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# Range management Newsletter

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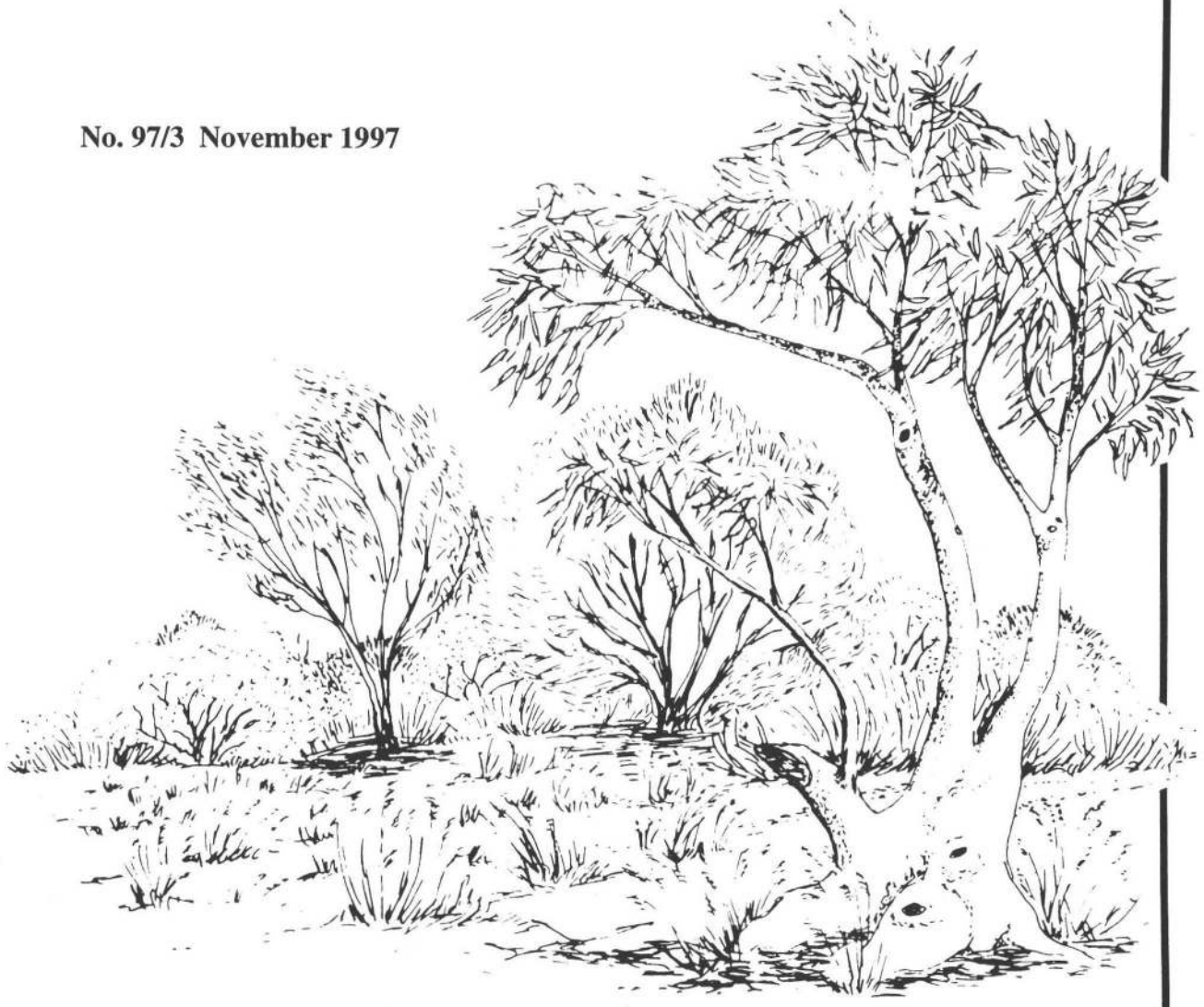

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# FROM THE EDITOR

*Gary Bastin, CSIRO, PO Box 2111, Alice Springs NT 0871*

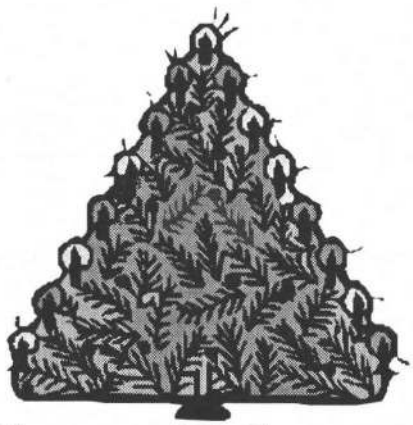
It is getting very close to the end of the year and time for another newsletter. This issue has two major articles, as well as a variety of reports from recent conferences, workshops and meetings. Members of the new Queensland Council are settling into their office-bearer positions and they introduce themselves later in the newsletter. In that section also Eugene Moll, the new President, fills us in on some of Council's recent deliberations.

In the first major article, Justin Costello describes his recent research on the flooding patterns of the Coongie Lakes Wetlands in north eastern South Australia. Justin used satellite images and data from a flow-gauge station to develop a relationship between flow patterns in Cooper Creek and flooding within the wetlands. This research provides valuable information for the management of the lower Cooper system. Hopefully, this information can contribute to sensible decision-making as future demands are undoubtedly made on the water resources of this major drainage system.

In another major article Andrew White reports that camels, through their browsing behaviour, have limited potential to control woody weeds. Through a series of observations and a feeding experiment, Andrew found that in western NSW camels ate species regarded as woody weeds. However, the camels did not actively select these species and their ability to reduce the density of woody weeds appears very limited.

So, take your time to look through this issue. I am sure you will find the various articles and reports of interest. As usual, feel free to respond with any comments you may have, and please keep any contributions of a different nature coming. My deadline for the next *Range Management Newsletter* is the end of February.

As this is the last newsletter for this year, may I take this opportunity to wish all Society members a merry Christmas and all the best for 1998. Oh, and one last request - most members will have a subscription renewal form included with this issue. Please pay promptly before you forget - it will help to keep the ARS finances in a healthy position and make the Subscription Manager's job much easier.



*Merry Christmas*

# FLOODING PATTERNS OF THE COONGIE LAKES WETLANDS
## North-Eastern South Australia

*Justin Costello, 109 George St, Fitzroy VIC 3065*

This article describes research on the flooding patterns of the Coongie Lakes Wetlands in north-eastern South Australia using satellite imagery and flow gauge station data from Cooper Creek. A relationship between the flow regime of the Cooper Creek and flooding within the Coongie Lakes has been developed for a range of flood pulse styles. This relationship provides baseline data for the improved management of the wetlands. The hydrological model is also useful for:

- Defining the impact on the Coongie Lakes Wetlands of proposals to remove water from the upstream reaches of Cooper Creek.
- Giving advance warning to the operators of gas and oil production and exploration facilities that will be affected by oncoming flood pulses.
- Allowing advance planning of the most effective stock movements pre and post-flooding.

## Importance of Flooding Patterns in the Coongie Lakes Wetlands

The Coongie Lakes is an area of freshwater wetlands located in the Strzelecki desert (Figs. 1 and 2). These wetlands are recognised for their "biological wealth and diversity" (Reid and Puckridge 1990) and are listed under the Ramsar Convention on Wetlands of International Importance. The annual flood pulse from the Cooper Creek is the principal supply of water to this area of wetlands and its hydrological characteristics are the crucial controls on the ecosystems of this area.

The vast array of habitats in the Coongie Lakes wetlands range from permanent aquatic to permanent terrestrial habitats, with the majority being in a state of flux between aquatic and terrestrial depending on the timing and degree of flooding (Reid and Puckridge 1990). Between flood events water is mostly confined to the major lakes and water holes of Cooper Creek. During very dry years only a few bodies of standing water may remain to sustain the aquatic ecology of the area (Reid and Gillen 1988).

In addition to its ecological importance part of the wetlands occurs within the Innamincka pastoral lease, which runs on average over 10,000 head of cattle. Use of water pumped from the permanent waterholes and grazing of vegetation growth following flooding of the ephemeral wetlands are an integral part of the management of the pastoral lease (Campbell 1994). The Coongie Lakes and Innamincka area are also a destination for over 30,000 tourists annually, with fishing, camping and bird-watching popular in the wetlands (Gillen 1987).

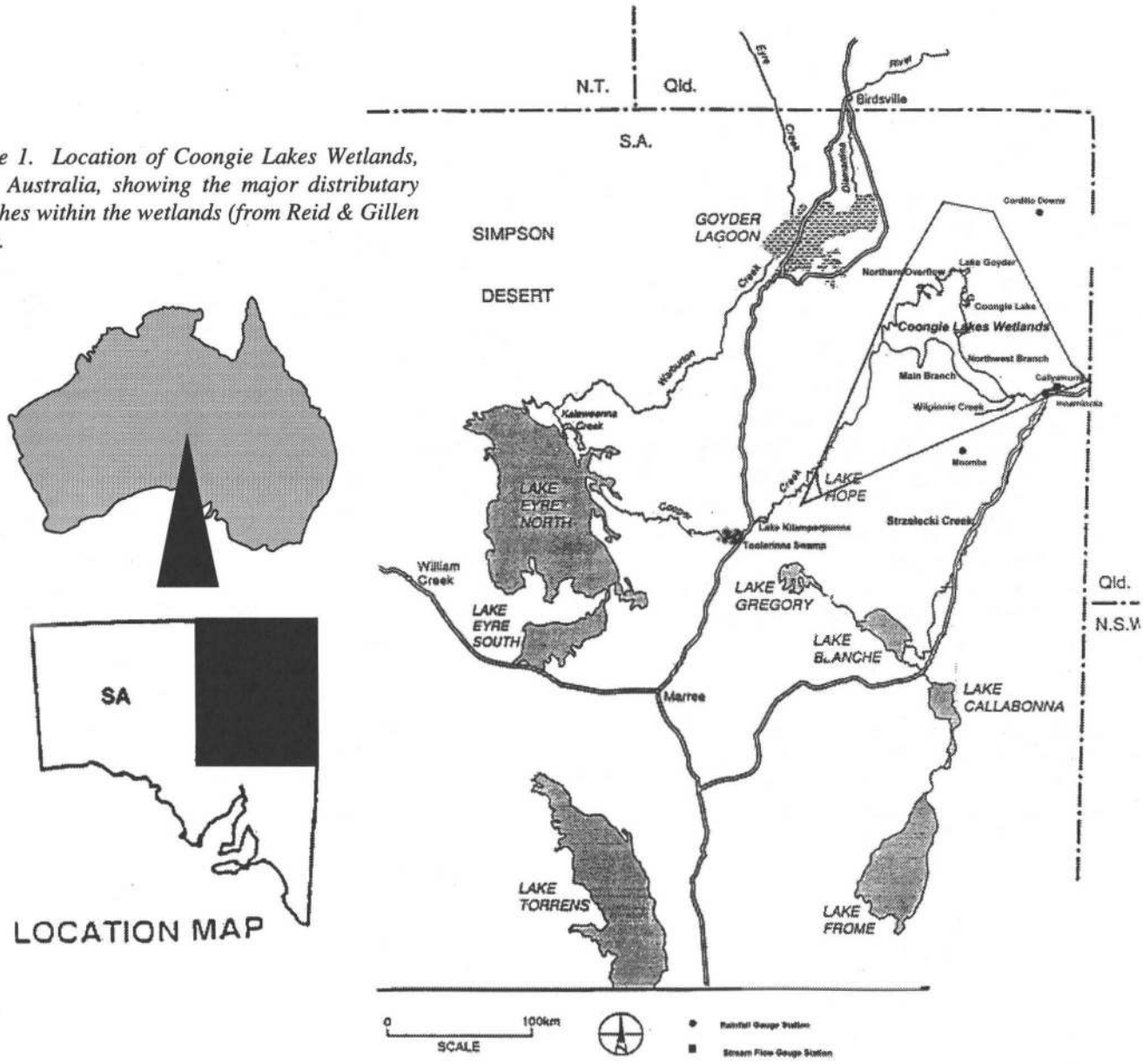



*Figure 1. Location of Coongie Lakes Wetlands, South Australia, showing the major distributary branches within the wetlands (from Reid & Gillen 1988).*

In excess of twenty major oil and gas fields occur in the Cooper Creek - Strzelecki Creek - Coongie Lakes Wetlands area. The annual floods, depending upon volume and area of inundation, can severely affect production and exploration activities associated with these oil and gas fields (Mauger and Pietsch 1988).

## Threats to Wetlands

Cooper Creek presently has a low degree of regulation along its course (Morton *et al.* 1995). A recent proposal was under assessment for the upstream diversion of water from the Cooper Creek for cotton growing at Currareva, Queensland (Hawkins *et al.* 1995). The proposal, which involved the withdrawal of 42,000 million litres of water per annum, was refused earlier this year on environmental grounds. However, the impact of any removal of water from Cooper Creek on the ecology and the flooding patterns within the Coongie Lakes was not assessed.

In order to determine the effects on the Coongie Lakes Wetlands of the upstream diversion of water from Cooper Creek it is vital to understand how flood pulses with differing hydrological characteristics move through the wetlands.

## Methodology

The spatial and temporal distribution of floodwaters in the Coongie Lakes was mapped for the period 1988-1990 using NOAA-AVHRR satellite imagery. Satellite data were acquired approximately weekly to fortnightly at the onset and peak of flooding in the wetlands and then monthly as the floodwaters slowly moved through the area.

AVHRR data are commonly used to calculate the normalised difference vegetation index (NDVI or "Greeness Index") over rangeland areas, but have not been used in a detailed study of the movement of water through a wetland system in Australia. The Coongie Lakes Wetlands are well suited for this research

as the flooding involves large volumes of shallow water, which maximises the areal extent of the flooding.

The NOAA-AVHRR satellite imagery has several advantages since it provides excellent temporal coverage (potentially daily), one image covers a very large area and it is much cheaper to acquire than other forms of remote sensing. Its disadvantage is that it has a coarse spatial resolution of 1.1 km pixel size and so is best used in large scale studies.

One water gauge station exists on Cooper Creek near Innamincka (Fig. 3). The hydrological records from this station were used to calibrate the relationship between the area of flooding (as measured by the satellite data) and the volume of water in the Coongie Lakes Wetlands.

The satellite images used in this project were purchased using funding from Kidman Holdings (owner of Innaminka pastoral lease) and Santos Ltd. Additional images were kindly donated by the CSIRO Division of Atmospheric Research, CSIRO Earth Observation Centre and the South Australian Departments of Primary Industry and Environment and Natural Resources.

## Study Period

The passage of water through the wetlands as a whole, for a range of flood volumes and shapes, is poorly documented. The study period, 1988-1990, covered a range of flood volumes and styles, and these are summarised in Table 1 and Fig. 3.

- The 1988 flood was a medium-sized event that resulted from heavy rainfall in the immediate area of the Coongie Wetlands and was supplemented by low to moderate flood levels sourced from rainfall higher up in the catchment.
- The 1989 flood was a twin peaked, large to very large volume flood event. The first peak resulted from rainfall associated with Cyclone Aivu and the second peak resulted from very heavy rainfall (highest rainfall averaging 125 mm) in south-west Queensland (mid-upper catchment) several weeks later.
- The 1990 flood was an extremely large-volume event and only second in size to the 1974 flood, the largest on record (Knighton and Nanson 1994). During April 1990, central Queensland experienced unusually heavy and prolonged rainfall. In parts of the upper catchment of Cooper Creek, the rainfall ranged from 400 to over 500 mm over a 20 day period.

