	+		
	Mulgul	29	+		
	Diorite	1	+		
Stony S.G.F.	Jamindie	395		+	
	George	90	+		
	Collier	32	+		
Stony Chenopod	Sugarloaf	53			+
	Bryah	38		+	
	Kurabuka	302		+	
	Nadarra	5		+	
Chenopod	Jingle	9		+	
	Warri	112		20	92
	Peedawarra	10		+	
	Bibbingunna	7		+	
Wandarrie	Flood	1		+	
	Doolgunna	10		+	
	Landor	2		+	
Mulga S.G.F.	Three Rivers	178		+	
	Frederick	12		+	
Sand dune Halophyte					
Sandplain	Divide	30		+	
River	Gascoyne	45		+	
Total area on Catchment		1598	389	1064	145

Area to be removed from use 145 Sq Miles

Area available for grazing 1453 Sq Miles

Sheep Unit Capacity (S.U.C.) 14 660

MT. CLERE STATION — UPPER GASCOYNE SHIRE

Mt. Clere Station is wholly on the catchment and is found on the Mt. Egerton and Robinson Range four-mile sheets.

One hundred and twelve traverse recordings were made on fourteen rangeland types and seventeen query points were selected on this property.

The lease has always been stocked with cattle. The accessible areas have therefore been subjected to heavy overuse which has led to their degradation. This applies particularly to those areas with perennial grasses.

Two hundred and sixteen square miles should have stock excluded. The rangelands involved are Bryah, Warri, Three Rivers, Frederick and Blech all of which are drainage plains. Landor rangeland which should support good perennial grass pastures is particularly degraded, but is not eroding. Ideally it should be removed from use. If grazing is controlled, however, a recovery could be effected.

The remaining 1022 square miles could be grazed under supervision, but at greatly reduced stocking rates.

This property is largely unfenced. It is impossible to maintain control of grazing without adequate fencing. It is recommended that this be undertaken as a continuing programme. With the withdrawal from use of the plains this will be essential if the protection necessary for landscape consolidation is to proceed.

A sheep unit capacity of 11 600 is recommended.

The area to be excluded lies on each side of the Gascoyne River and on its tributaries.

Traverse Summary - 112 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	26	None	33	Pristine	0
Sheeting	10	Sealing	33	Good	5
Surface redistribution	58	Minor rilling	8	Vegetation degraded	56
Hummocking	4	Stripping	10	Vegetation degraded; some erosion	38
Major drift	2	Lower slope gullies	16	Vegetation degraded; major erosion	1
		Upper & lower slope gullies	0		

STATION MT. CLERE 1238 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	111	+		
	Agamemnon	30	+		
Stony S.G.F.	Phillips	153		+	
	Thomas	67	+		
	Jamindie	134	+		
	George	55	+		
	Collier	3	+		
Stony Chenopod	Bryah	11		11	
	Yinnietharra	31		+	
	Woodlands	3	+		
	Durlacher	114		+	
Chenopod	Warri	44		15	29
	Peedawarra	6		+	
Wandarrie	Landor	118		118	
	Blech	24			24
	Winmar	36		+	
	Bubbagundy	21		+	
Mulga S.G.F.	Three Rivers	133		14	119
	Macadam	19	+		
	Frederick	67		23	44
Sand dune Halophyte					
Sandplain	Divide	5		5	
River	Gascoyne	53		+	
Total area on Catchment		1238	422	600	216

Area to be removed from use 216 Sq Miles

Area available for grazing 1022 Sq Miles

Sheep Unit Capacity (S.U.C.) 11 600

MOUNT JAMES STATION UPPER GASCOYNE SHIRE

Mount James is wholly on the catchment and is found on the Mt. Phillips and Mt. Egerton four-mile sheets.

Fifty one traverse recordings were made on seven rangeland types and seven query points were selected.

The property is predominately hill and stony short grass-forb pastures of inherently low carrying capacity. Very large numbers of sheep were carried and this has led to degradation of the accessible parts of Durlacher, but not enough to recommend that stock be excluded.

The total area should be grazed under supervision and the sheep unit capacity is 8 100 which is the same as the present stocking rate. The current E.C.C. of 1:31 is too high and should be amended.

Traverse Summary - observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	67	None	71	Pristine	0
Sheeting	8	Sealing	13	Good	2
Surface redistribution	21	Minor rilling	12	Vegetation degraded	78
Hummocking	4	Stripping	2	Vegetation degraded; some erosion	20
Major drift	0	Lower slope gullies	2	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION MOUNT JAMES 777 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	27	+		
	Agamemnon	114	+		
	Glenburgh	6	+		
Stony S.G.F.	Jamindie	18		+	
	Phillips	280		+	
	Thomas	110		+	
	Mabbutt	9	+		
	James	14	+		
	George	4	+		
	Collier	4	+		
Stony Chenopod	Durlacher	130		+	
	Woodlands	21		+	
Chenopod					
Wandarrie	Flood	5		+	
	Winmar	19		+	
	Landor	13		+	
Mulga S.G.F.	Three Rivers	2		+	
	Frederick	1		+	
Sand dune Halophyte					
Sandplain					
River					
Total area on Catchment		777	178	599	

Area to be removed from use Nil Sq Miles

Area available for grazing 777 Sq Miles

Sheep Unit Capacity (S.U.C.) 8100

MOUNT PHILLIPS STATION UPPER GASCOYNE SHIRE

Mt. Phillips station lies entirely on the catchment and occurs on the Mt. Phillips four-mile sheet.

One hundred and sixteen traverse recordings were made on thirteen rangeland types and seven query points were selected on the property.

Mt. Phillips consists of stony short grass-forb and hill pastures in the main, and these are in acceptable or supervised condition. Durlacher rangeland is the only area requiring remedial treatment which will necessitate the exclosure of 45 square miles.

The current E.C.C. is too high since it has caused the worth of the stony pastures to be reduced. A S.U.C. of 7 700 is recommended. This could be increased to approximately 9 000 - 10 000 once rehabilitation was achieved.

Traverse Summary - 116 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	56	None	58	Pristine	0
Sheeting	16	Sealing	9	Good	9
Surface redistribution	28	Minor rilling	10	Vegetation degraded	66
Hummocking	0	Stripping	9	Vegetation degraded; some erosion	25
Major drift	0	Lower slope gullies	14	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION MOUNT PHILLIP 896 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	53	+		
	Agamemnon	117	+		
	Glenburgh	40	+		
Stony S.G.F.	Jamindie	11	+		
	Phillips	350		+	
	Thomas	118		+	
	James	58	+		
	Collier	2	+		
	George	15	+		
	Durlacher	65		20	45
Stony Chenopod					
Chenopod					
Wandarrie	Landor	1		+	
	Outwash	3		+	
	Wimnar	4	+		
Mulga S.G.F.	Frederick	5		+	
Sand dune Halophyte					
Sandplain	Divide	45	+		
River	Gascoyne	9		+	
Total area on Catchment		896	345	506	45

Area to be removed from use 45 Sq Miles

Area available for grazing 851 Sq Miles

Sheep Unit Capacity (S.U.C.) 7 700

MOUNT SANDIMAN STATION UPPER GASCOYNE SHIRE

(now united with Minnie Creek)

Mt. Sandiman Station occurs wholly on the catchment and on Kennedy Range and Mt. Phillips four-mile sheets.

Fifty traverse recordings were made on eight rangeland types and four query points were selected on the station.

Much of the property consists of stony pastures and this is reflected by its lower erosion status. Only Jimba rangeland has deteriorated to the extent that stock should be removed. The remainder of the property could be used with supervision. However, it should be noted that the reduction of 87 square miles of Jimba rangeland has reduced the sheep unit capacity by half.

The current E.C.C. is 6 886. The recommended stocking rate is 2 810 sheep.

The area to be removed from use lies west of the shearing shed and along the north part of Woodcocks Creek. The pastoral inspection report of 1920 refers to saltbush in both these localities where none may now be found.

Traverse Summary - 50 observations

Wind Erosion	%	Water erosion	%	Condition	%
None	18	None	22	Pristine	0
Sheeting	24	Sealing	46	Good	0
Surface redistribution	52	Minor rilling	24	Vegetation degraded	79
Hummocking	6	Stripping	4	Vegetation degraded; some erosion	21
Major drift	0	Lower slope gullies	4	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION MOUNT SANDIMAN 294 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Pells	25		+	
	Agamemnon	22	+		
	Fossil	4	+		
	Moogooloo	1	+		
Stony S.G.F.	Phillips	24		+	
	Thomas	10		+	
	James	10		+	
Stony Chenopod	Jimba	87			+
	Mantle	65		+	
	Wooramel	7		+	
	Sandiman	6		+	
	Yinnietharra	6		+	
	Durlacher	8		+	
Chenopod					
Wandarrie	Winmar	1		+	
Mulga S.G.F.					
Sand dune Halophyte	Lyons	4		+	
	Bidgemia	3		+	
Sandplain					
River	Gascoyne	11		+	
Total area on Catchment		294	27	180	87

Area to be removed from use 87 Sq Miles

Area available for grazing 207 Sq Miles

Sheep Unit Capacity (S.U.C.) 2810

MULGUL STATION | MEEKATHARRA SHIRE

Only part of Mulgul Station occurs on the catchment and it is found on the Mt. Egerton and Collier four-mile sheets.

Forty eight traverse recordings were made on seven rangeland types and six query points were selected on the property.

Over three quarters of the area on the catchment consists of either hill or stony short grass-forb pastures of an essentially ephemeral nature. The low producing Jamindie rangeland forms a large proportion, about twenty five per cent, of the property. There are only small amounts, 136 square miles, of readily accessible pastures.

No area need be excluded from stocking, but consideration should be given to the reduction of the E.C.C. rate of 1:30. The numbers of stock on the property have never exceeded more than half this and have declined sharply under stress. A more realistic figure would be 1:80.

The recommended sheep unit capacity on the catchment is 6 600. This level of use would allow for the rehabilitation of some of the small inclusions such as in Mulgul rangeland.

Traverse Summary - 48 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	54	None	52	Pristine	0
Sheeting	19	Sealing	29	Good	4
Surface redistribution	27	Minor rilling	8	Vegetation degraded	63
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	31
Major drift	0	Lower slope gullies	10	Vegetation degraded; major erosion	2
		Upper & lower slope gullies	1		

STATION MULGUL 975 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	236	+		
	Mulgul	76		+	
	Agamemnon	1	+		
	Diorite	4	+		
Stony S.G.F.	Jamindie	254		+	
	Collier	113		+	
	George	25	+		
Stony Chenopod	Sugarloaf	45		+	
	Bryah	3		+	
Chenopod	Warri	11		+	
	Jingle	4		+	
Wandarrie					
Mulga S.G.F.	Frederick	21		+	
	Three Rivers	45		+	
Sand dune Halophyte					
Sandplain					
River	Gascoyne	7	+		
Total area on Catchment		845	273	572	Nil

Area to be removed from use Sq Miles

Area available for grazing Sq Miles

Sheep Unit Capacity (S.U.C.) 6 600

(ECC 17 500)

THREE RIVERS STATION MEEKATHARRA SHIRE

Three Rivers Station is wholly on the catchment and is found on the Peak Hill and Collier four-mile sheets.

Ninety seven traverse recordings were made on thirteen rangelands and nineteen query points were selected on the property.

The extensive plains of Three Rivers type and of Peedawarra which are typical of this property are extremely degraded and extensively stripped and gullied. They are often eroded to the hardpan, a condition from which recovery will be doubtful and even if it is possible, will take a great number of years. Most of these rangelands should have stock excluded. Four hundred and nine square miles are involved in the exclusion.

The remaining 1 138 square miles of the lease could be grazed with care. Some areas on the south, notably Horseshoe pastures are in good condition and have only been recently used.

A sheep unit capacity of 14 000 is recommended for the property. This is substantially below the E.C.C. current for the property.

The area of country to be excluded includes the tributary plains below the confined drainage of the south branch and the plains associated with the north and middle branches.

Traverse Summary - 97 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	34	None	36	Pristine	3
Sheeting	24	Sealing	36	Good	11
Surface redistribution	35	Minor rilling	16	Vegetation degraded	56
Hummocking	7	Stripping	8	Vegetation degraded; some erosion	26
Major drift	0	Lower slope gullies	3	Vegetation degraded; major erosion	4
		Upper & lower slope gullies	1		

STATION THREE RIVERS 1547 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	74	+		
	Peak Hill	1	+		
Stony S.G.F.	Jamindie	137	+		
	Collier	23	+		
	Phillips	24		+	
	George	5	+		
	Beasley	2	+		
	Thomas	35	+		
Stony Chenopod	Bryah	98		+	
	Durlacher	208		+	
	Horseshoe	35	+		
Chenopod	Warri	155		+	
	Peedawarra	6			+
	Jingle	3		+	
Wandarrie	Flood	45		+	
	Doolgunna	14		+	
	Landor	26		+	
	Blech	2		+	
Mulga S.G.F.	Three Rivers	437		34	403
	Frederick	148		+	
Sand dune Halophyte					
Sandplain	Divide	41	+		
River	Gascoyne	28			
Total area on Catchment		1547	353	785	409

Area to be removed from use 409 Sq Miles

Area available for grazing 1138 Sq Miles

Sheep Unit Capacity (S.U.C.) 14 000

WALDBURG STATION — UPPER GASCOYNE SHIRE

Waldburg station is entirely within the catchment and is found on the Mt. Egerton four-mile sheet. It is an inherently poor property and is virtually abandoned at present.

Nine traverse recordings were made on four rangelands and two query points were selected on the property.

The lease is on the edge of the Bangemall province and suffers from the disability associated with such poor producing rangelands as Augustus, Jamindie, Collier and George. These make up almost 75 per cent of the available area. It is not surprising therefore that this property has been so little used. Yet the E.C.C. of 1 to 35 appears to be very much greater than would be prudent.

None of the property should be removed from the permissable stocked area. However, some reduction in stocking rate is desirable. A sheep unit capacity of about 3 980 sheep is recommended.

Traverse Summary - 9 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	44	None	44	Pristine	0
Sheeting	56	Sealing	45	Good	11
Surface redistribution	0	Minor rilling	0	Vegetation degraded	78
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	
Major drift	0	Lower slope gullies	11	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION WALDBURG 512 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	208	+		
	Agamemnon	3	+		
	Diorite	1	+		
Stony S.G.F.	Jamindie	136	+		
	Phillips	27	+		
	Collier	22	+		
	George	14	+		
Stony Chenopod	Durlacher	25		+	
	Woodlands	10	+		
	Bryah	3		+	
Chenopod	Warri	14		+	
Wandarrie					
Mulga S.G.F.	Three Rivers	40		+	
	Frederick	9		+	
Sand dune Halophyte					
Sandplain					
River					
Total area on Catchment		512	421	91	Nil

Area to be removed from use Nil Sq Miles

Area available for grazing 512 Sq Miles

Sheep Unit Capacity (S.U.C.) 3 980

WANNA STATION — UPPER GASCOYNE SHIRE

Wanna Station forms part of the divide on the north side of the catchment and only half of it occurs on it. It is found on the Edmund four-mile sheet.

Twelve traverse observations were made, but no query points were selected on the property.

Only a very small area, 71 square miles, is other than hill or stony short grass-forb pastures. However, unless supervision of use is initiated it can be expected that these areas will be subjected to excessive use leading to erosion and degradation.

No part of the station is recommended for remedial treatment, but there should be some substantial changes in the permitted carrying capacity. The present E.C.C. of 1:30 acres is grossly excessive when the ratio of hill country to the remainder is considered Stock numbers on the catchment area should be limited to 4 000 sheep. Most animals are carried on the catchment area.

Traverse Summary - 12 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	85	None	66	Pristine	0
Sheeting	15	Sealing	22	Good	0
Surface redistribution	0	Minor rilling	12	Vegetation degraded	100
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	0
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION WANNA 1019 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Augustus	351	+		
Stony S.G.F.	Jamindie	43	+		
	George	27	+		
	Collier	14	+		
Stony Chenopod	Kurubuka	30		+	
	Nadarra	20		+	
	Sugarloaf	15		+	
Chenopod	Bibbingunna	4		+	
Wandarrie					
Mulga S.G.F.					
Sand dune Halophyte					
Sandplain					
River	Gascoyne	2	+		
Total area on Catchment		506	437	69	

Area to be removed from use - Sq Miles

Area available for grazing 506 Sq Miles

Sheep Unit Capacity (S.U.C.) 4 000

WOODLANDS STATION MEEKATHARRA SHIRE

Woodlands Station lies entirely within the catchment and is found on the Mt. Egerton four-mile sheet.

One hundred and twenty seven traverse recordings were made on thirteen rangelands and eleven query points were selected on the property.

Almost three-quarters of the property consists of hill and stony short grass-forb pastures of very low carrying capacity and limited accessibility. The more easily grazed areas such as Bryah, Three Rivers and Frederick have therefore been severely eroded and degraded. They should be removed from the stocked area. The affected areas comprise 78 square miles.

The remaining 757 square miles can be grazed, but at lower rates than the current E.C.C. A sheep unit capacity of 6 000 is recommended to be increased to 7 000 once the excluded areas have rehabilitated. Some care should be taken with sections of Jamindie rangeland particularly on slopes below the hills south of the homestead where incipient gullying is a feature.

The areas proposed for exclusion lie in the valley which passes through the homestead towards Mt. Augustus.

Traverse Summary - 127 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	43	None	51	Pristine	0
Sheeting	18	Sealing	24	Good	7
Surface redistribution	36	Minor rilling	4	Vegetation degraded	50
Hummocking	2	Stripping	11	Vegetation degraded; some erosion	39
Major drift	1	Lower slope gullies	9	Vegetation degraded; major erosion	4
		Upper & lower slope gullies	1		

STATION WOODLANDS 835 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	P
Hill	Augustus	279	+		
	Mulgul	6	+		
	Diorite	1	+		
Stony S.G.F.	Jamindie	215		+	
	Collier	78		+	
	George	37	+		
Stony Chenopod	Woodlands	10	+		
	Sugarloaf	1	+		
	Bryah	3			3
Chenopod	Warri	27		+	
Wandarrie	Flood	39		+	
	Blech	4		+	
	Bubbagundy	11		+	
Mulga S.G.F.	Three Rivers	87		16	71
	Frederick	16		12	4
Sand dune Halophyte					
Sandplain	Divide	21	+		
River					
Total area on Catchment		835	354	403	78

Area to be removed from use 78 Sq Miles

Area available for grazing 757 Sq Miles

Sheep Unit Capacity (S.U.C.) 6 000

YARLARWEELOR STATION MEEKATHARRA SHIRE

Not all of Yarlarweelor lies on the catchment, approximately half occurs on the Murchison River watershed. The 500 square miles of Gascoyne catchment area on Yarlarweelor occurs on the Robinson Range four-mile sheet..

Twenty six traverse recordings were made on five rangelands and four query points were selected on this property.

The lease has large areas of hill and stony short grass-forb country not prone to erosion. The areas of erodible country are limited and very little used. This applies particularly to Three Rivers rangeland on the north near Yarlarweelor Creek which is ungrazed at present.

No area is considered in need of remedial stocking so the whole of the property on the catchment may continue to be used. The E.C.C. of 1:45 is comparatively high.

The sheep unit capacity under supervised use should be 6 200 for the catchment area.

Traverse Summary - 26 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	62	None	69	Pristine	8
Sheeting	19	Sealing	31	Good	8
Surface redistribution	19	Minor	0	Vegetation degraded	77
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	7
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

STATION YARLARWEELOR 1088 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Peak Hill	6	+		
	Augustus	8	+		
Stony S.G.F.	Phillips	114	+		
	Thomas	49	+		
	Beasley	44	+		
	Jamindie	7	+		
	George	3	+		
Stony Chenopod	Durlacher	54		+	
	Yinnietharra	10		+	
	Horseshoe	4		+	
Chenopod	Warri	1		+	
Wandarrie	Flood	61		+	
	Landor	38		+	
	Winmar	35	+		
Mulga S.G.F.	Three Rivers	52		+	
	Frederick	3		+	
	Clare	3		+	
Sand dune Halophyte					
Sandplain					
River	Gascoyne	8	+		
Total area on Catchment		500	274	226	

Area to be removed from use Sq Miles

Area available for grazing 500 Sq Miles

Sheep Unit Capacity (S.U.C.) 6 200

Yinnietharra station is wholly on the Gascoyne catchment and is found on the Mt. Phillips and Glenburgh four-mile sheets.

Seventy traverse recordings on seven rangeland types were made and three query points were selected on the property.

Stony short grass-forb and hill pastures make up over half the property, but stony chenopod pastures make up over one-third. As part of the property has never been used and as large numbers have been carried, the more accessible and durable pastures have received considerable use leading to degradation and erosion. The pastoral inspection report of 1920 refers to good open saltbush plains on many parts of the property, only remnants of which are present now.

The Durlacher and Yinnietharra rangelands are seriously eroded and degraded and parts should be removed from the available grazing land. These pastures are found north of the Thomas River - Gascoyne confluence and from there extend to the Thirty-three River and Morrissey Creek. They also occur west of the Thomas River - Gascoyne confluence. The area involved is 168 square miles.

The remaining 657 square miles of available country could be grazed but at rates lower than the present E.C.C. A sheep unit capacity of 7 600 is recommended. Once recovery is achieved a sheep unit capacity of 10 500 is recommended.

Traverse Summary - 70 observations

Wind Erosion	%	Water Erosion	%	Condition	%
None	18	None	23	Pristine	0
Sheeting	26	Sealing	11	Good	7
Surface redistribution	53	Minor rilling	20	Vegetation degraded	49
Hummocking	3	Stripping	30	Vegetation degraded; some erosion	42
Major drift	0	Lower slope gullies	16	Vegetation degraded; major erosion	2
		Upper & lower slope gullies	0		

STATION YINNIETHARRA 789 Square Miles

Pasture Group	R.L.T.	Sq. Miles	A	S	R
Hill	Agamemnon	32	+		
	Augustus	20	+		
	Glenburgh	7	+		
Stony S.G.F.	Phillips	318		+	
	James	50		+	
	Mabbutt	9		+	
	Thomas	2		+	
Stony Chenopod	Durlacher	195		70	125
	Yinnietharra	78		35	43
	Nadarra	25		+	
	Bryah	7		+	
Chenopod					
Wandarrie	Winmar	5		+	
Mulga S.G.F.					
Sand dune Halophyte					
Sandplain					
River	Gascoyne	77		+	
Total area on Catchment		*825	59	598	168

Area to be removed from use 168 Sq Miles

Area available for grazing 657 Sq Miles

Sheep Unit Capacity (S.U.C.) 7 600

CLIMATE OF THE GASCOYNE CATCHMENT

INTRODUCTION

The Gascoyne catchment lies in an area of erratic and unreliable rainfall. An annual rainfall of about eight inches is received over the catchment and although half is received in summer and half in winter, the analysis of growth data shown here demonstrates that the winter precipitation produces more growth periods.

The major summer weather controls affecting vegetation response are the cyclonic disturbances which usually move into the area during summer in a southern or south-easterly direction from the coast between Port Hedland and Carnarvon. The accompanying rain is usually heavy, though cyclonic disturbances with no rain, but with high winds have been recorded, e.g. cyclone Ingrid in 1970 and cyclone Mavis in 1971. Cyclones cannot be relied upon every year and the table of growth periods indicates that they are erratic in incidence. In the absence of cyclonic disturbances a recurrent pattern of high pressure ridges, and subsequent troughs move eastwards over the area. These bring little or no rain to the region. In some circumstances heavy, sporadic rainfall from thunderstorm activity can be important locally.

In winter the southern anti-cyclonic systems reach their northern limit in the Gascoyne area and slightly to the north. These bring rain and high winds to the catchment. It should be noted, however, that only intense depressions penetrate the catchment so that rainfall in this season, too, cannot be relied upon.

In spring the rising temperatures further north in the tropics, maintain low pressure systems which develop as troughs towards the south and adversely affect the movement northwards of late anti-cyclones from the south. In this period the rainfall is low. The driest months of the year are recorded during the spring season from September to November.

A reverse situation applies during autumn, from March to early May, when the northern low pressure systems relax and the southern anti-cyclones move north. During this period the chances of rain from northern systems becomes increasingly remote, while the possibility of rain from the southern systems increases. As a general rule, though, rainfall during autumn is low, and only exceeds the drier spring in total increment.

CLIMATIC FACTORS

1. TEMPERATURE

The catchment is characterised by high summer maximum temperatures and low winter maxima. The daily fluctuations are between 20° and 30°F. Table I shows the daily maxima and minima for each month at two stations, Peak Hill in the east and Gascoyne Junction in the west. The lack of topographical change and the very size of the climatic controls in relation to the relatively small size of the catchment with its main axis east-west, would preclude any chance of great deviation from the means implied between these two stations. E.A. Fitzpatrick (priv. comm.)

TANK EVAPORATION IN INCHES
(Australian sunken tank)

Based on observations for 70 stations with records ranging from 5 to 82 years.

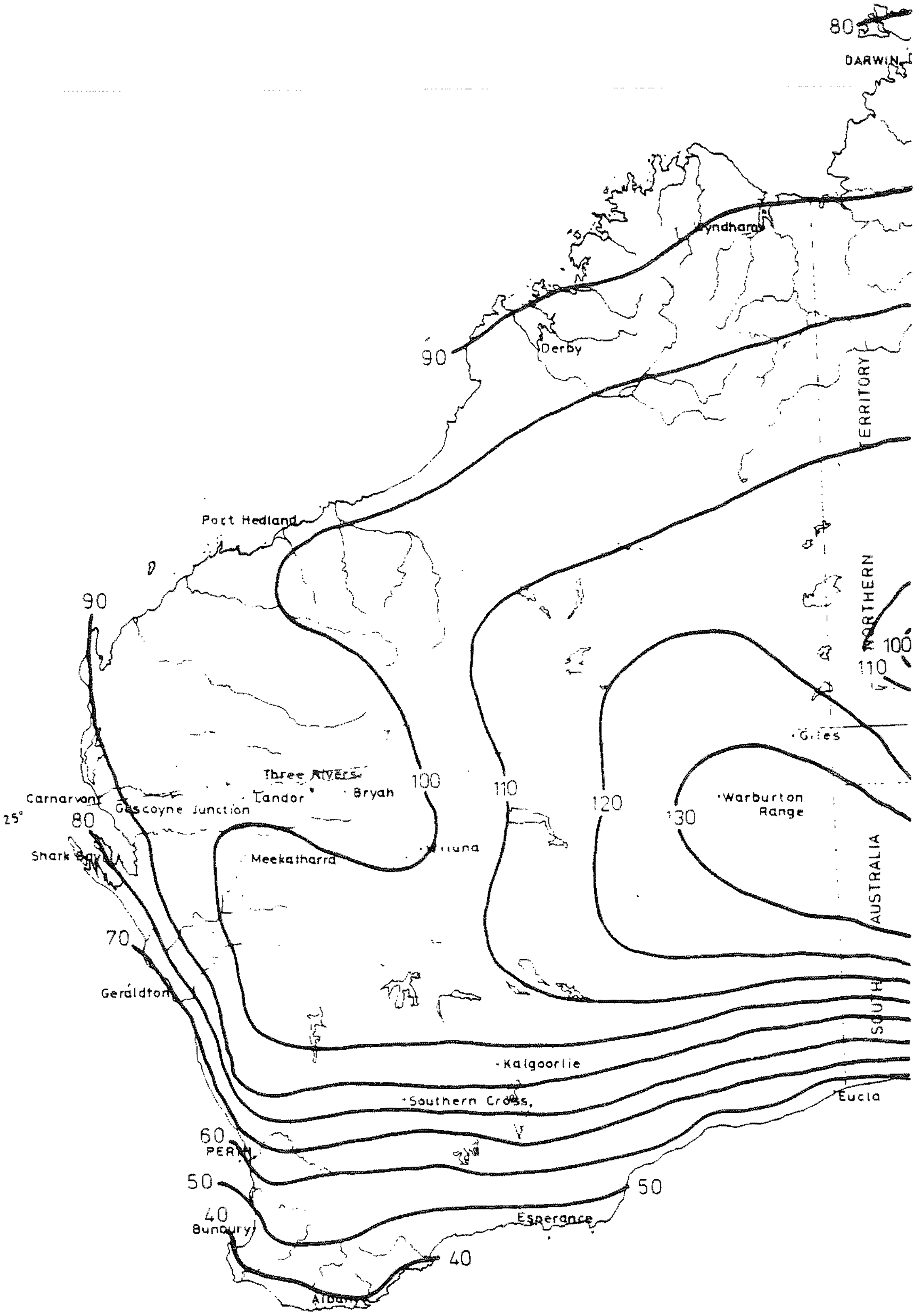


Figure 1 - Tank evaporation in inches,
(Australian Sunken Tank) Western Australia.
by courtesy Bureau of Meteorology.

advises that Penman evapo-transpiration data calculated from maximum temperatures and dew points at these two stations vary very little, indicating a uniformity in temperature and humidity across the catchment.

TABLE 1. Mean temperatures at two stations

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Peak Hill												
Mean Max.(^{O}F)	99.5	98.0	94.2	85.3	74.5	67.3	66.0	70.2	78.2	85.1	93.6	99.2
Mean Min.(^{O}F)	74.4	73.9	70.2	62.5	53.6	47.6	45.5	47.6	52.9	58.5	66.5	72.7
Gascoyne Junction												
Mean Max.(^{O}F)	104.6	102.5	98.0	91.3	81.6	74.7	72.5	76.7	82.7	88.9	95.3	100.0
Mean Min.(^{O}F)	73.8	73.2	71.3	64.1	56.3	49.5	48.1	49.6	53.0	58.9	64.4	68.6

Frosts occur irregularly in winter, but are rarely severe enough to affect vegetation in a significant way. From November to March temperatures are significantly above the comfort zones acceptable to western civilisation.

2. HUMIDITY

In this environment humidity is usually low except after rainfall. The mean and 9 a.m. average monthly humidities are shown in Table 2 for Peak Hill and Gascoyne Junction respectively.

TABLE 2. Relative humidity for two stations

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Peak Hill Relative Humidity (mean daily)	31	34	34	40	48	55	53	48	37	32	29	31
Gascoyne Junction Relative humidity (9 a.m.)	42	41	42	48	55	65	70	51	47	41	43	42

3. EVAPORATION

Evaporation is extremely high as the map of state evaporation shows (Figure 1.) The catchment lies entirely within the area of 90" to 100" of annual evaporation. Values of evaporation of up to 15 inches are recorded in the area for the month of January.

The graph in Figure 2 shows potential evaporation for Peak Hill which has been calculated from data supplied to E.A. Fitzpatrick. The values (priv. comm.) are an approximation of the Penman value calculated by a method devised by Fitzpatrick (1968). The values have been calculated for pentad (five day) periods. The particularly low pentad values for the winter period emphasise the significance of winter rainfall in the area, for although it may be lower than the total increment of summer rain it undoubtedly is more effective.

The difference in effect between winter and summer rainfall has profound influence upon management patterns which should be adopted for the maintenance of the pastoral resource in the area. The scheduling of rest or "spelling" periods for maintenance should obviously be geared to the winter rainfall period. Wilcox (U.S.D.A. in press) has pointed out that shrubby pasture development in Australia has depended upon the effectiveness of the more reliable winter rainfall. Regeneration of shrubby pastures from germination to establishment appears to depend upon effective late summer rains. These excess rainfall years occur irregularly, but a pattern of management which aims at rehabilitation must allow for freedom from grazing during summer excess rainfall years and for the following winter season.

Rainfall

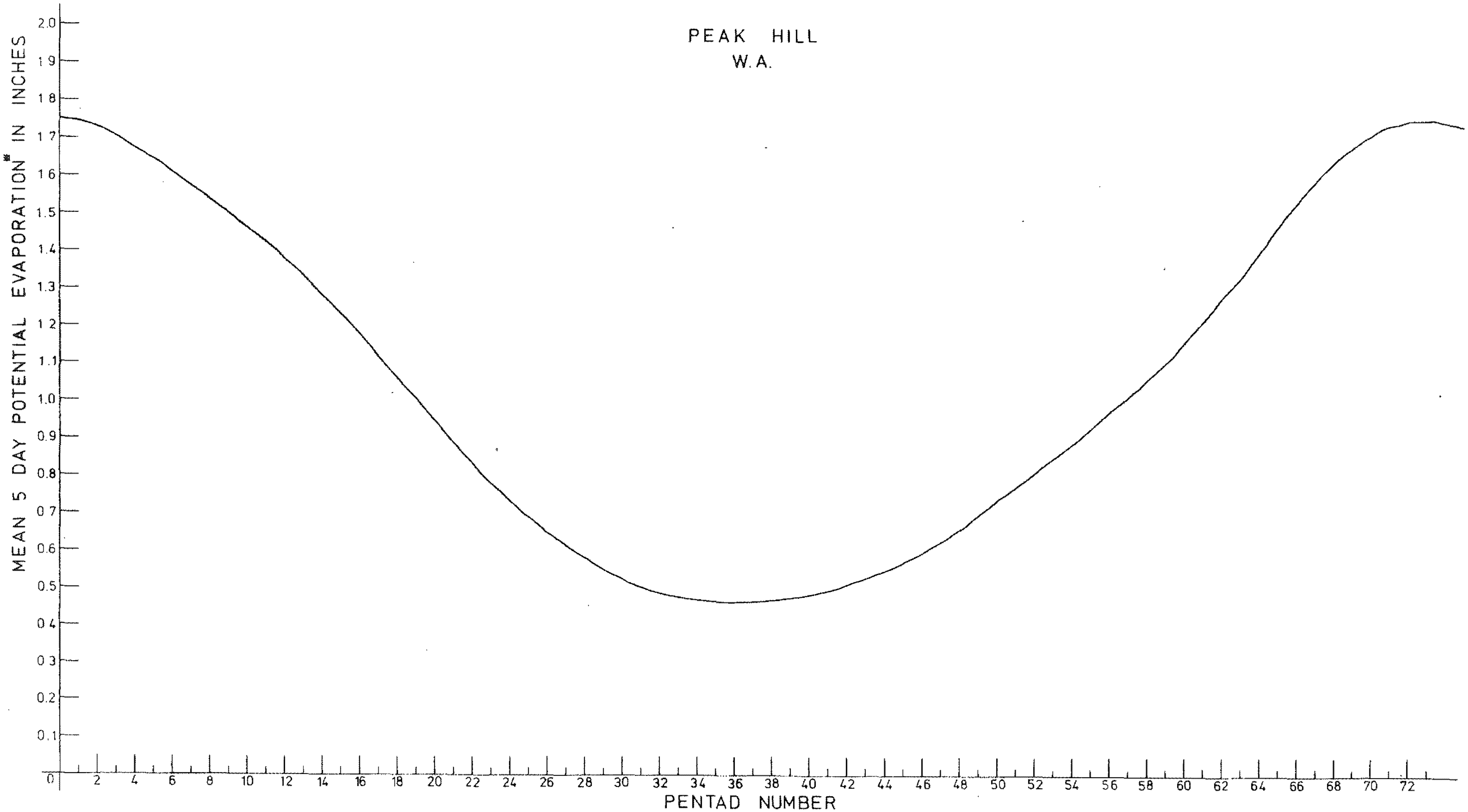
Rainfall data for the catchment has been treated for four stations. These are Bidgemia in the south-west, Minnie Creek in the north-west, Yarlarweelor in the south-east and Mount Augustus on the mid-north boundary. There were no recording stations in the far east of the catchment with records of sufficient length for proper evaluation. The recording station at Peak Hill ceased operation some years before the survey so it was excluded from the data evaluated.

Average monthly rainfall data for the four stations are included in Table 3.

TABLE 3. Average monthly and total rainfall for four stations, varying years to 1968

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Bidgemia (70 years)	122	99	107	47	109	128	95	48	9	11	9	14	798
Minnie Creek (68 years)	117	157	90	64	109	130	72	45	7	9	10	35	845
Yarlar-weelor (43 years)	117	144	158	49	96	110	52	26	9	6	15	31	813
Mt. Augustus (63 years)	154	180	115	60	96	118	58	30	9	8	16	27	871

Figure 2 - Mean 5 day
potential evaporation in inches for
Peak Hill Western Australia.



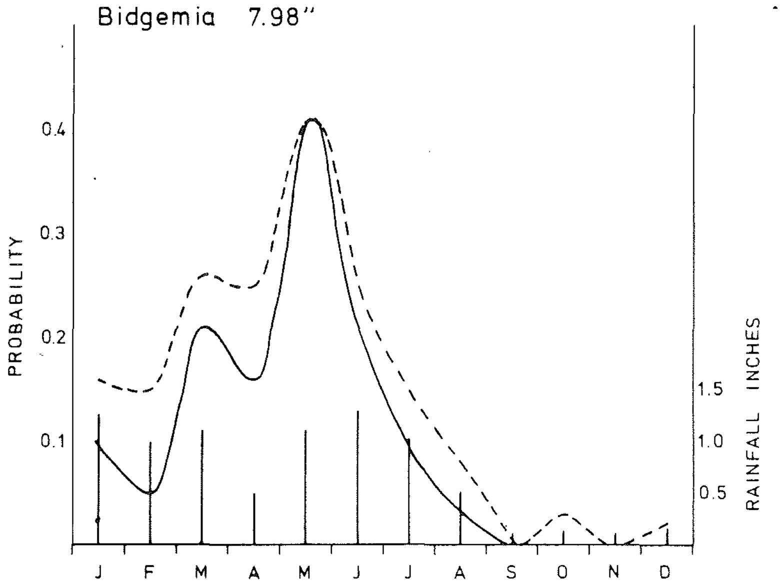
*Potential Evaporation is an approximation of Penman value calculated by method described by Fitzpatrick (1968)

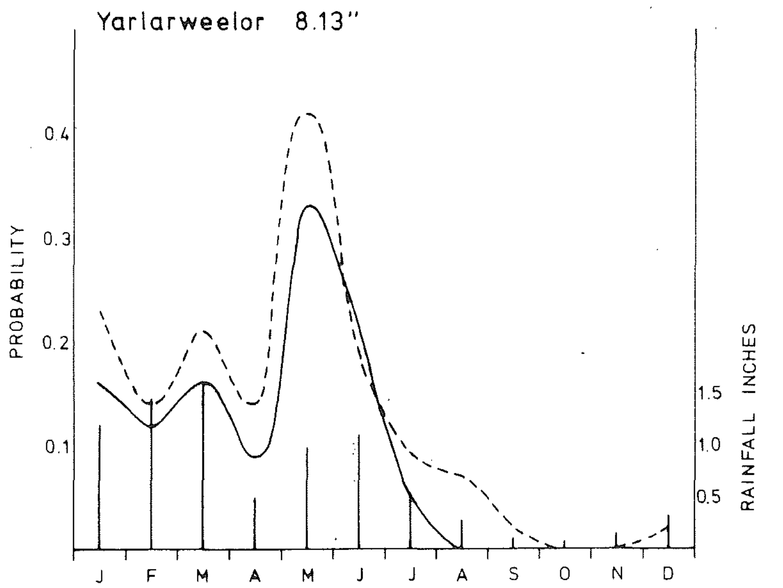
6.7

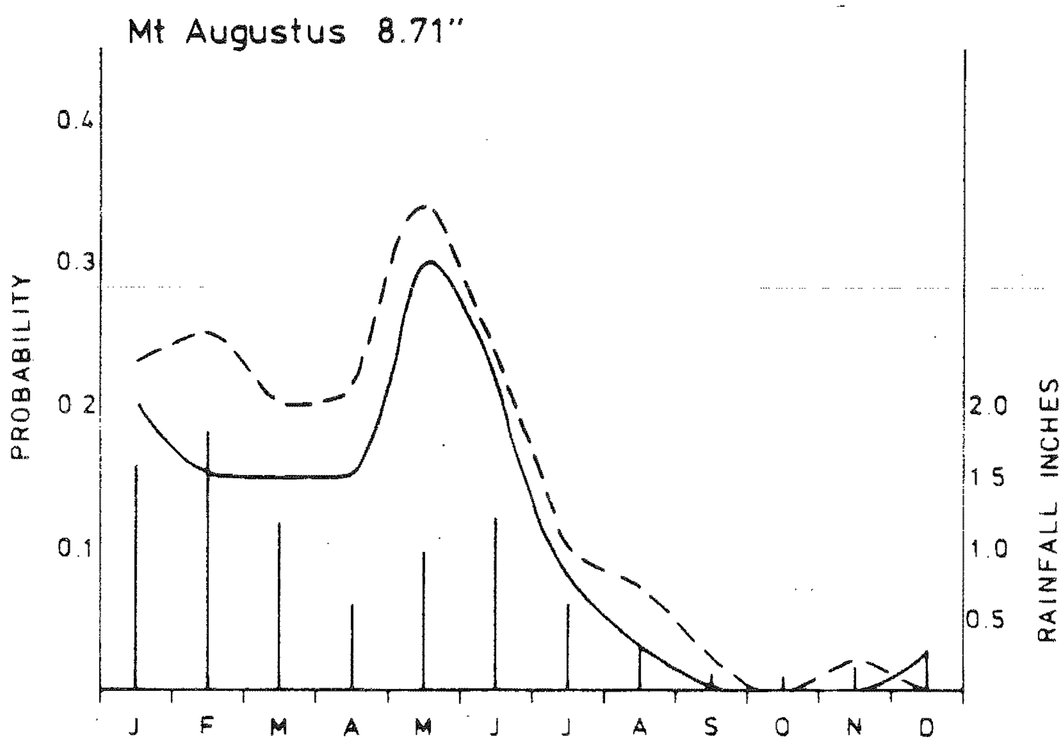
Figure 3 - Probability of positive soil water store (less than - 15 bars) at four stations plotted for periods of more than 30 days in each month positive store (unbroken line ——) and for periods of more than 15 days positive store (broken line - - -).

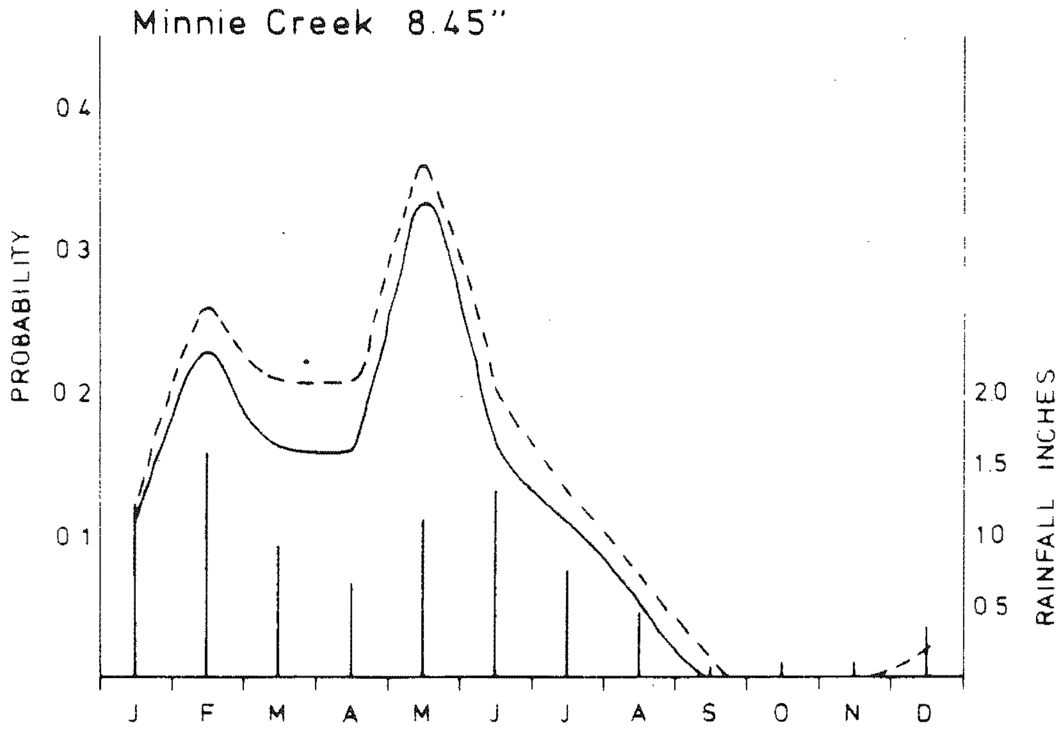
Rainfall is shown as vertical bars in inches for the four stations.

Probability of positive soil water store (less than -15 bars) at four stations; plotted for periods of more than 30 days in each month positive store (unbroken line —) and for periods of more than 15 days positive store (broken line ---).
Rainfall is shown as vertical bars in inches for the four stations.






Mt Augustus 8.71"
PROBABILITY
0.4
0.3
0 2
0.1
RAINFALL INCHES
2.0
1 5
1.0
0.5
J F M A M J J A S O N D


Minnie Creek 8.45"
PROBABILITY
0 4
0 3
0 2
0 1
RAINFALL INCHES
2.0
1.5
10
0 5
J F M A M J J A S O N D

It will be observed that the annual average for summer months are greater than those for the winter for all stations except Bidgemia where the averages for the January to March period is approximately the same as that for the May to July period. An examination of the daily rainfall records indicates greater, but more erratic falls during summer at the other stations, presumably as a result of cyclonic disturbances.

As already discussed, rainfall effectiveness rather than average rainfall is the consideration in pasture management. It is effective rainfall and its use which must be considered in the discussion on maintenance of the resource and of the processes which will facilitate regeneration. The daily rainfall data was therefore analysed on a computer programme prepared by E.A. Fitzpatrick *et al.* (1967). The programme allows for changes in soil water availability due to rainfall and evapotranspiration. E.A. Fitzpatrick supplied the programme information which was translated for use on PDP-6 computer from the CDC 3600 by Mr. L. Heinrich of the Department of Agriculture.

The daily rainfall is variously allotted to Store A (less than -15.0 bars potential) and to Store B (greater than -15 bars potential) and to run-off and deep water percolation. The models were validated on information gained in the Alice Springs area. The climate and vegetation at that station bears a striking resemblance to that of much of the catchment so the model system developed was used in the evaluation of catchment rainfall data. Other data developed for the programme includes the estimated potential evapotranspiration or adaptation of Penman's evapotranspiration obtained by a method of Fitzpatrick's (1968) involving 9 a.m. dew points and daily maximum temperatures. Extraction of moisture from the soil is allowed for at varying levels dependent upon the amount of storage in Store A, the extent to which Store B is used and upon the time of year that the moisture is actually used.

Treating the daily rainfall in pentad (5 day) groupings, the rainfall records for the above stations were analysed for the duration of growth and non-growth or drought periods. This treatment clearly allows for the differentials imposed by season and is a close approximation to the field situation. The results obtained are a better representation of actual rainfall effectiveness than a study of annual, or even monthly values only. Growth was assumed to cease in that pentad when Store A reached zero. Provided that Store B was not exhausted in the ensuing period it was assumed that growth would commence again with a subsequent rainfall. If, however, Store B was exhausted, rainfall had to exceed the value of 0.5 times the potential evaporation for the particular period before it could be assumed that growth would recommence. This demand for additional water to initiate growth is well known after prolonged droughts and supports the contention of Fitzpatrick *et al.* that more stringent conditions for rainfall to be effective are required at these times.

The accompanying graphs in Figure 3 show the average rainfall as vertical bars for the four stations for each month. Curves of monthly probabilities for rainfall to exceed the requirements for growth for greater than 15 and greater than 30 day periods respectively are also shown. A number of features of the rainfall patterns are worthy of mention.

Rainfall sufficient for growth ceases effectively in August of each year and, at Yarlarweelor, in July. Although small amounts have been recorded for December, their very unreliability makes them insignificant.

Winter rainfall is more reliable at each station, with Bidgemia, the south-west station, having a decided peak of reliability in May. Bidgemia is closer to the influences of the winter anti-cyclones and would be expected to receive more rainfall during this period than the other properties. Summer rainfall, by contrast, has a much reduced reliability though there are regional differences here again. The northern stations Mt. Augustus and Minnie Creek, have a higher probability for effective summer rain than have Yarlarweelor and Bidgemia, particularly when the 30 day growth period is considered.

The 15 day and 30 day growth period probabilities follow closely related patterns. However, in any consideration of rainfall effectiveness, the 30 day period is probably the only significant one for the growth of grasses and adequate growth of annuals. The 15 - 30 day period is very likely to be adequate for the growth of perennials, but its effect on annual growth will be indifferent. The importance of perennial vegetation in productivity on the catchment is therefore quite clear since the 15 day rainfall growth occurs more frequently. Areas which have been denuded of perennial vegetation have a lower chance of annual production than areas which have not been so depleted.

Table 4 shows the expected number of growth periods and non-growth periods at the various stations during the summer and winter periods. At each station a growth period of 30 days or more can be expected annually in winter and summer, but growth periods of 60 days or more occur less regularly. There is a 1:4 chance of a drought period greater than three months duration at Yarlarweelor, descending to a 1:8 chance at Bidgemia. At Yarlarweelor, a drought period of 465 days was recorded on one occasion in 43 years. There were two droughts which lasted 285 days or more and four which lasted more than 250 days. At Bidgemia the longest drought period was 255 days but five others lasted 210 days. Complete years without effective rain can occur therefore at Yarlarweelor, and may even continue to include drought in either the succeeding summer or winter, but droughts of this magnitude do not occur at Bidgemia. Minnie Creek and Mt. Augustus fall between these two stations in reliability.

The analysis of the data shows that drought periods have occurred on a number of occasions, particularly in 1935 to 1937 and in 1943 and 1944. However, good seasonal sequences are also experienced and it is these which should be utilised to maintain the productivity and the resources base.

It is not possible from the data to predict any temporal trends in rainfall incidence and therefore of pastoral productivity. The inherent unreliability of rainfall should be recognised and included in the total management scheme. The increased reliability of positive water storage for periods of about 15 days makes it clear that management geared to perennial shrubs and grasses should be adopted as these are adapted to utilise smaller increments of rain than are the more spectacular annual species which need prolonged wet conditions to achieve their maximum growth.

It is possible to relate management plans with expected rainfall Work by Burbidge (1945), Trumble (1932) and Wilcox (unpub.) indicates that the optimum germination temperature for saltbushes and bluebushes is about 60^{o}F, which corresponds to March to May rainfall. Rain can be expected with some confidence at this time in the catchment. Management schemes which will promote the germination and establishment and therefore regeneration of these important browse plants will clearly involve spelling, during this period and the following winter. If winter rains fail, grazing must not recommence till a further season of effective rain occurs. Other germination criteria are not clearly known, but field observation indicates a response situation similar to this for other shrubs. Therefore, while drought is the memorable characteristic of the environment there is obviously a rainfall pattern which can be utilized to maintain and to rehabilitate pastures.

BIBLIOGRAPHY

Burbidge, N.T. 1945. Germination studies of Australian chenopodiaceae with special reference to the conditions necessary for regeneration. Trans. Roy. Soc. S. Aust. 69 : 73-85.

Fitzpatrick E.A., Slatyer R.O. and Krishman A.I. 1967. Incidence and duration of periods of plant growth in Central Australia as estimated from climatic data. Agr. Meteorol., 4 (1967) 389-404.

Fitzpatrick E.A. 1968. An appraisal of advectional contributions to observed evaporation in Australia using an empircial approximation of Penman's potential evaporation. J. Hydrol 6(1) : 69-94.

Trumble, H.C. 1932. Preliminary ivestigations on the cultivation of indigenous saltbushes in an area of winter rainfall and summer drought. Jour. CSIRO 5 : 152-161.

TABLE 4

Table showing the number of years and expected number of occasions per year in which growth periods and non-growth (drought) periods occurred in summer and winter at four stations.

A. GROWTH PERIODS	Summer (Jan-Nov)	Winter (May-July)	Annual
Minnie Creek (61 years to 1968)			
Greater than 15 days			
- No. of years	36	42	
- expected number	0.59	0.69	1.28
Greater than 30 days			
- No. of years	30	37	
- expected number	0.49	0.61	1.10
Greater than 60 days			
- No. of years	16	25	
- expected number	0.26	0.41	0.67
Mt. Augustus (61 years to 1968)			
Greater than 15 days			
- No. of years	41	41	
- expected number	0.67	0.67	1.34
Greater than 30 days			
- No. of years	30	36	
- expected number	0.49	0.59	1.08
Greater than 60 days			
- No. of years	19	28	
- expected number	0.31	0.46	0.77
Bidgemia (61 years to 1968)			
Greater than 15 days			
- No. of years	35	49	
- expected number	0.57	0.80	1.37
Greater than 30 days			
- No. of years	22	44	
- expected number	0.36	0.72	1.08
Greater than 60 days			
- No. of years	11	37	
- expected number	0.18	0.61	0.79

TABLE 4 Continued

Yarlarweelor (43 years to 1968)	Summer (Jan-Nov)	Winter (May-July)	Annual
Greater than 15 days			
- No. of years	25	30	
- expected number	0.58	0.70	1.28
Greater than 30 days			
- No. of years	19	25	
- expected number	0.44	0.58	1.02
Greater than 60 days			
- No. of years	12	15	
- expected number	0.28	0.35	0.63

B. NON-GROWTH PERIODS

Minnie Creek	Summer (Jan-Nov)	Winter (May-July)	Annual
Greater than 15 days			
- No. of years	41	14	
- expected number	0.67	0.23	1.00
Greater than 30 days			
- No. of years	26	9	
- expected number	0.42	0.15	0.57
Greater than 60 days			
- No. of years	15	4	
- expected number	0.25	0.06	0.31
Greater than 90 days			
- No. of years	9	2	
- expected number	0.18	0.03	0.21
Longest drought period			
- 345 days			

Mt. Augustus	Summer (Jan-Nov)	Winter (May-July)	Annual
Greater than 15 days			
- No. of years	36	16	
- expected number	0.59	0.26	0.85
Greater than 30 days			
- No. of years	26	9	
- expected number	0.43	0.15	0.58
Greater than 60 days			
- No. of years	14	4	
- expected number	0.23	0.06	0.29

TABLE 4 Continued

	Summer	Winter	Annual
Mt. Augustus (cont'd)			
Greater than 90 days			
- No. of years	4	4	
- expected number	0.06	0.06	0.12
Longest drought period			
- 435 days			
Bidgemia			
Greater than 15 days			
- No. of years	45	18	
- expected number	0.74	0.29	1.03
Greater than 30 days			
- No. of years	32	12	
- expected number	0.52	0.20	0.72
Greater than 60 days			
- No. of years	15	6	
- expected number	0.24	0.10	0.34
Greater than 90 days			
- No. of years	6	5	
- expected number	0.10	0.08	0.18
Longest drought period			
- 255 days			
Yarlarweelor			
Greater than 15 days			
- No. of years	20	14	
- expected number	0.46	0.32	0.78
Greater tha- 30 days			
- No. of years	15	9	
- expected number	0.35	0.21	0.56
Greater than 60 days			
- No. of years	7	7	
- expected number	0.16	0.16	0.32
Greater than 90 days			
- No. of years	3	7	
- expected number	0.07	0.16	0.23
Longest drought period			
- 465 days			

THE GEOMORPHIC PROVINCES AND THE ASSOCIATED RANGELANDS

The Gascoyne catchment lies between longitudes 119° 45' and 113° 50' and between latitudes 23° 45' and 25° 30'. It falls within the Murchisonia province described by Jutson (1934). Salinaland, or the area of internal (endoreic) drainage, lies to the east and Pilbaraland lies to the north. It forms a broad ellipse about 350 miles long and 120 miles wide with the long axis lying east-west. The valleys of the rivers are extremely large and ill-defined and in this way they differ from the well defined valleys of the northern Pilbaraland.

In the east and north the watersheds between the Ashburton, Minilya and Murchison catchments are clearly visible. In the south-west the sandplain divide between the Gascoyne and the Wooramel rivers is indistinct, though the erosional divide between these two is quite clear south of Dairy Creek Station.

The area of the catchment is 27,382 square miles and is located principally on the Precambrian Yilgarn shield although it also includes the Permian basin in the west, which is south of Minnie Creek homestead and west of Dairy Creek homestead. The geologic origin has conferred some differences in topography which are principally characterised by a lack of relief in rangeland types associated with the Permian basin. Relics of the Precambrian such as Mt. Augustus, Mt. Gascoyne and Mt. Egerton extend as much as 2500 feet above the plateau plain which itself attains a height of about 2000 feet above sea level in the east.

Although the area is designated as the Gascoyne Catchment, the Gascoyne itself does not drain the whole through its length. Its major tributary, the Lyons River carries the drainage of the northern part of the catchment. It rises on Woodlands Station and proceeds west towards Minnie Creek where it turns abruptly south to join the Gascoyne just east of the Kennedy Range at Jimba Jimba homestead. Jutson (q.v.) considers that the present west-flowing Lyons was formerly part of the Minilya River, and that the rapid advance of the lower south-flowing Lyons through the soft Permian strata has resulted in the capture of the upper Lyons, leaving the present Minilya River as a diminished stream.

Both these rivers slowly descend to the sea at rates of about six feet per mile as measured by Gregory (1858). They are fed by numerous streams and rivers, some of which are significant though, like the Gascoyne and Lyons, quite intermittent. The Frederick and Edmund rivers and the Elliott and Kurubuka Creeks join the Lyons River, draining the divide on the north. The Gascoyne is fed by Dalgety Brook and the Daurie, Pells, Bush, and Durlacher Creeks.

The catchment can be divided into six physical provinces which owe their origin to geology and current landforms. Many of the rangelands described belong exclusively to particular provinces.

1. THE EASTERN TRIBUTARY PLAINS

This province forms the eastern divide and extends between the Bangemall Province and the Eastern Uplands till it reaches the central Archean Block. It therefore reaches westwards to about Landor Station

and is characterised by its extensive tributary drainage plains.

Several rangeland types are found within the area and these include the sandplain Divide which forms the watershed here between Salinaland and Murchisonia. Thomas, the breakaway type, is also represented on the watershed. Beneath Thomas rangeland the tributary sheet drainage plains of Three Rivers, Flood and Macadam type stretch out towards the trunk drainage. Areas of Durlacher type, the gneissic or quartz covered plains, are also found beneath the dissected breakaways. The floodplains discharge into the calcreted drainages of Warri type and into the major rivers and creeks of Gascoyne rangeland type.

Where the slope is favourable the alluvial plains have been modified to produce the barred and arcuate groved patterns of mulga found in Frederick type. These may lead to Three Rivers type, or may alternatively discharge directly into the lines of major flow. Belts of wandarrie grass banks typified by Landor, Doolgunna and Bubbagundy type are found associated with the areas of tributary sheet flow and always marginal to them. Where the marginal plains of the river systems are large, Jingle rangeland type becomes important enough to be described. Sluggish drainage tracts such as Peedawarra type characterise the lowest parts of the tributary drainage plains. Large sandy bank pastures of the Stonehut type are found in the west of the province.

The relief here is provided by low hills which rise a few hundred feet above the plains. These are mainly derived from Bangemall series sediments so that the rangeland types associated with this geological formation such as Augustus, George, Collier, Jamindie and Bryah are also found regionally. However, it should be noted that these never assume the importance they have in the Bangemall Province.

2. THE BANGEMALL PROVINCE

This province extends along the northern side of the catchment where it forms the watershed. The rangeland types are variable, but always are tied to their geologic origin except where their depositional character masks the nature and expression of the underlying rocks.

The rocky divide on the north consists of massive Bangemall (middle pre Cambrian Proterozoic) series ranges where severe dissection of the softer sediments of slates, shales and mudstones has produced a rugged terrain in which sharp cliffs and truncated bottle-necked canyons are common. Minor flattended uplands in the valleys formed in these rugged hills provide the only accessible pastures in this part of the Augustus rangeland type.

