

AUSTRALIAN RANGELAND SOCIETY

Australian Rangeland Society 15th Biennial Conference

Charters Towers Queensland
Sunday 28 September to Thursday 2 October 2008



**'A CLIMATE OF CHANGE
IN THE RANGELANDS'**

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Foreword

Welcome to the 15th Biennial Australian Rangeland Society's Conference in Charters Towers. Our conference theme, 'A Climate of Change in the Rangelands' is intended in the broadest context, not simply a reference to rainfall. It focuses on the changing environmental, social, cultural, and economics facing Australia's rangelands in the future and linking this dynamic to the broader community's real values concerning the rangelands.

The Upper Burdekin Region is on the edge of Australia's rangelands and actually joins the wet tropics region. The change of vegetation communities and climatic zones from NE to SW is dramatic. The range of land uses is also wide and includes extensive beef production, protected areas, military training, indigenous use, mining, irrigated cropping and tourism. The field trips will provide conference delegates with an opportunity to see these land uses first hand. Thank you to the landholders, traditional owners and government agencies who have given us the opportunity to see the land and meet the local people.

In addition to the field-trips, the social events on each evening of the conference will allow time for some fun, relaxation and maybe some sharing of experiences from the recent IRC in China and Mongolia.

The organising committee have collated a good suite of presented papers supported by broad range of posters. Please take the time to meet the authors and extend your professional and social networks – a major objective of the Society's conferences.

The cost of the Australian Rangeland Society's Conference would be much higher without the generosity of our sponsors, many of which have trade displays at the conference. Thank you for your support.

Like all good conferences, the 15th Australian Rangeland Society's Conference has been made possible thanks to the efforts of a dedicated organising committee and efficient conference organisers 'JK Connections'. Your enthusiasm and dedication to task is appreciated– thank you one and all.

Bob Shepherd
Chairman
Conference Organising Committee

AUSTRALIAN RANGELAND SOCIETY 15TH BIENNIAL CONFERENCE

A CLIMATE OF CHANGE IN AUSTRALIA'S RANGELANDS

WORLD THEATRE, CHARTERS TOWERS

28 September – 2 October 2008

SUNDAY 28 SEPTEMBER – World Theatre

3.00pm – 7.00pm

Registration

6.30pm – 8.30pm

Civic Reception hosted by the Charters Towers Regional Council Mayor – Ben Callcott

MONDAY 29 SEPTEMBER – World Theatre

7.30am

Registration Desk open

8.00am

Field Tours depart

6.00pm for 6.30pm

BBQ Dinner at Stock Exchange Arcade

TUESDAY 30 SEPTEMBER – World Theatre

7.30am

Registration Desk open

8.30am

Conference Opening

Keynote Addresses – *Change in the rangelands: past, present & future* (sponsored by the Australian Government)



Paper 1. A climate of change: informed by the Australian Collaborative Rangeland Information System (ACRIS). - by Mark Stafford Smith, CSIRO, Canberra, ACT

Paper 2. Reporting change in the rangelands: how well can we integrate biophysical drivers of change? - by Gary Bastin, CSIRO, Alice Springs, NT

Paper 3. Developing a collaborative biodiversity monitoring program for Australian rangelands - by Alaric Fisher, NTDNRE&A, Palmerston, NT

Paper 4. Change in Australia's rangelands: is there need for a national approach? - by Charlie Zammit, DEWHA, Canberra, ACT

10.20am

Morning Tea – **Arthur Titley Centre**

11.00am


Session 1 – Capacity building and social issues in rangelands (sponsored by Rangelands Australia)



Paper 1. The costs and benefits of buffel grass and its management: How are they valued? - by Margaret Friedel, CSIRO, Alice Springs, NT

	Paper 2. Conceptual and theoretical aspects of ‘payment for ecosystem services’ in the tropical savannas of northern Australia - by Iain Gordon, CSIRO, Townsville, Qld
	Paper 3. Policy implications for capacity building - by Dana Kelly, Uni of Qld, Ipswich, Qld
	Paper 4. Desert Uplands Committee leads the way in achieving biodiversity outcomes - by Andrea Lingard, Desert Uplands Build Up & Development Strategy Committee, Barcaldine, Qld
12.30pm	Lunch - Arthur Titley Centre
1.30pm	Session 1 (continued) - World Theatre
	Paper 5. Critical success and failure factors of a new extension approach to achieve increased capacity of beef producers and improved beef enterprise profit and sustainability - by Brigid Nelson, DPI&F, Charters Towers, Qld
	Paper 6. Keeping under 35’s in the rangelands: why they stay, and why they go - by Delphine Puxty, North Australian Pastoral company, Brisbane, Qld
2.10pm	Youth Forum
3.20pm	Afternoon Tea - Arthur Titley Centre
4.00pm	Poster Viewing Sessions - Arthur Titley Centre
	1. Capacity building and social issues in rangelands
	2. Grazing management, land condition and monitoring in rangelands
6.30pm for 7.00pm	Informal Dinner at Charters Towers Equestrian Centre
WEDNESDAY 1 OCTOBER – World Theatre	
8.00am	Registration Desk open
8.30am	Keynote Address Climate change impacts on rangeland livestock carrying capacity: more questions than answers - by Greg McKeon, Qld Climate Change Centre of Excellence, EPA, Brisbane, Qld
9.20am	Sponsor Address by Meat & Livestock Australia
9.30am	Session 2 - Grazing management, land condition and monitoring in rangelands (sponsored by MLA)
	Paper 1. Integrated land condition monitoring for reef catchments: a New Era - by Robert Karfs, DPI&F, Townsville, Qld
	Paper 2. Monitoring land condition in tropical savannah rangelands using MODIS imagery in the Northern Territory - by Kathryn Graham, NTDNRE&A, Palmerston, NT
	Paper 3. Rangeland monitoring – it’s not as simple as 1, 2, 3 - by Paul Novelly, DAF, Kununurra, WA



10.30am	Morning Tea - Arthur Titley Centre
11.15am	Session 2 (continued) - World Theatre
	Paper 4. Ecosystem response to cell grazing – Case studies - by Bruce Alchin, Uni of Qld, Gatton, Qld
	Paper 5. Maintaining production and meeting conservation goals on grazing properties in the rangelands - by Neil MacLeod, CSIRO, St Lucia, Qld
	Paper 6. A rangeland renaissance in (Western) Australia or denial of dissonance and maintaining mythology? - by Hugh Pringle, Bush Heritage, Fremantle, WA
12.15pm	Lunch - Arthur Titley Centre
1.15pm	<div style="display: flex; justify-content: space-between; align-items: center;"> <div> <p>Session 3 – Biodiversity management and conservation in rangelands (sponsored by Burdekin Dry Tropics Natural Resource management)</p> </div> <div style="text-align: right;">  </div> </div>
	Paper 1. Vegetation structure and resource dynamics in fire responses of Kimberley mammals – by Ian Radford, WADEC, Kununurra, WA
	Paper 2. Can ground cover function as a surrogate for biodiversity condition in the rangelands? - by Juliana McCosker, EPA, Emerald, Qld
	Paper 3. A method for assessing biodiversity condition in the arid rangelands, using the stony desert country as an example - by Anita Smyth, CSIRO, Glen Osmond, SA
2.20pm	Student Presentations
	Paper 1. Biogeography and biodiversity of biological soil crusts across Queensland - by Wendy Williams, Uni of Qld, Gatton, Qld
	Paper 2. Responses of small mammals and lizards to cattle grazing and cattle removal in arid Australia - by Anke Frank, Uni of Sydney, Sydney, NSW
	Paper 3. Are current measures of landscape health useful indicators of arthropod community structure in rangelands? - by Alan Kwok, Uni of NSW, Sydney
	Paper 4. Can reintroduction of the bilby and bettong aid ecosystem restoration in arid Australia? - by Alexandra James, Uni of NSW Sydney, NSW
3.20pm	Afternoon Tea - Arthur Titley Centre
4.00pm	Poster Viewing Sessions - Arthur Titley Centre


	3 – Biodiversity management and conservation in rangelands
	4 – R&D in rangelands
	5 – Multiple use and restoration in rangelands
6.30pm for 7.00pm	Desert Knowledge CRC Conference Dinner at Charters Towers Equestrian Centre
	
THURSDAY 2 OCTOBER – World Theatre	
8.00am	Registration Desk open
8.00am	Australian Rangeland Society General Meeting
9.00am	Session 4 – R&D in rangelands
	Paper 1. Bringing together traditional owners and pastoralists in the use of fire management through the Gulf Fire Project - by Kevin Anderson, Southern Gulf Catchments, Mt Isa, Qld
	Paper 2. Fire frequency mapping using satellite imagery for land management and research - by Peter Thompson, Cape York Peninsular Development Association, Cairns, Qld
	Paper 3. Savannas FACE the future: windows into a future CO2-rich world - by Chris Stokes, CSIRO, Townsville, Qld
	Paper 4. Impact of a management intervention on the greenhouse budget of a Queensland grazing business - by Steven Bray, DPI&F, Rockhampton, Qld
10.30am	Morning Tea - Arthur Titley Centre
11.10am	Session 5 – Multiple use and restoration in rangelands
	Paper 1. Assessing the cumulative effects of water management by the mining industry in rangeland environments - by Don Burnside, URS Australia Pty Ltd, Perth, WA
	Paper 2. A role for reintroduced native animals in the restoration of degraded rangelands - by David Eldridge, Uni of NSW, Sydney, NSW
	Paper 3. Landholders and kangaroos in the rangelands: Can collaboration complete the puzzle? - by Alex Baumber, Uni NSW, Sydney, NSW
	Paper 4. Development of a value-driven bush foods industry chain that rewards Aboriginal people - by Jennifer Cleary, Desert Knowledge Cooperative Research Centre, Alice Springs, NT
12.30pm	Plenary/Conference Summation and Close
1.00pm	Lunch - Arthur Titley Centre

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A CLIMATE OF CHANGE: INFORMED BY THE AUSTRALIAN COLLABORATIVE RANGELAND INFORMATION SYSTEM (ACRIS)

M Stafford Smith^{1}, G Bastin² and the ACRIS Management Committee*

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The governments of the rangelands jurisdictions are ultimately responsible for ensuring the rangelands resources are managed in the best interests of all Australians.

On behalf of these governments, the ACRIS has investigated the capacity of current monitoring programs to report recent change for a number of biophysical and socio-economic themes and to better inform regulatory and policy decisions.

These decisions take place against a background of constant change in the rangelands' biophysical resources, with climate variability the most obvious. The highs and lows of productivity related to this variability make it difficult to identify signals of management failure, where and when they may occur.

Is it possible to see beyond this difficulty?

Rangeland 2008: taking the pulse represents the first time that the disparate data sets on rangeland resources have been brought together to assess their capacity to report change.

Major findings include:

- over the period 1992-2005, landscape function increased or remained stable at a majority of pastoral monitoring sites;
- available evidence suggests that there is continuing decline in at least some elements of rangeland biodiversity;
- the recent increase in pastoral land values does not reflect an equivalent increase in real productivity;
- the maintenance and enhancement of the existing monitoring programs and the development of new targeted monitoring programs is essential for our ability to effectively detect and respond to significant trends;
- there are a number of new or emerging rangelands stakeholders, particularly Indigenous land managers and the regional NRM groups, whose needs are not adequately met by current monitoring programs

Now that we understand something of the strengths and weaknesses in our current capacity to identify and track change, where should the next generation of effort focus?

Key words: *ACRIS, monitoring, data, change, government, decision*

REPORTING CHANGE IN THE RANGELANDS HOW WELL CAN WE INTEGRATE BIOPHYSICAL DRIVERS OF CHANGE?

G. Bastin & the ACRIS Management Committee

This paper illustrates change in critical stock forage as an example of the more complete account of recent changes in the rangelands reported in *Rangelands 2008 – Taking the Pulse* (produced by ACRIS). In the southern rangelands, decreaser shrubs constitute critical stock forage with palatable perennial grasses important in the north and elsewhere. Data derive from site-based pastoral monitoring programs in WA, SA, NSW and the NT. Pasture utilisation simulated by AussieGRASS is used to infer sustainability of long-term forage supply in Queensland.

Change in critical stock forage between 1992 and 2005 was interpreted with regard to seasonal quality prior to each site reassessment. Generally <20% of reassessed sites in pastorally important bioregions showed decrease in the indicator of critical stock forage following above-average seasonal quality (increase expected at this time). Bioregions with $\geq 20\%$ of sites having decreased critical stock forage were the Northern Kimberley (Mitchell sub-IBRA), Ord Victoria Plain and Coolgardie (Eastern Goldfield sub IBRA), all in WA. In Queensland, the Desert Uplands, Mulga Lands, much of the Channel Country and parts of the Mitchell Grass Downs bioregions had simulated pasture utilisation above the safe threshold suggesting unsustainable use of the forage resource. Elsewhere, pasture utilisation was close to, or below, the safe threshold.

Livestock densities showed consistent decrease in some south eastern bioregions and continuous growth for some northern regions. Wildfire was also extensive and frequent in much of northern Australia. In some bioregions, livestock density has remained high in recent years as seasonal quality has declined. These areas may require more intense monitoring to determine recent changes in critical stock forage.

Significantly, the examples demonstrate how data representing various drivers of change (season, livestock numbers and fire) can be used to provide more complete understanding of one aspect of sustainable management in the rangelands, i.e. critical stock forage.

Key words: *change; critical stock forage, livestock density, monitoring; seasonal quality*

DEVELOPING A COLLABORATIVE BIODIVERSITY MONITORING PROGRAM FOR AUSTRALIAN RANGELANDS

A Fisher^{1}, T Eyre², L Hunt³, A Kutt⁴ and the Biodiversity Working Group of ACRIS*

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The health of rangeland biodiversity is an important component of reporting on rangeland condition and ecologically sustainable management. This has been recognised by the Australian Collaborative Rangeland Information System (ACRIS), with the inclusion in *Rangeland 2008: taking the pulse* of a substantial section on biodiversity. The report examined ten indicators, believed to be those most informative about biodiversity at landscape scales and for which data was currently available across most rangeland jurisdictions. However, the report concluded that there is only limited capability to report trends in biodiversity in rangelands at the national scale because of inconsistencies between jurisdictions in data collection, data gaps and limited specific monitoring of biodiversity. Available evidence suggests a continuing decline in at least some elements of rangeland biodiversity.

It is clear that a comprehensive, broadscale and collaborative monitoring program is required to adequately report on trends in rangeland biodiversity across all jurisdictions. Although there have been a number of previous attempts to describe appropriate indicators and frameworks for monitoring rangeland biodiversity, these have not developed into coherent programs. We propose a monitoring framework with four main elements: targeted monitoring of selected significant (and informative) species; surveillance monitoring of a broad range of taxa at both representative and biodiverse sites in most or all rangeland bioregions; meaningful landscape-scale surrogates for biodiversity (typically derived from remote sensing); and site-based metrics for habitat condition appropriate to rangeland ecosystems and biota. This framework has a strong emphasis on direct monitoring of rangeland biota, rather than on surrogates that, while readily amenable for reporting, have only weak or uncertain relationship with biodiversity. This will require long-term investment to enhance existing biodiversity inventory and monitoring capacity in the States and Northern Territory, as well as national coordination, collation and meta-analysis similar to existing arrangements under ACRIS.

Key words: *biodiversity, monitoring, framework, trends, national and coordination*

CHANGE IN AUSTRALIA'S RANGELANDS: IS THERE NEED FOR A NATIONAL APPROACH?

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During the 1990s the Commonwealth worked cooperatively with State and Territory governments, traditional owners, industry, the farming community and conservation groups towards a national rangeland strategy. The result was production, in 1999, of *National Principles and Guidelines for Rangeland Management*.

The *Principles and Guidelines* provided a framework for management oriented outcomes, particularly establishment of a national Rangelands monitoring program and NRM regional planning in rangeland bioregions, but there were clear gaps in knowledge. Following on from the *Principles and Guidelines*, the National Land and Water Resources Audit produced *Rangelands – Tracking Changes* (NLWRA, 2001), defined the elements of a comprehensive monitoring and reporting program and the scope and structural arrangements for the Australian Collaborative Rangelands Information System (ACRIS).

The 2008 ACRIS report has substantially addressed science and information gaps and provides renewed impetus to revisit Rangelands issues and management practices articulated in the *Principles and Guidelines*.

Implicit in much of the ACRIS 2008 report is the need for better policy and policy coherence, across all levels of Australian government and administration, to accommodate accelerating change and increasing diversity in Rangelands economic and social activity. The report provides a sound scientific and technical basis upon which to inform current decisions and to open up a broader discussion about future approaches and policy issues for the sustainable management of Australia's Rangelands.

The scope of any ensuing policy discussion would logically include sustainability and 'best practice' issues related to pastoralism and agriculture, indigenous interests and aspirations, governance and institutional arrangements, water, tourism, biodiversity conservation, and emerging national policy issues with implications for the Rangelands, such as water resource use and global warming.

Against this background, a national Rangelands policy could provide a flexible, cooperative and adaptable high level intergovernmental framework to deliver real gains in Rangelands productivity, sustainability and conservation.

Key words: *administration, change, government, rangelands policy*

THE COSTS AND BENEFITS OF BUFFEL GRASS AND ITS MANAGEMENT: HOW ARE THEY VALUED?

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Buffel grass (*Cenchrus ciliaris*) is a contentious species, being valued in many regions of the Australian rangelands for its contribution to livestock production, while also being widely regarded as a threat to biodiversity assets, sometimes within the same region. The development of broad policy relating to the management of buffel grass has not advanced to the extent it might have given the controversy surrounding the species. We believe that impediments to sustainable management are often embedded in social and cultural attitudes. Hence, our approach to improving the management of buffel grass is to consider the environmental, social and economic costs and benefits from environmental and pastoral perspectives. If we can understand the range of concerns and values surrounding buffel grass, we can develop sound recommendations that can help maximise the benefits from buffel grass but minimise any negative impacts and may contribute to policy development.

Our approach to determining the environmental, social and economic costs and benefits associated with buffel grass has four elements. The first is a desktop review of literature that documents available information about environmental, social and economic benefits and costs of buffel grass and its control or management. The second engages organisational stakeholders from four case-study regions in a discussion of buffel grass in their region to elucidate the costs and benefits of buffel grass and to document perceptions, values and attitudes of each organisation. The third element assesses costs and benefits of buffel grass as judged by individual pastoralists through surveys in each of the case-study regions. The final element synthesises the results of the study so that researchers, the community and organisations can appreciate the complexity of the buffel grass issue and can recognise the most appropriate pathway toward more effective management. This project will deliver its conclusions by mid-2008.

Key words: *Buffel grass, production, conservation, perception, value*

CONCEPTUAL AND THEORETICAL ASPECTS OF 'PAYMENT FOR ECOSYSTEM SERVICES' IN THE TROPICAL SAVANNAS OF NORTHERN AUSTRALIA

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Paying landholders to produce environmental goods and services is not a new concept. A generic term for such transactions is 'payments for environmental services' (PES), but they are also referred to as stewardship payments (Australia), green payments (USA), or agri-environmental schemes (Europe). Environmental services typically include water quality improvements, nature conservation and restoration, landscape management and carbon sequestration. PES describe voluntary transactions whereby well-defined environmental services are being 'bought' by at least one buyer (including business, government, non-government organizations) from at least one provider. PES schemes typically operate where environmental services are scarce and are therefore valuable. The need for relative scarcity poses a challenge for the application of PES in the tropical savannas, where natural capital is abundant; however, in the abundance also lies a market opportunity in that buyers aiming to protect existing services consider associated option values and/or anticipate emerging threats and future rises in opportunity costs. If potential buyers delay purchasing services until after changes have occurred, stocks of natural capital will be low and ecosystem services scarce, and services may already have been (irreversibly) lost. This paper explores the conceptual challenges that PES pose in a resource rich environment and explores the feasibility of the concept beyond agriculture-related activities.

Key words: *Payments for environmental services, tropical savannas, exploratory review*

POLICY IMPLICATIONS FOR CAPACITY BUILDING

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This paper focuses on ‘collaboration for capacity building’ in rural industries and natural resource management in Australia. It describes results from a 12 month project *Synthesising Policy Implications for the Co-operative Venture for Capacity Building (CVCB)*, implemented by a University of Queensland team. This project reviewed existing CVCB research from the past 5 years and other relevant literature, conducted interviews, seminars, web-based discussion group, and workshops involving both national policy makers and identified key stakeholders.

The paper provides direction on how to achieve collaboration for capacity building in rural industries and natural resource management (NRM) in Australia. It highlights the opportunity for rural industry Research and Development Corporations (RDCs) and other agencies to collaborate for capacity building. It identifies barriers, benefits and potential risks, suggests ways to move forward in this area, and provides a foundation for appropriate policy development.

The aim of this project was: “*to engage with national policy makers and inform the development of emerging policies and institutional arrangements regarding capacity building and extension in rural industries and natural resource management*”.

While there is considerable interest in capacity building within rural industries and NRM in Australia, the effectiveness is often questioned. A change of approach to achieve stronger collaboration is required if capacity building is to reach its full potential. Such a cultural change, at both the individual and institutional levels, does not just happen. An evidence-based strategic approach is required.

Five key strategies for collaboration for capacity building were identified by the *CVCB Synthesising Policy Implications* project. These will assist in the development of emerging policies and institutional arrangements for building rural industry and NRM capacity:

- 1 Sharing a common language;
- 2 Linking a diversity of models and activities for capacity building;
- 3 Enhancing collaborative teamwork, including appropriate skills for managing change;
- 4 Re-orientating institutional arrangements to include integrative structures; and
- 5 Developing a collective knowledge synthesis.

The paper provides recommendations for action, to address identified barriers to collaboration for capacity building. Collaboration is seen to be the key requirement in achieving the potential of capacity building.

Key words: *Collaboration; Capacity building; Policy, Institutions; Research and Development Corporations; action learning.*

DESERT UPLANDS COMMITTEE LEADS THE WAY IN ACHIEVING BIODIVERSITY OUTCOMES

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The Desert Uplands Committee (DUC) carried out an innovative conservation tender to achieve a wildlife corridor 'Landscape Linkages' across the southern Desert Uplands bioregion. The multiple round auction process was developed in a unique collaboration of the DUC, Central Queensland University, CSIRO, EPA and Desert Uplands landholders. The process, including promotion, site inspection, metric development, bid assessments and contract signing was carried out over 6 months.

An effective communication strategy with landholders was developed which included a series of on-property workshops to ensure a clear and transparent process of delivery was initially communicated to likely participants. In addition, the project officer visited each landholder who submitted an expression of interest. There were 25 participating bidders in the auction and 15 were successful. A total area of 85,000 ha was secured of which 75% had landscape connectivity to other bid areas. One year into the project, condition measurements taken in the form of ground cover and pasture biomass taken reveal an average of 40% condition improvement. This is well in excess of the management standards outlined in the contracts.

The project demonstrates the ability of a sub-regional group to develop a sophisticated and innovative method of delivery for regional biodiversity outcomes. The process was also logical and palatable to Desert Uplands landholders who especially liked the fact that they could determine both the cost of delivering these ecosystem services and the manner in which they achieved the conservation outcomes. Landholders were greatly motivated by their ability to provide ecosystem services from their remnant vegetation to the broader Australian community.

Key words: *conservation tender, landscape linkage, land condition, biodiversity outcomes.*

CRITICAL SUCCESS AND FAILURE FACTORS OF A NEW EXTENSION APPROACH TO ACHIEVE INCREASED CAPACITY OF BEEF PRODUCERS AND IMPROVED BEEF ENTERPRISE PROFIT AND SUSTAINABILITY

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The Burdekin Catchment is the second largest catchment in Queensland. Beef production is the dominant land use and a significant contributor to the local and state economy. Key sustainability issues include water quality, land degradation, weed control and feral animals. These issues alongside the catchments proximity to the Great Barrier Reef have accelerated the need for a producer-driven, participative process that provides tangible evidence of the impact of adoption of new and best technology, strategies and practices, for beef enterprise profit and sustainability. As a result, the Research to Reality Project was designed and supported with funding from the Burdekin Dry Tropics NRM, the Department of Primary Industries & Fisheries, and the Beef CRC Beef Profit Partnerships Project. The Research to Reality Project involves three beef producer teams encompassing 19 businesses, 680,000 ha of land and the management of 162,000 large stock units. A multi-disciplinary team from the Department of Primary Industries & Fisheries manages the project with consultants and technical experts assisting with specific research issues as they arise.