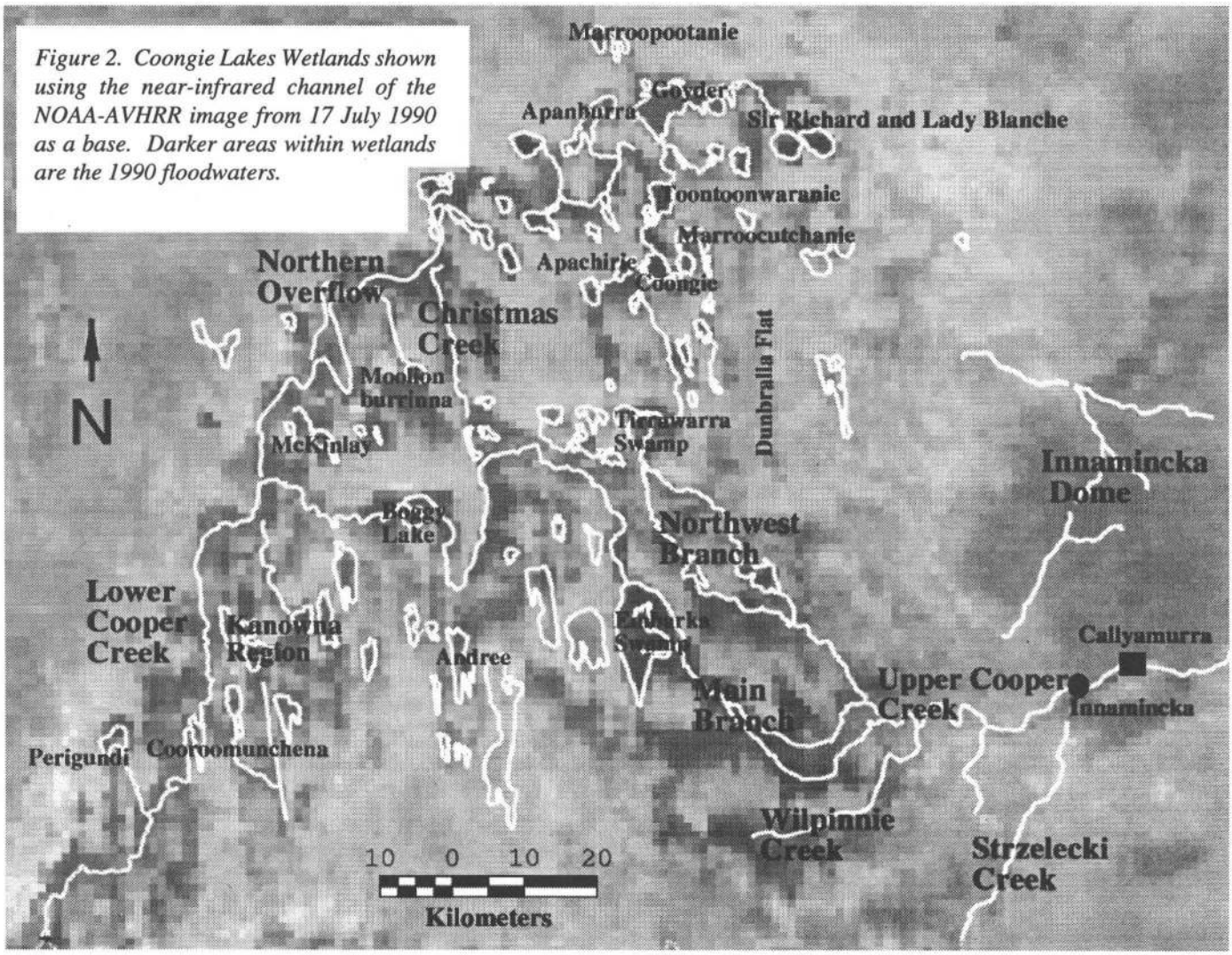



*Figure 2. Coongie Lakes Wetlands shown using the near-infrared channel of the NOAA-AVHRR image from 17 July 1990 as a base. Darker areas within wetlands are the 1990 floodwaters.*

Table 1. Hydrological characteristics of examined flood pulses

| Year | Pulse | Period | Total volume (Ml) | Peak Volume (Ml) | Class |
|---|---|---|---|---|---|
| 1988 | First | 31/3/88 - 18/4/88 | 171,132 | 67,300 | 3 |
| | Second | 19/4/88 - 4/6/88 | 120,041 | 5,150 | 1 |
| 1989 | January | 25/12/88 - 11/1/89 | 13,131 | 7,226 | 1 |
| | Feb-April | 21/1/89 - 10/5/89 | 93,917 | 1,826 | 1 |
| | First | 11/5/89 - 2/6/89 | 478,950 | 30,600 | 2 |
| | Second | 3/6/89 - 5/11/89 | 4,065,415 | 155,000 | 4 |
| 1990 | First | 11/5/90 - 23/6/90 | 7,381,600 | 425,000 | 5 |
| | Second | 24/6/90 - 18/11/90 | 2,128,929 | 64,200 | 3 |

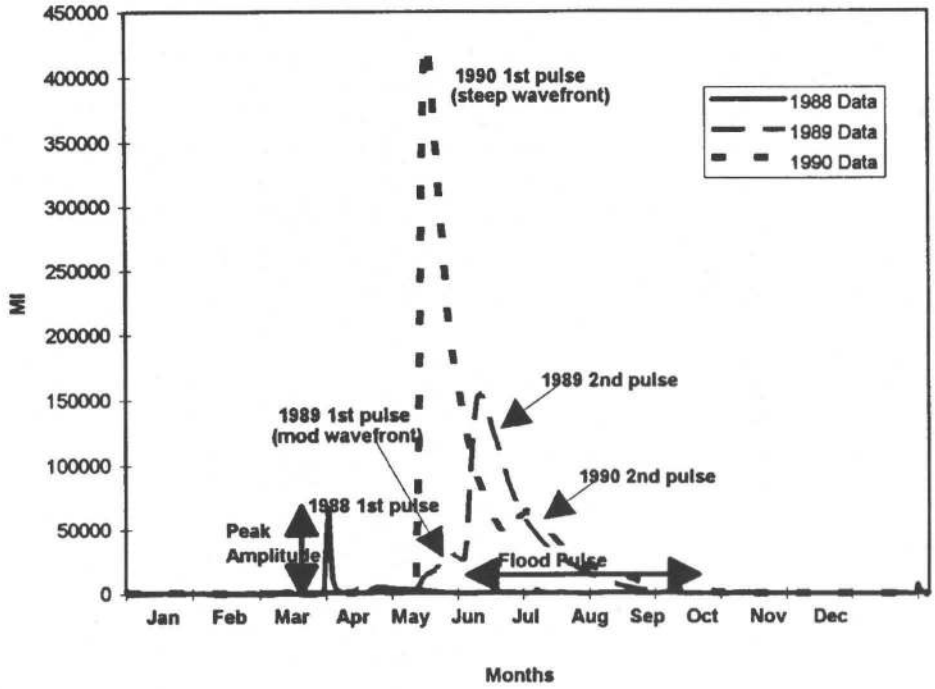



*Figure 3. Hydrograph of water flowing through Callyamurra gauge station, Cooper Creek, for the years 1988-1990. Diagram illustrates the range of peak amplitudes, total volumes and pulse shapes for the flood events of this period.*

## Results

### *Principal Hydrological Factors Affecting Flood Patterns*

The pattern of flooding within the Coongie Wetlands caused by water flow from Cooper Creek was most influenced by the amplitude (peak at flood head), shape and total volume of the flood pulse. Other critical factors included the immediate history of flooding in the 12 months prior to the flood pulse arriving at the wetlands, and the catchment source of the flooding.

*Flood amplitude*

The peak amplitude of the flood pulse determined which of the main creek systems the water would flow into. All of the major rivers (Main Branch, Wilpinnie Creek, Strzelecki Creek; see Fig. 2), with the probable exception of the Northwest Branch, have threshold daily flow volumes that are required before flow is initiated into these systems. This is due to the presence of bars or sills at the entrance to these rivers that form a physical barrier to waters below a certain flood level.

*Total volume*

The total volume of the flood pulse is the major influence on the extent of the flooding in any given river system. The lake systems occurring along the major flow paths of Cooper Creek and the Coongie Lakes Wetlands (i.e. non terminal lakes and lake systems) fill in a sequential manner. That is, a lake is filled to a certain volume (level) before water then overflows into an outlet channel or another lake (Reid and Puckridge 1990). In this way, the flood pulses travel through the main river systems of the wetlands by sequentially filling lakes, swamps and other water bodies en route. Therefore, it is the total volume of the flood pulse that determines how far it will travel along a sequentially filling river system rather than the peak amplitude of the flood.

*Shape of flood pulse*

The most important characteristics of the shape of the wave pulse in determining flood patterns are the 'steepness' of the wave front and its amplitude. Flood pulses with steep, high-amplitude wave fronts have different patterns of areal inundation to those pulses with more gentle wave fronts. Within the Coongie Lakes Wetlands, the shape of the flood pulse determines what percentage of the flood initially enters the Northwest Branch and the Main Branch. Flood pulses with steep wave fronts (and amplitudes sufficient to initiate flow into the Main Branch) allow a large percentage of the total

Table 2. Flow classes for Cooper Creek and Coongie Lakes Wetlands.

| Flow Class | Daily Flow Volume (Ml) | Frequency | Extent |
|---|---|---|---|
| Class 1 | 300-5,000 | Annual | Coongie Lake to Northern Lakes (Northwest Branch) |
| Class 2 | 5,000-35,000 | 2 years | Cooroomunchena Waterhole, Lady Blanche, Apanburra, Christmas Creek |
| Class 3 | 35,000-100,000 | 5 years | Lake Hope, Wilpinnie Creek, Northern Overflow |
| Class 4 | 100,000-150,000 | 10 years | Strzelecki Creek, Toolerinna Swamp |
| Class 5 | 150,000-450,000 | 30 years | Lake Blanche, Lake Eyre North |
| Class 6 | >450,000 | 100 years | Lake Callabonna-Gregory, Lake Eyre |

volume to flow into the Main Branch in preference to the Northwest Branch. During very large flood events (e.g. the 1990 flood) the Northwest Branch receives a larger percentage of water than the Main Branch.

*Source of flood pulse*

The source of the run-off causing the flood pulse has an important control on the shape of the pulse. Floods caused by rainfall in the immediate catchment area of the wetlands tend to have short wavelengths, steep wave fronts and relatively low volumes for a given peak amplitude. Floods sourced from run-off in the mid or upper catchment contain larger volumes for a given peak amplitude and may have either gentle or steep wave fronts.

*Recent history of flooding*

The recent history of flooding determines the amount of water occurring within the wetlands immediately prior to the arrival of the flood pulse. The pre-existing volume of water strongly influences the possible maximum extent of the flood pulse in any river system in two ways:

- In sequentially filling flood paths, a greater pre-existing volume of water will allow subsequent flood pulses to travel further because less volume is required to fill lakes en route.
- Previous floods can saturate the flood path resulting in less water lost to subsurface infiltration. The previous floods can also saturate the catchment area resulting in more run-off and larger volume floods.

***Flood Classes***

The floods which occurred between 1988 and 1990 have been assigned to various classes (Table 2) based on the threshold volumes required to initiate flow into the major anabranch and distributary systems. The flood classes defined in a previous study (Mollenmans *et al.* 1984) were used as the basis for the following definition but were significantly redefined based on the results of this project.

***Extent of Flooding***

*Class 1*

The low amplitude flows of Class 1 floods were particularly reliant on the total volume of the flood pulse and pre-existing water in the wetlands in determining the areal extent of inundation resulting from any given flood in this class. Likely minimum and maximum flood patterns are shown in Fig. 4.

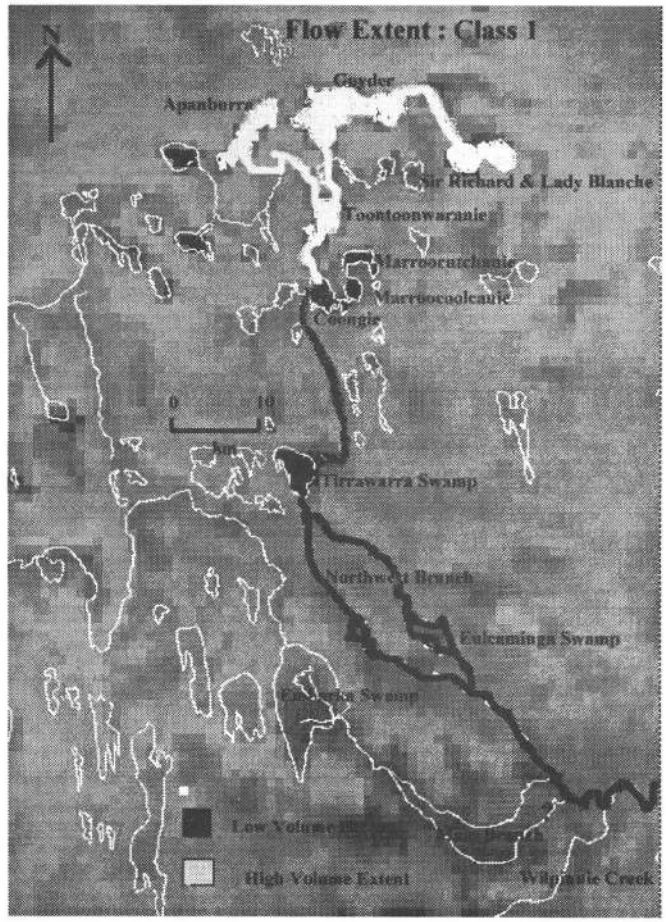



*Figure 4. Typical flood extents for "low volume" and "high volume" Class 1 flood events in the Coongie Lakes Wetlands. Note that flow only enters the Northwest Branch.*

The minimum flow amplitude for water to reach Lake Coongie was in the region of 300 Ml/day. A hydrological study of Coongie Lake (Allan 1988), aerial photographs and the satellite images were used to determine probable volumes that would sequentially fill the Coongie group of lakes from a dry state (zero volume). A flood with a total volume of:

- <4,000-5,000 Ml would only fill Coongie Lake,
- <12,000 Ml would fill Coongie, Maroolcoolcanie and Maroocutchanie,
- <20,000 Ml would also fill Lake Toontoonwaranie,
- <48,000 Ml would also flow into Lake Goyder and perhaps Marradibbadibba,

- >48,000-60,000 Ml would flow into Lakes Sir Richard, Lady Blanche and Lake Apanburra.

Class 1 flows can result from moderate rainfall events in the immediate upstream catchment or from heavier rainfall higher in the catchment. As a guide, rainfall events leading to a low volume and a high volume Class 1 flood, and their flood extent, are described below.

- Rainfall of approximately 50 mm fell at Nappa Merrie and Innamincka in December 1988 within one to two days (Bureau of Meteorolgy data). This resulted in a low-volume Class 1-2 flow (peak amplitude 7,226 Ml/day, total volume 13,000 Ml). Much of this flow (approximately 80%) flowed into Coongie Lake and such a flood pulse would partly fill Coongie, Maroocutchanie and Maroocoolcanie from a dry state.

- A rainfall event in March 1988 involved 60-139 mm falling in the immediate catchment in one day. This resulted in a Class 3 initial pulse from the local rainfall but also in a large-volume Class 1 flood (peak amplitude 5,150 Ml, total volume 120,047 Ml) sourced from rainfall higher in the catchment. This scale of Class 1 flow was capable of reaching Lakes Sir Richard and Lady Blanche, in addition to putting water into Lake Apanburra.

*Class 2*

The defining characteristic of Class 2 floods is that they flow into both the Main Branch and the Northwest Branch. As the flood is partitioned between these two river systems, the maximum extent will vary according to the total volume that flows into each branch (Fig. 5). If the flood pulse has a steep wavefront, then a higher percentage of its volume will flow into the Main Branch, while for floods with more gentle wave fronts, the distribution of waters will be more equitable.

