



**Cooperative Research Centre**  
for the **Sustainable Development**  
of **Tropical Savannas**

ANNUAL REPORT  
1995-96



ESTABLISHED AND SUPPORTED UNDER THE  
AUSTRALIAN GOVERNMENT'S  
COOPERATIVE RESEARCH CENTRES PROGRAM



## OUR MISSION

To undertake cooperative research and education to enhance for all Australians the sustainable development of our tropical savannas.

## VALUE-ADDING FOR STAKEHOLDERS



*Provide advice on sustaining Aboriginal use of natural resources.*

*Pictured: Nancy Dayii, Finnis River country, NT.*



*Assist in achieving access for mining with sustainable rehabilitation*



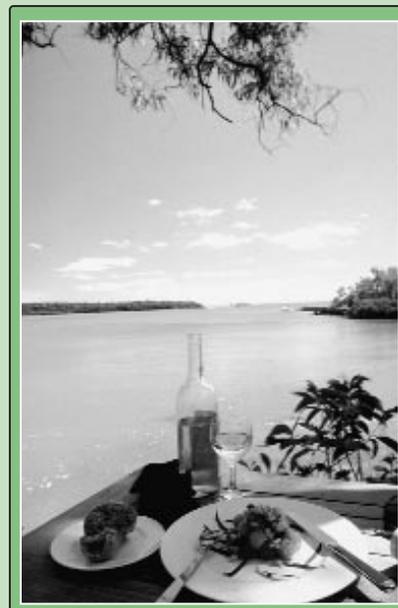
*Contribute to sustainable pastoral enterprises*



*Provide research input for sustainable management of defence training areas*

## OUR OBJECTIVES

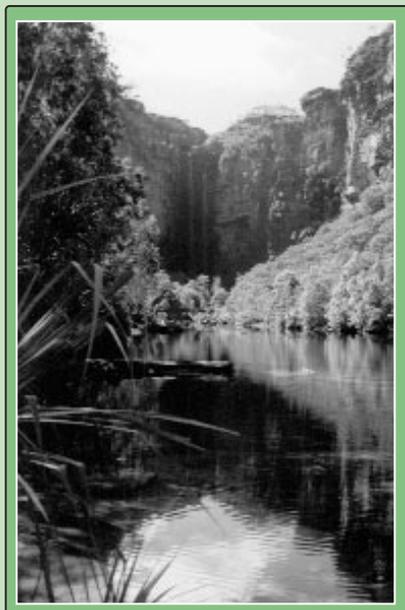
- Integrate savanna research, education and extension activities of the centre across parties, disciplines and stakeholder interests.
- Form linkages with relevant organisations in Australia and overseas.
- Create an environment to initiate and conduct a high quality, integrated research program clearly identified with the centre.
- Develop and implement education and training programs integrated with the research program, including input from stakeholders, and produce skilled motivated and employable individuals.
- Identify and communicate effectively with stakeholders and parties.
- Develop and promote outputs which are adopted in best practice management, planning and policy development in Australia and overseas.
- Develop and implement adaptable, transparent and accountable centre management.
- Develop an operational structure and strategies to ensure the continued viability of the centre.



*Contribute to the sustainable development of tourism*

## OUR CHALLENGE

Australia's vast region of tropical savanna is a significant contributor to the nation's culture, biodiversity and economy. While pastoralism remains the dominant land use, there is a rapidly growing development of land for other, often conflicting, purposes. Conservation, tourism, Aboriginal and regional communities, farming, defence and mining are all expanding, and have the capacity to increase pressure on existing resources. Optimising wealth creation and social equity demands a clear understanding of the priorities of these sectors and the integration of resource-based enterprises. By undertaking research into the region's ecological, economic and social needs, the centre seeks to identify pathways to sustainable development for these sectors and for the people and communities within them — the major stakeholders of our tropical savannas.



*Contribute to sustainable conservation management.  
Pictured: Kakadu National Park.*

## CONTENTS

<i>Chairman's Report</i>	4
<i>Director's Report</i>	5
<i>Highlights</i>	7
<i>Structure and Management</i>	8
<i>Cooperative Linkages</i>	12
<i>Research</i>	15
• <i>Responses of savannas to stress and disturbance</i>	15
• <i>Biological diversity in the savanna landscape</i>	18
• <i>Indicators for sustainable land use</i>	23
• <i>Sustainable management</i>	27
<i>Education</i>	43
<i>Utilisation and Application of the Research; Links with Users</i>	48
<i>Staffing and Administration</i>	51
<i>Publications</i>	52
<i>Presentations, Public Relations and Communication</i>	56
<i>Grants and Awards</i>	59
<i>Performance Indicators</i>	60
<i>Finance and Resources</i>	64
<i>Abbreviations and Acronyms</i>	72

Cooperative Research Centre for the Sustainable Development of Tropical Savannas  
Director: Dr Phil West  
Northern Territory University, Darwin NT 0909  
Phone: (08) 8946 6834 Facsimile: (08) 8946 7107  
Email: p\_west@bligh.ntu.edu.au

Deputy Director: Dr Ross Hynes  
James Cook University, Townsville QLD 4811  
Phone: (077) 81 4128 Facsimile: (077) 81 5515  
Email: ross.hynes@jcu.edu.au  
World Wide Web Home Page: <http://www.cs.ntu.edu.au/crc>

*Front cover montage photos were supplied by Northern Territory Department of Parks and Wildlife, Jewel Hotels and Resorts, Dr Deborah Bird Rose, CSIRO Division of Wildlife and Ecology, James Cook University.*

*Stakeholder photos: CRC SDTS, Dr Deborah Bird Rose, McArthur River Mining Pty Ltd, James Cook University, CSIRO Division of Wildlife and Ecology.*



## CHAIRMAN'S REPORT

Of all the research centres in the world, this CRC must be one of the most geographically widespread. Our brief is to conduct research and education over the tropical savannas of northern Australia. These cover almost 25 per cent of the continent. Our professional staff of just over 100 are scattered right across the region, with a few in parts of southern Australia as well. Obviously it has been difficult in the past for researchers to interact and avoid duplication of effort across state, territory and organisational boundaries of such a vast region. At the end of our first year, it has been pleasing to see some of these barriers being overcome. Researchers who have not had the opportunity to meet and work with each other are now undertaking collaborative work.

There can be little doubt of the potential for this centre to contribute to the development of northern Australia. Whilst the region has only about five per cent of the population of the country, it produces about one quarter of Australia's annual export income, principally through the mining industry.

The region is developing — despite its tropical heat, its storms, cyclones, floods and droughts, its poor soils and the infrastructure limitations that exist because of the region's size. Particularly as Asian markets develop, new opportunities are arising for the pastoral, mining and education industries. Tourism is also developing, with increasing numbers of visitors discovering a rich and unique natural environment. The region also has by far the highest proportion of the population of Aboriginal Australians. They are major landowners and managers and their life-style and aspirations are often different to those of other Australians. Development of their land will require different approaches and management practices.

The challenge for this centre is to undertake research to ensure that development is sustainable for all savanna stakeholders. To do this, we will have to take account of the social and economic issues that drive development. Combining these with ecological issues will ensure the maintenance of natural processes on which life depends. We spent much of this year developing this focus in our research program whilst ensuring it will satisfy the needs of our major stakeholders.

I would like to acknowledge the support of the Board of the centre over this year and the periods leading up to its establishment. The commitment of the parties to the centre has been vital. Our biggest challenge from here is to see that our research outcomes reach our stakeholders in the most appropriate fashion so that they can benefit from them.

John Kerin

Chairman



*The CRC for the Sustainable Development of Tropical Savannas is one of the most geographically spread of all the CRCs. Research is carried out from 20 locations based in 14 towns or centres mainly in the tropical savannas.*



## DIRECTOR'S REPORT

As with most CRCs, the first year of the life of this centre was concerned with its establishment as an operational entity. That has meant developing the relationship with the stakeholders we aim to serve, focusing and refining the program and engaging all our people in our activities, from the Board right through to the staff.

None of this was easy, because of the enormous area over which our staff and stakeholders live and the variety of disciplines involved in research on sustainable development. Many staff members had not met each other and did not know each other's interests. But as they have started to interact, the potential of the CRC is becoming apparent. Enormous value will be added to the research effort right across northern Australia by integrating research programs and bringing together researchers from many disciplines and geographic regions.

Early in the year, the Board resolved to consult widely with our principal stakeholders: the pastoral, mining and tourism industries, Aboriginal land owners and conservation interests. These groups have often considered their land-use problems in isolation from each other. One of the aims of the centre is to bring them together so they can identify their common problems and influence the direction of northern Australian research more directly than they have done in the past.

The then Chair of our Consultative Committee, Ms Deborah Cope of the Office of Northern Development, and senior staff of the CRC travelled widely across the region during the year. They met with representatives of more than 70 stakeholder groups. They discussed with them the objectives and role of the centre and the importance of research issues. The centre also convened a workshop of peak conservation groups across Australia to identify their particular concerns.

These consultations culminated in a workshop of the Consultative Committee, whose members are representatives of the various stakeholder groups. The Committee members established the research priorities for their various interests and considered how well the centre program related to those priorities. They found a surprising degree of commonality in their priorities. This convergence of priorities will allow the centre to work simultaneously on issues that address the needs of several stakeholders. The committee also stressed the difficulty of communicating research outcomes in an appropriate way to the diverse range of stakeholders scattered right across northern Australia. This suggested that the centre must expand the scope and variety of its communication activities well beyond its initial plans. The outcomes from this workshop have proved very valuable to the centre in developing both its strategic plan and its research program.

Considerable effort was spent in focusing the research program and the involvement of staff in it. Whilst doing that, the particular research niche this centre can occupy started to become apparent. Various research groups in Australia undertake ecologically based research relevant to the tropical savannas. However, efforts are limited in combining outcomes from that research with the economic and social issues that must be considered when examining land management options for sustainable development. Development can be sustainable if the enterprise concerned is economically viable and fulfils the social aspirations of the land owner.

The centre has several strengths to allow it to fill this niche. Firstly, it can make a coordinated effort across the whole savannas. Secondly, it can take a very broad approach to sustainable development because its staff are so diverse. They include plant and animal ecologists, plant physiologists, anthropologists, historians, economists, geographers, lawyers, educators, extension specialists, modellers and system analysts. All these skills are necessary to bring together the elements necessary for sustainable development. Thirdly, the staff come from a wide range of levels within the parties to the centre. This means we can take research from fundamental levels right through to stakeholder applications.

The staff of the centre met as a body once during the year. Given our geographic spread, it is unlikely that they will be able to meet more often than once a year. Our first meeting has served as a starting point for collaboration between staff who have not met each other before. Members of the Board, the Consultative Committee, the Scientific Program Advisory and Evaluation Group (SPAEG) and our Visitor also came to the meeting so they, too, had a chance to interact with the staff. The SPAEG has had some opportunity to comment on the quality of the program. Its role will increase as we continue to develop the program from its starting point and as they review and evaluate it annually. The meeting concluded with the official opening of the centre by Senator the Hon. Bob Collins, then Minister for Primary Industries and Energy and Senator for the Northern



Territory. At the same time, Senator Collins unveiled the logo for the CRC. Symbolising the biophysical elements of the savannas, the logo was developed in a competition among CRC staff members and their families.

Two issues of the centre's newsletter were published during the year. They reported both our internal activities and our research outcomes to the staff of the centre and our stakeholders. It represents the first step in the development of what will need to be an extensive communication network if we are to keep both our staff and stakeholders informed of our activities.

I believe this year we have achieved the satisfactory establishment of the basic elements of a CRC, with a research program directed towards the needs of our stakeholders. The Board has been able to appreciate fully the potential of the centre program as they, the stakeholders and the staff have become engaged in it. The Board and Management Committee developed a strategic plan for the CRC during the year which sets the scene to develop its full potential.

The challenge for next year is to develop further the value-adding components that we believe this centre can bring to savanna research. In particular, we need to:

- Develop a CRC culture amongst our staff to enable research outcomes to serve our stakeholder needs,
- Consult and interact more with stakeholders to better focus our research,
- Develop strategies to ensure effective communication of outcomes to stakeholders and the community at large,
- Develop further interaction with other research groups in Australia and overseas to expand the scope and quality of the research,
- Expand education activities to all levels within the community, and
- Develop commercial potential to secure the long-term future of the centre.

We look forward with enthusiasm to encouraging and facilitating progress in these value-adding activities during the coming year.

Phil West



Director



*The centre was officially opened by Senator the Hon. Bob Collins in Darwin, in November 1995. Pictured at the opening (from left) is chairman John Kerin, Senator Bob Collins and director Dr Phil West.*



## HIGHLIGHTS

**T**he centre seeks to serve a diverse group of stakeholders and this is reflected in the wide range of research activities in which it is currently involved. These research areas are contributing to better understanding of options for sustainable land management. Key themes focus on the linkage between socio-economic values of communities and the integration of ecological and economic aspects of managing sustainable savanna enterprises.

### INNOVATIVE RESEARCH AND PLANNING STRATEGIES FOR SUSTAINABLE ENTERPRISES

- The measurement of key parameters needed for modelling water fluxes in the savannas. This research should prove significant in maintaining enterprises and ecosystems that depend seasonally on access to groundwater.
- Development of remote sensing techniques to estimate savanna tree and grass cover.
- Use of satellite generated remotely sensed data for land condition monitoring in a pilot study in the Northern Territory's Victoria River District.
- Rapid and expanding implementation of the computer-based economic management package for graziers (Breedcow and Dynama) facilitated through local consensus data groups in Queensland and used elsewhere for best practice beef herd management.
- An economic analysis of the potential impact of weeds on the pastoral industry in the Northern Territory.
- Development of community-scale land management systems for Gulf savanna lowland Aboriginal communities.
- Analysis of the legal basis of land tenure in the Northern Territory.

### RESEARCH AND STAKEHOLDER-LINKED ACTIVITIES

- Invitations to the centre to provide input to the Mary River Task Force which is examining sustainable land use over an entire catchment area.
- Invitations from the Northern Land Council to the centre to contribute to the development of management plans for 10 important catchments and their biophysical assessment resources and sustainable use.
- The centre is developing cooperative fire management programs with regional committees of the Northern Territory Bushfires Council and community-based groups in conjunction with the Western Australian Bushfires Board.
- The centre has given input to the development of ecotourism through the interpretation site management plans for Savannah Guides for sustainable site values and ecotourism.