The Bangemall series probably extended much further south in geologic time. However, remnants only of these deposits are found today. On the Archean block they are represented by Mt. Gascoyne and Mt. Dalgety. Isolated massive remnants such as Mt. Augustus, Mt. Genoa and Mt. Isabella occur in the Bangemall Province and are now associated with the major drainage plans and not with the watersheds. These are massive sandstone or layered monoliths arising abruptly to up to 2500 feet above drainage plains.

The differences in erodibility of the sediments, quartzites and dolerites of the Bangemall uplands has produced the prominent residual

quartzite ridges of Augustus and George rangeland type. Hills such as Mt. George and Murnang-Yanna have a major influence upon the direction of the major drainages.

The undulating and flatter plains below the hills of Augustus type, such as Collier, Jamindie and Bryah are the dominant rangelands in the province. The platy plains of Jamindie form the major rangeland type. This unproductive rangeland type tends to characterise the depauperate nature of the pastures in the Bangemall block, for, with the exception of the sluggish drainage saline types, Bryah, Kurubuka and Bibbingunna, most of them are inherently poor.

The variable sediments and volcanic flows in the Bangemall block are responsible for minor areas of special rangeland types. Diorite type for example, is often found as remnant isolated dolerite hills and slopes on drainage plains and in hill belts. Mulgul, Woodlands and Sugerloaf types are always associated with the beds of dolomites low in the stratigraphic succession. They are most common in the floors of the broad valleys of the uplands where Mulgul forms low hills in this subgroup of special types.

In the southern part of the Bangemall province the Archean basement is often exposed in the valley bottoms. This is particularly obvious in the broad valleys south of Mt. Egerton on Mt. Clere Station where gneiss and schist of Archean age form special rangeland types within the valleys bounded by the Bangemall hills.

Minor areas of sandplain occur around the bases of Mt. Augustus and hills such as L 17 and may almost be considered as aberrant types in this predominantly strew covered province.

The plains and uplands of the Bangemall block discharge their water into the Lyons River and onto minor tributary drainage plains where Three Rivers, Frederick, Blech and Warri can be found.

Occasionally the major drainages in this and other provinces break their banks. This is most frequent on the bends of rivers and appears to be due to a much greater river flow in recent times. The increased flow on the marginal plains and on tributary plains produces the characteristic pattern and pastures found in Clere rangeland type.

Two rangeland types typical of the Bangemall block should be described. They are drainage forms, and include Bibbingunna, a clay swamp type always associated with confined sub-terminal drainage, and Kurubuka type, an alluvial plain with areas of strew and very reduced slope. Kurubuka type is restricted almost entirely to the area between the Frederick River and the Elliott Creek upstream of the constriction of the Lyons Valley. It appears to be an alluvial plain with a reduced slope through which the Frederick and Elliott have cut channels leaving the plain between them. The plain therefore does not receive run-on from the hills, since the rivers take it. The drainage is extremely sluggish. The plains are usually saline and have the potential to produce halophytic pastures.

3. THE EASTERN UPLAND PROVINCE

This comparatively small province is developed on very much weathered, folded and intruded Archean sediments and igneous rocks. It occurs on the south-east side of the catchment and forms the divide in that area. Peak Hill township and other goldmining centres are found in this province, where local mineralisation is common.

The upper portions of the relief are the essentially low hills such as Mt. Beasley which form the Peak Hill rangeland type. The relief is rarely more than 300 to 500 feet above the plain. Undulating areas of Beasley type, occur below the hills and intrusive quartz ridges, both of which produce the stone mantle on the slopes which are common in the type. The slopes of Beasley rangeland lead towards weathered, strew covered, flatter slopes of Horseshoe type which themselves drain into the major river systems of Gascoyne type.

Some confusion of rangeland types exists near Mt. Labouchre on Milgun Station where Bangemall and Archean based rangelands exist close together.

4. THE ARCHEAN PROVINCE

This province is interposed between the plains and uplands of the east and the Permian basin of the west. It is characterised by abundant, unweathered Archean igneous rocks which, as hill belts and remnants, extend above the restricted drainage plains and flatter areas of the province. The province begins just west of Landor homestead and continues to Minnie Creek, Mt. Sandiman and Dairy Creek. It borders the Bangemall block just south-west of Mt. Augustus. The rivers lose their hitherto broad waterway pattern in the Archean province and are found rather as confined deeply channelled rivers which twist among the stony hills and plains typical of the province.

Although the whole province is elevated, a number of hills provide low relief of up to 500 feet above the plains. These are Mt. Agamemnon Mt. James and Mt. Thomson. Large granite belts can be found in parts of the province, though most of it is formed of more obviously metamorphic rocks such as gneiss and schist. The major granite belt lies near Glenburgh Station though the bald low hills and domes typical of granitic rangeland types can be found on Yinnietharra, Mangaroon and Minnie Creek Stations. The rangeland types found on the hills have been described as Glenburgh and Agamemnon, depending upon the closeness of their affinity with either granite or other basement rocks respectively.

In this report on the catchment no attempt has been made to subdivide the rangeland types further on the basis of their geological control. Highly weathered and altered sediments of the Wyloo group of middle Proterozoic have been included in the metamorphic group of rangeland types, Agamemnon, Phillips and Durlacher. The effects of laterization and weathering produced in Tertiary times have similarly not been distinguished except where dissection has produced strikingly different rangeland types such as Thomas which is characterised by the presence of mesa groups and breakaway cliffs.

Agamemnon, Glenburgh and Thomas rangeland types therefore provide the upper parts of the relief on this catchment. As indicated already they consist of schist hills, gneissic uplands, bald granite hills, and areas of pronounced dissection. Some of the hill belts are very extensive, particularly south of Dairy Creek. They are frequently intruded by dolerite dykes and features such as large quartz ridges are common.

Extensive, undulating areas extend away from the hills and hill belts towards the flatter plains below. The undulating areas, James and Phillips, in both granitic and metamorphic types respectively, have prominent dykes and quartz strike ridges, though these are reduced in the former. There is abundant outcrop particularly in the upper sections, and in James rangeland, the granite-based type, low, bald, tor groups are common. Phillips rangeland type can be variable due to regional geologic changes.

The flatter plains leading to the drainage are characteristically covered with a stony mantle which is predominantly quartz, but locally modified with gneissic material. In the granitic plains the strew is much reduced, a reflection of the less resistant properties of the granite shed. In the lowest parts of the plains, in both Yinnietharra and Durlacher rangelands, the plains have a typically sluggish drainage which increases salinity locally and thereby produces areas of halophytic pastures. Plain development in some areas of this province may be very extensive producing large stony plains rarely broken by creeklines, and often several miles long and equally wide. Mabbutt rangeland type has been described to include this class of country.

The flattened plains in places are characterised by extensive wind-sorted sandy banks which are arranged on the stony plains. This type of rangeland, known as Winmar, has been distinguished from Durlacher as it possesses the potential for the development of perennial grass pastures. Frederick rangeland type, the mulga-grove pattern rangeland, is found on the western edge of the province and discharges water into Gascoyne rangeland.

Tributary plain and depositional types such as Three Rivers, Landor and Flood occur only rarely in the Archean Province and are always restricted in area.

Relics of the Bangemall series, noted already, produce pastures belonging to the Augustus and Collier rangelands in isolated places on the catchment. Sheets of Pleistocence deposits, producing the pastures described as Nadarra rangelands, are found associated with some of the major river systems, and alternatively as thin sheets up to 30 feet thick above the Archean plains where they effectively mask the expression of the underlying rangeland. Pleistocene residuals may also be found on the tops of some of the hills in Agamemnon type, giving them as mesa-like appearance from a distance.

5. THE PERMIAN BASIN PROVINCE

The Permian basin shore extends in a northwest - southeast direction along the margins of the Archean block. The province begins on the catchment about 10 miles north of Mt. Sandiman homestead and the eastern edge continues to the southeast passing through a point about 8 miles east of Dairy Creek homestead and thence further south to Coordewandy.

It is an area of very low relief, of flattened drainage plains with undulating stone-mantled areas between the hills and plains. In this report Kennedy escarpment is considered to form the western edge of the catchment for the sandplains and dunes on the Gascoyne cuesta (Jutson 1934) contribute little if anything at all, to the drainage.

Condon and others (1963) have prepared detailed geological maps of the Kennedy Range, Wooramel and Glenburgh four-mile sheets on which the Permian basin is best developed. The basin also extends onto Mt. Phillips sheet which has not yet been the subject of a detailed geological report. These authors recognised three series in the Permian beds, the Sakmarian, Artinskian and Kungurian. The rangeland types, however, are not differentiated on a geological basis at all in this report, but rather upon their stone cover and pasture type. In general terms, as noted in the rangeland descriptions, the Sakmarian series produce rangelands with an abundant surface strew which is absent in many of the Artinskian based types. The folding of the strata has resulted in Sakmarian types predominating against the Archean block while the Artinskian series are found in the valley between the Archean block and the Kennedy scarp. The Kungurian series are present only on the Gascoyne cuesta and in the Minilya catchment and are not treated in this report.

A thin wedge of Devonian beds is developed in the extreme north-west of the catchment, but it is not significant and its associated rangeland type can be considered here as belonging to the Permian basin.

The soft rocks of the basin have given rise to very clayey soils, often of a duplex nature. They are extremely alkaline, and very prone to the effects of water erosion. They are therefore quite unlike the soils of the Archean block and the Bangemall uplands, which are, in general, resistant to water erosion, if not to wind erosion.

The highest parts of the relief, up to 300 feet, are provided by weathered, or poorly weathered, hill ranges, isolated hills and ridges. The tops are often capped with laterite or billy of Tertiary age which gives some hills a mesa-like appearance. Fossil and Moogooloo rangeland types form the highest relief. Pells, which forms breakaway groups with associated alluvial fans, should also be considered in this upland group.

Undulating stone covered slopes extend away from the hills. Sandiman and Two Hills and parts of Mantle can be grouped here. They are abruptly undulating, dissected with fine creeklines, and are found above the plains of the province.

Jimba and Mantle rangeland types form the plain type systems comparable with Durlacher, Yinnietharra and Jamindie. They are generally flattened plains with low ridges of exposed sediments, sandy banks, and stone covered undulating sections to relieve the monotony, They are frequently very degraded. Where there is an extreme development of sandy banks upon the plains, Wooramel rangeland type has been described so as to distinguish the sandy bank phase. In some places run-on water onto well developed sandbanks has produced Outwash rangeland.

In this area of low relief the tributary drainage plains such as

Three Rivers, are absent, but their place is taken by plains with sand dunes arranged along the direction of water flow. This rangeland type has been described as Bidgemia. The interdunal flow areas frequently have duplex soils. The water flow from Bidgemia and from Jimba and Mantle is discharged into Gascoyne rangeland type which naturally is well developed at this end of the catchment.

Massive sanddune-claypan complexes have developed towards the western edge of the Permian basin. These have been described as Lyons system. The encircling dunes are presumed to have been derived from the sands behind the face of the Gascoyne cuesta.

Small areas of Nadarra rangeland type are found within the Permian basin, but most have been etched away by geologic erosion processes and nowhere is the type significant. It is certainly not as well developed as on the Archean upthrust block.

6. THE SANDDUNE PROVINCE

The sanddune country is found above the Kennedy Range escarpment and in the south-west of the catchment where it forms a diffuse divide between the Wooramel and Gascoyne rivers. Yalbalgo type is the only rangeland in this province. It consists of sandplain formed into stabilised dune fields. The dunes may be up to 40 feet or more above the interdunal areas. The interdunes are alternatively sandy-bottomed or clayey. Dense Acacia scrub dominates the sanddunes with an understorey of mixed shrubby vegetation. There is virtually no drainage out of this province. Water accumulating evaporates in the claypans found irregularly in the province.

BIBLIOGRAPHY

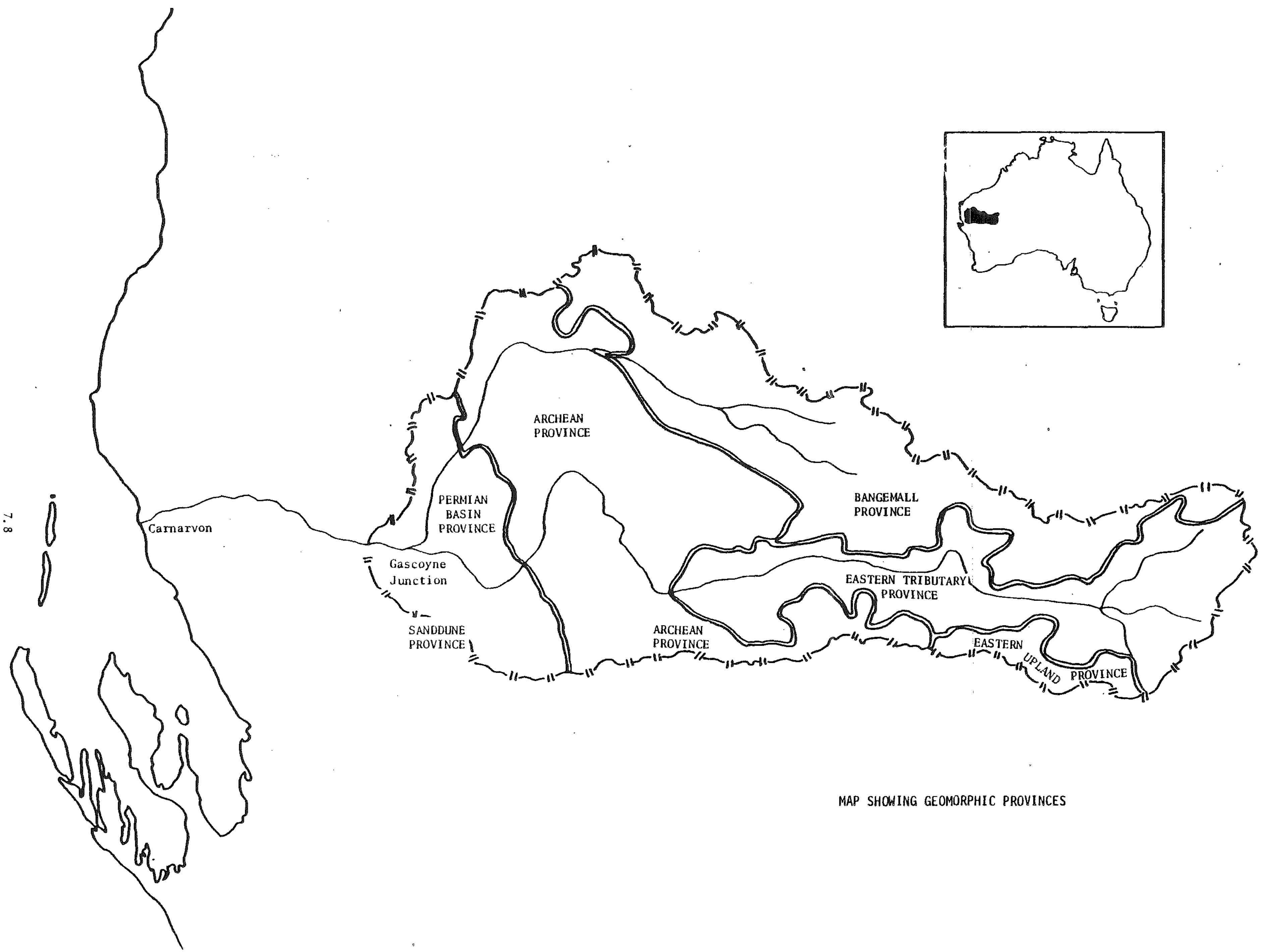
Condon, M.A. *et al* (1963) - Geological Report Kennedy Range four-mile sheet. Bureau of Mineral Resources, Canberra. 1963.

Condon, M.A. *et al* (1963) - Geological Report Glenburgh four-mile sheet. Bureau of Mineral Resources, Canberra. 1963.

Condon, M.A. *et al* (1963) - Geological Report Wooramel four-mile sheet. Bureau of Mineral Resources, Canberra. 1963.

Gregory, F.T. (1858) - Report of Surveyor-General, Western Australia.

Jutson, J.T. (1934) - The physiography (geomorphology) of Western Australia. 2nd Ed. Geol. Surv. W. Aust. Bull No. 95.



MAP SHOWING GEOMORPHIC PROVINCES

THE PASTURES OF THE GASCOYNE CATCHMENT

The fifty-one rangeland types of the Gascoyne Catchment can be arranged into nine pasture groups. Table I shows the grouping of the rangeland types, the area of each kind of pasture, and the characteristics and condition of each. The pasture descriptions given in the table are for rangelands in good condition. The effects of erosion and degradation in each pasture are also described.

<u>HILL PASTURE GROUP</u>   Plates 1 and 2

1. <u>Area</u> - 5 613 square miles

2. <u>Landform</u>

These pastures are found in the highest parts of the relief of the catchment. They are prominent, of course, in the divide or watersheds, but they can also occur as massive uplands and as isolated hills. The Archean and Bangemall geomorphic provinces contain large areas of these pastures, while the total area is restricted in the others. In the Permian basin relief is reduced due to the general softness of the sediments and the uniformity of the weathering process; extent here is therefore limited.

Many of the hill pastures are inaccessible to sheep and, by inference, would be less accessible to cattle. They have an abundant strew of boulders, cobbles and pebbles which tend to make them unattractive to the larger animals.

3. <u>Pastures</u>

The regional geology exercises special controls over many of the species in this pasture grouping. Mulgul, Glenburgh and Augustus rangelands have markedly different species compositions, though all have variable densities of the ubiquitous mulga, *Acacia aneura.*

A. aneura, A. linophylla, A. tetragonophylla and *A. eremea* form a low, sparse canopy between 6 and 20 feet high, over a variable shrub layer which may achieve high densities locally, but which is usually sparse. The shrubs are of a variable height, but usually are between 2 and 4 ft and spaced between 12 and 20 ft apart. Species such as *Cassia oligophylla, C. helmsii, Eremophila maitlandii, E. latrobei, E. cuneifolia, E. spathulata, E. exilifolia, E. greelingii, E. fraseri, Solanum lasiophyllum, Ptilotus obovatus, Kallstroemia platyptera, Rhagodia* sp. and *Kochia* spp. occur as the shrub layer on a regional basis. These, and the trees provide the basis of the pastures durability

After effective rains annual species such as *Aristida contorta,* compositae and other forbs provide sparse grazing for sheep and some for cattle, but they are shortlived and cannot be relied upon. In the isolated pockets of deep soils in Agamemnon and Glenburgh rangelands the perennial grass *Cymbopogon exaltatus* (lemon scented grass) may be common. However, it appears to be unpalatable and is not eaten to any extent.

Small halophytic inclusions can be found alongside some of the major drainages and below breakaways. *Frankenia* sp. is most common, but *Kochia* spp. may also be present. Very small areas of the perennial grass, *Chrysopogon fallax*, are present in alluviated non-saline drainages.

4. Condition

The accessible parts of this pasture group are degraded and often eroded. However, it is difficult to see how erosion and degradation of the alluvial areas or saline inclusions could have been avoided as the total area is small and these parts would have been preferentially grazed.

The inaccessible parts of the pasture are commonly in good condition.

5. Proper use

The pastures should be utilised after seasonal rains when other pastures should be allowed to regain vigour. Where the area of degraded inclusion is large, special measures to achieve rehabilitation should be adopted. This will involve freedom from use of build up the seed supplies of perennials and to allow re-establishment. Reseeding may be necessary in the future. Where the pattern of inclusions is sporadic and they are small, the loss of these will have to be accepted under low grazing pressures and extensive management practices common on the catchment.

STONY SHORT GRASS-FORB PASTURE GROUP   Plates 3 and 15

1. Area - 8 583 square miles.

2. Landform

For the most part this group is formed of undulating and often dissected terrain, though flat, strew covered plains of Jamindie and Mabbutt type are included here. The other rangelands in this group form those parts of the uplands below the highest relief found in the Hill pasture group.

Phillips rangeland type in the Archean province, makes up over one-third of the group and Jamindie rangeland type in the Bangemall province, somewhat less than one-third.

Occasional ridges and abrupt outcrops in this group may be inaccessible, but these occur infrequently and for the most part all the group is grazable. Some of the higher parts may be unattractive to cattle due to the abundance of heavy cobble strew, and in part as well, to the restricted grazing available there in terms of ground feed.

3. Pastures

The pastures should be considered as falling into two groups. In the first instance these are the undulating and dissected terrains of Beasley, Phillips, Collier, George, James, Two Hills and Thomas ranglelands, and in the second these are the flat stony covered plains of Jamindie and Mabbutt rangeland types.

In the first group, stunted trees form the upper storey including *Acacia aneura, A. linophylla, A. tetragonophylla, A. eremea* and *A. pruinocarpa*, which provide a cover of up to 8 per cent with the trees between 20 and 25 ft apart, and rarely more than 15 ft high. The middle storey has a wealth of shrub species between 15 and 30 ft apart and usually between 2 and 4 ft high. Common species are *Eremophila margarethae, E. cuneifolia, E. fraseri, E. freelingii, E. exilifolia, Cassia helmsii, C. sturtii, Solanum lasiophyllum, Kochia* spp., *Rhagodia* sp., *Scaevola spinescens* and *Ptilotus obovatus*. The distribution of these species alters with geologic and landscape controls. Annual grasses and forbs occur beneath the shrub layer according to season. Annual chenopods are prominent among the ephemerals and provide partly durable feed.

Minor halophytic inclusions are present, particularly in Phillips, Beasley and Thomas rangelands. *Frankenia* sp. and *Kochia* spp. are found 15 to 20 ft apart on these drainage floors beneath a sparse tree layer comprised of *Acacia victoriae* and *A. eremea*. The river and creekline marginal plains frequently support a denser tree layer over shrubs and perennial grasses such as *Themeda australis* and *Chrysopogon fallax*. These areas must receive the greatest use, and as they are small and isolated, they are heavily overused, degraded and eroded.

The flatter rangelands in this group, Jamindie and Mabbutt, are characterised by a mantle of small stones and pebbles over their extensive broad plains. The plains are generally sparsely vegetated with low *Acacia aneura, A. kempeana* and *A. pruinocarpa*. The highest cover recorded was 11 per cent but it is commonly lower, the trees usually being 30 ft or more apart and mostly less than 8 ft high. Scattered low shrubs such as *Eremophila fraseri, E. maitlandii, Ptilotus obovatus, Cassia sturtii, C. helmsii* and *Scaevola spinescens* at varying distances apart down to 10 ft, but more commonly 15 to 20 ft, are found with some species more important regionally than others. Annual species and the herbaceous perennial *Ptilotus schwartzii* provide ground feed in season.

The pebble strewn surfaces appear to restrict water infiltration. They shed water onto areas of accumulation most notably in Jamindie, where very dense mulga groves and irregular areas of dense vegetation support most of the sheep on these rangelands. Apart from pasture degradation, the rangelands in this subgroup show little or no erosion.

4. Condition

These pastures are not obviously eroded except in the marginal plains and saline inclusions. They are, however, degraded. The unused or relic areas, support rather more durable species such as *Kochia georgei, K. melanocoma, K. planifolia* and *K. triptera*, all of which are absent in the used state. The saline areas are mostly stripped of their perennials and are gullied and eroded.

5. Proper use

Use of these pastures must be necessarily associated with a programme of spelling or protection from use, which should include regular winter spelling for maintenace. Less frequently, summer spelling to take advantage of excess rainfall, will result in the germination and establishment of perennials. Where the saline plains and marginal river plains are badly overused some positive steps towards reclamation should be taken. These will include freedom from use for extended periods in order to build up vigour and establish new plants.

STONY CHENOPOD PASTURE GROUP   Plates, 3, 5-8, 17, 18, 23-28

1. Area - 5 631 square miles

2. Landform

This group of rangelands forms the lowest part of the strew covered drainage plains. They occur as gently undulating areas beneath the stony, short grass-forb group and above the major drainages and flatter drainage plains. They are characterised by a general absence of pronounced relief. Areas of great undulation are also severely reduced. The constituent rangelands are found on all the geomorphic provinces, but are least common on the eastern tributary plains.

The upper parts of the relief in this group provide the run-off areas for the plains below. These plains are commonly saline, and have the capacity therefore to support perennial halophytic pastures.

Nadarra rangeland type in this group is derived from Pleistocene deposits which are unweathered and in this way differs from the basements of other types within the group.

3. Pastures

This group may be considered under two headings; those rangelands of the Permian basin and those from elsewhere. The Permian basin soils are usually heavy clays with a high pH, usually between 7.5 and 9, and all are capable of carrying halophytic vegetation. The non-Permian sub-group has duplex soils or alternatively highly alkaline soils derived from basic rocks in sluggish drainage areas supporting the halophytes. Significant parts of the latter sub-group though are non-saline with sparse ephemeral pastures only and serve as run-off areas or watersheds for the lower and sluggish drainages.

(a) Permian subgroup

In Sandiman, Jimba, Mantle, Wooramel and Nadarra rangelands, the heavy clay soils usually have a pebble mantle except for some parts of Jimba which are bare of this cover, and therefore prone to the effects of water erosion.

Acacia eremea, A. victoriae and *A. aneura* form a sparse canopy over the plains, the trees usually being up to 12 ft high and between 20 and 40 ft apart. Shrubs beneath the tree layer include *Kochia polypterygia*

K. pyramidata, *K. melanocoma*, *Ptilotus polakii*, *Arthrocnemum* spp., *Eremophila cuneifolia*, *E. maculata*, *Frankenia* spp., *Rhagodia* sp. and *Scaevola spinescens*. Shrub densities of up to 400 per acre have been recorded in some of the favoured parts, but they are usually less frequent.

The ground cover, in season, is strongly halophytic and includes such genera as *Bassia* and *Atriplex*.

Drainage accumulation in crabholes (gilgais) and other foci for run-on water produce restricted and localised well vegetated areas.

(b) Non-Permian subgroup

In the remaining rangeland types, the chenopod or halophytic vegetation is restricted to areas of duplex soils in the sluggish drainage plains. In the higher parts, such as on the isolated ridges and rocky undulations, pastures similar to those found in the stony short grass-forb group are more common. In the lower parts *Acacia victoriae*, *A. tetragonophylla* and *A. eremea* form a low, sparse canopy over shrubs. The trees are usually 8 to 10 ft tall and usually 30 ft or more apart. The shrubs may be as close as 10 ft apart and consist of *Kochia pyramidata*, *K. polypterygia*, *K. melanocoma*, *K. triptera*, *Solanum lasiophyllum*, *Scaevola spinescens*, *Cassia* spp., *Eremophila freelingii*, *E. duttonii* and *E. maculata*. The ground flora consists of halophytic annuals. Most of these pastures have been preferentially grazed and are severely overused, degraded and eroded.

All types in this group have minor inclusions of sandy banks and marginal river plains with typical vegetation. Strew covered areas in Kurubuka form a mosaic with apparent small gilgais, the two forming the basis of the pasture.

4. Condition

With the exception of the minor Nadarra rangeland type, these pastures, and particularly the halophytic parts, are severely degraded and eroded. This situation has resulted from a combination of accessibility, frequent run-on water, and palatability factors which have complemented each other to produce pastures which have been preferentially grazed. The resultant degradation is often extreme over very large areas and is associated with deflation, scalding, hummocking and gullying, particularly in Jimba, Durlacher, Bryah and Yinnietharra types. Only remnant relic areas of original pastures remain on these rangelands.

5. Proper use

The chenopod content of these pastures requires freedom from use for long periods in order to maintain the vigour of the stand. This will involve spelling in the winter for maintenance, with less frequent summer spells to provide for germination. Much longer periods without stock will be necessary if regeneration is required. Two successive seasons of growth, including a summer rain, will be required to effect even partial recovery. Most rangelands in this group on the catchment

fall into the class which requires prolonged protection from use.

Degradation appears to be absolute and almost irreversible on some area of this pasture group at least in the short term (20 to 50 years). Much of it (the Permian subgroup) should never have been leased for grazing as it is so prone to degrading forces. Where degradation is severe, reseeding will have to be attempted or else grazing restricted until at least partial return of the original vegetation is achieved.

CHENOPOD PASTURE GROUP Plates 19, 20 and 22

1. Area - 754 square miles.

2. Landform

These pastures fall into two distinct subgroups. The first is that in which chenopod (saltbush and bluebush) pastures occupy virtually all the rangeland and the second, that in which these pastures occupy only part of the area. Both groups, however, are associated with tributary or major drainages and frequently have much reduced slopes resulting in ponding which produces salinity locally.

In Peedawarra and Bibbingunna, slopes are dramatically reduced. In Bibbingunna they are less than one in 2 500 and in Peedawarra not much greater. Bibbungunna is characterised by heavy clay soils, while Peedawarra has duplex soils generally with associated sandbanks and circular drainage depressions arranged sub-linearly along the lines of water flow.

In Warri and Jingle, the halophytic plains are associated with parts of the through drainage systems, and are only a part of those types. In Warri they represent 25 per cent, and in Jingle up to 80 per cent of the area. Calcrete tables, sandbanks and non-saline alluvial plains are found in the other parts of these two types.

3. Pastures

The total chenopod pastures have a sparse overstorey of trees up to 30 ft tall including *Eucalyptus microtheca*, *Acacia aneura*, *A. tetragonophylla* and *A. sclerosperma* over a variable shrub layer of *Chenopodium auricomum*, *Muhlenbeckia cunninghamii*, *Kochia pyramidata*, *Rhagodia* sp., *Enchylaena tomentosa* and *Cratystylis subspinescens*. Soil type influences the occurrence of these, the two former being restricted to Bibbingunna. The shrubs may be as close as 10 ft apart. Ground cover consists of variable perennial and annual grasses and forbs, notably perennial grasses such as *Eragrostis setifolia* and *Eriachne flaccida* in Bibbingunna and being particularly dense in the sink holes. Sandy banks carry typical wandarrie pasture species.

Warrie and Jingle type chenopod pastures have scattered stunted trees rarely closer than 20 ft apart; usually *Acacia victoriae* or *A. sclerosperma* over low shrubs such as *Kochia pyramidata*, *Cratystylis subspinescens*, *Enchylaena tomentosa*, *Ptilotus obovatus*, *Atriplex rhagodioides* and *A. paludosa*. Ground cover in season, is limited to halophytic genera such as *Atriplex*, *Bassia* and *Pterigeron*. The

associated sandbanks, non-saline plains and calcrete islands carry typical vegetation.

4. Condition

With the exception of Bibbingunna, these pastures are severely degraded and, in many cases, eroded to a condition of no return. In less severe cases scalding, deflation and guttering have reduced productivity and added to the erosion hazard. Much of the durable pasture has been removed and its place has been taken by annual species.

5. Proper use

These valuable pastures will require freedom from use for long periods if they are to be rehabilitated. Initially they will require protection for at least two complete growing seasons to allow for the establishment of young seedlings and for the buildup of seed supplies and vigour. This process will also aid in the alleviation of some of the scalded areas.

A long term study of regeneration at Meekatharra (Wilcox unpub.) in this environment has clearly shown that even with complete freedom from use rehabilitation may take in excess of twenty-five years in chenopod pastures. Under use it will take longer. Where erosion, scalding and pasture removal are extreme, it may be necessary to prohibit grazing for periods as long as this, for reseeding may not be easy nor economically justifiable. The position could be reviewed with time. If the present management practices which do not take the special needs of the pasture species into account are not altered the complete degradation of these valuable pastures can be expected.

Where degradation is not extreme, regular winter spelling is recommended for the maintenance of vigour in the stand. Occasional spells to take advantage of summer rainfall for germination and establishment of the young plants will be necessary to maintain the age structure of undegraded communities.

WANDARRIE PASTURE GROUP Plate 4

1. Area - 1 529 square miles.

2. Landform

This pasture group is formed on alluvial drainage plains where sand banks have been formed as a result of wind and water action (Mabbutt 1963). They provide the soil types for perennial grass pastures. In some instances, e.g. Bubbagundy, extensive areas of sandplain occur along with the more obviously wind and water sculptured banks. The banks provide the principal pastures of this group, but they do not occupy all of the pasture land. In Doolgunna and Landor they occupy about half, and in Bubbagundy about 80 per cent of the area. In Blech, sandbanks and sandy tracts transverse to water flow occur over half the rangeland land. The remainder of each rangeland is taken up with interbank areas, areas of sheet flow and lines of concentrated flow which are always associated with shallow soils and much reduced productivity.

3. Pastures

The pastures on the banks and sandplains consist of a dense to sparse cover of *Acacia aneura*, *A. kempeana* and *A. linophylla*; up to 25 per cent cover being recorded. The trees are up to 15 ft high and can be as close as 12 ft apart. A shrub layer, which includes *Eremophila leucophylla*, *E. gilesii*, *E. fraseri*, *Rhagodia* sp., *Cassia sturtii*, *C. helmsii*, *C. charlesiana*, *Ptilotus obovatus*, *Prostanthera* and *Solanum lasiophyllum* occurs beneath the tree layer. Shrubs can be up to 4 ft high and are spaced between 12 and 15 ft apart. Drought-evading perennial grasses occur in the ground storey and include *Danthonia bipartita*, *Neurachne mitchelliana*, *Eragrostis xerophila* and *Eriachne helmsii*. Plant density indices (Parker 1953, 3 step method) as high as 2.5 were recorded. Annual grasses such as *Aristida contorta* and *Eriachne aristidea* and forbs occupy inter-tussock spaces in season. These annuals assume dominance in the pastures under conditions of overuse.

The interbanks, sheet flow and other areas of shallow soil carry a mulga short grass-forb pasture (q.v.) of considerably lower potential and lower durability. It is important to realise that estimates of potential in these pastures should be related to the total productivity of the sandy bank area together with the areas of shallow soil. It is clearly incorrect to assess these pastures as being capable of producing perennial grass over the entire area.

4. Condition

Most of this group have deteriorated to the extent that the perennial grasses have disappeared and have been replaced by *A. contorta*, *E. aristidea* and annual forbs. Valuable shrub species such as *E. leucophylla* and *Rhagodia* have also disappeared with overuse. However, it should be noted that under use by cattle the shrub component appears to have little changed whereas under use by sheep all levels of available material have been severely overgrazed. In this situation perennial grasses and shrubs disappear.

In Blech rangeland, overuse has been associated with severe erosion in which surface stripping of the interbanks or intergroves is widespread. In the other rangelands erosion is limited to scoring and gullying on the more concentrated flow lines, and to some erosion of the edges of the sand banks near lines of concentrated flow. The cover of trees and shrubs has limited the effects of wind erosion on all the constituent rangelands in the group. However, some instances of hummocking and windpiling were observed in areas where degradation was complete.

5. Proper use

Where degradation is limited to the depletion of perennial grasses grazing management which allows freedom from use for six to twelve months after effective summer rains, should rehabilitate the pasture (Wilcox, 1960). The process would not necessarily be completed in one cycle, but would take a series of spellings. Grazing at appropriate levels which will not reduce the number of plants could be allowed between these resting periods.

Where the depletion also involves shrubs, much longer periods of rest will be required. These will include protection for two complete growing seasons in a succession of cycles of resting until the potential of the site is again realised.

Once the pasture has rehabilitated it will be necessary only to provide rests when the vigour of the pasture declines. This will be particularly obvious after prolonged dry periods.

MULGA SHORT GRASS-FORB PASTURE GROUP   Plates 4, 9-14, 16

1. Area - 2 461 square miles

2. Landform

This group of pastures contains the non-saline tributary drainage plains of the catchment which were characterised by much reduced slopes; 1:300 to 1:1000; and by a lack of local outcrops of basement rock such as found in the stony short grass-forb pasture group. The plains may extend up to six miles downslope and can be several miles wide. They are most frequent in the eastern tributary province, but can occur in the others.

In Frederick rangeland the surface of the plains has a pebble mantle, and the vegetation is arranged in arcuate bands or groves transverse to the slope. Series of groves are separated across the regional slopes by areas of concentrated flow. Minor grove patterns occur in the other rangelands.

Sandy banks are common on all the rangelands in the group, being most frequent in Three Rivers type. The areas of more concentrated flow found in every type can be incised and channelled, especially in the lower parts.

Macadam rangeland has regions of marked dissection into the silcrete or hardpan, especially where it occurs below the ill-defined divide on the southern part of the catchment.

3. Pastures

The frequency of sheet flow and the depth of soil are dominant controls in the cover on the plains in this pasture group. The drainage plains carry *Acacia aneura*, *A. tetragonophylla*, *A. craspedocarpa* and *A. pruinocarpa* in the tree layer. The individuals are scattered, but a canopy cover of up to 10 per cent was recorded. Most of the trees are 10 to 20 ft high, though *A. pruinocarpa* often reaches 30 ft. In favoured situations trees may be 10 to 15 ft apart, but where the soil is shallow they are frequently 30 ft or more apart and correspondingly shorter. In the groved areas of Stonehut and Frederick, canopy covers of up to 25 per cent are common, with trees as close as 10 ft apart.

The shrub layer beneath the trees is variable in composition and density. Shrubs may be up to 12 ft apart, though commonly they are less, and in extreme cases have been removed due to overuse. *Eremophila fraseri*, *E. freelingii*, *E. georgei*, *E. latrobei*, *E. hugelii*, *E. margarethae*, *Cassia sturtii*, *C. helmsii*, *C. desolata*, *Solanum lasiophyllum*,

Ptilotus obovatus, *Kochia* spp. and *Rhagodia* sp., are important regionally. The herbaceous species, *Ptilotus schwartzii* and *P. roei* occur after useful rains.

The ground flora is limited to annual species after rains. *Aristida contorta* and composites are most common, production varying between zero and 2000 pounds per acre, dependent upon season. The durable parts of the pasture of this group are clearly the shrubby elements.

The groved vegetation is similar in composition to that of the plains with the addition of *E. gilesii*, which is prominent in the shrub layer. The ground layer is often absent under the dense canopy.

The sandbanks carry typical wandarrie group pastures.

4. Condition

Some of the more spectacular forms of erosion on the catchment are found in this group of pastures. Sheet erosion, terrace erosion or surface stripping, gullying and the effects of wind erosion are very common. The shallower alluvial plains are particularly susceptible to degradation, and a common feature of their degradation is widespread wind erosion with surface stripping. Gullies and gutters in the lowest parts are very frequent.

Where complete degradation has not been reached changes in pasture composition are frequent. *E. fraseri* is often the only perennial left in the pasture. It is unpalatable and replaces more valuable species such as *Rhagodia* and *Kochia*.

Easy accessibility to these pastures after rain has led to trampling of the wet soil surface and thereby exacerbated the sealing process leading to greater run-off and erosion down slope. The more frequent accretions of water in these pastures has also led to their overuse, since in the original state, or even in acceptable condition, they would produce more available feed, more often.

5. Proper use

In many situations, e.g. Milgun, Three Rivers, Mt. Clere and Woodlands stations use of these pastures should not be allowed until rehabilitation is effected. On these properties where erosion is extreme, prolonged protection from use will be required to provide for the healing of the erosion scars and for regeneration of the principal pasture species. In some instances this will involve a reduction of the amount of run-on water through controlled use of the upstream pastures. The regeneration process will be extremely slow. Investigations conducted at Meekatharra (Wilcox unpub.) indicate that rehabilitation of even slightly eroded pastures will take in excess of twenty years. Shallow soils and erratic rainfall are probably responsible for the slowness of the recovery.

Where pasture degradation and erosion is not severe, proper use will dictate regular spelling to coincide with winter rain and less frequent spelling to allow for occasional summer rains which will germinate and establish perennial shrubs.

SAND-DUNE HALOPHYTE PASTURE GROUP   Plate 21

1. Area - 637 square miles.

2. Landform

In Lyons rangeland, sand derived from the weathering of the sandstones near the Kennedy Ranges has been moulded by wind into a complex mosaic of dunes surrounding claypans on lower vegetated areas. Areas of through drainage are restricted, water run-off if any, being discharged onto the claypans which form a type of internal drainage.

In Bidgemia sand-dunes have been formed in sub-parallel rows along the line of water flow. They appear to have been placed upon the tributary drainage plains of the Permian Basin.

3. Pastures

The pastures on the dunes in both types are similar though they are denser in the Lyons type. The tree layer is occupied by low shrubby trees up to 12 ft high including *Acacia tetragonophylla, A. linophylla, A. sclerosperma, Grevillea* sp. and, occasionally, *Hakea priessii*. The trees are as close as 15 to 20 ft apart on Lyons, but are much sparser on Bidgemia. The shrub layer is rich, though not very attractive to stock. It comprises *Rhagodia* sp., *Hibiscus pinonianus, Cassia* spp., *Verticordia* sp., *Prostanthera* sp. and *Eremophila* spp. The shrubs reach to 6 ft and are between 10 and 30 ft apart. The ground pasture is restricted to sparse perennial grasses such as *Danthonia* and *Eriachne*.

The interdune areas in Lyons and Bidgemia support low halophytic pastures on their duplex soils. *Frankenia* sp., *Ptilotus polakii* and *Kochia polypterygia* are common, often as close as 10 ft apart, but usually more distant. Tree cover is rare on these soils and is restricted to very sparse *Hakea priessii, Acacia victoriae, A. tetragonophylla* and *Eucalyptus camaldulensis*. The ground cover is ephemeral.

4. Condition

The dunes and sandy interdune areas support pastures which show little sign of degradation. It is possible that some of the better shrub species have been removed, and it is certain that the grassy perennials have been reduced.

The interdunal duplex soil areas are severely degraded. The perennial shrub component has been greatly overused, and in many cases has been completely removed. Its removal has been associated with scalding and removal of the sandy surface of the duplex soil.

5. Proper use

Correct use of these pastures will centre upon the use of the interdunal areas as these are capable of producing abundant feed. They receive additional water, and consequently produce more frequently than the regionally associated pasture group, the stony chenopod. The management practices recommended for stony chenopod and chenopod

pastures should, however, be adopted. These will include spelling during both the winter and the summer seasons to allow for maintenance and regeneration with establishment respectively.

Under the situation of overuse so common on the catchment, regeneration procedures which require prolonged freedom from use for at least two growing periods, will have to be adopted. Repeated spelling will rehabilitate much of the pasture, but some areas are so bad that regeneration will only be accomplished through freedom from use for very long periods.

SANDPLAIN PASTURE GROUP

1. Area - 1 251 square miles

2. Landform

The sandplain pasture group is found in three distinct areas on the catchment. It forms the divide in the east and west of the catchment where bare rocky watersheds are absent. In addition isolated pockets of sandplain without dunes, are found associated with some of the very large hills of the Bangemall province, notably Mt. Augustus. Here they appear to have been derived from the weathering products of the sandstone of that geological series.

The plains are gently undulating and formed into a series of dune fields in the west. In the east small dune fields are found within the sandplain.

The drainage is principally internal and restricted to areas of run-on which may be variously expressed as areas of denser vegetation, or as claypans. Yalbalgo rangeland occurs in the west and Divide in the east.

3. Pastures

In the east *Acacia aneura* forms an irregular canopy over scattered shrubs and spinifex. The trees are rarely taller than 12 ft and only in run-on areas are they common. Elsewhere they occur with lower *Hakea* and *Grevillea* spp. over an almost homogeneous stand of *Triodia basedowii* which achieves a cover of up to 25 per cent. Other grasses and forbs are rare even after good rains. Following burning, genera such as *Goodenia* and *Newcastlia* are common, but soon give way to the aggressive *Triodia* species.

In the west the dunes are vegetated with *Acacia sclerosperma*, *Acacia* spp., and low shrubs such as *Eremophila leucophylla*, *Calythrix* sp., *Scaevola spinescens* and *Prostanthera* sp. The grass cover is variable. Some of the swales carry scattered *Ptilotus polakii* and *Frankenia* sp., but their occurrence is irregular. The total cover in Yalbalgo usually exceeds 20 per cent, and is rarely found disturbed.

The islands of sandplain in the centre of the catchment carry dense *Acacia aneura*, *A. linophylla*, *A. pruinocarpa* and *Grevillea nematophylla* up to 20 ft high, above a less dense shrub layer in which *Eremophila leucophylla*, *Solanum lasiophyllum*, *Ptilotus obovatus*, *Cassia*

sturtii and *Prostanthera* are common. In some areas *Danthonia bipartita* occurs in small pockets, while in others *Plectrachne melvillei* is more important. Total cover of all layers often exceeds 25 per cent.

4. Condition

These pastures, particularly those in the east, are still in good condition as they tend to be unattractive to stock. In country used by sheep the palatable grasses have declined, but cattle do not appear to use the area to any extent. In the south-west a reduction of palatable shrubs such as *Scaevola spinescens* and *E. leucophylla* has contributed to a decline in the productivity of these pastures.

5. Proper use

Proper use of these pastures will require regular winter spelling and occasional summer spells so that the pastures may be kept vigorous and the proper age structure maintained.

RIVER PASTURES

1. Area - 878 square miles

These pastures have been dealt with in the section dealing with rangeland types where they are described under the title Gascoyne rangeland.

BIBLIOGRAPHY

Mabbutt, J.A. 1963 - Wandarrie banks; micro-relief patterns in semi arid Western Australia. Geol.Soc.Amer.B. 74(5) : 529-540

Parker, K.W. 1951 - A method for measuring trend in range condition on national forest ranges. U.S.Forest Service, Washington D.C. 1951 (Processed).

Wilcox, D.G. (1960) - Studies in the mulga zone. 1. The grazing of wandarrie grass associations. J.Agric.W.Aust. (4) 1 : 475-9

TABLE 1

TABLE OF PASTURE GROUPS AND THE ASSOCIATED RANGELANDS

Pasture Group	Area (sq. miles)	Component Rangelands	Pasture Characteristics	Condition
Hill pasture group	5,613	Fossil Pells Diorite Peak Hill Agamemnon Augustus Glenburgh Mulgul Moogooloo	Partly inaccessible, particularly for cattle; stunted, sparse trees and variable shrubs; abundant strew on pockets of shallow soil; otherwise bald rock outcrop; short grass-forb pastures with minor halophyte plains below breakaways and in drainages	Resistant to erosion Degradation of accessible pastures common. The remainder of the grouping in good condition. Some gullies on the lower parts particularly in the inclusions.
Stony short grass-forb pasture group	8,583	Beasley Phillips Collier Jamindie George James Two Hills Thomas Mabbutt	Undulating, sometimes dissected, strew covered areas below the highest relief flatter strew covered plains carrying tributary drainage; stunted trees, sparse shrubs, short grasses and forbs in season; some rangelands with saline inclusions and halophytes; dense groves of vegetation in others.	Resistant to erosion except in lowest, flatter parts. Degradation of pastures very common with reduction to less durable ephemeral species being common.
Stony chenopod pasture	5,675	Sandiman Jimba Horseshoe Durlacher Bryah Yinnietharra Sugarloaf Kurabuka Nadarra Mantle Wooramel Woodlands	Generally flattened strew-covered or bare plains and interfluves; undulating areas common in highest parts with abundant strew; saline soils common, either duplex or heavy clays both supporting halophytes and stunted trees. Run-off areas within each rangeland generally non-saline and with stony short grass-forb pastures with sparse stunted trees and shrubs.	Susceptible to erosion, particularly areas with no strew protection. Degradation of pastures very common, often to almost irreversible stage except for Nadarra type. Gullies, gutters, scalding and excessive sealing of the surface common.

TABLE 1 (Continued)

Pasture Group	Area (sq. miles)	Component Rangelands	Pasture Characteristics	Condition
Chenopod pasture group				
(a) all chenopod	86	Peedawarra Bibbingunna	Flat areas with very reduced slope and sluggish drainage often terminal locally; halophytic pastures.	Peedawarra type badly degraded. Bibbingunna type protected by inaccessibility during wet periods. Peedawarra degraded and severely eroded. Bibbingunna partly degraded, erosion infrequent.
(b) with minor halophytes	668	Warri Jingle	Minor halophytic pastures within these rangelands where short grass-forb pastures are common; principally tributary and minor trunk drainages.	Warri and Jingle both degraded and subject to erosion being part of the drainage; gullies and scalding frequent.
Total	754			
Wandarrie pasture group	1,529	Landor Doolgunna Winmar Blech Outwash Flood Bubbagundy	Sandy banks and larger sand areas on tributary drainage plains; perennial grass pastures beneath a moderate canopy of low trees and shrubs.	Resistant to wind erosion; water erosion of some edges of sand banks near major flow; major erosion in Blech rangeland. Pastures generally degraded to annuals below trees and shrubs; in some instances shrubs have been removed. Surface stripping common in Blech and deflation of banks common in Doolgunna.
Mulga, short grass-forb	2,461	Three Rivers Frederick Clere Stonehut Macadam	Drainage plains tributary to main or confined flow areas; strew covered or bare plains with areas of arcuate grove vegetation and sandy banks; segmented by concentrated flow lines.	The unprotected surfaces susceptible to erosion as in Three Rivers and Clere. The others generally resistant though Frederick can be severely degraded. Pastures degraded and even totally removed in places. Gullies in lower parts, surface stripping, gutters through groves and scalding common.
Sand-dune - halophyte pasture group	637	Lyons Bidgemia	Sand-dunes with claypans dunal flow areas with duplex soils. Bidgemia with drainage flow plains and dunes.	Lyons not subject to erosion, but Bidgemia very prone to erosion. Duplex interdune areas very degraded and stripped; dunes stable. Gullies, stripping and scalding on the interdune duplex soils.

TABLE I (Continued

Pasture Group	Area (sq. miles)	Component Rangelands	Pasture Characteristics	Condition
Sandplain pasture group	1,251	Divide Yalbalgo	Sand plains with vegetated dunes in the east and west of the catchment.	Not subject to erosion. Degradation absent in the east, though common in the west through removal of palatable shrubs and grasses. No water erosion; sand hummocking in parts of the west.
River pasture	878	Gascoyne	The major rivers and creeklines of the catchment, with associated islands and narrow plains marginal to rivers.	Creek and river beds subject to episodic erosion, particularly when the drainage is not completely incised and confined. Pastures degraded; evidence of stabilisation of some river banks and inundation areas with Buffel grass. Erosion of marginal plains common, though never measured in the field as standards were absent.

THE RANGELAND TYPES OF THE GASCOYNE CATCHMENT

The rangeland types found on the Gascoyne Catchment are described in this section of the report. A simplified block or plan diagram is provided for each of the rangelands so that its general form may be appreciated. The component units of the rangeland are indicated on the diagram and these are described in the table which lists the percentage of each unit in the type, gives a brief soil description and the potential and condition of each unit.

The pastures are described in detail for each unit particularly with reference to the desirable condition. The effect of degradation and overuse on pasture composition is also reported. The common names for the pasture species are listed in a table at the back of the section. Most plants had no common names, and for this report many have been devised. It is hoped that they will come into common use.

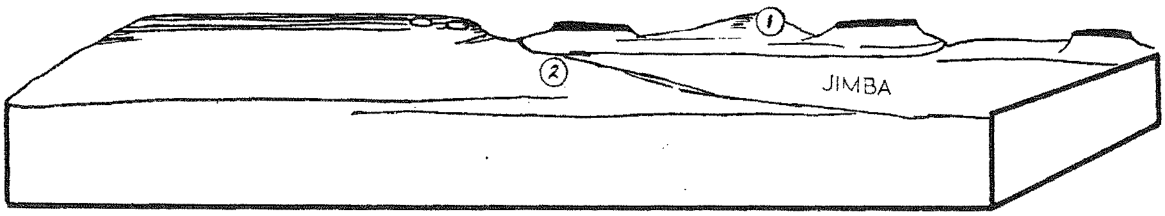
The usefulness and current condition of each rangeland is described under the general statement heading. The extent of erosion is described and brief suggestions as to the methods for rehabilitation of the rangeland are made. It was not possible to be more than general in respect of the regeneration schemes since conditions in each situation in the field would never be constant and would be continually tempered by other factors such as the associated rangeland condition proximity of fencing and the extent of the erosion and degradation.

The traverse summary table shows the situation for the whole catchment for each rangeland. The percentages of wind and water erosion found are shown in the appropriate categories and the general summary of range condition is also listed. Previous sections should be consulted for the definitions of the various types of erosion and condition.

This table does not describe the condition of the rangeland on each station. It serves rather to show the susceptibility of the type to erosion and degration. Comparisons may be made between rangeland types by comparing the individual traverse summary tables.

The final statement in the rangeland type description deals with the significance of the type to erosion and its contribution to total degradation on the catchment.

FOSSIL RANGELAND TYPE 124 square miles



Unit	%	Landform	Soils	Potential	Condition
1	40	Hill tops	Rocky, shallow soils in pockets, brown clays pH 8	Low; sparse shrubs, partly inaccessible	Good
2	60	Hill slopes	Rocky, shallow soils, brown gritty clay pH 8 Cobble and pebble strew	Low; sparse shrubs annuals, partly inaccessible	Vegetation degraded

Fossil rangeland type occupies the highest parts of the Permian basin. Relief of up to 300 ft can be achieved but it is generally lower. The type occurs on the Mt. Phillips, Glenburgh and Kennedy Range four-mile sheets and occupies 124 square miles.

The hills may be capped with tertiary "billy" which has given them a distinctly mesa-like appearance. Elsewhere massive hills orientate the drainage lines. In many instances the beds in the Permian sequence have contributed to the character of the hills. For instance, Fossil Hill on Bidgemia Station takes its name from the Callytharra deposits which are highly fossiliferous. The slopes to the hills are abrupt in general, and covered with cobble strew. They slope at between 1:5 and 1:40 towards the plains and undulations of Jimba, Mantle or Sandiman rangeland types. Some parts of the slopes may be bare of stone cover.

PASTURES

The hill tops (1) carry low *Acacia aneura* and other *Acacia* species above a sparse middle storey in which *Eremophila* spp., *Rhagodia* and *Solanum* are common. The slopes (2) have a similar vegetation though it may be regionally denser.

General statement

This rangeland type does not contribute much to pasture on offer. In many cases it occurs as isolated hills which are partly inaccessible. The mantle of cobbles and stones has protected the environment from erosion.

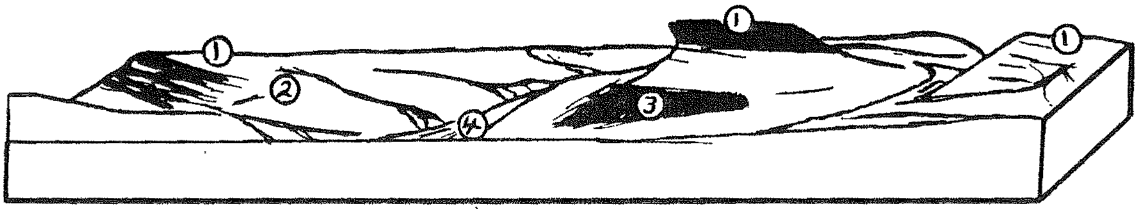
Traverse Summary - 4 observations

Wind erosion	%	Water erosion	%	Condition	%
None	75	None	100	Pristine	0
Sheeting	25	Sealing	0	Good	0
Surface redistribution	0 0	Minor rilling	0	Vegetation degraded	100
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	0
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

This rangeland type is not important in the consideration of erosion on the catchment.

MOOGOOLOO RANGELAND TYPE 196 square miles



Unit	%	Landform	Soils	Potential	Condition
1	45	Weathered and partly weathered ridges, flattened summits and isolated mesas	Shallow rocky soils in pockets, usually sandy	Low; partly inaccessible	Vegetation degraded; no erosion
2	35	Stony slopes with outcrops	Shallow soils; brown loamy sand up to 18", pH 7-8; with abundant weathered and unweathered mantle	Fair	Vegetation degraded
3	15	Alluvial fans	Duplex soils of variable depth, pH 8	Moderate; halophytic pastures	Vegetation degraded; active erosion and gullies in parts
4	5	Creeklines	Sharply incised	Fair	Vegetation degraded

Moogooloo rangeland type covers 196 square miles. It is restricted to the Permian basin west of the Archean shield. It is found on the Kennedy Range, Mt. Phillips and Glenburgh four-mile sheets. It forms the significant part of upper relief in the Permian basin, but never compares in size and extent to the massive hills and uplands of the Precambrian series to the east.

The highest parts of this type are found as low ridges and hills with relief up to 250 ft. Weathering is rarely deep, but is present as extensive thin caps on long ridge lines and isolated mesa tops. Unweathered rock is frequently exposed in flattened summits and rocky

slopes beneath the lateritic cap. The most prominent natural feature in this rangeland type is the eastern edge of the Kennedy Range where the abrupt dissection of the partly weathered face forms the western boundary of the Gascoyne Catchment. Stony slopes frequently extend away from the rocky summits and ridges. These are covered with a heavy mantle of weathered and unweathered cobbles and pebbles. In some instances these slopes reflect the particular stratigraphy of the region since quartz pebbles in the sediment may be the only shed upon the stony slopes. On the margins of the system and beneath the isolated mesas, alluvial fans with duplex soils make a sharply disjunctive contact with the scree slopes. Creeklines from the lowest part of the type. They have cobble bed loads and are sharply incised.

PASTURES

The ridge lines, mesas and summits (1) carry a variable upper storey of *Acacia aneura* above *Eremophila freelingii*, *Cassia helmsii*, *A. linophylla*, *Corchorus wolcottii* and *A. tetragonophylla*. The ground flora is sparse and ephemeral. In some instances the flattened summits may carry relatively sparse tree cover, but with moderately dense *Cassia desolata*, *Eremophila cuneifolia*, *E. platycalyx*, *Ptilotus polakii* and *Kochia* spp. The alluvial fans (3) are almost all degraded and support *Acacia victoriae* and *A. eremea* above *Frankenia*, sp. *P. polakii* and *Cassia* spp. The creeklines (4) have a dense marginal vegetation with *A. aneura* and *A. holosericea* above variable shrubs.

General statement

Much of Moogooloo rangeland type is inaccessible and consequently it provides little pasture. The generally small inclusions of duplex soils on the alluvial fans should support halophytic pastures, but these have been seriously degraded due to over-use. Because of their restricted size it is probably difficult to prevent this.

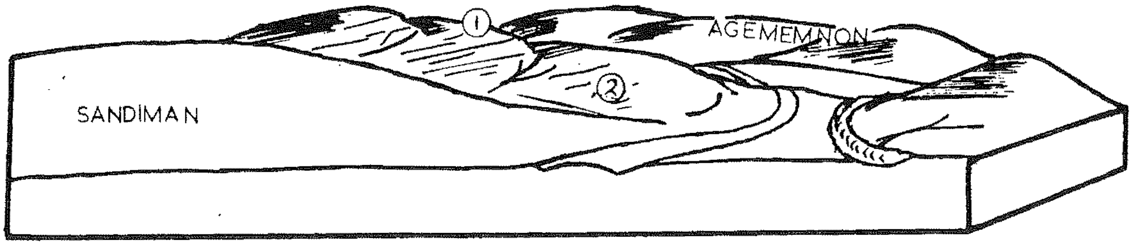
Traverse Summary - 16 observations

Wind erosion	%	Water erosion	%	Condition	%
None	38	None	44	Pristine	0
Sheeting	6	Sealing	12	Good	6
Surface redistribution	50	Minor rilling	13	Vegetation degraded	63
Hummocking	6	Stripping	6	Vegetation degraded; some erosion	31
Major drift	0	Lower slope gullies	12	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	13		

Significance to erosion

Although contributing to general pasture degradation and to the aspect of erosion on the catchment, Moogooloo rangeland type is not significant in the total framework of erosion and vegetation degradation.