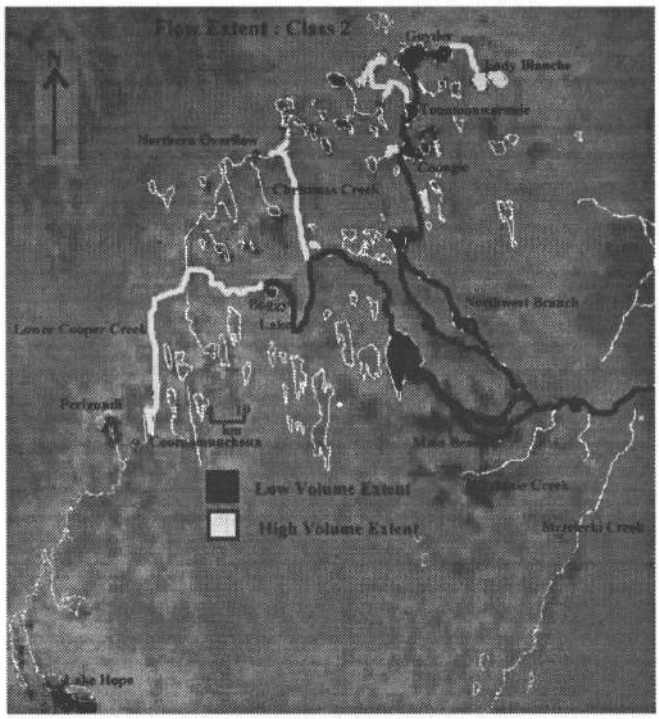



*Figure 5. Typical flood extents for "low volume" and "high volume" Class 2 flood events in the Coongie Lakes Wetlands. Note that flow enters both the Northwest Branch and Main Branch of Cooper Creek.*

Along the Northwest Branch system, Class 2 floods generally flow into Lake Goyder and then into Lakes Sir Richard and Lady Blanche, if the total volume is sufficient. Flow is also likely to occur into Lake Apanburra and the Northern Overflow, via the Apanburra Channel. Flow into some of the terminal lakes in the vicinity of Coongie Lake may also occur. The larger-volume Class 2 floods cause floodplain inundation along the Northwest Branch and around the Coongie Lakes.

Along the Main Branch, the lower-volume Class 2 floods will flow to Embarka Swamp and often into the Lower Main Branch, as far as Boggy Lake.

*Class 3*

Class 3 floods will initiate flow into Wilpinnie Creek. This system acts as an outflowing creek that links up with Strzelecki Creek in exceptionally large floods (e.g. Class 5, possibly Class 4), but also links back into the Main Branch in the Embarka Swamp area. The area can also act as a terminal region for ponded floodwaters. Flooding in this area can cut off the Innamincka-Moomba road and also inundate the Gidgealpa gas field.

The extent of Class 3 floods along the Northwest Branch again depends upon the total volume and shape of the flood pulse. The first pulse of the 1988 flood was a small-volume, high-amplitude Class 3 flood that mostly flowed into the Main Branch. This flood was only observed to have flowed into Lake Goyder with no flow into the Northern Overflow. However, larger-volume Class 3 flows would be expected to flow with considerable volume into Lakes Sir Richard and Lady Blanche and also into the Northern Overflow.

The minimum extent of flooding along the Main Branch would be as far as Boggy Lake on the Lower Main Branch with no flow into Christmas Creek. The extent of larger-volume Class 3 flows would lie between the 1989 first pulse (large volume, Class 2) and the 1989 second pulse (large volume, Class 4). These would result in a probable flow through the entire Lower Main Branch-Christmas Creek-Northern Overflow network and flow as far as Lake Hope on the Lower Cooper Creek.

*Class 4*

The defining characteristic of Class 4 flows is that they initiate flow into Strzelecki Creek but may not reach Lake Blanche. The flow into this system also occurs via Ooranie Creek.

The 1989 second pulse resulted in almost the entire Wilpinnie Creek flood path being inundated. The floodwaters connected to the Main Branch / Embarka Swamp floodwaters in several areas and there may have been linkage to the Lower Main Branch / Lake Andree regions. The floodwaters also flowed south as far as Big Lake Moomba and cut the Moomba road connecting to the Strzelecki Track.

Class 4 floods cause extensive inundation of the floodplains around the Northwest Branch, particularly south of Tirrawarra Swamp, and around Upper Cooper Creek, between Cullyamurra Waterhole and the Northwest Branch-Main Branch junction. Much of this floodplain inundation is caused by waters banking up behind Tirrawarra Swamp and

consequently initiates flow into the Dunbralla Flat flood path. The flooding causes the amalgamation of the Coongie group of lakes and fills surrounding terminal lake systems.

The Lower Cooper Creek is inundated from its junction with the Northern Overflow and Main Branch until Toolerinna Swamp. The large lakes along this stretch are also inundated, such as Lake Hope and Kilamperpunna.

*Class 5*

One of the defining characteristics of the Class 5 flood (e.g. 1990 first pulse) is that the south flowing waters from Wilpinnie Creek join the Strzelecki Creek floodwaters which then fill Lake Blanche. Outflow from this lake into Lakes Callabonna and Gregory may possibly occur but does not involve significant volumes of water.

The other defining characteristic of Class 5 floods is that they reach, and contribute large volumes of water to, Lake Eyre North but do not completely fill the lake.

The flooding of the wetlands is the same as for Class 4 floods. In addition, the Northern Lakes are filled to the point that water flows north from Lake Goyder and fills Lake Marroopootanie. Flow also occurs in a flood path that follows the base of the Innamincka Dome and connects the Upper Cooper Creek with Lake Lady Blanche.

*Class 6*

No Class 6 floods were observed during the study period and the only example on record was the 1974 flood. The purchase of images covering this flood was outside the scope of my project but the likely area of inundation, as determined from 1:250,000 scale maps, was:

- Lakes Callabonna and Gregory filled from overflow from Lake Blanche (Strzelecki Creek).
- The complete area of Northwest Branch, Main Branch and Northern Overflow filled as for a Class 5 flood and, in addition, further flow occurred to the north of Lake Marroopootanie.
- Lake Eyre North was filled by Cooper Creek flow, independent of any contribution from other sources (e.g. the Diamantina and Warburton rivers).

## Conclusions

The results of this study have demonstrated the complexities that determine the flooding pattern within the Coongie Lakes Wetlands. Understanding the hydrological factors that affect the flood patterns in arid-zone wetlands is vital when assessing the likely ecological effects of any upstream diversion of water from rivers such as Cooper Creek. The variability of the flood regime of many of these rivers requires that the flooding patterns from a range of flood pulses, with widely differing characteristics, need to be examined in order to better understand the subtle and complex interactions that are occurring.

The NOAA-AVHRR images are a highly useful tool in conducting research into the hydrology of arid-zone wetlands. These images provide excellent temporal and spatial observations of large-scale water movements. Combining this interpretation with any available stream-flow volume data greatly enhances the reliability of hydrological modelling.

The hydrological model developed from this research project can predict the pattern and extent of flooding in the Coongie Lakes Wetlands, based upon the characteristics of the flood pulse that passes through Callyamurra gauge station at Innamincka. The amount of pre-existing water in the wetlands needs to be established, however, before the extent of flooding of an oncoming flood pulse can be predicted. This is best achieved using NOAA-AVHRR images, which are relatively inexpensive and readily available from a variety of sources. Ground or aerial observations may also suffice in estimating the pre-existing water volume.

Further research is required to determine flood classes in terms of upstream hydrological data. The availability of this information would increase warning and planning times for the extent of flooding by the order of several weeks. The most obvious upstream location for collecting hydrological data is Currareva, Queensland. The re-establishment of a flow gauge station at this site would be highly beneficial for this purpose, however, flow level measurements could provide a reasonable approximation of the daily flow volumes.

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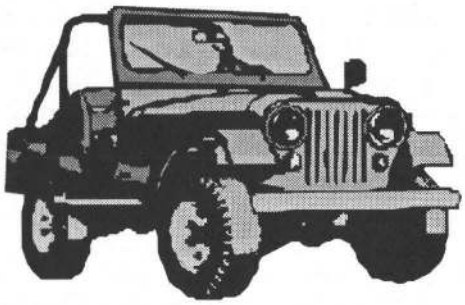

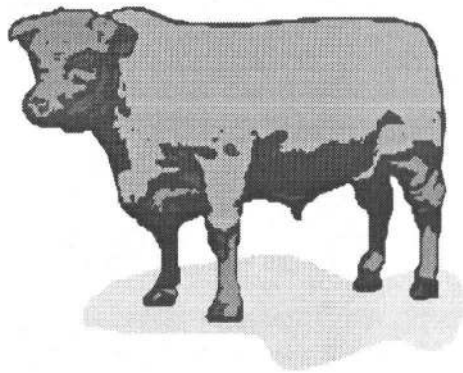

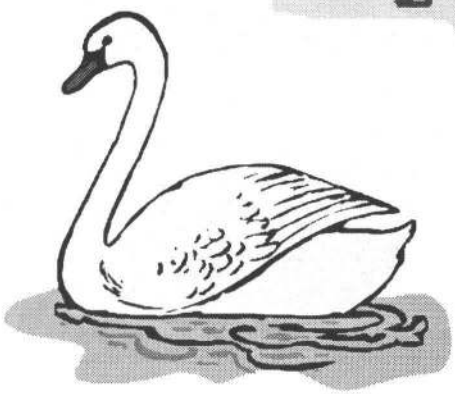

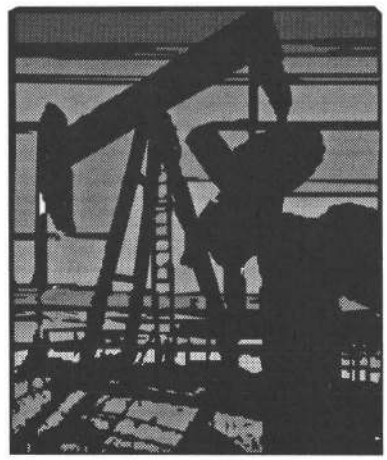

# GRAZING STUDIES REVEAL CAMELS HAVE LIMITED POTENTIAL TO CONTROL WOODY WEEDS IN WESTERN NEW SOUTH WALES

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## Introduction

Woody weeds have become a problem in Australia and other arid and semi-arid rangelands (Jacoby 1986) following the introduction of intensive grazing by domestic livestock (Hodgkinson 1979). In Australia, Booth (1986) estimated that the woody biomass has changed on 210 million ha of *Acacia* woodlands over time. Shrubs have replaced palatable grasses and livestock production has been reduced due to poorer nutrition. Reduced production is expressed through lower reproductive percentages, smaller wool cuts, reduced carrying capacity and less efficient and more costly musters (Condon 1979). Over a ten year period, shrub invasion was blamed for an average decrease in grazing capacity of 5 to 14% on four properties in north-west New South Wales (Booth and Barker 1981). Germination and establishment of shrub species is a periodic occurrence which happens with high rainfall. Pasture species should also proliferate at such times, and in the absence of heavy grazing this growth dries off and fire can be a critical factor in reducing the successful establishment of shrubs. The interaction between fire and grazing is therefore a major factor in the control of shrub encroachment (Hodgkinson 1986). Fire is recommended for brush control in parts of Africa and North America, but where rainfall is less than 400 mm/annum, the vegetal cover is generally too sparse to support a fire (Trollope 1986).

Sustainable grazing management is a potentially effective technique for maintaining country in an open, productive condition (Tatnell 1993). However, the use of grazing animals to control established shrub populations has largely been unsuccessful (Batianoff and Burrows 1973) because livestock tend to select young forage first, meaning that mature plants are rarely killed (Jacoby 1986), and because the stocking density required to achieve control generally places severe nutritional stress on the browsing animal (Scanlan and Pressland 1984). Wilson *et al.* (1976) and Harrington (1979), however, concluded that goats were of value in controlling some shrubs in western New South Wales.

A number of herbivores, particularly camels, are more predominant browsers than goats and should have a greater effect on woody weeds. Additionally, because camels are anatomically adapted to browsing (Wilson 1984), they should survive better on browse than goats. The proportion of trees and shrubs in a camel's diet can vary from 29% (Lamprey 1986) to 77% (Field 1979), and the proportion of feeding time spent browsing (as opposed to grazing) has been reported as

high as 99% (Belete 1985). Observations from Australia and other countries have shown that if stocking rates are high, camels can have a severe impact on woody vegetation (Leese 1927, Heady 1975, Heucke *et al.* 1992). East African cattle properties use camels at very high densities, up to 10 per sq km, to reduce woody weeds and to increase grass production (Schulte and Klingel 1991). It has been suggested that running camels with cattle in central Australia might achieve the same result (Dörges and Heucke 1989). The density of camels in central Australia is around 0.05 to 0.15 per sq km and with experimental densities of 2.0 per sq km, severe browsing damage was recorded on a number of species (Heucke *et al.* 1992). McKnight (1976) claimed there was scarcely any plant in central Australia that camels did not relish, including spiny *Sclerolaena* and *Solanum* species and other species shunned even by goats.

Where shrub encroachment has become so dense that there is insufficient grass to maintain sheep or cattle, or as fuel for an effective fire, and the shrubs are inedible to goats, then camels may be useful in controlling shrub numbers. Such browsing may open up the country sufficiently to allow grasses to re-establish, thereby making fire and other management options possible.

We investigated the dietary preferences of camels to determine their potential as a control agent for woody weeds. Dietary preferences were determined from field observations of free-ranging camels in western New South Wales, and from a cafeteria-style feeding study made using penned camels at the Western Plains Zoo at Dubbo in central NSW.

## Grazing Experiment

*The site*

Observations of plant species eaten by camels were recorded from two paddocks at Urisino Station, approximately 35 km west of Wanaaring, north-west New South Wales. The two paddocks on a sand plain were predominantly "open", with trees clumped over 30% of the area at an average spacing of 30 m. Mulga was the dominant species, with poplar box, bloodwood, beefwood, ironwood, whitewood, needlewood and corkwood also present (see Tables 1 and 2 and Fig. 1 for scientific names). Bushes and shrubs were clumped over 30% of the area and included turpentine, punty bush, prickly wattle, sandhill wattle, emu bush, dead finish, native apricot and hopbushes. Forbs and grasses were very scarce at the time of observation due to extreme drought conditions. Urisino was in the fourth year of drought when the browsing observations were made. Seventy-five millimetres of rain were recorded in the year of the study (1994), compared with an annual average of 239 mm, and the last significant fall prior to the study was in December 1992 when 15 mm were recorded.

*Livestock*

The eight camels observed were domesticated and were accustomed to human presence. Observation distances of 10 to 15 m were possible without interfering with the camels' feeding behaviour.

*Grazing observations*

Direct observation (Rutagwenda *et al.* 1990) was used to determine the dietary preference of the camels. The relative importance of plant species was calculated using a frequency method (Leuthold 1970) by accumulating the number of times an animal fed on a particular species expressed as a percentage of all observations. That is,

$$\text{selection frequency index} = \frac{\text{number of times an animal selected a particular species}}{\text{total number of selections for all species}} \times 100$$

Time spent eating a particular species was also recorded. This enabled time preferences to be calculated using the time-observation method of Leuthold (1970). This index was calculated as:

$$\text{time observation index} = \frac{\text{time spent grazing a species}}{\text{total grazing time}} \times 100$$

Observations of the eight camels were made over a number of days until 100 food records for each animal in each paddock were obtained. A food record was completed when:

- the animal began feeding on a different species,
- the animal walked for more than three seconds from its previous feeding site, or
- more than 60 seconds had elapsed without feeding being resumed. (For the latter two occurrences, if feeding resumed on the same species before the allotted time elapsed then the food record continued.)

Each food record detailed duration, shrub or tree species and plant part browsed, or whether a grass or forb was grazed (without details of species or plant part). If all animals were browsing one particular plant, then this was recorded as eight separate feeding events and the particular time noted for each camel. The order in which animals were observed as the "focal animal" was determined by the use of a random number table as outlined by Altman (1974). Very few feeding events were of short duration and times recorded were rounded to the nearest 30 seconds.

*Observation times*

All camels were observed in Paddock One for three consecutive days during November and December 1994, at times of 1030 to 1830 on day one, 1230 to 1900 on day two and 1300 to 1800 on day three. In Paddock Two all camels were observed for two consecutive days during December 1994, from 0800 until 1700 on day four (i.e. the fourth day of observations, but the first day in this paddock) and from 0915 until 1500 on day five. The two days of observation were sufficient for 100 food records to be obtained for each camel. At night, the camels were yarded with a small amount of hay and each morning they were ridden before release.

*Vegetation records*

To determine the selection for or against a particular species, a detailed analysis of the available vegetation was necessary. In Paddock One (area of 2 km by 1 km), plant abundance was estimated by dividing the paddock into 100 m grids and recording the presence or absence of each shrub or tree species within a 5 m radius from the intersection of the grid lines. These frequencies in the habitat (i.e. abundance data) were compared with the frequencies as food records to give a selection value. A Chi-squared test (Leuthold and Leuthold 1972) was carried out between the abundance data and mean number of selection events for individual woody weed species (mulga, turpentine, turkey bush, hopbush and punty bush) and all other species grouped.

Paddock Two was larger, at about 5 km by 5 km, and plant frequency estimates were not attempted.

## Results

In both paddocks camels tended to select a plant species, graze it heavily for a while and then move on to another species. Chosen plants were often separated by considerable distances and the camels generally only nibbled other species on their way to new plants. It was not uncommon for the camels to browse one particular plant as a group. Due to the drought conditions, at no time were grasses or forbs consumed. The camel group went to the water trough at least once each day and all animals watered at least once during that time.

In Paddock One mulga had an abundance of 71% but made up only 34% of the total grazing time (calculated from Table 1), while punty bush and turkey bush had abundances of 21% and 16% respectively but were not selected in the diet (Fig. 1). Sandhill wattle and prickly wattle, on the other hand, had frequencies of 1% each, but made up 14% and 33% of the grazing time respectively.

Eleven tree and shrub species were eaten in Paddock Two. Data for the mean time camels spent grazing each species and the mean number of times each species was selected are shown in Table 2.

## Discussion

*Paddock One*

Grazing preference is governed by previous experience of animals to their grazing environment and if animals are introduced to a new environment, then an acclimatisation period is necessary (Arnold and Maller 1977). The camels used in this grazing experiment were familiar with both paddocks.

Mulga and prickly wattle were the two most preferred species, with grazing time-values ranging between 24 and 39% and 13 and 44% respectively. Sandhill wattle was a distant third in the preference stakes for all but two animals. For these two animals, the index for sandhill wattle at 17% either equalled or marginally exceeded that for prickly wattle.

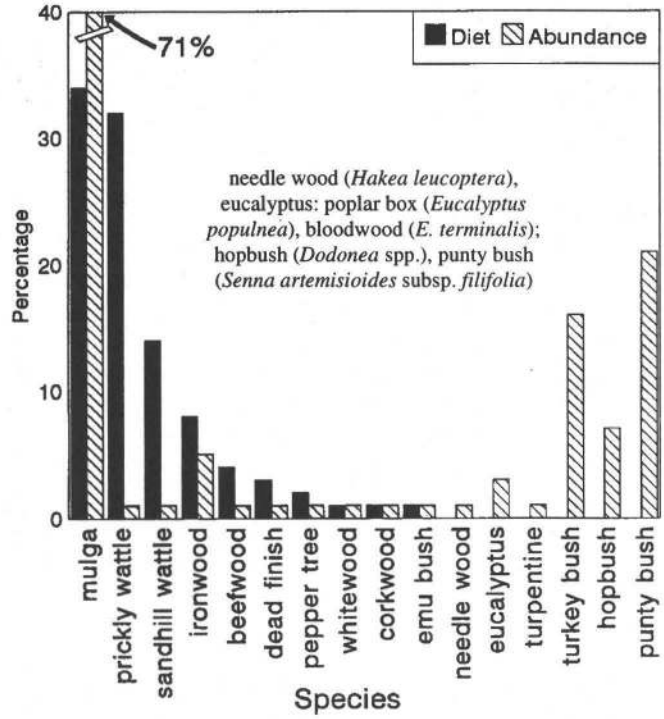


*Figure 1. Paddock One: time spent grazing each species compared with the abundance of the species.*

There was generally strong agreement between the time-observation and selection frequency indices, with correlation coefficients between 0.94 and 0.99 (mean of 0.97) for all camels grazing in Paddock One. However, for five of the eight camels, the time-observation index exceeded the frequency index for mulga by a notable margin. This difference between the two indices could be interpreted in a number of ways. It could mean that mulga was actively selected because the proportion of time spent grazing this species exceeded the relative number of times it was selected. Alternatively, it could imply that mulga was physically difficult to eat causing camels to spend proportionally more time eating this browse than selecting it. As none of the species were considered physically difficult to eat (e.g. lacking thorns), this alternative was rejected. Prickly wattle could also be considered an actively selected species because the time-observation index exceeded the frequency index for six of the eight camels. The largest individual difference in observations amongst camels for prickly wattle was where the time-observation index was 41% and the frequency index was 28%.

Only one camel showed a reversal of the trend to actively select mulga. In this case, the time-observation index of 24% was less than the frequency index (at 32%). Other apparently non-selected species for individual camels were sandhill wattle and ironwood (for two camels).

The conclusion that a species was actively selected was based on the time-observation index exceeding the frequency index by greater than 5%. That is, once an animal selected a species, it willingly consumed it for a greater proportion of time than its proportional selection indicated. Calculations show that if the coefficient of variation of grazing events and grazing time is approximately 50% or less, then a 5% difference in

Table 1. Paddock One: mean time (in minutes) spent grazing each species and mean number of times each species selected per 100 grazing events (± standard errors)

| Species | Grazing time | Selection frequency |
|---|---|---|
| mulga *(Acacia aneura)* | 110 ± 7.4 | 29.6 ± 1.4 |
| prickly wattle *(A. victoriae)* | 107.3 ± 14 | 26.8 ± 2.7 |
| sandhill wattle *(A. ligulata)* | 45.7 ± 2.1 | 15.9 ± 0.7 |
| ironwood *(A. excelsa)* | 26.9 ± 2.2 | 11.9 ± 1.2 |
| beefwood *(Grevillea striata)* | 11.5 ± 2.8 | 4.4 ± 0.7 |
| dead finish *(A. tetragonophylla)* | 9.1 ± 4.0 | 3.1 ± 1.6 |
| pepper tree *(Schinus molle)* | 5.9 ± 1.8 | 2.9 ± 0.8 |
| corkwood *(Hakea* spp.) | 5.1 ± 0.8 | 3.1 ± 0.4 |
| whitewood *(Atalaya hemiglauca)* | 2 ± 1.0 | 1.1 ± 0.4 |
| emu bush *(Eremophila longifolia)* | 1.4 ± 0.5 | 1.3 ± 0.3 |

percentages between grazing events and grazing time would be significant (J. James pers. comm.).

A more reliable measure of a species being selected or not selected is based on the assumptions that:

1. if there is no dietary preference for any individual species, then the percentage of the total amount of time spent grazing each species should not be statistically different from the proportion of the total abundance of each species, and
2. the number of times each species is selected should reflect the presence of that species within the whole community.

Based on the high correlation coefficients discussed above, it would appear reasonable to assume (1) and (2) would also be highly correlated and as such, both could be considered from a calculation of either. A comparison of the time spent grazing each species and the abundance of species in Paddock One is displayed in Fig. 1. Of the top ten woody weed species in the Western Division of NSW (Booth 1985), four were recorded in Paddock One. These were turpentine, hopbush, punty bush and mulga, with abundances of 1%, 7%, 21% and 71% respectively. For each of the first three species, the mean percentage of time grazed was nil, and for mulga it was 34% (Fig. 1), in each case the abundance exceeding the grazing time. The Chi-squared test carried out on the abundance data and the mean number of selection events indicated that selection was occurring, and it is asserted that this selection was against the woody weeds and for other species.

*Paddock Two*

As for Paddock One, there were high correlation coefficients between the time spent grazing each species and the number of times each species was selected by each camel (mean 0.98). Mulga was selected by five of the eight camels, with observation indices exceeding the frequency indices by 5% or more. Sandhill wattle was a selected species for another camel. Ironwood was a non-selected species for two camels, with the frequency index exceeding the time-observation index by greater than 5%.

Table 2. Paddock Two: mean time (in minutes) spent grazing each species and mean number of times each species selected per 100 grazing events (± standard errors)

| Species | Grazing time | Selection frequency |
|---|---|---|
| mulga *(Acacia aneura)* | 123.4 ± 10 | 25.8 ± 1.2 |
| ironwood *(A. excelsa)* | 88.3 ± 5.7 | 23.9 ± 1.1 |
| beefwood *(Grevillea striata)* | 65.7 ± 8.7 | 18.1 ± 1.6 |
| sandhill wattle *(A. ligulata)* | 64.4 ± 5.6 | 15 ± 2.3 |
| emu bush *(Eremophila longifolia)* | 11.8 ± 2.1 | 5.5 ± 0.7 |
| turpentine *(E. sturtii)* | 8.3 ± 2.9 | 2.1 ± 0.7 |
| whitewood *(Atalaya hemiglauca)* | 7 ± 1.7 | 1.8 ± 0.3 |
| native apricot *(Pittosporum phylliraeoides)* | 4.6 ± 0.6 | 3.9 ± 0.5 |
| eucalypt *(Eucalptus* spp.) | 4 ± 1.2 | 1 ± 0.3 |
| corkwood *(Hakea* spp.) | 1.1 ± 0.5 | 0.9 ± 0.4 |
| dead finish *(A.. tetragonophylla)* | 0.8 ± 0.5 | 0.3 ± 0.2 |

Turpentine and mulga had mean time-observation indices of 5% and 27% and mean frequency indices of 2% and 25% respectively. Although this implies that these species were selected, this could not be confirmed statistically because abundance data were not collected.

From general observations of the vegetation, it appeared that the species composition between paddocks was different. The abundance of species which were common to both paddocks also appeared to differ. Of the common grazed species (mulga, ironwood, sandhill wattle and beefwood), mulga appeared to be less abundant in Paddock Two and all other species more abundant. The data supported this as ironwood, sandhill wattle and beefwood all constituted a higher percentage of both the number of grazing events and grazing time in Paddock Two compared with Paddock One. Conversely, mulga had lower values for both indices in Paddock Two. Values for mean grazing time and mean grazing event within Paddocks One and Two were highly correlated (0.99 and 0.98 respectively) implying that grazing followed a similar pattern in each paddock. If the vegetation was the same in both paddocks then the indices between paddocks should also be highly correlated. Mean grazing time and grazing event of the common species (mulga, ironwood, sandhill wattle and beefwood) in each paddock had correlations of 0.82 and 0.65 respectively, supporting the assertion that the vegetation between the two paddocks was different. Data representing total grazing time for 100 records for each camel in both paddocks were compared using a paired-value *t* test and the difference was found to be significant. We suggest that this difference is related to the preference of camels for a varied diet. It seems that the camels preferred the second paddock and spent a longer time for each grazing event (3.25 minutes for Paddock One and 3.74 minutes for Paddock Two).

## Cafeteria Experiment

*Experimental procedures*

A cafeteria-style feeding study was undertaken using the four woody weed species, hopbush, punty bush, turpentine and

mulga. It was carried out at the Western Plains Zoo, Dubbo, by observing the intake of seven camels over four consecutive days during February 1995. For the first day, 10 kg fresh weight of each species, cut on the previous day, were offered to the seven camels. These were presented as individual piles of small stems and leaves, randomly placed within the same yard when the camels were brought in for feeding. On subsequent days, 5 kg of each plant species were offered to the camels, with the positioning of the piles differing from any of the previous days. During the day the camels were on display with other animals in a grassy paddock. The mean values of selection of the four species offered during the cafeteria grazing trial were analysed using a series of Chi-squared tests.

Camel dietary preferences were quantified by recording the number of animals eating each different species at 60 second intervals over a one hour period each time. The camels were then put in the adjoining yard where their normal feed ration of hay and chaff was available, and the remainder of the four shrub species was collected and weighed. After the third day the piles of shrubs were left with the camels overnight to determine whether they would eat all the species if given more time.

*Results*

The counts of eating events are presented in Fig. 2. The intake figures tend to support the results obtained from the previously reported grazing counts. The camels not only ate all the mulga during the last three days, but the time taken to consume it was less each day. Punty bush was consumed almost as readily as the mulga on day three, and on day four only 0.5 kg was left. Hopbush and turpentine were barely touched after the first day, even after leaving the uneaten woody weeds in the yard overnight on day three.

*Discussion*

Results from Chi-squared tests confirmed that significant selection differences occurred between the different species on the different days. The mean grazing count for each species was significantly different indicating that definite selection was occurring for each species. At no stage following the first day was hopbush or turpentine eaten. The selection for turpentine and hopbush was not significantly different, but the difference for mulga and punty bush (compared with turpentine and hopbush) was highly significant. For the last three days the mulga was consumed almost exclusively until finished, and then the punty bush was eaten.

Numerous authors have made mention of the camel trait of food familiarity and the need for camels to become accustomed to new foods (Leese 1927, Arnold and Maller 1977). Grazing counts increased from day one to day three and then fell on day four. Although only conducted over four days, the general trend of greater interest in some shrubs as the study progressed supported this trait of food familiarity. The last day of observations was an apparent anomaly. On this day, the camels seemed more interested in fighting and playing than eating. This restless behaviour had not been observed on any previous day.

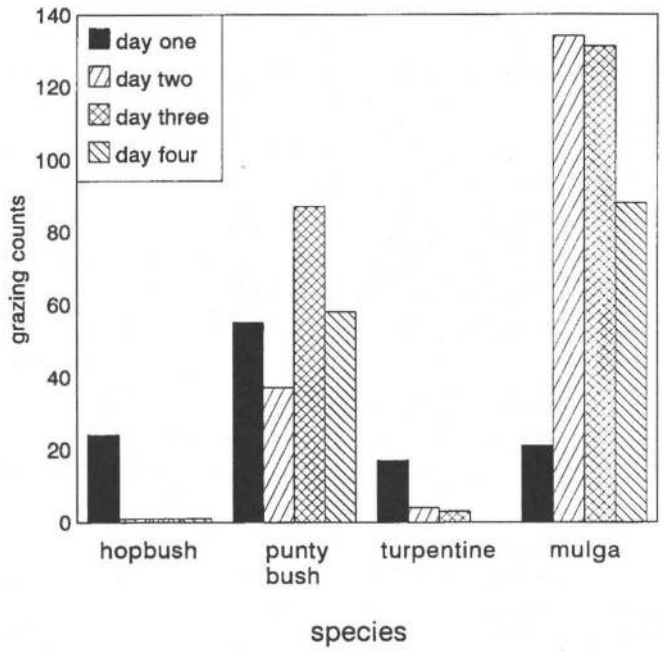


*Figure. 2. Grazing counts from the cafeteria grazing trial at Western Plains Zoo showing that mulga and punty bush were the preferred species.*

## Implications for woody weed control

Camels graze selectively and choose a wide range of plants in their diet. Where many plant species are present, camels will utilise a substantial range and only have an impact on a species if it is actively selected for browsing. In Paddock One, camels actively selected plants other than those classified as woody weeds. Of those species regarded as woody weeds, the only consistent trend shown from the results over the two paddocks and the cafeteria study was that mulga was readily eaten in all situations. This agrees with findings from other researchers (Dörges and Heucke 1989, Newman 1984). As for the other woody weeds, turpentine was eaten in Paddock Two, not eaten in Paddock One and only eaten to a minor extent in the cafeteria study. The camel owners at Urisino were surprised that the camels consumed turpentine (A. Rudd and P. Hansen, pers. comm.). Punty bush was readily eaten in the cafeteria study but not in the paddocks. Hopbush was not consumed to any degree in any of these studies. This result differs from the findings of Hunt (1994) who found hopbush to be significantly more palatable than turpentine and even suggested a possible use of camels to control hopbush.

Mulga was consistently grazed while the other species were grazed inconsistently. These results seem to be a reflection of the past experiences of individual animals, with the significant point being that all four shrubs are edible and it is individual selection which determines whether or not plants are eaten.

## Conclusion

This study has provided further evidence that while camels are selective feeders, they can and will eat plants that are classified

as woody weeds. In this study, however, the plants classified as woody weeds were not actively selected and camels do not appear to be potentially useful for controlling shrub encroachment in paddocks with mixed vegetation. Stocking densities would have to be high to overcome species selection and this would, at first, adversely impact on preferred species before less attractive woody weeds were browsed.

