Range Assessment Newsletter

Produced by Officers of the C.S.I.R.O. Riverina Laboratory on behalf of the
N.S.W. Range Assessment Committee

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EDITORIAL

The response to the first issue of the Range Assessment Newsletter has been fairly good, with numerous requests for additions to the mailing list from people around Australia and some from North America. However, the Committee has not been deluged with comments on the value of the Newsletter, nor with spontaneous contributions.

It has been suggested that the title and aim of the Newsletter are too narrow. Range assessment is only one part of the planning, development and management of rangelands, and therefore it may be better to keep it in proper perspective by giving the Newsletter a broader base. The attitude of the Committee is that the Newsletter arose more or less spontaneously to fulfill a need expressed by those who attended the Range Condition Workshops at Alice Springs and Fowlers Gap. The Newsletter seems to be serving a purpose at present, but its scope can be changed as dictated by the expressed needs of its recipients, and as influenced by progress towards the formation of an Australian Rangeland Society (see news item).

Comments have also been made on the use of the terms "range" and "rangeland" in the Australian context. "Range" is a foreign word and up to date has not been accepted and put into common usage by those most intimately associated with management of the land. Also the definition of Australian "rangelands" most widely held by professional personnel is challenged in a comment from John Taylor (see later). Your comments on these and any other matters related to the Newsletter are sought by the Editor.

In the development of methods for the assessment of range we are concerned with questions such as: What should be measured? How will it be measured? Who will measure it? What use will be made of the assessment? This Newsletter contains articles from: Ron Hacker, on the development of a range assessment method in W.A.; Allan Wilson, proposing "A Rangeland Method" for immediate field testing; John Taylor and Wal Whalley, stressing the need to develop a method based on a sound knowledge of plant succession; and Dean Graetz, pressing for a fresh approach to range assessment in Australia. The contributors are seeking feedback from the readers of the Newsletter.

Bibliography. As papers and reports relevant to range assessment come to your notice, we invite you to submit the titles to the Editor. We expect to commence the Bibliography with the next issue of the Newsletter.

Contributions requested. With your participation through contributions, the Newsletter will be able to fulfill our expectations. Letters to the Editor, comments, and reports are all acceptable. The reading audience is keen to know what you are thinking and doing in the area of range assessment.

Drawings and photographs. Drawings and photographs can be printed in the Newsletter but such contributions should be outstanding to merit serious consideration for inclusion, as space and costs are limiting.

Closing date for next Newsletter. Contributions should reach the Editor by 1st October, 1974 to meet a mailing deadline of 1st November, 1974. We are working on the basis of three issues per year, but this will depend on the response from the readers.

Mailing list. Please check the address on your copy and let us know as soon as possible if your name and/or address is/are incorrect. We do not wish to send the Newsletter to persons who are not interested, but we are very keen that everyone who could be interested should receive it.

GRAEME TUPPER
On behalf of the Committee

THE AUSTRALIAN RANGELAND SOCIETY

At the 4th U.S./Australia Workshop on Range Science, held at Alice Springs in March/April, 1974, a committee was formed to "investigate the potential for and the purpose of an Australian Society of Range Management".

The committee meeting resumed in Perth in May 1974, to discuss a number of aspects relating to such a society, including the society's name, membership, membership fees, aims of the society, and organization of the society. The corresponding members of the committee are currently making comments on these matters to the Perth section of the committee. It has been suggested that the society should aim at holding an annual meeting, the first to be at ANZAAS in Canberra in January 1975.

Further developments will be advised directly and/or per medium of the Range Assessment Newsletter.

A POINT OF DEFINITION

John A. Taylor, Department of Natural Resources, U.N.E., Armidale, N.S.W.

The need for studies to enable sound management of all Australian natural pasture lands used primarily for livestock production, has not yet been recognized.

By definition, range research in Australia is restricted to the arid and semi-arid regions (Box and Perry 1971). However, grazing lands in need of protective management extend far beyond this arbitrary boundary. Sparser vegetation, a decrease in perennial grasses, an increase in woody plants and annual herbage, exposure of scalded surfaces, erosion and silting up of creeks and dams are evidence to this. These signs of deterioration are features of both the more humid 'unimproved' grazing lands and the arid and semi-arid 'rangelands'.

The similarity of the principles of sound management warrant extension of the definition of the term 'rangelands', and greater emphasis on the study of the more humid 'rangelands' than is at present the case. Perhaps we should re-examine our definitions and the orientation of range research?

Box, T.W. and Perry, R.A. (1971). Rangeland management in Australia. *J Range Manage* 24(3): 167.

DEVELOPMENT OF RANGE ASSESSMENT METHODOLOGY IN WESTERN AUSTRALIA

Ron B. Hacker, District Office, Department of Agriculture, Kalgoorlie, W.A.