TWO HILLS RANGELAND TYPE 13 square miles



Unit	%	Landform	Soils	Potential	Condition
1	50	Hills	Shallow rocky soils	Low; sparse shrubs and annuals	Vegetation degraded
2	50	Slopes	Shallow rocky soils	Low; sparse shrubs and annuals	Vegetation degraded

Two Hills rangeland type is derived from Devonian deposits which separate the Permian basin from the Precambrian basement. The total width of these Devonian sediments is never greater than one mile and is usually much less. The series is developed more in the Minilya River catchment to the north of the Gascoyne Catchment.

The rangeland consists of very low hills of surface weathered siltstones, sandstones and greywacke up to 40 ft high. Quite narrow, 10 chains or less, pebble strewn slopes extend from these towards the Precambrian or Quarternary series on the east and to the Permians on the west. It is difficult to distinguish the rangeland from many of the types in the Permian group, and it is here distinguished only because of its distinct geological origin.

PASTURES

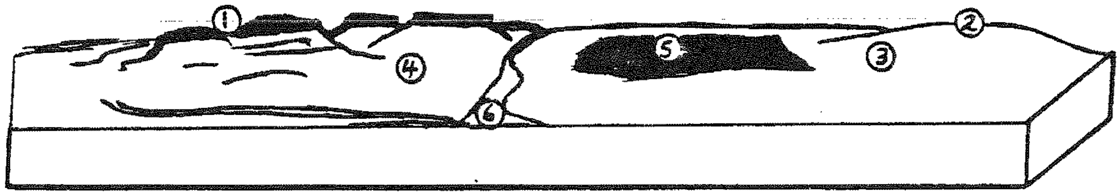
The low hills (1) carry low and scattered *Acacia victoriae* and *A. tetragonophylla* with a mid-storey of *Eremophila* spp. *Ptilotus* spp. and *Solanum* spp. The ground storey is restricted to annuals. The slopes (2) carry a similar vegetation to the low hills, though halophytic species may occasionally be present.

General statement

Two Hills type occupies only 0.04% of the catchment. It is difficult to distinguish the pastures from those of the adjoining Permian strata. As the area is restricted it contributes very little to pasture on offer, and does not influence the condition or erosion status of the catchment.

PELLS RANGELAND TYPE

307 square miles



Unit	%	Landform	Soils	Potential	Condition
1	30	Mesas	Rocky; shallow soils in pockets	Low; partly inaccessible	Vegetation degraded
2	20	Low round topped hills and ridges	Rocky; shallow soils in pockets	Low	Vegetation degraded
3	25	Stony slopes with out-crops	Shallow sandy soils with abundant weathered and weathered mantle	Fair	Vegetation degraded
4	15	Alluvial fans	Duplex soils of variable depth. pH 8	Moderate; halophytic pastures	Vegetation degraded; active erosion and gullies in parts
5	5	Sandy banks	Brown sand at variable depths up to 36", pH 7.0	Moderate; perennial grass pastures	Vegetation degraded; active wind and water erosion
6	5	Creek lines	Deeply incised creek lines with very sandy bottoms	Fair	Vegetation degraded

Pells rangeland type covering 307 square miles, is found on the Glenburgh, Wooramel and Kennedy Range four mile sheets. It is very similar to Moogooloo and differs only in its lack of long lateritised ridges. The highest parts of the relief are the mesas which characterise the type.

The weathered and partly weathered mesas and residuals offer

relief of up to 100 feet above the plains. Stony slopes supporting these highest parts slope at up to 1 in 25, but are often flatter and covered with a heavy mantle of cobbles and pebbles. Alluvial fans extend away from the bases of the mesas and ridges. Sandy banks are found on the plains and flatter stony slopes. The creeklines are frequently incised to several feet.

PASTURES

The mesas and residuals (1) carry relatively inaccessible pastures in which *Acacia aneura* and *A. grasbyi* are found above *Cassia* spp., *Eremophila* spp., and sparse *Kochia* species. The low rounded hills and small ridges (2) carry a similar vegetation, though the mid-story shrub species may be rather denser. The stony slopes (3) support *Acacia aneura* and *A. victoriae* above shrubs such as *Rhagodia, Ptilotus polakii, Solanum lasiophyllum, Cassia desolata* and *Eremophia cuneifolia.* The alluvial fans (4) with the duplex soils are commonly degraded and eroded, and should support *Kochia polypterygia, P. polakii* and *Frankenia* beneath a sparse *A. victoriae* tree cover. In most cases this shrub layer is absent and pasture is reduced to annual species. The sandy banks (5) carry *A. aneura* and *A. tetragonophylla* above moderately dense *Eremophila leucophylla, E. exilifolia, Rhagodia* spp. and *Cassia helmsii* with drought-evading perennial grasses such as *Danthonia bipartita.* The creeklines (6) have dense marginal vegetation.

General statement

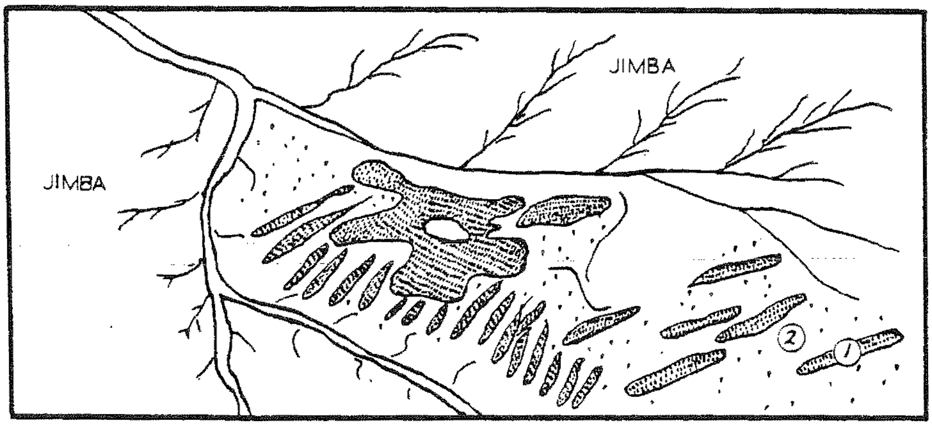
Much of Pells rangeland type is inaccessible and consequently it provides little pasture. The small alluvial fans are badly degraded and need remedial treatment which could even extend as far as reseeding. Rehabilitation will prove difficult on these very saline sites.

Traverse Summary - 18 observations

Wind erosion	%	Water erosion	%	Condition	%
None	11	None	11	Pristine	0
Sheeting	33	Sealing	67	Good	0
Surface redistribution	56	Minor rilling	11	Vegetation degraded	94
Hummocking	0	Stripping	6	Vegetation degraded; some erosion	6
Major drift	0	Lower slope gullies	5	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

About 40 square miles of alluvial fan in this type exist on the catchment. Although severely degraded, the contribution to overall erosion is not significant.



Unit	%	Landform	Soils	Potential	Condition
1	40	Sandbanks or dunes	Red-brown fine sand on gravels or Hard Pan greater than 36" pH 6-7	Moderate; palatable shrubs and perennial grasses	Good or degraded; some wind erosion and hummocking
2	60	Interbanks	Red-brown gritty clays or sandy clay loams of shallow depth, usually less than 12", pH 5-6	Fair; palatable grasses and forbs	Vegetation degraded; gullies and gutters

Wooramel rangeland type on the Permian basin has affinities with both Bidgemia and Jimba but, because of the extensive development of low sandy banks, it has been separated from these types. In this way it resembles Winmar which is distinguished from Durlacher by its sandy banks in Precambrian based systems.

The sandy banks up to 50 chains long and five chains wide, are disposed upon a tributary drainage plain with a slope of 1:250 to 1:500. Some of the banks are arranged transverse to the slope while others are obviously arranged by active wind movements and have associated claypans similar to those in Lyons and Bidgemia. In general the banks are less than 36 inches high, but can approach dune-like proportions in some areas. In the lower parts of the drainage, the claypans and crabholes, common in Jimba, can be found in this rangeland type.

PASTURES

Elements of a number of rangeland types can be found in Wooramel and these are described in the appropriate places of the description of the other rangeland types. Sandbanks and interbanks only will be

described here. The banks (1) carry moderately dense *Acacia linophylla* and *A. aneura*, up to 10 per cent cover, over a mixed mid-storey which includes *Rhagodia*, *Ptilotus obovatus*, *Eremophila maitlandii*, *Solanum lasiophyllum* and *Hakea priessii*. *Danthonia bipartita* is common in the ground storey. The interbanks (2) are variable and carry a wealth of shrub species beneath a sparse layer of *A. aneura*. Up to 1000 individual plants per acre were recorded at some sites and included *P. obovatus*, *Kochia* spp., *S. lasiophyllum* and *E. leucophylla*. The ground flora was restricted to annuals.

General statement

This rangeland type can produce very useful pastures though half of it, the interbanks, is not as productive as the other. In some sections of the catchment it has been severely over-used on both banks and interbanks causing wind erosion on the former and gutters with gullies on the latter. Rehabilitation through freedom from grazing is recommended.

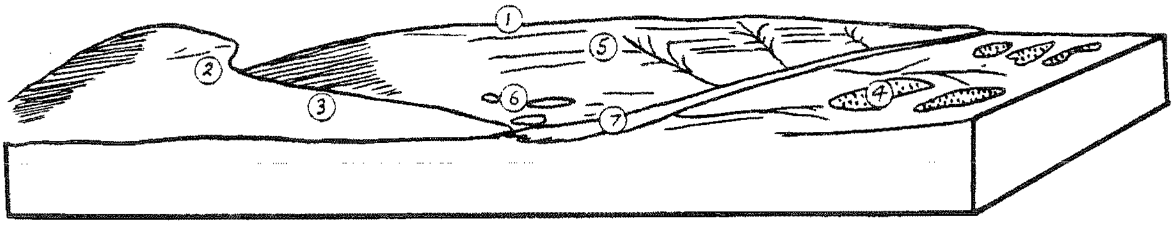
Traverse Summary - 22 observations

Wind erosion	%	Water erosion	%	Condition	%
None	9	None	18	Pristine	0
Sheeting	36	Sealing	41	Good	14
Surface redistribution	45	Minor rilling	23	Vegetation degraded	64
Hummocking	10	Stripping	9	Vegetation degraded; some erosion	22
Major drift	0	Lower slope gullies	9	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

The type is degraded over much of its area and therefore contributes to the erosion of the catchment.

SANDIMAN RANGELAND TYPE 479 square miles



Unit	%	Landform	Soils	Potential	Condition
1	15	Low breakaways, ridges, summits and plateaux	Often rocky soils, or brown clay of variable depth beneath stone mantle; pH 7-8.5	Fair, sparse palatable shrubs	Vegetation degraded; little erosion
2	20	Steep upper slopes	Cobble and pebble strewn red brown to brown clays of variable depth on P.M.; pH 8	Fair, sparse palatable shrubs	Vegetation degraded; little erosion
3	40	Lower stony slopes	Brown or red brown clayey soils increasing in texture with depth; pH 7-8.5 often on P.M; pebble strewn	Fair to moderate, palatable shrubs	Vegetation degraded; erosion gullies on lower slopes
4	5	Sandy banks and dunes	Brown fine sands greater than 36" pH 7-8	Moderate, palatable shrubs and grasses	Vegetation degraded; hummocking in places
5	5	Terraced slopes	Terraces - brown clay greater than 36"; pH 8 Inter-terraces - pebble strewn brown clay; pH 8	Fair to moderate, palatable shrubs	Vegetation degraded; little erosion
6	5	Drainage floors with crab-holes	Variable red brown and brown clays; pH 7-8	Moderate, palatable shrubs	Vegetation degraded; eroded and gullies
7	10	Incised drainage	Up to 8' incision and 50' across, bedloads of sands and cobbles	Variable	Vegetation degraded; banks, consolidated in places

Sandiman rangeland type lies above the Jimba and Mantle rangeland types, and often forms the major part of the relief on the Permian basin where the ridges and hills are very low and have been reduced by natural erosive processes. It is found on the Glenburgh, Mt. Phillips, Kennedy Range and Wooramel four-mile sheets and it covers 479 square miles of the catchment. It has an extensive mantle of cobbles and pebbles over most parts. Substantial glacial erratics can be found on the surface, some of these reaching 10 ft in diameter, but their occurrence depends upon regional geology.

Low breakaways, with minor plateaux behind, form the highest parts of the type. These may provide 150 ft of relief above the drainage. The prominent features though, are often low ridges up to 40 ft high and several miles long. These form striking patterns on the aerial photographs due to the variable erosion of the constituent beds, the presence of boulder beds and the variability in total weathering. Where low rounded hills form the highest parts, abrupt scree slopes of 1:5 unite the hills with lower portions. The scree slopes are frequently tillitic with prominent granitic and glacial boulders.

Supporting slopes to the hills have a heavy cobble strew up to 9 in. in diameter. They slope at 1:10 to 1:50 and have finely etched creeklines set in their faces. Lower slopes with much reduced cobble strew, but with extensive pebble cover, extend further downslope to the drainage. In Sandiman the interfluves on the slopes are rarely more than 20 chains across and usually much less. They extend up to 50 chains downslope. Sand dunes and sand banks, obviously wind sorted, may occur irregularly on the plateaux surfaces and areas of much reduced slope. They may be up to 10 ft high, with interdunal areas up to 450 ft wide. In most cases they should be regarded as inclusions into this type. Terraced slopes occur in Sandiman as they do in Jimba and Mantle, though here the opportunities for development are restricted as slopes are more pronounced. Crab-holes occur on the lowest drainage flats and plains, but the development is never extensive. Drainage lines within the systems are often prominent with incision exceeding 6 ft, with a width of 30 ft. Sandy bedloads are usual.

PASTURES

The hills, ridges and plateaux (1) carry variable pastures in which stunted and sparse *Acacia tetragonophylla, A. aneura, A victoriae* and *A. eremea* are found over a shrub layer of variable density in which *Eremophila cuneifolia, Solanum lasiophyllum* and *Cassia* species may be dominant. Non-halophytic species such as *Kallstroemia, E. margarethae, E. freelingii* and *C. desolata* may be present where soil conditions permit it, but where there is apparent salinity species such as *Kochia melanocoma, K. georgei, K. murrayana* and *Ptilotus polakii* occupy the mid-storey. The ground storey is entirely ephemeral. The shrub layer is always sparse and, in most cases, has been reduced by over-use. The pastures on the upper and lower slopes (2 and 3) are not much different to those on the plateaux and hills, varying only in density and in species, where this is induced by soil type or salinity. *Frankenia, K. polypterygia* and *P. polakii* are common in alkaline habitats beneath scattered *Acacia* species. *Hakea priessii* is important locally where degradation has been allowed to become extreme and the valuable pastures removed. The banks and dunes (4) carry

A. linophylla above a variable shrub layer in which *Cassia desolata* and *Corchorus wolcottii* are now the dominant species, more useful species have been removed. The terraced slopes (5) are in no way different to those in Jimba and Mantle. The drainage floors and crab-holes (6) have a low shrubby vegetation, usually halophytic, with dense rings of trees about the crab-holes. The creeklines (7) are lined with *A. eremea*, *A. victoriae* and *A. tetragonophylla*, above scattered shrubs. The creekline vegetation is always in narrow bands rarely more than 30 ft wide.

General statement

Sandiman rangeland type has valuable, if scattered and somewhat sparse pastures. The reduced soil cover compared with Jimba and Mantle, makes it less productive. Nevertheless it has the potential to produce durable pastures, but due to over-use this capacity has been reduced. In most cases the pastures have been changed to unpalatable types, with associated annuals after rain. The lower slopes are frequently guttered and gullied.

The stony environment and the presence of outcropping sediments in places makes the task of rehabilitation difficult. The obvious course is one of freedom from use, but recovery by this method will be tedious. In some instances, the situation, due to erosion, is serious enough to suggest that grazing be restricted altogether. Where gutters and gullies are not present a restricted use could be permitted. Reseeding will never be possible due to the presence of very stony and saline soils on most sections.

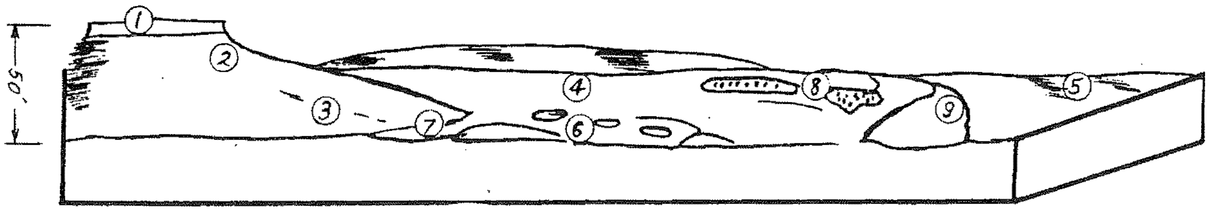
Traverse Summary - 53 observations

Wind erosion	%	Water erosion	%	Condition	%
None	19	None	26	Pristine	0
Sheeting	34	Sealing	36	Good	2
Surface redistribution	41	Minor rilling	15	Vegetation degraded	74
Hummocking	6	Stripping	10	Vegetation degraded; some erosion	24
Major drift	0	Lower slope gullies	11	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	2		

Significance to erosion

Unrestricted use has allowed greater run-off from this type to parts further down slope, which has aggravated the erosion condition of the plains. The type contributes in a major way to erosion on the catchment.

JIMBA RANGELAND TYPE 718 square miles



Unit	%	Landform	Soils	Potential	Condition
1	15	Flattened low ridges and platforms	Red brown or brown clay of variable depth in P.M. pH 6-8 and with out-crop	Moderate; scattered useful shrubs	Vegetation degraded; erosion gutters and gullies
2	10	Pebble strewn upper slopes	Brown gritty clay up to 24 in, pH 8-8.5, scattered cobbles and boulders with pebble strew	Moderate; scattered useful shrubs	Vegetation degraded; erosion gutters and gullies
3	10	Lower slopes with drainage foci	Red-brown to brown gritty to fine clay, pH 7, of variable depth to 36 in, pH 6-8	Moderate; palatable shrubs	Vegetation degraded; erosion gutters and gullies
4	30	Diffuse drainage plains	Brown clay of variable depth, pH 7.5 - 9, with and without pebble strew	Good; many palatable, useful shrubs	Vegetation degraded; major erosion, sealing, gutters, gullies and truncation
5	10	Terraced tributary drainage slopes	Vegetated areas; brown fine clay to 36 in, pH 7.5, bare areas; brown clay to fine clay with pebble strew	Moderate; good useful shrubs and grasses	Vegetation degraded; restricted erosion
6	5	Crab-holes and major drainage foci	Brown clay to more than 36 in, pH 7-8	Fair to moderate; useful shrubs and grasses	Vegetation degraded; little erosion

Unit	%	Landform	Soils	Potential	Condition
7	5	Tributary sheet flow drainage	Brown clay, pH 7-8	Moderate; useful shrubs and grasses	Vegetation degraded; erosion gutters
8	10	Sandy banks	Red-brown loamy and greater than 36 in, pH 6.5	Moderate; useful shrubs and grasses	Vegetation degraded; hummocking of sand
9	5	Drainage lines	Up to 600 ft wide, braided; incision to 4 ft	Moderate; much good grass	Vegetation degraded; some banks consolidated others guttered

Jimba rangeland type is confined to the Permian basin west of the Precambrian block. It is found on the Glenburgh, Mt. Phillips, Kennedy Range and Wooramel four-mile sheets. It is an alluvial plain rangeland type occupying 718 square miles of catchment. The pattern is very confused, a reflection of the sedimentary geology, over-use and regional topography. The plains are based on Artinskian series of Permian sediments which are essentially free of boulders and pebbles, and which give rise to plains which have generally no pebble and cobble mantles. In this way, Jimba differs from Mantle, which is derived from Sakmarian series Permian sediments, and in which tillitic, boulder and pebble-studded sediments are common. The absence of the pebble mantle has resulted in quite different erosion patterns in the two groups, being very severe in Jimba, and much reduced in extent in the stone-shielded pastures of Mantle rangeland type.

Flattened ridges and domes up to 50 ft high above the drainage characterise this rangeland type. They are covered with cobbles and pebbles, and have outcropping areas which may be partially weathered. Stony slopes extend away from the ridges, sloping at 1:50 to 1:75, and frequently dissected by fine creeklines. Lower slopes with cobbles and pebbles, but with reduced regional slope and local drainage foci unite the upper slopes with the diffuse drainage plains. These plains are frequently bare of stone cover and have been subjected to severe sheet and gully erosion. They slope at 1:250 to 1:750. Terraced, tributary drainage slopes, in which bands of stone-free clayey soils transverse to the slope, are separated from each other by long transverse stony areas, occupy areas above the drainage plains in some instances. They are common where the regional slope is about 1:100 to 1:250. The terraces are up to a mile long and usually less than 100 ft wide. Large crab-holes and other local drainage areas occur on the drainage plains. These may be up to twenty chains in diameter, but are usually smaller. Discharge water from the drainage plains frequently collects in sluggish swamps which have very heavy clay soils. Sandy banks are found on the drainage plains. Some may be aggregated to form minor sanddune-claypan complexes which may be up to 25 ft high. In other instances, they may have resulted from water flows in the plains

and here they are elongate with the flow, and merely three feet high and up to 25 chains long. Flowlines carrying the concentrated drainage may be up to 1000 ft wide, and are often incised to 10 ft and up to 50 ft across. The bedloads are principally sand.

PASTURES

The low ridges and platforms (1) carry *Acacia victoriae, A. eremea* and *A. tetragonophylla*. These trees provide a sparse cover over a very variable shrub layer. Where soil conditions are suitable halophytic species such as *Kochia polypterygia* and *Arthrocnemum* are common. In most instances, though, these have been depleted by severe over-use. Where the soils have not favoured the development of halophytic species, *Cassia desolata, C. helmsii, Eremophila spathulata* and *Solanum lasiophyllum* are common. In situations of severe degradation *Hakea priessii* often assumes dominance, *Ptilotus obovatus* and *Corchorus wolcottii* then being the major mid-storey species. The upper and lower slopes (2 and 3) have a sparse overstorey of *A. victoriae, A. eremea* and *A. tetragonophylla* over similar species to those on the ridges. *E. cuneifolia* may be locally important, and halophytes such as *K. polypterygia* and *K. pyramidata* can be found in the non-eroded state. In most instances, however, the more valuable species have been removed and the pastures are restricted to annuals and species such as *P. polakii* beneath the tree cover. The diffuse drainage plains (4) are so frequently eroded and degraded that it is difficult to generalise upon the original pastures. Sufficient was found, however, to indicate that halophytic shrubs such as *K. pyramidata, K. polypterygia* and *Arthrocnemum* were important species, occupying from 10 per cent to 15 per cent cover beneath scattered, taller trees. Where the soil conditions are not so alkaline, species such as *C. sturtii, C. desolata* and *S. lasiophyllum* are common. Where degradation only, with little erosion had taken place, *H. priessii, E. pterocarpa* and *E. cuneifolia* are the dominant species. Where severe over-use has reduced the pasture to annuals only, *Bassia* and *Atriplex* form the basis of the pastures beneath very scattered and stunted *Acacia*. The terraced drainage slopes (5) in good condition carry a sparse tree cover of *A. tetragonophylla* and *A. eremea* above *K. pyramidata* and *K. polypterygia* with *Eragrostis setifolia* as the ground storey. Degradation was found to reduce the clay terraces to annuals and some perennial grasses. It is doubtful if anything but sparse annuals grew on the stony inter-terrace areas, and then only after effective rainfall. Crab-holes and major drainage foci (6) support a dense marginal vegetation in which *Eucalyptus microtheca, Scaevola spinescens, A. tetragonophylla, K. pyramidata* and *H. priessii* frequently surround a vegetated claypan dominated with *Eriachne flaccida*. The tributary sheet flow drainage areas (7) with heavy clay soils have a vegetation rather similar to that found in Bibbingunna rangeland type. The sandy banks (8) are very variable though this is, in part, due to their derivation and partly to their degradation. Low elongate banks are usually very degraded and carry *A. tetragonophylla* and *A. sclerosperma* with *H. priessii* above worthless species such as *Eremophila maitlandii* and *E. margarethae*. Valuable species such as *E. latrobei, Rhagodia* and *K. polypterygia* are found infrequently and then only in conditions of little use. Creeklines (7) in Jimba rangeland type are often colonised with Buffel grass *(Cenchrus ciliaris)*. This has prevented any extensive erosion of the banks and incised drainage. However, in the absence of this resistant cover, severe gullying can

occur beneath the tree species which include *Eucalyptus camaldulensis*, *E. microtheca* and *Acacia holosericea*. The shrub layer is usually variable and depressed when Buffel grass is dominant.

General statement

This rangeland type provides very valuable pastures on the western part of the catchment. The halophytic sections are durable and palatable, but almost without exception have been severely degraded by over-use to the extent that the valuable species have been removed. The soils derived from the Permian deposits are highly alkaline clays which are extremely susceptible to gutter and gully erosion, particularly when surface cover is removed. In many instances erosion gutters are initiated by quite small surface disturbances upslope. A number of Permian deposits underlay areas particularly prone to degradation and these include the Bulgadoo Shales and the Callytharra formations.

A dramatic increase in *Hakea priessii* has occurred due to over-use in this rangeland type. This situation is particularly grave on the lower slopes and drainage plains, where this unpalatable and pungent-pointed leafed shrub has assumed dominance over very extensive areas.

Rehabilitation of this type in the first instance will only be effected by extensive spelling. Much has deteriorated so far as to be incapable of restoration as the parent rocks have been exposed. In some areas rehabilitation through reseeding could be effected, but this will be a tedious process and a costly one. The type is particularly prone to over-use. Supervision of its use should have begun when the area was first leased or, alternatively, much of it should have been excluded from leases.

Dominance of the pasture by *Hakea priessii* poses a separate problem. Protection alone will eventually promote its removal, but this will take many decades. With the low returns per acre common in pastoral areas it is difficult to conceive of any other management practise which could be feasible.

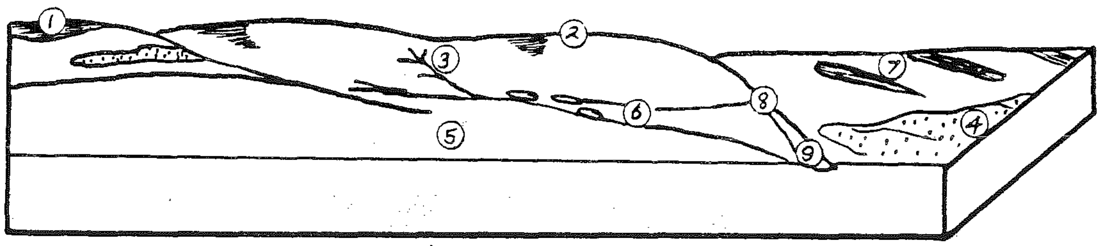
Traverse Summary - 141 observations

Wind erosion	%	Water erosion	%	Condition	%
None	2	None	11	Pristine	0
Sheeting	18	Sealing	34	Good	2
Surface redistribution	63	Minor rilling	21	Vegetation degraded	70
Hummocking	17	Stripping	10	Vegetation degraded; some erosion	28
Major drift	0	Lower slope gullies	24	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

This rangeland type is grossly degraded and eroded and contributes in a major way to degradation on the catchment.

MANTLE RANGELAND TYPE 613 square miles



Unit	%	Landform	Soils	Potential	Condition
1	10	Rounded summits	Cobble strewn and with minor areas of sand usually brown clay of variable depth to PM	Fair to moderate; scattered useful shrubs	Vegetation degraded; little erosion
2	25	Low gently undulating stony plains	Red-brown and brown clay up to 36 "; pH 8-9, abundant cobble and pebble strew	Moderate; useful palatable shrubs	Vegetation degraded; some gullies down slope
3	10	Stony slopes with slightly incised creeklines	Brown fine clay on P.M. at variable depths, pH 7-9 sandy and cobble strew	Fair to moderate; scattered useful shrubs	Vegetation degraded; gullies at the tops of creeklines
4	5	Sandbanks	Red-brown sand 36"; pH 6.5	Fair to moderate; useful shrubs and grasses	Vegetation degraded; some hummocking
5	30	Lower slopes and pebble strewn plains	Brown clays of variable depth, pH 8-9, variable mantle of cobbles and pebbles	Moderate; useful shrubs	Vegetation degraded; erosion in gutters and gullies
6	5	Sluggish drainage and crab-holes	Brown clays greater than 36"; pH 8	Moderate, useful shrubs	Vegetation degraded; usually not eroded
7	5	Terraced slopes	Terraces - brown clay Inter-terrace - pebble strewn brown clay	Moderate; useful shrubs on terraces only	Vegetation degraded; little erosion

Unit	%	Landform	Soils	Potential	Condition
8	5	Concentrated flow areas	Brown clays with braiding	Moderate; useful shrubs	Vegetation degraded; braided gutters
9	5	Minor water-courses and drainage floors	Brown clays with braiding and minor incision to 10 ft and 100 ft across	Fair to moderate	Vegetation degraded; consolidation on banks, severe gutters in other banks

Mantle rangeland type is restricted to the Permian basin on the west side of the catchment. It is found on the Glenburgh, Mount Phillips, Kennedy Range and Wooramel four-mile sheets, where it occupies 613 square miles. This type is derived in the main from Sakmarian formations in the Permian beds. These are stratigraphically lower in the succession and are characterised by a series of boulder beds. In the current sequence these beds are exposed most frequently on the eastern side of the basin. Consequently Mantle rangeland type is most common in that section of the catchment. The boulder beds have given rise to soils which in general are covered with a cobble or pebble mantle. The broad flattened and unprotected plains common in Jimba are lacking and the topography tends to be more undulating.

Rounded and sometimes flattened summits and low ridges rise up to 100 ft above the drainage plains. Minor areas of sand accumulation are found on some of the summits. In many instances, the more abrupt summits are replaced by gently undulating stony plains with only local high points below which stony slopes with minor creeklines on their faces extend towards larger and flatter stone-covered plains. Sandy banks up to 10 ft high and 300 ft across occur sporadically upon the lower slopes, but are apparently wind caused and are not the result of water flow. These lower plains discharge water into sluggish drainage lines, concentrated flow areas, or on to minor watercourses and drainage floors. Where the slope is suitable, about 1:150, the vegetated areas are arranged in a series of terraces as in Jimba rangeland type. They are found transverse to the flow of water and are separated by stony inter-terrace areas marginally different in slope to the terrace itself. These inter-terrace areas seem to serve a similar purpose to that of the inter-groves in Frederick type as they augment the available water supply in the vegetated terraces.

PASTURES

The summits (1) carry sparse and stunted *Acacia aneura*, *A. sclerosperma* and *A. victoriae* above a variable shrub layer in which *Eremophila platycalyx*, *Cassia oligophylla* and *Solanum lasiophyllum* are common. The stony plains and slopes (2 and 3) carry *A. victoriae*, and the shrub layer is dominated by *Eremophila cuneifolia*, *Cassia desolata* and *Solanum lasiophyllum*. Less commonly, valuable species such as *Kochia* and *Rhagodia* are found where grazing has been light. The sand

banks and low dunes (4) have a moderately dense tree layer in which *A. linophylla* and *A. aneura* may be common above a shrub layer in which *Corchorus wolcottii* has now replaced the more useful of the shrub species such as *Eremophila leucophylla* and *Rhagodia*. The unpalatable *Eremophila granitica* is common with *C. wolcottii* in the over-used condition. The lower slopes and plains (5) carry a vegetation not much different to that of the upper plains, though species such as *A. eremea* and *Exocarpos* sp may be common locally. *Kochia polypterygia*, *Rhagodia* and *K. georgei* occur in the pasture when these areas are in good condition. The sluggish drainage plains (6) should carry halophytic vegetation such as *Kochia* spp., *Frankenia* and *Arthrocnemum*, but are usually severely degraded. The terraced slopes (7) support a very sparse and stunted tree layer of *A. victoriae* and *A. tetragonophylla* above species such as *K. pyramidata*, *K. polypterygia* and *Ptilotus polakii*, but in most cases only the latter survives. The drainage floors and flow areas (6 and 7) support a variable shrub population dependent upon the alkalinity of the soil. In many instances buffel grass is important.

General statement

Mantle rangeland type has many affinities with Jimba and differs only in the cover of stones. While this has reduced the effects of soil erosion it has not relieved the pressure of stocking and the vegetation is extremely degraded. Favoured areas such as the sandy areas on the summits are frequently heavily over-used and are unstable. The lower plains are also guttered in many instances particularly where water flow from upper areas is unrestricted due to vegetation stripping.

Accordingly then, this type along with Jimba will prove difficult to rehabilitate. In the first instance it may be possible only with prolonged freedom from use and in many places this should be implemented immediately in order to prevent further deterioration of the environment. Some reseeding may be attempted in more favoured sites, but in general this should prove difficult.

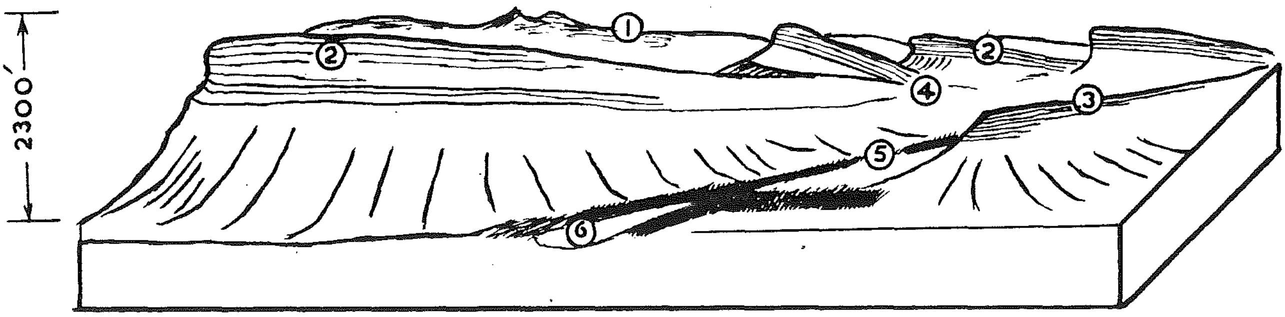
Traverse Summary - 118 observations

Wind erosion	%	Water erosion	%	Condition	%
None	3	None	25	Pristine	0
Sheeting	43	Sealing	52	Good	2
Surface redistribution	50	Minor rilling	14	Vegetation degraded	91
Hummocking	4	Stripping	7	Vegetation degraded; some erosion	7
Major drift	0	Lower slope gullies	2	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

The type is severely degraded and in places guttered and gullied. It contributes significantly to the erosion in the catchment.

AUGUSTUS RANGELAND TYPE 3183 square miles



Unit	%	Landform	Soils	Potential	Condition
1	40	Mountains and summits with included slopes Northern divide	Rocks, isolated soil in pockets	Poor; inaccessible	Good
2	25	Ridges and rocky uplands; isolated massive hills e.g. Mt. Augustus	Rocks, isolated soil in pockets, heavy boulder and cobble strew	Poor; partly inaccessible	Good
3	10	Quartzite ridges e.g. Mt. George	Shallow rocky soils, boulder and cobble strew with prominent subconchoidal fracture	Poor; partly inaccessible	Good
4	15	Upper slopes and interfluves	Shallow soils with abundant stone mantle	Low, sparse scattered shrubs only	Good
5	5	Drainage floors	Some duplex red-brown soils, some gr. clay of variable depth	Fair; some areas of good shrub pasture	Vegetation degraded; some gullies and sheet erosion
6	5	Incised drainage	Mostly incised into bedrock with heavy cobble bedloads	Poor	Good

Augustus rangeland type covers 3183 square miles on Peak Hill, Glenburgh, Collier, Mt. Egerton, Edmund and Robinson Range four-mile

sheets. It forms the divide on the northern side of the catchment and is found in isolated monoliths penetrating almost as far as the Permian Plains (Mt. Dalgety) in the south and west. The highest part of the catchment, Mr. Augustus, is 3627 feet above sea level affording about 2366 feet of relief above the plain. It is sandstone monolith standing freely in the drainage plain of the Lyons River.

Rugged mountain ranges, quartzite ridges and vast, rocky dissected uplands, all of middle Proterozoic age (Bangemall series) in the Precambrian era, form the basis of this rangeland type. Many of the sediments of the Bangemall series are comparatively soft, particularly the mudstones and lower dolomites. Geologic erosion of these strata has produced spectacular dissections and abrupt cliffs several hundred feet high in the divide area. These dissections are emphasised by the caps of diorite which as thin flows often surmount the Bangemall series. In some instances basaltic flows are found interbedded with the sedimentary rocks of the series.

Quartzite ridges up to 200 ft high and several miles long are found on drainage plains where they influence the direction of major water flow. The ridges are almost completely unweathered, and the upper slopes are covered with massive boulders and large cobbles exhibiting typical sub-conchoidal fracture. Slopes of 6^{o} are not uncommon. Tributary slopes which descend to the plain from the ridges and lower slopes vary between 1:50 and 1:100. Flattened drainage floors which are often saline are common within the rocky uplands and carry distinctive vegetation. They are frequently strewn with flat angular "desert varnished" fragments. Major drainage within the type is incised into the bedrock and usually has cobble bedloads. This drainage is usually fine and dendritic, though major trunk drainage frequently traverses the type.

PASTURES

The rocky mountain summits (1) carry a stunted but moderate cover of *Acacia aneura* and *A. grasbyi* with *Grevillea nematophylla* prominent locally. *Cassia, Ptilotus* and *Eremophila* species above annuals occur beneath the low tree layer. The ridges (2) are similar to the summits, but *Eremophila margarethae* and *E. compacta* may be characteristic of some locations, apparently the subject of some geologic control. The quartzite ridges (3) are typically sharp and comparatively unweathered falling away steeply to lower slopes and plains. They carry a moderate cover of low *A. aneura, Solanum, Eremophila margarethae, E. freelingii, Halgania* sp. and annuals. The upper slopes and interfluves (4) are rather similar to the foregoing, though it is noticeable that the vegetation is limited on the interfluves to scattered low shrubs such as *Eremophila freelingii* and *Acacia aneura,* but concentrated in the barely incised drainages. The drainage floors (5) carry sparse halophytic pastures where saline conditions exist, but can also carry *Eremophila leucophylla,* perennial grasses and taller trees where the drainage is less sluggish and soil depth is above 18 inches. The drainage (6) carries marginal vegetation where *A. aneura* is usually dense above dense *E. margarethae, E. freelingii* and *Solanum* spp.

General statement

Augustus rangeland type dominates the landscape over much of the

catchment, but it is virtually worthless apart from the resticted areas of drainage flats where useful pastures are found.

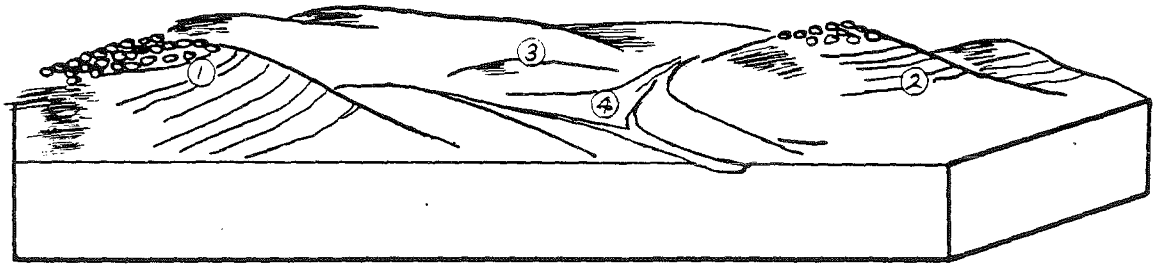
Traverse Summary - 24 observations

Wind erosion	%	Water erosion	%	Condition	%
None	79	None	76	Pristine	5
Sheeting	8	Sealing	8	Good	21
Surface redistribution	13	Minor rilling	4	Vegetation degraded; some erosion	67
Hummocking	0	Stripping	8	Vegetation degraded; some erosion	8
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	4		

Significance to erosion

Some of the drainage floors are badly eroded and should be rehabilitated. However, this could prove difficult as these are only found as small inclusions.

MULGUL RANGELAND TYPE 120 square miles



Unit	%	Landform	Soils	Potential	Condition
1	70	Hills with and without dolerite caps sediments exposed in benches	Shallow soil in pockets, pink brown sandy clay of variable depth, pH 9, abundant cobbles and pebbles	Low; scattered shrubs and	Vegetation degraded; no erosion
2	10	Scree slopes to the hills	Brown sandy clay loam, shallow depth to P.M., pH 8.5	Fair; scattered shrubs and annuals	Vegetation degraded; no erosion
3	5	Low domes of freshly exposed rocks	Fresh rocks, very fragile and crumbly	Low; principally annuals	Vegetation degraded
4	15	Drainage floors and incised drainage	Red-brown gritty clays of variable depth on P.M., pH 7-8	Fair to moderate; useful shrubs in places	Vegetation degraded; erosion gullies

Mulgul rangeland type is part of the Precambrian Bangemall series of rangelands. It is a hill type and is based upon the comparatively unaltered dolomites of this series. It is frequently capped with a layer of dolerite which confers a distinct photopattern on the type, while the calcareous soils derived from the dolomites are themselves responsible for special distributions of calciphilous plants. Mulgul rangeland type occurs on the Robinson Range, Mt. Egerton and Collier four-mile sheets and occupies 120 square miles of the catchment.

Low hills with up to 200 ft of relief dominate this rangeland type. They may be capped with thin basaltic flows, but their principal characteristic is the bench-like arrangement of the sediments. These dip variously at 15^{o} to 25^{o}, and are arranged in terraces up to 12 inches high, and some 15 ft across of partly weathered and weathered material. The total regional slope of the terraced hill faces is

usually 1:20. Slopes beneath the hills carry dolomitic cobbles and pebbles, and extend onto narrow drainage floors which are rarely more than 200 ft wide. The drainage leads naturally to Sugarloaf type, which makes up the plains beneath Mulgul. Fresh exposures of dolomites on the lower slopes cause stark patches of white in the photopattern. These grow little feed, but are never extensive, rarely more than 150 ft across.

PASTURES

The hills (1) carry low *Acacia aneura* which is moderately dense though the total cover is small, over dense *Cassia oligophylla*, *Eremophila compacta*, *Ptilotus obovatus*, *Indigophera* sp. and *Eremophila freelingii*. The annual species are always calciphilous and include *Helipterum sterilescens*, *Enneapogon*, *Bassia* and *Zygophyllum*. The slopes (2) are similar to the hills. The low domes (3) are usually bare of perennial vegetation and carry annual species only. The drainage floors (4) carry scattered halophytic shrubs such as *Kochia pyramidata* beneath *A. victoriae* and *Santalum* sp. in patches.

General Statement

Mulgul rangeland type is restricted in area and not significant in the total pasture situation. It is a short grass-forb pasture and responds chiefly to seasonal rains.

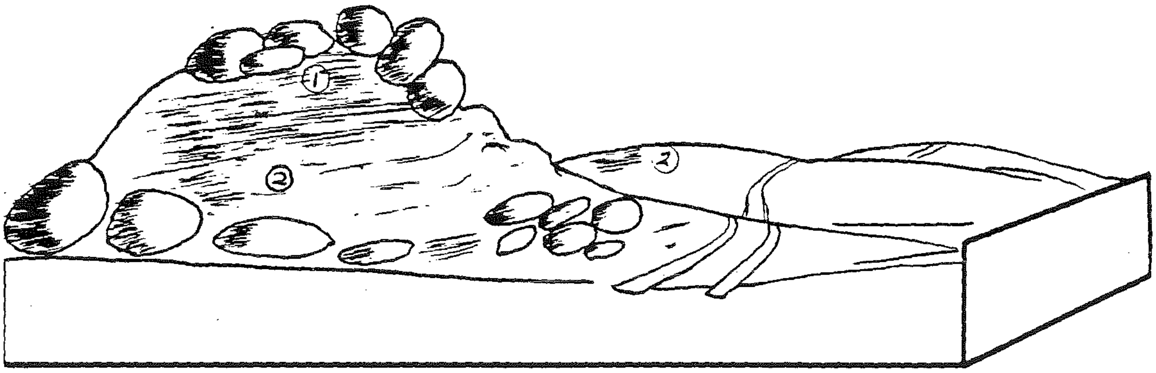
Traverse Summary - 7 observations

Wind erosion	%	Water erosion	%	Condition	%
None	86	None	72	Pristine	0
Sheeting	14	Sealing	14	Good	0
Surface redistribution	0	Minor rilling	0	Vegetation degraded	57
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	29
Major drift	0	Lower slope gullies	14	Vegetation degraded; major erosion	14
		Upper & lower slope gullies	0		

Significance to erosion

Although the drainage floors are eroded it is difficult to imagine these small inclusions reacting in any other way to grazing since they would be preferentially used. The type is not significant to the total erosion situation but action should be taken to prevent further severe erosion in the drainage floors.

DIORITE RANGELAND TYPE 19 square miles



Unit	%	Landform	Soils	Potential	Condition
1	75	Hills	Bare rock or shallow soil in pockets	Low; sparse shrubs inaccessible	Vegetation partly degraded but usually good
2	25	Slopes	Bare rock or shallow soil in pockets	Low, sparse shrubs	Usually good with some degradation in accessible parts

Diorite rangeland type is associated with the Bangemall series of Precambrian sediments where basaltic flows are found. These are currently expressed in places on the catchment by small rock strewn, and bare rocky hills of diorite. The type is nowhere extensive and occurs as isolated remnants on the Mt. Egerton and Glenburgh four-mile sheets. It occupies 19 square miles of the catchment.

Low, bald or sparsely vegetated basaltic domes and low rough hills are the outstanding feature of this type. They rise to about 75 ft and are characterised by very large subconchoidal boulders at their base. The slopes of rough hills are often strewn with these boulders and rounded smaller cobbles. The slopes range between 1:5 to 1:25.

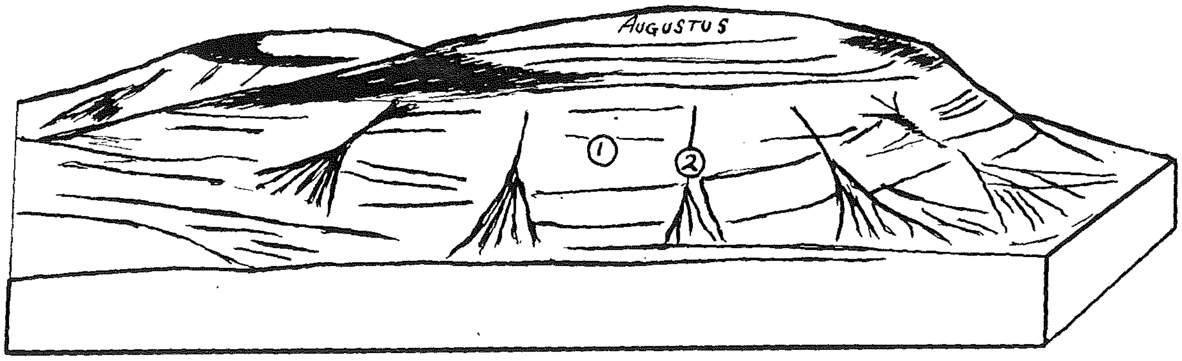
PASTURES

The low hills (1) carry sparse *Acacia aneura, A. tetragonophylla* and *A. grasbyi* above a variable shrub layer in which *Eremophila spathulata, Ptilotus obovatus* and *Solanum lasiophyllum* are common. The ground cover is frequently absent or is restricted to pockets of soil where it is expressed as annuals. The rock strewn slopes (2) carry similar vegetation.

General statement

This rangeland type is partly inaccessible and as it has considerable areas of bare rock face, it produces very little in terms of forage. It is not significant in the erosion situation.

GEORGE RANGELAND TYPE 492 square miles



Unit	%	Landform	Soils	Potential	Condition
1	90	Interfluves	Red-brown or brown gritty clay of shallow depth on rock, pH 6-7.5, abundant cobble and pebble strew	Low	Vegetation degraded; no erosion
2	10	Creeklines	Cobble and pebble bed loads	Fair	Vegetation degraded; no erosion

George rangeland type covers 492 square miles and occurs in association with Bangemall series hills on the Peak Hill, Collier, Robinson Range, Mt. Egerton, Mt. Phillips, Edmund and Glenburgh four-mile sheets. It always occurs below the summits of Augustus rangeland type, and could have been included with this type, but it is extensive enough to stand apart. It can be distinguished from the former by its greatly increased accessibility to stock, and its essential simplicity of pattern.

Two units make up this type. Rounded, cobble strewn interfluves sloping regionally at 1:50 to 1:150, up to 25 chains wide though commonly narrower, extend away from the more abrupt hills and towards the lower and gentler slopes of Jamindie rangeland type. The streamlines are incised into bedrock, and have loose cobble and pebble bed loads. There is very little sand in the creek beds, particularly in the upper parts. Incision can reach 36" with total width up to 80 feet in the lower parts.

PASTURES

The pastures on the interfluves (1) are poor and depauperate. Sparse stunted *Acacia aneura* and *A. tetragonophylla* occur over a sparse shrub layer where *Eremophila freelingii*, *Cassia* spp., *Kalstroemia*, *Ptilotus obovatus* and *Solanum ellipticum* predominate. In the ungrazed situation total cover can reach 10 per cent when *Cassia sturtii*, *Kochia triptera* and other Kochia species can be important.

The creeklines (2) carry relatively dense marginal vegetation in which *Grevillea striata, Acacia holosericea* can be found in addition to other species common on the interfluves.

General statement

George rangeland type is a poor producer of pasture. The more valuable elements have been removed and their restoration will be difficult in this rather harsh environment. The production by annuals is low even under good conditions, so that optimum use is likely to be achieved only after effective rains.

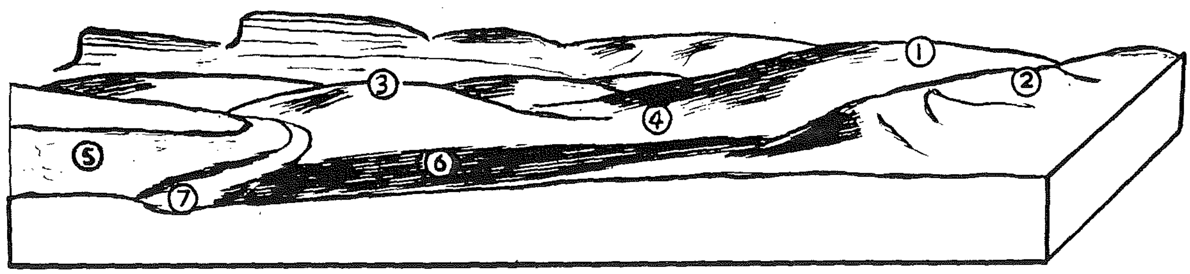
Traverse Summary - 13 observations

Wind erosion	%	Water erosion	%	Condition	%
None	62	None	69	Pristine	0
Sheeting	23	Sealing	23	Good	0
Surface redistribution	15	Minor rilling	·	Vegetation degraded	71
Hummocking	0	Stripping	8	Vegetation degraded; some erosion	29
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slopes gullies	0		

Significance to erosion

Some erosion was found in this type on the catchment. However, the protection afforded by the stone mantle should prevent serious erosion except in the lowest parts.

COLLIER RANGELAND TYPE 620 square miles



Unit	%	Landform	Soils	Potential	Condition
1	10	Flat stony uplands	Abundant cobble and pebble strew with gravels. Red-brown gritty clay of variable depth on rock	Low	Good
2	10	Low ridges	Shallow rocky soils in pockets, extensive stone mantles	Low	Good
3	40	Undulating low rounded areas	Very shallow soils with gravels and cobbles	Low	Vegetation degraded
4	20	Stony plains	Shallow soils and also calcareous earths	Low	Vegetation degraded
5	10	Lower plains	Strew covered brown sand clays of variable depth	Low	Vegetation degraded; gullies on the lower portions
6	5	Drainage flats	Some duplex soils; also red-brown loamy sands and gritty clays	Fair	Vegetation degraded; extensive gullying on the saline areas
7	5	Incised drainage	Cobble bedloads though sandy in the lower reaches	Low	Vegetation degraded

Collier Rangeland type covers 620 square miles on the Mt. Egerton, Mt. Phillips, Collier, Edmund and Peak Hill four-mile sheets. It is usually associated with Augustus which forms the major regional upland.

However, it can also occur as isolated, local, low, stony uplands with small plateaux and ridges formed, from the Bangemall series of Middle Proterozoic of the Precambrian.

Flat, stony uplands with up to 150 ft of relief occur as the dominant features of this rangeland type. They are strewn with quartzite, dolerite, and sedimentary fragments which may often be extensively weathered. Long, low ridges up to 4 miles long and up to 75 ft high are significant lineaments in the type occurring independently of the uplands. More undulating, low, rounded summits up to 50 ft high with abundant outcrop form the major part of the type. In this sedimentary series the geology is extremely variable, sandstones, shales, quartzites and dolerites being common. Low, rounded dolomitic hills up to 50 feet high, which arise from deposits laid down early in the sequence, are found at the base of the current dissection patterns. Special pasture inclusions are usually associated with the dolomites.

Stony plains and interfluves with regional slopes of about 1:50 extend away from the more undulating sections and uplands towards lower plains and drainage flats. The drainage is incised to bedrock in most instances and, accordingly, shallow.

PASTURES

The flat stony uplands (1) carry stunted sparse *Acacia aneura* and *A. tetragonophylla* above *Cassia sturtii* and *Eremophila fraseri*. The ground cover is ephemeral. The low ridges (2) have similar pastures of limited value, with the character changing according to the geologic control. The low summits (3) support very sparse *A. aneura* over low *Eremophila freelingii*, *Cassia sturtii*, *C. helmsii* and *Solanum lasiophyllum*. Where dolomites form the base of undulations, *C. oligophylla*, *C. desolata*, *A. victoriae* and *E. leucophylla* are more prominent. They stony plains and interfluves (4) and the lower plains (5) carry sparse shrubs and ephemeral grasses and forbs in season. The drainage flats and valley floors (6) have variable pastures dependent very largely upon the nature of the drainage. Where it is non-saline *Acacia grasbyi*, *A. linophylla* and *A. kempeana* are found over variable shrubs. Halophytic shrubs are common when drainage is sluggish. Where the dolomites influence the soil type the lower plains and stony plains carry *Exocarpos* and *A. eremea* over *Rhagodia* sp. *Exocarpos* is indicative of the presence of dolomites or at least high alkalinity in many parts of the catchment. The incised drainage (7) has dense fringing vegetation not unlike that of the drainage floors.

General statement

Collier rangeland type provides rocky pastures of low pastoral value. The inclusions of better soils and pastures have been extensively over-used and are now quite degraded and eroded. There is no erosion on the cobble and pebble strewn areas, but run-off has increased due to vegetation degradation.

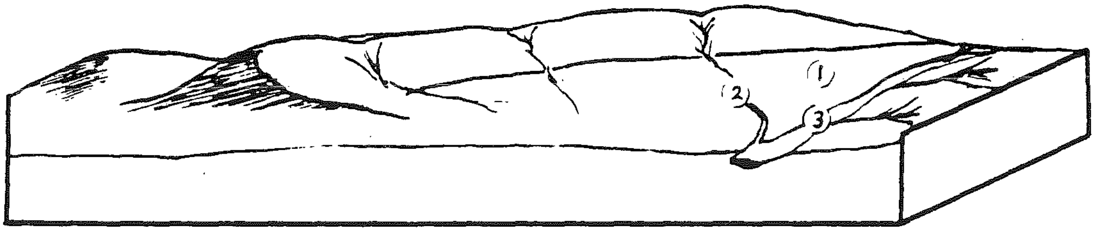
Traverse summary - 19 observations

Wind erosion	%	Water erosion	%	Condition	%
None	84	None	84	Pristine	0
Sheeting	11	Sealing	6	Good	26
Surface redistribution	5	Minor rilling	5	Vegetation degraded	48
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	26
Major drift	0	Lower slope gullies	5	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

This rangeland type does not contribute much to the overall erosion situation on the catchment.

WOODLANDS RANGELAND TYPE 44 square miles



Unit	%	Landform	Soils	Potential	Condition
1	85	Valley floors	Light brown gritty loam up to 24" on P.M., pH 8.5, scattered pebble and calcareous strew	Low; harsh grasses and annuals	Good; little used, no erosion
2	10	Drainage floors	Brown clay of variable depth pH 8, with scattered strew	Fair to moderate; palatable shrubs	Vegetation degraded; some erosion rills
3	5	Incised drainage	Incised to 10', and up to 30' wide, with sandy bed loads	Fair; palatable shrubs	Good; little use

This small rangeland type occurs on the Mt. Egerton four-mile sheet. It is based on Bangemall series dolomites which are exposed as slightly dissected flat sheets in the valleys formed by the upper beds of this series. As the dolomites are low in the stratigraphic succession it is not unusual for them to fill the valley floors in some of the Bangemall uplands. This type covers 44 square miles.

Woodlands type lacks the resistant hills and terraced rises found in Mulgul, and consists of strew covered low valley floors up to 4 miles long and a mile wide, which have a characteristic vegetation. Gentle drainage lines and floors provide a slight amount of dissection to the type.

PASTURES

The valley floors (1) have a surface strew of small ferruginised pebbles and occasional outcrops of dolomites. They carry relatively dense *Acacia aneura* with *Eucalyptus oleosa* over *Exocarpos*, *Acacia* sp.

and *Eremophila* spp. The cover of shrubs can reach 8.5%. Where the soil is suitable *Triodia basedowii* is dominant, providing up to 20 per cent of the cover, but otherwise the ground flora is restricted to calciphilous annuals. The drainage floors are sparsely vegetated with *E. oleosa*, *Exocarpos* and scattered halophytes such as *Kochia* spp. and *Eremophila maculata*. Ground species are again calciphilous. The creeklines (3) are well vegetated with *Acacia aneura*, *A. sclerosperma*, *A. tetragonophylla* and *Eucalyptus camaldulensis* above a variable shrub layer.

General statement

The upper parts of this type are comparatively unaltered by grazing. The *T. basedowii* sections are not grazed. The valley floors tend to be over-used since they form the most accessible parts of this pasture and that of the rangeland types around it. Erosion rills occur therefore in some places, accompanied by depleted vegetation.

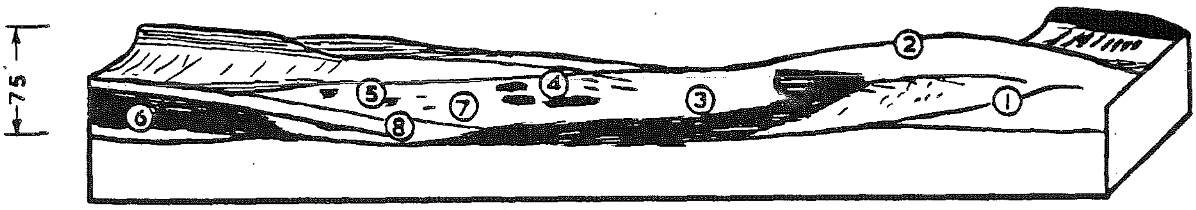
Traverse Summary - 5 observations

Wind erosion	%	Water erosion	%	Condition	%
None	80	None	80	Pristine	0
Sheeting	20	Sealing	0	Good	60
Surface redistribution	0	Minor rilling	20	Vegetation degraded	20
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	20
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

The small size of this rangeland type makes it unimportant in the erosion situation.