As an alternative management option, perhaps the most practical use of camels through their predominantly browsing habit is to prevent, rather than control, shrub encroachment. That is, shrub populations might be maintained in a stable state by running camels with other stock at reasonable stocking densities.

## Acknowledgments

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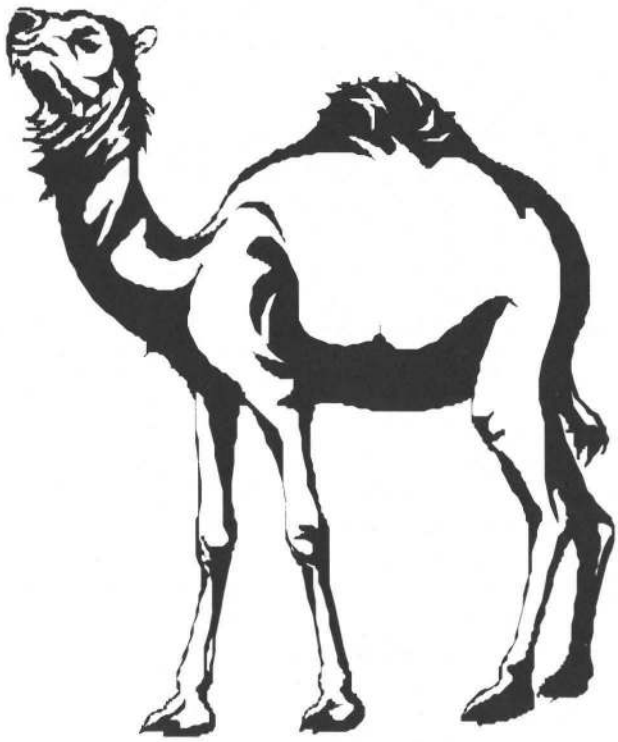

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## FOR SALE
### Proceedings of Fire Workshop

*Tony Grice, CSIRO Tropical Agriculture, Private Mail Bag, P.O. Aitkenvale, Townsville QLD 4814*

The Proceedings of a fire workshop held in Townsville in 1996 are now available. Entitled "Fire in the Management of northern Australian Pastoral Lands" and edited by Sonja Slatter and myself, the proceedings give an indication of the "state of play" in relation to fire in this vast region. They also present results of the workshop's consideration of the constraints to the use of fire, and research and other needs for the future.

Copies are available for $25 from Cam McDonald, Tropical Grasslands Society, 306 Carmody Road, St Lucia QLD 4067.

## NATIVE TITLE - ADDRESS BY JUSTICE ROBERT FRENCH
### Thursday April 3, 1997

*Don Burnside, Member, ARS WA Branch, 29 Woodsome St, Mt Lawley WA 6050*

A stray invitation to join a group of young Perth lawyers to listen to Justice French (President of the Native Title Tribunal) came my way last April. It was too good an opportunity to miss, although I stood out in the crowd owing to my advanced years and less than sartorial elegance. Despite my discomfiture, I made some notes of what was a very lucid and dispassionate 40 minute account of the issues surrounding Native Title. What is written below is my best attempt to record what I heard Justice French say in his address. *(Justice French has since kindly checked my interpretation and is happy to see it published.)*

Justice French began by defining *Native Title* - a concept not known to 'western law'; but one which exists in indigenous life; as cultural or spiritual 'rules of law'. The High Court rulings on native title (referred to here as the 'Mabo ruling' and 'Wik ruling') represent 'judge-made law', as opposed to legislated law. In the Mabo ruling, this judge-made law recognised the concept of a law grounded in indigenous life.

Justice French emphasised that at the time of British annexation of Australia, the Crown took sovereignty (note - not ownership) which gave the Crown the power to make laws. Under the assumption of *Terra nullius*, the common law operational in Australia could not recognise indigenous law.

Essentially what happened in the Mabo ruling, and which was restated in the Wik ruling, is that one system of law (the 'western law') has recognised the existence of land rights deriving from another system of law (the 'indigenous law'), or as it is called - native title. Further, the High Court ruling noted that this other system of law could still be operational where it had survived in a continuous way since European colonisation.

What that means is that the law-making activity which has occurred under the Crown's jurisdiction until the Mabo ruling did not actually *extinguish* any 'indigenous law', but lay 'above or over' native title. Justice French stressed the importance of this point. However, the more european law applying to a given area, the more likely is it that the indigenous law has become unrecognisable, inoperable or inconsistent with 'western law'. For practical purposes, native title is considered as extinguished in such situations. For instance, the granting of freehold title is inconsistent with the operation of native title - hence native title is extinguished. Thus it is the 'weight or volume' of european law operating upon a piece of land which determines whether native title is still functioning.

Further, when indigenous people have left or been moved away permanently from an area of traditional occupation, native title to that area can be considered as abandoned or lost.

Where does this put leasehold land in the rangelands? Justice French noted that under existing legislation, leasehold law sits 'on top of' native title, but in the Wik ruling, the High Court decided that the weight and volume of this law does not result in complete extinguishment of any valid native title. However, he also said that none of the uses permissible under existing leasehold titles can be impeded by native title, and the rights of the leaseholder to carry out legitimate business specified under the Acts providing for leasehold use must be respected. The added ingredient from the Wik and Mabo rulings is that the leaseholder will need to respect the rights of native titleholders to the area, where that native title can be shown to be valid.

What will this mean in practice? Ignoring for now any proposed changes to existing legislation, Justice French's view is that where native title can be shown to co-exist with existing leases, then management arrangements will need to be negotiated that recognise the rights of both parties. The key question to be answered is 'If native title can be recognised for an area, what is its relationship to everything else (e.g. Pastoral Lease, Mining Lease, Local Government, State Acts etc.)?' Within all this, he said there is no doubt that the Mabo and Wik rulings have produced a change in the way authority operates in areas where native title has not been extinguished, and indigenous people are beginning to assert their new relationship with existing leaseholders.

On the other hand, it is important to re-state that rights of existing leaseholders cannot be eroded by native title. Although Justice French recognises that many leaseholders believe their rights on pastoral leasehold land will be affected by native title, he said that it is his observation, that over time, some have assumed rights to activity or possession on their leases which are beyond their true leasehold conditions and rights, as specified in the Acts. Thus the unpalatable reality is not that these leaseholders are losing existing rights to native title, but instead they may never have had them in the first place. While he recognised the anger and distress this situation is causing, Justice French said that in many situations the new relationships between leaseholders and traditional titleholders can be worked out within some small, but significant symbolic acknowledgment and respect for each other's rights to be in the area.

Sorting out new management relationships required by the recognition of native title is a role for the Native Title Tribunal, which he stressed is a mediating body, not a court. At the time he spoke, he said the Tribunal was handling over 500 claims, and was forming a number of regional working groups to overcome conflicts between existing title holders, and one or more native title claimants.

The point he stressed several times, was that because of the different nature of european and native titles, reconciling the different rights from each 'law' applying to the same piece of land is a management issue, not a tenure issue. He said that management of the issues requires respect for another's position, an understanding of the law, negotiation skills, time and a willingness to reach a solution.

# REPORT ON AN ARS TRAVEL GRANT XVIII International Grassland Congress and Research Stations in Canada and United States

*Trevor Hall, Roma Research Station, PO Box 308, Roma QLD 4455*

## Overview

The Congress, called "Grasslands 2000", was held at Winnipeg, Manitoba and Saskatoon, Saskatchewan in Canada in June 1997. The organisers categorised research reports into 30 themes covering topics from conservation, grazing systems, forage and land constraints, production levels, grassland and grazing management, community grazing, climate change, grazing systems ecology, biodiversity, to social and economic aspects of grasslands. There was a Trade Show for companies displaying their technology, equipment and knowledge. Opportunities for discussions with other people interested in grasslands were provided throughout the Congress.

Some 1200 people attended from over 90 countries. There were three concurrent sessions, each with invited speakers reporting on a major theme which was followed by a discussion session and then a poster session. A farmers' forum provided producer speakers with an opportunity to set the agenda with most describing their farming operations. There were mid-congress tours to see Canadian agriculture and culture first hand. Australian research was well represented in the papers and posters.

The opening ceremony of traditional dances showed the cultural and ethnic diversity of the Canadian population. Their politicians reported having "some of the finest agricultural land in the world" and "were meeting the challenge of increasing agricultural productivity while preserving resources for future generations". Increasing amounts of money are being invested in forage research in Canada with the Government matching investments made by the private sector. The IGC leadership reported the need for the research community to be leaders in the community debates about grasslands and land resources. There will be increasing community concern about the future use of land resources and decisions will be made regarding land management with, or without, the input of scientists who may have the best knowledge in regard to these matters.

## World Food Requirements

The International Food Policy Research Institute suggested that the world can continue to increase food production as the human population continues to increase. However, the questions remain "will this increased production be economic", and "will the countries with the capacity for creating great increases in production choose to use their resources, including their grassland areas, for food production for other populations"? From an Australian perspective, the predicted

increase in demand for meat and cereals by the rapidly increasing population, combined with changing dietary habits to more western-style foods and a demand for increased calorie intake will provide expanding opportunities for our farmers. The demand for meat products in Asia is predicted to expand 20-fold by the year 2020. A world beef production increase of 1.9% per year and a 1.5% increase per year in grain production are required to meet this challenge. Real food prices will continue to fall but at a lower rate than in the last decade.

## Rangelands

More research into the less favoured areas of the world, including rangelands, was requested. This will require strong decisions and action by governments. Poor economies and lack of knowledge will continue to contribute to environmental degradation. Less than 0.5% of agricultural research money is channelled into research that benefits low-income, developing countries. There will be increasing competition for water and a demand for more efficient and cost-effective use of water resources in the future.

The **importance of rangelands**, covering some 70% of the world's land surface, for providing food, fibre, fuel, water, recreation and tourist values was highlighted. However, the critical issue is continued degradation, erosion and loss of biodiversity on these lands by mismanagement of livestock and poor agricultural practices from a rapidly expanding population. For example, the African population is expected to double in 25 years. This will force farming into more arid regions and increase the grazing pressure on more marginal lands causing more degradation and reducing livestock production.

Arid and rangeland areas of the world have been a low **priority area for research** and have received significantly less research than temperate grasslands. This is evident in more rapid degradation of the arid areas contrasting with management changes in temperate areas where less demands are being made on the resource (extensification). A higher level of research into the ecology of temperate areas has resulted in a better understanding of these areas which has translated into improved management.

**Biodiversity** is now a major subject. Its discussion covered a variety of scales: community, landscape and pattern diversity developing from the smaller-scale stand diversity and the still smaller scale local-patch diversity measured as richness and evenness of a specific community. One view is that grazing promotes biodiversity by reducing tall thick-stemmed species and providing opportunities for smaller species to grow. Embodied in this is the notion that isolation leads to monoculture.

Because different grassland species show marked differences in their responses to increasing carbon dioxide concentrations, rising temperatures and water regimes, we can expect major changes in botanical composition and plant community structure with the likely **changes in climate** caused by global warming. Grasslands and forages act as carbon stores and these may be significant in mitigating the effects of increased carbon dioxide on climate change. The potential for rangeland areas to act as carbon sinks needs to be researched and this research warrants support from the wider community.

The GRAZPLAN group of **decision support** packages were cited as an example of the use of simulation models to add value to physiological and agronomic research. Other speakers emphasised the importance of understanding the ecological processes that can be controlled by land managers. This understanding is critical to the success of grazing systems. Stocking rate is the most important factor influencing production per unit area and per animal, and the sustainability of grassland systems. Robust and user-friendly models that can produce outputs for land managers from complex interacting ecological processes will have a role in whole-property management - to provide both management options and allow analyses of risk. Some speakers suggested that the role of researchers was to provide these tools so that land managers can make their own informed decisions.

Stocking rate is the most important production variable influencing viability of grazing enterprises. Allied with this, land managers need to understand how to manipulate stocking rate to maintain optimal botanical composition and biodiversity. More research on the ecology and biological processes associated with pasture utilisation rates is warranted. More widespread implementation of grassland / **pasture monitoring** programs by land managers is necessary.

Comments from speakers such as "grassland research has made little influence on improving management of arid lands" highlights the need for governments to place more resources into this science. Other speakers suggested that more progress could be made into the management of arid areas by researchers and extension officers making greater use of local knowledge. Imposing inappropriate 'imported' management practices has often been ineffective.

## Visits to Other Research Centres

The **Texas A&M University** cattle nutrition management service based on near-infrared spectrometry (**NIRS technology**) and a nutritional computer package (NUTBAL) is becoming widely accepted across the US. Using this service, producers send in faecal samples for an analysis of diet quality. This technology, if adopted in Australia, has potential for assisting cattle producers to formulate least-cost supplement programs to meet target markets.

**Yellowstone National Park** has spectacular scenery, with bison and elk grazing grassy flats, pine-clad steep slopes and 11,000 feet-high snow-covered mountains. The strong ecological message from the management of the park is that preventing fires for decades creates an uncontrollable fire hazard. Over 1.3 m acres of pine were totally destroyed by an unmanageable fire in 1988. Very little recovery has occurred beyond patches of dense seedling trees to 60 cm high. There are still areas with no seedlings. This fire decimated the

wildlife populations as well, although the bison have returned and are overgrazing the smaller areas of available vegetation on open flats. Australia's policy of strategic controlled burns every few years is justified.

At the **Idaho Sheep Experiment Station,** long-term grazing trials are considered necessary to study grazing effects on the botanical composition of sage brush rangelands. One trial examining the effects of spring and autumn grazing has been running since 1923, with the treatments subdivided in 1950. Spring grazing promotes unpalatable weed species compared with autumn grazing.

Ak Bosh **guard dogs** protect flocks of greater than 1000 ewes plus their lambs from predation in unfenced range pastures. In more closely settled and fenced areas, **llamas** are run with ewes to reduce lamb losses to foxes and coyotes. The African dauper breed of sheep is being evaluated for fat lamb production on sage brush range.

On **community grazing land** in Canada, the Government provides officers to supervise the pasture management and cattle husbandry of producers during summer. Each producer pays a weekly agistment fee.

There is a successful **farmers' cooperative** bison abattoir (200/day capacity) in North Dakota. This cooperative markets all the farmed bison available in northern US. The industry is expanding by promoting a quality speciality product to restaurants where a premium price can be attracted. There could be lessons for some rural communities in Australia from this farming and local-business cooperative.

The next International Grasslands Congress will be in Brazil in 2001. In ending this report, I thank the Australian Rangeland Society for its financial contribution towards the cost of my trip.

# HOME FROM THE RANGE
## Musings from a study tour of Canada and the USA

*Mick Quirk, QDPI, PO Box 967, Charters Towers QLD 4820*

In June of this year, I visited several rangeland areas of Canada and the US during a study tour that included the International Grasslands Congress in Winnipeg and Saskatoon. The trip was supported by the A.W. Howard Memorial Trust, Meat Research Corporation (MRC) and Queensland Department of Primary Industry (QDPI). My aim was to visit centres that were successfully developing and applying principles of grazing ecology for sustainable grazing management. I was particularly interested in bio-physical planning frameworks for assessing both carrying capacity and range condition/health, and in the delivery of information on grazing management in the context of whole property management. I trust the following "snapshots" are of interest to *RMN* readers. I have additional information on each of the programs I visited - contact me on 077-872155 if you are interested.

In Saskatchewan, the Grazing and Pasture Technology (GAPT) program has increased producer demand for information and help on designing better grazing management systems. It's success is attributed to:

- the support and active participation from the Saskatchewan Stock Growers Association in partnership with the provincial extension service;
- the low-key but professional approach of the rangeland extension staff; and
- the availability of a system for rangeland analysis and planning.

The latter system mimics that available in the USA, being based on mapping of range sites (ecological subdivisions into which rangeland is divided for the purpose of evaluation and management), assessing range condition, estimating grazing capacity, managing grazing distribution, and developing grazing plans (for spelling etc).