The project foundations lie in continuous improvement and innovation, with the project teams using a range of extension methods to develop and implement high priority research projects for business growth and land condition improvement. Extension methods include one-on-one property planning activities, rigorous economic and environmental benchmarking, on-property demonstration sites, field days and forums, information and awareness activities and products, and where required, structured learning workshops. An industry representative also acts as a project champion. Research projects range from wet season spelling and land reclamation to heifer nutrition, feral dog control and succession planning.

This paper outlines the extension approaches that have been used, specifically the critical success and failure factors and suggestions for improvement. The paper also reports on the projects impact on beef producer capacity, enterprise profit and sustainability, and the role of targeted evaluation in capturing these results. .

Key words: *extension; continuous improvement and innovation; profit and sustainability; evaluation*

KEEPING UNDER 35'S IN THE RANGELANDS: WHY THEY STAY, AND WHY THEY GO

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Much discussion has been had about the reasons young people are not entering and/or not staying in rural industries. This paper provides information gathered from employees of The North Australian Pastoral Company (NAPCO), a large pastoral company employing over 200 people across the Northern Territory and Queensland on cattle stations, and from members of the Future Farmers Network (FFN), a national not-for-profit organisation run by young people to support others pursuing careers in rural industries.

The general trends show that most young people appreciate the lifestyle that working in rural industries affords, and value highly the relationships they have with others they work and interact with. They are motivated by the challenges of rural industries and by finding alternative solutions to problems faced by previous generations. When questioned why they leave, reasons include a lack of support, services, succession planning and adequate remuneration. They also leave largely because of poor relationships with supervisors and others in the rural business. While both groups of respondents differ in their motivations, these motivations are largely driven by the individual's situation at the time of questioning.

Suggestions for improvement are provided by both groups of respondents and include; selling a positive lifestyle to encourage young people to join rural industries; creating greater awareness of career opportunities; promoting diversification in industries; providing a secure future for all industries; and improving the skills of leaders and supervisors to provide feedback and encouragement to young people.

Key words: *Youth, rural industries, relationships, social, skills*

CLIMATE CHANGE IMPACTS ON RANGELAND LIVESTOCK CARRYING CAPACITY: MORE QUESTIONS THAN ANSWERS

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Climate change has been identified as a major issue for Australia's rangelands. The *Garnaut Interim Climate Change Review* highlighted the risk that Australia, with an 'already hot, dry and variable' climate, faces under global warming. Large trends in rainfall and temperature have been occurring, particularly since the 1970s, with a general increase in rainfall in the north-western rangelands and a decrease in eastern Australia.

Livestock (mainly cattle and sheep) carrying capacity (LCC) is a major determinant of production (\$/ha), resource condition and property viability. Many studies have indicated that spatial variation in LCC is strongly related to interactions of land-type attributes (e.g. soil properties and tree density) and climatic variation. Climate factors such as rainfall, temperature, humidity, solar radiation, wind, potential evapo-transpiration and CO₂ interact with land-type attributes to affect pasture and shrub growth. Similarly, land-type and climate factors affect potential pasture utilisation, animal production per head (liveweight gain and wool), choice of breed, enterprise type, animal husbandry and supplementation, and the impact of grazing in resource components such as runoff, cover, fire frequency and species composition.

A risk management framework is being developed by QCCCE to assess the potential impact of climate change on the grazing industry at a regional scale. Current work has identified the importance of quantifying the current and potential impacts of climate change projections. A difficulty in risk assessment is that climate factors such as increasing temperature can have opposing effects on both pasture growth and animal nutrition. To address these complex issues, simulation models have been developed to estimate the effects of climate variability and projected climate change on pasture growth and other components of the grazing system. These models represent an important distillation of rangeland science conducted since the 1930s through pasture growth studies (e.g. Elderslie in 1935) and grazing trials (e.g. Gilruth Plains in the 1940s). A perceived strength of the models is their ability to explain much of the current spatial variation in key attributes, particularly LCC. However, a weakness is that many of the climate change projections involve climate and CO₂ factors outside the current range of climates experienced across the rangelands. Thus, there are major uncertainties in projecting how different species of plants and animals will respond to future unprecedented climate change.

An analysis of historical degradation and recovery episodes in the rangelands has indicated the importance of components of the climate system affecting rainfall at different timescales. Climate phenomena such as the El Niño Southern Oscillation (ENSO), and quasi-decadal and inter-decadal variability in sea surface temperatures and atmospheric pressures have had major impacts on variability in rainfall driving the 'cycle' of degradation and (partial) recovery. There is uncertainty in how these important drivers of climatic (rainfall) variability in the rangelands will behave in the future.

In the presentation, major issues being encountered in climate change impact studies in the rangelands will be reviewed, including the adequacy of biophysical models of grazing systems; linking models with climate change projections; assessing the importance of quasi-decadal and inter-decadal climatic variability, and human-induced forcings other than greenhouse emissions; and adaptation responses needed for uncertain climatic and economic futures.

INTEGRATED LAND CONDITION MONITORING FOR REEF CATCHMENTS: a NEW ERA

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Strategic management and understanding of processes which affect the iconic Great Barrier Reef (GBR) depend on basic natural resource monitoring information. Yet for grazing properties situated in adjacent catchments, and whose streams drain into the GBR, there has been a lack of location specific monitoring information – until recently. This paper provides an overview of integrated land monitoring activity since 2006 in two of the largest GBR catchments. This collaborative work has used new technologies in producing sophisticated ‘state-of-the-art’ monitoring information for assessing land condition at both property and regional scale.

Through support from regional bodies BDTNRM and FBA, agency partners DPI&F, NRW, and CSIRO have been successful in developing new products for decision-makers in Reef catchments. The acquisition and calibration of 20+ years of annual Landsat satellite data by NRW has been fundamental in product development. This satellite data used with other spatial data sets, groundtruthing, as well as feedback from local experts has set new standards in the assessment of land condition and management impacts. Monitoring products include:

- satellite-based assessments of groundcover at property scale;
- summaries of groundcover trend at the sub-catchment scale;
- basin-wide assessment of D-condition (very poor) lands for prioritising areas for proactive management (to deliver maximum benefit to reef and enterprise);
- rapid land condition assessment via vehicular traverses (over 10,000 observations);
- supplementary scientific land monitoring sites for cover index calibration and benchmarking (over 75 sites);
- land condition photo-standards developed for major land types; and
- explorations in the use of new monitoring technologies in enterprise level grazing production systems.

As availability of these spatially explicit monitoring products increases, a new era begins where land managers are provided with the essential information to assess management against best practice, for achieving both reef health and sustainable production outcomes.

Key words: *land condition, monitoring, remote sensing, Great Barrier Reef, grazing*

MONITORING LAND CONDITION IN TROPICAL SAVANNAH RANGELANDS USING MODIS IMAGERY IN THE NORTHERN TERRITORY.

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Rangelands make up 75% of the Australian continent and contain a range of habitat types and land uses, however their remote nature impacts on land condition monitoring in terms of access and expense. Vegetation cover in rangelands is an acknowledged indicator of rangeland condition, and this surrogate measure is applied here in a remote sensing study.

This paper describes a methodology to monitor change in land condition across the tropical northern savannahs of the Northern Territory rangelands, and is part of a larger project encompassing the entire Territory. Low resolution 16-day composite MODIS satellite images from July 2000 to December 2007 are used to gather information to be used in time-series analysis. The commonly accepted Normalized Difference Vegetation Index (NDVI), also known as a 'greenness index', will be used as a surrogate for vegetation flush.

A hierarchical approach has been developed to increase the understanding of the time-series of image data. The stratification is based on major vegetation and pasture type encompassing uppermost pastoral district levels, sub-districts, pastoral properties, sub-property level. A time-series is extracted for each land type within each hierarchal level relating to once yearly vegetation flushes. These are statistically evaluated to produce phenology parameters for each yearly season, based on a vegetation response to rainfall.

Phenology parameters for each pastorally significant land type are compared temporally using a predictive model based on rainfall, and spatially across sub-properties, properties, regions and districts. The effects of fire are also noted. Those areas that have had a major and consistent departure of condition from a regional average are extracted and flagged for further analysis. These results are combined with those derived from the southern approach, as documented in the paper *Monitoring land condition in semi-arid and arid rangelands of the Northern Territory using MODIS imagery*, to produce a yearly product for across the Northern Territory.

Key words: *Rangeland, MODIS, NDVI, condition, time-series, phenology.*

RANGELAND MONITORING – IT'S NOT AS SIMPLE AS 1, 2, 3.

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Rangeland administrators, regional NRM bodies and pastoral managers all have a need to implement range monitoring systems to meet a range of objectives. Unfortunately, matching monitoring systems to management objectives is not well understood, sometimes resulting in implementation of generic systems inappropriate to the task. The specific objectives of the user should drive the system's design and operational aspects; such as sampling strategies, site location and information recorded. Instead, 'recipe' type systems are often implemented on the assumption that they are suitable for dealing with all rangeland situations or aspects of change. Considerations of "what to measure", "where to monitor", "when to sample" and "how to interpret data", which should all be a function of the objective(s) of the proposed monitoring program, are often inadequately dealt with by the individual or group doing the monitoring because of the convenience of adopting a generic, "off-the-shelf" approach. The consequences of this situation are threefold. Firstly, monitoring personnel (government employees or land managers) may reach erroneous conclusions concerning management impact if the monitoring results are used within an adaptive management cycle. This will lead to ineffective or even counterproductive responses. Secondly, the existence of an established monitoring system is often a barrier to the implementation of a new one even when the existing one it is recognised as inappropriate for the new task. Finally, monitoring systems are often criticised for their inability to provide information for new domains of decision-making, although in many cases this is simply because the established system was not designed for the current purpose. This paper will discuss maximizing returns from monitoring and ground-based monitoring sites in particular, pitfalls to be avoided and the implications of incorrect site or system management.

Key words: *indicators, adaptive management, monitoring sites, rangeland monitoring, monitoring system, ground based sites*

ECOSYSTEM RESPONSE TO CELL GRAZING – CASE STUDIES

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Although ‘cell grazing’ was introduced to Australia in the early 1990s, there is still a dearth of scientific data on ecosystem responses and changes under cell grazing. The aim of this research was to develop an understanding of the ecosystem response to cell grazing, using conventional (continuous) grazing systems as a benchmark.

Study sites on commercial scale ‘cells’ adjacent to conventional grazing locations have been established across an array of rangeland types and climatic regimes. All sites are in the summer-dominant rainfall zone in northern Australia. Parameters assessed included Landscape Function Analysis, soil physical and chemical properties, soil biological crusts, soil microbes, plant community composition and soil cover.

Results to date suggest that, under a well-managed grazing enterprise in a range of environments, many ecosystem parameters perform at a higher level under cell grazing than conventional grazing. It is anticipated that further results may provide additional guidelines for grazing management to enhance ecosystem functioning and sustainable livestock productivity.

MAINTAINING PRODUCTION AND MEETING CONSERVATION GOALS ON GRAZING PROPERTIES IN THE RANGELANDS

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Extensive beef production remains the most widespread land use in Australia's tropical rangelands. Producers face a number of challenges to maintain their profitability (e.g. declining terms of trade, increasing land prices, distance and remoteness, changing market requirements, alternative land uses). At the same time there have been adverse changes in land condition (e.g. soil erosion, loss of desirable pasture and shade species and biodiversity, increases in native and exotic weeds) and the wider community is actively seeking more environmentally friendly land use and management. Some management options (e.g. altered grazing regimes, riparian enclosure) will invariably have opposing impacts on production and conservation goals, and decisions on their use will necessarily involve trade-offs.

We describe a frame work for consistently examining such trade-offs based on the impacts of management options on financial performance (based on a herd economic model) and ecological health (a set of attributes and indicators relating to maintenance of ecosystem function and stability and conservation of biodiversity). The application of the framework and typical output is illustrated through its application to a hypothetical beef enterprise in the Charters Towers region. Some comments are made on the value of the framework and suggestions made for its further refinement.

Keywords: *management, financial performance, ecological health, trade-offs, land condition*

A RANGELAND RENAISSANCE IN (WESTERN) AUSTRALIA OR DENIAL OF DISSONANCE AND MAINTAINING MYTHOLOGY?

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The poor state of formal environmental auditing of Western Australian rangelands does not appear to have limited adequately the expansive environmental reporting on their health in terms of resource (range) and biodiversity condition. This “pragmatism” is self-defeating on two fronts. First, invalid inference is usually revealed and reflects poorly –sometimes unfairly so - on the projects supplying the results. Second, reporting on what politicians require without adequate data is likely to send the message that significantly more resources are not needed to do the job and therefore sampling will not improve. The important gaps in capacity to report validly on key issues should be highlighted.

Unlike Government organisations, NGOs are expected to convince financial backers that they are returning biodiversity outcomes on investments. Independent scientists review our reports. Bush Heritage Australia is well advanced in building and implementing an Ecological Outcomes Monitoring (EOM) Programme to evaluate whether its Adaptive Ecological Management System is functioning well and returning biodiversity outcomes that have been identified as most important, on owned and partnership rangelands. Perhaps there are lessons to be learnt from this relatively new player in the rangelands?

VEGETATION STRUCTURE AND RESOURCE DYNAMICS IN FIRE RESPONSES OF KIMBERLEY MAMMALS

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A key issue facing Kimberley rangelands is the threat to critical weight range (CWR) mammals. CWR mammals have been nationally prone to extinction since European settlement in Australia, and recent declines suggest that this is continuing in the far north. A key hypothesis explaining recent declines is that out-of-control fire regimes are a major cause. However, the evidence for this is inconclusive, and we're not sure what it is about fire regimes that might directly impact the mammals. After all, Australian mammals have lived with fire for millions of years. Incorrect diagnosis of fire related mechanisms could lead to exacerbation of existing problems through incorrect management actions. It is therefore important to work towards identification of fire related mechanisms, where fire management has the potential to save or doom threatened species. Hypotheses based on previous work concerning fire related mechanisms include 1) that declines are due to increased predation (e.g. feral cats) through widespread removal of ground cover; 2) that fire regimes cause declines in resource availability; and 3) that declines are driven by demographic processes associated with population fragmentation. I present results from a pilot study conducted in the north Kimberley to begin addressing these hypotheses. CWR mammal abundance was most closely related to permanent habitat structures (e.g. habitat rocks), but ground level vegetation structure related to time since fire was also important. This is consistent with the predator driven fire hypothesis. In contrast, preliminary ecosystem resource data did not show a clear relationship with mammals. The finding that healthy mammal communities occurred in areas with patchy, heterogeneous fire history (compared to areas with widespread, homogenous fires), is consistent with the demographic fire decline theory. However, sampling needs to be extended into rocky areas with extensive fires to test for the importance of demographic processes on mammal numbers.

CAN GROUND COVER FUNCTION AS A SURROGATE FOR BIODIVERSITY CONDITION IN THE RANGELANDS?

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Should ground cover prove to be a satisfactory and consistent correlation to key biodiversity attributes such as plant composition and abundance, a digital bare ground index provides a rapid, accurate and repeatable methodology to comprehensively measure the biodiversity condition of an ecosystem across its bioregional distribution. Over ninety sites were assessed across the distribution of silver-leaved ironbark woodlands in the Desert Uplands bioregion. These sites were located on twenty-five properties where the details of grazing management, vegetation type assemblage and infrastructure of each paddock were documented. The sites were identified by their bare ground index measurement at a 30m by 30m pixel level for September 2006 (this index was developed by the Department of Natural Resources and Water) in a desktop assessment. Ground cover is a key measurement of ecological integrity. The sites were measured in the field in May 2007 for plant composition, ground cover, biomass and birds and in October 2007 for ground cover and biomass. The sites showed a significant correlation of the bare ground index measurements with the ground cover and biomass measurements in May 2007. Several plants species displayed a significant negative relationship with bare ground such as *Sehima nervosa*, *Tripogon loliformis*, *Chrysopogon fallax*, *Enneapogon lindleyanus*, *Themeda triandra*, and *Themeda avenacae*. While, *Scleroleana birchii*, *Sida fibulifera*, *Gomphrena celosoides* and *Cynodon dactylon* displayed a significant positive relationship with increasing bare ground. This methodology also allows for the establishment of a relationship between the site assessment and landscape assessment as well as establishing a relationship of paddock condition with grazing management. However, bare ground is strongly associated with seasonal conditions, and will only be useful in relation to the regional average for a land type.

Key words: *silver-leaved ironbark, bare ground index, plant composition, biodiversity condition*

A METHOD FOR ASSESSING BIODIVERSITY CONDITION IN THE ARID RANGELANDS, USING THE STONEY DESERT COUNTRY AS AN EXAMPLE

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Managing the rangeland ecosystems services for all Australians is becoming increasingly important as regions experience a decline in primary productivity, aging rural communities and changing climates. Ecosystem services in the rangelands are mainly based on a familiar component of biodiversity, vegetation dynamics. Changes in the vegetation (e.g., palatable species, structural diversity and regeneration) are driven by biophysical processes and land use patterns. In this context, biodiversity and ecosystem function influences the availability and quality of ecosystem services. Government agencies acknowledged the significance of these relationships by identifying resource condition targets in NRM plans and trends in natural resources (including biodiversity) through National Land and Water Resources Audits. The challenge facing governments is the lack of a national framework for biodiversity condition assessment. In this paper, we present a method for assessing biodiversity condition at a regional level as an example of the issues and principles that underpin assessment of biodiversity condition. At the highest level, we identified three broad information domains (ecosystem services, biodiversity assets, monitoring). Focusing on the biodiversity assets domain first, we undertook a “biodiversity at risk” assessment and then focused on the monitoring domain. Using the risk information, we first identified the objectives and the desired outcomes for management as precursor to identifying the biodiversity surrogates for monitoring, so that we could identify outcome-based indicators for measuring the surrogates. We applied a set of 33 selection criteria that covered such properties as conceptual relevance, historical information, measurement qualities, feasibility of implementation, and policy and management utility to select the most appropriate indicators for monitoring. We developed a sampling design and a transparent method for interpreting results. We discuss the relevance of this work relative to the design issues of a national framework for biodiversity condition assessment.

BIOGEOGRAPHY AND BIODIVERSITY OF BIOLOGICAL SOIL CRUSTS ACROSS QUEENSLAND

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Recent field research has established widespread biological soil crust communities (cyanobacteria, lichens, liverworts and mosses) occurring across the rangelands of Queensland. Our survey has covered many national parks and reserves or private properties where necessary, to take in changes in rainfall gradients, vegetation communities and soils. We documented for the first time well-established and extensive cyanobacteria-dominated soil crusts occurring throughout much of the gulf-savannah. An ecologically important biological crust system was found across a fragile dune and flood plain near Scull Hole, Bladensburg NP. Other noteworthy biological crusts with significant biodiversity and cover were found in the jump-ups Diamantina NP; Spinifex ridges, Minerva Hills NP; Grey Range (west of Thargomindah); Sturt Stony Desert (Arabury region); Stony plains (Coorabulka, Windorah Rd) and Arcadia Valley (Old Towrie). There were considerable and diverse cyanobacteria-dominated soil crusts found south-east of Cunnamulla (Glencoban), Currawinya NP, Bindegolly NP, Boodjamulla NP (Lawn Hill Gorge and Riversleigh sections), sand dunes (various sites, far western QLD) and in the estuarine sand-flats around Karumba. Across western QLD several mesas were surveyed. Here we report on unique ecosystem biodiversity of both biological soil crusts and vegetation communities. There were also good representations of hypolithic (cyanobacteria - under quartz, Boulia-Djarra Rd), epilithic (cyanobacteria and lichens) and endolithic (cyanobacteria) communities on various granite or sandstone rocky outcrops. Early results clearly show these biogenic soil crusts are unique in their biodiversity, structure and function. There are exceptional and rare community ecosystems, particularly those recorded at Bladensburg, Diamantina and Boodjamulla NP's that deserve special protection and more detailed study. We are continuing to expand the sample sites to include the Cape and other national parks. To date, this research has resulted in exciting new discoveries that are unique to the Australian rangelands and significant on an international basis.

Key words: *biological soil crusts, cyanobacterial soil crusts, lichens, cyanobacteria, biodiversity.*

RESPONSES OF SMALL MAMMALS AND LIZARDS TO CATTLE GRAZING AND CATTLE REMOVAL IN ARID AUSTRALIA

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Dominated by sand dunes covered with spinifex (*Triodia basedowii*), the Simpson Desert of central Australia contains one of the richest known assemblages of insectivorous mammals and lizards among the world's deserts. Although behavioural studies elsewhere in central Australia have shown that cattle usually avoid spinifex grassland and prefer riverine zones and woodlands on richer soils, much of the Simpson Desert is used for beef cattle grazing. In this study we aim to clarify which habitats cattle use and what effects cattle grazing has on the abundance, species richness and composition of small mammals and reptiles in the north-eastern part of the Simpson Desert in western Queensland.

Habitat use by cattle was measured by scan and focal sampling as well as dung counts along 100 m transects. Small vertebrates were live-trapped in pitfall traps during drought and after rain in different seasons to quantify the effects of cattle grazing and removal of cattle under different conditions.

Our results show that cattle prefer small patches of gidgee (*Acacia georginae*) woodland between dunes for resting and feeding. Activity patterns appeared not to change much between drought and in good conditions, but the condition of cattle improved markedly after rainfall.

The abundance and species richness of mammals and reptiles increased significantly after rain. Grazing intensity in the past seems to be more important for small vertebrates than the removal of cattle in the present.

Small mammals seemed to avoid gidgee woodland patches during drought. Some reptile species, usually rare in spinifex grassland, have been trapped in gidgee woodland.

We speculate that gidgee woodland is important for cattle to meet their food and shelter requirements, and might also provide an important habitat for reptiles. Therefore we suggest that these patches should be foci for protection and management.

Key words: *cattle removal , grazing history, spinifex, gidgee, small mammals, lizards*

ARE CURRENT MEASURES OF LANDSCAPE HEALTH USEFUL INDICATORS OF ARTHROPOD COMMUNITY STRUCTURE IN RANGELANDS?

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We investigated the use of several current measures of landscape health (Landscape Function Analysis, structure/composition/function (SCF)) as surrogates or indicators of arthropod biodiversity in the Pilliga region of NSW. We sampled arthropods (beetles, ants, wasps, spiders, butterflies) and measured landscape health at 43 Bimble Box (*Eucalyptus populnea*) remnants. We investigated the response of each of the arthropod taxa (abundance, species/family richness, and community composition) to variation in landscape health. There were very few consistent relationships between landscape health and species/family richness, or the total abundance of individuals in each taxa. In contrast, the community composition for three orders (beetles, ants, and spiders) consistently varied in relation to landscape health (for both sets of measurements), though the ability landscape health to explain this variation was quite weak. Responses to landscape health were both species- and family-specific, and index-dependent. Overall therefore we found that two current measures of landscape health reflect variation in the arthropod community composition of arthropods (albeit weakly), but were of limited use in indicating species richness or the total abundance of arthropods.

CAN REINTRODUCTION OF THE BILBY AND BETTONG AID ECOSYSTEM RESTORATION IN ARID AUSTRALIA?