JAMINDIE RANGELAND TYPE 2458 square miles



Unit	%	Landform	Soils	Potential	Condition
1	10	Low stony ridges and outcrops	Shallow rocky soils	Poor; few shrubs	Vegeation degraded; no erosion
2	20	High rounded interfluves	Cobble and pebble strew. Red-brown gritty clay of variable depth	Poor; few shrubs	Vegeation degraded; no erosion
3	5	Upper flattened groved drainage	In groves red-brown sand to fine clay 36" + pH 5.5-7, little strew. Intergroves Red-brown gritty clay to 10", pH 5.5-7, platy strew	Fair; adequate shrubs to support animals in stress periods	Vegetation degraded; no erosion
4	45	Flat pebble strewn plains with bare areas, groves and heavily vegetated areas	Red-brown gritty clay 6-14" on Hard Pan pH 6-7, In groves and drainages as above in 3, abundant platy strew on plains	Poor; extensive plains are low producers Major production from limited groves	Vegetation degraded; on erosion
5	8	Crab-holes and drainage foci	Red-brown or brown gritty clay 36"+	Fair; moderate some areas have many crab-holes downslope	Vegetation degraded
6	2	Sandy banks	Brown coarse gritty loam 15" on P.M., with sparse strew	Fair	Vegetation degraded; some wind erosion

Unit	%	Landform	Soils	Potential	Condition
7	5	Lower plains	Brown coarse gritty loam 8" on P.M., pH 6, with angular strew	Fair	Vegetation degraded; gullied in parts
8	5	Creeklines and incised drainage	Incision into rock and P.M., cobble and sandy bedloads	Fair	Vegetation degraded

Jamindie rangeland type covers 2458 square miles. It is one of three most extensive types on the catchment, being second only to Phillips and Augustus in size. It occurs on the Edmund, Mt. Egerton, Robinson Range, Mt. Phillips, Collier and Peak Hill four-mile sheets. Individual areas of Jamindie are usually very extensive and are tributary to higher types such as Collier and Augustus. On many stations Jamindie rangeland type forms the bulk of the pastures available.

Low ridges and outcrops form the highest parts of this rangeland type. The ridges of Bangemall series quartzites, mudstones and sandstones stand up to 50 feet high and can be up to 50 chains long. Their shed spreads over the plains below. Beneath the ridges and outcrops, or even occurring as the highest points in the system, high rounded summits or rounded interfluves with relief of up to 75 feet above the flow lines, and sloping up to 1:40 or 50, are a major part of the type. They are covered with an extensive small cobble strew of weathered Bangemall fragments and are up to 40 chains across. The drainage between the interfluves is frequently flattened and not incised, and consists of very closely spaced mulga grove patterns. The groves are up to 10 chains long and about 100 feet thick. The largest element in this rangeland is the extensive flattened pebble strewn plains up to 10 miles wide and extending down slope up to 4 miles and right up to the drainage. The plains slope at about 1:150 to 1:200 regionally, but become even flatter at the extremities distal from the rounded interfluves and ridges. They are covered with platy, weathered Bangemall strew over a soil up to 15 inches deep. The vegetation is very sparse and it would appear as if the bare plains shed a considerable amount of their sheet flow onto small grove groupings and shallow drainage depressions. In some locations small drainage depressions or even crab-holes are found on the plains. Some of the drainage depressions can be up to 10 chains long and 5 chains wide, and have extremely dense vegetation. The photo response on the plains is frequently tempered by the nature of the strew on the surface.

Small sandy banks marginal to flow lines are found on the lower reaches of the plains. Very flat lower plains with restricted drainage are found tributary to the major drainage though not in every situation. The incised drainage is finely cut into the plains and never becomes substantial till the lowest parts of the type are reached where incision up to 36 inches is attained with creek beds up to 75 feet across.

PASTURES

The ridges and outcrops (1) carry sparse low *Acacia aneura* and *A. eremea* over sparse *Cassia helmsii, C. prunosa, C. charlesiana, Eremophila cuneifolia* and scattered *Frankenia*. Ground cover is limited to ephemerals. The high interfluves (2) support *A. aneura* and variable other *Acacias* over *Eremophila fraseri, E. margarethae, E. georgei, E. maitlandii* and *Cassia* spp. over annual species. Total shrub cover was between 100 and 400 plants per acre. The upper groved drainage (3) carry very dense *A. aneura*, other *Acacia* spp., variable shrubs including *Rhagodia, Enchylaena, Indigophera, Eremophila* spp. and *Cassia* over essentially annual species.

The large flat strew covered plains (4) support a sparse vegetation with very scattered *Acacia tetragonophylla* and *A. pruinocarpa* over a very sparse *Eremophila freelingii, E. fraseri, E. maitlandii, Ptilotus obovatus, P. schwartzii, P. roei* and *Halgania*. The ground cover is always annuals. Shrub numbers vary between 100 and 500 plants per acre, total cover being between 1 and 5 per cent. The groves on the plain support very similar pastures to those found in the upper drainages (3). The crab-holes and drainage foci (5) have rings of dense *Acacia* species around internal grassed areas.

The small sand banks (6) carry *Acacia linophylla, A. eremea* and *Canthium* over relatively dense shrubs and grasses. However, although this element is good in itself, the total contribution to pasture is small. The lower plains (7) carry limited vegetation though there is evidence of considerable loss of perennial grasses. The creeklines (8) have marginal vegetation characterised by *Acacia* spp. and shrubs.

General statement

Large areas of Jamindie rangeland type are unproductive and appear to serve as watersheds for associated drainage foci and groves. As a result these special areas are usually severely overgrazed. However, they are not significantly eroded. The pebble and cobble strew generally has reduced the erosion hazard. Stocking policy on this rangeland appears to have considered the total area which, as indicated above, is a poor guide to capacity. A real measure of productivity, and particularly of durability, will come from an appreciation of the more favoured sites.

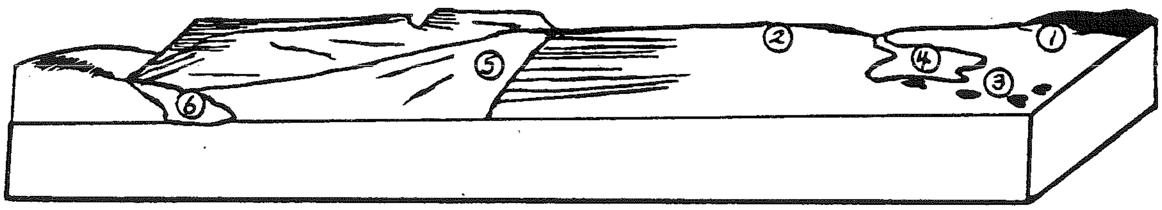
Traverse Summary - 195 observations

Wind erosion	%	Water erosion	%	Condition	%
None	59	None	65	Pristine	1
Sheeting	26	Sealing	21	Good	12
Surface redistribution	12	Minor rilling	7	Vegetation degraded	64
Hummocking	3	Stripping	2	Vegetation degraded; some erosion	21
Major drift	0	Lower slope gullies	5	Vegetation degraded; major erosion	1
		Upper & lower slope gullies	0		

Significance to erosion

Run-off from the extensive plains has probably increased due to some reduction in cover, but this is not likely to be significant. Some areas are gullied in the lower slopes and protection from use should be introduced as a grazing practise.

BRYAH RANGELAND TYPE 290 square miles



Unit	%	Landform	Soils	Potential	Condition
1	5	Low hills, ridges and mounds	Shallow rocky soils mostly in pockets	Low	Good
2	15	Upper slopes	Brown gritty clay of variable depth to 36", pH 7-8.5; angular, platy seal	Fair	Vegetation degraded; - little erosion
3	45	Plains with local crab-holes and drainage foci	Brown clay loam of shallow depth with variable weathered strew; pH 7-8.5	Fair	Vegetation degraded; some gullies and with crab-holes scalded
4	20	Sluggish internal drainage tracts	Frequently duplex soils on brown clay 36"; pH 7-8.5	Moderate	Vegetation degraded; gullied and scalded
5	10	Concentrated flow areas	Brown clay or clay loams with variable strew	Moderate	Vegetation degraded; gullied down slope
6	5	Major drainage	Slight incision with pebble bed loads	Fair	Vegetation degraded

Bryah rangeland type occurs on 290 square miles of the catchment. It is by definition always associated with the Bangemall geological series, and is found on the Mt. Egerton, Collier, Peak Hill and Robinson Range four-mile sheets. It occupies the low parts of the area where the drainage is restricted or sluggish, though it may also be found with highly weathered surfaces which contribute locally to salinity.

Low ridges and hills with up to 75 feet of relief form the borders of this type. They may be deeply weathered, but can also occur as sharp, unweathered quartzite ridges which confine the drainage. The tributary slopes to the hills are usually narrow, ceasing abruptly on the flat, broad plains which are characteristic of the type. These plains are usually covered with fine, highly weathered gravels, angular platy fragments, and occasional sub-botryoidal haematitic pebbles. They have local crabholes and drainage foci which are usually free of pebble cover. Sluggish internal drainage flats are found traversing these plains. Where the flow increases, concentrated sheet or braided flow areas discharge water into major drainage, or into associated clay flats of the Bibbingunna rangeland type.

PASTURES

The hills and weathered ridges (1) carry vegetation similar to that on Augustus and Collier rangeland types. The upper strew covered slopes (2) support a moderate tree cover of *Acacia eremea, A. victoriae* and *A. aneura* over scattered low shrubs. The extensive strew covered plains (3) carry an irregular vegetation confined for the most part to the frequent, slightly lower drainage foci. *Acacia victoriae* and *A. tetragonophylla* occur as a sparse cover. *Rhagodia, Stylobasium, Kochia* and *Scaevola* occur beneath the tree cover in the pristine state though mostly restricted to the run-on areas. Due to over-use, this unit has been seriously degraded and the pasture is confined to trees and annual species.

The sluggish internal drainage tracts (4) are frequently sheeted, scalded and gullied. When seen on the survey, they were almost always badly degraded and only carried remnants of the original halophytic cover. *Rhagodia, Frankenia, Kochia* and *Eremophila duttonii* at densities of up to 2000 individuals total per acre are found in the pristine state. The concentrated flow areas (5) carry an irregular vegetation with remnants of an original halophytic pasture. The drainage lines (6) carry a typical marginal vegetation of moderate dense *Acacia* species and scattered shrubs.

General statement

Bryah rangeland type has the potential to contribute significant amounts of durable and valuable pasture. However, it is extremely degraded and in most instances reduced to an ephemeral pasture. As it is in a position of run-on, it is continually over-used. Extended periods of freedom from grazing are prescribed for the rehabilitation. Some parts may even require reseeding.

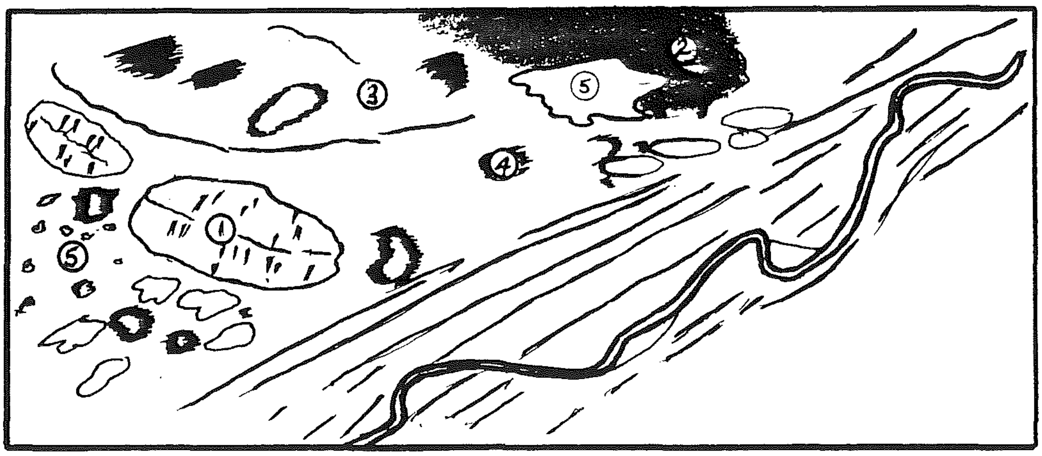
Traverse Summary - 35 observations

Wind erosion	%	Water erosion	%	Condition	%
None	32	None	40	Pristine	6
Sheeting	18	Sealing	34	Good	9
Surface redistribution	37	Minor rilling	14	Vegetation degraded	37
Hummocking	5	Stripping	9	Vegetation degraded; some erosion	45
Major drift	8	Lower slope gullies	3	Vegetation degraded; major erosion	3
		Upper & lower slope gullies	0		

Significance to erosion

This rangeland type is seriously degraded and is discharging increased water and silt load into the main drainage. This is particularly significant in situations where the area of rangeland is extensive.

KURUBUKA RANGELAND TYPE 340 square miles



Unit	%	Landform	Soils	Potential	Condition
1	5	Low hills	Shallow rocky	Low	Good; no erosion
2	40	Dark pebble strewn interfluves	Brown gritty clay to 14", pH 6-7; platy, dark coloured strew	Low	Vegetation degraded; no erosion
3	35	Pebble-free drainage	Brown clay; pH 8.5; of variable depth to 36"	Moderate to good	Vegetation badly degraded
4	1·5	Scalded crabholes	Brown clay to 36"+ pH 7-8	Moderate	Vegetation badly degraded
5	5	Drainage foci	Brown clay to 36"+ pH 7-8	Moderate	Vegetation degraded

Kurubuka rangeland type occupies 340 square miles of the catchment and occurs in the north-west part of the area where it is associated with major tributaries of the Lyons River. These rivers, the Frederick and Kurubuka, rise in the Gregory Range and have comparatively short courses. They flow through Mt. Augustus Station where most of this rangeland type is found.

This rangeland type has a typically sluggish drainage and occurs as a plain elevated only a few feet above the through-going major drainage from the hills above. The plain slopes regionally at about 1:1500 with variable cross-slopes from 1:3 000 to 1:12 500 which lead to local drainage foci and flat, internal drainage plains. The higher parts rising one or two feet above the internal drainage are characterised by a dense, dark, platy strew, whereas the drainage areas are free of an extensive mantle. Low hills of Bangemall quartzites and shales obtrude through the plains, but are never significant in the type.

PASTURES

The low hills (1) carry the characteristic vegetation associated with Bangemall series quartzites and shales. The dark pebble interfluves (2) are sparsely vegetated and appear to serve as run-off areas for the sluggish intra-plain drainage. *Acacia pruinocarpa*, *A. victoriae* and *A. eremea* occur as a very sparse canopy above sparse low shrubs such as *Cassia pruinosa*, *Eremophila freelingii* and *Ptilotus obovatus*. In extreme cases this unit may be completely bare.

The internal drainages (3), which are almost all saline, carry variable halophytic shrubs. In the pristine state *Eremophila maculata*, *P. obovatus* and *Kochia* species occur, but in most instances these plants were replaced by *Bassia patenticuspis* and *Atriplex inflata* which are indicators of over-use. The scalded crab-holes (4) occur along with the internal drainage. They are usually bare of perennials apart from isolated *A. victoriae* and *Rhagodia*, but support sparse annuals and rare perennial tussock grasses such as *Eragrostis setifolia*. The heavily vegetated drainage foci (5) have a characteristic dense fringe of *Acacia tetragonophylla* and *A. victoriae* which occur above *Rhagodia*, *Eremophila leucophylla*, *E. latrobei*, *E. longifolia* and *Cassia* species. Where the foci are in a ring form, the centres are free of shrubs and support grasses such as *Eriachne flaccida* and *Eragrostis setifolia*.

General statement

Kurubuka rangeland type could provide durable and valuable pastures, but due to over-use it is essentially ephemeral in character and does not contribute much to pasture on offer during moisture stress.

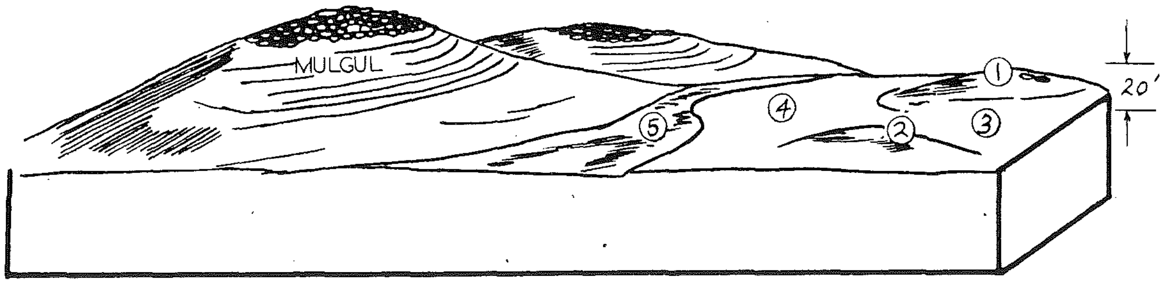
Traverse Summary - 65 observations

Wind erosion	%	Water erosion	%	Condition	%
None	58	None	46	Pristine	0
Sheeting	25	Sealing	36	Good	6
Surface redistribution	17	Minor rilling	9	Vegetation degraded	51
Hummocking	0	Stripping	3	Vegetation degraded; some erosion	32
Major drift	0	Lower slope gullies	6	Vegetation degraded; major erosion	11
		Upper & lower slope gullies	0		

Significance to erosion

The heavy clays and stony mantles found in the type make it resistant to most forms of erosion. However, run-off from the severely degraded pastures can be expected to have been increased. In the lower parts gullies are extensive and the type is extensively degraded.

SUGARLOAF RANGELAND TYPE 121 square miles



Unit	%	Landform	Soils	Potential	Condition
1	5	Low dolomite hills	Rocky soils, pink brown loams pH 8.5-9	Low; sparse shrubs and annuals	Vegetation degraded; no erosion
2	15	Slight domes	Light brown gritty clay of shallow depth on diorite or dolomite, pH 9, outcrops of diorite and dolomite	Fair; sparse shrubs and annuals	Vegetation degraded; no erosion
3	30	Tributary slopes	Light brown gritty clay of variable depth, abundant calcareous nodules, pH 8.5, strew of pebbles	Fair to moderate, shrubs and annuals	Vegetation degraded; minor erosion
4	40	Drainage floors	Brown fine clays with calcareous nodules in profile, variable depth to 36", pH 8.5	Moderate; palatable shrubs and perennials	Vegetation degraded; gullies and gutters.
5	10	Creeklines	Mostly finely braided with very little incision	Fair; shrubs and annuals	Vegetation degraded; minor erosion

Sugarloaf rangeland type is associated with the dolomitic hills found in Mulgul type. It receives run-on water from Mulgul, and hence is capable of producing pasture growth when total rainfall is low. It occupies only 121 square miles of the catchment and is, accordingly, of little consequence to the total pasture. It occurs on the Mt. Egerton and Mt. Phillips four-mile sheets.

Although it is essentially a plain type of rangeland, occasional low dolomitic hills up to 20 ft high extend above the general level of the plain. Where these are absent, slightly raised domes with abundant diorite or dolimite outcrop and some 20 chains across and 6ft high, form the highest part of the relief. Tributary slopes from Mulgul hills or from the low internal hills, extend towards a sluggish drainage plain. The slopes are up to 10 chains long and of variable width. They have a cover of pebbles and some cobbles, dolomite outcrops in places but diorite outcrop is rare. The drainage floors have a very reduced slope, never more than 1:500. They may be up to 20 chains long and can be as wide. The lines of concentrated flow are usually braided and rarely, if ever, incised.

PASTURES

The low hills (1) carry *Acacia aneura*, and *A. victoriae* over *Cassia oligophylla* and *Ptilotus obovatus* and annuals. The domed areas (2) support sparse *A. aneura* and *A. victoriae* over *C. oligophylla* and annual calciphilous species. Total shrub cover is usually about 2 per cent. The slopes (3) carry a sparse and stunted *A. aneura* and *A. victoriae* over *C. oligophylla*, *C. helmsii*, *Kochia pyramidata*, and *Sida* sp. with annuals. The drainage floors (4) carry *A. victoriae* and *A. tetragonophylla* in patches over *Scaevola spinescens*, *Rhagodia* and *Kochia* sp. together with perennial grasses and forbs. The drainage lines (5) have a dense vegetation of *A. aneura* and *Hakea lorea* over *Acacia pyrifolia* and other shrubs. Calciphilous ground storey annuals are prominent in the drainage lines.

General statement

The lower plains of Sugarloaf are capable of supporting large numbers of stock. As the type is found within less attractive ones these plains have been grossly over-used. They are now depleted and eroded. Where possible they should be rehabilitated through protection from grazing.

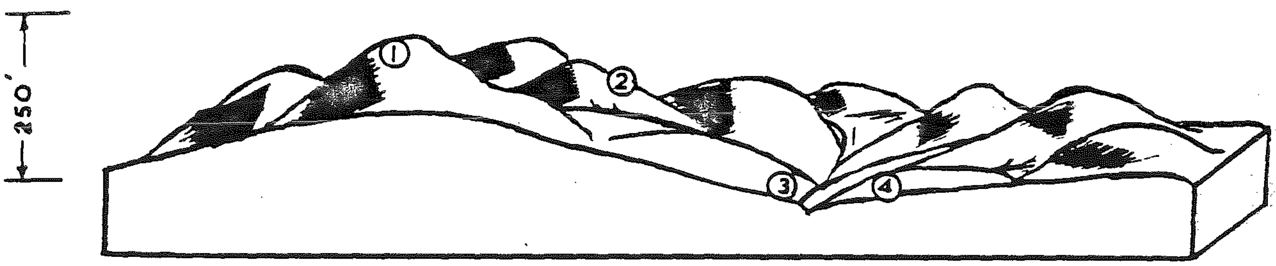
Traverse Summary - 38 observations

Wind erosion	%	Water erosion	%	Condition	%
None	40	None	47	Pristine	0
Sheeting	18	Sealing	32	Good	8
Surface redistribution	42	Minor rilling	5	Vegetation degraded	39
Hummocking	0	Stripping	5	Vegetation degraded; some erosion	53
Major drift	0	Lower slope gullies	11	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

Erosion gullies and extensive sealing of the surface are common. Although the area is restricted the type contributes to the erosion on the catchment.

AGAMEMNON RANGELAND TYPE 1337 square miles



Unit	%	Landform	Soils	Potential	Condition
1	35	High peaks and ridges	Rocky with pockets	Poor	Good, no erosion
2	50	Rounded summits and slopes	Shallow soils of variable depth on rock, some outcrop, pebble strew	Low	Vegetation degraded - no erosion
3	5	Drainage flats	Duplex soils to 36"+ pH 7-8; locally saline	Moderate; receiving run-on palatable	Vegetation degraded; severely eroded - guttered, windswept and surface stripped
4	10	Channelled drainage	Sandy and cobbly bedloads	Moderate	Vegetation slightly degraded; little or no erosion

This rangeland type occurs essentially in the central Archean block between the Permian sediments on the west and the Proterozoic sediments to the east and north. It is most common on the Glenburgh, Mt. Phillip and Mt. Egerton four-mile sheets. It occupies 1337 square miles of discontinuous pasture land, but on occasions the area may be extensive as, for example, on Mooloo Downs.

Agamemnon rangeland type consists of low schist-like hills and strike ridges, quartz ridges, and massive gneissic outcrops which jut to about 250 feet above the rocky undulating plains beneath them. On the west they may be capped with flat Pleistocene calcareous residuals. Within the type frequent outcrops of granite may occur which give a

typical appearance to the landscape. The type is strongly dissected with minor, rounded and elevated stony domes, and slopes which have an extensive cobble strew with outcrops. The drainage is fine and dendritic, often associated with small drainage flats and scalds, and leads to major creeklines which are usually found outside the type, but may also traverse it.

PASTURES

In keeping with the shallow soils, the vegetation is typically low and scattered. The shrub layer predominates with *Eremophila freelingii* and *E. exilifolia* the most frequent on the hills and slopes (1 and 2). Associated with these are *Solanum lasiophyllum*, *S. ellipticum*, *Ptilotus rotundifolius*, *P. obovatus* and *Rhagodia*, which are never more than sparse. Stunted *Acacia aneura*, *A. linophylla* and *A. tetragonophylla* occur very sparsely with occasional *Grevillea nematophylla*. The ground flora is restricted to annual grasses and forbs in season, though lemon-scented grass, *Cymbopogon exaltatus* may be found in isolated sandy pockets receiving run-on. The drainage flats (3) support a slightly denser vegetation in the pristine condition characterised by halophytic shrubs such as *Frankenia* and *Acacia victoriae*, but in the degraded state, tree forms only survive. The creekline (4) carry strictly marginal vegetation of dense low trees and shrubs, with occasional patches of perennial grasses.

General statement

These pastures are only partly accessible to stock and form only a minor part of the total pasture. They have not deteriorated greatly. However, the drainage flats have been badly degraded due to over-use by stock of the palatable pastures they support. In most cases this would be unavoidable and must be accepted. However, where the drainage flats are at all large some benefit would result from seasonal protection.

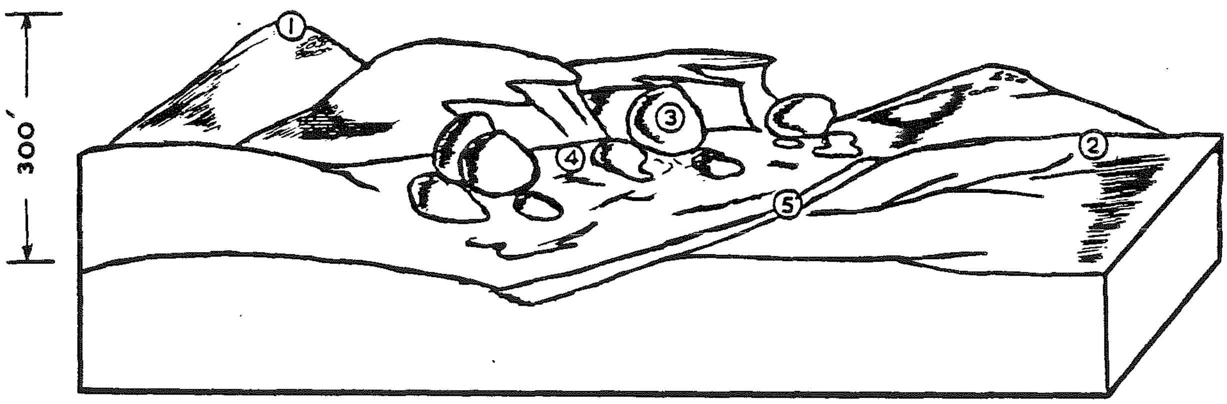
Traverse Summary - 49 observations

Wind erosion	%	Water erosion	%	Condition	%
None	74	None	67	Pristine	0
Sheeting	18	Sealing	19	Good	10
Surface redistribution	8	Minor rilling	4	Vegetation degraded	80
Hummocking	0	Stripping	2	Vegetation degraded; some erosion	10
Major drift	0	Lower slope gullies	8	Vegetation degraded; major erosion	
		Upper & lower slope gullies	0		

Significance to erosion

This rangeland does not contribute to increased erosion hazard.

GLENBURGH RANGELAND TYPE 247 square miles



Unit	%	Landform	Soil	Potential	Condition
1	30	High peaks intrusive dykes	Rocky with shallow pockets	Poor	Good; no erosion
2	40	Rounded slopes and interfluves	Shallow sandy soils. pH 8, with many o/c of granite boulders	Low	Vegetation degraded; major rilling and guttering on the lower slopes
3	10	Unweathered granite tors	N/A	N/A	N/A
4	15	Plains between tors	Brown gritty sand at variable depth, sometimes to + 36", pH 8.0	low	Vegetation degraded; active guttering in the flow lines
5	5	Channelled drainage	Coarse sandy cobbly bedloads	Fair to moderate	Vegetation degraded

Glenburgh rangeland type covers 247 square miles. It is found principally on the Glenburgh four-mile sheet, but extends into the Mt. Phillips sheet.

High, granitic hills characterise this rangeland type, relief being up to 300 ft above the plains. Intrusive dykes are very common and their shed often obscures that of the granitic hills which are subject to more rapid breakdown. Unweathered granites extend away from the bases of the hills. These can be large and monolithic, but more often are found as groups. These are never large, rarely greater than 20 chains across, and slope gently towards the major drainage and occasionally towards the rounded slopes and interfluves which subtend

the hills and tor groups. These slopes are up to 30 chains across and slope at 5 per cent. Cobble and pebble covering is sparse, but there is abundant surface outcrop.

PASTURES

The hills and tors (1 and 3) carry sparse stunted trees and shrubs in pockets and round their bases, though around the base locally concentrated water promotes the growth of more fortunately placed individuals. *Acacia tetragonophylla, A. quadrimarginea, Eremophila platycalyx, Dodonea* and *Cassia* spp. are found in discontinuous groups related to shallow pockets of soil. Very sparse *A. aneura, Hakea lorea, Eremophila fraseri* and *S. lasiophyllum* over annuals and sparse *Cymbopogon* are found on the inter-tor plains (4). Stunted *A. aneura, Eremophila macmillaniana, E. platycalyx* and annuals are found on the plains and tributary slopes (2).

General statement

Glenburgh rangeland type is distinctive, but produces only limited amounts of pasture. The most valuable sections between the tors are over-used and commonly eroded as the soil is particularly unstable.

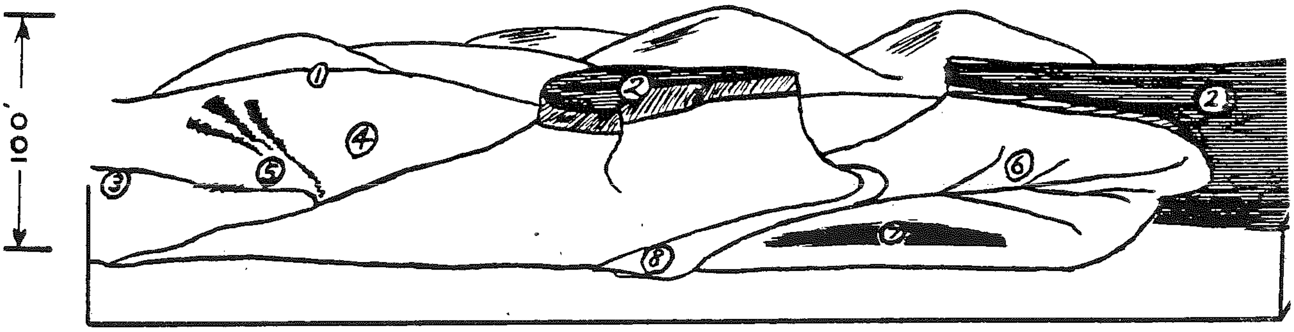
Traverse Summary - 20 observations

Wind erosion	%	Water erosion	%	Condition	%
None	60	None	65	Pristine	0
Sheeting	20	Sealing	0	Good	15
Surface redistribution	20	Minor rilling	20	Vegetation degraded	70
Hummocking	0	Stripping	10	Vegetation degraded; some erosion	15
Major drift	0	Lower slope gullies	5	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

The limited amount of this rangeland type makes it unimportant in the consideration of erosion.

THOMAS RANGELAND TYPE 1035 square miles



Unit	%	Landform	Soil	Potential	Condition
1	5	Unweathered hills and domes	Shallow soils on rock	Low	Good
2	10	Stripped lateritised surfaces	Outcrop only with small pockets of soil	Poor	N/A
3	10	Rounded weathered gravelly hills	Very shallow, red-brown gritty clay on rock	Low	Vegetation degraded; no erosion, increased run-off
4	45	Pebble strewn plains and interfluves	Pebble strewn red-brown gritty clay on rock, pH 6-8, variable depth	Low	Vegetation degraded; no erosion, increased run-off
5	15	Lower stony plains	Fine pebble strew, red-brown gritty clay, pH 8, of variable depth	Fair	Vegetation degraded; gullied on the lower margins
6	10	Alluvial fans and drainage floors	Duplex soils with random quartz strew, pH 8-9, variable depth	Fair	Gullies and sealing; pasture degradation
7	2	Sandbanks	Red-brown sand 36"+	Fair	Vegetation degraded
8	3	Drainage lines	Sand and cobble bedloads	Fair	

Thomas rangeland type occupies 1035 square miles on the Glenburgh and Mt. Phillips four-mile sheets. It forms some of the higher parts of the central Archean block being lower only than the hills of Agamemnon

rangeland type. It is always very dissected and comprises a number of quite distinct units which differ markedly in pasture quality.

The characteristic features of Thomas are the lateritised breakaways and mesas which form a backdrop up to 50 ft high to lower plains, and the low, rounded rocky hills up to 100 ft high. The lateritised surfaces are flat, usually stripped, and formed on the granites and gneisses of the area. Unweathered summits and low hills are common, along with gravelly weathered rises, on the stony plains which extend away from the breakaways. Extensive areas of unweathered rock form a rim to the rangeland type. Small alluvial fans up to half a mile wide extend away from the immediate bases of the breakaways and mesas, their expression coloured by the accretion of pallid zone material. Small sandy banks can be found on the alluvial fans, but they are never extensive. Drainage from stony slopes and alluvial fans concentrates in incised watercourses.

PASTURES

The unweathered hills (1), gravelly hills (3) and pebble strewn plains (4) carry very sparse stunted *Acacia aneura, A. eremea, A. tetragonophylla* and *A. victoriae* above a sparse shrub layer in which *Cassia helmsii* and *C. pruinosa* dominate. Other species such as *Eremophila fraseri, E. cuneifolia* and *E. exilifolia* may be important locally. Where there is some indication of salinity *Kochia melanocoma, K. tomentosa* and *Bassia* are important herbaceous species in some locations. The stripped lateritised surfaces (2) have little, if any, soil. Stunted sparse trees and shrubs not unlike the vegetation described above are common. Myrtaceous shrubs such as *Calythrix* and *Thryptomene* are also found on the stripped laterite.

Lower stony plains (5) which are usually flattened, may carry *Arthrocnemum* and *Kochia triptera* as a moderately dense stand, but this condition was only found in little used situations. The alluvial fans with duplex soils carry very sparse *Acacia eremea* and *Hakea preissii,* the latter being found only in the degraded state. Beneath the tree layer *Frankenia, Cassia helmsii, Kochia polypterygia* and *Eremophila cuneifolia* provide a durable pasture in the unused situation. The sandy banks on the alluvial fans carry a similar vegetation though *Frankenia* is absent and *Eucalyptus oleosa* appears. The drainage lines can carry very dense vegetation predominantly *A. aneura* and *A. holosericea,* with shrubs beneath.

General statement

With the exception of the alluvial fans and lower stony plains, this rangeland type provides ephemeral pastures beneath scattered shrubs, some of which may be palatable and therefore subject to over-use. The alluvial fans and lower slopes have a restricted area and occur as inclusions within less attractive pastures, and are subject to extreme over-use. This has resulted in extensive pasture degradation associated with sealing and gullying of the unstable duplex soils. Protection from use should be adopted as the first step towards these units' rehabilitation.

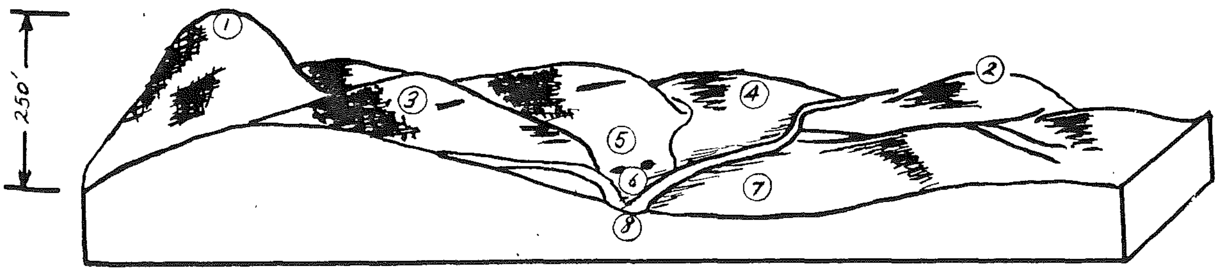
Traverse Summary - 24 observations

Wind erosion	%	Water erosion	%	Condition	%
None	50	None	50	Pristine	0
Sheeting	8	Sealing	8	Good	13
Surface redistribution	38	Minor rilling	13	Vegetation degraded	54
Hummocking	4	Stripping	8	Vegetation degraded; some erosion	33
Major drift	0	Lower slope gullies	21	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

Run-off from the stony plains has increased due to pasture degradation. Over-use of the lower parts has contributed significantly to discharge and silt load.

PHILLIPS RANGELAND TYPE 3000 square miles



Unit	%	Landform	Soil	Potential	Condition
1	5	High peaks and ridges	Rocky with pockets	Poor	Good; no erosion
2	30	Rounded summits	Shallow with o/c red-brown gritty clay to 15" on rock, pH 6, cobbles and pebbles	Low; shrubs have durability	No erosion; pasture deterioration
3	1	Dolerite dykes	Shallow soils with o/c and cobbles	Low; insignificant to total	No erosion; pasture deterioration
4	30	Rounded slopes and interfluves	Shallow soils of variable depth on rock, some o/c, pebble strew	Low; shrubs confer durability at low stocking rates	No erosion; pasture deterioration
5	20	Lower interfluves	Shallow brown gritty loam to rock at variable depth. pH 6-7	Low; shrubs confer durability at low stocking rates	No erosion; pasture deterioration
6	1	Crabholes	Brown clay to 36"+, pH 6.5-7	Fair; insignificant to total	No erosion; pasture deterioration
7	5	Drainage flats	Duplex soils of depths to 36"+, pH 7-8 locally	Moderate; receiving run on; palatable pastures	Windswept and surface stripped; guttered in places, vegetation severely degraded

Unit	%	Landform	Soil	Potential	Condition
8	8	Channelled drainage	Sandy and cobbly bedloads	Moderate	No erosion; little pasture deterioration

Phillips rangeland type covers 3000 square miles, and occurs beneath the hills and strike ridges of Agamemnon rangeland type. It is not always associated with Agamemnon locally. The geologic erosional sequence has created extensive areas of Phillips which are unmarked by abrupt hills or violent dissection. It occurs on the Mt. Phillips, Glenburgh, Edmund and Mt. Egerton four-mile sheets in the central Archean upthrust block.

The high points in the type rise to about 250 feet above the drainage tracts, and are usually found as quartz ridges and massive, bare, gneiss and schist-like residuals. Rounded, cobble strewn summits below the hills form the major part of this landscape; and abundant low outcrop is characteristic. They rise up to 100 feet above the watercourses and slope at up to 5^{o} away from the rounded summits. Doleritic dykes up to 15 chains across traverse these summits and the elements below them. They are often weathered in contrast to the generally unweathered rocks found in this type.

Cobble and pebble strewn slopes extend below the summits towards the major drainage. They are found as rounded interfluves dividing fine, channelled watercourses, and slope regionally at 1:70 to 1:90. In the lower parts local drainage foci and minor crabholes occur above the sluggish drainage flats. The low flats have a typically sluggish drainage discharging into more defined and dissected creeklines, or they may occur as minor deltas between more active streamlines. The major drainages can be up to 200 ft wide with 6 ft of incision carrying variable bedloads, but are usually sandy, with minor areas of cobbles and pebbles.

PASTURES

The vegetation reflects the shallow, rocky nature of the soil. It is characterised by stunted, sparse *Acacia aneura*, *A. kempeana* and *A. tetragonophylla* above a moderately sparse layer of *Cassia helmsii*, *C. pruinosa*, *C. charlesiana*, *Eremophila fraseri*, *E. cuneifolia*, *E. freelingii*, *Solanum* spp., *Ptilotus* spp. and *Rhagodia* on units 1 to 5. *Arthrocnemum*, *Kochia polypterygia* and *Acacia victoriae* occur infrequently on the duplex soils (7). Dense *A. aneura*, *A. eremea*, *A. tetragonophylla* and *A. sclerosperma* and dense shrubs line the larger creeklines and watercourses (8). Perennial grasses such as *Chrysopogon* occur on the non-saline alluvial flats associated with terminal tributary drainage. For the most part of the ground flora is limited to annual grasses and forbs. The drainage foci and crabholes (6) are ringed with *A. tetragonophylla* and *A. victoriae* which surround a central core of dense *Eriachne flaccida* or *Eragrostis setifolia* and sparse shrubs.

General statement

This rangeland type provides only ephemeral ground pastures, and the shrubs provide only limited amounts of durable pasture in times of stress. The sluggish drainage flats are overgrazed, and eroded, and contribute to the increased discharge of rivers on the catchment. Without protection and remedial treatment they will continue to deteriorate and erode. The duplex soils on which they are based are unstable and need careful treatment.

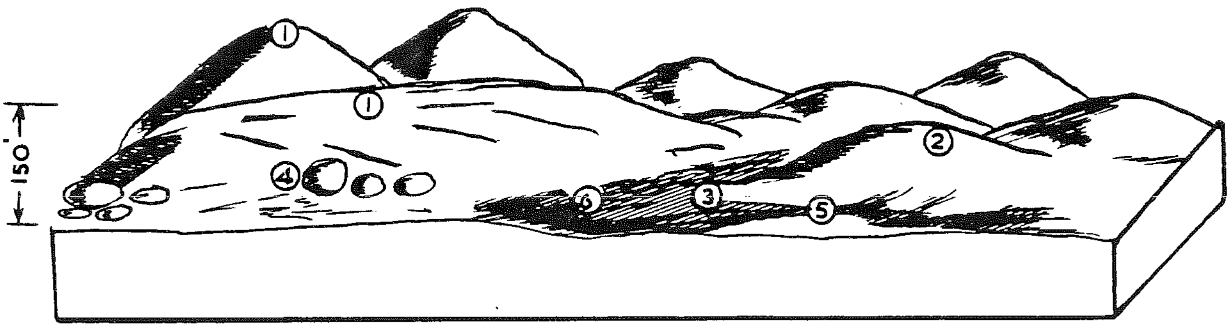
Traverse Summary - 216 observations

Wind erosion	%	Water erosion	%	Condition	%
None	45	None	52	Pristine	1
Sheeting	29	Sealing	14	Good	7
Surface redistribution	24	Minor rilling	12	Vegetation degraded	71
Hummocking	2	Stripping	11	Vegetation degraded; some erosion	21
Major drift	0	Lower slope gullies	11	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

The eroded drainage flats contribute to erosion. Increased run-on due to sealing adds to erosion hazards downslope.

JAMES RANGELAND TYPE 650 square miles



Unit	%	Landform	Soil	Potential	Condition
1	20	Hills and ridges	Rock and small pockets of soil	Low	Good - no erosion
2	40	Low undulating rises up to 25'	Rocks and shallow soils	Low; Useful shrubs	Vegetation degraded; soil loss in the lower slopes
3	10	Lower plains	Duplex soils	Moderate	Vegetation degraded; gullied and sealed
4	10	Granite tors	N/A	None	N/A
5	15	Drainage floors	Some duplex soils but generally a red-brown gritty clay. pH 7-8.5	Fair; would provide most of the pasture	Vegetation degraded; gullied and sealed
6	5	Main drainage	Coarse sand and cobbly bedloads	N/A	

James rangeland type occupies 650 square miles principally on the Mt. Phillips four-mile sheet though it does extend onto the Edmund and Glenburgh sheets. It occurs beneath Glenburgh rangeland type though, like Phillips, it may occur independent of hill landforms. It is an important part of the central upland block.

This rangeland type consists of low granite hills up to 100 ft high with associated schist, gneiss ridges and intrusive dykes which may provide up to 150 ft of relief. Undulating plains occurring beneath the more abrupt hills, and rises sloping at 1:50, extend towards flattened lower plains marginal to defined drainage. The drainage tracts in the upper portions are poorly etched, but with a

reduction in slope are found as broad sandy, often braided watercourses up to 10 chains wide. Where slope is not reduced the drainage becomes incised down slope, forming creeks up to 100 ft across with variable depth up to 10 ft. Outcrop is common on the plains, and tor fields can be recognised as separate units on these plains.

PASTURES

Acacia aneura is conspicuously absent from this rangeland type. On the hills and ridges (1) stunted *Acacia victoriae, A. tetragonophylla, Cassia pruinosa, Eremophila freelingii* and *E. platycalyx* are found making a sparse cover on irregular pockets of soil. Very scattered trees are found on the upper slopes (2) above *Eremophila cuneifolia, E. freelingii, Cassia helmsii, C. sturtii, C. leursenii* and very sparse *Kochia.* The lower plains (3) may have a sluggish drainage which has resulted in increased salinity locally. In the undegraded state *Frankenia* and *Kochia polyterygia* are prominent, 1100 plants per acre being found at one investigation site. With severe over-use these species have been removed. Where the drainage is less sluggish the vegetation is not much different to the upper slopes. Vegetation is restricted to the bases and clefts of the granite tors (4) with *A. tetragonophylla* forming a very sparse and stunted overstorey above *Eremophila platycalyx* , *Solanum lasiophyllum, Cassia helmsii* and *Ficus* sp. *Cymbopogon* is common in the sandy pockets. The braided drainage floors carry dense *Acacia eremea* above *Eremophila, Kochia* and *Rhagodia.* The creeklines have typical dense marginal vegetation with *A. tetragonophylla, A. sclerosperma* and *A. grasbyi* over variable shrubs.

General statement

James rangeland type is valuable only for its inclusions of duplex soil based pastures where drainage is sluggish. Where these occur vegetation deterioration has been extensive and erosion is pronounced. The plains and slopes carry valuable, but very sparse, shrubs capable of supporting small numbers of animals, the bulk of the pasture available always being ephemeral.

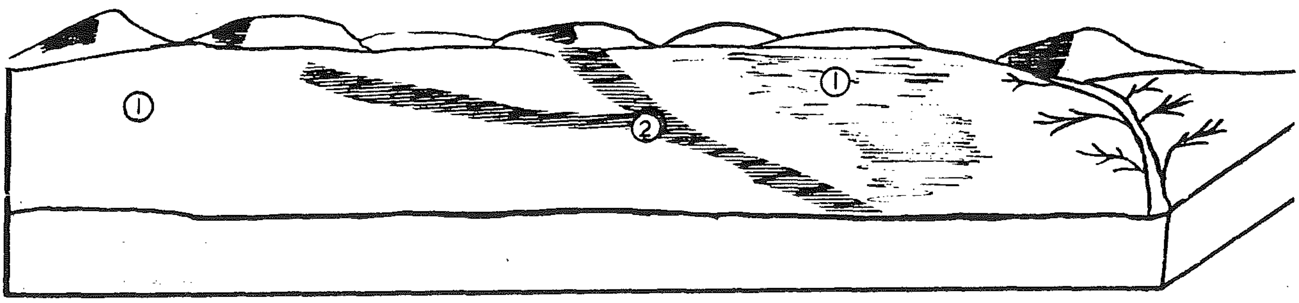
Traverse Summary - 40 observations

Wind erosion	%	Water erosion	%	Condition	%
None	22.5	None	30	Pristine	0
Sheeting	55.0	Sealing	28	Good	2
Surface redistribution	17.5	Minor rilling	22	Vegetation degraded	88
Hummocking	5.0	Stripping	12	Vegetation degraded; some erosion	10
Major drift	0	Lower slope gullies	8	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

Run-off from stony slopes and ridges will always be considerable. Over-use of the lower plains has resulted in gullying, sheeting and sealing adding to siltload and water discharge. Rehabilitation through protection is desirable.

MABBUTT RANGELAND TYPE 35 square miles



Unit	%	Landform	Soil	Potential	Condition
1	80	Plains	Shallow gritty clay loam on rock, pH 7.0	Low	Vegetation degraded
2	20	Grove - intergrove	Grove;- red-brown gritty sand + 36", pH 6.0 Intergrove;- sealed, red-brown gritty clay loam on rock at shallow depth. pH 7.0	Fair	Vegetation degraded

Mabbutt rangeland type covers 35 square miles and occurs as a further variation of Durlacher. It is found principally on Glenburgh sheet and rarely on others.

Mabbutt rangeland type consists of large, gently sloping stony plains over three miles wide and with a slope of 1:500. These plains extend away from more undulating areas in Durlacher or Phillips and often discharge water directly into major drainage. Grove-intergrove mulga patterns pass through the plains and carry the major part of the run-off to areas of channelled flow.

PASTURES

The plains (1) carry very sparse *Acacia aneura* above very sparse shrubs such as *Eremophila fraseri*, *Ptilotus obovatus*, *P. schwartzii*, *Solanum lasiophyllum* and *Cassia sturtii*. The groves (2) support sparse *A. aneura* above somewhat denser *Rhagodia*, *Kochia*, *Solanum* and *Eremophila leucophylla*. The intergroves (2) lack any tree layer and carry a vegetation not unlike that of the plains.

General statement

This is a depauperate pasture of low value. The groves have some use, but they do not contribute much to total productivity in the type.

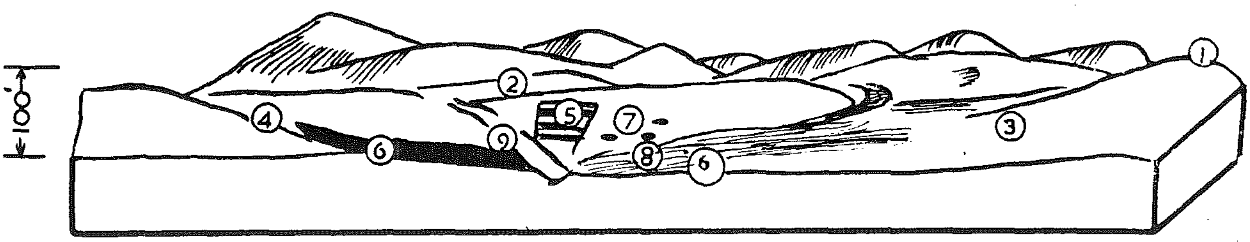
Traverse Summary - 6 observations

Wind erosion	%	Water erosion	%	Condition	%
None	0	None	83	Pristine	0
Sheeting	83	Sealing	0	Good	0
Surface redistribution	17	Minor rilling	17	Vegetation degraded	83
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	17
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

Apart from increased run-off in some sections the type does not materially influence the erosion status of the catchment.

DURLACHER RANGELAND TYPE 1937 square miles



Unit	%	Landform	Soil	Potential	Condition
1	15	Low rounded summits and strike ridges	Rocky, shallow pockets of soil	Poor	Good, no erosion
2	20	Rounded upper interfluves	Red-brown gritty clays on rock at variable depth. pH 5-7 mantle of cobbles and pebbles	Low	Good, no erosion
3	35	Flat stony plains	As for Unit 2	Fair	Degraded pastures; gullying in the lower portions
4	2	Upper tributary fanned drainage	As for Unit 2	Low	Degraded pastures; actively eroding at the drainage heads
5	2	Groved mulga watercourses	Grove - red-brown fine sandy clay loam 36"+, pH 6.5 Inter-grove - red-brown loamy clay 15", pH 6.5	Fair	Degraded pastures

Unit	%	Landform	Soil	Potential	Condition
6	15	Lower tributary drainage flats	Duplex soils pH 8 sandy A horizon stripped	Moderate	Degraded pastures; extensive stripping and gullying and hummocking
7	1	Crab-holes	Brown clay 36"+, pH 6.5-7	Moderate	Degraded pastures
8	5	Broad marginal flood plains	Red-brown gritty clay, to 18", but variable	Moderate	Degraded pastures
9	5	Channelled drainage	Sand and cobble bedloads often braided	Fair	Fair, active current incision into the bed

Durlacher rangeland type covers 1937 square miles and occurs below the undulating hills and uplands in the central Archean block. It is also found on the watershed divide above the sweeping alluvial plains of the Eastern Tributary Province. It occurs on every four-mile sheet of the catchment.

Occasional sharp quartz ridges and strike residuals mark this type. It is also characterised by stony plains and wide drainage sections with a reduced slope compared to slopes in the Phillips rangeland type. The upper parts consist of low rounded summits, quartz ridges up to 50 ft high and, more rarely, summits up to 100 ft. There is abundant outcrop of gneiss, quartz and schist-like material in these upper portions. Rounded, cobble and pebble strewn interfluves up to half a mile wide and sloping at 1 in 50-70 occur beneath the summits and ridges, and lead to flat stony plains up to one mile wide. Small creeks and watercourses arise within these plains and interfluves and discharge onto flattened alluvial plains which slope at 1 in 150 to 1 in 200. These are tributary to the channelled drainage. Where the slope is greater, groved mulga patterns occur tributary to the channelled drainage. Sandy banks are found on the flatter tributary drainage plains. Crab-holes and local drainage foci occur frequently on the flatter drainage plains. Marginal alluviated plains up to 300 ft wide are often associated with the channelled waterways which, themselves, may be up to 200 feet wide with up to 8 feet incision.

PASTURES

The ridges and summits (1) of Durlacher differ little from those in Phillips and Agamemnon. Sparse and stunted *Acacia aneura* and *A. eremea* occur above a slightly denser shrub layer in which *Eremophila cuneifolia* and *Corchorus wolcottii* dominate over *Ptilotus* spp., *Cassia* spp., *Rhagodia* and *Kochia*. The tree layer is somewhat denser on the upper rounded interfluves (2) but rarely exceeds 100 trees per acre. *A. aneura, A. eremea* and *A. victoriae* occur over *Eremophila cuneifolia, Cassia helmsii, C. pruinosa, C. oligophylla, Kochia, Solanum* and *Rhagodia*. Under severe use and degradation the community is reduced in density and the more palatable species, e.g. *Kochia* and *Rhagodia*, disappear.

A. eremea is the dominant tree on the flat stony plains (3). The shrub component is little different from that in (2) above except for an increase in *Kochia* species, *K. planifolia, K. polypterygia* and *K. melanocoma* being predominant. These latter species decrease with over-use. In the most degraded condition found, sparse *A. victoriae* was the only woody species found on stony plains.

Groved mulga watercourses (5) occur in areas where the slopes are suitable. Groves of mulga up to 50 chains wide and up to 50 ft through are common. *Acacia aneura, A. kempeana* and *A. tetragonophylla* form a dense canopy over shrubs such as *Cassia helmsii* and *Ptilotus obovatus*. The inter-groves are essentially bare.

Low, halophytic shrubs such as *Frankenia* sp. and *K. polypterygia* are common on the lower tributary drainage flats (6) when these are in good condition. In the over-used situation they are absent and the remaining vegetation consists of *A. victoriae* and *Solanum lasiophyllum*. In the completely degraded state *A. victoriae* only is present, and annual species predominate. Crab-holes and drainage foci (7), with marked rings of dense tree cover on the circumference surrounding grassy centres, are also found on these sluggish tributary drainages.

Broad floodplains marginal to major drainage and broad sandy washes (8) possess a denser vegetation often characterised by the presence of perennial grasses *Chrysopogon* below moderately dense *A. aneura, A. eremea* and *A. holosericea*. Shrubs such as *Cassia desolata, C. pruinosa* and *C. helmsii* can be important locally.

The creeklines (9) have dense *A. aneura, A. victoriae, A. grasbyi* and *A. sclerosperma* above *C. helmsii, Solanum, Rhagodia, Eremophila fraseri, E. cuneifolia* and *Corchorus wolcottii*.

General statement

Durlacher rangeland type is the major pasture on a number of properties, particularly on Mt. Phillips and Glenburgh sheets. The small areas of productive pastures found on units 6, 7 and 8 have been severely over-used and on the unstable suplex soils this has resulted in severe sheeting and gullying. The other accessible parts of the pasture are degraded, but, apart from the upper fan drainages, show little active erosion. Rehabilitation of this pasture land will involve prolonged protection of the eroded areas, and even reseeding. Pasture

degradation on the stony upper portions has increased run-off from this rangeland type.

The gullied and sheeted areas will continue to deteriorate without remedial treatment, thereby lowering grazing capacity and increasing run-off.

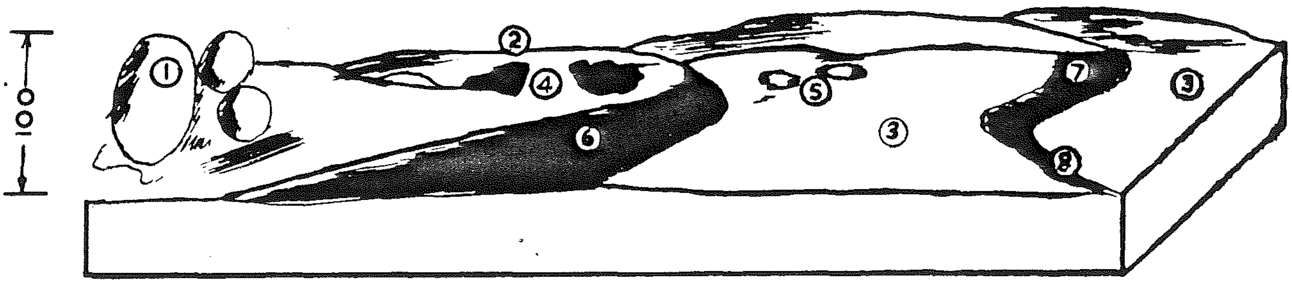
Traverse Summary - 308 observations

Wind erosion	%	Water erosion	%	Condition	%
None	24	None	33	Pristine	
Sheeting	25	Sealing	17	Good	2
Surface redistribution	41	Minor rilling	16	Vegetation degraded	63
Hummocking	9	Stripping	18	Vegetation degraded; some erosion	35
Major drift	1	Lower slope gullies	16	Vegetation degraded; major erosion	0
		Lower & upper slope gullies	0		

Significance to erosion

The eroded drainage flats contribute to erosion. The increased run-off and sealing of the upper slopes can only add to the erosional hazard.

YINNIETHARRA RANGELAND TYPE 305 square miles



Unit	%	Landform	Soils	Potential	Condition
1	10	Isolated domes and tors	None	Low; shrubs have use in stress periods	Good
2	15	Upper interfluves	Shallow soils, abundant outcrop	Low; shrubs have use in stress periods	Vegetation degraded
3	40	Flat plains	Some duplex soils other with sparse pebbles on red-brown gritty clay to 15"	Low to moderate, depending upon vegetation	Vegetation degraded; gullied and sheeted
4	3	Low tors	None	Low	Good
5	2	Crab-holes	Brown clay 36"+	Moderate, but insignificant to total	Vegetation degraded; some siltation deposits
6	15	Broad, braided drainage	Up to 300' wide sandy bedloads	Fair	Vegetation degraded; gullies
7	5	Grove patterns	Groves - red-brown gritty clay 36"+, pH 7, inter-grove - variable to 15", red-brown gritty clay	Fair	Vegetation degraded
8	10	Concentrated flow lines		Fair to moderate	Vegetation degraded; gullied and sheeted

Yinnietharra rangeland type occurs over 305 square miles on Mt. Phillips, Glenburgh and Robinson Range four-mile sheets. It is similar to Durlacher in most respects, but the extensive cobble and pebble strew is lacking and the drainage tends to be wide and sandy in the lowest parts.

Isolated granite domes and tors up to 100 ft high dominate this rangeland type. Where they are grouped together to form an area of generally higher ground, rounded, upper interfluves sloping at 1:50 regionally, with abundant surface outcrop, extend from their bases towards broad, flattened or slightly convex plains. These flattened plains may be up to three miles long and one mile wide between streamlines or watercourses. Low granite tors and crab-holes are found scattered on the plains which feed their run-off into broad flattened areas of concentrated flow and sandy watercourses up to 10 chains wide in the lowest parts. Grove - intergrove situations are common where the regional slope approximates 1:250 and water flow is concentrated.