At the second annual conference of the Rangeland Management Branch held at Carnarvon in November 1973, two proposed methods of range condition assessment were presented and subjected to a limited field evaluation. The proposals, as presented, have been published in the conference proceedings.

Following discussion of the methods, after field evaluation, it was decided that while neither method was entirely satisfactory a combination of the two approaches should contain the elements of a workable system. Broad guidelines for the development of such a system were laid down.

Subsequent development has resulted in the production of a definite technique which, it is hoped, should be suitable for range assessment in Western Australia. The method is basically aimed at measuring trend rather than condition. Details will be published in the next Journal of Agriculture of W.A.

Further field evaluation of the method will be carried out by regional officers during 1974 and criticisms and suggested amendments will be discussed at the next Branch Conference at the end of the year.

A RANGELAND METHOD

Dr. A. D. Wilson, Rangelands Research Section, CSIRO, Division of Land Resources Management, Deniliquin, N.S.W.

The experience at Fowlers Gap of various methods for assessing Range Condition has given rise to a great deal of thought about the whole concept of Range Condition and about the methods that could be applied.

Before discussing possible methods for Australia, several points need to be emphasized. The first is that a method is required *now*. Land managers cannot wait ten years for research people to refine their methods, because a great deal of degradation of lands could occur in that time. The second is that the method should be flexible so that new improvements, either through experience or research, can be incorporated without major upheavals. The final point is that there is need for close co-operation between the various groups that are concerned with Range Condition assessment. It would be tragic if these various groups went their separate ways, particularly if each group or State worked on a different method.

Method outline

The following method is proposed for initial assessment by the Range Condition working group. It includes aspects of the Quantitative Climax, 3-step, and Soil Conservation Service methods and represents a proposal for discussion and modification.

Step 1. Pasture composition

Pasture composition (by weight) should be estimated on a large scale (paddock?) basis by trained observers. This information could be compiled in several alternative ways:

a) Into five groups according to value for grazing (or for other purposes) along the following lines -

Species	Proportion of Plant Composition (e.g.)	Rating Factor	Score
Best value perennials	20	1	20
Other desirable perennials Valuable annuals	50	$\frac{3}{4}$	38
Soil protecting perennials Annuals of no particular value	10	$\frac{1}{2}$	5
Unpalatable or low value plants	10	$\frac{1}{4}$	3
Weeds	10	0	0
Total			66

The placement of each species would be decided initially on experience, but this could be altered later as further information is accumulated. Listing of the major components by species would allow recalculation of old ratings at a future date if changes are made in these classifications.

The score for a particular site would then be corrected for seasonal variation by reference to an area in "good" condition (reference area),

i.e. $$\frac{\text{location score (66)}}{\text{reference area score (80)}} \times \frac{10}{1} = \text{condition rating (8)}$$

The condition rating is rounded to the nearest unit to avoid the impression of unwarranted accuracy.

b) Into three groups along the lines of the Quantitative Climax method, but with a simpler description of plant types -

Species	Composition	Composition of Reference Area	Score
Desirable plants	70	85	70
Neutral plants	20	10	10
Undesirable plants	10	5	0
			80

The reference area would be lightly or moderately grazed.

Step 2. Tree and tall shrub

Two systems are possible here. The rating system outlined by the Soil Conservation Service could be used and the ratings improved by further experience. Some allowance is needed for the clumping of trees. The result would be a rating from 10 (no shrub problems) to 1 (dense shrub).

Another alternative is to include all shrubs under the "weed" or "undesirable" categories of botanical composition. This offers the significant advantage of reducing the number of condition scores and of placing shrubs directly in the group where it matters - as a competitor with the herbaceous species.

Step 3. Erosion

A rating system would be developed for each range site to describe the erosion occurring at various ratings from 10 (no erosion), 8, 6, 4, 2 to 0 (all eroded). This would be aided by reference areas and photographic standards for each range site.

Step 4. Photography

Photographs of permanently marked areas would be a significant aid to the education of both the assessment officers and graziers. No scores would be made from them at this stage, but in future aerial photographs could be used to reduce the amount of field work necessary to make assessments.

Total Assessment

The final assessment would be a series of ratings,without combination in a single condition score;

e.g. Vegetation : 8
Shrubs : 7
Erosion : 9

These ratings could be left as numbers, or assigned to the categories Excellent, Good, Fair, Poor, as in the American systems.

As experience is gained it may be possible to combine these ratings. The advantage of keeping them separate is that future changes in the system can be made without altering the overall score and a good score for one item (e.g. erosion at a site of low erosion potential) does not mask poor results for another item.

Research and Experience

It is suggested that the working committee test the various alternatives on a number of contrasting sites (e.g. saltbush, grassland, woodland) for a limited period (e.g. 1 year). A provisional method could then be agreed on for initial application and further testing. Research on this method would include the statistical analysis of repeatability and sensitivity, reproducibility in drought years, the classification of plant species and the assessment of animal productivity in relation to condition ratings.