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The substantial range declines of the greater bilby (*Macrotis lagotis*) and the burrowing bettong (*Bettongia lesueur*) are thought to have had dramatic effects on ecosystem processes in the Australian arid zone because of their impacts on surface soils. We studied the effects of their reintroduction on litter and seed capture and soil nutrient levels, in comparison to two prevalent fossorial animals; the exotic European rabbit (*Oryctolagus cuniculus*) and the native sand goanna (*Varamus gouldii*). Bilbies and bettongs dug deeper and wider pits and excavated significantly more soil than rabbits or goannas. Litter and viable seed was restricted almost exclusively to the pits and soil in the pits had significantly higher levels of labile carbon and mineralisable nitrogen than surface soils. Compared with surface soils, bilby, bettong and goanna pits contained relatively more labile carbon than rabbit pits. The significantly greater soil excavation by bilbies and bettongs and the higher concentration of carbon in their pits, demonstrate that these reintroduced fossorial mammals play important roles in the creation of fertile patches. Whilst the primary goal of reintroductions has been the establishment of wild populations, there is increasing recognition of the potential for reintroductions to restore ecosystem function. This study demonstrates that through habitat modification, reintroduced species can affect ecosystem function by enhancing resource retention at a local scale.

Key words: *reintroduction, restoration, bilby, bettong, rabbit, ecosystem engineer*

BRINGING TOGETHER TRADITIONAL OWNERS AND PASTORALISTS IN THE USE OF FIRE MANAGEMENT THROUGH THE GULF FIRE PROJECT

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The Gulf Fire Project was a concept put together by the Traditional Owners (TOs) of the Gulf along with Southern Gulf Catchments, Rural Fire Service, the North Australian Indigenous Land & Sea Management Alliance (NAILSMA) and pastoralists. The principle of this project was to put in place working relationships between TOs and pastoralists in the use of fire management. The region's TOs use fire for a number of reasons such as thinning out wooded country by burning early in season to produce 'green-pick' for hunting and food gathering later in the dry-season so they won't need to travel long distances for food and most important, to protect sacred sites. On the other hand, the pastoralists use fire late in the dry when the first couple of storms move through to burn off the old standing grass and to induce a fresh crop for next season while at the same time reducing ground fuel in case of wild fires. Through this project, traditional knowledge of early burning was re-established when a wild fire broke at the end of last year. Indigenous fire rangers, the Rural Fire Brigade and National Parks responded along with graders and water tankers from the local council. Due to the early burning patterns of one of the pastoralists and TOs, it saved time and effort in establishing fire breaks and most importantly decreased damage to the environment by having the graded break. Now, plans for next year are put in place to carry out early burning to prevent large scale fires ever happening again. The most important outcome is that everyone can work together and feel safe and accept that we all carry good knowledge of fire in the Gulf.

Key words: *Collaboration, fire management, indigenous, working on country, community, land management*

FIRE FREQUENCY MAPPING USING SATELLITE IMAGERY FOR LAND MANAGEMENT AND RESEARCH

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Over northern Australia approximately 40 million hectares burns annually. An average 5.2 million hectares is burnt annually in Queensland's Cape York Peninsula (CYP) region alone. Firescars in CYP have been mapped using satellite imagery since 1999 and a 9-year fire history GIS database has now been compiled. Mapping was initiated to determine the scale, extent, timing and use of fire and its influence on land condition and biodiversity, to improve decision making and planning. The database created is a remarkable tool relating fire to topography, landuse, biodiversity and pastoral economics.

Fire scars are mapped using MODIS satellite imagery. Fire scars are identified by creating a 'difference' image highlighting changes between two images taken of the same locations roughly a week apart. ERDAS IMAGINE and eCognition programs 'segment' the 'difference' image into polygons which are then compiled using ArcView GIS program. Each year's firescars are converted to raster grids which are summed to produce a 'fire frequency' layer showing the number of years a pixel (6.25ha) has been burnt in a given time period.

The 9-year 'fire frequency' layer graphically illustrates fire patterns associated with topography, landform, regional ecosystems, infrastructure and landuse. It also may link to land condition status, highlighting over-burnt, over-grazed or under-burnt areas. Landuse (pastoral, indigenous and conservation) can be differentiated, identifying appropriate fire management regimes so guidelines can be developed eg. best practice fire regimes to manage woody thickening. The firescar data is also being used in applied projects like investigating the effect of fire on CYP pastoral economics.

Fire frequency maps provide a formal, effective mode of presenting large amounts of fire information visually correlated with on-ground factors. The maps demonstrate regional climatic and environmental variability on fire regimes, but are also useable at the extensive property scale to investigate management and infrastructure effects and the consequent drivers of change.

Key words: *Fire, Frequency, Satellite, GIS, Biodiversity, Management*

SAVANNAS FACE THE FUTURE: WINDOWS INTO A FUTURE CO₂-RICH WORLD

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The most immediate and certain aspect of climate change impacts on pastoralism will be through the way rising CO₂ influences the use of limiting resources (water and nutrients) in rangeland plant communities. We tested the responses of a northeast Queensland tropical savanna ecosystem to elevated CO₂ using a Free Air CO₂ Enrichment experiment, the first such experiment in the tropics and the first in a C₄-dominated ecosystem. We found that rising atmospheric CO₂, even without changes in climate, will profoundly affect the structure and function of savannas. The primary ecological mechanism for these responses was mediated mainly through the influence of CO₂ in altering the patterns of water availability and use. Reduced transpiration of tropical grasses under elevated CO₂ prolonged the short-term availability of soil moisture after rainfall events and, over the longer term, lead to increases in soil moisture below the grass rooting zone. These changes, in turn, stimulated grass production, particularly in moderately dry years, and lead to a shift in grass community composition favouring *Themeda triandra* (kangaroo grass). Increases in plant production diluted limiting nitrogen resources in plant tissues, reducing the quality of forage for livestock and other herbivores, and reducing the decay rates of plant litter. The influence of elevated CO₂ on savannas will have both positive (e.g., increased forage production) and negative (e.g., reduced diet quality) practical implications for land managers: understanding these effects will assist in developing adaptive strategies that maximize the benefits while minimizing the negative impacts of rising CO₂. By changing the way that limiting resources are utilized within ecosystems, elevated CO₂ will have a far-ranging influence on ecosystem processes with implications for the services (e.g., forage for cattle, runoff from river catchments, wood production) these ecosystems provide. In particular, the contribution of C₄ plants (which account for a fifth to a quarter of terrestrial carbon fixation) to global responses to rising CO₂ may currently be under-appreciated.

Key words: *carbon, C₄, grass, climate change*

IMPACT OF A MANAGEMENT INTERVENTION ON THE GREENHOUSE BUDGET OF A QUEENSLAND GRAZING BUSINESS

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The emerging carbon economy will have a major impact on grazing businesses due to significant livestock methane and land-use change emissions. Livestock methane alone accounts for around 11% of Australia's reported greenhouse emissions while livestock industries only contribute around 1% to gross domestic product.

Grazing businesses need to develop an understanding of their greenhouse gas contribution and assess the impact of alternative management options. Development of a property-scale greenhouse budget is one possible tool, however it requires information which is not currently readily available at the region, property, management and land-type scale. This paper presents a simple greenhouse budget for one major land-type '20 year old regrowth brigalow' on an indicative grazing property in the brigalow bioregion of Queensland. The 50 year analysis demonstrates the likely impact of three alternative regrowth management options on the greenhouse budget and livestock carrying capacity: retain regrowth (sequester 71.8 t CO₂-e/ha), clear all regrowth (emit 41.2 t CO₂-e/ha) and clear regrowth strips (emit 4.5 t CO₂-e/ha). Significant assumptions were required to complete the budget due to gaps in current knowledge particularly in relation to the response of woody vegetation and soil carbon to different management options. Improved prediction of livestock methane emissions at the property-scale is also required.

ASSESSING THE CUMULATIVE EFFECTS OF WATER MANAGEMENT BY THE MINING INDUSTRY IN RANGELAND ENVIRONMENTS

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Iron ore mining is expanding in the Pilbara region of WA with new prospects being developed. While each project is assessed for its environmental impact separately, it is apparent that in rangeland environments with many mines in close proximity, there may be cumulative impacts on regional landscape values.

We report an approach in developing methods and tools for assessing cumulative impacts of altered hydrology associated with mining activity on vegetation and water assets in an area (6,200 km²) of the Central Pilbara. In the Pilbara, intensive mine dewatering and associated drawdown of groundwater levels is contrasted with additional discharge of used groundwater to waterways. Location of linear infrastructure can affect landforms and vegetation reliant on localised overland flow. All of these activities have a capacity to affect water-dependent vegetation.

The aim of the project, which was commissioned by the Department of Water is to provide resource managers with a tool to determine where cumulative impacts need to be considered, and the relative importance of those impacts.

The project involves the use of Geographic Information Systems (GIS) to assemble data layers of geology, geomorphology, topography and drainage patterns, land systems and groundwater. The land system information has been analysed for the nature and relative area of land units that have ecological site types with varying sensitivity to changes in surface and/or groundwater hydrology. The spatial presentation of these data allows scrutiny and reporting on a location-by-location basis across the whole area. The reports produced provide an assessment of the relative sensitivity to altered hydrology in those areas, and can highlight where more intensive environmental monitoring may be required.

This innovative use of rangeland survey data for the Pilbara highlights the value of this information resource in providing regional connectivity between more focused site-by-site biophysical information assembled by individual mining companies.

Key words: *water management, mining, hydrology, cumulative impacts, vegetation*

A ROLE FOR REINTRODUCED NATIVE ANIMALS IN THE RESTORATION OF DEGRADED RANGELANDS

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Animal reintroductions are becoming increasingly popular in many ecosystems. Although their primary goal is to increase the size of dwindling populations, there is increasing recognition that reintroduced animals have the potential to contribute positively to the restoration of degraded ecosystems. The loss of animals such as bilbies and bettongs over large areas of the continent is thought to have reduced the structure and function of Australia's arid landscapes. The pits of soil-foraging animals intercept water, sediment, seed and litter that flow across the surface, becoming areas of higher moisture and litter mass, and nutrient-rich hotspots of litter decomposition. Foraging pits help to maintain a mosaic or patchwork of fertile patches, ultimately benefiting other biota. We discuss field studies of two animals whose reintroduction is critical for the restoration of degraded ecosystems, and compare their effects with those of the European rabbit and echidna. We describe the effects on soil and water processes, how their disturbances affect patches, and how this influences soil nutrient concentrations and ultimately, landscape function. The results give us valuable insights into how arid systems functioned prior to species losses, and provide renewed impetus for the reintroduction of animals outside formal reserves.

Key words: *ecosystem engineers, foraging pits, ecosystem function, reintroductions, decomposition, biopedurbation*

LANDHOLDERS AND KANGAROOS IN THE RANGELANDS: CAN COLLABORATION COMPLETE THE PUZZLE?

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For three years the FATE Program has been working towards achieving multiple benefits by applying conservation through sustainable use (CSU) approaches to the kangaroo industry. A critical component is landholder involvement in kangaroo management that results in commercial gain. We are developing strategies for landholders to add value to the harvest at the same time as achieving better control of the impact that kangaroos can have on their land. We have sought close collaboration between members of the Barrier Area Rangecare Group (BARG), harvesters, processors and regulators to achieve this end.

This paper reports on progress in the Barrier Ranges Sustainable Wildlife Enterprise Trial which is part of a larger program funded by RIRDC to develop Sustainable Wildlife Industries (SWEs) in the rangelands. The paper includes:

- analysis of harvest data across collaborating BARG properties;
- results of discussions between stakeholders and other groups seeking similar outcomes;
- progress towards allocation of harvest tags on a group rather than an individual property basis;
- synergies with recent marketing research on consumer and industry attitudes to and acceptance of kangaroo meat;
- description of models for landholder involvement and analysis of the extent to which they can achieve multiple benefits.

As a result of this work we are developing and trialling a system that integrates kangaroo management with good land management for the benefit of the rangelands and rangeland communities. We are seeking contact with other rangeland communities who are interested in our approach.

Key words: *kangaroo industry, collaborative kangaroo management, kangaroo harvest variability, conservation through sustainable use, wildlife conservation, models for landholder participation*

DEVELOPMENT OF A VALUE-DRIVEN BUSH FOODS INDUSTRY CHAIN THAT REWARDS ABORIGINAL PEOPLE

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The Australian bush foods industry comprises products derived from uniquely Australian flora and fauna and is founded primarily on traditional Aboriginal knowledge of the collection, preparation and uses of the resources. Many of the plants used in the commercial industry are sourced from the Australian rangelands and yet few Aboriginal people have engaged successfully in market-based commercial ventures. The exceptions have been in the use of plants as a medium for creative expression and the basis for art and craft enterprises. This paper examines the use of a value chain approach to research which supports the development of the Australian bush foods industry, with a focus on desert Australia and the increased participation of Aboriginal people.

The bush foods industry is emergent and characterised by very small, and small to medium enterprises operating as sole traders or limited companies. Some supply chains exist, although a high level of fragmentation, which typifies emergent industries, is evident and policy and standards which support the industry at the national scale do not exist. All this means that the focus within the chain is on minimising transaction costs and maximising the net gain associated with each transaction along the chain. This leads to competition both within established supply chains and across supply chains. We propose that the industry needs strengthening in key strategic areas and should move from an adversarial approach to one that seeks to integrate resource flows in a manner which creates value for all members of the chain. Such a chain will need to be built around seven key ingredients of modern successful value chains – trust, satisfaction, appropriate power structures, commitment, communication, relationship-specific investment and strong personal relationships.

Key words: *Aboriginal, bush foods, value chain, industry participation, relationships, resource integration*

POSTERS

Session 1

Capacity building and social issues in rangelands

SMALL BUSINESS AND CHANGE: IDEAS FROM THE BUILDING BLOCKS OF ABORIGINAL ENTERPRISE

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This presentation outlines how the building blocks of Aboriginal enterprise can assist all small businesses to manage change. Through research into Aboriginal enterprise in selected remote and regional areas of Australia, five enterprise building blocks were established. The building blocks are: culture; family and community; motivations, goals, aims and priorities; decision-making and commercial considerations. These building blocks link to each other through the “whole process of enterprise.” However within the whole process of enterprise, each small business or enterprise is unique, holding its own identity – this is referred to as “unique accretion”. Enterprise building blocks, the whole process of enterprise and unique accretion can be used by government and industry to help support small businesses experiencing change. In particular, government and industry can work with the concepts difference and power to achieve effective support measures for small business.

Key words: *small business; Aboriginal enterprise; remote and regional areas; managing change; identity; power;*

LIVELIHOODS IN THE ANMATJERE REGION: EMPLOYMENT, UNCERTAINTY, AND INSTITUTIONS

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In a scoping study leading to this project, local government in the Anmatjere (Ti Tree) region, 200km north of Alice Springs, identified high Aboriginal unemployment as a core issue for sustainable regional development. Unemployment (as conventionally defined) is high despite the availability of seasonal labour jobs in an expanding horticulture industry in the region. CSIRO researchers are investigating the factors that affect local people's access to employment and identifying livelihood activities that are important to them, with funding from the Desert Knowledge CRC. More than seventy people in the Anmatjere region were interviewed; the demographic profile of the interviewees paralleled that of the Anmatjere region where there is a predominantly Aboriginal population.

The research applies the sustainable livelihoods framework (SLF) as a tool to help understand the complexity of and relationships between the factors that influence livelihoods. Livelihoods encompass the range of activities that people undertake to improve their income, health and wellbeing. The SLF is used in community development research and practice internationally.

Three important findings have emerged from analysis. Firstly, there are significant differences in the way Aboriginal and non-Aboriginal people view the availability of jobs in the region. Secondly, among Aboriginal people some of the available jobs and livelihood activities are valued more highly than others, influencing participation rates in different industries. Thirdly, there is high uncertainty in the availability and security of employment, caused partly by the periodic and short-term nature of many of the available jobs. High socio-ecological uncertainty is typical of rangelands and especially arid environments. People in desert environments have often developed institutions (rules, norms and strategies) that mitigate this uncertainty. However, employment-related institutions operating in the Anmatjere region seem to add to rather than mitigate uncertainty. This research will improve understanding of the factors influencing livelihoods and employment in remote Australia.

Key words: *sustainable, livelihoods, employment, uncertainty, institutions, Aboriginal*

BUILDING PARTNERSHIPS TO IMPROVE RANGELAND MANAGEMENT - CASE STUDY, GAWLER RANGES SOUTH AUSTRALIA

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The recognition of collaborative, partnership-based approaches to natural resource management (NRM) in South Australian rangelands has grown from the extension of Government policy and regulations to the development of community initiated programs.

The Building Partnerships to Improve Rangeland Management project, funded by the Natural Heritage Trust is a project promoting a grass-roots approach to NRM that also had pastoral profitability outcomes.

The project aims to facilitate the process of change toward improved management, in response to pastoralists' aspirations.

In the Gawler Ranges region of South Australia the pastoral community have proved that with open, unbiased extension and engagement, pastoral and production aspirations can be compatible with successful and rewarding NRM outcomes.

The first step taken to engage the pastoral community was a fact finding process that allowed pastoralists to express their immediate issues, both productive and natural resource; identify learning and development gaps and then explore innovative solutions to address these.

Pastoralists' past experience with other Government driven projects meant there was some initial scepticism towards the project. However, with committed extension support and the development of on ground projects, barriers began to dissolve.

The outcome achieved resulted in the development of four property trials, two workshops and a biodiversity study of ephemeral lakes in the southern Gawler Ranges. The Gawler Ranges pastoral group are committed rangeland managers who have shown that improvement to natural resource condition can be achieved without compromising livelihoods.

Key words: *community, production, rangelands, natural resource management, engagement, partnerships*

PRODUCTIVITY, WATER QUALITY AND SALINITY - ACTION LEARNING TOOLS TO HELP PEOPLE OF ALL AGES AND BACKGROUNDS TO UNDERSTAND THE BENEFITS OF BEST PRACTICE IN AGRICULTURE FOR PRODUCTION AND FOR THE ENVIRONMENT

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The Queensland Murray Darling Committee (QMDC) is working with the community in the Maranoa Balonne and Border Rivers catchments to encourage and support sustainable use of natural resources. A number of initiatives have given QMDC direct contact with landholders managing over 30% of the catchment. Sharing a vision for healthy landscapes and viable communities, it is important that stakeholders gain insights into the links between production systems and the condition of our natural resources.

Some simple action learning activities have been used to assist with information exchange. Cover, erosion, water quality, infiltration and salinity are discussed during these activities with equipment including lunch boxes and paint trays. Drink bottles and table salt are also used to demystify landscape salinity. Activities link grazing and natural resource management issues in simple terms. They are in no way comprehensive but they have helped to build a common understanding of landscape processes providing a platform for planning to address specific issues.

These simple activities, or tools, can be adapted onsite to suit specific interests or time constraints. They have been delivered with moderate success on kitchen tables, town halls and in the paddock. Beneficiaries have included the young and the not so young, school of hard knocks and PhD graduates, and various NRM agencies' staff. Even those who "knew that" have commented that the perspectives and productivity links are enlightening and beneficial.

Key words: *Productivity, Water Quality, Ground Cover, Erosion, Salinity, Action Learning*

TOOLS FOR SUCCESSFUL NRM ENGAGEMENT IN THE LAKE EYRE BASIN

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Achieving successful NRM in Outback Australia depends upon effective social engagement processes which are adapted to suit remote regions. In line with the notion of ‘desert syndrome’ remote regions tend to be characterised by sparse populations with distant voices. In this context we present a suite of key factors, tools and principles for successful community engagement processes relating to remote areas. We begin by drawing out key themes from literature on successful community engagement in NRM, followed by a case study to identify ‘success factors’ of the engagement processes in the Lake Eyre Basin. The case study presents findings from a series of interviews conducted with the government liaison officers responsible for facilitating regional NRM; and community interviews conducted between residents of the case study region. The results draw attention to general principles such as building trust, working in partnership; supporting community champions; and maintaining transparency. In addition, characteristics relating specifically to arid areas relate to timeframes, such as developing long term relationships and committing to long term NRM outcomes; as well as being able to take advantage of (potentially infrequent) opportunities in the operating environment when they do occur. In conclusion, it is apparent that successful NRM engagement for remote areas requires a multitude of seemingly contrasting characteristics: to be independent yet maintain effective partnerships; to be the voice of the community whilst being in alignment with government priorities; and to be determined yet adaptive, creatively operating within resource and capacity constraints. This research was developed as part of the People, Communities and Economies of the Lake Eyre Basin (LEB) project, funded through the Natural Heritage Trust with the support of the Desert Knowledge CRC.

Key words: *Desert, trust, participation, social dimensions, outback communities*

FILING PHOTOGRAPHIC SEQUENCES IN A DIGITAL DATABASE

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Monitoring plant population changes efficiently is achieved by repeated sampling at fixed points (Philleps *et al.* 1998). Often accompanying such data are a plethora of pictorial data that are often underutilized in supporting quantitative findings. This usually occurs because photographs are forgotten, lost and awkward to retrieve and organise. Hence there is a requirement for a system to readily store, retrieve and aid in the interpretation of digital photographs, especially those taken along a time series, and any associated data.

This paper outlines an adaptable database and storage technique that can be used to organise digital photographs associated with plant monitoring sites. This technique will enable a more efficient use of photos to support research findings and prevent the loss of important data associated with such samplings. Additionally, it ensures a consistent nomenclature and filing system for storing digital photographs. This paper also presents graphical outputs from the database highlighting the importance of digital photographs in monitoring plant population dynamics as the communities respond to imposed management regimes and seasonal variations. It is suggested that this system is very relevant to many researchers and managers as a method of complimenting and enhancing current monitoring systems for recording plant populations within Australian rangelands.

Key words: *plant population changes, digital photographs, database.*

UNDERSTANDING THE INFLUENCE OF IDENTITY, TRUST AND SENSE OF PLACE ON GRAZIER'S CHANGE TO MORE SUSTAINABLE NATURAL RESOURCE MANAGEMENT

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As a consequence of droughts, climate change, international markets and societal pressure, the tropical rangelands of eastern Australia are experiencing increasingly complex natural resource problems that are having negative economic and social impacts on beef grazing enterprises. Subsequently, many graziers are making changes to their land management practices in an attempt to improve their situation. In this research we are finding out how landholders are making this change and the influence of trust, sense of place and occupational identity on this process. The study regions are the Burdekin River catchment and the Northern Gulf, Queensland. This research involves a scoping study (one-on-one interviews with 20 graziers) followed by a questionnaire survey of landholders in the two regions. Preliminary results suggest that changes in grazing management to improve land condition and economic viability are largely driven by family goals, a sense of responsibility, attending training courses, social interactions and emotions such as feeling dissatisfied and unchallenged. More specifically, role as a parent; a strong attachment to life as a grazier, the landscape and rural living; and, trust in particular characteristics of people (rather than who they are and where they come from) appear to be strong influences on the decision process to change management. Results from this research will inform the design of future policies to accelerate graziers' change to practices that reduce biodiversity loss, productivity decline and poor land condition in the tropical rangelands.

Key words: *Decision making, adoption, family, social learning, place attachment, beef industry*

IMPROVING PASTURE MANAGEMENT CAPACITY THROUGH SUBDIVISIONAL FENCING ON RIVERSLEIGH PASTORAL STATION

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This paper describes a National Landcare Program (NLP) funded project on co-owned (Indigenous and Zinifex Century Mining) Riversleigh Pastoral Station in the Gulf of Carpentaria. Riversleigh Pastoral Station is a rural beef property utilising land adjacent to the Gregory and O'Shannassy rivers. Over the years, stock numbers have contributed to erosion and pasture degradation along these river and its environs. Consequently, pasture quality and usability has suffered in these areas due to the lack of suitable watering points. The project targeted improvements to pasture management and sustainable production in the pastoral industry and was successful due to a strong partnership with Wanyyi people, who have a commitment to the ideals of sustainable land management and care for country. The project consisted of riparian fencing and the installation of alternative watering points delivering strategic benefits for both land managers and the conservation of river systems, which are regarded by many as two of Australia's remaining pristine river systems.