### EDUCATION AND COMMUNICATION ACTIVITIES

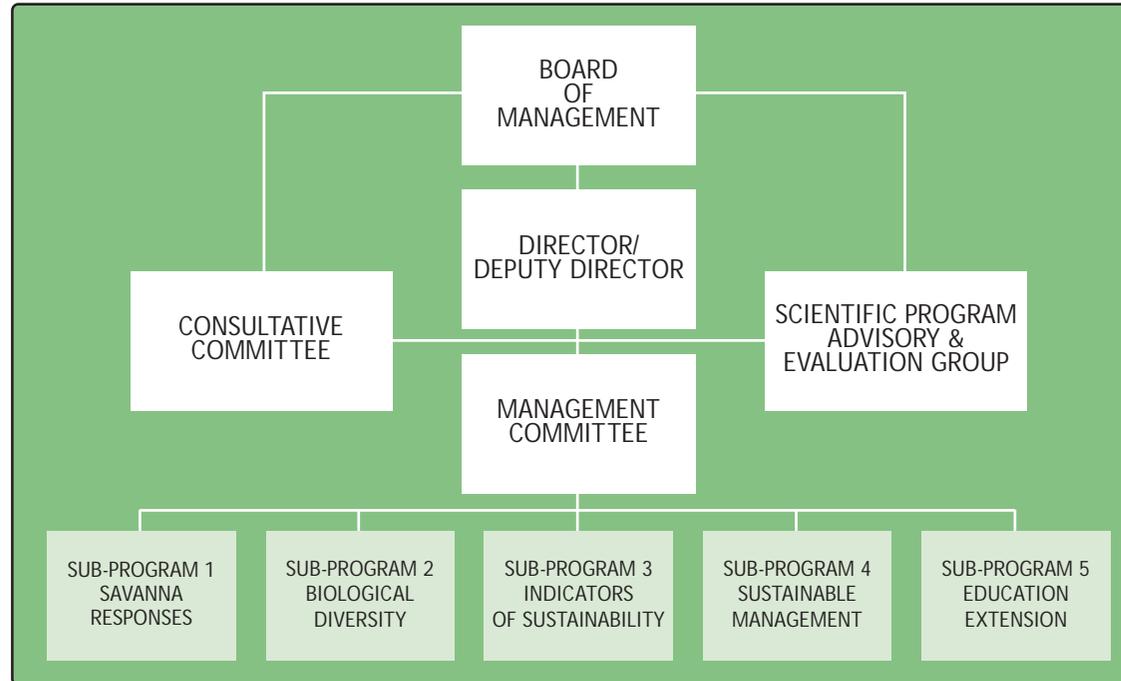
- Establishment of a Master of Tropical Environmental Science degree at the Northern Territory University.
- Development of client-oriented weed management training modules.
- Nine scholarships or operational grants for studies toward PhDs and one grant towards an MSc degree.

### CENTRE MANAGEMENT STRATEGIES AND SYSTEMS

- A strategic plan with relevant goals, strategies and performance indicators.
- The basis for an information network to enable staff and stakeholders to have wide access to necessary data.
- Identification of what stakeholders see as their major research and education needs and wants in managing savanna enterprises and regions.
- Identification of the centre's major research and education niche, namely the integration of ecological, social and economic knowledge about the savannas. This will provide new information for stakeholders on sustainable management in terms of knowledge bases and values.
- Restructuring of the fourth research sub-program, Sustainable Management, as the central business of the centre
- Initiation of an extensive communication strategy for the centre.



## STRUCTURE AND MANAGEMENT



**DIAGRAM 1**  
The centre's organisational structure

The centre's organisational structure is made up of a Board, Consultative Committee, Management Committee and a Scientific Program and Evaluation Advisory Group linked to five sub-programs through the sub-program leaders (see Diagram 1).

The Board, Management Committee and Consultative Committee are responsible for the strategic direction of the centre while SPAEG plays a crucial role in controlling the quality and rigour of the research effort. The management and operational structure of the centre is integrated so the views of representative groups can be incorporated into the decision-making process. Over time, this will ensure that our contribution to better decision-making on the management of the savannas at regional, national and international levels is relevant and useful.

The Board regulates all operations of the centre. These include monitoring and determining strategic development, reporting to the parties and the Commonwealth, and approving centre sub-programs, the annual budget, financial arrangements and commercialisation of intellectual property. It also appoints the director, deputy director and sub-program leaders. During the centre's first year the Board made key decisions on the management and development of the centre's program, and its major output was the development of a strategic plan. It met seven times during the year.

The Management Committee is responsible for the day-to-day management of administrative activities as well as the research and education activities of the centre. Its major task during this first year has been establishing management systems which enable the centre to function. It met 15

times during the year, implementing the policies of the Board both on a strategic and day-to-day basis. It also met with the North Australian Beef Research Council (NABRC) on two occasions.

Members of the Consultative Committee represent the social and enterprise groups across the savannas and they are the major links between the centre and its stakeholders. The Committee advises the Board on stakeholder research and education needs and associated issues. It met three times during the year. Its first meeting was held during the opening of the centre in November 1995, and its second in February 1996, where it produced the report *What the Stakeholders Want*. This report presented the key issues identified by many of the centre's stakeholders: the pastoral, tourism and mining industries and Aboriginal and conservation interests.

**CENTRE PARTIES**

*The CRC for the Sustainable Development of Tropical Savannas is an unincorporated joint venture between:*

- The Northern Territory University
  - Australian National University
  - James Cook University of North Queensland
  - STATE OF WESTERN AUSTRALIA
  - Department of Conservation and Land Management
  - Agriculture Western Australia
  - STATE OF QUEENSLAND
  - Department of Primary Industries
  - Department of Natural Resources
  - NORTHERN TERRITORY OF AUSTRALIA
  - Parks and Wildlife Commission
  - Power and Water Authority
  - Department of Lands, Planning and Environment
  - Department of Primary Industry and Fisheries
  - Department of Mines and Energy
  - COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION
  - Division of Wildlife and Ecology
  - Division of Tropical Crops and Pastures
  - Division of Soils
  - and
  - The Australian Nature Conservation Agency
- Established and supported under the Australian Government's Cooperative Research Centres Program.

**BOARD OF MANAGEMENT**

*The Board is made up of key representatives of the parties to the centre and the user groups it aims to serve.*

Members in 1995-96 were:



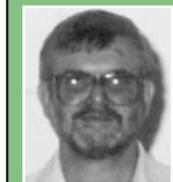
THE HON. JOHN KERIN (CHAIR)  
Australian Meat and Livestock Corporation  
Sydney, NSW



PROFESSOR RON MCKAY  
Northern Territory University,  
Darwin, NT



MR JOHN MORRISEY  
Agriculture Western Australia,  
Kununurra, WA



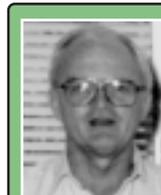
MR ROGER SMITH  
Department of Lands,  
Planning & Environment,  
Darwin, NT



MR STEWART WOOD  
Department of Primary Industries,  
Townsville QLD



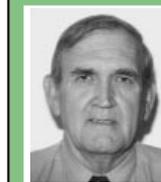
DR TONY PRESS  
Australian Nature  
Conservation Agency,  
Darwin, NT



DR BRIAN WALKER  
CSIRO,  
Canberra, ACT



MS DEBORAH COPE  
Office of Northern Development,  
Darwin, NT



MR JOHN STEWART  
Glenlyon Pastoral  
Management Pty Ltd,  
Townsville, QLD



MR JOHN LEWINS  
McArthur River Mining Pty Ltd,  
Winellie, NT

MR DARRYL PEARCE  
Northern Land Council,  
Darwin, NT



## STRUCTURE AND MANAGEMENT

### CONSULTATIVE COMMITTEE

*The committee strongly assists the centre's staff in developing networks and delivering relevant services to our clients. It met three times during the year.*

Members at various times during 1995-96 were:

MS DEBORAH COPE (CHAIR)  
Office of Northern Development

MR ROSS BRUNCKHORST  
Pastoral Enterprises

MR TOM COLLIS  
Batchelor College,  
Community Education

MS CATH ELDERTON  
Kimberley Land Council,  
Aboriginal Enterprises

MR ROWAN FOLEY,  
Kimberley Land Council

MR DAVID EPWORTH  
Cape York Land Council

MR DON HEATLEY  
Pastoral Enterprises



*The consultative committee at work in Darwin in June 1995*

MS SUE JACKSON  
ANU, Conservation Interests

DR PHIL PRICE  
Land & Water Resources  
R&D Corporation,  
Sustainable Land and  
Water Management

MS PENNI TASTULA  
Northern Gateway Pty Ltd,  
Tourism Enterprises

MS CORINNE UNGER  
ERA Environment Services,  
Mining Enterprises

MR CHRIS UREN  
Northern Land Council,  
Aboriginal Enterprises

DR BARRY WALKER  
Meat Research Corporation,  
Pastoral Enterprises

### THE SCIENTIFIC PROGRAM ADVISORY AND EVALUATION GROUP — SPAEG

*SPAEG comprises eminent researchers whose role is to ensure quality in all the research activities of the centre.*

Members in 1995-96 were:

PROFESSOR JOHN ALTMAN  
ANU, Centre for Aboriginal Economic Policy Research

PROFESSOR IAN NOBLE  
ANU, Research School of Biological Sciences

ASSOCIATE PROFESSOR ROY POWELL  
Centre for Agricultural and Resource  
Economics, University of New England

DR JOHN TAYLOR  
CSIRO, Division of Tropical Crops and Pasture

PROFESSOR ROD GERBER  
Faculty of Education, Health and Professional Studies  
University of New England

DR DOUG COCKS  
CSIRO, Division of Wildlife and Ecology

## MANAGEMENT COMMITTEE

*The Management Committee consists of the director of the centre and the leaders of the five research sub-programs.*

In 1995-96 its members were:

DR PHIL WEST  
Director, CRC for the Sustainable Development of Tropical Savannas

DR JOEL BROWN  
Principal Research Scientist, CSIRO Division of Tropical Crops and Pastures, Townsville  
(Leader Sub-Program 1)

MR PETER WHITEHEAD  
Principal Wildlife Research Officer, Parks and Wildlife Commission, Northern Territory, Darwin  
(Leader Sub-Program 2)

DR PAUL NOVELLY  
Manager, Sustainable Rural Development Program Kimberley, Agriculture WA, Kununurra (Leader Sub-Program 3)



*Standing (from left) Professor Greg Hill, Dr Joel Brown, Dr Phil West  
Sitting (from left) Mr Peter Whitehead, Dr Paul Novelly, Dr Ross Hynes*

DR ROSS HYNES  
Deputy Director, CRC for the Sustainable Development Tropical Savannas, JCU, Townsville  
(Leader Sub-Program 4)

PROFESSOR GREG HILL  
Professor of Environmental Sciences, Northern Territory University, Darwin  
(Leader Sub-Program 5)

## MANAGEMENT NETWORKS

In January a working group met to provide input on key conservation issues and needs. It included representatives from the World Wildlife Fund for Nature, Australian Nature Conservation Agency, Australian Conservation Foundation, the Queensland Wildlife Preservation Society, the Arid Lands Coalition, and representatives of most State and Territory government conservation agencies. Representatives of Aboriginal groups concerned with conservation also attended the meeting.

From a meeting held in February with a representative from the mining industry and centre party representatives, the terms of reference were framed for a consultancy to identify priorities for research and education within the mining industry as they relate to the centre's charter. Terra Search, a geological consulting service has been contracted to carry out this consultancy during the coming financial year.

Sub-Program 4 project leaders also met in January and February to develop the terms of reference for a consultancy to explore research and education needs and issues concerning Aboriginal stakeholders. The focus of this consultancy is presently being finalised.

The Consultative Committee's third meeting, held in June, evaluated the progress of current research projects and assessed new developments within the centre, including research proposals. This meeting was followed by a one-day workshop which developed the first phase of a communication strategy that will be critical to the development and overall effectiveness of the centre.

A tourism research meeting, held in May 1996, examined key issues concerning savanna tourism identified by the Consultative Committee. An outcome of the meeting was the establishment of a Tourism Research Network whose role is to keep stakeholders informed of research and related education issues and opportunities.

SPAEG met twice during the year and established mechanisms for the review and maintenance of research quality. Research leaders also met in November and May to review and evaluate the progress of new research projects and consider current and new research proposals. Nine new proposals were submitted at this meeting, all of which have now been approved by the Board.



## COOPERATIVE LINKAGES

**T**he centre has worked to develop a strong collaborative base between enterprise groups, researchers and policy-makers and is beginning to link with existing networks within its partner agencies. Particular effort has been made to develop collaboration in communicating research results to users. This is allowing us to facilitate the adoption of savanna management advice resulting from research and development. Strategic planning, priority-setting, review and assessment procedures have been implemented with the involvement of all core participants.

Staff of the centre are drawn from 16 different agencies from nine separate parties operating across almost one-quarter of Australia. More than 100 researchers working in 20 different locations are involved in the centre's research and communication effort. Because the centre has such a widely dispersed research network, it needs to make as much use as possible of information technology-based systems of communication.

For this reason the centre is developing a virtual community among all centre parties, participating researchers and educators as an integral part of the Savanna Information Management project (Project 4.1). This will enable the centre to make use of the World Wide Web and access essential databases. A home page for the CRC for Tropical Savannas has been designed by the School of Information Technology at Northern Territory University (<http://www.cs.ntu.edu.au/crc>). This will give information on centre activities, a list of participating researchers, excerpts from the centre's newsletter and, where appropriate, strategic documentation. Ultimately, the centre plans that the World Wide Web will become one of its major tools with which to reach stakeholders who are spread over an extensive geographic area. This project has also evaluated the electronic mail linkages of participating researchers and

educators within the centre to enable more effective communication.

Links are also being established with the Centre for Interactive Multi-Media (CIMM) at James Cook University of North Queensland. Two proposals for short video programs and computer-assisted learning kits on the savannas have been submitted to CAUT (Committee for Advancement of University Teaching). JCU has committed \$50,000 of its agreed funding support to the centre to develop a multi-media package with CIMM on the savannas, their people and best practice management techniques.

### INTER-PROJECT COLLABORATION

Important links are developing within each of the centre's five research sub-programs and their projects. The development and consolidation of these links are integral to the success of the centre as its major goal is to integrate biophysical research with social and economic needs in the savannas. Sub-Programs 1, 2 and 3, which focus on the biophysical research of the savannas, have developed cross-links within various research projects and with Sub-Program 4, which combines ecological and socio-economic issues to explore options for savanna management with stakeholders. Sub-Program 5 then disseminates the results of the research through education, extension packages and wider

communication to stakeholders (See Diagram 2).

All project leaders identified links with other centre research projects as one of their major tasks during the first year of operation. Cross-project collaboration between Sub-Programs 1, 2 and 3 has included extensive discussion on sharing field sites and ensuring similar sampling protocols. For example, Project 2.1 studies the distribution of native animals across the savannas, and how different practices, such as grazing and fire, affects them. It has established links with Project 2.4 which examines fire management in the savannas. Both projects now use the same sites and methods of sampling. This integrated approach will increase the range of applications for which their data can be used. It will also allow more robust conclusions to be drawn about the effects of fire on native animals and the incorporation of this data into management practices.

The establishment of the centre has encouraged staff to seek cross-disciplinary research opportunities. For example, ecologists from Sub-Program 2 have attracted funds to work with economists and social scientists from the NTDPF and NTU. This research will determine the economic and social benefits of a reserve network that also meets national objectives for the conservation of biodiversity.

**COLLABORATION WITH OTHER RESEARCH PROVIDERS**

Significant linkages were made between centre research projects and external agencies during the year. The Northern Territory Power and Water Authority, which funds half of Project 1.2, also provides support staff, vehicles and equipment to the centre. Two intensive field programs were undertaken as part of Project 1.2 in collaboration with the CSIRO Division of Water Resources (Canberra). These measured energy and moisture fluxes to and from field sites. This collaboration has now been broadened through a major new research grant from the Land Water Resources R&D Corporation.