PASTURES

Vegetation around the tors and ridges (1 and 4) resembles that of James and Glenburgh. *Acacia tetragonophylla, Eremophila exilifolia* and *Solanum lasiophyllum* are common. The upper interfluves (2) support stunted and very sparse *Acacia aneura, A. victoriae* and *A. eremea* over a variable sparse shrub cover of *Eremophila fraseri, E. freelingii, E. cuneifolia, Cassia helmsii* and *Rhagodia.* Cover ranges between 3 and 5 per cent. The broad flattened plains (3) support a variable vegetation depending upon the flow of drainage. In the more saline or sluggish drainage sections *Frankenia, Kochia polypterygia* and *Kochia* spp. are found beneath *Eremophila pterocarpa, E. cuneifolia* and scattered trees. This situation was rarely found in the field due to severe over-use. With over-use the valuable *Frankenia* and *Kochia* spp. were absent. Crab-holes (5) found on the plains, have a characteristic ring of vegetation of dense trees such as *Acacia victoriae, A. tetragonophylla* and *A. sclerosperma* over a reduced shrub layer characterised by *Scaevola spinescens, Solanum* and *Rhagodia.* The central portion of the crab-holes carry variable amounts of *Eragrostis* and *Eriachne.* Groves (7) marginal to, or above the more concentrated drainage areas, supported a typical vegetation of moderately dense mulga over shrubs and grasses.

Broad, flattened, braided and sandy drainage lines (6) and areas of concentrated flow (8), characteristic of the pattern, support a variable cover of *Acacia aneura* and *A. eremea* over scattered shrubs and grasses. These areas are frequently degraded, especially where the inflow from upper slopes has caused recent incision and gullying.

General statement

Yinnietharra rangeland type provides valuable pastures on its plains and flow lines and these are usually degraded, gullied and sealed. Areas of outcrop and with low hills, are poorly productive and carry shrubs and scattered ephemerals. While the shrubs are durable under stress they cannot support many stock.

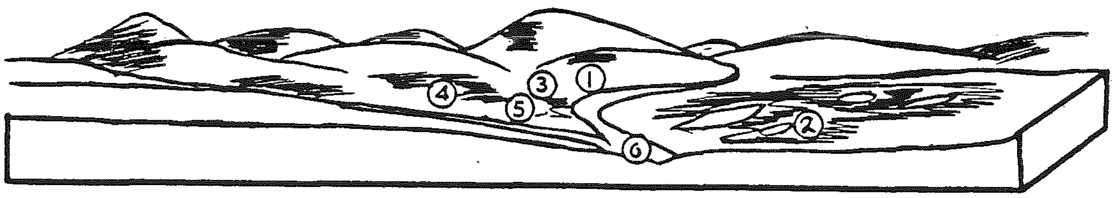
Traverse Summary - 41 observations

Wind erosion	%	Water erosion	%	Condition	%
None	5	None	15	Pristine	0
Sheeting	51	Sealing	19	Good	0
Surface redistribution	39	Minor rilling	37	Vegetation degraded	76
Hummocking	5	Stripping	19	Vegetation degraded; some erosion	24
Major drift	0	Lower slope gullies	10	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

Where the lower plains are extensive this rangeland type contributes to erosion to a considerable degree. Run-off can be expected to be high.

WINMAR RANGELAND TYPE 351 square miles



Unit	%	Landform	Soil	Potential	Condition
1	30	Stony plains	Shallow soils on rock, pebble strew	Low	Vegetation degraded; no erosion
2	10	Sand dunes	Red-brown sand - 36" +	Moderate; grasses are drought evading	Vegetation degraded; no erosion
3	30	Sand banks	Red-brown sand to variable depth on rock, pH 5.6	Moderate; grasses are drought evading	Vegetation degraded; no erosion
4	25	Grove - intergrove	Grove; red-brown sand to 24" +, pH 5-6, Intergrove; shallow clayey soils, sealed	Moderate	Vegetation degraded; no erosion
5	4	Concentrated flow area	Red-brown on hardpan up to 24" pH 7; sealed	Moderate	Vegetation degraded; some gullies
6	1	Creeklines	Sandy bedloads up to 200' wide	Moderate	Some increased incision

Winmar rangeland type occupies 351 square miles and is a modified form of Durlacher in which sandy banks and sandplain sheets are found developed on the flat stony plains of the latter. It occurs principally on Mt. Phillips four-mile sheet, but it can occur on other parts of the catchment.

Stony plains extending from Durlacher form the upper parts of this system. They can be up to one mile across and are gently rounded

sloping interfluves covered with a variable stony mantle. They are characterised by gentle sheet flow over usually sealed surfaces. The sandy banks found on the stony plains may be up to 50 ft across and up to half a mile long. They may be up to 4 ft high. In areas of more concentrated flow, grove/intergrove patterns of mulga trees and shrubs are formed, leading eventually to non-differentiated flowlines and watercourses. In the western part of the catchment, particularly on Mt. Phillips sheet, there is an extensive development of sand dunes on the stony plains. The dunes may be up to 20 ft high and up to a mile and a half long. They are separated by anastomosing lines of concentrated flow with a marked groving pattern.

PASTURES

Sparse, stunted *Acacia aneura, A. eremea, A. pruinocarpa* and sparser *A. quadrimarginea* are found on the stony plains (1) over a variable shrub layer of *Cassia helmsii, C. sturtii, Solanum lasiophyllum, Eremophila fraseri* and *Scaevola spinescens*. Cover of up to 6 per cent was measured. The ground cover is exclusively annual though the herbaceous perennial *Ptilotus schwartzii* may be important locally. On the dunes (2) and banks (3) *A. linophylla, A. pruinocarpa* and *A. aneura* form a moderately dense cover, up to 10 per cent, over scattered shrubs such as *S. lasiophyllum, E. leucophylla, C. sturtii and C. helmsii*. In most cases the perennial grasses, *Danthonia bipartita, Eriachne helmsii* and *Eragrostis xerophila* are present, with *Danthonia* disappearing with over-use.

The groves (4) carry dense *A. aneura, A. linophylla* and *A. pruinocarpa* over a variable shrub layer of *Indigophera, S. lasiophyllum* and *Kochia*. *Eriachne helmsii* is the principal perennial grass found, but ground flora composition varies with the degree of use. The intergroves (4) are typically poorly vegetated with stunted trees on shallow soils. The concentrated flow areas (5) support moderately dense *A. aneura, A. pruinocarpa, A. kempeana, A. linophylla, A. tetragonophylla* and *Grevillea striata* over a shrub layer consisting of *E. leucophylla, Canthium, E. fraseri, Scaevola spinescens* and *S. lasiophyllum*. The creeklines (6) carry marginal vegetation similar to that of (5).

General statement

The sandy banks and dunes are the major part of this rangeland type and provide good perennial grass pastures in the non-degraded condition. However, over-use has depleted the palatable perennial grass store and has resulted in wind erosion on some of the banks.

Experimental evidence indicates that rehabilitation can be effected easily on the banks and dunes of this pasture type.

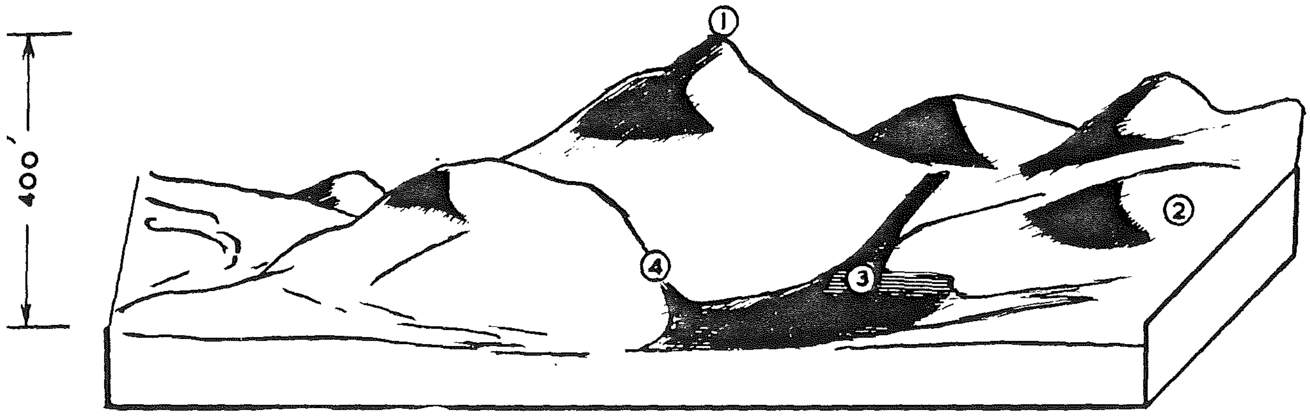
Traverse Summary - 58 observations

Wind erosion	%	Water erosion	%	Condition	%
None	28	None	47	Pristine	-
Sheeting	29	Sealing	47	Good	3
Surface redistribution	41	Minor rilling	2	Vegetation degraded	93
Hummocking	2	Stripping	1	Vegetation degraded; some erosion	4
Major drift	0	Lower slope gullies	1		
		Lower & upper slope gullies	2	Vegetation degraded; major erosion	0

Significance to erosion

This rangeland type is comparatively unimportant in the catchment, however, there is no doubt that wind erosion is significant on the discontinuous sand banks found on stony plains.

PEAK HILL RANGELAND TYPE 79 square miles



Unit	%	Landform	Soils	Potential	Condition
1	50	Hills, mountain ranges with steep slopes	Rocky for the most part, shallow soils in pockets	Low; poor pastures	Good
2	40	Lower slopes and interfluves	Shallow soils on hardpan or rock	Low	Vegetation degraded
3	5	Drainage floors	Some duplex soils or red-brown gritty clays of variable depth	Fair; - some halophytes	Vegetation degraded; some sheet erosion and gullies
4	5	Incised drainage	Cobble or sand bedloads	Fair	Vegetation degraded

Peak Hill rangeland type is restricted to the Peak Hill and Robinson Range four-mile sheets and occupies 79 square miles. It forms the watershed between the Gascoyne and Murchison rivers in the south-eastern part of the catchment.

The type consists of low, mountain ranges which may often be extensively weathered. Relief up to 400 ft above the plain is common on hill ranges which are up to 2 miles wide, and often sinuate in form. Within the hills, rocky slopes and interfluves with abundant rock strew are found above narrow drainage floors up to 400 ft wide and often with reduced slope which induces salinity locally. The drainage floors lead to channelled drainage incised into bedrock or into hardpan. The drainages are up to 25 ft wide with incision up to 2 ft.

PASTURES

The hills (1) carry stunted *Acacia aneura* and *A. tetragonophylla*

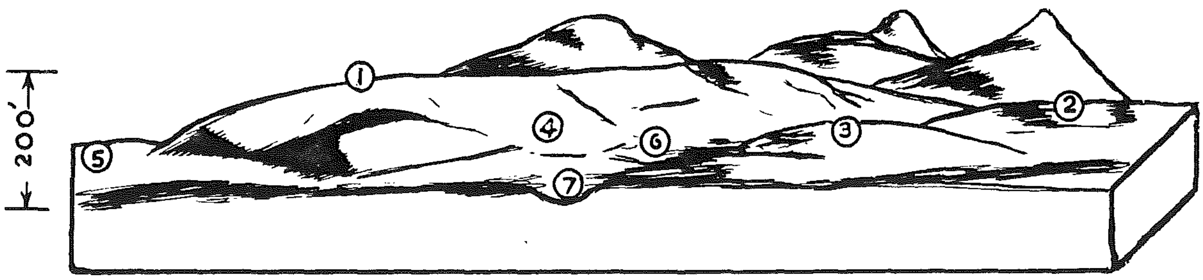
above scattered low shrubs such as *Eremophila*, *Cassia* and *Solanum*. The ground vegetation is restricted to isolated pockets of soil and is always sparse. The slopes (2) carry a denser vegetation of *A. aneura* and shrubs. *A. linophylla* is prominent on weathered surfaces along with *Eremophila latrobei*, *E. exilifolia* and *Dodonea*. *Eriachne* and *Eragrostis* are found in rare pockets of deeper soil. The drainage floors (3) carry sparse *A. aneura*, *A. victoriae* and *A. tetragonophylla* above sparse shrubs in which halophytic herbaceous and durable perennials are prominent. The incised drainage (4) is similar to the drainage floors, but the halophytic shrubs are reduced.

General statement

Peak Hill rangeland type is not productive. Ninety per cent of the area is poor quality pasture.

There has been little increase in run-off from this rangeland type. Rangeland types lower in the system influence erosion on the catchment more than Peak Hill type.

BEASLEY RANGELAND TYPE 278 square miles



Unit	%	Landform	Soils	Potential	Condition
1	5	Ridge and intrusive dykes	Shallow soil in pockets	Low; somewhat inaccessible	Good
2	15	Stripped lateritised surfaces and round lateritised summits	Bare soilless surfaces, shallow brown gritty loam pH 7	Poor; very little ground production	Good
3	15	Rounded, unweathered summits and rises	Red-brown clay or rock to 6", pH 6	Low; scattered shrubs only	Vegetation degraded
4	40	Slopes and lower interfluves	Red-brown gritty clay of variable depth to Hard Pan or rock, abundant cobbles and pebbles	Fair; shrubs though scattered, are useful	Vegetation degraded
5	15	Flattened plains	Red-brown clay on Hard Pan at variable depth, pebble strewn surfaces, some duplex soils	Fair; halophytic shrubs are valuable	Vegetation degraded; often gullied and sealed
6	5	Grove Intergroves	Groves - red-brown gritty clay 36"+, Intergroves - red -brown gritty clay, shallow soils	Low; shrubs have value, but intergroves are extensive and almost valueless	Vegetation degraded
7	5	Flowlines and creeks	Variable incision with cobble bedloads	Low	Good

Beasley rangeland type is restricted to the Peak Hill and Robinson Range four-mile sheets of the catchment area. It is not an extensive system, but it is characteristic of the south-eastern divide, forming the watershed below Peak Hill rangeland type. No distinction is made here between the igneous and sedimentary rocks of Archean age which form the basement of this rangeland type. The pastures produced by the influence of each vary very little. Weathered and unweathered geological sequences have also been grouped in order to avoid excessive splitting of essentially similar pastoral situations.

Low ridges and hills with abundant quartz intrusives are found in the highest parts of the rangeland. The ridges are discontinuous, and may be up to one mile long and with up to 100 ft of relief. Rounded summits and low hills with relief up to 200 ft above the plains also occur in the upper parts of the system. They may be up to two miles across, sloping at 1:30 or slightly less. In some instances the hills are characterised by lateritised, gravelly, summits with minor stripped portions, but in others the hills can be found strewn with cobbles and pebbles from recent shed. Slopes and lower interfluves sloping regionally at 1:50 and up to half a mile wide extend below the low hills and lead on to flatter drainage plains confined between the undulations. Short stubby mulga groves up to 5 chains long can be found on the lower plains. The drainage on these plains is frequently sluggish. Flow lines with dense vegetation on their margins border the lower plains. The drainages are from 100 to 200 feet across, with incisions 15 ft across and up to 2 ft deep.

PASTURES

Stunted, sparse *Acacia aneura* is found on the ridges (1) above a moderate cover of *Eremophila maitlandii, Solanum lasiophyllum, Ptilotus obovatus* and annual grasses and forbs. The lateritised surfaces (2) carry sparse, low *A. aneura, E. freelingii, Cassia desolata* and typically carry low myrtaceous shrubs such as *Baeckea* and *Micromyrtus*. The ground cover is usually sparse and restricted. The unweathered summits (3) are similar, but lack the myrtaceous shrubs. Slopes, lower interfluves and flattened plains (4 and 5) carry a denser vegetation. The tree canopy occupying about 2 per cent to 5 per cent above a variable shrub cover of *P. obovatus, P. schwartzii, Kochia triptera, K. georgei, K. thesioides* and *Eremophila* spp. Ground cover is restricted to annual species following rain. The groves (6) support dense *A. aneura* above shrubs and the creeklines dense, marginal vegetation of *A. aneura, A. pruinocarpa* and *A. tetragonophylla* above variable shrubs.

General statement

Beasley rangeland type is valuable only for its halophytic shrubs on the plains and slopes. On the lower and more accessible sections these have been severely over-used and erosion has been initiated. On the stony slopes the vegetation has been reduced, but there has been little associated erosion. On both these sites rehabilitation will prove difficult and will be achieved only through a prolonged protection incorporated into station management plans.

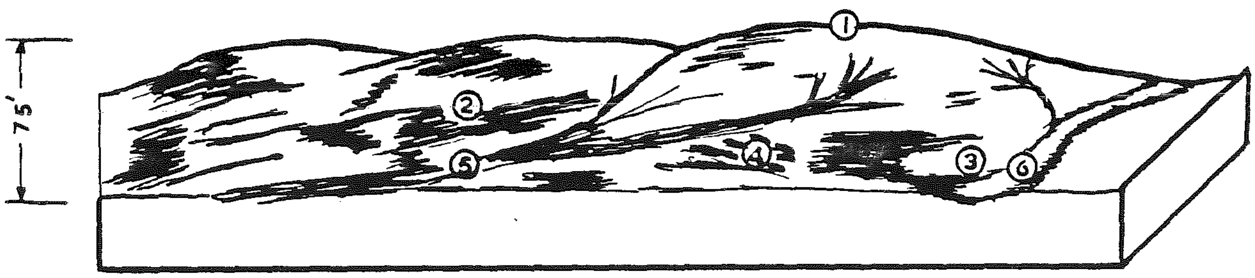
Traverse Summary - 10 observations

Wind erosion	%	Water erosion	%	Condition	%
None	45	None	67	Pristine	0
Sheeting	33	Sealing	11	Good	20
Surface redistribution	22	Minor rilling	0	Vegetation degraded	60
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	20
Major drift	0	Lower slope gullies	22	Vegetation degraded; major erosion	0
		Upper and lower slope gullies	0		

Significance to erosion

The area of Beasley on the catchment is small. Over most of its area erosion is not significant though currently gullied areas will continue to degrade if no remedial measures such as protection are adopted.

HORSESHOE RANGELAND TYPE 266 square miles



Unit	%	Landform	Soils	Potential	Condition
1	10	Low unweathered and weathered summits	Heavy strewn surfaces Red-brown gritty loam on H.P. or rock at shallow depth	Low; sparse shrubs offer low capacity in drought	Vegetation degraded
2	55	Slopes and interfluves	Red-brown gritty clay with abundant cobble and pebble strew variable depth	Fair; halophytic shrubs are	Vegetation degraded
3	15	Flatter plains	Often duplex soils, otherwise as for "2"	Fair to moderate; useful, durable shrubs	Vegetation degraded; often sheeted and gullied
4	5	Groves and intergroves	Red-brown gritty clay in groves of variable depth, shallow red-brown gritty clay in intergroves with pebble strew	Low; groves are restricted and poor, intergroves are large	Vegetation degraded
5	10	Braided flow lines with marginal plains	Braided incisions to 30", the whole often over 400 ft wide, very little pebble strew	Fair	Vegetation degraded
6	5	Incised drainage	Sandy and cobble bedloads	Fair	Vegetation

Horseshoe rangeland type occupies 266 square miles on the Peak Hill, Robinson Range and Glenburgh four-mile map sheets. It is usually associated with the more undulating Beasley type and like its counterparts, Durlacher and Yinnietharra, it is not necessarily found with Peak Hill rangeland type which is the hill form of this group. It forms part of the southern and eastern divide and watershed, and is basically Archean though in this report portions of the Wyloo Group of middle Proterozoic rocks give rise to pastures not much different to those based on the former and are here described together.

Small, weathered and unweathered low hills and summits with upto 75 feet of relief form the upper parts of this type. A number of quartz dykes and other intrusives spread their sheds over the lower slopes and interfluves. The slopes themselves can extend onto flatter internal plains where drainage is restricted and saline situations have developed. The slopes often carry small stubby groves of mulga where the fall is suitable. Drainages in the lower parts are frequently braided and may be accompanied by marginal plains up to 10 chains wide. Incised drainage is common in the upper parts of the type and in the lowest sections where the water is discharged into major trunk drainage.

PASTURES

Acacia aneura, A. tetragonophylla and *A. grasbyi* are found occurring as sparse low trees on the upper parts (1). *Eremophila* species such as *E. cuneifolia, E. fraseri* and *E. freelingii* and *Cassia* species are found beneath them, but these, too, are never more than sparse. The slopes and interfluves (2) carry a richer flora with *Kochia* species prominent though, principally, in the herbaceous perennial form. *A. aneura* is the dominant, if scattered, tree and occurs over these *Kochia* spp., *E. latrobei, Scaevola* and *Cassia* species. The flatter plains (3) carry a similar vegetation to (2), but in the more saline situations support abundant *Arthrocnemum, K. pyramidata* beneath *A. victoriae* and *A. eremea*. The groves (4) are short and stubby, rarely longer than 5 chains and only 50 to 75 feet thick. *A. aneura* is dominant within them. The braided flow lines and associated plains (5) carry *A. aneura, A. eremea* and *A. tetragonophylla* over *Rhagodia, Solanum, E. cuneifolia* and *Cassia*. In suitable situations *Eriachne flaccida* occurs on deep, clayey soils on the marginal plains. The lower flood plains and sluggish drainage areas are often eroded and scalded and carry vegetation not much different to the braided areas. The creeklines (6) have a typical marginal vegetation.

General statement

Valuable durable pastures can exist on Horseshoe though they can be over-used and have been, due to preferential use of the better sections. Gullies and sheet erosion are common in the lower parts.

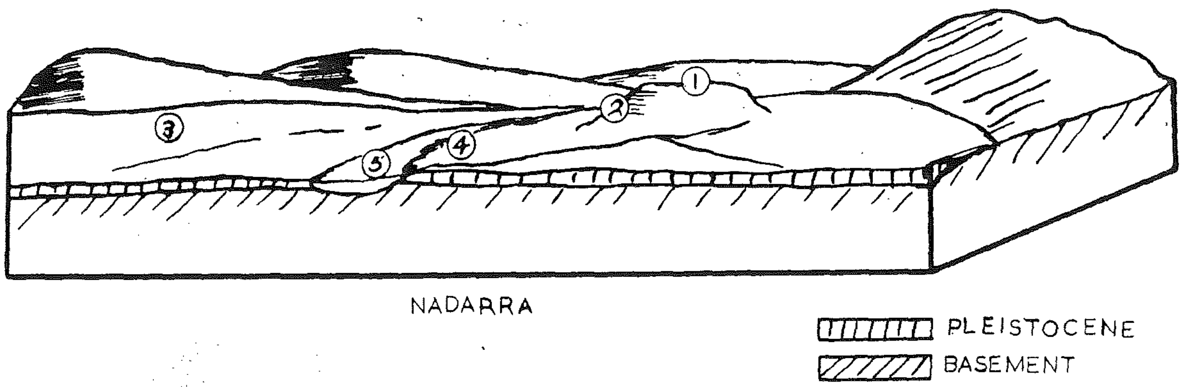
Traverse Summary - 19 observations

Wind erosion	%	Water erosion	%	Condition	%
None	42	None	42	Pristine	6
Sheeting	26	Sealing	37	Good	17
Surface redistribution	21	Minor rilling	5	Vegetation degraded	33
Hummocking	11	Stripping	5	Vegetation degraded; some erosion	44
Major drift	0	Lower slope gullies	11	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

The type is over-used in the lower parts and eroded. The area involved is comparatively small so that on a regional basis it is not significant. However, the degraded areas should be rehabilitated since they are significant to total productivity on some properties.

NADARRA RANGELAND TYPE 362 square miles



NADARRA

Unit	%	Landform	Soils	Potential	Condition
1	10	Ridges, plateaux, caps and hills	Rocky soils, light brown clays up to 30", pH 9 with calcareous nodules at depth, abundant strew	Fair to moderate; palatable shrubs	Good to vegetation degraded; no erosion
2	10	Abrupt slopes to hills and ridges	Cobble and pebble strew	Fair; scattered palatable shrubs	Vegetation degraded; no erosion
3	60	Gently sloping plains and plateaux	Light brown gritty clay on P.M. at variable depth, pH 9, pebble strew and occasional sealing	Moderate; good palatable shrubs	Vegetation degraded; minor erosion
4	10	Drainage floors	Brown clay of variable depth on P.M., pH 9, exposures of basement rocks in places, variable strew	Fair to moderate scattered palatable shrubs	Vegetation degraded; some gutters and gullies
5	10	Creeklines	Up to 300' wide braided and minor incision	Fair; palatable shrubs and ephemerals	Vegetation degraded

Nadarra rangeland type is based upon Pleistocene limestone, cherts and sandstone which occur as thin caps over much older rocks. The types is also associated with travertines found allied with old river deposits.

It is found on the Edmund, Mt. Phillips and Kennedy Range four-mile sheets and covers 362 square miles of the catchment. As it is post-Tertiary it has little weathering. The landscape is, in general, relatively undisturbed, and the type frequently has exposures of basement rocks in its lowest parts.

Major relief in this type is from small flat-topped hills up to 40 ft high. These may occur in extensive valleys and be actually below the extreme relief of the basement rocks which may extend to 300 ft above the drainage plains. The slopes to the hills are usually abrupt, ranging between 1:5 to 1:20 and are covered with a coarse calcareous strew. The scree slopes lead to very gently sloping plains and drainage floors with crab-holes. The major drainages are characteristically broad and flat, up to 200 ft wide and very densely vegetated.

Remnants of these Pleistocene deposits are also found as residuals on more resistant Precambrian crystalline and sedimentary rocks. In these cases they impart a special character to the major rangeland type in which they occur. The type may also occur without major relief as extensive sheets several miles wide near the major streamlines.

PASTURES

The low hills and ridges (1) carry stunted *Acacia aneura, A. eremea* and *A. victoriae* and a typically calciphilous mid-storey in which *Cassia oligophylla* and *C. helmsii* are prominent. In the undisturbed state *Kochia georgei, K. polypterygia* and *Eremophila leucophylla* can occur. The ground flora consists of characteristic species such as *Helipterum sterilescens, Zygophyllum* and *Enneapogon*. The slopes (2) vary but little from the hills though the soils are frequently shallow. The very gently sloping plains and unrelieved plateaux (3) have similar vegetation to the hills though the cover may be quite dense, up to 15 per cent cover in places. Where the water relations are good halophytic shrubs including those above with *Scaevola spinescens* and rarer *Atriplex* species are well developed. The drainage floors (4) are similar to the plains except for the crab-holes which are richly and densely vegetated on their margins. Here, *Grevillea striata, A. aneura* and *A. kempeana* are prominent above *Cassia, P. obovatus, Rhagodia* and *Scaevola*. The wide creeklines (5) are densely vegetated with *A. aneura, A. tetragonophylla, Eucalyptus oleosa, A. eremea, Cassia* spp., *Scaevola, Santalum* and *Ptilotus*.

General statement

Nadarra rangeland type is restricted in its occurrence. It offers valuable pastures off the hills and in most places on the catchment is not severely degraded or eroded. This is clearly fortuitous and related to stocking policy, e.g. the north-western end of Gifford Creek Station. Where the type has been subjected to excess use it has degraded and rehabilitation through relief from stocking is recommended.

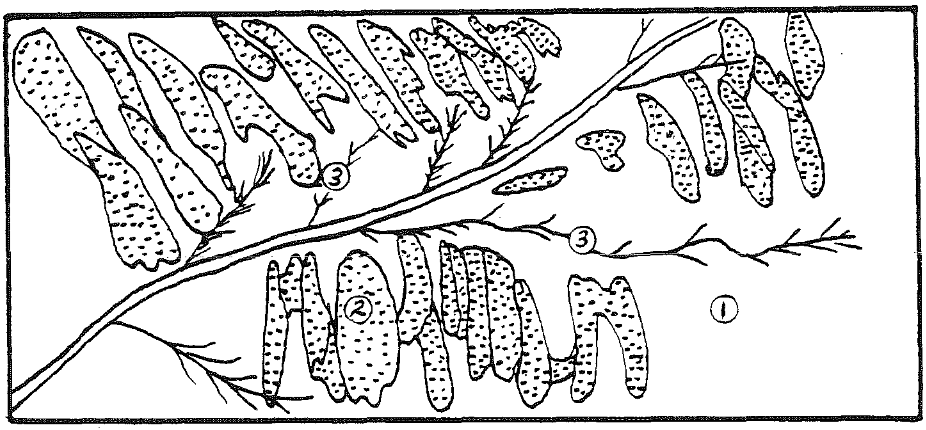
Traverse Summary - 54 observations

Wind erosion	%	Water erosion	%	Condition	%
None	46	None	55	Pristine	0
Sheeting	32	Sealing	11	Good	11
Surface redistribution	22	Minor rilling	17	Vegetation degraded	76
Hummocking	0	Stripping	15	Vegetation degraded; some erosion	13
Major drift	0	Lower slope gullies	2	Vegetation degraded, major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

Although parts are quite degraded, Nadarra rangeland type has not deteriorated to any great extent. Where over-use has been severe it contributes to the erosion on the catchment.

MACADAM RANGELAND TYPE 118 square miles



Unit	%	Landform	Soils	Potential	Condition
1	40	Stony plains	Dense pebble strew over a sealed surface; red-brown clayey sands up to 13" deep on Hard Pan, pH 7	Low - sparse shrubs and annuals	Good, no erosion, some pasture degeneration
2	50	Sandy banks	Red-brown clay sand up to 20" on Hard Pan, pH 7	Fair, sparse shrubs, scattered perennial grass	Vegetation degraded, erosion limited to minor surface redistribution
3	10	Dissection zones	Sandy floors to the dissection zones. Upper dissection into the Hard Pan layer	Low	Good - no erosion

Macadam rangeland type is restricted to the Glenburgh four-mile sheet. It forms the slopes of the southern divide of the catchment south of Landor homestead. The type takes its name from the plains described by F.T. Gregory in 1858. It covers 118 square miles of the catchment and appears to differ little from Gregory's description of "a nearly level and barren plain, evenly and closely paved with small stones, amongst which a few stunted acacia found a precarious existence" (Gregory, 1858. Report to the Hon. Surveyor-General, Western Australia).

The principal feature of this rangeland type is the stony flat alluvial plain upon which are found low sandy banks up to 800 yards long and transverse to the water flow. The stony plains extend seven or more miles down slope at about 1:500. They are two miles across being

abruptly separated by sharply incised creeks which can be up to 20 ft across and 12 ft deep. The dissection zones are up to 600 ft wide.

PASTURES

The stony plains (1) carry very sparse and stunted *Acacia aneura* and *A. tetragonophylla* with sparse shrubs such as *Eremophila margarethae, E. spathulata, Solanum lasiophyllum* and *Ptilotus schwartzii*. The annual growth after rain is sparse. The sandy banks (2) carry sparse and stunted (15') *A. pruinocarpa, A. aneura* and *A. linophylla* over a shrub layer of *Eremophila leucophylla, S. lasiophyllum, Cassia sturtii* and *P. obovatus*. Perennial grasses are present but are restricted. The dissection zone (3) supports *A. eremea* and *A. tetragonophylla* together with a low myrtaceous shrub (4' to 5') and *P. obovatus, A. aneura* occurred irregularly

General statement

This rangeland type is depauperate and does not contribute much to total pasture. Sandy banks have some value, but they are not as productive as those in the Landor and Flood types.

Traverse Summary - 2 observations

Wind erosion	%	Water erosion	%	Condition	%
None	0	None	0	Pristine	0
Sheeting	0	Sealing	100	Good	0
Surface redistribution	100	Minor rilling	0	Vegetation degraded	100
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	0
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

No erosion was evident, though over-use of the banks has led to surface redistribution.

BIBBINGUNNA RANGELAND TYPE 18 square miles

Unit	%	Landform	Soils	Potential	Condition
1	75	Clay swamps	Red-brown or brown clays greater than 36", pH 8.5	Good, valuable shrubs	Degradation in places
2	20	Drainage lines	As above, channels to 12 feet wide and incised to 2 feet	Fair, grass cover limited to banks	Degradation in places
3	5	Elevated areas	Red-brown clay soils with scattered pebble strew	Fair, moderate dense shrubs	Some vegetation degradation

Bibbingunna rangeland type occurs on the Mt. Phillips and Mt. Egerton four-mile sheets and covers 18 square miles. It is always associated with sluggish drainage and very heavy clay soils. It appears to have affinities with the *Chenopodium auricomum* areas found on the Barkly Tablelands in the Northern Territory where the combination of drainage and soil type has produced these typical pastures.

Heavy clay drainage swamps characterise this type. They are marked by a finely etched meandering drainage typical of flat plains. Very slightly higher pebble strewn areas may occur within the swamps, but they are never very significant.

PASTURES

The flat clay swamps (1) support *Chenopodium auricomum* and *Muhlenbeckia* beneath a sparse cover of *Eucalyptus cameldulensis* and *Acacia victoriae* or *A. farnesiana*. Covers of up to 7 per cent were recorded. The ground cover may be ephemeral with *Trigonella sauvissima*, *Lotus* spp. and *Swainsona* spp. common, or it may consist of dense stands

of *Eriachne flaccida* and *Eragrostis setifolia* with a plant density index of up to 4.5. The incised creeklines (2) lack any shrub cover and have generally bare beds with dense grasses on their immediate margins. The slightly elevated areas (3) often have *Hakea, Acacia* spp., *Eremophila compacta* and *Rhagodia* sp. above annual growth after seasonal rains.

General statement

After good rains these swampy pastures supply abundant feed upon which cattle fatten rapidly. Although they are severely over-used in drier periods, they would tend to be inaccessible in the active growing season and hence receive protection during the critical growing period.

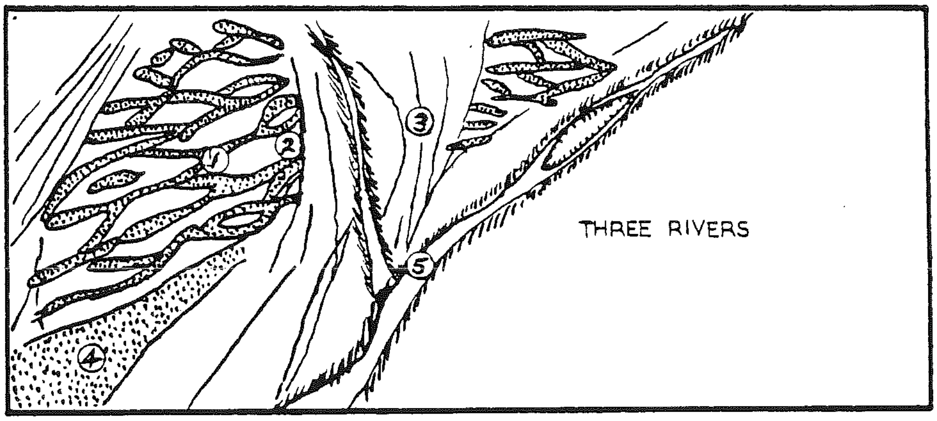
Traverse Summary - 2 observations

Wind erosion	%	Water erosion	%	Condition	%
None	100	None	50	Pristine	0
Sheeting	0	Sealing	50	Good	0
Surface redistribution	0	Minor rilling	0	Vegetation degraded	100
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	0
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

The type is degraded slightly, but not to any great extent and does not appear to be contributing to the erosion of the catchment. Drainage is too sluggish to promote gullies.

FREDERICK RANGELAND TYPE 554 square miles



Unit	%	Landform	Soils	Potential	Condition
1	20	Groves	Red-brown loamy sand increasing to sandy clay loam greater than 30" pH 6-7	Fair to moderate, some palatable shrubs and grasses but also inedible species	Vegetation degraded, frequently guttered and eroded
2	60	Inter-groves	Red-brown gritty clay of variable depth usually shallow, abundant pebble strew pH 5-7	Low, very sparse shrubs and sparse ephemerals	Vegetation degraded; sometimes eroded
3	10	Flood plains	Red-brown gritty clay, shallow soil on Hard Pan sealed beneath a dense pebble mantle	Low, very sparse shrubs and sparse ephemerals	Vegetation degraded; very little erosion
4	5	Sandy banks	Red-brown loamy sands of variable depth, usually greater than 36" pH 6-7	Moderate, palatable shrubs and grasses	Vegetation degraded; no erosion
5	5	Concentrated flow areas	Often braided and sealed, minor incision	Low, sparse palatable shrubs and ephemerals	Vegetation degraded; no erosion

Frederick rangeland type is found on all four-mile sheets with the exception of the Kennedy Range and Wooramel. It is a tributary plain type pasture occupying 554 square miles of the catchment. It is

characterised by the arcuate bands of vegetation which are found transverse to the flow of water across the plain.

The alluvial plains which slope at between 1:300 to 1:600, are marked by pronounced dense mulga and shrub groves arranged transverse to the slope. They may be up to half a mile long. Individual groves frequently inter-connect and thereby produce much longer vegetation bands across the slope. The bands of vegetation are separated by inter-bands which are pebble strewn and sealed, up to 600 ft wide, and as long as the groved areas. These grove-intergrove sections are segmented by areas of more concentrated sheet flow which is occasionally braided and channelled in the lower parts. Sandy banks occur on the plains. They are low and up to a mile long downslope. Sheet flow areas, without groving, but with a strongly developed surface strew, occur above the grove-intergrove sections.

PASTURES

The groves (1) have a dense tree canopy, very often exceeding 25 per cent (Wilcox unpublished) in which *Acacia aneura, A. grasbyi* and *A. pruinocarpa* are common. The shrub layer is variable. *Eremophila leucophylla, Rhagodia, Canthium,* and *Ptilotus obovatus,* which are desirable species, are frequent in some areas, but in others, unpalatable species such as *E. gilesii, E. fraseri* and *E. exilifolia* are dominant. Where the tree cover is dense, grasses are restricted, but *Danthonia bipartita* and *Eriachne helmsii* can be found in places where the canopy is reduced. In the east, *Triodia basedowii* excludes other species from the ground storey. The inter-groves (2) are usually very bare. The shallow soils of these areas support very little growth. Sparse stunted *A. aneura* and *Grevillea striata* are found over sparse *Eremophila fraseri, E. margarethae, E. spathulata* and *E. cuneifolia.* The herbaceous perennial, *P. schwartzii,* may be important locally, but generally the ground flora is typified by sparse grasses and forbs in season. The flood plains (3) carry a similar vegetation to the inter-groves though it will always be denser and includes *P. obovatus* and *Solanum lasiophyllum.* The sandy banks (4) support a moderate canopy of *A. aneura* and *A. linophylla,* up to 15 per cent cover, with a sparser shrub layer. Grasses are infrequent. The drainage tracts (5) carry a vegetation not much different to the stony plains. It may be denser in more favoured locations.

General statement

Although Frederick rangeland type has areas of potentially good pastures, these are restricted to a quarter of the total area of the type. Stony plains with shallow soils make-up the remainder. Levels of grazing should therefore be related to the total amount of good pasture available since the shallow soil areas are infrequently grazed.

Over-use of areas upslope has led to increased run-off which has, in turn, destroyed the delicate balance of water flow and retention in groves which is necessary for the preservation of the dense vegetation there. This increased water flow has created marked channels through some groves, with the result that the vegetation has died due to lack of moisture. Rehabilitation of areas upslope will be the only way to halt this degradation pattern.

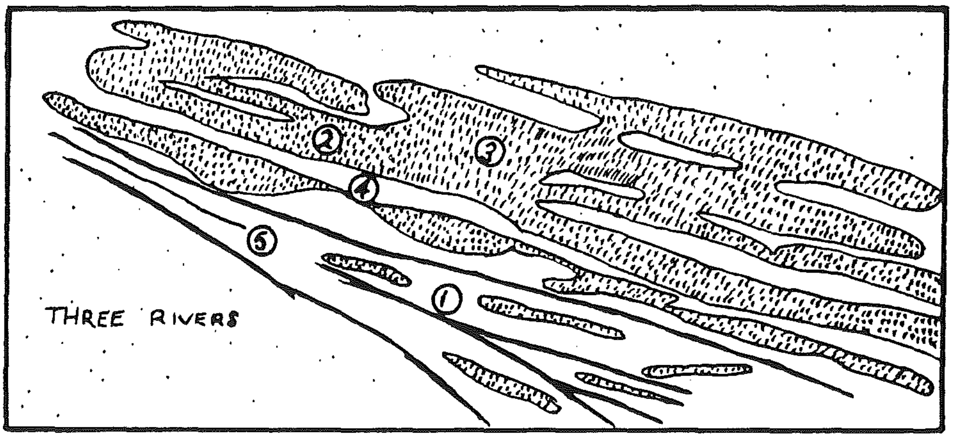
Traverse Summary - 52 observations

Wind erosion	%	Water erosion	%	Condition	%
None	21	None	27	Pristine	4
Sheeting	38	Sealing	48	Good	13
Surface redistribution	35	Minor rilling	11	Vegetation degraded	60
Hummocking	4	Stripping	6	Vegetation degraded; some erosion	19
Major drift	2	Lower slope gullies	8	Vegetation degraded; major erosion	4
		Upper & lower slope gullies	0		

Significance to erosion

In general, Frederick type is not severely eroded, but some sections are, and are significant in the overall concept of catchment degradation as the traverse summary demonstrates.

FLOOD RANGELAND TYPE 476 square miles



Unit	%	Landform	Soils	Potential	Condition
1	20	Alluvial plains	Red-brown gritty clay on Hard Pan 8", sealed	Fair; shrubby pastures	Vegetation degraded; occasional gullying
2	50	Longitudinal sandy banks	Red-brown sand +36"	Moderate; shrubby pastures with perennial grasses	Vegetation degraded
3	10	Transverse sandy banks	Red-brown sand +36"	Moderate; shrubby pastures with perennial grasses	Vegetation degraded
4	15	Interbanks	Red-brown gritty clay loam on Hard Pan 6" pH 6-7.5	Fair	Vegetation degraded; some erosion
5	5	Areas of concentrated flow and creeklines		Fair	Vegetation degraded; occasional gullying

Flood rangeland type is associated with Three Rivers type and is distinguished from it by the presence of abundant large sandbanks. It occurs on the Glenburgh, Robinson Range and Mt. Phillips four-mile sheets, and it covers 476 square miles.

The elements which make up Flood rangeland type are similar to those of Three Rivers. However, the total pasture available in Flood is much greater in volume and quality than that from Three Rivers due to the presence of much greater areas of perennial grass the former rangeland type. The floodplain has similar characteristics here to the plains of Three Rivers in terms of slope and pebble strew. The sandy

banks, however, are up to four miles long and up to twenty chains wide, and arranged longitudinal to the flow of water. They are often interconnected by narrow banks transverse to the flow of water, and with associated interbanks higher than the lines of more concentrated flow. Areas of concentrated flow and braided streamlines are thus marginal to the areas of sandy banks.

PASTURES

Pastures on the plains (1) interbanks (4) and the lines of flow (5), are the same as those in Three Rivers rangeland type. The sandy banks (2) and connecting banks (3) carry a dense cover of *Acacia linophylla, A. kempeana* and *A. aneura* above a shrub layer in which *Cassia sturtii, Solanum lasiophyllum, Eremophila leucophylla* and *Prostanthera* may be prominent. Cover estimates as high as 15 per cent were made. In less wooded areas the perennial grasses *Danthonia bipartita, Eragrostis xerophila* and *Eriachne helmsii* may be found, though with over-use, this valuable pasture is reduced to *E. helmsii, Aristida contorta* and winter growing herbs.

General statement

This pasture land provides valuable and moderately durable perennial grass pastures readily accessible to sheep. Where it is degraded, rehabilitation may be effected by spelling after effective summer rails. Careful husbandry of the pasture after the initial resurgence of the grass will promote the total vigour.

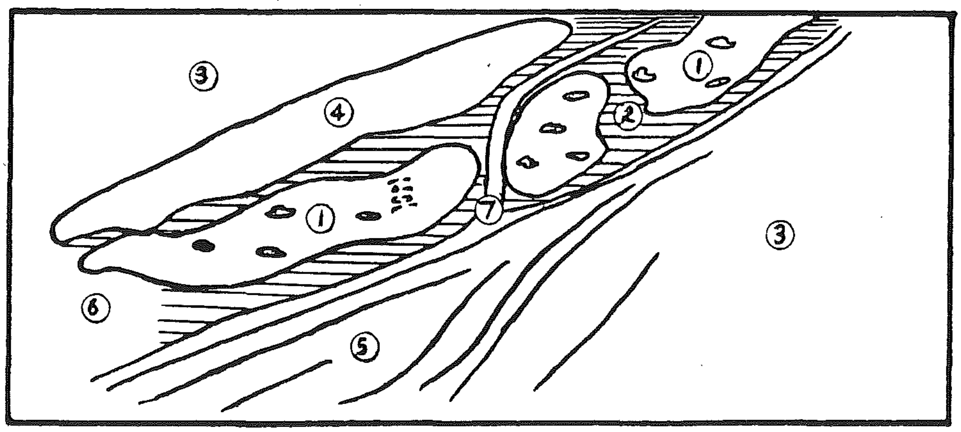
Traverse Summary - 75 observations

Wind erosion	%	Water erosion	%	Condition	%
None	12	None	27	Pristine	0
Sheeting	40	Sealing	62	Good	3
Surface redistribution	47	Minor rilling	5	Vegetation degraded	88
Hummocking	1	Stripping	3	Vegetation degraded; some erosion	9
Major drift	0	Lower slope gullies	3	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

Although some parts of the floodplains associated with this rangeland type are gullied, it is only vegetation degradation which has reduced its usefulness. Protection of the floodplains and rangeland types above this one will promote healing of the gullies. Drifting of the banks could be alleviated in places.

WARRI RANGELAND TYPE 587 square miles



Unit	%	Landform	Soils	Potential	Condition
1	25	Calcrete tables	Light brown calcareous soil, extensive areas of calcrete exposures pH 8.5-9	Fair, sparse shrubs	Vegetation degraded; little erosion
2	5	Intertable areas	Red-brown clay overlaying calcareous Hard Pan at 24" - 30", pH 7.5-8.5	Fair, shrubs and annual grasses	Vegetation degraded; little erosion - some channelling in parts - sealed
3	15	Marginal strew covered areas	Red-brown clay with gravel in profile on Hard Pan at 8", weathered strew. pH 6.5	Low, sparse shrubs	Vegetation degraded; some sheeting evident
4	20	Non saline alluvial plains	Brown gritty clay loam - clay to 30" + pH 7-7.5, extensively sealed	Moderate, good shrub cover	Vegetation degraded; sheeting; sealing and minor rilling
5	20	Saline alluvial plains	Duplex soils of variable depth. pH 6.5-8.5	Moderate, halophytic pastures	Vegetation degraded; heavily eroded and extensively sealed

Unit	%	Landform	Soils	Potential	Conditions
6	5	Scalds and internal drainage flats	Heavy brown clay to +36" in low portions, pH 6.5-8, sealed surfaces	Moderate halophytic pastures on internal drainage flats	Vegetation degraded; extensive surface sealing, stripping
7	10	Drainage lines	Variable soils, shallow clays on Hard Pan, deep brown clays and pebble strewn beds	Fair	Vegetation degraded; heavily eroded and channelled

Warri rangeland type occupies 587 square miles. It occurs on all the four-mile sheets except Kennedy Range and Wooramel. It is characterised by extensive calcrete or "opaline" tables, and is always associated with trunk drainage systems. It is frequently associated with the major river systems, extensive elements of Warri type being found within Gascoyne rangeland type. Very large exposures of calcrete table can be seen on the Gascoyne River south of Landor Station homestead. The type is an important source of stock water, though it may be saline locally in sluggish sections.

The calcrete tables may be up to ten feet high, and over eight miles long and two to three miles wide, though they are commonly smaller. The surface is frequently pitted with small circular drainage or sink holes up to 30 feet across. Dark intertable areas occur between the platforms. They carry large volumes of surface water flow following rain and are often sealed, though the vegetation may be dense. Higher strew covered alluvial plains from neighbouring types obtrude into Warri and may be included in the description. These are frequently one mile wide and of very low gradient, often less than 1:1000. Non-saline alluvial plains with gradients of 1:500 carry the bulk of the drainage through the system. The tables affect the flow to some extent and fine, dark strew is found deposited down-stream from the tables. Where drainage is sluggish the alluvial plains become decidedly saline and are marked by duplex soils. Scalded areas and attendant internal drainages are found within the saline plains. Where drainage is confined it is braided and, in many cases, incised. Incision to 12 or 15 feet over a width of 80 feet is common.

PASTURES

The calcrete tables (1) carry *Acacia aneura* of variable density. In favoured locations such as sink holes on the table it may be very dense, but more commonly it is sparse and low. *A. tetragonophylla*, *A. sclerosperma* and *Hakea lorea*, are common in the upper layer. *Solanum lasiophyllum* is the dominant shrub such as *Ptilotus obovatus*, *Cassia desolata*, *C. oligophylla*, *Scaevola spinescens* and *Rhagodia* are found locally. The ground flora is peculiar to the table, *Helipterum sterilescens*, *Zygophyllum* sp. and *Enneapogon* sp. are found rarely elsewhere. The inter-table areas (2) support a moderate cover of

A. aneura, A. tetragonophylla, A. victoriae and *Grevillea striata* over variable shrubs including *A. craspedocarpa, Cassia sturtii, Scaevola spinescens, Eremophila maculata* and *E. longifolia*, the ground cover being annuals. Dense fringes including *Eucalyptus camaldulensis* are common round the table edges. The marginal stony plains (3) carry sparse *A. aneura, A. kempeana* and *A. tetragonophylla* above sparse shrubs and ephemerals. The non-saline plains (4) are dominated by *A. aneura* which can be moderately dense. Associated tree-like species are *A. tetragonophylla, A. pruinocarpa, A. victoriae* and *A. sclerosperma*. Shrubs such as *Eremophila fraseri, Cassia desolata, Acacia pyrifolia* and *Rhagodia* are common. The saline plains (5) carry *A. victoriae* and *A. tetragonophylla* above halophytic shrubs such as *Cratystylis subspinescens, Eremophila maculata, Atriplex paludosa* and *Kochia pyramidata*. The scalds and internal drainage flats (6) are found on the saline plains. The scalds are virtually bare, having been stripped of their cover. The drainage flats, however, carry a halophytic vegetation together with dense annual grasses in places. The streamlines (7) are characterised by *Eucalyptus camaldulensis* which may reach a height of 60 feet above a lower canopy of *Acacia* spp., *Melaleuca* spp. and shrubs.

General statement

Warri rangeland type can provide valuable durable pastures, but it is frequently degraded and eroded. Over-use has reduced the shrub population in the less favourable sites such as the calcrete tables, marginal and non-saline plains. The saline plains and internal drainage flats are usually guttered. Rehabilitation through prolonged freedom from use in a succession of good seasons is recommended.

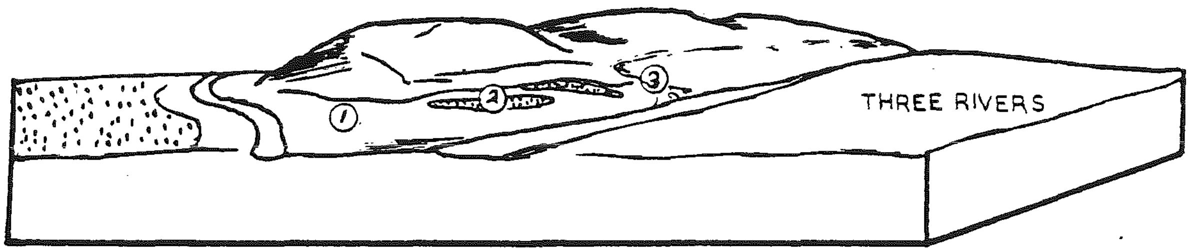
Traverse Summary - 86 observations

Wind erosion	%	Water erosion	%	Condition	%
None	15	None	19	Pristine	0
Sheeting	34	Sealing	36	Good	1
Surface redistribution	33	Minor rilling	14	Vegetation degraded	49
Hummocking	18	Stripping	23	Vegetation degraded; some erosion	40
Major drift	0	Lower slope gullies	8	Vegetation degraded; major erosion	10
		Upper & lower slope gullies	0		

Significance to erosion

This rangeland type is badly degraded and eroded and contributes in large measure to deterioration on the catchment and reduction in productivity.

JINGLE RANGELAND TYPE 81 square miles



Unit	%	Landform	Soils	Potential	Condition
1	80	Floodplains	Red-brown gritty clay of variable depth on Hard Pan; pH 7-8; variable, fine, weathered gravel strew	Moderate, good durable palatable shrubs and ephemerals	Vegetation degraded - eroded
2	15	Banks	Red-brown clayey sands greater than 36"; pH 6.5 - 7.5	Moderate, good palatable shrubs and perennial grasses	Vegetation degraded - eroded
3	5	Drainage lines	In sluggish areas brown clays. Otherwise braided channels and incised creeks up to 15' deep and 200' wide	Fair, shrubs and ephemerals	Vegetation degraded - eroded in parts

Jingle rangeland type occurs marginal to the main drainage systems and can be found on most of the four-mile sheets of the catchment. It occupies 81 square miles and is now characterised by extensive degradation and erosion, particularly where the river plains are wide. Elements of other types, particularly of Warri type, can be found within this rangeland type.

The river plains consist of flood plains of variable width, marginal to the rivers. They are usually non-saline and up to five miles wide. Areas of fine gravel strew may be found associated with bare, scalded sections, and these give a patterned appearance to the plains. Sandy banks are found disposed on the plains. These may be up to four feet high and two miles long. They are frequently eroded and cut away on the margins. Concentrated and frequently braided flow lines up to 200 yards

wide are common; in some instances braiding gives way to channelling.

PASTURES

The plains (1) carry variable pastures often influenced by the presence of calcareous soils of the Warri type. In these instances, *Eucalyptus camaldulensis*, *Stylobasium* sp. and *Acacia sclerosperma* are common. However, in most cases *A. aneura* and *A. tetragonophylla* provide a sparse canopy, up to 5 per cent cover, above shrubs including *Eremophila fraseri*, *E. maculata*, *Kochia* spp., *Scaevola* sp. and *Rhagodia*. There is little obvious influence from the strew. Sandy banks (2) are frequently degraded and, in this condition, carry *Eremophila margarethae* and *Cassia helmsii* above *Corchorus wolcottii*. Perennial grasses such as *Danthonia bipartita* and shrubs such as *Eremophila leucophylla* and *Rhagodia* are found only in the better condition pastures. The braided flow lines (3) carry *A. tetragonophylla*, *A. craspedocarpa* and *A. aneura* as a variable layer, up to 10 per cent cover, above mixed shrubs and ephemerals. The incised areas carry *E. camaldulensis* in addition to the species listed above.

General statement

Although the total area is small, Jingle rangeland type can produce valuable pastures. Through its position downslope of run-off systems, it has the potential to produce consistently more pasture due to frequent accessions of run-on water. Because of this capability the type has been subjected to severe over-use. Rehabilitation can be effected in the first instance through protection from grazing. Reseeding may be essential in some particularly degraded sections, but only after excess flooding has been alleviated.

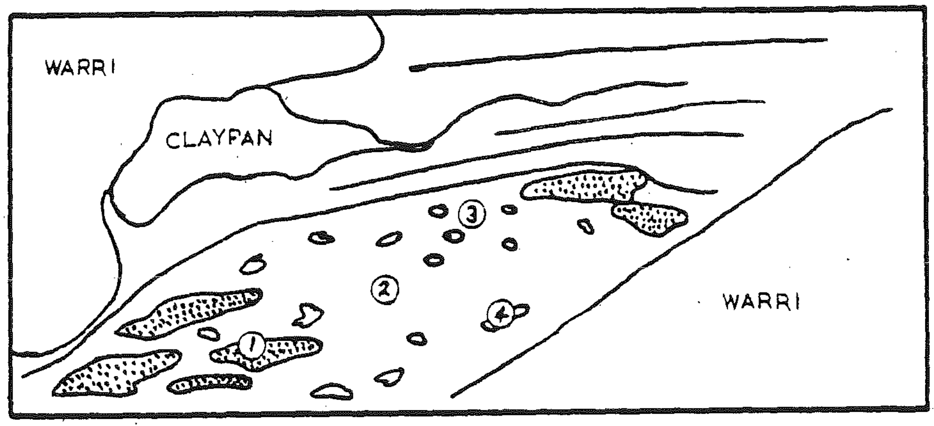
Traverse Summary - 25 observations

Wind erosion	%	Water erosion	%	Condition	%
None	8	None	8	Pristine	0
Sheeting	8	Sealing	32	Good	12
Surface redistribution	24	Minor rilling	16	Vegetation degraded	32
Hummocking	60	Stripping	28	Vegetation degraded; some erosion	56
Major drift	0	Lower slope gullies	16	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

Erosion of Jingle type has been severe and it contributes to the degraded condition of the catchment.

PEEDAWARRA RANGELAND TYPE 67 square miles



Unit	%	Landform	Soils	Potential	Condition
1		Sandy banks	Red-brown fine sand on fine gritty clays at 12 to 20". pH 6-8	Moderate, grasses and shrubs	Vegetation degraded, eroded and hummocked
2		Plains	Duplex soils of variable depths; pH 7-8; carpets of black weathered gravels and patches of water sorted sand give pattern to the plain	Good, halophytic pastures	Vegetation degraded; extensively sheeted, gullied and stripped
3		Drainage depressions	Red-brown gritty clay. pH 6-7	Fair; perennial grass	Vegetation degraded; no erosion
4		Scalds	B horizon of gritty clay. pH 7-8	Poor, no vegetation	Already grossly eroded

Peedawarra rangeland type is found on the Robinson Range and Peak Hill four-mile sheets where it occupies 67 square miles of catchment. It is a tributary plain drainage system which is characteristically sluggish and, consequently, markedly saline.

Sandy banks are found on the alluvial plains which slope at 1:1000 or less. Small circular drainage depressions up to 100 ft in diameter are found arranged on the plain in line with the direction of water flow. This rangeland is extremely degraded with newly scalded and sheeted areas contributing to the current photopattern. In the centre of the catchment on Landor station, Jingle rangeland type (q.v.) has been

seriously eroded. The pattern produced by this current, active erosion resembles that of Peedawarra in every way. In this report this area of Jingle rangeland is described as belonging to Peedawarra.

PASTURES

The sandy banks (1) carry *Acacia aneura* and *A. tetragonophylla* over *Eremophila margarethae*, *E. cuneifolia*, *Cassia desolata* and *Rhagodia* On the survey there were no signs of perennial grasses, and the shrubs and trees were found to be actually diminishing in number in response to increases of *Hakea priessii*. The plains (2) are sealed, and in some places have a gravelly strew. They have been stripped of all vegetation save for a few dead chenopod shrubs. Circular drainage depressions (3) have dense rings of *A. tetragonophylla* around grassy centres where *Eragrostis setifolia* and *Eriachne flaccida* are prominent. The scalds (4) are bare. In most instances they are formed by deflation of the A horizon of the duplex soils of the plains.

General statement

This valuable pasture land has been extensively degraded. Severe over-use has led to this decline since it has always been grazed preferentially. Protection from use could permit some recovery, but experience with similarly ill-used areas indicates that reseeding will probably be essential to achieve full potential.

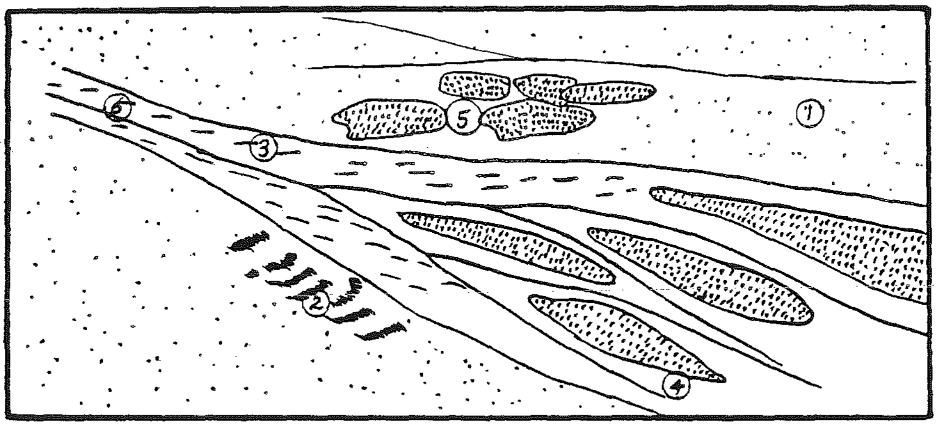
Traverse Summary - 13 observations

Wind erosion	%	Water erosion	%	Condition	%
None	0	None	0	Pristine	0
Sheeting	0	Sealing	23	Good	0
Surface redistribution	8	Minor rilling	15	Vegetation degraded	0
Hummocking	92	Stripping	46	Vegetation degraded; some erosion	54
Major drift	0	Lower slope gullies	16	Vegetation degraded; major erosion	46
		Upper & lower slope gullies	0		

Significance to erosion

Although of limited size, this type is extremely degraded and contributes significantly to the deteriorated condition of the catchment.

THREE RIVERS RANGELAND TYPE — 1739 square miles



Unit	%	Landform	Soils	Potential	Condition
1	50	Alluvial plains	Red-brown gritty clay on Hard Pan at variable depth pH 6-7, extensive areas either sealed or have a stone mantle	Fair; shrubby pastures	Vegetation degraded generally eroded, major erosion in parts
2	2	Groves	Red-brown sandy loam to clay loam on Hard Pan at 24"+	Fair; shrubby pastures	As above
3	20	Alluvial plains receiving concentrated flow	Brown gritty clay on Hard Pan 24", pH 6, extensive areas sealed	Fair; shrubby pastures	As above
4	15	Sandbanks	Red-brown sand to +36" pH 5.5-6	Fair; some perennial grasses	As above
5	10	Interbanks	Red-brown clay on Hard Pan, pH 6	Low	As above
6	3	Channelled drainage		Fair	Vegetation degraded, some erosion

Three Rivers rangeland type occupies 6.35 per cent of the catchment, covering some 1739 square miles on the Peak Hill, Robinson Range, Mt. Phillips, Mt. Egerton, Glenburgh and Collier four-mile sheets. It is the dominant landscape form of the eastern tributary plains. It is frequently sealed, guttered, scalded and stripped.

The type is commonly found as a large, non-saline, alluvial plain sloping at about 1:500, though occasionally less. The plains which carry sheet flow may be up to seven miles wide and six miles long. They discharge their water into trunk or tributary drainage. Some areas of more concentrated flow may be braided, or may be marked by a locally dense shrubby vegetation cover. Sandbanks up to one foot high and a mile long are common on the plains. They extend, longitudinally with the slope, and mostly at the margins of sheet flow areas. Channelled areas may occur in the lines of concentrated flow. Down slope, the flat tributary plains become scalded and stripped, and present a different aspect in this condition to their original state.

PASTURES

The flat alluvial plains (1) carry sparse *Acacia aneura* up to 12 feet high, and very scattered tall *A. pruinocarpa* up to 30 feet high, above a variable shrub later dominated by *Eremophila fraseri* and *Solanum lasiophyllum.* Other shrub species such as *Eremophila georgei, E. margarethae, E. freelingii, Ptilotus obovatus* and *Cassia* spp. are common. In the undegraded state *Kochia* species and *Rhagodia* are common, but these disappear with over-use. The herbaceous perennial *Ptilotus schwartzii* can be common in some situations and occurs with ephemerals after rains. Total perennial species cover on the alluvial plains lies between five and eight per cent. Where the soil surface is pebble strewn, the vegetation is much sparser and more stunted. These areas are more prevalent upslope and tend merely to discharge water on the sealed areas below. The principal pastures on these are ephemerals.

The grove and intergrove complexes (2) are comparatively minor constituents of the total pasture and support *A. aneura* and variable shrubs. The plains with concentrated flow (3) have pastures rather similar to those on the plains with more diffuse flow. Cover on these areas can be as high as 10 or 12 per cent and consists of *A. aneura, A. pruinocarpa* and *A. tetragonophylla,* with *A. craspedocarpa* in the lowest parts. The shrub cover is little different, but as the soil is commonly deeper, the perennial grass *Chrysopogon latifolius* becomes common among denser annual grasses and forbs.

The sandy banks (4) carry *A. aneura, A. tetragonophylla, Canthium* sp. and sparse *Hakea lorea* above a shrub layer dominated by *Eremophila leucophylla, Cassia* spp., *Solanum* sp. and perennial tussock grasses. Under conditions of over-use the perennial grasses and useful shrubs disappear. The interbanks (5) carry a very sparse cover of low shrubs; *Eremophila fraseri* and *Cassia* sp. predominate under very sparse and stunted *A. aneura.* The channelled drainages (6) carry dense marginal vegetation similar to that found in the concentrated flow areas, though in the areas of deep incision *Eucalyptus camaldulensis* may be common.

General statement

This rangeland type produces fair ephemeral pastures with scattered palatable shrubs when it is in good condition. As it is a unit of tributary drainage it is subject to frequent run-on water and hence has the potential to produce ephemeral pastures when the total rainfall may be insufficient in less favoured sites. As such the type has been subjected to severe over-use. The absence of a pebble strew and the soil

type itself, have, under this over-use, combined to produce extensive sealing, gullying and erosion. In many instances soil stripping has reduced the alluvial plain to hard pan exposure which is quite incapable of producing pasture and incapable of rehabilitation. It is significant that those properties selected early in the settlement of the catchment and subjected to continuous and heavy use by sheep, have large areas of Three Rivers type, almost all of which are severely degraded. Rehabilitation will be extremely slow. Freedom from use is the only technique of regeneration likely to be effective.

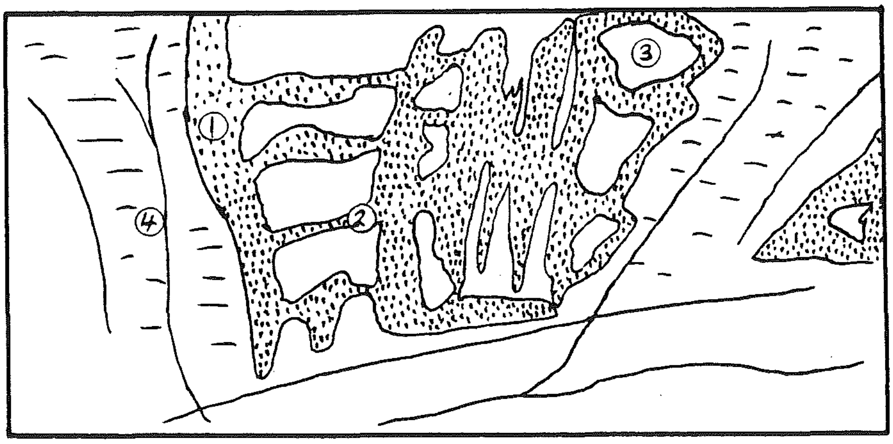
Traverse Summary - 290 observations

Wind erosion	%	Water erosion	%	Condition	%
None	10	None	13	Pristine	1
Sheeting	29	Sealing	58	Good	6
Surface redistribution	52	Minor rilling	6	Vegetation degraded	51
Hummocking	8	Stripping	17	Vegetation degraded, some erosion	38
Major drift	1	Lower slope gullies	6	Vegetation degraded, major erosion	4
		Upper & lower slope gullies	0		

Significance to erosion

The traverse record indicates that this type is severely degraded and eroded. Over one-third shows moderate to severe erosion and must contribute, in a large measure, to the total erosion situation on the catchment.

BLECH RANGELAND TYPE 44 square miles



Unit	%	Landform	Soils	Potential	Condition
1	25	Sand banks	Red-brown sand greater than 36"	Fair to moderate	Vegetation degraded
2	30	Connecting banks and groves	Red-brown loamy sand increasing in texture with depth, or sandy clays, pH 6.5	Moderate	Vegetation degraded
3	40	Interbanks and scalded areas	Red-brown sandy clay to 15" on Hard Pan, pH 6-7, sealed and with a pebble strew	Low, ephemerals only beneath sparse shrubs	Extensive step terrace erosion above the banks and groves due to greatly increased water flow, vegetation degraded
4	5	Through drainage	Red-brown gritty clay 36" or more, pH 7	Low, ephemerals only	Gullies, degraded and eroded

Blech rangeland type is found on the Mt. Egerton and Robinson Range four-mile sheets. It is limited to 44 square miles on the catchment, but it is significant in the general erosion situation.

Blech type has affinities with the other sand bank - alluvial plain rangelands such as Landor and Doolgunna. It is characterised by large sandy banks up to a mile long and half a mile wide which are connected to one another by several arcuate bands. Interbank areas occur between the sandy banks and these may coalesce into discernible

through drainage plains in some instances.

PASTURES

The sandy banks (1) carry a moderately dense canopy of *Acacia aneura*, *A. grasbyi* and *A. tetragonophylla* above a sparse shrub layer in which *Eremophila leucophylla*, *Cassia helmsii* and *C. desolata* are prominent. Total cover can be up to 10 per cent. The connecting banks and groves (2) have a similar vegetation, though it is less dense. *A. aneura* and *A. grasbyi* are found over *Eremophila fraseri*, *Cassia desolata*, *C. helmsii*, *Solanum lasiophyllum*, *Sida* sp. and *Scaevola spinescens*. Covers of up to 8 per cent were recorded. Perennial grass remnants were recorded on banks and groves. The interbanks and scalded areas (3) have only a very sparse cover of *E. fraseri*, *C. helmsii* and *S. lasiophyllum*. These areas are very frequently degraded and eroded. The through-drainages (4) are similar to the interbanks and are also gullied.

General statement

This rangeland type is not extensive, but it is frequently severely degraded and eroded. It has the potential to provide moderately good pastures of perennial grasses below the shrub layer on the banks and groves. Step terracing erosion which is common will be difficult to halt, but if unchecked, will extend up slope to the groves above, thereby robbing them of their water and creating extensive death of the vegetation on the groves and banks.

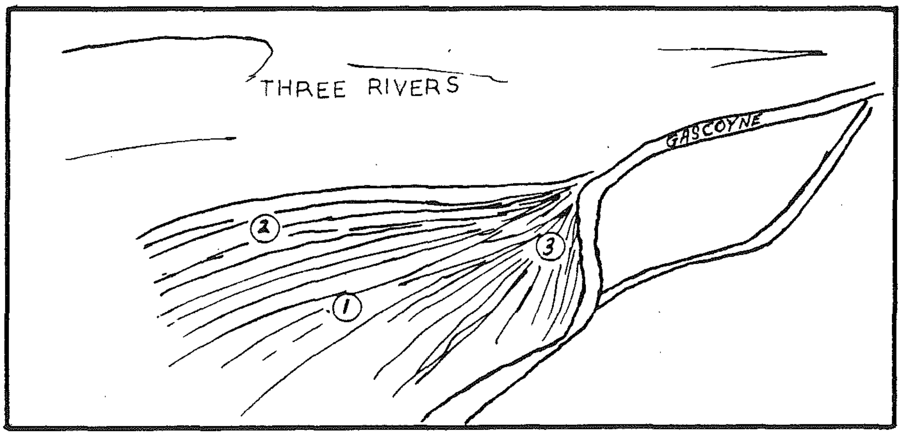
Traverse Summary - 4 observations

Wind erosion	%	Water erosion	%	Condition	%
None	0	None	0	Pristine	0
Sheeting	0	Sealing	50	Good	0
Surface redistribution	75	Minor rilling	0	Vegetation degraded	0
Hummocking	25	Stripping	50	Vegetation degraded; some erosion	100
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0

Significance to erosion

This type is degraded and is a member of the group of types which are commonly eroded and gullied all over the catchment.

CLERE RANGELAND TYPE 46 square miles



Unit	%	Landform	Soils	Potential	Condition
1	30	Flood plains with active sheet flow	Shallow red-brown gritty clay on Hard Pan; pH 5; minor sand banks	Low, sparse shrubs	Degraded with erosion
2	40	Slightly higher interfluves	Brown to red-brown gritty clay on Hard Pan to 12", pH 6, often with scalding and with irregular strew	Low, sparse shrubs	Degraded
3	30	Areas of concentrated flow	Red-brown gritty clay, shallow depth; pH 6-7	Fair, moderate shrubs	Degraded with erosion

Clere rangeland type occupies 46 square miles. It is found associated with tributary drainage plains and floodplains marginal to rivers and also below flood-outs of creeks on plains. It is found on the Glenburgh, Collier, Robinson Range and Peak Hill four-mile sheets.

This rangeland type is identified by the streaky nature of the photo-pattern which shows a succession of scalds, waterways and interfluves aligned along the drainage. It is often found downstream of bends in major streamlines, in which increased water flow breaks the confines of the banks and discharges over the marginal plain, altering the form of the marginal plain thereby, and imposing the new pattern of drainage upon it. As such, Clere rangeland type can be recognised as a pattern produced by active current erosion and superimposed upon the natural patterns of the catchment. It is characterised by extensive gullying, sand bank movement and encroachment onto the bordering rangeland types.

PASTURES

The floodplains (1) with active sheet flow, carry a moderate cover of *Acacia aneura*, *A. tetragonophylla* and *A. pruinocarpa*, with up to 8 per cent cover. Sparse shrubs occur beneath the *Acacia* spp. and include *Eremophila fraseri*, *E. margarethae*, and *Cassia helmsii*. In places where water accumulates or where run-on is more frequent, *Acacia kempeana* appears to be increasing in dominance. Newly formed small sandy banks on the plain carry sparse *Eriachne aristidea* below the above cover. The slightly higher interfluves (2) are frequently bare, or may carry a very sparse vegetation, principally stunted *A. aneura* over *E. fraseri* and *Cassia desolata*. The lines of concentrated flow have a variable plant population which may include dense areas of *A. kempeana* above *C. helmsii*, *A. tetragonophylla* and *E. fraseri*, the cover often exceeding 12 per cent.

General statement

This apparently new rangeland type is extremely degraded and the vegetation is unstable, ephemeral and unproductive.

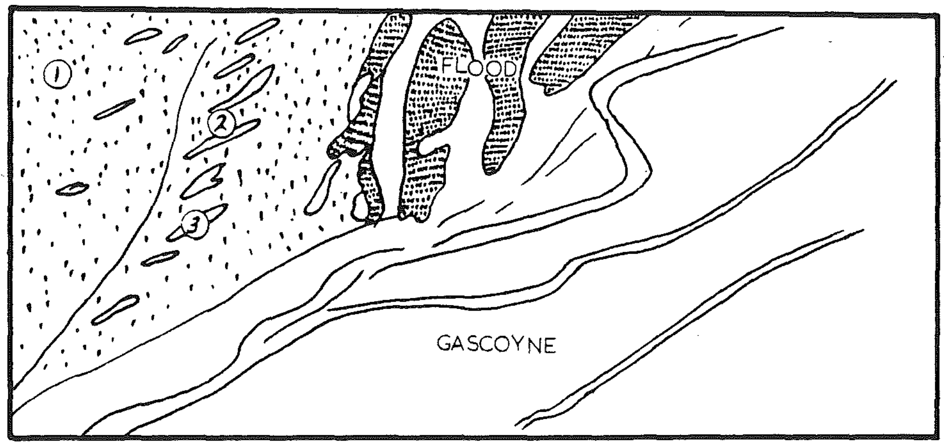
Traverse Summary - 6 observations

Wind erosion	%	Water erosion	%	Condition	%
None	0	None	0	Pristine	0
Sheeting	33	Sealing	67	Good	0
Surface redistribution	50	Minor rilling	16	Vegetation degraded	43
Hummocking	17	Stripping	0	Vegetation degraded; some erosion	29
Major drift	0	Lower slope gullies	17	Vegetation degraded; major erosion	28
		Upper & lower slope gullies	0		

Significance to erosion

The type sheds large amounts of water onto surrounding pasture types. In some instances current water flows from this rangeland are contributing to active erosion of the sandy banks of associated and neighbouring rangeland types. In extreme cases active water flow from Clere has cut through banks and groves located on nearby alluvial plains and has contributed to the erosion problem on the catchment.

BUBBAGUNDY RANGELAND TYPE 123 square miles



Unit	%	Landform	Soils	Potential	Condition
1	80	Large sand masses	Red-brown loamy sand greater than 36" wind sorted surface pH 6.5	Moderate; palatable shrubs and grasses	Vegetation degraded; no erosion
2	10	Sand banks	Red-brown loamy sand greater than 36", wind sorted surface pH 6.5	Moderate, palatable shrubs and grasses	Vegetation degraded; some surface redistribution
3	10	Interbanks	Red-brown gritty clay of shallow depth on Hard Pan, pH 6.5	Fair to low; sparse shrubs and annuals	Vegetation degraded; minor erosion, rills

Bubbagundy rangeland type is related to the Landor type and is distinguished from it by its very large and extensive sandy banks which approach sandplain in their quality and expression of vegetation. This type is found in the main on the Glenburgh four-mile sheet, and only as small areas on the sheets surrounding this.

A lack of through drainage which is found in the allied Landor type, leaves large sand masses, sand banks and interbanks as the three constituent elements of this type. The sand masses are elevated four to six feet above the surrounding drainage. They may be four miles long and one or two miles wide. Where there is a tendency towards through drainage the sand mass edge breaks to form sandbanks which lie very generally transverse to the direction of water movement and thereby effectively impede its through flow.

PASTURES

The sand masses (1) and the banks (2) carry dense *Acacia linophylla* with *Grevillea nematophylla* above a variable shrub layer in which *Eremophila leucophylla, Rhagodia,* sp. *Solanum lasiophyllum* and *Ptilotus obovatus* are common. Total canopy cover exceeds 20 per cent. The ground flora consists of perennial grasses such as *Danthonia bipartita, Eragrostis xerophila* and *Eriachne helmsii.* In most cases the grasses have been reduced to annual species such as *Eriachne aristidea* and *Aristida contorta.* The interbanks (3) have a sparse cover of *A. aneura* and *A. tetragonophylla* above shrubs such as *E. fraseri* and *Solanum* with annual grasses and forbs in season.

General statement

Bubbagundy type is capable of providing valuable pastures which are durable in part. With a good grass cover it can support large numbers of stock and has obviously been preferentially grazed. This over-use has resulted in removal of the accessible and useful species such as *Danthonia.* However, the protection given by the upper storey has prevented much wind erosion.

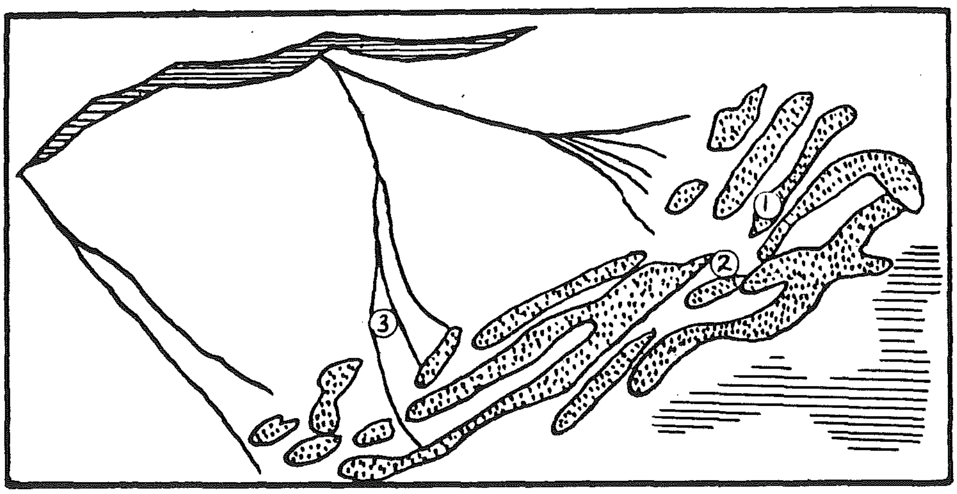
Traverse Summary - 19 observations

Wind erosion	%	Water erosion	%	Condition	%
None	10	None	79	Pristine	0
Sheeting	0	Sealing	16	Good	0
Surface redistribution	90	Minor rilling	5	Vegetation degraded	37
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	63
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper and lower slope gullies	0		

Significance to erosion

Erosion is limited to the rills on the interbanks and some surface redistribution on the more vulnerable banks as distinct from the sand masses. It is not significant to the erosion on the catchment.

STONEHUT RANGELAND TYPE 3.4 square miles



Unit	%	Landform	Soils	Potential	Condition
1	40	Banks	Red-brown sand on decomposing parent material at about 30" pH 7	Moderate	Vegetation degraded; no erosion
2	40	Interbanks	Red-brown fine gritty clay, shallow soil about 9" on Hard Pan pH 7	Low, only ephemeral pasture	No erosion
3	20	Flowlines	As above, but variable	Low, only ephemeral pasture	No erosion

Stonehunt rangeland is a minor rangeland type covering only 3.4 square miles on the Glenburgh four-mile sheet. It is confined to Landor Station.

This type is found on tributary drainage plains and marginal to areas of sheet flow. It is characterised by long sandy banks arranged in rows transverse to the water flow. They occur in slight interconnected arcs up to 60 chains long and 8 chains wide. The bank crests are about two feet above the interbanks which are as long as the banks and about 200 feet wide. Drainage tracts with braided and sheet flow segment the bank-interbank sequences.

PASTURES

The banks (1) have a moderately dense tree canopy in which *Acacia pruinocarpa, A. aneura* and *A. kempeana* are common. The shrub layer consists of *Eremophila leucophylla, Rhagodia,* sp. *Ptilotus obovatus* and *Solanum lasiophyllum.*. These two layers are dense enough to exclude perennial grasses from the gound storey. The interbanks (2) have a much reduced cover. *A. pruinocarpa* occurs as a very sparse canopy, less than one per cent cover, over very scattered *Eremophila fraseri* and *P. obovatus*.

The flowlines (3) carry similar vegetation to the interbanks, though it becomes denser in the areas of more concentrated flow.

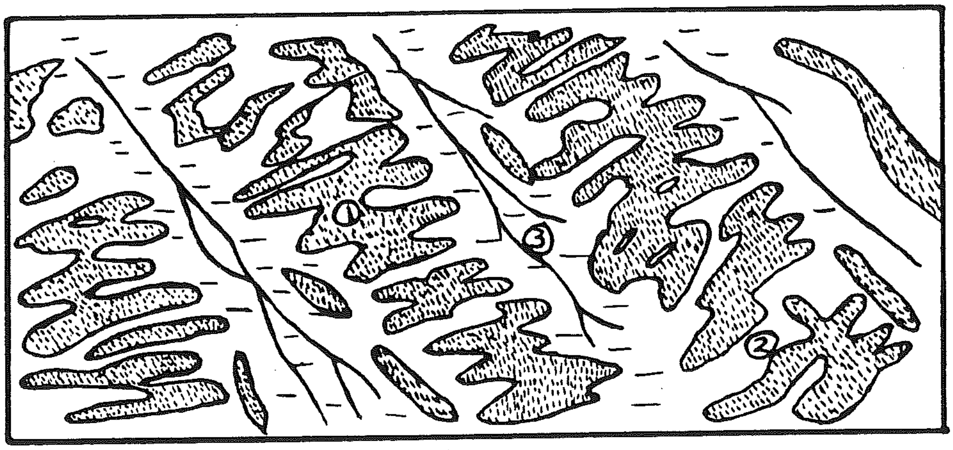
General statement

Stonehut rangeland type is very restricted and not significant on the catchment. The pastures are durable on the banks and ephemeral elsewhere. Stocking considerations, as with Landor and Doolgunna, should be based on the area of bank and not on total area.

Significance to erosion

The type was sampled only once and was in good condition. There was no erosion.

LANDOR RANGELAND TYPE 496 square miles



Unit	%	Landform	Soils	Potential	Condition
1	40	Wandarrie banks	Red-brown sand to sandy loam with depth to 36" on Hard Pan, pH 6-7	Moderate to good; perennial grasses and good shrubs	Vegetation degraded; marginal erosion
2	30	Interbanks	Shallow red-brown sandy or gritty clay on Hard Pan, pH 6.5, sealed surfaces	Low; annual pastures only and sparse shrubs	Vegetation degraded; sealing
3	30	Drainage floors	As above, often with locally higher areas with sparse mantles of weathered pebbles	Low; annual pastures only and sparse shrubs local benefits from run-on water	Vegetation degraded; some surface stripping on wide fronts down slope

Landor rangeland type covers 496 square miles. It is associated with the alluvial drainage plains found in the east of the area. It is rare on the Permian basin. It occurs on the Glenburgh, Peak Hill, Robinson Range and Mt. Phillips four-mile sheets.

The type consists of low "Wandarrie banks" up to three feet high, sometimes achieving a length of two miles, and up to 20 chains wide. These banks are disposed on a drainage plain with marked through sheet flow. The banks and the associated interbanks occur on slightly higher areas between the lines of more concentrated sheet flow.

PASTURES

Landor rangeland type is characterised by the occurrence of "wandarrie" grasses on the banks (1). These drought-evading perennial grasses *Danthonia bipartita, Neurachne mitchelliana, Eragrostis xerophila* and *Eriachne helmsii*, occur beneath a moderate canopy of up to 10 per cent tree cover, of such species as *Grevillea nematophylla, Acacia aneura, A. pruinocarpa, A. grasbyi* and *A. tetragonophylla*. A variable shrub layer contributing itself up to 10 per cent cover occurs beneath the tree layer. Species such as *Eremophila leucophylla, E. margarethae, Prostanthera, Solanum lasiophyllum, Cassia sturtii, C. helmsii* and *Rhagodia* sp. assume dominance in specific locations. Over-use in sheep grazing country has reduced the pastures to sparse trees over the unpalatable *E. helmsii* and annual grasses such as *Aristida contorta* and *Eriachne aristidea*. Over-use by cattle appears to result in a loss of grass species only. The interbanks and lines of through drainage (2 and 3) have very similar pastures in which *A. aneura, A. tetragonophylla, A. pruinocarpa* and *Grevillea nematophylla* occur as a sparse canopy (about 0.5 to 1.0%) over sparse shrubs such as *Eremophila margarethae, E. fraseri, Cassia sturtii, C. helmsii, Ptilotus obovatus* and *S. lasiophyllum*. Herbaceous perennials such as *P. schwartzii* may be common after good rains. The ground flora is never more than sparse grasses and forbs.

General statement

Landor rangeland type can provide valuable grass pastures which respond rapidly to rain. However, over-use has produced pastures which are ephemeral. Species such as *A. contorta* and *E. aristidea* which are of low value and acceptability have become dominant. In these reduced conditions the pastures are of doubtful value. Rehabilitation involving rest after good summer rains can be effected comparatively easily. Future use would then be dictated by species composition and vigour.

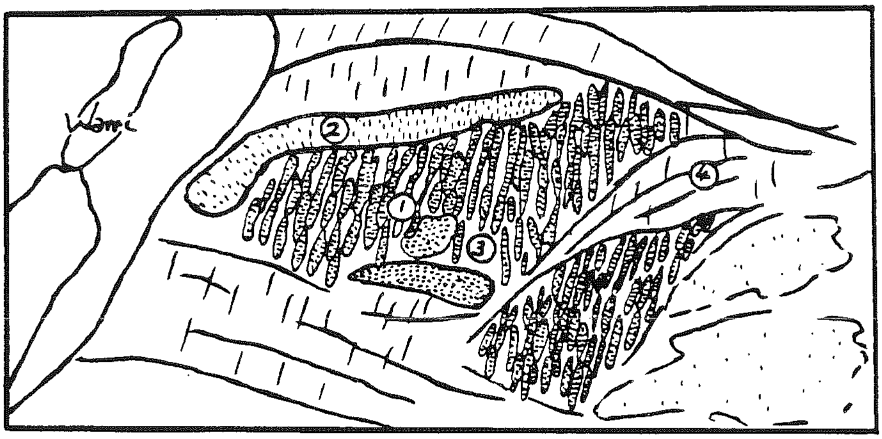
Traverse Summary - 62 observations

Wind erosion	%	Water erosion	%	Condition	%
None	18	None	60	Pristine	0
Sheeting	26	Sealing	31	Good	3
Surface redistribution	53	Minor rilling	6	Vegetation degraded	74
Hummocking	3	Stripping	3	Vegetation degraded; some erosion	20
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	3
		Upper & lower slope gullies	0		

Significance to erosion

The areas of sheet flow are extensively sealed, the soil surface being stripped away in a "step-terracing" erosion form on wide fronts down slope. Where water flow rates are substantially increased the edges of the fringing banks are significantly eroded. With severe over-use by sheep, the sandy banks have become hummocked and are now subject to sand drift.

DOOLGUNNA RANGELAND TYPE 36 square miles



Unit	%	Landform	Soils	Potential	Condition
1	20	Sand banks	Red-brown fine loamy sand on Hard Pan at 30" pH 6	Moderate; good perennial grasses and shrubs	Vegetation degraded severe active erosion
2	20	Sandy bands	Red-brown clayey sand on Hard Pan at 30" pH 6	As above	Vegetation degraded; severe active erosion
3	30	Interbanks	Red-brown gritty clay on Hard Pan, shallow soils 6" to 8", pH 6	Low; sparse shrubs and ephemeral ground cover	Vegetation degraded; sealing
4	30	Flow lines	Red-brown gritty clay, pH 6, of variable depth but usually shallow	Low; sparse shrubs and ephemeral ground cover	Vegetation degraded; severe active erosion

Doolgunna rangeland type occurs on 36 square miles of the Gascoyne Catchment and is restricted to the eastern tributary plains on Peak Hill sheet. It is confined to Doolgunna and Three Rivers station and appears to be a modification of Landor by its narrower banks and fine interconnecting sandy segments between the banks .

Large sandy banks about two feet above the plain up to 15 chains across and up to 60 chains long, are found aligned along the line of water flow on tributary drainage plains. Fine, sandy tracts and bands rarely one foot above the plain and commonly less, 2 to 5 chains wide and up to 20 chains long, extend in an interconnected fashion between the major banks, but these are arranged transverse to the water flow.

Central drainage tracts through the type have slightly braided lines of concentrated flow. Interbanks between the bands and banks resemble the flow lines and have shallow, sealed soils.

PASTURES

Sandy banks and fine interconnecting bands (1 and 2) support perennial grass pastures with a cover of *Acacia aneura*, *A. grasbyi* and *Canthium* above *Eremophila gilesii*, *E. leucophylla* and *Solanum lasiophyllum* with *Danthonia bipartita*, *Eragrostis xerophila* and *Eriachne helmsii*. In most instances this valuable grass community is reduced to annual species. On the eastern edge of the catchment where *Triodia* is more common, *T. basedowii* is found in place of the above perennial grasses, and there produces a pasture of very much reduced value. The flow lines and interbanks (3 and 4) carry sparse *A. aneura* or very sparse *E. fraseri*. The ground component is restricted to sparse annuals.

General statement

Although Doolgunna rangeland type is capable of producing good pastures it has been over-used and is commonly severely degraded. Where *T. basedowii* is the dominant ground cover the type provides very little pasture acceptable to animals.

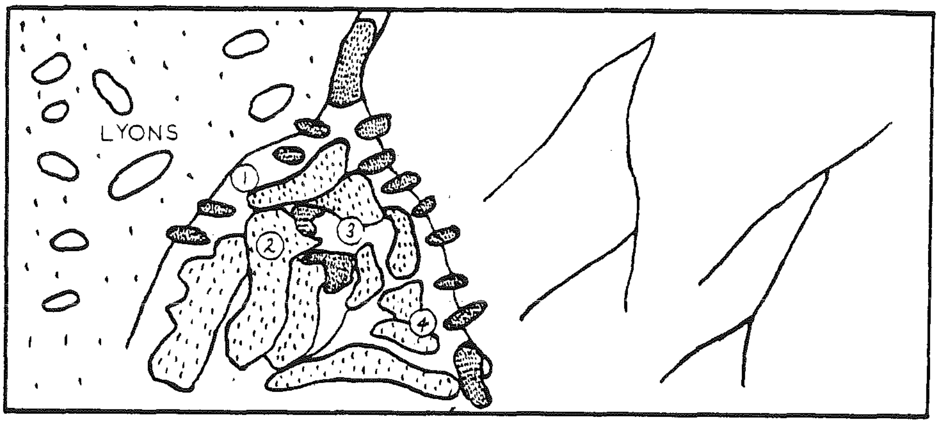
Traverse Summary - 3 observations

Wind erosion	%	Water erosion	%	Condition	%
None	33	None	0	Pristine	0
Sheeting	0	Sealing	33	Good	33
Surface redistribution	67	Minor rilling	67	Vegetation degraded	0
Hummocking	0	Stripping	0	Vegetation degraded; - some erosion	67
Major drift	0	Lower slope gullies	0	Vegetation degraded; - major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

There is only a small area of Doolgunna rangeland type but it contributes to the erosion situation due to over-use, particularly on Doolgunna Station. Here there was abundant evidence from the 1:40,000 aerial photographs that current erosion is removing the sandy inter-and connecting bands and thereby obliterating the pattern.

OUTWASH RANGELAND TYPE 4 square miles



Unit	%	Landform	Soils	Potential	Condition
1	10	Groves	Red-brown gritty clay 24" on P.M. pH 8.0	Fair; good shrubs	Vegetation degraded no erosion
2	80	Sand banks and sandy tracts	Brown sand greater than 36"	Fair; good shrubs	Vegetation degraded; no erosion
3	5	Scalds	Red-brown gritty clay to 24" on P.M. pH 8.0	Fair; but now poor	Very degraded; sealed and rilled
4	5	Interbanks and areas marginal to flow lines	Duplex soils and red-brown gritty clays of shallow depth	Fair or low	Vegetation degraded; no erosion

Outwash rangeland type is a comparatively rare type found only on the Wooramel four-mile sheet and associated with sandy areas receiving run-on water. It occurs on only 4 square miles of the catchment.

This rangeland type is characterised by dense mulga groves arranged in the lines of concentrated sheet flow and by sandy tracts between the flow lines. Small scalded areas are found associated with the inter-groves between the groves.

PASTURES

The groves (1) carry dense *Acacia tetragonophylla* and *A. aneura* above a sparse shrub layer of *Solanum lasiophyllum, Kochia planifolia, Rhagodia* sp. and *Eremophila leucophylla.* The sandy tracts (2) are rather bank-like and support *A. aneura, A. tetragonophylla* and *Hakea priessii* over *Eremophila margarethae, Cassia helmsii* and *Scaevola spinescens.* The scalds (3) are bare, and are a function of a current active erosion system. The inter-groves and areas marginal to flow (4) carry *H. priessii* only.

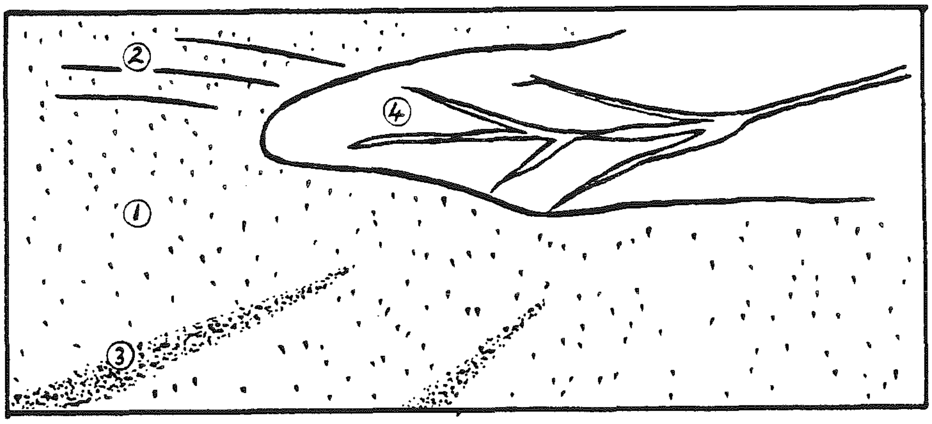
General statement

Outwash rangeland type is insignificant on the catchment. It has been subjected to severe over-use on the duplex soils of the inter-groves and marginal flow area.

Significance to erosion

This rangeland type is unimportant even though degraded in part. It was visited once only on the survey.

DIVIDE RANGELAND TYPE 561 square miles



Unit	%	Landform	Soils	Potential	Condition
1	60	Sandplain	Red-brown fine sand 36"+; pH 6	Poor, sparse edible shrubs	Good; no erosion
2	5	Sand dunes	Red-brown, fine sand 36"+; pH 6	Poor, sparse edible shrubs	Good; no erosion
3	30	Run-on areas	Red-brown clayey sand 36"+; pH 6	Low, some edible shrubs	Vegetation degraded some wind erosion
4	5	Exposures of rocks	Shallow soils variable depth	Low, scattered edible shrubs	Vegetation degraded; no erosion

Divide rangeland type occurs on the eastern part of the catchment where it forms the divide between Murchisonia and Salineland described by Jutson (1934). It occupies 561 square miles which is principally on the Peak Hill four-mile sheet. A small area occurs beneath Mt. Augustus on Mt. Phillips sheet. Isolated sections also occur on Glenburgh and Mt. Egerton sheets.

This type consists of sandplain with minor dunes. The terrain is gently undulating, and the drainage is essentially internal and rarely, if ever, incised. Run-on water accumulates in areas of denser vegetation which are usually characterised by soils of a higher texture. Small breakaways and rock exposures occur at the margins of the type and occasionally within it.

PASTURES

The sandplain and sand dunes, (1) and (2), carry dense *Triodia basedowii* and *Plectrachne melvillei* beneath a variable cover of *Acacia*

aneura and *A. linophylla*, with sparse *Eremophila leucophylla* in the mid-storey. In the west, *Triodia* and *Plectrachne* are absent, but shrubs such as *Solanum lasiophyllum*, *Ptilotus obovatus*, *Cassia sturtii* and *Prostanthera* sp. can assume dominance locally. Very sparse ephemerals follow rain between the grass tussocks and these, with the shrubs, provide the bulk of feed in both areas. In the run-on areas (3) an increased canopy cover of trees and shrubs is found over the spinifex tussocks, or above palatable perennial grasses. Small breakaways and rock exposures (4) carry stunted, sparse *A. aneura* and sparse shrubs with annuals in season.

General statement

Sandplains in the east are of limited value and can only be stocked safely after good rains when the seed heads of spinifex can be eaten. In the west the run-on areas provide fair shrubby pastures, but the development of grasses is limited to isolated tussocks.

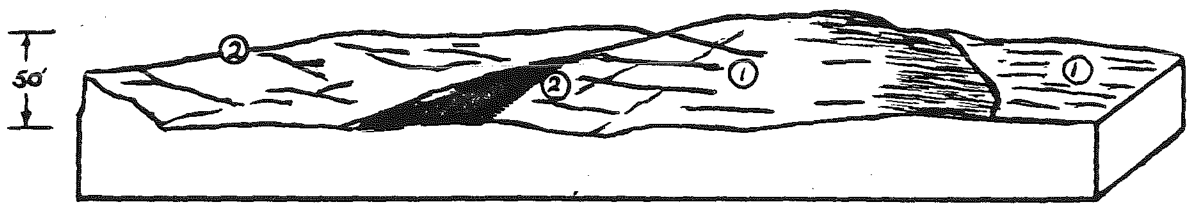
Traverse Summary - 17 observations

Wind erosion	%	Water erosion	%	Condition	%
None	71	None	94	Pristine	6
Sheeting	6	Sealing	6	Good	0
Surface redistribution	23	Minor rilling	0	Vegetation degraded	88
Hummocking	0	Stripping	0	Vegetation degraded; some erosion	6
Major drift	0	Lower slope gullies	0	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

There is little erosion in Divide rangeland type.

YALBALGO RANGELAND TYPE 690 square miles



Unit	%	Landform	Soils	Potential	Condition
1	85	Swales and sandplains	Red-brown sand to 36"+	Low	Good; vegetation degraded in places; some erosion on the margins
2	15	Sand dunes	Red-brown sand	Poor	Good

Yalbalgo rangeland type occurs principally on the Wooramel four-mile sheet, though it can also be found on the Kennedy Range sheet. It forms part of the south-western divide of the catchment as a large sand plain extending from just south of Gascoyne Junction to the coast.

The characteristic feature of the type is the red sand arranged in a sub-regular dune pattern. The dunes may be up to 50 ft high, and are often over two miles long. They are frequently branched though the trend is generally north-east to south-west and their form is generally linear. The dune crests are for the most part stable, and only in exceptional circumstances are they subject to movement. The swales frequently open to large tracts of dune-less sand plain several miles wide.

PASTURES

Two forms of pasture are found in Yalbalgo rangeland type. Behind the face of the Kennedy Range *Plectrachne* is found beneath a moderately dense canopy of *Acacia* spp. and shrubs. In the south *Acacia brachystachya* and *Acacia* spp. are found above shrubs such as *Eremophila leucophylla, Ptilotus obovatus* and *Prostanthera* sp. *Thryptomene, Scaevola spinescens* and *Calytrix* are also found in the shrub layer. Sparse perennial grasses occur beneath the shrub and tree canopy.

General statement

In the south this rangeland type has been used fairly intensively dependent upon water supply availability. It has been over-used and the shrub and grass layers are depleted.

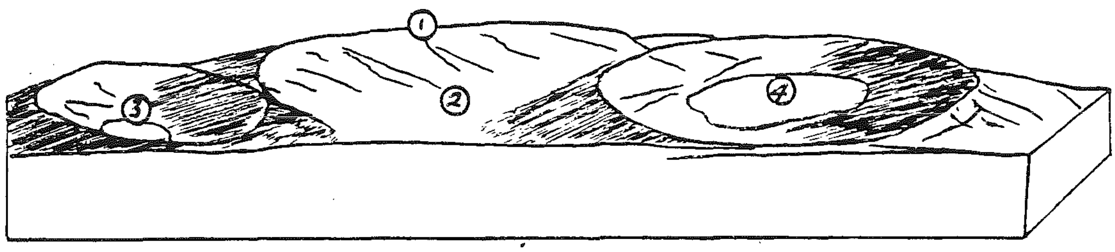
Traverse Summary - 6 observations

Wind erosion	%	Water erosion	%	Condition	%
None	0	None	83	Pristine	0
Sheeting	0	Sealing	0	Good	0
Surface redistribution	67	Minor rilling	0	Vegetation degraded	100
Hummocking	33	Stripping	0	Vegetation degraded; some erosion	0
Major drift	0	Lower slope gullies	17	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

The extensive tree canopy and sandy soils are an effective barrier to erosion. On the margins there is evidence of erosion due to wind and water but this is comparatively unimportant.

LYONS RANGELAND TYPE 200 square miles



Unit	%	Landform	Soils	Potential	Condition
1	35	Sand dunes	Red-brown fine sand, pH 7	Fair; shrub component is durable	Good; some erosion due to wind
2	15	Interdunes	Duplex soils of variable depth, pH 6.5 - 8.5	Moderate; halophytic pastures	Vegetation degraded; some erosion on marginal areas
3	40	Sandy interdunes	Brown fine sand greater than 36"	Fair; shrub component valuable	Vegetation degraded; erosion due to wind in places
4	15	Claypans	Brown clay greater than 36"	Poor to fair; dependent upon vegetation	Vegetation degraded; no erosion

Lyons rangeland type is found on the western side of the catchment. It covers 200 square miles on the Wooramel and Kennedy Range four-mile sheets. It appears to be associated with Bidgemia rangeland type, but is always distinguished by its reticulate dune pattern, sharp dune crests and reduced through drainage.

The reticulate dunes prominent in this type, can be up to 50 feet high and have sparsely vegetated crests. The sides slope abruptly to low-lying interdunal areas up to 15 chains wide which are almost always completely surrounded by dunes. In areas of concentrated flow the interdunal areas may run together unimpeded, and here the soils may be duplex in nature. Where the interdunal area is swale like the soils are fine sands. In some situations the interdunes are marked with prominent claypans up to 20 chains across

PASTURES

The sand dunes (1) carry *Grevillea* sp. *Acacia tetragonophylla*, *A. linophylla* as a moderately dense canopy of up to 10 per cent cover above a sparser layer of shrubs such as *Sida*, *Hibiscus pinonianus*, *Prostanthera* and *Cassia*. Lower sandy banks have a variable cover in which trees are rather limited. Shrubs such as *Cassia helmsii*, *Solanum lasiophyllum*, *Eremophila leucophylla* and *Rhagodia* occur as a moderately dense layer above perennial grasses. The interdunal flats with drainage (2) have duplex soils and support a halophytic vegetation not unlike that of the Bidgemia rangeland type. The sandy interdunes (3) support a vegetation not unlike that of the sand dunes, *Acacia sclerosperma* being moderately dense along with *Grevillea* above shrubs similar to those found on the dunes. The claypans (4) have a dense marginal tree and shrub layer in which *A. sclerosperma*, *A. tetragonophylla*, *A. victoriae* and *Hakea priessii* can be common. The shrub component consists of *Cassia oligophylla*, *C. helmsii*, *Rhagodia*, sp. *Scaevola spinescens* and *Ptilotus*. The pan centres may be bare or may carry variable shrubs and trees, chiefly halophytic species though *Eucalyptus camaldulensis* is common on some.

General statement

Lyons rangeland type provides a durable if low capacity pasture. The central drainage tracts have been over-used and are degraded. Because these tend to be isolated they will be difficult to rehabilitate without abandoning use on the whole of the type.

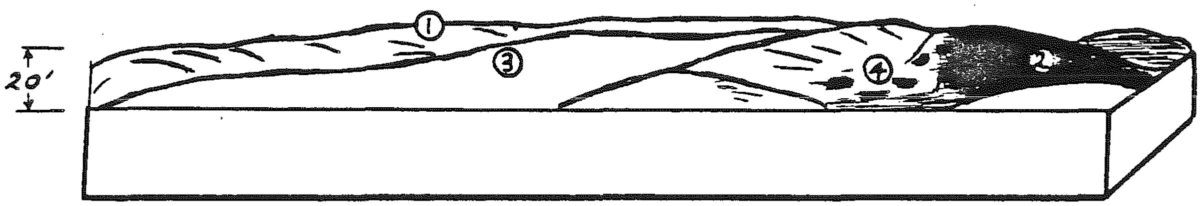
Traverse Summary - 16 observations

Wind erosion	%	Water erosion	%	Condition	%
None	0	None	25	Pristine	0
Sheeting	6	Sealing	12	Good	0
Surface redistribution	63	Minor rilling	19	Vegetation degraded	94
Hummocking	31	Stripping	19	Vegetation degraded; some erosion	6
Major drift	0	Lower slope gullies	25	Vegetation degraded; major erosion	0
		Upper & lower slope gullies	0		

Significance to erosion

Wind and water erosion occurs on this type, particularly near water supplies and on the margins. Gullies are common on the central drainage tracts.

BIDGEMIA RANGELAND TYPE 438 square miles



Unit	%	Landform	Soils	Potential	Condition
1	35	Sand dunes	Red-brown sand greater than 36", pH 6.5	Fair; shrubby pastures	Vegetation degraded no erosion
2	30	Sand banks	Red-brown sand usually greater than 36"	Fair; shrubby pastures	Vegetation degraded; slight marginal erosion
3	30	Interdunes	Duplex soils, pH 6-8, up to 36" deep sand surface on gritty clay	Moderate to good; halophytic pastures	Vegetation degraded extensive gullies and surface stripping in places
4	5	Claypans and drainage foci	Brown clay greater than 36" pH 6-7	Fair; some perennial grass	Vegetation degraded some scalding of surfaces

Bidgemia rangeland type covers 438 square miles. It is confined to the Permian basin west of the Archean shield and is found on the Kennedy Range, Wooramel, Mt. Phillips and Glenburgh four-mile sheets. It is associated with a very flat topography and with the trunk or major tributary drainage.

In Bidgemia rangeland type, low sand dunes up to 20 ft high are found arranged linearly upon a tributary drainage plain. In most cases the dunes are arranged longitudinal to the water flowing towards major drainage. In the region of confluence of the two drainage systems or in areas of less concentrated sheetflow, low sandy banks rather similar to those in Landor rangeland type or in Three Rivers can be found.

Their position and shape is apparently modified by water and wind movement. They are irregularly placed, but occasionally form rings about small claypans. Local drainage foci and claypans are found in the lines of general concentrated sheet flow. The interdunal areas carrying the sheet flow may be up to 20 chains wide, though commonly narrower, and up to several miles long.

PASTURES

The sand dunes (1) carry shrubby vegetation in which *Acacia linophylla*, *A. sclerosperma* and *A. tetragonophylla* can be found above a moderately dense shrub layer with *Eremophila leucophylla*, *E. granitica*, *E. maitlandii*, *Rhagodia*, sp. *Corchorus wolcottii*, *Cassia helmsii* and *Calythrix* sp. In good conditions perennial grasses such as *Danthonia bipartita* and *Eriachne helmsii* can be found, but in the over-used condition these are reduced considerably. The lower sandy banks (2) carry very similar vegetation though the shrub layer is complemented with *Kochia planifolia* and *Scaevola spinescens*. The interdunal areas (3) usually have duplex soils and, in good conditions, support *Kochia polypterygia*, *K. georgei*, *K. planifolia*, *Frankenia* sp. and *Ptilotus polakii*, but these valuable species are absent in the over-used state, when the pasture consists of scattered *Hakea priessii* and *Acacia victoriae* over mainly annual species. The claypans and drainage foci (4) support a dense cover of trees and shrubs, with *Eriachne flaccida* covering the central claypan. In some instances over-use has reduced the cover on the claypans.

General statement

Bidgemia rangeland type provides good durable pastures, but has been over-used. Where erosion is common rehabilitation will prove difficult. Freedom from use has proved effective in some instances in the promotion of volunteer perennials.

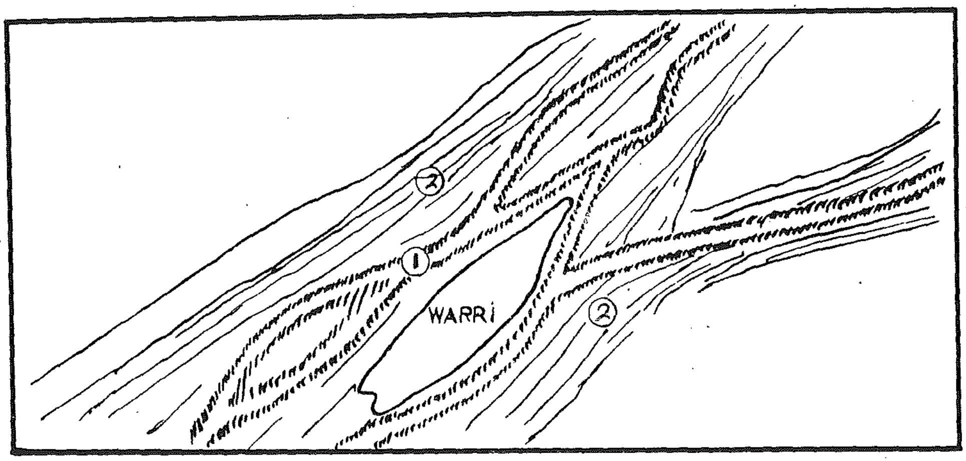
Traverse Summary - 22 observation

Wind erosion	%	Water erosion	%	Condition	%
None	0	None	0	Pristine	0
Sheeting	0	Sealing	27	Good	0
Surface redistribution	68	Minor rilling	50	Vegetation degraded	82
Hummocking	22	Stripping	0	Vegetation degraded; some erosion	18
Major drift	0	Lower slope	23	Vegetation degraded; major erosion	0
		Upper & lower slope gullies			

Significance to erosion

The interdunal areas carry considerable water. The removal of the sandy surface of the duplex soils on these has undoubtedly caused greatly increased watershed. The interdunes are frequently gullied and sealed. Over-use of these valuable pastures has contributed to their decline.

GASCOYNE RANGELAND TYPE 878 square miles



Unit	%	Landform	Soils	Potential	Condition
1	60	River bottoms	Bedloads of sand and cobbles	None	Not applicable
2	40	Banks, islands and margins	Variable silty soils	Moderate, shrubs and perennial grasses	Vegetation degraded, margins and banks often gullied and eroded

Gascoyne rangeland type is found on every four-mile sheet in the catchment. It consists of the major streamlines of the area, and as these are often very large, they have been withdrawn from those rangeland types through which they flow so that the latter's description, for clarity, need not include these large elements. The type occupies 878 square miles.

The Gascoyne and Lyons rivers are the major streamlines of the area, but substantial creeks and rivers such as the Elliott, Edmund, Frederick, Daurie and Dalgety also form part of this rangeland type. The characteristic part of the system is the wide, sand or cobble strewn beds of the major drainages. The channels may occur as single, deeply incised water ways, or they may occur as a series of interlaced channels with a reduced, but still significant, incision.

As the major streamlines traverse a number of distinct rangeland types, the elements which make up the pattern are confused. Two major parts can be recognised. These are the river banks and within-pattern islands, and the river bottoms. The marginal plains and the calcrete islands belong to Jingle and Warri types and are described there.

PASTURES

The banks and islands carry a dense marginal vegetation in which *Eucalyptus camaldulensis* is found up to 60 ft high. *Acacia aneura, A holosericea, A. tetragonophylla* and *A. grasbyi* occur beneath the taller tree cover as trees up to 25 ft high. The shrub layer is variable and consists of *A. pyrifolia, Eremophila* spp., *Cassia* spp. and *Rhagodia* spp. The ground flora is now frequently dominated by *Cenchrus ciliaris* (Buffel Grass), and particularly on the silty soils subject to infrequent inundation found within the river systems and at its margins. Buffel grass and the above shrubs are also common on the islands and steep banks.

General statement

Gascoyne rangeland type provides good pastures on the banks, islands and margins. Many are now colonised by *C. ciliaris* which has prevented erosion and increased productivity. Where colonisation has not been successful erosion has been very severe and landscape deterioration has followed. This is particularly noticeable along the Gascoyne River and the Upper Lyons. The lower and middle Lyons and the middle Gascoyne flow through Durlacher type in the main, where plain development is restricted.

Remedial treatment can only be expected after prolonged freedom from use. Structures to prevent erosion could not be used in this type. It may be possible to establish reseeding "nurse" plots to promote Buffel grass establishment in areas not subject to current erosion and excessive flooding.

Traverse Summary - 60 observations

Wind erosion	%	Water erosion	%	Condition	%
None	10	None	13	Pristine	0
Sheeting	7	Sealing	18	Good	9
Surface redistribution	63	Minor rilling	20	Vegetation degraded	37
Hummocking	18	Stripping	30	Vegetation degraded; some erosion	51
Major drift	2	Lower slope gullies	19	Vegetation degraded; major erosion	3
		Upper & lower slope gullies	0		

Significance to erosion

Erosion of Gascoyne is significant in many places and contributes in a major way to the deteriorated condition of the range and its erosion status.

TABLE OF SCIENTIFIC AND COMMON NAMES

Acacia brachystachya	False bowgada
Acacia aneura	Mulga
Acacia eremea	Snakewood
Acacia grasbyi	Minni richi
Acacia holosericea	Black wattle
Acacia linophylla	Bowgada, Wanyu
Acacia craspedocarpa	Hop mulga
Acacia farnesiana	North West curara
Acacia kempeana	Sandplain wattle
Acacia pruinocarpa	Gidgee
Acacia pyrifolia	Fire wattle
Acacia sclerosperma	Limestone wattle
Acacia tetragonophylla	Curara
Acacia quadrimarginea	Four sided wattle
Acacia victoriae	Bohemia, Acacia
Aristida contorta	Windgrass
Arthrocnemum spp.	Samphire
Atriplex inflata	Dwarf saltbush
Atriplex paludosa	Silver saltbush
Canthium latifolium	Wild lemon
Cassia charlesiana	Tall Cassia
Cassia desolata	Desolate or Grey Cassia
Cassia helmsii	Blunt leafed cassia
Cassia leursenii	Many leafed cassia
Cassia oligophylla	Limestone cassia
Cassia pruinosa	Silver cassia
Cassia sturtii	Grey cassia
Cenchrus ciliaris	Buffel Grass
Chrysopogon fallax	Ribbon grass
Chenopodium auricomum	Northern bluebush
Corchorus wolcottii	Grey-leafed flannel weed
Cratystylis subspinescens	Sage
Cymbopogon exaltatus	Lemon-scented grass
Danthonia bipartita	Broad-leafed wandarrie grass
Enneapogon sp.	Nigger head grass
Eragrostis setifolia	Neverfail grass
Eragrostis xerophila	Wire wandarrie grass
Eriachne aristidea	False broad-leafed wandarrie grass

Eriachne flaccida	Claypan grass
Eriachne helmsii	Buck wandarrie grass
Eucalyptus camaldulensis	River gum
Eucalyptus microtheca	Coolibah
Eucalyptus oleosa	Straggly gum
Eremophila compacta	Dense poverty bush
Eremophila cuneifolia	Royal poverty bush
Eremophila duttonii	Saline fuchsia bush
Eremophila exilifolia	Little turpentine bush
Eremophila freelingii	Long-leafed fuchsia bush
Eremophila fraseri	Turpentine bush
Eremophila georgei	Low poverty bush
Eremophila latrobei	Native fuchsia
Eremophila leucophylla	Grey-leafed poverty bush
Eremophila maculata	Fuchsia bush
Eremophila maitlandii	Red flowered poverty bush
Eremophila margarethae	Narrow grey poverty bush
Eremophila longifolia	Berrigan
Eremophila macmillaniana	Granite turpentine bush
Eremophila platycalyx	Granite poverty bush
Eremophila pterocarpa	Silver poverty bush
Eremophila gilesii	Grove poverty bush
Eremophila granitica	Wandarrie poverty bush
Eremophila spathulata	Grey turpentine bush
Exocarpus spartea	Lime broombush
Ficus sp.	Native fig
Frankenia sp.	Frankenia
Grevillea nematophylla	Honey flowered grevillea
Grevillea striata	Beefwood
Hakea lorea	Corkwood
Hakea priessii	Needle bush
Helipterum sterilescens	Limestone daisy
Hibiscus pinonianus	Native hibiscus
Kallstroemia platyptera	Cork barked Kallstroemia
Kochia georgei	Large fruited blue bush
Kochia melanocoma	Black haired blue bush
Kochia murrayana	Murray's blue bush
Kochia polypterygia	Gascoyne sago bush
Kochia planifolia	Low blue bush
Kochia pyramidata	Sago bush
Kochia suedifolia	Lax blue bush
Kochia triptera	Three winged blue bush
Kochia thesioides	Mulga blue bush
Kochia tomentosa	Felty blue bush
Muhlenbeckia cunninghamii	Lignum

Neurachne mitchelliana	Soft wandarrie
Plectrachne melvillei	Feathertop spinifex
Ptilotus obovatus	Cotton bush
Ptilotus polakii	Saltland mulla-mulla bush
Ptilotus roei	Prostrate mulla-mulla
Ptilotus schwartzii	Leafless mulla-mulla
Ptilotus rotundifolius	Perennial pink mulla-mulla
Rhagodia sp.	Tall saltbush
Scaevola spinescens	Currant bush
Solanum ellipticum	Hillside flannel bush
Solanum lasiophyllum	Flannel Bush
Stylobasium	
Trigonella suavissima	Sweet fenugreek
Triodia basedowii	Buck spinifex

The photographs shown in the following section were taken on the survey and have been identified on the appropriate aerial photograph so that the site may be revisisted for comparisions.