The well-regarded Total Ranch Management course, developed by Larry White of Texas A&M, has been successfully adapted to Wyoming, Utah, Idaho, and Montana. This was achieved through the Western Integrated Ranch/Farm Education (WIRE) program, which is federally-funded and managed by the respective State University extension systems. WIRE emphasises the process of management at the whole-property level by working through a structured series of strategic (where are we going?), tactical (how do we plan to get there?), and operational (how do I apply the plan and monitor its success?) steps. Experience gained with WIRE since 1992 has highlighted the need for:

- recognising the over-riding importance of the human element in planning;
- putting price-tags on goals;
- budgeting all resource flows: cash, labour, forage etc;
- a balance between strategic, tactical and operational components;
- substance as well as process; and
- training of staff for professional delivery.

In Colorado, controversy over use of public lands for livestock grazing is being addressed by a community-based approach that is trying to put substance to the emerging concept of "ecosystem management". For example, the Owl Mountain Partnership (OMP) in north-central Colorado seeks consensus solutions from open dialogue amongst all stake-holders. Successes to date include replanning of grazing practices on public allotments so that seasonal use by livestock was maintained at the same time as protecting wetland habitat. The OMP emphasises the people component in solving natural resource management problems, but is also ensuring that the best possible information on resource inventory and management is available.

The rangeland analysis and planning system for private rangeland in the USA, developed by the Natural Resource Conservation Service (formerly the Soil Conservation Service), is the linchpin for all approaches to improving rangeland management in the USA. It is being revised to incorporate recent advances in the understanding of successional processes. The system, which is based on mapping land into range sites, has traditionally used criteria for assessing range condition (poor to excellent) based on similarity of vegetation to climax. Where appropriate, state and transition concepts are being included in range site descriptions, and management goals for structure and composition of vegetation are more explicitly based on primary uses (livestock, game animals, wildlife habitat, watershed, etc).

There is rapidly growing use of a nutritional management service based on predicting diet quality of grazing animals from scanning of faecal samples using NIRS (Near Infrared Spectroscopy). The service is based in Jerry Stuth's lab at Texas A&M and currently has over 900 clients. In addition, extension agencies are supporting analysis of samples from 300 cooperating ranches throughout the USA over the next two years to raise the profile of the technology and to provide further geographical testing of the NIRS equations. The NIRS procedure now uses several prediction equations, each calibrated for a specific application depending on dominant dietary components (native grass, improved temperate grasses, legumes, browse), rather than using one universal equation. The dietary predictions are fed into a nutritional decision-support system (NUTBAL) to assess feeding options. Wide-scale testing of the system with growing heifers showed clear benefits over alternative nutritional assessment procedures. (NOTE: David Coates at CSIRO Davies Lab, Townsville, is adapting this technology for use in northern Australia, with support from the MRC.)

The XVIII International Grasslands Congress in Winnipeg and Saskatoon was attended by about 1200 delegates from over 80 countries under the theme of "Grasslands 2000". Trevor Hall has provided a detailed report of the conference elsewhere in this newsletter, so I will give only general impressions. The meeting was an excellent opportunity to update on many "big picture" and traditional issues and was invaluable for networking with colleagues. However, sessions often failed to meet their potential usefulness because of the general nature of many of the topics and the conservative approach of many of the speakers. Several of the more challenging opinions or facts presented included:

- Meat imports by Asia will increase by a factor of 20 between now and the year 2020.
- To meet demand, world meat production will need to increase by 1.9% per year.
- Real food prices will continue to decline but not as steeply as in the 1980's.
- Good understanding of the grazing ecology of improved temperate pastures has translated into improved management practices, but this is less evident in the rangelands.
- Foraging ecology has been well served by mechanistic studies of grazing behaviour and, more recently, by studies into mechanisms based on post-ingestive feedback and adaptive learning. Unfortunately, there was no attempt at the Congress to bring these concepts together.
- Most effects of increasing atmospheric $CO_2$ are still uncertain, particularly as spatial scale increases. The soil carbon pool will moderate some of the increases in $CO_2$ levels. Management (mainly harvest rate) will determine the extent to which grasslands modify global change.
- Pattern diversity is critical for grasslands and is reduced by heavy grazing and by exclosure. Diversity of ungulates in African savannas is under threat: the smaller body-size categories are the most species rich but are also the most susceptible to habitat disturbance.
- Preservationists, and not just rangeland managers, need a good dose of education about principles of range management.
- Grassland science has made little useful input into management of semi-arid and arid grasslands: the challenge is how to make it more relevant?
- Participatory research and extension that recognises local knowledge is required for progress in range management, particularly in areas with a recent history of nomadic and communal grazing systems; top-down approaches have been ineffective and inappropriate.
- Research and extension needs to identify the drivers of the decision process.

As part of my reporting from the study tour, I made some inferences about things that government and industry could do to improve rangeland management, particularly in northern Australia. Those recommendations were:

1. Programs aimed at improving management, be it grazing management, herd/nutritional management or whole-property management, should be formed and steered by a partnership between producers and agencies. Adequate resourcing of both producer AND agency input is essential.

2. Queensland and other State agencies are a long way from the capability of most North American agencies to provide comprehensive, specific, practical and ecologically-sound planning of grazing/range management. Development of a credible system for rangeland analysis and planning, similar to that used in North America, is urgently required. To this end, relevant agencies in north Australia should use systems in use within North America as a source of ideas and as a source of staff training.

3. Successful programs that deliver whole-property planning in a rangeland context are available in the USA. These programs should be a source of ideas, and provide an avenue for staff training/staff exchange for similar programs in northern Australia. For example, the current development of property planning and management modules (PMP) for extensive livestock enterprises within QDPI would benefit from comparative analysis with the WIRE program in terms of both process and content.

4. Pro-active grazing management should be promoted as a tool for reaching production/enterprise goals, rather than being pushed on the basis of fears about "society's expectations" of sustainability or biodiversity (the "fear" approach being trendy in research organisations these days!).

5. Ecosystem Management (or Integrated Catchment Management), whole-property planning, and grazing/range planning are a hierarchy of activities. The broader-scale activities (e.g, ecosystem management) help provide the context and reason for finer-scale activities, but the mechanics of doing finer-scale activities (e.g, planned grazing management) can only be sorted out at that scale. Programs that do not put the appropriate balance of resources into each of these activities will fail. Process without content is as undesirable as content without process.

6. The NIRS/NUTBAL package has tremendous potential for nutritional management of livestock production systems throughout Australia. Transfer of the NIRS component to northern Australia is progressing well through MRC-supported work by David Coates at CSIRO. QDPI should join with CSIRO in developing and testing the NIRS/NUTBAL technology.

7. Texas A&M provides annual refresher courses in rangeland ecology to federal agency extension staff. The course structure and content is extremely good and, in combination with material already compiled by Joel Brown and others in north Queensland, should form the basis of courses offered to agency staff in northern Australia.

## *THE RANGELAND JOURNAL*
## Special Issue on Water in Rangelands

*Allan Wilson, Editor,* The Rangeland Journal, *"Cal Col", Deniliquin NSW 2710*

The second issue of the Journal for 1998 will be devoted to collected papers on the topic of "water in rangelands".

Water is the most scarce resource in the rangelands and its abundance or absence affects nearly every biological function and productive output. It is therefore appropriate that we should devote a special issue of the Journal to water. Water is interpreted broadly to include rainfall, runoff and redistribution, streamflow and groundwater.

A number of papers have already been offered. There will be a group of papers on rainfall variability and climate forecasting. These papers will have an emphasis on the implications of variability for managing natural resources and pastoral production.

There will also be several papers on the redistribution of rainfall across the landscape and its impact on herbage production. The emphasis will be on landscape ecology and the effects of grazing management.

Papers on streamflow will include the effects of El Nino on streamflow and the impacts of irrigation withdrawals on inland river systems. A paper on lake-bed farming will examine the ecological impacts of cropping and how these might be minimised.

Papers on groundwater will cover catchment water balances in relation to land use and the management of small and large artesian and sub-artesian basins.

The papers will include both review articles and the results of specific research.

Offers of further papers are welcome. Final manuscripts must be in my hands by March 1998. Please contact me if you wish to make a contribution.

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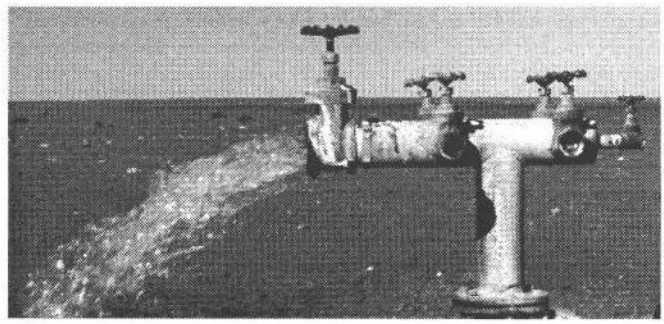
email: adwilson@deni.net.au



# FERAL GOATS - WHAT'S THE FUTURE? A workshop in Port Augusta, South Australia.

*Merri Tothill, Primary Industries, PO Box 357, Port Augusta SA 5700.*

The Northern Flinders, Marree, Gawler Ranges and North East Soil Conservation Boards have been involved in a coordinated feral goat control program over the past three years (see map below). The feral goat control program has been funded through the National Landcare Program (NLP). Landholders within the Eastern Districts Soil Board, whilst not originally included in the project, have also been actively participating in controlling feral goats within their district.

The coordinating committee for the project is made up of members of the representative Soil Boards, National Parks and Wildlife staff and Animal and Plant Control Commission representatives. The committee decided to convene a meeting on feral goat control in the rangelands of South Australia at the end of the NLP project. All stakeholders involved in the management of feral goats were invited including landholders and land managers, government agencies and goat industry representatives. The aim of the meeting was to determine a clear and consistent direction for the future of feral goat control in the rangelands.

A great deal of effort has gone into feral goat control in the past few years and feral goat numbers have dropped significantly. A better understanding of the problem has been achieved and practical experience gained in successful feral goat control methods. In general, the community and landholders are committed to the removal of feral goats from the rangelands.

The challenge for the future is to maintain and strengthen this commitment to ensure that all landholders and supportive bodies, such as the Pastoral Board and the Animal and Plant Control Commission, are working together with a clear and consistent approach to the control of feral goats in the rangelands. A national coordinated approach is also vital.

A report has been produced which presents the views of the various speakers and participants who attended the meeting and who have an interest in controlling feral goats in the rangelands. Outcomes of workshop sessions are also included. Participants in each workshop group dealt with "possible futures" for controlling feral goats, including identifying strategies for their implementation and highlighting any problems associated with those strategies.

A brief list of the workshop outcomes includes:

- a resolution to advise the State and Federal Ministers for Environment and Ministers for Primary Industries that eradication of feral goats remains a 'primary aim',
- that feedback be sought from landholders unable to attend the workshop, and
- that extension of the term for the Feral Goat Control Committee be investigated

Copies of the full report are available for $10, plus postage, from Primary Industries, South Australia at the mail address above, or by phoning 08 8648 5160.

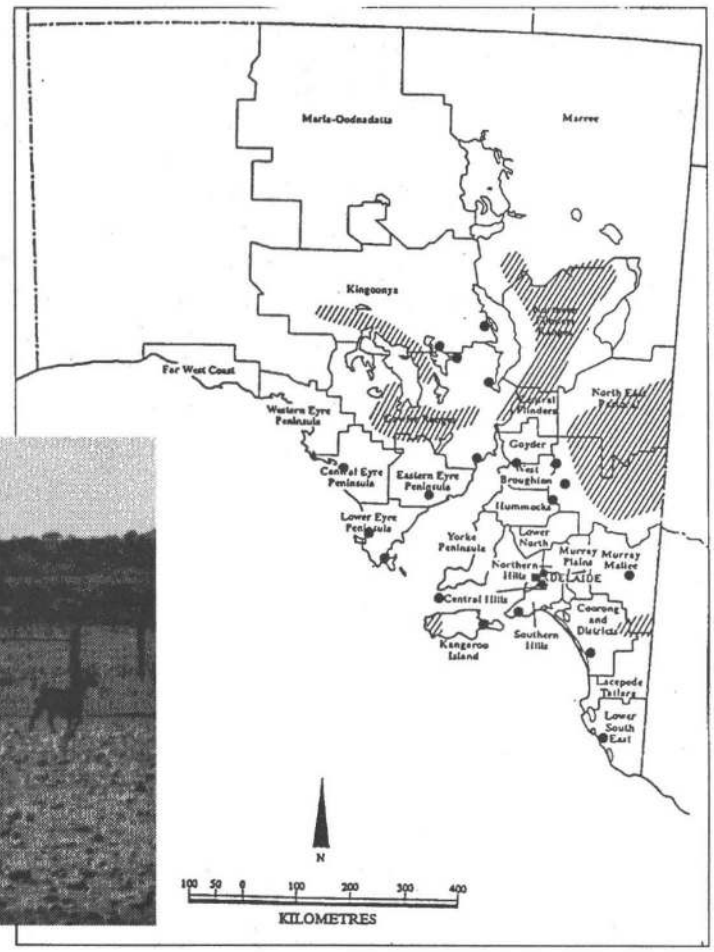



*Figure 1. Distribution of feral goats in South Australia*

# REMOTE SENSING MONITORING MEETING AND FIELD TRIP
## Kununurra - 5 to 7 August 1997

*Ian Watson, Agriculture Western Australia, PO Box 483, Northam WA 6401*
*Paul Novelly, Agriculture Western Australia, PO Box 19, Kununurra WA 6743*

A meeting and field trip recently held in the East Kimberley addressed the status of remotely sensed rangeland monitoring data and its relationship to ground based data. The genesis was a joint Agriculture Western Australia / CSIRO Division of Mathematics and Information Sciences project. The NT Dept. of Lands, Planning and Environment and the Tropical Savannas CRC were also involved. The project attempts to link various monitoring scales in tropical grasslands, and the meeting was a chance to receive feedback on how potential end-users assessed the emerging products. Participants were a mixed bag from WA and the NT, mainly from agencies, the most likely end-users. However, several producers attended to ensure some practical utility.

There is a very strong demand for information about rangeland change. Not merely at the landholder scale, but through to the national scale, such as reporting for State of the Environment. Moreover, there is an expectation that somehow new technology will provide an answer. The demand is clearly there. Our job is to meet it. The demand is relatively unsophisticated. Does continued grazing at current levels get a "red light" or a "green light"? After 25 years of effort in Australia, we still can't provide an answer on a broad spatial scale. This highlights the real challenge for those involved in rangeland monitoring - to set in place a wide-area, long-term operational range monitoring system.

Some indication of the difficulty of meeting this challenge was given by the inability of the workshop to successfully answer the question, "How long before the R & D work presented at the meeting will be a useable product"?

Two common threads emerged at the workshop that explain much about why we are in this position.

**1. Monitoring systems are expected to be "all things to all people"**

It emerged several times during the meeting that we were trying to provide monitoring systems expected to be all things to all people. Problems here include:

- Poor understanding by end-users of the importance of spatial scale in interpreting range monitoring data.
- Poor understanding of both temporal scales involved in rangeland monitoring reassessments (e.g. once every 3-5 years generally) and the amount of observable change over time on monitoring sites.
- Continual confusion about the required scale for end-users. Is the monitoring system for use by land managers at the paddock scale, or is it to be used at a regional or state scale to make decisions about land use options?

Monitoring practitioners also have high expectations of the systems we are developing. We attempt to meet varied and varying end-user demands, and in the process lose focus on the scale of applicability of our systems. It is unclear if this is because we are so willing to please, recognising the impossibility of having a separate system for all possible combinations of temporal and spatial scale, or simply because we are (understandably) afraid to explain to some end-users that our system will not meet their needs.

- Working within systems with inherently confused objectives. Those paying for, or at least supplying the demand for monitoring information, don't know what to ask for. Those developing the range monitoring systems don't know (and often don't ask) what is expected of them.

Even monitoring systems with clear objectives can be derailed by changes in those demanding the output or by changes in end-users expectations and value systems over time. A range monitoring system might begin life within a state primary production agency, but become part of a state natural resource agency following a public sector reshuffle. In this case, if the system cannot address wider issues of biological diversity, then it is probably not satisfying its new end-users.

