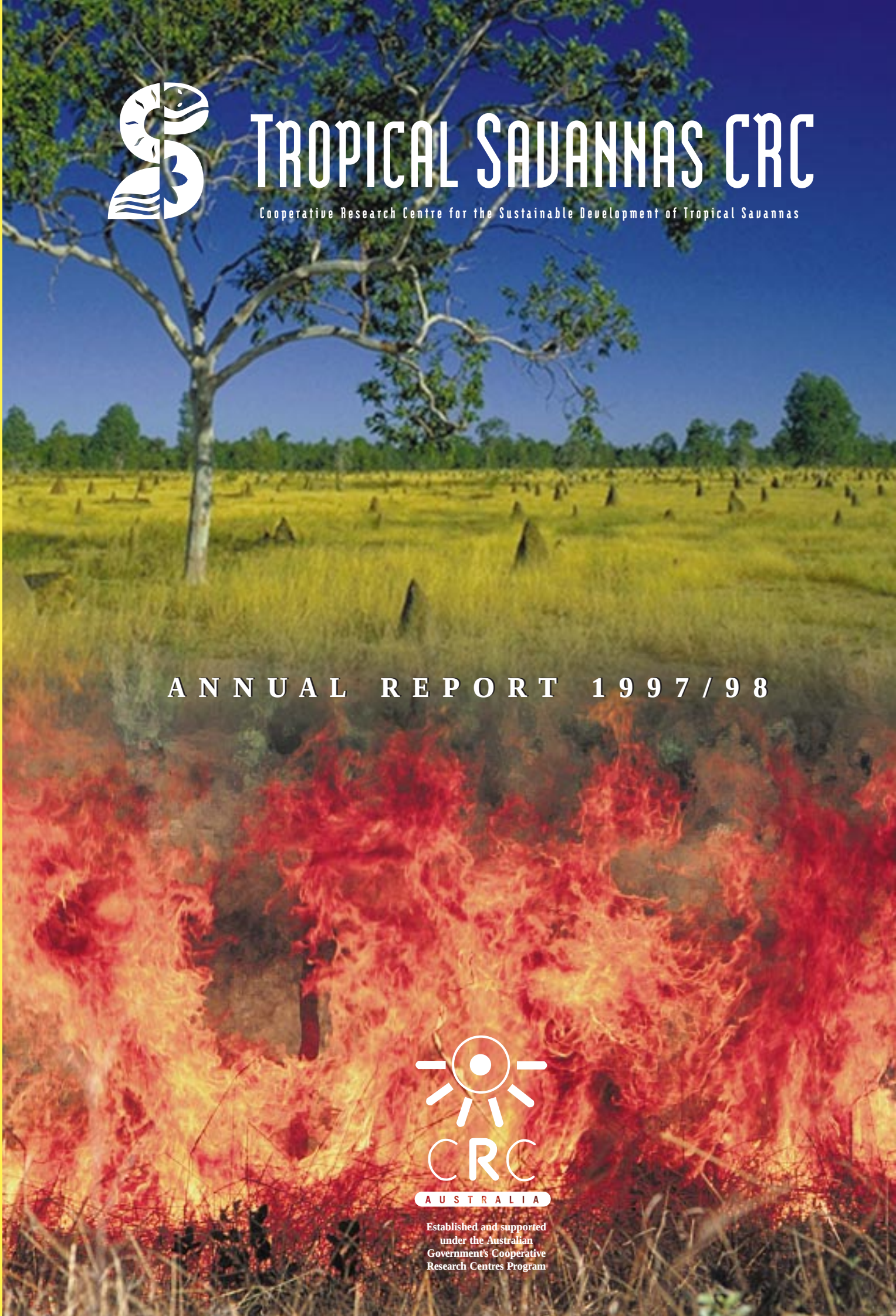


TROPICAL SAVANNAS CRC

Cooperative Research Centre for the Sustainable Development of Tropical Savannas

ANNUAL REPORT 1997/98

CRC AUSTRALIA

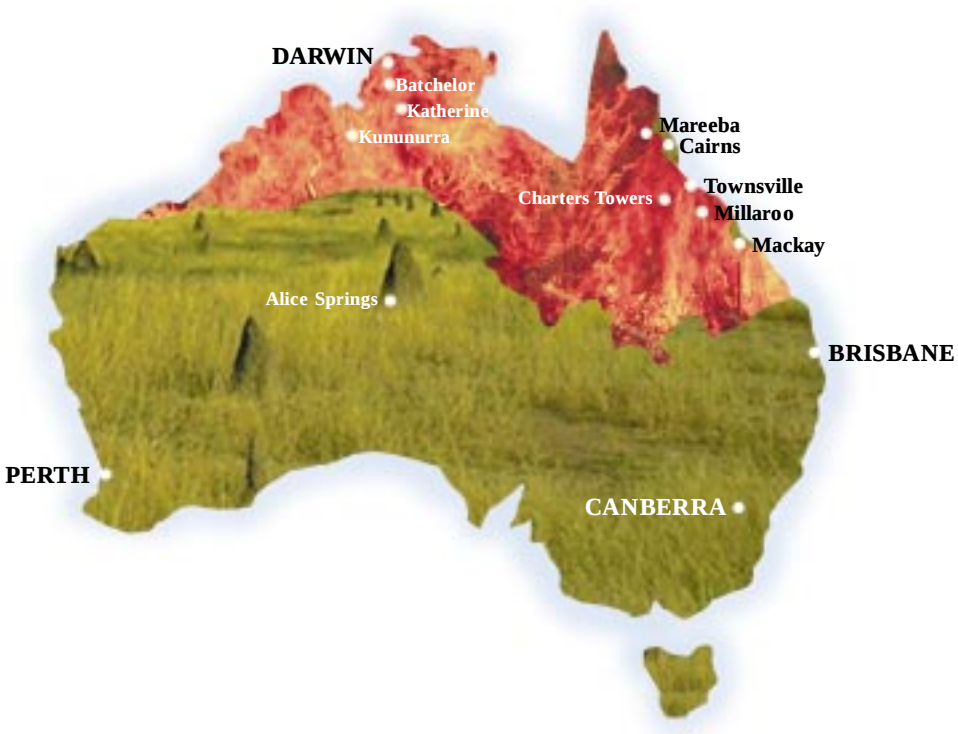
Established and supported under the Australian Government's Cooperative Research Centres Program

MISSION

To achieve sustainable use and conservation of Australia's tropical savannas through excellence in collaborative research, communication and education.

KEY RESULT AREAS

- Definitions of healthy landscapes at spatial and temporal scales useful to landholders, managers and users.
- Methods for assessing landscape health which incorporate landscape processes and resource status at a range of spatial and temporal scales.
- Management options for ensuring sustainable use and conservation of tropical savannas at scales relevant to decision makers.
- Information and learning products and access processes for tropical savanna stakeholders.



The shaded area shows the tropical savannas stretching across 1/4 of Australia. The Tropical Savannas CRC carries out research from 20 locations right across this vast area.

TROPICAL SAVANNAS CRC

Cooperative Research Centre for the Sustainable Development of Tropical Savannas

3rd Annual Report 1997/98

CRC AUSTRALIA

ISSN 1327-4902

For more information regarding the Tropical Savannas CRC contact:
Director: Mr John Childs
Northern Territory University, Darwin, NT 0909
Tel: (08) 8946 6834
Fax: (08) 8946 7107
Email: john.childs@ntu.edu.au

Dr Peter Jacklyn, Communication Coordinator
Northern Territory University, Darwin, NT 0909
Tel: (08) 8946 6285
Fax: (08) 8946 7107
Email: peter.jacklyn@ntu.edu.au

Ms Kate O'Donnell, Communication & Publications Officer
James Cook University,Townsville, Qld 4811
Tel: (07) 4781 5967
Fax: (07) 4781 5515
Email: kate.odonnell@jcu.edu.au

Website: http://savanna.ntu.edu.au

CONTENTS

OVERVIEW

The third year of the Tropical Savannas CRC (TS CRC) has been both challenging and exciting.

During the year, the Board identified that long-term contributions to stakeholders and the wider community could only occur with improved collaboration, integration and communication both internally and externally. The Tropical Savannas CRC is spread over an enormously vast region, northern Australia, and encompasses over 15 office and field locations and involves over 130 staff. Within this context, the challenge of bringing researchers and educators from many diverse backgrounds and interests spread over 190 million hectares of remote Australia to work together was formidable.

As a result an intensive and comprehensive strategic planning process was initiated by the Board and undertaken by the new Director to ensure that future efforts of the Centre are delivering tangible outcomes in the northern Australian savannas. Project Leaders, the Scientific Program Advisory and Evaluation Group, Management Committee, Consultative Committee and the Board participated in the process.

The final result is a *Strategy Statement 1998-2002* which will ensure the Centre achieves the desired outcomes which saw it established in 1995.

The Mission of Tropical Savannas CRC is to achieve sustainable use and conservation of Australia's tropical savannas through excellence in collaborative research, communication and education.

In order to frame CRC research in a more holistic and collaborative way, the Centre's priorities now focus on 'Themes' rather than segregated scientific Sub-Programs. The 'Themes': Northern Australia Landscapes, Landscape Processes, Ecosystem Management and Human Capability Development encompass biophysical, ecological, social and economic aspects of sustainable use and conservation of the environment. The Centre's projects and management studies enable researchers and educators from different disciplines, working collaboratively to contribute to theme outputs and products for landowners, users and managers of tropical savannas.

Based on the Strategy Statement, projects have been modified and enhanced. A more balanced and comprehensive portfolio of project activities will ensure the Centre's objectives are met.

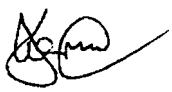
The excellent research and education activities of the Centre have contributed significantly to an understanding of the ecology of the environment during the past year. Research has provided new understanding of the fluxes of water and nutrients in tropical savanna woodlands. The role of 'patchiness' in the landscape in ecosystem processes involving tree and grass condition and granivorous bird distribution and populations is being defined. The effect of fire on vegetation, vertebrate and invertebrate populations are better understood. The Masters in Tropical Environmental Management enrolled its first students.

The important role of the Tropical Savannas CRC in facilitating collaboration among stakeholders and partner agencies was demonstrated at the North Australia Fire Management Workshop. This major event, sponsored by the Centre, assembled all the relevant players; pastoralists, Aborigines, conservationists, tourism operators, defence force personnel, miners, researchers, communicators and educators, to address issues of fire and its management in the tropical savannas. The regional and sectoral workshop groups identified the major problems and issues, and then determined the actions that need to be taken to address these. This has resulted in new activities for the Centre. It has also led to the establishment of a North Australia Fire Managers Forum consisting of the rural fire authorities in Western Australia, Queensland and

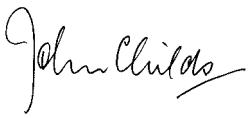
Northern Territory, and Tropical Savannas CRC to progress coordination in communication, research and policy development in fire management across north Australia. This is a most encouraging and exciting testament to what the collaborative approach of the Centre can achieve.

This past year has been an important transitional period for our Centre. We have collectively set a focused course for the future. The research and education program is producing significant performance outputs. We have demonstrated our ability to contribute to resolving stakeholder issues of sustainable use and conservation of the tropical savannas environment.

The Centre's program is set to be productive and rewarding for those involved.



John Kerin
Chairman



John Childs
Director

HIGHLIGHTS 1997/98

RESEARCH

- The Victoria River District (VRD) Management Study has commenced a major field work program.
- A quantitative assessment of daily and seasonal water use by eucalypt woodlands has been completed.
- The Centre's research on the distribution of key flora and fauna has now been extended to Queensland.
- The clear responses of ants to sulphur dioxide in the Mt Isa Mines (MIM) trials indicate that ant communities are a useful indicator of the impacts of sulphur dioxide on biodiversity.
- The Centre has carried out a comprehensive, savanna-wide review of the conservation status of all species of birds that are substantially dependent on seeds for at least part of the year.
- Three regional management studies commenced over the past year, one addressing fire management on Cape York and the north Kimberley, and two in the Northern Territory.
- Time series image analysis techniques used in assessing landscape condition and indicators of change have been refined.
- A conceptual framework for understanding the landscape ecology of rubbervine *Cryptostegia grandiflora* in northern Australia has been developed.

STAKEHOLDER-LINKED ACTIVITIES

- A very successful and large fire management workshop has been held which has strengthened the Centre's links with land managers across northern Australia. A publication on fire aimed at land managers has been produced as a result of this workshop.
- An innovative North Australia Fire Managers Forum has been established. This forum is chaired by TS CRC involving heads of WA, Qld and NT Bushfire Services to provide strategic planning and communications assistance to fire management across north Australia.
- This year new fire management projects have established strong stakeholder links across the Top End and in Far North Queensland.
- The VRD Management Study has strengthened links with stakeholders. An on-ground stakeholder liaison officer has been appointed.
- The Centre has continued to play a major role in the stakeholder-driven Desert Uplands Management Study.
- The CRC started a major contract with Mt Isa Mines to assess the impacts of the SO_2 plume from Mt Isa Mine.
- The Centre's external newsletter *Savanna Links* has been re-established with an emphasis on stakeholder interests and information-linking and has been well received.

EDUCATION AND COMMUNICATION

- A multimedia CD-ROM is now in use by Masters of Tropical Environmental Management students, allowing greater access to the course from remote locations.
- An Education and Training Database for the tropical savannas has been released. The database is also accessible through the Centre's website.
- A Graduate Diploma in Tropical Environmental Management was introduced in response to a survey of educational needs in the savannas.
- TS CRC now has 30 Masters of Tropical Environmental Management students and 27 postgraduate and honours students.
- Workshops in remote sensing, vegetation mapping, landscape modeling, communication, extension and vocational education activities brought together people in these fields from across the savannas.

- The 1997 Northern Landscapes Symposium was held involving social and cultural studies researchers from across the savannas.
- A website-linked internal newsletter *Topical Savannas* was launched.
- This year saw over 50 interviews and articles related to the CRC on radio, television and in print.
- A series of seminars for tour guides on scientific and cultural issues was conducted in association with the tourist industry.

CENTRE MANAGEMENT

- The Centre developed a *Strategy Statement 1998-2000* and new management arrangements with the active participation of the Board, Consultative Committee, Management Committee members and Project Leaders.
- The Centre has refocused its research program to produce more integrated, relevant and distinctive outcomes, by organising the research around 'Themes' which are the core elements of the sustainable use and conservation of the tropical savannas.

Through the CRC management studies, pastoralists and researchers are brought together to solve savanna management problems.

STRUCTURE AND MANAGEMENT

STRUCTURE

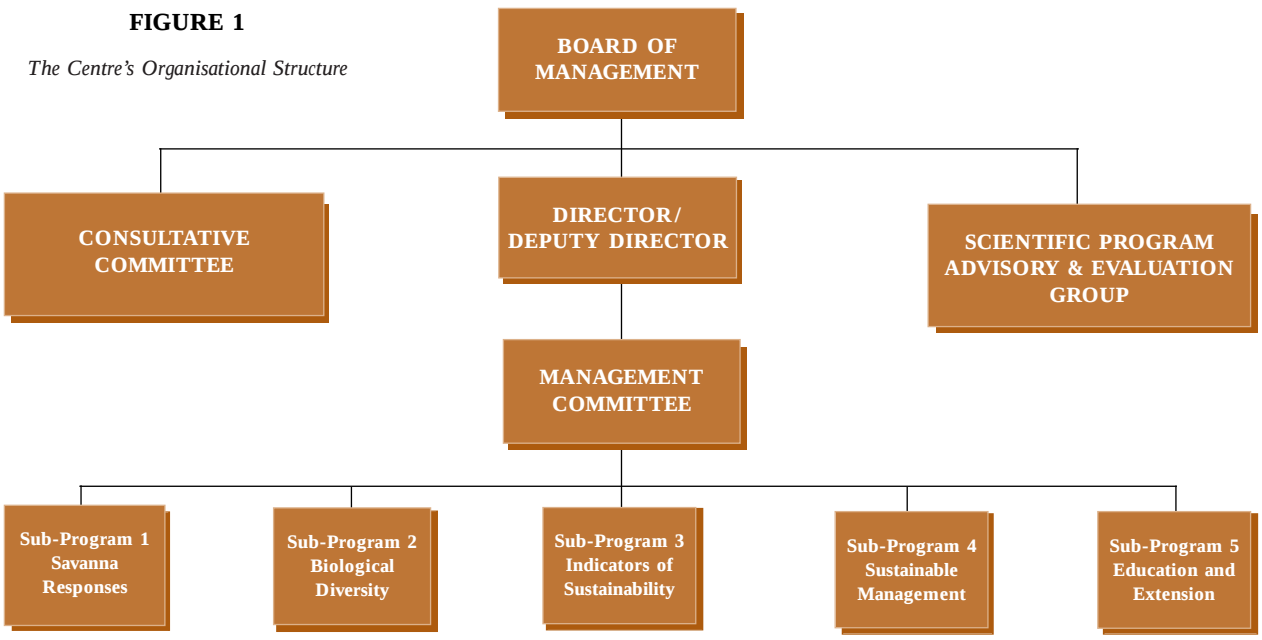
The Tropical Savannas CRC is an unincorporated joint venture established by an Agreement between the Commonwealth of Australia and following Centre parties:

- Agriculture Western Australia (AgWA)
- Australian National University (ANU)
- CSIRO Division of Land and Water (formerly Division of Soils) (CSIRO L&W)
- CSIRO Division of Tropical Agriculture (formerly Division of Tropical Crops and Pastures) (CSIRO TAG)
- CSIRO Division of Wildlife and Ecology (CSIRO DWE)
- Department of Conservation and Land Management (CALM WA)
- Environment Australia, Biodiversity Group (formerly Australian Nature Conservation Agency)
- James Cook University of North Queensland (JCU)
- Northern Territory Department of Lands, Planning and Environment (NTDLPE)
- Northern Territory Department of Mines and Energy (NTDME)
- Northern Territory Department of Primary Industry and Fisheries (NTDPIF)
- Northern Territory Power and Water Authority (NTPAWA)
- Northern Territory University (NTU)
- Parks and Wildlife Commission of the Northern Territory (PWCNT)
- Queensland Department of Natural Resources (QDNR)
- Queensland Department of Primary Industries (QDPI)

Since 1995 the Centre has operated under an organisational structure as outlined in figure 1.

FIGURE 1

The Centre's Organisational Structure



The four different management groups, the Board, Scientific Program Advisory and Evaluation Group (SPAEG), Consultative Committee and Management Committee are structured so that broad representation from relevant parties and groups is maintained at all levels and facets of decision making. Overall they contribute to ensuring the direction of the CRC is independent of any one agency, that high quality research is relevant to the CRC's aims and that outcomes are being directed to those on the land. Accountability for delivering outcomes rests with the five Sub-Program Leaders who report to the Director.

In March 1998, the Board initiated a major strategic review of the Centre's program and management arrangements. This followed reports by the Centre's CRC Visitor and SPAEG expressing concern that the Centre was not meeting its performance indicators and goals.

A strategic planning process involving Project Leaders, Consultative Committee, Management Committee and Board, developed the *Strategy Statement 1998-2002*. This was approved by the Board. It more concisely defines the Centre's Mission, Key Result Areas and Key Strategic Issues.

The Board determined that implementation of the Strategy Statement required more appropriate management arrangements. These were developed by the Director in an interactive process with Project Leaders and the Management Committee. The new management arrangements replace the hierarchal and sub-program approach with four 'Themes'. These 'Themes' define the elements of sustainable use and conservation of the tropical savannas and are the basis for integration of the Centre's projects and management studies (see figure 2 for the links between the new 'Themes' and projects).

The management structure was revised in order to better align it with the Centre's strategic directions (see figure 3 for the new administration and management structure). This new structure will apply from 8 July 1998. Consequently this Annual Report is largely aligned to the previous sub-program structure. The research 'Themes' are mentioned in the Cooperative Linkages section.

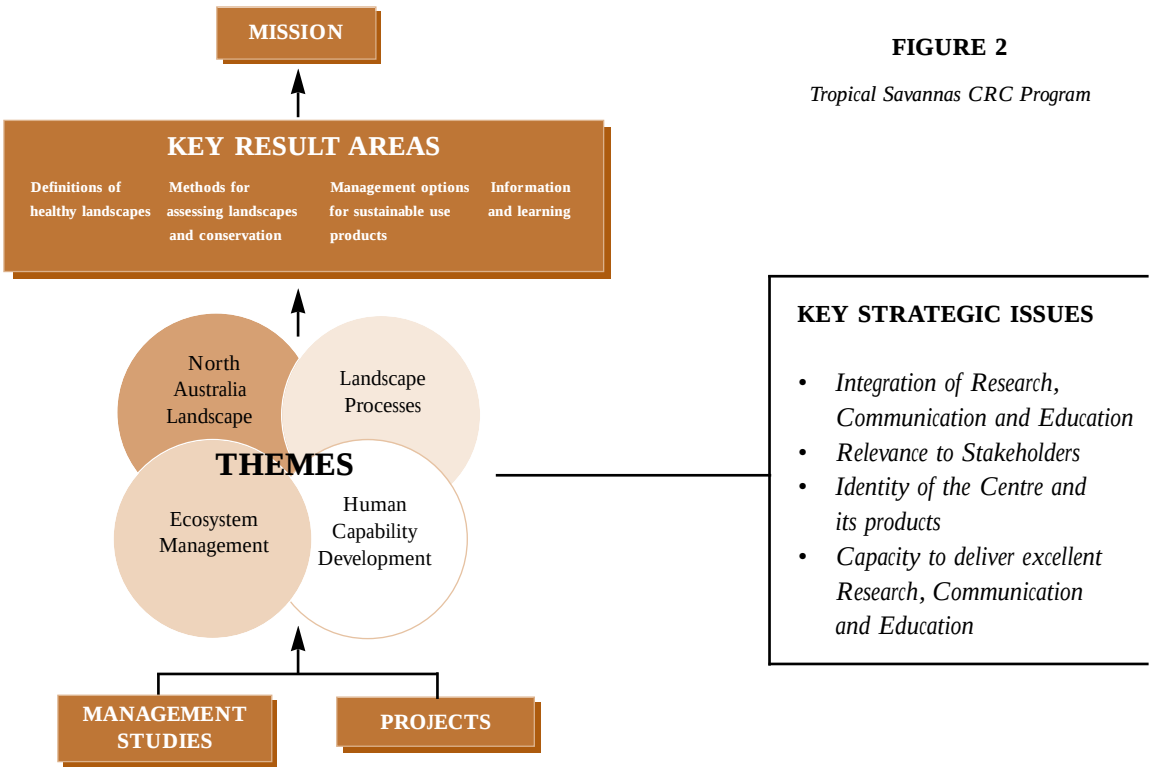


FIGURE 2

Tropical Savannas CRC Program

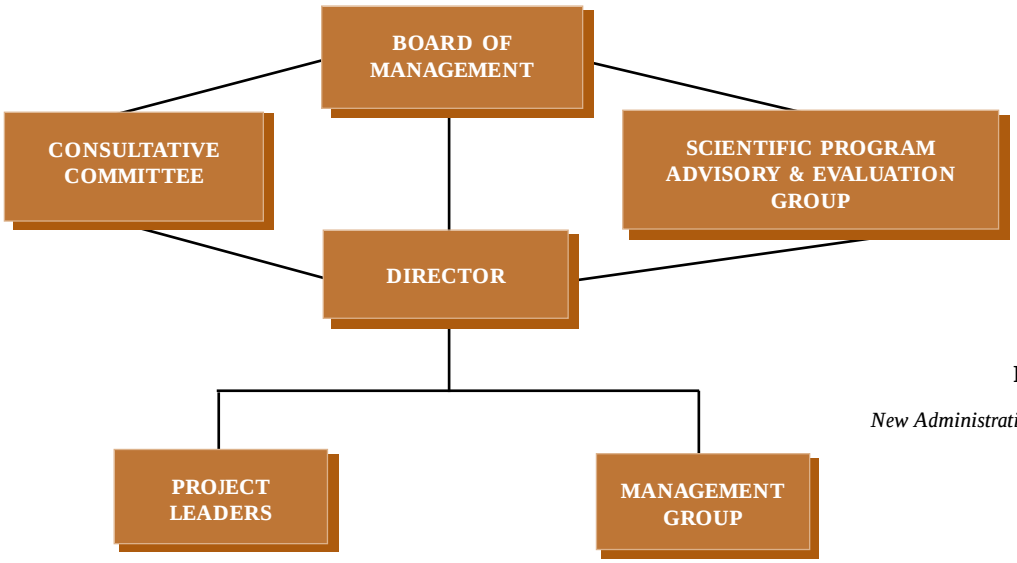


FIGURE 3

New Administration and Management Structure

BOARD OF MANAGEMENT

The Board is responsible for :

- monitoring and determining strategic development of the Centre;
- reporting to the Commonwealth on Centre achievement of obligations and agreed outcomes;
- ensuring the commercialisation of intellectual property; and
- approval of the Centre's sub-programs, annual budget and financial plans.

Because of the balanced representation of partner agencies and stakeholders, the Board has considerable strategic influence. The decision-making power is significantly enhanced by this breadth of representation. The Board met three times over the past year.

The Board of Management after approval of the Strategy Statement 1998-2002.

STRUCTURE AND MANAGEMENT

Membership (as at 30 June 1998):

The independent Chair of the Board is the **Hon John Kerin.**

Centre's partner agencies representation:

A/Prof Charles Webb	Universities
Mr Roger Smith	Northern Territory of Australia
Mr Kevin Goss	State of Western Australia
Dr Warren Hoey	State of Queensland
Dr Brian Walker	CSIRO
Mr John Hicks	Environment Australia
Mr Darryl Pearce	Chair of the Consultative Committee*

Stakeholder representation:

Ms Katy Haire	Aboriginal Land Councils
Mr John Stewart	North Australia Beef Research Council (pastoral industry)
Dr Tony Milnes	ERA Environmental Services (mining industry)
Mr Rick Murray	Australian Tourism Council (tourism industry)*
Mr Jamie Pittock	World Wide Fund for Nature (conservation)*

Director (ex officio):

Mr John Childs	Director of Tropical Savannas CRC**

* These were new positions added to the Board this year to increase the breadth of its representation.

** In April 1997 Associate Professor Charles Webb was appointed Acting Director of the Centre following the resignation of foundation director Dr Phil West. Mr John Childs was appointed Director from 4 August 1997.

CONSULTATIVE COMMITTEE

The Committee provides a relevance check on the Centre's research, communication and education programs. Members of the Consultative Committee represent the social and enterprise groups across the savannas and they are a major reference for stakeholder values. The Committee:

- provides advice to the Board on stakeholder needs and issues; and
- advises on the relevance of the Centre's program.

It met twice during the year.

Membership (as at 30 June 1998):

Mr Darryl Pearce	Chair (appointed during the year)
Mr Ross Brunckhorst	Pastoral Enterprises, Yeronga, Qld
Dr Laurie Corbett	ERA Environment Services
Mr David Epworth	Balkanu Cape York Development Corporation, Cairns, Qld
Mr Rowan Foley	Kimberley Land Council, Kununurra, WA
Mr Don Heatley	Pastoral Enterprises, Home Hill, Qld
Ms Sue Jackson	Environment Sector, Darwin, NT
Dr Phil Price	Land & Water Resources R&D Corporation
Mr Phil Styles	Tourism Council of Australia (NT)
Dr Sonia Tidemann	Batchelor College, Batchelor, NT
Dr Barry Walker	Meat Research Corporation, Buddina, Qld

SCIENTIFIC PROGRAM ADVISORY AND EVALUATION GROUP (SPAEG)

SPAEG consists of eminent researchers whose role is to ensure quality and rigour in all the Centre's research activities. SPAEG conducted a major review of the Centre's program and all projects on 24-26 February 1998, in preparation for the Year 3 Review.

SPAEG members reported a considerable improvement in project performance since the February 1997 review. They were particularly pleased with the development of the two management studies: Victoria River District (NT) and Desert Uplands (Qld). They expressed the need for a greater emphasis on integration.

Members in 1997-98 were:

Prof Jon Altman	Centre for Aboriginal Economic Policy Research Australian National University, Canberra
Prof Ian Noble	Research School of Biological Sciences Australian National University, Canberra
Dr Roy Powell	Centre for Agricultural and Resource Economics University of New England, Armidale
Dr John Vercoe	Tropical Beef Centre, Rockhampton
Prof Rod Gerber	Faculty of Education, Health and Professional Studies University of New England, Armidale
Dr Doug Cocks	CSIRO, Division of Wildlife and Ecology, Canberra

STRUCTURE AND MANAGEMENT

MANAGEMENT COMMITTEE

The Management Committee played a major role in the development of the *Strategy Statement 1998-2002* and the new management arrangements. They were instrumental in refocusing the direction of the Centre's program and the management processes adopted to enhance accountability and performance, project management, project selection, strategic planning and financial reporting.

With the appointment of the Business Manager, Dr Brok Glenn, the Centre's financial management was streamlined and greatly enhanced. The new Communication Coordinator, Dr Peter Jacklyn, substantially improved relations among Centre participants and stakeholders. These two new positions contributed significantly to the Centre's overall performance.

The Management Committee met eight times during the year.

Members as at 30 June 1998:

Mr John Childs	Director, TS CRC
Dr John Ludwig	CSIRO DWE, Leader Sub-Program 1
Dr Peter Whitehead	PWCNT, Leader Sub-Program 2
Dr Paul Novelly	AgWA, Leader Sub-Program 3
A/Prof Ross Hynes	Deputy Director, TS CRC (Townsville) Leader Sub-Program 4
Prof Greg Hill	NTU, Leader Sub-Program 5
Dr Brok Glenn	Business Manager, TS CRC
Dr Peter Jacklyn	Communication Coordinator, TS CRC

COOPERATIVE LINKAGES

In the last year, the Centre developed distinctive interdisciplinary research and non-research activities which span different sectors and regions to produce outcomes at a savanna-wide level. CRC Management strengthened cooperation between various projects towards the end of this year by the adoption of unifying 'Themes' which focus Centre research and activities on issues that affect sustainable land management right across the tropical savannas. The linkages between the projects, partners, other research institutions, and national and international agencies are outlined below according to the four 'Themes'.

In addition to collaboration in research activities, the Centre implemented a Communication Strategy which has fostered internal linkages. Several of the initiatives, such as the new email newsletter for all CRC staff/collaborators, an internal website for staff and students and several combined workshops held for staff across the CRC's numerous locations, have created more alignment and cohesion between the CRC's widely dispersed and diverse players.

NORTH AUSTRALIA LANDSCAPE THEME

This theme deals with qualifying and quantifying what is unique about the north Australia landscape as opposed to any other tropical savanna.

A tropical savanna landscape near Kununurra, Western Australia.

Collaboration between researchers in Projects 2.1, 2.2 and 4.2 are necessary in order to develop a comprehensive and detailed picture of the tropical savannas.

Biogeographic Overview

A major linkage was forged between Project 2.1, Biogeographic Overview and Queensland Department of Environment and Heritage (QDoE). CRC expertise and supervision were provided on a major project examining the impacts upon biodiversity of tree clearing in the poplar box woodlands of the Northern Brigalow Belt and Desert Uplands. This is important as it extends CRC biodiversity research beyond its main core within the Northern Territory and will provide substantial data on a process which may affect far more of the tropical savannas.

Researchers within Project 2.1 have also forged links with two bodies undertaking multi-disciplinary studies of the impacts and benefits of a range of grazing regimes in Queensland. Vertebrates will now be sampled and their abundance and composition related to grazing regimes, at QDPI sites (in cooperation with Peter O'Reagain) and CSIRO sites (in cooperation with Andrew Ash).

This project also links in with a range of studies, over a very broad range of disciplines, being undertaken in the Arafura Swamp region of northern Arnhem Land.

Linkages previously established or proving fruitful in 1997/98 include Project 3.2 (for analysis of invertebrate data from Barkly Tablelands survey), 3.1 (for relating remote-sensed indices of condition with biodiversity data), 2.4 (for relating site-based biodiversity data to experimental fire regimes and long-term fire monitoring sites), 2.2 (for analysis of patterns of changing status in granivorous birds) and 1.1 (for analysis of vertebrates along the North Australian Tropical Transect (NATT)).

Granivorous Birds

The Declining Granivorous Birds project (2.2) has formed links with other projects that examine some of the important disturbance factors that affect granivorous birds, especially Fire and Savanna Landscapes (2.4). Logistical and cost-sharing links with that project include complementary purchases of satellite imagery for the provision of relevant fire histories, and collection of data on fire extent and intensity for ground-truthing satellite imagery. Interpretation of patterning of grassland resources will be assisted by the long-term analysis of vegetation response to fire being gathered in a variety of savanna types under that project. In addition, the land condition studies underpinning the project Indicators of Sustainable Land Production and Condition (3.1) will provide data on density of perennial grasses in pastoral landscapes. These data will provide an additional perspective on the availability of favourable high-density patches in landscapes of different types and the effects of grazing on those patches.

A savanna-wide perspective has also been taken in Don Franklin's analyses of geographic patterns of granivorous bird decline, involving cooperative arrangements with the QDoE. That Department will investigate habitat features at Queensland sites in which two species of the finch (Crimson Finch and Star Finch) have declined in abundance or disappeared altogether, for comparison with similar habitats in the Northern Territory which retain healthy populations. The development of such linkages is an important development for conservation in northern Australia, where cooperation between governments is likely to be necessary to protect highly mobile species that range across state borders.

Habitat Features

Information on habitat features, especially the spatial configuration of patches, needed to maintain these quintessentially savanna birds will be important inputs to the CRC's efforts to produce models for sustainable management of the savannas. These and other inputs will be organised under the Landscape Processes Theme led by Dr John Ludwig.

Environmental Values

A strong cooperative linkage has been developed in the environmental values project activity of Project 4.2, Social and Environmental Values. The links are to the national studies being undertaken by a team led by A/Prof Jeff Bennett of UNSW/ADFA. An important link in this project is to Mr John Rolfe of the University of Central Queensland.

Through the Symposium, Northern Landscapes in Story and History, organised by Dr Deborah Rose, a better network with other academics was established.

LANDSCAPE PROCESSES THEME

This theme examines how the various processes of the tropical savannas function.

Savanna Form and Function

Project 1.1, Savanna Form and Function, forms the scientific framework for much of the CRC's biophysical research program and has a number of links with other CRC projects - 2.1 Biogeographic Overview; 3.2 Invertebrate Indicators; 3.3 Landscape Restoration and the Victoria River District (VRD) Management Study. This cooperation has allowed researchers from these projects to sample from a shared group of sites along the NATT and in the VRD which will enable clearer links to be made between the different aspects of the savanna system covered by the projects.

The project also has a number of national and international links with:

- other CSIRO researchers regarding grazing impact and land condition studies;
- the Australian National University's Professor Graham Farquar, GCTE member, who is a joint supervisor of Mr Geoff Miller's PhD project, Carbon isotopes in trees along NATT. This study

follows on from work initiated by Professor Detlef Schulze, University of Beyreuth, Germany (see Schulze *et al*. 1998 for an account of this work);

- International Geo Biosphere Program through transect studies;
- Australian NATT and African transect comparisons; Dr Dick Williams' visit to the Kalahari transect and presentation of an invited paper on the NATT at the Kalahari transect workshop;
- NASA due to Dr Waqar Ahmad's visit to the Jet Propulsion Lab; and
- the University of Virginia, USA regarding remote sensing.

Water Use

Project 1.2 Water Use by Tropical Savannas is a multidisciplinary one requiring the skills of ecophysiologists, micro-meteorologists, hydrologists and chemists. Because of the cooperative arrangements between partners, a team involving the following agencies has been brought together:

- CSIRO, Soils and Water Division labs in Adelaide (for CFC analyses);
- CSIRO, Soils and Water Division labs in Perth (sapflow measurements and eddy covariance equipment);
- NT Department of Lands, Planning and the Environment (hydrology);
- NT Power and Water Authority (soil water engineers/technicians); and
- NTU (ecophysiology and micro-meteorology and sapflow measurements).

In addition, collaboration with Professor G. Stewart, formerly University of Queensland (UQld), now University of Western Australia (UWA), on isotope analyses of leaves has been established. International links are being fostered with Centre d'Etudes Spatiale de la Biosphere at the Paul Sabatier University in Toulouse and the Suivi des Savanes a Long Terme in Africa.

Invertebrates

There is no other research group in northern Australia working on either savanna invertebrate biodiversity or on bioindicators. However, Project 3.2, Invertebrate Indicators, has strong links with CRC Projects 1.1 (using NATT sites and associated environmental and vegetation data), 2.1 (vertebrate biodiversity), and 3.1 (land condition). In addition, staff are involved in collaborative projects with CSIRO Tropical Agriculture (grazing impacts on biodiversity), QDPI (grazing impacts on biodiversity), and Qld Forest Research Institute (ants as indicators in forest management).

Prior to the CRC, the field of invertebrate biodiversity and bioindicators in Australian savannas was represented by a single researcher (Andersen) working on a single invertebrate group (ants). The CRC has value-added by providing (1) the resources to cover other invertebrate groups; (2) opportunities to cover a range of land uses through linkages with other agencies; and (3) direct linkages as CRC partners to Government land management agencies, the primary stakeholders of the project.

Project 3.2 has also developed a number of links with external bodies:

- Qld Forest Research Institute (ants as bioindicators in forest management);
- Olympic Dam Mine (ants as bioindicators);
- University of South Australia (ants as bio-indicators); and
- various spider taxonomists throughout the world.

ECOSYSTEMS MANAGEMENT THEME

This theme identifies impacts and interrelationships between different savanna uses. It aims to develop a more comprehensive natural resource management framework for the savannas, so that multiple use can take place while still managing to sustain the integrity of the ecosystem.

COOPERATIVE LINKAGES

Fire Management

Fires know no boundaries, between states or land tenures. Cooperation across state and territory borders and between different land managers is a key part of Project 2.4 (Fire and Savanna Landscapes) and through the CRC crucial and extensive linkages have been made between these groups and across these regions. The regional fire management studies involve nine TS CRC partner agencies and 13 other organisations including government land management agencies, bushfire services, CSIRO, universities, landcare groups, regional bushfire committees, Aboriginal land councils, the Department of Defence and conservation agencies. Linkages have also included the development of a project in eastern Indonesia, mostly through the Australian Centre for International Agricultural Research (ACIAR) and World Wide Fund for Nature (WWF).

Land Condition

Project 3.1 Indicators of Sustainable Land Production and Condition requires interdisciplinary linkages involving remote sensing, vegetation, soils and fire expertise among others, as well as links across different sectors because of the different land tenures involved. Collaboration has been excellent from both core TS CRC and non-core TS CRC organisations with a range of activities from research to extension and statutory functions. This project has been strongly involved in the VRD Management Study through production of a specialised field map, joint data collection and sharing results and the completion of a change detection project based on historical aerial photography.

The value of the results from Project 3.1 have been recognised extensively and the Natural Heritage Trust and National Land and Water Resources Audit have now provided financial support to trial the techniques developed in other parts of the tropical savannas. Under the auspices of this project, data sharing has occurred which represents considerable savings in resources for a range of projects as well as in the operational application of monitoring techniques developed by CSIRO.

Landscape Restoration

In Landscape Restoration (3.3) links are established between the main groups focusing on the restoration of northern Australian landscapes that are prone to invasion by exotic trees and shrubs. These groups include CSIRO Tropical Agriculture, Queensland Department of Natural Resources and CSIRO

Participants at the North Australia Fire Management Workshop.

Division of Entomology. It also involves collaboration with land-holder groups, notably, the Balfe's Creek Landcare Group. Much of the research taking place within this project is conducted on commercial beef properties in the Charters Towers, Richmond and Julia Creek areas. More recently, the project has been able to consolidate linkages with the QDoE and the BFC. These linkages will be utilised in a new project due to commence in January 1999. Data from work on both prickly acacia and rubbervine has been made available to Darren Kriticos (UQld PhD student) as a major contribution to the development of climate-dependent population models for these species.

HUMAN CAPABILITY DEVELOPMENT THEME

Activities within this theme aim at improving the awareness, education and training of those who study, use and manage the tropical savannas. The CRC services and products are provided to enrich existing programs and foster collaboration in this field.

Tourism Training

Management Options for Savanna Land Managers (4.3) has strengthened important links through the year with the nature and culture-based tourism industry through Savannah Guides Inc.

As part of a professional development course, A/Prof Ross Hynes convened three action learning and research sessions at two Guide Schools. Two were held at Tyconnell Historic Gold Mine in October 1997 the other in April 1998 at Undara Experience Savannah Guide Station. Dr Neil Black (JCU) participated in both Schools and Tim Nevard (JCU) participated in the Undara program.

Tourism Ministers from both the Northern Territory and Queensland attended the opening of the Tyconnell site. Ross Hynes was recognised on that occasion for his contribution to Savannah Guide training by being made the only Honorary Member of the Savannah Guides.

Ross Hynes was a member of a Savannah Guide Working Group that examined strategic organisational options for the Guides. He also wrote the terms of reference in conjunction with NT Tourism Commission (NTTC) representative, Ms Pauline Rayner for a consultancy, funded by the NT and Queensland Governments. The consultancy provides a strategic plan for the future expansion of a Savannah Guides Network across the Top End.

Education and Training in Environment Management

Project 5.1 facilitates the delivery of different education and training products tailored to the varied requirements of people across the savannas. This occurs through the networking and cooperative efforts of staff throughout the entire CRC.

One of the positive outcomes of the education and training needs analysis survey this year was the establishment of extensive networks between the CRC, education and training providers and the stakeholders who were involved in consultations.

The education and training project has also developed cooperative linkages in a number of areas with the newly established Centre for Indigenous Natural and Cultural Resource Management (CINCRM) based at NTU. In particular, the CRC and CINCRM are collaborating on curriculum development projects in VET and undergraduate resource management programs, and on the Arafura Wetlands Management and Training Project.

Linkages are also being developed with the newly established CRC for Sustainable Tourism, and we look forward to a number of collaborative education and training projects addressing the needs of stakeholders in the tourism industry.

Linking People to Information about Savannas

Savanna Information Management Project 5.3 is designed to exploit the links made by the CRC and

develop many more. Links have been made with the website of the Western Australian Department of Land Administration. Their website allows access to remote sensed fire maps (partly funded by the Centre - see Project 2.4). This site has now been linked to the Centre's home page. Other links are being developed with sites being set up by the NTDLPE and the National Land and Water Resources Audit.

The project is also making international links in collaboration with Project 2.4. Dr Sindre Langaas of the Department of Systems Ecology, Stockholm University, has been invited to visit the Centre in October 1998. Dr Langaas is internationally recognised for his state-of-the-art InterNet information dissemination systems for environmental decision making in the Baltic region. His advice will be invaluable in developing the savanna information clearing house.

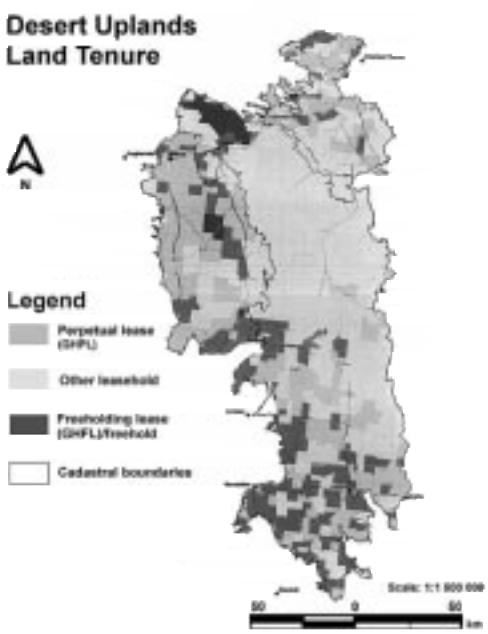
THE REGIONAL MANAGEMENT STUDIES

The two regional management studies are by far the most cooperative projects the CRC has established. They involve cooperation between different CRC projects, across Government agencies, community groups and with international researchers as well.

Desert Uplands Study

Useful links have been created through the Centre's involvement in this study as the Queensland Government partners QDPI and QDNR are fully committed to it. Strong collaborative commitment achieved with QDoE, the Desert Uplands Build-Up and Development Strategy Committee (DUBDSC), JCU and a number of community groups, with funding support respectively from Queensland Treasury and Commonwealth DPIE and Department of Environment Sport and Territories (DEST). Links are also established with:

- A/Prof J. Bennett (UNSW) and J. Rolfe (UCQ) on Choice Modelling in the Desert Uplands;
- Dr J. Davie and Dr M. Shrapnel (UQld) on producers' present coping strategies; and
- Dr G. Kirby (NTDPIF) on regional economic analyses.



The Centre has produced Desert Uplands GIS maps which help landowners and planners in making regionally based decisions.

VRD Study

Working out and implementing practical land management practices tailored to a particular region requires knowledge from a number of disciplines and backgrounds (biophysical sciences, pastoral and traditional knowledge, social and economic expertise). This study has been a catalyst for many of the region-specific linkages made by the Centre.

In particular, this study has allowed a number of Centre partner agencies and other bodies to collaborate on developing fire management strategies in the region. The groups involved are: PWCNT, CSIRO, NTDPIF, NTU, NTDLPE, NARU, BFC, Colorado State University, and Lewis and Rose and Associates.

RESEARCH

SUB-PROGRAM 1

Responses of Savannas to Stress and Disturbance

Sub-Program Leader

Dr John Ludwig

CSIRO, Division of Wildlife & Ecology

The aim of this sub-program is to gain understanding of how savanna ecosystems respond to water and soil fertility stresses and how these responses are altered by disturbances such as fire and grazing. This understanding is necessary to achieve the sustainable use and conservation of tropical savannas.

During 1997/98, research conducted in the two projects in this sub-program contributed to signficant gains in knowledge. For example, the importance of how landscape patches function to regulate resources in savannas, and how patch structure and size varies with rainfall and soil type, has been elucidated by research activities in Project 1.1. Variations in water use by savanna trees and understorey vegetation from wet to dry season have revealed the importance of ground-layer evapotranspiration in yearly water budgets.

These results are detailed in the project reports.

PROJECT 1.1

Savanna form and function in relation to gradients of moisture, nutrients and disturbance

Project Leader

Dr Dick Williams

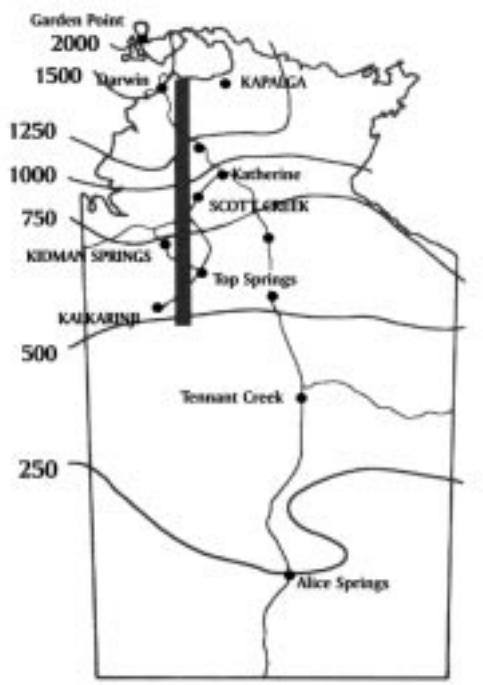
CSIRO, Division of Wildlife & Ecology

Project Summary

The sustainable use of savanna resources requires an understanding of basic savanna ecology - the environmental factors which determine the key features of savanna vegetation. These features include tree cover, species composition, grass abundance, soil surface condition, and susceptibility to disturbance. The primary determinants of these components of savanna form and function are plant available moisture and available nutrients.

The research within this project aims to determine the responses of key ecosystem features such as those listed above to variation in moisture, soil texture and disturbance. The framework being used is a continental-scale transect through the savannas of north-western Australia - the North Australian Tropical Transect (NATT).

The Masters by coursework program develops new researchers committed to tropical environmental management.



The NATT is a 1000 km long, 250 km wide transect with a series of research sites following the major rainfall gradient south of Darwin. It covers a gradient of decreasing mean annual rainfall from 1600 mm in the north to 500 mm in the south. A wide range of soil types is also represented so that the NATT encompasses the major variations in the biophysical environment of the savannas in north-western Australia.

From this and other transect studies elsewhere in the world's savannas, variation in ecosystem responses to key climatic and soil factors are being quantified. Predictive models are being derived and tested. This project provides a framework within the Centre to study many key properties and processes in savannas, including ecological structure and composition, plant-water relations and disturbance.

Research Progress

There have been significant achievements during the year.

- The NATT has been extended to include sites in the east Kimberley in Western Australia. Data on the composition and structure of the savannas at these sites have been collected on 1 ha geo-located plots as per the methodology used for the NATT sites in the Northern Territory.
- Dr Garry Cook, CSIRO DWE and Mr Richard Heerdegen from Massey University in New Zealand have collaborated on a project examining the rainfall regimes of the NATT sites and a comparison of these climatic parameters with the West Africa and Southern Africa International Geo Biosphere Program (IGBP) savanna transects commenced in 1997. A paper has been submitted to *Climate Research*.
- A project on the influence of grazing intensity on landscape patchiness and plant diversity has commenced at Kidman Springs and Mt Sanford Station in the VRD. A paper detailing the preliminary results has been submitted to the *Rangeland Journal*.
- A five-year Land, Water Resource Research and Development Corporation (LWRRDC) project, predicting the determinants of land and degradation along environmental gradients, is nearing completion. A major outcome of this project has been the biogeographic and experimental assessment of landscape patchiness and soil surface indicators of savanna form along the NATT. The final report has been submitted.
- Landscape function analysis along 100 metre transects has been completed for all current 1 ha NATT sites. Work using the Surface Soil Condition Assessment indicator (Section 3, Cooperative Linkages) as a predictor of nutrients is in the preliminary stages of development.
- One paper on landscape patchiness along the NATT has been published in *Landscape Ecology*.
- One review chapter on disturbance regimes in savannas has been published in a recent book. These and other manuscripts formed part of the final report to LWRRDC.
- Analyses of the nutrient status of soils beneath perennial grass tussocks and in inter-tussock areas along the NATT has begun. This project is

examining the degree to which nitrogen availability varies in rangeland condition.

- Dr Ahmad from NTU spent several months at the NASA Jet Propulsion Laboratories (JPL) in the USA working on the development of new techniques for classifying multipolarisation AIRSAR data.

The resultant software has been brought to the Remote Sensing and Geographic Information System (GIS) laboratory at NTU for further research. Additional 1 ha calibration sites for ground-truthing the use of radar in predicting soil texture and tree abundance have been established at Kidman Springs Research Station in the VRD and comparison of both broad-scale and high-resolution imagery and various classification routines in predicting land cover types in VRD is continuing.

Milestones

- Extension of the current NATT to include sites in the Kimberley (WA) and southern Northern Territory completed.
- Dr Ahmad continued work on radar data at NASA and research on the software at NTU, and published a preliminary paper on the development of a system to predict tree cover using Synthetic Aperture Radar.
- Progress report submitted to LWRRDC on relationships between vegetation structure and composition in relation to environmental and disturbance gradients.
- Establishment of reference 1 ha sites in conjunction with Sub-Programs 2 and 3. Vertebrate and invertebrate diversity mesasured on 1 ha NATT sites completed in 1997. Additional grazing gradient sites established in the VRD in conjunction with the VRD Management Study.
- Characterisation of nutrient status of soils at core NATT sites completed.
- Assessment of landscape patchiness at core NATT sites. One paper accepted for publication.
- Preliminary work on the use of soil surface condition as a predictor of nutrient availability has commenced on clay soils in the VRD.
- Provision of ecological data to other sub-programs and GCTE (as outlined above) continued throughout the year.
- Preliminary testing of the GCTE climate-vegetation process model with NATT data was undertaken by Dr Brian Walker and colleagues in the IGBP/GCTE Project.

Highlights and Challenges

The main highlights of the year have been:

- A more complete understanding of landscape patchiness and its role in determining nutrient patchiness at the landscape scale.
- The relationship between landscape patchiness and diversity along grazing gradients in the VRD.
- Intercontinental comparisons between NATT and similar transects in Africa.
- Continued involvement with NASA through research into radar applications in savannas.
- Use of new image processing software for working on AIRSAR (radar) data sets.

Future Directions

In conjunction with Dr Ludwig's modelling project, a general predictive model of savanna form will be developed. This will involve the testing of the SAVANNA model, developed in other areas of the world's savannas, by CRC Visiting Scientist Dr Mike Cougenhouer. Another component of the NATT-modelling activity, focused on the VRD, will be developing ecological response models for biodiversity in relation to grazing intensity which will be used in Dr Ludwig's project on socio-economic trade-off models relating production to biodiversity conservation.

The role of tree patchiness, as well as grass patchiness, in savanna dynamics will be investigated. The study will commence with an examination of

tree/grass patchiness in two contrasting savanna areas - the VRD in the NT and the Dalrymple Shire near Townsville, Queensland.

Project Team

Nominated Staff

Dr W. Ahmad, NTU (Activity Leader, Remote Sensing)
Dr G. Cook, CSIRO DWE (Activity Leader, Nutrients)
Dr J. Ludwig, CSIRO DWE (Activity Leader, Landscape Patchiness)
Dr A. Noble, CSIRO L&W
Mr D. Tongway, CSIRO DWE
Dr M. Stafford Smith, CSIRO DWE
Dr D. Williams, CSIRO DWE (Activity Leader, NATT)

Support Staff

Mr J. Cusack, CSIRO DWE
Mr R. Eager, CSIRO DWE
Mr M. Greatz, CSIRO DWE
Mr N. Hindley, CSIRO DWE
Mr M. Hope, CSIRO DWE

Collaborating Researchers

Prof G. Farquar, Research School of Biological Sciences, ANU
Mr R. Heerdegen, Dept of Geography, Massey University, NZ.
Prof G. Hill, Centre for Remote Sensing and Geographic Information Systems, NTU
Ms J. Langridge, CSIRO DWE
Prof H. Shugart, Dept of Environmental Sciences, University of Virginia, USA
Dr J. van Zyl, NASA/JPL, USA

Students

Mr H. Khwaja, NTU*
Ms A. Lane, NTU
Mr C. Menges, NTU*
Mr G. Miller, ANU
Ms K. Pfitzner, NTU*

*CRC-funded PhD students

PROJECT 1.2

Water fluxes in savannas

Project Leader
A/Prof Derek Eamus
Northern Territory University

Project Summary

The number of water bores in the Darwin region has increased by a factor of 40 in the past 40 years. Water requirements of northern Australia are likely to more than double over the next 50 years because of increased horticultural activity and population growth. In a climate dominated by seasonal availability of water, it is important to know the extent to which vegetation utilises soil water as vegetation and human consumption of water are liable to be competing.

Savannas of northern Australia are a mosaic of communities including riparian systems, monsoon vine forests, eucalypt woodlands, paperbark swamps and floodplains. This diversity results in a wide range of human activities requiring scientifically based management strategies.

Project 1.2 investigates the hydro-ecology of savannas of northern Australian and seeks to quantify seasonal rates of water use by savanna vegetation, with the goal of assessing water use of the major vegetation types. Knowledge of the role of vegetation in the water cycle is vital to achieving ecologically sustainable development of this region,

especially in terms of the exploitation of groundwater reserves.

This project needs to track complex water flows from rain, to plants, into the soil and finally down to the groundwater in the aquifers. To tackle this problem the CRC has brought together researchers with expertise in the following disciplines:

- plant physiologists to measure how plants use water on the surface;
- ecologists to map and classify different types of plants in the area;
- soil scientists to analyse soil moisture changes through the seasons;
- hydrologists to analyse groundwater levels and measure groundwater age and the rate at which it is renewed; and
- ecological modellers to work out how the whole system is affected by climate.

Research Progress

During the year there were several new developments including estimates of understorey and soil evaporation rates using open-top chambers; measurements of paperbark vegetation leaf area index and transpiration rate; and determinations of CO_2 fluxes to a savanna canopy.

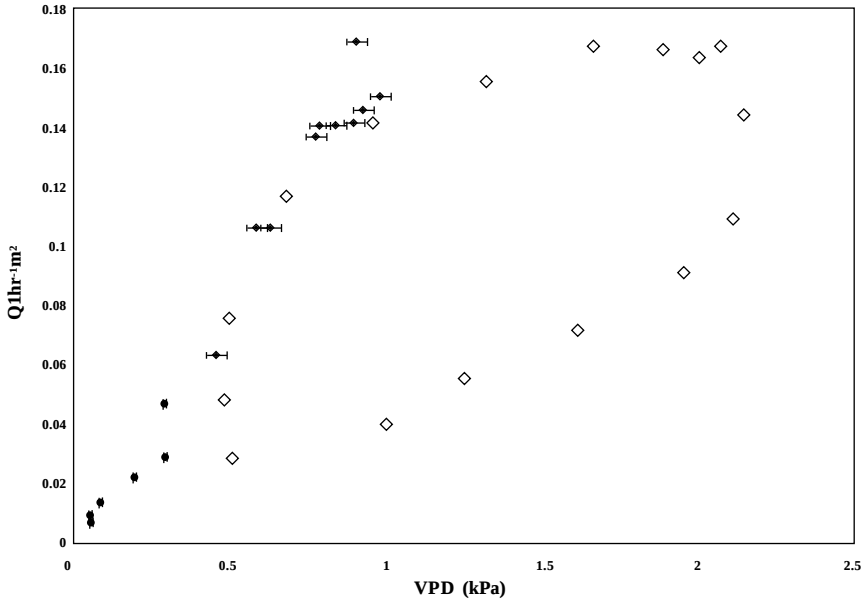
Extensive field research in 1997/98 using sapflow technology, open-top chambers and eddy covariance has shown the following key results:

- Transpiration rate from individual trees was typically ca 1.0 mm per day with only small variation between wet and dry seasons.
- Whole canopy (under and overstorey) transpiration rates were typically ca 3.0 mm per day in the wet season, declining to ca 1.0 mm per day in the dry. The difference between tree and whole canopy rates was due to understorey transpiration, which was maximal towards the mid-to-end wet season and declined rapidly throughout the dry season.
- The relationship between diurnal transpiration rate and vapour pressure deficit shows considerable hysteresis in the dry season but not in the wet season.
- Diameter at breast height (DBH) was a very good scalar for both leaf area and daily cumulative transpiration rate. The relationship between DBH and these variables was the same for all five species sampled.
- Overstorey leaf area index (LAI) varies seasonally between 0.8 (wet season) and 0.5 (dry season).
- Transpiration rate per unit leaf area was significantly larger in the dry season than the wet season.
- The magnitude of the decline in LAI in the dry season and the increase in transpiration rate are approximately equal and opposite so that total water use is approximately equal in both seasons.
- Chlorofluorocarbon concentration of groundwater declines with depth beneath the soil surface, and groundwater age increases with depth.
- The rate of recharge of groundwater is estimated to be between 20 and 200 mm per year.
- Rates of transpiration from *Melaleuca spp* (paperbarks) are similar to those for eucalypt savannas, with rates varying between 1.1 mm per day at the end of the wet season to 1.6 mm per day in the early dry season. LAI varied over the same period from 0.7 to 1 over the same period.

Milestones

- Completion of a quantitative assessment of daily and seasonal water use by eucalypt woodlands.
- Submission of a paper to *Tree Physiology* on work undertaken to assess water use by individual trees of a savanna woodland.
- Models of vegetation water use of savanna woodland determined to be of little relevance.
- The application of eddy correlation techniques for the determination of wet and dry season canopy water use of savanna woodlands completed.

FIGURE 4



Transpiration rates exhibited a hysteresis in relation to vapour pressure deficit (VPD). The rates are higher in the morning than in the afternoon for similar VPD. The hysteresis is much more marked during the dry season than the wet.

- The application of sapflow measurement techniques for the determination of individual tree water use in paperbark swamps completed.
- Report and newsletter articles on grass-tree competition and pastoral production completed in year two.

Future Directions

There are two principal goals for the 1998/99 period:

(i) To write up the tree water use, vegetation structure and eddy covariance data obtained for the eucalypt savanna over the previous three years; and

(ii) To undertake measurements of water and CO_2 flux above eucalypt savannas along the NATT. The addition of measurements of CO_2 fluxes to that of H_2O fluxes represents a substantial increase in the value of the eddy covariance measurements and will allow the Centre to contribute to the national and international debate of carbon fluxes and climate change following the Kyoto agreement of 1997.

Project Team

Nominated Staff

A/Prof D. Eamus, NTU
Dr L. Hutley, CRC/NTU
Ms G. Kelley, NTU*
Mr A. O'Grady, CRC/NTU
Mr C. Xiaoyang, NTU*

Support Staff

Mr W. Ahmad, NTU
Mr D. Chin, NTDLPE
Mr E. Kerle, NTDLPE
Mr I. Lancaster, NTDLPE

Collaborating Researchers

Dr P. Cook, CSIRO L&W
Mr R. Dyer, NTDPIF
Dr T. Hatton, CSIRO L&W
Mr D. Pidsley, NTDLPE
Dr D. Thomas, NTU
Dr D. Williams, CSIRO DWE

*CRC-funded PhD students

SUB-PROGRAM 2

Biological Diversity in the Savanna Landscape

Sub-Program Leader

Dr Peter Whitehead

Northern Territory University

Studies of savanna biota are sparse when compared with environments in other more densely settled parts of Australia. The development of savannas for production and the development of ecological understanding have both accelerated substantially in recent years, but many gaps in knowledge remain. As it is impracticable to delay management decisions while waiting for the knowledge gaps to be comprehensively filled, it is important to adopt a strategic approach that provides the ecological understanding most likely to advance sustainability.

Sub-Program 2 was designed to provide information on relationships between biological diversity and patterns of land use at a number of relevant spatial scales, using a strategic approach that focuses special attention on a few aspects of savanna ecology. Emphasis is placed on research outputs that offer the greatest potential for general application to a range of savanna environments and various development options, yet are achievable on relatively modest budgets over a reasonable time frame.

The sub-program comprises four closely linked projects which examine vulnerable species, a vulnerable habitat, the influence of a ubiquitous process on vulnerable habitats and species, and provide a context to permit extrapolation from site-bound studies to the wider landscape.

PROJECT 2.1

Biogeographic overview (savanna fauna)

Project Leader

Dr John Woinarski

Parks & Wildlife Commission of the NT

Project Summary

Project 2.1 provides an overview of the biogeography of vertebrates in the northern Australian savannas. It seeks to consolidate existing information and include information from new surveys to describe the broad patterning of distribution of species, including the identification of sites and environments that are unusually rich in biological diversity and the factors underlying these.

The project includes a detailed study of the faunal distributional patterns in a major north Australian landscape, the Mitchell grasslands. The distributional patterning and its relationship with environmental factors, is being examined at a range of spatial scales, including intensive work in the two regions in which the CRC has major management studies (in the Victoria River District (VRD) and the Desert Uplands).

This project also considers the response of vertebrates to a range of disturbance and land-use regimes, including fire and grazing. These studies have included the response of birds and reptiles to a

The Mitchell grasslands.

series of experimental fire regimes in the VRD, the response of vertebrates to gazing gradients, and the relationships between remotely sensed values of land condition and faunal composition.

Research Progress

The major advances in 1997/98 were:

- Completion of many analyses from a very large database on the biogeography of Mitchell grasslands, and the impacts of grazing on biodiversity in this environment. This work is being extended via a collaborative project with CSIRO (funded by LWRRDC) to consider options for optimising economic and biodiversity values.
- The completion of a study on the variation in vertebrate species richness, composition and total abundance along the NATT, which examines how soil nutrients and water availability structures these vertebrate communities.
- The completion of a study on the relationship of reptile and bird communities to a range of experimental fire regimes in the VRD, with the study sited at NTDPIF plots to allow for increased dimensionality of research outcomes.
- The commencement of field work for a study examining the distributional patterning of biodiversity in the Desert Uplands.
- The commencement of CRC involvement in a study examining the impacts of tree clearing in the northern Brigalow Belt and Desert Uplands.
- The completion of a series of papers reporting the biodiversity of islands off Arnhem Land.
- The commencement of a study relating remote sensed indices of condition (on black soils of the VRD) with vertebrate biodiversity (in collaboration with CRC Project 3.1).
- The collation of a large database of quadrat-based vertebrate samples, with additional survey being undertaken in areas to fill major geographic or environmental gaps, or to provide finer resolution in areas of unusually high biodiversity. This database now includes vertebrate information for about 100 quadrats used for fire monitoring (under CRC Project 2.4).

Milestones

Several milestones for Project 2.1 were achieved in the second year of the CRC. The remaining milestones were achieved this year.

- Procedures and protocol for shared field sites and complementary data collection and exchange with other sub-programs established in second year.
- Existing relevant databases collated, where possible, by the second year.
- Sampling in more than 300 quadrats completed by the second year.
- Overview of distribution and reservation status of plants and vegetation published in *Australian Journal of Botany* in second year.
- Field work for survey of Mitchell grasslands wildlife completed by second year.
- Sampling of NATT sites commenced by June 1997.
- Commencement of field work for the survey of chenopod shrublands.
- Near completion of distributional patterns of fauna in Mitchell grasslands.
- Sampling of NATT sites completed, results analysed and a paper submitted for publication.
- Analysis of historic changes in distribution or status of savanna wildlife has started, but future progress is dependent upon further funding.

Highlights and Challenges

The major highlights in 1997/98 were:

- Development of studies linking this project with work being undertaken in Queensland (e.g. Desert Uplands biogeography, QDoE research on impacts of tree clearing, QDPI and CSIRO grazing studies).

- Establishing linkages between quadrat-based biodiversity modelling and remote-sensing studies of land condition.
- Collaborative studies of the NATT, which provided vertebrate data at communally used sites, and allowed comparisons of vertebrate patterning with that of other taxa.
- Substantial contributions to VRD Management Study.

The major challenges were balancing a desire for a tight focus, with an interest in contributing to a broad range of studies and areas, and the collation of data across studies and especially across jurisdictions.

Future Directions

Several of the projects noted above will be continued or concluded in 1998/99. Major new directions or extensions of existing projects include:

- In conjunction with CSIRO, modelling economic costs and biodiversity benefits of a range of conservation management scenarios relating to the Mitchell grasslands study.
- Completion of a broad biogeographic study of bluebush *(Chenopodium)* shrublands/swamps in the Barkly Tableland, as an example of a very poorly known environment thought to be particularly favoured by cattle.
- Extension of the current collaborative study examining the relationship between remote-sensed indices of condition and biodiversity in the VRD.
- Examination of the impacts of increased tree cover in the VRD upon vertebrates.
- (Depending upon funding), to extend research undertaken in CRC Project 2.2, to examine changing status of a broader range of vertebrates across northern Australia, and to establish distributional databases for an atlas of vertebrates across northern Australia.
- Comparison of the impacts of military and pastoral land use (Bradshaw Station).
- Conservation planning in two regions with possible major development issues (Daly Basin and Mary River catchment) and cooperatively with Aboriginal landowners (Arafura Swamp).

Project Team

Nominated Staff

Mr M. Armstrong, PWCNT
Mr C. Brock, PWCNT
Mr D. Cheal, PWCNT
Mr G. Connors, PWCNT
Mr A. Fisher, PWCNT
Mr D. Franklin, PWCNT
Mr A. Kutt, JCU*
Dr N. McKenzie, CALM WA
Mr D. Milne, PWCNT
Mr O. Price, PWCNT
Dr J. Woinarski, PWCNT

Collaborating Researchers

Dr R. Fensham, QDoE
Mr J. McCosker, QDoE
Mr D. Hannah, QDoE
Ms N. Thurgood, QDoE

*CRC-funded PhD student

PROJECT 2.2

Declining granivorous birds

Project Leader
Dr Peter Whitehead
Northern Territory University

Project Summary

Project 2.2 examines the ecology of granivorous birds. These animals depend on an essential feature of savannas, the seed-producing annual and perennial grasses that also support grazing, one of the savannas' major production activities. The central aim of the project is to use this suite of species as a model to explore interactions between savanna wildlife and land use dependent on the health of the same resource, and so develop principles for land management capable of sustaining both natural and production systems.

Many granivorous birds have been shown, as part of this project, to have declined markedly in range and abundance. To understand the factors affecting their status requires an examination of fundamental processes in grassland dynamics, and how those dynamics change with different land-use intensity or with the application of management tools such as fire.

Research Progress

Work completed or substantially advanced during the year includes:

- A comprehensive, savanna-wide review of the conservation status of all species of birds that are substantially dependent on seeds for at least part of the year. An analysis of change in reporting rates through time showed that 29% were now much less commonly encountered than previously, and that the total area of the savannas from which they were reported had also contracted.
- Identification of ecological attributes common to those birds that have clearly declined in range and abundance. Examination of a suite of ecological features of this avifauna, including such attributes as the placement of nests, clutch size, feeding mode and diet, showed that the only characteristic closely associated with decline was the habit of feeding on the ground.
- Description, at a range of spatial scales, of grassland and woody species patterning in sites used by Gouldian Finches for wet season feeding. Preliminary results indicate that foraging areas support relatively higher densities of these plants than the wider landscape, often clumped into patches exceeding 50 metres wide.
- Completion of field studies of home range and features of habitat used by the Partridge Pigeon throughout the year.
- Completion of experimental field studies of depredation of artificial ground nests and observations of patterns of loss of genuine Partridge Pigeon nests. Observations and evidence of predators taking nests suggests that losses were primarily due to native predators and that disturbances associated with roads, tracks or firebreaks are unlikely to cause increased rates of nest failure.

Milestones

- Draft begun on NT Government management program for the Gouldian Finch.
- GIS coverage of relevant habitat features at four major sites - completed Yinberrie Hills and well advanced Newry Station.
- A methodology has been established for data collection for models of grassland dynamics and the manner in which it will be analysed. Field work was completed at two sites and linkages to formal models are to be developed.
- Good linkages have been established with other relevant projects, especially fire management, where protocols have been established for linking field studies of grassland patterning to studies of fire patterns and ground-truthing of remotely sensed images. Links to formal modelling projects require additional work.

- Study sites have been established and work begun on Aboriginal land used for subsistence hunting, mining, grazing and protected areas.
- Testing of sampling methodologies is behind schedule and will be completed in mid-1999.
- Publication of details of grassland typology is behind schedule and grassland typologies developed for relevance to conservation of granivorous fauna will be completed in late 1999.
- Relevant data on habitat associations of assemblages of granivorous birds have been collected and now need to be analysed in association with Project 2.1.
- Relevant papers on the review of conservation status of grassland birds and threatening processes have been submitted, although not yet accepted.

The achievement of some milestones have been compromised by staffing difficulties, and in these instances the program has been deferred and expenditure reduced.

Highlights and Challenges

Progress of the project has continued to be compromised by changes in the participation of key researchers. Dr David Choquenot, appointed as Project Leader in March 1997, took up another appointment in New Zealand in November 1997. Dr Peter Whitehead resumed leadership, but has also changed employers, moving in May 1998 to the Northern Territory University to pursue research opportunities regarding management of wetlands and waterbirds. His ongoing role in the project is yet to be settled in detail.

These changes have slowed progress in some parts of the field program, particularly those relating to work on grassland patterning and its implications for the status of granivorous fauna. More recently, substantial advances have been made in association with studies of habitat use by the Gouldian Finch. Staffing arrangements have also been revised to enhance involvement of staff dedicated entirely to the CRC program (David Cheal and Chris Brock) and so buffer the project against personnel changes in participating agencies.

Completion of the laborious task of assembling, verifying and analysing a database of more than 60,000 historical and contemporary records of bird distributions, represents a major accomplishment, culminating in the submission of an important paper on the status of savanna birds.

Associated outcomes include studies of biogeographic patterns at the national scale, confirming the existence of a distinct 'savanna' community of granivorous birds.

The robust identification of those species that have undergone decline has facilitated the design of new projects that take advantage of the geographic variation in status. Collaborative studies with the QDoE will allow researchers to more rigorously explore changes implicated in loss of species. This should permit a robust identification of characteristics of 'healthy' savannas and the potential to develop corrective management responses.

Future Directions

The demonstration of a widespread decline of many savanna birds that feed on the ground provides a context for design and interpretation of other studies. Complementary work on the Gouldian Finch reveals three important patterns that may be related to this wider problem. The range of foraging options contracts in the wet season, the sites that attract the birds occupy a small proportion of the landscape and important grass species are spatially clumped within those sites.

The project is therefore switching from description of savanna-wide patterns of granivore decline and studies of the natural history of declining species to an examination of the factors influencing distribution of critical resources. Work to date has erected a platform from which more detailed studies of grassland patterning and avifaunal responses can

be launched, with the aim of identifying important patch types and developing management regimes that maintain their suitability for birds. This will be the emphasis during the coming year and beyond.

Project Team

Nominated Staff

Mr D. Cheal, PWCNT

Dr D. Choquenot, PWCNT
(Project Leader March 1997 to November 1997)

Mr G. Connors, PWCNT

Mr P. Dostine, PWCNT

Ms F. Fraser, PWCNT*

Dr R. Noske, NTU

Dr S. Tidemann, Batchelor College

Dr P. Whitehead, PWCNT/NTU
(Project Leader from December 1997)

Dr J. Woinarski, PWCNT

Support Staff

Mr C. Brock, PWCNT

Mr D. Hooper, PWCNT

Mr D. Milne, PWCNT

Mr J. Scott, PWCNT

Collaborating Researchers

Ms G. Crowley, Private Consultant

Mr D. Franklin, PWCNT

Dr S. Garnett, QDoE

Dr B. van Horne (Visitor), Colorado State University, USA

Prof J. Wiens (Visitor), Colorado State University, USA

*CRC-funded PhD student

PROJECT 2.3

Riparian habitats

Project Leader
Dr Tony Start
Department of Conservation and Land Management, Western Australia

Project Summary

Project 2.3 seeks a better understanding of the role of riparian systems - the margins of wetlands, rivers, streams and other drainage lines - in the sustainable land management of tropical savannas. These systems are known to support a large proportion of the system's biodiversity as well as being a focus for economic activity. The proper management of these relatively small components of the landscape is of particular importance because great benefits are likely to be realised through relatively localised and hence achievable research effort.

Research Progress

- A major broad-scale sampling of vegetation, floristics and bird use of riparian habitats across the Top End was undertaken by PWCNT contributing staff John Woinarski, David Cheal, Chris Brock and Martin Armstrong. Study sites were those used by the National River Health Monitoring Program (now called the AUSRIVAS Program), which had been stratified by land condition and remoteness.
- The database, based on more than 60 sampled sites, provides a very comprehensive inventory of vegetation structure, floristics and bird use across a wide range of riparian habitats. At every site, botanical sampling was conducted in riparian and adjacent non-riparian vegetation to quantify structural and floristic differences between riparian and non-riparian habitats.
- The results of the survey:
  - Identified the bird species that are more or less dependent on riparian zones.

- Indicate that riparian zones were structurally and floristically distinct and a large number of bird species were associated with them, including Crimson Finch, White-browed Robin, White-gaped Honeyeater, Purple-crowned Fairy-wren and Shining Flycatcher.
- Show how several species (such as Blue-winged Kookaburra) extend their range into relatively low rainfall areas only because of riparian vegetation.

- This broad biogeographical study is nearly completed. The initial survey of all sites will be completed by August 1998. A subset of sites will be visited again in the late dry season and mid-wet season of 1998/99 to examine for seasonal change. The results will be analysed and related to the accompanying riparian floristic study.

Milestones

There have been substantial delays in the implementation of some components of this project because of resource and staffing problems in WA. This situation has been substantially overcome and progress is expected to be rapid in the future.

- Desk survey of riparian systems including draft publication of results has been postponed but the survey will be an integral component of the Ord River Project.
- Identification of study sites is completed in the NT where the sites used by the National River Health Monitoring Program were used. This compliments the 'in-river' data collected under that program. In WA a major project will examine the whole of the Ord River's riparian zone.
- Initial, descriptive, flora and fauna surveys of sites are nearly complete in the NT. These will be completed during 1998/99. Survey on the Ord will commence in 1998/99.
- Characterisation of riparian habitats in the NT will be undertaken during 1998/99 by analysing the data set that is now nearly complete. It will not occur for the Ord system until after 2000.
- Submission of publication on distribution and characteristics of riparian habitats in the savannas of the NT may be possible during 1998/99 but will take longer for the Ord system.
- Completion of initial floristic and faunal surveys of riparian habitats in the NT will occur in 1998/99 but will continue on the Ord River until at least 2000.

Highlights and Challenges

Progress of this project has been compromised from its inception by staff and resource difficulties in CALM WA. This difficulty has been substantially resolved with CALM's appointment of Dr Tony Start to the CRC. He has accepted the role of Project Leader and will commence work during 1998 from Perth before transferring to Kununurra in early 1999.

His work will focus on the riparian zone of the Ord River, a major tropical Australian river. Its riparian zone has been substantially modified by construction of dams and it is used for purposes as diverse as nature conservation and pastoralism. Siltation, fire grazing, weeds and feral animals have all affected it. His work will provide an overview of the physical and biological properties, uses, changes and processes of the system. This will provide a context for more collaborative studies with other parties managing projects on the Ord.

The survey of vegetation, floristics and birds of riparian zones on a broad range of rivers in the NT's tropical savannas and comparison with adjacent, non-riparian communities is nearly complete.

Future Directions

While the work in the NT has examined relatively few sites per river, on a wide array of rivers, work on the Ord will concentrate much more detail on the one river system. Comparison of predictions made from one study against the findings of the other will allow us to test how well tentative generalisations derived from the study of one river system can be applied with confidence to other rivers in the tropical savannas. This is important if management options developed from study of sample systems are to be useful for managers striving for sustainable development throughout the tropical savannas.

On the Ord River, a whole-of-system study will profile the riparian zone by addressing:

- the biological and physical properties of the Ord's riparian zones;
- the economic and ecological values of the Ord's riparian zones and management of them;
- the advantageous and deleterious processes occurring within the Ord's riparian zones;
- the downstream consequences of those processes;
- management options, pertinent to present uses and future developments, that would maintain or enhance the economic and ecological values of the Ord's riparian zones; and
- the most important issues requiring research to develop management options that will enhance the sustainability of economic and ecological values of the Ord's riparian zones.

This will be a survey, not an experiment. The survey will include:

- acquisition and collation of data held in disparate locations (remote sensing, departmental records, literature and tenure, botanical, geological and soil mapping, etc.);
- interaction with managers and users - social and economic history, local knowledge;
- field survey;
- an accurate, integrated regional overview, description and evaluation of the riparian system of a major river and the dynamic processes that affect it. Against this profile planners and managers will be better able to judge the consequences of local management options;
- objective identification of issues that are insufficiently understood and warrant further research; and
- an integrated 'state-of-the-environment' baseline data set against which future land use and management affecting the Ord's riparian zone can be assessed.

The external deliverable products include resource and impact data required by land managers (e.g. CALM WA) and service providers (e.g. regional fire control, water supply including irrigation, pest/weed management, pastoral advisers, etc.).

Project Team

Nominated Staff

Mr M. Armstrong, PWCNT
Mr C. Brock, PWCNT
Mr D. Cheal, PWCNT
Mr B. Harwood, PWCNT
Mr C. Mangion, PWCNT
Dr T. Start, CALM WA
Dr J. Woinarski, PWCNT

PROJECT 2.4

Fire and savanna landscapes

Project Leader
Dr Jeremy Russell-Smith
Bushfires Council NT

Project Summary

Project 2.4 examines fire management in the tropical savannas. The broad-scale patterning of fire across northern Australia is being studied using remote sensing and GIS technologies to provide a continental framework. Five regional management studies have commenced, or are under development, to address a range of sectoral and national issues. These studies will provide direct inputs into fire management planning, practice and policy development. Collectively these studies also assist in developing management tools, including regional satellite monitoring and associated information systems, monitoring of fuel loads, curing rates and biodiversity indicators.

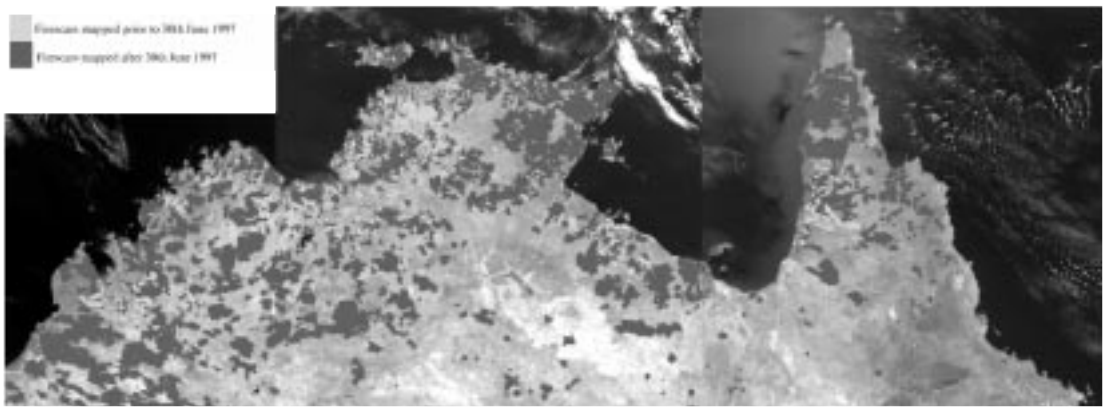
Combined with the regional management studies, the fire histories of selected sites are being examined in detail and monitored over a number of years. Permanent monitoring plots on conservation, pastoral and Aboriginal lands are exploring relationships between fire regimes and vegetation responses. These studies are linked to projects being undertaken by other Centre research projects, including ecological and biogeographical studies, land condition assessment and indicators of sustainability. The primary goal is the development of ecologically and economically sound fire management strategies relevant to a wide range of land users.

Research Progress

Substantial progress was made over the past year in the following key areas:

- The North Australia Fire Management Workshop with representatives from a broad range of land management sectors, regions, agencies and researchers made a significant contribution to defining the core fire management issues across the north.
- Three regional management studies were commenced over the past year, one addressing fire management on Cape York and the north Kimberley, and two in the Northern Territory. One of the NT studies, examining fire management options mostly for pastoral and conservation land uses in the Sturt Plateau and VRD region, provided the basis for the Centre's undertaking of the integrated VRD Management Study.
- Mapping of fires across the north over the dry season using NOAA-AVHRR imagery was undertaken for the first time in 1997 by Department of Land Administration (DOLA), one of the program partners. The mapping component recently has been expanded to a

WESTERN AUSTRALIA, NORTHERN TERRITORY and QUEENSLAND FIRE HISTORY 1997



Fire history maps assist researchers and landowners in fire management planning.

national program, via a consultancy to the Centre. As well, a number of localised fine-resolution fire mapping studies using LANDSAT imagery are being undertaken. Substantial work is being undertaken to ground-truth all fire-mapping products.

- The Centre received a grant from Rural Industries Research and Development Corporation (RIRDC) to assist with research and development of a rapid data dissemination systems for end-users via the internet.
- As well as two current PhD students undertaking fire research as part of the Centre's program (G. Calvert, P. Ryan), a further PhD student (T. Vigilante) and MSc student (C. Rodriguez) were awarded Centre scholarships. Mr Rodriguez is undertaking an assessment of the fire history of the Laura Basin (Cape York) and associated mapping of the expansion of *Melaleuca* communities into former grasslands. Mr Vigilante will commence studies later in 1998.

Milestones

- Fire history maps for significant parts of the savannas have been prepared. Mapping of fires across northern Australia, at the NOAA-AVHRR scale, is now being undertaken through DOLA WA, and analysis of the distribution of fires for 1997 with respect to broad vegetation categories, land tenure, bio-geographic regions and soils has been undertaken.
- LANDSAT-scale fire history assessments are also being undertaken for selected areas of WA, NT and Qld. Ground-truthing of the accuracy with which the mapping of fires is being undertaken is in each of these regions.
- Over 280 permanently marked and fully inventoried fire monitoring plots have been established in the NT alone.
- Maps of sensitive target communities in Queensland, Northern Territory and Western Australia have been established recently and the ability to map them from satellite data assessed. Products will be available over the next year.

TS CRC researchers work with communities to better manage fire.

Highlights and Challenges

Highlights for the year included:

- The establishment of the North Australia Fire Managers Forum which will assist the development of management guidelines, information transfer, policy development and integration of research activities across the north.
- The convening of two major fire symposia, which included for the first time in the Northern Territory the national biennial bushfires conference, Bushfires '97.

A major challenge for the project is to continue to increase institutional support. Slow but significant progress was made during the year.

Future Directions

A key objective for the year ahead will be to set up a number of satellite monitoring and regional fire management studies, appoint research staff and establish these projects on a firm footing.

Further work in 1998/99 will be required to complete development of other major proposals under advanced stages of development (eastern Indonesia, Cape York, Kimberley), as well as a major integrating project managing fire across northern Australia. This project will develop fire management capacity, communication and coordination.

Project Team

Nominated Staff

Mr G. Allan, BFC/PWCNT
Dr D. Bowman, PWCNT
Mr G. Calvert, JCU*
Mr D. Cheal, CRC/PWCNT
Mr A. Craig, AgWA
Mr A. Edwards, BFC/PWCNT
Mr C. Rodriguez, NTU (MSc)
Dr J. Russell-Smith, BFC/PWCNT
Mr P. Ryan, NTU*
Mr T. Vigilante, NTU*

Collaborating Researchers

Mr R. Anderson, BFC/PWCNT
Mr P. Barrow, EA/PAN
Ms M. Bowe, WWF
Mr B. Ciffuentes, QFS/Rural Fire Division
Ms L. Collett, QDNR
Mr P. Cooke, NLC
Mr R. Craig, DOLA
Ms H. Crompton, ACIAR
Dr G. Duff, NTU/CINCRM
Mr R. Dyer, NTDPIF
Mr D. Fell, Balkanu
Dr R. Fensham, QDoE
Ms J. Fox, Jawoyn
Dr S. Garnett, QDoE
Dr M. Gill, CSIRO
Mr G. Graham, CALM WA
Dr T. Grice, CSIRO TAG
Mr R. Hassett, QDNR
Prof G. Hill, NTU
Maj S. Hickey, DoD
Mr B. Karfs, NTDLPE
Mr D. Lewis, Consultant
Mr D. Luxton, QFS, Rural Fire Service
Mr T. McGuffog, BFC/PWCNT
Ms C. McMillan, DOLA
Dr B. Myers, NTU
Mr C. Roberts, Balkanu
Dr J. Robinson, Murdoch University
Mr T. Rosling, EA/BG
Mr P. Saint, BFS
Dr R. Smith, DOLA
Mr P. Stanton, Consultant
Dr T. Start, CALM WA
Mr R. Thackway, EA/ERIN
Mr P. Wilson, QDNR
Dr J. Woinarski, PWCNT
Members of BFC VRD Region Committee
Members of Sturt Plateau Best Practice Group
Staff of BFC, NT
Staff of BFS, WA
Staff of Gregory, Kakadu, Litchfield and Nitmiluk National Parks, NT

*CRC-funded PhD students

SUB-PROGRAM 3

Indicators of Sustainable Land Use

Sub-Program Leader
Dr Paul Novelly
Agriculture Western Australia

Changes to savanna landscapes may take years or even decades to become evident. By the time the changes are visible, it is often too late to reverse any that are considered undesirable. Sub-Program 3 aims to address this problem by developing indicators of sustainable development readily useable by land and enterprise managers, and by policy makers. Such indicators would allow timely and proactive assessment of land potential and appropriate use and trend monitoring of both savanna resources and enterprises, as well as assessment of the resilience or susceptibility of savannas to modification through either natural or enterprise-based stress.

Sub-Program 3 remains on time, within budget and meeting its milestones, and doing some excellent work. The projects within this sub-program continue to draw on information and resources provided from other CRC projects and sub-programs, as well as information from a wider network.

PROJECT 3.1

Indicators for sustainable land production and condition

Project Leader
Mr Rod Applegate
NT Department of Lands, Planning & Environment

Project Summary

Sustainable land management requires that the maintenance of productive potential in one land use does not compromise the ability of the land to support that land use, or other land uses, in the future. A key to developing management systems for sustainable land use is a set of reliable indicators of the state and condition of the land, the ability to monitor these and present this information in map form at a range of scales.

Permanent research sites have been established and regularly monitored to provide detailed data on the condition of the sites and indicators have been determined based on the analysis of both vegetation and soil surface condition parameters. Remote sensing enables the extrapolation of land condition assessment data from the research sites through the broader landscape of similar land type.

Using remote sensing and GIS technologies, combined with detailed assessment of rangeland ecosystems, it possible to predict land condition trends and provide scientific evidence to support sustainable management and conservation of the tropical savannas.

Research Progress

Quantitative landscape, vegetation and surface soil condition data has been collected over the last four years at 33 research monitoring sites established on the Victoria River Downs property in the Northern

Territory. Additional sites have now been established on adjacent properties, bringing the total number of research sites established in the Victoria River District (VRD) to 63.

Field work to the end of the 1998 year will again focus on the Victoria River Downs property and the establishment of sites on at least one additional property. This will allow temporal land condition analysis over a significant number of sites on several representative rangeland types, and encompasses all pastoral properties within two LANDSAT Multi-Spectral Scanner scenes.

- Collaboration between the NT Department of Lands, Planning and Environment (NTDLPE) and Agriculture Western Australia (AgWA) on land function analysis and vegetation analysis has been ongoing with a joint field trip to northern VRD (Spirit Hills) in May 1998 to identify and form common linkages in the site data between Project 3.1, the Tier 1 pastoral monitoring program (NTDLPE), and the WARMS sites of AgWA.
- Vegetation, soil and landscape data for all sites assessed by Project 3.1 since 1995, have been recorded in Visual dBASE. Complimentary floristic and soil pit data, collected in 1993 by NTDLPE from 71 representative land types located throughout the VRD, have also been linked to the database. Integration of the vegetation and environmental data with the land function analysis data has occurred, with some encouraging preliminary results.
- All of the research and additional NTDLPE sites have been classified into seven range types according to landform, soil and vegetation. This process has involved investigating various classification and ordination techniques for range condition and trend analysis. Links between the vegetation, soil and LFA databases have been made, preliminary indicators of landscape condition are being investigated, with the addition of this year's data for further analysis.
- Time series image analysis techniques developed by CSIRO Division of Mathematics and Information Science (MIS) have been introduced into the system for assessing landscape condition and indicators of change. Further refinements of this technique has been one of the highlights of this year's research.
- Time series satellite data is continuing to be integrated with ground-based monitoring data to produce image maps showing trends in tropical savanna grasslands.
- A four-scene, calibrated base image mosaic was produced through the efforts of AgWA staff in collaboration with MIS and NTDLPE comprising four adjacent LANDSAT (satellite) images, covering a total area of 360 km x 360 km in both Western Australia and the Northern Territory. Initial results for available nitrogen in soil samples, collected from the 33 Victoria River Downs sites, did not show a clear correlation with site condition on cracking clay soils (e.g. Vertosols).
- A digital data entry program for automating vegetation survey data capture is nearing completion.
- As part of the VRD Management Study, a sub-project to detect change in woody vegetation (Landscape Change in the VRD, using historical aerial photography from 1970 and 1991) was completed. Results have shown little overall increase in woody vegetation over a study area of 2700 km. However, in some landscapes, such as alluvial environments, substantive increases of woody vegetation were observed. A final report is near completion.

Milestones

- 30 monitoring research sites established in Victoria River Downs and detailed assessments completed in second year.

- The extension of research sites in the VRD to a total of 63 sites.
- Vegetation, soil and landscape data for all sites assessed by this project since 1995 have been recorded in visual dBase.
- Time series image analysis techniques have been introduced into the system for assessing landscape condition and indicators of change.
- All of the research and additional NTDLPE sites have been classified into seven range types according to landform, soil and vegetation.
- Collaboration between the NT Department of Lands, Planning and Environment and Agriculture WA on land function and vegetation analysis.
- Production of a four-scene calibrated base image mosiac of an area covering 360 km x 360 km.
- Initial testing for available nitrogen in soil samples from 33 VRD sites.

Highlights and Challenges

The further refinement of time series image analysis techniques used in assessing landscape condition and indicators of change has been a major highlight.

Other highlights include:

- The preliminary indicators of change that have been identified in the form of (i) change in cover as detected by temporal satellite data through time (ii) fetch distance within Landscape Function Analysis methodology and (iii) trends in vegetation species and abundance as determined through statistical ordinations of site data.
- Further development of the Landscape Function Analysis database and analysis techniques of the data.
- Refinement of monitoring techniques and integration with NT and WA State monitoring programs, and the use of these tools for extension purposes to the various stakeholders.

Future Directions

The relationship between ground-based land condition data and time series remote sensing data will continue to be integrated and enhanced. Refinement of methods, assessment and analysis will be ongoing to suit the tropical savannas.

Development will occur of land condition image maps with a more accurate assessment, for example utilising digital land unit mapping to negate drainage lines and areas inaccessible to cattle.

Participation will continue in the development of a landscape stratified fire history and detection of landscape change using remote sensing techniques in conjunction with PWCNT, BFC, NTDPIF and CSIRO Division of Wildlife and Ecology.

Project Team

Nominated Staff

Mr R. Applegate, NTDLPE

Dr A. Cowie, NTDPIF

Mr A. Craig, AgWA

Mr B. Karfs, NTDLPE

Ms D. Lynch, CRC/NTDLPE

Dr P. Novelly, AgWA

Support Staff

Mr L. Peel, CRC/NTDLPE

Mr R. Hodges, NTDLPE

Collaborating Researchers

Mr J. Wallace, CSIRO

Mr D. Tongway, CSIRO DWE

Dr J. Ludwig, CSIRO DWE

PROJECT 3.2

Invertebrate indicators of biodiversity and ecological change

Project Leader
Dr Alan Andersen
CSIRO, Division of Wildlife & Ecology

Project Summary

One of the major tasks of the Tropical Savannas CRC is to develop reliable paddock-scale indicators of the ecological health of the savanna lands that consider biodiversity as well as ecosystem function. Attention throughout the world has focused on the use of invertebrates as bioindicators in ecosystem management, because invertebrates contribute most to global biodiversity as well as drive many of the key processes maintaining ecosystem function. Invertebrates have a long history of use as bioindicators in aquatic systems, and for two decades ants have been extensively used by the Australian mining industry as indicators of restoration success.

The objective of this project is to develop protocols for the use of ants and other invertebrates (spiders, beetles, grasshoppers and termites) as indicators of biodiversity change for a range of savanna land uses at the paddock scale. Some key issues are:

- the distribution of savanna invertebrate assemblages in relation to rainfall, soils and vegetation;
- the response of these assemblages to disturbance;
- the extent to which such responses reflect those of other components of biodiversity; and
- the identification of the invertebrate group(s) and the parameter(s) that provide the best indication of biodiversity responses to different land uses.

The project is closely associated with other projects from Sub-Programs 1-3, with data on soils and vegetation (Projects 1.1 and 3.1), invertebrates (Project 3.2) and vertebrates (Project 2.1) collected at the same sites. Taken together, these taxa represent a considerable proportion of total biodiversity.

Research Progress

Research in the past year has addressed: (i) the distribution of invertebrate assemblages across the NATT (Project 1.1) and in Mitchell grasslands (with Project 2.1), and (ii) the responses of invertebrates to land use, particularly grazing and mining. Field work and the huge effort in the laboratory to sort and identify the vast number of specimens has gone well. Specific research outcomes for the year were:

- completion of sampling for invertebrate assemblages along the NATT;
- completion of sorting of NATT grasshoppers, beetles and spiders;
- identification of beetles from Mitchell grasslands study;
- completion of sampling and sorting of selected invertebrate taxa (ants, beetles, scorpions, centipedes, mutillid wasps) for the MIM project;
- sampling of ants at CSIRO Tropical Agriculture's long-term grazing trials near Charters Towers;
- completion of identification and analysis of ant samples from German Creek's 1998 sampling program; and
- preliminary sampling and sorting of invertebrates from the VRD grazing gradients.

Milestones

- The sorting and preliminary analysis of all taxa, except ants, from NATT samples was completed.
- Sorting and analysis of methodology trials has been completed. A manuscript is in preparation.
- Ants samples from Mitchell grassland grazing study have been sorted and preliminary analyses completed.

Highlights and Challenges

Highlights for the year were:

- The large number of undescribed species and even genera, of invertebrates collected during field trips.
- The clear responses of spider taxa to gradients of grazing intensity may be useful indicators of the ecological impacts of grazing.
- The clear responses of ants to sulphur dioxide in the MIM trials indicate that ant communities are a useful indicator of the impacts of sulphur dioxide on biodiversity.

The major challenge has been dealing with the vast number of invertebrate specimens, most of which have no scientific name, and many have never previously been collected. Project staff are working closely with taxonomists from CSIRO Entomology's Australian National Insect Collection.

Future Directions

Protocols have been established for using ants as indicators of the success of mine site restorations. Future work will focus on other land uses, particularly relating to pastoral management (grazing and tree clearing), and the use of other invertebrate bioindicators.

Project Team

Nominated Staff

Dr A. Andersen, CSIRO DWE

Dr R. Blanche, CSIRO DWE

Dr T. Churchill, CRC/CSIRO DWE

Dr J. Orgeas, CSIRO DWE

Support Staff

Mr A. Chapman, CSIRO DWE

Mr T. Hertog, CRC/CSIRO DWE

Ms L. Lowe, CRC/CSIRO DWE

Dr C. Orgeas, CSIRO DWE

Mr G. Wanganeen, CSIRO DWE

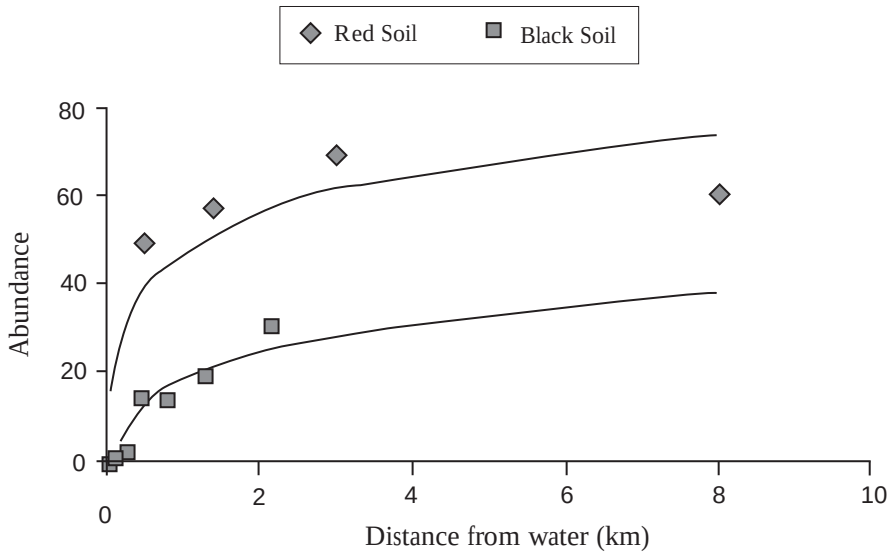
Students

Mr B. Hoffmann* CSIRO DWE

Mr A. Salvarani* CSIRO DWE

*CRC-funded PhD students

FIGURE 5



The graph indicates the relationship between ant abundance and decreasing grazing intensity (increasing distance from water).

PROJECT 3.3

Landscape restoration

Project Leader
Dr Tony Grice
CSIRO, Divison of Tropical Agriculture

Project Summary

Exotic weeds are a major threat to both the productive capacity and the native ecosystems of northern Australia. Because invasions by most exotics are recent, much of the potential range has yet to be occupied. Even within the current range, many landscapes are heterogeneously occupied. There are real opportunities to limit further spread and reclaim landscapes that are already invaded.

Over the past 10 years, work by state and federal research agencies has identified techniques for containing invasions by limiting dispersal and for removing weeds from small areas. However, the high costs of treatment, relative to the value of the land that is being invaded, has limited the application of these techniques and the risk of reinvasion persists. This project is seeking to develop management tools that will help make the most effective decisions in complex landscapes about containment, control and prevention of reinfestation.

Research Progress

A conceptual framework that describes the landscape ecology of rubbervine has been developed. It highlights the role of landscape heterogeneity in the spread of this important noxious weed.

Analysis of data gathered during the Dalrymple Land Resources Survey has demonstrated that rubbervine and chinee apple, two of the prominent invasive shrubs in northern Queensland, are very unevenly distributed at a regional scale. The frequency of occurrence of both species is considerably greater within 20 km of Charters Towers, the main settlement in the region, than it is elsewhere in the Shire.

The weight of evidence is that the regional patterns are largely attributable to historical factors. However, there are large areas of suitable habitat within the Shire that have not yet been colonised. This implies that there is scope at a range of scales - paddock, property, sub-catchment, catchment, region - for applying management strategies that will contain the species.

Data from the Dalrymple Land Resources Survey and other sources have been assembled to provide a comprehensive GIS (Geographical Information System) for the entire Dalrymple Shire. For the Balfe's Creek section of the Dalrymple Shire, our intention is to incorporate data on rubbervine distribution at higher resolution.

Ground-truthing of our capacity to detect fine-scale variation in the distribution and abundance of rubbervine has been carried out using data from Dotswood Station. Indications are that the technique can be at least 80% accurate. Reliability depends upon the seasonal timing of aerial passes (via its affects on the phenological state of both the rubbervine and the surrounding vegetation) and the inclusion of both visible and infra-red portions of the electromagnetic spectrum.

A simple stochastic model for predicting changes in the distribution and abundance of prickly acacia at the paddock scale has been developed. At this stage the model is limited to predicting changes in the density of prickly acacia in each cell of an homogenous array representing a hypothetical paddock.

The spatial patterns that occur in the cattle-aided dispersal of prickly acacia seeds in the Mitchell grasslands have been quantified. There are effects of distance from water and seed source but also considerable variation between paddocks. It is clear

from this work that very large numbers of viable seeds are dispersed considerable distances by cattle and that control of this dispersal mechanism could be a crucial element of a strategy for restoring shrub-invaded Mitchell grasslands.

The roles that fire may play in the landscape scale restoration of rangelands invaded by prickly acacia or mesquite *(Prosopis pallida)* have been examined. Seedlings and juvenile plants of both species are fire-prone. Large established plants of *Prosopis pallida* can be killed by an intense fire. The efficacy of fire against seedlings of these shrubs highlights the value of early action against invading species.

Milestones

- The arrangements for collaboration between the Centre and CSIRO finalised and Post-doctoral Fellow, Dr Ian Radford appointed to the Weed Management Systems Project.
- A computer-based geographic information system (GIS) for the entire Dalrymple Shire (which included both of the target sub-catchments) was developed. Data on the distribution of *Cryptostegia* was derived from the Dalrymple Land Resources Survey and incorporated.
- A conceptual model of the invasion of *Cryptostegia* was devised. The model incorporated an understanding of dispersal mechanisms, habitat preferences, the impacts of fire and climate.
- The efficacy of burning for the control of both *Cryptostegia* and *Acacia nilotica* tested. The effects of fire on *Cryptostegia* have been tested in riparian and 'upland' parts of the landscape.
- Testing alternatives for management of *Cryptostegia* at sub-catchment scale completed.
- A test of this model was carried out using data from the Dalrymple Land Resources Survey. A paper presenting the conceptual model and results of the testing was submitted to the scientific journal *Biological Invasions.*

Highlights and Challenges

The highlights of this year's research have been:

- Development of a conceptual framework for understanding the landscape ecology of rubbervine *Cryptostegia grandiflora* in northern Australia.
- Completion of an analysis of the regional scale distribution of rubbervine (and other species) in the Dalrymple Shire.
- Development of a comprehensive GIS database for the Dalrymple Shire as a basis for attributing landscape and regional patterns.
- Development and ground-truthing of capacity to describe the landscape-scale patterns of distribution of rubbervine.

A challenge has been attempts to carry out further ground-truthing of our capacity to detect rubbervine with low-level aerial photography, due to the combined effects of the most favourable wet season in six years and major and widespread infestations of rubbervine by the rust fungus *Maravalia cryptostegiae.*

Future Directions

In the future this project area will continue to focus on regional and landscape patterns and processes of plant invasions.

A recent successful project proposal will examine three important issues in relation to rubbervine:

- the impacts of rubbervine in the riparian ecosystems that it invades;
- the potential for using fire to control rubbervine in riparian areas; and
- the effects of prescribed fires for the control of rubbervine on non-target components of riparian ecosystems.

There is scope for broadening the application of the results of work on rubbervine, prickly acacia and mesquite to deal more adequately with weed systems rather than simply individual weed species.

Project Team

Nominated Staff

Mr B. Abbott, CSIRO TAG

Dr J. Brown, CSIRO TAG (Project Leader to October 1997)

Dr S. Campbell, QDNR

Dr T. Grice, CSIRO TAG

Dr I. Radford, CSIRO TAG

Dr T. Stanley, QDNR

Support Staff

Ms M. Keir, QDNR

Mr M. Nicholas, CSIRO TAG

Collaborating Researchers

Dr W. Forno, CSIRO Division Entomology

Dr R. McFayden, QDNR

Dr R. Sutherst, CSIRO Division of Entomology

Student

Ms J. Jackson, JCU*

*CRC-funded PhD student

SUB-PROGRAM 4

Sustainable Management

Sub-Program Leaders

A/Prof Ross Hynes
Tropical Savannas CRC and
James Cook University

Dr Graham Kirby
NT Department of Primary Industry & Fisheries

Sub-Program 4 aims to develop better options for land managers and policy makers in managing interactions between production, ecosystem function, the natural resource base, communities and governments.

The research strategy integrates socio-economic activities with relevant biophysical relationships (as developed in Sub-Programs 1-3 and other sources). Integration is a key process in the sub-programs, research and development strategy.

Research products are better information and procedures for decision making by savanna managers and policy makers.

Sub-Program 4 has undergone four phases of refinement and one major restructure. Following the advice of SPAEG and the Centre's Board, regional case studies have been given special emphasis as a major integrating strategy.

During the year Project 4.1 was incorporated into the new Project 5.3.

PROJECT 4.2

Social and environmental values

Project Leaders

Dr Graham Kirby
NT Department of Primary Industry & Fisheries

Dr Deborah Rose
North Australia Research Unit (NARU),
Australian National University

Project Summary

The objective of this project is to develop an understanding that allows predictions about how decisions affecting tropical savanna use and management are made.

The component objectives in this project are:

- To analyse and define the cultural perceptions and decision-making processes among tropical savanna users and managers.
- To assess the value of the tropical savanna environment for the wider Australian community.

Historically, the costs and benefits associated with social and ecological components have not been adequately included in the management of savanna enterprises. Increasing social and political pressures now require more accountable outcomes to meet the practical requirements of sustainable development.

These social and ecological values are non-market values and as such are much more difficult to determine and incorporate into management decisions than are market values such as mineral prices. A better understanding of how these non-market values for the tropical savannas are formed is required.

Research Progress

A series of 13 investigations and reports on cultural perceptions, land management decisions, communications and knowledge in Aboriginal and Settler communities are being undertaken using standard social inquiry techniques.

Dr Deborah Rose, Senior Fellow, NARU, ANU, continued her work in several domains: analysis of indigenous knowledge systems; analysis of frontier culture; comparative analysis of settler society ecologies (US and Australia).

A draft report on the Natural Resources and Development in the Daly River-Sturt Plateau Region of the Tropical Savannas of the Northern Territory was prepared as a guide to focus groups' discussions held in Brisbane and Darwin. The focus groups contributed effectively towards the design and planning of the future questionnaires.

The report provides an information base on the current production, ecology and policy of the region.

The 1996 Northern Landscapes Symposium has resulted in a book (in press) titled *Tracking Knowledge: Studies in Northern Landscapes.*

A new CRC Post-doctoral Fellow was appointed by the CRC/NARU late in the year to develop and refine social models relevant to cultural perceptions, land management decisions, communications and knowledge in Aboriginal communities.

A workshop on decision making was held in December 1997. Symposium participants considered the three issues of concepts of time, place and community; local knowledge and community; and models and processes. The discussions and conclusions of the workshop will be edited and published.

Milestones

- The second Northern Landscape Symposium was held in 1997/98 which continued to identify ways to link cultural beliefs with ecological knowledge.
- Several PhD students and Visiting Fellow Dr Tom Griffiths made good progress in their research into the understanding of frontier culture through examination of cultural perceptions, land management decisions, communications and knowledge in Aboriginal and Settler communities.
- A workshop on decision making was held in December 1997.
- Two focus groups in Darwin and two in Brisbane were organised to explore attitudes and understanding of the regional and environmental characteristics of the Desert Uplands in Queensland and the Daly River-Sturt Plateau in the Northern Territory.
- Completion of a draft report on the Natural Resources and Development in the Daly River-Sturt Plateau Region of the Tropical Savannas of the Northern Territory.

The milestones of this project have evolved into slightly different ones through the work resulting from the project.

Highlights and Challenges

With 16 speakers presenting new analytic knowledge and comparative analyses of particular case studies, the 1997 Northern Landscapes Symposium was a major highlight. The second day of the Symposium was held in Wagaite country with the presentation of land management and lands knowledge information by a group of Aboriginal landowners.

Another highlight was the completion of four focus group meetings in Darwin and Brisbane to explore attitudes to industry and the environment in two savanna regions.

Future Directions

The newly appointed Post-doctoral Fellow, Dr Richard Davis will undertake detailed anthropological studies working with Aboriginal men on Aboriginal pastoral communities in the Kimberley. His research will include the integration of traditional and indigenous knowledge systems in decision making by Aboriginal men.

A survey questionnaire will be designed for distribution to a sample population in Darwin and Brisbane. The survey technique to be used is Choice Modelling. The analysis of the survey responses will enable marginal environmental values to be predicted for a wide range of savanna environments.

Project Team

Nominated Staff

Dr R. Davis, NARU
A/Prof R. Hynes, CRC/JCU
Dr G. Kirby, NTDPIF
Mr J. Monaghan, JCU
Dr D. Rose, NARU

Collaborating Researchers

A/Prof J. Bennett, UNSW/ADFA
Dr J. Davie, UQld
Dr C. Fletcher, NARU
Dr T. Griffiths, ANU
Ms V. Hristova, NTDPIF
Prof M. Langton, NTU
Mr S. Murti, NTDPIF
Dr L. Robin, ANU
Mr J. Rolfe, CQU

Students

Ms J. Atchison, Wollongong University
Ms J. Bathgate, NTU
Ms A. Dee, ANU*
Mr N. Gill, UNSW/ADFA
Ms R. Lane, ANU
Ms S. Lovin, JCU*
Mr S. Negri, JCU
Ms C. Robinson, Monash University
Dr M. Schrapnel, UQld (BSc/BM)
Mr J. Wearne, Melbourne University

*CRC-funded PhD students

PROJECT 4.3

Management options for savanna land managers

Project Leaders
A/Prof Ross Hynes
Tropical Savannas CRC and
James Cook University

Dr Graham Kirby
NT Department of Primary Industry & Fisheries

Project Summary

The objective of this project is to develop options for decision making by savanna land managers for use in achieving sustainable development that optimises relationships between long-term savanna industry use, the natural asset base and the maintenance of natural ecosystems.

The component objectives in this project are:

- to collate and review the existing industry/sectoral information relevant to the sustainable development of each industry/sector.
- to develop improved options for decision making by savanna industry/sectoral managers to use in achieving sustainable development.

There is a wide range of potential savanna uses. Currently, the principal uses are pastoral, mining, tourism, Aboriginal community and conservation reserves. The key challenges facing these social groups and enterprise users are, firstly, their profitability while sustaining their natural assets resource base and, secondly, the maintenance of ecological functions associated with enterprise management of the natural assets resource base. Both these challenges derive from the two-way interactions between the savanna and its uses. Central to these interactions are critical decisions by savanna land managers on the nature and intensity of savanna resource use.

Preparing for a grazing trial at Wambiana Station, Charters Towers. Photo: P. O'Reagain

Research Progress

The collation and review of the existing information relevant to the sustainable production of savanna industries/sectors (pastoral, mining, tourism, Aboriginal communities, conservation reserves, other (farming, defence) as the intensity of land-use changes commenced. The primary information required relates to the joint effects of changing the intensity of savanna resource use on industry/sectoral output and the natural asset base over time.

Collation and review commenced of existing information of the tropical savannas relevant to sustainable ecosystem functions, such as biodiversity indicators. The primary information required relates to the joint effects of changing the intensity of savanna resource use on ecosystem functions and the natural asset base over time. The available information includes published papers and reviews and current CRC-related sectoral studies.

A considerable amount of initial effort has been devoted to planning and modelling various aspects of the decision-making process. These aspects include the incorporation of risk and uncertainty, beliefs and preferences, multiple objectives, whole enterprise planning and activity analysis. A core aim is to develop generic and useful models for incorporating production, ecological and natural asset base objectives more quantitatively into the savanna decision-making practices, such as enterprise budgeting.

A Microsoft Excel Visual Basic program called SavannaFutures is being developed to link the various operational and information resource modules as they are developed. A module called Pastoral has been developed specifically for the pastoral industry and further extensions to incorporate biodiversity objectives are planned.

CRC-related sectoral activities included the preparation of training documentation for the Savannah Guides Inc. to be used as practical guides to decision making.

Milestones

The milestones of this project are in the process of being substantially changed. The following represents a more accurate view of the project's achievements.

- Commencement of the collation and review of the existing information relevant to the sustainable production of savanna industries/sectors.
- The collation and review of the existing information relevant to sustainable ecosystem functions of the tropical savannas as the intensity of land-use changes has commenced.

- Contributions to the training documentation for the Savannah Guides Inc.
- Progress with the development of a Microsoft Excel Visual Basic program called SavannaFutures.

Highlights and Challenges

The Board approved a major revision of this project early in the financial year. The focus adopted was the decision-making concepts and processes. Sectoral activities remained in support of this approach.

Future Directions

Future research will focus on the core issues of decision-making processes. Developments will include completion of the reviews of responses to land-use intensity, the specification of a socio-economic conceptual framework for sustainable enterprises, and the application of decision-making principles to the ongoing development of the SavannaFutures modules.

Project Team

Nominated Staff

Core Research Activities:

Mr M. Forster, JCU
A/Prof R. Hynes, JCU
Dr G. Kirby, NTDPIF
Dr J. Ludwig, CSIRO DWE
Dr R. Vemuri, NTU

Stakeholder Sectoral Research Activities:

Pastoral

Mr M. Bolam, AgWA
Mr B. Holmes, QDPI
Dr P. O'Reagain, QDPI
A/Prof R. Monypenny, JCU
Dr P. Novelly, AgWA
Dr M. Quirk, QDPI
Dr M. Stafford Smith, CSIRO DWE

Tourism

Dr N. Black, JCU
Mr T. Nevard, JCU
Dr P. Trembley, NTU

Conservation

CRC Project Staff

Dr S. Campbell, QDNR
Mr J. Vitelli, QDNR

Collaborating Researchers

Ms V. Hristova, NTDPIF
Mr S. Murti, NTDPIF

Students

Ms R. Allison, JCU**
Mr G. Whiteman, JCU*
Mr G. Calvert, JCU*
Mr N. Cuff, JCU**
Ms B. McCallum, JCU**

*CRC-funded PhD students
**CRC-funded Honours students

PROJECT 4.4

Regional sustainable development

Project Leaders
A/Prof Ross Hynes
Tropical Savannas CRC and
James Cook University

Dr Graham Kirby
NT Department of Primary Industry & Fisheries

Project Summary

This project aims to develop options for savanna regional policy makers to use to achieve regional sustainable development that optimises the relationships between long-term savanna industries/sectors, environments, communities and governments.

Specific objectives in this project are:

- To identify the structural profiles (policy, social, economic and environmental) of Australia's tropical savannas including the key issues contributing to regional sustainable development.
- To develop policy models for regional sustainable development (including multiple and integrated land use).

The socio-economy of the tropical savanna is closely interwoven with the broader Australian society and economy. The region competes for developmental capital and contributes substantially to national wealth. Optimising wealth creation and social equity demands a clear understanding of sectoral priorities and of the integration of the resource-based enterprises.

These are complex issues arising out of conflicting and changing social goals and ambitions, the interactions between social groups and economic sectors, and the major problems arising out of 'market failure' situations.

The achievement of sustainable development requires urgent attention to multiple resource use management to improve productivity in balance with the maintenance of ecological integrity. The barriers and opportunities to effective multiple savanna use are poorly understood.

A considerable amount of data exists relating to regional development. To this will be added the range of case studies being planned and undertaken by the CRC. The development of better models will enable policy makers to modify sectoral policies to ensure the optimal outcome for sustainable development at the regional level.

Research Progress

The earlier savanna profile work in 1995 on defining The Tropical Savanna Economy of Northern Australia was extended with the presentation of a paper to the 1997 Northern Australian Regional Outlook Conference on Northern Australian Regional Developments. The paper included new population and employment data from the 1996 Population Census and reviewed the structure of business enterprises in northern Australia.

Research into aspects of the role of government in the tropical savannas continued in two disciplines. Freya Dawson in her PhD studies continued the investigation of the legal basis of land tenure in relation to the conservation of the environment and biodiversity.

James Binney continued a research study, funded by Environment Australia, on The Economic and Social Role of Existing Reserves and of an Enhanced Comprehensive, Adequate and Representative Protected Area System in the NT. This study aims to ascertain the economic and social role of reserves in the Northern Territory, and of an enhanced comprehensive, adequate and representative system of protected areas. A major focus is on integrating economic, social and

biophysical assessment methodologies to enable holistic assessment of potential enhanced reserve systems in the NT. A number of potential configurations of enhanced reserves have been designed addressing deficiencies in the current reserve system and the constraints and opportunity costs faced in overcoming these deficiencies are being assessed.

Colin Macgregor made significant progress in his PhD studies during the year. He focused on the processes by which small communities and towns across the tropical savanna region make their various decisions, particularly in relation to the provision of services and their influence on sustainability. The work aims to develop and test an operational model that aids in examining the sustainability of small town communities in the tropical savannas.

Decision processes relating to community land management in western Cape York Peninsula were studied by Jim Monaghan. Dorothy Anyango completed a regional assessment of dry season grazing areas in Cape York community and pastoral lands in her Masters degree. David King commenced planning for a detailed analysis of the 1996 Population Census.

The new appointment of Dr C. Kannapiran was made late in the year by the North Australia Research Unit to investigate concepts and modelling related to regionalism.

Catherine Mobbs (ANU) continued her PhD studies on regional environmental assessment and management. Her work relates to the concepts and policy options for improved regional development approaches.

Milestones

(Note: these have been changed from last year)

- Study on linkage between dry season grazing management and Aboriginal community decision making.
- Evaluation of feasibility and scope of land-use case studies.
- Presentation of a paper on Northern Australian Regional Developments to the 1997 Northern Australian Regional Outlook Conference.
- Progress of research into the role of government and communities in the savannas.
- The appointment of Dr C. Kannapiran to investigate concepts and modelling relating to regionalism.
- Progress with research into the concepts and policy options for improved approaches to regional development.

Highlights and Challenges

The level of interest expressed in the methodology for multi-objectives decision making as it is being developed in James Binney's project on the socio-economy of NT reserves was a major highlight.

The key challenge is to develop a more suitable conceptual framework for regional sustainable development and to model this in a manner useful to stakeholders at government and community levels.

Future Directions

A major review involving internal and external participants will examine and recommend on the best investment for the CRC in regional sustainable development research.

Project Team

Nominated Staff

A/Prof R. Hynes, CRC/JCU
Dr G. Kirby, NTDPIF
Dr C. Kannapiran, NARU
Dr D. King, JCU
Mr J. Monaghan, JCU
Mr G. Conners, PWCNT
Mr J. Binney, NTDPIF

Students

Ms D. Anyango, JCU
Ms F. Dawson, University of Wollongong
Mr C. Macgregor, JCU*
Ms C. Mobbs, ANU*

*CRC-funded PhD students

PROJECT 4.5

Regional management studies

Project Summary

Management studies are a key means the Centre uses to ensure its research is integrated, distinctive and relevant. The studies developed out of work in Project 4.4 and as their importance within the overall aims of the CRC increased they evolved into a separate project, thus 4.5.

The studies aim to work out land management solutions in particular places by getting researchers to work with land managers and land users. The studies may operate on a catchment, regional or community scale.

The studies focus on integrating knowledge by bringing together research disciplines and experiential knowledge bases to build up a whole-of-system approach to land management in a landscape. This approach is not restricted to biophysical issues of land management, but as in the case of the Desert Uplands study, they also examine potential economic and social issues of sustainability arising from changes in landscape processes and provide a framework and options for future development.

Management studies are focused on relevance by providing practical management guidelines and tools for stakeholder use. Importantly, they provide an opportunity for stakeholders to participate in the development of these products by working with researchers. This process means products are more likely to be used.

Because of the way management studies bring different researchers and land users together to work on concrete problems, they also play a major role in improving communication between the different stakeholders in the tropical savannas.

4.5.1 VRD MANAGEMENT STUDY

A very active component of the Tropical Savannas CRC is a study of land management in the Victoria River District (VRD), located about 500 km south of Darwin in the NT. The VRD is a mix of grassy plains, rolling savannas and rocky spinifex country. Much of the plains is under pastoral lease, but other lands belong to Aboriginal people, National Parks and the Department of Defence.

This study was initially a sub-project within TS CRC Project 4.4 on 'Regional Sustainability and Case Studies', with Graham Kirby and Ross Hynes as Project Leaders. This sub-project was titled 'Sustainable fire management options for the Victoria River District' (the VRD Case Study), with John Ludwig as Sub-Project Leader. This sub-project is now a management study within the new TS CRC structure with leadership being taken up by Peter Whitehead (1 July 1998).

The aims of this VRD Management Study is to have its stakeholders achieve the following outcomes: (i) an improved knowledge of how to effectively (sustainably) manage strategically their lands as they change, and (ii) a greater understanding of how to deal economically and environmentally with short-term changes caused by both natural and land-use factors.

The approach in this study is to (1) first understand the history of change that has already occurred on the lands of the VRD, then (2) use results from on-going and new field studies to understand the major causes of change, then (3) predict what could happen in the future given the interacting impacts of climate, fire and land use, and finally (4) produce guidelines and 'rules-of-thumb' that land managers in the VRD can use to deal with short- and long-term changes in economically and environmentally sound ways.

Methods being used to produce outputs from this VRD Management Study are:

1. Documentation of historical landscape changes in the VRD

- A series of 'then and now' photographs has been compiled by Darell Lewis.
- Interviews with long-time residents in the VRD have documented changes.
- Sequences of aerial photographs of the VRD has documented that some savanna types have changed, but others have not.

2. Understand the natural causes of landscape changes in the VRD

- Climate is changing - how this might impact on savannas is being investigated in collaboration with other groups in Australia and internationally (e.g. IGBP).
- Shorter-term fluctuations in climate also cause changes in savanna vegetation - these changes are being monitored on the VRD by Bob Karfs and others, and is being investigated by using a SAVANNA simulation model, developed by Mike Coughenour, an international CRC visitor in June and July 1998.

3. Understanding changes caused by fire

- The historical extent of wildfires in the different savanna types in the VRD has being mapped by Grant Allan, Bob Karfs and others.
- The impacts of natural, prescribed and wildfires on the vegetation and soils of the VRD has been measured by Rodd Dyer, Jeremy Russell-Smith and others.
- The impacts of fire on vertebrate fauna in the VRD has been measured by John Woinarski, Alaric Fisher and others.
- The impacts of fire on invertebrates in the VRD was measured by Alan Andersen, Tracey Churchill and others in March/April of 1998.

4. Understanding changes caused by different land uses

- The impacts of livestock grazing on the vegetation and soils of the VRD has been measured by Bob Karfs, Rodd Dyer, Jeremy Russell-Smith and others.
- The impacts of grazing on biodiversity is being investigated by Alan Andersen, Tracey Churchill, Alaric Fisher, John Woinarski and others.
- The impacts of tourism in Gregory National Park in the VRD is being evaluated by Jeremy Russell-Smith in collaboration with Park staff.
- The impacts of Army training on the landscapes of Bradshaw Station in the VRD is being evaluated in a collaborative project with John Woinarski and others.

5. Predicting what changes could occur in the future with different climates, fire regimes and land management strategies

- Simulation modelling is a valuable tool for predicting potential changes which could occur under different climate and land-use scenarios. The SAVANNA model will be used for these forecasts.

- Landscape, vegetation, soil and biodiversity changes caused by fire interacting with grazing and climate will be a prime focus of these modelling studies.

Achievements

Progress on the VRD Management Study has resulted in four products as of 1 July 1998. These are as follows:

- Historical landscape changes: A matching set of photographs has been compiled contrasting historical landscape scenes with recent scenes (at the same photo-point), which documents where vegetation has changed and where it has not changed. More historical photos have been uncovered, many of which be will be rephotographed this dry season. Comparisons have been been made of tree-shrub cover on aerial photos from the 1960s with more recent aerial photos. These data document where cover has increased, decreased or remained static.
- Fire history mapping: A fire history map of the VRD was produced and its accuracy being checked. The aim is to extend the history back to the early 1980s using available Multi-Spectral Scanner imagery.
- Ecological assessments: Vertebrate population assessments in numerous sites around the VRD were completed including monitoring sites, fire experiment plots on Kidman Springs and sites in Gregory National Park. These sites were stratified by substrate and fire history. To compliment a study by Alaric Fisher on how plants, vertebrates and invertebrates change with distance from a water point (a surrogate for grazing pressure) on the black soils of Mt Sanford, another nearby grazing gradient was studied. Changes were measured in plant patchiness and composition away from a water trough at Bore No. 1. Two teams worked along the gradient to measure plant diversity and collect invertebrates. Similar measurements were made away from water on red soils on Kidman Springs, using sites near Rodd Dyer's fire experiment, and in some cases including the vegetation monitoring sites of Michael Cobiac (NTDPIF, Katherine).
- Savanna modelling: Mike Coughenour's SAVANNA simulation model has been set up for two paddocks on Kidman Springs to explore how different fire regimes effect the balance between tree-shrub and grass cover (woodies vs. herbs), and how this balance is effected by interactions between fire and grazing (fuel vs. forage). Collaboration with Mike on the use of his SAVANNA model is continuing.

Future Directions

Future directions are being planned to fit in with the new mission statement of the Tropical Savannas CRC, which is to achieve a sustainable use and conservation of savannas. Basically, some existing projects are being revised and new projects are being considered. These include:

- Further evaluations of historical changes in tree-grass cover on the VRD could use existing 1948 aerial photos (complete coverage of VRD) to match-up with aerial photos in the 1970s and 1990s (partial coverage) along a belt running from grey soils in the south (Victoria River Downs) to red soils in the north (Bradshaw).
- New work to test whether measurements of land condition and landscape function can be predicted or serve as surrogates for biodiversity is being planned as part of existing CRC projects.
- The use of aerial videography to document fire impacts (e.g. Gregory National Park) and grazing impacts (e.g. with distance from water points in the VRD) is planned.
- Continued studies in the VRD on the interactions between fire and grazing is planned, involving Benjamin Sharp, an Oxford University PhD student, and the continued research and extension activities of Rodd Dyer and others on 'Best Bet Fire Management' and other fire treatments on Auvergne Station.

A strategy for communications with stakeholders is essential if the VRD Management Study is to achieve its desired outcomes. The approach will be to work directly with VRD stakeholders through their organisations (e.g. VRD Conservation Association).

Project Team

This study was designed to build on the work undertaken by various researchers working in the VRD. As a result it involves CRC researchers from many projects including those in 1.1, 2.1, 2.2, 2.3, 2.4, 3.1, 3.2 and 4.3.

4.5.2 DESERT UPLANDS MANAGEMENT STUDY

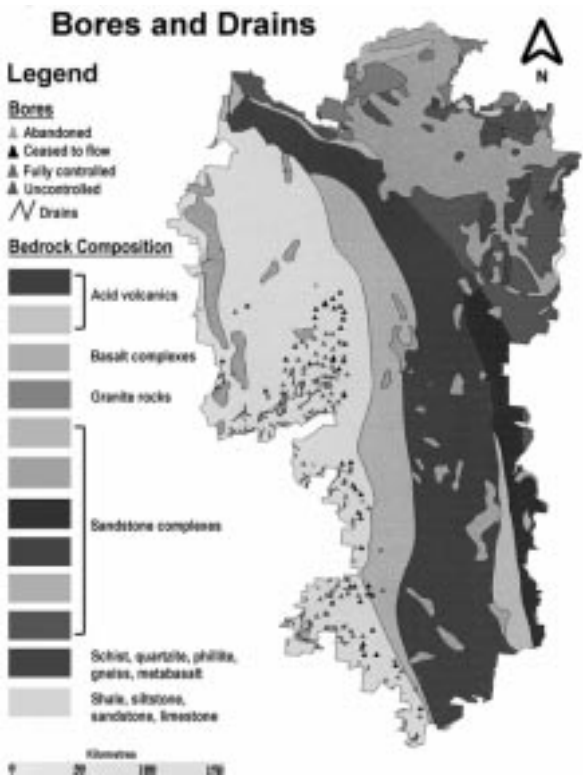
The Desert Uplands is a very suitable region for a case study: it is one of the few areas in Australia where the Agro-Ecological Zone corresponds strongly to the Biogeographic Region. Its 75,000 sq km supports 56 ecosystem types on 320 grazing properties and several national parks. Average property size is 23,500 ha. Cattle production is the main land use with mean herd size, 1200 head. Average debt $215K. Producers on smaller properties and some larger properties see the advantage of aggregation and in some cases, diversification and specific development.

A representative group, the Desert Uplands Build-Up and Development Strategy Committee (DUBDSC), has developed a whole-of-Government supported scheme to pursue rural adjustment and regional sustainability. The Centre is an invited member of the Committee and is value-adding through four research activities and the provision of specific training and policy advice. Ross Hynes is chair of the Scheme's Integrated Regional Development Sub-Committee (IRDS).

Research Progress

The following steps assess the value-adding research and communication processes the CRC is seeking to develop for regional sustainability. Following a technical workshop in June 1997, research activities were identified and developed. These involve:

- development of a GIS that can be applied and integrated with a multi-objective DSS;
- enterprise level investigations: transition management for sustainable adjustment (case studies, surveys and management models) and benefit/cost case studies at enterprise level regarding aggregation, diversification, development and exiting; and
- development of indicators of sustainability at enterprise and regional scales for environmental, economic and social values. They value-add to the Committee's approved Scheme for regional sustainability.



Independent data sets, both human installation and underlying geological strata, are brought together in this GIS map. This makes it possible to see how they are cross-linked and enables strategic analysis and planning at a regional level.

The study also allows the project to assess:

- the degree of improvement in sustainability indicators and from this contribute to the development of a predictive capacity for other savanna areas;
- the degree to which local and regional savanna decision makers become engaged and empowered to improve various sustainability indicators; and
- the improvement in the quality/quantity of information and procedures provided to improve indicators of local and regional sustainability.

The approach is consistent with the 11 regional research planning and analysis priorities identified by Dale and Bellamy (1996). The GIS has been developed with cooperation from highly competent JCU researchers. Dr P. Lawrence of QDNR is developing the MSS and A/Prof R. Monypenny, Head of Economics JCU, is conducting the cost/benefit analyses. A/Prof R. Hynes is leading the regional studies including GIS analyses and the development of indicators. Four PhD students are carrying out valuable supporting research activities. Dr N. Black JCU is researching potential tourism. The Centre's activities closely cross-link with ongoing government research.

During 1998/99 further Desert Uplands clients, ie. graziers, committee members and the Scheme's coordinator will be trained or complete training in the use of ARCVIEW for the GIS. The multi-objective Decision Support System will be established to operate in conjunction with the GIS. A number of preliminary activities will be conducted. Indicators of sustainability for key economic, social and environmental factors will be identified and trialed. Cost-benefit case studies will be completed that focus on examples of aggregation, development and succession.

Guidelines for diversification of enterprises will be formulated and a number of pilot applications will commence that will take an action research assessment approach. An action learning and action research approach will be applied to the work of the Integrated Regional Development Group's business as chaired by the project leader. A number of strategic analyses of regional trends will be generated using the GIS and cross-linked to multi-objective DSS outputs. Further workshops or short-course modules will be conducted as requested by the DU Committee.

Achievements

- Workshop on performance indicators held October 1997.
- Meeting with researchers from Project 3.1 regarding method for remote sensing land condition trend indicators for application in DU convened in December 1997.
- Basic regional GIS established with 44 data sets.
- DU atlas produced. Multi-objective DSS for the region being developed with QDNR.
- Transition management research activity, literature review completed, two working papers drafted.
- Final version of draft tourism and marketing audit in press.
- Development of MRC and State of Environment compatible land sustainability indicators for land condition monitoring are progressing.
- Facilitation of application by DUBDSC of GIS in regional land pattern reviews and links to possible rural adjustment options are progressing.
- Facilitation of strategies (with DUBDSC members and representative landholders) for sustainable industries in region has commenced.
- Action research approach to the work of the IRDS has been initiated.

Project Team

Nominated Staff

Ms A. Appleman Activity Leader, CRC/JCU
Dr N. Black, JCU
Mr M. Forster Activity Leader, CRC
A/Prof R. Hynes Project Leader, CRC/JCU
A/Prof R. Monypenny Activity Leader, JCU

Collaborating Researchers

Dr P. Lawrence, QDNR
Mr J. Rolfe, CQU
Dr J. Davie, UQld
Dr M. Shrapnel, UQld
Dr M. Lorimer, QDoE
Mr B. Sheppard, QDPI
Dr G. Kirby, NTDPIF
Mr B. Karfs, NTDLPE

Students

Mr M. Forster, JCU (PhD)
Ms S. Lovin, JCU*
Ms B. McCallum, JCU**
Mr S. Negri, JCU (Honours)

Associated Students

Mr A. Kutt, JCU*
Mr G. Calvert, JCU*

*CRC-funded PhD students
**CRC-funded Honours student

EDUCATION AND EXTENSION

EDUCATION AND EXTENSION

Sub-Program Leader
Prof Greg Hill
Northern Territory University

Project 5.1 Education and training
Project Leader
A/Prof Gordon Duff
Northern Territory University

Project 5.2 Extension
Project Leader
Prof Greg Hill
Northern Territory University

Project 5.3 Savanna information management (formerly Project 4.1)
Project Leader
Mr Alan Cowie
Northern Territory University,
School of Information Technology

Overview

The Centre's Education and Extension Sub-Program is aimed at developing quality educational programs in resource management and providing stakeholders with training and extension services that are useful and that take a whole-of-savannas perspective. Underpinning much of this is the CRC's ability to develop communication linkages across the savannas, across research disciplines and with the various stakeholders.

This year was rewarding for the Education (5.1) project team because work and research completed in previous years is now being utilised to develop activities that suit the educational, training and information needs of stakeholders. There are increases in the TS CRC enrolments of postgraduates and more and more new units developed within the Masters by coursework program. Both suggesting that the TS CRC is a quality educational provider in the field of sustainable land management in tropical savannas.

There were major changes and shifts in focus in Projects 5.2 and 5.3 (formerly 4.1). The role and structure of the Communication Project (5.2) was

The Masters by coursework program has proved to be a noteworthy achievement of the TS CRC.

revised during 1997/98. This re-evaluation resulted from the appointment of the Communication Coordinator and the general revision of education and communication activities within the CRC as a whole. Project 5.2 is now focused on developing extension services with our partner agencies and stakeholder groups that take a whole-of-savannas perspective. The broader communications strategy of the Centre, under the direction of the Communication Coordinator, operates at a whole-of-CRC level and is dealt with in the section on Communications and Public Outreach (page 69).

Surveys of the Centre's stakeholders showed that many of them wanted the Centre to provide a 'clearing-house' of information that would give them easier access to existing research relevant to managing the tropical savannas. Consequently, the focus of Project 4.1 has been changed to meet this need of our stakeholders; it has become Project 5.3 which is more clearly linked to education and extension.

Progress in 5.3 is still hampered by the same problem that has persisted since its inception: a high staff turnover. This will be addressed next year by outsourcing the core of the clearing house project to consultants and placing the project under the leadership of the Communication Coordinator.

Education and Training (Project 5.1)

Stakeholder Training Needs

An important factor in the success of the Education and Training Project (5.1) is the CRC's knowledge of the real training needs of those that use and manage the tropical savannas. The analysis of education and training needs amongst stakeholders in northern Australia, completed at the end of 1996, yielded several significant bonuses. One was a database of relevant courses and providers, now available on our website. Another bonus was the creation or strengthening of networks across a wide spectrum of stakeholders and education and training providers. These networks and linkages provide a strong platform for future project activity.

The focus for Project 5.1 over the next few years will centre on implementation of the recommendations arising from the needs analysis research project. This will include:

- Assistance in improving the provision of education and training in tropical savanna management. This will include providing assistance in course development and delivery, in organising and participating in seminars, and offering advice and support where appropriate. The course development and delivery will place more emphasis on the Vocational Education and Training Sector and includes courses aimed at certificate and diploma level. The Centre has already been approached by the tourist industry to jointly develop a series of seminars for tour guides (see page 64).
- Maintaining a strong and distinctive research activity, focusing initially on the pastoral stakeholder group, but expanding to include other groups. A research project was started in 1997/98 and will continue well into the next year. The aims of the project are to determine how various stakeholder groups are stimulated to learn, how they access information and the implications for education and training.

Multimedia educational tools developed by CRC staff enable students across Australia access to tropical savanna management studies.

Certificate and Degree Programs

New units are also in an advanced stage of development and will be introduced into the Resource Management Certificate and Degree programs offered by the Faculty of Aboriginal and Torres Strait Islander Studies at the beginning of 1999.

Masters by Coursework Program and the new Graduate Diploma in Tropical Environmental Management

Further development of teaching units relating directly to the sustainable development of tropical savannas have been included in the coursework Masters programs for NTU. A unit on research methodology will be introduced in 1999 as a flexible delivery package. Curriculum packages entitled 'Ecology and Management of Tropical Savannas', 'Tropical Rangeland Management', 'Tropical Wetland Management, Flora and Fauna Survey Techniques for Tropical Savannas' are now under development. These packages will be made available to other education and training providers for general course development.

Postgraduates

The CRC introduced a number of new initiatives during the year. The establishment of Honours Scholarships has proved particularly successful in encouraging high-performing students to become involved in savanna research. The CRC now has a large and productive group of postgraduate research students.

The number of new PhD, MSc and Honours students starting on research projects within the CRC was very rewarding.

The CRC now provides scholarship support to 20 PhD and one Masters by Research, and additional logistics support to three other PhD students undertaking research projects. In 1998, five Honours students were awarded scholarships to undertake research in relation to CRC projects. These projects will make a significant contribution to CRC research (see Table 1 pages 61-63 for list of all students and their projects).

A program of communication and presentation skills workshops has been implemented for CRC postgraduate students. Workshops run by Jenni Metcalfe and Toss Gascoine of Econnect were conducted for students in Darwin and Townsville during the year and have proved very successful.

Myf Runcie setting traps for the elusive and mysterious rock-dwelling, Scaly-tailed Possum for her PhD research.

TABLE 1

PhD STUDENTS

Student	Project Title	University	Supervisor/s	Funding
G. Calvert	Effects of grazing on plant biodiversity in the Dalrymple Shire	JCU	B. Jackes (JCU) R. Hynes (JCU/CRC) P. O'Reagain (QDPI)	QDPI CRC
A. Dee	Exploitation of the Arafura wetlands and surrounds by Yolungu women	ANU	D. Rose (ANU) N. White (LaTrobe) H. Nix (ANU CRES) J. Woinarski (PWCNT)	CRC
M. Forster	An exploration of the theory and principles of transition dynamics for the pastoral industry	JCU	R. Hynes (JCU/CRC)	JCU
F. Fraser	The ecology of the Partridge Pigeon and habitat impacts due to fire and grazing	ANU	T. Norton (RMIT) H. Nix (ANU CRES) P. Whitehead (NTU) S. Garnett (QDoE)	CRC* PWCNT
B. Hoffmann	Responses of ant communities to land-use impacts in northern semi-arid Australia	NTU	A. Andersen (CSIRO DWE) G. Hill (NTU) K. McGuinness (NTU)	APA CRC
H. Khwaja	Study of remote sensing and GIS for the assessment of their capabilities in mapping the vegetation form and structure of tropical savannas in northern Australia	NTU	W. Ahmad (NTU) D. Williams (CSIRO DWE)	CRC*
J. Jackson	Exotic grass species in tropical savannas of northern Australia	JCU	T. Grice (CSIRO TAG) B. Jackes (JCU)	CRC CSIRO TAG
G. Kelley	Soil properties and plant water use of tropical savannas	NTU	D. Eamus (NTU) L. Hutley (NTU) J. Landsberg (CSIRO L&W)	CRC NTU LWRRDC
A. Kutt	Spatial patterns of distribution, abundance and diversity in the vertebrate fauna assemblages of the Desert Uplands bioregion, northern Queensland	JCU	J. Woinarski (PWCNT) C. Johnson (JCU) R. Pearsen (JCU)	CRC AHC AGS JCU IRA
S. Lovin	Cultural tourism: consuming or sustaining the bush	JCU	R. Hynes (JCU/CRC) J. Elder (JCU)	CRC

Student	Project Title	University	Supervisor/s	Funding
C. Macgregor	Achieving sustainable urban communities in the Australian Savanna by ecological planning and community participation	JCU	R. Hynes (JCU/CRC) D. King (JCU TESAG) M. Fenton (JCU TESAG)	CRC*
C. Menges	The application of radar remote sensing to tropical savannas in the NT	NTU	W. Ahmad (NTU) J. van Zyl (NASA)	APA CRC*
C. Mobbs	Regional resource use planning: the potential and limits of adaptive and collaborative models	ANU	H. Ross (ANU) S. Dovers (ANU) H. Nix (ANU CRES)	LWRRDC CRC*
K. Pfitzner	The use of remotely sensed data, ancillary data and GIS technologies for the evaluation and comparison of the rehabilitation of two uranium mine sites in the Northern Territory, Australia	NTU	W. Ahmad (NTU) R. Clifton (NTDME)	CRC NTDME NTU
C. Rodriguez	Monitoring past and present fire regimes and development of fire management strategies for conservation of biodiversity in Cape York	NTU	J. Russell-Smith (BFC) W. Ahmad (NTU) P. Stanton (Balkanu)	EA CINCRM
M. Runcie	The ecology and behaviour of tropical rock-dwelling possums *(Petropseudes dahli* and *Wyulda squamicaudata)*	NTU	G. Hill (NTU)	CRC* NTU APA
P. Ryan	Spatial and temporal variability in fire regimes from three dominant land management practices (Aboriginal, pastoral and conservation reserves) in the North West Kimberley, Western Australia	NTU	G. Hill (NTU) W. Ahmad (NTU) J. Russell-Smith (BFC)	CRC* BFC
A. Salvarani	Biogeographical patterns of ant distribution in Australia's tropical savannas	NTU	A. Andersen (CSIRO DWE) K. McGuinness (NTU)	CRC
G. Whiteman	The impact of livestock grazing on the genetic diversity of the grass *Heteropogon contortus* in Queensland tropical savannas	JCU	J. Brown (NMSU) R. Hynes (JCU/CRC) K. Rice (UCD) M. Waycott (JCU)	CRC JCU CSIRO
C. Xiaoyong	Carbon balance of a tropical savanna Northern Territory	NTU	D. Eamus (NTU) L. Hutley (NTU)	CRC

EDUCATION AND EXTENSION

MSc STUDENTS

Student	Project Title	University	Supervisor/s	Funding
M. Geyer	An investigation of the usefulness of LANDSAT Thematic Mapper (TM) for identifying and mapping land cover types in the Oenpelli floodplain	NTU	W. Ahmad (NTU) G. Hill (NTU) G. Cook (CSIRO DWE)	CRC NTU

HONOURS STUDENTS

Student	Project Title	University	Supervisor/s	Funding
R. Allison	Ecological patterns in vegetation and avifauna within fragmented tropical woodlands	JCU	R. Pearson (JCU) R. Congdon (JCU)	CRC QDNR JCU
R. Bartolo	Mapping and visualising the geomorphology of the Arafura Swamp using remote sensing and GIS technologies for resource management	NTU	G. Hill (NTU) C. Davenport (NTU)	CRC NTU
N. Cuff	Aspects of tropical heathland ecology: floristics and patterning of vegetation communities at Cape Flattery, North Queensland	JCU	B. Jackes (JCU) R. Hynes (JCU/CRC) R. Coventry (JCU)	CRC JCU
K. Harvey	An analysis of the utility of remote sensing and GIS for mapping potential Saltwater Crocodile nesting habitat	NTU	G. Hill (NTU) C. Davenport (NTU)	NTU Australian Research Council
B. McCallum	An investigation of tree incursion into native grassland at Moorrinya National Park, North Queensland	JCU	J. Luly (JCU) R. Hynes (JCU/CRC)	CRC JCU TESAG
N. Thurgate	The impact of cattle grazing of the Great Basalt Wall	JCU	R. Alford (JCU) J. Luly (JCU)	CRC AGS JCU TESAG

*receive operational funding

Greater Access to Education and Training for Stakeholders

Research by the project team has identified the need for the CRC to provide increased access to education and training through interactive information technology. The CRC Course Co-ordinator, Dr Samantha Setterfield and staff from the Centre for Interactive Multimedia at JCU have converted the unit 'Ecology and Management of Tropical Savannas' to a multimedia format that is available on CD-ROM. Work has also commenced on the development of a multimedia version of the 'Rangelands Management' unit.

A multilevel training package aimed at weed management is also being developed and has been used for training exercises for Rangers and other land managers during 1998.

The Centre has part-funded the production of a CD-ROM by the NTU's Centre for Indigenous Natural and Cultural Resource Management on traditional fire management practices in Arnhem Land. The CD targets an indigenous audience.

Tour Guide Seminar Series

Following an approach by the Tourist Council of Australia (NT), the Centre and the newly formed Institute of Australian Tour Guides have started a series of monthly seminars on scientific and cultural issues for tour guides in the Top End of the NT. The industry is keen to meet an increasing demand for accurate and up-to-date information on what are often complex issues. Because of its various contacts across disciplines the Centre has been well placed to facilitate seminars on a variety of scientific and cultural issues including fire ecology and termite biology. The series started in June 1998 and has been very well received.

The Centre is looking to extend this idea to WA and Queensland, where Deputy Director A/Prof Ross Hynes has already developed a series of publications and workshops on culture and nature-based tourism for Savannah Guides Inc. (see below).

Extension (Project 5.2)

Development of the new focus for the project was an outcome of the Extension and Education Workshop run in Darwin from 16-18 March 1998. Designed and facilitated by the Rural Extension Centre (University of Queensland, Gatton College) and the Research and Extension Unit (Queensland Department of Primary Industries), the workshop brought together key extension staff from Queensland, the Northern Territory and Western Australia. The process for the workshop was designed using the Change Process Design, Management and Evaluation Framework. Workshop participants developed nine areas where action can be taken to improve the extension and education outcomes achieved by the Tropical Savannas CRC.

The CRC is currently in the process of appointing a new Project Leader who will provide a focus for CRC research and development in the extension field across the tropical savannas. Project funding has been allocated in the 1998/99 budget to support new initiatives in this area and final structure of the project is being negotiated with CRC senior management.

Project 5.2 has been effectively put on hold pending the appointment of the Project Leader, however, throughout the year there were numerous extension activities with industry in which the Centre played a major role.

EDUCATION AND EXTENSION

Highlights include:

September 1997

Mt Sanford Open Day

This event run by NTDPIF provided an opportunity for TS CRC researchers to meet with pastoralists and extension workers. CRC researcher Rodd Dyer spoke on Using Fire Regimes for Sustainable Pasture Management and Dr Jeremy Russell-Smith spoke on Fire, Pastoralism and Biodiversity.

October 1997

Savannah Guides Training School, Tyconnell Historic Gold Mine

Ross Hynes developed and delivered two action learning training units for the School titled *Interacting Positively with the Media* and *How to Write Technical Reports*. These are part of a professional development course for a major operator in the tropical savanna tourist industry (see Utilisation and Application of Research section).

Facilitator: Deputy Director, Ross Hynes.

Desert Uplands Indicators Workshop, James Cook University

This workshop brought together 17 participants including DUBDSC members and staff from JCU, QDNR, QDoE and the CRC. The workshop developed a set of indicators for DUBDSC's sustainable land-use and enterprise-development strategy.

Facilitator: Deputy Director, Ross Hynes.

November 1997

Ranger Uranium Mine Open Day and Minesite Rehabilitation Workshop, Jabiru

Paper Presentation and workshop demonstration by Dr John Ludwig.

Australian-Indonesian Inter-Governmental Meeting, Jakarta

John Childs was appointed Coordinator of an Indonesian/Australian working party on education and training cooperation on sustainable land management.

Participant: Director, John Childs.

February 1998

'Discovering Nature in the Top End' at the Northern Territory Museum

A public event to communicate the importance of biodiversity with faunal displays, computer interactives, nature walks and talks by experts, featured TS CRC panel display, and Project 3.2.

Coordinater: Dr T. Churchill.

March 1998

North Australia Communication Workshop, Darwin

This workshop gathered communication people from the various agencies involved in the Tropical Savannas CRC to:

- exchange information about the mission, tactics and resources used by each agency;
- establish links and enhance the sharing of information between the agencies to make communication more efficient; and
- suggest initiatives that the CRC can take to improve the communication network across northern Australia.

Communication/information staff from various partner agencies attended including: NTDPIF, QDPI, AgWA, CALM WA, JCU, NTU, and Parks Australia North.

Organised by TS CRC.

Learning Processes for Pastoralists Workshop, Darwin

This workshop prepared the ground for the TS CRC proposed project 'Learning Processes for Pastoralist Stakeholders'. It provided an opportunity for researchers and field workers from various agencies in the NT, Qld and WA to get together and share ideas about the proposed project.

Organised by TS CRC.

Extension and Vocational Education Workshop, Darwin

Extension officers associated with the TS CRC came together for a workshop in Darwin to work out a more useful way of integrating their extension activities with the Centre's research, education and communication activities.

Organised by TS CRC.

North Australia Fire Management Workshop, Darwin

One of the main aims of the workshop was to clarify the fire management issues across northern Australia so plans could be made to address them. There were over 100 invited participants including bushfire officers, pastoralists, ecologists, Aboriginal people and representatives from the tourist and mining industries and the defence forces. Many new links were made and fire management issues identified; there are some plans for fire management projects as a result - some with CRC involvement.

Remote Sensing and Fire Workshop

A workshop to clarify remote sensing issues associated with fire management in north Australia. Participants included remote sensing practitioners from across Australia.

International Workshop on Tree/Grass Interactions

Santa Barbara, California.
Participant: Dr John Ludwig.

April 1998

Savannah Guides Training School, Undara, Queensland

Ross Hynes developed and delivered an action learning unit for the School titled 'Understanding and Maintaining Biodiversity'. The unit is part of a professional development course for a major operator in the tropical savanna tourist industry (see Utilisation and Application of Research section).
Facilitator: Deputy Director, Ross Hynes.

May 1998

Inaugural meeting of the North Australian Fire Managers Forum, Brisbane

The forum links the Bushfire Authorities of the Northern Territory, Western Australia and Queensland in tackling fire management issues unique to northern Australia. Tropical Savannas CRC, a facilitator for the forum, provides scientific and communication support. The forum consists of the heads of the north's fire agencies: Mrs Pamela Millican, Queensland's Rural Fire Service Commissioner; Mr Bill Harris, Executive Director of Bushfires WA; and Mr Russell Anderson, Chief Fire Control Officer of Bushfires Service Council NT.
Chair: TS CRC Director, John Childs.
Scientific and communication support: Dr Jeremy Russell-Smith and Dr Peter Jacklyn.

'Clearing-house' of savanna information (Project 5.3)

Following feedback from stakeholders, a major new initiative has been the setting up of a savanna information 'clearing-house' which will provide web-based summaries of research, bibliographies, contact lists, remote-sensed information, calendars of events, etc. relevant to the regions and land management issues of the tropical savannas. This website will be linked to the Centre's other information networks that service stakeholders, such as newsletters, publications, CD-ROMs and media releases.

Four main sources were used to gauge the information needs of savanna users including the Tropical Savannas CRC Consultative Committee, the External Communication and Consultation Report (Econnect, December 1996), Identification of Mineral and Energy Exploration, Development and Management Priorities in the Australian Tropical Savannas (QMI joint venture, June 1998), and interviews with key stakeholder representatives (March-June 1998).

Completion of a pilot site for a stakeholder-focused 'clearing-house' of land management information is planned for early 1999. The pilot site will offer the following information:

- bibliographies of land management research relevant to particular savanna topics (e.g. fire management, weed management) and regions (e.g. VRD, Cape York);
- summaries or overviews of land management research relevant to these topics and regions;
- events of interest and research contacts relevant to these topics and regions; and

- photo images relevant to these topics and regions.

A test web design has been developed which serves the needs of savanna users and the TS CRC. The design will allow users to search for land information using two criteria: regions (VRD, Kimberly, Cape York, etc.) or topics (fire, weeds, grazing, etc.).

The TS CRC is in a good position to access the relevant research here as our cooperative research program brings together researchers from across the savannas who have expertise in many of the areas addressed by the database.

The pilot site will be part of a redesigned TS CRC website. The redesign of the CRC home page will be completed by October 1998.

Project 5.1 Milestones

- Four new units will be shortly available to both NTU and JCU MSc students, with information packages on these courses available to other training providers.
- A series of tourism training seminars, jointly facilitated with industry, has commenced.
- Completion of the accreditation document for the Certificate 1 in Land Management.
- Participation in the development of a suite of courses from Certificate IV to postgraduate in resource management at NTU.
- Development of curricula for Masters courses.
- Research into the ways stakeholders acquire information and reach decisions relating to land management was undertaken, with completion of the methodologies and data collection started.
- Data and feedback on postgraduate programs from students and employers is being collected and collated regularly.
- Significant progress has been made in the development of a full MSc program in Tropical Environmental Management.
- Units and courses in Ecology and Management of Tropical Savanna and Tropical Rangelands Management will be available on CD-ROM in 1999.
- A database of education and training courses available in the region has been produced and distributed to educational institutions, key stakeholder user groups and regional libraries across the savannas. It is also accessible via our website.
- Development of strategies to recover the costs of the Centre's educational activities will be more actively pursued with the appointment of a new Business Manager.

Project 5.2 Milestones

(Achieved by the broader communication strategy, or by Projects 5.1 or 5.3).

- Completed recommendations for use of internet in second year.
- Established the CRC web pages in second year, - now redesigning.
- Display panel developed in second year, used at seven events this year.
- Established an effective system for internal communication through development of Communication Strategy.
- Several mass media stories to publicise Centre prepared and released.
- Internal review of Centre outcomes completed through strategic planning process and development of Communication Strategy.
- Multimedia packages for weed management used for training exercises during 1998.
- Best-practice workshops for pastoralists on hold pending appointment of new Project Leader.

- Completed Communication Strategy for CRC in December 1997.

Note new milestones will be developed for this project.

Project 5.3 (formerly 4.1) Milestones

- Appointment of information technology facilitator in second year.
- Negotiated data access agreement with Bibliographic and Research Database consultants completed.
- Facilitated internet access for 90% of staff and continuing for new staff.
- Complete catalogue of modellers, tools and data specifications no longer a priority in new project.
- Web pages developed in second year and being redesigned.
- Implement early version of virtual community no longer a priority as extensive links across CRC via mail and internet.
- The forming a computer advisory group was overtaken by establishment of Clearing-House Steering Committee.

Note that new milestones are being developed for this project.

Project Teams

Project 5.1

A/Prof G. Duff, NTU

Dr S. Setterfield, CRC, Course Coordinator

Research Associates

A/Prof G. Arger and staff, CIMM, JCU

Dr A. Arnott, NTU

Mr A. Barnaart, NTU

Ms R. Benson, CRC

A/Prof B. Devlin, NTU

Prof G. Hill, NTU

Ms L. Molloy, Dhimurru Land Management Aboriginal Corporation

Mr G. Shaw, NTU

Mr M. Storrs, NLC

Mr G. Wearne, NTU

Ms B. White, JCU/NTU

Ms P. Wignell, NTU

Mr G. Williams, NTU

Ms P. Wurm, CRC/NTU

A/Prof R. Young, NTU

Project 5.2

Ms L. Benson, NTLPE

Ms N. Campbell, NTDPIF

Mr R. Clark, QDPI

Mr R. Fell, QDPI

Mr J. Kernot, QDPI

Mr J. Rolfe, QDPI

Ms S. Strutt, AgWA

Mr R. Sullivan, NTDPIF

Ms J. Timms, QDPI

Mr M. Whitehead, QDNR

Project 5.3

Mr A. Cowie, NTU

Mr S. Caple, NTU

Mr H. Davis, NTU

Mr M. Hawkes, NTU

Collaborating Staff

Ms D. Bisa, CRC

Dr P. Jacklyn, CRC

Ms K. O'Donnell, CRC

COMMUNICATION AND PUBLIC OUTREACH

Communication

Last year the CRC initiated a review of its internal and external communications. The review was conducted by an external consultant, Econnect. As a result of the recommendations, based on extensive consultation with stakeholders, major changes regarding the way the CRC communicates internally and externally were effected.

First the CRC appointed a Communication Coordinator, in August 1997, who took responsibility for improving communication across the CRC. Instead of communication being the sole responsibility of Project 5.2, it became a 'whole-of-CRC' perspective. A Communication Strategy was developed based on the recommendations of the Econnect report. The strategy targets the needs of the CRC's three main audiences and was shaped to support the Centre's new strategic directions and management structure.

The strategy focuses on achieving three aims:
Better meeting the information needs of stakeholders by exploiting the savanna-wide, cross-disciplinary and cross-sectoral aspect of the Centre. The 'clearing-house' of information in Project 5.3 will play a major role here (see Education and Extension). In the meantime, the Centre's external newsletter *Savanna Links* has been refocused to provide stakeholders with useful land management information. The Centre's workshops also play a major role in information dissemination.

Creating a more cohesive and distinctive Centre identity for staff, savanna land users and the general public. In 1997/98 the Centre more clearly identified how it makes a difference by publicising the following initiatives:

- The integration of research efforts of the partner agencies into outcomes that have savanna-wide perspectives.
- The interdisciplinary work of the management studies which bring researchers from different disciplines and land managers together.
- The workshops, seminars, educational and extension activities and material that take a whole-of-savannas view.

Better meeting the information needs of Centre Staff and encouraging cooperation across the Centre's activities. This has been done by using workshops, newsletters, email and internet facilities, information packs and by emphasising how the Centre makes a difference and adds value to the work done by its partner agencies.

These aims have seen numerous communication initiatives taken in 1997/98. These are listed below under three broad audiences.

Stakeholder Communication

- The **external newsletter** *Savanna Links* has been redefined with an emphasis on stakeholder interests and information-linking and has been well received.
- A very **successful and large fire management workshop** has been held which has strengthened the Centre's links with land managers across northern Australia. A publication on fire aimed at land managers has been produced as a result of this workshop.
- The **innovative North Australian Fire Managers Forum**, chaired by the CRC, will allow strategic approaches to fire management and communication to be taken across the whole of north Australia.
- A **prototype website for a 'clearing-house' of information** has been designed and has been tested by selected stakeholder user groups. A database specialist with science expertise started compiling a bibliography of land management references and summaries that will form the first stage of the site's content. The entire website will soon be redesigned so that it is focused on the information needs of our stakeholders.
- The Centre is starting to be used as a **neutral broker in sensitive land management issues.**

General External Communication

- The Centre now has a **higher public profile as a result of media releases** on our workshops and seminar initiatives, selected research projects and the CRC as a whole. Note that this represents a significant improvement on the electronic media coverage mentioned in last year's Annual Report, much of which covered the research conducted by Centre partner agencies but did not mention the CRC itself.
- **Attractive information packs on the Centre** are now available. This includes various brochures and a new booklet that outlines the Centre's new strategy and vision.
- **Information stands on the Centre** have been distributed around the partner agencies - and are being used at various other display opportunities.

Internal Communication

- A **new email internal newsletter** is now well established and is available in colour with internal navigation as well as in a paper version.
- An **internal website** for staff and students has been launched. It allows access to all issues of the newsletter.
- Holding the **North Australia Communication Workshop** involving people from the various agencies involved in the Tropical Savannas CRC to: exchange information about the mission, tactics and resources used by each agency; establish links and enhance the sharing of information between the agencies to make communication more efficient; and suggest initiatives that the CRC can take to improve the communication network across northern Australia.
- **Several other workshops** have been held which brought TS CRC staff and other researchers together from across the savannas. The workshops were on remote sensing, extension activities, vegetation mapping and landscape modelling.
- **Successful presentation skills workshops** have been held for students in Darwin and Townsville.
- The Centre is starting to be used as a **source of communication assistance** for our partner agencies.
- **Publicity and Publications Protocols** have been produced.

Allied with these communication initiatives, researchers from the Centre have taken part in the numerous public outreach activities which follow.

Public Outreach

Andersen, A.N. (1998) *Fire Ecology and Management in Northern Australia*. TS CRC Tour Guides Seminar.

Andersen, A. & Churchill, T. (1998) *Biodiversity in the Top End: Why are Insects and Other Inverts so Important?* Seminars for Teachers training course.

Andersen A.N. (1998) *The Role of Science in Fire Management*. TS CRC Fire Workshop, Darwin, NT.

Applegate, R. (1998) *Tropical Environmental Studies and Geography.* 1998 Postgraduate Conference, JCU, Townsville.

Applegate, R. (1998) Joint NT and WA rangeland monitoring workshop, Kununurra.

Appleman, A. (1998) *The Desert Uplands GIS data directory and training module in ARCVIEW for Desert Uplands people.* DUBDSC meeting, Jericho.

Bowman, D. (1998) *Marsupial Megafaunal Extinction: were the Aborigines Superhuman Hunters?* University of Wollongong, University of Sydney, Australian National University, University of Tasmania, Northern Territory University.

COMMUNICATION AND PUBLIC OUTREACH

Bowman, D. (1998) *Ecology and Evolutionary Impact of Aboriginal Landscape Burning on the Australian Biota*. CSIRO, Darwin and ANU.

Bowman, D. (1998) *What are the Ecological and Evolutionary Consequences of Aboriginal Landscape Burning on the Australian Biota?* CSIRO Seminar Series, Darwin.

Childs, J. (1997) Presentation to NT Research and Development Advisory Council at the NT Museum.

Churchill, T.B. (1998) *The Amazing World of Spiders and Insects.* Northern Territory Museum, Darwin.

Churchill, T.B. (1997) *At the Top End of the Web: Spiders as Indicators of Ecological Diversity.* CSIRO Seminar Series, Darwin.

Cook, G. (1998) *Soils Ain't Soils: Looking at Landscapes in the Top End*. CSIRO Seminar Series, Darwin.

Cook, G. (1998) *Fire in the Top End*. NT Field Naturalists Club, Darwin.

Cook, G. (1998) *Climate and Landscapes of the Top End*. In-service training for science teachers, Northern Territory Dept of Education, Darwin.

Dyer, R. (1998) *Sectoral Fire Issues - Pastoral Industry.* North Australia Fire Management Workshop, Darwin.

Eamus, D. (1997) *Ecophysiology of Savanna Trees: A Cost/Benefit Analysis*. CSIRO Seminar Series, Darwin.

Forster, M. (1997) *Sustainable Transitions in the Desert Uplands.* The University of Sydney's Orange Agricultural College.

Fraser, F. (1997) *The Ecology of the Partridge Pigeon and Some Behavioural Observations*. NT Field Naturalists Club, Darwin.

Fraser, F. (1997) *The Ecology of the Partridge Pigeon and Habitat Impacts Due to Fire and Grazing.* Mid-term seminar, ANU.

Godfrey, V. (1997) *The Development and Use of GIS in Planning in the Desert Uplands*. DUBDSC meeting, Jericho.

Grice, T. (1998) *Acacia Management*. Department of Natural Resources Field Day, Acacia Downs, Muttaburra, Queensland.

Grice, T. (1997) *Rubbervine Management*. Field Day, Department of Natural Resources/Mitchell River Catchment Group, Kollatah Station, Queensland.

Harvey, K. (1998) *Applications of Remote Sensing Technology*. NTU remote sensing class, Darwin.

Hutley, L. (1997) *What the Flux is Up?: Water Vapour and Carbon Dioxide Exchange from a Tropical Savanna Woodland*. CSIRO Seminar Series, Darwin.

Hynes, R.A., Godfrey, V. & Forster, M. (1997) *CRC Research Activities in the Desert Uplands.* DUBDSC meeting, Charter Towers.

Hynes, R.A. (1997) *Development of Performance Indicators for Desert Uplands Strategy*. DUBDSC workshop on Performance Indicators, JCU, Townsville.

Hynes, R.A. (1997) *Introduction to Performance Indicators*. DUBDSC meeting, Aramac.

Hynes, R.A. (1997) *Overview of Strategic Planning Process*. Strategic Planning Workshop, Townsville/Thuringowa Landcare Group, Davies, Laboratory, Townsville.

Hynes, R.A. (1997) *Overview of Draft Desert Uplands Tourism Audit and Marketing Strategy.* DUBDSC meeting, Pentlands.

Hynes, R.A. (1997) *Sustainable Regional Futures: A Planners Dream or Adaptive Social Evolution*. [Keynote address] Federated PhD Scholars Scheme Program, ANU, Canberra.

Hynes, R.A. (1997) *Sustainable Rangelands - Sustainable Economics in Woody Weed Infested Savannas*. Tropical Weeds Research Centre Seminar Series, Charters Towers.

Hynes, R.A. (1998) *Understanding and Maintaining Biodiversity Regarding Your Guiding Enterprise*. Presentation, workshop and field exercises at Savannah Guides Training School, April 1998, Undara Lava Lodge, Undara Experience, Savannah Guide Station.

Hynes, R.A. (1998) *Using GIS in Regional and Property Level Planning*. DUBDSC meeting, Jericho.

Hynes, R.A. (1997) *Writing Good Technical Reports*. Savannah Guides, Tyconnell Historic Gold Mine, Savannah Guides School.

Hynes, R.A. (1997) *Interacting Positively with the Media*. Workshop presentation and exercises for Savannah Guides, Tyconnell Historic Gold Mine, Savannah Guides School.

Janos, D. (1997) *The Significance and Role of* Mycorrhiza *in Tropical Savannas*. TS CRC Visiting Scientist Seminar Series, JCU, Townsville.

Janos, D. (1997) *Investigations into the Diversity and Ecological Function of* Mycorrhiza *in Tropical Forest on Barra Colorado Island, Panama*. TS CRC Visiting Scientist Seminar Series, CSIRO Davies Laboratory, Townsville.

Karfs, B. (1998) *Monitoring the Home Where the Cattle Roam: A Case Study in the Victoria River District*. CSIRO Seminar Series, Darwin.

Kirby, G. & Hynes, R. (1997) *Savannas Futures-Decision Support Tools*. QDPI, Charters Towers.

Ludwig, J. (1998) *Landscape Processes*. In-service training for science teachers, Northern Territory Dept of Education, Darwin.

Ludwig, J. (1997) *Landscape Function Analysis to Identify Rehabilitation Success.* Ranger Uranium Mine Open Day and Minesite Rehabilitation Workshop.

Macgregor, C. (1998) *Theoretical Model Used in the Project to Measure Community Sustainability.* TESAG Postgraduate Conference, JCU, Townsville.

Nicholas, M. (1997) *Prickly Acacia Management Based Ecological Research*. Julia Creek Landcare Meeting, Julia Creek.

Price, O. (1997) *Fruit Eating Birds and the Conservation of Rainforest*. NT Field Naturalists Club, Darwin.

Price, O. (1997) *Fruit Eating Birds and the Conservation of Rainforest*. Top End Native Plant Society, Darwin.

Price, O. (1997) *Fruit Eating Birds and the Conservation of Rainforest*. ANU, Canberra.

Price O. (1997) *Reserve Design: Strategy and Methodology*. NTU, Darwin.

Rose, D. (1997) *Nourishing Terrains: Indigenous Creation of Australian Eco-Systems*. University Forum, University of Tasmania, Launceston.

Radford, I. (1998) *Weed Control Research*. MRC Meat Profit Day, Emerald, Queensland.

Russell-Smith, J. (1998) *Fire Ecology and Management in Northern Australia*. CRC Tour Guides Seminar.

Tongway, D. (1998) *Indicators for Minesite Rehabilitation*. AMIRA Workshop on Indicators of Minesite Rehabilitation, Melbourne.

COMMUNICATION AND PUBLIC OUTREACH

Tongway, D. (1998) *Training Course for Minesite Rehabilitation Staff*. MIM coal mines, Pilbara district, WA.

Tongway, D. (1998) *Training Course for Minesite Rehabilitation Staff*. BHP iron ore mines, Pilbara district, WA.

Whitehead, P.J. (1997) *Conservation Issues in the Mary River Catchment*. Lecture to students in Masters of Tropical Environmental Management, NTU, Darwin.

Whitehead, P.J. (1998) *Sustainable Harvesting of Living Resources*. Lecture to students in Masters of Tropical Environmental Management, NTU, Darwin.

Whitehead, P.J. (1998) *Biology and Conservation of the Magpie Goose*. Lecture to students in Parks, Lands and Wildlife Management Certificate, Palmerston Campus of NTU.

Whiteman, G. (1998) *The Effect of Livestock Grazing on Speargrass Genetic Diversity - Relating Phenotypic and Genetic Variation*. TS CRC Seminar, JCU, Townsville.

Williams, R.J. (1998) *The North Australian Tropical Transect*. Victoria River Research Station Open Day, Kidman Springs.

Williams, R.J. (1998) *Fire in Savanna Vegetation*. Institute of Australian Tour Guides Seminar, Darwin.

Williams, R.J. (1998) *Vegetation in the Top End*. In-service training for science teachers, Northern Territory Dept of Education, Darwin.

Woinarski, J. (1997) *Fire and Biodiversity*. Workshop, Kalumburu.

Woinarski, J. (1998) *Animal Distributions in Arnhem Land*. NT Field Naturalists Club, Darwin.

Woinarski, J. (1998) *Landscape Processes and Nectar Availability and Plants in Arnhem Land*. Top End Native Plant Society, Darwin.

Displays

Bushfire '97 Conference, Darwin, 8-10 July 1997. Panel display, CRC.

Darwin Show, 25-27 July 1997. Invertebrate display, Andersen, A. & Churchill, T.B.

James Cook University Open Day, 7 September 1997. Panel display, CRC.

NT Research and Development Advisory Council, NT Museum, 6 November 1997. Panel display, CRC.

"Discovering Nature in the Top End" at the Northern Territory Museum, February 22 1998. Panel display, CRC.

Victoria River Research Station (Kidman Springs) Open Day, 27 March 1988. Posters displayed on the NATT, Project 1.1.

CRC Association Conference, Adelaide, 14-15 April 1998. Panel display, CRC.

Science and Engineering Fair at James Cook University, part of National Science Week, 7 May 1998. Panel display, CRC.

International Symposium on Learning Communities, Regional Sustainability and the Learning Society, Launceston, Tasmania, 17-19 June 1998. Panel display, CRC.

Media

Radio

July 1997

Andersen, A. Fire management in northern Australia. ABC 8DDD news. 7 Jul.

Andersen, A. Fire management in northern Australia. ABC Radio, World Today. 8 Jul.

Andersen, A. Fire management in northern Australia. ABC Radio, SA Regional. 14 Jul.

Russell-Smith, J. Bushfires '97 Conference. ABC Radio.

Andersen, A. Fire management in northern Australia. ABC Radio 5UV. 16 Jul.

Andersen, A. Fire management in northern Australia. ABC Radio, National Science File. 21 Jul.

August 1997
Andersen, A. Invertebrate biodiversity. ABC Radio 8DDD. 6 Aug.

September 1997
Russell-Smith, J. VRD Fire Project, ABC Radio, NT Country Hour. 11 Sept.

October 1997
Childs, J. Goals of CRC. ABC 8DDD News 9 Oct.

Senator Bob Collins. Mortimer Report and TS CRC. ABC Radio, Alice Springs. 17 Oct.

Childs, J. Mortimer Report and TS CRC. ABC 8DDD. 21 Oct.

Childs, J. Mortimer Report and TS CRC. ABC Radio, NT Country Hour. 21 Oct.

November 1997
Childs, J. Goals of TS CRC. ABC 8DDD.

Andersen, A. & Salvarani, A. Ants. ABC 8DDD. 12 Nov.

January 1998
Griffiths, A. MIM Sulphur Plume Project. ABC Mt Isa. 29 Jan.

Griffiths, A. MIM Sulphur Plume Project. ABC Radio, NT Country Hour. 30 Jan.

February 1998
Griffiths, A. MIM Sulphur Plume Project. ABC 8DDD News. 2 Feb.

Andersen, A. Ants as bioindicators. ABC Radio Kalgoorlie. 18 Feb.

March 1998
Karf, R. Fire and monitoring in the Victoria River District. ABC Radio, NT Country Hour.

Applegate, R. Rangeland Monitoring in the Victoria River District. ABC Radio, NT Country Hour.

Russell-Smith, J. Fire Management Workshop. ABC Radio, NT Country Hour. 24 Mar.

Woinarski, J. Vertebrate biodiversity and fire. ABC 8DDD. 24 Mar.

Various managers and researchers Fire Management Workshop. ABC Radio, NT Country Hour. 24 Mar.

April 1998
Childs, J. Funding maintained for TS CRC. ABC Radio, NT Country Hour. 15 Apr.

May 1998
Andersen, A. Ants as bioindicators. ABC Radio 3LO. 5 May.

Andersen, A. Ants as bioindicators. ABC Radio Bega. 6 May.

Andersen, A. Ants as bioindicators. ABC Radio Newcastle. 8 May.

June 1998
Franklin, D. Granivorous birds in the savannas. ABC Mt Isa.

COMMUNICATION AND PUBLIC OUTREACH

Franklin, D. Granivorous birds in the savannas. ABC Radio, NT Country Hour.

Franklin, D. Granivorous birds in the savannas. ABC Radio, Alice Springs.

Television

July 1997
Andersen, A. Fire management in northern Australia. ABC Stateline. 4 Jul.

Andersen, A. Fire management in northern Australia. ABC National News. 11 Jul.

October 1997
Childs, J. Mortimer Report and TS CRC. ABC News. 21 Oct.

February 1997
Griffiths, A. MIM Sulphur Plume Project. ABC News Brisbane.

March 1998
Various researchers. TS CRC Fire Workshop. ABC News. 24 Mar.

Print Media

September 1997
TS CRC and Mortimer Report, *Townsville Bulletin*, 6 Sept, featuring Deputy Director Ross Hynes.

New Director for TS CRC, *Townsville Bulletin*, 10 Sept, featuring Director John Childs.

October 1997
Mad About Mesquite, *Townsville Bulletin*, 27 Oct, featuring Deputy Director Ross Hynes and others working in the CRC in Sub-Program 4 in Queensland.

December 1997
TS CRC Fire Project and Fire in Northern Australia, *The Age*, 6 Dec, featuring Dr Alan Andersen, Dr Jeremy Russell-Smith and Dr Peter Jacklyn.

TS CRC Invertebrate Bioindicators Project, *The Age*, 6 Dec, featuring Ms L. Lowe and Dr Alan Andersen.

January 1998
TS CRC/JCU Tourism Survey in Gulf Country, *The Sun* (Townsville), 28 Jan, p 26, featuring Neil Black.

MIM Sulphur Plume Project, *North West Star* (Mt Isa), 30 Jan, p 3, featuring Dr Tony Griffiths.

February 1998
TS CRC/JCU Tourism Survey of Gulf Country, *North West Star* (Mt Isa), 3 Feb, p 3.

MIM Sulphur Plume Project, *The Age*, 4 Feb, p 4, featuring Dr Tony Griffiths.

TS CRC/JCU Tourism Survey of Gulf Country, *North Queensland Register*, 5 Feb, p 22.

MIM Project Wildlife Survey, *The North West Star* (Mt Isa), 6 Feb, p 7, featuring Dr Tony Griffiths.

Museum Open Day - advertisements, *Northern Territory News*.

MIM Sulphur Plume Project, *The Courier Mail*, featuring Dr Tony Griffiths.

Impact of Grazing on Reptiles, *JCU Outlook*, Vol. 9, No. 1.

March 1998
MIM Sulphur Plume Project, *Groundwork*, featuring Dr Tony Griffiths.

Sustainable Rural Development and the TS CRC, *SRD News* (AgWA).

MIM Sulphur Plume Project, *Savanna Links*, Issue 5, p 3, featuring Dr Tony Griffiths.

Wambiana Station Grazing Trials, *Savanna Links*, Issue 5, p 5, featuring Dr Peter O'Reagain.

Impact of Grazing on Reptiles, *Savanna Links*, Issue 5, p 6.

Mycorrhyzae **in the Savannas**, *Savanna Links*, Issue 5, p 7, featuring Dr David Janos.

GIS in the Desert Uplands, *Savanna Links*, Issue 5, p 8.

Cattle and Exotic Weeds, *Savanna Links*, Issue 5, p 9, featuring Dr Ian Radford.

TS CRC/JCU Tourism Survey of Gulf Country, *Savanna Links*, p 10, featuring Dr Neil Black.

April 1998

Student Project Awards from TS CRC, *Northern Territory News*, 15 Apr.

Impact of Grazing on Reptiles, *Townsville Bulletin*,15 Apr, p 7.

June 1998

Impact of Grazing on Reptiles, *Land and Water News*, Vol. 2 (5).

TS CRC Fire Workshop, *Savanna Links*, Issue 6, pp 4-5.

Granivorous Birds in the Savannas, *Savanna Links*, Issue 6, p 8, featuring Mr Don Franklin.

Internet

2-10 May 1998. **Dr Churchill** participated in National Science Week as a scientist for an ABC Internet Website.

Carl Menges - A personal website is available for further details including photos and abstracts of publications:
http://www.gis.ntu.edu.au/staff/carl/cm.html

UTILISATION & APPLICATION OF RESEARCH

Sustainable use and conservation of tropical savannas can only occur when researchers work together with land managers and users to identify and solve problems on the ground. The efforts of the CRC over the past year have focused on providing expertise, training and educational services which enable a greater degree of awareness and understanding of sustainable use and conservation processes in those that manage and use the land.

The Tropical Savannas CRC not only services a wide geographic region of Australia but serves many different stakeholders and industry groups (see Table 3 on pages 82-84 for the extensive nature of the CRC's interaction with 'Users'). Many of the Centre's projects provide research that serves not just one but a number of land-user groups.

To achieve a greater transfer of technology an integrated Communication Strategy was developed and a range of initiatives implemented. The Consultative Committee continued to ensure the Centre's research provides benefits relevant to its stakeholders and industry groups. A Business Manager's position was established to focus the Centre's research towards achieving tangible outcomes. The establishment of a Communication Coordinator ensured the CRC developed improved communication processes with its stakeholders, most notably through the development of the savanna information 'clearing-house' initiative. The Education and Training Project conducted an extensive survey of potential end users to ensure the outcomes in education and training are designed to meet their needs.

The primary stakeholder groups who use and benefit from the Tropical Savannas CRC research and activities are government, pastoral, Aborigines, mining, tourism and conservation sectors.

GOVERNMENT

Many of the CRC's partner agencies are government land management or research agencies. Their involvement in the CRC enables them increased interdisciplinary and inter-sectoral links as well as links across state and territory boundaries. The Centre also provides the means for agencies' research to be practically implemented through its management studies and education and extension activities.

Some of the specific products for the government sector include:

- Provision of a draft Gouldian Finch management program for the Northern Territory Government has been developed from work in Project 2.2. The landscape-level perspective sought in these studies comprises an important part of that plan. The biogeographic studies have also encouraged the QDoE to establish joint programs to explore the management implications of granivore decline.
- A better understanding of invasion processes at landscape scale gained through activities in Project 3.3 has enabled the QDNR to better structure its woody weed extension activities. Both Shane Campbell and Tony Grice are members of the National Rubbervine Strategy Working Group and this presents opportunities to highlight and implement the results of the project.
- The Northern Australia Fire Management Workshop in March 1998 has enabled the Australian Defence Forces to participate in and better understand effective fire management strategies.

PASTORAL INDUSTRY

Pastoralists are key land users of the tropical savannas with over 55% of the 193 million hectares of tropical savannas in pastoral tenure. The two CRC management studies provide an excellent example of how a range of scientists and land managers can work towards sustainable development in a particular region.

The Victorian River District (VRD) Management Study

The aims of the VRD Management Study are to improve stakeholders' knowledge of how to

Much of the CRC research effort involves extension activities, such as this Mt Sanford Open Day for pastoralists.

strategically manage their lands and to help them effectively deal with short-term changes caused by both natural and land-use factors.

Research in this study has involved scientists from across many disciplines and projects working together. Their aim is to produce a unique integrated picture of the impact of different fire regimes in the VRD which can be used as the basis for a fire management plan for the whole region. So far researchers have:

- documented historical landscape changes in the VRD;
- identified the natural causes of landscape changes in the VRD;
- identified changes caused by fire;
- identified changes caused by different land uses; and
- developed a SAVANNA simulation model with the assistance of visiting scientist, Mike Coughenour which will predict what changes could occur in the future with different climates, fire regimes and land management strategies.

Desert Uplands Management Study

The main objective of this study is to develop principles and procedures that can provide advice on sustainable land use and conservation options at local and regional scales. The major deliverables to date are:

- access to a far greater range of information through the development of a GIS to enable more integrated landcare strategies;
- enterprise level investigations: transition management for sustainable adjustment (case studies, surveys and management models) and benefit/cost case studies at enterprise level regarding aggregation, diversification, development and exiting; and
- development of indicators of sustainability at enterprise and regional scales for environmental, economic and social values.

Other CRC initiatives designed to deliver improved outcomes for pastoralists continue. They are:

- development of remote sensing technology for rubbervine - so that pastoralists can detect the widespread weed early and implement strategic approaches to its management; and
- development of optimal cattle stocking strategies in variable rainfall regions through the Dalrymple Shire grazing trial.

MINING INDUSTRY

Mt Isa Mines (MIM) will be installing a sulphuric acid plant in remote Queensland by 2000. In order to determine the impact of the SO_2 emissions on the wildlife in the region, they contracted the CRC to survey the flora and fauna in the region which will be used as a baseline for the impact of their future operations.

Investigations by Tony Griffiths (CSIRO Wildlife and Ecology) have allowed MIM to:

- better determine the effects of SO_2 on flora and fauna diversity;
- identify critical atmospheric and soil SO_2 concentrations;
- develop more cost-effective methods and protocols for environmental monitoring; and
- undertake their own sampling of biodiversity by having staff trained in the techniques and methods.

In the long term MIM will be better equipped to make judgements on the long-term effects of their

plant on biodiversity in the region. The general community has benefited largely due to the biological surveys which have collected information on a region which was little known or understood before. Of note was the discovery of a Fat-tailed Mouse found far from its known habitat and now featured in the Queensland Museum.

Fat-tailed Mouse. Photo: Bruce Cowell, courtesy of Qld Museum.

Other CRC research that has benefited the mining sector includes:

- contributions to the development of a minesite rehabilitation handbook based on landscape function analysis (Project 1.1); and
- invertebrate monitoring protocols adopted at Mt Isa and German Creek Mines (Project 3.2).

ABORIGINAL COMMUNITY GROUPS

Researchers and collaborators in Project 2.4 have been working on the process of better land management by building capacities within Aboriginal communities to manage fire issues more effectively.

Building capabilities varies from community to community. In Eastern Cape York, historically, there has been a lack of burning and resultant thickening of the bush. The fire project on Cape York is working with the Balkanu Cape York Development Corporation in providing information and advice on how to burn to keep the land open.

In the Kimberley some fire regimes have been out of control and the local Aboriginal community needed more information and advice on how to determine conservative fire management strategies in order to conserve the land and preserve the wildlife.

A major new Aboriginal Land Management project for 1998/99 will allow the CRC to add value in a substantial way to research directed towards Aboriginal communities.

THE CONSERVATION SECTOR

The government conservation agencies in WA (CALM) and the NT (PWCNT) are partner agencies and are closely involved in TS CRC projects (see Government sector page 77). The Queensland agency (QDoE) will be involved in the Centre's research program from 1998/99.

While the government conservation sector is closely involved with and served by the Centre's research program, this has not been the case with the non-government conservation sector which includes a number of conservation umbrella groups across the savannas. These groups want easier access to land management information across the savannas and the Centre's 'clearing-house' of information should provide this.

THE TOURISM INDUSTRY

The NT branch of the Tourism Council of Australia requested the CRC facilitate a monthly seminar series for NT tour guides in association with the Institute for Australian Tour Guides. With its many links to scientific and cultural organisations across the savannas, the CRC is well placed to provide such a service to the tourist industry.

The seminars are designed to keep tour operators in touch with the latest developments in scientific and cultural issues relevant to the industry, and to ensure accurate information is passed on to their clients.

Seminars presented have covered fire ecology and termite biology. Questionnaires circulated within the industry show the seminars have been well received.

In Queensland, the Centre has been working closely on the professional development of nature and culture-based tourism through its two-year association with Savannah Guides Inc. The CRC provides action learning and research training units for the Savannah Guides, focusing on sustainable land use and conservation for nature and culturally based bush tourism. These units are presented at the Savannah Guides Training Schools, which are held twice each year and are an integral part of the group's training and accreditation program for its guides.

A/Prof Ross Hynes has presented eight units including writing technical reports; dealing with the media; and maintaining biodiversity in a tourist site. The materials from these units have now been developed into a cohesive module focusing on land use and conservation for nature and culturally based bush tourism.

A/Prof Ross Hynes working with the Savannah Guides at their Cobbold Gorge Interpretation Site. A/Prof Hynes worked with the Guides to develop the strategic and operational plans to ensure sustainable management of the site.

As further testament to the application of the CRC's research the following consultancies have been requested by various industry groups and agencies.

TABLE 2

CONSULTANCIES

Industry or Sector	Agency	Purpose	Project and Researcher	Amount	Dates
Government	Environment Australia - State of Environment Unit	Assessing fire patterns and their environmental impacts for national state of environment reporting	2.4 Dr J. Russell-Smith	$12,000*	Jun 1998 - Dec 1999
Government	Bushfires Council NT (through a Natural Heritage Trust consultancy)	Documentation of social and photographic history of the Sturt Plateau - VRD region	2.4 Dr J. Russell-Smith	$58,200*	1997/98 -2000/01
Government	Bushfires Council NT (through a Natural Heritage Trust consultancy)	VRD and Sturt Plateau project coordinator	2.4 Dr J. Russell-Smith	$216,000*	1997/98 - 2000/01
Government	Defence Science and Technology Office, Ministry of Defence	A bioaerosal survey of ambient air in Darwin	1.2 A/Prof D. Eamus	$15,500	1998
Government	Bureau of Resource Sciences	An assessment of above and below ground biomass of an Australian savanna site	1.2 A/Prof D. Eamus	$3,500	1998
Conservation	Sanctuary Park Endangered Wildlife Foundation Australia	Kadi-Makara: An australian wilderness and conservation project	4.3 A/Prof R. Hynes and Dr G. Kirby	$10,000	

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Industry or Sector	Agency	Purpose	Project and Researcher	Amount	Dates
Pastoral	RIRDC	Developing a sustainable satellite fire monitoring program for rural northern Australia	2.4 Dr J. Russell-Smith	$86,160*	1997/98-2000/01
Mining	Capricorn Management Pty Ltd	Ant monitoring at German Creek Mine, Queensland	3.3 Dr A. Andersen and B. Hoffmann		1998
Mining	Capricorn Management Pty Ltd	Ant monitoring at German Creek Mine, Queensland: sampling report	3.3 Dr A. Andersen and B. Hoffmann		1998
Mining	MIM	Ant component	3.3 Dr A. Andersen and B. Hoffmann		
	LWRRDC	Biological and economic consequences of managing water-point distribution in rangelands	2.1 Dr J. Woinarski Mr A. Fischer Dr N. McKenzie	$70,000	1997-2000
Government	Environment Australia National Reserves Systems Program	Development of a conservation plan for the Sturt Plateau bioregion	2.1 Dr J. Woinarski Ms T. Leary Mr A. Fischer	To be confirmed	1996-97
Government	Environment Australia	Wildlife of Mitchell grasslands	2.1 Mr A. Fischer	$4,000	1995-97
Government	Environment Australia	Preliminary bioregional analysis	2.1 Dr J. Woinarski	$12,000	1995-97
Government	Environment Australia	Refining reserve design methodology	2.1 Dr J. Woinarski	$7,500	1994-97
Government	Australian Heritage Commission	English Company Islands survey	2.1 Dr J. Woinarski	$16,500	1996-97
Government	Environment Australia	Effect of fire on birds	2.1 Dr J. Woinarski	$1,760	1995-96
Government	Environment Australia	Economic and social values of NT Reserve System	4.2 & 2.4 Dr P. Whitehead Dr G. Kirby	$70,000	1996-98
Government	Environment Australia, Endangered Heritage Unit	Gouldian Finch recovery	2.2 Mr P. Dostine	$100,000	1997
	Pegasus Gold	Gouldian Finch management	2.2 Mr P. Dostine	$75,000	1996-97
Pastoral	Meat Research Corporation	Develop approaches for increasing availability and use of sustainable grazing systems	4.3 Dr M. Quirk	$12,000	1996-97
Pastoral	Meat Research Corporation	Inspect and assess programs for improving rangeland management via whole property planning	4.3 Dr M. Quirk	$4,000	1997

*invoiced through the Tropical Savannas CRC - all other contracts invoiced through partner agencies.

TABLE 3

CENTRE RESEARCH USERS AND THE BASIS OF INTERACTION

ORGANISATION	Represented on Board Committee	Partner Agency	Collaborative Research	Information/ Research Exchange	Contract Research	Cooperative Training	Collaborative Grants	Contracted by Centre
Pastoral Industry Sector								
MRC				√				
North Australian Beef Research Council	√			√		√		
United Graziers Association				√				
QCU				√				
Katherine Pastoral Industry Advisory Committee				√				
Kimberley Beef Research Committee				√				
Cattleman's Union of the NT			√	√		√		
Northern Territory Pastoral Land Board			√	√				
Conservation Interest Groups								
ACF			√					
WWF	√			√				
The Wilderness Society				√				
Environment Centre of the NT	√			√				
Arid Lands Environment Centre				√				
Kimberley Conservation Group				√				
VRD			√	√				
Queensland Conservation Council				√				
Queensland Wildlife Preservation Society				√				
Mining Industry Sector								
MIM Group of Companies/McArthur River Mining Pty Ltd					√		√	
ERA			√					
ERA Environmental Services Pty Ltd	√							
QMI Joint Venture				√				
Aboriginal Community Groups								
Bawinaga Association, Arnhem Land				√				
Cape York Land Council	√			√		√		
Kimberley Land Council	√			√		√		
Indigenous Land Corporation				√				
Northern Land Council	√			√		√		
Jawoyn Association			√	√				
Tourism Industry Sector								
Alliance for Sustainable Tourism				√				
Northern Gateway Pty Ltd				√				
National Centre for Studies in Travel and Tourism Pty Ltd			√	√				
Australian Tourism Council (NT)	√		√	√				
Institute of Australian Tour Guides				√		√		
Savannah Guides Inc.				√		√		
GLADA				√		√		

UTILISATION & APPLICATION OF RESEARCH

ORGANISATION	Represented on Board Committee	Partner Agency	Collaborative Research	Information/ Research Exchange	Contract Research	Cooperative Training	Collaborative Grants	Contracted by Centre
Queensland Tourist Commission			√	√				
Undara Experience				√		√		
Sanctuary Park Endangered Wildlife Foundation			√	√			√	
Funding Agencies								
ACIAR			√	√			√	
LWRRDC	√			√			√	
EA/BG	√	√		√	√		√	
DEST				√			√	
MRC, NAP	√			√				
RIRDC							√	
Bureau Resource Sciences				√				
Government Agencies								
Australian Defence Force			√	√				
Bureau of Meterology			√					
Great Barrier Reef Marine Park Authority				√				
AgWA		√						
DOLA			√			√		
Bushfires Board of Western Australia			√	√		√		
CALM WA		√						
Caring for Country Unit, NLC			√	√				
Kakadu, Nitmiluk Litchfield, National Parks			√	√				
NTDME		√						
NTPAWA		√						
BFC			√	√		√		
NTDPIF		√						
PWCNT		√						
CYPLUS			√	√				
SA Dept of Environment and Natural Resources			√	√				
ERIN			√					
NRIC			√					
CSIRO DWE	√	√						
CSIRO TAG		√	√	√				
CSIRO L&W		√						
CSIRO MIS			√	√				
QDPI	√	√						
QDNR		√	√					
QDoE			√	√				
Queensland Department of Main Roads				√				
Queensland Forest Research Institute				√				
Townsville City Council				√				
Cooperative Research Centres								
CRC for the Conservation and Management of Marsupials				√				
CRC for Tropical Rainforest Ecology and Management			√	√				
CRC for Sustainable Sugar Production				√				
CRC for Freshwater Ecology			√					

ORGANISATION	Represented on Board Committee	Partner Agency	Collaborative Research	Information/ Research Exchange	Contract Research	Cooperative Training	Collaborative Grants	Contracted by Centre
CRC for Sustainable Tourism				√				
Community Groups and Professional Bodies								
DUBDSC			√	√				
Mary River Landcare Group			√					
Mary River Technical Working Group			√					
Savanna Landcare Groups				√				
Balfes Creek Catchment Landcare Group			√	√				
Fletcher Creek Catchment Landcare Group				√				
Sturt Plateau Best Practice Group				√				
Daly River Landcare Trust			√	√				
Sustainable Beef Group, Torrens Creek, Qld			√	√				
Landcare North West Initiative Group (NW Qld)				√				
Regional Bushfire Council Committees (NT)			√					
WA Land Conservation District Councils				√				
Educational Institutions								
CINCRM (NTU)						√		
University of Western Sydney			√	√				
JCU		√						
UQld, REC			√			√		√
University of Sydney			√	√				
University of South Australia				√				
Curtin University			√					
UNSW				√				
NTU	√	√						
Murdoch University, WA			√	√				
ANU		√	√					
Central Queensland University			√	√				
International Collaboration								
Oregon State University			√					
Colorado State University			√					
University of Virginia			√					
University of Miami			√					
Indonesian Government Agricultural Agencies			√					
University of Wisconsin			√					
Museum of Natural History, New York			√					
University of Botswana			√					
NASA			√					

STAFFING AND ADMINISTRATION

The Centre's main headquarters are at the Northern Territory University in Darwin where the Director and four administration staff; the Business Manager, Communication Coordinator, Director's Assistant and Administration Secretary, are located. The Queensland operations are also supported by the Deputy Director and Communication and Publications Officer who are located at James Cook University, Townsville.

Several major changes in staff resources occurred during the year. In August the new Director, John Childs was appointed and promptly led the CRC through an extensive strategic planning process. Two new managerial positions were also established, the Communication Coordinator and Business Manager. Recruitment to the positions was finalised in August and December 1997 respectively. The new Communication Coordinator, Peter Jacklyn, has over the year transformed communication within the CRC and its links with stakeholders. Brok Glenn took on the role of Business Manager and was instrumental in overhauling the financial management and reporting of the CRC. A new support position, Administration Secretary, was also created to provide assistance to both these two new roles. Deborah Bisa was appointed to the role in January 1998.

For a complete breakdown of total staff resources applied to the Tropical Savannas CRC including in-kind contributions refer to the companion document, *Financial Statements 1997/98*.

TABLE 4

SPECIFIED PERSONNEL

Name	Role at CRC	Organisation	CRC Commitment
John Childs	Director	CRC	100%
Peter Jacklyn	Communication Coordinator	CRC	100%
Ross Hynes	Deputy Director and Sub-Program Leader 4	CRC/JCU	80%
Brok Glenn	Business Manager	CRC	50%
Paul Novelly	Sub-Program Leader 3	AgWA	30%
Peter Whitehead	Sub-Program Leader 2	NTU	30%
John Ludwig	Sub-Program Leader 1	CSIRO DWE	20%
Greg Hill	Sub-Program Leader 5	NTU	20%

PUBLICATIONS

Refereed Papers

Andersen, A.N. (1997) Using ants as bioindicators: multi-scale issues in ant community ecology. *Conservation Ecology* (on line) Vol. 1, p 8.

Andersen, A.N., Morrison, S., Belbin, L., Ashwath, N. & Brennan, K. (1998) The role of ants in minesite restoration in the Kakadu Region of Australia's Northern Territory, with particular reference to their use as bioindicators. Supervising Scientist Report 130, *Supervising Scientist*, Canberra.

Andersen, A.N. & Morrison, S. (in press) Myrmecochory in Australia's seasonal tropics: effects of disturbance on distance dispersal. *Australian Journal of Ecology.*

Andersen, A.N. (submitted) *The Ants of Northern Australia: A Guide to the Monsoonal Fauna*. CSIRO Publishing, Melbourne.

Atchison, J.M., Head, L.M. & McCarthy, L.P. (submitted) Stomatal indicies and atmospheric change since 7500BP: evidence from *Eremophila deserti* (Myoporaceae) leaves from the Flinders Ranges region, South Australia. *Australian Journal of Botany.*

Atchison, J.M. & Fullagar, R.K.L. (in press) Starch residues on pounding impliments from Jinmium rock shelter. *A Closer Look: Recent Australian Studies of Stone Tools.* Fullagar, R.K.L. (ed.) Sydney University Archaeological Methods, Series No. 6.

Benson, R. (1998) Sustainable land management and adult education: issues for the stakeholders of Australia's tropical savannas. *Australian Journal of Adult and Community Education*, Vol. 38 (1), pp 9-20.

Blanche, K.R., Andersen, A.N. & Ludwig, J.A. (submitted) Responses of ground-active beetle assemblages to experimental fire regimes in an Australian tropical savanna. *Ecology*.

Bowman, D.M.J.S. (1997) Observations on the demography of the Australian Boab *(Adansonia gibbosa)* in the north-west of the Northern Territory, Australia. *Australian Journal of Botany*, Vol. 45, pp 893-904.

Bowman, D.M.J.S. (in press) Death of biodiversity - the urgent need for global ecology. *Global Ecology and Biogeography Letters*.

Bowman, D.M.J.S., Panton, W.J. & Head, J. (in press) Abandoned Orange-footed Scrubfowl (*Megapodius reinwardt*) nests and coastal rainforest boundary dynamics during the late Holocene in monsoonal Australia. *Quaternary International*.

Bowman, D.M.J.S. (in press) Tansley Review: The impact of Aboriginal landscape burning on the Australian biota. *New Phytologist*.

Choquenot, D. & Bowman, D.M.J.S. (in press) Marsupial megafauna, Aborigines and the overkill hypothesis: application of a two species predator-prey model to the question of Pleistocene extinction in Australia. *Global Ecology and Biogeography Letters*.

Churchill, T.B. (1998) Spiders as ecological indicators in the Australian tropics: family distribution patterns along rainfall and grazing gradients. *Bulletin of the British Arachnological Society*, Vol. 11, pp 325-330.

Cook, G.D. & Heerdegen, R. (1997) The length of the rainy season can be more important than the amount of rain for savannas in the Northern Territory. *Australian Collaborative Land Evaluation Program Newsletter*, Vol. 6 (4), pp 18-20.

Craig, A. (1997) A review of information on the effects of fire in relation to the management of rangelands in the Kimberley high rainfall zone. *Tropical Grasslands*, Vol. 31, pp 161-187.

Davie, J. & Hynes, R. (1997) Integrating nature conservation and sustainable rural management. *Australian Biologist*, Vol. 10 (4), pp 185-199.

CRC core researchers are underlined where non-centre researchers have contributed to the publication. An * indicates an invited paper.

Duff, G.A., Myers, B.A., Williams, R.J., Eamus, D., Fordyce, I. & O'Grady, A. (1997) Seasonal patterns in canopy cover and microclimate in a tropical savanna near Darwin, northern Australia. *Australian Journal of Botany*, Vol. 45, pp 211-224.

Eamus, D. & Prior, L.D. (1998) Seasonal changes in leaf water characteristics of *Eucalyptus tetrodonta* and *Terminalia ferdinandiana* saplings in a northern Australian savanna. *Australian Journal of Botany*, Vol. 47, pp 1-8.

Fisher, A., Woinarski, J.C.Z., Churchill, S., Trainor, C., Griffiths, A.D., Palmer, C., & Cooper, N. (in press) Distribution of the rock-dwelling dasyurids *Pseudantechinus bilarni* and *Pseudantechinus ningbing* in the Northern Territory. *NT Naturalist*.

Fordyce, I., Eamus, D., Duff, G.A., & Williams, R.J. (1997) The role of seedling age and size in the recovery of *Allosyncarpia ternata* following fire. *Australian Journal of Ecology*, Vol. 22, pp 262-269.

Franklin, D.C., Dostine, P.L., Tidemann, S.C. (in press) Post-juvenile moult strategies of co-existing Gouldian, Long-tailed and Masked Finches. *Corella*.

Goodfellow, J., Eamus, D., & Duff, G.A. (1997) Diurnal and seasonal changes in the impact of CO_2 enrichment on assimilation, stomatal conductance and growth in a long-term study of *Mangifera indica* in the wet-dry tropics of Australia. *Tree Physiology*, Vol. 17, pp 291-299.

Grice, A.C., Radford, I.J. & Abbott, B.N. (submitted) Landscape ecology of the invasive *Cryptostegia grandiflora* R. Br.: a qualitative framework and analysis of land resource survey data. *Biological Invasions*.

Heerdegen, R.G. & Cook, G.D. (submitted) Rainy season length and dry spells in monsoonal Australia. *Journal of Climate*.

Hoffmann, B.D., Andersen, A.N. & Hill, G.J.E. (submitted) Impact of an introduced ant on native rainforest invertebrates: *Pheidole megacephala* in monsoonal Australia. *Oecologia*.

Kriticos, D., Brown, J., Radford, I. & Nicholas, M. (submitted) Biological control of invasive perennial plants in rangeland ecosystems: *Acacia nilotica* as a case study. *Biological Control*.

Ludwig, J.A., Eager, R.W., Williams, R.J. & Lowe, L.M. (submitted) Declines in vegetation patches, plant diversity and grasshopper diversity near cattle watering points in the Victoria River District, northern Australia. *Rangeland Journal*.

Ludwig, J.A., Tongway, D.J., Williams, R.J. & Cook, G.D. (in press) Fine-scale patchiness in savanna landscapes along the North Australian Tropical Transect. *Landscape Ecology*.

Menges, C.H. (submitted) Use of airborne video data for the characterisation of tropical savannas in northern Australia: the optimal spatial resolution for remote sensing applications. *International Journal of Remote Sensing*.

Menges, C.H., van Zyl, J.J., Ahmad, W., & Hill, G.J.E. (submitted) A procedure for the correction of the effect of variation in local incidence angle on AIRSAR data. *International Journal of Remote Sensing*.

Menges, C.H., Hill, G.J.E., & Ahmad, W. (1998) LANDSAT TM data and potential feeding grounds for threatened marine turtle species in northern Australia. *International Journal of Remote Sensing*, Vol. 19 (6), pp 1207-1221.

Menges, C.H., Ahmad, W., Khwaja, Z.H., & Hill, G.J.E. (1996) Merging minimum distance to mean and maximum likelihood algorithms for classifying *Mimosa pigra* in northern Australia. *Asian-Pacific Remote Sensing Journal*, Vol. 9 (1), pp 51-59.

Myers, B.A., Williams, R.J., Fordyce, I., Duff, G.A. & Eamus, D. (1998) Does irrigation affect leaf phenology in deciduous and evergreen trees of the savannas of northern Australia? *Australian Journal of Ecology*, Vol. 23, pp 329-339.

CRC core researchers are underlined where non-centre researchers have contributed to the publication. An * indicates an invited paper.

Myers, B.A., Duff, G.A., Eamus, D., Williams, R.J., Fordyce, I. & O'Grady, A. (1997) Seasonal variation in water relations of trees in a tropical savanna near Darwin, northern Australia. *Australian Journal of Botany*, Vol. 45, pp 225-240.

Palmer, C., & Woinarski, J.C.Z. (in press) Seasonal roosts and foraging movements of the black flying fox *Pteropus alecto* in the Northern Territory: resource tracking in a landscape mosaic. *Wildlife Research*.

Rose, D. (1998) Signs of Life on a Barbarous Frontier: Intercultural Encounters in North Australia. *Humanities Research*, Spring.

Runcie, M.J. (in press) Movements, dens and feeding behaviour of the tropical Scaly-tailed Possum *(Wyulda squamicaudata)*. *Wildlife Research*.

Runcie, M.J. (1997) Defensive behaviour in the Death Adder *(Acanthophis praelongus)*. *Herpetofauna*, Vol. 27 (2).

Russell-Smith, J., Ryan, P.G., Klessa, D., Waight, G. & Harwood, R. (in press) Fire frequency and fire-sensitive vegetation of the sandstone Arnhem Plateau, monsoonal northern Australia. *Journal of Applied Ecology*.

Schulze, E-D., Williams, R.J., Farquhar, G.D., Schulze, W., Langridge, J., Miller, J. & Walker, B.H. (1998) Carbon and nitrogen isotope discrimination and nitrogen nutrition of trees along a rainfall gradient in northern Australia. *Australian Journal of Plant Physiology*, Vol. 25, pp 413-425.

Setterfield, S.A. (1997) The impact of experimental fire regimes on seed production in two tropical eucalypt species in northern Australia. *Australian Journal of Ecology*, Vol. 22, pp 279-287.

Thomas, D.S., Turner, D.W., & Eamus, D. (1998) Independent effects of the environment on the leaf gas exchange of three banana (*Musa* spp.) cultivars of different genomic constitution. *Scientia Horticulturae*, Vol. 67, pp 1-15.

Williams, R.J., Cook, G.D., Gill, A.M. & Moore, P.H.R. (in press) Fire regime, fire intensity and tree survival in a tropical savanna in northern Australia. *Australian Journal of Ecology*.

Williams, J. & Eamus, D. (1997) Plant ecophysiology: linking patterns and processes - a review. *Australian Journal of Botany*, Vol. 45, pp 311-318.

Williams, R.J., Myers, B.A., Muller, W.J., Duff, G.A. & Eamus, D. (1997) Leaf phenology of woody species in a northern Australian tropical savanna. *Ecology*, Vol. 78, pp 2542-2558.

Woinarski, J.C.Z., Reichel, H. & Andersen, A.N. (submitted) The distribution of ants on the Wessel and English Company Islands, in the seasonal tropics of Australia's Northern Territory. *Australian Journal of Zoology*.

Woinarski, J.C.Z. (in press) The conservation status of rodents in the Top End of the Northern Territory. *Wildlife Research*.

Woinarski, J.C.Z., Horner, P., Fisher, A., Brennan, K., Lindner, D., Gambold, N., Chatto, R. & Morris, I. (in press) Distributional patterning of terrestrial herpetofauna on the Wessel and English Company Island groups, north-eastern Arnhem Land, Northern Territory, Australia. *Australian Journal of Ecology*.

Woinarski, J.C.Z., Brennan, K., Cowie, I., Fisher, A., Latz, P.K. & Russell-Smith, J. (in press) Vegetation of the Wessel and English Company Islands, north-eastern Arnhem Land, Northern Territory, Australia. *Australian Journal of Botany*.

Woinarski, J.C.Z., Reichel, H. & Andersen, A.N. (in press) The distribution of ants on the Wessel and English Company Islands, in the seasonal tropics of Australia's Northern Territory. *Australian Journal of Zoology*.

CRC core researchers are underlined where non-centre researchers have contributed to the publication. An * indicates an invited paper.

PUBLICATIONS

Woinarski, J.C.Z., Gambold, N., Wurst, D., Flannery, T.F., Smith, A.P., & Chatto, R. (in press) Distribution and habitat of the Northern Hopping Mouse *Notomys aquilo*. *Wildlife Research*.

Woinarski, J.C.Z., Brock, C., Fisher, A., Milne, D., & Oliver, B. (in press) Response of birds and reptiles to fire regimes on pastoral land in the Victoria River District, Northern Territory. *Rangeland Journal*.

Books or Chapters

Bowman, D.M.J.S. (in press) *Australian rainforest: scattered and burnt*. Cambridge University Press.

Grice, A.C. & Brown, J.R. (1997) Managed fire to control the impacts on northern Australian plant communities of the invasive shrub *Cryptostegia grandiflora*. In *Conservation Outside Nature Reserves*, Hale, P. & Lamb, D. (eds), pp 356-358. Centre for Conservation Biology, University of Queensland.

Griffiths, T., & Robin, L. (eds) (1997) *Ecology and Empire: Environmental History of Settler Societies*. Melbourne University Press, Melbourne.

Griffiths, T. (1997) Ecology and Empire: Towards an Australian History of the World. In *Ecology and Empire: Environmental History of Settler Societies*, Griffiths, T. & Robin, L. (eds), pp 1-16, Melbourne University Press, Melbourne.

Horner, P. & Fisher, A. (in press). *Ctenotus rimacola* sp. nov. (Scincidae), a new species of lizard with two allopatric subspecies, from the Ord-Victoria region of northwestern Australia. In *Records of the Western Australian Museum*.

Hynes, R.A. (in press) Dalrymple Shire - A Case Study. In *Queensland State of Environment Report*. Queensland Department of Environment.

James, C.D., Stafford Smith, M., Landsberg, J., Fisher, A., Tynan, R., Maconochie, J. & Woinarski, J. (in press) Biograze - melding off-reserve conservation of native species with animal production in Australian rangelands. In *Nature Conservation - managing the matrix*. Surrey Beatty, Sydney.

Robin, L. (ed) (1997) Ecology: a science of empire? In *Ecology and Empire: Environmental History of Settler Societies*. Melbourne University Press, Melbourne.

Rose, D. & Clarke, A. (eds) (1998) *Tracking Knowledge: Studies in North Australian Landscapes*. NARU, Darwin.

Rose, D. (in press) Hard times, an Australian Study. In *Quicksands: Foundational Histories in Australia and Aotearoa New Zealand*, Neumann, K. & Thomas, N. (eds).

Rose, D. (in press) Indigenous Ecologies and an Ethic of Connection. In *Global Ethics for the 21st Century*, Low, N. (ed). Routledge.

Rose, D. (in press) Sacred Site, Ancestral Clearing, and Environmental Ethics. In *Emplaced Myth: The Spatial and Narrative Dimensions of Knowledge in Aboriginal and Papua New Guinea Societies*, Rumsey, A. & Wiener, J. (eds).

Rose, D. (1998) The Year Zero and the North Australian Frontier. In *Tracking Knowledge in North Australian Landscapes*, Rose, D. & Clarke, A. (eds). NARU, Darwin.

Rose, D. (1998) Introduction. In *Tracking Knowledge in North Australian Landscapes*, Rose, D. & Clarke, A. (eds). NARU, Darwin.

Rose, D. (1998) Ned Kelly Died for Our Sins. In *Religious Business, Essays on Australian Aboriginal Spirituality*, Charlsworth, M. (ed.), pp 103-119. Cambridge University Press (reprint).

Rose, D. (1997) Dark times and excluded bodies in the colonisation of Australia. In *The Resurgence of Racism: Hanson, Howard and the Race Debate*, Gray, G. & Winter, C. (eds), pp 97-116. Monash Publications in History, Monash University.

CRC core researchers are underlined where non-centre researchers have contributed to the publication. An * indicates an invited paper.

Williams, R.J., Cook, G.D., Ludwig, J.L. & Tongway, D. (1997) Torch, trees, teeth and tussocks: disturbance in the tropical savannas of the Northern Territory (Australia). In *Frontiers in Ecology, Building the Links*, Klomp, N. & Lunt, I. (eds), pp 55-66. Elsevier, Oxford.

Woinarski, J.C.Z. & Dawson, F. (in press) Limitless lands and limited knowledge: coping with uncertainty and ignorance in northern Australia. In *Ecology, Uncertainty and Policy: managing ecosystems for sustainability*, Norton, T.W., Handmer, J.W. & Dovers, S.R. (eds). Longmans, London.

Conference and Workshop Papers

*Ahmad, W., Khwaja, Z.H., Menges, C.H., Hill, G.J.E., Williams, R.J. & Cook, G.D. (in press) Airborne Radar as an input to conventional remote sensing in the Kidman Springs area of the Northern Territory. NARGIS 97. In *Proceedings of the 3rd North Australian Remote Sensing and GIS Workshop*, April 1997.

*Ahmad, W., van Zyl, J.J., Menges, C., O'Grady, A. & Hill, G.J.E. (1998) Preliminary results of supervised and unsupervised AIRSAR data classification techniques in the tropical savannas of northern Australia. *PACRIM Airborne Synthetic Aperture Radar (AIRSAR) Workshop*, 26-28 July, Sydney.

*Ahmad, W., Williams, R.J., Cook, G.D. & Hill, G.J.E. (1997) Synthetic aperture radar and environmental gradients in the Northern Territory, Australia. The environment, data and land cover types. In *Proceedings of the International Workshop on Radar image processing and applications*, Milne, A.K. (ed), COSSA Publication No. 40, pp 21-24. CSIRO, Canberra.

Andersen, A.N. (1997) Fire research for conservation management in Australia's tropical savannas: introducing the Kapalga fire experiment. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), pp 39-44. CSIRO, Darwin.

Blake, P., Kirby, G.W.M. & Hooper, K. (1997) Northern Australian Regional Developments. Paper to the 1997 Northern Australian Regional Outlook Conference, 24 September, Darwin.

Bowman, D.M.J.S. & Panton, W.J. (1997) Abandoned Orange-footed Scrubfowl (Megapodius reinwardt) nests and coastal rainforest boundary dynamics through the late Holocene in monsoonal Australia. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), pp 18-23. CSIRO, Darwin.

Cook, G.D., Andersen, A.N., Blanche, K.R., Churchill, T.B., Ludwig, J.A., Williams, R.J., & Tongway, D. (1998) Indicators of ecosystem change along the North Australian Tropical Transect. *The Earth's Changing Land: Abstracts of the GCTE-LUCC Open Science Conference on Global Change*, 14-18 March 1998, Barcelona, Spain.

*Cook, G.D., Ludwig, J.A., Williams, R.J. & Tongway, D. (1998) Ecological patterns and processes along the North Australian Tropical Transect. *The Earth's Changing Land: Abstracts of the GCTE-LUCC Open Science Conference on Global Change*, 14-18 March 1998, Barcelona, Spain.

Cook, G.D. & Mordelet, P. (1997) A tale of two savannas: The effects of fire on vegetation patterns in West Africa and the Northern Territory. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), pp 45-50. CSIRO, Darwin.

Cook, G.D., Ronce, O. & Williams, R.J. (in press) Suppress thy neighbour: The paradox of a successful grass that is highly flammable, but harmed by fire. In *Proceedings, 13th Conference on Fire and Forest Meteorology*, International Association of Wildland Fire, October 1996, Lorne.

Craig, A. (1997) Fire management issues in Kimberley pastoral lands. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), pp 227-232. CSIRO, Darwin.

CRC core researchers are underlined where non-centre researchers have contributed to the publication. An * indicates an invited paper.

PUBLICATIONS

Craig, A. (1998) Fire and vegetation. In *Proceedings of the Fourth North Australia Fire Manager's Workshop*, Saint, P. & Russell-Smith, J. (eds), Kalumburu, WA, pp 12-14. Bush Fires Board WA, Western Australia Lotteries Commission, TS CRC, Darwin.

Dyer, R. (1997) Maintaining a balance: managing fire, trees and pasture on pastoral land in the Victoria River District, Northern Territory. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), pp 233. CSIRO, Darwin.

Grice, A.C. (1997) Fire for the strategic management of rubbervine (*Cryptostegia grandiflora*), an invasive shrub. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), pp 239-244. CSIRO, Darwin.

Hynes, R.A. (1998) Developing a cooperative regional management study as part of the Desert Uplands Community Scheme for DUBDSC with the Tropical Savannas CRC. In *Proceedings Desert Upland Technical Workshop*, June 1997. TS CRC, Townsville.

Hynes, R.A. (ed) (1998) *Proceedings of Desert Uplands Technical Workshop*, June 1997. TS CRC, JCU, Townsville.

Hynes, R.A. (1998) Using geographic information systems in planning for sustainable land management at regional and property levels. In *Proceedings of Desert Uplands Technical Workshop*, June 1997. TS CRC, JCU, Townsville.

Jacklyn, P. & Russell-Smith, J. (eds) (1998) *Proceedings from the North Australia Fire Management Workshop*. TS CRC, Darwin.

Lane, A.M. & Williams, R.J. (1997) The effect of wet season burning on understory vegetation in a humid tropical savanna in northern Australia. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), pp 25-30. CSIRO, Darwin.

*Ludwig, J.A. & Tongway, D.J. (1997) Modelling scale-dependent process and impacts of agricultural disturbances on tropical savanna ecosystems in northern Australia. In *Proceedings, International Congress on Modelling and Simulation, MODSIM97*, 8-11 December 1997, University of Tasmania, Hobart.

*Ludwig, J.A. & Tongway, D.J. (1997) Viewing rangelands as landscape systems. In *Abstracts of the International Workshop on Rangeland Desertification*, 16-19 September 1997, Iceland.

Ludwig, J.A. & Tongway, D.J. (1997) Modelling scape-dependent processes and impacts of agricultural disturbances on tropical savanna ecosystems. In *Proceedings, International Congress on Modelling and Simulation*, McDonald, A.D. & McAleer, M. (eds), Vol. 4, pp 1875-1880. Modelling and Simulation Society of Australia, Canberra.

*Menges, C.H., Ahmad, W., Khwaja, Z.H., Hill, G.J.E. & Cook, G.D. (1997) The role of remote sensing in monitoring the management of a *Mimosa pigra* stand in the Northern Territory. NARGIS 97. In *Proceedings of the 3rd North Australian Remote Sensing and GIS Workshop*, Cairns.

*Menges, C.H., Crerar, J., Hill, G.J.E. & Ahmad, W. (1998) A Method for Estimating the Effect of Variation in Local Incidence Angle on AIRSAR Data. In *Proceedings of the 9th Australasian Remote Sensing Photogrammetry Conference*, 20-24 July, Sydney, Australia. CD-ROM.

Monypenny, R. (1998) Cost and Benefits of the Development of a Cattle Property. In *Proceedings of Desert Uplands Technical Workshop*, June 1997. TS CRC, JCU, Townsville.

Monypenny, R. (1997) Sustainable Development of Tropical Savannas. In *Proceedings of the Third Australian and New Zealand Systems Conference*, Wollin, A. & Ricketts, K. (eds), pp 146-154, October, University of Queensland, Gatton.

CRC core researchers are underlined where non-centre researchers have contributed to the publication. An * indicates an invited paper.

Monypenny, R. (1997) The approaches, issues and outcomes of regional studies of the savannas of northern Australia. In *Proceedings, International Congress on Modelling and Simulation*, McDonald, A.D. & McAleer, M. (eds), pp 498-501, December, Hobart.

Robinson, C.J. (1997) Nature and Encounter: Early Colonial Interactions with the Coastal North. In *Proceedings of the Symposium on Northern Landscapes in Story and History Symposium*, December 1997, Darwin.

Rose, D. (1997) Indigenous ecological knowledge and the scientific community. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), pp 69-74. CSIRO, Darwin.

Russell-Smith, J. (1997) Developing a coordinated fire management and research program for northern Australia: the role of the CRC for Tropical Savannas. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W.M. (eds), pp 12-17. CSIRO, Darwin.

Russell-Smith, J. (1997) The relevance of indigenous fire practice for contemporary land management practice: an example from western Arnhem Land. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W.M. (eds), pp 81-85. CSIRO, Darwin.

Russell-Smith, J. (1998) Traditional resource management using fire in the Kalumburu region. In *Proceedings of the Fourth North Australia Fire Manager's Workshop*, Saint, P. & Russell-Smith, J. (eds), Kalumburu, WA, pp 9-11. Bush Fires Board WA, Western Australia Lotteries Commission, TS CRC.

Ryan, P.G. (1997) Spatial and temporal fire regime variability under differing management practices in the North West Kimberley, Western Australia. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), pp 251-256. CSIRO, Darwin.

Saint, P. (1997) Real time satellite imagery and the land manager. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), pp 247-250. CSIRO, Darwin.

Saint, P. & Russell-Smith, J. (eds) (1998) *Proceedings of the Fourth North Australia Fire Manager's Workshop*, Kalumburu, WA. Bush Fires Board WA, Western Australia Lotteries Commission, TS CRC.

Southgate, R., Allan, G., Paltridge, R., Masters, P. & Nano, T. (1997) Management and monitoring of bilby populations with the application of remote sensed rainfall and fire patterns: preliminary results. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W.M. (eds), pp 140-145. CSIRO, Darwin.

Whitehead, P.J. & McGuffog, T. (1997) Fire and vegetation pattern in a tropical floodplain grassland: a description from the Mary River, monsoonal northern Australia and its implications for wetland management. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W.M. (eds), pp 115-120. CSIRO, Darwin.

Williams, R.J. (1997) Fire and floral phenology in a humid tropical savanna at Kapalga, Kakadu National Park, northern Australia. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), pp 54-59. CSIRO, Darwin.

Williams, R.J. (1997) The effect of wet season burning on understory vegetation in a humid tropical savanna in northern Australia. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W. (eds), CSIRO, Darwin.

*Williams, R.J, Ahmad, W., Hill, G.J.E. & Cook, G.D. (1997) Synthetic aperture radar and environmental gradients in the Northern Territory, Australia. Applications in the ecology and management of tropical savannas. In *Proceedings of the International Workshop on Radar image processing and applications*, Milne, A.K. (ed), COSSA Publication No. 40, pp 25-28. CSIRO, Canberra.

CRC core researchers are underlined where non-centre researchers have contributed to the publication. An * indicates an invited paper.

PUBLICATIONS

Williams, R.J. & Cook, G.D. (1998 in press) Fire and trees in the savannas of the World Heritage Kakadu National Park, northern Australia. Fire Management: Shifting the Paradigm from Supression to Prescription, Brennan, L. (ed), *20th Tall Timbers Fire Ecology Conference*. Tall Timbers Research Station, Tallahassee, Florida.

Woinarski, J.C.Z. (1997) An overview of research on the impacts of fire on Australian birds. In *Bushfire '97 Proceedings*, McKaige, B.J., Williams, R.J. & Waggitt, W.M. (eds), pp 127-131. CSIRO, Darwin.

Reports

Natural Resources and Development in the Daly River-Sturt Plateau Region of the Tropical Savannas of the Northern Territory was prepared as a guide to focus groups discussions. The report provides an information base on the current production, ecology and policy of the region.

Black, N. & Clark, A. (1998) *Tourism in North West Queensland: 1996. Tourist Characteristics, Numbers and Travel Flows*. TS CRC, JCU, 63 pp.

Bowman, D.M.J.S. & Milne, D.J. (1998) *Rainforest triage; exploration of methodologies to identify rainforest patches in need of immediate management*. Report prepared for the Heritage Commission, Canberra.

Calvert, G. & Hynes, R. (1998) *High Range Burning: An Assessment of Origin, Size and Spread of Grassfires on the High Range Training Area 1980-1997*. Report to the ADF. TS CRC, Townsville.

Cook, P.G., Herczeg, A.L., Pidsley, D. & Farrow, R. (1998) Hydrological investigation at Howard East, NT. 2. Soil physics and groundwater geochemistry. Technical report 13/98.

Clark, A. & Black, N. (1997) *Tourism Audit and Marketing Strategy for the Desert Uplands*. TS CRC, JCU, 114 pp.

Hatton, T. (1997) *Dependence of ecosystems on groundwater and its significance to Australia*. Sinclair Knight Merz Pty Ltd.

Hatton, T.J., Pidsley, D., Held, A.A., Reece, P.H., Richardson, D.P., Kerle, E. & O'Grady, A.O. (1997) *Hydrological investigation at Howard East, NT. 1. Eucalypt savanna site transpiration and evaporation 1994-1996*. Technical report 25/97.

Head, L., Fullagar, R., Tacon, P., Price, D., Atchison, J., Ouzman, S. & Mulvaney, K. (1997) *Prehistoric Aboriginal Landscapes in the Keep River Region, NT.* Report for the Marralam Community and Warringarri Aboriginal Corporation on 1996 fieldwork and research.

Hynes, R.A. (1997) *Dealing Positively with the Media. A Background and Work Manual for Savanna Guides*. TS CRC, JCU, Townsville. October, 43 pp.

Hynes, R.A. (1997) *Guide to Technical Report Writing for Savannah Guides*. TS CRC, JCU, Townsville, October, 56 pp.

Hynes, R.A. (1997) *Introduction to Performance Indicators*. Report to the Desert Uplands Build-Up and Development Strategy Committee. TS CRC, JCU, October, 10 pp.

Hynes, R.A. (1997) *Sustainable Rangelands - Sustainable Economics in Woody-Weed Infested Areas*. Tropical Weeds Research Centre, Charters Towers, September, 10 pp.

Hynes, R.A. (ed) (1998) *Understanding and maintaining biodiversity: background information for Savannah Guides*. TS CRC, JCU, Townsville.

Nevard, T. (1998) *Management Models for Private Sector Natural Area Conservation and Visitation: The First Stage - Nature Beyond Government*. Research report. TS CRC, JCU, May, 30 pp.

CRC core researchers are underlined where non-centre researchers have contributed to the publication. An * indicates an invited paper.

QMI Joint Venture (1998) *Identification of Mineral and Energy Exploration, Development and Management Priorities in the Australian Tropical Savannas*. TS CRC commissioned consultancy report, June, 26 pp. plus appendices.

Other Publications

Applemann, A., Godfrey, V. & Hynes, R. (1998) *Desert Uplands Atlas: A Product of the Desert Uplands Community Scheme's Geographic Information System*. TS CRC, JCU, Townsville.

Calvert, G. (1998) *The Influence of Fire on the Australian Tropical Savanna Landscape: A Literature Review*. TS CRC, Townsville.

Cook, G.D. (1998) *Rainfall reckoning in rangelands: The case of north Australian savannas*. Range Management Newsletter, July 1998, pp 10-12.

Forster, M. (1997) *Sustainable Beef Production in the Desert Uplands*. Working paper submitted to Desert Uplands Sustainable Beef Group. TS CRC, JCU, 10 pp.

Forster, M. (1998) *Transition Management in Pastoral Enterprises in the Desert Uplands*. Working paper for submission to Enterprise Reconstruction Group, Desert Uplands Strategy. TS CRC, JCU, 20 pp.3

O'Donnell, K. (ed) (1997-98) *Savanna Links* newsletters, Issues 5 & 6. TS CRC, Townsville and Darwin.

O'Donnell, K. & Hynes, R. (eds) (1997) *Tropical Savannas CRC (1997) Annual Report*. Cooperative Research Centre for the Sustainable Development of Tropical Savannas, pp 88.

CRC core researchers are underlined where non-centre researchers have contributed to the publication. An * indicates an invited paper.

PRESENTATIONS

Conference Presentations

(These presentations did not appear in proceedings)

Andersen, A.N. (1997) *Responses of Arthropods to Experimental Fire Regimes in an Australian Tropical Savanna*. Ecological Society of Australia, Albury, NSW.

Atchinson, J. (1998) *Fruit Orchards at Jinmium? The Biogeography of Cultural Landscapes*. Institute of Australian Geographers Conference, Fremantle, Tas.

Bathgate, J. (1997) *Environmental Refrains of Pine Creek, NT*. Northern Landscapes Symposium, NARU/TS CRC, Darwin.

Benson, R. (1998) *Learning Processes of Pastoralist Stakeholders of the Tropical Savannas*. International Symposium on 'Learning Communities, Regional Sustainability and the Learning Society', Launceston, Tas.

Benson, R. (1998) *Researching for Context: Pastoral Stakeholders of the Tropical Savannas.* Northern Territory Institute of Educational Research Symposium, Darwin.

Bowman, D. *Marsupial Megafaunal Extinction: Were the Aborigines Superhuman Hunters?* NARU/TS CRC Landscape History Conference, Darwin.

Bowman, D. *Marsupial Megafaunal Extinction: were the Aborigines Superhuman Hunters?* Vertebrate Extinction Conference, Perth, WA.

Churchill, T.B. (1997). *Spiders in the Seasonal Tropics: Family Scale Changes along Grazing and Rainfall Gradients*. Ecological Society of Australia, Albury, NSW.

Cough, G. (1997) *Regional Economies*. Northern Australian Regional Outlook Conference, Darwin.

***Eamus, D.** (1997) *The Ecophysiology of Savanna Trees*. Australian Society of Plant Physiologists Conference, Melbourne.

Forster, M. (1997) *Sustainable Transitions in the Desert Uplands*. Centre for Systemic Development, University of Western Sydney, Hawkesbury.

Fraser, F. (1997) *The Ecology of the Partridge Pigeon and Habitat Impacts due to Fire and Grazing*. Ecological Society of Australia Conference, Albury.

Fraser, F. (1997) *Fire: too much too late or a bit too soon*. Bushfire '97 Conference, Darwin.

Grice, T. (1998) *Weeds and Regrowth*. North Australia Fire Management Workshop, Darwin

Hynes, R.A. (1997) *Sustainable Regional Futures: A Planners Dream or Adaptive Social Evolution*. [Keynote address] Federated PhD Scholars Scheme Program, ANU, Canberra.

Jacklyn, P. (1998) *Communication and Fire Management: the Role of the Tropical Savannas CRC*. North Australia Fire Management Workshop, Darwin.

***Kelley, G. & Eamus, D.** (1997) *Hydraulic Architecture of* Melaleuca spp *in a North Australian Savanna*. Australian Society of Plant Physiologists Conference, Melbourne.

Kelley, G. (1997) *Whole Tree Hydraulic Conductivity in two Northern Australian Ecosystems.* Australian Society of Plant Physiologists Conference, Melbourne.

Ludwig, J. (1998) *Predictive Modelling to Develop Tools for Fire Management*. North Australia Fire Management Workshop, Darwin.

***Rose, D.** (1998) *An Ethic of Hope* [Keynote Speech] The Third Annual Environmental Justice Symposium, Pitzer College.

***Rose, D.** (1997) *Indigenous Ecologies and an Ethic of Hope*. [Plenary Speech] International Conference on Environmental Justice; Global Ethics for the 21st Century, Melbourne.

Rose, D. (1998) *Love and Reconciliation in the Forest: A Study in Decolonisation*. [Keynote Speech] Institute of Australian Geographers Conference, Fremantle.

Russell-Smith, J. (1997) *Fire Management and Research in Kakadu National Park: Ethical Implications.* Ethics of research and management practices in World

An * indicates an invited paper.

Heritage and other environmentally sensitive areas: Policy and practice. Fenner Conference, Canberra.

***Russell-Smith, J.** (1998) *Fire Program of the Tropical Savannas Cooperative Research Centre*. North Australia Fire Management Workshop, Darwin.

Runcie, M. (1997) *Biparental Obligate Monogamy in a Marsupial*. Australian Mammal Society Conference, Perth.

Runcie, M. (1997) *Management Considerations of Two Rock-dwelling Possums (*Wyulda squamicaudata and Petropseudes dahli*)*. Australian Mammal Society Conference, Perth.

Whitehead, P.J. (1997) *Effects of Fire on Floodplain Vegetation*. Bushfire '97 Conference, Darwin.

***Williams, D.** (1997) *The Torch, Trees, Teeth and Tussocks: Disturbances in Australia's Tropical Savannas*. Ecological Society of Australia, Albury.

Woinarski, J. (1998) *Fire Management Issues for Biodiversity Conservation in Northern Australia*. North Australia Fire Management Workshop, Darwin.

International Presentations

Bowman, D. (1997) *Ecology and Evolutionary Impact of Aboriginal Landscape Burning on the Australian Biota*. Harvard University, Boston, USA, and Oxford University & Cambridge University, London, England.

Bowman, D. (1997) *Marsupial Megafaunal Extinction: Were the Aborigines Superhuman Hunters?* Harvard University, Boston, USA, and Oxford University & Cambridge University, London, England.

Churchill, T.B. (1998) *Sampling Spiders: A Comparison of Sampling Methods*. Seminar for University of New Mexico Student Project.

Churchill T.B. (1997) *Spiders as Ecological Indicators in the Australian Tropics: Family Scale Patterns along Rainfall and Grazing Gradients*. 17th European Colloquium of Arachnology, Edinburgh, Scotland.

***Ludwig, J.** (1998) *Tree/Grass Balance in Savannas at Kidman Springs, Australia*. International Workshop on Tree/Grass Interactions, Santa Barbara, California, USA.

Monypenny, R. (1997) *Sustainable Development of Tropical Savannas*. Third Australian and New Zealand Systems Conference, University of Queensland, Gatton.

Rose, D. (1998) *Totemism, Regions, and Co-management in Aboriginal Australia*. Crossing Boundaries: 7th Conference of the International Association for the Study of Common Property, University of British Columbia.

***Russell-Smith J.** (1997) *Natural Resource Management in Savanna Regions of Irian Jaya (Indonesia) and south-west Papua (PNG).* WWF, Djakarta.

***Williams, R.J.** (1998) *The North Australian Tropical Transect*. International Workshop on IGBP Kalahari Transect, Gaborone, Botswana.

***Williams, D.** (1998) *Fire and Biodiversity in Tropical and Temperate Australian Forests and Woodlands*. 21st Tall Timbers Fire Ecology Conference, Florida, USA.

CRC-Organised Workshops and Symposia

December 1997

Northern Landscapes in Story and History Symposium, Field Trip and Workshop, Darwin.

The symposium drew together CRC, interstate and overseas scholars to explore cross-cultural analysis of northern Australian landscape history. Workshops centred around developing a deeper understanding of different cultural groups and ways they remember and forget the history of their land. The long-term aim of the symposium is to develop better understanding of frontier culture so that those living on the land can achieve more sustainable habitation of tropical savannas.

Organiser: Dr Deborah Rose.

Participant: TS CRC Deputy Director, Ross Hynes.

An * indicates an invited paper.

PRESENTATIONS

February 1998

North Australian Vegetation Mappers Workshop, Darwin.
The CRC helped broker an agreement between a range of government agencies from Queensland, Western Australia and the Northern Territory to collaboratively undertake a fine-scale mapping of forest and woodland cover in northern Australia.

North Australian Ecological Modellers Workshop, Darwin.
A TS CRC-sponsored workshop to explore opportunities for collaboration between groups doing ecological modelling and fire monitoring across the savannas of northern Australia. 14 participants attended from various agencies across Australia.

March 1998

North Australia Fire Management Workshop, Darwin.
One of the main aims of the workshop was to clarify the fire management issues across northern Australia so plans could be made to address them. There were over 100 invited participants including bushfire officers, pastoralists, ecologists, Aboriginal people and representatives from the tourist and mining industries and the defence forces. Many new links were made and fire management issues identified; there are some plans for fire management projects as a result - some with CRC involvement.

Remote Sensing and Fire Workshop, Darwin.
A workshop to clarify remote sensing issues associated with fire management in north Australia. Participants included remote sensing practitioners from across Australia.

April 1998

Student Presentation Skills Workshop, Darwin.
A two-day workshop for TS CRC students designed to improve their presentation skills.

May 1998

Inaugural meeting of the North Australian Fire Managers Forum, Brisbane.
The forum links the Bushfire Authorities of the Northern Territory, Western Australia and Queensland in tackling fire management issues unique to northern Australia. TS CRC, a facilitator for the forum, provides scientific and communication support. The forum consists of the heads of the north's fire agencies: Mrs Pamela Millican, Queensland's Rural Fire Service Commissioner; Mr Bill Harris, Executive Director of Bushfires WA; and Mr Russell Anderson, Chief Fire Control Officer of Bushfires Council NT.
Chair: TS CRC Director, John Childs.
Scientific and communication support: Dr Jeremy Russell-Smith and Dr Peter Jacklyn.

For a complete list of TS CRC-organised workshops, refer to the Extension section.

GRANTS AND AWARDS

TABLE 5

GRANTS (all invoiced through partner agencies)

Researcher	Research Program	Title of Grant	Source of Grant	Amount of Grant	Period of Award
Dr Dick Williams CSIRO DWE with Dr Garry Cook CSIRO DWE	Project 1.1	Savanna biogeography and land degradation	Land & Water Resources Research & Development Corporation	$350,000	To be completed 1998
A/Prof Derek Eamus, NTU	Project 1.2	Water content of soil as a function of proximity to trees	NTU	$12,000	1998
			NTU, Area of Strength Funds	$23,500	1998
		Hydraulic architecture of savanna trees	ARC	$120,000	1998-2000
		Ecologically sustainable groundwater pumping rates	LWRRDC	$80,000	1997-1998
Peter Dostine	Project 2.2	National Gouldian Finch Recovery Plan	Environment Australia	$100,000	
		Gouldian Finch research in the Yinberrie Hills region	Pegasus Gold	$75,000	
Anthea Dee, ANU, Centre for Research and Environmental Studies	Project 4.2	The Arafura Wetlands - ecology and ethnobiology	CSIRO/ University Collaborative Research Scheme	$7,602	1998-1999
A/Prof Ross Hynes, JCU/CRC A/Prof Richard Monypenny and Dr Paul Lawrence	Project 4.5	Desert Uplands Management Study	Queensland NHT and QDNR	$47,000	1998-2000
		The economic and social role of existing reserves and of an enhanced comprehensive, adequate and representative protected area system in the NT	Environment Australia	$90,000	

Awards

Ross Hynes elected as first Honorary Member of Savannah Guides.

Fiona Fraser - Student travel award to attend ESA 97, October 1997, Albury/Wodonga.

Nicole Thurgate awarded the James Cook University Medal at her graduation in April 1998.

PERFORMANCE INDICATORS

COOPERATIVE ARRANGEMENTS

Indicator	Assessment
Level of participation of the participants and users in major decisions concerning activities of the Centre	• The Consultative Committee, the Board, the Management Committee and the Project Leaders actively participated in the strategic planning process this year. • Stakeholders are well represented on the Board and the Consultative Committee, which determines research activities of the Centre. • Stakeholders were involved in identifying education and training needs, communication needs and strategic direction. • The Centre's Communication Strategy has been heavily influenced by feedback from savanna users through the Communication Consultancy Report.
Extent and frequency of the interaction of the personnel from the participants in the conduct of the activities of the Centre	• 11 Projects had active research programs that involve substantial collaboration between partner agencies. • The Board met three times during the year. The Management Committee met eight times throughout 1997/98. • The VRD Management Study involved six partner agencies in a program of field work and several workshops and strengthened links between CSIRO, NTU, NTDLPE, NTDPIF, PWCNT and NARU. • The North Australian Fire Management Workshop drew people from 11 partner agencies and numerous stakeholder groups involving the pastoralist, Aboriginal, defence, conservation, tourism and mining sectors. • Workshops involving partner agency staff were held to determine future directions pursued in the fields of remote sensing, vegetation mapping, landscape modeling, extension, vocational education and communication.
Extent of interaction with other research funding bodies	• Meetings held with LWRRDC, MRC, NLWRA, RIRDC, Environment Australia and ACIAR. • Working with MRC on a series of biodiversity and grazing workshops.

Indicator	Assessment
Extent and form of interaction between other researchers, research groups and institutions in Australia and overseas	• The North Australia Fire Management Workshop brought together researchers and managers from most institutions and user groups involved in fire management in northern Australia. • North Australia Fire Managers Forum established strategic alliance between CRC and the Bushfire Agencies in WA, Qld and the NT. • Project 2.4, savanna fire management, involves personnel from nine partner agencies working with people from 11 other research institutions and agencies. • Various research workshops (see above) drew researchers together from non-CRC institutions across the savannas, in the fields of vegetation mapping, ecological modelling, extension and vocational education. • Important overseas links were made with the Indonesian Government, Colorado State University, IGCP and Miami University.
Extent and form of commissioned, collaborative and contract research undertaken with the users and owners of tropical savanna land	See figures 7a and 7b on page 102 and Tables 2 and 5 in the sections Utilisation and Application of Research (pages 80-81) and Grants and Awards (page 98) for more details. • Collaborative research undertaken with Cattleman's Union of the NT, NT Pastoral Land Board, VRD Conservation Association, DUBUDSC, Mary River Land Care Group, Mary River Technical Working Group, Balfes Creek Catchment Landcare Group, Daly River Landcare Trust, Sustainable Beef Group, Energy Resources of Australia, Jawoyn Association, National Centre for Studies in Travel and Tourism, Australian Tourism Council, Queensland Tourist Commission, Sanctuary Park Endangered Wildlife Foundation, ACIAR, Australian Defence Force, Bureau of Meteorology, DOLA WA, Bushfires Board of Western Australia, Bushfires Council NT, CYPLUS. • Ongoing involvement with MIM in SO_2 plume monitoring studies. • Ant monitoring at German Creek Mine, Qld with Capricorn Management Pty Ltd. • Minesite rehabilitation workshops with ERA.

PERFORMANCE INDICATORS

RESEARCH AND RESEARCHERS

Indicator

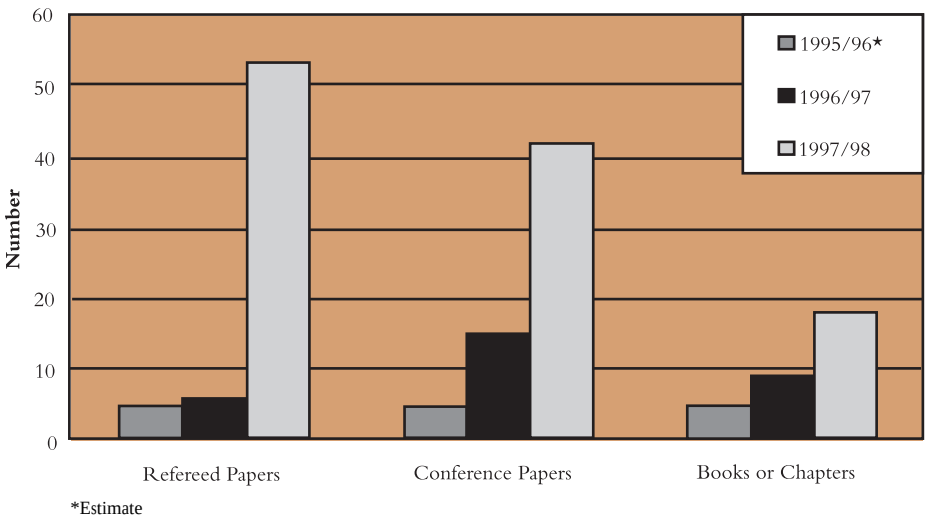
Extent to which program objectives and milestones have been achieved

Assessment

- Achievements were made in the areas of collaboration, communication and utilisation of research. The management studies are providing a stimulus for collaborative work between several projects and many researchers. Communication has been substantially improved across the Centre and with stakeholders. Research is being directed more and more towards the needs of the CRC major stakeholder groups.
- There were significant delays in Project 2.3 and Sub-Programs 4 and 5. These have been addressed with the renewed involvement of CALM WA in leading Project 2.3, a refocus of Project 4.1 into 5.3 which is now aimed more broadly at stakeholders, and the strategic planning process which saw research 'Themes' developed and on-ground management studies replace Sub-Program 4 as the integrating elements in the Centre's research program. Projects 4.3 and 4.4 have been modified and the milestones associated with these projects will be renegotiated to more accurately reflect anticipated outcomes.

FIGURE 6

Number of Publications that acknowledge the CRC

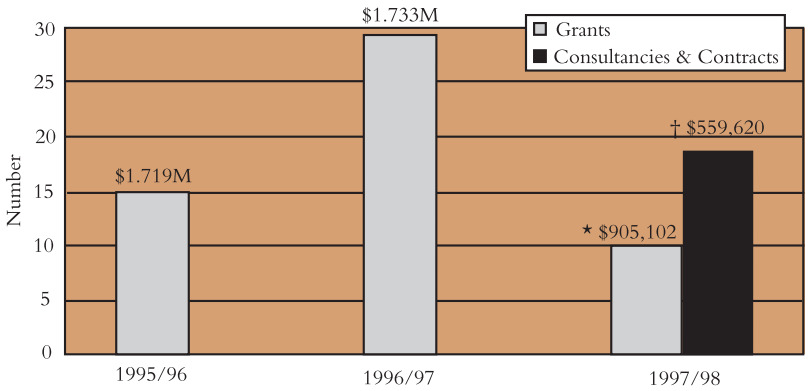


Indicator

Level of success in obtaining Research Grants and other Research Funds from External Bodies

FIGURE 7a

Grants and Constultancies not Administered by the CRC



* Figure includes grants/consultancies/contracts to year 2001 in some instances
† Figure does not include commercial in confidence contracts

FIGURE 7b

Grants and Constultancies Administered by the CRC

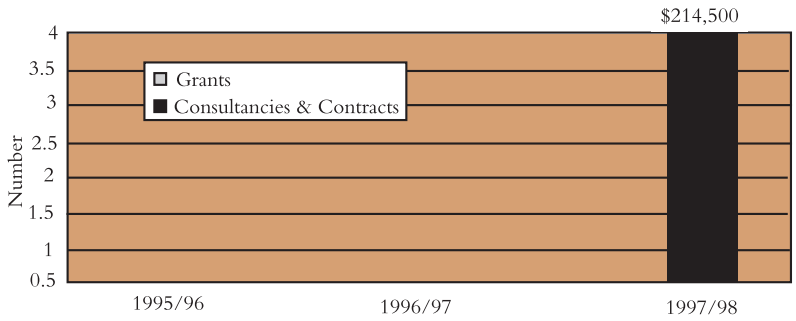
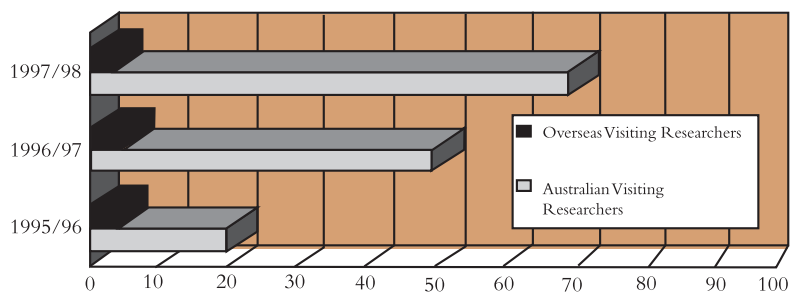


FIGURE 8

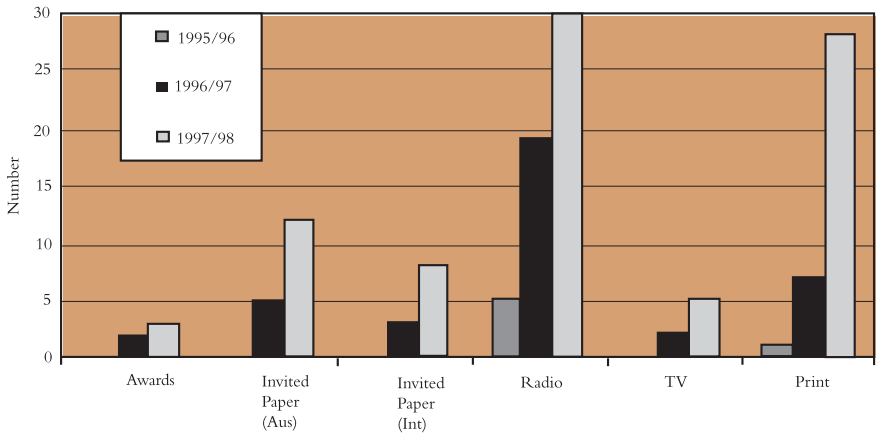
Extent to which Researchers are Attracted to Visit the Centre



PERFORMANCE INDICATORS

FIGURE 9

Extent of National and International Recognition of Centre



EDUCATION AND TRAINING

Indicator

Extent and nature of graduate training programs developed by the Centre

Assessment

- Masters and Graduate Diploma of Tropical Environmental Management (TEM) now have 31 students. CD-ROM module on Ecology and Management of Tropical Savannas in this course now being used by students. Further module being developed on Rangelands Management.
- A new Graduate Diploma in Tropical Environmental Management was introduced this year. Students can articulate into the Masters by coursework program.
- New teaching units have been incorporated into the Masters by coursework program.
- Vocational training package on weed management has been trialed.
- Two communication skills courses conducted for postgraduate students in Darwin and Townsville.

Number of postgraduate students in the Centre and their ability to find employment after graduation

- See figure 10 on page 104 for numbers of students.
- No students have graduated as yet.

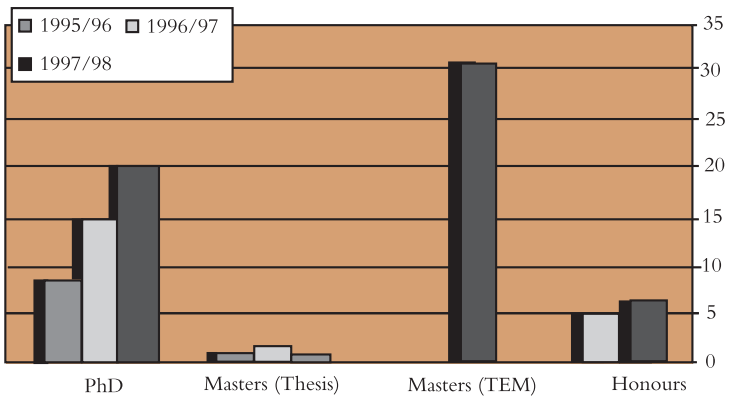
Extent to which non-university and collaborative staff involved in supervising students and the distribution of students among participating organisations

- See figure 11 on page 105 for numbers of supervisors.
- Students at NTU, JCU, ANU, CSIRO DWE, CSIRO TAG, PWCNT, BFC, and QDPI.

Indicator	Assessment
Extent to which extension services of the Centre are successful in modifying management practices within tropical savannas	• Fire management strategies are being developed with stakeholders as part of Project 2.4. • Range of sustainable land planning and skills-based training modules implemented for tourism industry. Selected competencies being incrementally incorporated into Savannah Guide management practices. • Strategic planning advice provided by the Centre and selectively incorporated into the Desert Uplands Build-Up and Development Strategy.
Extent and nature of the involvement of users in the development and conduct of training programs	• Tourism Council of Australia involved in initiating and developing tour guide seminars. • Graduate Diploma in TEM developed in response to education and training needs survey involving stakeholders. • John Ludwig has conducted minesite rehabilitation workshops for ERA and MIM. • Desert Uplands indicators workshop driven by stakeholders. • Savannah Guides workshops and training seminars driven by Savannah Guides Inc. • (For a full list of workshops conducted with savanna users see Communication and Public Outreach and Presentation sections).

FIGURE 10

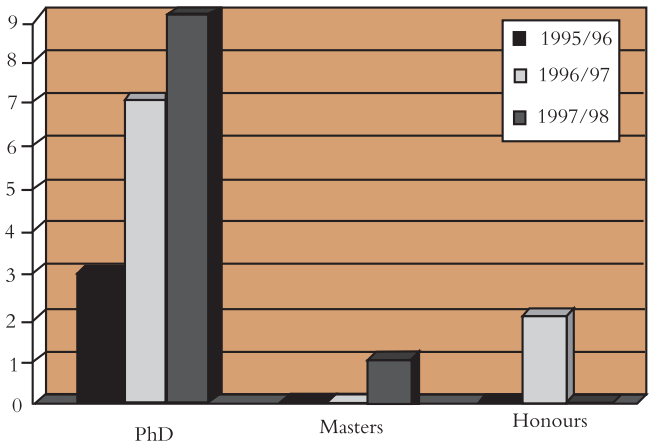
Number of Postgraduates



PERFORMANCE INDICATORS

FIGURE 11

Number of Non-University or Collaborative Staff Involved as Supervisors



APPLICATION OF RESEARCH

Indicator

Extent to which Australian and overseas industry and users adopt research technology developed by the Centre

Extent nationally and internationally to which Centre recommendations for land management practices are adopted

Assessment

- Development of annual fire management programs for Jawoyn traditional lands in Mt Todd region.
- Experimental management regimes established on pastoral properties on Cape York to test responses of Golden-shouldered Parrot to altered fire and grazing regimes.

- ERA applied Landscape Function Analysis at sites on the Ranger Uranium Lease.
- Land management strategies and conservation plans proposed to Northern Territory Government for development of Daly Basin bioregion.
- Conservation values established by project staff are being used to devise land-use plans for Ord Stage II development area.

Indicator	Assessment
Extent of advice and consultancy services provided to users and industry	• Advice given to NT Pastoral Board on land management strategies in Sturt Plateau. • Monitoring of SO_2 plume for MIM. • Monitoring of German Creek Mine for Capricorn Management Pty Ltd.
Level of financial returns to savannas users stemming from Centre research	• A method for determining these benefits at the enterprise and regional levels is being developed.

MANAGEMENT AND BUDGET

Indicator	Assessment
Establishment of procedures to monitor and report on research progress and other achievements of the Centre	• A series of project reviews has been established within the project management system. • In the course of compiling the internal newsletter *Topical Savannas*, Project Leaders regularly report on achievements that can be publicised internally and externally. • Communication Coordinator on Management Committee and is in a position to regularly monitor progress of projects with a view to internal and external publicity.
Extent to which activities of the Centre are modified in line with new knowledge or changed expectations of users	• Strategic planning process involved partner agencies and stakeholders on Board and Consultative Committee and was partly undertaken in response to feedback from savanna users. • Survey of educational and training needs led to development of Graduate Diploma. • Centre responded to tourist industry requests in developing Tour Guide Seminar Series. • Centre responded to stakeholders feedback in developing its communication strategy and in developing a 'clearing-house' of savanna information. • Centre responded to suggestion of Bushfire Authorities to facilitate North Australia Fire Management Forum. • Fire managers from across the savannas have been able to use the North Australia Fire Management Workshop to shape the Centre's fire management research.

PERFORMANCE INDICATORS

Indicator	Assessment
Extent to which the activities of the Centre are integrated across state, territory and sectoral boundaries	• The Centre's research program is now integrated into research 'Themes' which ensure that savanna-wide, cross-sectoral approaches are taken. • Nine Projects involve substantial collaboration between researchers in either the NT and WA, the NT and Qld, or all three states. The spread of projects still tends to be NT centred. • The North Australian Fire Management Workshop drew stakeholder groups involving the pastoralist, Aboriginal, defence, conservation, tourism and mining sectors. • Project 2.4, the savanna fire management project involves personnel representing the pastoral, Aboriginal, defence and conservation sectors. • The VRD Management Study currently involves people from the pastoral, Aboriginal and conservation sectors. • The Desert Uplands Management Study involves people from the pastoral, conservation sectors together with socio economic researchers. • The other projects in Sub-Program 4 involve biophysical and socio-economic researchers.
Accuracy of recording and reporting financial transactions, the balance of expenditure against budget and the efficiency of the audit process	• Financial management system implemented, accounting conforms to Australian standards, reports have met required timeframes.

ABBREVIATIONS AND ACRONYMS

ACIAR	Australian Centre for International Agriculture Research
ACF	Australian Conservation Foundation
ADFA	Australian Defence Force Academy
AGS	Australian Geographic Society
AgWA	Agriculture Western Australia
AHC	Australian Heritage Commission
AIRSAR	Airborne Synthetic Aperture Radar
ANU	Australian National University
APA	Australian Postgraduate Award
AUSRIVAS	Australian Rivers Assessment
BFC	Bushfires Council Northern Territory
BFS	Bushfires Service Western Australia
CALM WA	Department of Conservation and Land Management, Western Australia
CIMM	Centre for Interactive Multimedia
CINCRM	Centre for Indigenous Natural and Cultural Resource Management
CRES	Centre for Resource and Environmental Studies
CQU	Central Queensland University
CSIRO	Commonwealth Scientific Industrial Research Organisation
CSIRO DWE	Commonwealth Scientific Industrial Research Organisation, Division of Wildlife and Ecology
CSIRO L&W	Commonwealth Scientific Industrial Research Organisation, Division of Land and Water
CSIRO MIS	Commonwealth Scientific Industrial Research Organisation, Division of Mathematics and Information Sciences
CSIRO TAG	Commonwealth Scientific Industrial Research Organisation, Division of Tropical Agriculture
CSIRO TERC	Commonwealth Scientific Industrial Research Organisation, Tropical Ecosystems Research Centre
CYPLUS	Cape York Peninsula Land Use Study
DEST	Department of Environment, Sport and Territories
DoD	Department of Defence
DOLA	Department of Land Administration
DPIE	Department of Primary Industry and Energy
DSS	Decision Support System
DU	Desert Uplands
DUBDSC	Desert Uplands Build-Up and Development Association Inc.
EA/BG	Environment Australia, Biodiversity Group
EA/PAN	Environment Australia, Parks Australia North
ERA	Energy Resources Australia
ERIN	Environmental Research Institution of the Supervising Scientist
GCTE	Global Change and Terrestial Ecosystems (IGBP project)
GIS	Geographic Information System
GLADA	Gulf Local Authorities Development Association Inc.
IGBP	International Geo Biosphere Program
IRDS	Integrated Regional Development Sub-Committee
JCU	James Cook University
LFA	Landscape Function Analysis
LWRRDC	Land and Water Resource Research and Development Corporation
MIM	Mt Isa Mines
MRC, NAP	Meat Research Corporation, North Australia Program
NARU	North Australian Research Unit
NASA/JPL	National Aeronautics and Space Administration/Jet Propulsion Laboratory
NATT	North Australian Tropical Transect
NHT	Natural Heritage Trust
NLC	Northern Land Council
NLWRA	National Land and Water Resource Audit
NMSU	New Mexico State University
NOAA-AVHRR	National Oceanic and Atmosphere Administration - Advanced Very High Resolution Radiometer
NTDLPE	Northern Territory Department of Lands Planning and Environment
NTDME	Northern Territory Department of Mines and Energy
NTDPIF	Northern Territory Department of Primary Industry and Fisheries
NTPAWA	Northern Territory Power and Water Authority
NTTC	Northern Territory Tourist Commission
NTU	Northern Territory University
PWCNT	Parks and Wildlife Commission of the Northern Territory
QCU	Queensland Cattlemen's Union
QDoE	Queensland Department of Environment and Heritage
QDNR	Queensland Department of Natural Resources
QDPI	Queensland Department of Primary Industry
QFS	Queensland Fire Service
RIRDC	Rural Industries and Research Development Corporation
RMIT	Royal Melbourne Institute of Technology
TCA	Tourism Council of Australia
TESAG	Tropical Environment Studies and Geography (JCU)
TS CRC	Tropical Savannas CRC
SPAEG	Scientific Advisory and Evaluation Group
UCD	University of California, Davis
UNSW	University of NSW
UQld	University of Queensland
UWA	University of Western Australia
VRD	Victorian River District
WARMS	Western Australian Rangeland Monitoring System
WWF	World Wide Fund for Nature