The Australian Rangeland Society

RANGE MANAGEMENT NEWSLETTER
An official publication of The Australian Rangeland Society
ISSN 0812-4930

Citation
The material in Rangeland Management Newsletter has not been subject to peer review and may not be acceptable to some editors.

If cited it should be in the form:
Bastin, G. and Allan, G. (2012). After the smoke has cleared: 2011 fire in Central Australia. In: Range Management Newsletter (Ed. N Duckett). 12/2:3-6. (Australian Rangeland Society: Australia).

ISSN 0812-4930

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Range management Newsletter

No. 01/3 December 2001

Registered by: Australia Post – Print Post No. 545270/00001

No. 01/3 November 2001

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CONTENTS **Range Management Newsletter 01/3**

FROM THE EDITOR

Noelene Duckett, 7 Belcarra Place, The Woodlands, Texas, USA, 77382

Welcome to another issue of the *Range Management Newsletter.*

This issue begins with two major articles relating to grazing. Amanda Brook and Mike Fleming give us an overview of a recent study carried out for the National Land and Water Resources Audit examining the use of the grazing gradients for rangeland monitoring. This tool, which uses satellite information to separate grazing effects on vegetation from those due to rainfall and local landscape variability, has been found to provide an objective and comprehensive audit of rangeland condition over large areas. Carly Ballenger has also provided a summary of a study investigating the changes in soil physical properties following grazing by cattle. Using data from a sandy open woodland site exclosed from cattle since 1968, Carly has suggested that only minimal impact on the physical properties of the soil could be detected.

The Federal and State Government funded Gascoyne Murchison Strategy (GMS) is outlined in this issue along with two projects funded by the initiative. Nicola Telcik describes a project which investigated the relationship between Northwest cloudbands and rainfall. Hugh Pringle and Ken Tinley also provide us with some details regarding the Regional Environmental Management Programme, an exciting new activity which seems to busy meeting demand.

As usual this issue contains other information which members and readers may find interesting. This includes the exciting news that the ARS will soon have a website at

www.austrangesoc.com.au

This site will initially contain details of the next Biennial conference to be held in Kalgoorlie, Western Australia in September 2002.

Other articles in this issue of the newsletter include an introduction to the new Council members and our usual Information Snippets section which includes details of various websites, conference, publications and awards currently on offer.

The next newsletter is due out in March next year so I would really appreciate receiving any contributions by early February. Although I am now living overseas contributions can still be emailed to me at nduckett@ozemail.com.au. They can also be posted directly to me at my new Texas address, or to any other member of Council (see the inside cover).

I hope you all have a happy and safe festive season.

BENEFITS OF A GRAZING GRADIENT APPROACH FOR RANGELAND MONITORING IN NORTHERN SOUTH AUSTRALIA

Amanda Brook and Mike Fleming, Pastoral Program, Primary Industries and Resources, South Australia, GPO Box 1671, Adelaide SA 5001

This project was carried out for the National Land and Water Resources Audit (NLWRA). Amanda Brook has worked for the past 9 years applying remote sensing and GIS methods for monitoring of rangelands in South Australia and the Northern Territory. Mike Fleming has worked for 7 years as a Rangelands Officer mostly in the cattle areas of South Australia.

Introduction

Rangeland Assessment in South Australia using conventional field-based methods

Rangeland managers and administrators face similar problems when trying to assess and monitor the condition of Australia's rangelands - how to separate grazing effects from seasonal vegetation changes?

In South Australia, the Pastoral Land Management and Conservation Act (1989) requires the condition of pastoral leases to be monitored to prevent degradation and loss of indigenous plant and animal life.

Monitoring of pastoral leases in South Australia has, for the most part, consisted of conventional field-based methods. These methods include the establishment of permanently marked monitoring sites (photopoints), calculation of a Land Condition Index (LCI), observations by Rangeland Officers, and previous inspection reports.

Photopoints are established to monitor grazing effects at individual permanent waters. There are over 5000 photopoints throughout South Australia's rangelands. They are located at a set distance from water for monitoring grazing effects (1. 5 km in sheep country and 3 km in cattle country). Standard information is collected at photopoints including a comprehensive flora inventory. Quantitative measurements of perennial vegetation cover may also be collected. Each site has at least one set of photographs taken when the site was established, and more if the site has been revisited.

Photopoints are an essential component of any rangeland monitoring system however, they cannot report on the condition over extensive areas, such as the cattle regions of northern South Australia. Photopoints are point-based and provide location specific information. They cover only a very small proportion of an entire property. They can suggest change but provide little information on the cause or extent of this change.

Not every waterpoint in the South Australian rangelands has a photopoint located for monitoring the effects of

grazing. Likewise, not all land types within grazing range have photopoints either. In the cattle areas especially, photopoints are very sparsely distributed, and are biased in their location along access-tracks. Only 900 of the 5000 photopoints established for monitoring grazing effects are located in cattle country (that is pastoral leases, mostly north of the dog fence). The large area requiring monitoring (approximately 41.5% of the State) and the number of sites mean that sites are visited infrequently – only a very small percentage of sites have been revisited. Also, given limited field staff, across a district sites are established and revisited under different seasonal conditions, making comparison between sites difficult.

For monitoring of pastoral leases it is critical the cause of change can be identified. We rely on the interpretive skills of experienced rangeland officers to make judgements on land condition. The only truly objective information people have at their disposal are comparisons of ungrazed areas of the same land type. Extrapolating point-based information to evaluate the area of an entire paddock, lease or landscape type is often used, simply because there is no other option.

To fulfil the requirements of the Pastoral Land Management and Conservation Act (1989), the Land Condition Index (LCI) method was developed for condition assessment of pastoral leases (Lange *et al.* 1994). The LCI is based on visual estimates of key perennial plant species at randomly selected sites along lease access tracks. This method was developed in the chenopod shrublands or sheep country where there is a large perennial vegetation component. It is not suited for use in cattle country due to the more seasonal (ephemeral) nature of vegetation communities (Bastin *et al.* 1998). Spatial and temporal variability add to this complexity.

The difficulty in assessing the rangeland condition in cattle regions of northern South Australia using field-based methods has led to the trial of remote sensing methods. Benefits of using remote sensing for rangeland monitoring have been well documented (Graetz and Pech 1987; Pickup 1989; Pickup *et al.* 1994; and Pickup *et al.* 1998). Imagery provides a wide spatial coverage, enabling all areas within a pastoral lease (and pastoral region) to be covered. Also, the vast archive of imagery permits analysis of past events - important for detecting change in arid rangelands.

Implementation of satellite-based grazing gradient methods for rangeland assessment

The grazing gradient method (Pickup *et al.* 1994) was implemented to provide objective and repeatable data on rangeland condition for an area of nearly 50,000 km^2 in the Marla-Oodnadatta Soil Conservation District, in northern South Australia (Figure 1).

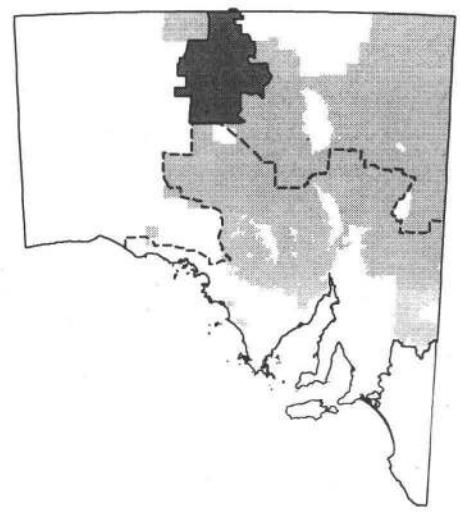

Figure 1. Location of pastoral leases (light grey) and project area (dark grey) in South Australia. Areas grazed by cattle are mostly north of the dog fence (dashed line).

The grazing gradient method allows grazing effects on vegetation to be separated from those due to rainfall and local landscape variability by examining patterns of cover change with increasing distance from water. In arid areas, vegetation cover tends to increase with distance from watering points as grazing intensity decreases, producing a grazing gradient. This pattern is expected in areas where stock graze, it does not necessarily indicate permanent impact. After large rainfall events vegetation cover may be restored. However, where a cover gradient persists after large rainfall events it indicates a degree of land degradation.

The grazing gradient method provides a system whereby we can:

- look at every part of a paddock, a pastoral lease or a number of leases, stratified by landscape type
- divide the region into a grid
- measure and record the distance from water for individual grid cells
- calculate and record the vegetation cover level of individual grid cells at a given point in time
- calculate the average cover value for grid cells at the same distance from water for selected landscape types
- compare the average vegetation cover level at the same distance from water for selected dates
- make the same comparison for every other grid cell.

The real bonuses are the end products of this process. Products include graphs, images and maps that provide a wealth of objective information at a range of scales.