**2. Operational range monitoring systems or a litany of special cases?**

The R & D work presented at the workshop showed we know much about rangeland change in parts of the East Kimberley and the Victoria River District. However, our aim is to know a lot about changes in rangelands across northern Australia. This reflects much of the history of range monitoring. A few well-studied, spatially explicit sites, but never making the quantum leap to a wide-area operational system. Again, we face challenges in turning successful R & D into systems that meet the high expectations of end-users. Issues that arose included:

- Developing confidence that methods developed on intensively studied sites are applicable at wider scales. Can the same methods be used or easily adapted for other rangeland types?
- Is it realistic to expect that insight gained from numerous ground-truthed sites in a remotely-sensed R & D project can be matched by that gained from fewer sites once the area of interest moves to another Landsat scene and becomes operational?
- Those working on range monitoring R & D develop expert knowledge in both their biological and technical fields of interest. How does this expert knowledge get transferred to those expected to service an operational system? Perhaps more importantly - can the operational system be expected to provide reliable information without the same level of expert knowledge of the operators?

- We need to face the issue of logistics early on to plan for a wide-area operational system. Are staff available? Can they service the required number of sites within the required season?

- We must accept that good quality range monitoring data on a wide-area basis are very expensive. We then need to educate those demanding the data of this fact, and stress that the expense will remain high over the life of the system. No "cheap" option awaits discovery.

- Long-term commitment is needed from all involved; from funders, from those managing staff and from the staff themselves. The world's rangelands are littered with monitoring sites installed with great enthusiasm, never to be reassessed.

- Many results will be unspectacular. Little change can be expected on most sites on an annual time scale, and most time traces will be composed of few points. This is not a signal to cut funding to the monitoring system but emphasises that if users demand output, then they must be prepared to invest heavily in it.

Much of the above was well recognised at the workshop, and requires no special insight. But the challenge is to educate funders and end-users of these issues.

There were numerous indications that range monitoring R & D is maturing, particularly in comparison to what is known of other groups working on indicators of agricultural sustainability. The good news discussed was:

- How much change is really change, i.e. when does an amount of change become important biologically?

- What is meant by condition, both ecologically and pastorally? Is "poor" condition (judged at ground level) likely to be reflected as "poor" condition (judged remotely) if a species composition change is all that occurred?

- Recognising that trend alone only supplies part of the decision-making information. Rangeland in "good" condition cannot be expected to improve. Maps showing areas that have improved, declined or remained stable can be misinterpreted by those only looking for improvement; i.e. areas that don't improve are often areas that we wouldn't expect to improve.

- Recognising that we best judge change by comparing it with some explicit (although possibly informal) models of expected change. Rather than judging observed change in isolation, we can compare it with expected change.

- Recognising that good ancillary data enable better judgments. This is an explicit recognition of complexity in the ecological environment.

- Consideration of comparing the size of error in the techniques with the size of change likely to be observed over the specified time period.

- Presenting results with some indication of the confidence limits. In what proportion of judgments are we likely to be wrong?

# REPORT ON BUSHFIRE '97 CONFERENCE

*Dick Williams, CSIRO Wildlife & Ecology, Private Bag No 44, Winnellie NT 0821*

Early in July, with dry season fires blazing on the city outskirts, Darwin hosted the Bushfire '97 conference. We didn't realise we had timed it so perfectly. Here was an opportunity to discuss fire and its impact in the environment with flames on the horizon and a huge pall of smoke hovering overhead!

Bushfire '97 was the sixth in a series of Australasian Bushfire conferences which started in 1987 at the Australian Defence Force Academy in Canberra. This was the first time that the conference had been held in northern Australia and we certainly attracted a good turnout. More than 160 delegates from Australia, the United States, Brazil, Venezuela, the United Kingdom and New Zealand participated. Northern Australia was strongly represented in the program: 25 of the 59 presented papers were by "Top Enders".

The Bushfire conferences aim to provide a forum for members of the Australian fire community to discuss the latest concepts, research findings and technologies in bushfire-related research and development. We chose "Fire as a Land Management Tool" as the theme of Bushfire `97 and the presented papers were arranged in eight topics relevant to fire and land management - north Australian issues, the Kapalga Fire Experiment, traditional Aboriginal burning, fire mosaics, ecological responses, operational and planning issues, pastoral applications, and remote sensing and modelling.

Three keynote speakers addressed themes relevant to fire and land management. Peter Latz, based in Alice Springs with the Northern Territory Parks and Wildlife Commission, took a provocative look at the paradoxes of fire in arid and semi-arid Australia and ended up spending more time doing media interviews than participating in the conference! On the second day, Malcolm Gill from CSIRO Plant Industry in Canberra, reflected upon fire mosaics. On the last day Roger Landsberg, a pastoralist from Trafalgar Station near Charters Towers, Queensland, brought the perspective of a pastoral producer to bear on the question of fire and land management. Roger also proved extremely popular with the media and his paper was broadcast across the country.

A highlight of the first day was the joint presentation by Djalalingba Yunupingu and Nanikiya Munungurritj from Dhimurru Land Management Aboriginal Corporation in east Arnhem Land. Djalalingba and Nanikiya were the last speakers in the Traditional Aboriginal Burning session and their presentation on fire management was captivating. There were probably very few people in the audience who had heard traditional Aboriginal landowners address a conference about fire management issues.

The field trip on the day after the conference was a highlight with about 100 people attending. The day proved to be a good

opportunity to showcase Kapalga - the World's largest fire experiment! - in Kakadu National Park. On the way out to the Park, the tour buses travelled through Darwin's urban / rural zone. Staff from the Bushfires Council NT, the NT Fire and Rescue Service and various fire management agencies in southern Australia highlighted the problems that exist in managing these areas. On the tour, various people spoke about issues ranging from introduced weeds, fire in pastoral areas, and fire on floodplains, to the management of defence lands and fire in savannas. Once inside Kakadu, Park staff spoke about fire management issues. Some of the tour participants from southern states listened wide-eyed as they were told of a fire scar in Arnhem Land about the size of Melbourne (including suburban sprawl) and the practicalities of fire management in such a huge area (Kakadu is 20,000 sq km in size). Some of the more sophisticated fire lighting methods, such as tossing incendiaries out of helicopters (and hoping they will hit the right spot!) and flicking matches out of moving 4WD's were discussed. At Kapalga, we visited a representative block from each of the main fire regimes - early dry season burn, late dry season burn and an unburnt area. Issues pertaining to the measurement of the fires and their impacts on nutrients, streams and wildlife (plant and animal!) were discussed.

The next Australasian Bushfires Conference will be held at Charles Sturt University in Albury, NSW, in July 1999. Book now!

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## LETTER TO THE EDITOR

*Ann Waters-Bayer and Wolfgang Bayer, Rohnsweg 56, D-37085 Goettingen, Germany*

Dear Gary,

Just a short note to you after having gone through the most recent *Range Management Newsletter* this afternoon (*Ed.* RMN *97/2*). The very readable articles on experiences in rangeland management and land-use planning in Australia (such as the Rangeways project described by Margaret Friedel) stimulate ideas for our support to similar work in Africa.

In the Report of the Publications Committee, we note the plans for "internationalisation" of *The Rangeland Journal*. This we would welcome. A new forum for international exchange has become all the more necessary since the demise of the Pastoral Development Network of the Overseas Development Institute. The journal *Nomadic Peoples* still exists, but tends more to the anthropological line. We need a journal for inter-disciplinary science (which rangeland management demands) and development-oriented research. Hopefully this will be *The Rangeland Journal*.

With best regards,
Ann Waters-Bayer and Wolfgang Bayer
Email: wb.waters@link-goe.de

## REPORT ON ARID LAND ADMINISTRATORS' MEETING
## Alice Springs - September i997

*Peter Walker, Department of Land and Water Conservation, PO Box 1840, Dubbo NSW 2830*

Arid Land Administrators have for some years held biennial meetings to discuss issues of mutual interest.

This year all mainland states and the Northern Territory met over three days at Alice Springs, with the Northern Territory as our hosts. The representatives were senior officers from State Departments and/or Pastoral Boards, about 15 in all, with Northern Territory local officers joining us for some sessions.

The meeting was opened by John Pinney, Deputy Secretary of the Northern Territory Department of Lands, Planning and Environment, followed by a scene-setting address by Emeritus Professor John Holmes from the University of Queensland on future land use and tenure trends in the rangelands.

After that followed a series of discussions on a wide range of tenure and land administration policy, progress, and development of legislation in various constituencies.

From my perspective, the main points to come out were:

- All states are facing the same issues with Native Title, with some activities stopped or severely curtailed. Some are taking a bit more "robust" approach than others.

It was agreed that negotiation with native title holders / claimants is going to have to become part and parcel of our land administration operations.

- Other states have a wider "definition" of pastoral use than us (NSW) and allow farm tourism, agriculture and rural-related activities and in some cases, non-pastoral activities (with permit) and allow "start-up" phases of new activities under the current lease purpose. They all require either excision or change of purpose when the activity gets bigger but there is some problem determining the threshold level.
- All states (except Victoria and NSW) determine rents by land value (Western Australia is about to change to this system).
- No real answers exist to the problem of "chronic overgrazing" in some areas with small leases and/or woody weed problems, except to assist people to get bigger (this is not always appropriate in our case) and to help people out of the pastoral industry if they wish to go.
- All states and the NT have the same issues with authorising tenures for telecommunication sites, and require excision and change of purpose from grazing leases.
- Clearing of timber is not a big deal outside of NSW. Queensland has a scheme of regional clearing guidelines and a tree clearing policy which requires a tree management plan for five-year approvals. Various procedures for

applications are in place elsewhere but these do not have the same emphasis on natural resource assessment as in NSW.

- Western Australia has a new Land Administration Bill which goes before Parliament in March 1998. This Bill has some useful ideas for us in NSW.
- Other states have a Pastoral Board which makes policies, forms rules, and gives approvals. Should we consider one for NSW?
- South Australia and Western Australia have policies to eradicate feral goats. We do not. There was no spirited discussion on this point but NSW's different position is noted.
- The Northern Territory Pastoral Board has a "tier 1" land condition monitoring system based on photopoints which is accepted by graziers. This is a worthy act to follow (we are just trying to get underway).
- Public access routes - in South Australia, these are gazetted with the approval of lessees. They are not maintained although the SA Government may give funds to lessee for some maintenance.
- Public access will become a greater issue in the management of arid lands.

There was some discussion about ways of levying tourists to help pay for roads and other infrastructure, e.g. through a "Desert Pass" system, registration levy on vehicles, bed tax etc. In essence, tourists pay nothing for resource use and maintenance. Should they?

- Diversification of land use in rangelands is being encouraged by all states and the NT. Other administrations seem to have greater scope than NSW within their current lease purpose to supply tenure authorisation.
- Western Australia and South Australia do not allow the establishment of non-indigenous species or crops. I was not aware of this.
- There has been an application in South Australia to irrigate from a Great Artesian Basin bore. The issue here is not a draw-down in the supply of water but rather the potential for land degradation and introduction of non-indigenous species.
- Western Australia requires notification of the intention to transfer a lease. This involves an assessment and report on the lease which the vendor is required to provide to intending purchasers. The purchaser is required to sign that he has read the report. A good idea!
- Discussion on the future role of community boards (e.g. South Australian Soil Conservation Board) in determining policies, etc. An important question here is "has the bureaucracy adapted to the greater involvement of community groups in land administration and management?".

For many of the delegates it was our first meeting, and all agreed on the immense value of comparing notes, picking up ideas and making new contacts. The meeting also reminded me (again) of how my own State and Department fit into the broader national context and how great are the scale differences between states.

The visit to the new Desert Park on the edge of Alice Springs was excellent (well worth a visit) and the local scenery, as much as we saw of it, was well and truly up to its spectacular best.

The next meeting is somewhere in Western Australia. I hope I can go!

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## CONFERENCE NEWS

*Eugene Moll, Dept of Natural & Rural Systems Management, University of Queensland, Gatton College, QLD 4345*

This December, the ARS conference is on at the Gatton College Campus of the University of Queensland. On Tuesday 2nd there is a one-day Symposium titled "where the City meets the Bush: the importance of effective communication". This will be followed on Wednesday and Thursday by workshops, posters and papers contributed by ARS members. The conference dinner is on Wednesday and on Thursday there is a meeting of ARS members where there will be an opportunity to express views.

The highlight of the conference is perhaps the Symposium. The day has been carefully planned to maximise the learning opportunities with lots of time set aside for informal discussions. The format of the formal proceedings is a little different from usual. We have invited key speakers to address the Symposium which starts with a session aimed at providing a contemporary and future context. Thus, Bob Beeton will set the scene by describing the "big picture" followed by Peter Ellyard with thoughts on "the future". These addresses will be followed by a talk on the legal framework and policies (Jenny Clark) and Jeffrey Rae on "A full repairing lease".

Following the coffee break Nick Abel will look at the political framework in which we, as rangelanders, operate. After Nick there are four invited "interventionists" who hopefully will stir the pot a little, and they are Beth Woods (QIDC Chair in Agribusiness), Rod Jensen (emeritus Professor of Economics), Michael Pinnock (Qld Mining Council) and Ian Buck (Westpac Agribusiness). Following lunch, Roger Landsberg and either Tracker Tilmouth or Peter Yu will give their presentations - land holder and Aboriginal perspective, the interventionists are John Holmes (Social Geographer), Jeff Coutts (Rural Extension), Jenny Crichton (from Morven) and a representative from Life Line.

The final session will be lead by Keith Woodford who will question our current animal production systems, followed by Brian Roberts on the need to change our ecological perspective, with Pat Comben providing the view of conservationists. Denzil Mills from Traprock and perhaps another producer will summarise the take-home messages from the day. We have then organised a sausage sizzle. Some of the poster presentations also relate to the theme of the Symposium and these will be on display throughout the day. Hopefully at the day's end we will all be better informed and less confused about the issues!

# MEET THE NEW COUNCIL

*The Federal Council of the Society has moved to Queensland for the next two year term. Please note the new contact details inside the front cover. Here, the new Council members briefly introduce themselves.*

## Eugene Moll - President

When Gary Bastin, the editor of our Newsletter, asked each of the new council members to write a few notes about themselves I shuddered. It is always difficult to write about oneself, especially in the first person, so here goes.

I consider myself to be a citizen of Gondwana and rangeland ecology is my profession and passion. As an academic, I have had wonderful opportunities during the last 25 years to work with a very wide range of interesting people in many different lands. I think the future of the Australian rangelands is exciting as there are many opportunities yet to be explored, and there are enormous challenges to be overcome. In my view we have not been too innovative in this last century: we produced the same products from the rangelands that we did in the century before (only more efficiently), and much of the research was built on the methods and paradigms of the past. Frankly we are, in general, a fairly conservative segment of the community. However, times have changed and are continuing to change, these are the "good old days".

When ecosystems change from one "stable state" to another there is usually a good deal of upheaval and transition until another, but different, "stable state" is attained. My impression is that we are in that transition phase. Thus I anticipate the future with a degree of excitement and trepidation - the future is ours to build. Will we do a better job this time around? We certainly accept that future activities must be ecologically sustainable, they must be socially acceptable and economically viable. Are we, the current rangeland managers / producers / researchers / inhabitants ready for change? I think we are, but I also believe that there is still a hard road to hoe before we secure a better future. To me, the ARS is a very important vehicle for change and innovation. Hopefully we, as the new Council, will be able to provide the kind of leadership necessary to build that better future.

## Eda Addicott - Secretary

Despite being born in the city I spent a large proportion of my childhood on various relatives' properties in central west NSW. During this time I worked at various tasks such as mustering, rouseabouting, cutting burrs and other jobs which I thought were wonderful! It was because of this background that I've always wanted to work in the rangelands.

I completed a science degrees at Sydney University during the first half of the 1980's. After a few years off, I started working at a 'serious' job about nine years ago in Kosciusko National Park. This was for NSW National Parks and Wildlife Service where I was involved mainly with development of Geographic Information Systems and research projects.