Key words: *Land condition, partnerships, indigenous, monitoring, biodiversity, sustainability*

WHAT CONSTITUTES AN “ENVIRONMENTAL DUTY OF CARE” OF GRAZIERS IN NORTH QUEENSLAND?

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Landholders in Queensland owe a duty of care to the environment *per se*, as legislated in the Environmental Protection Act 1994, Land Act 1994 and the Aboriginal Cultural Heritage Act 2003. The environmental duty of care under the Land Act 1994 is of particular relevance to leaseholders as the State Rural Leasehold Land Strategy links land condition—as a measure of compliance with environmental duty of care—with lease conditions, specifically the length of lease renewal. An environmental duty of care requires landholders to take ‘all reasonable and practical’ measures to prevent or minimise environmental harm. It puts the onus of proof of compliance on landholders while giving them flexibility in how to achieve compliance. Many agricultural industries have developed industry-specific codes of practice that aid members to comply with duty of care requirements. No code of practice exists for the grazing industry. However, past research has established environmental management principles (EMPs) for grazing, which contain a combination of grazing land management guidelines and specific strategies such as control of feral animals. The graziers in the Northern Gulf region of Queensland, through the Northern Gulf Resource Management Group, want to work towards a grazing code of conduct for their region. A first step in the process is to determine what constitutes ‘reasonable and practical’ environmental management practices.

This paper presents the results from a grazier survey in the Northern Gulf region into what EMPs graziers think form part of an environmental duty of care. Respondents were asked to rate their level of agreement with each of the 16 EMPs. The majority of graziers agreed with all the EMPs, but important considerations for sub-regional variation were identified and thoughts about monitoring and proof of compliance provided. The paper concludes with recommendations on how this information can be used to inform a code of practice for the grazing industry in the Northern Gulf region.

Key words: *Grazing, tropical savannas, Northern Gulf region, environmental duty of care, leasehold land, code of conduct*

FORAGE – A WEB-BASED FRAMEWORK FOR GENERATING AND DISTRIBUTING DECISION SUPPORT INFORMATION FOR SUSTAINABLE GRAZING LAND MANAGEMENT

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FORAGE is a web-based framework developed to generate and distribute climate and pasture condition information at a specific location (e.g. specified by lot plan or a latitude and longitude position) for clients to facilitate decision making in grazing and environmental land management. The system takes requests from a web page, processes those requests and generates products which are then emailed back to the client. The primary aim of FORAGE when developed was to provide a method of delivering a climate risk assessment and carrying capacity report to clients. It currently offers a Rainfall and Pasture Summary Report, a Ground Cover Report and a means to request satellite imagery products. The Rainfall and Pasture Summary Report provides a time-series of annual rainfall, and estimated annual pasture growth, pasture total standing dry matter (TSDM) and pasture litter cover. The Ground Cover Report provides a time-series of estimated and satellite imagery derived pasture ground cover. The satellite imagery products are sourced from the Statewide Landcover And Trees Study (SLATS) project. To produce climate reports, FORAGE obtains climate data from the Silo enhanced meteorological datasets and calculates pasture growth, TSDM and pasture litter cover using the GRASP and AussieGRASS Environmental Calculator models. The outputs are then customised into a report and delivered to the client as a one-page 'PDF' file.

FORAGE is currently used by a range of clients including government agencies, extension officers and land managers to assess climate risk and land conditions and to support their decision making in sustainable environmental and grazing land management.

Key words: *decision support information, grazing land management, ground cover, climate risk assessment, AussieGRASS, GRASP.*

THE SA ARID LANDS BIODIVERSITY STRATEGY: MOVING FROM BIOLOGICAL INVENTORIES TO AN INVESTMENT AND DECISION-MAKING FRAMEWORK

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Planning for biodiversity conservation has traditionally focussed on compiling all information relating to the biodiversity assets within a region and describing asset specific management actions. Plans developed in this manner typically describe a large number of actions and often inadequately address strategic policies and processes. Consequently they are often difficult to successfully implement because of the sheer volume of actions, and lack of a strategic framework in which to categorise, prioritise and resource individual actions. The development of the South Australian Arid Lands Biodiversity Strategy represents a major shift away from biodiversity planning based on biological inventories towards a framework for investment and decision-making.

The South Australian Arid Lands Biodiversity Strategy is a partnership between the South Australian Arid Lands NRM Board and the South Australian Department for Environment and Heritage. The Interim Biogeographic Regionalisation of Australia (IBRA) provides the structure for the strategy and within each bioregion the priority biodiversity assets have been grouped into conservation priorities and mapped at various spatial scales, depending upon their ecology, threat profile and distribution. The mapping of conservation priorities greatly assists in communication and engagement with a wide variety of stakeholders.

The strategy is structured in a manner that separates the strategic level actions to address the system-wide threats to biodiversity from actions necessary to conserve priority biodiversity assets. Benefits to this approach include:

- empowering stakeholders to begin addressing system-wide threats to biodiversity across the region;
- establishing the context in which research; policy, capacity, and individual conservation priorities can be resourced; and
- ensuring the strategy functions at multiple levels and accounts for the different stakeholders with an interest in biodiversity conservation and the associated resourcing and decision-making processes.

Key words: *Biodiversity; Planning; Inventories; Decision-making; Investment: SA Arid Lands*

QUANTIFYING DEGRADATION RISK – INTEGRATING CLIMATE RISK INTO RANGELAND MANAGEMENT

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Prolonged drought and overgrazing have been indicated as the major drivers of rangeland degradation in Australia. A range of techniques are being developed to assist in the identification of regions subjected to overgrazing and to quantify the severity of existing and potential degradation risks. These techniques allow the analyses of current land condition, climate risk and grazing land ecosystem processes. With such tools, appropriate policies and management practices could be taken to prevent resource damage and maintain the long-term profitability of grazing enterprises.

In this study, we synthesised previous research outcomes on “safe” pasture utilisation rate and developed a long-term “safe” carrying capacity for Queensland. Calculations were made using the AussieGRASS environmental model based on predictions of long term (1957 – 2007) median annual pasture growth and median growth index which previous studies have shown to provide a useful indication of carrying capacity. By comparing the calculated “safe” carrying capacity and the best knowledge of current stocking rate, potential “at risk” areas of overgrazing could be identified.

A decision tree model was developed to quantify the existing and potential degradation risks in Queensland. The model considers a number of factors including livestock numbers, pasture growth, pasture cover and the seasonal outlook. This model is integrated with a Geographic Information System (GIS) to visualise different levels of degradation risk on a spatial basis, allowing government agencies, extension officers and land managers to take appropriate actions to prevent resource damages and reduce production and financial loss.

Limitations of this decision support tool may include the coarse scale of relevant information such as rainfall, pasture growth and stocking rate. Therefore this decision support tool is recommended to be used at regional scale (e.g. shire) rather than at property scale for policy making and pasture management.

Key words: *AussieGRASS, climate risk, decision tree, degradation, drought, rangeland management.*

TECHNIQUES TO IMPROVE GROUNDCOVER IN THE WESTERN CATCHMENT OF NSW

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This poster aims to depict the types of management strategies that landholders are employing in the Western Catchment, to improve or maintain groundcover, so they remain sustainable both environmentally and economically. Strategies are designed by the landholders to suit the issues they have on their properties and implementation is facilitated by the Western Catchment Management Authority (CMA) staff.

The Western CMA has implemented a Groundcover Incentive Program. This provides financial assistance to landholders to implement on ground works and infrastructure which assists them to manage their landscape more strategically, so the catchment target of 40% groundcover can be achieved through sustainable grazing practices.

It is widely recognised to improve and increase vegetative groundcover, total grazing pressure (TGP) must be controlled. A number of projects have been funded by the Western CMA to assist landholders to exclude feral animals (goats) and native herbivores (kangaroos) from pastures and improve grazing management of domestic stock, thus providing more effective control of TGP.

Examples of on ground works that have been funded to improve groundcover (in turn reducing soil erosion) include TGP fencing (hinged joint, electric Weston fencing, upgrading existing boundary and internal fences to TGP standard); trap yards for removal of goats; managing water by fencing tanks (to exclude ferals and stock), turning off troughs and installing additional water points to spread grazing pressure evenly across a paddock. Funding has also been provided to landholders to attend educational workshops / courses which aim to enhance landholders grazing management, these includes Pasture to Pocket, Grazing for Profit, Business of Farming courses and a Sustainable Grazing Forum. These courses encourage landholders to use grazing strategies such as rotational grazing, use of grazing charts and destocking when critical pasture levels are reached. They also provide a valuable learning opportunity to share with others who may have similar problems in their districts.

Key words: *groundcover, total grazing pressure, native pasture, fencing, water, management*

**LAND MANAGERS AND LANDSCAPE FUNCTION ANALYSIS (LFA):
ENHANCING ADAPTIVE ENVIRONMENTAL MANAGEMENT WHILE
MONITORING RESOURCE CONDITION IN WESTERN NEW SOUTH WALES.**

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LFA is a rigorously developed methodology that can be used to assess and monitor how a hill slope is functioning as a biogeochemical system. It is extensively used in mine reclamation and in rangeland monitoring, particularly in WA, and if used in a time sequence and in context can show the extent to which a landscape is retaining and cycling its vital resources. This paper describes progress of research being supported by RIRDC and WCMA to determine how useful LFA is to land managers. We are attempting to answer questions such as: Can land managers learn how to do it? What does it mean to them? Do they find it useful? Is it useful as a community monitoring tool?

This paper documents an adaptive learning cycle incorporating the development and trialing of an on-site training package, an evaluation of its use leading to modification, then use in the modified form by new groups. The evaluation incorporates comparing the use of LFA by novices to its use by an expert. The work took place in the Barrier Ranges north of Broken Hill in Western NSW, Australia.

Broad conclusions are that the package improved as a result of the learning cycle and that novices using the modified package generated data very similar to the expert after a 2 day training course. In addition, land managers responded very positively to LFA, expressing a desire to incorporate it into their day-to-day management as well as work together with other land managers to develop group monitoring using LFA. Finally the paper speculates about the possibilities of an integrated monitoring system using LFA that includes sites monitored by agencies and land managers.

Key words: *landscape function analysis (LFA), community monitoring, expert/novice comparison, learning cycle, adaptive management, resource condition*

SOUTHERN GULF CATCHMENTS' SARUS CRANE AWARD AS AN INCENTIVE REWARD TO INCREASE PARTICIPATION IN NATURAL RESOURCE MANAGEMENT ACTIVITIES

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The Southern Gulf catchments region covers 215,200 km², an area nearly the size of the state of Victoria. Within this part of Queensland, there lies over 600 pastoral stations, nine shire councils and a population of approximately 35,000 people. A need to utilise an incentive tool which is low in cost but highly effective became a priority to accomplish the catchments NRM Regional Body's (Southern Gulf Catchments) natural resource management outcomes. Thus, a certificate and medal were developed to be presented at each Annual General Meeting to applicable individuals and groups who displayed outstanding contributions to natural resource management. Southern Gulf Catchments iconic Sarus Crane (*Grus antigone*), which is pictured in the organisations logo, was picked for the name of the reward to further relate recipients' understanding that 'good work will gain recognition'. The aim of the Sarus Crane Award is to not only have a positive reaction within the partisan to continue monitoring their project but to entice other community members to get involved and complete innovative natural resource management activities. At the inaugural ceremony, nine station managers and two of the regions shires accepted their reward retributions for projects they successfully completed and overachieved in collaboration with Southern Gulf Catchments. Resulting from this initial incentive attempt, feedback has been extremely positive from the winners and those who attended the Annual General Meeting.

Key words: *Incentive, community, collaboration, natural resource management, participation, motivation*

EVALUATION OF PAST PARTICIPANTS FUNDED TO PURCHASE COMPUTER MAPPING SOFTWARE AND OTHER TECHNOLOGIES FOR PROPERTY MANAGEMENT PLANNING

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As part of the Neighbourhood Catchment Incentive Scheme (NCIS), the Fitzroy Basin Association (FBA) has funded the purchase of property mapping and/or planning software, GPS units, and imagery for landholders over the past five years. A survey of 22 landholders funded to purchase these property mapping and planning technologies was conducted as a means of evaluating the effectiveness of these technologies in promoting improved property planning and management. The survey found that funding landholders for the purchase of property mapping and planning technologies has led to improved property planning and property management. Despite 41% of landholders finding the software / GPS hard to use, 82% continue to use the software, with 94% of these on an as need basis. The ability for landholders to use the software for property layout design, record keeping and management decision making has enabled them to continue to use these tools after purchase on an as need basis.

Property maps have been the most important tool as 91% of participants said their property map has led to planning projects or on ground improvements. Continued funding of up to date property maps and satellite imagery would ensure further property planning and on ground improvements in the Fitzroy Basin.

Minor technical issues and a reduced need for the technologies prevented 18% of landholders from continuing to use their software. Support for the use of these technologies, particularly for mapping and software, in the form of workshops, is necessary and would be supported by the landholders. Information outlining the different software available and the associated pros and cons of these products determined by past landholder experiences would also help landholders use this technology.

Key words: *Survey, software, mapping, property planning, funding*

THE WESTERN CATCHMENT MANAGEMENT AUTHORITY'S INCENTIVES PROGRAM: WHAT HAVE WE LEARNT FROM THE PAST THREE YEARS

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The Western Catchment Management Authority (WCMA) Incentives Program is the delivery method for WCMA investment into on-ground works in natural resource management. To date, the WCMA has conducted three major funding rounds (2005, 2006 and 2007), totalling around 22 million dollars. The WCMA also coordinates the delivery of National Landcare Program funding.

In November 2007, the Western CMA completed an evaluation of its Incentives Program. The key objectives of the evaluation were:

1. determine how adequately the Program is meeting needs of WCMA Catchment Plan;
2. assess the adequacy of the Program's delivery and Program structure; and
3. determine how effective recent changes in the Program Structure has been in engaging the community.

The evaluation sought comments from all WCMA's district and regional staff, past participants of the Assessment Panels and a range of landholders. It was found that there has been a gradual increase in the number of applications received in each of the three funding rounds, despite the fact that in 2007 some landholders submitted multiple applications. Although the number of 'new' applicants has decreased since the Program's inception in 2005, the number remains at 50% of total applicants. The WCMA will need to decide whether this is an acceptable level of engagement.

In terms of whether the Program is meeting the targets of the Catchment Plan, it was found that the WCMA's landscape and pest management targets are on track to be reached. However, the WCMA may have difficulty attaining the sustainable agriculture target if new landholders are not engaged. Water quality targets may be difficult to attain due to the limited nature of works that the WCMA can fund that will have an influence instream. A number of internal administrative and processing issues were also identified as part of the review and will be discussed briefly as part of this paper.

THE Y-NOT BEEFPLAN GROUP

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The Y-Not BeefPlan group in Central Western Queensland is a proactive collective of like-minded progressive graziers, predominantly beef producers. They became increasingly concerned by the disconnection between producer and consumer, and the growing misconceptions being fostered by select but loud minorities in the urban populace. So in 2005 at their field day in Jericho, they started a petition demanding their agri-political bodies actively promote a positive media image and message of rural Australia. Agforce answered with their *'Every Family Needs a Farmer'* campaign. On a regional level, the Y-Not group then produced a colour brochure *'Meat the World'* that explains and illustrates their beef industry to outback tourists and visitors, which has been very successful and now in its second print run.

Now, the group will graphically illuminate the many oft understated benefits and reasons for choosing natural red meat over synthesised cereal derivatives. A holistic view of the rangeland pasture, with ecology intact and bovines a'grazing down the left half of the poster will contrast the right half - a soya field, a monoculture requiring irrigation and fertilizers, with harvesters and factories required to manufacture the tofu. Across the images will be the contrasting positive and negative messages of natural versus synthetic.

The left image will have the 'typical' hayed-off native grasses with sporadic and varied trees and shrubs. Kangaroos, emus, a lizard and birds will illustrate a natural, rich ecosystem. The cows, steers and calves graze and grow utilising the existing rainfall, and few other inputs. Without the extensive beef industry converting energy to protein, the inevitable burning of this forage would release mega tonnes of carbon into the atmosphere to much damage.

The soya field will highlight all the opposing elements – regimented green crop replacing nature, with tractors, irrigation spraying water, harvesters, trucks and factories.

Key words: *Nature, Biodiversity, Sustainability, Carbon Converters, Grassfed Beef*

HISTORY OF THE DESERT UPLANDS

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The formation of the Desert Uplands began, when in 1994, the Aramac Landcare group applied to extend a scheme initiated by the South West Strategy, the Mulga Land Degradation Voluntary Property Build-up Scheme, to the Desert Uplands region. In 1995, the Desert Uplands Build-up and Development Committee was established. Its role: to address economic, environmental and social issues, borne out of characteristics unique to the Desert Uplands Bioregion. The Desert Uplands Committee is one of the longest running regional strategy groups in Queensland and they consult extensively with the wider rangeland community and public authorities.

The area of involved is broadly based on the Desert Uplands Biogeography Region as identified in the Interim Biogeography Regionalisation of Australia (Thackeray and Creswell, 1995). The area has since been increased and now covers 75,000 km² to allow for properties which were only partly covered within the biogeography region. In 1994 the region produced approximately \$366.5 million of agricultural products.

In 1998 the Desert Uplands Committee introduced the Enterprise Reconstruction Program to provide financial assistance for property build-up, on-property development, capital restructuring, partnership arrangements and enterprise succession.

More recently the Committee have been involved in a Property Management Planning project, and the Landscape Linkages project which is the first trial of an environmental stewardship program in Central Western Queensland.

Since 1999 the Desert Uplands Committee also managed a total of 132 On Ground Nature Conservation projects and devolved over \$1,660,000 (Approx 4.2 Million including land holders in-kind contribution). In 2006/07 26 projects were funded by the National Heritage Trust through Desert Channels Queensland and one project was funded by Qantas which equated to \$290,000 going towards nature conservation. Landholders, on average, contributed over 60% of the total project costs.

The Committee have also conducted a Social Research project, two Monitoring and Evaluation surveys, which were completed by land managers in the region, and, after identifying the need for detailed land resource information at a scale that relates to individual properties, they conducted research into the different soil types of the region and produced a disc of information which is available to graziers.

Key words: *Innovative, highly motivated, passionate, grass roots, result focused, integrity.*

CO-ORDINATING FIRE MANAGEMENT FOR THE GREAT MOUNT ISA AREA

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In this project, Southern Gulf Catchments (SGC) contracted Lesie Felderhof of Firescape Science to develop a detailed proposal for addressing fire management issues in the Greater Mount Isa (GMI) region. Decades of research into fire ecology shows fire is instrumental in shaping the environment and that active fire management is required for conserving species, cultural heritage and ecological communities. SGC is responding to concerns that altered fire regimes since European settlement has resulted in vegetation modification and species loss. The extent of concern has led to issues of inappropriate fire regimes being nominated for the listing as a threatening process under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*. Some flora and fauna are killed by fire, but for others it is a catalyst for regeneration. Responses depend on species characteristics and the areas fire history. Further, Aboriginal occupancy of Australia before settlement is well recognised. Indigenous people have special interests relating to land management – and fire is integral to cultural heritage and tradition. Across tenure, cultural heritage is given recognition, protection and conservation under the *Aboriginal Cultural Heritage Act 2003*. In short, the influence of fire on the landscape means land managers committed to sustainable land management need to address fire management issues. This is the basis of SGC promoting best-practice fire management in the GMI area. Dr. Felderhof has been working on a draft project framework with modules for fire planning, implementation, knowledge gathering, acquiring new knowledge and extension. She will be consulting with the SGC and with stakeholders, community members and potential partners to finalise this framework which will be used to seek funding. Dr. Felderhof believes the elements to produce a successful project include: on-ground activity, community engagement and support; cross sectoral involvement; engagement with Traditional Owners; valuing community experience and knowledge; bridging the gap between science and practice; and employing local residents.

Key words: *Fire management, partnership, consultation, community, indigenous, heritage*

IVORY TOWERS, SILOS AND THE REMEDY

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It is not lack of scientific knowledge, or money, or will that is the *root* cause of continued perceived distress in the rangelands. It is that groups of stakeholders communicate within semi-closed networks so their special insights and powers are not shared more widely. Participants do not speak the same language or share the same view of reality.

Communication *among* scientists, rangelands landholders, line public servants and, preeminently, the economic elite can be quite intensive and extensive. But communication *between* these groups can be non-existent. Worse, they prefer to avoid each other.

The ultimate cause of these barriers lies in inadequate education and life experience. Few economists or lawyers, for example, study any ecology. Yet half of most federal Cabinets are lawyers. Unsurprisingly, year after year, the environment drops off the policy agenda and budget provisions. Long term, the remedy lies in multidisciplinary education; but this won't help practitioners in the meantime.

Government portfolios are divided along functional and sometimes disciplinary lines. This allows technical expertise to flourish but reinforces the 'silo effect'. Superimposed is a science-policy-operations axis. Yet natural resources inevitably are managed locally as *places*. At what scale should specialist knowledge be translated into place-based terms? Currently this happens mainly within landholders' brains. But reality is becoming too complex; landholders need spatially-organised support.

NRM regions are an appropriate scale to measure landscape condition and to undertake landscape planning. However, they are too broad to engage most property holders. District-scale forums bringing together science, government, policy, planning and local expertise would match the horizons of those who exercise sovereignty over rangelands resources – landholders including public authorities.

Functions deliverable at this scale include brokering knowledge, covenants, financial grants, carbon trades and government programs; planning public works; public budgeting; targeting stewardship payments; sharing labour and equipment; and even precisely-targeted regulation.

Key words: *disciplinary silos, landholder sovereignty, district-scale coordination*

WATERSMART PASTORAL PRODUCTION™ – A DEMONSTRATION AND EVALUATION OF INNOVATIVE STOCK WATER DELIVERY AND MANAGEMENT TECHNOLOGIES IN DESERT AUSTRALIA

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The Desert Knowledge Cooperative Research Centre WaterSmart Pastoral Production™ Project was established in 2005 with the aims of (i) encouraging pastoralists to understand how to optimise the benefit of rainfall; (ii) assist them to understand the mechanics of and make informed decisions about technologies for water pumping, reticulation and remote management and control of water systems; and (iii) promote knowledge of water-point placement in relation to tactical grazing, environmental sensitivity and biodiversity. This presentation focuses on the second of these objectives.

The project team consulted with pastoral producers across desert Australia to identify a variety of water management technologies to be evaluated within the on-property demonstration sites. These included a range of commercially available telemetry systems, evaporation control devices, and solar pumping technologies. Four demonstration sites were established on pastoral properties in South Australia, the Northern Territory and Queensland. The properties represent a range of grazing scales, infrastructure types, environmental conditions and different capacities to invest in new water management technologies.

With the project team, pastoral producers have recorded the implementation and operating costs of the water management technologies. These include changes in their business operation and costs, changes to their lifestyles, and the ease-of-use and reliability of the new technologies. The results of the project have been extended to a wider audience of pastoralists through field days, media articles, the WaterSmart website (<http://www.desertknowledgecrc.com.au/watersmart.html>) and to come a WaterSmart™ Pastoral Production handbook.

Key words: *arid rangelands, solar pumps, telemetry, evaporation control, cost savings*

A PARTICIPATORY APPROACH TO TRAINING FOR THE HERDERS OF THE INNER MONGOLIAN GRASSLANDS.

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Inner Mongolia is home to one of the world's largest but most endangered grasslands. These grasslands are currently suffering from overgrazing which is having a significant effect on plant diversity, plant health, plant numbers and consequent loss of productivity and increased soil erosion, threatening the future sustainability of the system.

Farming the grasslands of Inner Mongolia is not a new concept. For thousands of years nomadic herders have raised horses, sheep, goats, cattle and camels. The farmers of this area are subsistence farmers who see their wealth in the number of animals they own. This has resulted in livestock numbers increasing rapidly over the last 50 years as herders have resided in villages and towns and no longer live a nomadic existence. The area has abundant resources but grazing management is based on the system which was used when they lived a nomadic existence and moved their livestock to the available feed. For this reason, it is necessary to give farmers the tools and training to assist them to protect their precious resources and ensure their long term survival.

Traditional Chinese training courses are conducted in very large groups using a lecture style format. On-farm training in small groups is a concept that is new to them and one that we explored during our time in Inner Mongolia. We collected information on the livestock and grassland system with the data then being used in an on-farm workshop in their village. Farmers responded favourably to these interactive training sessions.

We believe it is possible to develop a training package that will enable farmers and herders to contribute towards their own learning, using a participatory approach. The outcome of this training is profitable and more sustainable grasslands in Inner Mongolia.

Key words: *Grasslands, sustainability, overgrazing, training, participatory, herders.*

Session 2

Grazing management, land condition and monitoring in rangelands

GRAZING PREFERENCE, PATCHINESS AND LAND CONDITION INTERACTIONS – IMPLICATIONS FOR RECOVERY IN GRANO-DIORITE LAND TYPES OF THE UPPER BURDEKIN REGION.

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Factors that influence selective grazing preference occur at a range of scales and include both edaphic elements such as topography, vegetation community, soil type and human influences such as paddock configuration, water and supplement placement and burning strategies. Cattle also graze patchily and many of the processes and interactions that impact upon land condition and hydrological function begin at the grazed patch scale.

A recent MLA funded study at Virginia Park, station, Mingela and other commercial paddocks in the upper Burdekin region of north Queensland identified a strong feedback link between pre-existing condition of vegetation patches and grazing selectivity. In paddocks with a mosaic of land condition patches, existing C (poor) and some D (very poor) condition patches were up to four times more likely to attract continued heavy grazing (defoliation >50%) than adjacent B or A condition patches. While this selection preference was observed across the whole landscape, when coincident with preferred or vulnerable frontage or sodic soil land types, the potential for degradation increased.

Virginia Park studies show that continued selection preference for C and D patches can significantly affect the spatial and temporal patterns of land condition recovery. This has important implications for managing recovery from C to B condition, especially in paddocks dominated by *Bothriochloa pertusa*. Wet season spelling is the key to reducing this selective targeting of C condition patches, when recovering remnant 3P grasses are most vulnerable to continued heavy grazing during the crucial growing season.

Key words: *grazed patches, land condition, selective preference, recovery, 3P grasses*

UNDERSTANDING CATTLE BEHAVIOUR IN RIPARIAN AREAS WITH AND WITHOUT ACCESS TO OFF-STREAM WATERING POINTS

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There are approximately 4.5 million cattle grazed in catchments along the Great Barrier Reef. Cattle that graze paddocks adjacent to rivers use them to obtain water, but this can cause damage to the bank and erosion. Recent advances in GPS technology (high fix rates) can provide researchers with the tools to accurately determine where the animals are in the paddock. In addition, the access of animals to riparian areas can be restricted using automated monitoring and control devices. This paper describes an experiment which investigated how the use of riparian areas by cattle can be influenced by providing access to off-stream water and discusses this in relation to automated animal control. The experiment was conducted at Belmont Research Station (150° 13'E, 23°8'S), located 20 km NW of Rockhampton. The paddock used for this experiment was 61 ha and had a 1 km riparian zone along the Fitzroy River. The experiment consisted of 4 deployments of 2 groups of cattle, each for one week during June, July and August 2007. Eighteen month old Brahman steers (*Bos indicus*) were used in the experiment and deployments 1 and 2 had the same 15 steers and deployments 3 and 4 the same 30 steers. During a deployment each steer wore a neck collar containing a GPS device collecting GPS fixes at 1 Hz. The results showed that the cattle used the riparian area less when provided off-stream and tended to concentrate in a relatively small area of the paddock. This concentration of cattle activity needs to be investigated further to determine the effect on pasture cover and utilisation across the paddock, including those areas the cattle chose to occupy more. Work is ongoing using automated control devices in conjunction with off-stream watering points to determine if cattle activity can be eliminated in riparian areas without the need to fence.

Key words: *pasture, grazing, environmentally sensitive areas, fix rate, automated animal control*

CATTLE DON'T NECESSARILY PREFER TO GRAZE IN RIPARIAN ZONES

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Under extensive grazing, cattle exercise choice in where they graze and the pasture species they prefer to graze. Often, these choices are influenced by physical drivers in the landscape, such as slope, tree cover and proximity to water and supplements. However, the relative importance of these drivers under different grazing situations is poorly understood. This makes it difficult to manage cattle for optimum economic and environmental benefits. To better understand animal movement behaviour, 12 out of approximately 500 breeder cows were fitted with GPS tracking units while grazing two 500 ha paddocks in central Queensland. Collars were fitted for 4 week periods in the late dry season (September), soon after calving in the wet season (January), just prior to weaning (March) and again during the early dry season (July). During GPS collar deployments, visual observations were also made to ascertain what behaviour (grazing, walking or resting) was being exhibited during daylight hours. An assessment of pasture availability was made, to coincide with the GPS observations, along two transects per paddock using the Botanal method (Tohill *et al.*, 1992). Activity (distance travelled between GPS positions in m/hr) exhibited a marked diurnal pattern with periods of high activity (<200 m/h) in the morning and late afternoon. Observations confirmed that this activity was related to grazing behaviour. There was little activity overnight and a brief nadir around midday, corresponding with peak ambient temperatures. Riparian areas (within 50 m of a hydrological feature (ephemeral or permanent open water, river or creek)) accounted for approximately 60% of the land area in both paddocks but only 40 to 50% of animal positions. This indicated that under relatively good pasture conditions (1800 to 2300 kg dry matter/ha), cattle did not preferentially enter riparian areas. The data suggest that cattle preference for riparian areas is dependent upon overall biomass availability.

Key words: *Grazing, riparian, cattle, GPS, behaviour, pasture*

TARGETING CATTLE GRAZING WITHOUT FENCING USING LOW-STRESS HERDING AND SUPPLEMENT PLACEMENT

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Livestock distribution is usually uneven with some areas, such as riparian zones, receiving heavy use, while other areas, including locations that are far from water or containing decadent vegetation, receive little grazing. The objective of this presentation is to examine efficacy of strategic placement of low-moisture blocks (LMB) and low-stress herding to manipulate cattle grazing distribution to protect riparian areas and improve wildlife habitat. In Montana, a replicated study evaluated 3 treatments: 1) free-roaming control, 2) herding from perennial streams to upland target areas, and 3) herding to upland sites with low-moisture block supplements. Herding (23 ± 2 cm) resulted in greater ($P = 0.07$) stubble heights in riparian areas compared to the control (15 ± 3 cm). Correspondingly, herding reduced the time cows spent within 100 m of perennial streams ($P = 0.01$) Forage utilization within 600 m of supplement sites was greater ($P = 0.06$) when cows were herded to low-moisture blocks (18 ± 6 %) compared to controls and herding alone (8 ± 2 %). In New Mexico, a study was conducted to determine if prescription cattle grazing could be used to improve pronghorn habitat without fencing. Two herding regimes (herd daily or herd once per week) were designed to 87 cows to 20-ha target areas containing LMB. Daily herding was more successful than herding once per week ($P = 0.05$) in holding cattle within the target areas. Distribution of pronghorn antelope was influenced by target areas ($P < 0.001$). Pronghorn were closer to target areas than expected by chance ($P < 0.01$). Moving cattle to uplands at midday using low-stress herding is an effective tool to reduce use of riparian areas. Herding cattle to LMB can increase grazing of nearby upland forage but may not provide additional reduction in cattle use of riparian areas compared to herding alone. When forage is dormant, herding combined strategic placement of LMB can sufficiently focus cattle grazing in areas with decadent vegetation so that wildlife habitat can be improved.

GENETIC AND ENVIRONMENTAL DETERMINANTS OF CATTLE GRAZING DISTRIBUTION PATTERNS

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Livestock grazing distribution is a critical component of rangeland management. Cattle tend to concentrate near water and avoid steep slopes and areas far from water. Previous research conducted in Montana suggested that selection has the potential to improve cattle distribution. The relative contribution of genetics and environment is a critical factor for developing management practices to improve grazing distribution through selection. Cattle grazing patterns appear to be at least partially affected by genetic factors. Several studies have shown differences in grazing patterns among breeds. Daughters from sires varied in their use of mountainous pastures in Montana, which also suggests that terrain use may be inherited. In the Chihuahuan Desert of New Mexico, an ongoing study compared grazing patterns of mature Brahman, Angus and Brangus (3/8 Brahman and 5/8 Angus) cows. Average distance from water of tracked cows was similar among breeds during the winter ($P = 0.75$) and early summer ($P = 0.83$). However, there were consistent differences in the areas used by the three breed groups. In another study, grazing patterns of mature Brangus cows with different experiences were compared. Cows originating from a subtropical environment (naïve) were brought to the Chihuahuan Desert and evaluated against native cows that were moved to subtropical environment (native-moved) during the preceding 3 years and cows that remained in the desert (native). These cows never grazed in the 3 experimental pastures before the study, but native and native-moved cows had grazed in adjacent pastures. Native cows (1629 ± 191 m) tended to be farther ($P = 0.09$) from water than naïve cows (788 ± 191 m). During winter, native ($6.6 \pm 0.3\%$) and native-moved ($7.7 \pm 0.3\%$) cows selected a diet with greater ($P < 0.05$) crude protein content (CP) than naïve cows ($4.5 \pm 0.3\%$). In contrast, naïve cows had higher ($P < 0.05$) diet CP than native cows in summer, whereas native-moved cows were intermediate. Native Brangus cows that had been moved to a subtropical environment for 3 years behaved similar to cows that remained in the desert; however, naïve Brangus cows from a subtropical environment spent more time near water and appeared to have less ability to select higher quality diets during drought conditions in the Chihuahuan Desert. Both genotype and learning appear to affect cattle grazing patterns on extensive and rugged rangeland pastures, and there is potential that some epigenetic factors could influence this trait.

USING NUTRITIVE VALUES OF RANGELAND SPECIES TO ENHANCE BEST PRACTICE GRAZING MANAGEMENT

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The nutritive value of pastoral plant species is currently under investigation in order to gain a better understanding of the best practice management of grazed rangeland pastures. Pastoralists from “Billa Kalina”, “Dulkaninna”, “Muloorina” and “Farina” stations located within the Outback Lakes region of South Australia, have collected samples of 16 plant species regularly over a two year period. Blood samples from sheep and cattle were taken to compare plant and animal mineral levels. While most blood mineral parameters analysed correlated well with plant nutritive values, blood phosphorus levels were unexpectedly high in relation to the plant phosphorus levels analysed, indicating that animals were likely to be accessing phosphorus from an alternate source(s). The nutritive value of grass species was found to decline with plant maturity. Decreasing nutritive value of grass species was also associated with a decline in grazing preference. The preferentially grazed species sampled to date appear to meet sheep and cattle requirements for maintenance and early pregnancy, however they do not meet the higher nutrient requirements for late pregnancy, lactation and weaner growth. It is becoming clear that indicator species such as *Trigonella suavissima*, *Cullen australasicum* and *Cullen cinereum* may provide a guide to the allocation of grazing stock to areas that most appropriately meet livestock requirements, and as an indicator for supplementation requirements or destocking. Further sampling over the next 6 months should help to determine changes in plant nutritive value attributed to stage of maturity, soil type and seasonal conditions.

Key words: *sustainable grazing management, metabolisable energy, crude protein, Outback Lakes*

GRAZING SYSTEMS AND SPATIAL UNIFORMITY

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A four-year, producer-inspired research project, jointly-funded by Queensland DPIF, CSIRO and MLA, is investigating different grazing systems across the northern beef industry. Nine commercial beef properties, each with two or three planned grazing systems (continuous, rotational, cell), were selected covering heavy (higher fertility) and light soils (lower fertility) in northern and southern Queensland. From three to eleven paddocks were selected on each property for soil and pasture measurements. A combined Botanal and LFA recording system based on quadrats located on a set sampling grid was used to assess pasture condition following the growing season in 2006 and 2007. Differences in pasture yield, pasture utilisation and ground cover across paddocks are investigated to assess if spatial uniformity of grazing changes between grazing systems. Preliminary results using the method of spatial analysis by distance indices are presented as an example of a possible approach.

SCALING UP FROM *ECOGRAZE* – THE VIRGINIA PARK EXPERIENCE

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The Ecograzing study explored pasture responses to a range of utilisation, spelling and burning treatments, using small paddocks on three land types in both good and fair-poor condition in the upper Burdekin region of North Queensland. This eight year study produced a set of sustainable grazing management principles advocating reduced utilisation rates and systematic wet season spelling to recover and maintain good pasture condition. These Ecograzing principles, always intended as broad guidelines, have since been widely applied at commercial scale with variable success over recent years.

A recent MLA funded study applied Ecograzing derived sustainable grazing strategies on commercial paddocks at Virginia Park station, Mingela, north Queensland and assessed the pasture, land condition and hydrological responses over a four year period between 2002 and 2006. This paper compares the pasture and land condition outcomes of the Virginia Park study with the earlier Ecograzing study (conducted on similar land type over similar rainfall years) and examines the impact of factors such as scale, starting land condition, seasonal conditions and land type variability on the Virginia Park outcomes.

Though Virginia Park paddocks started in poorer condition, both study sites showed similar biomass recovery trends over the first four years. However 3P grass recovery (from a low starting base) has been slower at Virginia Park and recovery patchier, in part due to increased land type and topographic variability associated with scaling up to commercial size paddocks. This provides a significant challenge for developing practical guidelines to manage recovery at paddock and property scale – a challenge which the recently release *Managing Recovery* information package, has attempted to address.

Key words: *Ecograzing, sustainable grazing, scale, patchiness, 3P grasses, recovery*

MANAGING PERENNIAL GRASS PASTURES AND SOIL MACROINVERTEBRATES TO MAINTAIN SOIL HEALTH AND PASTURE PRODUCTIVITY IN GRAZED TROPICAL SAVANNAS

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While the importance of protecting the soil in grazed systems has long been recognised, grazing management has traditionally been focussed on the herbaceous plants in a pasture and scant attention has been paid to the soil. There has been an acceptance that management that maintains the pasture is adequate to maintain soil condition. However, recent research has provided a better understanding of the role of soil macroinvertebrates such as termites and earthworms in maintaining vital soil processes such as infiltration and nutrient cycling, and the potential effects of grazing on these processes. This understanding prompts questions about the interactions and relative role of perennial plants and soil macroinvertebrates in maintaining ecological function, and what grazing management practices are needed to optimise pastures, soil health and livestock production. In this paper we discuss the role and interaction of perennial grasses and soil macroinvertebrates in maintaining ecological function, the relative impacts of grazing on both elements of the system, and the factors that might alter grazing impacts on soil health and pastures. We consider these issues in the context of management requirements for (a) maintaining productive pastures under grazing and (b) restoration of degraded pastures.

Key words: *grazing, grasslands, above-ground processes, below-ground processes*

SUSTAINABLE GRAZING MANAGEMENT – A BALANCING ACT

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Animal production in the arid lands of the Pilbara is limited more by the lower carrying capacity of much of the country and limited cattle control than the low nutritional value of the feed on offer. In the interest of improving pasture, land condition and cattle management some forward thinking pastoralists are implementing alternate grazing management techniques.

Continuous grazing at low stock density over large areas has resulted in selective grazing of more desirable species and an increase in undesirable grasses in some areas of the Pilbara. Cattle on these large properties are usually mustered once a year resulting in limited opportunity to implement cattle management practices to improve herd productivity.

Grazing pressure in these continuous systems is difficult to control. Watering points are used to disperse grazing throughout large areas although this does not overcome the natural behaviour of animals to selectively graze the 'sweeter grasses'.

Rotational grazing systems have been implemented in the Pilbara to increase the desirable plants that are being grazed. Spelling paddocks allows for the pasture to build up root reserves, produce new leaf matter and replenishes seed banks in the soil. The growth of pastures in spelled areas can occur up to months after good rain on some soil types due to stored soil moisture.

The increase of infrastructure, primarily fencing and changes to waters allows for improved cattle control and the opportunity to improve herd management and animal productivity. While one pastoralist has included their whole breeder herds in an intensive grazing system, others are utilising the controlled areas for specific groups of cattle e.g. heifers and young breeders.

Information and pastoralists experience will be presented on one intensive time control or cell grazing system and paddock rotation systems in operation in the Pilbara. Information presented will include observations of pasture changes, cattle management and productivity changes as well as economic aspects of these of these more intensive grazing systems in the Pilbara environment.

Key words: *Grazing management; land management; cattle management; grazing systems, Pilbara*

GRAZING LAND IN “A” CONDITION IS STABLE AND RESILIENT

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The stability and resilience of grazing land in “A” condition was demonstrated in a central Queensland grazing trial where landscape stability was potentially compromised when short term grazing pressure was too high for long term sustainable use (Silcock *et. al.* 2005). The pasture at the site was characterised by a predominance of the 3P (palatable, perennial, productive) grasses Desert bluegrass (*Bothriochloa ewartiana*), Black speargrass (*Heteropogon contortus*) and Golden beardgrass (*Chrysopogon fallax*). These grasses are the mainstay for animal productivity and sustainable long term grazing. The density of these grasses was maintained through seven years of mostly high annual utilisation levels with associated high grazing pressure. Increasing landscape instability was expressed through increasing runoff and soil movement, decreasing ground cover, and reduced perennial grass basal cover and pasture yield. With improving seasonal conditions towards the end of the trial there was an improvement in ground cover, perennial grass basal cover and pasture yield. The maintenance of the 3P grass density was able to generate the recovery. This data demonstrates the benefits of grazing land being in “A” condition when dry seasons occur.

Key words: *Stability, resilience, condition, 3P density, utilisation, basal cover*

IS PASTURE REST TIME OR TIMING?

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Everybody knows pastures have to be rested, however there is no consensus on what this means. Those who prefer to use the term recovery, in preference to the term rest, appear to have a better understanding. They appreciate the issue is actually allowing plants to grow and become healthy, rather than the removal of animals from pastures for a given length of time.

There is increasing agreement that simply a rest at the right time is the basic catalyst to achieve all the desired outcomes of: -

- improving soil structure,
- increasing perennial plant population,
- species change,
- increased plant production and,
- reduced drought impact.

As well as the public good issues including water quality, salinity, and greenhouse mitigation (including methane).

Carbon Grazing, which is four to six weeks of rest after plant growing rain, achieves the following outcomes:-

- 1) Spells all plant species for greater health and increased production;
- 2) Promotes plant regeneration in favourable years;
- 3) Increases soil fertility and it's ability to absorb and hold water;
- 4) Postpones drought;
- 5) Maximises profit; and
- 6) Contributes to reducing greenhouse and all the other environmental issues like water quality, salinity, erosion, biodiversity and acid soils.

Carbon management has always been important, but with climate change, it is going to be even more important. It is increased carbon that provides the landscape with increased resilience. It is ironic that climate change is going to make us focus on what we always needed to do to run a successful rural operation, "manage carbon better".

Carbon Grazing[®] is the unification of all the carbon processes. Therefore the only logical conclusion is that the time to prepare for drought and a more sustainable world is the period immediately after rainfall. This is why pasture rest is TIMING not TIME."

Key words: *Carbon, Carbon Grazing, pasture rest, carbon management, greenhouse mitigation, methane, drought, profit, climate change, timing not time.*

STRATEGIC MANAGEMENT OF WATER INFLUENCES GRAZING DISTRIBUTION AND PASTURE UTILISATION IN SUBTROPICAL SAVANNAS

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Installation of multiple water points in extensive paddocks (>1000 ha) such as those typical of the Barkly Tablelands intuitively suggests that cattle grazing in them will be more evenly distributed and that piospheres would be less likely to develop. However, cattle may show a preference for a particular water source, even though more may be available, which results in over-grazing close to the source and under-utilisation further away. In a preliminary study conducted in paddocks of Mitchell (*Astrebla* spp.) and Flinders (*Iseilema* spp.) grass pastures water availability was managed sequentially at different locations. Geographic information system data was collected and GPS devices were used to track 16 cattle (Senepol x Charolais x Santa) for two, eight-week deployments in two paddocks of 280 km² and 253 km². In the first paddock three water points operated at all times. In the second paddock, which had 7 water points, approximately 9 km apart, each source operated sequentially for 6 weeks and animals were accustomed to move between water points. Positional data were collected at 15 min intervals from ≥ 4 satellites during each deployment. Maximum convex polygons (95% MCP) and distances travelled were obtained using ArcGISTM. Initial results from the first deployment in September/October 2007 have suggested that the cattle used 14 ± 1.6 % of similar-sized paddocks when one water point was available, compared to 11 ± 2.4 % when water was available from all sources. Strategic management of multiple water points is required to achieve more uniform and sustainable grazing, resulting in better use of pastures in rangelands characteristic of the northern beef industry. Positional data, collected in the second deployment, will be used to further spatially and temporally quantify the effect of sequential access to water on the grazing distribution of cattle and their utilisation of pastures in rangelands typical of northern Australia.

Key words: *Rangeland, GPS, grazing, sustainability, beef cattle, piosphere*

MANAGING RUNOFF FROM GRAZING LANDS

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Studies have shown that gully and stream bank erosion contribute much of the sediment exported from grazing lands. These processes are driven by the amount of runoff leaving hillslopes and there is a correlation between poor land condition and high amounts of runoff. Improvements in pasture condition can be achieved through changes in land management over several years, however the time it takes to reduce hillslope runoff is less well documented. The quantity of runoff leaving two adjacent hillslopes on grazing lands near Mingela, Australia was monitored for 7 years. Both hillslopes were grazed for the first two years and then cattle were removed from one hillslope for the following five years. The grazed hillslope exported three times as much runoff as the ungrazed hillslope over the seven year period. Interestingly, the annual runoff coefficients and the ratio of discharge between the two treatments was the same at the beginning of monitoring as at the end. This suggests that there has been insufficient time for hydrological recovery to occur five years after the complete removal of grazing. The results also suggest a hysteresis in the recovery of the soils capacity to infiltrate rainfall following changes in grazing management.

SOME ECONOMIC AND ECOLOGICAL ASPECTS OF A LONG-TERM VARIABLE GRAZING REGIME IN THE BRIGALOW BIOREGION

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Resource managers require a range of financial and ecological information to evaluate rangeland pastoral systems, given the competitive pressures for improving productivity and environmental standards. This paper presents a number of economic and ecological performance measures from a long term variable grazing regime that formed part of the Brigalow Catchment Study (BCS). The BCS commenced in 1965 to determine the impact on hydrology and resource condition when native brigalow (*Acacia harpophylla*) is cleared for cropping or grazing. The fenced grazing area of 17 ha was sown to buffel grass (*Cenchrus ciliaris* cv. Biloela) in November 1982 and grazing commenced in December 1983. Stocking rates were adjusted to maintain a residual biomass of at least 1 t/ha of total standing dry matter, which resulted in high associated ground cover in excess of 80%. The pasture composition remained relatively stable with a dominance of buffel grass as a desirable perennial species. Discounted cash flow analysis was used to evaluate the development and adoption of the grazing regime based on a typical 200 ha paddock. The net present value (NPV) of the investment was calculated over a 22 year period, assuming a discount rate of 6%. Gross margins were incorporated using live weight turn-off and changes in stock inventory in conjunction with saleyard prices and variable costs. The mean annual gross margin over the period was \$70/ha (SD±72), with 50% of annual returns above \$48/ha. The NPV of the project, excluding the opportunity cost of land, was \$516/ha. When indicative costs for undeveloped land of \$600/ha and \$800/ha were included the NPV was negative. However, the internal rate of return for these land cost scenarios was 4.7% and 2.3% respectively. The combined use of economic and ecological performance information can assist in the evaluation of grazing management for a range of objectives and related trade-offs between financial and environmental outcomes.

