



SAVANNA LINKS

Cooperative Research Centre for Tropical Savannas Management

Issue 32
July–Dec. 2005

ISSN: 1327-788X
<savanna.cdu.edu.au>

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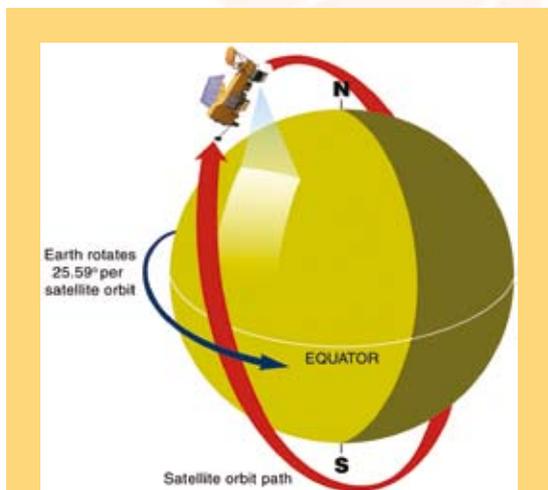
Travelling museum

A new research project aims to use Aboriginal knowledge to complement Western science to help explain where and why our northern mammals are in decline. See pp. 8–9.



Mighty bugs

A research team from the Tropical Savannas CRC and CSIRO has found that providing the right conditions for earthworms, termites and ants will all improve the health of tropical pastures. —Turn to pp. 10–12.



Satellite know-how

While online fire-tracking tools are remarkably helpful for land managers, there are some tricky elements to turning satellite imagery into the firespots we see on the web.

Peter Jacklyn explains some of the behind-the-scenes technology to help improve decision making based on fire-tracking websites. — See pp. 4–5



Landscapes: role of trees

There is a lot we don't know about long-term consequences of tree clearing on long-term grass production, water and nutrients in savanna landscapes. This issue, two articles explore some of the research and findings in this area. Turn to pp. 14–17.

Photos this page, clockwise from top: Carol Palmer, Garry Cook.



Established and supported under the Australian Government's Cooperative Research Centres Program

Tropical doctorate for land managers

FOR those already working in environmental management in the tropics, and keen to gain a professional doctorate in their area of expertise, a new qualification is available through the Tropical Savannas CRC's three partner universities.

The Professional Doctorate in Tropical Environmental Management (DTEM), set to start in 2006 at Charles Darwin University, offers research and coursework, but also a professional placement at one of the CRC's partner agencies where candidates can conduct their research on the ground.

While professional doctorates have been available in Australia for more than a decade, it is the first time such a qualification is being offered in environmental management.

The concept for the doctorate originated within the TS-CRC education program, as a way of addressing the need for professionally focused educational opportunities in tropical northern Australia.

The award is now available through Charles Darwin University, but is also being considered for accreditation at the CRC's other two university partners, James Cook University and the University of Queensland.

A professional doctorate is equivalent to the usual research PhD, but has clear links to industry through a professional placement and research program. Candidates should be able to make a significant contribution to their chosen area of study.

The three-year DTEM comprises two semesters of coursework and a four-semester research component which features a professional placement. At least one coursework unit must be undertaken at partner universities. For example, candidates enrolling this year at Charles Darwin University will undertake at least one coursework unit at both JCU and UQ.

Before starting their candidature, applicants prepare a comprehensive program of study that integrates all three elements of the DTEM.

Co-program advisors, Dr Penny Wurm and Dr Lindsay Hutley from CDU, will be advising potential candidates on the research programs, and will also be liaising with natural resource management agencies across Queensland, the Northern Territory and Western Australia.

"Candidates need to put together a comprehensive program where the coursework, professional placement and research all integrate and take the candidate where they want to go professionally," said Penny. "We will be able to help them with that."

Dr Paul Novelty, Manager, Rangeland Research at Western Australia's Department of Agriculture, welcomed the new award.

"In the last decade—through things like the decade of Landcare—a diverse range of people have come into this area and people are re-assessing their qualifications," said Paul. "I think the DTEM is going to be very useful—the biggest issue is going to be the small population base from which potential students will be drawn."

The DTEM will ensure links with industry through:

- Candidates collaborating with the users of research in developing the project proposal and /or setting of the research activity.
- Industry partners will be included in the development of the curriculum.
- Professional placements, in which students apply problem-solving models in a new workplace.
- Co-supervisory arrangements with industry for research supervision, similar to those required of CRC-supported PhD students.
- A communication strategy is included within project proposals

"It's a very practical qualification," said Paul, "close to a US-type of degree with a whole raft of coursework, as well as research degree. "The option of having it linked to various universities rather than just to one is also good."

More information: refer to the CDU Courses Repository:

<www.cdu.edu.au/> Type 'professional doctorate' in the Search box, under the Courses option

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Tropical Savannas CRC: Linking the North

The Tropical Savannas CRC is a joint venture of the major organisations involved in land management of the savannas of northern Australia.

It comprises three universities, government agencies from the NT, Qld and WA and the Commonwealth, CSIRO, and representatives from Aboriginal groups and the pastoral industry.

The Centre promotes sustainable use and conservation of Australia's tropical savannas by acting as a bridge between agencies engaged in land and resource management

research, and research users and decision makers. These include pastoralists, conservation managers, Aboriginal land managers, and the tourism and mining industries.

The Centre communicates outcomes of its research and other knowledge about the savannas to ensure this knowledge can be used effectively by people living and working in Australia's savannas.

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Australian soils online

THE Australian Soil Resource Information System (ASRIS) provides online access to the best publicly available information on soil and land resources in a consistent format across Australia. It provides information at seven different scales. The upper three scales provide general descriptions of soil types, landforms and regolith across the continent. The lower scales provide more detailed information in regions where mapping is complete. The lowest scale consists of a soil profile database with fully characterised sites that are known to be representative of significant areas and environments.

Go to: <www.asris.csiro.au>

World-beating fire resource nets award

UNIVERSITY students and Charles Darwin University's Teaching and Learning experts joined forces with research partners in the Tropical Savannas Cooperative Research Centre (CRC), Bushfire CRC and CSIRO to develop a world-beating online educational resource, drawing on the latest fire research. They have won a national award for "exemplary use of electronic technologies in teaching and learning in higher education."

The 'Fire Ecology & Management in Northern Australia' teaching and learning material has won a prize in the coveted 2005 National ASCILITE Award for Educational Design & Technology in Tertiary Education, announced in Brisbane in early December.

The collaboration has produced an online teaching resource on fire ecology and management for use as part of several graduate programs, with all the material tailored for the North's unique conditions.

"This network of collaborators ensured the quality of the materials produced," CDU Educational Designer, Dr Lesley Instone said.

"It gives graduate students 'real world' problems and resources. They can tackle challenges faced annually in the Top End, and listen to interviews with fire fighters, researchers, land owners and other professionals actually working in the field today," said Lesley.

However, the fire unit has a whole-of-northern-Australia focus, bringing together case studies, research and references that bridge the Kimberley, Top End and northern Queensland.

"Fire management in the north is a culturally, ecologically and politically complex issue. Our graduates have to understand far more complex political issues than those



Winners of the ASCILITE Award: From left: Lesley Instone (CDU), Helen Rysavy (CDU), Penny Wurm (TS-CRC) and Kate Parr (Bushfire CRC/CSIRO)

down south," said co-project leader Dr Penny Wurm, from the TS-CRC. The unit will form part of a Bachelor degree in Science or Environmental Science.

"These graduates work in situations where an understanding of the impact of fire on landscapes and the complex policy issues involved is crucial," Penny explained.

"They need to work cooperatively with managers of adjacent lands and appreciate that different groups can have diverse fire management objectives," she said.

While the new unit is fully integrated it can also be used as a set of resources. For example, a lecturer may just want some north Australian case studies, or to concentrate on fire science—the unit is set up so they can select the materials they wish.

The entry was sent to an international panel of eight judges from USA, UK, Australia, NZ and the Netherlands, who judged it an outstanding entry among the finalists. The entry won for its appropriateness to target audience, its appropriate and effective learning design, creativity, significant impact on teaching practice, and its overall quality.

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Google Earth brings 3D interface to the world

THE highly enjoyable Google Earth brings a planet's worth of imagery and other geographic information to your desktop. The tool brings together local search with keyhole satellite imaging technology and mapping capabilities from all around the world.

For most of north Australia the imagery is medium resolution which means you can view major geographic features and man-made development such as towns, but not the detail of individual buildings. but improved coverage is on the way. While the site looks like it's happening in real time, the images are photographs taken by satellites and aircraft sometime in the last three years.

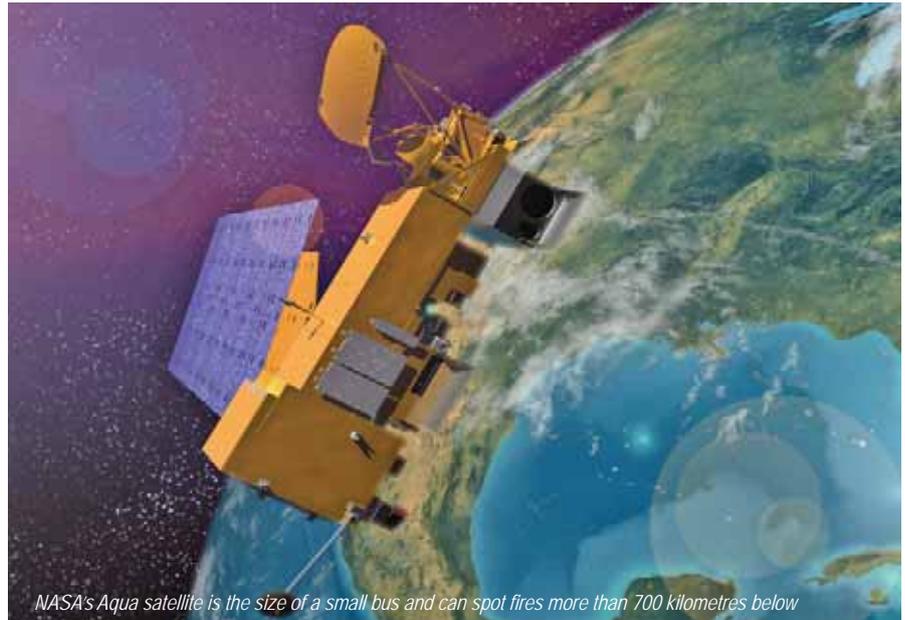
Three versions are available for free download: Google Earth Free; Google Earth Plus and Google Earth Pro.

Go to: <earth.google.com>



Just how does satellite tracking of bushfires work? And how does different technology affect what you see on online tools such as the North Australian Fire Information website?

Peter Jacklyn explains



NASA's Aqua satellite is the size of a small bus and can spot fires more than 700 kilometres below

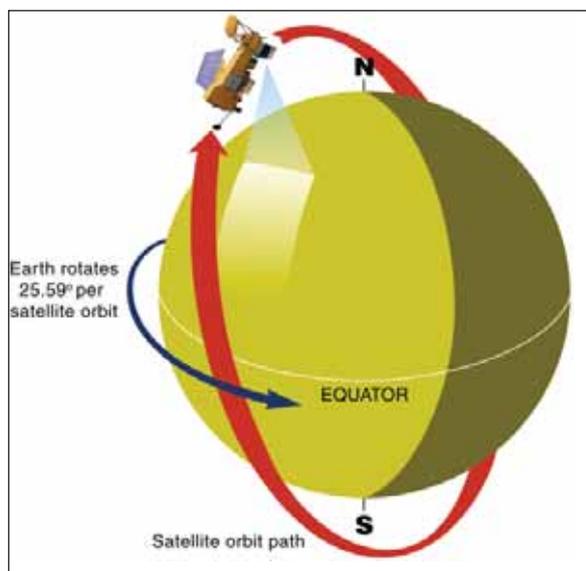
Satellite know-how helps track hotspot quirks

If you track bushfires using the NAFI website or other fire-tracking websites, you will know that these sites is a remarkably useful tool that saves people time and money. However, it has its foibles: smaller fires may not be picked up as 'hotspots', or when they do appear, the location of hotspots may sometimes be out by over a kilometre, or they may not be near a fire at all. Knowing a bit more about the satellites and computers behind the scenes should help decision making based on the NAFI site and other fire-tracking websites.

How often is a fire monitored?

You may have noticed that sometimes the location of a fire on the website is updated a few times in a few hours and at other times there are longer gaps between updates. Much of this can be explained by the orbits of the satellites that monitor the fires. In late 2005 the NAFI website was receiving fire data from five satellites: two minibus-sized satellites

Satellites move in orbits designed to monitor the entire globe; they are not designed to continuously monitor rapidly changing events like burning fires, but rather climate and vegetation change etc.



operated by NASA, named Terra and Aqua, and three slightly smaller satellites operated by the US National Oceanic and Atmospheric Administration (NOAA): NOAA-12, NOAA-17 and NOAA-18.

These satellites move in orbits designed to monitor the entire globe, roughly north-south paths that pass close to the poles and are synchronised with the rotation of the Earth. As the satellites follow these paths at around 20,000 kilometres an hour, on-board sensors continually generate images of the Earth below in strips 2300–2400 km wide depending on the satellite. As the images are created they are beamed down to receiving stations.

These orbits allow the satellites to see almost the entire globe in daylight and to do this they actually see most points twice a day, once on the daylight side and once on the night side. As fires can be detected at night this means most fires in Australia could be seen twice a day by each of the five satellites that feed the NAFI site, i.e. 10 times on a good day.

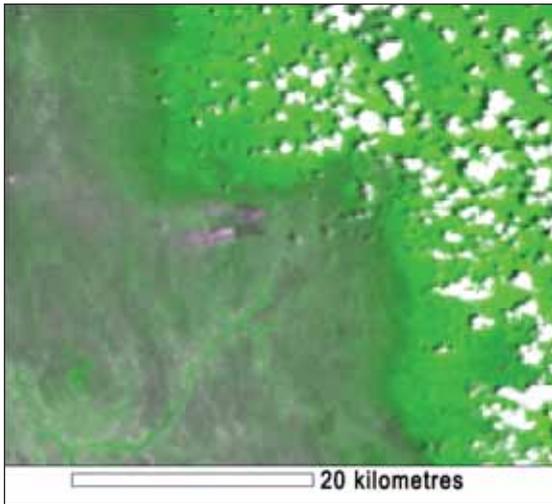
In practice, the coverage is not as good as this because often a fire will be obscured by clouds, smoke or haze or it may not be large enough or hot enough to be detected, particularly if it lies near the edge of a satellite view.

In the fire season a large fire in northern Australia is typically detected perhaps two to four times in daylight hours and two or three times at night by the five satellites. However, as the satellites passes are not evenly spaced through the day, there may be no passes for several hours or more. This means smaller, short-lived fires that flare up in the afternoon and then die down at night may not be detected.

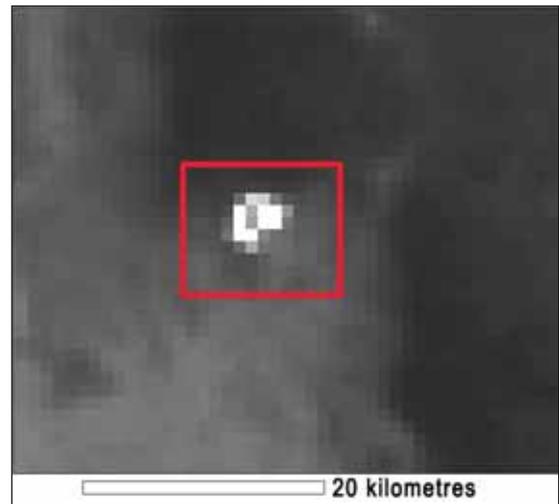
How accurate are hotspots?

Whether or not a fire is detected and the accuracy of its mapping is partly related to the satellites' sensors. Two types of sensors are used to detect fires: the NASA satellites use a MODIS—Moderate Resolution Imaging Spectroradiometer. It is the size of a small fridge and takes digital images of the Earth's surface using a number of different wavelengths or 'spectral bands'.

Images in some of these bands are pretty good at picking out burning fires in the landscape, and they rely largely on



Satellite photo showing a fire left of centre with grey smoke streaming to the left



Lower resolution thermal MODIS image showing same fire. Each pixel is around a kilometre across.

Detecting fires with these sensors is one thing, accurately locating them is quite another. The picture above left shows a satellite photo of a fire inland from Port Douglas, to the right is the same fire from a MODIS image in the thermal wavelengths used to detect the heat signals of fires. Note that while the thermal image has starkly highlighted the fire, because the image is made up of pixels a kilometre or more across, the boundaries of such fires can't be narrowed down to within a kilometre or so.

When you zoom right in on a hotspot on the NAFI site, however, you do get a false impression of precision because the hotspot symbols end up being a lot smaller than a kilometre across. There is a warning about this imprecision below the maps on the NAFI site, but we will have better ways of visualising the uncertainty in hotspots in the 2006 NAFI site.



Hotspots from this fire as seen when zoomed in on NAFI website. Although the hotspots can only be mapped to within a kilometre or so of their actual location, they appear to be located with a higher precision of around a hundred metres at this magnification.

the heat signals given off by the fires rather than how bright they are (see images above).

The NOAA satellites use a similar instrument of older vintage: the Advanced Very High Resolution Radiometer (AVHRR) which was presumably an apt description when it was designed in the 1970s. The AVHRR uses less spectral bands and has a lower resolution than MODIS but also detects fires by their heat.

The fire data from the sensors will be picked up by a number of ground stations across Australia. The WA Department of Land Information (DLI) in Perth and Geosciences Australia in Canberra will then process the data to create the satellite images. All the images in the key thermal bands are then analysed by computers to detect the tell-tale heat signals of burning fires. Once detected, the latitude and longitude of the fires—the hotspots—are then sent to fire-tracking websites including the NAFI site—see web links at the end of the article.

Given that the satellites orbit 700–800 km above the Earth the fires need to be reasonably hot to be detected in this way or, more specifically, hot compared to their surroundings.

Nevertheless quite small 'fires' can be picked up. For example, the heat signals from the top of the stacks in Mount Isa are detected despite being only a few metres across. While other islands of heat such as warm water in dams and hot rock outcrops can sometimes register as fires, the great majority of hotspots appear to be real fires.

Some of these limitations can be overcome by tweaking the computer programs that analyse the satellite images, but most improvements will come from changes such as using geo-stationary satellites that can see the ground continuously and using more sensitive sensors. In the meantime we will continue to improve the NAFI site to make the information it does display easier to use.

Fire scars, areas of burnt country, are also displayed on the NAFI site and WA DLI's Firewatch site. These are generally more accurately located than hotspots and will be dealt with in a future article. Thanks to John Adams and Jackie Marsden of WA DLI for reviewing this article.

North Australian Fire Information: <www.firenorth.org.au>
 WA Dept Land Information: <firewatch.dli.wa.gov.au>
 Sentinel: <sentinel.ga.gov.au>

Fire management advocate for Indigenous people

Jean Fenton has recently begun working with the North Australian Indigenous Land and Sea Management Alliance (NAILSMA), as the new Indigenous Fire Project Officer.

Here, Jean tells *Savanna Links* about her new position.



The project is part of the Northern Australia Fire Project, a Tropical Savannas Cooperative Research Centre (TS-CRC) project which is coordinated by Dr Jeremy Russell-Smith.

Essentially, I see one of the primary roles in my current position is lobbying and relationship building and the advocacy of Aboriginal natural and cultural resource management interests.

Much of the talk about Aboriginal natural and cultural resource management concerns ‘capacity building’ and this is needed to create an equal playing field that allows for democratic community decision-making, negotiations etc. and I also believe there is always scope to build on a person’s or organisation’s skills.

However, I consider this to be a two-way process and that the key to better Indigenous engagement and participation in NRM and particularly in the case of fire management is very much based on the ability of research organisations, government, conservation groups and the wider community in general to ‘shift’ or broaden their approach to NRM. They need to use different approaches and models that better suit Aboriginal perspectives and worldviews. This is particularly relevant when dealing with vast tracts of Aboriginal owned and managed lands as in northern Australia.

In relation to fire management, this area is very new to me, however, I wasn’t employed for my fire knowledge but more for my skills to ensure Aboriginal participation in regional NRM processes, research and other fire initiatives. For example, I’m now working with NAILSMA partner organisations, like the Kimberley Land Council on the EPA Fire Review for the Kimberley, as well as with the community driven Aboriginal fire control teams for enterprise development. I’m working with the Carpentaria Land Council Aboriginal Corporation to help develop a Fire Project Officer position to work across the Waanyi-Garrawa lands in the Gulf in collaboration with the Northern Territory. I’m also working with Balkanu Cape York Development Corporation and the Queensland Rural Fire Services to put in place an Aurukun elder into the position of Fire Warden for the Aurukun community.

If you would like to discuss some of the fire initiatives that are taking place with Aboriginal communities across northern Australia please give me a call.

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Email: jean.fenton@cdu.edu.au

NAILSMA Web: <www.nailsma.org.au>

TS-CRC Fire project: TO COME

North Australian Fire Information: <www.firenorth.org.au>

Graduate rangers for remote north

ONE of the largest graduations of Indigenous rangers took place earlier this year when 32 Northern Territory Indigenous rangers graduated from Charles Darwin University. The rangers successfully completed their studies and received certificates in Resource Management.

The group included 12 Wagiman Guwardagun rangers based in Pine Creek, 17 ‘Djelk’ rangers from Maningrida and three Mimal rangers from the Bulman, Weemol area.

Vocational Education Training resource management lecturer and coordinator David Wise said the course

had been developed in conjunction with the Larrakia Nation Aboriginal Corporation, the Bawinanga Aboriginal Corporation, the NT Primary Industry Training Council and the Northern Land Council.

“It contains many units of particular relevance to remote Indigenous people managing natural and cultural resources,” he said. “These units recognise Indigenous knowledge of land management, history and culture not available in any other course.”

“The Wagiman people have lands in the upper Daly River region and want to have an integrated land manage-

ment program which involves pastoral enterprise such as cattle grazing and weed and feral animal control.”

David also said the Djelk ranger program at Maningrida was one of the NT’s longest running and most successful Indigenous ranger programs and had been associated with the university for a decade.—Lisa Binge.

Read more about Indigenous land management issues in *Kantri Laif*. <lisa.binge@cdu.edu.au>

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Eureka Prize for research on land clearing

DR Rod Fensham and Mr Russell Fairfax from the EPA's Botanical Sciences Unit (Queensland Herbarium) have won this year's Sherman Eureka Award for Environmental Research and \$10,000 prize money. The work of the two botanists has significantly contributed to the understanding of issues related to land clearing in northern Australia and provided impetus for developing a range of conservation measures for protecting native vegetation. Their research has influenced management of native vegetation in Queensland, resulting in the acquisition of reserve areas and a range of co-operative measures to protect native vegetation. Some of their work highlighted the biodiversity consequences of dramatic rates of clearing and underpinned the scientific rationale for legislation that will phase out broadscale clearing of remnant vegetation in Queensland by the end of 2006.

Their work shows that climate change is a significant factor in vegetation change in the savannas, with climate cycles driving woody "thickening" and that bush clearing would not stop this trend.

"The dominant influence is climatic," said Rod, "particularly when you've got multi-year droughts—and particularly in Queensland's savannas south of the monsoonal regions.

President of the Australian Museum Trust and sponsor of the prize, Brian Sherman, said that the two looked outside the square when trying to work out the cause of vegetation thickening and thinning in northern Australia.

"Starting with explorers' reports, old diaries, half a century's worth of aerial photos and many other sources, they were able to identify the real changes that had occurred in natural vegetation and to search for the causes of those changes," he said.



From left, Rod Fensham, Russell Fairfax and Brian Sherman at the awards

Stuart Humpreys © Australian Museum

Rod has also just completed a major component of his work with the TS-CRC's Vegetation Change project, led by Prof. Dave Gillieson, where he has helped improve the accuracy of interpreting aerial photography. This work has a very practical application because aerial records of vegetation are now used in Queensland as the basis for whether or not a landholder can thin vegetation that has thickened up.

"The work that I've done creates a recipe for how you can use aerial photography to measure vegetation change," he explained. "... we will be able to pick up a pair of photos of a single area of ground that span time and come up with an objective decision on whether it's thickened or not."

But for Rod it's now time for a change.

"As far as I'm concerned I'm looking forward to doing something different," said Rod. "It's been eight years of my life on tree change and looking at photos at continental scale. So, I'm getting back to biodiversity, that's my interest."

Rod Fensham, Email: <rod.fensham@epa.qld.gov.au>

TS-CRC Vegetation change project:
<savanna.cdu.edu.au/research/projects/vegetation_change.html>

Eureka Prize, Australian Museum online:
<www.amonline.net.au/eureka/environmental_research/2005_winner.htm>

CRC weed fighters honoured

THE Invasive Species Council Australia (ISC) recently honoured Dr Samantha Setterfield and Dr Michael Douglas of Darwin with its annual Froggatt award. The pair won the prize for their research on the severe impacts of tropical grassy weeds in northern Australia, and advocacy for a strong response from government.

Michael and Sam have shown that the impacts of gamba grass, and other invasive grasses, can cause significant change to the structure and function of some parts of the tropical savannas.

This grass, which was initially released as a pasture for the pastoral industry can be problematic once it es-

capas into lands not used for cattle production. It builds up fuel to a level that encourages much hotter fires, killing native trees, and transforming diverse savanna ecosystem into landscapes dominated by the African grass.

Current research on exotic grass species in the Tropical Savannas CRC is led by Sam and Michael, and John Clarkson from the Queensland Parks & Wildlife Service.

Sam Setterfield & Michael Douglas, CDU
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<michael.douglas@cdu.edu.au>

CRC Research: Impacts of Exotic grasses
<savanna.cdu.edu.au/research/projects/impacts_of_exotic_g.html>

Track birds online

FOR those interested in tracking the flock bronzewing pigeon and Australian bustard, you can now use an online form on the TS-CRC website to give input on where you have seen the birds.

Last issue we asked interested pastoralists to become part of a project that is tracking native flock pigeons and the Australian bustard, both highly nomadic birds. The data will be used to produce a map of the birds' distribution and to analyse environmental factors that determine this distribution.

Go to: <savanna.cdu.edu.au/information/bird_survey.html>

A new research project aims to use Aboriginal knowledge to complement Western science to help explain where and why our northern mammals are in decline. *Mark Ziebicki* explains.



Above: Kakadu resident and ranger Jessie Alderson talks with Mark Ziebicki about the status of mammals in the region. Mark is holding a stuffed nail-tail wallaby
 Photo: Carol Palmer



Mark Ziebicki prepares museum specimens (left) at the Biodiversity Conservation Unit Laboratory for the project.
 Photo: Jenni Risler

Museum mammals to help track decline

Mammals in northern Australia are in trouble. On the surface, our northern landscapes appear largely intact, but recent evidence suggests that not all is as it should be with our environments. Many mammal species and some birds have declined or disappeared across northern Australia, representing the major loss of biodiversity in the tropical savannas. These declines reflect those that have occurred in central Australia in the past where 15 species have become extinct, most of them throughout their entire range. Many of the species that appear to be declining in northern Australia are from the same groups as those that have proved most susceptible to decline elsewhere in Australia: the so-called ‘critical weight range’ mammals including bandicoots, possums, quolls, smaller wallabies and larger rodents. Comparisons of the present situation with historical records gives us an idea of the scale of these losses. Knut Dahl, an early zoologist/explorer, wrote of his experiences in the south-east Kimberley and Arnhem Land in 1897. His accounts provide some insight into how things have changed. He writes, for example, of the golden bandicoot in the Broome region: “very numerous in the coast country around Roebuck Bay... great numbers being brought to me”. These bandicoots are now only found in a small area of the

Kimberley, two small islands off Western Australia and one island off Arnhem Land (see map, opposite page).

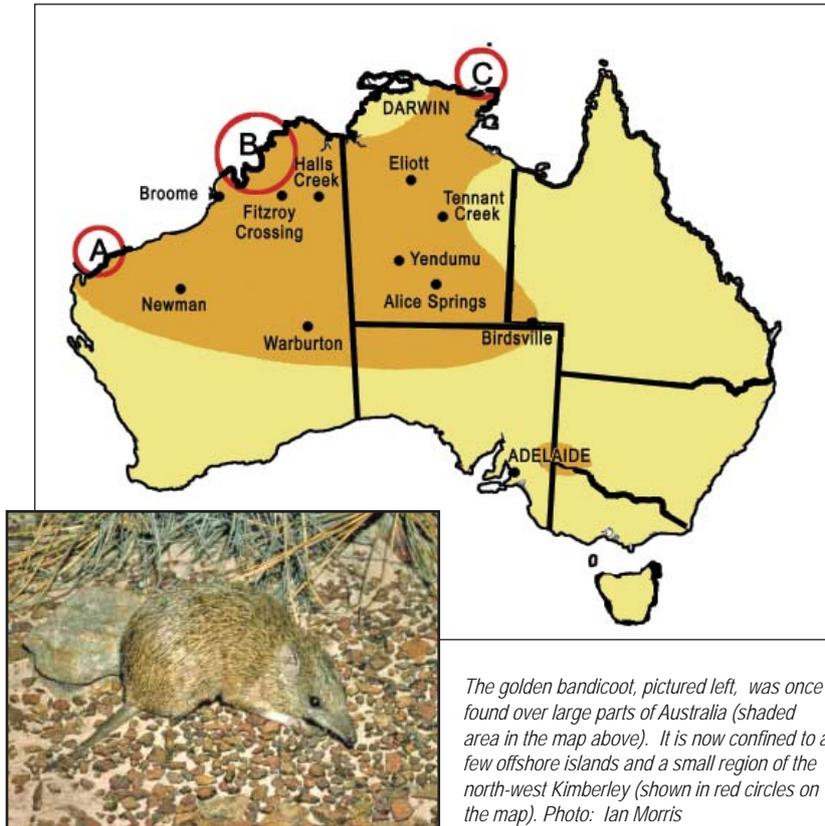
Similarly, the golden backed tree-rat: “the houses of settlers...are always tenanted by (this species)”. It has not been seen in the Northern Territory since 1969 and now occurs only in a few small areas of the Kimberley.

Ecological research in northern Australia has historically lagged behind that of other regions. Although there had been a handful of baseline studies, pioneering surveys and unrelated studies of individual species in the past, most studies of northern Australia’s mammals began 10–15 years ago. Much of the focus of these recent efforts has been on broad-scale surveys of representative sites across northern Australia, re-surveys of baseline sampling sites and targeted, selected studies of individual, representative species.

The relative infancy of wildlife research in the north compounded by the inherent difficulties associated with studies of a largely nocturnal, secretive group of animals over large and sparsely settled regions means that much of our scientific knowledge is fragmented, punctuated by gaps in our understanding—making it difficult to pinpoint the extent and timing of losses that may have occurred.

Two Tool-Box Approach

To get a broader perspective in geography and time of the changes in mammal status in northern Australia, and to fill in



The golden bandicoot, pictured left, was once found over large parts of Australia (shaded area in the map above). It is now confined to a few offshore islands and a small region of the north-west Kimberley (shown in red circles on the map). Photo: Ian Morris

Previous studies

Our present study is modelled on a similar study conducted in the mid-1980s by Burbidge et al. (1988) that aimed to document the status of mammals across Australia's deserts using Aboriginal knowledge.

Aboriginal people living in communities scattered across Australia's deserts were shown museum skins and asked to provide local names, current and past status, and aspects of biology and ecology of each species.

This study demonstrated very successfully the use and importance of such knowledge by presenting new information about the distribution patterns and ecology of many species that would otherwise have been unavailable. The mammals of the central deserts were richer and more widespread than generally believed, but these regions underwent massive and rapid losses of species—a situation that seems to be repeating itself across Australia's north.

some of these gaps in our knowledge, we aim to complement the scientific studies and historical records with the perspectives of Aboriginal people.

By using these two knowledge systems, we aim to use 'two-tool boxes' to address a common problem that is too difficult to tackle with just one set of solutions.

Many Aboriginal people that have been able to remain on country, or spend significant time there, retain an intimate knowledge of many of the plants and animals on their lands.

In collaboration with Aboriginal participants, we propose to chart the pattern of mammal decline across much of northern Australia through documentation of Aboriginal knowledge of the current and past status of mammals.

This approach is modelled on that used very successfully across Australia's central deserts in the mid-1980s (see Burbidge et al. 1988) to describe the pattern of decline in the central Australian mammal fauna.

Over the 2005–06 dry seasons we will visit numerous communities and outstations across the Top End and Kimberley to speak to Aboriginal people about the status of mammals that live, or have lived, on their country. To help stimulate discussions, and also

to help identify each species, we will travel with a suite of stuffed, museum specimens of each species—in effect a traveling mammal puppet show!

The study aims to support a two-way flow of information. Knowing about science helps Aboriginal rangers and communities look after animals and country at a time when things have greatly changed since the old days. And knowing about Aboriginal knowledge helps scientists understand country and what is important to Aboriginal people living on country.

We hope to get this exchange in the course of discussions and by the preparation of educational materials as requested by communities (for example, teaching materials, videos and posters.)

The results of these investigations, together with complementary information derived from western scientific studies, will enable us to chart the geographic and ecological pattern of decline of fauna across northern Australia.

These patterns can then be related to a broad set of environmental factors (including topographic relief, land use and tenure, fire regimes, history of settlement, feral animal distributions, etc.) to examine the processes underlying patterns and the causes of mammal declines. The information could then be used to assess the success of the region's

protected areas in conserving biodiversity and the kinds of management regimes needed to improve long-term conservation objectives both on and off reserves.

Project details

This is a collaborative project between the Australian National University (ANU), the Biodiversity Conservation Unit of Dept. Natural Resources, Environment & the Arts (NRETA), Northern Land Council, the North Australian Indigenous Land and Sea Management Alliance and the Wilderness Society. It is funded by an ARC linkage grant to John Woinarski (NRETA) and Brendan Mackey (ANU).

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Reference

Burbidge, A.A. & Johnson, K.A. et al. 1988, 'Aboriginal knowledge of the mammals of the central deserts of Australia,' *Australian Wildlife Research*, 15: 9–39.

Bugs key to productive, healthy pastures

Many indicators of how grazing affects land condition are based on assessments of the effects of changing soil health rather than the causes.

But a team from the Tropical Savannas CRC and CSIRO has gone to the source, by researching processes that maintain the soil's ability to capture rainfall.

They've found that providing the right conditions for earthworms, termites and ants will all improve tropical pastures.

Further, these macro-invertebrates can also provide an early-warning system for soils on a downward spiral. The research team* explains



Photo: Adam Liedloff

Termites constitute 10% of all animal biomass in the tropics, and up to 95% of soil insect biomass. They are the major determinants of soil structure and the biological processes that underpin soil health. Termites have been shown to have spectacular effects on soil hydraulic function, leading to increased rainfall use efficiency and pasture production.

Australia's tropical savannas are characterised by low fertility soils, highly variable rainfall and long dry seasons.

The amount of rainfall captured and stored by the soil is the key driver of plant growth, but this can vary considerably across the landscape. If the soils capture the first rains of the wet season effectively, the longest possible growing season for pastures is ensured.

However, landscapes that don't capture this rain effectively will have a longer dry season, which in turn will cause further declines in soil health and productivity. In contrast to southern Australia, high intensity storms account for most of the rainfall in tropical savannas. Therefore we need to maintain high soil infiltration rates to ensure that as much of this water as possible is retained in the landscape.

How is soil health important in savannas?

Soil health, like human health, comprises two important aspects. Firstly, there is the absence of disease and secondly fitness, or general well being. In north Australian savannas, the fitness of soils, and in particular their ability to capture and retain rainfall, is the most important aspect of soil health and the major factor that can limit plant production.

In contrast, where the physical properties of soils are either satisfactory or can be cost-effectively manipulated (e.g. by tillage) such in the cropping lands and sown pastures of southern Australia, the disease aspect of soil health can become a more important limitation."

Role of macro-invertebrates

The critical role of termites and earthworms in maintaining hydrological function of tropical savanna soils is widely

recognised. Soil macro-invertebrates such as termites, earthworms and ants create large holes in the soil (macro-pores) that facilitate the infiltration of rainwater.

These macro-invertebrates increase water infiltration, facilitate gaseous exchange and provide a favourable environment for root growth. Increased infiltration rates can reduce surface run-off and soil erosion.

Macro-invertebrate activity also increases litter decomposition, carbon and nutrient turnover, nutrient storage and soil turnover. These animals are most active in patches of perennial vegetation, and help the patches capture and store run-off water. Grazing animal management can greatly influence the sustainability of these perennial vegetation patches.

Under conservative stocking, the activity of soil macro-invertebrates is high, but under high rates of pasture use, activity declines, leading to reduced soil porosity and reduced rainfall capture. This in turn reduces the length of the growing season for pastures. We have found that simple assessments of macro-invertebrate activity are good on-ground indicators of the state of soil health.

Automated soil moisture data collection

The Tropical Savannas CRC project, *Soil health in savannas*, is examining the effects of stocking rates on soil health and landscape productivity within the Wambiana Grazing Trial near Charters Towers, Queensland, which is co-funded by the Queensland Department of Primary Industries & Fisheries and Meat and Livestock Australia. Previous research using soil infiltrometers contributed to understanding the impacts of stock management on soil-water.

However, the artificial and 'one-off' nature of this method



Photo: Garry Cook

How much rain soaked in?

High tech electronics and remote communications are being used to validate our indicators, by measuring the actual variation in rainfall capture across the landscape. Four stations are used for the automatic collection of soil water data. Each station is connected to sophisticated soil moisture measurement probes.

Three stations communicate with a base station by radio signals, with all data collected monthly via the CDMA mobile network. Rainfall and flume data are automatically collected, with SMS messages sent to researchers when overland flow occurs to enable the quick collection of sediment samples.



Photo: Adam Liedloff

restricts its applicability. This project developed an automated soil moisture data collection facility which gives a better method of assessing soil health, by directly measuring daily changes in soil water throughout the year.

In paddocks of different stocking rates, probes in different patch types (bare, grass and shrub patches) record the amount of soil water at four soil depths down to 0.5 metres. Integration with existing automated rain gauges and run-off flumes is allowing a full eco-hydrological understanding to be developed.

The project is integrating its understanding of the dynamics of soil health with measurements of pasture and livestock productivity and enterprise profitability. This information is also being incorporated into computer simulations such as the Tropical Savannas CRC Savanna.au model, to predict the outcomes of different management decisions on landscape ecohydrology, soil health and productivity.

Soil health indicators

Many indicators of how grazing affects land condition have been developed, but they are often based on assessments of the effects rather than the causes of changing soil health. The ability of indicators to provide early warning of soil health decline will be greater if they measure the cause rather than the effect.

For example, vegetative cover alone has been shown to be a poor indicator of soil-surface properties and water infiltration, because pasture quality and economic productivity can remain high over the short term while the ability of soils to capture and retain resources declines.

Heavy use of pastures can start a process of declining soil health that will reduce soil water availability and limit pasture regrowth and further reduce soil health. This negative feedback means that poor soil health is very difficult to reverse and such efforts are unlikely to be cost-effective.

Continued on page 12



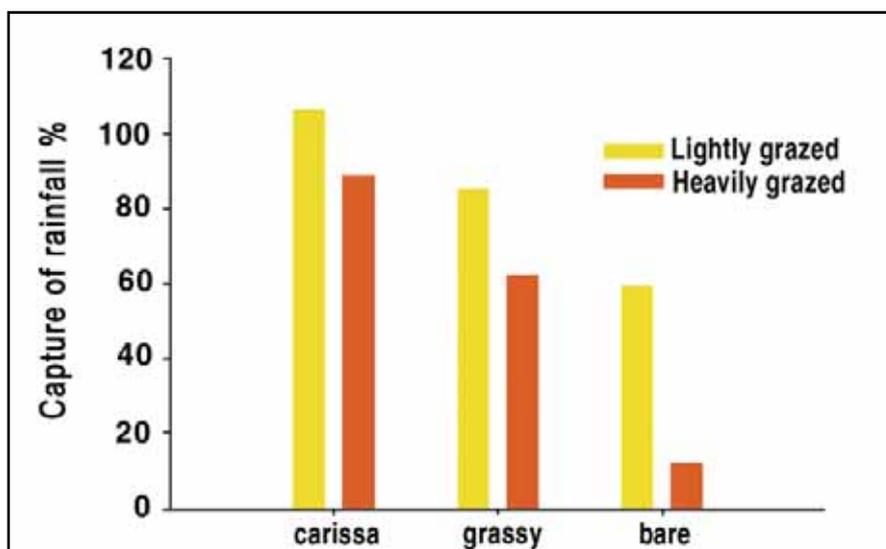
Question: How can we tell if a paddock has high macropore densities and therefore good water infiltration and soil health?

Answer: Search for signs of the presence of macro-invertebrate activity. Results from the current research show that termite sheeting (shown above), earthworm casts and ant nests on the soil surface provide an indication of the levels of macro-invertebrate activity and the presence of macropores. Assessment is easy and provides a simple direct measure of soil health.



Photo: Garry Cook

Above: One of the flumes used to measure the volume of sediment, nutrient and water run-off. Interest in the impacts of soil macrofauna on infiltration has been motivated by previous research showing changes in surface runoff with variation in grazing intensity. This study is showing that soil macropores created by macro-invertebrates are a key factor leading to high infiltration rates.



Above: the percent of rainfall entering the soil within the different vegetation patch types considered in this study. As grazing intensity increases, the percentage of rainfall captured is reduced.

Right stocking rates equal pasture health

Results from the research so far are showing that conservative stocking maintains the ability of soils to capture rainfall.

Under conservative stocking, soil macro-invertebrates such as termites, earthworms and ants create large holes in the soil that facilitate the infiltration of rainwater (macro-pores).

However, under high rates of pasture use, macro-invertebrate activity declines, reducing soil porosity and rainfall capture.

This in turn reduces the length of the growing season for pastures. We have found that simple assessments of macro-invertebrate activity are good on-ground indicators of the state of soil health.

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Bugs key to productive pastures

From page 11

By studying the biological processes that maintain the soil's ability to capture rainfall, the project has shown that there is potential for early warning indicators of soil productivity decline which could be used to prevent degradation occurring. This project is developing and testing the validity of soil macro-invertebrates as indicators of soil health. As well as being the key drivers of nutrient cycling and hydrological processes in tropical soils, they also have many other attributes that make them ideal indicators of soil health. They are sensitive to a range of environmental stresses; easily measured and quantifiable; their functional role is easily understood; and they are simple to use, rapid and inexpensive. The assessment of broad groups of soil macrofauna such as termites, worms and ants can often permit the evaluation of the sustainability of a system without the need for taxonomic expertise.

Results from our work are showing that simple measures of macro-invertebrate activity, such as the density of macropores in the soil surface and the proportion of the soil covered

by worm casts and termite sheeting, correlate highly with the amount of rainfall captured during storms. Recently, in some of our restoration manipulation studies, the indirect introduction of soil macrofauna led to a 30% increase in soil-water infiltration and retention rates during the first rains of the wet season, and a 60% increase in litter decomposition rates.

Manipulation experiments are also under way to examine what effect the removal of specific soil macrofauna has on soil ecohydrology and nutrient dynamics.

Conclusion

Benefits from devising and implementing optimal grazing management that promote sustainable soil health through the management of vegetation and associated soil macrofauna, will include improved pasture productivity, drought survival, biodiversity, soil organic matter levels, improved soil structure and reductions in sediment, nutrient and water run-off. Most importantly, improvements in all these factors will strengthen rural enterprises through maintaining productive landscapes.

Healthy outlook for Cape venture into fruit business

AN unusual tree with an unusual reputation could be the means for a new industry in the remote township of Pormpuraaw on Cape York Peninsula. *Morinda citrifolia* is famous across the south Pacific for the alternative health drink, Noni Juice—but its taste is unlike any other fruit, with some likening it to a combination of blue-veined cheese and hot mustard! Yet this hot fruit could become hot property for the Christmas Creek Aboriginal Corporation, which plans to enter the fledgling Australian Noni juice market with its first plantation scheduled for picking in 2006.

Eddie Holroyd, chairman of the corporation, said that the Noni Juice production project would mean a steady income for the Pormpuraaw people. Pormpuraaw is located in the Gulf of Carpentaria near Weipa and supports between 750 and 1000 residents.

“Aboriginal people have always chewed the fruit as a medicine for many illnesses,” said Mr Holroyd. He also doesn’t have a problem with the fruit’s taste. “I like it; it’s very different to every other fruit, like apples and oranges. It’s bitter and smells horrible—but it does have a lot of good properties.”

The potential new business began with a 2002 feasibility study undertaken by the Indigenous Business Unit of the Queensland Department of State Development, Trade and Innovation. The Christmas Creek Aboriginal Corporation has now received a \$197,000 grant from the department to develop and market the product.

Dr Tony Page, at James Cook University’s School of Tropical Biology, has been involved with the project since its inception, researching domestication of the crop and how to develop cultivated varieties with improved fruit size and yields—which can lead to greater volumes of juice and long-term profitability for the corporation.

“We looked at a number of sites on traditional land on



Morinda fruit: the source of Noni Juice. Challenging in appearance, but good for you

Photos: Greg Calvert

Christmas Creek,” he said, “Looking at fruit size, variation in habit and yield, and found considerable variations. So we thought it would be great to undertake a commercialisation project with the community.”

There is no previous history of large-scale production in Australia, but the fruit is starting to be grown south of Cairns, where a growers’ association is now based. In the early stages, the Christmas Creek Noni Juice will be sold to the association, which Tony says is a good step into the market for the corporation.

The fruit does have high amounts of vitamin C, but its health tonic reputation is still largely anecdotal. It is used for ailments as diverse as colds, flu, diarrhoea, asthma and sore throats—not to mention joint pain, heart palpitations and cancer.

“It’s powerful and potent stuff,” said Eddie. “Take my word for it—it won’t cure in a day or two, but over the years you will feel as good as gold again.”

Contact Eddie Holroyd, Christmas Creek Aboriginal Corporation
Tel: 0420 104 164 Dr Tony Page, Tel: (07) 4042 1673

Email: <tony.page@jcu.edu.au> Read an article on Noni Juice and Morinda fruit by Greg Calvert at Australian Plants Online:
<<http://farrer.riv.csu.edu.au/ASGAP/APOL21/mar01-5.html>>

Grazing land management for the Gulf

A **GRAZING Land Management (GLM) package** is now being designed for the southern gulf region in Queensland. Vanessa Alsemgeest and Rebecca Anders from the Qld Department of Primary Industries and Fisheries in Mount Isa, working with the Southern Gulf Catchments group, have been gathering information from local graziers, government agencies and other sources. The end result will be a three-day workshop for beef producers which will focus on and cover grazing management, use of

fire, pasture improvement and weed management.

The workshop aims to give participants an appreciation of environmental and ecological issues in the southern gulf using research collected from grazing trials and Landcare activities as well as local knowledge.

Using a local property as a case study, graziers will be able to look at different management options and how they affect profits and land condition—culminating in the development of a grazing land

management plan for their own property. There will also be a follow-up day and on-going support for the participants. The Tropical Savannas CRC played a major role in developing the basic GLM package which is an MLA initiative in partnership with QDPIF.

The GLM package will be ready after July 2006. Until then, if you have information that could be used to develop a profile on the case study property or would like to be involved, please call Vanessa or Rebecca on Tel: (07) 4747 2028.

Trees vs pastures in the Territory's monsoonal savannas

Results from experiments conducted in Katherine contradict previous studies that showed no real benefits from tree clearing in the monsoonal savannas.

Studies in these areas of the Territory showed that pastures did benefit from removing trees—but the jury is still out on whether or not the effect is long term, and sustainable over the long haul.

Robyn Cowley reports on initial results from a study conducted by the NT's Department of Primary Industries, Fisheries & Mines.



In most regions it is generally acknowledged that trees and grass compete for water—the more trees, the less grass. However, studies by CSIRO in Katherine in the 1960s (Norman 1966) and 1970s (Winter et al. 1989) found little or no long-term benefits from tree clearing in the tropical north. It was assumed that this was because there was little competition for water between trees and grass during the growing season, when water is plentiful. However, it was proposed in the 1980s that trees and grass might compete for a more scarce resource—nutrients.

This matters because various studies have shown that tree and shrub thickening is occurring in the savanna woodlands. In other regions, increasing woody vegetation has been shown to decrease pasture production and livestock carrying capacity.

To help predict the impact of woody thickening in the Katherine and Victoria River regions and, in turn, develop appropriate management responses, the NT Department of Primary Industry, Fisheries & Mines investigated the effects of trees on native pasture growth and quality at Katherine and Kidman Springs from 1995 to 2000. Their results contradicted previous findings, but have not been widely disseminated to date.

What did they do?

Tree–grass study sites were established at Katherine Research Station and Kidman Springs (Victoria River Research Station) during 1995 and 1996. At each location two replicated sites were established.

A 60 metre x 60 metre area was cleared of all standing trees and shrubs using a chainsaw. Felled debris was removed from the plots and remaining stumps poisoned with herbicide (Tordon). A 30 m x 30 m plot in the centre of the cleared area was chosen as the sampling plot and fenced to prevent livestock grazing. An adjacent uniform uncleared 30 m x 30 m plot was also chosen and fenced. The paired treed and no trees sites were monitored for soil water and pasture variables for between three and five years.

What did they find?

Rainfall during the study was generally above average at all sites. While soil moisture was on average 7.5% higher in cleared plots, differences were only statistically significant on two occasions (1995–1996 and 1999–2000 at the Katherine sites). Despite this, plots in the cleared sites grew on average between 35–70% more grass than treed plots (Table 1).

At the Katherine sites there was also significantly higher nitrogen yield (total kg of nitrogen/hectare) and percent nitrogen on treeless sites, but this was not the case at Kidman Springs.

So what does it all mean?

There was more pasture and sometimes pasture of higher quality in cleared sites compared to treed sites. The Kidman sites had more grass, but it was of lower quality when trees were removed. This suggests that woody thickening could have negative impacts of pasture growth, and hence carrying capacity.

| Site | Katherine | | | | Kidman Springs | | | |
|--------------------------------------|-----------|-------|----------|-------|----------------|-------|----------|-------|
| Replicate | Dixon | | Paige | | Loungers Hill | | Native | |
| Treatment | No trees | Trees | No trees | Trees | No trees | Trees | No trees | Trees |
| Tree basal area (m ² /ha) | — | 17.2 | — | 12.4 | — | 11.2 | — | 24.2 |
| Pasture Yield (kg/ha) | 3019 | 2089 | 3621 | 2013 | 2462 | 1637 | 5053 | 4253 |
| Total nitrogen (kg N/ha) | 15.6 | 8.2 | 15.5 | 9.0 | 5.6 | 5.6 | 13.0 | 17.7 |
| Nitrogen % | 0.56 | 0.41 | 0.47 | 0.45 | 0.26 | 0.40 | 0.32 | 0.45 |
| Years | 4 | 4 | 5 | 5 | 5 | 5 | 3 | 3 |

Table 1: Average differences of tree and pasture characteristics observed in cleared and treed treatments at Katherine and Kidman Springs.



Above: Katherine Research Station sites (above) showed significantly higher nitrogen yield and percent nitrogen on treeless sites. Previous page: Loungers Hill (Kidman Springs) Paired sites were monitored for soil water and pasture variables. Plots in the cleared sites grew about 35–70% more grass than treed plots.

What should we do about it?

Fire studies at Kidman Springs have demonstrated that regular burning of country (every four to six years) is a cheap and effective way to control woody plants. Keeping fire in the system may be the best way to ensure that your country remains productive for the long haul.

Further studies

Because the results are only over a relatively short time, it may be that at the Katherine sites removal of trees resulted in an initial flush of nitrogen released from decaying roots, which would eventually decrease through time. For this reason we are assessing the trial sites again this growing season to see if the original differences between plots are still there 10 years after the trees were removed.

Winter et al. (1989) found that the increased growth in cleared treatments only lasted for three years post clearing, with the rate of rundown greatest in the highest stocking rates. Because our sites were not grazed, it may be that nutrients are not being harvested by grazers at our sites and why our findings differ to previous studies. If cleared sites are still producing significantly more grass next year, the next step would be to remove fences and monitor changes under grazing.

Honours project

Would you like to be involved in further research into this study?

The NT Department of Primary Industry, Fisheries & Mines has an Honours project available, looking at the longer-term effects of tree removal at the Katherine sites.

Contact: Dr Lindsay Hutley, Charles Darwin University

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Email: <lindsay.hutley@cdu.edu.au>

Acknowledgement: Linda Cafe conducted the research outlined here. This study is published in the report Dyer et al., 2003, *Developing sustainable grazing management systems for the semi-arid tropics of the Northern Territory*, Meat and Livestock Australia, North Sydney.

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Norman M.J.T. 1966, Katherine Research Station 1956–1964: A review of published work, Division of Land Research Technical Paper No 28. CSIRO, Australia.

Winter, W.H., Mott, J.J. & McLean, R.W. 1989, 'Evaluation of management options for increasing the productivity of tropical savanna pastures 3. Trees', *Australian Journal of Experimental Agriculture* 29: 631–34.

Role of trees not so clear in the dynamic savanna

As shown by the article on page 12, there is still a lot we do not know about the long-term consequences of tree clearing on long-term grass production and water and nutrient conservation in savanna landscapes. In an excerpt from a forthcoming TS-CRC publication on the role of trees in the landscape, a group of ecologists* explore some of these issues.

Log mounds create barriers in the landscape that trap litter and sediment that might otherwise be lost. They also support rich biological activity as seen here by the earthworm casts and termite runways. These invertebrates help enhance soil structure and recycle nutrients. Photo: Adam Liedloff.



The role of trees in the water cycle is not just as users of stored soil water, they also enhance the ability of landscapes to capture rainwater. The soil under trees is typically covered with a layer of dead leaves, bark, twigs and branches. Under the soil are channels made by roots as well as decomposing remains of both fine and coarse roots. The annual drop of litter by trees can be substantially greater than that from grasses growing between the trees.

By providing a source of energy, nutrients and shelter, trees encourage soil biological activity. The activity of soil macro-invertebrates such as earthworms, termites, ants, centipedes, millipedes and spiders contributes greatly to the formation of large pores in the soil. Exudates from decomposer organisms dependent on the litter help stabilise the soil structure and maintain the integrity of the friable soil structure under trees. These pores greatly enhance the rate of water infiltration into the soil. This leads to reduced runoff of water and greater soil water storage. The reduced runoff decreases the likelihood of nutrients and soil being eroded from the landscape.

Trees also reduce soil erosion caused by rain drop splash. This process involves the displacement of surface soil by the impact of raindrops during high intensity rainfall events. Any interceptor, such as a tree canopy, can reduce the effect of raindrop erosion considerably. Grass cover also reduces raindrop erosion but problems occur when the grass cover is reduced due to extreme events such as drought or intense wildfire.

Trees and soil erosion

By causing obstructions in the landscape, trees and fallen logs can reduce the speed of overland flow of runoff water. This causes flowing water to deposit suspended particles such as litter and soil materials. Trees can thereby reduce the erosive potential of water. The deposition of materials around log mounds helps create rich patches in the land-

scape, which contribute to increased productivity in otherwise poor soils. Along the banks of rivers and streams, trees help maintain healthy riparian ecosystems. Their roots help bind the soil and reduce river bank erosion. By slowing down water flow they encourage the deposition of silt on levee banks. Streambank erosion is a major source of sediment, which is deposited in estuaries, and of suspended solids which affects marine and freshwater plants and animals. Although in some areas much effort has been put into removing logs from streams and rivers, these obstructions and snags are important to freshwater ecology and can reduce the maximal level of floods by slowing water flow and increasing the time of concentration of floodwaters.

Trees and dryland salinity

Current estimates suggest that the risk of dryland salinity developing in north Australian savannas is somewhat lower than in southern Australia. However, certain savannas with a particular combination of rainfall, soils type and hydrology are susceptible to dryland salinity. A major cause of salinity is a change in hydrology due to changes in water use of vegetation. If vegetation is altered to use less water than the original vegetation, groundwater is recharged at a faster rate transporting salt into the upper soil profile. The extraction of soil water by trees plays an important role in preventing dryland salinity.

Trees, nutrients and water

Savanna soils typically have low nutrient levels, particularly with respect to nitrogen and phosphorus. Australian savannas in particular are associated with ancient and highly leached soils and are considered less productive than African and American savannas. Eucalypts dominate the Australian tropical savannas because they can tolerate low nutrient soils, having low requirements for nutrients and specialised fungi associated with their roots, which increase access to nutrients.

Trees can create 'islands of fertility' by enhancing the availability of nutrients and water. Trees live generally for a long time; their roots penetrate deep into the soil, and their leaf litter accumulates on the soil surface. Because of this, trees can act as pumps, bringing nutrients from deep in the soil to surface layers. Consequently, concentration of soil nutrients, such as nitrogen, are often higher under trees than out in the open.

Trees can also cause hydraulic lift of water. This process involves the uptake of water from deeper and wetter layers in the soil by tree roots and the releasing of that water into shallow drier layers where it is available to plants with shallower root systems, including grasses. Furthermore, by providing shade which reduces temperatures and evaporation, and obstructing wind flow at ground level which reduces the demand for water by plants growing there, trees can also alter the micro-climate to the advantage of grass growth.

Trees and grass production

The influence of trees on microclimate, nutrient and water cycling can produce a beneficial 'tree halo' effect, with more palatable species of grass growing under the trees. For example patches of kangaroo grass (*Themeda triandra*) or golden beard grass (*Chrysopogon fallax*) may grow under a tree, while wire grasses (*Aristida* spp.) grow outside its canopy. These tree halos may persist for many years or even decades after the trees have died.

On the other hand, trees compete for nutrients and water with grasses, though at present, we do not know how much competition actually occurs. We do know that there is usually a marked increase in pasture production in recently cleared savannas. While some of this is undoubtedly due to removal of competition, at least part of it is due to the release of nutrients formerly stored in the trees.

Land clearing and landscape health

The enhanced pasture growth after clearing usually declines over time. Although the reasons are not well understood there is great potential for ongoing change in soil nutrient relations. For example, nitrate can leach from soils during

the intense wet seasons that occur in savanna regions, and this probably contributes to the decline in grass production with increasing time after clearing. In addition, the boost in phosphorus released from cleared vegetation may soon fall away, as phosphorus is immobilised in soil minerals. We already know that trees help conserve water, nutrients and soil in the landscape by helping capture, retain and recycle them locally. This is why cleared catchments usually experience greater runoff and sediment loss than uncleared catchments. For clearing to be justified economically the boost in pasture productivity that follows clearing needs to be sustained over the long-term.

Clearing does not always result in a degradation of the soil and water processes, provided it is well sited and executed, and includes an ongoing maintenance regime that is strictly adhered to. The potential for increased erosion and sedimentation that follows clearing is particularly high after extreme climatic events, such as drought and intense wildfire, due to the increased surface runoff resulting from decreased vegetation and groundwater infiltration rates. Maintaining good grass cover at such times is both more important and more difficult in landscapes with reduced tree cover.

At present, there is a lot we do not know about the long-term consequences of tree clearing on water and nutrient conservation, and hence long-term grass production, in savanna landscapes. For example, how much of the increased grass growth after tree clearing is a short-term boost provided by nutrients released from dead trees? Will the loss of trees as nutrient pumps cause a gradual rundown of the ecosystem? Will the long-term costs outweigh short-term gains?

Current research aims to answer these questions but we do not yet have all the answers. What we do know is that they will be much more complicated than 'fewer trees = more grass'.

* By Garry Cook¹, Susanne Schmidt², Ian Lancaster³ and Adam Liedloff¹. 1. CSIRO Sustainable Ecosystems, 2. University of Queensland, 3. NT Dept. Natural Resources, Environment and the Arts

Sticker to provide funds for quolls' Island Ark



Photo: Ian Morris

THE Australian Geographic Society is raising money for the Northern Territory Island Ark Program, which rescues populations of quolls from the invading cane toad and protects them on toad-free islands.

By buying a sticker at an Australian Geographic Store, or donating money to the AG Society for the quoll program, you'll help scientists monitor the health and safety of these populations.

"They're going to be the only populations of quolls that are going to be maintained away from the cane toads", said Brooke Rankmore, one of the biologists in the program.

Your donations will help scientists check that the quolls are doing okay, breeding and maintaining genetic diversity. Please send cheques or money orders to the AG Society, marking them For The Island Ark Program, PO Box 321, Terrey Hills, NSW 2084.

More information on quolls:
See 'Quolls decline with advance of toads', *Savanna Links*, Issue 26, July–Oct. 2003
<savanna.cdu.edu.au/publications/savanna_links26/grim_news_for_nt_qu.html>

New era for fire management in Indonesia

The first phase of a project looking at fire management in eastern Indonesia is now complete.

Jeremy Russell-Smith describes how the project, which has partners from both Australia and eastern Indonesia, has helped chronic fire management problems



The project has concentrated on the province of Nusa Tenggara Timur (NTT)—home to more than 4.5 million people, with more than 85 per cent relying on subsistence agriculture. NTT includes West Timor (Timor Barat), Flores, Sumba and a multitude of smaller islands.

Four villages from eastern Sumba and Central Flores agreed to take part in the study. Rural incomes, both in these villages and surrounding areas, are very low compared to Indonesian national standards—the average annual income per capita is much less than \$100. Also, while villages encompass mostly extensive areas of grassland savanna, proportionately most income and products are derived from limited areas of arable cropping and very diminished forested lands, and small livestock, such as pigs.

Much of NTT comprises fire-prone savanna under very similar climatic conditions to northern Australia. And while fire is used as an essential tool in both pastoral and cropping management systems, there has been a breakdown of traditional forms of locally coordinated fire management across much of the region. The result today is that uncontrolled fires significantly impact on environmental assets, livelihoods, and economic conditions.

However, against this reality, Indonesian national fire policy currently proscribes all use of fire, but with the effect that, “...the current zero burning policy does not address regional management needs, is unenforced, and is unenforceable” (Tacconi & Ruchiat 2005).

Community-based approach to fire

The project has demonstrated coordinated, community-based approaches to fire management at the four villages. Working with local communities, NTT Government (Provincial Planning Board—BAPPEDA NTT, Forestry Dept—Dinas Kehutanan), higher education (Wira Wacana Christian School of Economics, Satya Wacana University), and the well-organised local NGO sector, the project has implemented:

- fire management activities at each of the four villages (ranging in size from 10–70 km²). These activities focused on protecting high-value agro-forestry plantings. Importantly, this component of the project was developed within an ‘action research’ framework, where activities are collectively developed, monitored and assessed by

community, institutional and research partners.

- community extension, planning and training activities—the latter including remote sensing (fire mapping using satellite data) and associated GIS training for BAPPEDA NTT staff, and, with the assistance of funding support from the Crawford Fund, resource inventory training focusing on assessing the status of limited remaining forest resources.
- educational capacity development, particularly through the transfer of Ecology & Management of Tropical Savannas and Landscape Ecology & GIS modules developed through the TS–CRC, and associated training courses, delivered to Satya Wacana University (based at Salatiga, Java), a major higher education supplier to NTT.

Remote sensing and GIS

The project has established that remote sensing and associated GIS tools as used for fire monitoring (e.g. ‘hotspot’ detection) and mapping in northern Australia, can also be applied to savanna landscapes in NTT, despite some detection issues associated with cloudiness and highly reflective limestone (Sumba) surfaces.

While the seasonality of burning is similar to that in northern Australia, with most fire activity occurring in the late dry season, the sizes of individual fires are substantially smaller, with the very great majority of fires being less than 5 hectares (Fisher et al., submitted). Overall, fires were found to burn an annual average (2003–04) of 29% of eastern Sumba (comprising mostly grassland savanna), and 11% of central Flores (with large forested areas).

Future directions

The project and its research approach has been widely accepted by local communities and institutions in eastern Sumba and central Flores. In a recent independent review of the project conducted by Indonesian and Australian consultants, the reviewers found that the project had performed ‘very successfully’ and congratulated ACIAR for supporting an action research, developmentally focused project outside of its normal, more conventional arena of research interest.

The reviewers recommended that the project be expanded to other areas of NTT, especially Timor Barat, and that a major regional workshop be held in Kupang to review work

How the project began

Building on regional workshops held in 1995 in Kupang, the capital city of the Province of Nusa Tenggara Timur (NTT), and in Darwin in 1998, the project formally began in 2000. With funding principally from the Australian Centre for International Agricultural Research (ACIAR), and also through Charles Darwin University, the Tropical Savannas CRC, and the Bushfires Council NT, the project has been assisting with chronic fire management problems facing rural communities in NTT.

to date, and prospects for further applied research initiatives addressing rural development needs in NTT.

Both initiatives will come to fruition in 2006, firstly through a follow-up two-year project due to begin early in 2006. The new project, funded primarily through AUSAID, and to be undertaken through CDU in partnership with BAPPEDA NTT, will extend remote sensing, GIS, and environmental planning initiatives for Provincial Government, university, and NGO staff, including in Timur Barat.

In a striking parallel with regional fire management projects being undertaken across northern Australia, it seems contentious fire management issues in eastern Indonesia may be used as an initial platform for addressing broader natural resource management and development agendas. A major three-day regional workshop, addressing rural development issues in NTT, will be held in Kupang, in early April. The workshop, hosted by BAPPEDA NTT with additional funding support from ACIAR, AUSAID, the Crawford Fund and the TS-CRC, will bring together, and help foster networking between, northern Australian and eastern Indonesian Government agencies, NGOs, research, education and training institutions, and international funding and R&D organisations.

Contact: Jeremy Russell-Smith <jeremy.russell-smith@nt.gov.au>

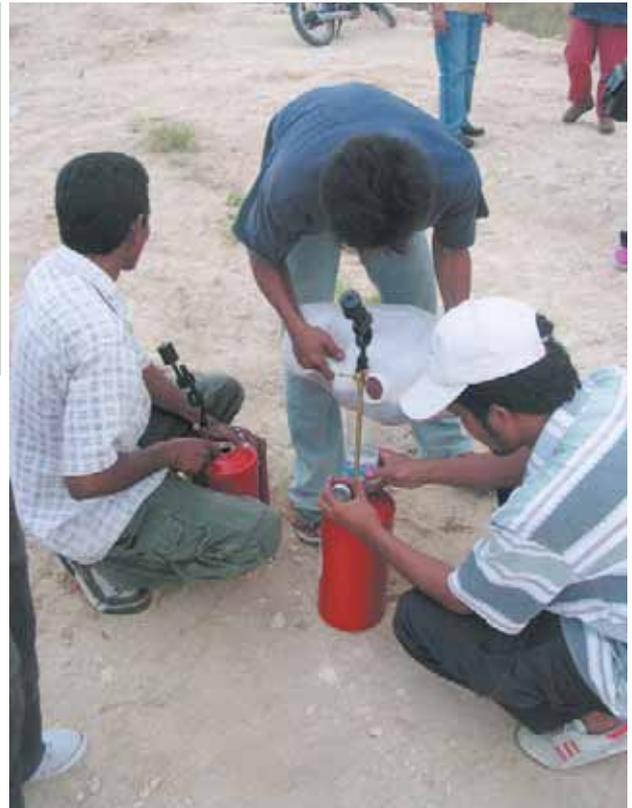


Photo: Rohan Fisher

Villagers prepare equipment for making firebreaks

References

- Fisher R, Bobalinda EW, Rawambaku A, Hill GJE, Russell-Smith J (2006). Remote sensing of fire regimes in semi-arid Nusa Tenggara Timur, eastern Indonesia: patterns and prospects. *International Journal of Wildland Fire*, submitted.
- Russell-Smith J, Djoeroemana S, Maan J, Pandanga P (2006) Rural livelihoods and burning practices in savanna landscapes of Nusa Tenggara Timur, eastern Indonesia. *Human Ecology*, submitted.
- Tacconi L, Ruchiat Y (2005) 'Livelihoods, fire, and policy in eastern Indonesia'. (Center for International Forestry Research: Bogor).

Vegetation officers to aid producers with Act

QUEENSLAND'S Department of Natural Resources and Mines has appointed new Vegetation Client Liaison Officers (VCLOs) to give land managers and primary producers advice and support on changes to vegetation management legislation. The new officers will be based in Mareeba, Gympie and Emerald. Another two officers will be available in Dalby and Roma from early 2006.

The role of these officers is to provide one-on-one advice to producers, directly assisting them through the process of confirming the exact area of their property that has been affected by the vegetation management legislation.

This confirmation of area will then provide producers with information required to apply for funding under the \$130 million Vegetation Financial Assistance package administered by

the Queensland Rural Adjustment Authority (QRAA). The VCLOs will also guide producers through the application process.

For example, producers affected by the Vegetation Management Act may be eligible for Enterprise Assistance through a non-repayable grant of up to \$100,000. So far, more than 50 applications have been approved and approximately \$5 million has been allocated to eligible producers.

Successful applicants implemented improved farming practices and used funding towards property build up such as purchasing new equipment and installing new infrastructure such as pivot irrigators and improved stock watering facilities.

The financial assistance package also includes Exit Assistance for primary production enterprises that

are no longer viable as a result of the new vegetation management laws. In these cases producers have the option to adjust out of primary production or relocate to another enterprise.

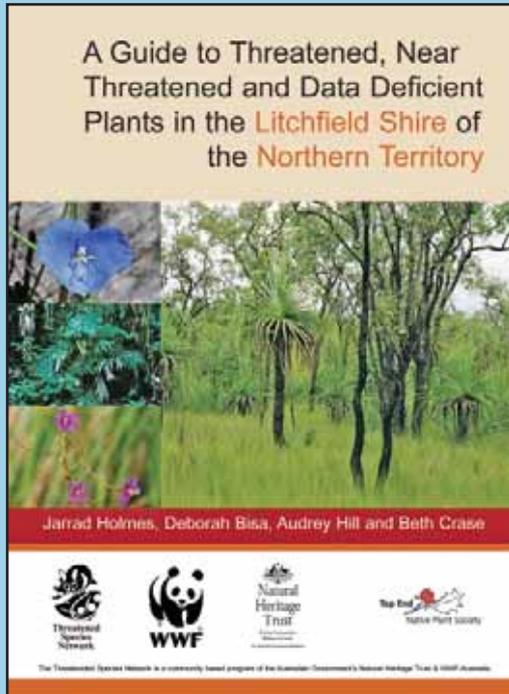
Clearing contractors affected by the changes to the Vegetation Management Act may also be eligible to access interest subsidies from QRAA.

The VCLOs will also be conducting free seminars in conjunction with QRAA, to further explain the changes to the legislation, details of the funding Information about the seminars and financial assistance:

Dept. Natural Resources & Mines <www.nrm.qld.gov.au> or
Queensland Rural Adjustment Authority <www.qraa.qld.gov.au>

VCLOs can be contacted at Mareeba (Peter Spies) Tel: (07) 4048 4701; Gympie (Mark O'Brien) Tel: (07) 5480 6230; and Central West (Kari Paton) Tel: (07) 49879331.

Local rare plant guides



Litchfield plants of conservation concern

A new guide enables local people to identify and record information about plants of 'conservation concern' in the Litchfield Shire of the Northern Territory. *A Guide to Threatened, Near Threatened and Data Deficient Plants in the Litchfield Shire of the Northern Territory* was written by Jarrad Holmes, Deborah Bisa, Audrey Hill and Beth Crase, with input from others, including the Top End Native Plant Society, Northern Territory Herbarium and local plant enthusiasts.

The book provides a resource on habitat preferences, known distributions, key features and usually a photograph

and/or diagram about each plant of conservation concern. In turn, people can record relevant information in the field to fill some of the knowledge gaps and subsequently enable more informed decisions and conservation of local plants.

As an incentive, anyone who locates a plant featured in the book (and an expert confirms its identity), will be able to give the species a common name that will be documented by the Threatened Species Network. Currently, only nine of the 55 species featured have a documented common name.

Published by the Threatened Species Network (TSN) August 2005 Cost: \$12; Contact TSN:

Email: <savannas@wwf.org.au> Tel: (08) 8941 7554

Buy: Charles Darwin University Bookshop

Rare plants of Townsville–Thuringowa

This colourful and informative book is a guide to the 40 rare and threatened plants in the Townsville–Thuringowa region in north-east Queensland. Compiled by expert botanists Con Lokkers, Greg Calvert and Russell Cumming, this book is the result of many years intensive research by the trio.

Each species is protected under state or Commonwealth environmental laws because of their rarity and/or vulnerability to extinction.

Each plant was subjected to intensive literature searches, field trips searching for the elusive plant and enquiries to numerous other botanists acknowledged in the text.

Plants in the book vary from tiny rainforest filmy ferns, to orchids, shrubs and eucalypts. Many of these species are unique to this region, and, as such, comprise an important part of the natural heritage of this area.

Buy from the James Cook University bookshop or contact the Coastal Dry Tropics Landcare Inc.

James Cook University Bookshop
<www.bookshop.jcu.edu.au/>

Coastal Dry Tropics Landcare Inc, The Landcare Centre
PO Box 1390 Townsville Qld 4810; Tel: (07) 4721 4322
Fax: (07) 4772 3077 Email: <landcare@bigpond.net.au>

Cape York Roundtable

THE Appropriate Economies Roundtable in Cairns in November 2003 brought together a range of participants to discuss and identify options for economic development for Cape York Peninsula compatible with the region's natural heritage values. The proceedings of the Roundtable can now be downloaded from the Rainforest CRC website.

Edited by Drs Rosemary Hill and Steve Turton, *Proceedings of an Appropriate Economies Roundtable* outlines key appropriate development options for the region. These include cultural industries, land and sea management, traditional medicines, nature-based and cultural tourism, protected areas, education and training, communications and information technology, eco-commodities including carbon-credits, non-

destructive research, feral animal and weed management, language renewal, market gardens, seed collection, bush foods, small-scale novel crops and nurseries.

Other outcomes from the Roundtable included the proposal to establish an Eco Trust for Cape York based on the Canadian Eco Trust concept.

Go to: <www.rainforest-crc.jcu.edu.au/publications/research%20reports/appropEconomiesRR.htm>

Woodlands in decline

WOODLANDS: A Disappearing Landscape explains the important role that woodlands play in supporting a range of native flora and fauna and the ongoing pressure that grazing and agriculture have placed on it over the past 200 years. Authors David Lindenmayer, Mason Crane and Damian Michael explain

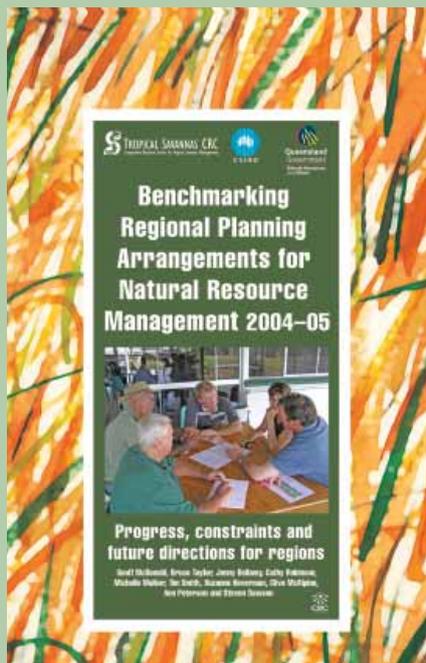
many key topics in woodland biology with text and images, illustrating important aspects of woodland ecology as well as woodland management and conservation.

Publisher: CSIRO Publishing ISBN: 0643090266 Cost: RRP \$39.95 60pp, Colour Illustrations and Photographs, Hardback August 2005

For an extract of the book go to: <www.publish.csiro.au/pid/4978.htm#features>

Framework to coordinate feral pig control

THE Threat Abatement Plan for the Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs (the Plan) sets out a national framework to guide coordinated actions to contain the spread of pigs and manage the impact on threatened spe-



Benchmarking regional NRM

A NEW report from the Tropical Savannas CRC provides a benchmark of regional planning for natural resource management in Queensland and other tropical savanna regions of northern Australia during 2004. *Benchmarking Regional Planning Arrangements for Natural Resource Management 2004-05* reviews regional plans and planning processes against a set of criteria designed to evaluate regional planning arrangements.

Regional policy frameworks are now widely promoted in Australia—the regional turn of governance frameworks reflects a global trend to devolve decision making to reflect the local geographical context.

The report analyses the progress of these regional arrangements, identi-

fies emerging constraints, and relates lessons and adaptive management opportunities for improving regional planning systems.

This report is the first of two from the CRC's project Healthy Savanna Planning Systems.

A second benchmark of regional NRM will be conducted during 2005-06. This second evaluation will draw on activities from the Northern Territory and Western Australia as well as Queensland.

You can download the report, and its standalone executive summary free from the CRC website. For a hard copy, please contact Bruce Taylor, CSIRO Sustainable Ecosystems.

Tel: (07) 3214 2638 E: bruce.taylor@csiro.au
Web: savanna.cdu.edu.au/publications/books_reports/natural_resource_ma.html

cies and ecological communities. The plan recognises that feral pigs are one of a number of factors that can impact on threatened species and ecological communities. Five main objectives are proposed to manage the threat by feral pigs.
Go to: www.deh.gov.au/biodiversity/threatened/publications/tap/pig/

Building capacity in rural Australia

THE Role of Extension for Building Capacity—What Works and Why provides a review of extension in Australia 2001-03 and its implications for developing future capacity on behalf of the Cooperative Venture for Capacity Building. Authors Jeff Coutts, Kate Roberts, Fionnuala Frost and Amy Coutts address the lessons that can be learnt and answer the fundamental question of "what works and why".

Download: www.rirdc.gov.au/reports/HCC/05-094.pdf

Landcare farmers and greenhouse

LANDCARE Australia: Meeting the Greenhouse Challenge highlights the work of Landcare farmers as a leading participant in the Greenhouse Challenge Plus Programme. The report is a useful resource to other land managers who want to reduce greenhouse gas emissions from their properties.

Go to: www.greenhouse.gov.au/agriculture

Landholder's guide to private land

LANDOWNERS will better understand options for protecting their privately owned land in perpetuity with the recent launch of a new conservation guide. *Gifts That Keep on Giving—a landholder's guide to land protection and conservation options* provides information about schemes that offer permanent protection and guidance to landholders on options for protecting their privately owned land.

Go to: www.deh.gov.au/biodiversity/publications/gifts-keep-giving/index.html

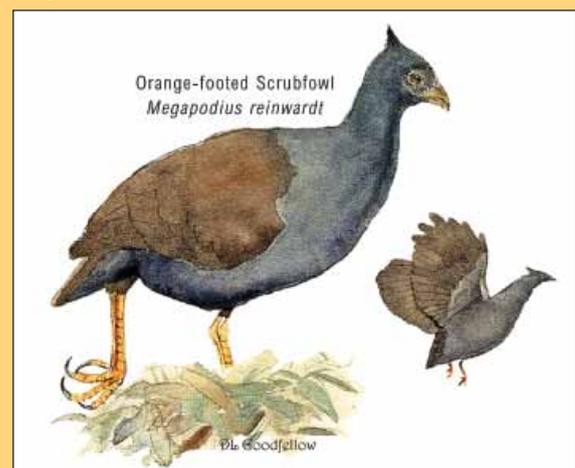
Daly River conservation values

AQUATIC Conservation Values of the Daly River Catchment assesses the Daly River system in the Northern Territory as

being of national significance due to a range of aquatic conservation values. Co-authors Dr Stuart Blanch, Dr Naomi Rea and Dr Gary Scott identify the aquatic conservation values that should be protected, and where necessary rehabilitated, through relevant laws, planning and on-ground actions.

Go to: www.wwf.org.au/News_and_information/Publications/PDF/Report/DalyConservationValues200509.pdf

Top End feathered friends



BIRDS of Australia's Top End, written and illustrated by Denise Lawungkurr Goodfellow, provides a comprehensive guide to birds of the Top End and is filled with her personal observations and experiences. In this second edition, Denise provides details about the birds' physical features and habits, specific locations to find them as well as 28 beautifully illustrated plate pages.

168 pp. Publisher: New Holland Price: \$33

Go to: www.denisegoodfellow.com/books.html

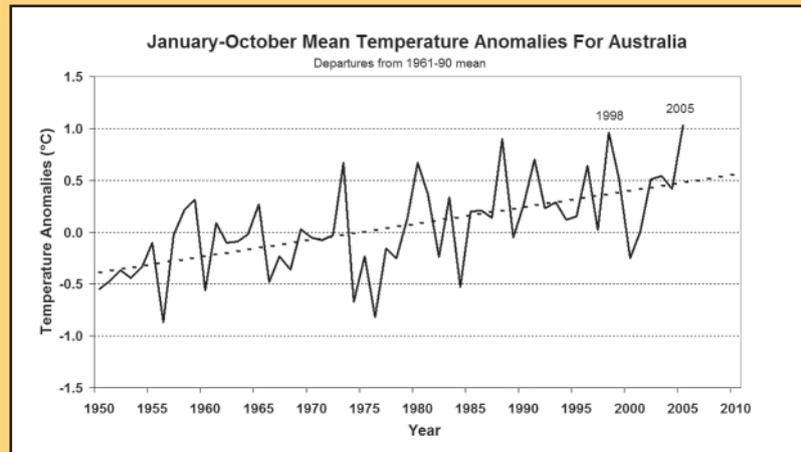
Tel: (08) 8981 8492 Email: goodfellow@bigpond.com
From selected bookshops

2005: Australia's record warm year

AUSTRALIA has experienced its warmest year on record with the temperature averaging 1.09 degrees Celsius above the 30-year average (1961–1990). This makes it the warmest year since at least 1910, when high quality Australia-wide temperature measurements first became possible. Rainfall for the full year was also below average, with an average of 399 mm falling nationwide. This is 73 mm less than the Australian mean rainfall of 472 mm.

“Annual mean temperatures have generally increased throughout Australia since 1910, particularly since the 1950s,” said Mike Coughlan, Head of the National Climate Centre within the Bureau of Meteorology. “As the average temperature has risen, we have also seen an increase in the incidence of hot days and hot nights, and a reduction in the number of cold days and nights,” he said.

Other changes include a marked decline in rainfall in south-west and parts of south-east Australia, and recent reduction in rainfall through the eastern states. At the



same time, rainfall in the arid interior and northwest has increased dramatically, in some places nearly doubling during the last 50 years.

“Work has only just begun to attribute causes to the observed climate changes in Australia. Nevertheless, many of the observed changes appear to be broadly consistent with those expected from human-induced climate change.”

—Australian Bureau of Meteorology.

Disturbed African savannas

TREES and shrubs could take over some parts of Africa's savannas if rainfall increases in the Sahel according to researchers.

Nature reported that Mahesh Sankaran and a team of researchers found that annual rainfall plays a key role in determining how the balance between trees and grass is maintained.

Using data from 854 sites across Africa, the researchers reported that maximum woody cover in savannas receiving average annual rainfall of less than 650 mm is constrained by, and increases linearly with average rainfall. These arid and semi-arid savannas may be considered ‘stable’ systems in which water constrains woody cover and permits grasses to co-exist. Above an average rainfall of 650 mm a year, savannas are ‘unstable’ systems in which rainfall is sufficient for woody canopy closure, and disturbances (such as fire and grazing) are required for trees and grass to co-exist.

Sankaran and the team's data suggest that if rainfall increases across parts of Africa, as several climate models predict, some stable savannas could become unstable, meaning they would gradually be taken over by trees and shrubs. Such changes in the tree–grass balance would significantly impact on plant and livestock production, biodiversity, and water and carbon cycles.

The research effectively combines the two dominant schools of thought on how trees and grasses can coexist in savannas—whether the balance is regulated by the availability of resources such as water, or by disturbances such as fire and grazing.

from *SciDev.Net*, 9 December 2005
www.scidev.net/News/index.cfm?fuseaction=readNews&itemid=2535&language=1

Kimberley projects

THE Kimberley Land Council has received two Threatened Species Network grants. One of the projects aims to conserve freshwater sawfish and other endangered sharks and rays in the Fitzroy River by building on community awareness. The project is a collaboration between Traditional Owners, the Kimberley Land Council, Murdoch University and the Yiriman Youth Development Project. It will involve a tagging program, as well as an education and public awareness campaign. The second project aims to monitor and manage a suite of threatened flora, bird and mammal species in the North Kimberley. It is a collaborative project between Traditional owners, the Kimberley Land Council, CALM WA, WA Museum and the WA Dept of Indigenous Affairs.

—*The Web*: newsletter of the Threatened Species Network

Sterile garden plants

AUSTRALIA'S gardeners are being urged to join a nationwide effort to stop ornamental plants from jumping the fence and becoming weeds, by growing sterile varieties in their gardens. Scientists and leading nurseries have joined in a call to promote cultivation of sterile variants of popular garden plants which have the potential to become invasive weeds of the environment. Developing sterile variants of popular and valuable garden plants would help keep Australia's gardens beautiful and Australia's landscape free from weeds, said Dr Tony Grice of the Weeds CRC and CSIRO.

“Sterile gardening wouldn't apply to everything—only to those species which we know could become an environmental weed,” he says. “But it would mean that if a sterile variety is available, gardeners could continue to grow favourite plants which otherwise would be high-risk weeds.”

Go to: www.weeds.crc.org.au

February

1st Australian Young Water Professionals Conference

15–17 February 2006, Sydney, NSW

Venue: University of New South Wales, Sydney

The first Young Water Professionals (YWP) Conference aims to provide a national forum at which postgraduate researchers and young professionals working in water and wastewater research, technology and management can present their research work and have the opportunity to meet their peers. Additionally, a mentorship program will be organised for improving career support, development and mobility.

Email: <ywp2006@unsw.edu.au>

Web: <www.cwwt.unsw.edu.au/ywp2006.html>

April

AWA Conference: From the Waters' Edge to the Red Centre

18–21 April, Alice Springs

Venue: Alice Springs Convention Centre, NT

The Australian Water Association will convene its second National Water Education Conference looking at water education and how it relates to sustainable water management; creating a climate of change and how to deliver and/or evaluate effective education programs and initiatives.

Contact: Corinne Cheeseman, Education Program Manager
Australian Water Association, Level 2, 44 Hampden Road

Postal: PO Box 388, Artarmon NSW 1570

Tel: (02) 9413 1288 **Fax:** (02) 9413 1047

Email: <ccheeseman@awa.asn.au >

Web: <www.awa.asn.au/Content/NavigationMenu/NewsEvents/2ndNationalEducationConference/WEN_Conference_Rego.pdf>

2006 World Meat Conference

26–29 April, 2006, Brisbane QLD

Venue: Brisbane Convention and Exhibition Centre.

There is an extensive program of local and international speakers covering topics relevant to all involved in the meat and livestock industry from both government and commercial sectors. Topics cover global trade and policy issues, consumer trends, health and safety, environment and sustainability. A major exhibition is an integral part of the congress. There will be opportunities to profile and promote product, brand and service to a new audience and market.

Associated with the Beef Conference are the following:

UNECE meeting for Meat Standards (Brisbane): 19–24 April

Web: <www.unece.org/trade/agr/standard>

Australian Meat Industry Council Conference : 26 April

Web: <www.apl.au.com>

World Braford Congress (Rockhampton): 1–8 May

Web: <www.braford.org.au>

Pan Pacific Pork Expo (Gold Coast): 4–6 May

Contact: The Meeting Planners

Postal: 91–97 Islington Street, Collingwood, VIC, 3066

Tel: (03) 9417 0888 **Fax:** (03) 9417 0899

Email: <meat2006@meetingplanners.com.au>

Web: <www.2006worldmeatcongress.com.au>

May

Beef Australia 2006

1–8 May, Rockhampton, QLD

Postal: PO Box 199, Rockhampton QLD 4700

Tel: (07) 4922 2989 **Fax:** (07) 4921 3787

Email: <beefexpo@beefaustralia.org>

Accommodation and Bookings: 1800 676 701

American Society for Photogrammetry and Remote Sensing (ASPRS) Conference 2006: Prospecting for Geospatial Information Integration 1-5 May, Reno Nevada, USA

Venue: Hilton Hotel, Reno, Nevada

The focus for the conference will be on new capabilities and technologies, and will be of interest to professionals in all aspects of remote sensing, geographic information systems, land and natural resources management, environmental management, photogrammetry, lidar and IFSAR, mapping, charting, and geodesy. Learn about the latest instruments, analysis techniques and sources for geospatial data and how their use and applications can integrate geospatial information.

Web: <www.asprs.org/reno2006/>

9th International Conference on Public Communication of Science and Technology: Scientific Culture for Global Citizenship 17–20 May, Seoul, Korea

Venue: COEX (Convention & Exhibition), Seoul, Korea

PCST-9 will include plenary and parallel sessions, and also a poster display. More than 500 participants from all over the world will discuss the latest thinking relating to science communication.

Email: <pcst9@pcst2006.org>

Web: <www.pcst2006.org/main.asp>

June

(Re) Contesting Indigenous Knowledge and Indigenous Studies Conference 2006: Engaging the interfaces between Indigenous educators, non-Indigenous educators and Indigenous communities

28–30 June, Surfers Paradise, QLD

Venue: Gold Coast Marriott Hotel, Surfers Paradise

Indigenous and non-Indigenous people are engaged in the recontestation of Indigenous knowledges and knowledge systems within and across many cultural interfaces. Abstracts close February 2006.

Contact: Kerry Williams, Conference Secretariat, Indigenous Knowledge Conference, QUT

Postal: GPO Box 2434, Brisbane QLD 4001

Tel: (07) 3864 2220 **Fax:** (07) 3864 5160

Email: <indigenousknowledge@qut.edu.au>

Web: <www.indigenousknowledge.qut.edu.au/index.jsp>

July

International Geographical Union (IGU) 2006 Regional Conference: Regional Responses to Global Changes: A View from the Antipodes 3–7 July, Brisbane

Venue: University of Technology, Gardens Point Campus

The conference will focus on geographical attention on critical physical and human processes driving global change.

Contact: Brisbane IGU Secretariat, Eventcorp
Postal: PO Box 5718, West End QLD 4101
Tel: (07) 3846 5858 **Fax:** (07) 3846 5859
Email: <igu2006@eventcorp.com.au>
Web: <www.igu2006.org/>

September

Australian Rangeland Society 14th Biennial Conference 2006: At the Cutting Edge 4–7 September, Renmark

Venue: Chaffey Theatre, Renmark, SA

The conference will examine management of rangelands that has been effective in sustaining ecosystems industries and livelihoods. It will also explore possible influences that climate change, governance and other services might have on the biology, the industries and people of the region.

Deadline for abstracts: 17 February, 2006

Contact: Sarah Nicolson, Intercomm Event Coordination
Postal: 22 Edmund Ave, Unley SA 5061
Tel: (08) 8357 3378 **Mob:** 0419 815 864
Email: <snicolson@intermode.on.net>
Web: <www.austrangesoc.com.au>

15th Australian Weeds Conference: Managing Weeds in a Changing Climate

Savanna Links is edited and produced by the Tropical Savannas CRC. Articles can be used with permission. For story ideas or contributions, please contact us. Views expressed in *Savanna Links* are not necessarily those of the TS-CRC.

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Front and back cover design
BoaB Interactive
 <www.boabinteractive.com.au/>
 Printed by LogicMedia, JCU, Townsville

Read *Savanna Links* online at <savanna.cdu.edu.au/publications/savanna_links_all.html>

24–28 September 2006, Adelaide

Venue: Adelaide Convention Centre

A four-day scientific program is planned in association with a trade exhibition. Sub themes include: politics, funding, research, social and economic climate, environment and climate change (global warming).

Contact: Plevin and Associates Pty Ltd
Postal: PO Box 54 Burnside, SA 5066
Email: <events@plevin.com.au>
 Brisbane IGU Secretariat, Eventcorp Pty Ltd
Postal: PO Box 5718, West End QLD 4101
Tel: (07) 3846 5858 **Fax:** (07) 3846 5859
Email: <igu2006@eventcorp.com.au>
Web: <www.igu2006.org/>

October

International Landcare Conference 2006: Landscapes, Lifestyles and Livelihoods

8–11 October, Melbourne

Venue: Melbourne Exhibition and Convention Centre

Focus: People and the environment, creating future landscapes, lifestyles and livelihoods. The conference aims to provide opportunities for ideas exchange and will also consider future issues building on the Landcare vision of cooperative community-based resource management.

It also aims to build on contributions made in previous international and national Landcare conferences; and contribute to building social capital and community and agency networks for rural, regional and urban resource management.

Contact: Ms Probarti Milton
 International Landcare Conference Coordinator
 Vic. Dept of Sustainability & Environment
Tel: (03) 9637 8050
Web: <www.internationallandcareconference2006.com.au>

OUR STAKEHOLDERS



ABORIGINAL COMMUNITIES



PASTORALISM



TOURISM



CONSERVATION



DEFENCE



MINING