About four years ago I started working for the Department of Environment based in Toowoomba. The area I cover ranges from the Great Dividing Range west to the QLD / NT border, north to about Winton and south to the QLD / NSW border. A large portion of this area is rangelands. My job is predominantly on national park estate and concerned with issues of fire and grazing as management tools for the landscape. Most of my job involves long term monitoring and research on the effects of grazing and destocking of domestic herbivores, and on the ecology of different fire regimes.

Having grandparents and numerous aunts, uncles and cousins in the sheep and cattle industry in NSW and Queensland has given me a bit of an insight into graziers' views and I have a strong belief in the necessity for a viable, long term industry. I'm also a firm believer in the notion that responsibility for caring for the rangelands should not rest solely on the shoulders of 'the people on the land' but be shared by all those who depend on the rangeland (which is the largest portion of the Australian population).

## Manda Page - Treasurer

I was very lucky when I was young as I had the best of both worlds. I grew up in South Australia where my mother lived in Adelaide and my father lived on a sheep station near Peterborough. I stayed in the city to go to school then spent every school holidays on the station. This is where I first experienced Australia's rangelands and grew very attached to the Australian bush.

Following high school, I decided that I wanted a job where I could work in the bush so I went to the University of South Australia and completed a degree in Conservation and Park Management with the dream of becoming a park ranger. My honors project took me to Innaminka Regional Reserve on the South Australia - Queensland border where I set up a monitoring program to measure visitor impacts. I then decided that I wanted to continue working in the arid zone, but by now I was more interested in the science of the rangelands than being a park ranger.

After completing my honors, I moved to Queensland to take up a tutorial fellowship with the University of Queensland. This position enabled me to complete a PhD in south west Queensland's Mulgalands and to work as a tutor part time at the University. My research has been going for about five years now and is centred on Currawinya National Park in south west Queensland. The project was jointly funded by the Department of Environment and the University. I spent five years measuring the effects of destocking on the vegetation and investigating various other sections of the vegetation community such as the role of woody weeds and the state of the seed bank. I finished writing my thesis earlier this year and am now anxiously waiting for the results. I am working as a lecturer at the University of Queensland but keep returning to Currawinya National Park to measure my monitoring sites.

In 1996, a colleague and I organised and ran a conference at the University of Queensland Gatton College titled "Research and Management in the Mulgalands". The conference ran smoothly and I learnt a lot about the Mulgalands and how to run a conference. I am now helping in the organisation of the next Rangeland Conference and hope to see you all here in Gatton in December.

Apart from work, I enjoy restoring my old house, playing with my dogs and participating in sports. My first aim of the future is to graduate. I have no concrete plans following this but I am keen to keep working in our arid rangelands and keep the work I began on Currawinya going and growing. Although my association with the rangelands may seem quite limited in terms of time, I am keen to build on this in an attempt to better understand the dynamics of this complex but fascinating system.

## Bruce Alchin - Subscription Secretary

I am a foundation member of the Society and have attended all but two of the Biennial Conferences. I spent almost 20 years in western NSW with the Soil Conservation Service and Western Lands Commission. This period involved advisory work, research and land administration. Regional and property mapping as well as research into erosion reclamation provided me with valuable hands-on experience. Time spent with the Western Lands Commission broadened my awareness of land administration and policy issues (as well as politics!).

I have been consulting since 1987 and a staff member at the University of Queensland Gatton College since 1988. Consultancies have involved a wide range of work, such as property management plans, financial negotiations and environmental assessment. Courses taught at the College include rangeland management and soils. My particular interests include grazing management, range condition assessment and woody weed control. I was the first Churchill fellow to study woody weed control. Other highlights include teaching rangeland management in Indonesia and attending the IRC at Utah in 1995.

# NEWS FROM THE DESK OF THE PRESIDENT

*Eugene Moll, ARS President, Dept of Natural & Rural Systems Management, University of Queensland, Gatton College, QLD 4345*

In some respects the future of our Society is at a cross-roads, and it seems to me that it is time that we, as members, think carefully about the kind of future we want for our Society and for the rangelands.

This year's Symposium on Tuesday 2nd December provides important background material for those interested in the future of the Society and rangelands. The Symposium topic is "Where the City meets the Bush: the importance of effective communication", and at this Symposium we will be able to listen to some of Australia's best thinkers and operators discussing relevant issues of today, and how these may change in the future.

When contemplating our future, there are a number of external forces driving the future of the rangelands over which we have little control. As a Society our operational framework has, therefore, to be well buffered to survive and thrive into the 21st Century. So let me consider some of these external forces:

- World population is steadily increasing. Can food production continue to sustain this?
- We are warned about "Global Climate Change". Predictions are contradictory at best, but the models are becoming better understood and more accurate. One certain trend is much increased $CO_2$ levels in the atmosphere which could have a major influence on one of Australia's most vital industries, an industry centred on the rangelands, namely mining. The next few months may be critical.
- We are the driest, most nutrient-poor inhabited continent in the world. We are remote from many traditional markets. World trade is not on our side and we need to build stronger ties to the growing economies of the Pacific Rim nations.
- In today's Global Village we have a responsibility to manage sustainably. Or in the words of Margaret Thatcher "No generation has a freehold on the earth. All we have is a life tenancy - with a full repairing lease".

Within Australia, things have changed greatly in recent decades. There seems some doubt over future political and economical stability. Crime and family violence are apparently on the increase, and there is little doubt that the future is more and more challenging and difficult to predict. In the rangelands some of the forces operating are:

- Uncertainty over land rights.
- Continuing ecological degradation.
- Reduced services.
- Worsening drought.
- Uncertainty over tariffs.

Yet there are opportunities in tourism, niche market development and in the capacity of people to bounce back.

Traditionally the ARS membership comprised both producers and researchers, providing the opportunity for a meaningful exchange of ideas, experiences and visions. Our biennial conferences have focussed on real issues facing producers and conservationists alike, with ample opportunity for researchers to exchange ideas. Our newsletter is a vehicle for general communication, and for those more scientifically minded the journal provides the opportunity to publish relevant papers. One task we as the new Council have to do is study the viability of these three major activities. Generally the conferences provide a small profit to the Society, the newsletter tends to stay in the black while the journal costs a little.

Our membership continues to grow slowly but there is a perception that we are losing producers and possibly becoming too scientific. Perhaps we need to survey members to discover their perceptions and try to meet their needs? What do you think?

**WHAT DO YOU THINK?**

***Please provide feedback on your perceptions of the future of the Society to members of Council***

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## NEW POSITION OF SUBSCRIPTIONS MANAGER

*Eugene Moll, ARS President, Dept of Natural & Rural Systems Management, University of Queensland, Gatton College, QLD 4345*

On the advice of the last Council, and in consultation with the new Council, it has been decided to retain the services of Rob Richards as SUBSCRIPTIONS MANAGER. In the past when Council changed, it has taken a while for the address of the new Subscriptions Secretary to become well known to the membership. As a result, this has caused delays and inefficiencies in dealing with membership matters (one of the most critical functions of the ARS). Also, there have been problems in changing systems of the membership records. It seems so much more sensible to try and keep the same membership address and system of records for a longer period of time. Rob Richards had just got the new system functioning and was willing to continue to do the paperwork for a period of time. So the Queensland Council have accepted that this would be a much more efficient way of handling membership issues and have retained Rob's services for the time being.

Bruce Alchin, who is the new Subscription Secretary, thought that this may leave him with little to do! Not true. One thing Council would like to do is run a membership drive and guess who has the task to mastermind and do this? Go for it Bruce. **So anyone with any ideas, please contact Bruce.**

## WORKSHOP ON REMOTE SENSING

*John Carter, Climate Impacts and Grazing Systems, 80 Meiers Rd, Indooroopilly QLD 4068*

A specialist workshop on remote sensing will be held in conjunction with the 10th Biennial Conference of the Australian Rangeland Society at Gatton during December 1-4 1997.

Contributions from rangeland scientists and other remote sensing practitioners are invited.

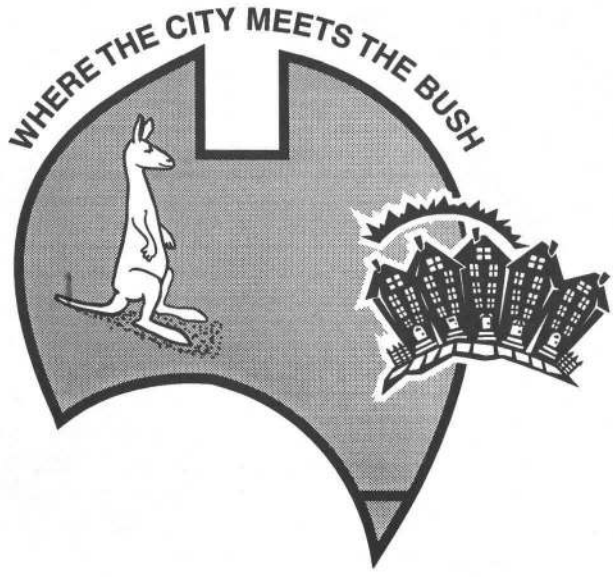
### Suggested Issues

- Uses and availability of remote sensing data from platforms other than NOAA and Landsat.
- Cloud masking in NOAA data.
- Fire and fire scar detection methods.
- Large scale land cover mapping.
- Collecting calibration data sets for remotely sensed data.
- Measuring bare soil and its influence on satellite-derived vegetation measurements.
- New decision support products derived from remote sensing (client use and extension).
- Novel applications.

If you can attend and would like to contribute, please supply an abstract on your application (one page or less) by 25 November. These abstracts will not be formally published but will be collated and handed out on the day.

Talks are limited to 10-15 minutes, reporting mainly on **new and updated work** in an informal setting. An overhead projector will be available.

Please send your contact details and abstract to John Carter (preferably by Email). Contact details:
Email: john.carter@dnr.qld.gov.au
Fax: 07 3985 9606
Phone: 07 3896 9588



# SUSTAINING THE WESTERN MYALL WOODLANDS: ECOLOGY AND MANAGEMENT

*Carolyn Ireland, Department of Environmental Science and Rangeland Management, The University of Adelaide, SA*
*MAILING ADDRESS: 13 Woodland Close, Aldgate SA 5154*

This article is a summary of the studies I undertook for a PhD thesis during the period 1992-1996. When the study began, the western myall (*Acacia papyrocarpa* Benth.) was widely perceived to be under threat. There were concerns about the future sustainability of the species. In the Whyalla area in South Australia where the species has been well studied, evidence suggested that the population was aging with regeneration being suppressed, apparently by herbivores. Compared to the pre-settlement era, the western myall woodlands are now subjected to sheep grazing, rabbit infestation and much larger kangaroo populations. The aim of this project was to assess the sustainability of western myall under current land usage across the major part of its range in South Australia and thus provide a basis for land management strategies to ensure its survival.

Key features of the population dynamics of western myall including life span, and controls over the species' infrequent recruitment events, were not well known. A review of the existing knowledge about western myall indicated the following issues as the most relevant to my broad objective:
its uncertain geographic range,
the impact today of the introduction of vertebrate herbivores about a century ago,
uncertainty about its population dynamics,
the lifespan of the species, and
variations in population structure across its range: are the Whyalla populations (located in the southern fringe of its range), typical?

I determined the geographic range of western myall in South Australia by field surveys and a review of the literature, including pastoral inspection records.

I used century-old maps of paddock subdivision and watering point location to investigate the historical impact of the introduction of vertebrate herbivores on the landscape. In the process I developed the new concept of "fossil paddocks" (FP). An FP is an old paddock that has had a new pattern of smaller paddocks and new watering points progressively imposed upon it. Evidence from this study suggests that many generations of western myall that emerged this century are essentially missing even in the absence of sheep grazing. The study also indicated that recruitment has occurred in the presence of sheep. There is no evidence that kangaroos suppressed the cohorts however rabbits are certainly implicated.

The population dynamics of the species were studied. The focus of that study was on the various factors that eliminate seedlings. It revealed that recruitment is much more common across the woodlands as a whole than has previously been assumed from the Whyalla research. Furthermore, the recruitment observed was associated with the absence of rabbits, but was apparently independent of the presence or absence of sheep and kangaroos.

My palatability studies showed that rabbits appear to be more of a threat to western myall seedlings than sheep. Sheep showed a clear preference for adult foliage over seedlings and rejected both (particularly seedlings) if other forage species were available. Rabbits appear not to discriminate between adult foliage and seedlings.

I studied the life span of western myall by tree ring dating, mortality (using old aerial photographs) and radiocarbon dating. Material from mature specimens was dated at around 300 years by each of these methods. The oldest trees must be at least 500 years old and are likely to be very much older.

I measured population patterns throughout the range. My studies show an aging population in the south with a younger, more vigorous population to the north. The woodlands we see today can only have existed no longer than about 10,000-15,000 years (since the last significant ice-age). Given that trees are slow-growing and long-lived, it appears that the western myall may still be expanding its range northwards, and retreating from prehistoric refugia located further south.

My mortality study also indicated that the life span of the oldest trees in the populations may be much more than 500 years. It also revealed higher rates of mortality in the south than in the north. While the levels of recruitment required to sustain the population are observed in some areas of the woodlands, particularly in the north, it is clear that in many areas the required rate of recruitment is not being sustained.

In aggregate, the results of these investigations cast doubt on the conventional view that the continued viability of the western myall woodlands is unsustainable in the current pastoral sheep-grazing regime. Rabbits, when present, remain a threat to both seedlings and juveniles; sheep on the other hand, consume only small quantities of either. Recruitment patterns vary significantly in different parts of the species' range, possibly due to long-term biogeographic trends. Currently in the north mortality is lower, trees are generally younger and rates of recruitment are higher than in the south.

If the western myall woodlands are to be preserved, the fundamental management aim must be to maintain the populations by enabling the recruitment of enough individuals and by maximising the survival of adults. Neither the reduction of current conservative pastoral stocking rates, nor the spelling of paddocks after recruitment occurs would obviously improve the situation for western myall in South Australia. Strategies for the management of the western myall woodlands include the control of rabbits (the recent release of calicivirus into the area coupled with follow-up warren ripping is an obvious one) and the protection of juveniles with rabbit-proof tree guards. These measures however, may be extremely time consuming and costly.

The greatest threat to western myall is at the contracting edge of its range (the south) and active management may be needed to ensure the maintenance of populations there. The precise technology to do this is not clear but this thesis provides insights for future research to this end.

## AUSTRALIAN RANGELAND MANAGEMENT
## A tour for overseas practitioners.

*Bren Lay, Dept. Environment & Natural Resources, GPO Box 1047, Adelaide SA 5001*

This tour encompasses some of the most spectacular landscapes in this country, from the Flinders Ranges to Lake Eyre and the channel country of Queensland. It has been put together by the Society to give participants from overseas first hand experience in how best-practice enterprises are managing our diverse natural rangeland resources, whether they be in grazing, mining, tourism, conservation or traditional use operations.

The tour will be lead by John Chappel, an ex-pastoral manager and now head of the Pastoral Program in SA, and Bren Lay, who works with John and has had 28 years experience as a rangelands scientist in the region.

At this stage we intend to run the tour, over some 12 days, in conjunction with the International Rangelands Congress in 1999, as an official pre-conference event.

The tour will involve staying with families and operators and obtaining first-hand experience in their operations. Cost will be about $A 2500, and numbers will be limited to about 14, in order to provide the quality experience we have arranged.

For anyone wanting further information, please ring me (phone 08 8204 8857) or contact me by Email (blay@denr.sa.gov.au).

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## FENNER CONFERENCE ON THE ENVIRONMENT

*Toss Gascoigne, Executive Director, Federation of Australian Scientific and Technological Societies (FASTS), PO Box 218, Deakin West ACT 2601*

The next Fenner Conference will have the theme: *Ethics of research and management practices in World Heritage and other environmentally sensitive areas: Policy and practice.*

The Conference is designed to provide a forum for substantial review of the issues and progress; and to ensure broadly based input into the formulation of national policy guidelines for research and management in protected areas.

The conference will be held at Becker House (The Dome), Australian Academy of Science, Canberra from 26-28 November 1997.

For copies of the registration brochure, please contact Conference Logistics at:
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