Interpretation of grazing gradient plots

A stylised example of a grazing gradient plot is shown in Figure 2. Vegetation cover is plotted against distance from water points. The lower line represents vegetation cover levels during dry conditions. The upper line

represents vegetation cover levels several months after a major rainfall event. In the example provided there is a gradual increase in vegetation cover from 0 to approximately 8km from water. Beyond 8km from water, the line flattens out indicating little grazing effect in these areas. The wet-period gradient is well above the dry-period gradient, revealing a strong seasonal vegetation response to rainfall at all distances from water. The wet-period gradient indicates long term or permanent grazing effects. This suggests that landscape function has been severely disrupted and the landscape has a reduced ability to produce vegetation in those areas. This type of grazing gradient is known as a permanent normal gradient (Bastin *et al.* 1993). Other common grazing gradients include inverse and composite gradients.

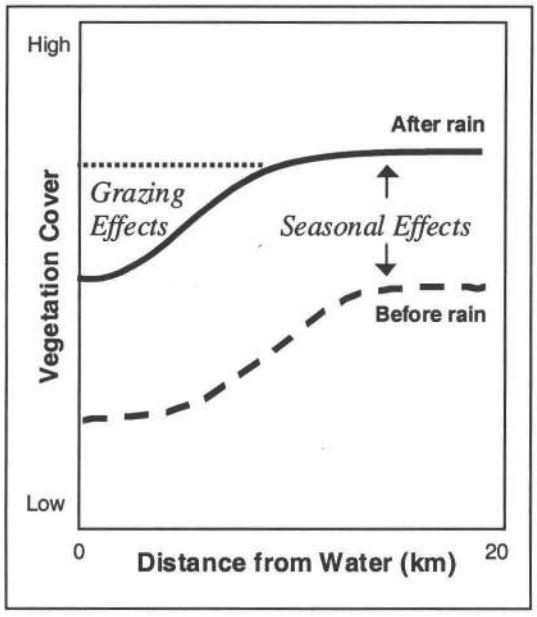

Figure 2. Stylised example of a permanent normal grazing gradient plot.

Methods

This project implemented the Wet Period Average Cover (WPAC) version of the grazing gradient method (Pickup *et al.* 1994). A more detailed description of the methods used in this study is provided in Brook *et al.* (2001).

Vegetation cover, station infrastructure (fence and waterpoints), and landscape stratification data were combined to perform grazing gradient analysis. The pattern of the grazing gradient (vegetation cover) was interpreted to determine the condition of a particular landscape type.

Creation of vegetation cover data sets

Vegetation layers were derived from Landsat Thematic Mapper (TM) satellite imagery. Three rainfall dates were selected for comparison. These were in the summer of 1988/1989 (an extensive and large rainfall event) and February 1997 (again extensive but not as large as the 1989 rain). The rainfall events were selected by checking pastoral lease rainfall records for the region. Landsat TM imagery was acquired for July 1989 and April 1997 for determining wet-period average cover and for October 1988 for determining dry-period average cover.

Prior to calculating a vegetation cover index for each date imagery were rectified and then radiometrically calibrated using invariant targets and robust regression techniques after Furby *et al.* (1996). Vegetation cover index layers were calculated for all image dates using the pd54 index (Pickup *et al.* 1994).

Creation of distance from water and landscape stratification data sets

In addition to vegetation cover data sets, there are 2 essential GIS data sets required. These are (1) distance from water layer and (2) landscape stratification layer to reflect the grazing preference of cattle. The distance from water data set was created from paddock boundaries and water point locations already available for the project area. A suitable landscape stratification layer was not available for the project area. As a result, a rapid method of creating improved landscape stratification was developed. Landscape stratification needs to reflect livestock preferences. The available regional-scale land system mapping was too coarse for this purpose. Geology data was used to subdivide mapped land systems into component geological units. Geology units were then grouped into major land types based on their vegetation composition and soils, better representing the grazing preference of cattle.

Grazing gradient analyses

Grazing gradient analyses was carried out using software developed by CSIRO, Alice Springs. Grazing gradient analysis was carried out at a regional scale for reporting to the NLWRA. Grazing gradient plots were produced for land systems and major landscape types within the study area for (1) permanent and major semi-permanent waters and (2) all waters.

Due to time constraints, field verification was not possible. Interpretation of grazing gradient plots was assisted by rangeland assessment officers with extensive experience in the study area. Existing ground-based monitoring data were used to verify results where available.

Results and Discussion

Grazing gradient plots, summarising vegetation cover changes with distance from water for all water points within a landscape type were produced for 19 land types, in 10 land systems in the project area. The landscape types analysed represented 70% of the project area, or 30,000 km^2. A selection of plots is presented below to illustrate information obtained from a grazing gradient approach.

Identification of grazing effects from seasonal vegetation response

The ability to separate grazing effects from those due to rainfall variability is shown very clearly in Figure 3. Vegetation cover is reduced between 0-9 km in both wet dates suggesting a reduction in landscape function within this distance range. Beyond 9 km, there is little change in average cover and the landscape appears fully functional with optimal cover levels occurring in both wet dates. A significant feature is the different responses in wet-dates to 9 km from water, beyond which the lines converge. Between 0-9 km, the different cover response to rainfall is due to grazing effects. Beyond 9 km, i.e. beyond the influence of grazing, cover response is similar for both wet dates. The difference in cover between the wet and dry dates reflects seasonal change in vegetation.

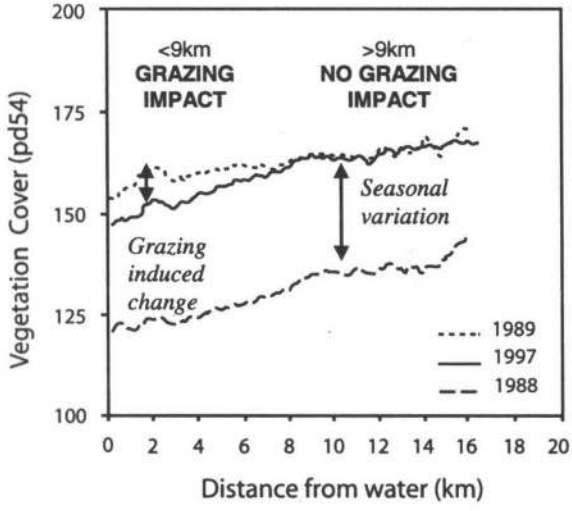

Figure 3. Grazing gradient plot for Alberga land system (mulga dominated sand plain) showing identification of grazing effects from seasonal effects on vegetation cover.

Ecosystem stability and species composition change

The basis of the Wet Period Average Cover method is to detect change in total cover. However, information about species composition change can also be provided. The grazing gradient plot for the Coongra land system revealed an increase in barley Mitchell grass, as well as less palatable shorter-lived species closer to water under favorable seasonal conditions (Figure 4). There is a consistent grazing gradient out to 11 km from water in both the 1988 dry and 1997 wet-period, indicating an increase in vegetation cover away from water. However, the 1989 wet-period shows a consistent decrease in vegetation cover from 2 to 11 km from water. There is also a much higher level of vegetation cover close to water following the 1989 rainfall than the 1997.

For the Coongra land system, the closeness in vegetation cover for the two wet-periods provides a measure of ecosystem stability. The largest fluctuations in cover, indicated by the greater separation between the 1989 and 1997 average cover levels, occur in the areas closer to water. Areas beyond 11 km from water are much more stable, as indicated by similar cover levels, and seasonal fluctuations in vegetation cover do not occur on the same scale.

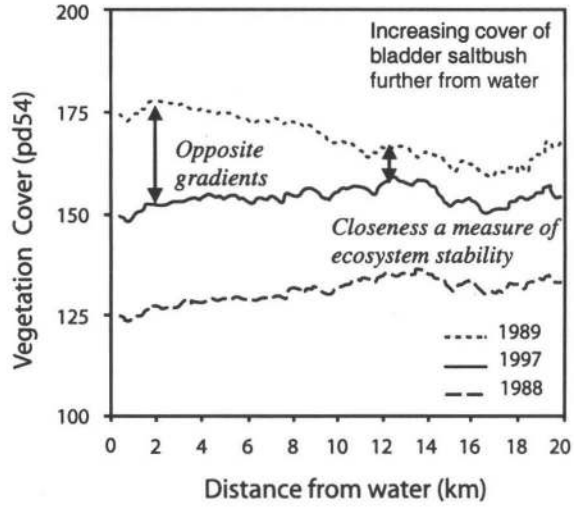

Figure 4. Grazing gradient for the Coongra land system suggests species composition changes in areas closer to water.

Comparison of vegetation response of sandy and stony landscape types

The main focus of the grazing gradient is to identify where grazing has reduced the ability of landscapes to respond to rainfall. However, it also provides information about the natural fluctuations in vegetation cover in response to rainfall events, increasing our understanding of ecological processes in different landscape types.

Some overall differences in the vegetation responses can be seen between sandy and stony landscape types. The 1989 rainfall event produced a consistently bigger vegetation response than the 1997 event in the stony landscape types (Figure 5a). In contrast, cover levels were very similar in the sandy landscape types (Figure 5b). There were much larger seasonal fluctuations in cover in the stony landscape types compared to the sandy landscape types. The similar cover levels in the sandy landscape types suggest maximum vegetation response occurred in both years, indicating that factors other than rainfall may limit plant growth when water is plentiful.

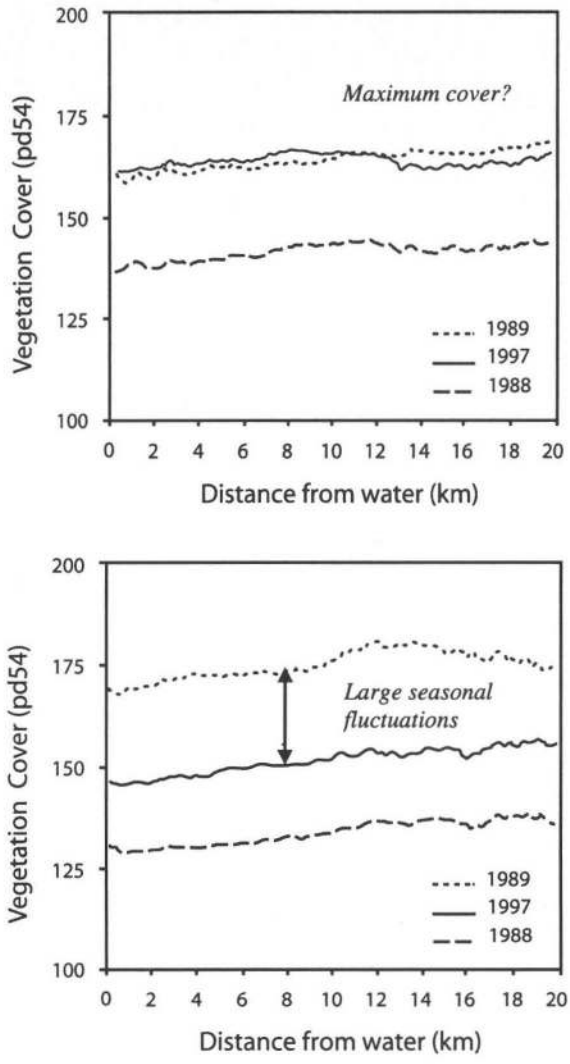

Figure 5. Grazing gradients for (a) above - stony landscape type (Oodnadatta land system) and (b) below - sandy landscape type (Pedirka land system).

Conclusions

The grazing gradient method provides an objective and comprehensive audit of rangeland condition over large areas. Major benefits of using the grazing gradient method for reporting are that it is objective, quantitative and repeatable. Importantly, it provides a benchmark from which future changes may be measured. Often, the complexity in the results poses further questions as to why a particular response has occurred. Investigating and accounting for these responses leads to greater understanding of ecological processes and an appreciation of subtle variations in the landscape.

The method does require local ecological knowledge and skill to interpret the results highlighting the need for a multi-disciplinary team. Consideration of a range of factors is essential in interpreting the grazing gradient plots including: landscape type, position of water points within the landscape, different seasonal responses of vegetation, changes in vegetation community species composition and differences in rainfall events. Although initially daunting, interpretation of the plots proved to be very rewarding in the additional information they provided.

Another output of the grazing gradient method is resilience images. These are maps of observed vegetation response compared to expected response with the difference providing a measure of resilience. Resilience images provide location-specific detail on vegetation response necessary for identifying areas with below average vegetation response. However, they were not generated for this project due to time constraints.

There is considerable potential to integrate ground-based monitoring to better understand the actual changes occurring to the soil and vegetation. This could occur by applying the grazing gradient method at the property and paddock scale. Ground-based monitoring sites could be located at distances from water where change in vegetation is indicated by the grazing gradient plots. Landscape function analysis criteria could then be used to measure the disturbance to ecological processes on the ground at these points (Ludwig *et al.* 1997). Establishment of ground-based monitoring sites to quantify the change in landscape function on the ground would enhance our ability to interpret change detected by remote sensing methods.

An advantage of the grazing gradient method is that the same data can be used to provide summaries of land condition at the regional, lease or paddock scale. Application at the lease scale identifies areas at risk of degradation and provides information for detailed land management objectives. Application at a regional scale (landscape types) provides information for national rangeland monitoring. Additionally, the outputs produced (statistics and output data sets) that are useful to other agencies involved in natural resource management.

The project report makes the following key recommendations:

1) The grazing gradient methodology be adopted as part of the National Rangelands Monitoring Program:
   a) Application at a lease and/or paddock scale to fulfil requirements of the South Australian Pastoral Land Management and Conservation Act (1989), to provide information for property land management objectives.
   b) Application at a regional scale (by landscape type) for reporting to National Rangelands Monitoring Program.
2) A network of ground-based monitoring sites be established, selected from paddock scale grazing gradient plots that can be used to quantify change in landscape function.
3) Further development of image based products such as change maps (resilience).

Further information

The full report produced for the NLWRA 'Indices of change in ecosystem function (cover) for northern South Australia using Landsat TM' can be downloaded from the

rangelands area of the Audit web site: www.nlwra.gov.au/atlas.

Acknowledgements

This project was carried out whilst the Pastoral Program was within the South Australian Department for Environment and Heritage (DEH). The authors acknowledge the funding support of the National Land and Water Resources Audit and DEH. We would particularly like to thank Gary Bastin and Rodger Tynan for support and advice. Our thanks also to the many people who assisted in the project.

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THE IMPACTS OF GRAZING ON SOIL PHYSICAL PROPERTIES IN A SANDY OPEN WOODLAND, CENTRAL AUSTRALIA

Carly Ballenger, Department of Primary Industry and Fisheries, PO Box 8760, Alice Springs NT 0871.

Background

Hard-hoofed domestic stock are known to cause changes in soil physical properties in Australia's rangelands. Despite the available literature on the impacts of grazing on soil compaction, no studies have been undertaken involving long-term cattle grazing exclosures in the Alice Springs region. In addition, the majority of similar studies were undertaken under stocking rates of approximately 0.1-39 sheep/ha. Such stocking rates are considerably higher than those in Central Australia, which are typically between 4-6 cattle/km^2 (or 0.04-0.06 cattle/ha) in open woodlands.

The objective of this project was to identify differences in soil physical properties as a result of thirty-two years of grazing exclusion in a sandy open woodland northeast of Alice Springs.

Methods

The study site

The study site for this project was Spinifex Bore exclosure on Mt Riddock Station, approximately 140 km northeast of Alice Springs. The exclosure was 1600 x 800 m in size and was situated between 1.6 and 3.2 km from the bore. The bore was drilled in 1954, suggesting that frequent cattle visitation to the site occurred for 14 years before the exclosure was constructed in 1968. The vegetation at the exclosure was a sandy open woodland with sparse low trees over kerosene grass (*Aristida contorta*) and woollybutt grass (*Eragrostis eriopoda*) (Perry *et al.* 1962). The soil at the study site was classified as a Kandosol and consisted of massive coarse sand surface (0-30 cm) overlying massive loamy sand (>30 cm).

Data collection

The experimental design consisted of 8 sampling locations inside the exclosure and 8 outside the exclosure. The soil parameters measured were bulk density, soil resistance, infiltration and the depth of tyre tracks.

Bulk density, the weight of a known volume of soil, was measured twice at each sampling location at depths 0-5cm, 10-15 cm, 20-25 cm and 30-35 cm.

Soil resistance was measured using a Cass Spring Penetrometer, which measures the mechanical resistance of the soil to penetration by a metal probe (Figure 1a). Eight soil resistance measurements were taken at each

sampling location at depth intervals of 5 cm to a depth of 60 cm.

A disc permeameter (Figure 1b) was used to measure two parameters of infiltration - sorptivity and steady state flow rate (SSFR). Sorptivity is the initial infiltration of water into the soil and is determined by the attractive forces between the soil and water. SSFR is the steady rate of water movement through the soil and is determined by gravity and capillarity.

The depth of tyre tracks was used as an illustrative and non-technical method. A Toyota Landcruiser Utility was driven over each sampling location at constant revs for approximately 50 m and 30 measurements of depth were taken from the driver's side tyre track.

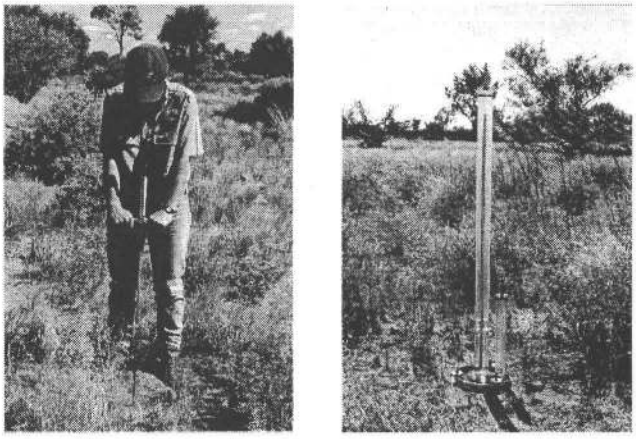

Figure 1. Some of the equipment used to measure soil parameters at the Spinifex Bore study site. (a) left - Measuring soil resistance with a penetrometer. (b) right - A disc permeameter used for infiltration measurement.

Results

Bulk density values were within the range of 1.46 – 2.00 g/cm^3 (Figure 2). Bulk density was higher in the grazed soil compared with the ungrazed soil at all depths but the difference was statistically significant at the 10-15 cm depth only (P<0.001). At this depth the average bulk density difference was 0.03 g/cm^3.

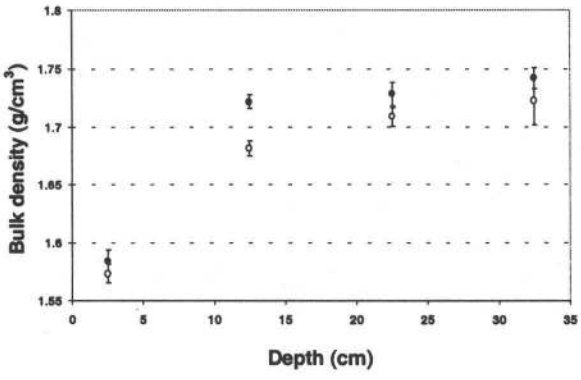

Figure 2. Average soil bulk densities (± standard errors of the means) for varying depths at sampling locations within and outside the exclosure. (• = grazed, • = exclosed).

Soil resistance was significantly higher in grazed soil compared with the ungrazed soil (P<0.001 for 5-55 cm depths, P=0.007 for 60 cm depth). The difference between grazed and exclosed soils ranged from 0.13-0.5 MPa, becoming smaller as sampling depth increased (Figure 3).

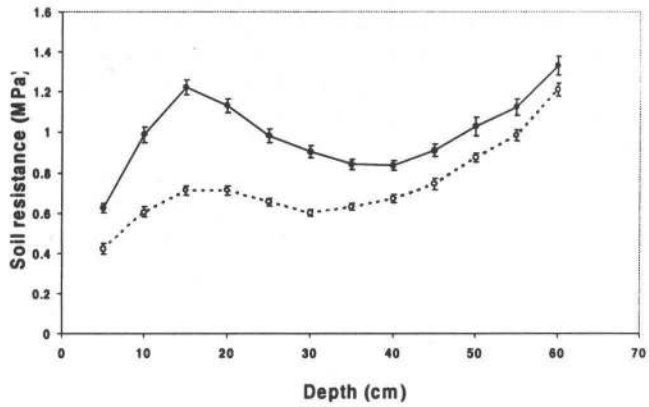

Figure 3. Average penetrometer values (± standard error of the mean) for sampling locations within and outside the exclosure (smooth line = grazed, dotted line = exclosed).

The depth of tyre tracks was significantly higher in the exclosure compared with grazed soil (Table 1).

Table 1. Average tyre track depth and standard errors for sampling locations within and outside the exclosure.

Treatment	Depth of Tyre Track (cm)	Standard Error
Grazed	1.20	0.050
Exclosed	3.05	0.056

There were no significant differences in infiltration between the grazed and exclosed soil (Table 2).

Table 2. Averages of infiltration parameters (with standard deviations, sd) for sampling locations within and outside the exclosure.

Treatment	Mean SSFR (and sd) (mm/min)	Mean Sorptivity (and sd) (mm/min$^{1/2}$)
Grazed	7.8 (3.7)	15.0 (4.4)
Exclosed	6.7 (3.2)	9.6 (4.9)

Discussion

The influence of grazing exclusion on soil physical properties

The soil resistance and tyre track depth results suggest that grazing has caused soil compaction around the exclosure. The differences in soil resistance are comparable to lower levels of differences observed in other studies (Braunack and Walker 1985; Greenwood *et al.* 1997; Pettit *et al.* 1998; Yates *et al.* 2000). These previous studies were undertaken under sheep grazing at intensities of 0.5 – 20

sheep/ha, with smaller differences in soil resistance being found when comparing ungrazed pasture with pasture under lighter stocking intensities.

Bulk density values at the study site correspond with typical sandy soil bulk density values as suggested by Vepraskas (1988). The differences in bulk density attributable to grazing were statistically significant at the 10-15 cm depth but this difference was only an average of 0.03 g/cm^3 - much less than differences found in other studies. Once again, differences in other studies were from soil subjected to sheep grazing (Witschi and Michalk 1979; Andrew and Lange 1986; Hacker 1986; Greene and Tongway 1987; Yates *et al.* 2000). Other studies in sheep country have found no influence of grazing on bulk density at stocking rates of 0.8 and 8 sheep/ha (Greene *et al.* 1994; Proffit *et al.* 1993).

The depth to which grazing appears to have influenced the soil is likely to be a result of the sandy nature of the soil. The majority of similar studies only measured bulk density to depths of 10 cm or shallower, however this is because in medium-heavy textured soils the effects of compaction tend to be limited to the top 10 cm of soil. Packer (1988) suggests the effects of compaction may be evident to 60 cm depth in lighter textured soils.

The minimal differences in soil compaction observed can be attributed to three main reasons. Firstly, due to the closely packed nature of particles in sandy soils, compaction cannot occur without crushing the particles (Daniel 1998). Secondly, due to the dry climate and thus dry nature of the soils in the region, the soils are less susceptible to compaction due to trampling than moister soils in higher rainfall regions. Thirdly, the Spinifex Bore study site has lower stocking rates compared with sheep grazing areas where the majority of similar studies were undertaken.

The tyre depth was used as a demonstration for visualisation of soil compaction only. Differences in tyre depths cannot be related directly to the influence of grazing on plant growth. Despite this, this method has proven to be a useful and simple illustrative method for reporting differences that can be felt when driving over the site.

The influence of grazing exclusion on the soil-water relationship

All infiltration rates at the Spinifex Bore study site were high in comparison with the majority of similar studies. However, as mentioned previously these similar studies were undertaken in heavier textured soils than at Spinifex Bore. The higher infiltration rates at Spinifex Bore appear related to the sandy nature of the soil.

Once again, significant differences in infiltration due to grazing in similar studies were found under stocking intensities higher than those in Central Australia. Similar studies found differences under higher stocking intensities (e.g. 7-22 sheep/ha) (Willatt and Pullar 1983; Proffitt *et al.* 1993; Yates *et al.* 2000).

The lack of significant differences in infiltration between grazed and ungrazed soils suggests that although differences in soil physical properties are present, these differences are not large enough to influence infiltration. This suggests that 32 years of grazing has resulted in minimal changes in soil porosity and thus minimal influence on the soil water relationship.

The potential influence of changes in soil physical properties on the pasture

The influence of soil physical properties on plant growth is difficult to assess due to variation in soils and variation in species physiology, morphology and growth. Particularly important is soil moisture and texture class differences (proportions of sand, silt and clay). In addition, the response of plants to altered soil physical properties is combined with the influences of livestock grazing. Despite this, some general comments can be made.

Although differences in soil resistance between grazed and exclosed sites are comparable to those of other studies, these differences are likely to have only minimal impact on vegetation. Cass (1999) has suggested some broad benchmark values for the impacts of soil resistance on root growth. These are:

- < 1 MPa - no restrictions to root growth;
- 1-2 MPa - retardation of seedling emergence and restriction to root growth;
- > 2-3 MPa - impedance of root growth.

Comparing these benchmark values with results from Spinifex Bore, the top 5 cm of soil inside and outside the exclosure would not be restrictive to plant growth. In grazed pasture the soil resistance at 10–25 cm depth is within the range at which root growth is likely to be restricted and seedling emergence retarded. However, soil resistance at this depth is unlikely to influence seedling emergence as the majority of seed germinations occur in the top 1.5 cm of soil (Silcock 1973). At 50 cm depth in grazed pasture, resistance increases again due to increased depth but this is likely to have only minimal influence on pasture growth.

Vepraskas (1988) has also suggested some benchmark values relating to bulk density in sandy soils whereby bulk densities of over 1.66 g/cm^3 will restrict root growth and over 1.85 g/cm^3 will prevent root growth. If this is related to Spinifex Bore, then from 10 cm depth and below, in grazed and exclosed sites, bulk density is restricting root growth. However, as mentioned previously, the difference in bulk density between grazed and exclosed soils at 10-15 cm depth is small (0.03 g/cm^3) and therefore the restrictions are not a result of grazing impacts.

These comparisons with benchmark values suggest that although differences in bulk density and soil resistance were statistically significant, they are unlikely to have any biological significance.

Further work

Further work is warranted on the impacts of grazing on other soil types in the region, particularly those soils with

higher clay content. In addition, the influence of soil physical property changes on plant growth characteristics of the dominant pasture species would be useful, as the majority of benchmark values currently available are based on cropping species (eg cotton and tobacco).

Conclusion

This study suggests that on sandy soils in Central Australia 32 years of cattle grazing has had minimal impact on soil physical properties. This is a result of the sandy nature of the soil, the comparatively low stocking rate and arid climate. The changes that have occurred after 32 years of grazing exclusion are small compared with previous studies conducted in sheep grazing areas. As a result of such minimal changes there is likely to be only limited influence on plant growth as suggested by the absence of significant differences in infiltration.

Acknowledgments

I would like to thank the Cadzow family for allowing this study to be undertaken on Mt Riddock Station.

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THE GASCOYNE-MURCHISON STRATEGY: A PILOT FOR THE NEW WAY FORWARD FOR RANGELANDS?

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The Gascoyne-Murchison Strategy (GMS) is a regional initiative implemented in 1998 to address critical economic development, structural adjustment and natural resource management needs in the Gascoyne-Murchison region of rangeland Western Australia.

Funded by the Western Australian Government, and the Federal Governments' Natural Heritage Trust and Rural Adjustment Scheme, GMS is based on an area in excess of 570,000 km^2, encompassing the entire Gascoyne River (the longest river in Western Australia) and Murchison River catchments.

Two of the main tasks over the next two years for GMS are to develop:

- new institutional arrangements for managing the rangelands; and
- management techniques for ecological sustainable pastoral management.

New institutional arrangements for managing the rangelands

Within this component we will be looking at:

- A body of rangeland stakeholders (based on regional NRM arrangements) to oversee and set triple-bottom line sustainability targets that meet industry and community expectations. This body needs to be part of and hooked into the decision making process like an NRM Council and/or Cabinet Sub-committees that oversees the meeting of ESD targets set by the Sustainable Development Unit of the Government.
- Developing a Quality Management Framework to drive the implementation of these targets. This framework will be based on setting:
  - social, economic and environmental aspects (impacts/risks),
  - targets to reflect these aspects,
  - standards and benchmarks to meet targets,
  - codes of practices and Best Management Practices to guide resource use, and
  - evaluation and reporting requirements to influence decision making and policy.
- A review of our tenure arrangements to meet the sustainable use of WA's rangeland for the benefit of all.
- Predicating the management and development of the rangeland within the State's planning process.
- The management of the natural resources through a quality assurance approach and statutory imposition of the environmental bottom-line.

Management techniques for ecological sustainable pastoral management

In this component we will continue to:

- Enhance the broadscale background landscape under production to increase biodiversity through total grazing management based on a landscape ecology, land capability approach;
- Develop off-reserve techniques to preserve isolated "gems" of biodiversity, e.g. hotspot areas within current production and areas outside water access; and
- Encourage the preservation of biodiversity "Jewels in the Crown" within managed reserves

We invite you to visit our region – come and stay with us, visit our station stays or our parks and reserves - experience the Gascoyne Murchison region and enter some dialogue with us on how we can inspire each other to maintain the passion, to make living and working in the rangelands better. Give us a call on 08 9956 3317 if you want to know more.

NORTHWEST CLOUDBANDS AND THE GASCOYNE-MURCHISON REGION

Nicola Telcik, Centre for Water Research, University of Western Australia, Nedlands WA 6009

Northwest cloudbands are one of three types of cloudbands that originate over tropical waters and cross Australia. The northwest cloudband forms off the northwest coast of Australia and can reach lengths of up to 8000 km, making it easily visible from space. But most importantly, they can be a vital source of rainfall to many regions of Australia during the April to October season.

The current research of northwest cloudbands has been conducted at the University of Western Australia and funded by the Gascoyne-Murchison Strategy. This study has investigated the behaviour of the large cloud structures and the resulting rainfall. The main objective of the study was to understand cloudband behaviour to enable a predictive capability.

The northwest cloudband season is from April to October. During this season, there are roughly 33 days when a cloudband is present over Australia. Of these 33 days, there are about 22 days when the cloudband has some portion specifically over the Gascoyne-Murchison region. Most of the cloudbands cross Australia during April to June, and most of these cloudbands will first cross Australia over the Gascoyne-Murchison region.

Northwest cloudbands have been known to contribute significant amount of rainfall to Australia. A study by William Wright at the Bureau of Meteorology (Wright 1997) showed that these cloudbands could contribute up to 80% of the northwest region's rainfall. The rainfall

contributions, however, vary considerably from place to place and from season to season. Some years this rainfall contribution may be 80% and the next year it could be less than 10%. Therefore, understanding what could be changing this rainfall percentage would be beneficial.

What influences these cloud structures? What could determine how many cloudbands will cross Australia and how much rain they will contribute? The answers to these questions are complex. Northwest cloudbands generally form in the tropical eastern Indian Ocean. The temperature of the air and sea surface, the associated wind patterns and circulations can all affect these clouds forming. But what is happening in the oceans all around the world can also affect what is happening off the northwest.

One particular circulation that receives a lot of media and scientific attention is the El Niño Southern Oscillation. Although this occurs in the Pacific Ocean, its effects are felt in the Indian Ocean. The El Niño Southern Oscillation (or ENSO) is the movement of unusually warm or cool waters in the Pacific Ocean. ENSO oscillates between two extremes: El Niño (warm phase) and La Niña (cool phase). The unusual sea surface temperatures are associated with unusual movements of air circulations, trade winds, convection and pressure.

So, in studying the northwest cloudbands, an almost global approach needed to be taken in examining its behaviour. Large data sets of sea surface temperatures in the Indian and Pacific Ocean were examined. The main regions that showed a relationship with northwest cloudband activity were in the region of cloudband generation and immediately adjacent; the waters off the southwest of Australia, and in the equatorial Pacific Ocean. Other data that showed relationships with the northwest cloudband activity were the Southern Oscillation Index (which is also associated with the El Niño Southern Oscillation) and a short-scale oscillation called the Madden Julian Oscillation, which originates in the same area as the cloudbands.

The effects of ENSO are usually seen when ENSO is in one of its extremes (either El Niño or La Niña). During these extremes, northwest cloudband activity tends to be either low (during an El Niño event) or high (during a La Niña event). During the neutral stages of ENSO (years between El Niño or La Niña), the effects of ENSO are difficult to observe. The effects of the Madden Julian Oscillation are seen every year. When there are years with many Madden Julian Oscillations moving from the tropical Indian Ocean towards Australia, there is more cloud formation and cloud movement towards Australia.

After investigating these relationships, a method for predicting northwest cloudbands was created. The prediction is for how many days there will be a cloudband over Australia (or the Gascoyne-Murchison region) in the approaching season. Predictions can be made up to eight months before the start of the cloudband season in April. As the season approaches, the method for prediction improves. Predictions for the cloudband season can be made up until the first week in June (which is during the cloudband season).

More information about northwest cloudbands can be found at the Centre for Water Research website - www.cwr.uwa.edu.au/~telcik/menu.html, or by contacting the Gascoyne-Murchison Strategy group on 08 9956 3317.

Acknowledgements

The Gascoyne-Murchison Strategy provided funding for this project. Guidance was obtained from J. Cramb, W. Drosdowsky, G. Meyers, N. Nicholls, I. Smith, M. Wheeler and W. Wright.

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LANDHOLDERS DESIGNING WITH NATURE: AN APPROACH TO OFF-RESERVE CONSERVATION IN THE GASCOYNE-MURCHISON STRATEGY AREA

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[Ed. – This paper was presented at the Northern Australia Beef Industry Conference held in Kununurra on the 8-9 November. Further details about this conference are given in the Information Snippets of this newsletter]

What is "the EMU process"?

The "EMU process" is a major activity within the Gascoyne-Murchison Strategy's Regional Environmental Management Programme. It aims to help pastoralists understand more intimately the critical ecological processes occurring across their stations and to respond in a way that uses, rather than opposes those processes. The underlying principle of the EMU process is "working with natural processes, not against them".

The process has been developed in shearing sheds, kitchens and on vehicle bonnets in the field. Pastoralists are legitimate (rather than token) partners in the process. These partnerships underpin the success of the process: we are struggling to meet demand, despite not having formally

advertised our services. Demand is being driven by word of mouth.

The EMU process is based on capturing local expert information on clear overlays on top of land system maps of stations. We then use simple questions to help pastoralists recognise the driving ecological processes and areas requiring concentrated management effort, be that to seize opportunities or to address problems (or both). The first mapping exercise produces a base line against which ongoing monitoring results are assessed. The process is entirely voluntary and all outcomes (e.g. overlay maps) belong to the participants.

Indigenous heritage values are included in the process, and play a major role when dealing with Aboriginal stations. Some non-Aboriginal pastoralists have also requested that local Aboriginal representatives' values be included in developing informal cultural management strategies for their stations. The process readily accommodates multiple land use objectives.

We have also developed monitoring techniques for initiating close dialogue with managed landscapes. Locating monitoring effort is strongly influenced by the overlay mapping procedure such that it is located at critical "finger on the pulse" locations and with specific issues and objectives in mind. Features monitored include a mix of retrospective "impact" attributes (e.g. soil erosion) and early warning (hazard or opportunity) variables (e.g. utilisation rates and recruitment).

The long-term objective of the EMU process is to empower individual managers and local pastoralist communities to take ownership of environmental management, recognise and address the critical issues together, and develop firm foundations for a sustainable future.