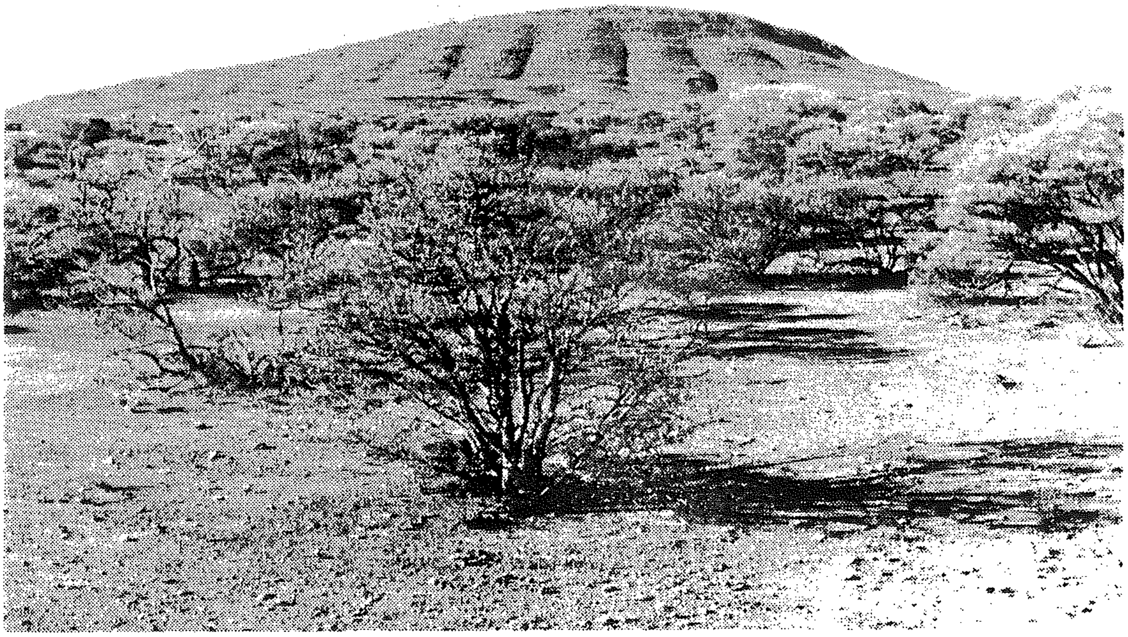
The principal pasture types found on the catchment are shown. In three cases, the progress of condition from good to poor are shown in a sequence of plates. In Plates 5-8 a stony chenopod pasture of Durlacher type is shown in several classes of condition. The same pasture but of Jimba rangeland, a Permian based system is shown in Plates 25-28.

A mulga short grass-forb pasture, Three Rivers rangeland type is shown in Plates 9-14 and the range of condition from good to profoundly degraded is exhibited.

PLATE 1. Hill pastures Augustus rangeland type

(a) L17 Hill Isolated hills relief up to 2 500 feet typically rounded scree slopes rise abruptly from stone covered plains. The hills are of low pastoral value. The plains have a cover of low mulga with very sparse shrubs and sparse annuals after rain.

(b) Calyie Hills. Low hill ranges occur throughout the catchment. These Bangemall Proterozoic hills occur near the north catchment boundary. The pastures are inaccessible and of low value.



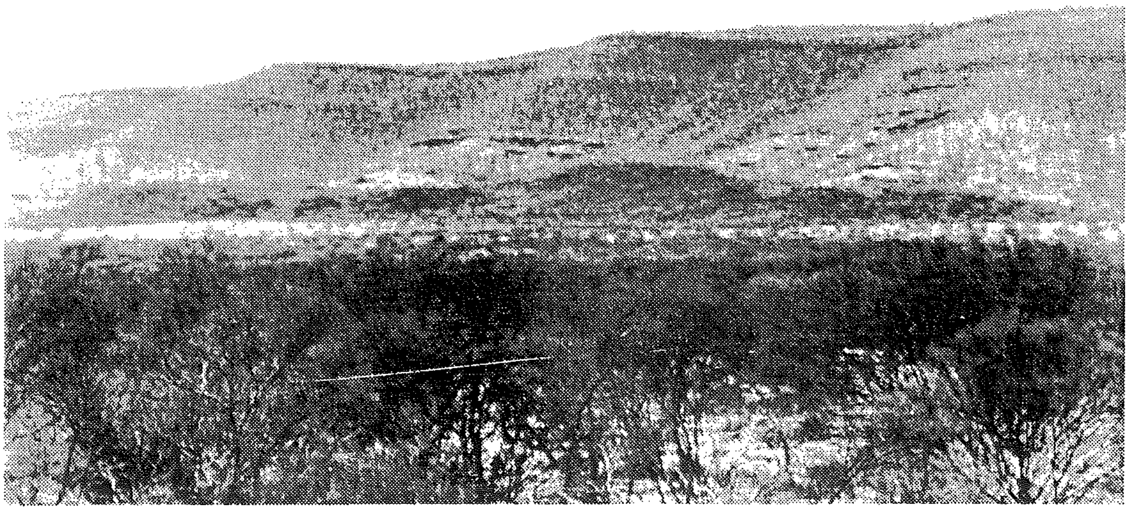


PLATE 2. Hill Pastures Agamemnon rangeland type

(a) Low hill ranges of crystalline rocks with relief up to 1 000 ft occur on the Gascoyne. The tree cover is sparse but there is a large shrub population which confers some durability on the type where it is accessible. Large areas of Agamemnon and Glenburgh rangeland are almost inaccessible to stock and poorly utilised. A carrying capacity of a sheep to 100 acres is recommended.

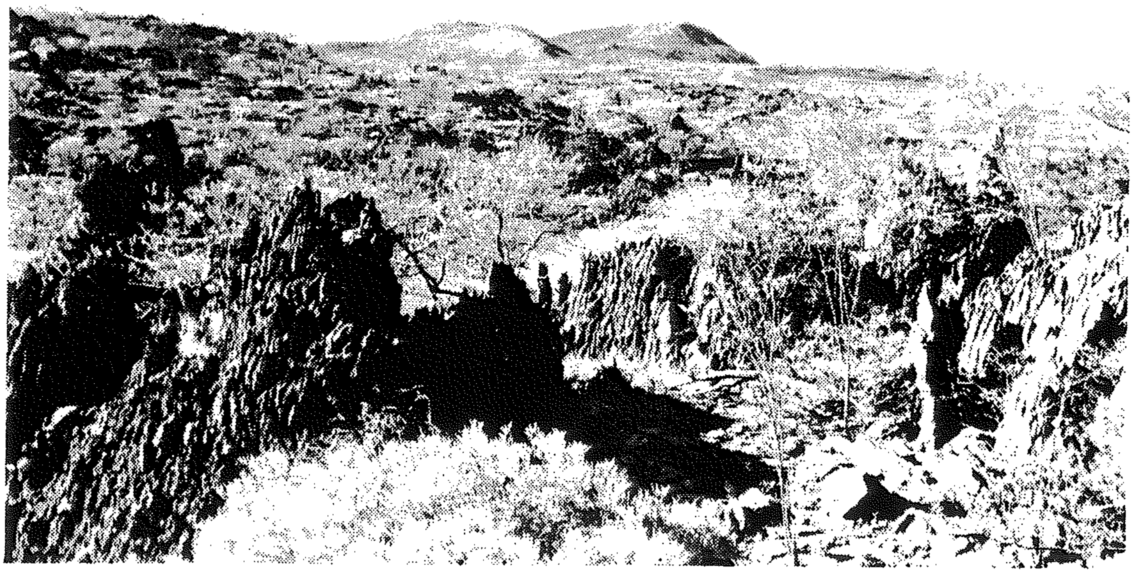


PLATE 3. Granitic based rangeland types

(a) Stony short grass-forb pastures - James rangeland type

These undulating sometimes dissected, strew covered pastures with frequent large outcrops and ridges are generally accessible to stock. The more desirable pasture species have been removed by overuse. These pastures have low durability

(b) Stony chenopod pasture - Yinnietharra rangeland type

These generally flattened and lower strew covered rangelands have extensive sluggish drainage tracts with duplex soils capable of supporting bluebush pastures. They are almost totally accessible and are usually severely degraded. In this photograph a crab-hole drainage focus has been completely filled with soil stripped from the plains above it.

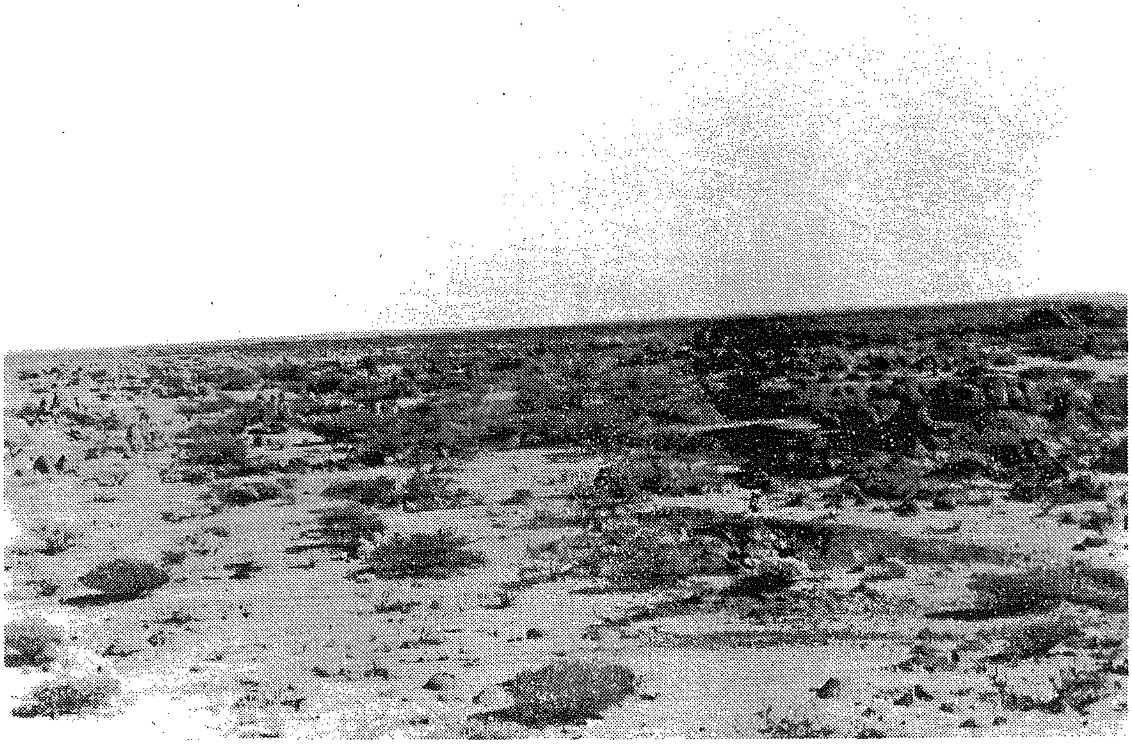


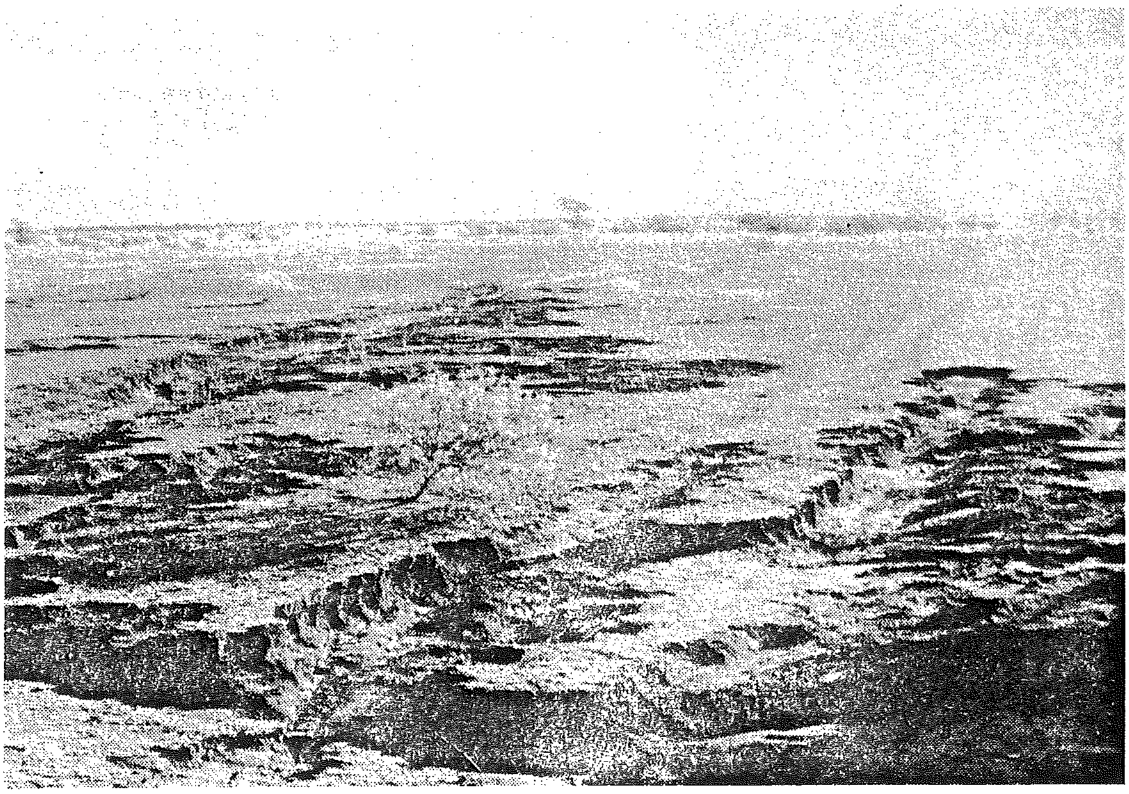
PLATE 4.

(a) Mulga, short grass-forb pastures - Clere rangeland type

The pastures are very low value. The soil surface does not have the protection of the stone mantle found in Durlacher and Yinnietharra and is frequently guttered and gullied. The pastures consist of low trees and shrubs and annual species after rain. Overuse has depleted the shrub population leading to increased wind erosion and scalding.

(b) Wandarrie pasture group Winmar rangeland type

Through drainages in wandarrie type pastures can become severely eroded and degraded. Note the exposure of roots in this photograph.



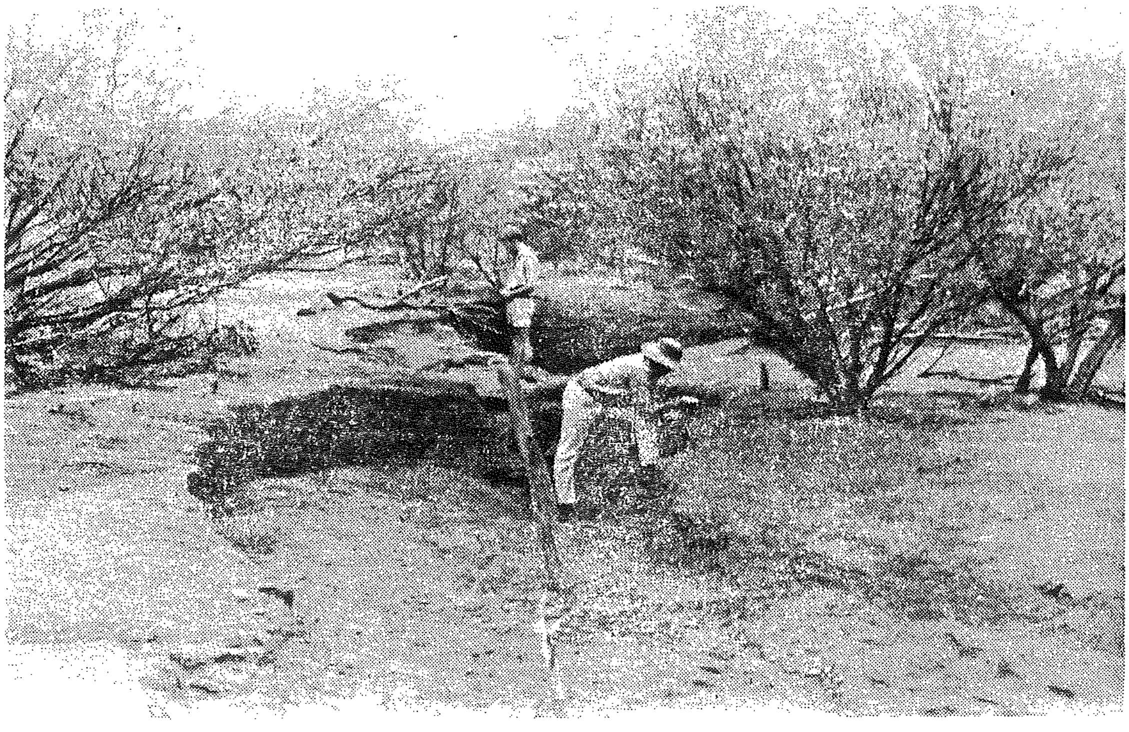
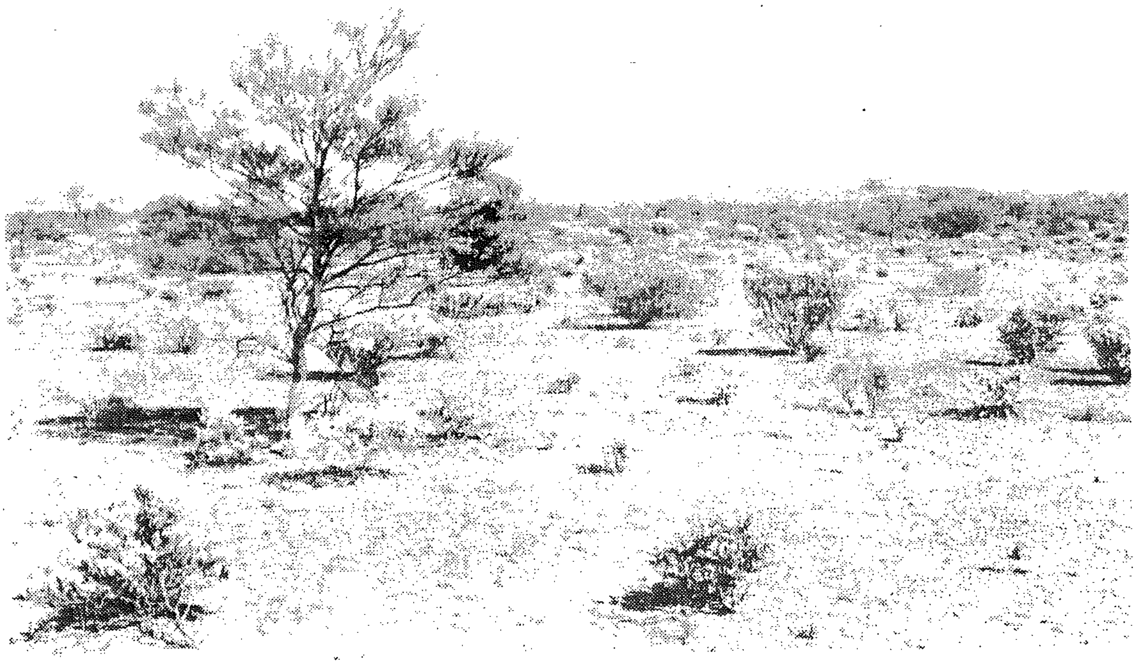


PLATE 5. Stony chenopod pastures Durlacher rangeland type

(a) The higher parts of this rangeland type consist of low hills and non-saline tributary plains. They have a lower carrying capacity than the sluggish drainages since they have shallow soils. They carry mostly annual species with scattered useful shrubs such as *Rhagodia*, *Kochia* and *Eremophila* species. This photograph shows an area in good condition.

(b) A sluggish drainage tract in good condition. Note the abundance of halophytic shrubs such as *Kochia* and *Frankenia* with scattered *Acacia victoriae* and *A. eremea*. The soil surface is undisturbed, a sandy surface above a clay horizon.



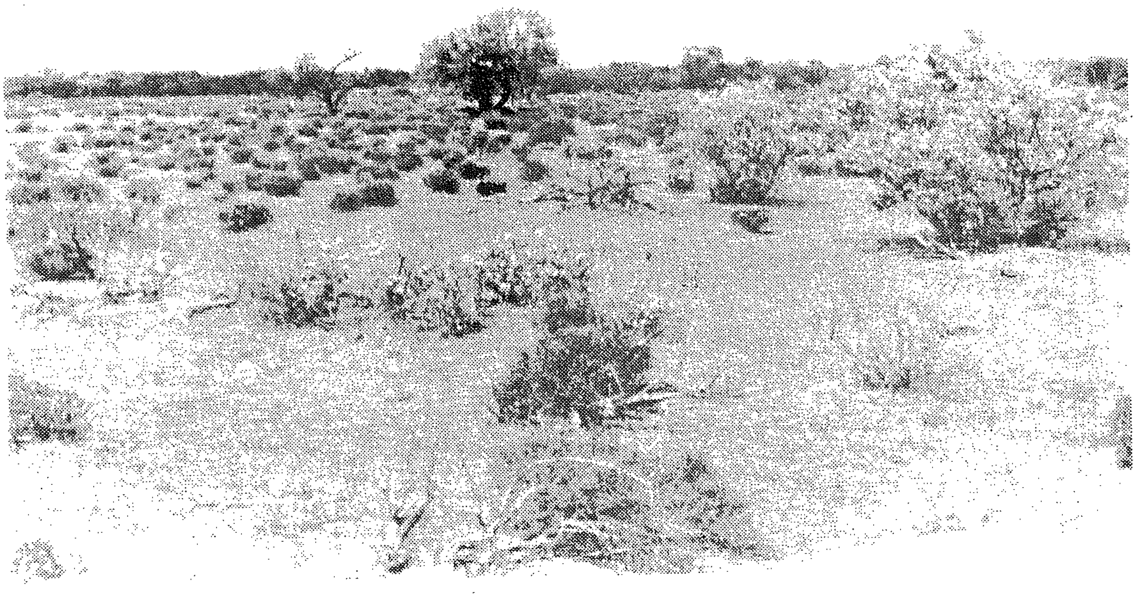
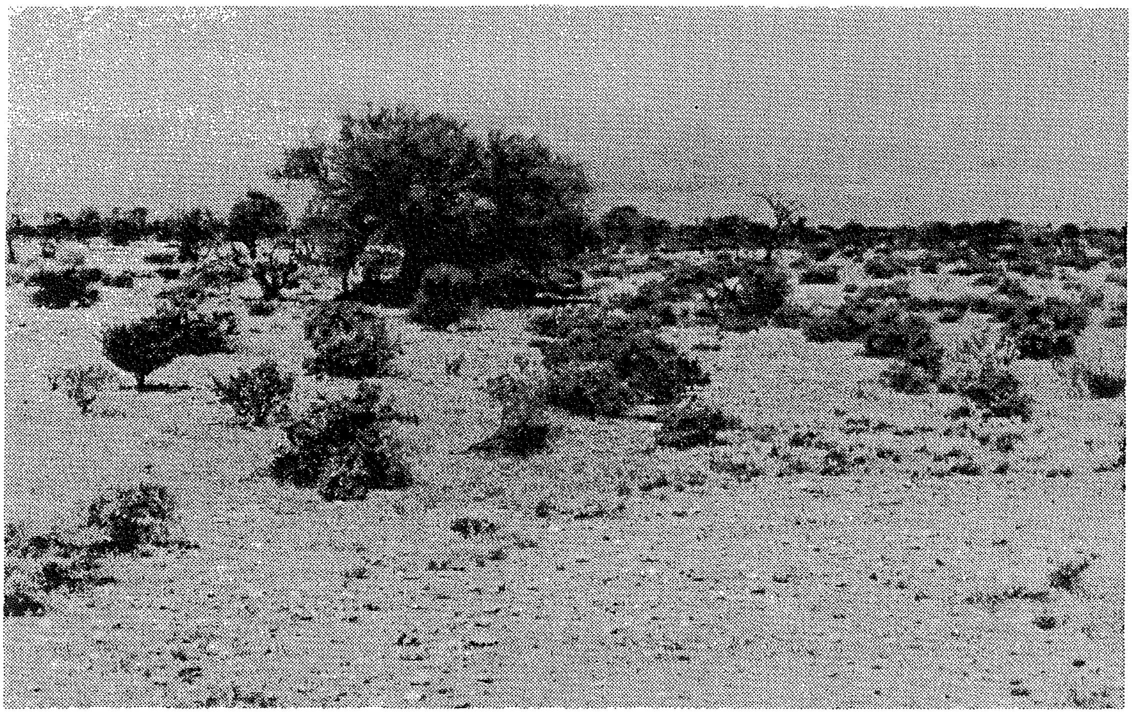


PLATE 6. Stony chenopod pastures Durlacher rangeland type

(a) A sluggish drainage in good condition. Soil surface undisturbed with scattered pebbles, sand on clay. *Kochia polypterygia* and *Eremophila cuneifolia* and scattered *Acacia victoriae*.

(b) A sluggish drainage in poor condition. Sandy horizon of the duplex soil has been removed leaving the clay horizon exposed. The useful shrubs have been removed leaving the volunteering and useless *Hakea priessii* (needlebush) to colonise this once valuable pasture.



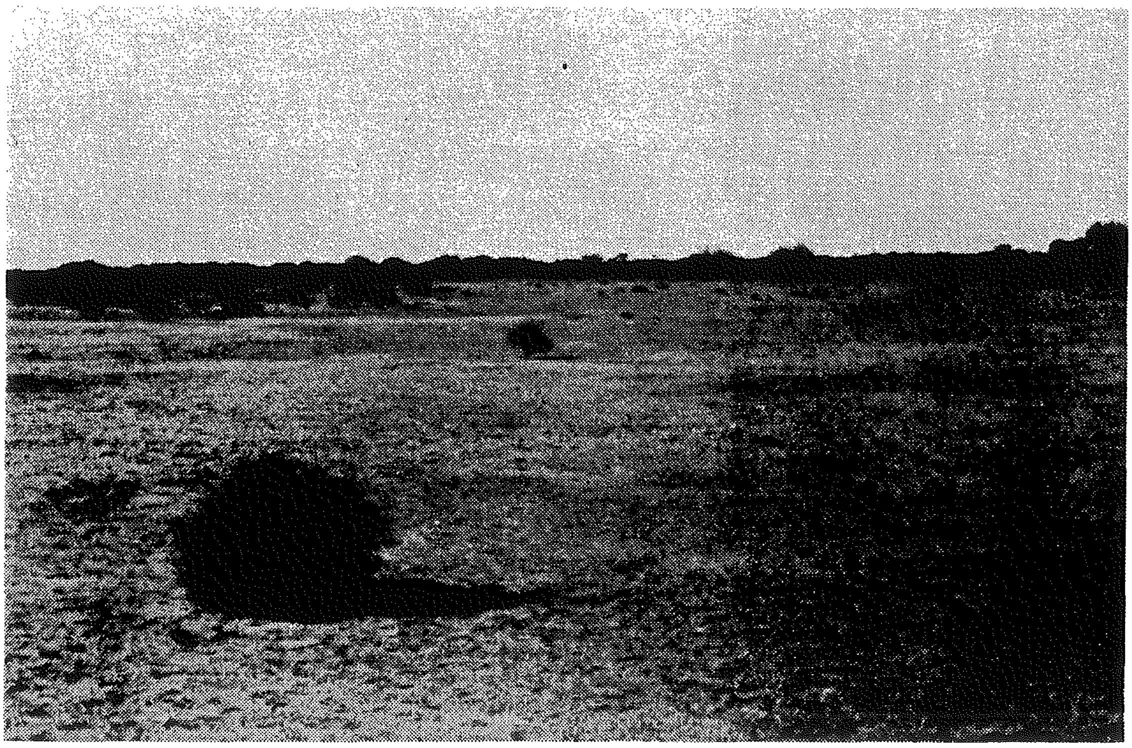


PLATE 7. Stony chenopod pastures Durlacher rangeland type

(a) A sluggish drainage area in poor condition. Note stripping of the sandy surface and loss of shrubs. This pasture is based essentially on annuals. Note the scattered *Acacia eremea*.

(b) A sluggish drainage area in poor condition. The sandy surface in the foreground has been stripped away. Note the death of *A. eremea* and paucity of shrubs.

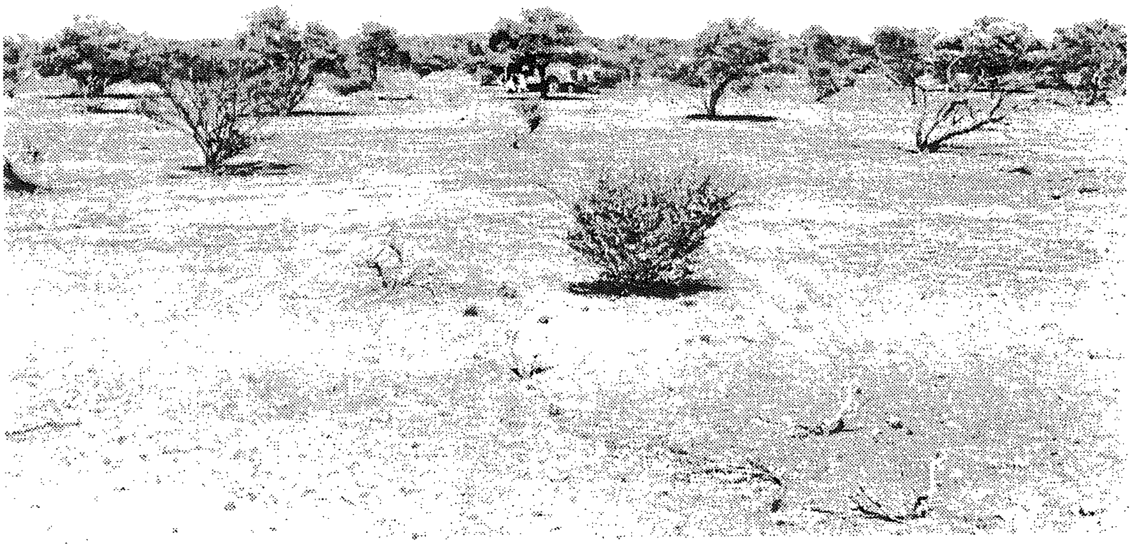
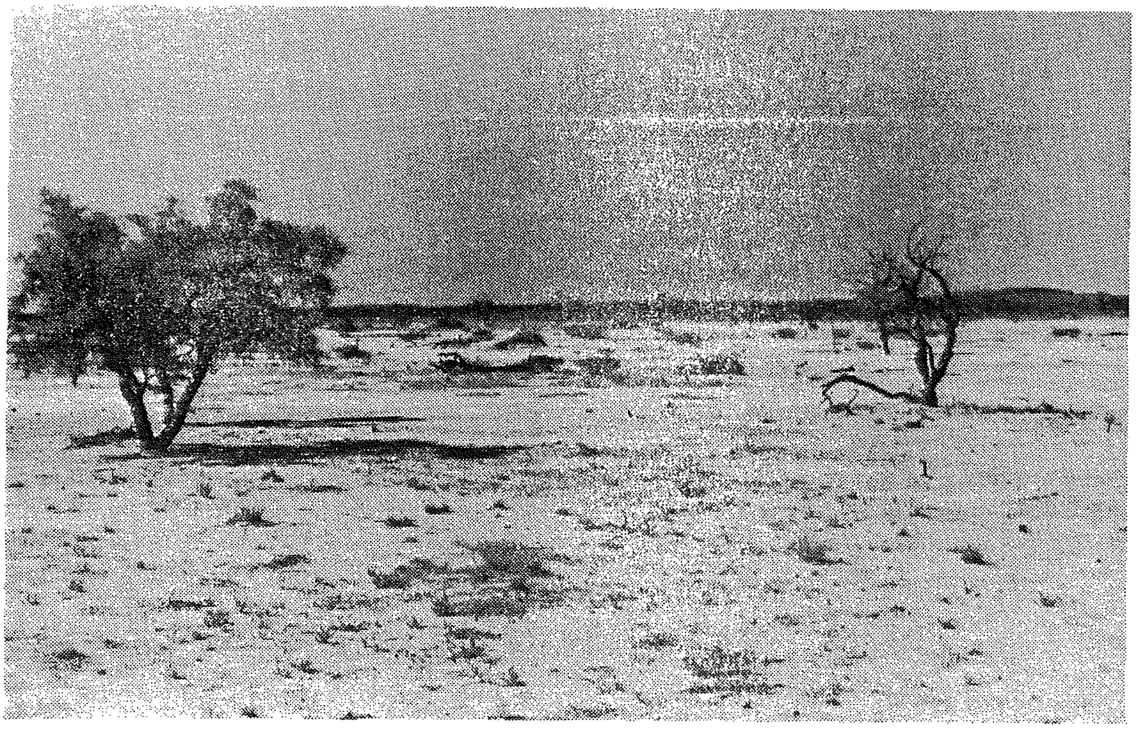


PLATE 8. Stony chenopod pastures Durlacher rangeland type

(a) and (b) These two photographs show complete degradation of the sluggish drainage. There has been extensive surface deflation, almost complete removal of shrubs and a reduction of the community to the annual state.



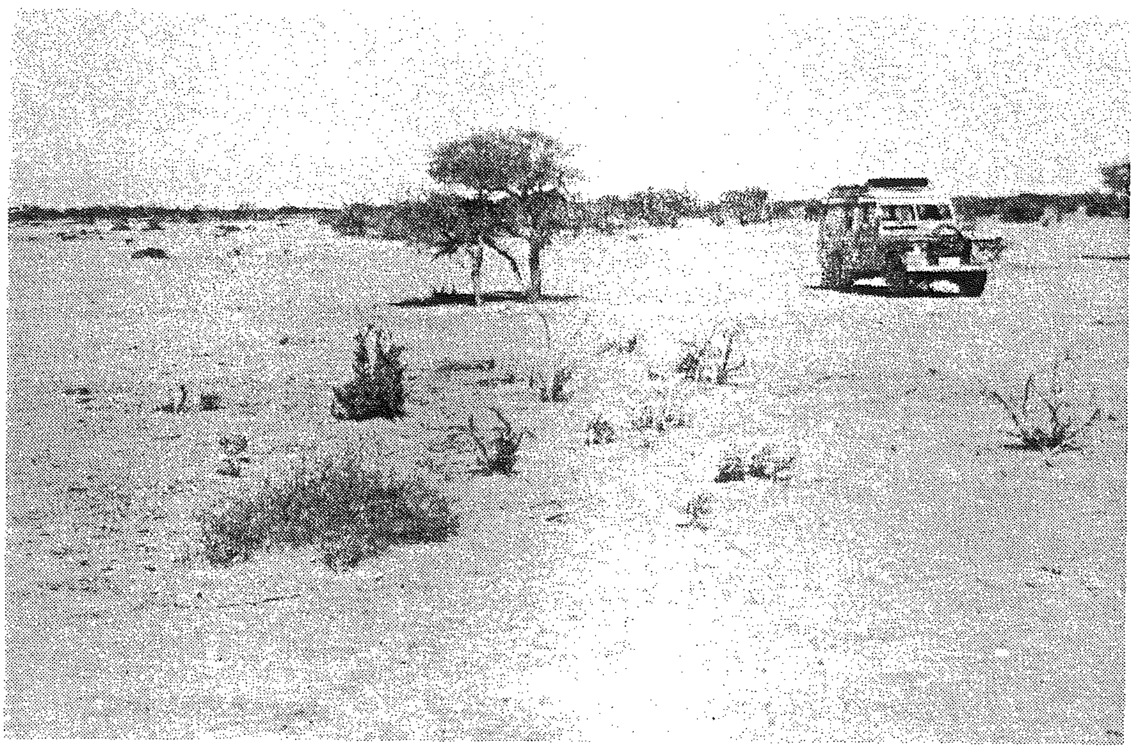
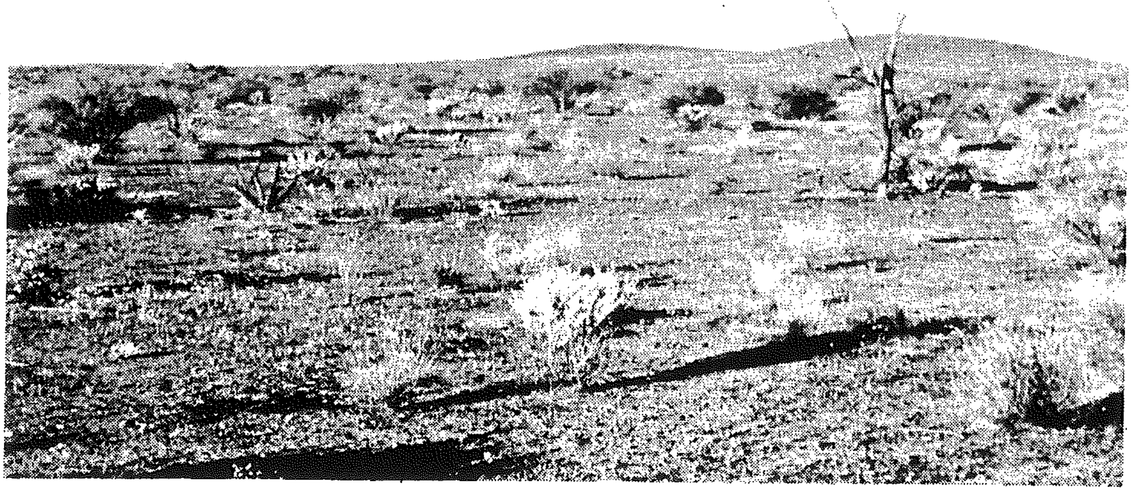


PLATE 9.

Mulga short grass-forb pastures Three Rivers rangeland type

(a) Extensive non-saline alluvial plains are the principal elements of this rangeland type. They have reduced slopes and generally shallow soils. In good condition they support useful shrubs beneath scattered trees. After rain they carry abundant ground feed of annual grasses and forbs.

(b) This alluvial plain is in good condition. It carries *Kochia spp.*, *Rhagodia*, *Solarum* and *Ptilotus* beneath the sparse tree layer of *Acacia* and *Canthium*.



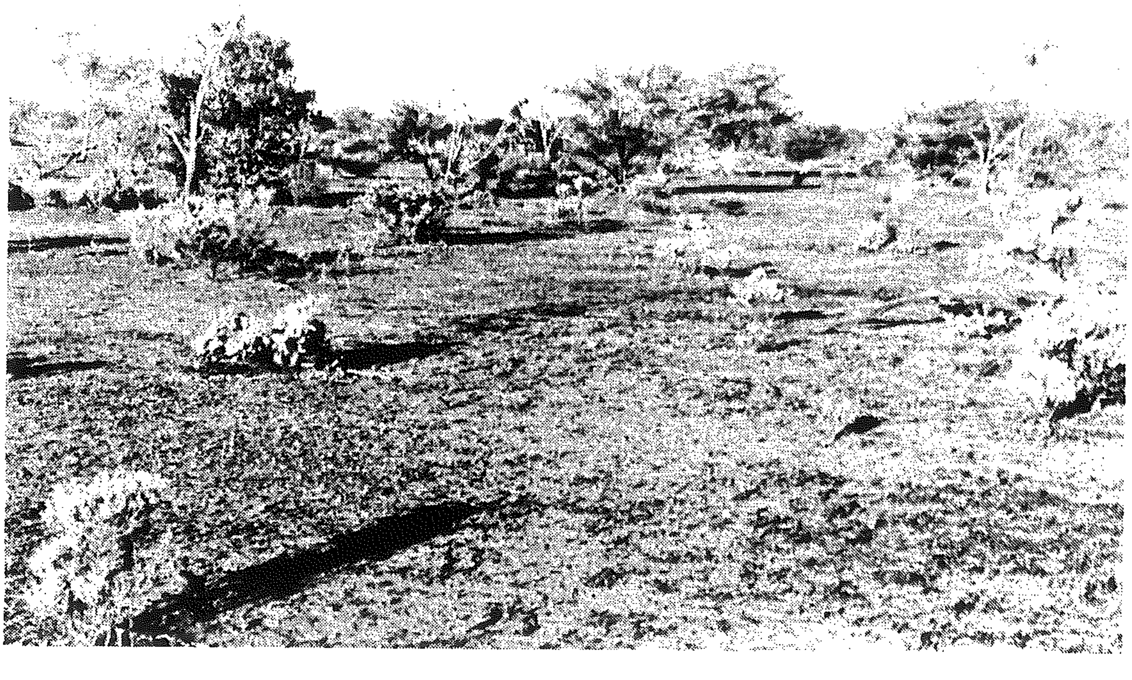
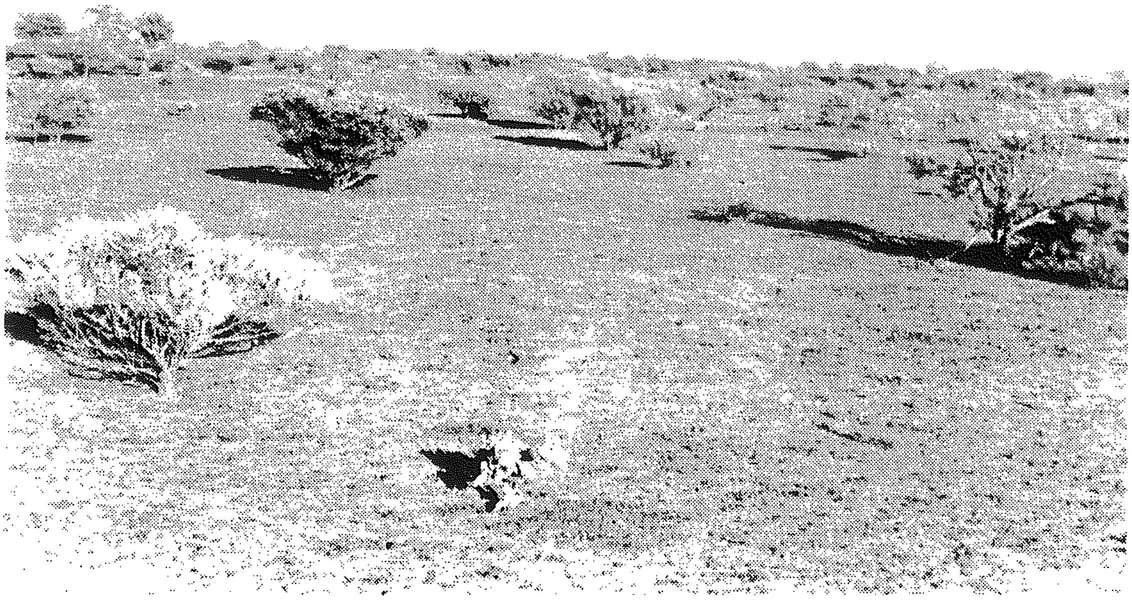


PLATE 10.

Mulga short grass-forb pastures Three Rivers rangeland type

(a) This plain is in fair condition. There has been a loss of desirable species and an increase in undesirables such as *Eremophila fraseri*. There has been little surface disturbance.

(b) This plain is in poor condition. Note the loss of shrubs, death of trees, scalding, root exposure and gully erosion. This site has the potential of those on Plate 9.



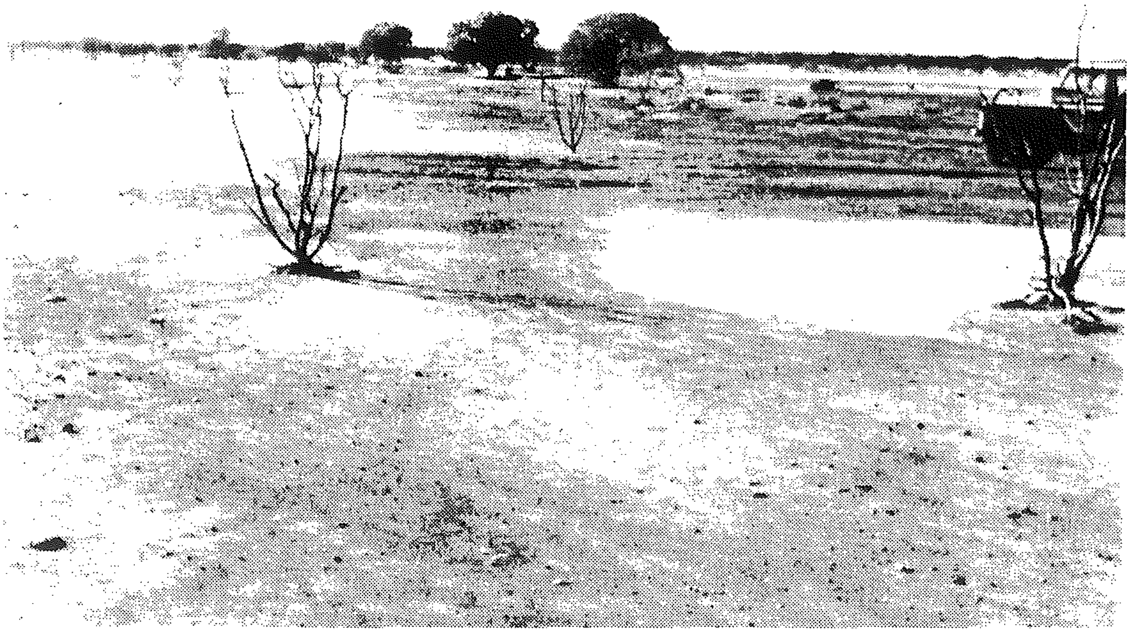
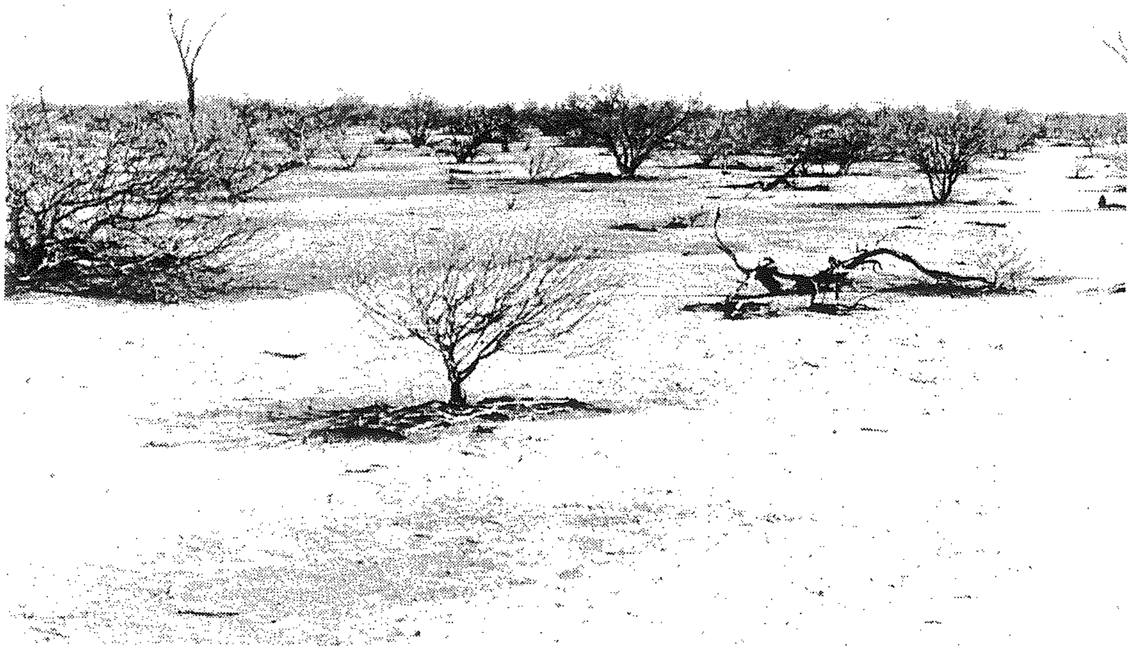


PLATE 11.

Mulga short grass-forb pastures Three Rivers rangeland type

(a) This plain is in poor condition. Most of the shrubs and trees are dead. Those shrubs surviving have very low vigour. The surface is bared of cover and sealed.

(b) A plain in poor condition with gullying in the middle distance. Note the reduced slope of these areas.



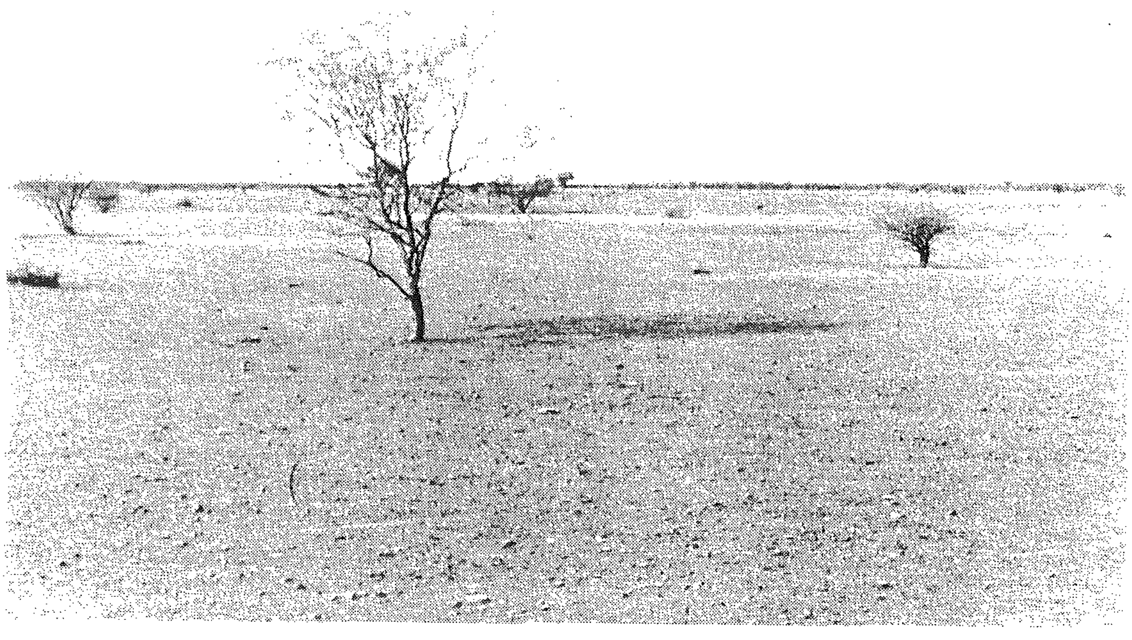
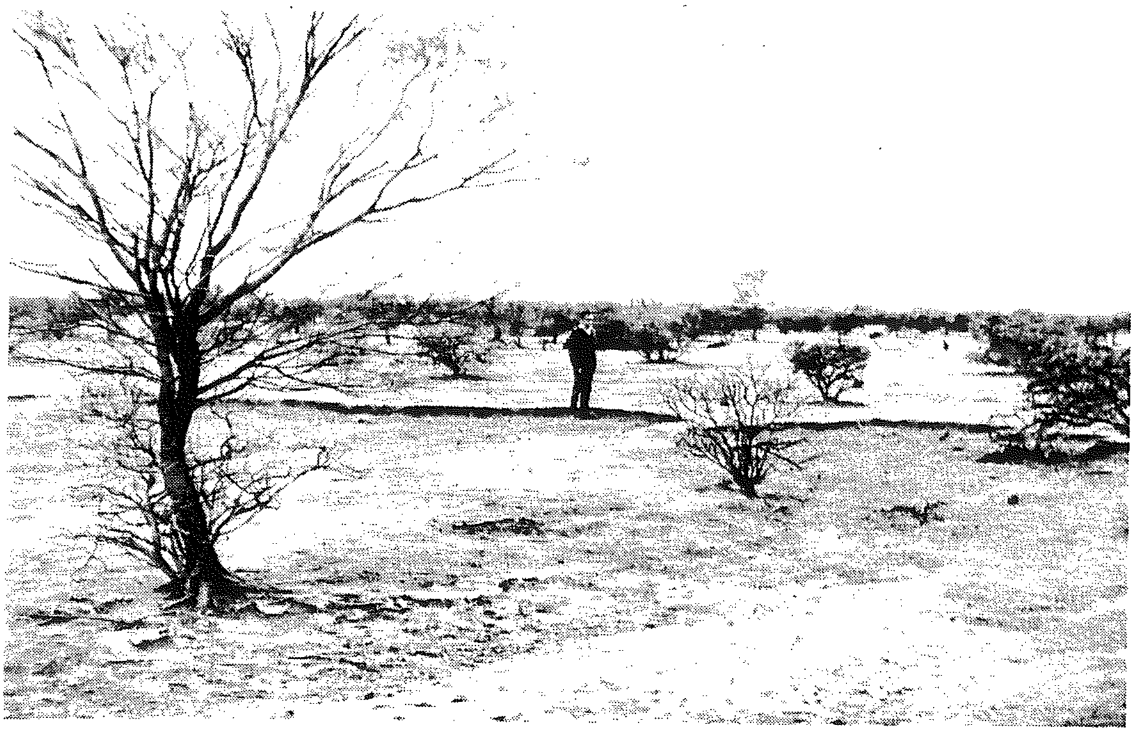


PLATE 12.

Mulga short grass-forb pastures Three Rivers rangeland type

(a) Erosion faces are common in areas of more concentrated flow in these rangelands. Note the root exposure, and the sealing in the middle and far distance. The shrub cover is almost entirely of worthless species.

(b) Erosion faces such as this shallow one are also common on the areas of diffuse flow. Note the much reduced vigour of the existing plants. Compare this with the photographs on Plate 9. There is extensive shrub death below the erosion line.



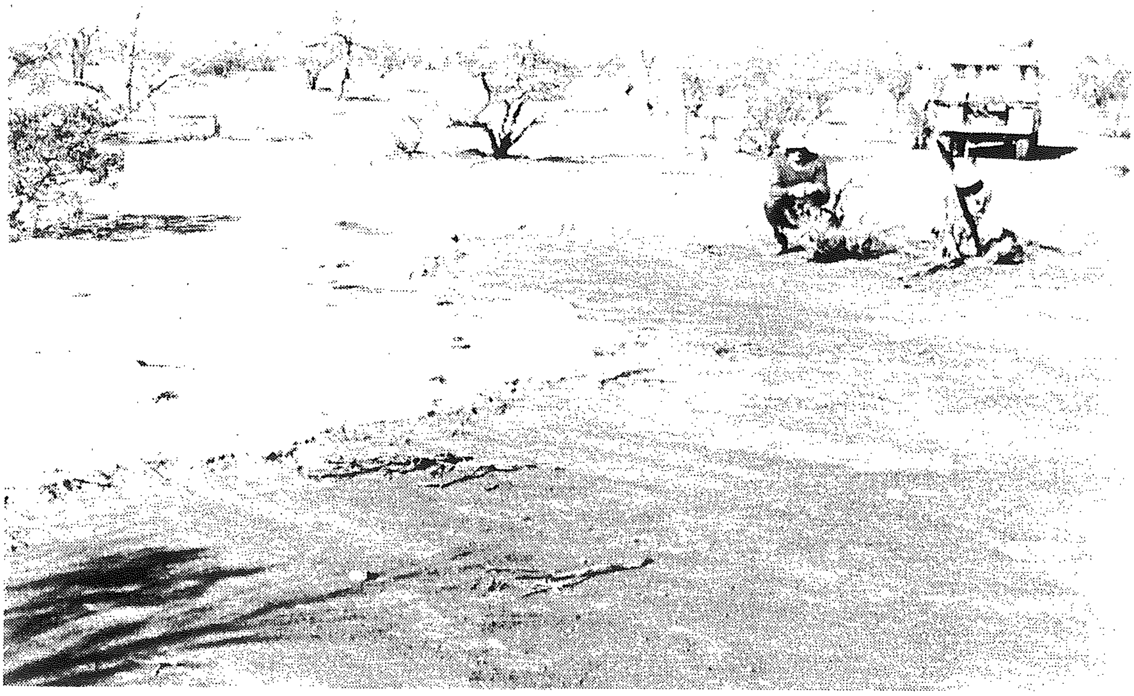


PLATE 13.

Mulga short grass-forb pastures Three Rivers rangeland type

(a) This alluvial plain does not show much evidence of erosion though the surface is sealed and water penetration reduced. There is a dearth of desirable shrubs.

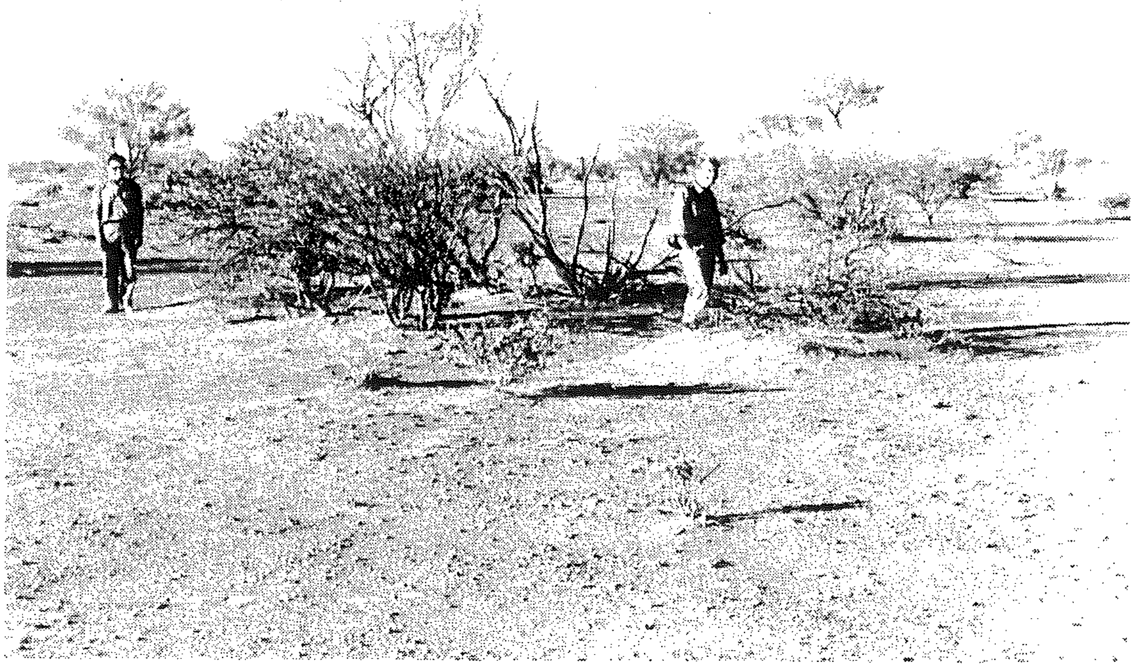
(b) This plain is almost completely degraded. Shrubby growth occurs only on the areas with a pebble mantle in the background.

PLATE 14.

Mulga short grass-forb pastures Three Rivers rangeland type

(a) Windpiling is common on some alluvial plains with a consequent reduction in productivity. These sites are essentially unstable.

(b) This alluvial plain is profoundly degraded. The soil has been stripped to the hard pan. Water erosion is unimpeded and wind erosion can continue quite unobstructed by shrubby elements. Recovery will take a considerable period of years.



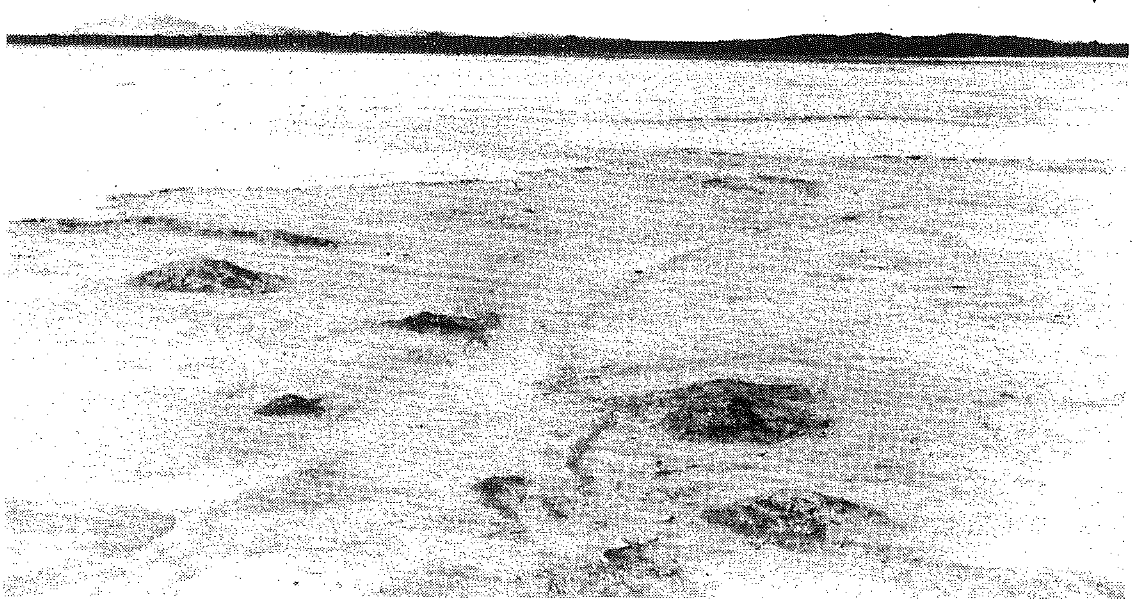


PLATE 15.

Stony short grass-forb pastures Jamindie rangeland type

(a) The alluvial plains beneath the Bangemall hills are covered with a dense stone mantle. The soil has a low pH(5 - 6) and supports only very scattered and usually low quality shrubs. There is a sparse annual cover after rain. Generally there is no erosion due to the protection of the mantle of stones.

(b) The pebble strewn plains shown in (a) shed water onto more densely vegetated areas. These masses of vegetation which comprise about 10 per cent of this rangeland support the stock, the stony plains are quite unproductive.

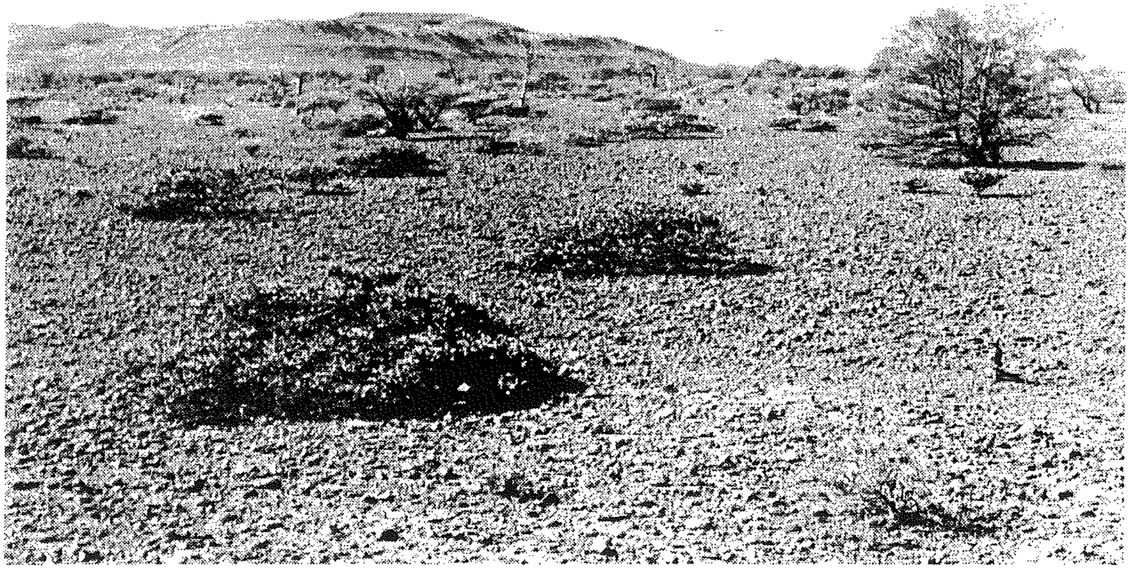
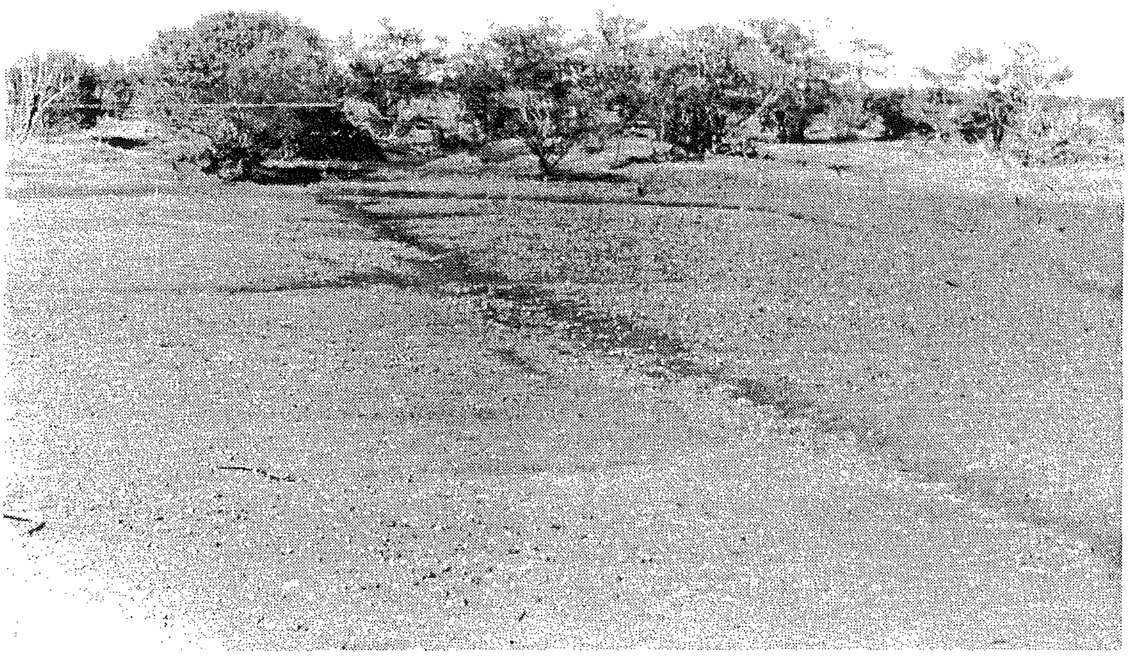


PLATE 16.

Mulga short grass-forb pastures Frederick rangeland type

(a) This rangeland is characterised by arcuate bands of vegetation arranged across the slope transverse to water flow. The interband areas have shallow soils with a sparse strew of pebbles. The denser vegetation in the groves is maintained by a complex shedding and retaining system in the grove/intergrove complex. In this photograph gullies can be seen developed on the left of the grove.

(b) This photograph shows a completely degraded grove system. The remnants of a grove can be seen in the foreground with others in the background. Water is no longer retained in the groves and as a consequence the principal productive element of this rangeland was destroyed.



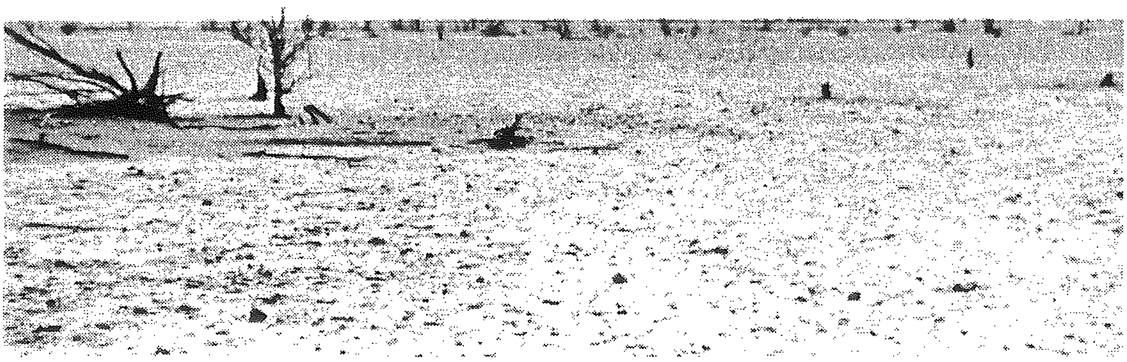


PLATE 17. Stony chenopod pasture Bryah rangeland type

(a) Sluggish drainages similar to those in Durlacher and Jimba can arise in Bangemall sediment based systems. They can support useful halophytic pastures such as *Frankenia* as this photograph shows.

(b) This sluggish drainage in Bryah rangeland has had all the useful perennials removed from it. Note the similarity of land form in (a) and (b). Also note the presence of *Eremophila duttonii* in both photographs. There is little erosion here but this site only produces annuals and has no drought durability.

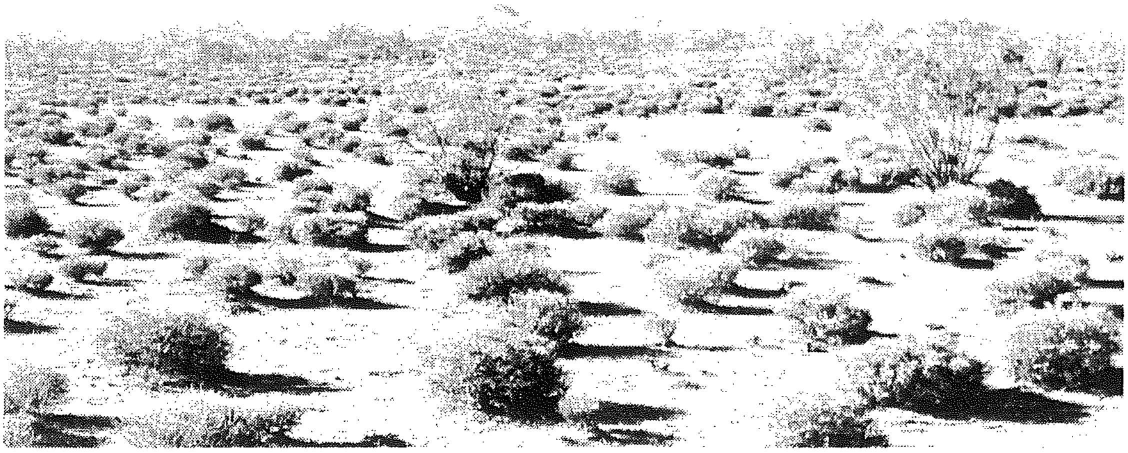


PLATE 18. Stony chenopod pastures Bryah rangeland type

Areas of concentrated flow in degraded Bryah rangelands can become braided and channelled with erosion gutters. Such sites will be difficult to repair and are unlikely in even the medium term to become productive.

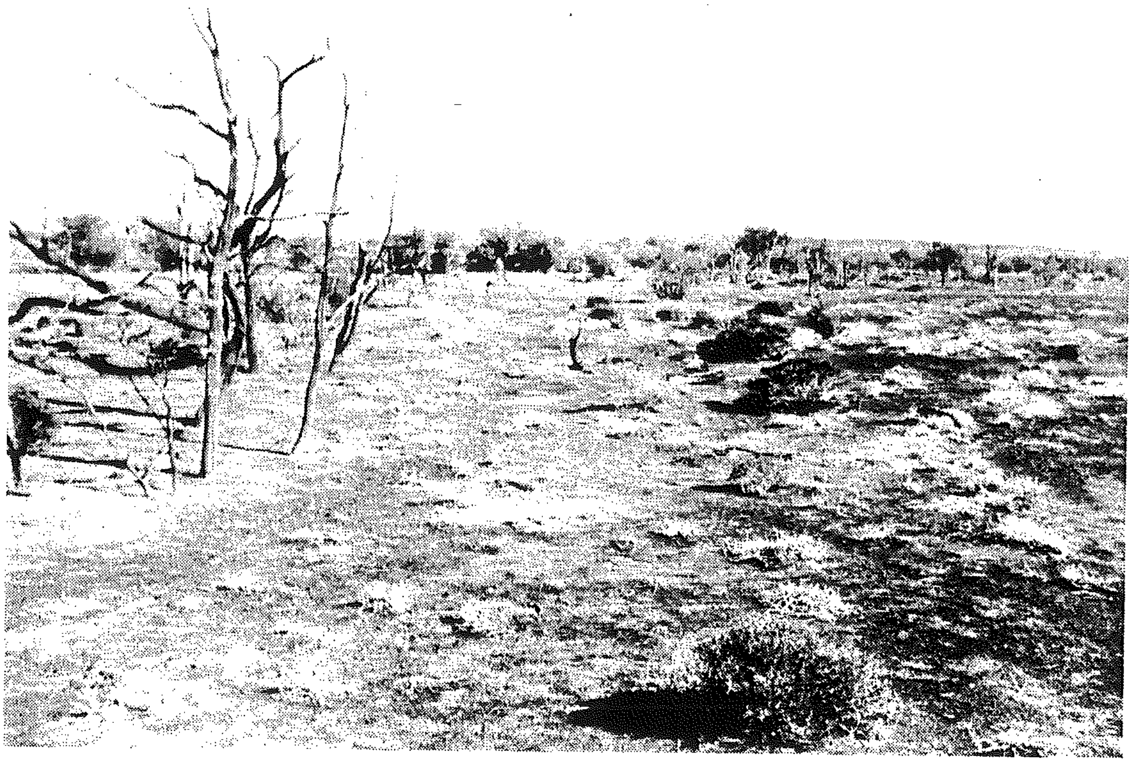
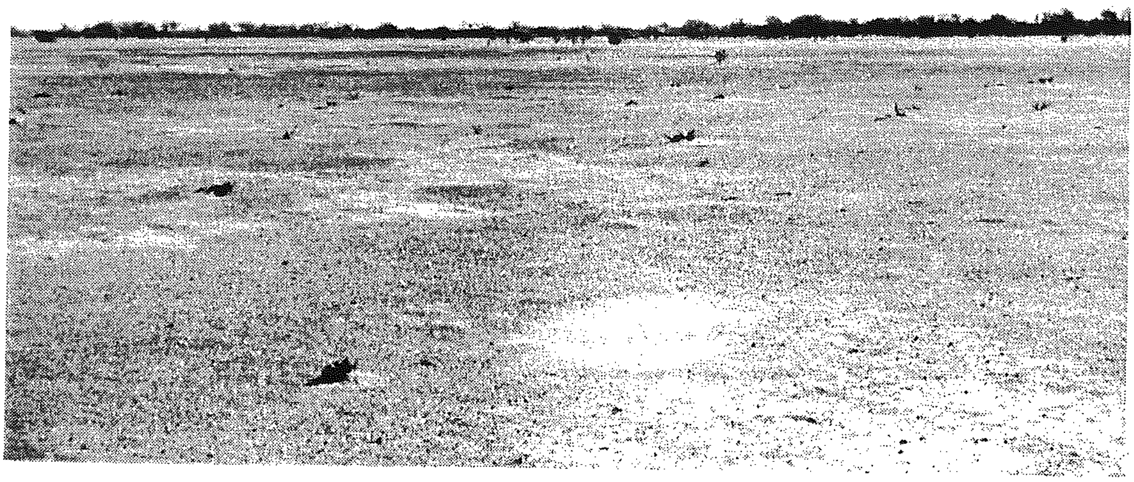


PLATE 19. Chenopod pastures Peedawarra rangeland type

(a) Some sluggish drainages produce very extensive halophytic pastures. Most of these have been preferentially used and are degraded. They can be identified by soil type and photopattern. In this photograph only remnant stumps can be seen and the soil is clearly sheeted and eroded.

(b) In some areas there has been substantial deflation as this photograph shows. Between three and five inches of soil has been lost and these *Rhagodia* bushes have died. Recovery of these rangelands to productivity is unlikely even in the long term.



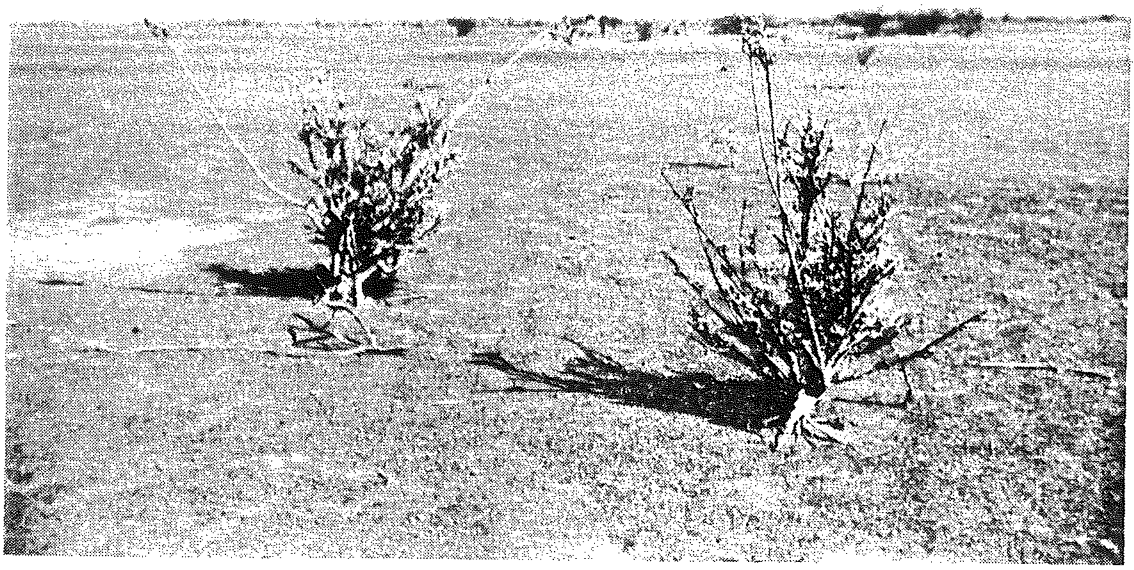


PLATE 20. Chenopod pastures Peedawarra rangeland type

Revegetation of degraded sandy banks in Peedawarra type can take place, but the colonising species in most cases in the valueless *Hakea priessii*.

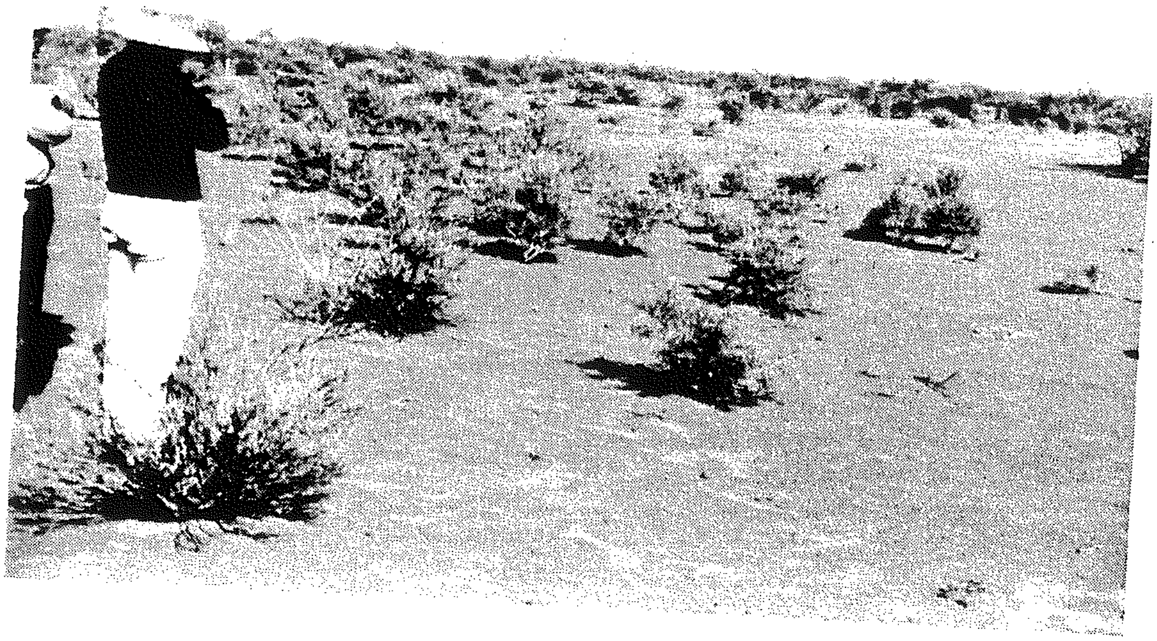
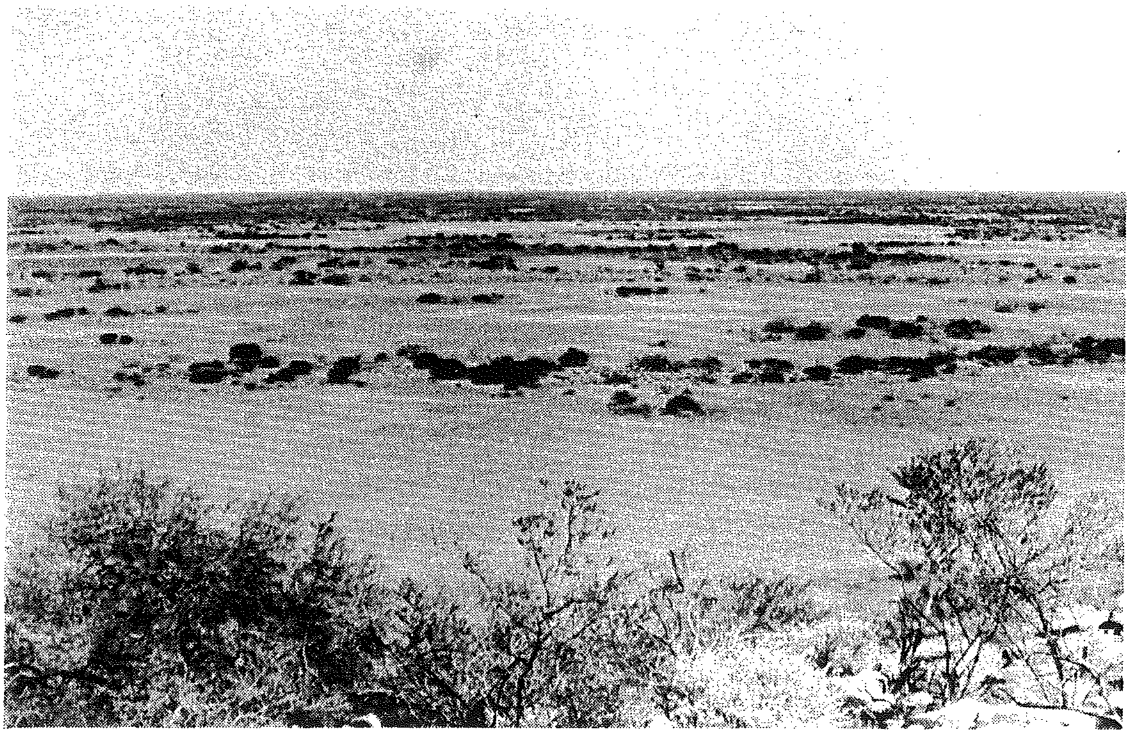


PLATE 21. Sanddune halophyte pastures

(a) Bidgemia rangeland type. In this type sanddunes are arranged longtitudinal to the water flow. The interdunal areas have duplex soils which can support useful pastures of halophytic species. In most cases these have been removed and the interdunal swales are bare as this photograph shows. Note the scalded areas over the first dune. These sites are very prone to erosion.

(b) Lyons rangeland type. Circular dunes surrounding vegetated and non-vegetated (claypan) interdunes are the dominant units of this type. In general there is no erosion problem in the type.



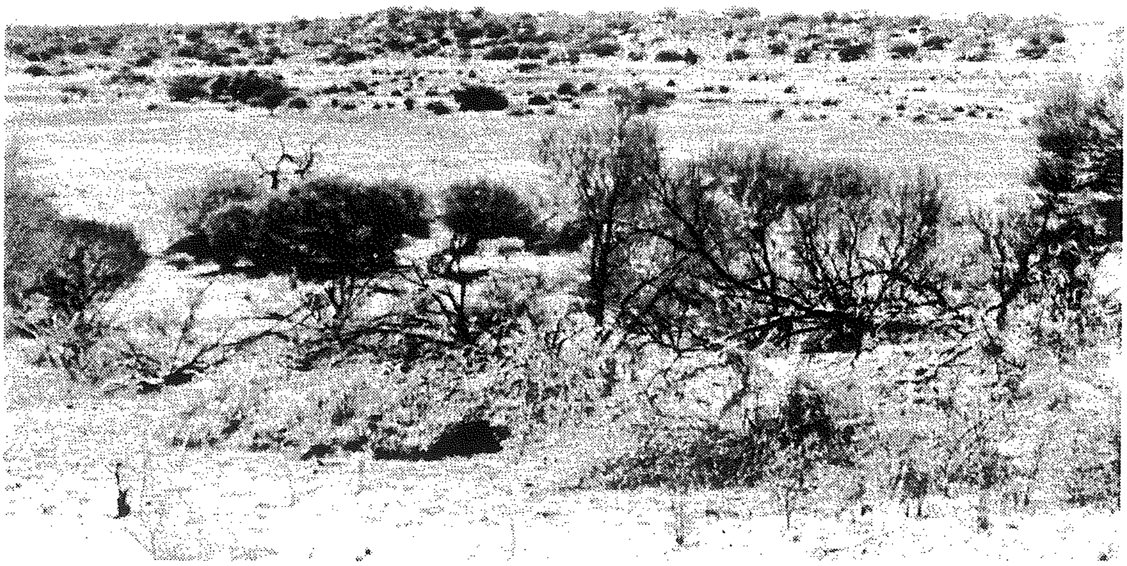


PLATE 22. Chenopod pastures Bibbingunna rangeland type

(a) This rangeland type is characterised by heavy clay soils an almost flat topography and its halophytic pastures. In the somewhat higher areas it carries *Chenopodium auricomum* as shown here. Due to reduced accessibility in wet periods the pastures are in fair to good condition with little erosion.

(b) In the lower areas of this rangeland *Eragrostis setifolia* and *Eriachne flaccida,* never fail grass and claypan grass are associated with a meandering drainage. They produce a spectacular flush of growth following rain.

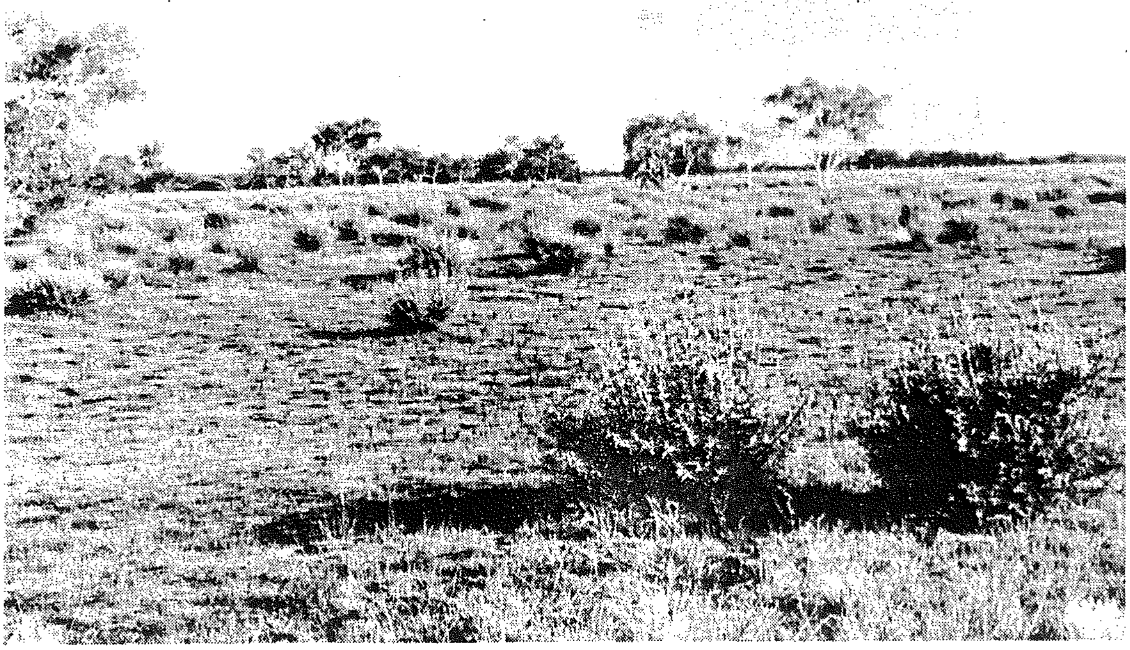
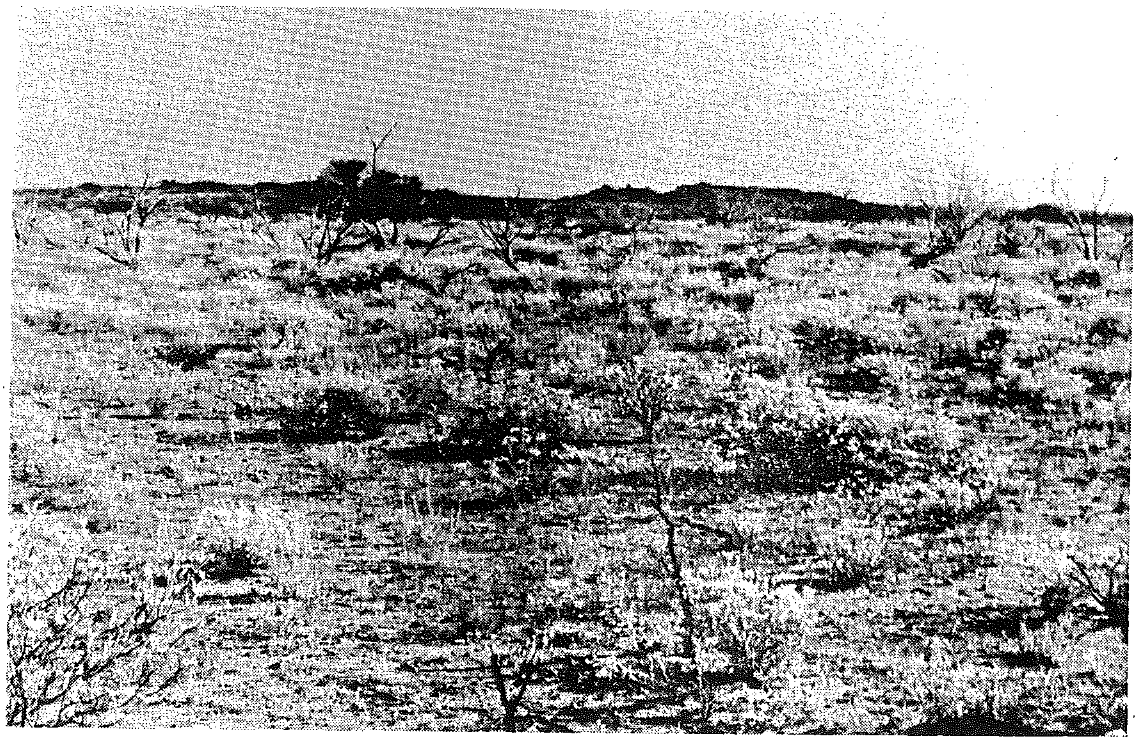


PLATE 23. Stony chenopod pastures Sandiman rangeland type

(a) The upper parts of these strew covered rangelands which are based on Permian rocks are generally in fair condition. The cover of low shrubs produces useful forage in short stress periods. The ground cover is fairly sparse, but consists of many herbaceous chenopod species of value.

(b) Lower slopes in Sandiman rangeland are frequently gullied and guttered as this photograph shows. The deep, highly alkaline and clayey soils of the Permian based rangeland types are particularly susceptible to water erosion. Erosion such as this has contributed to increased water flow.



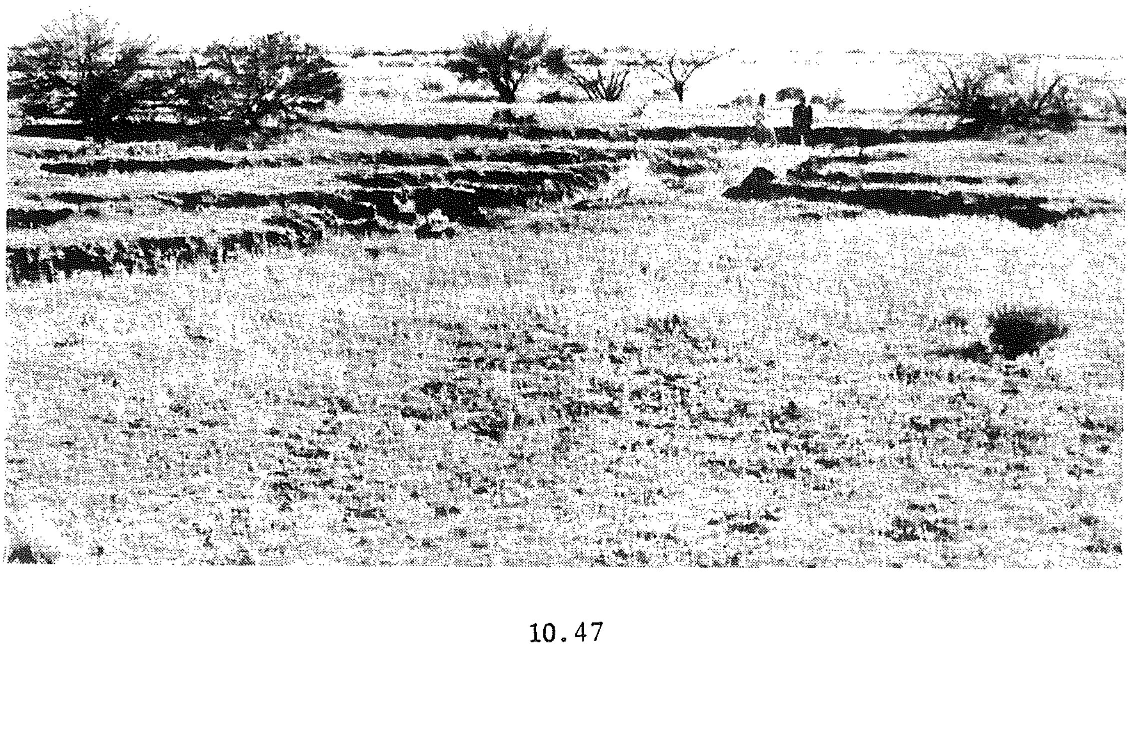
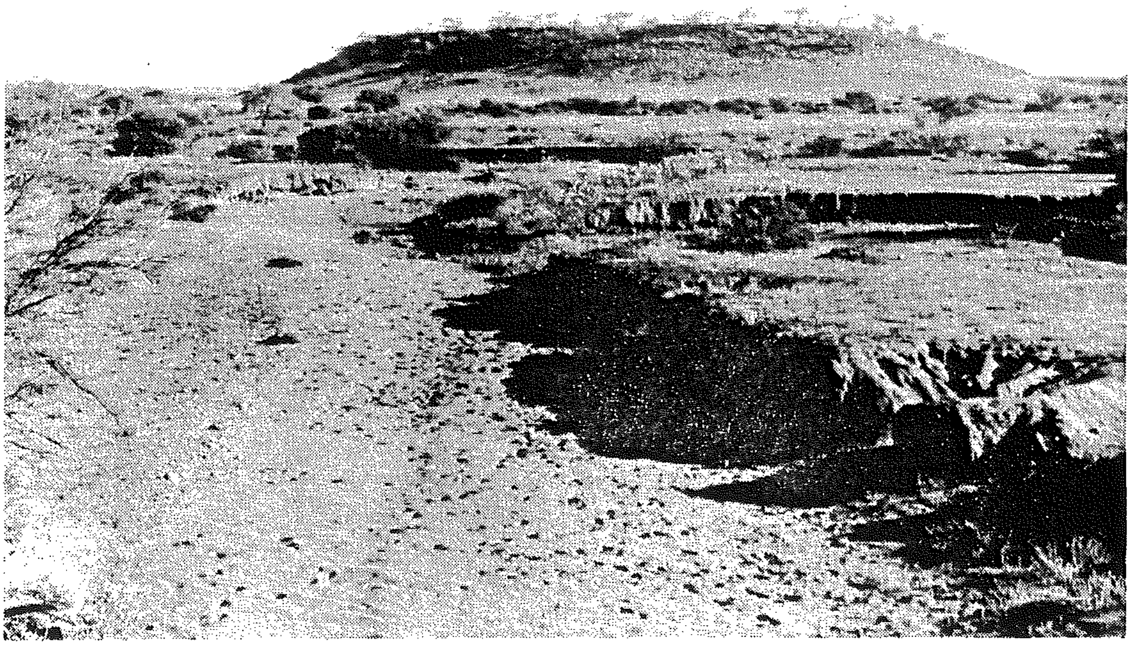


PLATE 24. Stony chenopod pastures Mantle rangeland type

(a) Current erosion on the unprotected areas of Mantle rangeland produces extensive gully systems even on restricted watersheds such as these.

(b) This drainage delta on Mantle rangeland shows no sign of erosion but exhibits considerable pasture decline.



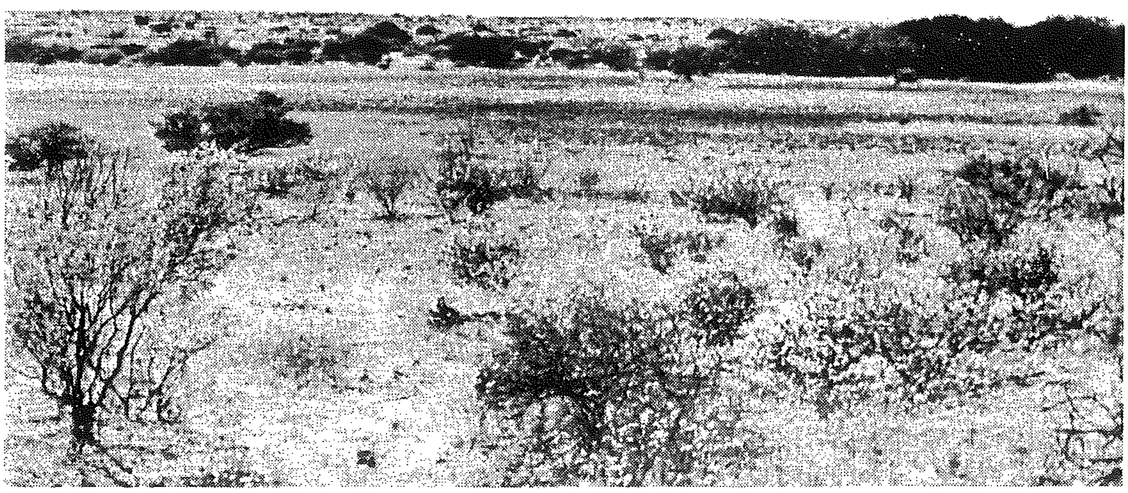
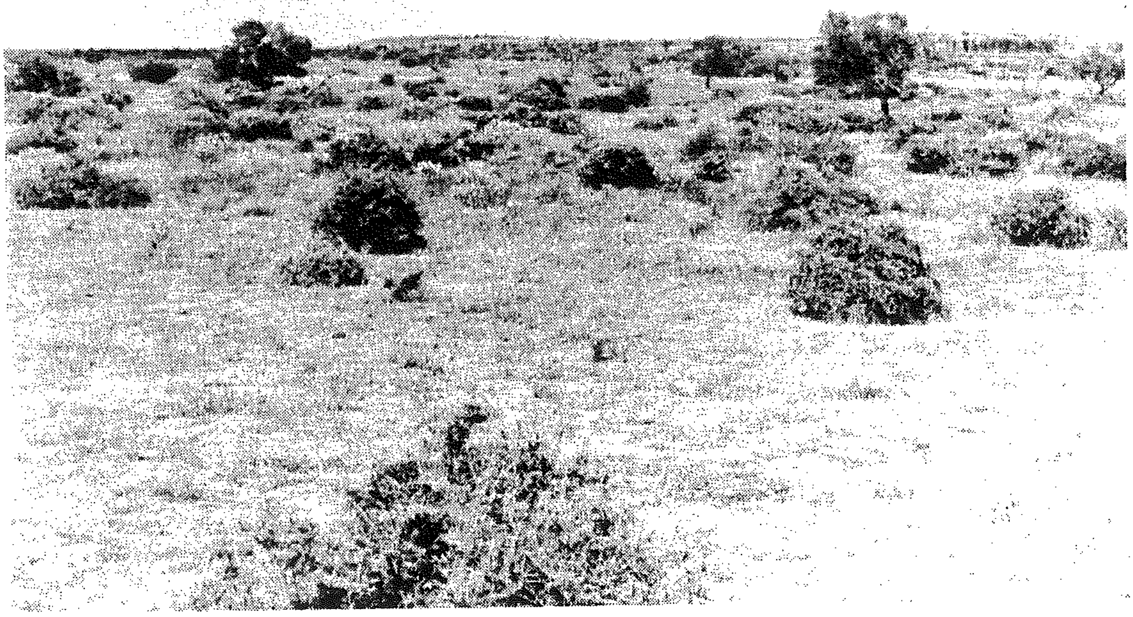


PLATE 25. Stony chenopod pastures Jimba rangeland type

(a) This drainage floor is in good condition. It has a good cover of *Kochia aphylla* and other halophytic shrubs. The ground production is noticeably good. There is no erosion.

(b) This drainage floor is in good condition. It has a good cover of *Arthrocnemum* species and abundant ground cover for its situation. There is no erosion.



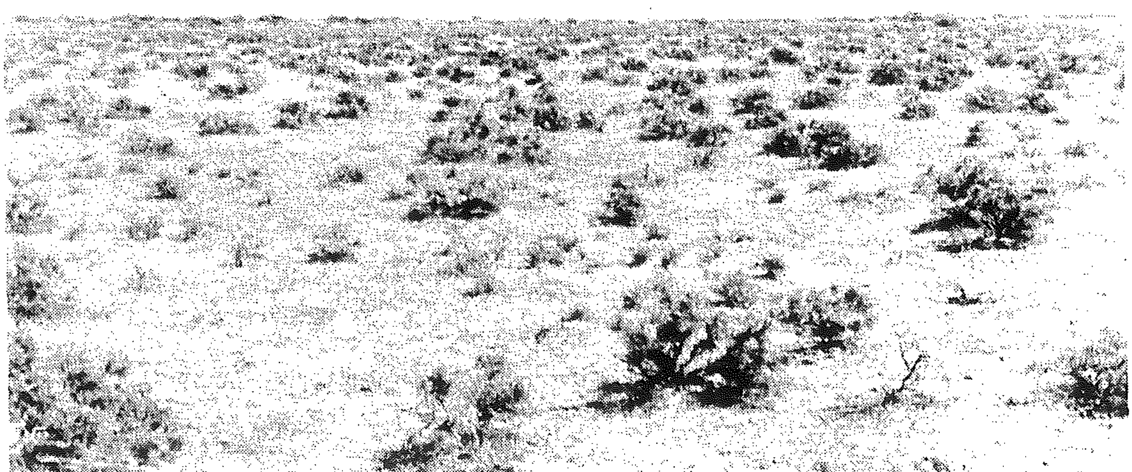
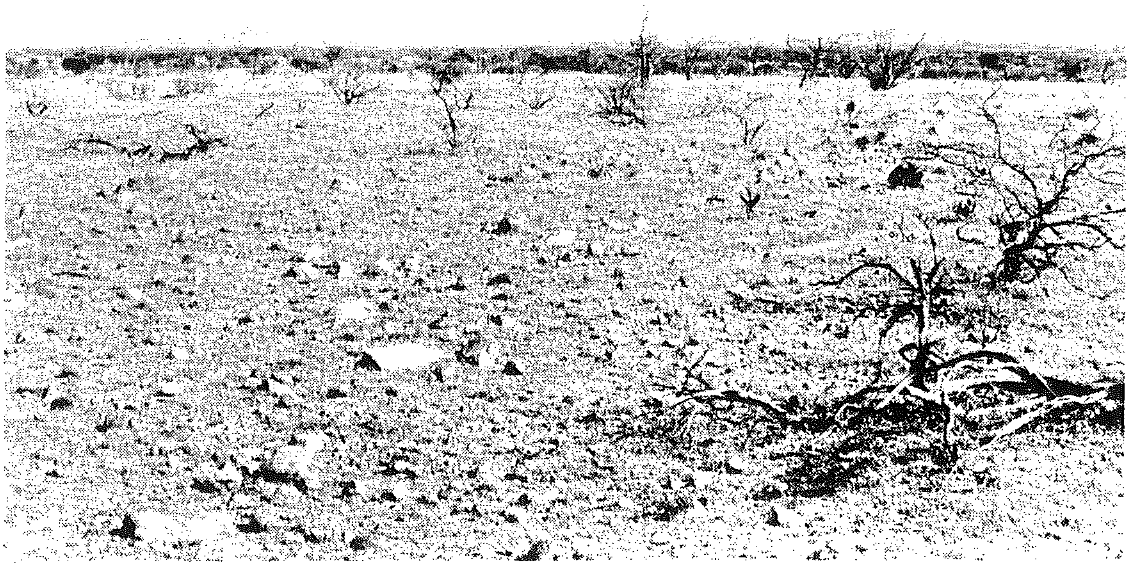


PLATE 26. Stony chenopod pastures Jimba rangeland type

(a) Rounded hill tops in Jimba rangeland type have an abundant strew of pebbles and cobbles. They are not productive sites. Although they are frequently degraded they show no signs of erosion.

(b) The drainage floors and alluvial plains of Jimba rangeland type are more favoured and productive. In this drainage floor scalding has increased and there has been a loss of perennial components.



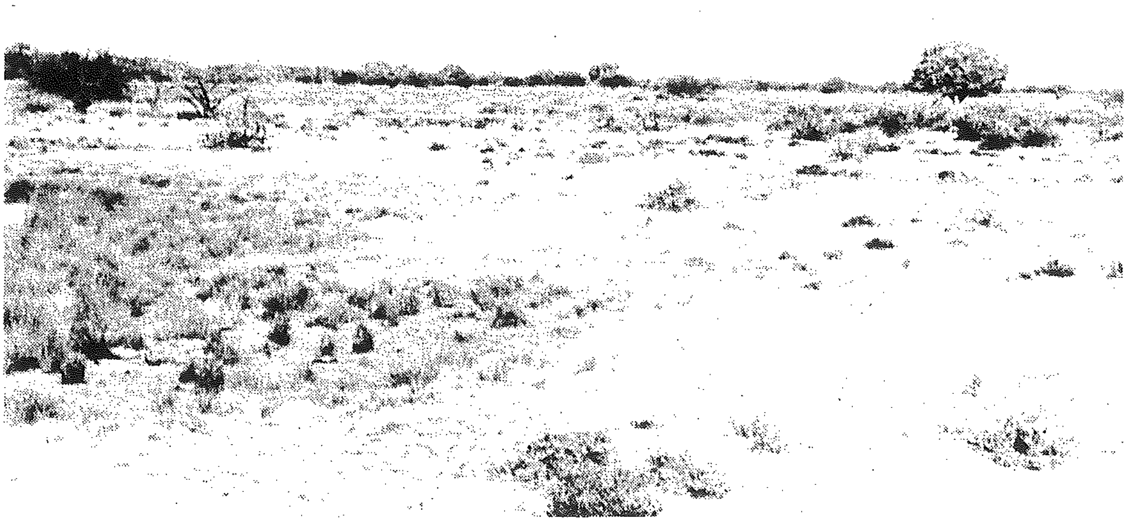


PLATE 27. Stony chenopod pastures Jimba rangeland type

(a) This fenceline effect in a Jimba rangeland shows the type of degradation which is common in this rangeland. The soil on the left is completely unprotected and vulnerable to water and to wind erosion. Scalding and wind disturbance is very clear on the left. Note the increased ground cover on the right of the fence.

(b) This alluvial plain has been extremely degraded and is subject to wind erosion. The only perennial species on the site are scattered *Acacia eremea* in the foreground and *A. victoriae* and *A. selerosperma* in the background. The ground cover here is *Atriplex spongiosa* an annual of little value.

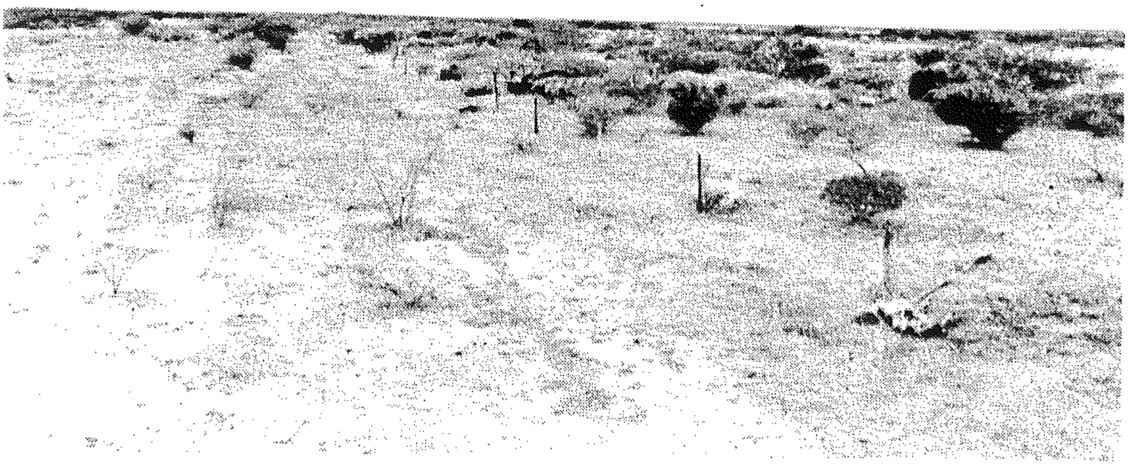
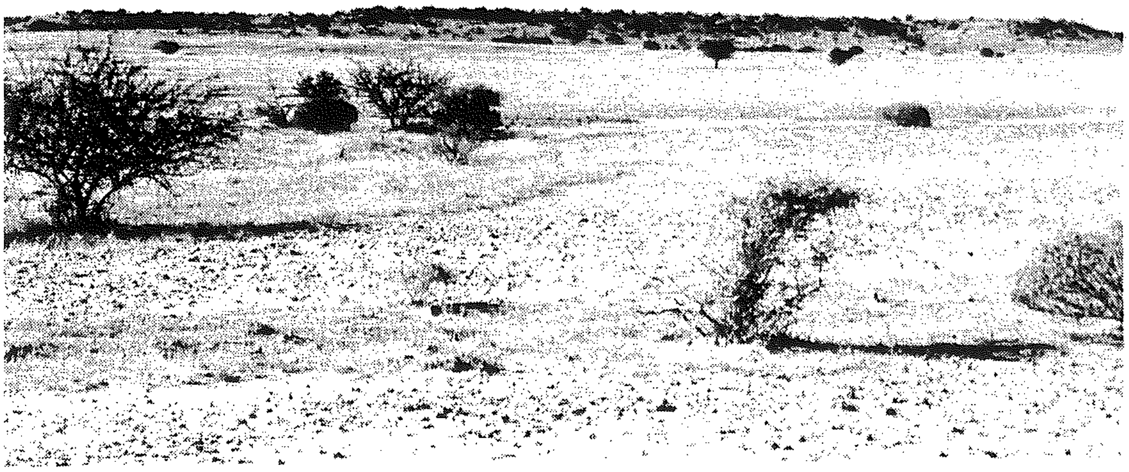


PLATE 28. Stony chenopod pastures Jimba rangeland type

(a) This alluvial plain has been almost completely bared of vegetation. The beginnings of erosion gutters can be seen moving from left to right. The thin strew of pebbles protects the surface to some extent, but the site is unproductive and unstable. It has the potential to support a vegetation similar to that in Plate 25(a). The similarity of land form should be noted.

(b) Parts of the Jimba rangeland are severely degraded and eroded. Areas which have been derived from Bulgadoo limestones are particularly prone to wind erosion as this photograph shows. There is extensive windpiling and hummocking, baring of the parent material and almost complete death of all perennial components.



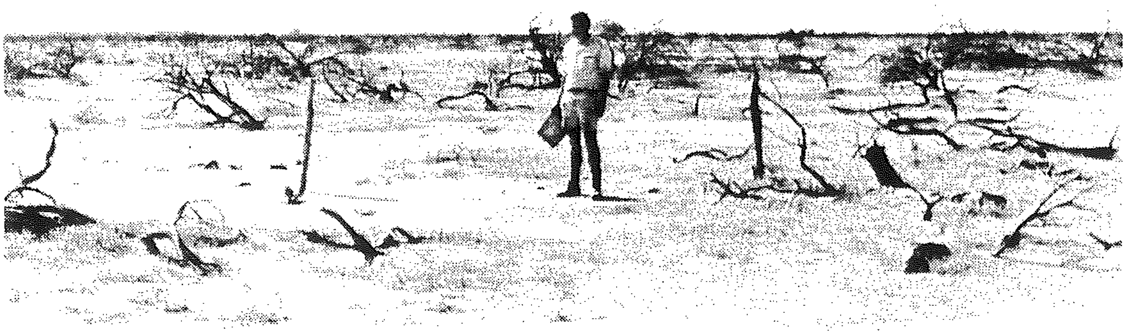
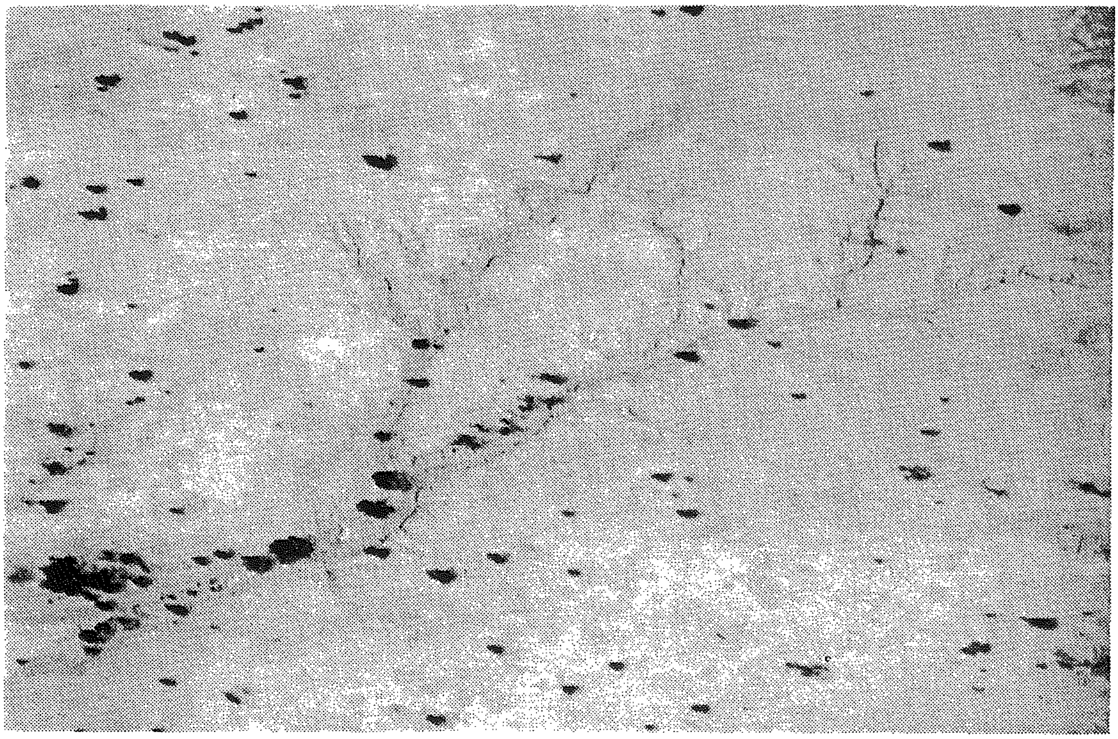


PLATE 29. Erosion patterns aerial views

(a) Erosion in stony chenopod rangelands is shown in this photograph. Notice the development of new gutters on the upstream side of the vegetated creek line. Note the lack of cover on this rangeland and the completely unprotected gully heads. Unless this area is protected erosion of this type will continue unchecked to the watershed.

(b) Erosion in a tributary drainage plain of Three Rivers rangeland type. Notice the development of erosion fans on the face of the alluvial plain and the formation of new waterways below the erosion face and how these lead to the trunk drainage in the upper part of the photograph. Observe the completely unprotected soil and the complete lack of cover. Compare this with the ground photograph of a Three Rivers rangeland in good condition.



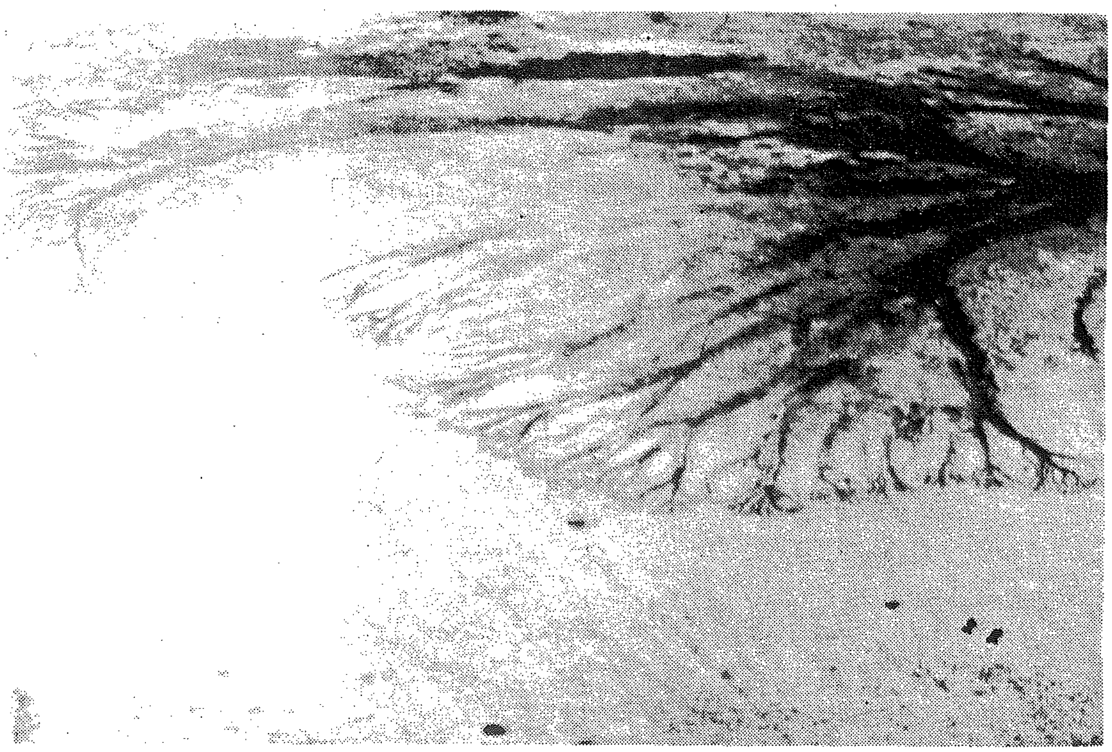


PLATE 30.

(a) Wooramel 1:250 000 sheet. Run 2, photo 5 057
Taken in 1952.

(b) Wooramel 1:250 000 sheet. Run 2 photo 5 206
Taken in 1964.

Note increased gullying on the right and left of the major creekline, the increased incision in the creekline, the widening of the bed of the creek and the major alteration in sand bands and pebble terraces on the left of the creek. The latter effect is due to increased water flow.