



TROPICAL SAVANNAS CRC

Cooperative Research Centre for the Sustainable Development of Tropical Savannas

ANNUAL REPORT

1996-97



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





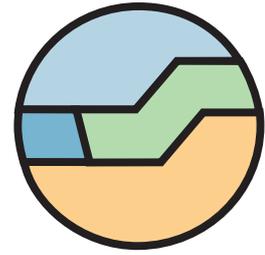
CSIRO
AUSTRALIA

DIVISION OF WILDLIFE AND
ECOLOGY
DIVISION OF TROPICAL CROPS
AND PASTURES
DIVISION OF SOILS



TROPICAL SAVANNAS CRC

Cooperative Research Centre for the Sustainable Development of Tropical Savannas



WESTERN AUSTRALIAN
DEPARTMENT OF
CONSERVATION AND LAND
MANAGEMENT



Biodiversity Group



THE
AUSTRALIAN
NATIONAL
UNIVERSITY



**JAMES COOK
UNIVERSITY**



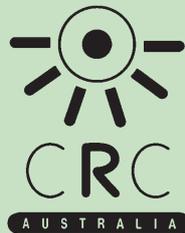
NORTHERN TERRITORY
DEPARTMENT OF LANDS,
PLANNING AND ENVIRONMENT



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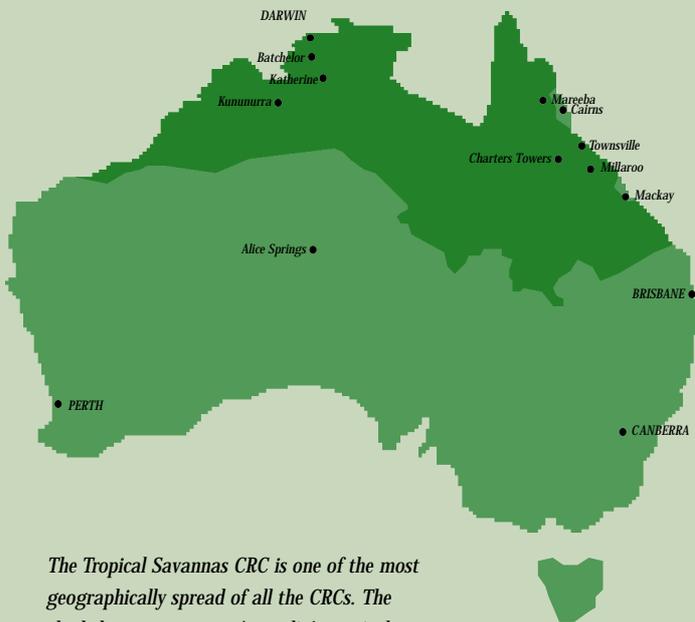


ESTABLISHED AND SUPPORTED UNDER THE
AUSTRALIAN GOVERNMENT'S
COOPERATIVE RESEARCH CENTRES PROGRAM



OUR MISSION

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



The Tropical Savannas CRC is one of the most geographically spread of all the CRCs. The shaded area represents Australia's tropical savannas, stretching across almost one-third of the country. Research is carried out from 20 locations based in 14 towns or centres.

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.

CONTENTS

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.

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The Hon. John Kerin

CHAIRMAN'S REPORT

The 1996-97 year was an eventful one in the life of the Centre. Significant outcomes were achieved both with regard to exciting research results and worthwhile educational activities.

Key actions were implemented consistent with the objectives of the Centre's Strategic Plan. These included:

- Creating a Centre research environment that produces high quality integrated research outputs relevant to sustainable land management in the tropical savannas
- Developing, identifying and implementing effective education and training programs for savanna stakeholders
- Forming linkages with relevant organisations in Australia and overseas
- Ensuring the Centre's management approach is adaptable, transparent and accountable.

Our information network was enhanced through both electronic applications (e.g. Email and a Website) and printed outputs (e.g. our annual report, newsletter, brochure shell and display). Further, contact with our constituents was significantly strengthened through increased activities with key representative stakeholder groups.

Valuable consolidation and further development concerning our understanding of the relationships between economics and environment in terms of sustainable outcomes in savanna land systems was achieved. The fourth research sub-program, Sustainable Management, was restructured and refined with regional case studies identified as the most appropriate strategy to integrate research outputs and facilitate the involvement of stakeholders. Good progress was achieved in this area.

Another encouraging feature was the considerable development of cooperation between Centre researchers in maximising opportunities to conduct complementary research investigations on the same ecological sites. This was particularly evident along the NATT (North Australian Tropical Transect).

Greater autonomy at the project leader level was fostered during the year and I am confident that this will pay good dividends for the future of our research program overall. Already a number of project leaders adjusted the focus of their projects to enhance the potential for their research to make substantial inputs into Sub-Program 4. Another eight PhD scholars are being assisted, bringing our total to 15 plus two MSc students. The Centre also awarded five Honours scholarships during the year. I am especially pleased with the progress of the case study activities in the Desert Uplands in Queensland and the Victoria River District and Mary River Catchments in the Northern Territory.

Our first director, Dr Phil West, has moved on to fresh pastures after establishing a strong administrative and financial base for the Centre. Dr West was one of a number of dedicated people instrumental in setting up the CRC. During his time with the Centre he played a major role in refining the direction of the research program. I thank Phil West for his efforts and wish him well in his new endeavours. The Board appreciated the contribution of Associate Professor Charles Webb (Northern Territory University), as Acting Director in the interim, and successfully expedited the appointment of Centre's second full-time Director, Mr John Childs, who will take up his position late in 1997.

The process of consolidation of the structure of the Centre and its activities during the year established a base from which to reach the wider savanna community. The challenge for the new Director is to take the Centre and its products out to its stakeholders and the broader Australian and overseas communities. Particular issues which need to be addressed next year include:

- Engaging the Centre and its staff in programs of national significance, such as work with the National Heritage Trust and State of the Environment reporting.
- Developing relationships with overseas savanna research centres to further broaden the scope of the program.
- Expanding the Centre's communication activities to reach stakeholders and the community at large.
- Developing strategies to secure the long-term future of the Centre through external funding, sponsorships and the possible establishment of a business arm to sell consulting and education services.

I am confident the Centre has the commitment, the expertise and ever-strengthening cooperative base to achieve positive outcomes concerning these issues.

John Kerin

Chairman



*Associate Professor
Charles Webb*

DIRECTOR'S REPORT

Consolidation has been a key factor in the Centre's second year of operation. The focus and integration of its research and education program was tightened, new activities building on the base of the initial program commenced, the roles of the contributed staff were substantially defined and staff being employed with the Commonwealth grant began work. Most importantly, outcomes from our research started to flow to assist our stakeholders pursue the sustainability of their savanna management practices.

Developing better options for savanna land managers and policy-makers is the focus of Sub-Program 4, Sustainable Management. Following advice from the Scientific Program and Evaluation Advisory Group, the Board of the Centre decided the best way to achieve enduring outcomes for our stakeholders in Sub-Program 4 was through regional case studies. In doing so, they established a clear ethos for the work of the Centre. Firstly, the Centre recognised that economic, social and ecological issues all determine sustainability. Unless all three elements are satisfied for stakeholders, it is believed there is little prospect savanna usage can flourish and continue in the long term. Secondly, it was recognised that the scale at which sustainability is assessed is important. To maintain sustainability over a region, a balance of activities was felt to be necessary at a regional scale. This leaves scope for individual land managers to undertake activities to their best advantage, consistent with overall regional sustainability.

The first case study was developed with the Desert Uplands Build-Up and Development Strategy Committee in north-central Queensland. This committee is addressing land management and sustainability issues that exist in their region, particularly for pastoralists. Work is continuing to develop a second case study in the Northern Territory, where the Victoria River District was identified as an appropriate region. The Centre will seek similar opportunities elsewhere in the savannas with other stakeholder groups. By working directly with stakeholders through case studies, we believe that the outcomes of research within all our Sub-Programs will reach our stakeholders directly and with maximum benefit to them.

While the program of the Centre is still developing, outcomes are now emerging. Strong progress has been made in innovative research and planning strategies for sustainable enterprises, research and stakeholder-linked activities, education and communication activities, and Centre management strategies and systems. Highlights of activities in these categories are listed overleaf.

A pleasing aspect of the Centre program has been the success in attracting graduate students. We are now supporting the work of 15 PhD, two MSc and five Honours students. Their work is spread widely across the Centre program and eight of the PhD students are being supervised by Centre staff who are not university academics.

The students are located across the three universities that are parties to the Centre. We plan to bring the students together so they can interact with each other to develop their own ethos as participants in the Centre, and to further their involvement and valuable contribution to the program.

The Scientific Program and Advisory and Evaluating Group of the Centre undertook the first formal review of the program this year. The group comprises distinguished researchers with expertise across the various components of the program. They were generally satisfied with the work of the Centre and made helpful recommendations regarding the nature of Sub-Program 4, which, as alluded to above, have been adopted.

Recruitment of new staff continued and reached nearly the full complement planned for the Centre. We now support six research staff, six technical support staff and four administrative staff. These staff work from various laboratories across the savanna region. Later this year, two key new appointments will be made: a business manager and a communications coordinator. These will provide the Director with the support necessary both to conduct the business affairs of the Centre and to ensure that the outcomes of its work start to reach our stakeholders in the most effective way. It was pleasing to see this year that Centre staff began to broaden their approach to their work across the savannas as a whole. This will have important advantages for the savanna region and reflects the cooperative ethos of the overall CRC program.

The Centre was also successful in attracting overseas visitors through its visiting researchers program. We hosted five visitors this year from, respectively, Colorado State University, the University of Virginia and Miami and Oregon State University. The visits varied in length from two to four months and covered a broad range of areas of interest to the Centre program. We feel that visits such as these are an important step in developing links with overseas organisations and expanding the horizons of our program.



DIRECTOR'S REPORT (CONTINUED)

The foundation Director of the Centre, Dr Phil West, left in April. Dr West played a crucial role in the formative stages of the Centre. We are delighted to have secured the services of Mr John Childs as the second full-time Director of the Centre.

I am confident that program of the Centre will continue to develop and deliver positive outcomes of significant value not only to our many stakeholders in the North, but to Australia as a whole.



Charles Webb (Acting Director)



HIGHLIGHTS

INNOVATIVE RESEARCH AND PLANNING STRATEGIES FOR SUSTAINABLE ENTERPRISES

- Important progress in developing a system to predict tree cover using Synthetic Aperture Radar (SAR) data in tropical savanna ecosystems
- Significant progress in estimating seasonal patterns of water use at the tree, stand and vegetation community levels in a representative tropical savanna catchment
- Advances in consolidating information, held by a wide range of sources, into accessible databases on tropical savanna biodiversity
- Progress in determining the distribution of the threatened Gouldian finch and indexing its abundance
- Effective broad-scale fire monitoring systems developed for savanna-wide use in conjunction with integrated, representative regional fire management studies
- Seven rangeland types classified and linked to a CSIRO time-series image-analysis technique for assessing land sustainability indicators in the Victoria River District
- Geographic patterns of invertebrate distribution (e.g. ants, spiders) are emerging that show clear responses to land use
- Key regional case studies established that encourage landholder participation and ownership in identifying pathways to sustainable enterprises and regional futures

RESEARCH AND STAKEHOLDER-LINKED ACTIVITIES

- Participation of Centre in regional planning strategy activities in the Mary River Catchment (NT) and the Desert Uplands (Qld) areas in conjunction with the Centre's regional case studies
- Significant progress in cooperative fire management programs with all key stakeholders across the Top End and Far North Queensland
- Site-management planning-template developed for Savannah Guides Ltd to enhance sustainable nature and culturally-based tourism enterprises across the tropical savannas
- Victoria River District regional case study initiated with an emphasis on grazing and fire management for sustainable land management

EDUCATION AND COMMUNICATION ACTIVITIES

- Development of units focusing on the savannas in Master of Tropical Environmental Management with 18 students enrolled at NTU
- A number of Masters-level subjects being developed by JCU for interactive multi-media learning
- Implementation of client-oriented sustainable land management training packages (including woody weed management)
- Seventeen scholarships or operational grants awarded for studies towards PhDs and MSc and five Honours assistance scholarships awarded

CENTRE MANAGEMENT STRATEGIES AND SYSTEMS

- Significant progress in implementing the Centre's strategic plan
- Email network and Website established
- Relevant geographic information systems being established in a range of research projects to facilitate sustainable management strategies
- Board approval given to expedite appointment of the new Director, Communication Coordinator and Business Manager for the Centre



STRUCTURE AND MANAGEMENT

The Centre's organisational structure consists 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.

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.

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.

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.

In April 1997 Associate Professor Charles Webb was appointed Acting Director of the Centre following the resignation of foundation Director Dr Phil West. New director Mr John Childs was formally approved at the Centre's most recent Board meeting held in Townsville. Mr Childs' appointment was approved by the CRC Secretariat and he will take up his

appointment on August 4, 1997.

This year the Centre developed and adopted a strategic plan that consolidates and refines its mission, vision and the concept of sustainable development. The plan aims to consolidate arrangements regarding partner agencies, major stakeholders and management philosophy. The strategy identifies eight goals. Each goal is linked to performance indicators, objectives and strategies. Goals 1 and 2 address cooperative arrangements. Goal 3 focuses on research and researchers. Goals 4 and 5 accommodate education and training. Goal 6 defines the Centre's application of its research. Goals 7 and 8 address the management and effective operation of the Centre's budget.

To successfully implement Goal 7 and 8 the Board approved the appointment of a business manager.

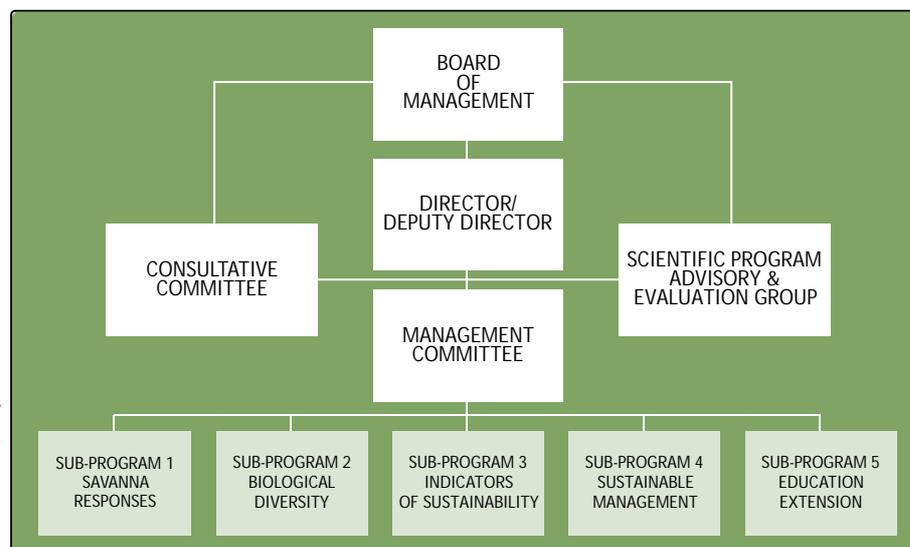


DIAGRAM 1
The Centre's
organisational structure

CENTRE PARTIES

The centre is an unincorporated joint venture established by an Agreement between the Centre parties:

- Agriculture Western Australia
- Australian National University
- Conservation and Land Management (WA CALM)
- CSIRO Division of Land and Water (Formerly Division of Soils)
- CSIRO Division of Tropical Agriculture (Formerly Division of Tropical Crops & Pastures)
- CSIRO Division of Wildlife and Ecology
- Environment Australia, Biodiversity Group (Formerly Australian Nature Conservation Agency)
- James Cook University
- Northern Territory Department of Lands, Planning and Environment
- Northern Territory Department of Mines and Energy
- Northern Territory Power and Water Authority
- Northern Territory Department of Primary Industry and Fisheries
- Northern Territory University
- Parks and Wildlife Commission of the Northern Territory
- Queensland Department of Natural Resources
- Queensland Department of Primary Industries

and an Agreement with the Commonwealth of Australia.

BOARD OF MANAGEMENT



THE HON. JOHN KERIN (CHAIR)
John Kerin & Associates Pty Ltd
Garran, ACT
Mortlake, NSW



DR ANTHONY MILNES
ERA Environmental Services
Darwin, NT



ASSOCIATE PROFESSOR
CHARLES WEBB
Northern Territory University
Darwin, NT



DR BRIAN WALKER
CSIRO,
Canberra, ACT



MR KEVIN GOSS
Agriculture Western Australia,
Kununurra, WA



MR JOHN HICKS
Parks Australia North,
Environment Australia, Biodiversity Group
Darwin, NT



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



MR JOHN STEWART
North Australia Beef Research Council
Brisbane, Qld



DR WARREN HOEY
Department of Primary Industries
Townsville, QLD

MR MICHAEL STORRS
Representing the Northern Land Council
Darwin, NT

The Board consists of key representatives of the parties to the Centre and the user groups it aims to serve. A number of changes were made to the Board's membership during the year in report.

Associate Professor Charles Webb replaced Professor Ron McKay from the Northern Territory University. Mr Kevin Goss, Agriculture WA, took up Mr John Morrissey's position on the Board following his resignation. Dr Warren Hoey took the place of Mr Stewart Wood, QDPI. Mr John Hicks, Parks Australia North, was appointed to the Board as was Dr Tony Milnes from ERA Environmental Services.

Dr Tony Press, Environment Australia and Mr John Lewins from McArthur River Mining Pty Ltd also resigned from the Board this year. Mr Michael Storrs acted as the representative of the Northern Land Council, Darwin, NT.

The Board met three times during 1996-97: July 16, 1996 at the NT Tourist Commission; November 13 1996 at James Cook University, Townsville; and March 26, 1997 at the NT Department of Primary Industry & Fisheries, Darwin.

STRUCTURE AND MANAGEMENT

The Board made a number of key resolutions that influenced the direction of the Centre. The Board developed and formalised a strategic plan for the Centre, adopted a communication strategy and initiated a business

management consultancy. It also facilitated SPAEG's review of the research and education program of the Centre.

The Board was a strong supporter of SPAEG's recommendation to

focus on regional case studies in Sub-Program 4. The Board also defined the role and expectations of both the Board and the Management Committee.

CONSULTATIVE COMMITTEE

Members during 1996-97 were:

MR JOHN KERIN, (Acting Chairman)
John Kerin & Associates Pty Ltd
Garran, ACT, Mortlake, NSW

MR ROSS BRUNCKHORST
Pastoral Enterprises, Yeronga, Qld

MR TOM COLLIS
Batchelor College, Community
Education, Batchelor, NT

MR ROWAN FOLEY
Kimberley Land Council, Kununurra,
WA

MR DAVID EPWORTH
Balkanu Cape York Development
Council, Cairns, Qld

MS SUE JACKSON
North Australian Conservation
Darwin, NT

MR DON HEATLEY
Pastoral Enterprises, Home Hill, Qld

DR SONIA TIDEMANN
Batchelor College, Batchelor, NT

DR PHIL PRICE
LWRRDC, Canberra, ACT

MS CORINNE UNGER/DR LEN
CORBETT
ERA Environment Services
Darwin, NT

DR BARRY WALKER
Meat Research Corporation
Buddina, Qld

MS WENDY JONES
NT Tourism Training, Katherine, NT



*Members of the
Consultative
Committee.*

*Standing from left:
Richard Ledger, David
Epworth, Wendy
Jones, Barry Walker.*

*Seated from left: Ross
Brunckhorst, Don
Heatley, Rowan Foley
and Corrine Unger.O*

The Committee assists the Centre's staff in developing networks and delivering relevant services to the Centre's clients. It met twice during the year. The Committee explored the reconciliation of divergent interests and values of the stakeholder groups. Mr John Kerin acted as chairman following the relocations of Ms Deborah Cope and Mr John Oakley.

THE SCIENTIFIC PROGRAM ADVISORY AND EVALUATION GROUP — SPAEG

SPAEG consists of eminent researchers whose role is to ensure quality in all the Centre's research activities. SPAEG met twice during year. SPAEG conducted a review of the research and education program in February 1997. It recommended the refinement of a number of projects in the biophysical sub-programs. It also recommended several significant structural adjustments in Sub-Program 4 (with an emphasis on regional case studies), and a need for strengthening the flow of information between the research sub-programs and Sub-Program 5, Education and Communication.



*Bottom left:
Dr Doug Cocks,
Professor Rod Gerber,
Professor Ian Noble.
Standing from left:
Chairman Mr John Kerin,
Dr John Vercoe,
Associate Professor
Roy Powell and
Professor Jon Altman*

Members of SPAEG in 1996-97:

PROFESSOR JOHN ALTMAN
Centre for Aboriginal Economic
Policy Research Australian National
University, Canberra.

PROFESSOR IAN NOBLE
Research School of Biological
Sciences
Australian National University,
Canberra

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

DR JOHN VERCOE
Tropical Beef Centre, Rockhampton

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

DR DOUG COCKS
CSIRO, Division of Wildlife and
Ecology, Canberra

MANAGEMENT COMMITTEE

The Management Committee
consists of the Director of the
Centre and the leaders of the five
research sub-programs.

As already noted, the resignation
of the Centre's Director's took
effect at the end of April 1997.

His place on the Management
Committee was filled by Associate
Professor Charles Webb. Dr John
Ludwig, the new Leader of Sub-
Program 1 took the place of
Dr Joel Brown, who will return to
the United States late in 1997. The
Management Committee met eight
times during the year. It addressed

all key recommendations of the
Board, SPAEG and the Consultative
Committee. Within a cooperative
framework with the Board it
contributed to the final form of
the strategic plan.



Dr John Ludwig



Mr Peter Whitehead



Dr Paul Novelly



Dr Ross Hynes



Professor Greg Hill

Members in 1996-97 were:

DR PHIL WEST
Director, CRC for the Sustainable
Development of Tropical Savannas,
until April 1997.

ASSOCIATE PROFESSOR
CHARLES WEBB
NTU, Acting Director from April to
August 1997.

DR JOEL BROWN
CSIRO Division of Tropical
Agriculture, Townsville
(Leader Sub-Program 1) until
October 1996.

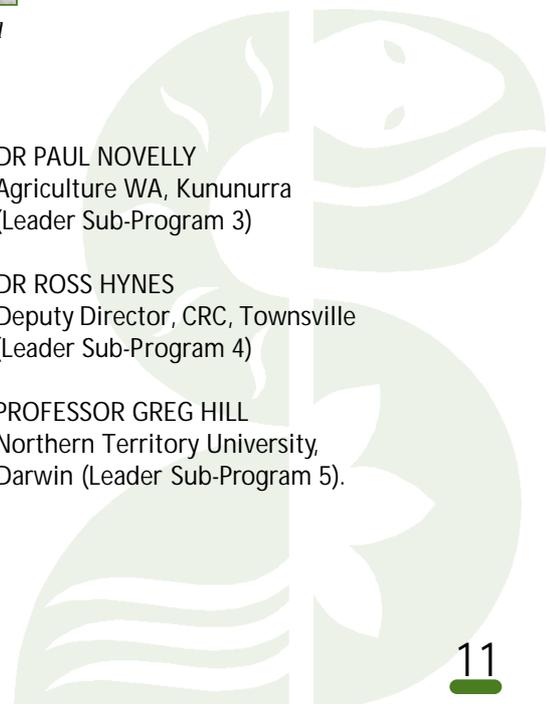
DR JOHN LUDWIG
CSIRO Division of Wildlife &
Ecology, Leader Sub-Program 1,
from October 1996.

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

DR PAUL NOVELLY
Agriculture WA, Kununurra
(Leader Sub-Program 3)

DR ROSS HYNES
Deputy Director, CRC, Townsville
(Leader Sub-Program 4)

PROFESSOR GREG HILL
Northern Territory University,
Darwin (Leader Sub-Program 5).





COOPERATIVE LINKAGES

EXTERNAL LINKS & LINKS WITH PARTNER AGENCIES

This year the Centre established two major regional case studies: the first in the Desert Uplands region of central-northern Queensland and the second in the Victoria River District in the Northern Territory. The Centre also continued its involvement in the Mary River Catchment case study as well as regional fire management activities. These case studies and fire management activities are inherently cooperative joint ventures and provide an initial platform to enhance a wide range of linkages between participating and collaborating researchers and the Centre's stakeholders.

In September 1996, the Centre was invited to participate in the work of the Desert Uplands Build-Up and Development Strategy Committee (DUBDSC), a community-based group established by landholders in the region. Their concerns focus on the sustainability of land use in the region and the continued viability of local industry (predominantly pastoral). Several government agencies are represented on the committee, including two of the Centre's partner agencies; QDNR and QDPI as well as QDoE. Through its participation with this group the Centre formed links with QDNR Land Planning; QDNR Resource Sciences Centre; QDNR Land Protection Branch and QDPI Extension Officers.

Links are also being developed with the James Cook University Department of Tourism which will conduct a tourism audit in the region later in 1997.

The Centre also developed linkages with a number of associated landcare groups both through its regional case studies



Dr Lindsay Hutley (left) and Mr Tony O'Grady of Project 1.2 in the field. Important links with a number of agencies are being established through this project.

PHOTO Adrian Paul

and the overall research program. These include the Daly River Land Trust; the Victoria River District Conservation Association; Sturt Plateau Best Practice Group; Balfes Creek Catchment Landcare Group (Queensland); Fletcher Creek Catchment Landcare Group (Queensland), Sustainable Beef Group (Torrens Creek, Queensland).

While the Mary River Catchment study began in 1992, prior to the Centre's establishment, links were formed with the Mary River Task Force and Technical Working Group. Centre staff contributed to the development of a draft management plan for the Mary River.

Collaboration between the Centre's research on water fluxes in savannas (Project 1.2) is continuing with partner agency NTDLPE through its Water Resources Division. This involves monitoring soil water dynamics at research sites. Cooperative links with the CRC for Catchment Hydrology are also being established.

Important contributions to Project 1.2 are being made by Dr Tom Hatton, Dr Peter Cook and Mr Peter Reece of the Centre's partner agency CSIRO Division of Land and Water (formerly Division of Soils). Another notable link was the appointment of Dr Derek Eamus to the LWRRDC Standing Committee

on Vegetation and Groundwater, which is charged with the assessment of groundwater usage and its possible effect on vegetation Australia-wide.

The Northern Australia Program (NAP3) of the Meat Research Corporation targeted the research project on water fluxes in its review of catchment management issues within the northern beef industry. Given the relationship between surface water fluxes and nutrient flow, input will be sought from project staff to identify gaps in current research and development activities in water resource management of northern Australia.

Within the biogeographic overview of savanna fauna (Project 2.1) linkages were developed with the ADF to monitor the impact of military training on wildlife.

The ADF is one of the largest land owners of tropical savannas in the Townsville region and is becoming increasingly interested in land management and sustainable use of its training areas. Through a PhD project funded by the Centre (carried out by Mr Greg Calvert) the Centre can provide the ADF with sound research foundations for the establishment of a fire management program. In return, the ADF is financing the analysis of the fire histories.

Project 2.1 also formed close links with Aboriginal and pastoral landholders and conservation and land management agencies. A consistent methodology is now used for wildlife surveys in the Northern Territory. Using comparable methodologies to those developed in the NT, a collaborative project is also being developed with QDoE on impacts upon wildlife of tree cover.

This project is also collaborating with CSIRO and the South Australian Department of Environment and Natural Resources to examine the relationship between grazing, biodiversity and land management in Australian rangelands.

Linkages are being developed with the Centre's partner agency QDPI to use long-term enclosure and pasture dynamics study sites in Queensland to elucidate the relationships between biodiversity and grazing management. Collaboration is also taking place with NTDLPE and NTPAWA to develop a land-use strategy plan for the Sturt Plateau in the NT.

The Centre's research project on declining granivorous birds (Project 2.2) formed links with a training program for park rangers. For example, a large field-based exercise on Bradshaw Station (now owned by the ADF) involved searches of prospective Gouldian finch habitats. The project also served as a focus for consultations with the Jawoyn Association whose lands include important Gouldian finch breeding habitats as well as a major mining company where all land use areas require fire management.

Through the Centre's research on riparian systems (Project 2.3) connections were made with water quality monitoring work done under the National River Health Assessment. Assistance was provided to the CRC for Freshwater Ecology in conducting freshwater turtle research, with special emphasis on the unique Pig-nosed Turtle in the Daly River.

The Centre is also sponsoring four regional fire management activities,



Research on the Gouldian finch is serving as a focus for consultation with the Jawoyn Association.

Photo: PWCNT

conducted under Project 2.4, in eastern Cape York, Northern Territory National Parks in the Top End, the VRD region and the north Kimberley. Significant links were formed with Aboriginal and pastoral stakeholders in a number of regions as well as staff from Kakadu, Litchfield and Nitmiluk National Parks; Bush Fire Council staff based at Darwin, Batchelor and Katherine and with Bushfires Board staff based at Kununurra, WA.

Broad-scale monitoring of fires in the Northern Territory and Western Australia is being undertaken through the WA Department of Land Administration (DOLA), with funding assistance from the Centre and other WA and NT agencies.

Similarly, partner agency QDNR will begin mapping fires for Queensland in the near future. Collectively, the Centre, DOLA, QDNR and a number of other agencies combined to successfully obtain funds through Rural Industries Research and Development Corporation (RIRDC) to develop this system.

Other organisations participating in fire management studies include the Northern Land Council, the Kimberley Land Council in WA, the Cape York Land Council, QDoE, NABRC, the Bureau of Meteorology, and CSIRO Office of Space Science & Applications (COSSA). Partner agencies NTDPIF, NTDLPE, CSIRO W&E, QDPI, QDNR,

CSIRO TAG, Environment Australia are also closely involved.

Development of a monitoring framework for analysing land condition data within the Centre's research on Project 3.1 (Indicators for sustainable land production and condition) involved close links with partner agency Ag WA. Data from the Victoria River District were shared with Ag WA for inclusion in its tropical savanna rangelands dataset. A joint workshop held in Perth in April 1997 involved two staff from Project 3.1 and two staff from Ag WA who addressed appropriate analytical methods.

Remote sensing change detection research by the CSIRO Division of Mathematical and Information Sciences (MIS) was a cornerstone for Project 3.1. Techniques developed by CSIRO MIS and adopted in the research project are also being used by Ag WA in the Kimberley Region. Collaboration between these agencies is ongoing and a workshop and field trip involving research and extension staff and pastoralists from both the Northern Territory and Western Australia was held in Kununurra in August. Participants assessed the current status of the work and the products being developed. The participants also discussed future directions for the work to ensure its relevance to as wide a group of users as possible.

Dr Alan Andersen, leader of Project 3.2, was involved in an advisory capacity with several external projects using faunal indicators (especially ants) of land-use impacts. These include an ant monitoring program conducted by the Queensland Forest Research Institute, another by German Creek Mine in Queensland, a major grazing-gradient study led by Dr Steve Morton (CSIRO W&E) and postgraduate student projects in South Australia, Western Australia and Argentina. Project 3.2 also made links with Curtin University's School of Environmental Biology and Macquarie University's Centre for Biodiversity and Bioresources.

COOPERATIVE LINKAGES

While collaboration between Project 3.3 and the CRC for Weed Management Systems was not achieved, a valuable link was developed between the project and the CRC for Tropical Pest Management. This project will now ensure the continuity of research initiated by CRC TPM into the exotic woody weed *Acacia nilotica*.

Within Sub-Program 4, linkages were fostered with decision-support researchers, such as Dr Paul Lawrence from the QDNR Resource Sciences Centre in Brisbane. Collaboration was formalised on part of the ACIAR proposal Africa/Australian savanna woodlands project. A close working arrangement was also developed with a team of resource economists led by Associate Professor Jeff Bennett of UNSW. Similarly, linkages were strengthened with the QDoE in Brisbane and Townsville.