RANGE CONDITION ASSESSMENT - A FORTUITOUS CONCOURSE OF IDEOLOGY?

John A. Taylor, Department of Natural Resources, U.N.E., Armidale

R. D. B. Whalley, Department of Botany, U.N.E., Armidale

The whole concept of range management is based on the existence of plant succession in response to grazing. By succession, we mean a predictable array of species assemblages produced by grazing of different intensity, type or season, or by other management procedures. These assemblages are different for different range sites. Management of any system depends on the knowledge of predictable responses to manipulations. Any attempt, therefore, to devise condition criteria should begin with the establishment of a successional framework for each range site under consideration. An abstract approach, or one which ignores plant succession, implies rejection of the accepted ecological principles on which range management is based.

Studies in the Northern Territory, Western Australia, south-western Queensland and western New South Wales have not as yet produced satisfactory simple, rapid and repeatable condition assessment methods. One would question whether sufficient attention has been paid to the elucidation first of appropriate successional frameworks? Without such frameworks an incomplete and illogical approach will result with insufficient understanding of the significance of the various species assemblages encountered. Variability between range sites produces further complications as similar species assemblages may have different implications on different range sites.

We are in the process of developing a method of condition and trend assessment suitable for use on the Copeton Dam catchment. Our attempt has been made along the following lines:-

(a) Areas of basalt, granite and sedimentary rocks have been delineated from geographical maps. These parent materials provide the preliminary separation into range sites. Other site and soil characteristics will be included later to give an increased number of range sites.

(b) Within these areas, properties have been selected for sampling on degree of use, the present state of the land, and availability of history of management. Where possible, large paddocks with different grazing intensities within the one paddock have been selected. Ungrazed or lightly grazed areas have been actively sought. As yet, areas which have been topdressed or oversown with exotic species have been excluded, but will be included later.

(c) Using a wheel point apparatus, 300 points have been examined at each sampling site using a similar technique to that described by Roberts (1972). By the end of next summer (1974-75), several hundred samplings should be completed. Using these data, it is hoped to build up a successional framework which includes the effects of intensity of grazing and nutrient transfer to stock camps for the different range sites.

(d) Permanent and moving cages are to be set up in the near future. By careful selection of sampling sites, and by sampling on an individual species basis, the acceptability and productivity of the different species can be ascertained. Nutritive value should also be considered.

When all this information is available, it should be possible to set attainable management goals in terms of species assemblages for various land uses on each range site, and to place this assemblage in a valid successional framework. Then, and only then, can appropriate condition assessment methods be considered.

A preliminary attempt at a successional framework for a granite range site follows (Table 1). This framework will have to be repeated for other range sites and extended to cover additional managerial manipulations.

TABLE 1

Effect of grazing intensity on percentage species composition*

Location: "Balala", Pine Ridge - 800 ha.
Altitude: 900 m; aspect: NW; slope: 3-70
Timber species: *E. youmanii*; spacing: open
Erosion status: some pedestaling evident
Soil type: Grey Brown podsolic
Parent material: acid granodiorite
Grazing history: sheep from 1880 to 1970. In that time carrying capacity dropped from 1 sheep/0.6 ha to 1 sheep/1.3 ha. Since 1970, a few cattle.

Percentage Composition \ Grazing Pressure	Very Heavy	Heavy	Moderate	Light
Bothriochloa macera	57	22	2	-
Aristida spp.	1	19	36	31
Themeda australis	-	-	1	25
Sporobolus elongatus	22	13	4	1
Eragrostis spp.	5	<1	2	2
Panicum effusum	5	1	<1	-
Sorghum leiocladum	-	-	6	3
Cymbopogon refractus	-	<1	3	4
Dichelachne sciurea	-	2	1	<1
Danthonia spp.	1	1	1	<1
Helichrysum spp.	-	13	2	3
Cheilanthes tenuifolia	-	4	2	9
Taraxacum officinale	1	3	7	-
Lomandra longifolia	-	<1	2	<1

* Note: These data were collected at varying distances from a stock camp and so nutrient transfer is confounded with grazing intensity.

From Table 1, species can be classified as decreasers, increasers, invaders or unaffected by grazing. The results of this classification are shown in Table 2.

TABLE 2

Reaction of different species to grazing intensity

Increaser	Decreaser	Invader	Unaffected
S. elongatus	*Aristida* spp.	*B. macera*	*Eragrostis* spp.
Helichrysum spp.	*T. australis*	*T. officinale*	*P. effusum*
	S. leiocladum		*D. sciurea*
	C. refractus		*Danthonia* spp.
	C. tenuifolia		*L. longifolia*

In the above tables, the effect of intensity of grazing is complicated by the transfer of nutrients to areas of heavy use. This requires clarification. It remains to be seen whether a grazing x fertilizer interaction has a similar botanical expression.

Roberts, B.R. (1972). Ecological studies on pasture condition in semi-arid Queensland. Charleville Pastoral Laboratory, mimeographed report.

RANGE ASSESSMENT IN AUSTRALIA: SOME THOUGHTS THEREON

Dr. R. D. Graetz, Rangelands Research Section, CSIRO, Division of Land Resources Management, Deniliquin, N.S.W.

INTRODUCTION

My purpose in writing a contribution to this Newsletter was to describe a methodology proposed during the 1973 September Workshop at Fowler's Gap by Peter Holst and myself. I found, however, that I was continually rethinking the basic assumptions that must underlie any method with little progress on the method itself. And so I have tried to set out, as logically as I can, these thoughts. The effort of trying to crystallize them into words has helped somewhat but I would be very grateful for feedback from people receiving this Newsletter.

Firstly, I suggest that we can completely disregard all the North American methods. I believe them generally to be inadequately based in ecological theory, often unsound in measurement technique and, as well, largely inappropriate to the pastoral systems operating in Australia.

Now, granted that these methods were developed in times of necessity to enforce and control the management of grazing in the U.S.A., they have since those times changed very little and have become almost dogmas. Ecological theory and experiment has, however, progressed considerably in the last 30 years, but, unfortunately, with little apparent influence upon range work.

An example of this inadequacy is the Parker 3-step method. Two recent reports (Francis *et al.* 1972; Reppert and Francis 1973) have examined the loop measurement technique and found it to be useless. What then of the data from the 16,500 sites that have been installed across the country? The only useful information (but not data!) is the fixed point photographs taken at each site during measurement programs.

The original purpose of the method was probably achieved, however, since the very *presence* of a measuring site and the regular visits by the leasing-agency personnel would influence the lessees. Scientifically and ecologically the measurements are largely a write-off!

I would venture that the range assessment programs in the U.S.A. have been effective largely for these reasons. As well, by comparison, the range systems are generally simple, seasonally grazed ones with very conservative upper limits advised for the amount of forage to be harvested by stock. The large tracts of land owned and administered by Federal agencies would certainly influence and stabilize grazing practice.

I wonder would there be a similar success story here if, under the conditions prevailing on Australian rangelands, we set off with a dud method?

I think we must make a fresh start. We should define with some precision the aims of range assessment, rethink all the basic underlying concepts and then, within the constraints characteristic of our rangelands, devise the appropriate measurement strategies. I am not making these points from nationalistic fervour but there is no point in adopting anything that is ecologically inappropriate. In all our considerations we must include or in some way reflect the ecological uniqueness of our semi-arid and arid rangelands, their characteristically variable physical environments as well as the established pastoral management of yearlong grazing, fixed watering points etc. (Perry 1968).

Towards this aim we can start by concerning ourselves with methods appropriate for pastoralism only. I cannot see how one could develop a generalized assessment method suitable for all forms of use, pastoralism, recreation etc. Any method or survey must be most accurate and sensitive in the area of the particular impact of the use. And differing uses have differing impacts!

The range resource is defined here as the vegetation and landscape, as well as the processes that couple these two elements together, the nutrient and hydrologic cycles. It is a renewable resource both in the ecological and economic sense (Kimmins 1973) and implied here is the value judgment that the renewable resource be maintained as such and not be mined. This value judgment is usually explicitly stated in the legislation relative to the pastoral leases of each State.

Now at the risk of being very pedantic I would like to point out that for renewable-resource management there are two separate information requirements. The first is the inventory stage wherein the resource is detected,mapped and some assessment given it. The second or monitoring stage is to detect absolute changes in the resource, such as the areal extent of its components, etc., or a trend in the condition. Range assessment has traditionally straddled both stages - the assigning of a condition and the assessment of trend. Much emphasis is being placed on 'condition'. Definitions of 'condition' are many (Roberts 1972) but may be fairly summarized as expressing relative health of the range resource. Three important points arise in my mind.

The concept of 'health' (- a bad word but I can't think of any other -) implies a functioning over time, not just a static inventory, so measurements should be capable of assessing this time-dependent functioning.

Secondly, it is a relative condition being compared with some reference; traditionally this reference has been the unused resource. Is this the best reference? The choice of reference, or the use of any reference at all, will completely determine the type of monitoring measurement and the accuracy needed. Also, should the reference sites be within paddock or property boundaries and so relate to the management practices of one man; or be within broad scale plant community boundaries only and be used to relate to the practices of many managers? How absolute and compatible can the measurement of resource parameters be?

To me these two points impose impossible demands on any practical, worthwhile measurement system. Assuming, however, that this is due to my own personal ignorance and lack of imagination, there are still further problems in assigning 'condition' to the range resource. Condition assessment requires the assessors to first construct a relationship (Fig. 1) for each major range type. In Fig. 1 the X axis represents a transforming and weighing of the specific measurements of the range resource (vegetation, soils) such that they may be equated to an *in perpetuity* productivity value which is not necessarily a stocking rate. The relationship should be linear for maximum sensitivity and the weighing and transformation *must* have the same precision as the field measurements.

For each curve certain range type-specific information must be incorporated, such as whether pristine and excellent are the same and whether the present pristine is irrevocably displaced from the original pre-settlement climax. Compounding this, the transforming and weighing (- scoring if you prefer -) of the measurements must be independent of the climatic conditions; the variability of which may often transcend the impact of the herbivores.

To me these three points appear insurmountable. I would make the suggestion therefore that the step of assigning a condition rating be dropped. I personally dislike to have emotive value words such as 'good' as the end product of scientific data collection. I also believe that there is no point in using such words if one condition class range cannot be *improved* by management practice *alone* to another class. In other words, the relationship in Fig. 1 must be a continuous one with no hysteresis.

Intuitively (there is no complete published data) I feel that this is not the case. Country managed into a 'poor' condition is irreversibly changed and can *never* by management inputs alone, at least within the lifetime of the lessee, return to the *excellent* class (- this damage is usually to the coupling process of net nutrient loss and scalding (Charley and Cowling 1968)-) and so Fig. 1 could really be a series of curves more like Fig. 2(a), (b) and (c).

I repeat I have no hard data on this but from my own meagre field observations of chenopod shrublands this is what appears to have happened, and is still happening. I have a hunch that the Mitchell grass range has behaved like Fig. 2(c) (see Roberts 1972).

I suggest therefore that we drop the transformation of scientifically based field measurements into condition classes because it would have to be done against a great background of *ecological* ignorance of the behaviour of our range ecosystems. We do not know *precisely* whether any one range is a one-, two- or many-curve type or to determine a change in stocking rate and predict what effect this will have.

As well I doubt whether we could *repeatedly* measure and hold standards of condition (Fig. 1) over any appreciable *area* of rangelands under a climatic regime of localized high variability and the spatial plant community diversity of range sites within one property. I also believe that from an *operational* point of view any use of condition classes should be restricted to within the sphere of management influence of one man only.

Let us then drop the idea of 'condition' as an *operative, absolute* thing and use it, if we must, only as a *relative* thing within the boundaries of one paddock. If we start our range assessment based on a *monitoring* program that is in turn based on a sound scientific and ecological basis we will, as we collect these data, and relevant climatic and management data, begin to understand 'condition' (Figs 1 & 2) much better.

I'd like to propose the following range assessment program based on what I have seen and heard of already in operation elsewhere around Australia, so my vast ignorance will now become more apparent.

Any implementing measurement program should concentrate primarily on monitoring for I regard the extension to direct management, i.e. stocking rates, to be a separate stage with additional information requirements. I cannot at present envisage a measurement program that would give stocking rates directly. We can be quite precise in monitoring but our level of ignorance of the second stage is high. Recommendations for stocking-rate changes may be 'reasonable' but, as yet, not 'scientific'. The scientific weight of monitoring precision should not be thrown behind the extension recommendations.

The first target is the management complex of one manager - the pastoral lease. The contextual information needed at a level above that of the individual lease is that relating to the broad scale vegetation and landscape features, rainfall data for annual amount, seasonal incidence and some index of variability. All of this information has now been generally systematized by State and National bodies.

The next stage should be the property plan - a very detailed map of vegetation distribution (or rangeland types if you prefer). Superimposed on this should be complete details of management impact, fencing and watering points etc. The map should be as detailed as is possible using 1:50,000 b/w panchromatic aerial photographs to include such things as soil erosion features, drainage patterns, etc. etc. Next, this map must be checked and updated by extensive ground truth surveys.

Stage three would be the installation of permanent monitoring sites within each management unit - each paddock. There should be at least one site for every range site present in the paddock and herein begin the many quandaries which can only be dissolved by compromise. The type of compromise would have to be determined by the agency involved and be dependent on the type of rangeland present - shrubland, woodland, grassland, etc. The monitoring technique must have maximum objectivity and repeatability and be within the operational capabilities of one man.

Now comes the 'put-up or shut-up' part. I have mulled over all the techniques available in the plant ecological literature and none of them would really be operational in the broad acres. Preferably we should obtain measures of the proportions of the component species and their abundance within the plant community; the *condition* of individuals of various species, their vigour, age, etc. and the presence and numbers of landscape-stability features such as erosion-rills or -pavements etc.

Permanent quadrats appear statistically attractive but very demanding of time and labour. I would plump therefore for line transect sampling using the wheel-point apparatus chosen by Roberts (1972). It can achieve all of the above; I think!

I would suggest a permanent plot be set out simply using five steel posts. I am always inclined to oblong shapes with the long axis placed *across* the gradient of animal use, but where this cannot be defined a pentagon pattern is the most useful (Fig. 3). The size can be scaled according to the need to collect a certain minimum number of point strikes etc.with the wheel point apparatus for statistical comparison and this will depend upon plant community type, e.g. grassland *vs* shrubland. I guess they would range from 100-500 metres per side.

The wheel point apparatus can be used either for direct hits, which will give an accurate value of % basal cover of any species, and/or for nearest neighbour to give an accurate value of community composition by species. The statistical theory is not treated by Roberts (1972) but is well done in the original paper of Tidmarsh and Havenga (1955). What appeals about this is that one's 'species' could include for example, sexually mature plants of species x, seedlings of species x, and senescent or dead plants of species x; that is, one could get a measure of population structure just by using photographic standards of age class. These 'species' may also include stages of soil erosion.

To get a measure of abundance seems a little harder, however. I believe, though I have not yet been able to do it, that one can incorporate nearest-neighbour type measurements (Batcheler 1971) into the wheel-point device. I'll pursue this further and report this and other refinements to the wheel in this Newsletter.

The procedure at each site then would be once around the course (see Fig. 3) with the wheel recording the hits and/or near-hit data. Permanent photographs should be made at the posts looking over the monitored area. Photographs are not easily quantified but they do contain a lot of information for public audience (Hastings and Turner 1965; Correll and Lange 1966; Pond 1971). I know Brendan Lay of the South Australian Department of Agriculture has been installing permanent photographic points over the rangelands and I hope he will report on it here. My guess is that each scene should be taken in stereo with colour film that is developed and copied to both positive (slides) and negative (prints) and archived. The extra cost of colour materials is insignificant compared with the extra amount of information stored.

I would think the lessee could be involved in this last stage and be given copies of the prints. If the monitoring frequency was of the order of once per seven years (as in South Australia) then change would be evident. A good argument might then begin about which way the 'country is going' - and this cannot be anything but useful. My experience of graziers is that they possess short, selective memories.

An alternative measurement scheme could be the use of belt transects (Burrows and Beale 1969). The choice, however, would need to be evaluated carefully with ecological measurement balanced against time and cost. I believe the wheel-point apparatus is a beauty and I would also recommend "The Roberts Report" (Roberts 1972) as compulsory reading for I think it is a real contribution to the field.

I must add these provisions. The above system might work best for a grassland. I have designed it with a shrubland in mind and it would be of limited use in rangelands with chronic scrub regeneration or annual pasture only. I can't think of any one technique that has adequate replication in space that will be

suitable for all the range types occurring within a 500 mile radius of where I sit writing now. However, that is not of great importance if one works just from monitoring data; - i.e. site 312 at Cobar is monitored using the brand-X technique, whereas site 401 at Broken Hill uses brand-Z only. It is of no moment as long as both brand-X and -Y are accurate (repeatable) and have the required resolution.

Now, how do we interpret the measurements. I have suggested that monitoring will give us real insight into 'condition' if any insight is possible. I think this can be done by evaluating the data against the following background:

1) *The unit of time management is the generation-length of the longest-lived dominant plant in the rangeland type.* That is, the necessity for ultimate replacement within each species population, if the present community is to be perpetuated. Our arid lands are often characterized by a lack of reproduction in one or more important species (has anyone ever seen a seeding of rosewood or western myall?). The key event is seedling establishment. Reduction of stock numbers for seedling establishment may be necessary for the successful regeneration of certain elements in the plant community.

2) *There must be the accumulation of reserves to carry individuals through adverse as well as favourable periods.* This pattern is found in the annual cycle of the stock and in the generation-cycle of the perennial plant population. The vigour of the individual can be maintained only if cropping is adjusted to *mean*, not maximum production. The principal tool here is intensity of stocking. The lesson to be learned is that naturally regulated animal (*and human*) populations in highly variable desert environments tend to stabilize at or below the mean pasture production levels of the ecosystem.

   Now, taking this one step further up the management chain, any pastoral system which is well buffered from the vagaries of climate will be a comparatively more profitable one since the buying/selling options will not be forced.

3) *The pressures of stock on plants are most significant in population control, not quantitative consumption.* While we ordinarily measure stock impact in terms of consumption, there are many cases where this is irrelevant: for example, in selective seedling removal, etc. A proper appreciation of these relations requires extended population studies of plant and of grazing animal alike.

4) *Pressures upon plants are increasingly significant as the physiological vigour of the plant declines.* This is the principal reason that plants in extreme situations - such as drought - are so susceptible to damage by stock. A corollary of this principle is that the control of competitors, disease, or other pressures, will yield the most significant results when the plant is in a low state of vigour. Another is that as vigour declines with age, productivity will decline and susceptibility to constant pressures will increase.