The "EMU" vision of ecologically sustainable rangelands

Managing biodiversity

Formal nature conservation is accommodated through a CAR reserve system and a network of smaller priority areas under formal conservation agreements. Some of these smaller areas are excised from pastoral leases and have legally binding conditions, particularly if public funds are involved. However, many small areas remain within pastoral leases and are managed sensitively. They remain important parts of stations (Pringle 1995). Three important types of "station reserves" exist:

1. *Ecojunctions*: Areas where many types of land come together. These areas are disproportionately highly representative of local biodiversity. They contain many ecotones supporting biodiversity adapted to "edges" and reveal linkages between landscapes. Sensitively managed ecojunctions can thus make a major contribution to conservation of local biodiversity, serve as "landscape laboratories" and may provide benchmark context for similar landscapes more widely spread across stations. Ideally they are protected from grazing by livestock and feral animals. Ecojunctions typically occupy little area of any station.
2. *Grazing refuges*: These are areas remote from natural and artificial sources of water. Refuges are used as benchmarks to understand monitored changes in similar, but more widespread and conventionally grazed landscapes. They are also likely to contain local biodiversity ill adapted to grazing management (James 2000).
3. *Specific biodiversity values*: These are local "jewels in the biodiversity crown" that require particular management not usually provided by conventional grazing management. Examples include particularly fragile landscapes susceptible to erosion (e.g. coastal dunes and breakaways), important wetlands and other drought refuges, or populations or rare species and their local habitats (Morton *et al.* 1995). These areas are identified from databases and importantly, by local experts; pastoralists.

Managing the pastoral matrix

The more conventionally grazed matrix is regularly monitored, particularly at critical control points and sensitive (rather than representative) areas of stations. Pastoralists have their fingers on the pulse of the land, manage variability in time (e.g. climate) and space (e.g. mixes of country types) with increasing effectiveness. This "learning pastoralism" (or ESPM) features:

1. Management priorities identified by mapping and assessing salient features on clear overlays
2. Strategic management focused on driving processes at critical control points across stations, sub-catchments and catchments
3. Regular monitoring on the ground and from the air and mapping of results on clear overlays
4. (At least) annual reviews in a never ending and systematic learning process
5. Regular meetings with neighbours to discuss landscape management and co-ordinate and review catchment management issues.

ESPM will not only benefit biodiversity; it will also strengthen pastoral landscapes, businesses and communities by:

1. Increasing rainfall efficiency as canalised drainage systems are gradually rehabilitated, thereby restoring soil moisture regimes and, as perennial plant cover is improved/maintained
2. Increasing production through more efficient use of landscape toposequences (strategic use/rest)
3. Improving flock/herd structure using Total Grazing Management systems (strategic use of infrastructure)
4. Decreasing cost of production through more strategic, rationalised infrastructure
5. Improving prices through environmentally certified production and strategic eco-branding
6. Socialising station management as management issues are discussed and mapped together
7. Increasing self-reliance among station enterprises as pastoralists realise their management potential and consciously wean themselves of Government advice

8. Environmental reporting conducted by pastoralists, with inspectors spending more time helping pastoralist groups than undertaking regulatory activities
9. Increasing local cohesion as Government dependence gives way to local inter-dependence and innovation, realising landholder potential.

Important features of this framework for ecological sustainability include:

1. Physical or psychological barbed-wire fences do not separate management of biodiversity and grazing management. Rather, emphasis varies across stations and regions in a shifting balance that is locally flexible and regionally effective (Morton *et al.* 1995). Biodiversity management becomes an opportunity for pastoralists, who are rewarded in the market place with assured access and price premiums.
2. ESPM is based on base-line maps of salient features and intimate dialogue with managed landscapes. The outcomes of those regular discussions are recorded visually. This mapping approach can be employed at a range of scales and accommodate multiple value systems. It allows changes to be assessed in terms of previously recorded salient features and dialogues as part of a learning process.
3. ESPM provides a framework for increased social cohesion at enterprise and community levels. Pastoralists become increasingly self-reliant and inter-dependent at enterprise and community levels, and Government officers become more focused on auditing station Environmental Management Systems and reports, as well as providing technical input on request. Apart from regulatory activities, Government services are provided to meet demand, rather than on the basis of perceived pastoralist needs.

Is the "EMU process" a dream, hallucination or emerging reality?

ESPM is an emerging reality in the Gascoyne-Murchison Strategy. Despite budget cuts in the region, Government Departments are currently organising additional resources to meet demand from pastoral communities for "the EMU process". Over twenty stations involving more than three million hectares have already commenced the "EMU process". At least that many stations have formally requested participation in the next year. Pastoralists and Government departments from other regions have also expressed interest in spreading the project beyond the current region.

The Murchison Land Conservation District Committee has engaged the EMU to help them with a catchment management initiative focused on recovering the health of the riverine plains and riparian habitats through co-ordinated and strategic catchment action. This innovative, catchment-level approach is underway.

Two formal off-reserve agreements have been developed and several are under negotiation. They include a major bioregional junction area occupying well over 100,000 ha on two adjoining stations, a nationally listed wetland of less than 5 000 ha and a population of rare and endangered plants on a single breakaway system occupying less than 2000 ha. Formal agreements being considered include covenants with the National Trust, Section 16A Agreements or legal contracts between pastoralists and the Department of Conservation and Land Management, Indigenous Protected Areas, and caveats on pastoral leases.

Experience shows that it is far easier to identify potential areas and plan their future management than it is to seal formal agreements. Pastoralists seem nervous about the implications of "signing away" land, and Government is anxious that public funds should provide lasting outcomes. A simpler outcome might be to leave agreements informal. This is happening, but sensitive management of biodiversity may be replaced at the whim of the pastoralist or at sale of the lease. Informal arrangements also rely on altruism from pastoralists, who have been suffering from severe financial stress in recent years.

The "EMU process" is changing pastoral management. One station has drastically reduced the number of watering points it maintains, another is developing a rotational grazing system based on spelling fertile bottom-lands (saltbush country) for 18 months of every two year period using trap yards at strategic locations. A number of pastoralists have renegotiated their grants to install watering points so as to protect fragile landscapes. Several stations have installed EMU Landscape Monitoring Level 1 sites and our first aerial monitoring has been conducted with the Rangeland Fibre and Produce group near Mt. Magnet. One station is requesting permission to destock for a few years after realising how badly the majority of landscapes need rest. The owner of an eco-branding enterprise has expressed interest in incorporating the "EMU process" into requirements for certification of participating producers.

The "EMU process" is no hallucination!

The wider context - systematic regional management

The grassroots focus of the "EMU process" is complemented by a GIS-based information system, which provides wider context for local initiatives. Information in the system includes land system and vegetation maps, distributions of watering points and natural surface water features, rare flora and fauna, wetlands, and so forth. These data can highlight and place some regional priority on local conservation values.

The system is *not* used to produce spatially explicit scenarios that may threaten participants. Rather, the information is presented to participants for consideration. Pastoralists have been quite interested in the information, and keen to incorporate these issues into their station management. This voluntary and unthreatening approach seems to be working.

Concluding comment

Most participants in the "EMU process" are adapting to a changing world. Yet they confront significant institutional barriers to change. Diversification is fraught with red tape, and Government departments are only just emerging out of institutional apartheid in rangelands. Public funding of off-reserve conservation is negligible. Government maintains a major controlling interest in the sandalwood industry. Couldn't exclusive access to sandalwood and other resources (e.g. tourist resources) be contingent on *quid pro quo* arrangements for formal off-reserve conservation? Disturbingly, the legal requirement to graze vast areas of rangeland in the face of financial, social and environmental forces seems anachronistic and defies contemporary models of sustainable rangeland habitation, which emphasise regional differences in opportunities and risks (Stafford Smith *et al.* 2000).

It might be argued that progressive elements in the pastoral industry are being brought back to the pack under current institutional arrangements. Hopefully, a recent State Government initiative to review these institutions and provide a new model will address this problem.

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BIENNIAL CONFERENCE UPDATE

Plans for the 2002 Kalgoorlie conference are progressing well. The Registration and Call for Papers Brochure were scheduled to be sent out before the end of the year. If members have not received a brochure after this time, or if they would like more copies please contact the Conference Organizer:

Sarah Nicolson,
Intercomm Event Coordination
22 Edmund Ave, Unley SA 5061
Ph: 08 8357 3378 Fax: 08 8357 3389
Email: nicolson@w130.aone.net.au

It should also be noted that the conference details will soon be available on-line at the Society's new website: www.austrangesoc.com.au. The site will include information on the conference program, registration, field tours, accommodation and paper submission.

NEW COUNCIL MEMBERS INTRODUCED

As indicated in the July issue of the Range Management Newsletter, three new Council members were endorsed by Council in June. Some brief biographical information about each of these is given below:

Vice President - David Lord, Thackaringa Station, New South Wales

David is a woolgrower living 40 km west of Broken Hill. He is the fourth generation to manage Thackaringa, with his family having settled the area before the ore body was discovered at Broken Hill.

In addition to his interest in the ARS, David is also involved with Landcare at a local level and represents The Lake Frome Catchment on the Lake Eyre Coordinating Group.

David has a particular interest in TPG (Total Grazing Pressure) especially rabbit control. He is currently working on a rabbit ripping program to complete the ripping of all the warrens on Thackaringa and extend the treated area in the Pine Creek Area Rangecare Group. He is also constructing an electric fence to eliminate kangaroos from one paddock to determine the impact kangaroos have on native pastures.

Communications Officer - Lachlan Pegler, Department of Natural Resources and Mining, Charleville, Queensland

Lachlan is currently a Land Management Extension Officer with the Department of Natural Resources and Mines in Charleville. He studied Rural Technology at Gatton College, and more recently Rural Extension. He hails from a sheep and cattle property near Eromanga (Far SW Qld) and remains a partner in the enterprise. He has worked in oil exploration, grazing and farming property management and for the Queensland Department of Primary Industries before coming to Charleville.

Lachlan was the former manager of the South West Strategy, although his main interests lie in land management, monitoring and extension. He has been a member of the South West Strategy Economic Reconstruction Group, the South West Queensland Bore Drain Advisory Group for five years. Lachlan is NR&M editor of the *Mulga Line*, which some readers may regularly peruse.

Lachlan has been a member of ARS since 1995, and attended all 3 conferences since. He is particularly interested in integration of production, economic, ecological and social factors in decision making in the rangelands.

Membership Officer - Ian Watson, Department of Agriculture, Northam, Western Australia

I recently joined the ARS Council as the Membership Officer. The functions of the Membership Officer are to provide the link between the membership subscriptions and Council, to overview and report on membership trends and to work with other members of the Membership Committee (Robyn Cowley, David Lord and Rob Richards) to make sure that members needs are met and that the society remains attractive to new and existing members. Given the general decline in membership over the last few years it is clear that the Membership Committee and Council have a lot of work to do to maintain and build our member base.

My entire working career in the rangelands has been with the Department of Agriculture, Western Australia. I worked in Carnarvon as a Rangeland Adviser from 1986 to 1993 doing all sorts of jobs including working with Land Conservation Districts, vegetation assessment and sheep work on the Boolathana grazing trial, cash flow budgeting, station management planning, rehabilitation work and rangeland monitoring. I then spent the years 1994 to 1996 on study leave at Macquarie University using the results from Boolathana to consider how shrub populations change over time and the implications of this for monitoring. From 1997 to now I have been based in Northam, about 100 km east of Perth. From here I manage the statewide activities of the Western Australian Rangeland Monitoring System (WARMS) and work on other tasks such as biodiversity monitoring and managing for climatic variability. Over the last two years I have been National Coordinator of the Rangeland Theme of the National Land and Water Resources Audit.

I joined the ARS in the first week I was in Carnarvon, it was simply the "done thing" to do when working in rangelands. These days many people who work in the rangelands are not members of the society and our membership numbers have suffered as a result. Over the next few years Council is hoping to re-establish the precedent by making the Society as attractive as possible to those living, working or just interested in the rangelands.

PAST JOURNAL ISSUES AVAILABLE

Leigh Hunt, Publications Committee, 6 Gwendoline Court, Coromandel Valley SA 5051

The Publications Committee has decided to reduce its stocks of past issues of *The Rangeland Journal*. Members who wish to obtain past issues may do so for a small fee to cover the cost of postage and packaging. This has been set at a flat rate of $10 per issue. A list of available issues is presented below. To obtain a copy of an issue write to Mr Malcolm Howes, c/- Agriculture WA, PO Box 1231, Bunbury WA 6231, giving details of the issue(s) wanted. Please ensure you include a cheque or money order for the correct amount (e.g. if you order two issues the fee will be $20). Cheques should be made out to 'Australian Rangeland Society'. We will not be sending out invoices so if payment does not accompany the request your order will not be processed.

It is also our intention to promote the Journal by sending copies of past issues to university libraries and the like, both in Australia and overseas, and inviting them to subscribe. This will begin in about March 2002 so I recommend that you submit your request for past issues promptly to avoid missing out.

The following issues of the Journal are available:

Volume (issue)	Year
1(1)	1976
1(3)	1979
1(4)	1979
2(2)	1980
3(1)	1981
3(2)	1981
4(1)	1982
4(2)	1982
5(1)	1983
5(2)	1983
6(2)	1984
7(2)	1985
8(1)	1986
9(2)	1987
10(1)	1988
10(2)	1988
11(1)	1989
11(2)	1989
12(1)	1990
12(2)	1990
13(1)	1991
13(2)	1991
14(1)	1992
14(2)	1992
16(1)	1994
17(1)	1995
18(1)	1996
19(1)	1997
21(1)	1999
22(1)	2000
22(2)	2000

INFORMATION SNIPPETS

Tracking changes in Australia's rangelands

The National Land and Water Resources Audit is soon to release the report "Rangelands - Tracking Changes: The Australian Collaborative Rangeland Information System."

The report outlines new capabilities in rangeland monitoring developed by the Audit and explores the essential elements of a proposed Australia-wide rangeland monitoring program. A coordinating mechanism for bringing together rangeland information from a wide range of sources is also outlined.

Over the last four years, the Rangeland Monitoring Theme of the Audit has sought to define the elements of a comprehensive monitoring program which would provide regular Australia-wide reports and enable people to make better land use and management decisions.

In proposing how rangeland monitoring may progress across Australia, "Tracking Changes" outlines existing State and Northern Territory monitoring activities and highlights individual case studies to demonstrate how monitoring systems are already being used to inform land use and management decisions at a variety of scales.

New capabilities

New capabilities and approaches to rangeland monitoring have been developed as a result of the Audit's work. These include a framework for monitoring biodiversity within the rangelands, an operational system using remote sensing that enables monitoring across huge areas of northern and central Australia and an approach to rangeland management driven by how landscapes function, rather than how they are used.

Contextual information such as land tenure, land use and seasonal quality has been collated and linkages to other work such as fire scar mapping and Aussie GRASS pasture monitoring are in place. Social and economic change has been also been considered, in recognition that such change can be just as important in rangeland management as biophysical change.

While these technical achievements are important, collaboration between state/NT and Commonwealth agencies has been strengthened. Consequently, there is a much better understanding of the monitoring systems in place across Australia and a great willingness to share data in order to provide an Australia-wide picture of change.

Australian Collaborative Rangeland Information System

Many of the issues facing Australia's rangelands extend across jurisdictional boundaries. Existing information and monitoring systems have been deficient in a number of ways and have not comprehensively reflected the condition of Australia's rangelands. A coordinated and collaborative Australia-wide information system is required to integrate data management and reporting across the states and the Northern Territory.

A system is proposed involving a series of interlinked activities that will build on new rangeland monitoring capabilities. Regular standard reports will be produced, as well as other specifically commissioned products as demanded by client need. The latter may involve, for example, biodiversity monitoring, the expanded application of remote sensing techniques, or reports produced from existing data for new or different client needs.

Information will be collated, interpreted and presented at a range of scales based on data collected from existing activities and will be presented through the Australian Natural Resources Atlas (see below) and as regular assessments on the condition of Australia's rangelands.

In the early stages, the information system will not be able to meet the needs of all its clients. The aim will be to provide a foundation upon which better information, analysis and reporting can be continually developed.

This Australia-wide collaborative approach is currently being considered by government agencies and preparation for its implementation is currently underway in rangeland states.

The "Tracking Changes" report will be available in hard copy and on CD-ROM. The latter will include project reports and extracts from the Australian Natural Resources Atlas.

To order a copy contact:

National Land and Water Resources Audit
Tel: (02) 6257 9516
Fax: (02) 6257 9518
Email: info@nlwra.gov.au.

For other information contact :

Maria Kraatz
Australia-wide rangeland coordinator
Tel/Fax: (08) 89273116
Email: maria.kraatz@octa4.net.au

Or check the Audit's website: www.nlwra.gov.au/atlas (see below).

Australian Natural Resources Atlas

The Australian Natural Resources Atlas is a web-based information system providing natural resource information from across Australia under the broad categories of agriculture, coasts, land, people, rangelands, vegetation and biodiversity and water.

Information is presented at regional, state and Australia-wide scales and is supported by a data library with links to Commonwealth, state and Northern Territory data management systems.

Summaries of existing rangeland monitoring systems in Australia can be accessed, as well as reports, maps and data sets developed for Audit projects.

The Atlas is continually updated as new information becomes available and enables users to produce summaries and maps according to specific queries

Find the Atlas at www.nlwra.gov.au/atlas.

Northern Australia Beef Industry Conference

The Northern Australia Beef Industry Conference was held in Kununurra, Western Australia on the 8-9 November. The conference addressed production, marketing and natural resource management issues for the northern pastoral zones of Australia (Queensland, Northern Territory and Western Australia) for the beef cattle and live export industries.

If you would like any further information about the outcomes of this conference, or a copy of the proceedings ($25 per copy plus postage and handling), please contact:

Kaz Price
WA Department of Agriculture
PO Box 278 Derby 6728 WA
Tel: (08) 9191 0326
Fax: (08) 9191 0334
Email: kprice@agric.wa.gov.au

Public Good Conservation Report Released

The House of Representatives Environment Committee has released its report into public good conservation and the impact of environmental measures imposed on landholders.

The report, entitled "Public good conservation: Our challenge for the 21st century", suggests that current federal and state policy settings are failing farmers and other landholders interested in undertaking conservation measures for the public good. According to the chair of the committee Ian Causley MP, present policy approaches are often out of touch with the realities of rural and regional Australia. "Very often landholders have to meet significant costs out of their own pockets for conservation works from which they can anticipate little immediate or even medium term benefit. The benefit flows to the community, but the cost is borne by the landholder." The report also acknowledges the anger expressed by many landholders at their perceived erosion of property rights and imposition of management controls without financial assistance.

The 217 page report is available on the Parliament House website as a series of downloadable pdf files. The address is www.aph.gov.au/house/committee/environ/pubgood.

Semi-Arid Tropics Publication Available Online

The recent publication "Pastoral Land Rehabilitation in the Semi-Arid Tropics " is now downloadable as a series of pdf files from the NT Lands, Planning and Environment website.

It documents the history of land rehabilitation in the Northern Territory, and outlines property by property, rehabilitation and research work undertaken and the success of these works. The report concludes with an assessment of the critical factors that enhance the chance of success when undertaking mechanical rehabilitation, such as soil type, time of planting, cultivation methods, plant species and seeding techniques.

The website can be found at:
www.lpe.nt.gov.au/advis/land/pastoralrehab/.

Land & Water Australia Plan

Land and Water Australia have released their 'Research and Development Plan 2001-2006'

L&WA is specifically responsible for research and development (R&D) aimed at the productive and sustainable management of the land, water and vegetation resources underpinning Australia's primary industries and regional communities. This document outlines the Corporation's Strategic R&D Plan for the period 2001-2006, developed through a process of internal analysis and structured consultation with key stakeholders through interactive workshops, interviews and surveys.

The Plan is presented in three sections. The context for the Plan outlines the opportunities open to Australia in natural resource management, and the challenges to be met if these opportunities are to be captured. It summarises the expectations that the Commonwealth Government has of L&WA, and explains some of the concepts and terminology used in the Plan. The strategic directions for the Corporation as a whole set out how this Plan relates to the previous R&D Plans for the Corporation.

The R&D Plan itself describes the Corporation's Vision, Mission, Values and Corporate Objectives, articulating what the Corporation is aiming to achieve at a corporate level through its R&D and communication investments. It outlines how Land & Water Australia intends to organise its research investments through five R&D Arenas and four Integrating Themes and explains how this matrix underpins the Plan. It sets out the planned outputs for each R&D Arena.

The Plan is available online to download, or view as web pages at:
www.lwa.gov.au/html/publications/catalogue/general/r&d_plan_2001-200>6/research.htm.

Graeme Caughley Travelling Fellowship - Ecology

The Fellowship commemorates the work of Dr G.J. Caughley, FAA in ecology and wildlife management. Dr Caughley was a chief research scientist with CSIRO Wildlife and Ecology, Canberra, until his death in February 1994. The Fellowship is financed through the generosity of his friends and colleagues.

The inaugural Fellowship was in 1996. The Fellowship is offered every two years. $5000 (inclusive of GST) is offered for the 2002 Fellowship.

The purpose of the Fellowship is to enable ecologists resident in Australia or New Zealand to share their expertise by visiting scientific centres and giving lectures in countries other than Australia or New Zealand. More information is available from the website http://www.science.org.au/awards/caughley.htm.

2002 Eureka Prizes

The Australian Museum has recently launched the 2002 Eureka Prizes, and they are bigger and better than ever, with 16 prizes on offer worth almost $160,000.

New prizes to be awarded in 2002 are for research in ethics (sponsored by the Australian Catholic University), engineering journalism (sponsored by the Institution of Engineers, Australia) and health and medical research journalism (sponsored by Pfizer). These join established prizes for environmental and science journalism; environmental education programs; industry commitment to science; critical thinking; promotion of science; secondary school biological and earth sciences; engineering innovation; biodiversity, environmental and scientific research; and science book authorship.

Information on the full range of prizes on offer in 2002, as well as entry/nomination forms, is available from the Australian Museum's website at www.amonline.net.au/eureka.

Entries in most prizes close on 17 May 2002, with winners to be announced in August 2002 at a gala award ceremony during National Science Week.

For further information, call (02) 9320 6224 or email rogerm@austmus.gov.au.

Global Warming Website

The "Paleo perspective on global warming" website was set up by the Paleoclimatology Program of the NOAA (National Oceanic and Atmospheric Administration) to explain clearly and accessibly global warming and climate change, and in particular how the study of past climates is important to our understanding of these phenomena today.

The site is arranged in two main sections - 'The Story' and 'The Data', which provide the background for understanding climate change and explain the types of data that have been available for recording variations in the Earth's temperature. 'A Final Word' looks at the causes of global warming and the impact of human activity on climate change.

For more (and exhaustive) information on any topic relating to the world's climate, weather patterns, oceans, coasts, marine environment, just follow the link to the NOAA, whose site map alone lists over 200 major sections. The address is:
http://www.ngdc.noaa.gov/paleo/globalwarming/

NEW MEMBERS

Angus Atkinson
PO Box 1840
Dubbo NSW 2830

Richard Hicks
DLWC
PO Box 1840
DUBBO NSW 2830

Renee Moore
244 Alfred St
Charleville QLD 4470

Helen Murphy
"Idracowra Station"
Alice Springs NT 0871

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Ned McCord
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Greg Martin
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Kingswood SA 5062

Angas Hopkins
WA Wildlife Research Centre
PO Box 51
Wanneroo WA 6946

Maria Kraatz
PO Box 40961
Casuarina NT 0811

MEMBERSHIP RATES FOR 2002

Rob Richards, Subscription Manager, Department of Land and Water Conservation, PO Box 235, Condobolin NSW 2877.

Council has decided not to increase subscription rates for 2002. The rates are as follows:

Individual or Family

Full (Journal & Newsletter)

Australia	$73
Overseas (Air Mail)	$96
Student	$56
Student Overseas	$73

Part (Newsletter only)

Australia	$40
Overseas (Air Mail)	$51
Student	$39
Student Overseas	$30

Institution or Company

Full (Journal & Newsletter)

Australia	$107
Overseas (Air Mail)	$130

Part (Newsletter only)

Australia	$56
Overseas (Air Mail)	$68

Serial Publications

2002 Bibliographic Details and Subscription

1. The Rangeland Journal

Title:	The Rangeland Journal
ISSN:	0313 4555
Volume Number:	23
Frequency:	Two (2) issues per year
Language:	English
Months of Publication:	June, November
Subscriptions:	For calendar year only
Cancellations:	Accepted
Claims:	Must be submitted within 6 months
Index:	No index or title page published

Subscription Rate:

Australia/NZ	A$90 per annum
Overseas (Air Mail)	A$107 per annum

2. Range Management Newsletter

Title:	Range Management Newsletter
ISSN:	0812 4930
Volume Number:	2001
Frequency:	Three (3) issues per year
Language:	English
Months of Publication:	March, July, and November
Subscriptions:	For calendar year only
Cancellations:	Accepted
Claims:	Must be submitted within 6 months
Index:	No index or title page published

Subscription Rate:

Australia/NZ	A$62 per annum
Overseas(Air Mail)	A$73 per annum

3. Joint Subscriptions

The Rangeland Journal and Range Management Newsletter

Joint Subscription Rate:

Australia/NZ	A$130 per annum
Overseas(Air Mail)	A$158 per annum

Note that Membership rates are quoted in AUSTRALIAN currency and must be paid in AUSTRALIAN currency. Visa card, BankCard, and MasterCard are accepted. All rates shown are for AIRMAIL.

AUSTRALIAN RANGELAND SOCIETY
MEMBERSHIP APPLICATION FORM

Please complete and return to the Subscription Secretary, Rob Richards, PO Box 235, Condobolin 2877 NSW

I, [name] .....

of [address] .....

.....

Postcode..... Email address .....

apply for membership of the Australian Rangeland Society and agree to be bound by the regulations of the Society as stated in the Articles of Association and Memorandum.

- Enclosed is a cheque for $AU..... for full/part* membership for an individual/student/institution* for the calendar year 2002

- Charge my Mastercard VISA Bankcard AU$.....for full/part* membership for an individual/student/institution* for the calendar year 2002

Card No.:_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Expiry Date: .....

Signature:..... Date: ..... Cardholders Name:.....

*delete as appropriate

If you were introduced to the Society by an existing member please include their name here .....

Please list details of your institution & student number if you are applying for student rates .....

Membership Rates:

	Australia	**Overseas Airmail**
Individual or Family -		
Full (Journal + Newsletter)/Student	$73.00/$56.00	$96.00/$73.00
Part (Newsletter only)/Student	$40.00/$30.00	$51.00/$39.00
Institution or Company -		
Full (Journal + Newsletter)	$107.00	$130.00
Part (Newsletter only)	$56.00	$68.00

Please Note –

1. Membership is for the calendar year 1 January to 31 December. All rates are quoted in AUSTRALIAN currency **and must be paid in AUSTRALIAN currency.**
2. **Year 2002 membership rates include Airmail for all overseas subscribers.**

For Office Use Only:

Membership Number .....

Date Entered in Member Register .....

Date Ratified by Council .....