Key words: *Brigalow bioregion; variable grazing regime; economic performance; ecological indicators; long term study.*

WET SEASON SPELLING - SOME ECONOMIC INSIGHTS FROM HERD MODELLING

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Degradation of pastures and declining land condition, particularly in response to overgrazing, is a significant and long-recognised problem across large tracts of the sub-tropical and tropical rangelands. Wet season spelling, particularly when systematically applied, has demonstrated considerable promise for restoring degraded pastures and their potential to support higher levels of animal production. For example, an MLA-supported grazing study conducted at Virginia Park (Charters Towers) has demonstrated that degraded pastures (e.g. land condition C) can be restored back towards better land condition (e.g. land condition B) with the strategic application of whole of wet season spelling, particularly when paddocks are initially rested for two consecutive wet seasons.

While the potential for improved animal productivity has been demonstrated by such studies, the economic value of the wet season spelling option has received only limited formal attention. We apply insights from the Virginia Park study to a beef herd economic model to determine the scope for wet season spelling to provide economic benefits to northern enterprises. The analysis is based on a hypothetical 28,000ha enterprise in the Charters Towers region, with 50% of pastures in C/C+ condition adopting a restoration strategy for the whole property utilising a 3 paddock and 1 spare rotation system with two consecutive wet season spells and a follow up spell in the fourth year. Projected economic outcomes per animal and per treated hectare based on 20 year cash flow and gross margin analyses are positive, even at relatively high discount rates. Some implications for wet season spelling management are also discussed.

Key words: *land condition, wet season spelling, economics.*

RETROSPECTIVE ANALYSIS: RAPID APPRAISAL OF SATELLITE DERIVED COVER INDICES

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Satellite imagery has provided an invaluable tool for assessing rangeland ground cover and condition. However, there is still significant variability in both the performance and availability of indices across different jurisdictions, bioregions, and land types. In the absence of a true universal index of ground cover or condition, there is a clear need for tools that validate indices as they are rolled out in new locations and circumstances.

Ideally, such indices are compared to ground measurements taken over a range of sites and years, at times coincident with satellite image capture. The cover index and ground cover measurements are then correlated to assess the capacity of the cover index to predict ground conditions. Whilst robust, the obvious difficulty of ground testing is the time it can take to determine whether the cover index works, particularly if tested over more than one year.

We trialled an alternative set of approaches to validating satellite cover indices that provide almost immediate feedback on the performance of a cover index. We call these approaches retrospective analysis, since they collate the historical records and observations of land managers regarding locations where noticeable variance in the temporal and spatial distribution of ground cover has occurred. These records are then compared to already existing index data to assess index validity.

This methodology is less robust than validations based long term ground site sampling, and we suggest retrospective analysis primarily as an adjunct to that method. However, it still provides a useful, more economical and much quicker first look at the performance of any ground cover index. Additionally it acts as a useful tool for engaging land managers in the technology, since many better appreciate the qualitative results of retrospective analysis compared to the more quantitative results of rigid site sampling.

Key words: *cover index, validation, retrospective analysis, satellite*

MONITORING LAND CONDITION IN SEMI-ARID AND ARID RANGELANDS OF THE NORTHERN TERRITORY USING MODIS IMAGERY.

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Historically, monitoring in rangeland environments is difficult and expensive due to their remote nature; however monitoring is essential for detecting and reporting change in land condition. Australian and international studies have determined that vegetation cover in arid rangelands can be used as an indicator of rangeland condition, and this can be applied to both on-ground monitoring and remotely sensed data collection.

This paper is part of a larger land condition monitoring project operating across the Northern Territory, and the methodology here describes remotely monitoring change in land condition across the semi-arid and arid southern regions of the Northern Territory. Low resolution 16-day composite MODIS satellite images from July 2000 to December 2007 are used to gather information for use in time-series analysis. Here the red band is used as a surrogate for vegetation cover.

Time-series data and cover images at various spatial scales are extracted for statistical analysis and comparison. Additional information such as rainfall, drought index and fire patterns are also incorporated to provide further temporal components to the analysis. The method developed is to form part a program that conducts yearly analysis for significant changes in vegetation cover.

Key words: *Remote sensing, rangeland, MODIS, red band, land condition.*

STUDY OF *MAIREANA PYRAMIDATA* AS AN INCREASER SPECIES IN GAWLER RANGES, SOUTH AUSTRALIA, USING PERMANENT VEGETATION MONITORING POINTS.

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Increaser species are useful indicators of rangeland condition. *Maireana pyramidata* (blackbush), as an increaser species may, in areas of high grazing pressure, eventually dominate due to a reduction in competition from palatable species. These areas usually occur near watering points on pastoral stations. Blackbush is a common perennial chenopod shrub of the Gawler Ranges pastoral district, South Australia. It can occur both in low densities with other shrubland or woodland species and as the dominant species on floodplains and watercourses. While considered relatively unpalatable to stock, it is often grazed during dry times when more palatable plants are not available.

During the second round of pastoral lease assessments, required under the *Pastoral Land Management and Conservation Act, 1989*, permanent vegetation monitoring points (photopoints) have been revisited. These sites are established out from watering points, within the grazing range of sheep. Through belt transect results, this paper illustrates how blackbush populations have changed over the last 15 years in the Gawler Ranges.

This paper studies 134 sites, assessed under the second round of assessments, located on 13 pastoral properties in the Gawler Ranges and all of which have blackbush present. Analysis of this data identifies a number of emerging trends. Sites where low bluebush (*Maireana astrotricha*) and pearl bluebush (*Maireana sedifolia*) is increasing, are often also experiencing an increase in blackbush. At sites where blackbush was not initially present only small numbers of individual plants have colonised 15 years later. At sites where blackbush has increased there has often been a reduction in palatable decreaser species such as bladder saltbush (*Atriplex vesicaria*). Improved densities of decreaser species can at some sites be explained by recent rainfall events and not necessarily a reduction in total grazing pressure. While this data is valid, better results will come from repeated visits over a longer period.

Key words: *blackbush, increaser species, monitoring, Gawler Ranges.*

STRATEGIC GRAZING FOR THE CONTROL OF THE INVASIVE WETLAND WEED LIPPIA (*PHYLA CANESCENS*)

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Lippia (Phyla canescens) is an invasive weed from South America that is now widespread throughout the Murray-Darling Basin. *Lippia* has invaded internationally significant wetlands often forming a dense ground-layer that excludes co-occurring native species and threatens the integrity of these wetlands. *Lippia* is unpalatable to grazing stock and in areas where invasion has occurred the loss of productive land causes managers to destock (55 - 100%). Traditional weed control measures including herbicides and mechanical means, are often impractical and unsuitable, particularly in environmentally sensitive areas and alternative measures need to be devised. *Lippia* is primarily dispersed by flood waters and establishment is enhanced by areas of bare ground. The grazing regime is generally continuous/set-stocked in these wetlands. We are using strategic grazing to manipulate species composition in order to select for desirable perennial species. In particular, we addressed whether providing periods of rest from grazing permits native species to establish and out compete *lippia* in different hydrological zones. Small enclosure cages (2 m x 2 m) were used on a fixed and rotational basis to preclude grazing stock, thereby providing a rest period at different stages of the year. Preliminary results suggest that maintaining native cover is an effective means of *lippia* control. Strategic grazing may provide a useful tool for managing weed invasions in areas managed for both conservation and production purposes.

Key words: *competition; floodplains; invasability; seasonal rest; weed control; grazing management*

Session 3

Biodiversity management and conservation in rangelands

DEVELOPING A RESEARCH AGENDA FOR THE DISTRIBUTION AND RATE OF SPREAD OF BUFFEL GRASS AND IDENTIFICATION OF LANDSCAPES AND BIODIVERSITY ASSETS AT MOST RISK FROM INVASION

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In 2007, the Biodiversity Working Group of the Australian Collaborative Rangelands Information System nominated buffel grass (*Cenchrus ciliaris*) as a transformer weed of Australian rangelands with potentially serious implications for biodiversity. As a step towards tackling the lack of biodiversity-related information about the grass, the federal Department of the Environment, Water, Heritage and the Arts funded a workshop to develop a research agenda addressing distribution and rate of spread of buffel grass, and identification of landscapes and biodiversity assets at most risk from invasion.

The workshop report provided a summary of existing knowledge, a prioritisation according to the importance for conservation management and the feasibility of research, a proposed research agenda and potential collaborating organisations. Priority research activities included:

- Develop a national GIS of buffel grass distributions consistent with that sponsored by the National Land and Water Resources Audit for invasive weeds.
- Conduct an expert workshop to determine the most appropriate approach to modelling buffel grass distribution and spread at a range of spatial scales.
- Develop and validate regional (sub-IBRA) models of buffel grass distribution and high biodiversity value areas, in one case study region where regional data availability is good. Combine the models to predict high risk areas.
- Research functional understanding to improve management e.g. Are there thresholds for cover levels of native vegetation which limit spread of buffel grass? Can we predict the distribution of buffel grass under climate change scenarios in case study areas?
- Develop an on-line bibliography for buffel grass (and potentially other transformer weeds) as part of research activities, and host it on the ACRIS website.

This poster paper will briefly describe the background to the workshop, provide some detail on the proposed research agenda and report more recent progress towards implementation.

Key words: *Buffel grass, spread, distribution, risk, biodiversity value*

CONTINUUMS OF FUNCTIONALITY OF AUSTRALIAN SAVANNA LANDSCAPES: ASSESSING CHANGES OVER TIME WITH REMOTE SENSING

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Unlike Australia's temperate ecosystems, the tropical savanna landscapes are in relatively unmodified condition. Disturbances such as fire, thinning and grazing occur within these landscapes increasing landscape heterogeneity but rarely resulting in well-defined patch boundaries. Traditional models for analysis of heterogeneity in landscape structure have depicted landscapes as static arrays of vegetation patches with discrete boundaries between habitat and matrix patches. However, many rangeland and savanna landscapes with gradual spatial and temporal variation in structure do not fit this model. Here we quantitatively test models of continuous variation in landscape structure in Desert Upland savannas to obtain measures of change in ecosystem function across gradients for biodiversity. Using a time series of Landsat imagery, habitat elements are mapped and spatial filtering allows for the creation of continuous surfaces of those habitat elements. Generalised linear modelling and information theoretic approaches are used to describe the relative importance of continuous metrics derived from those surfaces for the diversity, presence and abundance of a variety of fauna. Our results show that there is much variation in the response of individual species to the spatial and temporal variation in amount and configuration of different habitat elements. The results demonstrate the need for managers to take into account the different habitat requirements of a variety of species, instead of assuming a generic response to landscape structure covering multiple species. The ability to quantitatively measure continuums in habitat structure is of particular relevance since savanna landscapes rarely exhibit distinct boundaries between vegetation cover types, nor are the fauna limited to one vegetation type. The approach is of use to land managers and policy makers in savanna landscapes where land management practices suited to the vegetation structure will enable continued provision of both agricultural and biodiversity services, particularly in the face of a changing climate.

Key words: *continuums, remote sensing, savannas, Desert Uplands, time-series*

CYANOBACTERIA WELL ADAPTED TO RESPOND TO DROUGHT AND CLIMATE CHANGE

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Cyanobacteria-dominated soil crusts are a significant component of Australian arid and semi-arid landscapes. Morphogenetic adaptation has enabled cyanobacteria to respond to both short and long term changes within their environment. During drought, at our study site in south-western QLD, we found cyanobacterial soil crusts were associated with landscape stability and nutrient inputs. Cyanobacteria thrive on intermittent ‘nuisance’ rain and have the capacity to withstand inundation by sand, excessive temperatures and long periods of desiccation. They respond to moisture within a few seconds of wetting where respiration commences with as little as 0.5 mm precipitation. Cyanobacterial soil crusts attained positive net photosynthesis at 37°C. Certain species appear to respond differently to the effects of drought. Our data showed that following two years of severe drought four species of cyanobacteria responded well to rain, recovering close to pre-drought levels after the first year. Two other species were much slower to recolonise, taking up to two years to recover. We observed that species like *Microcoleus* and *Schizothrix* had high motility, travelling 10-20 mm to the surface in response to light and moisture. In contrast, *Stigonema*, *Scytonema* and *Porphyrosiphon* were surface dwellers with strong pigmentation in their outer sheaths providing good UV protection. At the study site, *Microcoleus* and *Phormidium* were found only in regions adjacent to a degraded (closed) bore drain. *Nostoc commune* was not apparent during dry periods however, after significant rain large colonies covered the existing cyanobacterial crust in the low-lying areas alongside the bore drain. We concluded that changes in species composition of cyanobacterial soil crusts over time may be important indicators of changes in soil nutrient gradients and rainfall patterns. Further detailed research of desiccation tolerances of individual species of cyanobacteria on a widespread basis across Australia is central to their potential use as bio-indicators.

Key words: *Cyanobacteria, cyanobacterial soil crusts, biological soil crusts, drought, soil nutrients, bio-indicators.*

THE CONSERVATION OF WIDELY DISTRIBUTED SPECIES: IMPLICATIONS OF DIFFERENCES BETWEEN WESTERN AND EASTERN KOALA POPULATIONS

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The species-habitat relationships and population dynamics of koalas in semi-arid regions of western Queensland/NSW are poorly understood in comparison with those of eastern koalas. Habitat loss/fragmentation, droughts, heatwaves and climate change may threaten their long-term viability. The project aims to identify the: (1) relationships between the amount and spatial configuration of habitat and koala distribution and viability; (2) impact of landscape history; and (3) likely impact of climate change/variability. A nested hierarchical approach will address the following objectives: (1) Determine actual and potential koala distributions, using community surveys to provide a snapshot of current koala distributions and modelling habitat suitability, using bioclimatic, environmental and ecological factors, to define the western boundary of koalas. (2) Assess population dynamics including the role of habitat loss/fragmentation, and landscape history in determining current koala distribution. Population density and habitat use will be established using faecal pellet surveys and the role of landscape attributes, including historical changes in land use/cover, will be quantified using empirical statistical models. (3) Assess the viability of koala populations in response to landscape change using satellite tracking to assess habitat use and physiological stress/physical condition to populate mechanistic space state models. (4) Assess the impact of climate change and the interaction with landscape change, using bioclimatic modelling to predict future koala distribution. (5) Integrate the outcomes from Objectives 1-4 to produce a koala management plan and guidelines for use by regional natural resource management bodies, to help identify how local landholders can help maintain viable koala populations in western Queensland/NSW. (6) Compare western koala population dynamics and threats with those of eastern koala studies. This research project will contribute to understanding of the long-term viability of koala populations in semi-arid Queensland/NSW, and will highlight issues involving the conservation of widely distributed species in a changing world.

**SEED PRODUCTION CHARACTERISTICS OF *DICHANTHIUM SERICEUM*,
HETEROPOGON CONTORTUS AND *THEMEDA TRIANDRA* ECOTYPES UNDER
INTENSIVE MANAGEMENT SYSTEMS IN NORTH QUEENSLAND.**

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Demand for seed of certain native grasses in Queensland is not being satisfied from wild-harvested product as that seed is often of poor quality, expensive and of inconsistent supply. The use of sown seed crops of other native grasses in southern Australia has resulted in the reliable supply of high quality seed of certain native grasses in recent years, but is yet to be widely appraised in northern Australia. Here, we report preliminary findings on the seed production performance, under north Queensland seed production conditions, of *Dichanthium sericeum*, *Heteropogon contortus* and *Themeda triandra* ecotypes collected between northern New South Wales and north Queensland. These were grown in small-plots at two sites over two years using local commercial seed production strategies. Three production cycles were completed over 18 months, with sequential harvests during June-August 2006 (following establishment), January-March 2007 and July-December 2007. There was substantial variation in flowering capacity and flowering time between the 8 *T. triandra* ecotypes, but little variation between the *D. sericeum* (7) and *H. contortus* (9) ecotypes. Seed production capacity of *H. contortus* was affected by susceptibility to leaf rust and seedhead ergot which varied between ecotypes. Seedhead ergot also affected some *D. sericeum* ecotypes. Commercially acceptable yields of intact, mature caryopses per unit area were achieved for those *D. sericeum* and *H. contortus* ecotypes not substantially limited by diseases. Although the amount of harvested seed material of *T. triandra* ecotypes was often higher than that of the other two grasses, low numbers of mature, intact caryopses per unit weight of the harvested material indicates that commercial seed production of *T. triandra* will be more marginal under local conditions.

Key words: *Native grasses, seed production, north Queensland*

SIMPLISTIC RULES FOR SOURCING 'LOCAL' PROVENANCE SEED IN REVEGETATION IGNORE COMPLEX ECOLOGICAL PROCESSES OF ADAPTATION

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The role of intra-specific diversity in maintaining species diversity and plant community is not well understood however has significant implications for rangeland restoration because intraspecific genetic variation may reflect different scales of adaptation. Variation in quantitative traits among 28 wild populations of *Austrodanthonia bipartita*, *A. caespitosa*, *A. eriantha*, *A. fulva* and *A. setacea* collected within central western New South Wales was examined using common-garden studies. Population effects were highly significant ($P < 0.001$) for all characteristics (total biomass, culm length, leaf length, leaf width, flowering time and number of flowers) suggesting local adaptation. A strong relationship between quantitative traits of *A. caespitosa* and both large-scale (spring rainfall and sunshine hours) and small-scale (shading effect and edaphic soil characteristics) and environmental variables strengthens this observation. Flow cytometry analysis confirmed the existence of polyploidy in most populations of all five *Austrodanthonia* species, however, no common ecological factors (small- or large-scale) clearly distinguished different cytotypes suggesting intra- or inter-specific hybridization. This is supported by evidence of intermediate cytotypes and overlapping flowering times may provide a possible mechanism to facilitate out-crossing. Molecular based markers (AFLP) were used to define the structure and quantify the amount of genomic variation in *A. caespitosa* and revealed low ($F_{st} = 0.16$) levels of differentiation between populations suggesting some geneflow between populations. It appears that *Austrodanthonia caespitosa* co-exists with a number of closely related species which may interact to provide both historic and contemporary broad-scale gene flow. This then provides a breadth of genetic variation that is subsequently selected for by the wide range of environment occupied by this species. Possible pathways in the evolutionary architecture of *A. caespitosa* are discussed. It is concluded that for this widespread native grass it may be over-simplistic to suggest local seed sources are always ideal for revegetation.

Key words: *native grasses, ecotypes, local provenance, adaptive diversity*

PIMELEA POISONING – THE PLANT ENIGMAS

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Pimelea poisoning of cattle has challenged scientists for decades. Most early research was done by animal health specialists and they made critical breakthroughs. Three ephemeral species of *Pimelea* are reported to be the cause. However, most producers are still unable to devise management strategies to adequately respond to the episodic outbreak of poisonings which seem poorly correlated with abundance of the plant in the paddock.

Renewed research has looked more closely at the 3 chief suspect plants, *P. simplex*, *P. trichostachya* and *P. elongata*. All 3 species contain significant amounts of the main putative toxin, simplexin, and the toxin is found in all parts of the plant. We have discovered that these plants have different microsite preferences for where they will grow and to what rainfall their seed will respond and germinate. The common factor seems to be open, bare or disturbed ground for germination to occur, but not on extensive scalded claypans. Also none establish well in competition with vigorously growing, tall pasture species nor under a significant tree canopy unless soil moisture is abundant.

Each species reacts differently to the post establishment environment. These differences will be documented along with the practical management challenges posed to producers by the multiple but similar looking plants.

Key words: *Pimelea, poisoning, management, simplexin, establishment*

LANDSCAPE LEAKINESS IN THE GRAZED RANGELANDS OF THE BURDEKIN

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Landscape leakiness describes the extent to which landscapes have lost their capacity to regulate rainwater and soil nutrients, the vital resources for plant growth and related livestock production. In the grazed rangelands of the Burdekin catchment, north east Queensland, functional (i.e. non leaky) landscapes maintain a good cover of palatable, perennial and productive (3P) grasses. Less functional (leaky) landscapes are generally dominated by either Indian couch (*Bothriochloa pertusa*) or ephemeral herbage species. While Indian couch provides reasonable ground cover in better seasons, its ability to protect the soil surface and reduce runoff and erosion diminishes in years of lower wet-season rainfall.

CSIRO has developed an index and calculator for monitoring changes in landscape leakiness over time. This index is based on the amount and spatial arrangement of persistent cover (e.g. 3P grasses). It uses a digital elevation model and remotely-sensed measures of vegetation cover as input. A simple calculator indicates the relative leakiness of a defined area (sub-catchment, paddock, sub-catchment within paddock) at each point in time.

Testing with archival Landsat imagery in selected sub-catchments of the Burdekin has shown that landscapes in better condition, that retain relatively high levels of persistent cover through time, had very low levels of indicated leakiness. Sub-catchments in the same general area dominated by Indian couch had much more variable cover and, in turn, indicated leakiness. In particular, leakiness increased dramatically in a run of drier years, such as the mid 1990s.

In this poster paper, we demonstrate typical time traces of indicated leakiness for non leaky and leaky landscapes. We briefly discuss management implications for these landscapes and demonstrate how management options that increase the amount of persistent cover (e.g. wet-season spelling) may decrease landscape leakiness. We also validate leakiness index values for selected areas with available ground data.

Key words: *Burdekin; cover; ground validation; Indian couch; landscape leakiness*

REGIONAL EROSION RISK ASSESSMENT IN AREAS OF SHRUB ENCROACHMENT IN CENTRAL WEST AND WESTERN NSW

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Soil erosion in the rangelands of the Central West and Western Division of New South Wales has been associated with shrub encroachment due to shrubs out-competing herbage and reducing live understorey plant cover. Depending on changes in other groundcover types, this lack of herbage may result in increased runoff and erosion following rainfall events. Although there are current efforts to map soil erosion rates nationally, little research has been undertaken into the link between shrub encroachment and soil erosion at a regional level. A spatially distributed erosion risk model would identify areas at risk of water erosion, help determine the spatial link between erosion and shrub encroachment and prioritise areas for invasive shrub management. In this work, the Revised Universal Soil Loss Equation (RUSLE) was integrated into a GIS to represent the erosion controlling factors and to develop an erosion risk map. The rainfall-runoff (R) factor was computed as a function of daily, monthly, seasonal, and annual rainfall amounts. The soil erodibility (K) factor was mapped using published K values from the Australian Soil Resource Information System. Topographic variables such as length of slope (L factor) and slope steepness (S factor) were estimated by applying stream power theory to a digital elevation model from the Shuttle Radar Topographic Mission. The land cover (C factor) was represented by the Normalised Difference Vegetation Index (NDVI) from SPOT 5 images for a first approximation erosion risk index. However, a more detailed estimation of the C factor in shrub encroachment areas is being developed in order to account for the effect of shrub encroachment on groundcover. The first version of the erosion risk map shows a marked influence of the R factor across the study area and is being validated with ground data collected during a regional survey of biophysical and management variables.

Key words: *Shrub encroachment, soil erosion risk, RUSLE*

AERIALY SURVEYING MESQUITE IN THE PILBARA

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Mesquite (*Prosopis* sp.) is one of 20 Weeds of National Significance, identified for its invasiveness, impacts on the environment, high potential for spread and the socioeconomic impacts within communities it inhabits. The Pilbara region of Western Australia currently has one of four core infestations of mesquite in Australia, of which 30,000 hectares is covered by a moderate to dense monoculture of the invasive weed. Additional scattered populations exist across a further 200,000 hectares of Pilbara pastoral leases.

In 2004, the PMMC recognised the requirement for accurate locations of mesquite to be identified to assist in the implementation of strategic control programs. An innovative aerial survey and mapping technique was developed, with the key ability to accurately detect low to moderate infestations of mesquite across vast areas.

The results of the aerial survey and mapping have assisted the PMMC in developing and implementing infrastructure to delineate heavily infested areas from cleaner counterparts. It has allowed for better management of grazing stock, identified as primary vectors for the spread of mesquite. It has allowed us to implement strategic chemical and mechanical control programs, targeted at populations which are isolated from primary infestations or those which are rapidly transforming into denser monocultures.

In the future, the mapping will allow us to evaluate the successfulness of each control program. We will be able to determine the exact amount of grazing pastures which have been reclaimed from mesquite, and identify new outbreaks of this invasive plant. This technique is readily adaptable to other plant species. It is more highly sensitive and can map at densities far lower than what is realistically possible with remote sensing in the foreseeable future, and is cost-competitive with this technology. It has been a valuable investment which will have long-term benefits for mesquite management and control in the Pilbara.

Key words: *mesquite, aerial survey, mapping, remote sensing*

MAPPING VERY POOR CONDITION GRAZED LANDSCAPES AT A REGIONAL SCALE – A REMOTE SENSING APPROACH

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In recent years there has been a recognition and importance placed on landscape rehabilitation of the Australian landscape. Rehabilitation targets are being set by natural resource management (NRM) bodies across the country, with at least some emphasis being placed on the recovery or reclamation of very poor condition landscapes within each NRM region.

Monitoring and assessment of landscape condition is by no means a new idea, but until recently has been a tool primarily used and understood by scientific and extension communities. More recently however the ABCD framework for land condition assessment has emerged in North Queensland, and has gained wide acceptance at the ground or cattle producer level. Wide acceptance of the framework has led Queensland NRM bodies, particularly in the Great Barrier Reef (GBR) region, to use the framework to set rehabilitation targets. However, the location and area of those landscapes in very poor condition or D-condition was not known.

The Burdekin catchment is the second largest catchment feeding into the GBR lagoon. It covers some 133,432 square km and supports a wide variety of resource based land users including mining, horticulture and agriculture. The cattle industry is the largest land holder in the Burdekin catchment and represents around 96% of total landuse.

Due to the large area of interest and limited access to grazing properties the most efficient way to map poor condition land in the catchment is by using existing remotely sensed data.

Here we present a method for mapping D-condition landscapes at a regional level, in this case within the Burdekin catchment. D-condition land was identified by thresholding Landsat and Spot5 derived cover maps to highlight all of the areas of less than 40% cover. The likelihood land being in, or trending towards D-condition was also calculated by combining a series of remotely sensed and GIS data, and analysing using a Naïve Bayesian Analysis model.

Key words: *Burdekin, Condition, Trend, Grazing, Remote sensing, NRM*

REMOTE WEIGHING AND AUTODRAFTING OF PREGNANT MERINO EWES

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Development of semi automated and remote walk-over-weighing systems for differential management of pregnant Merino ewes to maintain maternal body weight is outlined. Radio frequency eartags were used for automatic tag reading and data capture. The animals were weighed twice weekly using fixed weighing with an autodrafter as well as having access in parallel to voluntary walk-over-weighing. Incorporated was an algorithm for prediction of pregnant ewe maternal body weight (live weight less weight of conceptus and fleece) and determination of auto-draft instructions for targeted feeding of lupins to ewes as required. Ewe maternal body weights derived from the algorithm showed 5.7 kg less decline during pregnancy days 40-120 in precision managed ewes compared with controls. These semi automated and remote walk-over-weighing systems allowed targeted feeding of ewes according to live weight targets. About 80% of the ewes used voluntary walk-over-weighing during days 40-120 of pregnancy indicating potential for a fully automated remote system. Improved precision of ewe live weight data from remote walk-over-weighing is discussed using data from a commercial rangeland enterprise. Variance in repeated ewe live weights was reduced by 91.6% with use of a Weight Matrix which eliminated inaccurate weights. Use of the semi automated fixed weighing and autodrafting are considered forerunners to fully automated remote walk-over-weighing systems which will be useful under rangeland conditions. Such systems will reduce labour and animal stress and will provide valuable animal live weight data for management decisions using the Weight Matrix to improve accuracy.

Key words: *differential ewe management, remote walk-over-weighing, improved accuracy of live weights, pregnant Merino ewes*

UNDERSTANDING HERBIVORE BEHAVIOUR IN RANGELANDS: DEVELOPING MORE ACCURATE RESOURCE SELECTION FUNCTIONS

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Foraging herbivores preferentially select resources; these resources include food, shade and water. The preferential selection leads to uneven use of the landscape. Understanding herbivore selection preferences has important implications for deriving sustainable land management options. A number of techniques have been used to quantify animal selection behaviour including observations, radio tracking and global positioning systems (GPS). By correlating where an animal is in relation to landscape features and deriving selection preferences it is possible to determine resource selection functions. Current monitoring techniques do not provide a complete record of selection behaviour; the assumption is that partial observations of animal activity provide a representative sample, which is then used to derive resource selection functions. Previous work has explored the absolute spatial precision of GPS data. This paper explores the validity of assumptions about deriving relationships from partial observations of animal activity and addresses issues related to temporal accuracy of GPS based animal location data.

Recent technological advances have provided the opportunity to monitor animal activity at a higher temporal resolution than has previously been achieved. Using these high sample rate (4 times per second) GPS data we demonstrate prediction errors for lower sample rate data and relate this to resource selection at the patch scale. The high sample rate data are also used to explore the implications for both absolute and relative spatial precision when using GPS data collected at a variety of sample rates. The high sample rate data are used to construct a simulation model, which is used to predict behavioural state and spatial movement. Finally in light of recent developments for enhanced monitoring of animal selection behaviour we demonstrate how compression algorithms can optimise GPS performance whilst maintaining data integrity.

Key words: *Herbivore, Behaviour, GPS, Spatial, Modelling, Grazing Selection.*

FAECAL NIRS MEASUREMENTS OF DIET QUALITY AND LIVELWEIGHT CHANGE IN STEERS GRAZING A SPEARGRASS PASTURE IN S. QLD

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The diet selected and liveweight (LW) change of 3 age groups of *Bos indicus* cross steers grazing a speargrass pasture (primarily black speargrass, Burnett blue grass and Indian couch) at Brian Pastures Research Station, Gayndah, in the southern speargrass region was measured using faecal near infrared reflectance spectroscopy (F.NIRS) over a 4-year period 2001-2005. The steers were weighed monthly and faecal samples obtained fortnightly. The amounts and distribution of rainfall were generally as expected for the experimental site. The F.NIRS measurements of diet quality did not differ between the 3 age groups. Diet non-grass, consisting of herbaceous dicotyledonous species, averaged 10% (s.d. 5) and there was no discernable seasonal pattern. Diet crude protein (CP) averaged 8.4% (s.d. 2.1) during the summer and 5.8% (s.d. 1.2) during the winter. DM digestibility (DMD) averaged 56% (s.d. 3.3) in the summer and 51% (s.d. 2.6) in the winter. The DMD/CP ratio was generally in the range 8-11 during the mid to late dry season, suggesting that the cattle may have responded to non-protein nitrogen supplement. Annual LW gain was influenced by steer age, with LW gain being highest for the youngest group and least for the oldest group. However, F.NIRS predictions of LW, which satisfactorily predicted LW gain of the youngest group, did not differ between the age groups and thus over-estimated LW gain of the older steers. The capacity of F.NIRS to measure the diet and productivity of grazing cattle was demonstrated.

Key words: *Cattle, grazing, F.NIRS, diet quality, growth.*

A NEW METHODOLOGY FOR THE CALCULATION OF PASTURE UTILISATION FOR GRAZING LANDS

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Pasture utilisation is a term used to describe the estimation of pasture dry matter animal intake expressed as a proportion of available pasture or pasture growth per season. The calculation has been used for purposes of animal production and also to describe grazing pressure on the pasture resource and the flow-on effects to runoff and soil loss.

Pasture biomass, cattle liveweight, pasture digestibility data along with general information from the Wambiana grazing trial at Charters Towers were used to model 'potential' pasture growth, and estimations of animal intake and pasture utilisation. This was done on a paddock-by-paddock basis for each draft of steers to the current end of data available (2006/07).

The GRASP model was used to produce daily pasture simulations from Swiftsynd data collected at the trial, while the QuikIntake spreadsheet model was used to calculate feed intake. Liveweight of steers and pasture dry matter digestibility were converted to daily values from longer time periods using an interpolation function in an MS EXCEL spreadsheet.

The resultant time-series includes accumulated pasture growth and feed intake, pasture digestibility and pasture utilisation. The information presented in the time-series provides a valuable summary of management outcomes and is used to compare differing grazing strategies across land types for both production and sustainability issues.

While this analysis has been based on the simulation of 'potential' pasture growth, it is possible to repeat this exercise with the paddock pasture data to ascertain estimates of 'actual' pasture utilisation across the treatments of a grazing trial. The analysis would involve accounting for any degradation effects on pasture growth. This methodology could be used to analyse historical grazing trials and grazing enterprises in the future.

Key words: *pasture, pasture utilisation, grazing trial, feed intake, QuikIntake, GRASP.*

ABANDONED PASTURE LEGUMES OFFER POTENTIAL ECONOMIC AND ENVIRONMENTAL BENEFITS IN SEMIARID CLAY SOIL RANGELANDS.

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In the 1980's CSIRO and QDPI established a number of pasture legume evaluation trials throughout clay soil regions in Queensland's semiarid tropical rangelands. These sites have long since been abandoned and incorporated into regularly grazed paddocks. Grass quality is often poor in semiarid rangelands. Surviving adapted legumes from these trials would potentially enhance pasture quality, and thus livestock production, in a region where suitable sown legume species are unknown. In addition, legumes also have the potential of enteric methane abatement, reducing greenhouse gas emissions from ruminant livestock in these vast rangelands environs. However, graziers are unlikely to use legumes solely for the environmental benefits of CH₄ mitigation, unless there are positive economic impacts particularly on livestock production. Legume species including *Alysicarpus*, *Arachis*, *Centrosema*, *Chamaecrista*, *Clitoria*, *Desmanthus*, *Macroptilium*, *Stylosanthes* and *Vigna* genotypes were planted in trial sites at Blackall, Barcaldine, Charters Towers, Isisford, Julia Creek, Longreach and Yaraka. Re-examination of the abandoned sites, years later, reveal that only accessions of *Desmanthus* survive.

Desmanthus species are bipinnate legumes, palatable to livestock and tolerant of heavy grazing. They are non toxic, non thorny, have high protein content, are adapted to clay soils, and are drought and frost resistant. These surviving *Desmanthus* genotypes offer exciting new prospects and choices for graziers, with associated potential economic and environmental benefits. This paper focuses on the results of surveys at "Hillgrove Station" Charters Towers where *Desmanthus* was found to be persisting some 25 years after the original trial was sown.

Key words: *legumes, semiarid, rangelands, Desmanthus, clay soils*

BARKLY TABLELANDS SEASONAL BURNING TRIAL – ON THE BLACK SOIL (MITCHELL GRASSLAND) PLAINS

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Understanding the relationship between fire and Mitchell grasslands has somewhat been overlooked in the past due to a historical view that “the Mitchell grasslands are too valuable as a pasture to be burnt....” However, more recent observations by station managers and naturalists of Mitchell grass recovery from wildfires have stimulated curiosity into whether fire is needed to maintain the Mitchell grasslands in good condition.

This trial aimed to better understand the importance of seasonal prescribed burning as a Mitchell grasslands management tool; and fire’s effect on;

- Native trees and shrubs
- Pasture dynamics
- Cattle diet quality and grazing characteristics.

The trial was implemented on Alexandria Downs Station on the Barkly Tablelands and consisted of two parts;

- A burning trial to measure the impact of early and late dry-season fires on the Mitchell grasslands dynamics and cattle behaviour; and
- A paddock scale demonstration of best practise prescribed burning techniques.

Average to below average growing seasons were experienced over the course of the trial and indicated that under these conditions fire appears to have had no medium to long-term negative impacts on Mitchell grassland condition. Following one growing season significant impacts were identified in pasture cover and yield. However yield did recover after the second growing season and cover had recovered by the end of the third season. Results suggest fire improved the pasture and cattle diet quality over the first growing season with cattle preferring the burnt areas. Fire also reduced the tree and shrub cover. Burn timing had no significant effect on Mitchell grassland dynamics.

The trial results suggest the Mitchell grasslands of the Barkly Tablelands are resilient to fire and that fire provides production benefits with relatively small risks to land condition. Late dry-season prescribed burning is a useful tool in maintaining healthy land condition.

Key words: *Mitchell Grasslands, Fire, Seasonal Burning,*

REVIEWING WOODY VEGETATION MANAGEMENT WITH FIRE IN WESTERN NSW RANGELANDS

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The management of invasive or thickening woody species on western NSW rangelands has a chequered history. In recent years, changing values have added to the complexity of the issue. Perceptions of the role of shrubby communities in biodiversity conservation have strongly influenced policy development, so woody vegetation management is now subject to greater legislative scrutiny. Pastoral industry capacity to manage woody vegetation has also declined through the financial consequences of drought, poor returns to conventional enterprises and diminishing manpower. At the same time, agency focus on shrub management has also dwindled.

A large body of existing research identifies the strategic use of fire as a key low cost tool for managing shrub density. Under recent NSW native vegetation legislation, fire management remains a flexible shrub control option. However, there are few landholders who have intentionally or successfully adopted this approach.

We seek to understand the factors currently influencing the level of adoption and success of fire to manage NSW rangelands. We interviewed twenty four landholders across the region who have actively used fire in the management of woody thickening, or have experienced vegetation change in response to wildfires. Most reported good results from the use of fire, but none utilised burning other than as a one-off treatment. However, previous research highlights that multiple treatments are essential for long-term success in reducing woody plant density. Among the factors contributing to the poor uptake of fire as a tool are unfavourable seasonal conditions, a lack of appropriate skills in prescribed burning, its limited effect in mature or thick woody cover and a perception of variable results. However the key factor remains the influence of total grazing pressure on fuel loads.

Key words: *Management, woody thickening, fire; grazing; legislation; total grazing pressure*

STRIKE THE MATCH, STRIKE THE BALANCE?: CATTLE, TREES AND FIRE IN THE GULF SAVANNAS OF NORTH QUEENSLAND

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A common view is that there have been significant increases in the density and biomass of native trees and shrubs in parts of the pastoral savannas of northern Australia. Increases in the abundance and density of the woody mid-storey challenge the profitability of grazing enterprises by reducing grass availability and increasing the difficulty of livestock mustering. In collaboration with pastoralists in the Northern Gulf region of Queensland, we conducted prescribed burning in grazing lands dominated by either gutta percha (*Excoecaria parvifolia*) or breadfruit (*Gardenia vilhelmi*) to test the hypothesis that late dry season fires could reduce density of native trees and shrubs.

A sequence of prescribed late dry season fires reduced densities of gutta percha and breadfruit and significantly altered the structure of the woodland dominated by these mid-storey species. Grass biomass was higher in burned treatments in the first year after fire and shifts in herbaceous species composition were apparent. Fire also appeared to reduce populations of *Hyptis suaveolens* at burned fire sites at which it occurred. The ability of producers to impose late dry season fires was strongly influenced by the availability and continuity of adequate grass fuel. Accumulation of grass fuel during the wet season prior to a planned fire was critical. Grazing management and, in particular strategic spelling of paddocks, are important in facilitating the use of fire in these systems.

Key words: *fire, savannas, management, shrubs, trees*

FORAGING PITS OF ECHIDNAS ALTER SOIL HYDROLOGICAL PROPERTIES IN A SEMI-ARID WOODLAND

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Soil foraging animals have multiple effects on ecosystem structure and function. One of their effects is to alter the flow of resource (water, soil and seed) across the landscape through the creation of a network of foraging pits. We used field-based rainfall simulation experiments to examine the effects of simulated echidna foraging pits on the capture of water, sediment and seed in a semi-arid woodland. Simulations were carried out on plots of increasing cover (0-27%) and density (0-6 pits per 0.64m²) of pits under a rainfall intensities of 38-40 mm h⁻¹. The initiation of runoff was delayed for longer as the number of pits increased, due to the greater retention of runoff on the surface. Increasing pit density had no significant effect on final runoff rates, but the rate at which runoff increased in the early stages of simulations increased with increasing pit cover and density. Sediment concentrations were greater on plots with more pits due to the greater level of soil disturbance. The seed dispersal experiment demonstrated that most seeds placed into pits prior to simulation were still present in pits after simulations, whereas most of those starting as surface seed were transported to pits over the course of the simulations. Our results indicate that animal foraging pits play an important role in soil hydrological processes in woodlands, and suggest that they may be important sinks for seed moved by water flow processes.

Key words: *ecosystem engineers, foraging pits, seed dispersal, erosion, runoff, sediment*

DISTURBANCE BY ANIMALS AT VARYING SPATIAL SCALES IN A SEMI-ARID AUSTRALIAN WOODLAND

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We studied soil disturbance by rabbits, echidnas, goannas, ants and termites at three spatial scales across four vegetation communities (dense woodland, open woodland, shrubland, grassland) in a semi-arid rangeland in western NSW. Bare and litter-covered surfaces (microscale) were nested within canopy and open patches (intermediate scale), which were nested within vegetation communities (landscape scale). Differences in disturbance measures (cover, soil excavation) between vegetation communities varied depending on the scale of disturbance and the scale at which the disturbance was measured. Our study documents the extent of animal activity in semi-arid woodlands and reinforces the notion that, as soil disturbance is scale-dependent, differences between species, habitats and communities will depend on the scale at which disturbances are examined.

Session 5

Multiple land use and restoration in rangelands

SILVOPASTORAL POTENTIAL IN CENTRAL QUEENSLAND: A CASE OF LOOKING FOR THE WOOD IN THE TREES

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Native forest management in Queensland has undergone significant change in recent years in response to national and state level natural resource management (NRM) policies. These policies are reducing the availability of timber from state forests while encouraging plantation development. In Central Queensland, primary producers have traditionally engaged in broad scale grazing on native and improved pastures while augmenting property incomes with small amounts of selective woodland harvesting. Historically, this private timber resource has been undervalued from a production and NRM perspective and has tended to be harvested on an opportunistic basis. However, public timber supply constraints may increase economic opportunities for quality hardwood timber from private freehold land. These issues, combined with emerging markets such as carbon trading, have initiated strategic partnerships to improve local silvicultural knowledge and facilitate increased investment and multi-functionality in private woodland and silvopastoral systems. This includes opportunities for increasing woody perennials in grazed (largely cleared) landscapes and improved management of existing woodland stands. Partnerships include landholders, NRM organisations, research bodies and private companies involved in a range of networking, training, research and development and demonstration projects. The paper examines, with the aid of a case study, the impact of historical market trends and land tenure arrangements on forest management in the open woodland savannahs of Central Queensland.

THE PROFITABILITY OF ALTERNATIVE SHEEP BREEDS IN THE PASTORAL ZONE OF NSW

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Following depressed wool prices, particularly in the 1970s and 1990s, a prolonged drought and increasing demand for lamb and sheep meat producers in the Pastoral zone of NSW have been considering meat producing sheep as an important part of their enterprise mix. The average price of wool increased by an annual rate of 0.3% whereas the price of lamb increased by about 2.1% per annum. Consequently, the trend in the relative prices provided some incentive to producers to adjust their traditional Merino based enterprises towards a greater focus on meat production. Representative farm models were developed for the Upper Darling, the Murray Darling and Far-West regions. The representative farm models were used to assess the profitability of traditional Merino based sheep enterprises with self replacing Merinos with a proportion of ewes mated to a terminal sire for prime lamb production, Merino wethers only, self replacing ewe Merinos only and self replacing Dorper and Damara enterprises. The results indicate that the traditional merino enterprises that have evolved in the pastoral zone are well suited to their respective environments; and the traditional mix of a self replacing Merino flock and wether flock are more profitable than the alternative enterprises, at least for the representative farms, under the relative commodity price assumptions and resource constraints.

Key words: *Pastoral zone, representative farm, profitability, Merino flock, Dorper and Damara*

A COOP FOR KANGAROOS? INNOVATIVE STRUCTURES FOR COOPERATION BETWEEN LANDHOLDERS AND HARVESTERS IN KANGAROO MANAGEMENT AND MARKETING

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This paper presents an innovative model for collaboration between kangaroo harvesters and rangeland landholders. The model encompasses cooperation in kangaroo harvesting, product development and marketing through the establishment of a Cooperative with landholders and harvesters as members. It is based on work with the Mitchell and District Landcare Association (Qld) and local harvesters, who are seeking to establish a Sustainable Wildlife Enterprise with the support of the Rural Industries Research and Development Corporation. The need for collaboration arises because of a set of interlinked problems with current kangaroo management: landholders typically gain no benefits from the kangaroos on their land; landholders and industry have radically different priorities for kangaroo management, precluding any integrated local management; there is little cooperation between landholders and harvesters in important areas such as feral and weed control; and finally, kangaroo remains a low-value commodity, despite its potential for marketing on the basis of product quality, environmental impact, and health benefits.

Successful establishment of this Cooperative would enable landholders and harvesters to better manage kangaroos to meet production and TGP management goals, and to offer kangaroo processors exclusivity and consistency of supply, consistent high quality, and the potential to develop "green" branded products. Members should benefit from better TGP management, more cooperative and secure relationships between harvesters and landholders, and higher economic returns, with potential long-term benefits for biodiversity conservation, NRM, and rural economies.

Key words: *kangaroos, wildlife, biodiversity, resilience, emerging industries*

A MARKET BASED APPROACH TO ADDRESSING THE NATIONAL FERAL CAMEL PROBLEM

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The feral camel population in Australia is approaching approximately one million animals, impacting aboriginal landholders, pastoral enterprises and the environment. Due to the increasing number of feral camels and subsequent threats, the requirement to effectively manage them is escalating.

Feral camel control options are currently limited, restricted by a range of environmental, legislative, economic and social constraints. Biological control provides the best opportunity for long-term management, however development of an appropriate biological control approach has not yet begun and would take many years to implement. Alternative methods are more dependent on direct human intervention, with associated logistical and financial implications. Aerial shooting, for example, is current best practice control but is expensive and logistically difficult to implement over extensive areas. Utilisation of feral camels as a resource has merit and general community support but is market sensitive.

While several methods of control have application, no single method meets all objectives or stakeholder expectations. Cross border and regional cooperation is essential to significantly reduce the population and impacts at a national scale. An integrated control approach utilising a combination of management techniques supported and administered via a Market Based Instrument (MBI) provides an innovative and appropriate opportunity for feral camel management. This will be a first for management of Large Feral Herbivores in Australia.

CARBON TRADING: AN INCENTIVE TO CHANGE RANGELAND GRAZING MANAGEMENT?

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With climate change firmly on the global agenda carbon trading is emerging as a growing industry. In Australia the rangelands has been identified as one of the country's largest carbon sinks. Increasing carbon sequestration is the key to the ability to trade. Though better grazing management practices it appears to be possible to increase the levels of carbon stored in the soil and above ground biomass. The potential income from carbon trading could provide an incentive for land managers to adopt grazing management practices such as cell and rotational grazing. Improved grazing management not only provides the potential for more sustainable land use but also higher productivity and profitability for pastoral enterprises.

Increases in carbon sequestration due to implementing grazing management systems such as cell grazing can be attributed to increases in above ground biomass and increased soil organic matter. At Cheela Plains Station in the Pilbara a cell grazing system has been operating for the last 10 years. Soil carbon comparisons between the cell grazed area and the set stocked area outside the cell give an indication of the potential increases that may be possible by adopting such grazing management systems. Soil carbon inside the cell was up to 39% higher than outside the cell. While the levels of carbon sequestration per hectare are relatively low (an average of 1.9t CO₂ eq/ha) when compared to agro forestry (approximately 10 t CO₂ eq/ha) the 90 million ha the Rangelands in WA alone means that it is a large pool. Carbon sequestration and trading represent an exciting new possibility for the rangelands and have the potential to have a significant impact on pastoral enterprises.

Key words: *Soil Carbon, Grazing Management, Carbon Sequestration, Carbon Trading, Pilbara, Rangeland.*

OPPORTUNISTIC CROPPING FOR CONTROL OF INVASIVE NATIVE SHRUB (INS) AND RESTORATION OF NATIVE PERENNIAL GRASSLANDS

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The spread of Invasive Native Scrub (INS) is regarded as one of the major problems threatening the pastoral lands of western New South Wales. Over the past 40 years several methods of controlling INS were evaluated with varying degree of success. One successful method was mechanical clearing. However, the cost of mechanical clearing is prohibitive under the economic reality of the area. Therefore, many landholders believe that opportunistic cropping is the only economically viable way of treating INS and regenerating native perennial grasses. Moreover the NSW Native Vegetation Act (2003) recognises that INS causes environmental degradation and lists cropping as an acceptable form of management to re-establish native herbaceous vegetation. This project is designed to test the hypothesis that native perennial grasslands do regenerate following cropping. To test this hypothesis, several paddocks that have been cropped during the last 20 years were selected from the Resource Assessment and Monitoring System (RAMS) database. The history of each paddock was then followed from the first time it was cropped to the present. Each field was classified based on crop type, number of years under crop and years since the last crop. In each paddock, a survey was undertaken to identify existing vegetation on randomly selected transects. The nutrient status of the soils was also determined to establish the relationship between soil fertility and vegetation type. Data analysis aimed to relate current vegetation type to management history and recent rainfall. The data will be used to develop BMP's for the management of INS using short-term cropping.

Key words: INS, opportunistic cropping, RAMS database, Western CMA, Perennial grasslands

REPAIRING DEGRADED RANGELANDS

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It has been over 30 years since early satellite imagery illustrated the extent of degradation across much of the high quality savanna rangelands, sparking a push for research and industry education to address the issue. A wide range of research, development and extension activities by government agencies, CSIRO, private providers, producer groups, industry employees and members of the industry itself, have been conducted into appropriate stocking rates and rehabilitation of land in poor condition. Despite clear evidence of the negative impact of degraded resource condition on gross margins, and best efforts to alter attitudes and introduce flexible grazing land management practices, overgrazing and degradation of the extensively grazed savannas continues to be a significant issue.

This widespread lack of adoption of improved land management practices is causing many to re-evaluate the delivery of the research, development and extension services to the extensive grazing industry. Generally, the grazing community has repeatedly indicated that it is not prepared to accept the downstream environmental impacts of degradation on the Great Barrier Reef or the Gulf of Carpentaria. Why are the successes so modest and how can adoption of new information and technologies be improved?

Probable reasons for lack of adoption

- Poor records of herd numbers and production efficiencies
- Set stocking rates commonly aligned to the occasional good season and a reluctance to match cattle numbers to pasture available in seasons with low feed supplies
- Unintentional rewards for inappropriate management
- A guarded approach by the industry peak body, and the landlord to address land condition decline has led to a low level of commitment to change
- RD&E programs do not have sufficient relevance to the day to day management of a beef business to gain a commitment to change land management decisions

Possible solutions

- Place monetary value on other values in the landscape according to landscape function and amenity
- Reward good managers on the basis of their attention to improving landscape values through rates and rent reductions or other payments according to public good.
- Strengthen landholder obligations or reward under the leasehold renewal process to account for loss or gain in landscape function.
- Use of reference sites and time series satellite imagery depictions of bare ground index as district or regional tools to identify where land condition issues are critical
- More closely link information delivery with the requirements of regulatory bodies

Key words: *rangelands, land condition, degraded, management practices*

THE RESTORATION AND REHABILITATION OF THE CARNARVON BASIN AND THE GASCOYNE CATCHMENT – PASTORAL INDUSTRY PLANNING FOR THE FUTURE.

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The Lyndon and Upper Gascoyne Land Conservation District Committees (LCDC) are some of the most active, innovative and longstanding committees of their type in the Western Australian southern rangelands. Active since 1988 and 1991 respectively, they have been extensively involved in the landcare movement and enhancing the biodiversity and productive viability of these rangelands.

Combined, the LCDCs encompass the Carnarvon Basin and the Gascoyne catchment covering some 73,000 square kilometers of the Gascoyne and Murchison regions. Their coastal boundaries include the Ningaloo Marine Park and the World Heritage area of Shark Bay and a wetland of national significance, Lake MacLeod, is situated in the western pocket of the districts.

After many years of Landcare activities the combined LCDC groups sought to strengthen their approach to land management. In 2007 the LCDC groups developed the 'Restoration and rehabilitation of the Carnarvon Basin and the Gascoyne Catchment project'. This is an important project as it is a catchment planning, works and development process that is being driven by the pastoral industry.

The project involves the:

- Development of individual Property Management Plans
- Integration of Property Management Plans into an overall Catchment Management Plan.
- Development of a works and monitoring program to address issues that require treatment within the catchment.
- Identification of sources of funding for on-ground works projects.
- Coordination and implementation of the works program.

The pastoralists of the LCDC have observed significant improvement in the condition of the rangeland and pastoral monitoring sites have verified these observations. However, they remain concerned about the historical degradation highlighted by the various rangelands condition reports undertaken by the Department of Agriculture and Food on behalf of the Pastoral Lands Board. This project is proving to be an opportunity to highlight the pro-active approach being taken by members of the pastoral industry in this region and it will help set the direction for continued improvement and productivity gains in the Carnarvon Basin and Gascoyne catchment.

Key words: *Carnarvon, Gascoyne, rehabilitation, Lyndon, Upper Gascoyne*

CAN REINTRODUCTIONS OF THE BILBY AND BETTONG AID ECOSYSTEM RESTORATION IN ARID AUSTRALIA? (STUDENT)

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The substantial range declines of the greater bilby (*Macrotis lagotis*) and the burrowing bettong (*Bettongia lesueur*) are thought to have had dramatic effects on ecosystem processes in the Australian rangelands because of their impacts on surface soils. We studied the effects of their reintroduction on litter and seed capture and soil nutrient levels compared with two prevalent fossorial animals; the European rabbit (*Oryctolagus cuniculus*) and the sand goanna (*Varanus gouldii*). Bilbies and bettongs dug deeper and wider pits and excavated significantly more soil than rabbits or goannas. Litter and viable seed was restricted almost exclusively to the pits and soil in the pits had significantly higher levels of labile carbon and mineralisable nitrogen than surface soils. Compared with surface soils, bilby, bettong and goanna pits contained relatively more labile carbon than rabbit pits. The significantly greater soil excavation by bilbies and bettongs and the higher concentration of carbon in their pits, demonstrate that these reintroduced fossorial mammals play important roles in the creation of fertile patches. This study demonstrates that through habitat modification, reintroduced species can affect ecosystem function by enhancing resource retention at a local scale.

HUDSON PEAR: A CO-ORDINATED WEED MANAGEMENT PROGRAM IN WESTERN NSW

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Hudson pear (*Cylindropuntia rosea*) is an introduced pest cactus plant that has become an invasive weed problem threatening large areas of Walgett Shire and potentially the greater Darling Riverine Plains Bioregion in western NSW. Recorded in the Shire in the late 1960s, Hudson pear has increased in extent, both in areas of core infestations and scattered new infestations spreading from red ridge country and into floodplain and plains country.

At the end of 2005, the Hudson Pear Task Force was established to co-ordinate existing and future Hudson pear control work. The Task Force is a collaborative group of stakeholders including landholders, opal miners and Government agencies. At that time, the problem of this pest cactus was considered very significant, and perhaps too big to successfully control.

The control program overseen by the Task Force involved a strategic approach to contain existing thick infestations and treat the scattered outlying infestations, as well as ongoing mapping and reporting. Substantial efforts have produced encouraging results and increased confidence in the control program, with greater areas of the core infestations also able to be treated, and potential for biological control trials and ongoing regrowth suppression and strategic control. The paper will describe the pest problem, collaborative approach, control program and outcomes in more detail.

Key words: *weed management community Hudson pear floodplain co-ordination*

OPTIMAL FREQUENCY FOR WOODY WEED MANAGEMENT FOR NORTH QUEENSLAND GRAZING PROPERTIES: AN ECONOMIC PERSPECTIVE

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Once an invasive plant has colonised an area, continuing weed management is required to maintain the lands' productive capacity. Woody-weeds detrimentally affect rangeland graziers by reducing stocking rates, increasing mustering effort, and impeding cattle from accessing water and poisoning of livestock. However, weed management is costly, so tradeoffs exist between the frequency of management and the productive capacity of the land. In the Australian rangelands weed management tends to be infrequent due to the weeds' slow growth, vastness of the rangelands, remoteness of infestations, and the relatively high cost of management with respect to grazing returns. We construct an analytical framework that synthesises the complex relationship between the weed population dynamics, weed costs imposed on grazing, and the efficacy of weed management, to determine the optimal frequency of managing *Ziziphus mauritiana* (chinee apple) in the northern Australian rangelands upland zones. Management is based on the mechanical removal of the plant with a blade-plough, as this is one of the most affective methods for chinee apple. The model output suggests that it is uneconomic to manage chinee apple with current management costs. We show that management decisions are more sensitive to changes in control costs than they are to grazing returns, and that there is a clear relationship between the frequency of weed management, density of infestation, and financial returns from weed management.

Key words: *Benefit-cost analysis, stage matrix, rangeland weed management, management frequency, NPV, woody-weeds.*

MANAGING SOIL FERTILITY FOR RESTORATION OF NATIVE GRASSLANDS

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Competition from annual species may be a significant factor limiting the re-establishment of native perennial species in degraded grasslands. In arid environments this may occur in post-drought situations when prolific annual growth results from relatively high levels of available nutrients. In more mesic environments growth of annuals may be promoted by increased soil fertility resulting from oversowing of native grasslands with legumes and application of superphosphate. Although growth of some native species responds favourably to increased fertility their regeneration in degraded communities could be compromised if increased fertility promotes stronger competition from annuals.

We conducted an experiment at Trangie Agricultural Research Centre, in the semi-arid aseasonal rainfall zone of NSW, in which fertility of the soil supporting degraded native grassland was either enhanced by addition of fertiliser, reduced by application of sugar as a readily assimilable source of carbon for soil micro organisms, or left untreated. After two years, the DM yield of annuals was significantly lower, and DM yield of perennials significantly higher, in the reduced fertility treatment. Density of the two major native perennial grasses (*Austrodanthonia caespitosa* and *Enteropogon acicularis*) increased in the reduced fertility treatment but declined in the other two treatments. Basal area of these species declined in all treatments but the decline was least with reduced fertility.

Our results support the hypothesis that competition from annual species can limit regeneration of native perennial grasses and that manipulation of fertility, and consequently the extent of this competition, may be important in facilitating grassland restoration. Where feasible, management techniques (eg pasture cropping) that achieve at least a temporary reduction in fertility may prove to be an important component of restoration management. Elsewhere, management of grazing may be the only tool available to manipulate the competitive balance or to ensure that infrequent regeneration opportunities are realised.

Key words: *fertility, grasslands, restoration, establishment, perennials, annuals*

GIFT OF THE GAB

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Upon approach along the Flinders Highway into the town of Julia Creek, a small town approximately 600km west of Townsville in the Mitchell grasslands of north west Queensland, you will read signs saying “Welcome to Julia Creek – Centre of the Great Artesian Basin” with a picture of a large gushing bore head of water. You will then get into town perhaps expecting to see something worthy of the title this little town claims as its own.

Julia Creek, of population around 550 is indeed in the heart of the big flows from the Great Artesian Basin (GAB) and yet, to a passing tourist the features to prove it are not obvious, mostly existing on outlying pastoral properties within the McKinlay Shire.

So, with tourists as the main target audience, “The Gift of the GAB”, a 16 minute documentary was created to give the total story of the GAB. It includes simple and comprehensive hydrogeological explanation of its formation and features accurate animations. It is delivered with a local perspective of the history and current views of the GAB via a chat to locals who can tell you from first hand experience and observation what the GAB means to them and their operations and that without it they doubt that they would still be here.

The movie was produced by McKinlay Shire Landcare Association. Film production company was Charlie Bravo, Sydney. Funding and in-kind donations were sourced from Australian Govt Envirofunds, BHP Billiton Cannington Mine, McKinlay Shire Council, Ouchy Alva Pastoral, Philmac, and Julia Creek Historical Society. Most of the time put into researching and scripting was volunteered freely.

The screening of this documentary will occur in the tourist centre in Julia Creek. Schools and information expos are other forums for screening.

POSTER SESSIONS & PRESENTERS

SESSION 1 - Capacity building and social issues in rangelands

01. Small business and change: ideas from the building blocks of Aboriginal enterprise – by Louise Moylan, Uni of Adelaide, Roseworthy, SA
02. Livelihoods in the Anmatjere region: employment, uncertainty and institutions by - Hannah Hueneke, CSIRO, Alice Springs, NT
03. Building partnerships to improve rangeland management – Case study, Gawler Ranges South Australia - by Deborah Allen, DPI&R, Port Augusta, SA
04. Productivity, water quality and salinity – Action learning tools to help people of all ages and backgrounds to understand the benefits of best practice in agriculture for production and for the environment - by Sid Cook, Qld Murray Darling Committee, Toowoomba, Qld
05. Tools for successful NRM engagement in the Lake Eyre Basin - by Thomas Measham, CSIRO, Alice Springs. NT
06. Filing photographic sequences in a digital database - by David Orr, DPI&F, Rockhampton, Qld
07. Understanding the influence of identity, trust and sense of place on graziers' change to more sustainable natural resource management - by Allyson Lankester, CSIRO, Townsville, Qld
08. Improving pasture management capacity through subdivisional fencing on Riversleigh Pastoral Station - by Kate Masters, Southern Gulf Catchments, Mt Isa, Qld
09. What constitutes an “environmental duty of care” of graziers in north Queensland? - by Owen Miller, River Consulting, Townsville, Qld
10. FORAGE – A web-based framework for generating and distributing decision support information for sustainable grazing land management - by Grant Stone, EPA, Brisbane, Qld
11. The SA Arid Lands Biodiversity Strategy: Moving from biological inventories to an investment and decision-making framework - by Anthony Freebairn, DEH, Port Augusta, SA
12. Quantifying degradation risk – integrating climate risk into rangeland management - by Baisen Zhang, EPA, Brisbane, Qld
13. Techniques to improve groundcover in the Western Catchment of NSW - by Suzie Bunting, Western Catchment Management Authority, Cobar, NSW
14. Land managers and Landscape Function Analysis (LFA): enhancing adaptive environmental management while monitoring resource condition in Western NSW - by Peter Ampt, Uni of NSW, Sydney, NSW
15. Southern Gulf Catchments' Saurus Crane Award as an incentive reward to increase participation in natural resource management activities - by Kate Masters, Southern Gulf Catchments, Mt Isa, Qld
16. Evaluation of past participants funded to purchase computer mapping software and other technologies for property management planning - by Gina O'Sullivan, Fitzroy Basin Association, Emerald, Qld
17. The Western Catchment Management Authority's Incentive Program: what have we learnt from the past three years.... - by Melinda Fletcher, Western Catchment Management Authority, Broken Hill, NSW

18. The Ynot Beef Group - by Robyn Adams, Desert Uplands, Build-Up and Development Strategy Committee, Barcaldine, Qld
19. History of the Desert Uplands - by Robyn Adams, Desert Uplands, Build-Up and Development Strategy Committee, Barcaldine, Qld
20. Co-ordinating fire management for the Great Mt Isa area - by Leasia Felderhof, Southern Gulf Catchments, Mt Isa, Qld
21. Ivory towers, silos and the remedy - by Geoff Edwards, Brisbane, Qld
22. WaterSmart Pastoral Production™ – A demonstration and evaluation of innovative stock water delivery and management technologies in desert Australia- by Andrew Bubb, Desert Knowledge Cooperative Research Centre, Alice Springs, NT
23. A participatory approach to training for the herders of the inner Mongolian grasslands - by Gemma Junk, NSW DPI, Bourke, NSW

SESSION 2 – Grazing management, land condition and monitoring in rangelands

24. Grazing preference, patchiness and land condition interactions – implications for recovery in grano-diorite land types of the upper Burdekin region - by Jeff Corfield, CSIRO, Townsville, Qld
25. Understanding cattle behaviour in riparian areas with and without access to off-stream watering points - by Greg Bishop-Hurley, CSIRO, Rockhampton, Qld
26. Cattle don't necessarily prefer to graze in riparian zones - by Ed Charmley, CSIRO, Rockhampton, Qld
27. Targeting cattle grazing without fencing using low-stress herding and supplement placement - by Derek Bailey, New Mexico State Uni, Las Cruces, USA
28. Genetic and environmental determinants of cattle grazing distribution patterns - by Derek Bailey, New Mexico State Uni, Las Cruces, USA
29. Using nutritive values of rangeland species to enhance best practice grazing management - by Casey Pfeiffer, Productive Nutrition Pty Ltd, Walkerville, SA
30. Grazing systems and spatial uniformity - by David Reid, DPI&F, Rockhampton, Qld
31. Scaling up from *Ecograz* – the Virginia Park experience - by Jeff Corfield, CSIRO, Townsville, Qld
32. Managing perennial grass pastures and soil macroinvertebrates to maintain soil health and pasture productivity in grazed tropical savannas - by Leigh Hunt, CSIRO, Darwin, NT
33. Sustainable grazing management – A balancing act - by Rebecca Dray, DA&F, Karratha, WA
34. Grazing land in “A” condition is stable and resilient - by Paul Jones, DPI&F, Emerald, Qld
35. Is Pasture rest time or timing? - by Alan Lauder, The Gap, Qld
36. Strategic management of water influences grazing distribution and pasture utilisation in subtropical savannas - by Nigel Tomkins, CSIRO, Rockhampton, Qld
37. Managing runoff from grazing lands - by Aaron Hawdon, CSIRO, Townsville, Qld
38. An economic assessment of a long term variable grazing regime in the brigalow bio-region - by Michael Stephens, CSIRO, Rockhampton, Qld
39. Wet Season Spelling – Some economic insights from herd modelling - by Neil MacLeod, CSIRO, Brisbane, Qld

40. Retrospective analysis: rapid appraisal of satellite derived cover indices - by Terry Beutel, DPI&F, Rockhampton, Qld
41. Monitoring land condition in semi-arid and arid rangelands of the Northern Territory using MODUS imagery - by Jason Barnetson, NTDNRE&A, Alice Springs, NT
42. Study of *Maireana pyramidata* as an increaser species in Gawler Ranges, South Australia, using permanent vegetation monitoring points - by Adrian Friedel, DPI&R, Port Augusta, SA
43. Strategic grazing for the control of the invasive wetland weed lippia (*Phyla canescens*) - by Jodi Price, Uni Of New England, Armidale, NSW

SESSION 3 - Biodiversity management and conservation in rangelands

44. Developing a research agenda for the distribution and rate of spread of buffel grass and identification of landscapes and biodiversity assets at most risk from invasion - by Margaret Friedel, CSIRO, Alice Springs, NT
45. Continuums of functionality of Australian savanna landscapes: Assessing changes over time with remote sensing - by Bromwyn Price, Uni of Qld, Brisbane, Qld
46. Cyanobacteria well adapted to respond to drought and climate change - by Wendy Williams, Uni of Qld, Gatton, Qld
47. The conservation of widely distributed species: implications of differences between western and eastern koala populations - by Leonie Seabrook, Uni of Qld, Brisbane, Qld

SESSION 4 - R&D in rangelands

48. Kenaf seeds (*Hibiscus cannabinus* L.) as a protein supplement for sheep by Chris Gardiner for Thulile Sgwane, Uni of Swaziland, Luyengo Campus, Swaziland
49. The nutritional profiles of native plants in the Arid Shrublands of Western Australia - by Fiona Daley, Curtin Uni of Technology, Perth, WA
50. Seed production characteristics of *Dichanthium sericeum*, *Heteropogon contortus* and *Themeda triandra* ecotypes under intensive management systems in north Queensland - by Kendrick Cox, DPI&F, Walkamin, Qld
51. Simplistic rules for sourcing 'local' provenance seed in revegetation ignore complex ecological processes of adaptation - by Cathy Waters, NSW DPI, Trangie, NSW
52. Pimelea poisoning - the plant enigmas - by Richard Silcock, DPI&F, Brisbane, Qld
53. Landscape leakiness in the grazed rangelands of the Burdekin - by Gary Bastin, CSIRO, Alice Springs, NT
54. Regional erosion risk assessment in areas of shrub encroachment in Central West and Western NSW - by Carlos Munoz, Uni of New England, NSW
55. Aerially surveying mesquite in the Pilbara - by Linda Anderson, Pilbara Mesquite Management Committee, Karratha, WA
56. Mapping very poor condition grazed landscapes at a regional scale - A remote sensing approach - by Brett Abbott, CSIRO, Townsville, Qld
57. Remote weighing and management of pregnant Merino ewes and their finishing lambs - by K. Geenty, Uni of New England, Armidale, NSW
58. Understanding herbivore behaviour in rangelands: developing more accurate resource selection functions - by Dave Swain, CSIRO, Rockhampton, Qld
59. Faecal NIRS measurements of diet quality and liveweight change in steers grazing a

- speargrass pasture in S. Qld - by Rob Dixon, DPI&F, Rockhampton, Qld
60. A new methodology for the calculation of pasture utilisation for grazing lands - by Grant Stone, EPA, Qld
61. Abandoned legumes offer economic and environmental benefits in semiarid clay soil rangelands by Chris Gardiner, James Cook Uni, Townsville, Qld
62. Barkly Tablelands Seasonal Burning Trial – on the black soil (Mitchell grassland) plains - by Chris Materne, DPIF&M, Alice Springs, NT
63. Reviewing woody vegetation management with fire in western NSW rangelands - by Brian Dohnt, Western Catchment Management Authority, Cobar, NSW
64. Strike the match, strike the balance?: Cattle, trees and fire in the Gulf savannas of north Queensland - by Tony Grice, CSIRO, Townsville, Qld
65. Foraging pits of echidnas alter soil hydrological properties in a semi-arid woodland - by David Eldridge, Uni of NSW, Sydney, NSW
66. Soil disturbance by animals at varying spatial scales in a semi-arid Australian woodland - by Alan Kwok, Uni of Sydney, Sydney, NSW

SESSION 5 - Multiple land use and restoration in rangelands

67. Silvopastoral potential in Central Queensland: a case of looking for the wood in the trees - by Anne Stünzner, Central Qld Forest Association, Rockhampton, Qld
68. The profitability of alternate sheep breeds in the Pastoral Zone of NSW - by Salahadin Khairo, NSW DPI, Trangie, NSW
69. A Coop for Kangaroos? Innovative structures for cooperation between landholders and harvesters in kangaroo management and marketing - by Rosie Cooney, Uni of NSW, Sydney, NSW
70. A market based approach to addressing the national feral camel problem - by Philip Gee, Rural Solutions, Port Augusta, SA
71. Carbon Trading: an incentive to change rangeland grazing management - by Manus Stockdale, DA&F, Karratha, WA
71. Opportunistic cropping for control of Invasive Native Shrub (INS) and restoration of native perennial grasslands - by Yohannes Alemseged, NSW DPI, Trangie, NSW
73. Repairing degraded rangelands by Kev Shaw, DPI&F, Kairi, Qld
74. The restoration and rehabilitation of the Carnarvon Basin and the Gascoyne Catchment – Pastoral industry planning for the future - by Alexandra Harper, Dust Up Projects, Carnarvon, WA
75. Can reintroduction of the bilby and bettong aid ecosystem restoration in arid Australia? - by Alexandra James, Uni of NSW, Sydney, NSW
76. Hudson pear: a co-ordinated weed management program in Western NSW – by Claire Bergin, Western Catchment Management Authority, Walgett, NSW
77. Optimal frequency for woody weed management for North Queensland grazing properties: an economic perspective - by Andrew Zull, CSIRO, Townsville, Qld
78. Managing soil fertility for restoration of native grasslands - by Ron Hacker, NSW DPI, Trangie, NSW
79. The gift of the GAB – Australia’s Great Artesian Basin - by Helen Lynch, McKinlay Shire Landcare Group, Julia Creek, Qld

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