   These qualitative statements need to be explored within a quantitative framework. What is the relation between 'site quality' and physiological vigour for a given plant species? Is physiological vigour, in plants, related in any way to life-expectation? Will the stimulation of regrowth, by browsing, affect life span?

EPILOGUE

At the end and looking back it *sounds* good (though not as good as when I started) but will it work - is it practical?

I'm still inclined to vote yes to both.

I'd be grateful for feedback in the form of letters, or stinging rebuttals in this Newsletter. I have a second part to the whole program, which I have not

described here, dealing with the research aspects of range condition and trend. I'd like to air these views - the use of association analysis etc., low level photography and satellite imagery, in later issues.

I believe that if we are going to assess the range then we have got to do it correctly from the beginning - there can be no reruns.

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An
in-perpetuity
productivity rating

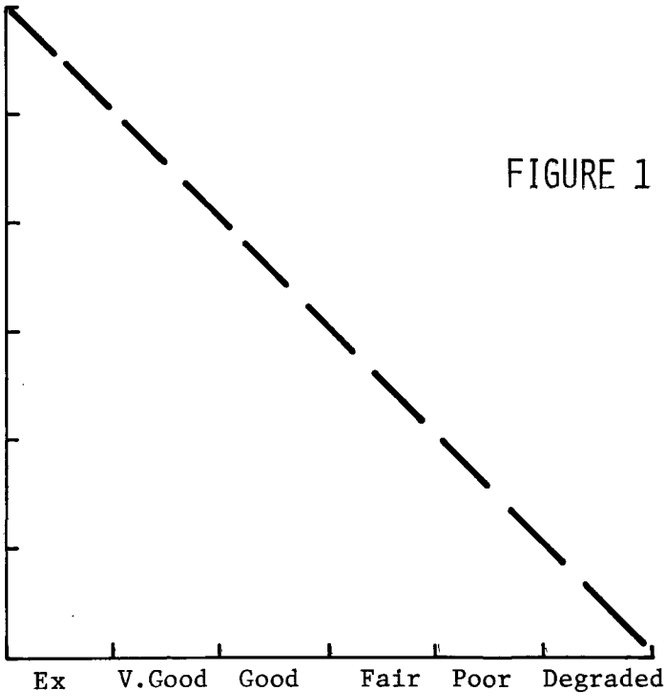


FIGURE 1

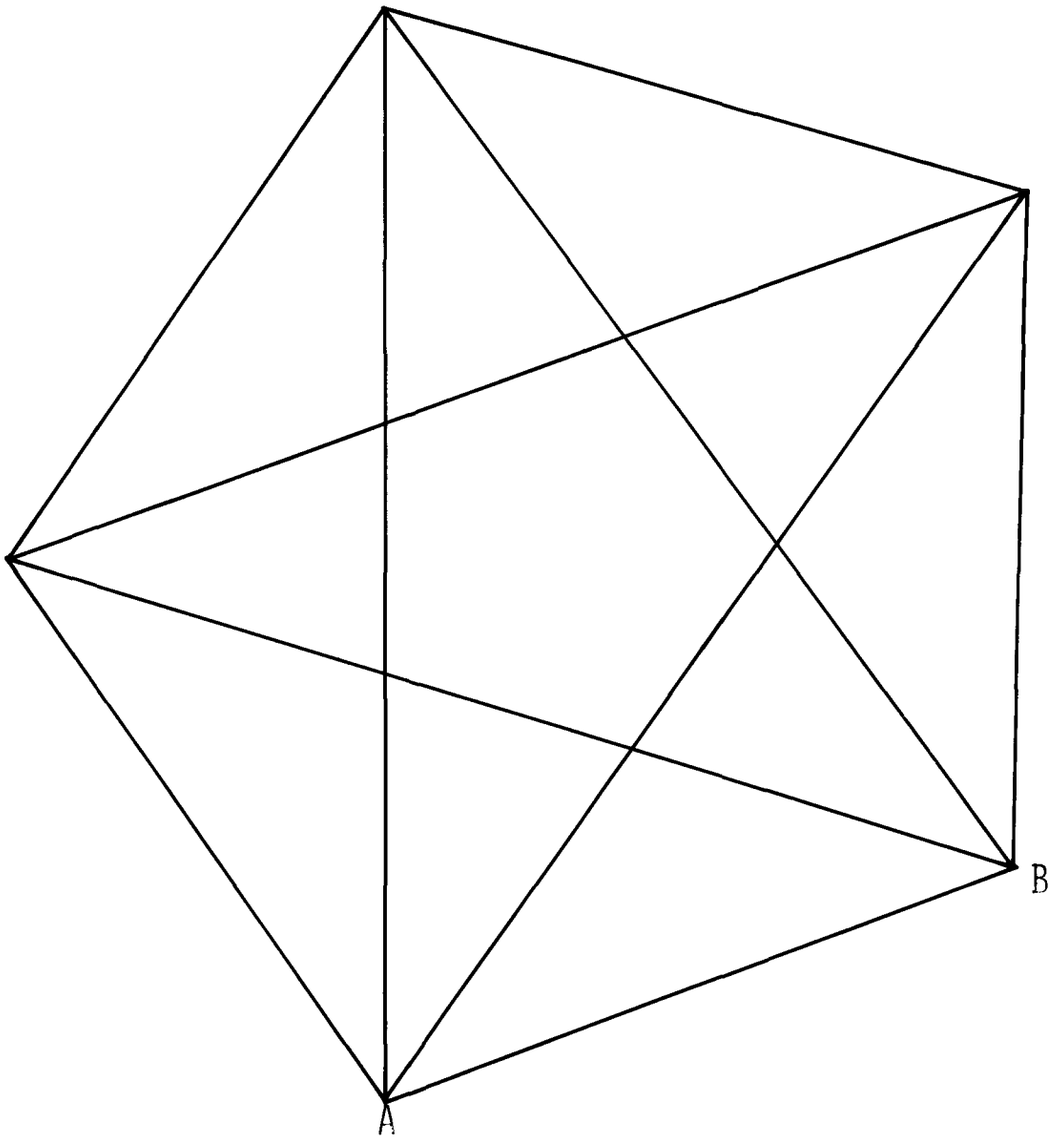


FIGURE 3 A PENTAGONAL LINE TRANSECT PATTERN WHERE TOTAL LENGTH OF TRANSECT = 13.2 x AB

Presettlement

In-perpetuity productivity rating

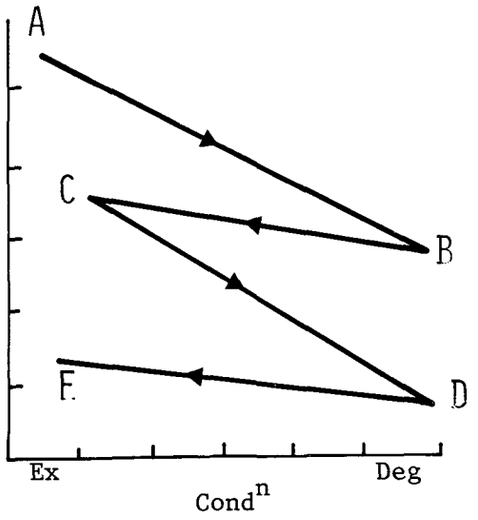
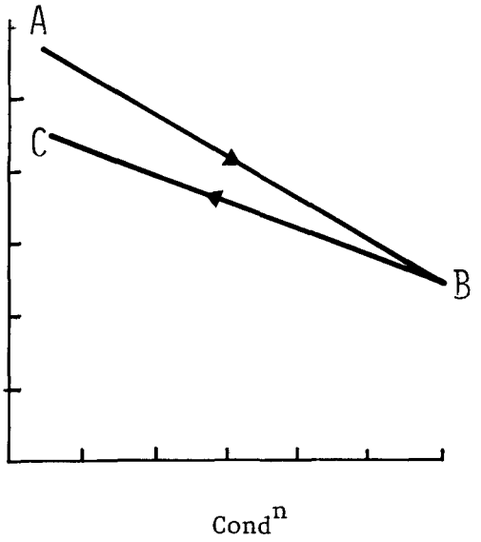


FIGURE 2

CHENOPOD SHRUBLANDS (OR MULGA GRASSLANDS) WITH HEAVY OVER-GRAZING AND TWO CATASTROPHIC DROUGHTS

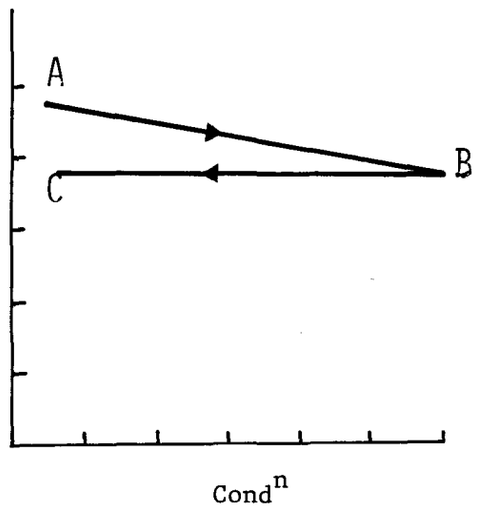
(A)

3



CHENOPOD SHRUBLANDS WITH INITIALLY UNWISE OVERGRAZING BUT WITH SUBSEQUENT EXCELLENT MANAGEMENT. THE SYSTEM IS STABLE ALONG B ⟶ C

(B)



MITCHELL GRASS - A VERY STABLE SYSTEM

(C)

SOME THEORETICAL CURVES OF THE BEHAVIOUR OF RANGE TYPES