Project 2.2, Landscape Pattern, Land Use and Status of Granivorous Birds established formal links with the Gouldian Finch Recovery Plan and has been endorsed by the National Gouldian Finch Recovery Team. A joint project was also initiated with the

Northern Land Council to consolidate data needed for the development of wetland management plans, including those of the Arafura Swamp.

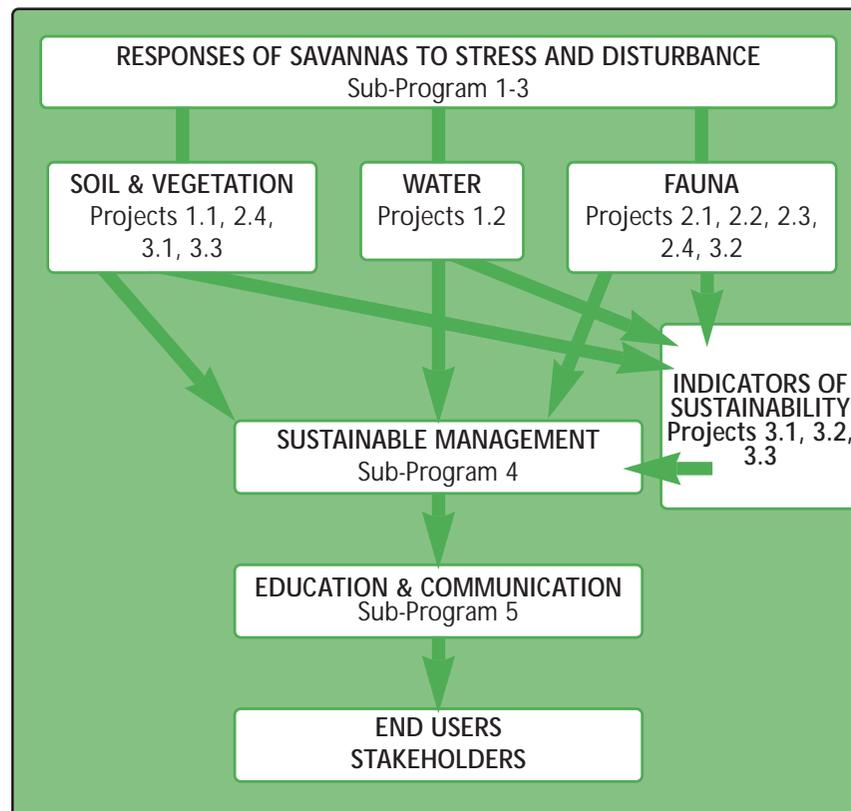
Sub-Program 2 developed links with the Queensland Department of Environment for the use of comparable sampling protocols for wildlife surveys on Cape York Peninsula and in other Savanna bioregions.

A major highlight of the centre's fire research, Project 2.4, was the desire on the part of stakeholder organisations and agencies to develop regional cooperative fire programs. The project established effective links throughout the year with many community groups within the Northern Territory and Western Australia. Regional committees of the Northern Territory's Bushfire Council, which are made up of land-owners and pastoralists, have contributed to meetings that have identified fire management priorities. In Western Australia the Land Conservation

District Councils have made significant contributions to identifying fire management issues, as have the Kimberley Land Council and the Bushfires Board of Western Australia. Aboriginal interests in the Northern Territory have been represented by the Caring for Country Unit of the Northern Land Council and the Bawinanga Association in north-central Arnhem Land.

As weed invasion and the need to improve weed management have been given priority by the Meat Research Corporation, regional beef research committees, conservation groups and the centre's Consultative Committee, a number of the centre's research projects have developed links with the CRC for Weed Management Systems. Sub-Program 3 (Indicators for Sustainable Land Production and Condition) and the CRC for Weed Management Systems are planning to enter into an arrangement to employ jointly a scientist to carry out modelling of weed invasions.

In Sub-Program 4, research planning included consultation with resource economists in the Australian Bureau of Agricultural and Resource Economics and with the research unit of AGB McNair in Sydney. The potential use of the well established Northern Territory Travel Monitor as a survey vehicle is also being explored with the Northern Territory Tourism Commission.



**DIAGRAM 2**  
Conceptual framework illustrating the integration of ecological projects within Sub-Programs 1-3 into Sub-Program 4, which largely drives and directs the centre's research effort and Sub-Program 5, which then disseminates research through educational, vocational and extension packages



## COOPERATIVE LINKAGES

### INTERNATIONAL LINKAGES

As almost one sixth of the world's land mass can be defined as some form of tropical savanna, the centre has considerable potential to provide important scientific and economic advice internationally as well as nationally. For example, most of the weed species common to northern Australia are also found in eastern Indonesia. Following a conference last year on agricultural development in Kupang, Indonesia, a steering committee was formed to explore funding sources for projects in the area. The centre, through Professor Greg Hill (who leads Sub-Program 5) will become actively involved in some of the research projects in this area in future years.

Cooperative links are also being developed with the Department of Environmental Science at the University of Virginia in the United States, which is a contributor to the International Geosphere Biosphere Program. Dr Dick Williams, leader of Project 1.1, began collaborative work with the department's head, Professor Hank Shugart during a month-long visit early in 1996. Modelling of savanna vegetation has begun between the two groups, the aim of which is to predict savanna attributes on the basis of climate and soil. As Professor Shugart's

group is studying the Kalahari Transect in Southern Africa, the Australian and American laboratories will also be able to make intercontinental comparisons on tropical savannas. This is a key project within the centre, and within the International Geosphere-Biosphere Program core project, Global Change and Terrestrial Ecosystems.

Dr Deborah Bird Rose, co-leader of Project 4.2, visited Norway in September, 1995, to conduct research on the Knut Dahl collection of the National Historical Museum for a case study on the Daly River Region.

Drs Alan Andersen and Tracey Churchill (Project 3.2 Invertebrate Indicators of Biodiversity and Ecological Change) have links with the major laboratories in Australia working on invertebrate biodiversity issues and with major international ant and spider researchers.

### VISITOR PROGRAM

The centre established a visiting scientist program during the year. Two distinguished scientists, Professor John Wiens, from the University of Colorado, Fort Collins Colorado, and Dr David Janos from the University of Miami, Florida, have been invited to visit the centre under the program.

Professor Wiens is a landscape ecologist of international standing and is a leader in the field of spatial scaling. He has extensive experience in multi-disciplinary studies of landscape scale ecology, including those encompassing biogeographic climatic gradients. He is also recognised as an outstanding community ecologist.

These skills are highly relevant to many of the projects in Sub-Programs 1, 2 and 3. Dr David Janos is a world expert in mycorrhizal fungi and how they contribute to above-ground plant productivity and below-ground biodiversity. He can contribute to the development of a more complete understanding of the factors influencing the structure and function of Australian savannas.



## RESEARCH

**T**he centre's research program is divided into five sub-programs, each of which is made up of individual research projects. The first three sub-programs deal with the ecology of the savannas and how its plants and animals are affected by land use. The fourth sub-program integrates this information and links it with socio-economic factors to help identify pathways to sustainable management. The final sub-program incorporates the resulting research into both educational and extension packages for stakeholders.

### SUB-PROGRAM 1

### RESPONSES OF SAVANNAS TO STRESS AND DISTURBANCE

*Sub-Program Leader:*  
DR JOEL BROWN,  
CSIRO Division of Tropical  
Crops and Pastures,  
Townsville



**A**ny use of the savannas that affects plants will also affect the animals that depend on them, both native and introduced. Researchers are examining why particular plants occur where they do, how

different land uses affect them and whether any changes that occur are reversible. This sub-program seeks to identify the limits on how much use can be made of savannas without

compromising their sustainability.

The objective is to provide the basic biophysical framework for the research results of other sub-programs, as well as information

on soil-water-vegetation relationships for the development of land and water resource management strategies. Sub-Program 1 uses a network of sites distributed across the range of rainfall and soil conditions which support tropical savannas. It also aims to integrate, with the other sub-programs, quantitative and qualitative models of the biophysical constraints on responses of the savannas to disturbance.

### 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,  
Northern Territory

**T**he tropical savannas of northern Australia occupy almost 25 per cent of the continent, yet contain less than 1 per cent of the Australian population. The savannas are relatively intact ecologically when compared with Australia's southern forests and woodlands.

However, sustainable resource management within each of the stakeholder sectors requires an understanding of the factors controlling the composition, structure and function of the savannas. This includes an understanding of species diversity, tree cover, standing crop of grasses, patterns of regeneration and susceptibility to land degradation.

This project aims to predict the variation in such characteristics in relation to three primary determinants — rainfall patterns, soil texture and disturbance regimes. The primary research focus is a 1000km-long transect through the Top End of the Northern Territory: the North Australian Tropical Transect (NATT). The NATT encompasses variation in annual rainfall (1800-500mm) and soil (sands, loams and clays) in the savannas. Models of variation in both cover and diversity of the tree and grass layers have been developed. Models of savanna responses to disturbance regimes, (such as defoliation of the ground layer) at a range of scales from metres to hundreds of kilometres are currently under study.

#### HIGHLIGHTS

Preliminary models of savanna structure have been developed and a

framework has been developed to use the NATT as a focus for further refinement of models. The newly developed remote-sensing technique Synthetic Aperture Radar has been used to estimate savanna attributes such as tree cover and grass cover.

#### MILESTONES

Five core sites have been established along the Northern Territory rainfall gradient where sand, loam and clay soils occur in close proximity; additional permanent 1ha sites have been established at four other locations.

Preliminary models of variation of basal<sup>1</sup> area, height and cover of trees as a function of annual rainfall and soil texture have been developed.

At each site, an inventory of vegetation characteristics and soil properties within permanent 1ha plots has been completed.

<sup>1</sup>. Tree basal area is the cross-sectional area over bark at 1.3m above ground level

**FUTURE DIRECTIONS**

**A** comparative study of different remote sensing techniques in savanna ecology and management will be conducted on NATT sites such as Kidman Springs in the NT. The investigation will evaluate these techniques to detect spatial change in key savanna attributes such as tree basal area, perennial grass cover and soil texture.

An evaluation of indices that assess soil-surface condition as a measure of disturbance are being applied in the savannas of northern Australia. These indices were originally developed in temperate rangelands. The methodology is being used to assess ecosystem state in a range of land tenures i.e. pastoral, mining and land conservation. The research will refine parameters for given soil types, especially cracking clays. The ability of various remote sensing techniques to assess soil-surface condition will also be examined.

**CORE PROJECT TEAM**

Dr Dick Williams, CSIRO DWE

Dr Garry Cook, CSIRO DWE

Dr Alan Andersen, CSIRO DWE

Dr John Ludwig, CSIRO DWE

Mr David Tongway, CSIRO DWE

Dr Mark Stafford Smith, CSIRO DWE

Dr Paul Novelty, Agriculture WA

Mr Andrew Craig, Agriculture WA

Dr Waqar Ahmad, NTU

Prof Greg Hill, NTU

Dr Gordon Duff, NTU

Mr Jack Cusack, CSIRO, DWE

Mr Michael Greatz, CSIRO DWE

**PROJECT 1.2 WATER USE BY TROPICAL SAVANNAS**

*Project Leader:*  
DR DEREK EAMUS,  
Northern Territory University



**T**he wet/dry tropics of Australia are characterised by seasonal drought. Despite a five-month period of essentially no rain, much of the vegetation (about 50-60 per cent of tree species) retain some or all of their leaves and transpire water. This suggests groundwater is an important source of water for these species. This in turn raises several crucial questions.

For example, how much groundwater can be sustainably pumped from groundwater reservoirs for commercial and domestic consumption before the vegetation is adversely affected? How dependent is the vegetation upon groundwater reserves? How much does vegetation rely on

groundwater? Does this vary between different vegetation types and between different sites? Since vegetation uses groundwater, what happens to the availability of

groundwater if the type of vegetation present is changed?

This project aims to provide information to stakeholders such as the Northern Territory Power and Water Authority, along with other resource managers, about the management of water and vegetation resources in northern Australian savannas. These resource managers need to increase access and use of groundwater resources in an ecologically sustainable manner, so that both the water and vegetation are conserved for future use. Similarly, landscape managers (pastoralists, Aboriginal owners and conservation agencies) and policy-makers need timely and credible information that informs

them of options and the likely impact of specific management decisions on water and vegetation.

During the development of this project, there has been a substantial increase in understanding the relationships between canopy density and tree diameter and the scale of water value over time. There has also been a realistic appraisal of problems associated with water measurements of soil water content at depth.

**HIGHLIGHTS**

■ A series of representative field study plots have been established within a larger catchment study site. This required developing infrastructure, including access roads, access bores for neutron moisture meter equipment and soil capacitance probes<sup>1</sup>; as well as micro-meteorological towers<sup>2</sup> and nested piezometers<sup>3</sup> in the range of 13-56m below ground level.

1. Neutron moisture meters and soil capacitance probes are sensors that measure the water content of soil.

2. A micrometeorological tower is a tower standing in the savanna with sensors to measure wind speed, wind direction, screened air temperature, solar radiation levels and atmospheric humidity.

3. Piezometers are boreholes sunk into the groundwater which allow ingress of water only from certain depths. The height of the water table is then monitored throughout the year to look at the rate of rise and fall of groundwater.

- Studies have established the water use of individual trees as a function of the time of day and season. This is needed to scale up from tree to canopy and in turn to catchment scale regarding water use.
- Findings on how canopy density varies seasonally for major woody species have been described. This knowledge is important because the amount of canopy varies with season and the amount of canopy determines the maximum rate of water use by each tree.
- Determination of the relationship between tree diameter, canopy area and water use per tree has been described. This information is required to allow the use of remotely sensed (i.e. satellite) information about canopy area and/or tree diameter to calculate canopy water use. These findings will be applied over larger areas using a geographic information system (GIS) at a later stage.
- Vegetation mapping for these investigations is almost completed. This information will be fundamental in developing a

GIS for calculating catchment-scale water use by vegetation. It is also important for stratifying vegetation sampling strategies within the catchment.

- Two intensive field programs were used to measure plot-scale energy and moisture fluxes to and from the field-site. Measurements were made in April (end of wet season) and will be carried out in September (end of dry season). These measurements provide essential calibrations of individual tree measurements of water use. Water loss from the field site includes loss through grasses, herbs, forbs, saplings, trees and evaporation from soil. Measurements of individual tree water use, although measuring the major path of water loss to the atmosphere, do not account for all pathways. However, the field programs for plot-scale energy and moisture fluxes overcome this limitation.
- Mr Rodd Dyer, NTDPIF, has been investigating how competition for soil moisture between trees and grass affects tropical savannas and pasture production. Soil moisture and plant

production throughout the growing season was measured on cleared and uncleared woodland plots at Katherine (970mm mean annual rainfall) and Kidman Springs (690mm mean annual rainfall) in the Northern Territory. Results over the past year indicate that competition from woody vegetation reduces annual pasture production by using available soil moisture in the rooting zone of the pasture layer. The work will help to quantify effects on available soil moisture and pasture production of the invasion of native woody plants into open savannas.