Links were also established between the Centre and relevant staff with market survey expertise in the Northern Territory Tourist Commission and NTU Department of Tourism and Hospitality.

Close links were also formed with nature-based tourism group Savannah Guides Ltd, within Sub-Program 4 through Dr Ross Hynes, Co-Leader of the Sub-Program.

Linkages were consolidated within a sectoral study being conducted by Dr Peter O'Reagain in Project 4.1 with CSIRO, QDNR, GBRMPA, and JCU.

The Centre's education and training program (Project 5.1) developed cooperative linkages with the newly established Centre for Indigenous Natural & Cultural

Resource Management (CINCRM), based at NTU. In particular, the Centre and CINCRM are collaborating on curriculum development projects in vocation, education and training (VET) and undergraduate resource management programs, as well as on the Arafura Wetlands Management and Training project.

Linkages were also developed with the newly established CRC for Sustainable Tourism, and plans are under way for a number of



Cooperative linkages are being developed through the Centre's education program. Mr Michael Stoors (NLC and Board member) talks to students about the weed Salvinia at the Magela Creek floodplain, NT. Photo Sam Setterfield

collaborative education and training projects addressing stakeholder needs in the tourism industry.

The education and training needs analysis (conducted by Project 5.1) established extensive networks between the Centre, education and training providers and stakeholders through consultation and surveys. Cooperative linkages are being rapidly developed through the Centre's postgraduate students in conjunction with relevant expert groups.

INTERNAL LINKAGES, RESEARCH COLLABORATION

Collaboration between the Centre's research projects

strengthened this year. Many of the Centre's first three sub-programs share research sites along the North Australia Tropical Transect (NATT), a 1500km long transect with a series of research sites that follow the major rainfall gradient south of Darwin. The transect encompasses the major variations in the biophysical environment of far northern Australian savannas.

Data from NATT sites are also shared between research projects.

Project 1.1 provides data on habitat to Projects 2.1 and 3.2 which are needed to interpret the distribution of fauna abundance. Information from Project 1.1 was used for initial modelling of invertebrates in relation to rainfall, soils and vegetation.

In conjunction with Project 1.2, variations in leaf area index (LAI) are being assessed by Project 1.1 as a subset of sites with a substantial

variation in tree cover. While LAI is an important component of many vegetation models, there is scant data on LAI for northern Australia. A combination of allometric methods and instrumental approaches are being applied to determine LAI.

Projects 1.1 and 3.1 both use the soil surface condition/landscape patchiness indicator developed by Dr John Ludwig and Mr David Tongway. This technique (originally developed for temperate semi-arid pastoral woodlands) was modified for pastoral lands of the wet-dry topics of north-western Australia. The technique quantifies the abundance and stability of run-on patches which trap resources such as perennial grass and those run-

off patches from which resources may be lost, such as bare inter-tussock spaces.

Project 1.2 is also working closely with the School of Remote Sensing at NTU to develop techniques for remote sensing of important structural variables using radar, Landsat TM and high resolution airborne video.

Links with other projects within Sub-program 2 included establishing a broad-scale context for process-oriented studies (grassland birds, fire and riparian strips); collaborative assessment of change in status for some wildlife groups (notably granivorous birds) and sharing of sites with fire monitoring projects.

Internal linkages were established with all research projects and Sub-Program 5 through numerous education and communication activities. These included the supervision of PhD and MSc projects; input into the development of a multi-media unit on savanna ecology and management (being produced by CIMM at JCU); seminars given through the Centre's Masters by Coursework and assistance in preparing communication materials.

A workshop held by the Centre at Darwin in May 1997 brought together more than 20 Centre participants who established a case study in the Victoria River District. A number of research projects will work on this case study including Projects 1.1, 1.2, 2.4 and 4.4. The study's major focus will be fire and grazing management.

INTERNATIONAL LINKAGES

Both Projects 1.1 and 3.1 made valuable connections with NASA through its mission to trial synthetic aperture radar. Data were already collected from a mission in 1993, and another mission took place earlier this year over the Daly River in the Northern Territory. Information collected by NASA is now being processed through these

research projects.

A collaboration of CSIRO, NTU, IGBP project and NASA and Project 1.1 examined the use of airborne synthetic-aperture radar measurements for predicting tree cover/leaf area.

This project team also formed both national and international



Visiting Researcher Dr David Janos

linkages with the Australian National University and the University of Beyreuth, Germany in studies of water-use efficiency and carbon isotope ratios along the NATT. Work was also undertaken with Mr Richard Heerdegen, Department of Geography, Massey University, Palmerston North, New Zealand in characterising rainfall regimes of NT savannas.

VISITING SCIENTIST PROGRAM

A number of distinguished researchers have visited the Centre this year under our visiting research program.

PROFESSOR JOHN WIENS
COLORADO STATE UNIVERSITY
VISIT: OCTOBER 1996 – JANUARY 1997

Professor Wiens is a landscape ecologist of international standing and an expert in scaling up results from local studies to a broader scale, especially concerning conservation issues. He has extensive experience in multi-disciplinary studies of landscape scale ecology, including those encompassing biogeographic climatic gradients. Professor Wiens visited the Centre from October 1996 to January 1997, working primarily with researchers from Sub-Programs 2 and 3. As a result, a multi-authored manuscript examining spatial scaling issues in savanna research and management

is being produced. Professor Wiens also gave seminars in both Townsville and Darwin. He was based at the CSIRO Division of Wildlife & Ecology during his stay.

DR BEATRICE VAN HORNE
COLORADO STATE UNIVERSITY
VISIT: OCTOBER 1996-JANUARY 1997

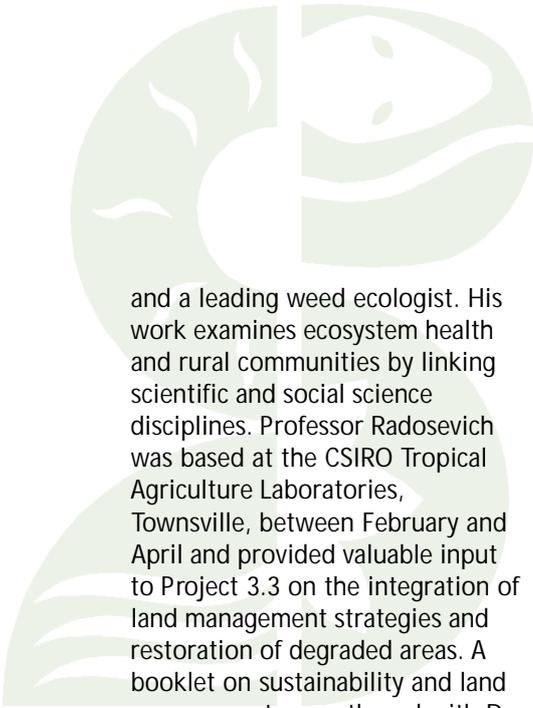
Dr Beatrice van Horne's research interests encompass the roles of social interaction and habitat heterogeneity in small mammal demography, and modelling other wildlife/habitat relationships. Her particular interest and experience is in developing workable models for decision-making in habitat management that incorporates knowledge gained from a range of sources. She introduced these ideas to a group of wildlife rangers and park rangers at a seminar conducted in Murgennella, and at TERC. She worked at the Northern Territory's Parks and Wildlife Commission laboratories with Centre researchers and contributed to the development of models suitable for savanna habitats for both mammals and birds.

MR PETER DOWTY
UNIVERSITY OF VIRGINIA
VISIT: MARCH-APRIL 1997

Mr Dowty is a key member of a University of Virginia group modelling vegetation ecosystems under the IGBP (International Geophysical Biosphere Program) climate change program. He is working on the Kalahari Transect in Southern Africa, a sister transect to the North Australia Tropical Transect (NATT). He visited all NATT sites during March and April 1997 to compare methods of measurements of savanna composition and structure with researchers in Project 1.1. Mr Dowty also gave a seminar and began work on modelling of leaf phenology, which will contribute both to the IGBP program and Project 1.1.

PROFESSOR STEVEN RADOSEVICH
OREGON STATE UNIVERSITY
VISIT: FEBRUARY-APRIL 1997

Professor Steven Radosevich is an expert in sustainability issues



COOPERATIVE LINKAGES

and a leading weed ecologist. His work examines ecosystem health and rural communities by linking scientific and social science disciplines. Professor Radosevich was based at the CSIRO Tropical Agriculture Laboratories, Townsville, between February and April and provided valuable input to Project 3.3 on the integration of land management strategies and restoration of degraded areas. A booklet on sustainability and land management, co-authored with Dr Joel Brown, leader of Project 3.3, is now being prepared as a result of this visit.

DR DAVID JANOS
UNIVERSITY OF MIAMI
VISIT: MAY-AUGUST 1997

Dr David Janos is a world expert in mycorrhizal fungi and how they contribute to above-ground plant productivity and below-ground biodiversity. He was based at the Northern Territory Parks and Wildlife Commission NT laboratories in Darwin. Dr Janos made important observations on the below-ground ecology of the northern savannas and is

interested in establishing an ongoing collaborative research program with Dr David Bowman. This project aims to understand the role of savanna roots in storing carbon and the importance of *mycorrhizae* (root-fungi) in controlling tree species distributions. Dr Janos established experiments dealing with elements of these questions which are being maintained by PWCNT staff in the NT. Dr Janos also visited the Townsville node of the Centre and the CRC for the Wet Tropics in Queensland. Dr Janos gave two well-attended seminars to appreciative audiences at James Cook University and the CSIRO Division of Tropical Agriculture in Townsville. He also taught a unit for the Centre's Masters by Coursework program at NTU.

VISITORS TO THE CENTRE

PROFESSOR JEFF BENNETT
Associate Professor
University of New South Wales
Australian Defence Force Academy

HON BOB COLLINS
MLA, Northern Territory

MR EMMANUEL GERATA,
Chief Park Ecologist
Serengeti National Park
Arusha, Tanzania

MR RICHARD HEERDEGEN
Department Geography,
Massey University,
Palmerston North, New Zealand

DR HUGH LAVERY
Chairman and Principal Consultant
Australian Environment
International, Brisbane

MS WENDY MCINTYRE
University of Virginia

DR NORMAN PLATNICK
Museum of Natural History,
New York (spider specialist)

DR ROBERT RAVEN
Queensland Museum, Brisbane
(Spider Specialist)

MR JOHN ROLFE
Head of Campus
Emerald Campus
Central Queensland University



RESEARCH

SUB-PROGRAM 1 RESPONSES OF SAVANNAS TO STRESS AND DISTURBANCE

SUB-PROGRAM LEADER

DR JOHN LUDWIG
CSIRO DIVISION OF
WILDLIFE & ECOLOGY
DARWIN, NORTHERN TERRITORY

The overall aim of Sub-Program 1 is to gain a better understanding of the ecological factors affecting savanna vegetation, water dynamics and soil fertility. This information is vital for developing sustainable management strategies for the tropical savannas of northern Australia.

There were many research innovations in Sub-Program 1 over the past year, and also a change in its leadership. Dr John Ludwig took over the Sub-Program in

October 1996 from the previous leader, Dr Joel Brown (CSIRO TAG).

Reflecting the Centre's mission as a whole, Dr Ludwig's vision for the Sub-Program emphasises developing the savannas while balancing ecological, economic and social factors.

Much of the research innovation in Sub-Program 1 took place in collaboration with both the Centre's partner agencies and national and international research groups.

Another innovation, in Project 1.2, was the use of C13 isotope analysis of leaf tissues* and sap flux and eddy covariance

measurement to assess long and short-term water use by savanna trees. Results so far from the use of these techniques may have significant implications for future application of our research.

Future directions include extending research sites along the North Australian Tropical Transect (NATT), the major research focus for Project 1.1, and a significant element of Project 2.1 and 3.2. A case study for the Victoria River District Region in cooperation with Sub-Program 4, is also under development (See Section 6, Application of Research).

*a measure of water-use efficiency

PROJECT 1.1 SAVANNA FORM AND FUNCTION IN RELATION TO GRADIENTS OF MOISTURE, NUTRIENTS AND DISTURBANCE

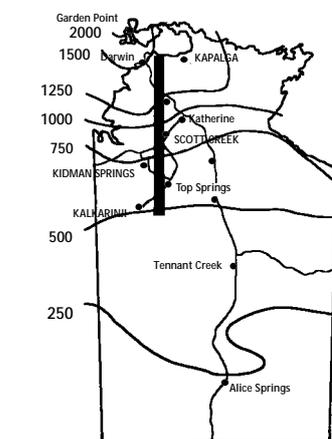
PROJECT LEADER

DR DICK WILLIAMS,
CSIRO DIVISION OF WILDLIFE &
ECOLOGY, NORTHERN TERRITORY

PROJECT SUMMARY

The sustainable use of savanna resources requires an understanding of basic savanna ecology – the environmental factors which determine key attributes of savanna vegetation. These include tree cover, species composition, grass abundance and susceptibility to disturbance. The primary determinants of savanna form and function are plant-available moisture and available nutrients. The research within Project 1.1 aims to determine the responses of key ecosystem attributes to variation in moisture, soil texture and disturbance along the NATT.

From this and other transect studies in savannas around the world, researchers are quantifying variation



Research in Project 1.1 focuses on a series of research sites along the NATT, a 1500km long, 250km wide transect south of Darwin.

CSIRO

in ecosystem responses to key climatic and soil factors. Predictive models are being derived and tested. Project 1.1 provides a framework within the Centre to study many key properties and processes in savannas, including ecological structure and composition, plant-water relations and disturbance.

RESEARCH PROGRESS

There were significant achievements in meeting the milestones of Project 1.1 during the year. NATT research sites were extended to include sites in the Kimberley, (Western Australia) and the southern Northern Territory. Replicate 1ha plots were established at the five current NATT sites, and additional 1ha NATT reference sites were established on sand, loam and clay soils at five more locations in the Northern Territory: Banka Banka, Newcastle Waters, Larrimah, Katherine and Pine Creek.

A system is being developed to predict tree cover using Synthetic Aperture Radar (SAR) data which were collected for sites in Kakadu, Manbulloo, Kidman Springs and Mt Sanford in 1993 as part of a joint NASA/GCTE (Global Change and Terrestrial Ecosystems) project. Additional SAR data were collected from the NASA 1996 mission in

RESEARCH

Australia. One 60 x 10 km strip was surveyed in the Daly River region, and the data are currently being processed by NASA.

A composite image from four Landsat scenes was constructed for the NATT in collaboration with Project 3.1, and a comparison of pixel-based and transect-based methods of correlating RADAR backscatter with tree abundance is being undertaken.

The four-year LWRRDC project predicting the determinants of land and degradation along environmental gradients, is progressing. A paper on tree abundance along the NATT was published in the *Journal of Biogeography* (Williams et al. 1996). A paper on landscape patchiness along the NATT was submitted to *Landscape Ecology* (Ludwig et al. 1997). A review paper (Williams et al. 1997a) on disturbance regimes in savannas will be published by the Ecological Society of Australia as part of a symposium on disturbance regimes in Australian biomes. All manuscripts will form part of the final report to LWRRDC.

Initial analyses began of the nutrient status of soils beneath perennial grass tussocks and in inter-tussock areas. Landscape function analysis along 100 m transects was completed for all current 1 ha NATT sites. Work using the Surface Soil Condition Assessment indicator (Section 3, Cooperative Linkages) as a predictor of nutrients is in the preliminary stages of development. Analysis of the impact of simulated disturbance on grass basal area, ground stratum composition and soil surface condition is scheduled for completion by the end of 1997.

As per Project 1.1 milestones, much ecological data were provided to other Sub-Programs and the GCTE project. Four papers were published on phenology and water relations in conjunction with

Project 1.2 (Duff et al. 1997; Myers et al. 1997a,b; Williams et al. 1997b), and fauna surveys were undertaken on five NATT plots in conjunction with Project 2.1 and Project 3.2 (Annaburroo, Douglas Daly, Willeroo, Kidman Springs and Mt Sanford). A joint BSc Honours Project with Professor Greg Hill on remote sensing and *Mimosa pigra* also commenced.

FUTURE DIRECTIONS

Further modelling of variation on tree and ground stratum structure and composition as a function of annual rainfall and soil texture will take place over the coming year. PhD student, Mr Carl Menges (NTU) will undertake further assessment of radar as a remote sensing tool in savannas.

There will be further development of a climate-soil-vegetation GIS of the NATT. Ms Jenny Langridge, (CSIRO W&E Canberra) will make a preliminary visit to Darwin and the NATT in September 1997. Mr Peter Brocklehurst and Mr Bob Karfs (NTDLPE) and Mr Z. H. Khwaja (PhD student NTU) will also work on this aspect of the project.

There will also be additional development and applications of vegetation composition, soil nitrogen, soil surface condition and landscape patchiness as indices of savanna state along environmental gradients. Investigations will also continue regarding variation in leaf area index and above ground biomass along the NATT. Ms Annie Lane (ERA Environmental Services Limited) commenced a PhD project examining the use of native grass species in the revegetation of mine sites.

Dr Garry Cook, and Mr Richard Heerdegen, a geographer from Massey University in New Zealand commenced work on defining the rainfall regimes of the NATT sites, in terms of the length of the dry season and the probability of rain-

free days during the wet season. The investigation will continue with comparisons of the rainfall regimes of north Australian and West African savannas.

PROJECT TEAM

Nominated staff

DR DICK WILLIAMS, CSIRO W&E, Darwin
DR GARY COOK, CSIRO W&E, Darwin
DR JOHN LUDWIG, CSIRO W&E, Darwin
MR DAVID TONGWAY, CSIRO W&E, Canberra
DR MARK STAFFORD-SMITH, CSIRO W&E, Alice Springs
DR WAQUAR AHMAD, NTU, Darwin
MR PETER BROCKLEHURST, NTDLPE, Darwin

Centre Support Staff

MR JACK CUSACK, CSIRO W&E, Darwin
MR ROBERT EAGER, CSIRO W&E, Darwin
MR MICHAEL GREATZ, CSIRO W&E, Darwin
MR MICHAEL HOPE, CSIRO W&E, Darwin
N HINDLEY, CSIRO W&E, Canberra

Participating Researchers

PROFESSOR GRAHAM FARQUAR, Research School of Biological Sciences, ANU.
PROFESSOR GREG HILL, Centre for Remote Sensing and Geographic Information Systems, NTU.
MS JENNY LANGRIDGE, CSIRO W&E, Canberra.
PROFESSOR HANK SHUGART, Dept. Env. Sciences, UVirginia, USA
MR RICHARD HEERDEGEN, Dept. Geog., Massey University, Palmerston North, New Zealand

PhD & MSc Students

Z. H. Khwaja, NTU*
Ms Annie Lane, NTU
Mr Carl Menges, NTU*
Mr Geoff Miller, ANU

*CRC funded PhD students.

PROJECT 1.2 WATER USE BY TROPICAL SAVANNAS

PROJECT LEADER:

DR DEREK EAMUS,
NORTHERN TERRITORY
UNIVERSITY

PROJECT SUMMARY

The water requirements of northern Australia are likely to more than double over the next 50 years, particularly in the Darwin region. Knowledge of the fluxes of water in the soil-plant-atmosphere continuum is desirable in a climate dominated by seasonal availability of water. As a result, the Centre is undertaking substantial research to investigate the hydro-ecology of savanna systems of northern Australian. Project 1.2 seeks to quantify the seasonal rates of water use by savanna vegetation, with the goal of assessing water use of the major vegetation types. Knowledge of the role of vegetation in the water cycle is vital to achieving ecologically sustainable development of this region, particularly in terms of the exploitation of groundwater reserves.

Seasonal patterns of tree transpiration (E_t) and total evaporation, evapotranspiration (ET), soil moisture levels, soil physical properties, water table depth and vegetation characteristics are being quantified in the Howard River catchment, 35 km south-east of Darwin, NT. A number of these measurement regimes are at an advanced stage of completion, others require further development. Ultimately these parameters will be estimated at other sites in the Northern Territory and all data will be integrated into a model of catchment evaporation, with the aim of contributing to improved water resource management.

RESEARCH PROGRESS

During 1996-97, extensive field research was initiated to estimate seasonal patterns of water use at the tree, stand and community level at the Howard River East research catchment. Using the data generated, total surface

evaporation can be estimated and used in hydrological models to examine how exploitation of groundwater resources impacts on vegetation. This involves the implementation of two measurement strategies (eddy covariance and sap flux techniques) to estimate water use at a range of scales from tree to stand to community type and ultimately at a catchment and regional scale.



Dr Lindsay Hutley in the field with eddy covariance equipment. Measurements using this equipment are critical for successfully modelling water use by savanna vegetation.

Photo: Adrian Paul

Both techniques were employed at the end of the dry season (October 1996) and the end of a record wet season (April 1997). Measurements at these seasonal extremes provides data on the expected range of water loss from this vegetation type which is critical for successfully modelling water use by savanna vegetation.

Data collected during these measurement periods were processed and total water flux was found to be approximately 1.55 mm day^{-1} during the dry and approximately 3 mm day^{-1} at the end of the wet season. Dry season tree transpiration contributed over half of this flux (approximately 0.84 mm day^{-1}) with a smaller contribution coming from soil and understorey vegetation. Although

individual tree water use was relatively high, total system flux was low relative to evaporative demand (potential evaporation for the measurement period was approximately 6 mm day^{-1}), suggesting that canopy surface resistance of this vegetation is significant.

Another important result was the finding that water loss from all major tree species increases or decreases with tree size and is independent of species. This could greatly simplify estimating stand water flux as tree abundance and size may give an acceptable estimate of surface evaporation, and be important in the application of this research.

In addition to eucalypt woodland vegetation, two important community types, monsoon vine forests and paperbark swamps were identified as being potentially sensitive to altered water tables from groundwater pumping. During April 1997, in collaboration with Dr Tom Hatton (CSIRO L&W Adelaide) sap flux and water relations measurements were made in a swamp/paperbark community. Similar work was planned for a monsoon vine forest site, but above average wet season rainfall prevented site access. This work will begin during the mid dry season 1997.

FUTURE DIRECTIONS

Measurements will continue for at least one more wet-dry seasonal cycle. Within-catchment spatial variation will be investigated by establishing other eddy covariance and sap flux sites within the vicinity of the Howard River catchment. At the tree and stand level, approximately three years worth of data are available and further work with this technique will investigate the extent of within-catchment spatial variation at the tree scale.

Future plans also include the collection of CO_2 data during eddy covariance measurement runs,

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greatly enhancing the data collected as both water and carbon relations of this community type can be investigated. This will contribute to climate change research. Current implementation of general circulation models (GCM) suggests that knowledge of carbon fluxes from tropical vegetation may be significant in improved climate change modelling.

In addition to quantifying above groundwater and CO₂ fluxes, future work will focus on aspects of soil water dynamics and hydrology of tropical savanna communities, critical to gaining a functional understanding of water movement through the soil-plant-atmosphere continuum. This aspect of the project will be undertaken by Ms Georgina Kelley, a PhD student funded by the Centre (commenced

February 1997). Seasonal patterns of soil water content will be monitored in continuing collaboration with the Division of Water Resources, NTDLPE.

In collaboration with Project 1.1, a major leaf area index survey down the NATT is planned for the dry season of 1998. At strategic sites, eddy covariance estimates of water and CO₂ flux will also be undertaken. Such measurements will provide crucial data on spatial variation of these parameters at a regional scale.

PROJECT TEAM

Nominated Staff

Dr Derek Eamus, NTU
Dr Lindsay Hutley, CRC/NTU
Mr Tony O'Grady, CRC/NTU
Ms Georgina Kelley, CRC/NTU*

Support Staff

Mr D Chin, NT Water Resources
Mr Errole Kerle, NT Water Resources
Mr Ian Lancaster, NT Water Resources

Collaborating Professional Staff

Mr Don Pidsley, NT Water Resources
Dr Tom Hatton, CSIRO L&W
Dr Peter Cook, CSIRO L&W
Dr Alex Held, CSIRO L&W.
Dr Dick Williams, CSIRO/TERC
Dr Dane Thomas, NTU

*CRC-funded PhD student

SUB-PROGRAM 2 BIOLOGICAL DIVERSITY IN THE SAVANNA LANDSCAPE



SUB-PROGRAM LEADER
MR PETER WHITEHEAD,
PARKS AND WILDLIFE
COMMISSION, NORTHERN
TERRITORY, DARWIN

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

Sub-Program 2 is therefore designed to provide information on relationships between biological

diversity and patterns of land use at a number of relevant spatial scales, using a strategic approach that focuses special attention on a few aspects of savanna ecology. The focus is on research outputs that offer the greatest potential for general application to a range of savanna environments and various development options, yet are achievable on relatively modest budgets over a reasonable time frame.

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

PROJECT LEADER:

DR JOHN WOINARSKI,
PARKS AND WILDLIFE
COMMISSION, NORTHERN
TERRITORY

Project 2.1 provides a biogeographic overview of the savannas that consolidates existing information and includes new surveys to identify sites and environments that are unusually rich in biological diversity. It establishes relationships among the distribution and abundance of flora and fauna and environmental variables, including the type and intensity of land use. The status of different components of the savanna biota is being re-examined, groups suffering adverse change identified, and the ecology of those species in difficulty are being compared to identify common features and draw inferences about the processes affecting them.

This understanding of the patterning of biological variation across the landscape and influences on it, provide background essential for design and interpretation of more detailed studies in both Sub-Programs 2 and 3 (Indicators of Sustainability). Another of the project's goals is to record and incorporate valuable Aboriginal traditional knowledge on wildlife and the land, much of which is being lost. The loss of wildlife in the tropical savannas is of increasing concern to Aboriginal people and wildlife authorities. Until the extent and causes of this loss are established, sustainability of land use cannot be achieved.

RESEARCH PROGRESS

This year saw the satisfactory completion of all field work for a survey of the Mitchell grasslands, involving about 100,000 km of travel, and the establishment of more than 1200 pitfall traps. Approximately 100 sites from 12 widely spaced locations were sampled, each in two contrasting seasons. Analysis of fauna distribution in the Mitchell grasslands began in June, and should

be completed by October 1997.

Additional to the Mitchell Grass study, more than 300 quadrats were sampled for vertebrates, including more than 30 fire monitoring sites. Sampling incorporated a variety of habitat types over a wide geographic range in the northern half of the Northern Territory with a smaller number of sites established in the northern Kimberley.

A wildlife and vegetation survey of islands off north-eastern Arnhem Land was completed. Visiting a large number of small islands in this very remote locality posed major logistical problems. The islands are about 600km east-north-east of Darwin and five to 80km from the Arnhem land mainland. The absence of infrastructure and lack of communication contributed to the difficulty of the survey. However this was compensated for by the information gained and the collaborative input from Aboriginal traditional owners. The project team was accompanied by four Aboriginal Elders for one to two weeks during the survey. Detailed discussions took place on the islands' history, land management, names, animal and plant distribution and stories.

Project staff also had a major impact on the development of policy for the future direction of the National Parks system in the Northern Territory, as well as making a substantial contribution to national guidelines for scientific criteria for the National Reserve System. These conservation assessments for the Northern Territory provided a major focus for the Northern Territory's Parks Master Plan – the discussion paper charting the future course for the conservation reserve system in the Northern Territory. Management advice presented in these surveys was generally implemented, and a consistent methodology is now used for wildlife surveys in the Northern Territory and in Queensland's Desert Uplands.

Three wildlife surveys for a number of existing and proposed

reserves in the Northern Territory – the Elsey National Park, the proposed Limmen Gate National Park and Litchfield National Park – were completed during 1996-97. Wildlife survey methodology developed by Project 2.1 was also used in sampling at Kalumburu in the northern Kimberley.

Substantial data were collected from the sub-humid or semi-arid zone of northern Australia – the Mitchell grasslands and adjacent habitats, the Barkly Tableland and Victoria River District – all previously poorly known zoologically.

All relevant existing wildlife and vegetation databases in the Northern Territory were collated, but problems remain with the collation of Queensland and Western Australian databases where the main custodians are not partner agencies to the Centre. An overview of the distribution and reservation status of individual plant species and vegetation was also undertaken in the Top End and a paper published.

A reconnaissance survey of bluebush (*Chenopodium*) shrublands on the Barkly Tableland was undertaken in June 1997, and further sampling is scheduled for later in 1997/1998.

FUTURE DIRECTIONS

In conjunction with CSIRO, Project 2.1 will model economic costs and biodiversity benefits of a range of conservation management scenarios relating to the Mitchell grasslands study. This approach will be extended, via cooperation with CSIRO W&E Canberra and Alice Springs, to conservation management strategies for water-points in the semi-arid area, probably through another case study in the Sturt Plateau bioregion.

The bluebush (*Chenopodium*) shrubland study will also be developed, complementing the Mitchell grasslands study. The aim will be to develop comparable management outputs. The project

RESEARCH

further plans to analyse the status of vertebrate species across northern Australia, in regard to a decline in distribution or population size, and the factors responsible for that decline.

Depending on external funding, an analysis of the impact of tree-clearing in Queensland is scheduled to begin, with the aim of assisting with appropriate

management advice. There will also be ongoing studies of impacts of pastoralism on wildlife and appropriate conservation management strategies.

Depending on external funding, Project 2.1 also aims to undertake an analysis of impacts of military land use and the development of monitoring techniques to assist management.

PROJECT TEAM

Nominated staff

DR JOHN WOINARSKI, PWCNT
MR CHRIS BROCK, PWCNT
MR DAVID CHEAL, PWCNT
MR GREG CONNORS, PWCNT
MR ALARIC FISHER, PWCNT
TONY GRIFFITHS, PWCNT
MR ALEX KUT T, JCU
MS TANYA LEARY, PWCNT
DR NORM MCKENZIE, WA CALM
MR DAMIEN MILNE, PWCNT
MS BELINDA OLIVER, PWCNT

Collaborating Researchers

DR ROD FENSHAM, QDoE
DR BRONWYN SCOTT, JCU

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



Granivorous birds such as the Partridge pigeon have declined in abundance and range. Study sites for the bird have now been established on grazed and ungrazed land.

Photo: Fiona Fraser

PROJECT LEADER

DR DAVID CHOQUENOT
PARKS & WILDLIFE COMMISSION
OF THE NT,
DARWIN, NT

RESEARCH SUMMARY

Project 2.2 examines the ecology of at least two species of granivorous birds, many of which have declined in abundance and range. These birds depend absolutely on the seeds of different grasses that are patchily

distributed through the savanna environment. To understand the factors affecting their status requires an examination of fundamental processes in grassland dynamics, and how those dynamics change with different land use or with the application of management tools such as fire. Information gained on how to manage grasslands to maintain the patterning of different communities needed for these birds will also be relevant to many other conservation issues.

RESEARCH PROGRESS

Progress in most parts of the study was steady rather than spectacular. Highlights include

- Resolution of the previously intractable problem of determining the distribution of Gouldian finches and indexing their abundance
- Completion of studies of wet season habitat use by Gouldian finches, which will provide the basis for framing hypotheses to be examined in experimental

- studies of grassland dynamics
- Major inroads into measurement of home range and studies of habitat selection in Partridge pigeons,
- Assembly and interrogation of major datasets on the contemporary and historical distribution of granivorous birds in the savannas.

Measuring changes in the abundance of rare species in extensive landscapes presented formidable sampling problems. A method for census of birds that visit water regularly was developed, involving simultaneous counts at a large sample of waterholes. The outcomes from trials are currently being examined by a CSIRO statistician. It is anticipated that details of methods and preliminary results will be submitted for publication shortly.

The field component of a study of wet and dry season habitat use by Gouldian finches was recently completed, and is currently being prepared for publication. Papers dealing with similar issues as they affect the status of the Endangered Golden-Shouldered Parrot *Psephotus chrysopterygius* in Cape York were prepared by Drs Crowley and Garnett under the aegis of this project.

Studies of the Partridge pigeon *Geophaps smithii*, by PhD student Ms Fiona Fraser, are well advanced. Sites were established on grazed and ungrazed lands, subjected to a range of fire treatments. Descriptions of relevant habitat attributes, including floristics, were completed across these various management regimes. These attributes will be compared with the characteristics of sites used by a substantial sample of radio-tagged birds to identify preferred habitat types. Studies of seasonal variation in foraging activity began, which will also be related to habitat attributes including measures of food availability.

A review of conservation status of grassland birds and threatening processes is well advanced and scheduled for

completion during the 1997 calendar year. Both contemporary and historical records were assembled from a wide range of sources, and biogeographic patterns described. Variation through time in reporting rates for a range of species were examined and this approach appears, in conjunction with analysis of spatial patterns, capable of robustly identifying those species that have declined in abundance and range. Biogeographic analyses have identified a suite of species that are strongly associated with Australia's tropical savannas.

GIS coverage of geology, broad-scale vegetation mapping, and topography is being assembled for identification of features common to sites still occupied by Gouldian Finches. Satellite imagery is being assembled and arrangements were made for its analysis. A landscape "signature" will be defined for occupied sites and used to identify other potentially suitable sites for further investigation.

An experimental approach to determine the impact of fire and grazing on dynamics of savanna grasslands was developed, and application is proposed for 1998. The procedure adopted is based on that used for studies of the interaction between herbivores and vegetation in Kinchega National Park, and uses small, relocatable exclosures to generate large, independent samples to which treatments are applied.

Gouldian finch breeding sites subject to intensive study include lands used predominantly for pastoralism, ungrazed areas associated with a major mining venture, and Aboriginal lands. The proposed studies of grassland dynamics incorporate sites that will encompass the region's dominant land uses. A Species Recovery Plan was prepared and is being considered by the National Gouldian Finch Recovery Team. Development of the Management Plan under Northern Territory legislation will follow acceptance of the Recovery Plan.

FUTURE DIRECTIONS

Much of the early effort in this project was necessarily devoted to provision of a sound natural history base, and that work was advanced satisfactorily. However, establishing links between autecological studies of declining fauna and processes affecting habitat quality at a landscape scale, remains an essential theme. Capacity to address these questions was strengthened by the addition of new project leader Dr David Choquenot, who specialises in studies of plant-herbivore dynamics.

PROJECT TEAM

Nominated Researchers

DR DAVID CHOQUENOT, PWCNT (project leader)
 MS FIONA FRASER, PWCNT (PhD student)
 MR PETER WHITEHEAD, PWCNT (former project leader)
 MR PETER DOSTINE, PWCNT
 DR JOHN WOINARSKI, PWCNT
 DR RICHARD NOSKE, NTU
 DR SONIA TIDEMANN, Batchelor College
 DR DAVID BOWMAN, PWCNT
 MR DAVID CHEAL, PWCNT
 MR GREG CONNORS, PWCNT

Support Staff

MR DAVID HOOPER, PWCNT
 MR DAMIAN MILNE, PWCNT
 MR JOHN SCOTT, PWCNT

Collaborating researchers

MR DON FRANKLIN, PWCNT
 DR STEPHEN GARNETT, QDoE (now private consultant)
 MS GABRIEL CROWLEY, QDoE (now private consultant)
 PROF JOHN WIENS (visitor), Colorado State University
 DR BEATRICE VAN HORNE (visitor), Colorado State University

RESEARCH

PROJECT 2.3

RIPARIAN HABITATS

INTERIM LEADER:

MR PETER WHITEHEAD,
PARKS AND WILDLIFE
COMMISSION OF THE NORTHERN
TERRITORY

PROJECT SUMMARY

Project 2.3 seeks 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. 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 research effort.

RESEARCH PROGRESS

Progress against milestones was constrained, because contributed staff (notably a research scientist to work full time on this project) originally to come from CALM has not become available. Assessment of research progress therefore relates only to activity supplementing other projects to establish connections between patterns of biodiversity associated with riparian habitats and the wider savanna landscape. This work was undertaken by the CRC botanist, Mr David Cheal, in cooperation with Project 2.1. However, staff associated with the project also made a significant contribution to a report for the Meat Research Corporation summarising the impact of grazing on wetland habitats.

A number of GIS coverages relevant to this task were aggregated, but analysis is yet to begin. Particular effort will be made to advance this work following the recent appointment the Centre's GIS specialist Mr Greg Connors.

Sites used by the Water Resources Division of the NT Department of Lands, Planning and Environment for monitoring of water quality under the National River Health Assessment were selected for additional sampling of fringing vegetation and vertebrate fauna. A similar procedure will be adopted in the Kimberley region of Western Australia. The Jawoyn traditional landowners sought assistance to establish river monitoring points in the headwaters of the Katherine River and, as a result, several sites were added to the national inventory. Final selections on all sites will not be made until staffing arrangements are finalised with CALM.

Sampling was completed at a number of Northern Territory water sampling sites. However, completion will be deferred until the situation with regard to CALM staffing is clarified. The characterisation of riparian habitats will not take place until all study sites are identified and surveyed.

FUTURE DIRECTIONS

Future directions will depend on decisions regarding the involvement of CALM personnel in the project. Should CALM be unable to increase its commitment, alternative arrangements will be pursued.

PROJECT TEAM

Nominated staff

DR JOHN WOINARSKI, PWCNT
MR MICHAEL DOUGLAS, NTU
MS ALISON POULIOT, NTU
MR GORDON GRAHAM, CALM
MR DAVID CHEAL, PWCNT
MR GREG CONNORS, PWCNT

Support Staff

MR DAMIAN MILNE, PWCNT
MR CHRIS BROCK, PWCNT

PROJECT LEADER:

DR JEREMY RUSSELL-SMITH,
NT BUSHFIRES COUNCIL,
DARWIN, NT
ADJUNCT FELLOW,
CENTRE FOR INDIGENOUS
NATURAL AND CULTURAL
RESOURCE MANAGEMENT
NTU, DARWIN.

PROJECT SUMMARY

Project 2.4 examines fire management in the tropical savannas. The broad-scale patterning of fire across northern Australia is being studied using remote sensing and GIS technology to enhance fire management strategies for fire management authorities and land managers alike. These studies will assist in developing management tools, such as monitoring fuel loads, curing rates and biodiversity indicators.

In addition, the fire history of selected sites will be examined at a much finer scale and monitored over a number of years. Permanent monitoring plots on conservation, pastoral and Aboriginal lands are exploring relationships between fire history and vegetation patterns. These plots will also be linked to the biogeographic and ecological studies, as well as the examination of land condition and indicators of sustainability (Sub-Program 3). The primary goal is the development of ecologically and economically sound fire management strategies relevant to a wide range of land users.

Operating under the banner of the Centre brought both benefits and challenges. Benefits included significant opportunities for developing inter-regional and inter-sectoral linkages, the availability of core funds as leverage for developing larger projects, and access to the technical expertise of other individuals and programs participating in the Centre. Constraints affecting the fire program included the lack of institutional commitment by some parties to the Centre; and indifferent perceptions of the

Centre conveyed by some agencies, funding bodies, and end-users.



The broad-scale patterning of fire across northern Australia is being studied using remote sensing and GIS technology to enhance management strategies for fire management authorities and land managers alike.

Photo: CSIRO

RESEARCH PROGRESS

Project 2.4 developed rapidly over the past year. It focused on identifying and defining key fire management issues across northern Australia as well as developing effective broad-scale monitoring systems at a range of useful spatial and temporal scales (e.g. NOAA-AVHRR, Landsat, historic photos/records). There was also an associated focus on developing effective, rapid data dissemination and interrogation systems, e.g. through the Internet, for access by end-users.

Regional activities were developed involving all land management sectors to address significant issues such as land-use sustainability, biodiversity, strategic fire management planning, economics and information through the development of cooperative, targeted, and funded research and management projects. Project 2.4 will be submitting a report to Environment Australia by the end of calendar 1998.

Broad-scale monitoring of fires in the Northern Territory and Western Australia is being undertaken using NOAA-AVHRR imagery on a daily basis, with cumulative mapping every two weeks. Project participants Mr Grant Allan and Ms Megan McNellie (PWCNT, Alice Springs), along with other Centre partners, were developing methods to reliably detect, map and monitor fires at broad landscape scales using remote sensing and GIS technologies. This program is being undertaken through the WA Department of Land Administration (DOLA), with funding assistance from the Centre and other WA and NT agencies. Ms McNellie also began work on the Centre's VRD case study, and is developing a recent (10-year) fire history for that region based on interpretation of Landsat imagery.

During the year, project participant Dr David Bowman (PWCNT, Darwin) assessed the use of historical and contemporary aerial photos to examine changes in vegetation boundary condition, and potential fire regimes.

Mr Andrew Craig (Ag WA, Kununurra), began development of a field monitoring program for the Kimberley region, to research and assist pastoralists in assessing the effects of burning in pasture management. In the past year he authored a review of fire in the management of rangelands in the Kimberley and, with others, a major review of fire in the northern Australian rangelands generally.

Dr David Bowman, with Mr Rod Fensham and Mr Bruce Wilson of ODoE undertook an examination of vegetation patterns in ungrazed (by domestic stock) and infrequently burnt savannas near Charters Towers in Queensland. This work is currently being prepared for publication.

Mr Gordon Graham (CALM, Kununurra) began development on a program to assess the status of fire-sensitive vegetation (rainforest, Cypress Pine) in the

RESEARCH

north Kimberley. However work in this project was complicated by the uncertainty of CALM's continuing participation in the Centre.

Mr Paul Ryan (NTU, Darwin) began development of a fire history for the north Kimberley region based on interpreting Landsat imagery, and assembling and developing associated GIS coverages – for example, topography, elevation and tenure. This work was undertaken as a PhD project, aimed at developing reliable information relevant to, and readily accessible by, both regional land managers and researchers.

In addition to these new studies, Dr David Bowman wrote a major publication on Australia's rainforests and the factors that shaped their contemporary distribution and status. An important element of the book is an examination of the influence of fire on savanna vegetation patterns.

FUTURE DIRECTIONS

A key aim over the next year is to develop good funding sources for the following few years. Funding partners are being sought for a major integrating project, Fire Management for North Australian Savannas, that developed in cooperation with a large number of partner organisations.

As well, more attention will be given to developing opportunities in eastern Indonesia; two projects are currently under development. The first, Sustainable Fire Management Systems for Agriculture and Forestry Development in Eastern Indonesia, is being developed with ACIAR. The second, Sustainable Land Management Practice in Eastern Indonesia, is being developed with a consortium of NGOs and Indonesian Government agencies.

PROJECT TEAM

Nominated staff

MR GRANT ALLAN, PCWNT
DR DAVID BOWMAN, PCWNT
MR ANDREW CRAIG, Ag WA
MR GORDON GRAHAM, CALM WA
MS MEGAN MCNELLIE, PCWNT
DR JEREMY RUSSELL-SMITH, BFC
MR PAUL RYAN, NTU*
MR GREG CALVERT, CRC/JCU*

*PhD students

Collaborating Researchers

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MR DAVID EPWORTH, Balkanu Cape York Development Association
MR PETER STANTON & MR DAVE FELL, Consultants to Balkanu Cape York Development Association
MS LISIE FELDERHOFF, QDoE
MR KEITH MCDONALD, QDoE
DR ROD FENSHAM QDoE,
MR BRUCE WILSON, QDoE
MR BRIAN CIFUENTES, QFS, Rural Fire Division
MR JOHN CARTER, QDNR
DR TIM DANIHER, QDNR
Members of VRD Regional BFC Committee, and Sturt Plateau Best Practice Group
The staff of Kakadu, Litchfield & Nitmiluk National Parks
Staff of Bushfires Council NT
MR RUSSELL ANDERSON, BFC
MR TIM MCGUFFOG, BFC
MR RODD DYER, NTDPIF
MR RIK DANCE, NTDPIF
MR DARELL LEWIS, Consultant.
MR ANDREW EDWARDS, PWCNT.
DR JENNIFER ROBINSON, Murdoch University, WA.
DR RICHARD SMITH, DOLA WA
MS CAROLINE MCMILLAN, DOLA, WA
MR RON CRAIG, DOLA, WA
MR MIKE STEBER, DOLA, WA
MR PETER SAINT, Bushfires Board WA
DR TONY START, CALM WA

SUB-PROGRAM LEADER:
DR PAUL NOVELLY,
AGRICULTURE WESTERN
AUSTRALIA, KUNUNURRA

The focus of Sub-Program 3 is to develop indicators of sustainable development readily useable by land and enterprise managers, and by policy makers. Such indicators allow proactive assessment of land potential and appropriate use and trend monitoring of both savanna resources, as well as assessment of how resilient or susceptible savannas are to modification either through natural or enterprise-based stress.

Sub-program 3 is essentially on time, within budget and meeting its milestones, and doing some excellent work. The projects are have increased their liaison with other agencies both intra and interstate, overseas and with other Cooperative Research Centres. Outputs from the three projects are starting to be used by both land managers and government agencies.

One change of face is Dr Tony Grice (CSIRO TAG) who will replace Dr Joel Brown as Project Leader of Project 3.3 as Dr Brown will be returning to the United States in late 1997.

Another highlight was the selection of the Centre as one of the agencies involved in co-convening one session, Rangeland Resource Accounting, at the International Rangeland Congress in 1999. This Centre has an ever increasing role to play in northern Australia, and its ability to bring groups together to address savanna issues in an integrated way is now being recognised.

PROJECT 3.1 INDICATORS OF SUSTAINABLE LAND PRODUCTION AND CONDITION

PROJECT LEADER:
MR ROD APPLIGATE,
DEPARTMENT OF LANDS,
PLANNING AND ENVIRONMENT,
NORTHERN TERRITORY

PROJECT SUMMARY

Sustainable land management means that the maintenance of productive potential in one land use does not compromise the ability of the land to support that land use, or other land uses, in the future. The key to developing management systems for sustainable land use is a set of reliable indicators of the state or condition of the land.

A combination of indicators needs to reflect both the health and productive potential of the land, and give prior warning that land may be about to change from one state to a less desirable state. At present, there is a basic understanding of how to determine land condition, but understanding the processes which govern the transition from one state to another, and our ability to assign value to various states, is limited.

Spatial analysis from the paddock to regional scale is being accomplished in Project 3.1 using



Staff from NT DLPE, Ag WA (both Perth and Kununurra based) and ERIN (Canberra) on site in the Victoria River District conducting monitoring assessment in Project 3.1.

a combination of remote sensing and GIS analysis. By making detailed assessments of the dynamic nature of rangeland ecosystems, it is then possible to predict land condition trends and provide scientific evidence to support sustainable management and conservation of the tropical savannas.

RESEARCH PROGRESS

Quantitative landscape, vegetation and surface soil condition data was collected over the past two years at 33 research monitoring sites established on

the Victoria River Downs property in the Northern Territory. Additional sites were established on adjacent properties, bringing the total number of research sites established in the Victoria River District (VRD) to 51.

Field work to the end of the 1997 will again focus on the Victoria River Downs property and the establishment of sites on three additional properties. This will allow temporal land condition analysis over a significant number of sites on several representative rangeland types.

RESEARCH

Collaboration between NTDLPE and Ag WA on surface soil condition assessment and vegetation analysis was ongoing.

A joint NTDLPE/Ag WA field trip to the VRD was completed in July 1996 with several refinements made to the soil surface technique to address local ecological conditions. This was necessary to assimilate the technique into operational monitoring systems without sacrificing the integrity of the data collected.

Vegetation, soil and landscape data, for all sites assessed by Project 3.1 since 1995, were entered onto Visual dBASE. Complementary floristic and soil pit data, collected in 1993 by NTDLPE from 71 representative land types located throughout the VRD, was also linked to the database.

All of the research and additional NTDLPE sites were classified into seven range types according to landform, soil and species composition. This process involved investigating various classification and ordination techniques for range condition and trend analysis.

Time series image analysis techniques developed by CSIRO MIS were introduced into the system for assessing indicators. The adoption and refinement of this technique was one of the highlights of this year's research.

A key factor in Project 3.1 is the integration of remote sensing and ground-based monitoring data. On several rangeland types, ground monitoring data was reflected in the findings captured by satellite imagery. Time series satellite data is continuing to be integrated with ground-based monitoring data to produce image maps showing trends in tropical savanna grasslands.

A four-scene, calibrated base image mosaic was produced through the efforts of Ag WA staff in collaboration with MIS and DLPE. The mosaic comprises four adjacent Landsat (satellite) images, covering a total area of 360km x 360km in both Western Australia and the Northern Territory. The mosaic will eventually be used in time series analysis, at a regional scale, for most of the East Kimberly and VRD regions.

Work is also continuing on refinements of the Carbon Management Index for application to Northern Territory soils. The method of Blair, Lefroy and Lisle is being tested for applicability to tropical savanna soils and chemical analysis of soils from a range of management regimes was completed. Collaboration between NTDPF and the University of New England to test the CMI methodology is continuing.

A Dry Season Greenness Index was developed for regional assessment of rangeland condition. The method uses the Normalised Difference Vegetation Index, derived from AVHRR data from the NOAA satellite. A description of the methodology, and findings for 1997 will be included in the first report on the sustainability of Australian agriculture by the National Collaborative Project on Indicators for Sustainable Agriculture (NCPISA).

The results of the rangeland assessment over the VRD covered by Project 3.1 will be incorporated into broader reporting on the state of the NT rangelands. The information is also a valuable dataset to State of Environment reporting.

FUTURE DIRECTIONS

The relationship between ground-based land condition data and time series remote sensing

PROJECT TEAM

Nominated staff

MS DOMINIQUE LYNCH,
CRC/NTDLPE, Darwin
MR BOB KARFS, NTDLPE, Darwin
MR ROD APPEGATE,
NTDLPE, Darwin
DR PAUL NOVELLY,
Ag WA, Kununurra
MR ANDREW CRAIG,
Ag WA, Kununurra
DR ANNETTE COWIE,
NTDPF, Darwin

Support staff

MR LUKE PEEL,
CRC, NTDLPE, Darwin
MR BRENDAN EWING,
NTDLPE, Darwin

Collaborating Professional Staff

MR JEREMY WALLACE, CSIRO, Perth
DR SHANE CRIDLAND,
ERIN, Canberra
MR DAVID TONGWAY,
CSIRO W&E, Canberra
DR JOHN LUDWIG,
CSIRO W&E, Darwin

data will continue to be investigated. An important task in the next year will be the integration of vegetation and environmental data with soil surface data. Refinement of methods, assessment and analysis will be ongoing.

Powerful, yet simple prototype land condition image maps will be developed for use by stakeholders in the Victoria River District.

A digital data entry program for automating vegetation survey data capture will be developed. Preliminary investigations show that recent developments in very small computers will allow for a Windows-based program to enable data collation directly into a spreadsheet format while in the field.

Project 3.1 is involved in the CRC-funded VRD Case Study Project in cooperation with several Centre organisations. Its role will be to develop a landscape stratified fire history and detect landscape change

using remote sensing techniques in conjunction with PWCNT, NTBFC, NTDPIF and CSIRO W&E.

If the CMI method is found to distinguish labile carbon fractions in tropical savanna soils, it may be

applied to monitoring sites in the Victoria River District to determine whether it is a successful indicator of sustainable pastoral management.

PROJECT 3.2 *INVERTEBRATE INDICATORS OF BIODIVERSITY AND ECOLOGICAL CHANGE*

PROJECT LEADER:

DR ALAN ANDERSEN,
CSIRO DIVISION OF WILDLIFE AND
ECOLOGY, DARWIN N.T.

PROJECT SUMMARY

Land monitoring systems in northern Australia developed historically in the context of grass production, and consequently focused on characteristics of the soil surface and perennial vegetation. The relationship between such 'land condition' variables and biodiversity, particularly faunal diversity, is yet to be determined. Current state-and-transition models were also developed primarily within a production context, and their applicability to faunal communities is unclear.

This project focuses on plants and vertebrates respectively because they are the primary contributors to biodiversity, and include faunal groups that are most likely to satisfy the criteria for selection as bioindicators. Invertebrates have an extensive history of use as bioindicators in aquatic systems, and, more recently, on land. In particular, ants have been widely used as bioindicators in land assessment programs, particularly in relation to mine site restoration, forest management practices, and, most recently, rangeland pastoralism.

The taxa targeted in this project are ants, termites, spiders, grasshoppers and beetles. These represent a diverse array of taxa, with a broad range of ecological requirements spanning all trophic levels. The project is closely integrated with other projects from Sub-programs 1-3, with data



Dr Alan Andersen with Third Year students from Northern Territory University.

Photo: Sam Setterfield

on soils and vegetation (Projects 1.1 and 3.1), invertebrates (Project 3.2) and vertebrates (Project 2.1) collected at the same sites. Taken together, these taxa represent a considerable proportion of total biodiversity.

RESEARCH PROGRESS

The highlight of this year's work was the excellent progress of the project, with geographic patterns of invertebrate distribution emerging with clear responses to land use.

Invertebrates were sampled by pitfall traps at all NATT sites on two occasions, July 1996 and April 1997 and a census was carried out on grasshoppers in April 1997. Spiders were sorted to family, with the dominant family *Zodariidae* identified to species. The sorting of ants, beetles and grasshoppers to species is progressing. Ants from the Mitchell grassland grazing trials (Project 2.1) were identified to species, and preliminary analyses completed.

The identification of spiders and beetles is nearing completion. Sampling and identification to species of ants from the NTDPIF's fire experiment at Kidman Springs was also completed.

One of the challenges of this project was processing the enormous numbers of specimens collected. For example, just one sampling trip along the NATT took six people working full-time three weeks to remove specimens from the traps. An average of 20 species of ants (and often thousands of individuals) are caught in each pitfall trap. Many of the species caught, and this includes the other invertebrates under study, have not previously been described, highlighting a further benefit arising from Project 3.2 activities. These new collections are making a valuable contribution to a book that Dr Andersen is writing on the ants of northern Australia.

The sorting and analysis of methodology trials was completed and a manuscript is in preparation.

RESEARCH

One PhD student commenced with Project 3.2, Mr Ben Hoffmann (Responses of ant communities to land-use in Australian tropical savannas) during the year in review, and another, Mr Andrea Salvarani (Ant distribution patterns in Australian tropical savannas), is now enrolled. Both are co-supervised by staff from CSIRO W&E and NTU.

Project 3.2 also completed a collaborative study of ants as indicators of fire management for Queensland State Forests. The study will now examine the impact of grazing on ants. Dr Andersen was also contracted to identify

ants and interpret data for ant monitoring programs being implemented at German Creek Mine in Queensland.

FUTURE DIRECTIONS

Two replicate NATT transects, including one in the Kimberley region of Western Australia, will be sampled to test the representativeness of the primary NATT sites. Over the next two years, invertebrates will be sampled at CSIRO TAG's long-term grazing trials in the Charters Towers region of Queensland. Project staff are involved with the CRC consultancy with Mount Isa Mines.

PROJECT TEAM

Nominated staff

DR ALAN ANDERSEN,
CSIRO W&E, Darwin
DR TRACEY CHURCHILL,
CRC/CSIRO W&E, Darwin

Support staff

MR TONY HERTOOG
CRC/CSIRO W&E, Darwin
MS LYN LOWE
CRC/CSIRO W&E, Darwin
MR GUS WANGANEEN
CSIRO W&E, Darwin

PROJECT 3.3 LANDSCAPE RESTORATION

PROJECT LEADER:

DR JOEL BROWN,
CSIRO TROPICAL AGRICULTURE
TOWNSVILLE, QLD

PROJECT SUMMARY

Exotic weeds are a major threat to both the productive capacity and the native ecosystems of northern Australia. However, as these invasions are recent in origin, much land is as yet uninvaded. Even within the current range, weed invasion occurs only in isolated sub-populations. There is, therefore, a genuine opportunity for focused management to both limit the spread and reclaim landscapes that have been already invaded.

Over the past 10 years, work by state and federal research agencies identified techniques for both containing invasions at current levels and removing weeds from small areas. However, the application of these techniques is only sporadic because of high treatment cost/land value ratios and climatic variability. One way to improve the economic



Exotic weeds such as Acacia nilotica, left, are a major threat to native ecosystems and capacity for production. Photo: CSIRO

effectiveness is to lengthen the time frame across which treatments are applied. By extending the time frame, the cost in any one year can be reduced and risk can be minimised. However, by selectively applying treatments to specific locations in the landscape over a longer period of time, reinfestation is a risk. This project is seeking to develop management models that can help overcome these problems.

RESEARCH PROGRESS

One of the highlight of the year's research was the acceptance and participation in Project 3.3 of the Balfes Creek and Fletcher Creek Catchment land care groups. A disappointment was the unsuccessful arrangement for a joint

post-doctoral appointment with the CRC for Weed Management Systems and the Centre. However, Dr Ian Radford began work in January 1997 in the post-doctoral position, jointly funded by the Centre and CSIRO TAG.

Geographic Information Systems for Balfes Creek Catchment and Fletcher Creek Catchment are now operational with data captured including soils, infrastructure and property boundary layers. Small area (less than < 1 ha) models were developed for rubbervine (*Cryptostegia grandiflora*) habitat susceptibility, climatic requirements and disturbance patterns associated with establishment, but dispersal patterns over larger areas have not yet been integrated.

When these data are integrated these models will be used to develop alternatives for management of rubbervine at the sub-catchment (<500,000 ha) scale. Population biology, dispersal systems, habitat quality and climate variability data will then be integrated into the spatial model, with a target date of June 1998.



Knowledge is being gained on the rate of infestation density of mesquite, above. Photo: CSIRO

Preliminary tests of this model in evaluating different weed control strategies is on track for a post-1999 target date.

The Tropical Weed Research Centre (TWRC) based at Charters Towers, is also working collaboratively within Project 3.3. TWRC is undertaking studies on the ecology and management of *Prosopis spp.* (mesquite) a potential threat to large areas of the tropical savannas. The experiment was initiated as part of a joint QDNR/CSIRO project that was funded by the MRC.

TWRC conducted research into the recruitment dynamics of mesquite over the past two wet seasons. Permanent transects were monitored in areas where mature mesquite trees were removed by bulldozing, and in standing infestations of varying densities. Knowledge was gained of the main factors influencing the emergence, establishment and survival of mesquite seedlings, including inter and intra-species competition, rainfall and soil moisture.

More than 7000 seedlings were tagged and monitored for survival and growth characteristics. Seedling characteristics were examined in transects located in areas of varying density, ranging from low (183 plants per hectare) to extremely

thick infestations (3350 plants per hectare). Relationships between total seedling emergence and the density of large trees (>2m) were developed. There were six germination events, with three occurring in each wet season. Survival of these cohorts was variable, with an average of 9 per cent survival recorded up to June 1997.

The initial and follow-up rainfall soon after emergence appeared to be the key factors influencing survival, although factors such as tree density and the level of grass competition may also have had an influence. There appears to be regular recruitment of small numbers of seedlings into existing

populations which more than compensates for mortality of older trees.

FUTURE DIRECTIONS

Work will proceed for the next 18 months on the rubbervine distribution model and applications for landscape scale restoration decision support. Difficulties were encountered in accurately mapping rubbervine distributions in heavily wooded areas of north-eastern Queensland in a cost-effective manner. The inclusion of remote sensing technologies (satellite imagery and aerial videography) should help overcome this problem. The remote sensing of rubbervine populations will be in collaboration with CSIRO W&E (videography) and CSIRO MIS (satellite imagery).

A proposal was also submitted to expand the decision support applications to the restoration of woody weeds (*Acacia nilotica*) invaded landscapes in western Queensland.

Work on mesquite will continue at TWRC for at least another 12 months so that conclusive results can be obtained. Data should be gained that will help identify conditions likely to bring about

increases in mesquite as well as identifying priority treatment areas and times. Knowledge of the rate at which infestation density increases, and of the amount of re-infestation occurring after initial removal of standing trees will be valuable in developing management strategies.

PhD students were recruited with Centre funding to expand the scope of the project over the next three years. One student will address implications of the genetic diversity in a native tussock grass species black speargrass (*Heteropogon contortus*) in terms of degradation and for restoration of grazed landscapes. Another will address the problem of the behaviour and impact of introduced pasture species on native plant communities in the north.

PROJECT TEAM

Nominated staff

DR JOEL BROWN,
CSIRO TAG, Townsville
DR TONY GRICE,
CSIRO TAG, Townsville
MR CHRIS GARDENER,
JCU, Townsville
MR BRETT ABBOT T,
CRC/CSIRO TAG, Townsville
MS MELISSA KEIR,
QDNR, Charters Towers
DR ANDREA LINDSEY,
QDNR, Charter Towers
DR IAN RADFORD,
CSIRO TAG, Townsville
DR TREVOR STANLEY,
QDNR, Charters Towers
MR JOE VITELLI,
QDNR, Charters Towers

Collaborating staff

MS CATHERINE SETTER, TWRC
DR SHANE CAMPBELL, TWRC
DR ROBERT SUTHERST,
CSIRO Division of Entomology,
Brisbane
DR WENDY FORNO,
CSIRO Division Entomology,
Brisbane
DR RACHEL MCFAYDEN,
QDNR, Brisbane
DR STEVE RADOSEVICH,
Oregon State University, US

RESEARCH

SUB-PROGRAM 4 SUSTAINABLE MANAGEMENT

SUB-PROGRAM LEADERS

DR ROSS HYNES,
COOPERATIVE RESEARCH CENTRE
& JAMES COOK UNIVERSITY
TOWNSVILLE, QLD
DR GRAHAM KIRBY
NT DEPARTMENT OF PRIMARY
INDUSTRY & FISHERIES
DARWIN, NT

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

The research strategy is necessarily socio-economic but incorporates the relevant bio-physical relationships (as developed in Sub-programs 1-3 and other sources). Integration is a key process in the research and development strategy of this Sub-program.

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

Sub-Program 4 has undergone four phases of refinement and one

major restructure. Following the advice of SPAEG and the Centre's Board, regional case studies are being given special emphasis as a major integrating strategy. See Diagram 2.

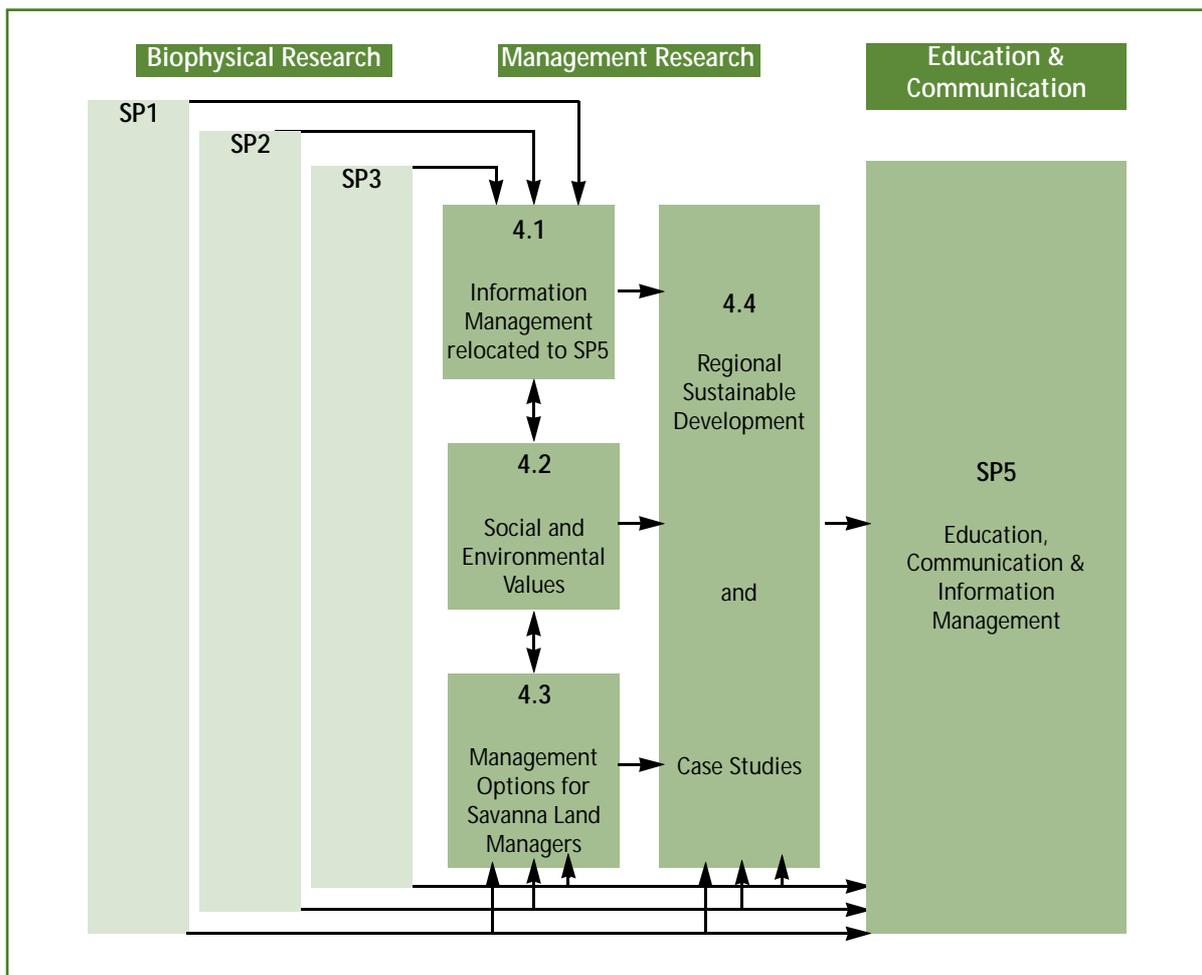


Diagram 2 shows linkages between biophysical and management research and the education and communication sub-program.

PROJECT LEADER

MS JEAN STEVENS
SCHOOL OF INFORMATION
TECHNOLOGY
NORTHERN TERRITORY
UNIVERSITY
DARWIN, NT

PROJECT SUMMARY

In such a geographically dispersed organisation as the Centre it is vital that the information and information needs of researchers, educators and stakeholders are met. An effective communication platform is required, in conjunction with supporting data access and modelling applications. The purpose of Project 4.1 is to provide both service and research functions to meet the Centre's information and communication requirements.

The School of Information Technology at NTU which leads and coordinates Project 4.1, undertook a comprehensive assessment of the Centre's Information Technology needs in July 1996. The report, *Information Technology Needs and Facilities*, outlined the 1996-97 goals and milestones.

RESEARCH PROGRESS

A half-time Information Facilitator, Mr Harvey Davis, was appointed on January 3, 1997, to help meet the Centre's Information Technology needs. Mr Davis oversaw the increase in Internet access for Centre staff, developed mailing lists for a virtual community and refined the Centre's Web pages.

The highlight of the year was the purchase of a DEC Alpha from Digital Corporation to serve the Centre's IT needs. Subsequently dubbed Savanna, the computer was used to facilitate mailing lists and Web pages, in addition to providing accounts for staff and research students.

Mr Alex Byrne of Infoscan (NTU) was commissioned by the Land and Water Research and

Development Corporation and Environment Australia to prepare a report *A Database on R&D for Australian Tropical Savannas*. Part One of this report was completed and its findings are being analysed.

Internet access for Centre staff was increased through the purchase of modems and connection to Internet Service Providers (ISP) for those members who formerly had no Internet access. A project was successfully completed by Miss Lee Lu, a third-year student with the School of Information Technology, to provide access to information on the Internet to those researchers with Email facilities only.

An electronic mailing list of Centre staff and researchers was set up by Dr Alex Kruchkoff early in 1997 as a basis for a virtual community. Mr Davis then took this prototype further, developing a series of mailings lists, each defined by a separate topic such as Geographic Information Systems. This extended virtual community will be made publicly accessible during July to August 1997.

The development of a Website for the Centre was completed. A prototype was created by Mr Todd Edwards in 1996 and from this a complete set of pages were realised in June 1997 through a joint project between Kate O'Donnell, the Centre's Publications Officer, and Mr Davis. The address for the Centre's Web site is <http://savanna.ntu.edu.au>

One of the difficulties encountered by Project 4.1 this year was the loss of a number of staff. Dr Alex Kruchkoff and Mr Richard Irvine both left NTU to take up positions elsewhere and Project Leader Ms Jean Stevens had to take an extended leave due to illness.

The development of a catalogue of modellers, tools and data specifications was planned for this year, but will be carried over to 1997-1998. The computer advisory group is yet to be set up, although the information facilitator acted as

a computer support person for a few individuals.

FUTURE DIRECTIONS

Following a recommendation by SPAEG, Project 4.1 will be amalgamated with Project 5.2, (Communication) in the near future. This amalgamation will ameliorate the staff losses experienced in Project 4.1 during the year, and will also bring Information Technology under the general umbrella of communication.

Collaboration will begin with Project 2.4 in posting satellite images of Australian bushfires on the Centre's Web site for perusal by concerned pastoralists and other stakeholders. A revision of NTU's GIS web pages will take place and there will be continued refinement of the Centre's Website.

PROJECT TEAM*Centre professional staff*

MS JEAN STEVENS, NTU, Darwin
MS BARBARA TUCK, NTU, Darwin
DR ALEX KRUCHKOFF, NTU, Darwin
MR RICHARD IRVINE, NTU, Darwin
MR HARVEY DAVIS,
CRC/NTU, Darwin

Collaborating staff

MS KATE O'DONNELL,
CRC/JCU, Townsville

RESEARCH

PROJECT 4.2 SOCIAL AND ENVIRONMENTAL VALUES

PROJECT LEADERS

DR GRAHAM KIRBY
NT DEPARTMENT OF PRIMARY
INDUSTRY & FISHERIES
DARWIN, NT

DR DEBORAH ROSE
NORTH AUSTRALIA
RESEARCH UNIT,
AUSTRALIAN NATIONAL
UNIVERSITY
DARWIN, NT

PROJECT SUMMARY

The objective of this project is to develop an understanding of cultural landscapes and to formulate models of how decisions affecting tropical savanna use and management are made.

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

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

KEY RESEARCH QUESTION

How do people make savanna management decisions and how important are environmental values in this process?

RESEARCH PROGRESS

SOCIAL VALUES AND DECISION MAKING PROCESSES

This research focuses on cultural perceptions of savanna environments among Settler and Indigenous people. A key outcome will be a basis for understanding values and belief systems.

Major studies in this area are being conducted by Dr Rose and a group of PhD students who have a variety of research themes. Most have received some funding assistance from the Centre, but a small number provide collaborative research inputs to this project. In 1996-97 this group included:

- Ms Jenny Atchison (Wollongong University)
- Ms Jane Bathgate (NTU)
- Ms Anthea Dee (ANU)*
- Mr Nicholas Gill (UNSW)
- Ms Catherine Mobbs (ANU)*
- Ms Cathy Robinson (Monash)
- Mr Jonathan Wearne (Melbourne University)

*Supported by Centre

Collective progress was achieved through the Tracking Knowledge Symposium, held in Darwin in December 1996. The symposium was organised by Dr Rose and Dr Annie Clarke (NARU). The focus was on different knowledge systems in the northern savannas with an interdisciplinary and cross-cultural approach.

The symposium was very successful with a large number of scientists and other researchers taking part. A symposium will now be convened annually and will seek to be both integrative and interactive. The series aims to produce new analytic knowledge, to offer a context for the comparative analysis of particular case material, and to communicate results of original work to other researchers and to the public.

There are three strategies:

- Organise and convene a series of symposia that provide a collegiate setting in which researchers can present their work to each other, engage in dialogue, and meet with interested Centre researchers and the public.
- Ensure the participation of outside specialists whose theoretical contributions help refine the analysis and place it in broader contexts of national and international expertise;
- Publish papers in revised form. Publications are not simply a record of conference proceedings, but enable the contributing scholars to refine their work as a consequence of their participation in the symposia.

During the year, Dr Rose continued her research on an Indigenous system of landscape knowledge and the links between land management practices and cosmology. She is also working on a photo-text project with a clan-group south-west of Darwin in collaboration with an American photographer, Ms Sharon D'Amico. The photographic section of the research is complete, and a manuscript is expected to be completed by early 1998.

Dr Rose also visited a number of First Nation communities in the United States in March/April 1997 as an initial investigation of possibilities for comparative research into Indigenous ecological knowledge and practice. This work is important for it provides an understanding of overseas experience in cooperative landscape management, including the management of divergent landscape values.

Ms Cathy Robinson continued her work on co-management of landscapes and resources with

fieldwork with the Dhimurru Land Management Aboriginal Corporation at Yirrkala. From November to mid January 1997, she visited British Columbia, Canada, to undertake comparative research.

Mr Jonathan Wearne continued his work into cooperative research and sustainable environmental management in north-east Arnhem Land, carrying out several periods of research in Arnhem Land. He worked cooperatively with NT Parks and Wildlife personnel. Ms Jenny Atchison began her field research into the history of fire management in the region of Keep River Park.

Regarding Settler value systems, Dr Rose continued her research in Frontier culture of environmental knowledge through library and archival research.

Mr Nicholas Gill continued his work with pastoralists in Central Australia and in the savannas of the Northern Territory. He carried out several field trips in 1996-97. His work is focused primarily on white pastoralists, but he also carried out some research recently with Aboriginal pastoralists on a number of stations.

ENVIRONMENTAL (NON-MARKET) VALUES

Tropical savanna environmental values are being assessed as part of an extension of current national projects being undertaken by a team of resource economists led by Associate Professor Jeff Bennett (UNSW/ADFA).

An important component of these projects is the environmental valuation in the Desert Uplands of Queensland. Centre staff will be led by Dr Kirby working closely with Professor Bennett.

Methods were chosen for a non-market survey pilot study. The analytical model used in the research is the population survey-based Choice Model method, with labelled options and a range of environmental attributes each with a number of levels. The statistical model is a nested multi-nominal statistical procedure (logit) that generates regression coefficients

and sampling errors for attributes and levels within attributes. The method allows predictions to be made to other environmental systems beyond those used in the assessment.

Appropriate use of ratios between certain regression coefficients allow estimations to be calculated for the value Australians have regarding for tropical savanna environmental attributes. The research team is developing an information base on the current production, ecology and policy of the Daly-Sturt region of the Northern Territory.

FUTURE DIRECTIONS

SOCIAL VALUES

A second Northern Landscapes Symposium is planned. A focus group is being organised to address the project's key research question. Investigations and reports will also continue on cultural perceptions, land management decisions, communications and knowledge in Aboriginal and Settler communities.

The Centre plans to appoint a post-doctoral Fellow in Aboriginal knowledge. Following this, a short-term survey will be undertaken to systematically identify the management research/extension needs of Aboriginal and Torres Strait Islander communities in the savannas. The survey method to be employed seeks to liaise at the institutional rather than the community level in order to bring together existing information. The outcomes of this activity will in turn assist in maintaining focus on the key question for these communities.

ENVIRONMENTAL VALUES

The development of an information base on the current production, ecology and policy of the Daly-Sturt region of the NT will continue.

Key issues of concern associated with development in the region are being identified through two focus group meetings in Darwin. Consequently, a survey will be designed to reflect the *a priori* importance of the attributes and the statistical requirement for the estimation of experimental design

that underpins the survey. When the design is completed the questionnaire will be distributed in Darwin and Brisbane. Data coding and analyses will follow.

Both the surveys for the Desert Uplands and the Daly-Sturt regions will be cross-tested in Darwin and Brisbane. This will enable the environmental valuation models to be adequately validated. After the model is validated it will be used to predict the environmental values of other areas of the tropical savannas. It is expected that further model development will be required.

PROJECT TEAM

Nominated staff

DR DEBORAH ROSE, NARU, Darwin
DR GRAHAM KIRBY, NTDPIF, Darwin
DR ROSS HYNES, CRC, Townsville
DR RAM VEMURI, NTU, Darwin
MS CATHERINE MOBBS, NARU, Darwin*

Collaborating professional staff

DR CHRISTINE FLETCHER, NARU, Darwin
ASSOCIATE PROF. JEFF BENNETT, UNSW/ADFA, Canberra
MR JOHN ROLFE, CQU, Emerald
MS CATHY ROBINSON, NARU, Darwin*
MR NICHOLAS GILL, NARU, Darwin*
MS JANE BATHGATE, NTU, Darwin*
MR SHIW MURTI, NTDPIF, Darwin
MS VALERIE HRISTOVA, NTDPIF, Darwin
MS SARA PITZERLE, NTTCC, Darwin
MR JOHNATHON WEARNE, NARU, Darwin*
MS JENNIFER ATCHISON, NARU, Darwin*
MS ANTHEA DEE, NARU, Darwin*
*PhD students

RESEARCH

PROJECT 4.3 MANAGEMENT OPTIONS FOR SAVANNA LAND MANAGERS

PROJECT LEADERS

DR ROSS HYNES
CRC/JCU, TOWNSVILLE, QLD
DR GRAHAM KIRBY
NTDPIF DARWIN, NT

PROJECT SUMMARY

The objective is to develop options for decision-making by savanna land managers to help achieve sustainable development. Following the review in conjunction with SPAEG, the project was redeveloped to reflect more clearly the value-adding roles of the Centre regarding the wide-ranging research being undertaken across all the sectors by partner agencies and other relevant research organisations.

The first component of the project, Information on Sustainable Development in Savanna Industries/Sectors, is collating and reviewing relevant existing information on the sustainable development of the various industries/sectors. This seeks to provide information on the optimal relationships between long-term savanna industry/sectoral use, the natural asset base and the maintenance of natural ecosystems.

The second component, Decision Support Systems and Models Of Savanna Sustainable Development, seeks to develop improved practical options for decision-making by savanna industry/sectoral managers to use in achieving sustainable development. Value adding is primarily concerned with the joint management of a common natural assets base for both production and ecological functions. An important challenge is to ensure that the decision support tools are developed in an accessible and relevant way for stakeholders.

KEY RESEARCH QUESTION

What are the most beneficial relationships between production and ecosystem function in terms of intensity of savanna use, that can achieve sustainable industry/sector management?

RESEARCH PROGRESS

INFORMATION ON SUSTAINABLE DEVELOPMENT IN SAVANNA INDUSTRIES/SECTORS

A major restructuring of the project was completed to clarify the special value-adding roles of the Centre. Meetings were held to begin the process of integrating the existing research findings for production and ecological functions. Conceptual developments on models for sustainable development were further developed.

Planning began for the collation and review of existing information relevant to land use intensity and the sustainable production of savanna industries and sectoral development. These sectors are pastoral, mining, tourism, Aboriginal communities, conservation/reserves and farming and defence.

Similarly, planning also began for the collation and review of existing information relevant to intensity of land use and sustainable ecosystem function. The information required needs to reflect the joint effects of changing the intensity of savanna resource use on industry/sectoral output and the natural asset base over time. The available information includes published papers and reviews and current Centre-related sectoral studies. These studies are listed in Table 1.

PROJECT TEAM

Centre professional staff

DR ROSS HYNES, CRC.
DR GRAHAM KIRBY, NTDPIF.
DR JOHN LUDWIG, CSIRO W&E.
DR RAM VEMURI, NTU.
DR GORDON DUFF, NTU.
DR MARK STAFFORD-SMITH, CSIRO W&E.
DR MICK QUIRK, QDPI.
DR PAUL NOVELLY, Ag WA.
MR KEN HOOPER, NTDME.
MR TIM NEVARD, JCU.
ASSOC PROF RICHARD MONYPENNY, JCU.
DR NEIL BLACK, JCU.
DR JOHN WOINARSKI, PWCNT.
MR PETER WHITEHEAD, PWCNT.
MR MIKE BUTLER, PWCNT.
DR D ROSE, NARU.
MR PASCAL TREMBLAY, NTU.
MR BILL HOLMES, QDPI.
MR BOB SHEPHERD, QDPI.
MR MOHAMMED DILSHAD, NTDLPE.
MR GREG CALVERT, CRC/JCU.
DR SHANE CAMPBELL, QDNR.
MR JOE VITELLI, QDNR.
MR MARK FORSTER, CRC (JCU)

Collaborating professional staff

MS VALERIE HRISTOVA, NTDPIF.
MR SHIW MURTI, NTDPIF.
MS CATHERINE SETTER
MR PETER JEFFREY

TABLE 1

PASTORAL	RESEARCHERS
Grazing management trial — differential preferences	P. Novelly Ag WA
Mt Sanford stocking rate trial	N. MacDonald NTDPIF
Savanna pastures greening index	R. Dyer NTDPIF
Analysis and interpretation of land resource data	M. Quirk, QDPI – R. Hynes, CRC – M. Forster CRC
Economic impact and woody weed control	V. Hristova, NTDPIF – E. Miller QDNR
North Queensland stocking rate demonstrations	K. Shaw NTU
Management of weed invasions	S. Campbell, J. Vitelli QDNR – T. Stanley QDNR
Grazing management strategies for seasonally variable tropical savannas	P. O'Reagain QDPI – J. Woinarski PWCNT
Benefit-cost analysis of introduced pasture species	C. Cieloska – G. McKeon QDNR – A. Andersen CSIRO DWE
	A. Chapman CSIRO DWE
MINING	
Analysis of the savanna mining economy	K. Hooper NTDME
Savanna mineral resource access	K. Whelan NTDME
Community employment prospects at mine locations	K. Whelan NTDME
Mining industry research priority consultancy	R. Hynes CRC – D. Kuchler JCU
TOURISM	
Institutional arrangements	P. Tremblay NTU
Outback tourism in the savannas	N. Black, A. Clark JCU
Private involvement in protected area management	T. Nevard, F. Barron JCU
Tourism and sustainable management	N. Black, J. Rutledge JCU
Sustainable management of ecotourism - Savannah Guides	R. Hynes CRC
FARMING & DEFENCE	
Economics of conservation farming	G. Kirby NTDPIF
Ecology of sustainable management of defence training areas – fire regimes.	G. Calvert CRC/JCU

DECISION SUPPORT SYSTEMS AND MODELS OF SAVANNA SUSTAINABLE DEVELOPMENT

This component concentrates on developing improved decision support systems and models suitable for easy use by savanna land managers in their own industry/sector.

Conceptual models necessary for defining sustainable savanna development are being developed by a modelling and integration project team involving production and resource economists and production and ecological

scientists. A review of the relevant economic and scientific literature on sustainable development is accelerating the task of developing a satisfactory conceptual framework for the Centre's integrated research. The savanna models that are evolving are consistent with the CRC Mission statement and will use a benefit-cost analysis (BCA) framework. In this first stage, general decision-support tools are being developed.

Planning began for the collation and review of information on existing industry/sector decision support systems and decision-support tools relevant to the

sustainable management of the tropical savannas. The available systems and tools also include current CRC related industry/sectoral activities listed in Table 2.



RESEARCH

TABLE 2

PASTORAL	RESEARCHERS
Modelling distribution and grazing patterns	P. Novelly Ag WA
Development of an expert system for grazier use	G. Fordyce QDPI
Paradigm shifts in sustainable management systems	P. Smith, J. Kernot QDPI
Grazing system – economic management packages	W. Holmes QDPI
State and transition modelling	G. McKeon QDPI – D. Howe NTDLPE
Systems analysis of management options for grazed woodlands	G. McKeon QDPI
Modelling sustainable pasture production	M. Dilshad NTDLPE
Biophysical framework for total property planning	M Quirk QDPI – K. Day QDNR – R. Shepherd, P. Smith QDPI – G. Rogers QDPI
Desert Uplands sustainable management package *	M. Forster CRC
Desert Uplands indicators of sustainability	R. Hynes CRC
TOURISM	
Cobbold Gorge site management plan	R. Hynes CRC
Hell's Gate site management plan	R. Hynes CRC
Site management planning template	R. Hynes CRC
*Part of PhD project	

PROJECT 4.4 REGIONAL SUSTAINABILITY AND CASE STUDIES

PROJECT LEADERS

DR GRAHAM KIRBY,
NTDPIF DARWIN, NT
DR ROSS HYNES,
CRC/JCU TOWNSVILLE, NT
MR GREG CROUGH
(NARU VISITOR) DARWIN, NT

RESEARCH PROGRESS

Research activities made progress through the successful identification and establishment of three regional case studies.

The project's first objective is to identify the policy, social, economic and environmental structure of Australia's tropical savannas. This includes an examination of key issues contributing to regional sustainable development. Supporting this is the development of policy models for regional sustainable development that includes multiple and integrated land use.

The second objective is to develop principles and procedures applicable widely across the

tropical savannas to advise on sustainable development options at local and regional scales to maximise benefits to all stakeholders. The relevance of the Centre's research will be tested in a variety of case studies. This is being facilitated by providing better information and approaches for savanna decision-makers, the research aims to engage and empower them to achieve sustainable development.

Whereas Project 4.3 addresses the issue of sustainable industries and community enterprises, sustainable enterprises alone do not necessarily lead to sustainable regional development. Governments, together with national and global events exert profound effects upon individual enterprises and communities to effect the levels of regional sustainability.

The Centre needs to address the issue of sustainable development at the regional level to present policy makers with a range of

relevant policy options for tropical savanna development.

To improve the sustainability of development of the tropical savannas, two conditions are necessary. Research information must be aggregated into a useful format and the people involved in the decision making process must have a real sense of ownership, participation and empowerment. The development of the regional case studies provides opportunities to assess community response to the Centre's research effort.

KEY RESEARCH QUESTION

What are the most beneficial relationships between industries/sectors, environments, communities and governments to achieve sustainable regional development?

KEY RESEARCH QUESTION

How useful is the Centre's socio-economic and bio-physical research in achieving sustainable development throughout the tropical savannas?

REGIONAL CASE STUDIES

DESERT UPLANDS CASE STUDY

The Desert Uplands case study involves working with pastoralists in the Desert Uplands Build-Up and Development Strategy Committee (DUBDSC) in using existing and newly developing property management tools to assess economic, social and ecological sustainability and to determine the constraints involved in any transitions. The Centre will also explore the possibilities for other land-use options to improve sustainability, including the trial of the Multiple Objective Decision Support System (MO-DSS) in collaboration with the Resource Sciences Centre of QDNR.

The Centre was formally invited to participate in the work of the DUBDSC in October 1996. A case study coordinator, Mr Mark Forster, was appointed by the Centre in February 1997 to help facilitate the Centre's involvement with the committee.

Mr Forster undertook preliminary literature reviews into the concepts of sustainability. He also collated materials addressing development and use of indicators. He examined the feasibility of certifying or accrediting sustainability, and collated material on networking and strategic alliances. Reviews were undertaken of literature on sustainable agriculture, change management, as well as methodologies for researching and facilitating enterprise/community change and development.

Ms Vicki Godfrey was appointed by the Centre in June 1997 to develop a Geographical Information System (GIS) for the region. The primary objective of the GIS is to assist Desert Uplands landholders to enhance their capacity for assessing natural resource and infrastructure patterns, land-use practices and options.

A technical overview for the region was compiled at a workshop (June 24-25, 1997) held by the Centre and three key research activities identified. These

activities comprise the application of a GIS; the development of a research investigation focusing on transition management from current status to more sustainable levels of property/enterprise management; and finally the development of key indicators of economic, social and environmental trends towards sustainable land management for the region.



Participants at the Desert Uplands Technical Workshop discuss indicators of economic, social and environmental trends towards sustainable land management.
Photo: Kate O'Donnell

MARY RIVER DISTRICT CASE STUDY

The Mary River Case Study originated in 1992 when various land-use conflicts emerged in the region and representations were made to the Northern Territory Government. Subsequently, the Mary River Task Force was established to advise government, and the Mary River Technical Working Group was formed. Centre staff contributed to the development of a draft Mary River Integrated Catchment Management Plan.

Procedures for resolving the various land use conflicts are evolving. A major focus is on options for controlling wetlands hydrology and a benefit-cost analysis is being planned as a decision making aid.

Research incorporates a review of the evolution of the Mary River land-use discussions leading to the Integrated Catchment Plan and an assessment of the role of benefit-cost analyses in resolving savanna development conflicts.

VICTORIA RIVER DISTRICT CASE STUDY

A scoping workshop was held on May 2, 1997, in Darwin. A range of potential case study sustainability issues and regions were

considered. The consensus was that the primary issues are fire and grazing management for the sustainable development for the Victoria River District and associated regions. Stakeholder involvement for further development of the case study is being sought. This case study will also develop procedures for the effective integration of a wide range of discipline and agency

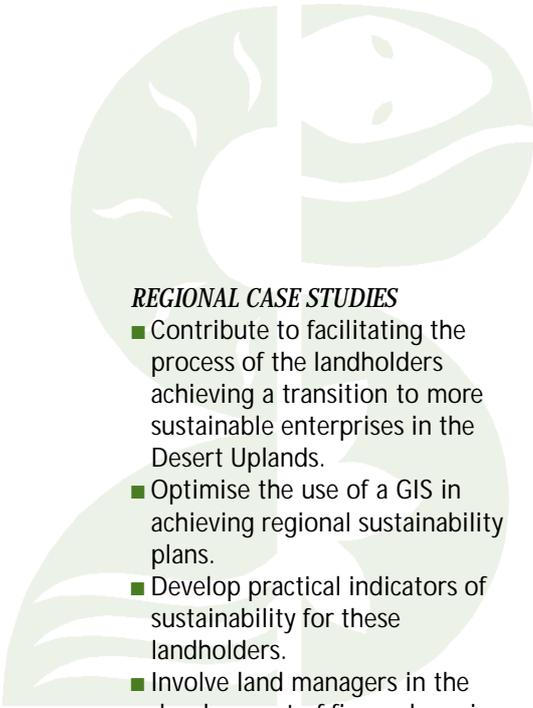
professionals within and external to the CRC.

The Centre is sponsoring four regional fire management studies (eastern Cape York, northern NT National Parks, Victoria River District in the Northern Territory, and the north Kimberley), with others under development. These studies have various objectives according to the regional/sectoral issues involved. For example, the VRD study, which combines more than 20 Centre researchers from across the program addresses ecological (e.g. pastoral sustainability, biodiversity) and economic (e.g. risk management, long-term viability) scenarios for fire management of lands under pastoral, conservation and Aboriginal tenures in that region.

FUTURE DIRECTIONS

REGIONAL SUSTAINABILITY

- Develop tropical savanna profiles.
- Review the role of government in tropical savannas.
- Review the role of savanna communities in tropical savannas.
- Review the diverse concepts and definitions of regionalisation.
- Develop new concepts and policy option models of regionalisation.



RESEARCH

REGIONAL CASE STUDIES

- Contribute to facilitating the process of the landholders achieving a transition to more sustainable enterprises in the Desert Uplands.
- Optimise the use of a GIS in achieving regional sustainability plans.
- Develop practical indicators of sustainability for these landholders.
- Involve land managers in the development of fire and grazing management systems in the Victoria River District and associated regions.
- Review Mary River land-use

discussions leading to the Integrated Catchment Plan.

- Assess the role of benefit-cost analyses in resolving savanna development conflicts.
- Explore further options for appropriate regional case studies.
- Compare the outcomes of regional case studies for the further improvement of sustainability indicators and procedures.

PROJECT TEAM

Centre professional staff

DR GRAHAM KIRBY, NTDPF.
DR ROSS HYNES, CRC/JCU.
MR GREG CROUGH, NARU Visitor.
REGIONAL ECONOMIST, NARU.
DR RAM VEMURI, NTU.
DR JOHN LUDWIG, CSIRO W&E.
DR DAVID KING, JCU.
MR JIM MONAGHAN, JCU.
MS FREYA DAWSON, NTU.
MR COLIN MACGREGOR, JCU.
ASSOC. PROF. RICHARD
MONYPENNY, JCU.
MR MARK FORSTER, CRC/JCU.
MS VICKI GODFREY, CRC/JCU.



EDUCATION

SUB-PROGRAM 5 EDUCATION AND COMMUNICATION

SUB-PROGRAM LEADER
PROFESSOR GREG HILL
NORTHERN TERRITORY
UNIVERSITY
DARWIN, NT

The 1996/1997 year saw a range of major achievements within the education and communication sub-program of the Centre.

Another cohort of postgraduate students was recruited to work on research priority areas with the CRC staff and researchers. There are now some 30 students enrolled through ANU, JCU and NTU who are sponsored through Centre scholarships or otherwise supported by the Centre in their research. These include 17 postgraduate students with either scholarship or

operational funding and five Honours students with assistance scholarships for the 1997 academic year.

Completion of an education and training needs analysis for the Centre's stakeholders was a highlight of the 1996/1997 program. The analysis yielded several significant outcomes, including a database of relevant courses and providers now available on the World Wide Web, and the creation or strengthening of networks among Centre staff, stakeholders and education and training providers.

This assessment of our clients' needs will direct the research for the sub-program over the next few years and a major report, *A Needs Analysis of Education and Training Relating to the Use and Management*

of Tropical Savannas, was published on these findings. State and Territory Pastoral Extension Staff continued to develop their programs in Property Management Planning and Best Management Practice. These initiatives were supported by Sub-Program 5 projects in the development of training programs in areas such as weeds management and landcare.

In July 1997 Dr Peter Jacklyn will be appointed Communication Coordinator for the Centre. Development of the Centre's communication strategy and consolidation of education and communication activities will receive a major boost through this appointment. The position will be further strengthened by the transfer of Project 4.1 (Savanna Information Management) to Sub-Program 5.

PROJECT 5.1 EDUCATION AND TRAINING

PROJECT LEADERS
DR GORDON DUFF
NORTHERN TERRITORY
UNIVERSITY
ASSOCIATE PROFESSOR
GEOFF ARGER
JAMES COOK UNIVERSITY

PROGRESS

The analysis of education and training needs among stakeholders in northern Australia provided a springboard for a number of initiatives in Project 5.1 in 1997.

Teaching units on the sustainable development of tropical savannas were developed and are now included in the Masters by Coursework programs for both NTU and JCU. Linkages between course units run at NTU and JCU were also increased. A paucity of postgraduate educational opportunities relevant to the management and development of tropical savannas led to the



*Professor Alan Arnott,
Dr Sam Setterfield,
Ms Rebecca Benson,
Dr Gordon Duff,
Professor Robyn Young*

development of curriculum packages covering:

- Ecology and Management of Tropical Savannas
- Tropical Rangeland Management
- Tropical Wetland Management
- Flora and Fauna Survey Techniques for Tropical Savannas

Research outcomes showed the need for increased use of interactive information technology to improve general access to

education and training opportunities. The Centre is using this technology wherever possible in developing and delivering training modules. Course Coordinator Dr Samantha Setterfield and staff from CIMM at JCU began converting the unit Ecology and Management of Tropical Savannas to a multimedia format that will be available on CD-ROM. A multi-level training package in text and CD-ROM format aimed at weed

EDUCATION

management is also nearly complete.

Research findings from Sub-Programs 1 to 3 are now at the point where they can be incorporated in the education and training activities of the Centre. Centre staff and collaborating researchers are also actively involved in presenting seminars and teaching units within the courses of NTU and JCU.

Students are enrolled at all partner universities, and staff from most of the non-university partner organisations are involved in their supervision. These arrangements significantly enhanced the day-to-day linkages between partner organisations.

The Centre aims to increase options for graduate students by allowing them to choose a mix of topics within units offered at NTU and JCU. Recently, the Centre provided logistic and financial support to the first NTU Masters by Coursework student, Ms Joanne Sedman, to complete a unit at JCU. Ms Sedman was the first recipient of a new scholarship scheme available to students enrolled at both institutions. Development and scheduling of new units are being carried out at NTU so that they complement existing units offered at JCU.

During the year, eight new PhD, one MSc and five Honours students started work on research projects within the framework of the Centre. The Centre awarded scholarships to 14 postgraduate students and operational funds to three others. Three other researchers in the Centre, Mr Tony O'Grady, Mr Alaric Fisher and Ms Freya Dawson, are also undertaking PhD research. While funding is not provided logistic support is available through research projects.

In 1997, scholarships were awarded for the first time to Honours students undertaking research in the Centre. Three \$2000 scholarships were awarded to students at NTU, and two to students at JCU.

FUTURE DIRECTIONS

Recommendations will be implemented arising from the needs analysis research project to form the basis for activities over the next three years. This includes providing assistance in course development and delivery, organising and participating in seminars, and offering advice and support where appropriate.

In keeping with the expressed needs of savanna stakeholders, activities such as course development and delivery will focus on the Vocational Education and Training (VET). This includes courses at certificate and diploma level. Support for students studying at this level complements that given to students at the higher education/postgraduate level through Project 5.1, to ensure the Centre's education and training project is balanced and meets the needs of all stakeholders.

The need to continue an active research direction was identified as a priority in a project strategic planning workshop at the end of February 1997. SPAEG recommended that the project should continue to incorporate a "strong and distinctive research component". The research project proposed for 1997-98 aims to examine what stimulates members of various stakeholder groups to learn, how they access information to do this, and the implications for education and training. Finally, a number of strategies to support postgraduate students in the Centre are proposed.



PhD student Myf Runcie with a Rock Ringtail possum

These include:

- Communications skills workshops for the CRC postgraduate students;
- Travel support for CRC postgraduates so that they can present their research findings at conferences and workshops;
- A conference aimed specifically at CRC postgraduate students;
- Travel and logistic support for coursework Masters students so that they can access units at NTU and JCU, greatly broadening the options and opportunities available to these students.

PROJECT TEAM

Nominated Staff

DR GORDON DUFF, NTU
ASSOCIATE PROFESSOR
GEOFF ARGER, JCU
DR SAMANTHA SETTERFIELD,
CRC/NTU
MS REBECCA BENSON, CRC/NTU
DR ALLAN ARNOT T, NTU
MR ANTOINE BARNAART, NTU
DR JIM CAMERON, NTU
ASSOCIATE PROFESSOR
ROSS COVENTRY, JCU
ASSOCIATE PROFESSOR
BRIAN DEVLIN, NTU
MR CHRIS GARDENER, JCU
PROFESSOR GREG HILL, NTU
MR GREG SHAW, NTU
MR GREG WEARNE, NTU
MS BARBARA WHITE, JCU
MS PETER WIGNELL, NTU
MR GREG WILLIAMS, NTU
A/PROF ROBYN YOUNG, NTU

TABLE 3 PHD STUDENTS

<i>STUDENT</i>	<i>PROJECT TITLE</i>	<i>UNIVERSITY</i>	<i>SUPERVISORS</i>	<i>FUNDING</i>
M. Runcie	The ecology of the Rock Ringtail Possum	NTU	G.Hill (NTU)	APA, CRC, NTU Environment Australia, Australian Geographic Energy Resources Australia
C. Macgregor	Community decision-making processes and sustainable outcomes at the Local Government level	JCU	R. Hynes (JCU) D. King (JCU) M. Fenton (JCU)	CRC Federated PhD Scheme ANU, JCU
*A. Kutt	Vertebrate fauna assemblage patterns in the Desert Uplands Biogeographic Region, North Queensland	JCU	C. Johnson (JCU) R. Pearson (JCU) J. Woinarski (NTPWC)	CRC Australian Geographic AHC, NTU
F. Fraser	The ecology of the Partridge Pigeon	ANU	P. Whitehead (PWCNT) T. Norton (ANU) S. Gannett (SA DENR) H. Nix (ANU)	CRC PWCNT ANU
S. Hopwood	Natural hazard mapping	NTU	G. Hill (NTU)	CRC, NTU
G. Calvert	The effects of fire on flora and fauna on the high-range training area	JCU	R. Hynes (JCU) B. Jackes (JCU) R. Pearson (JCU)	CRC ADF JCU
G. Whiteman	The effect of livestock grazing on the genetic diversity of the grass <i>Heteropogon contortus</i> in a tropical savanna	JCU	J. Brown (CSIRO) R. Hynes (JCU) K. Rice (UCalifornia)	CSIRO CRC JCU
C. Menges	The application of Radar remote sensing to tropical savannas in the NT	NTU	W. Ahmad (NTU) J. van Zyl (NASA)	APA CRC CSIRO, NTU
*M. Forster	Transitions towards sustainability	JCU	A. Buttery (JCU) R. Hynes (JCU)	CRC, JCU
B. Hoffman	Responses of ant communities to land condition	NTU	G. Hill (NTU) A. Andersen (CSIRO) K. McGuinness (NTU)	APA CRC CSIRO, NTU
K. Pfitzner	An investigation and evaluation of the rehabilitation of the Rum Jungle Mine Site	NTU	W. Ahmad (NTU) G. Hill (NTU)	CRC NTDME, NTU
G. Kelley	Water use by savanna	NTU	D. Eamus (NTU)	CRC, NTU
C. Mobbs	Regional environmental assessment and management: spanning scales and trading values	ANU	H. Ross (ANU) S. Dovers (ANU) H. Nix (ANU)	CRC LWRRDC ANU
*P. Ryan	Developing satellite fire monitoring for the north Kimberley region in Western Australia	NTU	G. Hill (NTU) W. Ahmad (NTU) J. Russell-Smith (BCNT)	CRC NTU Bushfire Board of WA
A. Dee	Exploitation of the Arafura wetlands and surrounds by Yolungu women	ANU	D. Rose (ANU) R. Jones (ANU) N. White (La Trobe) H. Nix (CRES)	CRC

*These PhD projects receive operational funding.

EDUCATION

TABLE 4 MSC STUDENTS

<i>STUDENT</i>	<i>PROJECT TITLE</i>	<i>UNIVERSITY</i>	<i>SUPERVISORS</i>	<i>FUNDING</i>
D. Anyango	Regional assessment in dry season grazing	JCU	J. Monaghan (JCU)	JCU, CRC
H.Z. Khwaja	Applicability of remote sensing & GIS technologies for ID and mapping savannas of the VRD of the NT.	NTU	W. Ahmad (NTU) G. Hill (NTU)	CRC NTU

TABLE 5 HONOURS STUDENTS

<i>STUDENT</i>	<i>PROJECT TITLE</i>	<i>UNIVERSITY</i>	<i>SUPERVISORS</i>	<i>FUNDING</i>
K. Lynch	The salinity tolerance of <i>Melaleuca</i>	NTU	M. Douglas (NTU) D. Eamus (NTU)	CRC, ERISS, NTU
M. Geyer	The use of Landsat Thematic Mapper TM and multi-spectral scanner (MSS) satellite imagery to study the invasion of the weed <i>Mimosa Pigra</i> at Oenpelli and Adelaide River, Northern Territory	NTU	W. Ahmad (NTU) G.Hill (NTU) G. Cook (CSIRO W&E)	CRC NTU
J. Crerar	Integrating GIS and remote sensing technologies to support natural resource management by indigenous people in the NT	NTU	G. Hill (NTU) W. Ahmad (NTU)	CRC NTU
A. Petersen	Environmental factors affecting germination and early seedling establishment of <i>Acacia nilotica</i>	JCU	J. Brown (CSIRO) J. Holtum (JCU)	CRC CSIRO, JCU
N. Thurgate	The impact of cattle grazing on the reptiles of the Great Basalt Wall	JCU	J. Luly (JCU) R. Alford (JCU)	CRC JCU Australian Geographic

ADDITIONAL EDUCATION AND TRAINING

Many staff and researchers are also involved in supervising students other than those funded by the Centre. Staff and participating researchers also conduct course units, give lectures and seminars either through their home universities or government departments. A number of Centre staff also gave seminars and lectures to students enrolled in the Masters by Coursework Tropical Environmental Management. These included Dr Tracey Churchill, Ms Freya Dawson, Dr Alan Andersen, Dr Garry Cook, Dr Dick Williams, and Dr John Ludwig.

Project 2.1 researchers regularly organise and run training workshops for rangers, and less regularly for other land managers. Mr Tony Griffiths supervised a Ranger Training Camp at Spirit Hills Station in August 1996. Mr Alaric Fisher and Dr John Woinarski organised a Ranger Training Camp, at Bradshaw Station, June 2-11, 1997.

Dr John Woinarski also ran the fauna section of the North Australian Fire Management Workshop, Kalumburu 16-25 June 1997.

Centre staff participated in a number of training workshops on Understanding the Environment of the Top End held by CSIRO W&E

and given for exploration staff of mining operator Rio Tinto, Normandy Queensland Mines, Stockdale exploration staff, the NT Education Department, Northern Territory primary and secondary school teachers. The workshops were held on February 25, April 7 and 23, 1997.

Research by Ms Freya Dawson was used to enrich the course in Environmental Planning and Law offered by the NTU Law Faculty in Semester 1, 1997. This course was attended by law students both at BSc and Masters level and externally audited.

Dr Ross Hynes (an Associate Professor in the Department of

Tropical Plant Science, JCU) presented lectures on Savanna Rangeland Sustainability and Savanna biodiversity in Third Year Tropical Landscape Ecology and Management Studies at JCU.



Honours student Alan Petersen, who is studying *Acacia nilotica*.

PROJECT 5.2 COMMUNICATION

INTERIM PROJECT LEADER

PROFESSOR GREG HILL
NORTHERN TERRITORY
UNIVERSITY

PROGRESS

This year Project 5.2 was repositioned to focus on the Centre's major communication needs. In November 1996 the Centre contracted an external communication consultant, Econnect (Environmental Science and Communication), to evaluate the Centre's existing communication effort and develop an effective strategy.

After extensive external and internal evaluation by Econnect, a strategy was developed and presented to the Centre's Board in March 1997. A broad range of recommendations were accepted for adoption by the Centre. Key recommendations adopted included the appointment of a full-time Communication Coordinator, the upgrade of Ms O'Donnell to a full-time position and a part-time position created to support the Communication Coordinator and Business Manager (to be appointed).

Centre communication needs to address several issues. First, internal communication should ensure all staff are informed of its activities. Second, the Centre's outcomes must be communicated appropriately to stakeholders to encourage better savanna management practices and third, we must make the public broadly aware of the Centre and its values.

FUTURE DIRECTIONS

Through this project, the Centre will develop its capacity to provide information on various aspects of tropical savanna management for our stakeholders, drawing on the Centre's extensive linkages across northern Australia. Another important aim addressed by this project will be to raise the profile of both the Centre and the tropical savannas as a region. This will occur through various channels including the mass media, display material and brochures.

Email systems will be further developed to improve communication within the Centre as well as an internal newsletter and holding more frequent face-to-face meetings on the Centre's activities.

Ultimately the delivery of many of the management tools from the Centre will depend on extension processes such as Property Management Planning and Local Best Practice. At the moment these activities have not been well integrated into the Centre. One of the aims of Project 5.2 during 1998 will be to explore ways to achieve integration. Below are the summary reports of the PMP and LBP activities of our partner agencies for this year.

PROJECT TEAM

Nominated staff

PROFESSOR GREG HILL,
NTU, Darwin
ASSOC PROF GEOFF ARGER,
JCU, Townsville
MS KATE O'DONNELL,
CRC/JCU, Townsville
MR JIM KERNOT, QDPI, Mareeba
MR PETER SMITH,
QDPI, Charters Towers
MR KEV SHAW, QDPI, Mareeba
MR LES WICKSTEED,
QDPI, Townsville
MS NARELLE CAMPBELL,
NTDPIF, Katherine
MR DARYL PARKER,
NTDPIF, Katherine
MR ROHAN SULLIVAN,
NTDPIF, Katherine





APPLICATION OF RESEARCH; LINKS WITH USERS

The Tropical Savannas CRC is classed as an Environmental Sector Centre and in this sense is an instrument of public good. Its benefits are likely to arise for both land managers and the wider community through the dissemination of research, the provision of expertise, training and educational services, that over time, develop a greater awareness of sustainability that can contribute to adjustments in how land resources are best managed.

The utilisation and application of research outputs means a relevant mix of strategies for sustainable land management must be adopted. Stakeholder ownership of these processes is essential both at the enterprise and regional levels if pathways to sustainability are to be developed.

The Centre's strategy for application of research focuses on integrated regional case studies where researchers, in collaboration with stakeholders, can provide and exchange information on a wide range of land sustainability issues. As reported in the Research Section the Centre developed two such case studies, in the Desert Uplands in Queensland and the Victoria River District in the NT. It was also involved with the Mary River Catchment project in the NT.

However, utilisation and application of research outputs also occurred through the Centre's existing research projects and activities.

HIGHLIGHTS OF RESEARCH APPLICATIONS

DESERT UPLANDS REGIONAL CASE STUDY

The Centre was formally invited to participate in the work of DUBDSC in October 1996.

DUBDSC is addressing land management and sustainability issues in the region, particularly for the 320 pastoralists. The case study is working to assist the assessment of the economic, social and ecological sustainability of their properties using existing and developing property management tools and is also seeking to determine the constraints involved in any transitions.

A GIS is being developed by the Centre and, in consultation with Desert Uplands landholders, specific uses of the GIS were identified. From this a conceptual model was developed outlining its contents. A liaison network made up of various government departments and agencies, research institutes and GIS project officers is being established to facilitate the sourcing of regional scale data, and sharing methods and techniques.

VICTORIA RIVER DISTRICT CASE STUDY

A large number of potential stakeholders were identified for the VRD case study. These included Aboriginal and conservation interests, (including "on-reserve" and "off-reserve" parties); the ADF, pastoralists, of both Aboriginal and European background, education providers; government agencies; and tourism. Although it was emphasised that the final selection of specific issues to be addressed by the case study will require active stakeholder participation, two main areas were identified as the study's focus, better fire and grazing management in the district.

The study will focus on how fire can be used to maintain economic and ecological sustainability. A major element will be to look at increases in woody vegetation in the region presumed to be

attributed, at least in part, to exclusion of fire.

MINE SITE REHABILITATION: INDICATORS OF SUCCESS MONITORING AND TRAINING

This project was developed in collaboration with the Centre (Dr John Ludwig and Dr Robert Egdar) and Energy Resources Australia (Ms Annie Lane and Mr Sven Sewell). It established permanent monitoring transects on five sites of different rehabilitation ages at ERA's Ranger Uranium mine, at Jabiluka in the Northern Territory.

On these transects a number of landscape, vegetation and soil indicators were measured. The attributes selected for monitoring had previously been identified as useful indicators for assessing the success of re-establishing an ecosystem. These indicators were shown to be applicable to mine site rehabilitation because they provide measures of how well rehabilitated mine sites are functioning as natural ecosystems.

Summary results suggest that the current rehabilitation procedures at the mine are appropriate for rehabilitating waste rock dumps. The procedures appear to be establishing vegetation that is likely to develop into savannas similar to those in the surrounding region. In addition to setting up and measuring permanent monitoring transects, Centre researchers will also train ERA Environmental Services personnel on how to measure and monitor landscape function indicators. Thus, ERAES staff will be able to collect monitoring data in the future, and will have the skills to set up additional monitoring sites if and when desired. The second and final phase of the project will conduct in-the-field training workshop for mine site rehabilitation personnel.

IMPACT OF SO₂ EMISSIONS ON SAVANNA BIODIVERSITY

MIM wishes to assess the effects of SO₂ emissions from its Mount Isa mine on floral and faunal biodiversity. A sulphuric acid plant is to be installed at the mine site in 1999, and it is planned to

substantially reduce SO₂ emissions. The investigation being developed by the Centre will establish a set of sampling sites at varying distances from the mine and assess floral and faunal biodiversity at those sites. Biodiversity will then be related to SO₂ concentrations at ground level. This should allow

assessment of impacts of long-term SO₂ emissions on flora and fauna biodiversity. As well, it will provide benchmark sites to allow assessment of biodiversity changes following reduction of emissions.



Tourism guides at the Savannah Guides school look over the potential value of a former mining exploration site at Hell's Gate (Gulf country)

Photo: Ross Hynes

LAND MANAGEMENT FOR NATURE-BASED TOURISM

The Gulf Savannah Guides Ltd, provide guiding services with a strong environmental focus at 20 sites across the gulf savanna region, which stretches across Queensland and into the Northern Territory.

With land management planning skills for the guides becoming increasingly important, the Centre conducted a series of land-use planning workshops at Savannah Guides Schools over the past year. These brought together more than 20 guides and site interpreters at Adel's Grove, Lawn Hill Gorge and later Hell's Gate in the Gulf Plains.

These workshops recognised an important and relatively new concept in Australia: that private enterprise can successfully manage highly valued conservation areas. They covered several key elements in land management processes, such as the development of strategic land management plans, how to prepare guidelines for park site management and how to conduct environmental impact assessment as well as the rehabilitation of degraded sites.

SAVANNA BIOGEOGRAPHY

Under Project 2.1, data held by a wide range of sources were consolidated into accessible flora and fauna databases. Centre participants accessed these databases to generate new analyses of savanna function. Special attention was given to the integration of all work with other CRC-supported studies, as well as establishing connections with national initiatives such as the National River Health Assessment and the National Reserves System Program.

Project staff regularly provide advice on the conservation status of wildlife species and conservation values of specified areas to management agencies and NGOs. Assessments of the reservation status and major gaps in the existing reserve system for the NT were provided to federal agencies. An assessment of ecological information pertaining to blacksoil environments in northern NT was submitted to Ecologia Environmental Consultants and related to environmental impact assessment for the proposed second stage of the Ord River Scheme area.

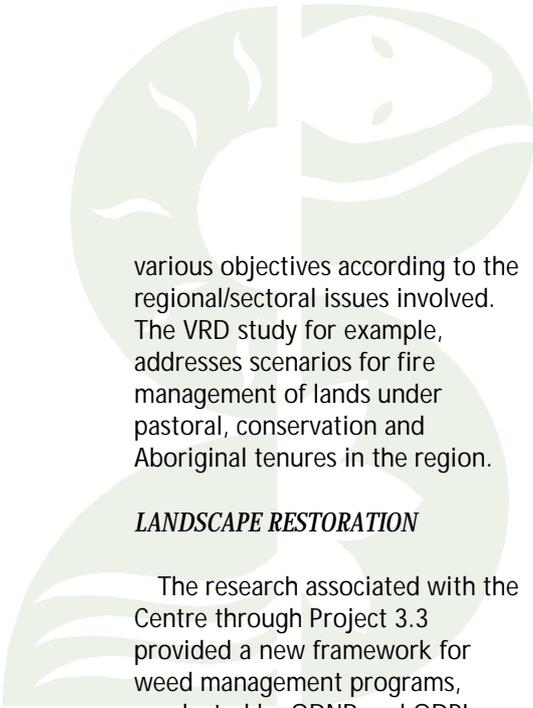
GOULDIAN FINCH RECOVERY

Outcomes from this research conducted under Project 2.2 were applied to the development of the National Species Recovery Plan for the Gouldian Finch, and is will be incorporated in the Northern Territory's Management Plan for the Species. Centre researchers also participated in the framing of regional plans for achieving sustainable development, e.g. the West Arnhemland Fire Management Strategy.

FIRE MANAGEMENT ACTIVITIES

Major progress was achieved in engaging agencies, organisations and sectors to further a common agenda within the Centre's fire management activities (Project 2.4). Access to remote sensing technologies was enhanced with a number of government agencies and some pastoral managers.

The Centre is currently sponsoring four regional fire management activities: eastern Cape York, northern NT National Parks, Victoria River District in the Northern Territory, and the north Kimberley. Others are under development. These studies have



APPLICATION OF RESEARCH; LINKS WITH USERS

various objectives according to the regional/sectoral issues involved. The VRD study for example, addresses scenarios for fire management of lands under pastoral, conservation and Aboriginal tenures in the region.

LANDSCAPE RESTORATION

The research associated with the Centre through Project 3.3 provided a new framework for weed management programs, conducted by QDNR and QDPI, where longer time scales and larger areas of research were developed. Also, the Centre was of assistance to these agencies in achieving a stronger focus on land management, as opposed to controlling weeds.

The project also developed a short course for graziers and land managers on sustainable rangeland management in northern Australia. Funding was provided by the MRC,

the Centre and CSIRO with in-kind contributions from QDPI and QDNR. The course is being offered to extension officers in Queensland, Northern Territory and Western Australia in July-September 1997.

In collaboration with Project 4.3 a computer-based decision-support system was developed for analysing strategic alternatives for the restoration of *Acacia nilotica* invaded landscapes. The target audience is intended to be extension agents and landcare groups.

OUTBACK TOURISM IN THE SAVANNAS TOURISM AND SUSTAINABLE MANAGEMENT

These studies, led by Dr Neil Black from the Department of Tourism at JCU, are well advanced. They are directed at collating information on resources and

integrating knowledge about visitors to the Outback. These core information needs are critical as a basis to enhance sustainable management of the region.

A successful tourism Audit in the Dalrymple Shire was undertaken in 1996 and an extension is planned for the Desert Uplands later in 1997. The Audit supplies lists of tourist attractions, operators, accommodation, transport and other tourist infrastructure. A proposed marketing strategy will also be included. The Audit will be a valuable addition to the data collected as part of the Centre's case study.

TABLE 6 CENTRE RESEARCH USERS AND THE BASIS OF INTERACTION 1996-97

ORGANISATION	REPRESENTED ON BOARD COMMITTEES	PARTNER AGENCY	COLLABORATIVE RESEARCH	INFORMATION/ RESEARCH EXCHANGE	CONTRACT RESEARCH	COOPERATIVE TRAINING	COLLABORATIVE GRANTS	CONTRACTED BY CENTRE
PASTORAL INDUSTRY SECTOR								
Australian Meat & Livestock Corporation				■				
North Australian Beef Research Council	■			■				
North Australian Beef Cattle Association				■				
United Graziers Association				■				
Queensland Cattlemen's Union				■				
Northern Territory Pastoral Land Board			■	■				
CONSERVATION INTEREST GROUPS								
Australian Conservation Foundation				■				
World Wide Fund for Nature				■			■	
The Wilderness Society				■				
Environment Centre of the NT				■				
Arid Lands Environment Centre	■			■				
Kimberley Conservation Group				■				
Victoria River District Conservation Association			■	■				
Queensland Conservation Council				■				
Queensland Wildlife Preservation Society				■				
MINING INDUSTRY SECTOR								
MIM Group of Companies/ McArthur River Mining Pty Ltd	■				■			
Energy Resources of Australia			■					
ERA Environmental Services Pty Ltd	■							
Pegasus Gold Pty Ltd					■			
*QMI Joint Venture				■				■
ABORIGINAL COMMUNITY GROUPS								
Bawinaga Association, Arnhem Land				■				
Cape York Land Council				■				
Kimberley Land Council				■				
Indigenous Land Corporation				■				
Northern Land Council	■			■				
Jawoyn Association			■	■				
TOURISM INDUSTRY SECTOR								
Alliance for Sustainable Tourism				■				
Northern Gateway Pty Ltd	■			■				
National Centre for Studies in Travel and Tourism Pty Ltd			■	■				
Northern Territory Tourism Council			■	■				
Townsville Tourism			■					
Savannah Guides Ltd				■		■		
GLADA				■		■		
Queensland Tourist Commission			■	■				
Undara Experience				■		■		
Sanctuary Park Endangered Wildlife Foundation			■	■			■	
FUNDING AGENCIES								
ACIAR			■	■			■	
LWRRDC	■			■		■	■	
*Environment Australia (Biodiversity Group)	■							
Department of Environment Sport and Territories	■	■		■			■	
Department of Primary Industries & Energy							■	
Meat Research Corporation	■			■			■	
Rural Industries Research Development Corporation							■	
Bureau Resource Sciences				■				

APPLICATION OF RESEARCH; LINKS WITH USERS

TABLE 6 (CONTINUED)

ORGANISATION	REPRESENTED ON BOARD COMMITTEES	PARTNER AGENCY	COLLABORATIVE RESEARCH	INFORMATION/ RESEARCH EXCHANGE	CONTRACT RESEARCH	COOPERATIVE TRAINING	COLLABORATIVE GRANTS	CONTRACTED BY CENTRE
GOVERNMENT AGENCIES								
Australian Defence Force			■	■				
Bureau of Meteorology			■					
Great Barrier Reef Marine Park Authority			■					
Agriculture Western Australia		■						
WA DOLA Department of Land Administration			■					
Bushfires Board of Western Australia			■	■		■		
WA CALM		■						
Caring for Country Unit, NLC			■	■				
Kakadu, Nitmiluk Litchfield, National Parks			■	■				
NT Department of Mines and Energy		■						
NT Power and Water Authority		■						
NT Bushfires Council			■	■		■		
NT Department Primary Industry and Fisheries		■						
NT Parks & Wildlife Commission		■						
CYPLUS			■					
South Australian Department of Environment and Natural Resources			■	■				
ERIN				■				
NRIC				■				
CSIRO Division of Wildlife & Ecology		■						
CSIRO Division of Land & Water		■						
CSIRO Division of Mathematical & Information Sciences			■	■				
Queensland Department of Primary Industries	■	■						
Queensland Department of Natural Resources		■						
Queensland Department of Environment			■	■				
Queensland Department of Main Roads			■					
Queensland Forest Research Institute			■					
Townsville City Council			■					
COOPERATIVE RESEARCH CENTRES								
CRC for Tropical Pest Management			■					
CRC for the Conservation and Management of Marsupials			■	■				
CRC for Tropical Rainforest Ecology and Management			■					
CRC for Sustainable Sugar Production				■				
CRC for Freshwater Ecology			■					
CRC for Sustainable Tourism				■				
COMMUNITY GROUPS AND PROFESSIONAL BODIES								
Desert Uplands Build-Up & Development Strategy Committee			■	■				
Mary River Landcare Group			■	■				
Mary River Technical Working Group			■					
Savanna Landcare Groups				■				
Balfes Creek Catchment Landcare Group			■	■				
Fletcher Creek Catchment Landcare Group			■	■				
Sturt Plateau Best Practice Group			■	■				
Daly River Landcare Trust			■	■				
Sustainable Beef Group, Torrens Creek Qld			■	■				

TABLE 6 (CONTINUED)

ORGANISATION	REPRESENTED ON BOARD COMMITTEES	PARTNER AGENCY	COLLABORATIVE RESEARCH	INFORMATION/ RESEARCH EXCHANGE	CONTRACT RESEARCH	COOPERATIVE TRAINING	COLLABORATIVE GRANTS	CONTRACTED BY CENTRE
Landcare North West Initiative Group (NW Qld)				■				
Regional Bushfire Council Committees (NT)			■					
WA Land Conservation District Councils				■				
EDUCATIONAL INSTITUTIONS								
Centre for Interactive Multi-Media (JCU)								■
Centre for Indigenous Natural & Cultural Resource Management (NTU)						■		
University of Western Sydney			■	■				
James Cook University		■						
University of Sydney			■	■				
University of South Australia				■				
Curtin University			■					
Macquarie University				■				
University of New South Wales			■					
Northern Territory University		■						
Murdoch University, WA			■	■				
Australian National University		■						
Central Queensland University			■	■				
INTERNATIONAL COLLABORATION								
Oregon State University			■					
Colorado State University			■					
University of Virginia			■					
University of Miami			■					
Indonesian Government								
Agricultural Agencies			■					
University of Wisconsin			■					
Museum of Natural History, New York			■					
Serengeti National Park, Tanzania			■					
University of Botswana			■					
Massey University, New Zealand			■					
University of Beyreuth, Germany			■					
NASA			■					





STAFFING & ADMINISTRATION

The Centre's administrative and support staff, including the director and deputy director, continued to work from the offices established in Darwin and Townsville in 1995. There was no major purchase of equipment

during the year. The Centre's foundation director, Dr Phil West, resigned in April and Associate Professor Charles Webb was appointed acting director. Dr John Ludwig took over Sub-Program 1 in October 1996, and Dr David

Choquenot was appointed leader of Project 2.2 in April 1997. Ms Kate O'Donnell, the Centre's publications officer was appointed to a full-time position in April 1997. Various staff categories are presented in the following tables.

TABLE 7 SPECIFIED PERSONNEL

NAME AND TITLE	ORGANISATION	% CRC COMMITMENT	ROLE AT CENTRE
Dr Phil West	CRC	100%	Director
Dr Ross Hynes	CRC and Old Department of Natural Resources	100%	Deputy Director, Leader Sub-Program 4
Dr John Ludwig	CSIRO Division of Wildlife & Ecology	80%	Leader Sub-Program 1
Dr Joel Brown	CSIRO Division of Tropical Agriculture	50%	Leader Sub-Program 1
Mr Peter Whitehead	NT Parks & Wildlife Commission	30%	Leader Sub-Program 2
Dr Paul Novelly	Agriculture WA	70%	Leader Sub-Program 3
Professor Greg Hill	Northern Territory University	50%	Leader Sub-Program 5

TABLE 8 STAFF CONTRIBUTIONS

NAME	EMPLOYER	ACTIVITY	SP1	SP2	SP3	SP4	TOT RES	EDUCN	COMM	ADMIN
T Churchill	CSIRO DWE	R			100		100			
L Hutley	NTU	R	100				100			
D Lynch	NTDLPE	R			100		100			
J Ludwig	CSIRO DWE	R	80				80			
D Cheal	NTPWC	R		50			50			
R Benson	NTU	R						50		
H Davis	NTU	R			20		20			
M Forster	JCU	R			20		20			
I Radford	CSIRO TAG	R			20		20			
P West	CSIRO	A								100
M Fraser	NTU	A								100
S Setterfield	NTU	E						100		
R Hynes	JCU	A								80
K O'Donnell	JCU	A								60
S Kelly	JCU	A								50
B Abbot	CSIRO TAG	S			100		100			
A O'Grady	NTU	S	100				100			
L Peel	NTDLPE	S			100		100			
M Greatz	CSIRO DWE	S	90				90			
L Hertog	CSIRO DWE	S			80		80			
J Cusack	CSIRO DWE	S	60				60			
R Eager	CSIRO DWE	S	45				45			
L Lowe	CSIRO DWE	S			20		20			
M Hope	CSIRO DWE	S	15				15			
Total			490	50	520	40	1100	150		390



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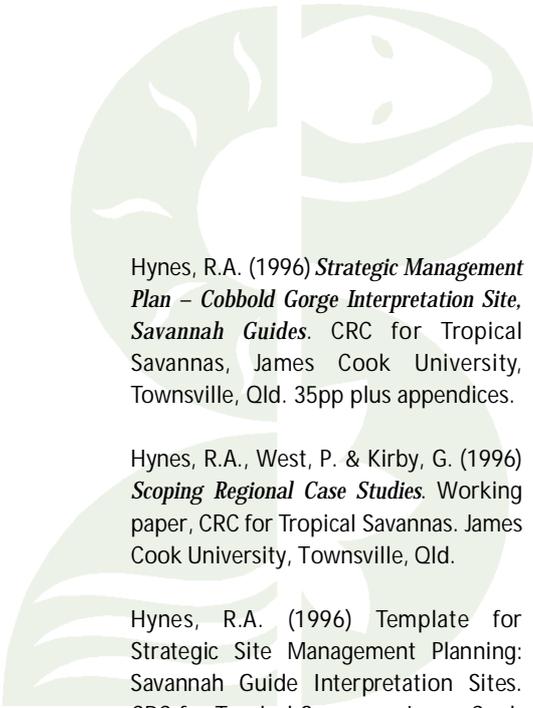
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PUBLICATIONS

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Hynes, R.A., West, P. & Kirby, G. (1996) *Scoping Regional Case Studies*. Working paper, CRC for Tropical Savannas, James Cook University, Townsville, Qld.

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Woinarski, J.C.Z. & Fisher, A. (eds) (1996) *Wildlife of the Wessel Islands*. Technical Report no. 60. PWCNT, Darwin.

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Woinarski, J., Oliver, B. & Connors, G. (1997) *Can reserve design based on prioritising 'reserve-dependent' species deliver better conservation value than design based on comprehensiveness?* Final report to ANCA National Reserves System Cooperative Program.

Annual Report 1995-96 Cooperative Research Centre for the Sustainable Development of Tropical Savannas (1996). Hynes, R.A. & O'Donnell, K.M. (eds). James Cook University, Townsville, Qld.

OTHER PUBLICATIONS

*Bowman, D.M.J.S. & Panton, W.J. (1997 in press) Abandoned Orange-footed Scrubfowl (*Megapodius reinwardt*) nests and coastal rainforest boundary

dynamics during the late Holocene in monsoonal Australia. *Proceedings of Bushfire '97 Conference*.

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Bowman, D.M.J.S. (1997) Arguments about bushfires: A dry season ritual. *Greening News: Greening Australian Newsletter* May/June/July 1997, 7.

Bowman, D.M.J.S. (1997 in press) *Report on Fire Workshop - Galtha Rom Worrk*. Unpublished Proceedings of a Fire Workshop, Dihimurru Land Management Aboriginal Corporation.

Hynes, R. (ed.). (1997). *Desert Uplands Technical Workshop. General Background Information Manual*. CRC for Tropical Savannas, Townsville, June.

Hynes, R. (ed.). (1997). *Desert Uplands Technical Workshop. Working Papers on Proposed Research Activities*. CRC for Tropical Savannas, Townsville, June.

Hynes, R. (1997) Issues and options in regional land sustainability. *Savanna Links*, No 3. pp 4-5.

Hynes, R.A. & O'Donnell, K.M. (1996) *Savanna Links*, Issue 3, November 1996. CRC for Tropical Savannas, James Cook University, Townsville, Qld, 16pp.

Hynes, R.A. & O'Donnell, K.M. (1996) *Savanna Links*, Issue 4, June 1996. CRC for Tropical Savannas, James Cook University, Townsville, Qld, 16pp.



PRESENTATIONS, PUBLIC RELATIONS AND COMMUNICATIONS

PRESENTATIONS

July 1996

Andersen, A.N. (1996) *Effects of disturbance on distance dispersal by ants*. Annual conference of the Ecological Society of Australia, Townsville.

Churchill, T.B. (1996) *Spiders as ecological indicators*. Annual conference of the Ecological Society of Australia, Townsville.

Fisher, A. (1997) *Wildlife of Mitchell grasslands in northern Australia: biodiversity and grazing effects*. Ecological Society of Australia conference, Townsville.

August 1996

Brown, J.R. & Ash, A.J. *Livestock grazing and land degradation in Tropical Savannas*. Environmental Management of Military Lands Workshop, Townsville. (Presented by J. Brown.)

Rose, D. (1966) *Land Claims and Deep Colonising: The Erasure of Women*, presented at Land Rights, Past, Present and Future, Old Parliament House, Canberra.

September 1996

Black, N. & Kirkham, J. *Outback tourist experiences: Opportunities for flow*. Paper presented at the APTA Conference, Townsville.

Brown, J.R. & Grice, A.C. *Repeated fire in the management of invasive tropical shrubs*. Australian Rangeland Society-Port Augusta (poster). September.

Hynes, R.A. (1996). *The Role of the CRC and its potential links to the DUBDSC*. Paper presented to the DUBDSC, Aramac.

Rose, D. (1996) *Common Property in Aboriginal Australia: Totemism Revisited*, presented at 'Common Property Issues' conference, National Centre for Development Studies, The Australian National University.

Rose, D. (1966) *Paradigms of Productivity, Everyday Life, and the Native Title Act*, Series Identity Rights organised by the

Australian Institute of Aboriginal and Torres Strait Islander Studies.

October 1996

Hynes, R.A. (1996). *The Use of Strategic Planning Site Templates for Sustainable Savanna Guide Stations*. Paper presented to the Savannah Guides Training School. Adel's Grove, Lawn Hill National Park.

November 1996

Cafe, L. *Savanna overstorey and understorey relationships: Do grasses compete with tree growth?* (preliminary results of NTDPIF project). NTDPIF 1996 Pastoral Division Conference, Timber Creek.

Hynes, R.A. (1996). *The Role of the CRC and its potential in contributing to sustainable pastoralism in tropical savannas*. Paper to the Agribusiness Conference, Normanton, Convened by GLADA.

Macgregor, C. (1996) *The relevance of sustainability principles for savanna towns and a view of philosophical issues*. Federated PhD Scheme in Housing and Urban Studies, Australian National University.

January 1997

Brown, J. R. & MacLeod, N. *Scale, process and context-case studies as a research communication tool*. Communicating Complex Information to Land Managers. Brisbane. (presented by J. Brown.)

Hynes, R.A. (1997). *Proposed Cooperative Research Activities for the DUBDSC Program*. Paper presented at Barcaldine to the DUBDSC.

Mobbs, C.D. (1997) *Regional environmental management – why can't we get it right (or is that the wrong question)?* Institute of Australian Geographers and New Zealand Geographers Society Joint Conference, University of Tasmania, Hobart.

Robinson, C. *Marine Co-Management with Indigenous Peoples: Issues and Options*, Institute of Australian Geographers and New Zealand Geographers Society Joint Conference, University of Hobart, Tasmania.

February 1997

Hynes, R.A. (1997). *The Role of the CRC in Integrating Economic and Environmental Factors for Sustainable Pastoralism in Tropical Savannas*. Paper presented at NABRC Meeting at Beef Centre, Rockhampton.

Rose, D. (1997) *Race, Caste, and Problem of Time in the Colonisation of Australia*, presented at the conference Is Racism Un-Australian?. Humanities Research Centre, ANU.

March 1997

Campbell, N. *Cross-cultural issues in the Rangelands*. National Forum on Property Management Planning, Coffs Harbour.

April 1997

Hynes, R.A. (1997). *Managing Rehabilitation of Degraded Areas: Best Practice Case Studies*. Paper presented in Workshop Session, Savanna Guides School, Hell's Gate.

Project 3.1 National Collaborative Project on *Indicators for Sustainable Agriculture* (NCPISA) Workshop; Adelaide.

May 1997

Hynes, R.A. (1997). *Sustainable Rangelands – Sustainable Economics*. Issues Paper, Queensland Conservation Council State Conference. Mackay.

June 1997

Hynes, R.A. (1997) *Development and application of GIS in regional sustainability planning for the Desert Uplands*. Background paper presented to Desert Uplands Technical Workshop.

Rose, D. (1997) *Aboriginal Sacred Sites* Contribution to Workshop for the Oxford Companion to Aboriginal Art and Culture. (eds) Neale, M. & Kleinert, S.

INTERNATIONAL PRESENTATIONS

August 1996

Andersen, A.N. (1996) *A global ecology of ant communities*, International workshop on rainforest Oants, Ilheus, Brazil.

Andersen, A.N. (1996) *An overview of Australian rainforest ant communities*,

PRESENTATIONS, PUBLIC RELATIONS AND COMMUNICATIONS

International workshop on rainforest ants, Ilheus, Brazil.

October 1996

Cook G.D., Ronce O. & Williams R.J. *Suppress thy neighbour: The paradox of a successful grass that is highly flammable, but harmed by fire.* The 13th Conference on Fire and Forest Meteorology, Lorne.

Williams, R.J. & Cook, G.D. *Fire and trees in the world-heritage Kakadu National Park, northern Australia.* Tall Timbers Fire Conference, Boise, Idaho, USA. (ed) Brennan, L. Tall Timbers Research Institute, Tallahassee, Florida, US.

Williams, R.J. & Lane, A.M. *Wet season fire as a fuel management tool in a humid tropical savanna in northern Australia.* The 13th Conference on Fire and Forest Meteorology, Lorne, US.

November 1996

Williams, R.J., Hill, G.J.E., Ahmad, W. & Cook, G. (1997). Remote Sensing and Savanna Ecology and Management: Applications along the IGBP North Australian Tropical Transect (NATT). Presentation to 10th CEOS Plenary Canberra.

May 1997

Ahmad W., O'Grady, A.P., Pfifzner, K., Hill, G.J.E. (1997) *Use of multi-spectral scanner data for the identification and mapping of tropical forests of northern Australia.* IUFRO Workshop on Forests at the Limit: Environmental Constraints on Forest Function, Skukuzza, South Africa.

O'Grady A.P., Eamus D. & Duff, G.A. (1997) *Daily and seasonal variation in transpiration measured in forest trees in the tropical savannas of northern Australia.* IUFRO Workshop on Forests at the Limit: Environmental Constraints on Forest Function, Skukuzza, South Africa.

Eamus D. & Pritchard H. (1997) *Carbon, nutrient and water relations of deciduous and evergreen tree species of tropical savannas of northern Australia.* IUFRO Workshop on Forests at the Limit: Environmental Constraints on Forest Function, Skukuzza, South Africa.

INVITED PAPERS

July 1996

Woinarski, J.C.Z. (1996). *Rodents of the Top End: Conservation and ecology of rodents in the monsoonal tropics of the Northern Territory.* Australian Mammal Society Symposium Biology and Conservation of Rodents in Australia, Melbourne.

Woinarski, J.C.Z. (1996). *Distribution and habitat of the Northern Hopping-Mouse Notomys aquilo.* Australian Mammal Society Symposium Biology and Conservation of Rodents in Australia, Melbourne.

August 1996

Andersen, A.N. *A global ecology of ant communities.* International workshop on rainforest ants, Ilheus, Brazil.

Andersen, A.N. *An overview of Australian rainforest ant communities.* International workshop on rainforest ants, Ilheus, Brazil.

Ludwig, J.A. & Tongway, D.J. *Arresting the desertification of Australian landscapes by rehabilitating Robin Hood.* Fifth International Conference on Desert Development, Texas Tech University, Lubbock, Texas, USA.

September 1996

Woinarski, J.C.Z. *The Effects of Fire on Australian Birds* (with H.F. Recher). The Southern Hemisphere Ornithological Congress, Albany, US.

November 1996

Hynes, R.A. *The CRC for Tropical Savannas – Working with Stakeholders* Agribusiness Conference convened by GLADA, Normanton.

Williams, R.J. *Remote Sensing and Savanna Ecology and Management: Applications along the IGBP North Australian Tropical Transect (NATT).* Committee on Earth Observing Satellites (CEOS), Canberra.

December 1996

Dr Woinarski was an invited delegate to a workshop on Scientific Criteria for the National Reserve System, Melbourne.

March 1997

Dr John Woinarski was an invited delegate to a workshop on Scientific

Criteria for the National Reserve System in Adelaide.

Ludwig, J.A. & Tongway, D.J. *Arid lands to tropical forests: a landscape function analysis approach to their ecology and restoration.* The Pace and Pattern of Landscape Change, 12th Annual Symposium, United States Regional Association, International Association for Landscape Ecology, Duke University Durham, North Carolina, USA.

May 1997

Hynes, R.A. *Sustainable Rangelands – Sustainable Economics.* Queensland Conservation Council State Conference.

WORKSHOPS, SYMPOSIA, SEMINARS AND MEETINGS

WORKSHOPS

August 1996

Workshop on Sustainable Management of Defence Lands. Townsville (ADF/LWRRDC).

Participants: Dr Joel Brown (Co-Convener) Dr Ross Hynes and Mr Greg Calvert

Workshop to prepare presentation to Lower Mary River Landcare Group. Annaburroo, NT.

Facilitator: Ms Narelle Campbell.

September 1996

Townsville Landcare Committee on Fire Management. James Cook University, Townsville.

Participants: Dr Ross Hynes, Mr Greg Calvert.

Catchment Workshop for Canefarmers on the Herbert River. (convened by CSIRO) Bureau of Sugar Experiment Stations Office, Ingham, Queensland. Participant: Mr Colin Macgregor.

October 1996

Scaling issues in savanna ecology. TERC, Darwin NT.

A workshop and an associated series of meetings was held with relevant Centre participants to explore the issues of scale in ecological studies, as they might be relevant to CRC-sponsored projects. Particular attention was paid

to the application of studies at one scale to other, generally larger, scales. Funded by the Centre. Convener and keynote speaker: Professor John Wiens, visiting scientist.

Developing a Coordinated Approach to Fire Management Across Northern Australia. Darwin, NT.

Funded by LWRRDC and the Centre. Participants: Wide representation of CRC researchers. Keynote speaker, Dr Jeremy Russell-Smith.

This workshop attracted senior representatives from all northern Australian rural fire agencies, and pastoral, conservation and Aboriginal land management sectors, to address the requirement for developing a more coordinated approach.

Rangers Planning Workshop on Land Management and Fire Ecology in Northern Australia. Murgonella, NT. Participant and speaker: Dr David Bowman

March 1997

SCARM Women in Agriculture and Resource Management Forum, Canberra. Participant: Ms Narelle Campbell (small group facilitator)

April 1997

National Collaborative Project on Indicators for Sustainable Agriculture (NCPISA) Workshop. Adelaide, 28-29 April. Participants: Project 3.1 staff

Catchment Workshop for Townsville Coastal Plains. Mecure Inn, Townsville. Participant: Mr Colin Macgregor.

Horticulture Industry Strategic Planning Workshop. Darwin. Participants: Ms Narelle Campbell, Mr Daryl Parker (facilitators).

May 1997

Scoping Workshop to Establish a Tropical Savannas CRC Case Study. TERC, Darwin. Participants: Dr Alan Andersen, Mr Rod Applegate, Mr James Binney, Mr Andy Chapman, Dr Gordon Duff, Dr Derek Eamus, Ms Valerie Haistova, Dr Lindsey Hutley, Mr Bob Karfs, Ms Barbie McKaige, Mr Shiw Murti, Dr Jeremy Russell-Smith, Dr Sam Setterfield, Dr Ram Vemuri, Dr Dick Williams and Dr John Woinarski. Facilitator: Dr Mark Stafford-Smith. Organisers: Dr Graham Kirby and Dr John Ludwig.

The workshop examined ways a new case study could be established and future actions for researchers identified. Participants agreed on the VRD as the core region for a case study.

Workshop to examine problem of introduced pasture species. Darwin.

Facilitator: Ms Narelle Campbell.

Workshop on Biodiversity (Meat Research Council), Katherine NT.

Participant: Dr David Bowman

Workshop for Landcare Unit of NTDLPE.

Katherine, NT.

Participant: Ms Narelle Campbell

June 1997

Fourth North Australian Fire Manager's Workshop. Kalumburu, WA.

Funded by the Centre and a range of West Australian Government agencies.

This 'hands-on' workshop over 10 days aimed to address serious fire management problems in the north Kimberley region of WA. It focused on management of Aboriginal lands (including the Carson River pastoral station), with participants attending from across northern Australia and the local Kalumburu community. Follow-up workshops are planned for pastoral lands (both Aboriginal and non-Aboriginal) and conservation lands, over the next two years.

Desert Uplands Technical Workshop. Davies Laboratory, CSIRO, Townsville. Funded by the Centre.

Participants: Dr Ross Hynes (convener), Dr Joel Brown, Ms Kate O'Donnell, Ms Sonya Kelly, Mr Peter O'Reigain, Mr Mark Forster, Ms Vicky Godfrey, Mr Jim Monaghan, Dr Graham Kirby, Mr Jim Kernot, Dr John Holt with representatives from DUBDSC, CSIRO and CIRM.

Delegates developed a technical overview of the region and drafted materials for three key research activities. These activities comprised the establishment and application of a GIS; the development of a research investigation focusing on transitions to more sustainable levels of property/enterprise management; and an investigation addressing the development of key indicators of economic, social and environmental trends towards sustainable land management.

SYMPOSIA

Tracking Knowledge Symposium. Darwin. December 1996,

Organiser: Dr Deborah Rose (CRC and NARU) and Dr Annie Clarke (NARU).

The focus was on different knowledge systems in the northern savannas. The approach was interdisciplinary and cross-cultural. The symposium was very successful, and there are plans to continue with an annual series. The purpose is to compile new analytic knowledge, to offer a context for the comparative analysis of particular case material, and to communicate results of original research to other researchers and to the public.

SEMINARS

August 1996

Dostine, P. *The Gouldian finch: Rare, endangered or what.* Nature '96 Public Forum, Darwin.

September 1996

Bowman, D.M.J.S. *Fire Ecology of Callitris Intratropica in the Northern Territory.* Government Nature '96 program in Darwin and Katherine. (public seminar).

November 1996

Hutley, L., *Vegetation and Hydrology,* Northern Territory University, Darwin, NT.

December 1996

Andersen, A.N. *Ants as bioindicators,* CSIRO seminar series, Darwin. December 1996.

Runcie, M. *Ecology and Behaviour of the Rock Ringtail Possum.* Seminar to the Science Faculty, Northern Territory University, Darwin.

Fraser, F. *The Ecology of the Partridge Pigeon and habitat impacts due to fire and grazing.* Centre for Environmental Studies, Australian National University, Canberra.

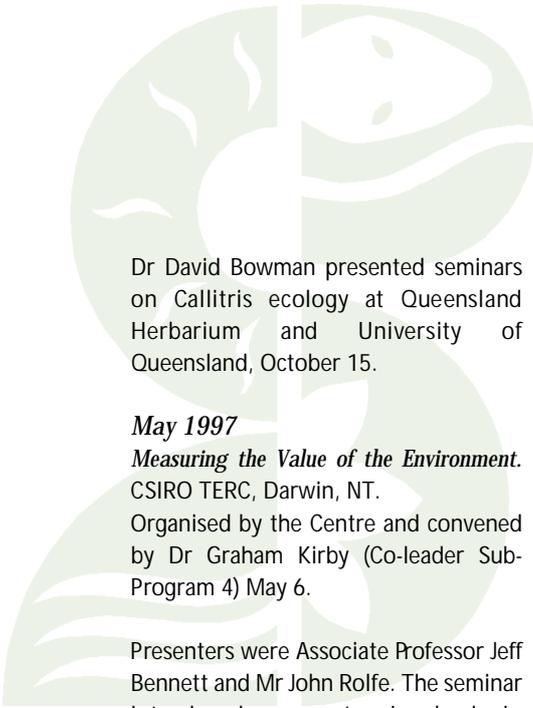
February 1997

Whiteman, G. *The effect of grazing on the genetic diversity of the grass Heteropogon contortus in a tropical savanna.* James Cook University, Townsville.

April 1997

Calvert, G., *Fire Ecology.* Townsville branch of the Society for Growing Australian Plants (SGAP).

Dostine, P. *Tracking Gouldians in space and time* CSIRO Tropical Ecosystems Research Centre.



PRESENTATIONS, PUBLIC RELATIONS AND COMMUNICATIONS

Dr David Bowman presented seminars on *Callitris* ecology at Queensland Herbarium and University of Queensland, October 15.

May 1997

Measuring the Value of the Environment. CSIRO TERC, Darwin, NT.

Organised by the Centre and convened by Dr Graham Kirby (Co-leader Sub-Program 4) May 6.

Presenters were Associate Professor Jeff Bennett and Mr John Rolfe. The seminar introduced concepts involved in measuring environmental values and gave some applied research examples. It also formed the basis to subsequent detailed research project planning for Sub-Program 4.

Choquenot, D. *Direct and indirect processes in plant-herbivore interactions.* CSIRO Tropical Ecosystems Research Centre.

June 1997

Macgregor, C. *Traditional Geographical Research Methods Continue to have useful Applications in the Savanna Region of Northern Australia.* Seminar to the TESAG Postgraduate Conference, James Cook University, Townsville, June 10.

Macgregor, C. *Research and sustainable Development in the Australian savanna and a view of methodological issues.* Federated PhD Scheme in Housing and Urban Studies, Australian National University.

Macgregor, C. *Sustainability in the urban centres of Australia's tropical savannas Seminars.* Local Government Authority Charters Towers.

MEETINGS

Dr Ross Hynes participated and made technical and research presentations to the DUBDSC strategy committee in September (Aramac) and October 1996 and March 1997 (Barcardine). A separate session was held at Trafalgar Station with Mr Mark Forster as part of DUBDSC's tour of the Desert Uplands. Mr Forster also participated fully in this tour which examined land types, problems and research demonstration sites throughout the region from 6-9 April, 1997.

Dr Hynes attended a joint meeting with QDPI and QDNR at Charters Towers regarding the Centre and DUBDSC activities on March 13, 1997.

Mr Mark Forster attended a meeting of the Northern Australian Beef research Council in Rockhampton on February 19, 1997. He participated in two meetings of the Sustainable Beef Group at Keen-Gea, Torrens Creek.

CRC Association Conference, April 13-15, 1997. Participants: Dr Ross Hynes (Centre Deputy Director), Dr Samantha Setterfield (Centre Course Coordinator).

MEDIA HIGHLIGHTS RADIO INTERVIEWS

Dr Tracey Churchill, Redback spiders – need for research, especially re exports. 8DDD ABC Radio News, Darwin, August 7, 1996, ABC Country Hour, Alice Springs, August 8, 1996, ABC Radio Geraldton, W.A., August 12 1996, 8DDD ABC Radio, Darwin, August 12 1996, ABC Triple J Radio National News, August 12 1996, 3LO ABC Radio, Melbourne August 13 1996.

Dr Dick Williams, NATT – current projects including general biogeography field work, radar work and soil surface condition. ABC Country Hour, Darwin, September 10, 1996.

Dr Joel Brown, Weed Management, ABC Radio, September 1996.

Dr Joel Brown, Fire for land management and weed control, ABC Radio, October, 1996.

Dr Joel Brown & Dr Steve Radosvich (Visiting Scientist) Exotic Weed Management February-ABC Radio, November 1996.

Dr David Bowman, Boab Tree Research. ABC Regional Radio, Darwin, November 6, 1996.

Mr John Kerin, International implications of savannas (Launch of Centre's first annual report), News Bulletin ABC Radio National, Townsville, November 14, 1996.

Dr Tracey Churchill, Spiders in the Top End/Indicator species. Earthbeat ABC Radio National November 16, 1996.

Dr Alan Andersen, Indicator species. Earthbeat ABC Radio National, November 16, 1996

Dr Ross Hynes, Savannah Guides Training School. ABC Radio, Mount Isa, November 17, 1996

Dr Garry Cook, Visit of the NASA DC-8 aircraft in the Daly River Region. ABC Drivetime Program, November 19, 1996.

Dr Garry Cook, NT vegetation and geography will be focus of joint CSIRO/NASA study. Alice Springs ABC Radio News, November 21, 1996.

Dr Alan Andersen, Ants as bioindicators. ABC Radio, Regional NT December 4, 1996.

Dr John Ludwig, Landscape Ecology – research tools for sustainable land management e.g. Assessing effectiveness of mine site rehabilitation success. ABC 8DDD morning news, February 7, 1997.

Dr Alan Andersen, Ants and Flooding. ABC Afternoon Show, February 25, 1997.

Dr Alan Andersen, National Science Week, Role of Science in Society. 8DDD ABC Radio, Darwin April 14.

Dr Alan Andersen, Research in NT – CSIRO's role vs other research and land management agencies. 8DDD ABC Radio, Darwin April 30, 1997.

Dr Tracey Churchill, Spiders in the NT, Tropical Savannas CRC indicators project. 8DDD ABC Radio, Darwin, May 14, 1997.

Dr Alan Andersen, Biodiversity and Pastoralism NAP3 program. ABC Country Hour, Alice Springs, May 23, 1997.

Dr Garry Cook, Fire in the Top End – rural/urban issues. ABC Morning Show, June 11, 1997.

Dr Joel Brown, Strategic Planning for weed Control, ABC Radio, June 1997.

TELEVISION

Launch of Centre's first annual report and first Board meeting in Townsville, News Bulletin, WIN TV, Townsville, November 13 1996.

Dr Bowman's Research on Boabs also featured on ABC TV's *7.30 Report* 18 June, 1997.

PRINT MEDIA

The *Northern Territory News* printed articles about the wildlife surveys at Litchfield Park (Project 2.1) in July 1996 and Spirit Hills Station in September 1996.

Townsville Bulletin featured two news items on Centre's first Board meeting in Townsville and launch of first annual report. Interviews were carried with Drs Ross Hynes and Phil West. November 14, 1996.

Queensland Country Life featured an interview with Mr John Kerin (Centre chairman) and Dr Ross Hynes on responsible land use in savannas. November 21, 1996.

Weekend Australian featured Dr David Bowman's research on Boabs, June 14-15, 1997.

Australian Geographic featured Dr Bowman's research on Boabs, June, 1997.

Australian Financial Review Magazine profiled Dr David Bowman's research on deciduousness in northern Australia July 25, 1997.

Australian Financial Review, Interview with Dr Derek Eamus, June 25, 1997.

DOCUMENTARIES

Mr Peter Whitehead gave technical advice and support to NHK (Japanese National Broadcaster), including an interview, in the making of a documentary on reproductive

behaviour and ecology of the Magpie Goose in April 1997. Mr Whitehead also provided technical advice and support to an ABC documentary on the ecology of the South Alligator River in Kakadu National Park in May 1997.

Mr Peter Dostine provided technical advice and support to a BBC documentary on the life of birds, including the filming of reproductive behaviour of the Gouldian Finch.

DISPLAYS

This year the Centre produced a portable nine-panel display which was taken to a number of conferences, workshops and events in both the Northern Territory and Queensland. They were:

Agribusiness Conference, convened by GLADA in Normanton, November 22-24 1996.

Desert Uplands Build-Up & Development Committee meeting in Barcaldine February 18, 1997

NABRC meeting in Rockhampton, February 19, 1997

Queensland Conservation Council State Conference, May 3-5, 1997.

Desert Uplands Workshop in Townsville, June 25 1997.

Orientation Week, James Cook University, Townsville, February 1997.

Science Week, Ignatius Park High School, May 1997.

CRC Board meetings: March 1997, DPIF (NT Department of Primary Industry & Fisheries), Darwin. July 1, Townsville. A duplicate was made of the display for more flexible use across the two states and territory.

POSTER DISPLAYS

Poster Display at *Measuring and Monitoring Vegetation on Pasture Lands in Northern Australia for Sustainable Use*. Gatton, Queensland October 1996, sponsored by the Meat Research Corporation. (Project 3.1 staff)

Poster display on Ringtail Possum behaviour and ecology for visitors to Kakadu National Park. (Ms Runcie, PhD student)

COMMUNICATION

There were two issues of the Centre's newsletter *Savanna Links*, and a prototype electronic email list developed for Centre staff. The Centre also produced an A4 shell for researchers and Centre staff to publish one-page descriptions of research activities.

This year a joint initiative between the communication officers of Queensland Cooperative Research Centres saw the Tropical Savannas CRC – along with 17 other CRCs who have either nodes in Queensland or are based in that State – take part in a ministerial briefing at Parliament House in Brisbane.

The briefing showcased the achievements of a selection of CRCs in Queensland, and was launched by the Hon Tony Staley, Chairman of CRC Association and the Hon Bruce Davidson, State Minister for Tourism, Small Business and Industry. There are plans to continue Ministerial Briefings in other States and at a national level.



GRANTS AND AWARDS

TABLE 8 GRANTS AND AWARDS

RESEARCHER	RESEARCH PROGRAM	TITLE OF GRANT	SOURCE OF GRANT	AMOUNT OF GRANT	PERIOD OF AWARD
Dr Dick Williams CSIRO DWE	Project 1.1	Savannas, land condition and the determinants of land degradation	LWRRDC	\$298,000	1994-97
Dr Dick Williams CSIRO DWE		Use of Synthetic Aperture RADAR in Savannas	IGPB/Australian Academy of Science	\$17,000	1996
Dr Derek Eamus NTU	Project 1.2	Estimating ecologically sustainable groundwater pumping rates	LWRRDC	\$160,000	1996-1998
Dr Derek Eamus NTU		Stomatal control of transpiration from savanna vegetation	Australian Research Council	\$40,000	1995-1998
Dr Derek Eamus NTU		Patterns of hysteresis of transpiration of the major savanna tree species of the Northern Territory	Australian Research Council	\$12,000	1996
Dr Derek Eamus NTU		Area of Strength – Tropical Environmental Science	Northern Territory University	\$60,000	1997
Dr John Woinarski, PWCNT Mr Alaric Fisher PWCNT Dr Norm McKenzie	Project 2.1	Biological and Economic Consequences of Managing Water-Point Distribution in Rangelands*	LWRRDC	\$70,000	1997-2000
Dr John Woinarski PWCNT Ms Tanya Leary, PWCNT Mr Alaric Fisher PWCNT	Project 2.1	Development of a conservation plan for the Sturt Plateau bioregion	Environment Australia National Reserves System Program	To be confirmed	1996-97
Mr Alaric Fisher PWCNT	Project 2.1	Wildlife of Mitchell Grasslands	Environment Australia	\$4000	1995-1997
Dr John Woinarski PWCNT	Project 2.1	Preliminary Bioregional Analysis	Environment Australia	\$12,000	1995-1996
Dr John Woinarski PWCNT	Project 2.1	Refining reserve design methodology	Environment Australia	\$7500	1994-1997
Dr John Woinarski PWCNT	Project 2.1	English Company Islands Survey	Australian Heritage Commission	\$16,500	1996-1997
Dr John Woinarski PWCNT	Project 2.1	Effect of fire on birds	Environment Australia	\$1760	1995-1996
Mr Peter Dostine PWCNT	Project 2.2	Gouldian Finch Recovery	Environment Australia Endangered Species Unit	\$100,000	1997
Mr Peter Dostine PWCNT	Project 2.2	Gouldian Finch Management	Pegasus Gold	\$75,000	1996-97
Dr Jeremy Russell-Smith BCNT	Project 2.4	Developing a Coordinated Approach to Fire Management Across Northern Australia Workshop, Darwin, NT	LWRRDC	\$5000	1997

**Portion of a collaborative project with CSIRO and SADENR.*

TABLE 8 (CONTINUED)

RESEARCHER	RESEARCH PROGRAM	TITLE OF GRANT	SOURCE OF GRANT	AMOUNT OF GRANT	PERIOD OF AWARD
Dr Jeremy Russell-Smith BCNT		To map vegetation boundary changes using aerial photographic records	Australian Heritage Commission	\$20,000	1996-97
Dr Jeremy Russell-Smith BCNT		Seed funding for CRC Project 2.4	Environment Australia States Cooperative Assistance Scheme	\$122,000	1996-97
Dr Jeremy Russell-Smith BCNT		Fire research projects in the north Kimberley, and eastern Cape York	Environment Australia National Reserves System Cooperative Program	\$200,000	1997-98
Dr Jeremy Russell-Smith BCNT		Development of NOAA-AVHRR fire monitoring across northern Australia	RIRDC	\$85,000	1996-97
Dr Jeremy Russell-Smith BCNT		Fourth North Australian Fire Manager's Workshop, Kalumburu, WA	Various WA agencies and organisations	\$55,000	1997
Dr David Bowman PWCNT	Project 2.4	Management Guidelines for Monsoon Rainforests	Australian Heritage Commission	\$20,000	1996-97
Dr David Bowman PWCNT		Management guidelines for Monsoon Rainforests	Australian Heritage Commission	\$20,000	1996-97
Dr Paul Novelly PWCNT Ag WA	Sub-Program 3	Grazing Systems and Management Guides for Kimberley Rangelands	Meat Research Corporation	\$160,000	1996-97
Drs Joel Brown & Tony Grice CSIRO TAG	Project 3.3	Managing Tropical Woodlands for Sustainable Production: Controlling Exotic Woody Weeds	Meat Research Corporation	\$60,000	1996-1999
Dr Joel Brown CSIRO TAG	Project 3.3	Sustainability short course for graziers and land managers	Meat Research Corporation	\$12,000	1997
Ms Jean Stevens NTU	Project 4.1	Developing a sustainable satellite fire monitoring program for rural northern Australia*	Bushfire Council of the Northern Territory	\$15,000	1996-97
Mr Peter Whitehead PWCNT, Dr Graham Kirby NTDPIF	Projects 4.2 & 2.4	Economic and social values of NT reserve system	Environment Australia	\$70,000	1996-1998
Dr Mick Quirk QDPI	Project 4.3	Develop approaches for increasing availability and use of sustainable grazing systems	Meat Research Corporation	\$12,000	1996-97
Dr Mick Quirk QDPI	Project 4.3	Inspect and assess programs for improving rangeland management via whole-property planning	Meat Research Corporation	\$4000	1997

**Part of RIRDC grant for Project 2.4*

AWARDS AND PRIZES

Dr Mick Quirk was awarded the A. W. Howard Memorial Trust travelling scholarship for 1996-97.

Ms Catherine Mobbs was awarded the Molly Huxley Prize in February 1997 for the outstanding female graduate of the Australian National University for 1995/1996.



PERFORMANCE INDICATORS

A COOPERATIVE ARRANGEMENTS

1. THE LEVEL OF PARTICIPATION OF THE PARTICIPANTS AND USERS IN MAJOR DECISIONS CONCERNING THE ACTIVITIES OF THE CENTRE.

1995-96

- Parties and stakeholders involved in development of the Centre's strategic plan; practices for consultation with stakeholders; communication practices within and outside the Centre; relationships with non-core participants; Centre budget; staff appointments; Centre management practices and structure and establishment of a research Centre on Cobourgh Peninsula, NT.
- Development of stakeholder priorities and identification of gaps in research sub-programs through the Consultative Committee.
- Strategic realignment of sub-program priorities through consultation with representatives of 70 stakeholder groups across northern Australia.

1996-97

- Parties and stakeholders continue to and in a number of areas have increased participation in major decisions of the Centre including communication practices within and outside the Centre through the Communications Consultancy Reports and the review of stakeholders educational and training needs: *A needs analysis of education and training relating to the use and management of tropical savannas*; Centre budget; staff appointments; Centre management practices, linkages with a wide range of regional and research bodies e.g. respectively DUBDSC and CINCRM.
- Strategic realignments in Sub-programs 1-4 were strongly associated with stakeholder advice through the Board and Consultative Committee.
- A wide range of ongoing meetings with stakeholder groups have continued through the year. These included NABRC, a representative group of Bushfire Councils and associated bodies across northern Australia including Governmental agencies QDoE and DOLA WA.

2. THE EXTENT AND FREQUENCY OF THE INTERACTION OF THE PERSONNEL FROM THE PARTICIPANTS IN THE CONDUCT OF THE ACTIVITIES OF THE CENTRE

1995-96

- Members of the Management Committee involved daily in administering sub-program management.
- Project leaders involved in developing links with research sub-programs outside the direct interest of their parties.
- Senior staff of parties regularly involved in Centre activities through the Board.

1996-97

- Members of the Management Committee involved daily in administering sub-program management.
- Project leaders took on a higher level of responsibility in the management of research activities during the year and were given greater autonomy in their roles. Project leaders were very active in optimising existing links, as well as establishing new links with associated research groups both within Australia and overseas.
- New members of the Board have, as senior staff of parties, brought increased energy and expertise to their involvement with Centre activities.

3. THE EXTENT OF INTERACTION WITH OTHER RESEARCH FUNDING BODIES

1995-96

- Meetings with MRC, LWRRDC, ANCA, ACIAR, RIRDC, BRS, DEST, DPI&E, GRDC, ERIN.

1996-97

- Meetings held with LWRRDC, Environment Australia (previously ANCA) ACIAR, RIRDC, MRC, BRS, DEST, DPI&E, GRDC and with various Governmental instrumentalities including the Tourism Departments of the Northern Territory and Queensland Governments.

4. THE EXTENT AND FORM OF INTERACTION BETWEEN OTHER RESEARCHERS, RESEARCH GROUPS AND INSTITUTIONS IN AUSTRALIA AND OVERSEAS.

1995-96

- Biodiversity studies with QDoE.
- Links in ecological modelling with the University of Virginia.
- Management strategies for the Arafura region with the NLC.
- Ecotourism links with Jewel Hotels and Resorts.
- Sustainability and land-use regional case studies with several organisations across the savannas.
- Establishment of a mining industry PhD scholarship with Mount Isa Mines.
- Meetings to identify national priorities and strategies with representatives of LWRRDC, ANCA, ACIAR, RIRDC, MRC, BRS, DEST, DPI&E, GRDC and ERIN.

1996-97

- Overall there was a substantial increase in the extent and form of interactions with other researchers and research bodies during the year. (Refer to body of report for details.)
 - Biodiversity studies further strengthened with QDoE.
 - Links strengthened with a range of ecological modelling groups including the University of Virginia.
 - Regional case studies established in the Desert Uplands of Queensland and the VRD in the Northern Territory.
 - Progress made in implementing SO₂ research project with Mount Isa Mines.
 - Involvement of a number of Aboriginal Land Councils in the work of Project 2.4 *Fire in Savanna Landscapes* (research and management coordination).
- (Contact with funding bodies covered under Perf. Ind. 3)

5. THE EXTENT AND FORM OF COMMISSIONED, COLLABORATIVE AND CONTRACT RESEARCH UNDERTAKEN WITH USERS AND OWNERS OF TROPICAL SAVANNA LAND.

1995-96

- Grant received from ANCA to establish savanna-wide research and bibliographic database.
- Grant from ANCA to assess the value of the National Parks Reserve System to the economy of the Northern Territory.
- Cooperative fire management regimes being developed in cooperation with community organisations across the Northern Territory and Western Australia. These include the NT Bushfire Council, Caring for Country Unit of the NLC, the Bawinanga Association in north-central Arnhem Land, WA Land Conservation District Councils, WA Bushfires Board and the Kimberley Land Council.
- Grant from LWRRDC to identify determinants of land degradation in wet-dry tropical savannas.
- Grant from LWRRDC to estimate ecologically sustainable groundwater pumping rates in wet-dry tropical savannas.
- Savanna wetlands GIS cooperative program with the Northern Land Council.

1996-97

- Twelve (12) commissioned research grants currently being conducted by researchers participating in the Centre, an increase of 100 per cent on 1995-96. These include:
- Grant from LWRRDC on biological and economic consequences of water point distribution in rangelands.
- Four (4) grants from Environment Australia on wildlife in Mitchell Grasslands; bioregional analysis; refining reserve design methodology and effects of fire on birds.
- Grant from Environment Australia National Reserves System program (to be confirmed) on a conservation plan for the Sturt Plateau bioregion.
- Grant from Environment Australia Endangered Species Unit on Gouldian Finch Recovery.
- Grant from Pegasus Gold on Gouldian Finch recovery.
- Two (2) grants from the MRC on approaches for increasing availability and use of sustainable grazing systems; and assessing programs for the improvement of rangeland management via whole-property planning.

RESEARCH AND RESEARCHERS

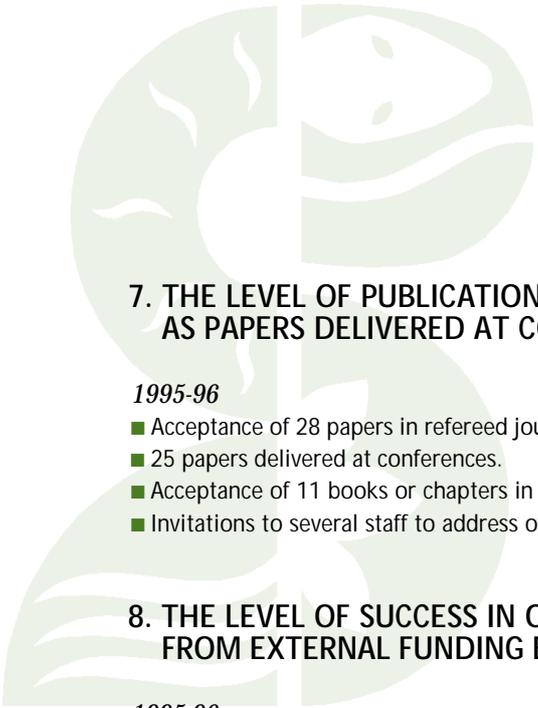
6. THE EXTENT TO WHICH PROGRAM OBJECTIVES AND MILESTONES HAVE BEEN ACHIEVED

1995-96

- Milestones achieved in all the current project investigations within Sub-Programs 1, 2, 3 and 5 and for sectoral investigations in Sub-Program 4.
- Refinements made to milestones to expand the scope of Projects 1.2, 3.1 and 3.3 to further align them with stakeholder needs
- The structure and form of Sub-Program 4 re-evaluated and redefined to provide a clear business focus for the Centre.
- Lack of staff delayed progress in Project 2.3.

1996-97

- Milestones achieved in almost all current project investigations within Sub-Programs 1, 2, 3, 4 and 5.
- Refinements previously made to expand the scope of Projects 1.2, 3.1 and 3.3 successfully incorporated and are operating under the adjusted milestones for these projects.
- Significant progress in implementing the adjustments made in restructuring and refocusing Sub-Program 4.
- Progress made regarding the refinement and preliminary implementation of Project 2.3.



PERFORMANCE INDICATORS

7. THE LEVEL OF PUBLICATION OF CENTRE OUTCOMES IN REFEREED SCIENTIFIC JOURNALS, AS PAPERS DELIVERED AT CONFERENCES OR AS BOOK CHAPTERS

1995-96

- Acceptance of 28 papers in refereed journals.
- 25 papers delivered at conferences.
- Acceptance of 11 books or chapters in books.
- Invitations to several staff to address overseas symposia.

1996-97

- Acceptance of 67 papers in refereed journals.
- Twenty-nine (29) papers delivered at conferences.
- Acceptance of 26 books or chapters in books.
- Invitations to several staff to address overseas symposia.

8. THE LEVEL OF SUCCESS IN OBTAINING RESEARCH GRANTS AND OTHER RESEARCH FUNDS FROM EXTERNAL FUNDING BODIES

1995-96

- Centre staff held 15 external research grants amounting to more than \$1.719 million. These span the period 1991-1998, but several were gained during 1995-96. (Five projects commenced before the establishment year of the Centre in 1995. These totalled more than \$1.313 million.)

1996-97

- Centre participating researchers held 29 grants amounting to more than \$1.733 million. Only two of these projects commenced before 1995, the establishment year of the Centre. These totalled \$0.303 million. A further project is awaiting confirmation. In actual figures an increase of more than \$0.023 million in research grant funds was achieved during 1996-97.

9. THE EXTENT TO WHICH RESEARCHERS IN AUSTRALIA AND OVERSEAS ARE ATTRACTED TO VISIT THE CENTRE

1995-96

- Four visits arranged through the Centre's visiting researcher program for 1996-97 from Colorado State University, University of Virginia, Oregon State University and the University of Miami.
- Contact with and visits by more than 20 Australian researchers to various Centre locations.
- Tour of inspection of the NATT by 40 researchers and stakeholders.

1996-97

- Five successful visiting scientist programs conducted. Internationally recognised researchers came from Colorado State University (two), University of Virginia, Oregon State University, and the University of Miami.
- Contacts and visits by more than 50 Australian researchers to various Centre locations.
- Substantially increased numbers of participants involved in research workshops, symposia and conferences convened by the Centre.

10. THE EXTENT OF NATIONAL AND INTERNATIONAL RECOGNITION OF CENTRE PARTICIPANTS THROUGH AWARDS, ACADEMIC INVITATIONS AND MEDIA INTEREST

1995-96

Awards: none registered.

- Academic invitations: a number of national and international invitations were made that included invited papers at conferences and symposia.
- Media interest: At least 5 radio interviews and 1 print media article.

1996-97

Awards:

- Dr M. Quirk – A.W. Howard Memorial Trust Travelling Scholarship.
- Ms C. Mobbs – Molly Huxley Prize; ANU outstanding female graduate.

Academic invitations:

- Thirteen (13) invited papers at conferences and symposia; 8 within Australia and 5 overseas.

Media Interest

- 27 radio interviews; 2 TV interviews; 7 print media articles; 3 technical inputs to film documentaries.

EDUCATION AND TRAINING

11. THE EXTENT AND NATURE OF GRADUATE TRAINING PROGRAMS DEVELOPED BY THE CENTRE

1995-96

- A master of tropical environmental sciences by coursework established at the Northern Territory University with eight students enrolled to date.
- Vocational course modules for weed management developed.
- Vocational training modules on environmental awareness for mining company employees being assessed for development.

1996-97

- Good progress achieved in the master of tropical environmental science program, 13 students enrolled to date; an interactive multi-media training module on Ecology and Management of Tropical Savannas being produced on CD-ROM.
- Multi-level training package on weed management, in text and CD-ROM format, nearing completion.
- Communication skills workshops for CRC postgraduate students under development.

12. THE NUMBER OF POSTGRADUATE STUDENTS IN THE CENTRE AND THEIR ABILITY TO FIND EMPLOYMENT AFTER GRADUATION

1995-96

- Nine PhD students supported fully or in part by the Centre.
- One MSc student supported in part by the Centre.

1996-97

- 15 PhD students supported fully or partly by the Centre.
- Two MSc students: one supported in part by the Centre and one on full scholarship.

3. THE EXTENT TO WHICH NON-UNIVERSITY STAFF ARE INVOLVED IN THE SUPERVISION OF POSTGRADUATE STUDENTS AND THE DISTRIBUTION OF STUDENTS AMONG PARTICIPATING ORGANISATIONS

1995-96

- Six non-university Centre staff are supervisors or co-supervisors of PhD students.
- PhD students are working in laboratories, or closely with non-university parties, such as CSIRO Divisions of Tropical Crops & Pastures, Wildlife & Ecology; NT Parks and Wildlife Commission; NT Power and Water Authority; Department of Defence.
- Centre staff involved in supervising at least another seven post-graduate and Honours projects.

1996-97

- Seven non-university Centre staff or collaborative staff are supervisors or co-supervisors of PhD students.
- PhD students continued to have positive working links with non-university parties and ongoing cooperative access to their laboratories.
- Non-university Centre participating researchers also involved in supervising at least another nine post-graduate and Honours projects.

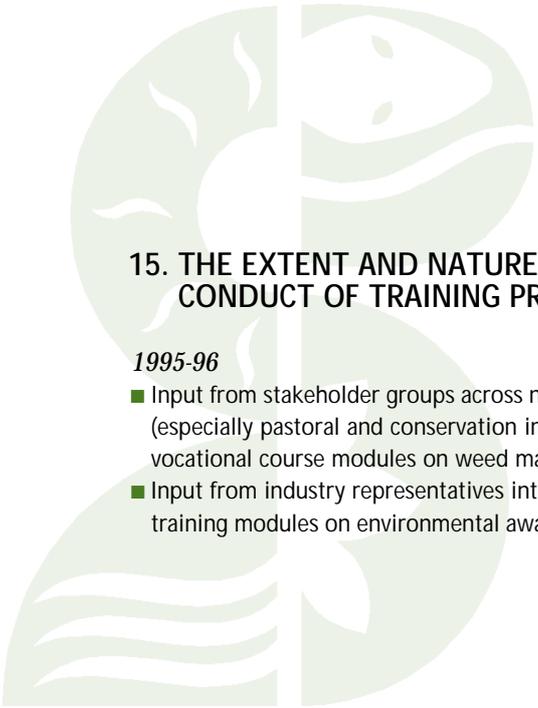
14. THE EXTENT TO WHICH THE EXTENSION SERVICES OF THE CENTRE ARE SUCCESSFUL IN MODIFYING MANAGEMENT PRACTICES WITHIN TROPICAL SAVANNAS

1995-96

- Adoption by significant parts of the northern beef cattle industry of the QDPI *Breedcow* and *Dynama* herd budgeting system.
- Application in northern WA, parts of Qld and in ANCA-managed areas of the NT Parks and Wildlife Commission's biodiversity survey, recording and analysis strategies.

1996-97

- Applications listed in 1995-96 continue to be implemented and adopted.
- Coordinated fire management strategies facilitated by the Centre being adopted incrementally across northern Australia.
- Range of sustainable land planning and skills-based training modules implemented and selected competencies being incrementally incorporated in Savannah Guide management practices.
- Strategic planning advice provided by the Centre selectively incorporated into the Desert Uplands Build-up and Development Strategy.



PERFORMANCE INDICATORS

15. THE EXTENT AND NATURE OF THE INVOLVEMENT OF USERS IN THE DEVELOPMENT AND CONDUCT OF TRAINING PROGRAMS

1995-96

- Input from stakeholder groups across northern Australia (especially pastoral and conservation interests) to vocational course modules on weed management.
- Input from industry representatives into vocational training modules on environmental awareness.

1996-97

- Stakeholders involved in a survey conducted by the Centre of perceived user training needs that highlighted a preference for short practical training modules.
- Sound progress made incorporating user input into vocational course modules on weed management.
- Specific user groups e.g. Savannah Guides Ltd and DUBDSC nominated the type of training modules they considered relevant to their current needs. Action taken to address these needs in training modules conducted and facilitated by the Centre.

APPLICATION OF RESEARCH

16. THE EXTENT TO WHICH AUSTRALIAN AND OVERSEAS INDUSTRY AND USERS ADOPT RESEARCH TECHNOLOGY DEVELOPED BY THE CENTRE

1995-96

- Centre staff are members of national and international steering and planning committees with direct input into recommendations on land management practices, including Australia/Oceania and Regional Australian Committee of IUCN, National Collaboration Project for Indicators on Sustainable Agriculture, National Rangeland Monitoring Program Working Party and the Australian Bureau of Statistics Agricultural Program – User Advisory Group.

1996-97

- Centre participating researchers and educators continue, as members of a wide range of policy advisory committees and working groups, to provide direct input into recommendations on the use of appropriate research technologies that can contribute to better understanding of sustainable land and resource management practices in savanna ecosystems and savanna communities. Increasingly, as outputs from the Centre's research emerge, opportunities are arising for these developing research techniques and associated training products to be incorporated in client activities at the enterprise and regional planning levels.

17. THE EXTENT NATIONALLY AND INTERNATIONALLY TO WHICH CENTRE RECOMMENDATIONS FOR LAND MANAGEMENT PRACTICES ARE ADOPTED

1995-96

More than 20 participating members of the Centre were involved in providing advice which contributes to policy development at national, state and territory level. Boards, committees and advisory groups include:

- Australia/Oceania and Regional Australian Committee of IUCN.
- National Collaboration Project for Indicators on Sustainable Agriculture.
- National Rangeland Monitoring Program.
- Far North Queensland Regional Economic Development Strategy Steering Committee.
- Northern Territory Management Committee of the Environmental Defender's Office.
- Board of Management for the Centre for Tropical Wetlands Management.
- Field Testing Group for the National Collaborative Project on Indicators for Sustainable Agriculture.
- Northern Territory Government Greenhouse Advisory Committee.
- Australian and New Zealand Conservation and Environment Council Migratory Species Network.

- Australian Bureau of Statistics Agricultural Program.
- Technical Advisory Committee for Caring for Country Wetlands Management Initiative.
- Steering Committee for the Control of Mimosa Pigra.
- Kakadu National Park Research Advisory Committee.
- Biodiversity Group of Northern Territory Department of Primary Industry and Fisheries.
- Conservation and Environment Council Wetlands Network.
- Queensland State of the Environment - Land and Soils Panel.

1996-97

- More than 25 participating members of the Centre were involved in providing advice which contributes to policy development at national, state and territory, and local and regional levels. Boards, committees and advisory groups include those listed for 1995-96 and also the following:
- Queensland Landcare and Integrated Catchment Council working parties and advisory groups; Board of the CRC Sustainable Tourism, Management Committee of CINCRM, DUBDSC. (See Table 6, p49).

18. THE EXTENT OF ADVICE AND CONSULTANCY SERVICES PROVIDED TO USERS AND INDUSTRY

1995-96

- Provision of property management planning advice to the pastoral industry.
- Advice to the tourism industry e.g. interpretation of sector management planning and characteristics of outback tourism.
- Consultancy reviews of key research and advisory needs initiated for Aboriginal interests and the mining industry.
- Consolidation of advisory links with the ADF.

1996-97

- Sound initial progress made in the areas listed in 1995-96. As a result, accelerated outputs are expected in outback and savanna bush tourism strategic planning; the identification of further specific Centre research priorities concerning Aboriginal interests, the mining industry and advisory links with the Australian Defence Force.
- Consultancy services provided to the Queensland Department of Tourism, Small Business and Industry.

19. THE LEVEL OF FINANCIAL RETURNS TO SAVANNA USERS STEMMING FROM CENTRE RESEARCH

1995-96

- Establishment of baseline economic data for sectoral interests across the savannas.
- Business strategy being developed to assess market potential for the Centre's products and services.

1996-97

- Value-adding through research outputs from the Centre in terms of financial returns to users will in the longer term contribute to reducing risk and optimising best practice management options at enterprise level and effective policy advice at regional level. Following on from the sectoral economic analysis of the savannas in 1995-96 the production of a comprehensive savanna economic profile is now well advanced. Complementing this, a preliminary Centre business strategy was produced which will be incorporated as part of a business action plan. These actions have set the stage, with other economic analyses, for an appropriate assessment of the Centre's value-adding to savanna users in 1998 and later.

MANAGEMENT AND BUDGET

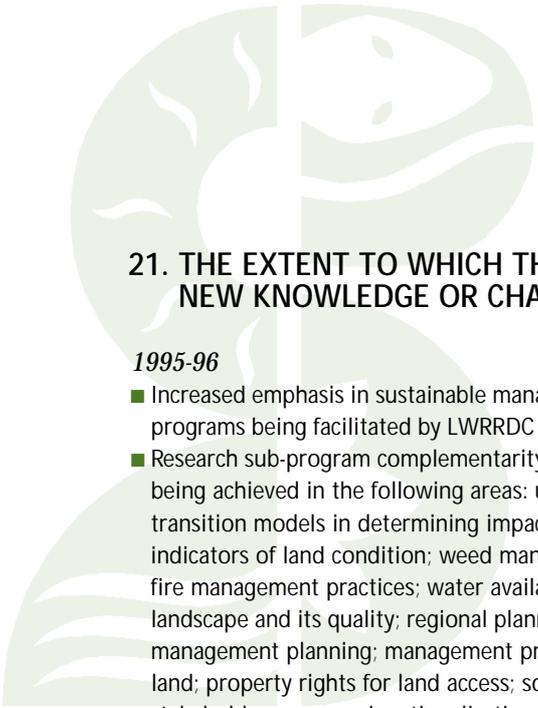
20. THE ESTABLISHMENT OF PROCEDURES TO MONITOR AND REPORT ON RESEARCH PROGRESS AND OTHER ACHIEVEMENTS OF THE CENTRE

1995-96

- Project charters with milestones and performance indicators produced and implemented.
- An annual review process established by SPAEG.
- A register of projects and investigations being developed.
- A communication strategy being developed to report achievements within and outside the Centre.

1996-97

- Updated set of project charters produced and being implemented.
- All major constructive advice received by the Centre from SPAEG incorporated in both project refinements and sub-program structural alignments during the year.
- Initial register of projects and investigations completed and under further development for wider access.
- Initial communication strategy for the Centre and its program developed. The strategy will be used by the newly appointed Communication Coordinator to develop an action plan for communication quality assurance within and external to the Centre.



PERFORMANCE INDICATORS

21. THE EXTENT TO WHICH THE ACTIVITIES OF THE CENTRE ARE MODIFIED IN LINE WITH NEW KNOWLEDGE OR CHANGED EXPECTATIONS OF USERS

1995-96

- Increased emphasis in sustainable management within programs being facilitated by LWRRDC and the MRC.
- Research sub-program complementarity for stakeholders being achieved in the following areas: use of state and transition models in determining impacts of land use; indicators of land condition; weed management practices; fire management practices; water availability in the landscape and its quality; regional planning; property management planning; management practices for public land; property rights for land access; social aspirations of stakeholders; economic rationalisation across regions; impacts of land-use on biodiversity maintenance; minimisation of social effects of change and constraints to multiple land use.
- Education program complementarity for stakeholders being achieved by taking up past work on methods to reform land use; making available research information in appropriate forms; providing information to geographically widespread stakeholders and education programs for savanna management.

1996-97

- The refinements addressed in 1995-96 have, as appropriate, been maintained and further adjusted as required.
- Throughout the year Centre participating researchers and educationalists sought to respond to both new knowledge, professional advice and changes in expectations of users. These modifications saw significant adjustments of approach and structure in Sub-Program 4, and in appropriate ways in other sub-programs. The overall program is considered to have been strengthened by these refinements. The appointment of a number of key staff will strongly complement the implementation of these realignments.

22. THE EXTENT TO WHICH THE ACTIVITIES OF THE CENTRE ARE INTEGRATED ACROSS STATE, TERRITORY AND SECTORAL BOUNDARIES

1995-96

- Research sub-programs are being integrated across state and territory boundaries with respect to biodiversity field survey methods and analysis; property management planning for pastoralists; regional fire management regimes and local authority planning for sustainable land management.
- Sub-Program developments across state and territory boundaries took place in flora and fauna ecology across the NT and Qld; conservation management practices across NT and Qld; internal communication across northern Australia; tourism management across NT and Qld; graduate education programs across NT and Qld; tertiary education programs across NT and WA and economic information compiled across the savannas.
- Sub-Program developments across sectoral boundaries were economic information compiled across sectors; education programs in savanna management across all sectors; savanna hydrology across all sectors; indicators of sustainability across pastoral and conservation interests and social attitudes to land use across settler and non-settler interests.

1996-97

- All integration strategies implemented previously were built on during 1996-97.
- Significant expansion and wider acceptance of regional coordinated fire management programs achieved during 1996-97. An excellent base has been established for major consolidation in coming years.
- Plans in progress to assess the coordination and enhancement of savanna-wide nature-based and culturally-based bush guiding and tourism in the coming year.
- Regional case study methodologies being used to best advantage within a cooperative framework across the savannas.

23. THE ACCURACY OF RECORDING AND REPORTING FINANCIAL TRANSACTIONS, THE BALANCE OF EXPENDITURE AGAINST BUDGET AND THE EFFICIENCY OF THE AUDIT PROCESS

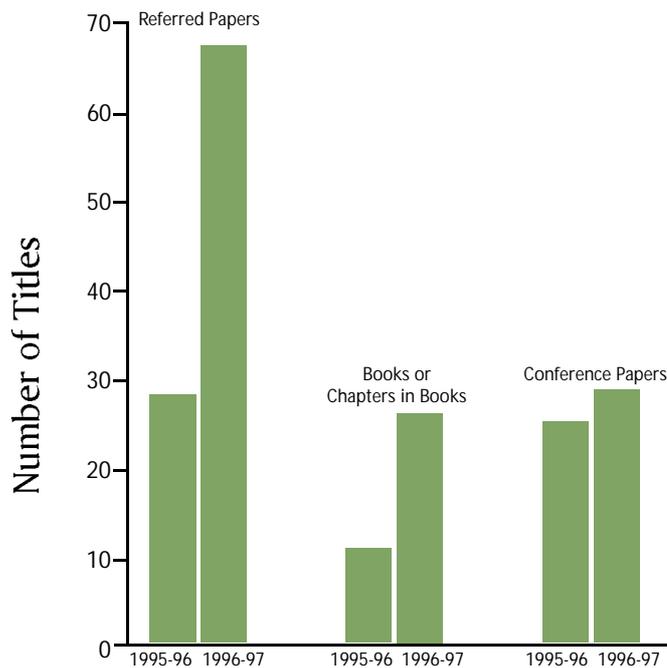
1995-96

- Financial management practices document was prepared to define responsibilities of parties, management agent and auditor.
- Financial staff of parties engaged to ensure efficient transfer of funds to parties and report to the Centre on expenditure quarterly.
- A management agent reports quarterly to the Centre on expenditure against budget.
- Budget accounts maintained and updated regularly.
- The auditor was consulted and was satisfied with the form of financial management practices.

1996-97

- The sound financial management system previously established is now being further refined to maximise efficiency while maintaining efficacy and accountability.
- Centre partners played a significant role in this refinement.
- This process will be overseen and coordinated by the newly appointed business manager during 1998-99.

PUBLICATIONS 1995-96; 1996-97 PERFORMANCE INDICATOR NO.7





FINANCE AND RESOURCES

Independent Auditors' Report to the Cooperative Research Centre Secretariat Department of Industry, Science and Tourism Representing the Commonwealth in Respect of

Cooperative Research Centre for the Sustainable Development of Tropical Savannas

Financial Information for the Year Ended 30 June 1997

SCOPE

We have audited the financial information of the Cooperative Research Centre for the Sustainable Development of Tropical Savannas as set out in Tables 1 to 7 of the Annual Report for the year ended 30 June 1997 as required by clause 13(1)(f) of the Commonwealth Agreement. The parties to the Cooperative Research Centre are responsible for the preparation and presentation of the financial information. We have conducted an independent audit of the financial information in order to express an opinion on it to the Commonwealth.

Our audit has been conducted in accordance with Australian Auditing Standards to provide reasonable assurance as to whether the financial information is free of material misstatement. Our procedures include examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial information, and the evaluation of accounting policies and significant accounting estimates. These procedures have been undertaken to form an opinion as to whether in all material respects, the financial information is presented fairly in accordance with Australian accounting concepts and standards and requirements of the Commonwealth Agreement so as to present a view of the sources of funding and the application of funding of the Cooperative Research Centre for the Sustainable Development of Tropical Savannas and the application of which is consistent with our understanding of its financial activities during the year and its financial position.

While we have not performed any audit procedures upon the estimates for the next period and do not express any opinion thereon, we ascertained that they have been formally approved by the Board of Management as required under the Joint Venture Agreement.

AUDIT OPINION

In our opinion, the financial information presented in Tables 1 to 7 presents fairly the sources of funding, the application of funding and the financial position of the Cooperative Research Centre for the Sustainable Development of Tropical Savannas for the year ended 30 June 1997 in accordance with Australian accounting concepts and applicable Accounting Standards, the CRC Secretariat's Guidelines for Auditors, and the requirements of the Commonwealth Agreement in terms of Clauses 4 (Contributions), 5(1), 5(2), 5(3) (Application for Grant Contributions), 9(1), 9(5) (Intellectual Property) and 12 (2) (Financial Provisions).

1. The multipliers adopted by the Centre to value in-kind contributions other than salary costs have a sound and reasonable basis and each partner's components of the Researchers Contributions for the year under report has been provided at least to the value for that year committed in the Budget as specified in the Agreement, with the following exceptions:

Organisation	Amount Committed (\$'000)	Amount Provided (\$'000)
Northern Territory University	1 226.6	1 199.6
Australian National University	390.6	211.8
James Cook University	387.7	295.8
Department of CALM (WA)	290.3	45.9
Agriculture WA	420.4	247.7
State of Queensland	985.2	495.6
Northern Territory of Australia	1 815.4	1 758.3
Commonwealth Scientific and Industrial Research Organisation	695.5	517.8

and the total value of all Contributions for the year under report equalled or exceeded the amount of grant paid during the year (not including advances).

2. The researcher has used the Grant and the researchers Contributions for the Activities of the Centre and in our professional opinion there appears to be no material reporting irregularities.

3. In the case of all Heads of Expenditure the researchers allocations of the budgetary resources has varied from the allocation in the budget by \$100 000 and/or 20%. No prior approval by the Commonwealth has been obtained.

4. Capital Items acquired from the Grant and researchers Contributions are vested as provided in the Joint Venture Agreement.

5. A statement signed by the Director or Board Chair, to the effect that Intellectual Property in all Contract Material is vested as provided in the Joint Venture Agreement and no Intellectual Property has been assigned or licensed without prior approval of the Commonwealth, has been seen by us.

6. Proper accounting standards and controls have been exercised in respect of the Grant and researchers Contributions and income and expenditure in relation to the Activities of the Centre have been recorded separately from other transactions of the Researcher, except for the Parks and Wildlife Research body within the Northern Territory of Australia, where a material variance exists between expenditure reported to the Centre and the internal records of the Research body.

Date: 4 November, 1997

KPMG
Chartered Accountants



Mark S Wilson
Partner

4 November, 1997

Mr Tony Hill
Director CRC SEcretariat and Policy Section
CRC Secretariat
GPO Box 9839
Canberra City ACT 2601

Dear Mr Hill

It is my belief that the appropriate multipliers set out in Schedule 4 of the Commonwealth Agreement have been applied consistently. In the opinion of the Directors of the CRC for the Sustainable Development of Tropical Savannas the financial information set out in the budget is drawn up to give a true and fair view of the sources of funding and application of funding for the year ending 30 June 1997, and in terms of clauses 5.2, 5.3, 9.1, 9.5, of the Commonwealth Agreement.

The financial information has been made out in accordance with applicable Australian accounting standards.

Signed in accordance with a resolution of the Directors.

Yours sincerely

Charles Webb
Acting Director
(from May 1997 - July 1997)



FINANCE AND RESOURCES

TABLE I RESEARCH STAFF RESOURCES

<i>Name</i>	<i>Employer</i>	<i>Activity</i>	<i>SP1</i>	<i>SP2</i>	<i>SP3</i>	<i>SP4</i>	<i>Tot Res</i>	<i>Educn</i>	<i>Comm</i>	<i>Admin</i>
NORTHERN TERRITORY UNIVERSITY										
W Ahmad	NTU	R	32		7.5		39.5			
G Hill	NTU	R	20	5	7.5		32.5	30.0		
D Eamus	NTU	R	32				32.0	5.0		
P Tremblay	NTU	R				30	30.0			
R Vemuri	NTU	R				30	30.0			
C Noske	NTU	R		20			20.0			
J Stevens	NTU	R				20	20.0			
B Tuck	NTU	R				20	20.0			
A Kruchkoff	NTU	R				20	20.0			
A Powell	NTU	R				20	20.0			
F Dawson	NTU	R				20	20.0			
G Duff	NTU	R	10				10.0	30.0		
P McConvell	NTU	R				10	10.0			
P Hiscock	NTU	R				10	10.0			
C Healley	NTU	R				5	5.0			
P Reynolds	NTU	R				5	5.0			
A Arnott	NTU	E						25.0		
A Barnaart	NTU	E						10.0		
J Cameron	NTU	E						15.0		
G Shaw	NTU	E						15.0		
G Wearne	NTU	E						30.0		
P Wignell	NTU	E						15.0		
G Williams	NTU	E						20.0		
R Young	NTU	E						15.0		
A Byrne	NTU	E						5.0		
A Cowie	NTU	E						2.0		
B Devlin	NTU	E						15.0		
TOTAL			94	25	15	190	324	232		
AUSTRALIAN NATIONAL UNIVERSITY										
D Rose	ANU	R			55	55				
G Crough	ANU	R				50	50			
P Sullivan	ANU	R				20	20			
C Fletcher	ANU	R				10	10			
TOTAL						135	135			
CALM										
G Waredell-Johnson	CALM	R		100			100			
G Graham	CALM	R		50			50			
N McKenzie	CALM	R		10			10			
K Morris	CALM	R		10			10			
N Burrows	CALM	R		5			5			
TOTAL				175			175			

TABLE I (CONTINUED)

<i>Name</i>	<i>Employer</i>	<i>Activity</i>	<i>SP1</i>	<i>SP2</i>	<i>SP3</i>	<i>SP4</i>	<i>Tot Res</i>	<i>Educn</i>	<i>Comm</i>	<i>Admin</i>
JAMES COOK UNIVERSITY										
A Kutt	JCU	R		37			37			
N Black	JCU	R				25	25			
B Guy	JCU	R				18	18			
J Rutledge	JCU	R				10	10			
J Monaghan	JCU	R				10	10			
T Nevard	JCU	R				20	20			
B Scott	JCU	R		8			8			
J Luly	JCU	R		6			6			
C Johnson	JCU	R		5			5			
D King	JCU	R				5	5			
R Monypenny	JCU	R				1	1			
C Gardiner	JCU	E						10		
R Coventry	JCU	E						6		
G Arger	JCU	E						5		
L Fitzpatrick	JCU	E						2		
B White	JCU	E						2		
P Arlett	JCU	A								6
TOTAL				56		89	145	25		6
AgWA										
A. Craig	Ag WA	R	30	30	20		80			
P. Novelly	Ag WA	R	10		30	10	50			
E. Jack	Ag WA	R				20	20			
TOTAL			40	30	50	30	150			
QLD										
T Stanley	QDNR	R			10		10			
A Lindsay	QDNR	R			25		25			
J Vitelli	QDNR	R			20	20	40			
W Palmer	QDNR	R			5		5			
M Keir	QDNR	R			20		20			
S Campbell	QDNR	R				20	20			
R Hynes	QDNR	A								20
P O'Reagain	QDPI	R				50	50			
M Quirk	QDPI	R				50	50			
J Kernot	QDPI	E				25	25			
K Shaw	QDPI	E				25	25			
B Shepherd	QDPI	E				25	25			
P Smith	QDPI	E				25	25			
L Wicksteed	QDPI	E				10	10			
TOTAL					80	250	330			20
NT										
G Kirby	NTDPIFR					50	50			
A Cowie	NTDPIF	R			30		30			
N MacDonald	NTDPIF	R			30		30			
M Ashley	NTDPIF	R			30		30			
R Andison	NTDPIF	R				30	30			
R Dyer	NTDPIF	R	25				25			
N Campbell	NTDPIF	R				20	20			
D Parker	NTDPIF	E						25		
D Pidsley	PAWA	R	21				21			
D Bowman	PWCNT	R		75			75			

FINANCE AND RESOURCES

TABLE I (CONTINUED)

<i>Name</i>	<i>Employer</i>	<i>Activity</i>	<i>SP1</i>	<i>SP2</i>	<i>SP3</i>	<i>SP4</i>	<i>Tot Res</i>	<i>Educn</i>	<i>Comm</i>	<i>Admin</i>
NT (CONT.)										
M McNelly	PWCNT	R		50			50			
J Woinarski	PWCNT	R		50			50			
A Fisher	PWCNT	R		50			50			
P Whitehead	PWCNT	R		30			30			
G Allan	PWCNT	R		25			25			
D Liddle	PWCNT	R		20			20			
W Andrew	PWCNT	R		10			10			
D Choquenot	PWCNT	R		10			10			
M Butler	PWCNT	R		10			10			
R Karfs	NTDLPE	R			100		100			
J Motha	NTDLPE	R			100		100			
D Lynch	NTDLPE	R			100		100			
M Dilshad	NTDLPE	R			70		70			
A Cowie	NTDLPE	R			50		50			
R Applegate	NTDLPE	R			30		30			
P Brocklehurst	NTDLPE	R		10			10			
E Hosking	NTDLPE	R			5		5			
Total			46	340	545	100	1031	25		
BIODIVERSITY GROUP - ENVIRONMENT AUSTRALIA										
J Russell-Smith	PWCNT	R		100			100			
D Franklin	PWCNT	R		80			80			
T Griffiths	PWCNT	R		60			60			
P Dostine	PWCNT	R		50			50			
B Oliver	PWCNT	R		30			30			
P Barrow	PAN	R		15			15			
G Fien	PAN	R		5			5			
Total				340			340			
CSIRO										
J Brown	TAG	R			10		10			
A Andersen	W&E	R	10		50		60			
G Cook	W&E	R	40				40			
R Williams	W&E	R	50		10		60			
D Tongway	W&E	R	10		10		20			
M Stafford-Smith	W&E	R	10				10			
J Holt	L&W	R			25		25			
Total			120		105		225			
CRC FUNDED										
T Churchill	W&E	R			100		100			
L Hutley	NTU	R	100				100			
D Lynch	NTDLPE	R			100		100			
J Ludwig	W&E	R	80				80			
D Cheal	NTPWC	R		50			50			
H Davis	NTU	R				20	20			

TABLE I (CONTINUED)

Name	Employer	Activity	SP1	SP2	SP3	SP4	Tot Res	Educn	Comm	Admin
CRC FUNDED (CONT.)										
M Forster	JCU	R				20	20			
I Radford	TAG	R			20		20			
S Setterfield	NTU	E						100		
R Benson	NTU	E						50		
P West	CSIRO	A								100
R Hynes	JCU	A								100
Total			180	50	220	40	490	150		200
Grand Total Research Staff Contributed			SP1	SP2	SP3	SP4	Total res	Educn	Comm	Admin
			480.0	1016.0	1015.0	834.0	3345.0	432.0		226.0

TABLE II SUMMARY OF PROFESSIONAL STAFF CONTRIBUTIONS (PERSON YEARS)

	Total	Research Sub-program					Total on Research	Educn	Comm	Admin
		1	2	3	4					
Total Contributed	31.6	3.0	9.7	8.0	7.9	28.6	2.8		0.3	
CRC Funded	8.4	1.8	0.5	2.2	0.4	4.9	1.5		2.0	
Grand Total	40.0	4.8	10.2	10.2	8.3	33.5	4.3		2.3	
Proportion of staff in each activity (%)	100	12	25	25	21	85	11		6	

TABLE III SUPPORT STAFF

CONTRIBUTED		CRC FUNDED	
Organisation	Person Years	Organisation	Person Years
JCU	0.17	NTU	1.0
NTDPIF	0.90	W&E	3.1
PAWA	1.16	TAG	1.0
PWCNT	4.30	JCU	1.1
PAN	1.00	LP&E	1.0
NTDLP&E	2.00		
QDNR	0.20		
Total	9.73	Total	7.2

FINANCE AND RESOURCES

TABLE IV IN-KIND CONTRIBUTIONS FROM PARTNERS (\$'000)

Partner	Actual		Cumulative total to date			Projected					Total
	95/96	96/97	Agree- ment 96/97	Actual	Agree- ment	97/98	98/99	99/00	00/01	01/02	
NORTHERN TERRITORY UNIVERSITY											
Salaries	542.0	515.0	346.9	1057.0	693.8	440.0	435.0	423.0	405.0	405.0	3165.0
Capital											
Other	683.0	651.3	846.4	1334.3	1692.8	555.7	549.8	533.9	511.3	511.3	3996.3
TOTAL	1225.0	1166.3	1193.3	2391.3	2386.6	995.7	984.8	956.9	916.3	916.3	7161.3
AUSTRALIAN NATIONAL UNIVERSITY											
Salaries	91.4	91.4	130.2	182.8	260.4	95.9	98.8	101.8	104.1	106.9	690.3
Capital											
Other	121.0	120.4	260.4	241.4	520.8	125.7	129.5	133.4	137.4	141.5	908.9
TOTAL	212.4	211.8	390.6	424.2	781.2	221.6	228.3	235.2	241.5	248.4	1599.2
JAMES COOK UNIVERSITY											
Salaries	97.4	131.7	120.4	229.1	240.8	131.7	131.7	131.7	131.7	131.7	887.6
Capital											
Other	146.2	114.1	216.7	260.3	433.4	114.1	114.1	114.1	114.1	114.1	830.8
TOTAL	243.6	245.8	337.1	489.4	674.2	245.8	245.8	245.8	245.8	245.8	1718.4
DEPARTMENT OF CALM, WA											
Salaries	67.4	24.0	135.0	91.4	270.0	8.8	8.8	8.8	8.8	8.8	135.4
Capital											
Other	61.3	21.9	155.3	83.2	310.6	8.0	8.0	8.0	8.0	8.0	123.2
TOTAL	128.7	45.9	290.3	174.6	580.6	16.8	16.8	16.8	16.8	16.8	258.6
AGRICULTURE WA											
Salaries	163.5	131.9	186.0	295.4	372.0	131.9	131.9	131.9	131.9	131.9	954.9
Capital											
Other	111.4	115.8	234.4	227.2	468.8	115.8	115.8	115.8	115.8	115.8	806.2
TOTAL	274.9	247.7	420.4	522.6	840.8	247.7	247.7	247.7	247.7	247.7	1761.1
STATE OF QUEENSLAND											
Salaries	217.3	196.4	364.9	413.7	729.8	196.4	196.4	196.4	196.4	196.4	1395.7
Capital											
Other	269.5	279.2	620.3	548.7	1240.6	279.2	279.2	279.2	279.2	279.2	1944.7
TOTAL	486.8	475.6	985.2	962.4	1970.4	475.6	475.6	475.6	475.6	475.6	3340.4

TABLE IV (CONTINUED)

Partner	Actual		Cumulative total to date			Projected					
	95/96	96/97	Agree- ment 96/97	Actual	Agree- ment	97/98	98/99	99/00	00/01	01/02	Total
NORTHERN TERRITORY OF AUSTRALIA											
Salaries	704.8	959.6	852.3	1664.4	1704.6	951.9	951.9	951.9	951.9	951.9	6423.9
Capital											
Other	1037.5	798.7	963.1	1836.2	1926.2	784.0	784.0	784.0	784.0	784.0	5756.2
TOTAL	1742.3	1758.3	1815.4	3500.6	3630.8	1735.9	1735.9	1735.9	1735.9	1735.9	12180.1
BIODIVERSITY GROUP - ENVIRONMENT AUSTRALIA											
Salaries	102.2	170.7	21.8	272.9	43.6	187.3	187.3	187.3	187.3	187.3	1209.4
Capital											
Other	166.4	91.3	33.6	257.7	67.2	97.0	97.0	97.0	97.0	97.0	742.7
TOTAL	268.6	262.0	55.4	530.6	110.8	284.3	284.3	284.3	284.3	284.3	1952.1
CSIRO											
Salaries	273.9	199.5	214.0	473.4	428.0	201.9	192.5	193.2	193.8	193.8	1448.6
Capital											
Other	455.9	318.3	481.5	774.2	963.0	321.4	306.4	307.4	308.4	308.4	2326.2
TOTAL	729.8	517.8	695.5	1247.6	1391.0	523.3	498.9	500.6	502.2	502.2	3774.8
Total in-kind contributions											
Salaries	2259.9	2420.2	2371.5	4680.1	4743.0	2345.8	2334.3	2326.0	2310.9	2313.7	16310.8
Capital											
Other	3052.2	2511.0	3811.7	5563.2	7623.4	2400.9	2383.8	2372.8	2355.2	2359.3	17435.2
GRAND TOTAL	5312.1	4931.2	6183.2	10243.3	12366.4	4746.7	4718.1	4698.8	4666.1	4673.0	33746.0



FINANCE AND RESOURCES

TABLE V CASH CONTRIBUTIONS AND EXPENDITURE '000

	<i>Actual</i>		<i>Cumulative total to date</i>			<i>Projected</i>					
	95/96	96/97	Agree- ment 96/97	Actual	Agree- ment	97/98	98/99	99/00	00/01	01/02	Total
Partners											
Northern Territory University	33.3	33.3	33.3	66.6	66.6	33.4					100.0
James Cook University		50.0	50.0	50.0	100.0	50.0					100.0
Environment Australia		25.0		25.0							25.0
State of Queensland	15.9	20.0		35.9		20.0	20.0	20.0	20.0	20.0	135.9
Total cash from participants	49.2	128.3	83.3	177.5	166.6	103.4	20.0	20.0	20.0	20.0	360.9
Other	8.4	52.0		60.4		10.0	10.0	10.0	10.0	10.0	110.4
Funding from the CRC grant	1217.7	2594.6	2500.0	3812.3	3700.0	2612.9	2691.3	2772.0	2855.2	2940.8	17684.5
Total CRC Cash contribution	1275.3	2774.9	2583.3	4050.2	3866.6	2726.3	2721.3	2802.0	2885.2	2970.8	18155.8
Cash carried over		512.2				1311.3	1657.6	136.5	103.4	49.8	
Less unspent balance	512.2	1311.3		1311.3		1657.6	136.5	103.4	49.8		
Total Cash expenditure	763.1	1975.8	2583.3	2738.9	3866.6	2380.0	4242.4	2835.1	2938.8	3020.6	18155.8
ALLOCATION OF CASH BETWEEN HEADS OF EXPENDITURE											
Salaries	334.7	1106.1	1380.9	1440.8	2023.2	1538.8	1618.6	1577.5	1504.3	1440.5	9120.5
Capital			200.0		200.0						
Other	428.4	869.7	1002.4	1298.1	1643.4	841.2	2623.8	1257.6	1434.5	1580.1	9035.3

TABLE VI SUMMARY OF RESOURCES APPLIED TO ACTIVITIES OF CENTRE

	<i>Actual</i>		<i>Cumulative total to date</i>			<i>Projected</i>					
			Agree- ment	Actual	Agree- ment						
	95/96	96/97	96/97			97/98	98/99	99/00	00/01	01/02	Total
Grand Total (In-kind)	5312.1	4931.2	6183.2	10243.3	12366.4	4746.7	4718.1	4698.8	4666.1	4673.0	33746.0
Grand Total (Cash Expenditure)	763.1	1975.8	2583.3	2738.9	3866.6	2380.0	4242.4	2835.1	2938.8	3020.6	18155.8
Total Resources applied to activities of Centre	6075.2	6907.0	8766.5	12982.2	16233.0	7126.7	8960.5	7533.9	7604.9	7693.6	51901.8
ALLOCATION OF TOTAL RESOURCES BETWEEN HEADS OF EXPENDITURE											
Total Salaries (Cash and In-kind)	2594.6	3526.3	3752.4	6120.9	6766.2	3884.6	3952.9	3903.5	3815.2	3754.2	25431.3
Total Capital (Cash and In-kind)			200.0		200.0						
Total Other (Cash and In-kind)	3480.6	3380.7	4814.1	6861.3	9266.8	3242.1	5007.6	3630.4	3789.7	3939.4	26470.5

TABLE VII ALLOCATION OF RESOURCES BETWEEN CATEGORIES OF ACTIVITIES

<i>Program</i>	<i>Cash \$'000</i>	<i>In-kind \$'000</i>	<i>Contributed Staff (Person yr)</i>	<i>Staff funded by CRC (Person yr)</i>
Research	1016.3	4260.6	31.8	4.9
Education	308.1	639.5	2.8	1.5
Commercialisation				
Administration	651.4	31.1	0.3	2.0
Total	1975.8	4931.2	34.9	8.4

APPENDIX

MILESTONES

PROJECT 1.1

Extension of the current NATT to include sites in the southern June 1997.

Development of system to predict tree cover using Synthetic Aperture Radar by June 1997.

Progress report submitted to LWRDC, on relationships between vegetation structure and composition in relation to environmental and disturbance gradients by October 1997.

Establishment of reference 1 ha sites in conjunction with Sub-Programs 2 & 3 by December 1997.

Characterisation of nutrient status of soils at core NATT sites by December 1997.

Completion of assessment of landscape patchiness (barriers to the broadscale movement of water across the landscape) at core NATT sites by December 1997.

Preliminary system to use soil surface condition as a predictor of nutrient availability by December 1997.

Provision of ecological data to other Sub-programs and GCTE (as required) by December 1997.

Testing of the GCTE climate-vegetation process model with NATT data by December 1997.

Replicate 1 ha plots established at five current Kimberley (WA) and Northern Territory by NATT sites. Additional 1 ha NATT reference sites established on sand, loam and clay soils at five more locations.

Composite image from four LANDSAT scenes constructed for NATT. Additional SAR data collected from NASA 1996 mission.

Interim report due December 1997. One paper published, one in press and one in review. All manuscripts to form part of final LWRDC Report.

Faunal surveys (with Project 2.1 and Project 3.2) undertaken at five NATT sites.

Initial analyses of the nutrient status of soils beneath perennial grass tussocks and in inter-tussock areas started.

Landscape function analysis along 100m transects completed for all current 1ha NATT sites. One paper submitted to *Landscape Ecology*.

Work in preliminary stages. Proposal to investigate the relationship between Nitrogen availability and vegetation composition on clay soils in the VRD was submitted.

Four papers published on phenology and water relations in conjunction with Project 1.2. Fauna surveys (Project 2.1; Project 3.2) undertaken. Joint PhD student project with Sub-Program 2. Participation of Project 1.1 staff in North Australian Fire managers workshop, June 1996. Visit by Mr Peter Dowty, UVirginia, who is working on GCTE Kalahari Transect. Joint PhD Project with Professor Graham Farquar (GCTE member). Joint BSc Honours Project with Professor Greg Hill, Sub-Program 5.

Preliminary work begun on GIS of NATT. Data being compiled by various NT and Commonwealth agencies.

PROJECT 1.2

A quantitative assessment of daily and seasonal water use by eucalypt woodlands

Publication of work undertaken to assess water use by individual trees of a savanna woodland

A comparison of applicability and accuracy of models of vegetation water use of a savanna woodland

Application of eddy correlation techniques for the determination of wet and dry season canopy water use of savanna woodlands

Application of sap flow measurement techniques for the determination of individual tree water use in paperbark and monsoon vine forest ecosystems

Completion of reports and newsletter articles on grass-tree competition and pastoral production. (Rodd Dyer)

Field installation of eddy covariance (EC) equipment and initial measurements of canopy water flux at the Howard River East field site. Research undertaken to estimate seasonal patterns of water use at tree, stand and community level at Howard River East research catchment.

One paper published (Hutley, Doley, Yates and Boonsaner); two papers submitted (O'Grady, Eamus and Duff; Cook, Hatton, Pidsley, Herczeg, Held and O'Grady); one conference paper (O'Grady, Eamus and Duff); one technical manual (Hatton, Pidsley, Held, Reece, Richardson, Kerle & O'Grady).

Literature search and assessment of water flux models. Some published models assessed.

Purchase, familiarisation and development of field installation of eddy covariance (EC) equipment and initial measurements of canopy water flux at the Howard River East field site.

Sap flux and water relations measurements made in a swamp/paperbark community. Above average wet season rainfall prevented site access to monsoon vine forest community.

Four sites set up in the Victoria River and Katherine districts to determine overstorey and understorey interactions in naturally densely treed and cleared areas. Initial data collected for the sites over one or two wet seasons. Data from first growing season run through GRASP model for two sites. Second season data being prepared for analysis.

PROJECT 2.1

Procedures and protocol for shared field sites and complementary data collection and exchange established with other Sub-Programs by June 1997

Existing relevant State/Territory databases collated, where possible by June 1997

Sampling undertaken in at least 300 quadrats, including at least 30 fire-monitoring sites by June 1997.

Overview of distribution and reservation status of plants and vegetation (in the Top End) completed and submitted for publication by June 1997

Field work for survey of Mitchell grasslands wildlife completed by June 1997.

Sampling of NATT sites commenced by June 1997.

Mitchell grassland survey sites all shared with Sub-Program 3. Various invertebrate taxa sampled at these sites contributing to Sub-Program 3. NATT sites shared with Sub-Programs 1 and 3. Northeast Arnhem Land field sites, trips, protocol and data shared with Sub-Program 4.

Relevant NT data bases collated. Problems remain with collation of Queensland and WA databases.

More than 300 quadrats sampled for vertebrates.

Paper on distribution and reservation status of NT plants published in *Australian Journal of Botany*.

Two years' field sampling completed May 1997. Approximately 100 sites from 12 locations sampled in two seasons.

Vertebrates sampled during April/May 1997 at five original NATT sites. At each location two replicate sites on each of three soil types were sampled.

PROJECT 2.1 (CONTINUED)

Fieldwork for survey of chenopod shrublands commenced by Dec 1997.

Analysis of distributional patterns of fauna in Mitchell grasslands completed by Dec 1997.

Sampling of NATT sites completed by Dec 1997.

Analyses of historic changes in distribution or status of savanna wildlife commenced by Dec 1997.

Ongoing. Reconnaissance survey of chenopod shrublands on Barkly Tableland took place in June. Further sampling scheduled for Oct/Nov 1997.

Analyses of distribution patterns commenced in June 1997, to be completed October 1997

Sampling of all five original NATT sites completed.

May start by Dec 1997

PROJECT 2.2

Acceptance of draft management program for the Gouldian Finch by NT Government

Completion of GIS coverages of relevant habitat features at 4 major study sites

Protocols for construction of models of grassland dynamics agreed and work commenced

Procedures for complementary data collection and exchange operating to satisfaction of all participants.

Study sites established on all land use types.

Sampling methodologies adequately tested and details submitted for publication

Publication of details of grassland typology

Paper on habitat associations of assemblages of granivorous birds submitted to refereed journal (in association with Project 2.1).

Review of conservation status of grassland birds and threatening processes completed and accepted for publication.

Species Recovery Plan was prepared and is being considered by the National Gouldian Finch Recovery Team.

Coverages of geology, broad scale vegetation mapping, and topography being assembled for identification of features common to sites still occupied by Gouldian Finches. Satellite imagery being assembled.

Experimental approach to determine impact of fire and grazing on dynamics of savanna grasslands developed. Application to begin during 1998.

Addressed chiefly under Project 2.1. Data relating to distribution and abundance of fauna being collected to a consistent protocol and, where feasible, study sites shared.

Addressed chiefly under Project 2.1. Data relating to distribution being collected to consistent protocol and, wherever feasible, study sites are shared.

Partridge pigeon sites established on grazed and ungrazed lands, subjected to a range of fire treatments. Descriptions of relevant habitat attributes completed across these various management regimes. Attributes will be compared with characteristics of sites used by a substantial sample of radio-tagged birds to identify preferred habitat types and attributes. Gouldian Finch breeding sites subject to intensive study include lands used predominantly for pastoralism, ungrazed areas associated with a major mining venture, and Aboriginal lands.

Field component of a study of wet and dry season habitat use by Gouldian finches completed. Papers dealing with similar issues as they affect the status of the Endangered Golden-Shouldered Parrot in Cape York prepared.

This work is being undertaken in association with milestone below.

Contemporary and historical records assembled. Biogeographic patterns described. Scheduled for completion during 1997.

PROJECT 2.3

Desk survey of riparian systems including draft publication of results
Identification of study sites in WA and NT

Initial descriptive floristic and faunal surveys of sites

Characterisation of riparian habitats

Submission of publication on distribution and characteristics of riparian habitats in the savannas

Completion of initial floristic and faunal surveys of riparian habitats

GIS's relevant to this task aggregated. Analysis yet to begin

Sites selected and under consideration. Final selections will not be made until staffing arrangements finalised with CALM

Sampling completed at a number of NT water sampling sites. Completion deferred until situation with regard to CALM settled

This milestone will not be met until all study sites were identified and surveyed

To be completed on finalisation of CALM staffing arrangements

Deferred pending finalisation of arrangements with CALM

PROJECT 2.4

Preliminary report on consultation with stakeholders on fire management and monitoring needs

Have prepared fire history maps for significant parts of the savannas

Have established a number of monitoring plots to assess impacts

Have established maps of some sensitive target communities and assessed the ability to map them from satellite data

Substantial progress. Preliminary report due end of calendar 1998.

Established. Broad-scale NOAA-AVHRR being conducted over NT and WA. Plans for Qld under way. Localised regional fire mapping with Landsat undertaken in WA, NT and Qld.

Established and undergoing further development.

Funding proposal which will assist in achieving this at the broad northern Australian scale, was submitted to LWRRDC.

PROJECT 3.1

Review methods and findings of the previous National Landcare Program (NLP) land resource monitoring project. Establish approximately 30 monitoring research sites on Victoria River Downs and undertake a detailed assessment of each site utilising existing land condition assessment methodology.

Commence establishment of research monitoring sites over properties adjacent to Victoria River Downs. Complete at least 15 properties in the Victoria River District by the end of 1997.

Convert all ground data collected at monitoring sites since 1995 into a digital format. A database developed and up to date.

Apply image processing techniques to adjacent LANDSAT scenes and complete production of image maps over the Victoria River District. Vegetation classification and coordination of data from established sites in the Victoria River District.

Thirty-three sites established. Assessment undertaken of each site in 1995, 1996. Time series image analysis techniques developed by CSIRO used for assessing indicators.

Ground-based research monitoring sites been established on four adjacent properties to Victoria River Downs.

Vegetation, soil and landscape data for all sites entered into database. New site data can be rapidly incorporated. 1993 DLPE floristic and soil pit data linked to database. Soil surface database using Excel under development.

Rectification, registration and calibration of the Landsat scene located south of the VRD scene completed. Dataset comprising 11 years of digital MSS imagery produced.

Fifty-one monitoring sites and 71 representative land resource survey sites classified into seven range types

PROJECT 3.1 (CONTINUED)	
Refine Carbon Management Index (CMI) for application to Northern Territory soils and analyse samples from Victoria River District monitoring sites.	Method of Blair, Lefroy and Lisle tested for applicability to tropical savanna soils. Chemical analysis of soils from a range of management regimes completed.
Collaboration between NTDLPE and Ag WA on the standardisation of Surface Soil Assessment techniques across state and territory boundaries.	Collaboration between DLPE and Ag WA ongoing. Refinements made to Surface Soil Condition Assessment technique.
Collaboration between NTDLPE, Ag WA and CSIRO Mathematical and Information Sciences to register and calibrate four adjacent Landsat scenes simultaneously. These four scenes cover both Western Australia and the Northern Territory centred approximately along the border.	Historical Landsat MSS data over four image scenes covering NT-WA border rectified, registered and calibrated. Four-scene calibrated base image mosaic produced by Ag WA in collaboration with CSIRO and NTDLPE.
Conduct meetings with relevant Queensland organisations directed towards creating cooperative links similar to those established between NTDLPE & Ag WA.	NTDLPE and Ag WA staff attended MRC workshop. Proceedings will provide framework for future action. Preliminary discussion with relevant Queensland personnel to initiate links between Qld,WA and NT took place. Visit by Project staff to key agencies and personnel targeting Qld rangeland monitoring programs planned for 1997/98.
Develop collaboration between Northern Territory Department of Primary Industries and Fisheries (NTDPIF) and the Environmental Research Institution of the Supervising Scientist (ERISS) to evaluate the CMI methodology for Northern Territory soils.	Collaboration between NTDPIF and ERISS did not eventuate due to instrumentation difficulties. