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**GRAZING MANAGEMENT BASED ON CARRYING CAPACITY - FACTORS IN  
DETERMINING LAND CONDITION IN SOUTH AUSTRALIA**

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**ABSTRACT**

Setting long term stock carrying capacities for arid rangelands is a problem faced by many arid land administrators throughout Australia. Large fluctuations in seasonal conditions, highly variable land types and various condition states are some of the factors that influence the capacity of the land to carry stock. In South Australia the new Pastoral Land Management and Conservation Act 1989 provides a legislative framework for the evaluation of carrying capacities based on objective scientific assessment of land condition. Management practices and stocking rates of leases assessed as being in good condition provide evidence of long term carrying capacities of various pasture types throughout a district, and these leases are used as benchmarks for establishing land management guidelines for the district. A critical component is the assessment of land condition. The methodology developed and applied in the first district to be assessed is described, and could be adopted for use in other rangeland environments.

**INTRODUCTION**

Community concerns over the condition and administration of the pastoral leasehold lands in South Australia in the 1980's led to a radical revision of the legislation, and culminated in a new Pastoral Land Management and Conservation Act 1989 (PLMC Act), which incorporates clear landcare objectives whilst also providing for pastoral continuity. The major changes are to rent, public access, and tenure, with a new 'rolling' form of pastoral lease that is conditional upon the lessee maintaining and improving land condition.

The strong emphasis on land condition is reliant on an objective measure of the condition of the land, and the Act specifies that scientific principles must be used and that an assessment of the capacity of the land to carry stock must be included. An important factor in determining the methodology to be used was the right of appeal (Section 54) of a lessee if dissatisfied with a decision to vary the conditions, or not to extend the term, of a pastoral lease. Consequently the methodology must be defensible in a tribunal situation, and must therefore strictly follow the objects and requirements of the Act.

The lease must also include a stock maximum; however, the lessee may apply to the Board at any time for an increase above this specified level. Under the previous Pastoral Act, stock maxima were based on a rated figure (upon which rent was paid). Each maximum represented the rated figure (an estimate of the potential capacity of the land to carry stock when fully developed), plus a 25% allowance to allow lessees "room to move" during favourable seasonal conditions. Subsequent examination of these calculated maxima has revealed that they varied from 10% to 104% above the rated figure, and do not represent the actual sustainable carrying capacity of the land. Land condition was not a determining factor under the previous Act, consequently the new legislation provides a framework for adjusting stock maxima according to land condition.

This paper briefly outlines the methodology used to assess land condition and the capacity of the land to carry stock, to meet the requirements of the PLMC Act. A more detailed paper is in preparation for submission to the Rangeland Journal.

**Objectives of the Act**

The Objects (Section 4) and other sections of the PLMC Act provide the legal charter and instructions about what is required of an assessment of the land.

The PLMC Act has the following land care objectives:

- \* to ensure that all pastoral land in the State is well managed and utilized prudently so that its renewable resources are maintained and its yield sustained
- \* to provide for :-
  - the effective monitoring of the condition of pastoral land;
  - the prevention of degradation of the land and its indigenous plant and animal life;
  - and the rehabilitation of the land in cases of damage.

The Act defines degradation of the land as "a decline in the quality of the natural resources of the land resulting from human activities on the land". Rehabilitation of degraded land means "to bring the land back to at least the condition it was in before its degradation, having particular regard to its capacity to carry stock and its level of soil stability".

The lessee has a duty (Section 7) to use good land management practices, prevent degradation of the land and to endeavour, within the limits of financial resources, to improve the condition of the land. They also have related and more explicit duties in connection with the Soil Conservation and Land Care Act, 1989.

#### **Tenure provisions**

Tenure provisions under the new Act include a 'rolling' 42 year lease, whereby the lease is assessed to determine its land condition every 14 years. Provided the lessee has not wilfully breached a condition of the lease resulting in, or likely to result in, degradation of the land, then the lease term is topped up from the remaining 28 years to a full 42 years. Land management conditions of the lease may also be varied every 14 years.

Section 43 of the Act provides for further protection of the land whereby the Board may direct the lessee to take action to prevent degradation of the land, e.g. to destock certain paddocks. There is no right of appeal under this section.

#### **Assessment of land condition**

##### *Requirements of the Act*

To be defensible in a tribunal the methodology used to assess land condition must strictly follow the directions of the Act. The Act specifies (Section 6) that the assessment of the condition of the land must :

- \* be thorough
- \* include an assessment of the capacity of the land to carry stock
- \* be conducted in accordance with recognised scientific principles
- \* be carried out by persons who are qualified and experienced in land assessment techniques.

The Objects refer to the *indigenous* plant and animal life, consequently there is a requirement to assess at the plant species level to determine to what degree the indigenous plant communities have been degraded or removed. It is important to note that replacement of indigenous species by introduced species is an example of degradation under this Act. Additionally, the composition of indigenous communities may be degraded under stock grazing by the replacement of palatable perennial plants with unpalatable species.

In the chenopod shrublands of S.A., the degradation sequence has long been specified in literature from the pastoralists themselves. There are no fundamental differences between sequences recognised here, and in historical pastoral literature.

The assessment of the condition of the various pasture types involves defining what constitutes an intact or un-degraded state, not harmed by human activities on the land, and deciding on the criteria that indicate to what degree disturbance has occurred to the indigenous plant life. The PLMC Act's emphasis on indigenous plant species largely determines an on-ground approach as it is necessary to ascertain the mix of plant species and to determine if seedlings are present whereby the land has a capacity to rehabilitate to its former state. It is for this reason that remote sensing techniques are not appropriate to determine land condition according to the Act, however such technology is used for mapping and highlighting areas where apparent cover changes have occurred.

The process of lease assessment involves a preliminary reconnaissance survey by senior scientific officers to determine pasture types and condition criteria. This is followed by a training period for field staff to become fully competent in using these criteria in assessing the various land condition states, before commencing the individual lease assessment programme. Suitably qualified staff were recruited in 1990 and have been further trained to ensure they are experienced in the land assessment techniques prescribed by the Senior Officers. The ten field staff work in teams of two on allocated leases, generally spending two weeks on each lease assessing land condition, setting up a baseline monitoring system, and describing and mapping land systems.

#### *Reconnaissance Survey (by Senior Officers)*

The purpose of this survey is to:

- \* identify the various pasture types ( e.g. chenopod shrublands, low woodlands) and the sub-units called pasture components (e.g. saltbush *Atriplex vesicaria* / bluebush *Maireana sedifolia* calcareous plains) that make up these pasture types within the district
- \* determine the criteria that will be used to identify three condition classes (1 = severely degraded, 2 = degraded and 3 = near intact) within each pasture component.

Only three land condition classes are described as this limits the number of choices and therefore reduces possible observer errors between the five assessment teams. To avoid the influence of seasonal changes and drought, the criteria are based primarily on perennial vegetation components, with erosion levels included where applicable. The issue of so-called "opportunity country" involving only ephemeral growth, is dealt with separately.

Each condition class for each pasture component is described according to key indicator plants. Photographs and written criteria are compiled that depict each of the three condition classes for each of the pasture components. The criteria and photo- standards are compiled into a manual which are subsequently used by the assessment teams in carrying out the lease assessments.

All field staff are then trained in the field to recognise the various condition classes for each of the pasture components to achieve a uniform standard, and tested, thereby ensuring that all staff will assess the condition of land uniformly and without bias.

The lease assessments are completed on a district basis within the eight Soil Conservation Board Districts established under the Soil Conservation and Land Care Act 1989. The first district completed is in the North West, covering the Kingoonya Soil Conservation Board District (Figure 1.) A field day is held prior to the commencement of the assessments to demonstrate the assessment and monitoring process to pastoralists.

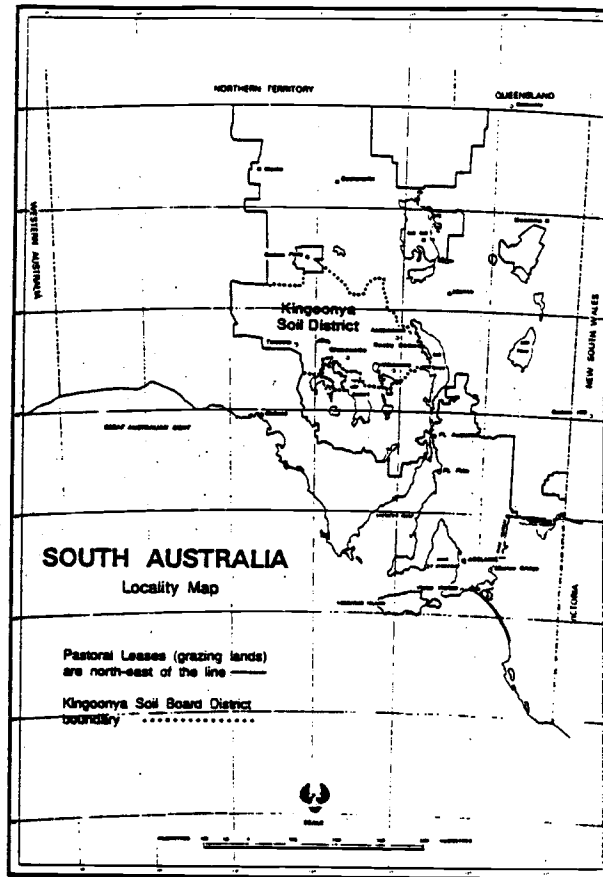


Figure 1. Location of Kingoonya Soil Conservation District

### Assessment of land condition for each lease

A restricted random survey technique is used to ensure minimal observer bias in deciding where and what to assess. The field teams are allocated a batch of leases to assess within the soil board district. A transect through each lease, along the existing station tracks, is planned that will cover most of the accessible parts of the lease in a systematic way. Its length (km) is measured from maps and a computer program divides this length into 100 equal parts, then generates a minimum of 100 restricted-random sample points along this transect. The number of random points may exceed 100, depending on the size of the lease.

When the team arrives at each pre-determined sample point in the field, (determined by an electronic trip meter) an assessment is made of the condition of the land in the view-field (50m x 50m) of the camera at a uniform distance (10m) from the left side of the vehicle. Firstly, the pasture type component is identified. (*Is this a saltbush/bluebush calcareous plain?*) Next, the appropriate condition state (1, 2 or 3) is determined by reference to the descriptions and photo-standards in the manual. (*Are the indicator plant species palatable to stock present?*) For a saltbush/bluebush community, saltbush must be present to score a 3 or bluebush seedlings must occur. A slide photograph is taken to provide verification of the condition class should this be later disputed in a tribunal. The slides are reviewed by senior officers to ensure all assessment teams are consistent in applying the criteria.

**How is the information used ?**

A *Weighted Average Condition index* (WAC index-now called the LCI or Land Condition Index) for each lease is determined by multiplying the percentage of sample points for each condition rating by the rating, giving a value range from 100 to 300. For example:

Condition	% of sites		weighting		
3	50	x	3	=	150
2	40	x	2	=	80
1	10	x	1	=	10
<b>WAC Index</b>					<b>= 240</b>

The maximum index score is 300 which would imply that all sample points complied with the Act, and a minimum of 100 would mean that all samples were severely disturbed and failed to comply with the Act. Thus all leases may be compared within a district according to their WAC index scores. However, throughout a district there are many pasture components and these have varied capacities to absorb stock impact over a 100 years or more of pastoralism. For example, heavy clay soils protected by a dense cover of gibbers and supporting saltbush are able to withstand grazing pressure much better than lightly textured soils or texture contrast soils. This inherent robustness of some pasture components may result in high WAC scores and tends to confuse inter-lease comparisons that involve a mix of pasture components. A *Robustness Index* (RI) has been calculated which allows for these differences, whereby stations which have a similar mix of pasture components, according to robustness, are compared on an equal basis. This index uses the district total of all WAC scores for each pasture component and is calculated as follows:

Pasture Component	% of samples		1% of district WAC for this component		
1(a)	10	x	2.6	=	26
1(b)	50	x	1.5	=	75
2(a)	20	x	2.7	=	54
2(b)	20	x	1.9	=	38
<b>Robustness Index</b>					<b>= 193</b>

Like the WAC index, the RI has limits of 100 and 300. It should be noted that comparisons of stations on their percentage mix of different pasture components alone (no reference to WAC scores), using similarity or distance measures and seriating tree diagram classifications, produces results almost the same as the easily calculated RI.

The two indices (WAC and RI) are used to provide a relative scaling of the leases within the district according to land condition within the pasture components. Fig. 2. shows all leases within the Kingoonya Soil Board District according to WAC and Robustness indices and illustrates the range in land condition throughout the district and reveals that all stations to some degree fall short of fully meeting the ideals of the Act i.e. a WAC score of 300. The leases that have the highest WAC scores for a given RI score represent the best land condition that the pastoral industry has achieved for the different types of country under prevailing pastoral management.

**Capacity of the land to carry stock**

The Board is required to specify a maximum stocking level for the lease, and the lessee is not permitted to exceed this figure without the prior permission of the Board.

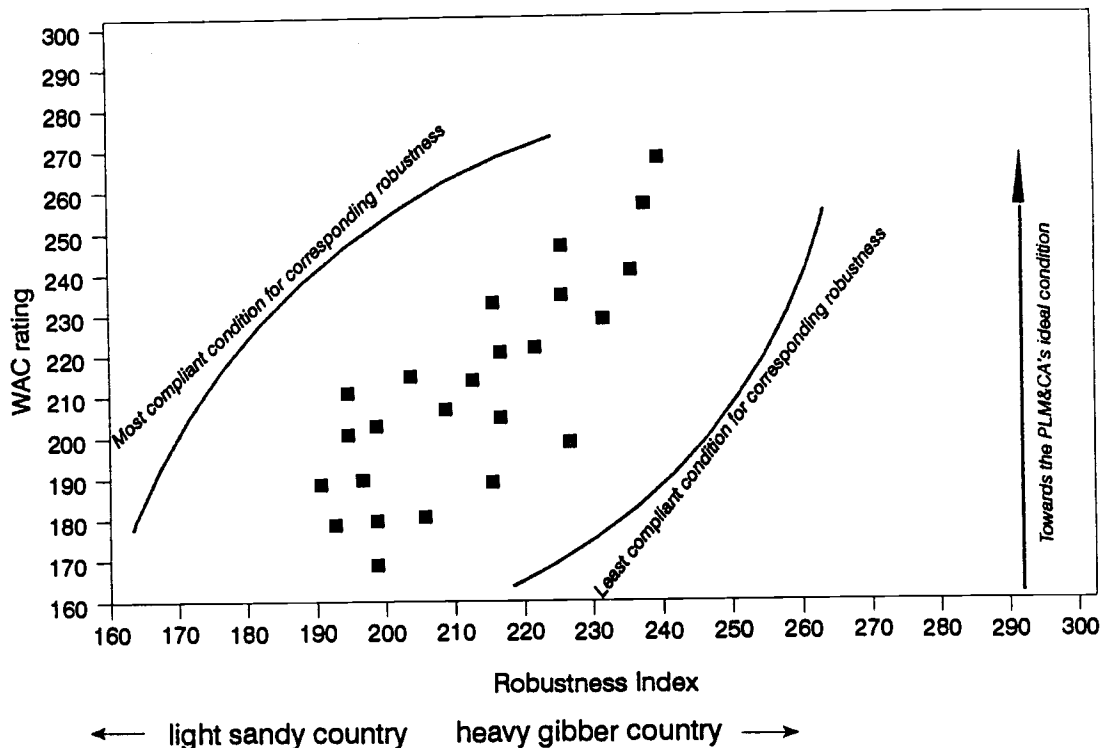


Figure 2. Assessed land condition of stations within the Kingoonya Soil Conservation District 1991

Stock maxima determined under the previous Act (Pastoral Act 1936-1989) did not include an assessment of the condition of the land and are inappropriate levels under the new PLMC Act. The previous maximum figure has long been represented by the pastoral industry as the actual carrying capacity of the lease.

The Objects of the Act specify that the Pastoral Board must ensure that degradation does not, or is not likely to occur. Maximum stocking levels for a lease are far from ideal as an effective method for ensuring that pastoral land is not degraded as they do not provide for stocking levels in individual paddocks under a range of condition classes and pasture components.

The evidence for appropriate long term stocking levels must come primarily from what the land has carried in the past without severe degradation; what successful management practices have been implemented for various pasture types, and how management practices generally are related to the present land condition. The Board has determined that the 10 year (1980-89) stock average (which includes a range of seasonal conditions) for leases assessed as being in good condition will be adopted as a benchmark for determining the capacity of the land to carry stock. Those leases that are assessed as being nearly intact ( i.e. high WAC score, good condition) set the land management standards for the various pasture components in the district, as they are deemed to meet the requirements of the Act in maintaining the renewable resources and thus represent the " capacity of the land to carry stock" without severe degradation. Other factors such as the number and location of waters, number of stock per water point, size of paddocks, grazing management and seasonal use, and land management problems, are also considered in determining the capacity of the land to carry stock and for determining the long term (maximum) stocking level.

Leases assessed as being in degraded or reduced condition states would have their stocking rates and management practices compared with those of the benchmark leases, and their stocking levels and trends in condition would be more closely monitored. The Pastoral Board would determine an appropriate stocking level based on the land condition and the above factors.

The Board may also elect to use Section 43 of the Act where a notice to destock or take other action may be required to prevent the likelihood of degradation of the land in the short term.

#### **Lease Assessment Reports**

Lease Assessment Reports are submitted to the Board in a district batch and contain an assessment of the condition of the land, factors that limit the capacity of the land to carry stock, and identified land management problems within each paddock with suggested strategies that might be adopted to alleviate these problems.

The Board considers these reports and they are then forwarded to the lessees, who have 60 days to consider and comment. The local soil conservation board is also invited to comment. The Pastoral Board then considers all comments before setting the land management conditions of the lease, which includes a maximum stocking level. The lessee may apply to the Pastoral Board at any time for a temporary increase above this maximum.

There is a requirement to assess the condition of the land every 14 years, and land management conditions may be adjusted and the term of the lease extended if the lessee has complied with the lease conditions and fulfilled a duty to improve the condition of the land.

#### **Monitoring**

During the assessment field survey, the assessment teams also establish a monitoring baseline in each paddock, which consists of a photopoint and a fixed belt transect to collect ecological data. The details are compiled into a manual and the lessee is given a copy and encouraged to photographically monitor the sites when a visible change becomes apparent. These sites are located on water runs to enable the lessee to inspect the sites on a regular basis. The sites will be re-measured by the Pastoral Management Branch every 5-7 years (depending on resources), and the combination of the short term details collected by the lessee and the long term monitoring by the Pastoral Management Branch, together with climatic data and stock management practices at the paddock level, will provide a valuable interpretative base for evaluating changes that have occurred within each paddock over a district. Soil Conservation Boards will play a major role in promoting sound land management practices, and in assisting lessees to improve the condition of the land identified by the assessment process.

Lessee involvement in the monitoring programme is strongly encouraged, and most lessees have been supportive of the establishment of baseline photopoints. Indeed, many have suggested that it should have been done 20-30 years ago as it would reveal that the condition of the land has improved, in their opinion, during the last 50 years.

NOAA imagery is being developed as a tool to monitor vegetation response to rainfall events and to target areas for further ground inspections. Geographic Information Systems are also being developed to produce maps and other products for lessees and soil conservation boards.

#### **SUMMARY**

The assessment method developed in South Australia for determining land condition employs standardised criteria and sampling routines consistent with State legislation, and provides an objective assessment of the land condition of properties within a district. The information provides the Pastoral Board with an objective basis upon which to consider stocking levels and other factors that affect land condition on pastoral leases. Photostandards provide an accurate standardised record of the criteria used to determine the various condition classes, and the survey can therefore be repeated in the next 14 year assessment period using consistent standards. The process is objective, relatively simple, easily demonstrated to pastoralists, and has wide potential application to other rangeland areas.