#### MILESTONES

In our first year we have successfully built a team of researchers, developed a digital database (including data sets on canopy cover, leaf area index and plant communities) and determined water use by individual trees in the savannas.

#### FUTURE DIRECTIONS

**A** communication strategy is being prepared to ensure the project's results reach stakeholders. Workshops to disseminate the outcomes of research are planned for the coming year.

#### CORE PROJECT TEAM

Dr Derek Eamus, NTU  
 Dr Waquar Ahmad, NTU  
 Mr Don Pidsley, NT PAWA  
 Dr Lindsay Hutley, NTU  
 Mr Tony O'Grady, NTU  
 Mr Rodd Dyer, NTDPIF

#### COLLABORATORS

Mr J. Paiva, NT PAWA  
 Mr Darryl Chin, NT PAWA

## SUB-PROGRAM 2

## BIOLOGICAL DIVERSITY IN THE SAVANNA LANDSCAPE

*Sub-Program Leader:*  
MR PETER WHITEHEAD,  
Parks and Wildlife  
Commission, Northern  
Territory, Darwin



Australia's tropical savannas are perhaps the last stronghold of much of the nation's biological heritage. In recent times, the area over which many of its animals range has been reduced. This suggests present management practices may be compromising the ecological diversity of the savannas.

This sub-program is designed to provide information on relationships between biological diversity and patterns of land use

through a strategic approach that focuses special attention on a few aspects of savanna ecology. The focus is on research that offers the greatest potential for general

application to a range of savanna environments and various development options, yet is achievable on relatively modest budgets within a reasonable time frame. Knowledge of savanna biota is currently uneven, but it is impractical to delay management decisions while waiting for gaps in knowledge to be filled comprehensively.

The sub-program aims to build upon the framework provided by Sub-Program 1 and concentrates

on the roles played by key resource patches within the habitat matrix of the savanna. It focuses on the determinants of biodiversity at a regional scale to provide guidelines for on and off-reserve maintenance of biological diversity. It comprises four closely linked projects which examine fauna distribution patterns, vulnerable species, a vulnerable habitat and the influence of fire on vulnerable habitats and species. It is designed to provide a context to permit extrapolation from site-bound studies to the wider landscape.

## PROJECT 2.1

## BIOGEOGRAPHIC OVERVIEW OF SAVANNA FAUNA

*Project Leader:*  
DR JOHN WOINARSKI,  
Parks and Wildlife Commission,  
Northern Territory

This project seeks to describe patterns and trends in the distribution of wild animals across the savanna landscape. It considers the changing status of the fauna, locations where there is exceptional diversity of animal life, and some of the responses of wildlife (particularly vertebrates) to land use and management.

The current information base for wildlife in the savanna lands of northern Australia is inadequate, in terms of limited records, biased geographical spread and unsystematic sampling methodology. This project is redressing some of those inadequacies through systematic sampling of wildlife in all major savanna environments.

Information from this project will be used to examine the

biodiversity costs of a range of land-use options and management practices as well as priorities and opportunities for reservation and management, so the savannas' distinctive wildlife can be maintained within a framework of sustainable development. An important objective is to relate patterns of biodiversity to intensities of various land uses. This information can be used to clarify the trade-offs between reduced biodiversity and various production outcomes. It can then be used to develop optimisation functions that involve Project 4.3.

## HIGHLIGHTS

Comprehensive wildlife surveys have been completed for two significant areas of the Northern Territory savannas, Litchfield and Limmen Gate parks. Sampling is comparable to that used for assessment of wildlife values in Kakadu and Bungle Bungle National Parks. This study will help guide the management of these parks and the results will contribute to

building a large distributional data set for savanna wildlife.

Two years of field work have been completed on a biogeographic study of the Mitchell Grasslands — one of the major savanna environments. This has documented the wildlife values of these grasslands, distribution patterns of wildlife and the impact of pastoral activities upon wildlife. The study will be completed in 1996-97 and will enable land managers to foster the maintenance of biodiversity within this environment.

Large data sets of the distribution of plants and animals in the Northern Territory have been compiled. These are now being analysed to describe distribution patterns. An assessment of the conservation values and reservation options for all Northern Territory bioregions has been published as a report to ANCA, and an assessment of the



*Alaric Fisher uses a soil auger to prepare pitfall traps for fauna surveys in the Mitchell Grasslands, Northern Territory*

reservation status of all plants and vegetation types in the Northern Territory is in press.

Analyses are being conducted on a data set of the distribution of landsnails to identify relationships between species richness, species distribution and environmental features.

#### **MILESTONES**

All accessible existing plant and animal data bases in the Northern Territory have been assembled. However, the inclusion and collation of other relevant databases from Queensland and Western Australia is presently limited by the fact that most of these databases are owned or administered by agencies that are

not party to the CRC (e.g. West Australia Museum, Queensland Department of Environment).

Much existing distributional data has been analysed and interpreted and a series of reports and papers published.

#### **FUTURE DIRECTIONS**

**R**esearch in 1996-97 will include the conclusion of the biogeographic survey of the Mitchell Grasslands as well as research on the effects of grazing in this area. Progress is expected towards the development of conservation planning in the grasslands and the establishment of wildlife monitoring in at least 100 fire-monitoring plots.

Substantial fieldwork will be done for a biogeographic survey of the Desert Uplands bioregion (Queensland) and fieldwork for a biogeographic survey of chenopod shrublands within the tropical savannas.

Cooperative arrangements are being sought to provide access to Queensland and Western Australian biodiversity data sets.

Sampling sites will be established to consider effects of grazing regimes on wildlife.

The first stage of collecting information on Aboriginal interests also began as a joint Northern Land Council and Parks and Wildlife Commission of the Northern Territory study in the Roper Bar area.

Work has begun on the production of a wetlands database in GIS format to assist the NLC Caring for Country wetlands management initiative.

#### **CORE PROJECT TEAM**

Dr John Woinarski, NTPWC  
 Mr Peter Whitehead, NTPWC  
 Dr Norm McKenzie, WA CALM  
 Dr Bronwyn Scott, JCU  
 Mr Alaric Fisher NTPWC/NTU (PhD student)

#### **COLLABORATORS**

Mr Greg Connors, NTPWC

## PROJECT 2.2 LANDSCAPE PATTERN, LAND USE AND STATUS OF GRANIVOROUS BIRDS

### Project Leader:

MR PETER WHITEHEAD,  
Parks and Wildlife Commission of  
the Northern Territory

This project seeks to understand the processes causing declines in the abundance and range of granivorous birds. It will examine the ecology of at least two species of particular concern. These birds depend absolutely on the seeds of a number of different grasses that are distributed patchily throughout the savanna environment. Understanding the factors affecting their status requires examination of fundamental processes in grassland dynamics and how those dynamics change with different land use or with the application of widely used management tools such as fire. Work in this project has to date concentrated on completion of natural history observations on foraging behaviour of the Gouldian finch *Erythrura gouldiae*. This information has been used to design and implement experimental studies on the effects of different fire regimes on seed production.

An important research focus is to explore some of the patterns revealed by Project 2.1. Studies of the use of resource-rich patches and the role they play in maintaining wildlife populations will help bridge the gap between recognition of a problem at a broad regional scale and the management actions that might be taken at a property scale to deal with it.

### HIGHLIGHTS

Completion of a description of seasonal shifts in the diet of the Gouldian finch, identification of the grass species exploited (including their status in the landscape) and establishment of experimental plots to study fire effects on seed production of important grass species in four savanna types. A floristic description of grassland



A number of granivorous birds are declining in range and abundance in the savannas. Pictured is a researcher taking field measurements of one of these species, the Gouldian finch.

Photo: NTPWC

types significant for Gouldian finches has been completed. Radio-tracking studies of the Gouldian finch have also begun.

A PhD program on the ecology of the Partridge pigeon *Geophaps smithii* has commenced. Acquisition of imagery and production of a preliminary habitat map for the Gouldian finch in the Yinberrie Hills by an NTU Honours student has been completed. This included first approximations of maps of patches of especially significant grassland types.

These studies have helped to identify the broad range of habitats that are used by

granivorous birds at different times of the year and have corrected earlier misunderstandings of the capacity of sorghum species to satisfy dietary needs for the Gouldian finch all year round. Knowledge of habitat types is needed to provide information on managing finch populations effectively. The study is in its early stages and outcomes in the form of robust management prescriptions will take some time to complete. Nonetheless, work to date has contributed to the capacity of relevant government agencies to provide informed comment on the implications of mining developments in areas of Gouldian finch habitat.

### FUTURE DIRECTIONS

Maintenance of fire experiments  
Studies of a second species, the Partridge pigeon, will be significantly advanced  
Subject to funding, studies of a third species (probably the Flock Bronzewing *Phaps histrionica*) will begin  
Radio-tracking studies, to provide information on the full range of habitat types and grassland patches exploited by the target species, will be emphasised.

### CORE PROJECT TEAM

Mr Peter Whitehead, NTPWC  
Dr John Woinarski NTPWC  
Mr Richard Noske NTU  
Mr Peter Dostine NTPWC  
Mr David Hooper NTPWC

### COLLABORATORS

Mr Greg Connors NTPWC  
Dr Sonia Tidemann,  
Batchelor College  
Mr Don Franklin, NTPWC

### PROJECT 2.3 CONSERVATION OF RIPARIAN VEGETATION

**Interim Leader:**  
MR PETER WHITEHEAD,  
Parks and Wildlife Commission of  
the Northern Territory

**P**roject 2.3 seeks a better understanding of the role and function of riparian systems (the margins of wetlands, rivers, streams and other drainage lines) for maintaining biological diversity. These systems are known to support a large proportion of regional wildlife diversity, especially in times of environmental stress, because of the ready

availability of water. They are also the focus of much land use activity. The proper management of these relatively small components of the landscape therefore assumes particular importance because great benefits are likely to be realised through relatively localised and hence achievable investment of effort.

Work on this project was curtailed this year because its two principal professional staff left the centre.

#### FUTURE DIRECTIONS

It is planned to further advance work during 1996-97 by appointing a researcher from the Department of Conservation and Land Management (WA CALM) to lead the project.

### PROJECT 2.4 FIRE AND SAVANNA LANDSCAPES

**Project Leader:**  
DR JEREMY RUSSELL-SMITH,  
Bushfire Council of the  
Northern Territory

**F**ire is widely used by Aboriginal, pastoral and conservation land managers across the savanna landscapes of northern Australia. However, fire management continues to be a highly controversial issue in the public domain, and there are many unresolved questions concerning the appropriate use of fire as a management tool under different conditions and circumstances.

The centre's fire research theme builds on the substantial fire studies undertaken over the past two decades in northern Australia. These include the long-term fire experiments at Munmarlary and Kapalga, the work on grass fire behaviour at Annaburoo, surveys of the status of a range of vegetation types and faunal communities and various studies documenting Aboriginal burning practices. Studies also include the assessment of the impact of burning on weeds and other pastoral management issues and numerous studies involving the

development of remote sensing and associated GIS technologies for monitoring the seasonal extent of burning at both large and small regional scales.

The project focuses particularly on resolving regional fire management problems and issues and aims to assist in development of better land management practices. It has three major components as outlined below.

The first component concerns the identification of major fire management problems and issues across Northern Australia, both on regional and sectoral bases. Through consultation with stakeholders, the centre's fire research priorities and directions are being established.

The second component involves the development of regional approaches to monitoring the seasonal extent of burning, as well as the long-term effects of different fire regimes on flora and fauna. Such work will combine broad-scale monitoring using remotely sensed, satellite imagery with ground-based monitoring plots.

The third component specifically examines the effects of different fire regimes on sensitive species (e.g. cypress pine, *Callitris intratropica*) and communities (e.g. rainforests, old growth paperbark forests, heath communities). This information will provide an independent measure of the impact of regional fire regimes on plant species biodiversity and an informed means for modifying fire management to achieve best practice. Project activities are being developed with a wide range of organisations representing all major land use sectors.





Photo: CSIRO DWE

*Cooperative research is being carried out to identify major fire management problems and issues for communities across northern Australia.*

*This research includes Aboriginal burning techniques. Pictured right is Margy Deveraux employing burning techniques in Marranungu country, Finnis River, Northern Territory.*

*Pictured above is dry season burning in the Kakadu region, Northern Territory.*



Photo: Dr D. Bird Rose

### FUTURE DIRECTIONS

- Undertake a substantial field program on the Mitchell Plateau (WA) in June 1997. This will comprise an integrated fire management exercise involving land managers from across northern Australia, to develop a practical regional fire management model. It will involve input from a large range of agencies and organisations, including the provision of funding from the private sector.
- Develop a program of remote sensing across northern Australia. The work will include monitoring of the distribution and extent of fires throughout the year and will consider issues relating to the prediction of curing and fuel load. It will involve cooperation with other interested parties and funding agencies.
- Continue development of fire histories, derived from remote sensing for Gregory, Kakadu, Litchfield and Nitmiluk National Parks, and associated ground-based fire monitoring.
- Assist the centre's work on the Victoria River District-Sturt Plateau, and on the Arafura Swamp in the Northern Territory.
- Facilitate a series of regional meetings involving land managers from all sectoral interests, including a major regional meeting in the Top End of the Northern Territory late in the dry season of 1996.

### CORE PROJECT TEAM

Dr Jeremy Russell-Smith, NTBC  
 Dr John Woinarski, NTPWC  
 Mr Grant Allan, NTPWC  
 Mr Andrew Craig, Ag WA  
 Mr Gordon Graham, WA CALM  
 Dr David Bowman, NTPWC

### COLLABORATORS

Mr Andrew Edwards, NTPWC

### SUB-PROGRAM 3 INDICATORS FOR SUSTAINABLE LAND USE

*Sub-Program Leader:*  
DR PAUL NOVELLY,  
Agriculture Western  
Australia, Kununurra



Natural or human-induced changes to the environment can significantly affect savanna plants and animals. Sometimes these changes take years or even decades to attract attention. But by then it may be too late to do anything about them. This sub-program is looking for early warning signs (indicators) that tell savanna users the land may be about to change, as well as finding ways to restore damaged land.

The research investigations draw upon information provided by Sub-Programs 1 and 2 to focus specifically on identifying

indicators of change in the condition of land, and in water and biological resources within the savannas. Land uses being addressed include grazing, tourism and

traditional use of resources by Aboriginal people. Issues such as the prevention and control of woody weed invasion are also being studied.

The aim is to determine the sustainable productive potential of savannas for a range of different land uses. In doing this it seeks to develop robust, sensitive, practical and cost-effective indicators of change in land condition, biodiversity and productive potential at a range of different scales. It is also concerned with cost-effective strategies for restoration of the savannas.

A variety of indicators are being studied ranging from soil surface condition to bio-indicators such as perennial grass abundance and the abundance of invertebrate and vertebrate animals. Extensive ground confirmation of remotely sensed data will enable the scaling up of these indices for application broadly over the savannas. These indicators will be applied in state and transition models to allow predictions of how and when the condition of the land might change as a result of use. Once established, the methodology will be extended to the identification of indicators suitable for other land uses, such as tourism in conjunction with management systems developed in Sub-Programs 4 and 5.

### PROJECT 3.1 INDICATORS OF SUSTAINABLE LAND PRODUCTION AND CONDITION

*Project Leader:*  
MR ROD APPLGATE,  
Department of Lands,  
Planning and Environment,  
Northern Territory



Land and resources form the basis of all the major savanna-based industries. These resources may include pasture grasses, native food species or landscapes and wildlife. Sustainable management means that the maintenance of productive potential in one land use does not compromise the ability of the land to support that use or other land uses in the future. The basis for sustainable land management practice is knowing when land is being used beyond its capability and taking appropriate management action. A system of reliable indicators of the state or

condition of the land is the key to achieving this.

The satellite-based monitoring program undertaken as part of this project is designed

to provide objective, detailed scientific information on the condition of the rangeland resources. The system uses satellite remote-sensing data to provide a means of assessing broad landscape change and to extrapolate information from permanent ground-based monitoring sites throughout similar land types.

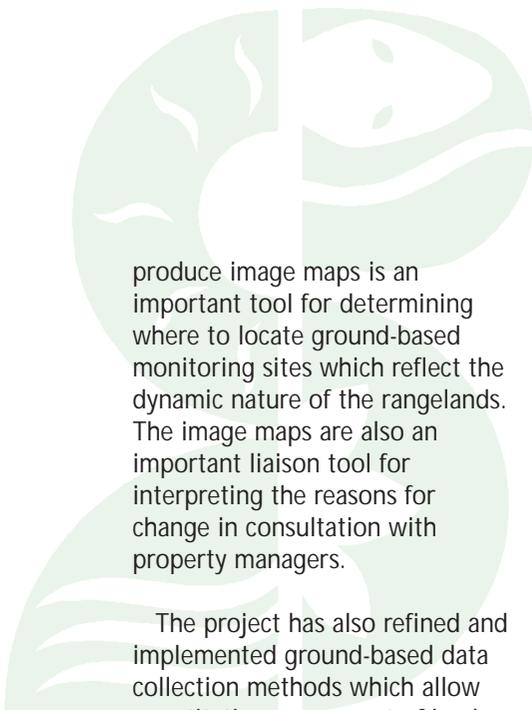
A rangeland monitoring pilot study is being conducted in the Victoria River District of the Northern Territory. To date 33 ground monitoring sites have been

established and approximately 120 more sites will be required to cover the entire district (125,000 km<sup>2</sup>). It is estimated that a total of about 400 ground sites will be needed to cover the semi-arid tropical savannas in the Northern Territory. Sites will be revisited every three years. Data collected includes detailed descriptions of vegetation, soils, landform and surface soil condition.

#### HIGHLIGHTS

Results from the pilot study have shown that carefully processed historical Landsat MSS<sup>1</sup> imagery can identify areas where the vegetation cover has either changed or remained stable over time. These trends appear to be useful indicators of land condition. The combination of the trend imagery and ancillary data to

1. Multi-spectral scanner aboard the Landsat satellite that acquires images at four wavelength bands in the visible and reflected infrared regions. It gives a synoptic view (180km x 180km) of changes in the rangeland.



## RESEARCH

produce image maps is an important tool for determining where to locate ground-based monitoring sites which reflect the dynamic nature of the rangelands. The image maps are also an important liaison tool for interpreting the reasons for change in consultation with property managers.

The project has also refined and implemented ground-based data collection methods which allow quantitative assessment of land condition and change. Rigorous site selection criteria for ground-based sites were developed. The adaptation of robust image processing techniques to detect change were adopted and can now be performed in-house.

Monitoring the behaviour of landscapes as well as seasonal and grazing impacts is providing knowledge for grazing pressure management. Areas exposed to heavy use can be identified and monitored to record how pasture species, soil condition and wildlife react to such treatment. By determining indicators which characterise discrete states of land condition it will be possible to provide advice on strategies for sustainable pasture management.

Spatial analysis from the paddock to regional scale is being accomplished using a combination of remote sensing and GIS analysis. By making detailed assessment of the dynamics of rangeland ecosystems it will be possible to

predict trends in land condition and provide scientific evidence to support sustainable management of the tropical savannas.

A temporal image analysis method developed by CSIRO has been incorporated in the monitoring system.

The development of a database has begun. Time series Normalised Difference Vegetation Index (NDVI) analysis from the NOAA (National Oceanic and Atmospheric Administration) satellite has been initiated with Dr Shane Cridland over the study area. Preliminary Canonical Variance Analysis (CVA) for land condition has been undertaken by Mr Jeremy Wallace.

### FUTURE DIRECTIONS

- Develop a monitoring framework for analysing land condition data
- Undertake detailed landform, surface soil and vegetation assessment of each site in the study area
- Establish research monitoring sites over properties adjacent to Victoria River Downs
- Develop image analysis methodology to enable regional extrapolation of site data
- Develop and analyse state and transition models and their thresholds
- Integrate site data with image data to develop appropriate techniques for the extrapolation of land condition assessment
- Establish additional sites in the Victoria River District.

### CORE PROJECT TEAM

Mr Rod Applegate, NTDLPE  
Ms Dominique Lynch, NTDLPE  
Mr Robert Karfs, NTDLPE  
Mr Luke Peel, NTDLPE  
Dr Paul Novelly, Ag WA  
Mr David Tongway, CSIRO DWE  
Mr Andrew Craig, Ag WA  
Mr Rodd Dyer, NTDPIF  
Ms Annette Cowie, NTDPIF  
Dr John Ludwig, CSIRO DWE  
Mr Neil McDonald, NTDPIF

### COLLABORATORS

Dr Shane Cridland, ERIN  
Ms Noelene Duckett, Ag WA  
Mr Jeremy Wallace, CSIRO  
Mr Brendan Ewing, NTDLPE  
Mr Paul Frazier, NTDLPE  
Mr Darryl Clift, NTDLPE

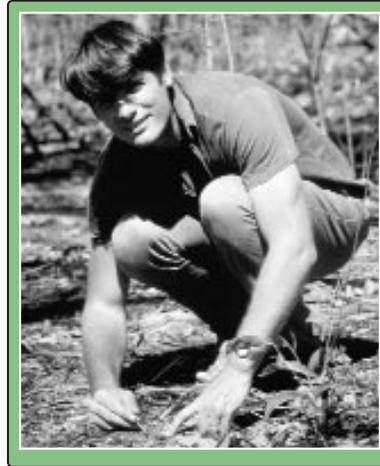
## PROJECT 3.2 INVERTEBRATE INDICATORS OF BIODIVERSITY AND ECOLOGICAL CHANGE

**Project Leader:**  
DR ALAN ANDERSEN,  
CSIRO Division of Wildlife and  
Ecology, Northern Territory

This project aims to develop protocols for using invertebrate fauna as indicators of the effects of land management practices on bio-diversity. These protocols can be incorporated into environmental monitoring programs which are an essential ingredient of sustainable management. Five invertebrate groups are being studied in detail: ants, spiders, grasshoppers, beetles and termites.

The specific objectives of the project are to:

- gain a predictive understanding of the distribution of selected invertebrate groups across Australia's savannas
- quantify their responses to different types of disturbance (land-use patterns)
- identify taxa that best provide an indication of biodiversity responses to disturbance; and
- develop a protocol for using these indicators in biodiversity assessment and monitoring programs.



*Dr Alan Andersen observes indicator species of ants in the field*

A number of research investigations took place leading up to the establishment of the centre which have made significant contributions towards Project 3.2. These studies, whose key researcher has been Dr Andersen, are providing appropriate protocols for using ants as bio-indicators in land assessment and monitoring programs.

### MILESTONES

Invertebrate ecologist Dr Tracey Churchill was recruited and locations of sampling sites on the North Australia Tropical Transect were identified. Most of the major

mines in northern Australia have conducted ant monitoring programs to evaluate the success of restoration after mining.

Projects 1.1, 2.1 and 3.2 have worked closely to ensure that, as far as is practicable, work is conducted on the same sites. Preliminary discussions have been held with personnel from Sub-Program 4, to ensure that the data collected is appropriate to their needs.

Preliminary sampling has been conducted along the Northern Australian Tropical Transect.

A study to identify optimal sampling methodology has been established.

Preliminary assessment has been made of responses of invertebrate biodiversity to grazing in Mitchell Grasslands.

### FUTURE DIRECTIONS

- Complete the methodological study identifying optimal sampling design.
- Complete the characterisation of selected invertebrates in relation to variation in rainfall and soil texture in North Australia Tropical Transect sites.
- Complete an assessment of the responses of Mitchell Grassland invertebrate communities to variations in grazing intensity.

### CORE PROJECT TEAM

Dr Alan Andersen, CSIRO DWE  
Dr Tracey Churchill, CSIRO DWE  
Ms Lyn Lowe, CSIRO DWE

### COLLABORATOR

Mr Tony Hertog, CSIRO DWE



*Ants under study as bioindicators in land assessment and monitoring programs*

Photos: CSIRO DWE

**PROJECT 3.3 SAVANNA LANDSCAPE RESTORATION****Project Leader:**

DR JOEL BROWN,  
CSIRO Division of Tropical Crops  
and Pastures, Queensland

**E**xotic weeds are a threat to both the ecological and economic sustainability of Australian tropical savannas. Weed species are widespread in range, but invasions are often limited to specific parts of the landscape, such as riparian areas. Although the amount of coverage is relatively low in terms of area occupied, these weeds have a major impact on the way landscapes function as catchments, habitats and grazing resources.

To date much of the research and technology transfer of weed management has been devoted to operational measures (e.g. chemical and mechanical control) in the belief that "if we can just kill these plants, the problem will go away". However, decades of failure and recent theoretical research has shifted the emphasis to the need for a more tactical and strategic approach that encompasses greater spatial and temporal scales.

The purpose of this project is to integrate existing knowledge about weed biology (seed production, growth rates, dispersal), savanna ecology (climate variability, soils, vulnerability to invasion) and weed control (chemical, mechanical, biological control and fire) into paddock and small-catchment strategies. The research approach is to apply mathematical modelling techniques to the problem of population spread across a variable landscape over a time-frame that encompasses extreme climatic events.

The intended output is management principles and techniques that can be developed into a pest management plan that is within a land manager's economic capacity for implementation. The goal of this project is to develop principles for restoring ecological function at the landscape level for a variety of weed types including both woody weeds and grasses.

**HIGHLIGHTS**

Much of the success of this project is dependent upon the synthesis, reinterpretation and

implementation of information held by existing research organisations. To make the best use of this information, several workshops, either sponsored in part or contributed to by the centre, have been held. In March 1995, a Woody Weed Workshop was held in Townsville involving all of the project's centre researchers. The purpose was to define the state of knowledge about problem species and identify opportunities for research.

In April 1996, the Meat Research Corporation sponsored a fire workshop in Townsville. The aim of this workshop was to improve the use of fire by land managers for multiple purposes including woody weed management. Perhaps the greatest accomplishment to date has been in gaining the interest and enthusiasm of small groups of landholders interested in participating in landscape-scale validation and refinement of existing scientific and management information.

**FUTURE DIRECTIONS**

Next year's most pressing need will be to assemble data for test catchments and integrate existing information (scientific data and local knowledge) into strategic development plans. In order to do this we plan to take a computer simulation approach to existing weed problems in the test catchments. With the involvement of land managers in those test catchments, control strategies and tactics will be designed and implemented. The challenge to both scientists and landowners at that point will be to objectively assess the impact of the strategies on landscape restoration goals.

The project is also undertaking a property level economic assessment of prickly acacia on the

Mitchell Grass Downs of western Queensland. The research will be used to provide a regional perspective across the Downs on the economic impact of prickly acacia.

**CORE PROJECT TEAM**

Dr Joel Brown, CSIRO TCP  
Mr Joe Vitelli, QDNR  
Dr Shane Campbell, QDNR  
Mr Mark Ashley, NTDPIF  
Dr Bill Palmer, QDNR  
Mr Elton Miller, QDNR  
Mr Chris Gardiner, JCU

**SUB-PROGRAM 4 SUSTAINABLE MANAGEMENT**

*Sub-Program Leader:*  
DR ROSS HYNES,  
CRC Tropical Savannas,  
Townsville,



*Associate Leader:*  
MR GRAHAM KIRBY  
Department of Primary  
Industry and Fisheries,  
Darwin



The role of Sub-Program 4 is pivotal to the centre's focus on sustainable development. It aims to develop better management options for land managers and policy-makers by concentrating on the interactions between ecology and production rather than separately on the ecology or the production of the savannas. These interactions span the various industry and community sector activities in the savanna region. With the results of its research the sub-program seeks to contribute to better decision-making within these sectors. The strategy is necessarily socio-economic and incorporates the

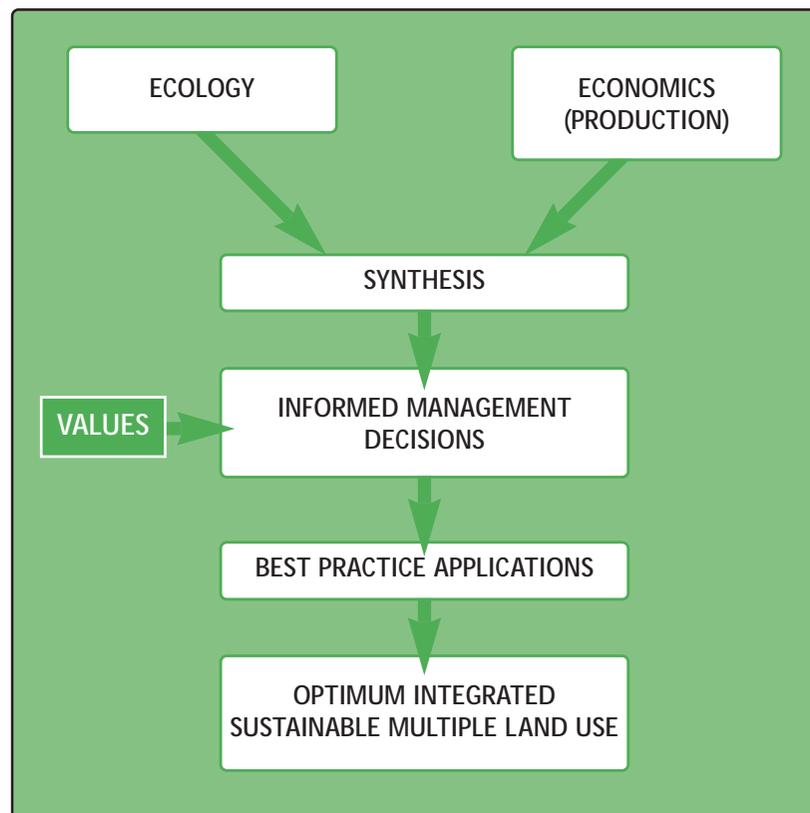
biophysical research of the savannas carried out in Sub-Programs 1 to 3.

Considerable effort was spent this year in developing the structure and focus of the sub-program. It is supported by a large number of investigations in various stakeholder sectors which have been initiated and supported by the parties to the centre. The role of the sub-program is to integrate the outcomes of these activities and use them in developing management options with our stakeholders. As the centre develops, it is planned that these activities will be further

integrated with the centre program. In this section we describe the structure of the sub-program as it has developed this year and then report on some of the research highlights from activities.

The prime objective of the sub-program is to maximise the net social benefit of the tropical savannas to the savanna and wider communities by promoting sustainable development of major savanna enterprises and regions. It will do this by providing better information and procedures for decision-making by savanna managers and policy makers.

Diagram 3 shows how ecological and economic elements and social values are brought together in the sub-program.



*DIAGRAM 3  
The broad conceptual relationships  
within Sub-Program 4*

## RESEARCH

Integration is the key to the research and development strategy of Sub-program 4. This is expressed through its four projects which are summarised below. Diagram 4 provides a structural overview of the links between these projects.

### PROJECT 4.1 SAVANNA INFORMATION MANAGEMENT

Information must be accessible to savanna researchers and to savanna decision makers. Information (communications, data and models) is the focus of Project 4.1. This project is facilitating the development of a virtual savanna community and through this, the networking of existing databases and models.

### PROJECT 4.2 SOCIAL AND RESOURCE VALUATION

Savanna cultural perspectives (indigenous, settler and scientific) and their social dynamics form the basis for all the savanna values. The construction, modification, transmission and institutionalisation of values is a social process. Market values (for commodities), non-market values (for ecological attributes such as biodiversity) derive from social processes and must be incorporated into all savanna resource management decisions. Market (priced) values are readily available from external sources. Cultural and non-market values form the focus of Project 4.2.

### PROJECT 4.3 MANAGEMENT OPTIONS

The various savanna management enterprises usually need to make difficult trade-off decisions between the level of production and the level of ecological integrity in order to achieve sustainable development. Managers of individual savanna enterprises require information about how the style and intensity of savanna use (such as cattle grazing pressure, tourist densities and food harvesting) jointly affects the levels of both production and ecological resources.

The trade-off decisions require information on the biophysical relationships between enterprise production and ecological integrity, as well as prices of commodities produced, cultural and non-market values of ecological attributes and related issues such as scale and risk. Project 4.3 aims to develop management systems which take account of all these issues and provide tools to allow managers make balanced decisions on best practice.

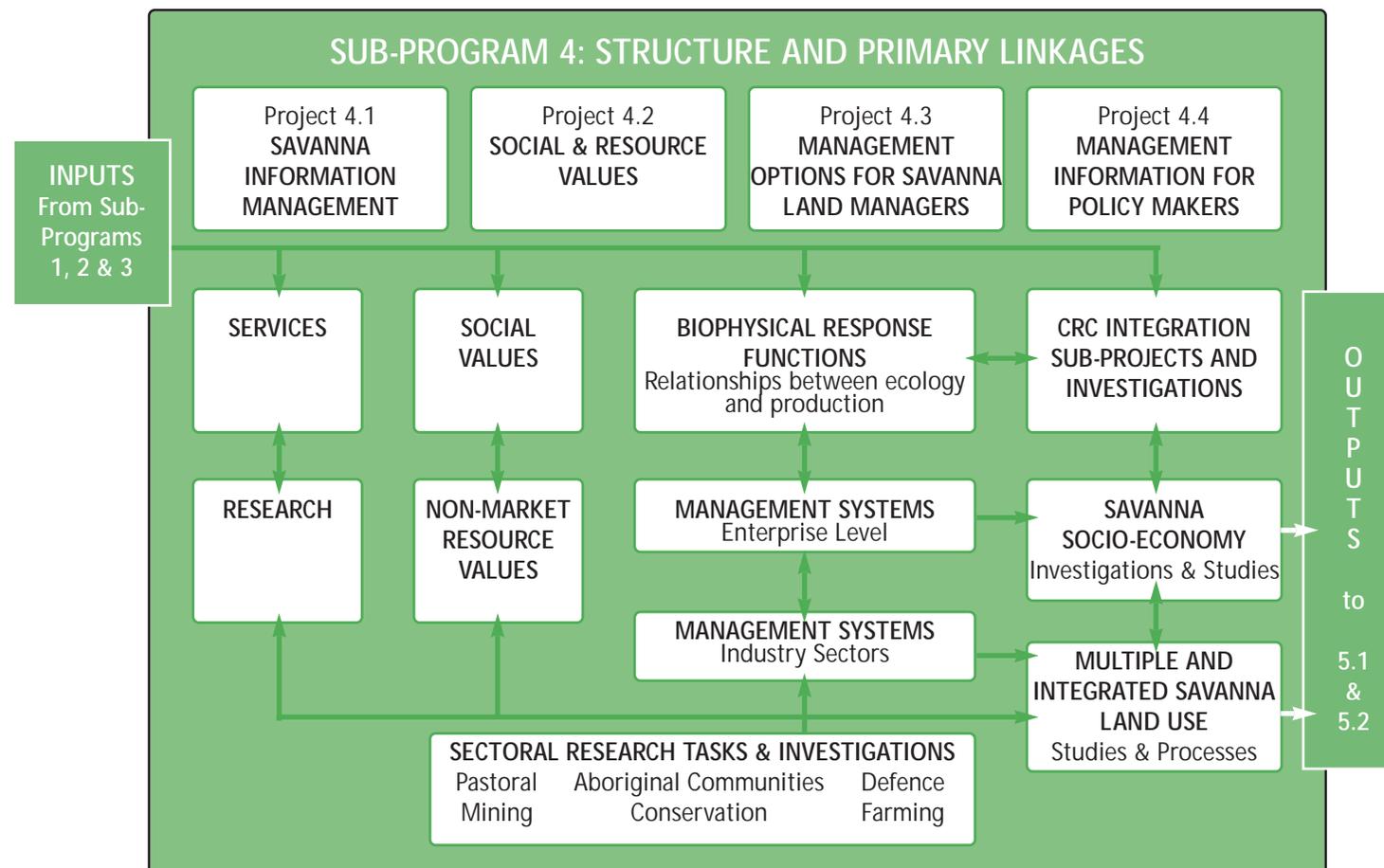


DIAGRAM 4 A structural overview of the project components making up Sub-Program 4

#### PROJECT 4.4 MANAGEMENT INFORMATION FOR POLICY-MAKERS

A balance between the level of different enterprises is usually necessary in order to maximise the net social benefit. This balance is additional to individual enterprises achieving sustainable development. Balance is achieved through regional savanna planning policies and practices leading to options for integrated and multiple land uses. To achieve this balance, policy makers must have information on the competitive or complementary relationships between

enterprises (or sectors of the economy) and the relative values of these different savanna activities. A range of political, legal, institutional, economic, administrative and social arrangements exist that influence regional savanna planning. While Project 4.3 provides the research information on how the enterprise sectors can best perform to maintain sustainable production, the focus of Project 4.4 is the development of better ways to achieve balances between enterprises.

#### PROJECT 4.1 SAVANNA INFORMATION MANAGEMENT

**Project Leader:**  
MS JEAN STEVENS,  
Northern Territory University

In such a large and diverse organisation it is vital that the information needs of the researchers be efficiently met. These needs include communication through networks, data access through networking and application of models incorporating data access. The aim of this project is to provide effective information technology services and research on computing needs to the centre, its participating researchers and other stakeholders.

An evaluation of the computer requirements of the centre emphasised the need for the immediate implementation of a virtual community using Email and the Internet to facilitate information exchange between researchers across the savannas. It also identified the urgency of establishing a data clearing house, where data can be converted to alternative formats and its collection, storage and developmental history processed.

The NTU School of Information Technology, which is leading and coordinating the project, is responsible for the

##### CORE PROJECT TEAM

Ms Jean Stevens, NTU  
Ms Barbara Tuck, NTU  
Dr Alex Kruchkoff, NTU  
Mr Richard Irvine, NTU

##### COLLABORATOR

Mr Todd Edwards, NTU  
(PhD student)

implementation of the project's two major themes. It will also assist where practicable in providing necessary information technology skills to researchers and centre staff. The project has two themes as outlined below.

##### THEME 1 ESTABLISH AND PROVIDE COMPUTING SERVICES

- Identify and implement software and hardware capacity to establish the centre as a virtual community
- Assist in the appointment of an information technology facilitator
- Establish a data clearing house facility
- Implement the LWRRDC bibliographic database for tropical savannas for centre researchers and other stakeholders

##### THEME 2 INITIATE AND CONDUCT RESEARCH OF THE CENTRE'S COMPUTING NEEDS

- Continue research on developing and maintaining a virtual community for the centre
- Ensure accurate delivery of data to researchers with restricted access to the Internet
- Identify problems in the interchange of data formats
- Conduct research into representative data sets and meta-data (information about the data itself) management
- Investigate the use of the World Wide Web as a tool for information exchange

**PROJECT 4.2 SOCIAL AND RESOURCE VALUES**

*Project Co-leader:*  
MR GRAHAM KIRBY,  
Department of Primary  
Industry and Fisheries,  
Northern Territory



*Project Co-leader:*  
DR DEBORAH BIRD ROSE,  
North Australia Research  
Unit, ANU, Northern Territory



**S**ocial perceptions and attitudes form the basis of all savanna management and development policies and practices. People bring to the savannas their historical cultural values, the attitudes and values fostered by society at local and national levels, information received through a range of technical and mass media and the social networks through which information is communicated, assessed and acted upon.

A clearer understanding of these different cultural perceptions and values opens up the prospect of a richer and more diverse set of options to develop and manage the savannas sustainably. Three important knowledge systems exist in the savannas: indigenous, settler and scientific. If the centre can facilitate the convergence of these systems it will open synergies for community empowerment in the sustainable development of the savannas.

Historically, the costs and benefits associated with social and ecological components have not been included adequately in the management of savanna enterprises. Increasing social and political pressures now require more accountable outcomes to meet the practical requirements of sustainable development. The project seeks to understand the different cultural perceptions among savanna users and managers and define and quantify non-market resource values critical to savanna management. The application of research methodologies to value non-market resources in the tropical savanna is new, with the exception of a much earlier study of Coronation Hill in Kakadu. Research planning for the centre included consultation with the Australian Bureau of Agricultural and Resource Economics, and with the research unit of AGB McNair in Sydney.

The project is divided into two sub-projects: Project 4.2.1 Social Values and Project 4.2.2 Non-Market Resource Values. Within the sub-projects are research themes with complementary tasks and investigations.

**PROJECT 4.2.1 SOCIAL VALUES**

**THEME 1  
ABORIGINAL SAVANNA RESEARCH  
AND DEVELOPMENT NEEDS**

- Negotiations between the centre and the Indigenous Land Corporation
- Aboriginal savanna culture and indigenous knowledge
- Indigenous management values
- Regional land use planning strategies for Australia's rangelands: stakeholder values and perceptions
- Studies on indigenous knowledge
- Investigations on linguistics and social anthropology
- Analyses of pre-European contact demographic and ecological changes

**THEME 2  
SETTLER SAVANNA CULTURE**

- Settler culture: frontiers
- Social identity and ecological knowledge in the pastoral community
- History of ecology and land use through settler records

**SUB-PROJECT TEAM**

*(Core Researchers)*  
Dr Deborah Bird Rose, NARU  
Mr Graham Kirby, NTDPIF  
Dr Greg Crough, NARU  
Ms Catherine Mobbs, NARU  
(PhD student)

**COLLABORATORS**

Professor Marcia Langton,  
FATSIS, NTU  
Ms Cathy Robinson, NARU  
(PhD student)

## SUB-PROJECT 4.2.2 NON-MARKET RESOURCE VALUES

### THEME 1

#### NON-MARKET USES AND VALUES

- Identification of non-market uses and values
- Review of non-market valuation methodologies
- Selection and adaptation of suitable valuation methods for the savannas

- Negotiation of use of existing monitors

### THEME 2

#### ECONOMY OF NON-MARKET SAVANNA RESOURCES

- Ecological values
- Biodiversity
- Sustainable indicators

- Weeds

- Tourism values

- Mixes of non-market and market values

### SUB-PROJECT TEAM

(Core researchers)

Mr Graham Kirby, NTDPIF

Mr John Koldowski, NTTC

## PROJECT 4.3 MANAGEMENT OPTIONS FOR SAVANNA LAND MANAGERS

### Co-leaders:

DR ROSS HYNES ,  
CRC for Tropical Savannas,  
Queensland,  
MR GRAHAM KIRBY,  
Department of Primary Industry  
and Fisheries, Northern Territory

Currently, the principal land activities in the tropical savannas are pastoral, mining, tourism, Aboriginal community resource use and conservation. The key challenges facing these social groups and enterprise users are firstly their profitability (or ability to produce net benefits) and secondly the ecological changes associated with their activities. This project aims to identify balances between maintaining productivity and sustaining ecological integrity at a property and enterprise level. While a wide range of uses in the savannas exist, the centre seeks to provide relevant advice on potential solutions to stakeholders. Final decisions on management must clearly be stakeholder driven.

For the pastoral industry, Project 4.3 is evaluating the profitability and impact of improved grazing management systems. For Aboriginal communities, the project is evaluating economic

savanna development prospects and the harvest management of traditional food species. For tourism, the project is evaluating economic savanna development prospects and the impact of tourist densities. For mining, the project is evaluating economic development prospects through savanna resource access and evaluating savanna water, vegetation and land management and rehabilitation associated with mining. For conservation, the project is providing a better understanding of the value of ecological functions and biodiversity and is evaluating better ways to promote conservation through changed attitudes to enterprise production.

The prospects for savanna economic development and enhanced savanna management systems require two essential sets of information. Firstly, information is being collated on the biophysical relationships between the ecological productivity of the land (how well it sustains life) and the production of commodities from the land (such as those from pastoral and mining uses). Secondly, information is being collated on the relativities between the prices of these commodities

and the non-market values of the ecosystems under investigation.

When these relationships are established balances can be identified where stakeholders can achieve the highest level of production while maintaining the greatest amount of biodiversity. The centre can then provide advice to stakeholders on identifying those optimal solutions, as well as offering a flexible range of pathways to provide assistance that will lead to sustainable outcomes. The project comprises three sub-projects that seeks to integrate progressively a large number of tasks and investigations across all savanna sectors.

These sectoral investigations provide essential inputs and support the integration processes of Project 4.3 (see Table I). These have been initiated and are largely supported by the parties to the centre. They will form the basis from which the project will develop options with our stakeholders. As the centre develops, it is planned that these activities will be further integrated with the centre program. Outlines of the sub-projects follow.

**SUB-PROJECT 4.3.1 RELATING ECOLOGY AND PRODUCTION**

This sub-project has three tasks. The first two collate information on ecological functions and enterprise production in response to changes in the intensity and style of savanna use. The third task takes these two sets of data to generate integrated ecological-production response functions that can provide potential options for sustainable savanna use (see Diagram 5).

Specific information that defines the relationship between land use intensity and ecological and production processes will be provided as outputs from projects in Sub-Programs 1 to 3 and appropriate external sources.

Activities related to these outputs have been initiated.

**SUB-PROJECT TEAM**  
*(Core Researchers)*

Dr Ross Hynes, CRC SDTS  
Mr Graham Kirby, NTDPPIF  
Ms Valerie Hristova, NTDPPIF  
Mr Shiw Murti, NTDPPIF

**SUB-PROJECT 4.3.2 SUSTAINABLE MANAGEMENT SYSTEMS**

**THEME 1**

**COLLATION OF COMMODITY PRICES AND NON-MARKET AND SOCIAL VALUES**

- Identify relevant social processes for decisions on how values are placed on different savanna resources
- Adapt Bayesian<sup>1</sup> procedures to incorporate missing information and risk and uncertainty into savanna decision-making processes
- Give mathematical descriptions of price/value response functions.

**THEME 2**

**PROVIDE SUSTAINABLE MANAGEMENT MODELS TO INDIVIDUAL ENTERPRISE MANAGERS**

- Seek to integrate local best practice with decision support packages for sustainable enterprise management.

**SUB-PROJECT TEAM**

*(Core Researchers)*

Dr Ross Hynes, CRC SDTS  
Mr Graham Kirby NTDPPIF  
Dr Mick Quirk, QDPI  
Dr Joe Scanlan, QDNR  
Assoc Prof Richard Monypenny, JCU

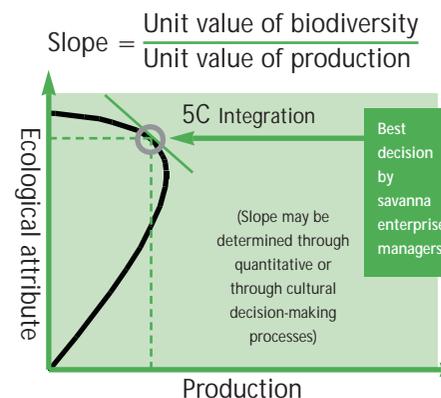
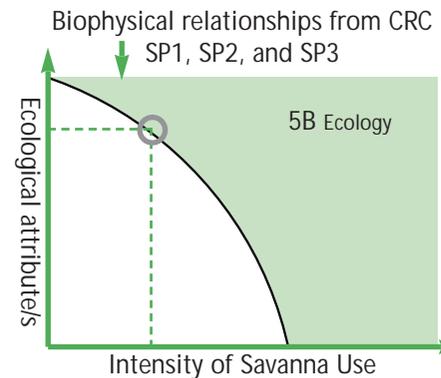
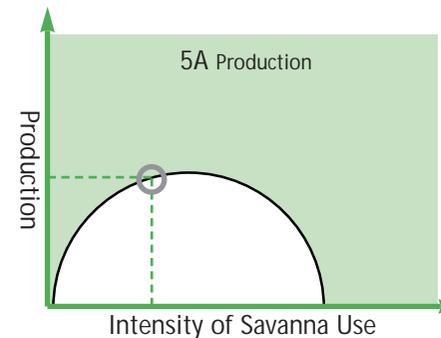


DIAGRAM 5 The focus of Project 4.3 is decision-making on the interaction between production and ecological attributes (e.g. biodiversity). Graph 5c is the resultant of the interaction of graphs 5a and 5b

1. Bayesian statistical procedures provide simple rules for the management of uncertainties based on the laws of probability. They provide a framework for coherent decisions in the face of uncertainty or where incomplete data sets only are available.

### SUB-PROJECT 4.3.3 *SUSTAINABLE INDUSTRIES*

This sub-project aims to develop industry-wide models and templates that can be used to monitor management progress for individual property or enterprise managers within industry.

#### SUB-PROJECT TEAM

*(Core Researchers)*

Mr Graham Kirby, NTDPIF

Dr Ross Hynes, CRC SDTS

**TABLE 1 SUSTAINABLE MANAGEMENT SECTORAL INVESTIGATIONS: PROJECT 4.3**

#### (A) CURRENT ACTIVITIES

<i>SECTORAL INVESTIGATION</i>	<i>RESEARCHERS</i>	<i>ORGANISATION</i>
<b>PASTORAL INDUSTRY</b>		
Analysis of savanna pastoral economy	G. Kirby S. Murti	NTDPIF
Modelling distribution and grazing patterns	V. Hristova	NTDPIF
Grazing management trial — differential preferences	P. Novelly	Ag WA
Mt Samford stocking rate trial	P. Novelly	Ag WA
Savanna pastures greening index	G. Kirby	NTDPIF
Analysis and interpretation of land resource data	R. Andison	NTDPIF
Economic impact and control of woody weeds case studies	M. Quirk, J. Scanlan	QDPI, QDNR
Development of an expert system for grazier use	V. Hristova, E. Miller	NTDPIF, QDNR
North Queensland stocking rate demonstrations	G. Fordyce	QDPI
Paradigm shifts in sustainable management systems	K. Shaw	NTU
Grazing system — economic management packages	P. Smith, J. Kernot	QDPI
Coordination, facilitation and editing of publications	B. Holmes	QDPI
State and transitional modelling	R. Hynes	CRC SDTS
	G. Kirby, J. Scanlan,	NTDPIF, QDNR,
	D. Howe	NTDLPE
Systems analysis of management options for grazed woodlands	G. McKeon, J. Scanlan	QDPI, QDNR
<b>MINING INDUSTRY</b>		
Consultancy to assess R&D priorities of centre for mining industry	B. Wilson,	Terra Search
Analysis of the savanna mining economy	S. Beams	Pty. Ltd.
Savanna mineral resource access	K. Hooper	NTDME
Community employment prospects at mine locations	K. Whelan	NTDME
	K. Whelan	NTDME
<b>TOURISM INDUSTRY</b>		
Institutional arrangements	P. Tremblay	NTU
Outback tourism in the savannas	N. Black	JCU
Non-government involvement in protected area management	T. Nevard, F. Barron	JCU, CRC TREM
Tourism and sustainable management	N. Black J. Rutledge	JCU
	T. Li-Sofield	JCU
Cobbold Gorge site management plan	R. Hynes	CRC SDTS
<b>OTHER SAVANNA ENTERPRISES</b>		
Economics of conservation farming	G. Kirby	NTDPIF
Ecology of sustainable management of defence training areas — fire regimes	G. Calvert	JCU



**TABLE 1 SUSTAINABLE MANAGEMENT SECTORAL INVESTIGATIONS: PROJECT 4.3**

<b>(B) DEVELOPING ACTIVITIES</b>		
<i>SECTORAL INVESTIGATION</i>	<i>RESEARCHERS</i>	<i>ORGANISATION</i>
<b>PASTORAL INDUSTRY</b>		
Grazing management strategies for seasonably variable tropical savannas (including evaluation of relationships between production and biodiversity)	P. O'Reagain J. Woinarski C. Cieloska G. McKeon A. Andersen	QDPI, NTPWC, QDNR QDNR QDNR
Biophysical framework for total property planning	M. Quirk, K. Day, R. Shepherd, J. Rolfe, P. Smith, G. Rogers, J. Scanlan.	QDPI, QDNR QDPI QDPI QDPI QDNR

<b>(C) PROPOSED ACTIVITIES</b>
<i>SECTORAL INVESTIGATION</i>
<b>PASTORAL INDUSTRY</b>
Economic analysis of industry data and review of grazing trials Non-cattle components of grazing management systems Reconciliation of agro-ecological zones with interim biogeographic regions.
<b>MINING INDUSTRY</b>
Mining savanna impact assessment and rehabilitation
<b>TOURISM INDUSTRY</b>
Tourism savanna models and information extension packages Sustainable processes for Aboriginal community tourism Ecotourism research, Cobourg Peninsular, NT Savanna sustainable tourism capacity and impact
<b>ABORIGINAL COMMUNITIES SECTOR</b>
Sustainable economic development opportunities Dynamics of sustainable Aboriginal food species

## PROJECT 4.4 MANAGEMENT INFORMATION FOR POLICY MAKERS

### *Co-leaders:*

DR GREG CROUGH,  
Northern Australian Research Unit,  
ANU, Northern Territory

MR GRAHAM KIRBY,  
Department of Primary Industry  
and Fisheries, Northern Territory

Project 4.4 is the centre's key integration project. Its objective is to develop options for regional policy-makers that enable optimal balances between savanna uses through multiple and integrated savanna practices. Savanna policy-makers are concerned with two key issues, firstly the sectoral and resource balances and secondly the institutional arrangements underpinning regional management in the tropical savannas.

This vast region is a significant contributor to Australian culture,

biodiversity and the economy, but of course competes for developmental capital with other areas. Optimising wealth creation and social equity demands a clear understanding of sectoral priorities and of the integration of 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 perceptions of market failure situations.

While pastoralism remains a dominant form of land use in the tropical savannas, there is a rapidly growing use of other, often conflicting, purposes. Conservation, tourism, Aboriginal and regional communities, farming, defence and mining are all expanding activities with the

capacity to increase pressure on existing resources. The achievement of sustainable development requires urgent attention to multiple resource use management to improve productivity in balance with ecological integrity. However, the barriers and opportunities to effective multiple savanna use are poorly understood. They include property rights, national and international obligations, equity, 'market failure' risk and social and institutional arrangements.

This project comprises three sub-projects which evaluate cross-sectoral information to understand the savannas in both regional and global contexts. Each sub-project is supported by a range of tasks and investigations.

### SUB-PROJECT 4.4.1 SAVANNA-WIDE INTEGRATION

This sub-project aims to provide a wide-window profile of the tropical savannas, by describing and analysing the region's major characteristics. Information will be obtained from all of the centre's research sub-programs as well as a wide range of outside agencies and groups. Two publications are in the planning stages. The first will provide a description and analysis of savanna society, economy, ecology and resources. The second will provide a

complementary overview of spatial relationships expressed in maps and statistics. These will include a range of basic attribute maps in conjunction with a series of derived maps e.g. a map reconciling savanna agro-ecological zones with biogeographic regions.

Another major research theme (perhaps the most important in the centre) is the development of socio-economic-ecological models

of the savannas. It aims to produce integrating thematic analyses and models that can provide an overview of the socio-economic and ecological factors that drive the savannas.

#### SUB-PROJECT TEAM

##### *(Core Researchers)*

Dr G Crough, NARU

Mr G Kirby, NTDPIF

Dr R Hynes, CRC SDTS

**SUB-PROJECT 4.4.2 SAVANNA SOCIO-ECONOMY**

Sub-Project 4.4.2 aims to provide a comprehensive, integrated analyses of Australia's tropical savanna biome that incorporates a background of pre-European Aboriginal land use and the development of modern savanna-based industries. It also seeks to identify a wide range of current and potential savanna uses. Further, it is describing the key characteristics of the savanna economy in terms of population and social issues, property rights and the mining, agricultural and tourism industries. There are three research themes as follow.

**THEME 1**  
**SAVANNA SOCIO-ECONOMY AND ITS GLOBAL CONTEXT**

This theme aims to compare and contrast Australia's savanna region in a global context. Research links are being developed with savanna regions in Africa and the South East Asian sub-continent.

**THEME 2**  
**SAVANNA COMMUNITIES — PEOPLE AND PROCESSES**

There are a number of serious challenges facing many smaller savanna communities, particularly those with relatively large populations of indigenous people. These challenges include the availability and cost of water, fuel and food resources; employment, particularly in resource-based industries; and financial constraints due to changes in the priorities of governments. Many indigenous communities are characterised by high rates of population growth, poor

infrastructure, serious health problems and pressure on the existing resources. The future of such communities will be the subject of ongoing research in the centre which will include work on:

- Population analysis of savanna communities
- Community land management
- A regional assessment of dry season grazing areas in Cape York community and pastoral lands
- Community decision-making patterns for sustainable rural futures

**THEME 3**  
**SAVANNA INFRASTRUCTURE — OVERVIEW AND ANALYSIS**

Investigations focus on developing profiles of infrastructural variation across the savannas in terms of settlement patterns, community groups,

sectoral patterns and government delivery systems. The results seek to identify variations in service delivery and gaps in service provision, as well as insights into towns and hinterland relationships and the effectiveness of existing infrastructural networks.

**SUB-PROJECT TEAM***(Core Researchers)*

Mr Graham Kirby, NTDPIF  
Dr Greg Crough, NARU  
Mr Ken Hooper, NTDME  
Dr Ram Vemuri, NTU  
Dr David King, JCU  
Assoc Prof Richard Monypenny, JCU  
Mr Jim Monaghan, JCU  
Mr Colin Macgregor, JCU (including PhD project)  
Mr Shiw Murti, NTDPIF

**COLLABORATORS**

Ms Dorothy Anyango, JCU (MSc student)  
Mr John Koldowski, NTTC

### SUB-PROJECT 4.4.3 MULTIPLE AND INTEGRATED SAVANNA USE

At a regional level the adjustments that lead to sustainable outcomes in land use can be achieved by using integrated approaches that accommodate a rigorous understanding of land capability potential of the land system. Stakeholder values and decision pathways are sought that can lead to an optimum balance of land allocation for sectoral and social groups, within a sustainable framework (see Diagram 6).

The following research themes examine and build on an understanding of the complexities of the issues involved and processes relevant in land use planning. They examine legal issues and opportunities for achieving integrated land use and methodologies at a regional level that can provide ways of achieving sustainable outcomes. The sub-project has three themes as follow.

#### THEME 1 LAND USE PLANNING

- Policy input to Indigenous Land Corporation as it develops its National Land Strategy 1996-2001 to develop a strategic approach to explore the issues and opportunities for land held by Aborigines.

- Review of existing land use regional studies
- Investigations assisting traditional land owners in the Arafura Catchment in Arnhem Land to identify, refine and adopt sustainable management practices consistent with their community aspirations.
- Participation in the Caring for Country initiative of the Northern Land Council in a cooperative environment of information exchange for Aboriginal land owners.
- Dalrymple and Desert Uplands integrated land use case study (initiated)
- Mary River integrated land use case study (initiated); Victoria River District (planned)
- Lower Ord River integrated land use case study (planned)

#### THEME 2 LOCAL AND REGIONAL AGREEMENTS

- Kakadu joint management plans (current)
- Regional agreements in south and south-west Kimberley (current)

- Resource development options — Aborigines and mining companies (current)
- CYPLUS and Cape York agreements (initiated)

#### THEME 3 CONSERVATION AND INTEGRATED LAND USE

- Socio-economic issues in Northern Territory Reserves System (current)
- Savanna legal basis of land tenure (report completed)

#### SUB-PROJECT TEAM

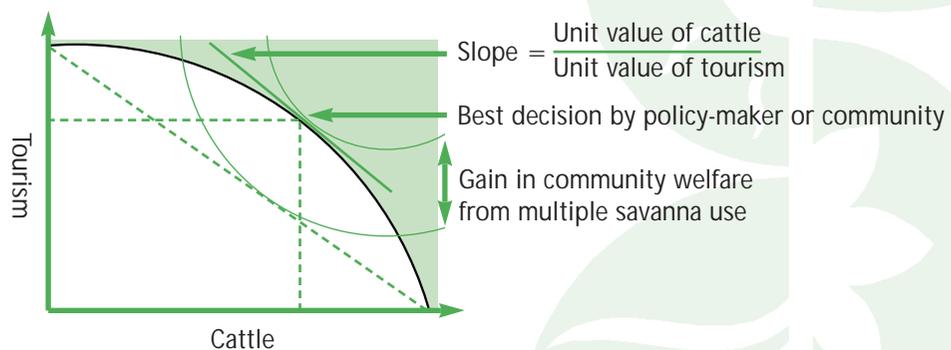
##### (Core Researchers)

Mr Graham Kirby, NTDPIF  
Ms Freya Dawson, NTU  
Dr Greg Crough, NARU  
Dr Ross Hynes, CRC SDTS  
Mr Peter Whitehead, NTPWC  
Dr John Woinarski, NTPWC  
Dr Jeremy Russell-Smith, NTFB  
Dr Patrick Sullivan, NARU

#### COLLABORATOR

Dr David Lawrence, NARU

DIAGRAM 6 The project focuses on decision-making about multiple and integrated savanna use (example uses tourism and cattle production)



HIGHLIGHTS OF SUB-PROGRAM 4 ACTIVITIES

**INFORMATION TECHNOLOGY**

The computer requirements of the centre were evaluated this year through a consultancy undertaken by the School of Information Technology at NTU. Focus group meetings took place in Charters Towers, Townsville, Darwin and Kununurra with a range of parties to the centre and centre staff. The report showed that while provision of hardware and software was generally adequate, it was uneven. Large file transfer and access to networks was found to be problematic. It also reported that some researchers may need

information technology assistance to develop essential predictive models.

The report recommended the immediate implementation of a virtual community using Email and the Internet to facilitate information interchange between researchers across the savannas. The appointment of an information technology officer was identified as essential to assist researchers with access to data sets, databases and other information. The implementation of a data clearing house, where data can be converted to

alternative formats and its collection, storage and developmental history processed, was also recommended. Digital/DEC has indicated a willingness to provide high quality hardware at low cost to support the establishment of a data clearing house. The appointment of a lecturer in geographic information systems at NTU was also strongly recommended.

*Principal Researcher:*  
MS JEAN STEVENS, NTU  
Project 4.1

**BIOPHYSICAL FRAMEWORK FOR TOTAL PROPERTY PLANNING**

Management of grazing pressure is a major pathway to sustainable use of tropical savannas, particularly in the Burdekin catchment of North Queensland. Encouraging holistic property management requires a biophysical framework that can spatially integrate information about resource inventory, vegetation dynamics, and forage and animal production. This will provide a context for understanding grazing management for each land type and allow for strategic and tactical assessment of stocking options on a paddock basis.

The core of the investigation is to integrate knowledge on a land systems/land type basis. In this way, information on resource inventory, community ecology (within a state and transition framework), forage production modelling, foraging behaviour of domestic and wild herbivores and animal production will be provided in a suitable format. This will allow questions regarding long-term carrying capacity and trade-offs between tactical stocking decisions and land condition to be addressed.

The investigation is initially focusing on the Dalrymple Shire of

North Queensland, but will also provide a methodology that can be applied throughout the tropical savannas. Development of this work is proceeding well. There has been strong interest from the MRC, CSIRO, QDNR and QDPI. The project will be a focus of the rangeland program in the Grazing Land Management Unit (GLMU) based at Charters Towers.

*Researcher:*  
DR MICK QUIRK, QDPI  
Project 4.3

**SYSTEMS ANALYSIS OF MANAGEMENT OPTIONS FOR GRAZED WOODLANDS**

Grazing trials have been conducted in northern Australia examining the impact of different stocking rates on animal performance and the composition and stability of pasture. Currently work is under way to analyse these trials further to establish the level

of utilisation (i.e. the amount of pasture eaten compared with the amount produced) used in the trials rather than simply the stocking rate.

This will enable trials from different regions to be compared on a common basis. In many cases the level of safe utilisation (i.e. the level which does not cause

undesirable pasture composition changes) is in the range from 15 to 25 per cent even though the related stocking rates may be in the range from 2 to 30 ha/head.

*Researcher:*  
DR JOE SCANLAN QDNR  
Project 4.3

#### STATE AND TRANSITION MODELLING

State and transition models are currently used as a communication tool in the pastoral industry. There are two possible enhancements in this area. Firstly, current state and transition models should be used as analysis tools as well as communication tools. Preliminary work has identified the possibilities of doing this, but

these have yet to be tested in a grazing system which has sufficient data for such an analysis. In conjunction with the project on grazing systems, a state and transition model of an area within the tropical savannas will be developed and analysed using tools developed to date.

The other enhancement is to use state and transition models in non-

pastoral industries. For example, it should be possible to use state and transition models to describe tourist sites, their level of use and the impacts of change in condition of those sites on visitor numbers and/or enjoyment.

**Researcher:**  
DR JOE SCANLAN QDNR  
Project 4.3

#### ECONOMIC IMPACT AND CONTROL OF WEEDS

Weed infestations and their effect on productivity and the environment are a growing problem throughout the Australian savannas. The study on the economic impact of weeds in the Northern Territory is complementing similar studies in Queensland. Weeds in the context of this study are pest plants of exotic origin.

The study is examining the present and potential costs of weeds to the pastoral industry of the Northern Territory due to loss

of production. It identifies the area over which each noxious weed occurs and its likely impact on the pastoral industry. This gives a measure of the loss of pastoral production due to weed. The study then determines from present knowledge the potential spread of each weed, its potential impact on the pastoral industry and its potential cost in loss of production in 10 years time.

Preliminary results indicate that the most threatening weeds affecting pastoral production at present are, in decreasing order,

*Parkinsonia aculeata* (Parksonia), a group of weeds (*Sida* spp., *Hyptis suaveolens* and *Senna* spp.), *Calotropis procera* (Rubber bush) and *Jatropha gossypifolia* (Bellyache bush). Those weeds expected to show the greatest relative impact on increase in production loss over the next decade are *Mimosa pigra* (Mimosa) and *Tamarix aphylla* (Athel pine).

**Researcher:**  
MS VALERIE HRISTOVA, NTDPIF  
Project 4.3

#### SUSTAINABLE SAVANNA TOURISM — CAPACITY AND IMPACT

The aim of this investigation is to assess the relationship between nature-based tourism enterprises and the carrying capacity of the environment in the savannas. As well, it will provide advice on sustainable tourism in terms of natural resource use. Current figures forecast that tourism in Australia will rise to five million visitors by 2000 and 10 million by 2010. Nature-based tourism in the tropical savannas will be an important component of this increase.

There are four major components of this investigation:

- To identify the contractual, legislative and financial instruments which facilitate non-government and private sector involvement in the management of areas of conservation value
- To produce an inventory of initiatives in Australia and overseas (particularly Southern Africa and Northern South America) where private and non-government sectors are managing areas of conservation value in accordance with acknowledged performance standards
- To identify the willingness to pay for wildlife tourism experiences through a series of surveys in appropriate locations within Australian savanna areas

- To establish the Gurig Research Centre at Seven Spirit Bay on the Cobourg Peninsula, Northern Territory.

To date a business plan for the Gurig Research Centre has been drafted, and an agreement outlined with the resort owners there and the Parks and Wildlife Commission of the Northern Territory for the establishment of the centre. Through the development of a field research facility in a unique savanna location, the centre proposes to contribute to the ecotourism experience for visitors to Seven Spirit Bay. The research station will be developed under cooperative arrangements with the Aboriginal Landowners of the Cobourg Peninsula.



## RESEARCH

The investigation has also developed a database of 386 private sector and non-government initiatives in Southern Africa and approximately 25 in Australia and North, South and Central America. The work will also seek to identify

a range of initiatives that perform to recognised sustainability standards. This will directly address tourism sector needs for greater participation in the conservation management process.

**Researcher:**  
MR TIM NEVARD, JCU  
Project 4.3

### ECONOMICS OF CONSERVATION FARMING

This study has made a first assessment of the economic issues and likely benefits of conservation farming in the semi-arid tropics (SAT) of northern Australia. The distribution, value and major trends in the enterprises comprising the agricultural sector of the SAT have been identified to provide an industry context.

The study has focused on the likely economic benefits from adopting conservation tillage and ley farming, using legume ley pasture and crops in various systems. For the farmer, the economic benefits from mulch retention with no-till or reduced till technologies are variable, with the benefits more likely to be larger in drier growing seasons.

The expected benefits are derived mainly through increased yields. Based on the early results of experiments and modelling of ley farming technologies in the SAT, the economic benefits to be derived from the commodity synergies vary with the frequency of grain cropping, the legume species used and the commodity price relativities. Some ley farming systems are more profitable than single enterprises in the short term. In the long term, the choice for sustainable farming systems appears to be between a legume pasture system and legume and legume pasture crop system.

Given the promise of important economic gains from ley farming systems, experimental designs need to be modified to incorporate higher cropping

frequencies and more comprehensive joint product measures in order to allow a more critical economic assessment.

Wider benefits are likely to flow from the adoption of conservation farming technologies to commodity consumers. This will occur through commodity price changes and to society generally through beneficial on-farm and off-farm effects on the environment, such as reduced sediment pollution in the aquatic ecosystems.

**Researchers:**  
MR GRAHAM KIRBY, MS VALERIE HRISTOVA AND MR SHIW MURTI, NTDPIF  
Project 4.3

### COMMUNITY DECISION-MAKING PROCESSES AND SUSTAINABLE OUTCOMES AT LOCAL GOVERNMENT LEVEL

If a sustainable society is to prevail in the savannas, then town planners need to ensure that ecological integrity is not compromised by community development. At the same time, equity processes need to be integrated into town planning structures. This investigation involves the design and testing of a land-use planning model for the savannas. It also seeks to provide

guidelines to local authorities for the sustainable development of their communities with an emphasis on the sustainability of environmental integrity and biological diversity. A baseline field survey of 19 savanna towns has been completed.

Ultimately the investigation seeks to refine a new land-use planning model. This is intended to integrate sustainability principles and economic influences with professional and local community aspirations for

development and environmental protection. The urban model developed should be able to be applied not only to the specific regions or hinterlands in question, but to any area where urban and land-use development is being proposed in the tropical savannas.

**Researcher:**  
MR COLIN MACGREGOR, JCU  
Project 4.4

#### COMMUNITY-SCALE LAND MANAGEMENT SYSTEMS

This investigation is researching and implementing decision-making systems for land management that can be used by indigenous communities in northern Australia. Activities to date have focused on the development of an information system and land management plan for the Pormpuraaw community on the Gulf savanna lowlands of Cape York Peninsula. The community has a population of about 400 people.

The Pormpuraaw system has been developed from a community desire to optimise the competing interests of different sections of the community. These sections include managed graziers, traditional landowners who are establishing outstation communities, and those with aspirations for developments such as nature-based tourism or

crocodile skin farming. There is also a wish to purchase some of the pastoral properties that adjoin the community area; these include areas recognised as traditional tenure in the community.

The work is being undertaken within the context of a regional land management plan for Cape York Peninsula by the Commonwealth and Queensland governments and provides the community with an instrument for negotiation with the state. At a community level it seeks to satisfy the desires of the people who live at Pormpuraaw that these activities be undertaken within a culturally sensitive framework that preserves individual sensibilities and community values for their land.

The investigation has made a detailed inventory and has mapped the natural resources, vegetation

and seasonally available biomass and water supplies as well as infrastructure in the form of trackways, fence lines and settlement. Sites of cultural significance have also been mapped. These include seasonal campsites used by traditional land users, story sites, conception and taboo sites, and clan affiliations within community defined tract boundaries. Currently, consultation is taking place with the community in prioritising areas of cultural and economic significance, in reviewing acceptable development scenarios and providing workable decision-making systems.

**Researcher:**  
MR JIM MONAGHAN, JCU  
Project 4.4

#### LEGAL BASIS OF SAVANNA LAND TENURE

The impact and significance of Aboriginal communal tenure to land and resources has not yet been adequately addressed in the Northern Territory. Pressure to recognise more clearly the rights of Aboriginal people to use and control biological resources is now arising out of recognition of native title and the process of making native title claims under the Commonwealth Native Title Act 1993. A key issue is the resolution of the question of whether native title has been extinguished on pastoral leases.

Pressure is also being placed on the existing property rights regime by moves to increase commercial use of wild animals and plants. Land tenure is a critical determinant in property rights to biological resources. The definition of land at common law includes some aspects of biodiversity, such

as plants. However, in the Northern Territory there is a clear duality in land tenure and other property rights to biological resources between Aboriginal land and pastoral land. In the case of wild animals there is considerable uncertainty attached to the question of who "owns" wildlife. This uncertainty arises out of the common law, and out of the relationship between common law and statutes with Aboriginal traditional law relating to wildlife.

This investigation examines the existing framework of property rights in environmental resources in the Northern Territory. It is also analyses the extent to which the legal rights and obligations and institutional structures that support existing property rights impede the conservation of biodiversity.

There are three main aspects to the investigation. The first

examines the major land tenures in the Northern Territory and their historical development. Particular emphasis is given to pastoral land, Aboriginal freehold land, protected areas and mining tenements. The second aspect examines property rights in biodiversity resources.

This involves an examination of the existing non-Aboriginal law relating to ownership and control of flora and fauna as well as those natural resources which support biodiversity such as water and soil. The third aspect examines the extent to which this framework of law presents an impediment to biodiversity conservation and suggest key areas for law reform.

**Researcher:**  
MS FREYA DAWSON, NTU  
Project 4.4

## RESEARCH

### ECONOMIC ANALYSIS OF MINING

The tropical savanna mining sector, which occupies small strategic sites throughout most of the Northern Territory and northern areas of Queensland and Western Australia, contributes substantially to Australia's economy.

This is evident as major components of national exports, company profits and Commonwealth taxation revenue, as well as the savanna economy. Mining sector employment in the region in 1994-95 was 12,146 people. This comprised 13.6 per cent of total national sector employment and 29.4 per cent of the total sector employment for the two states and the Territory. Given the depth of production and employment of the mining sector across northern Australia, and the flow-on effects to other

sectors, strategic research that relates the mining industry to sustainable savanna communities and regional outcomes will be addressed in research by the centre.

During 1995-96, the Northern Territory Department of Mines and Energy as a party to the centre

- put in place procedures to computerise all mining statistics on a regional basis
- collected an expanded range of Australian Bureau of Statistics and Australian Bureau of Agriculture and Resource Economics statistics for use in regional analyses
- developed contacts with the Queensland and Western Australia Departments of Mines & Energy on statistical areas and also with mining sector industry groups within the northern region

- participated in joint authorship of a paper for the North Australian Regional Outlook Conference in 1995 on the Tropical Savanna Economy of Northern Australia that described the mining industry sector's contribution to the savanna economy.

The research focus for 1996-97 is to broaden research in the above areas with a view to increasing time-series data with regard to all economic issues relating to mining sector activity in Northern Australia at a regional level.

#### *Researcher*

MR KEN HOOPER, NTDME,  
Project 4.3



Photo:  
McArthur River  
Mining Pty Ltd

*The mining sector in the tropical savannas contributes substantially to Australia's economy. In 1994-95 mining sector employment in the region was 12,146 people.*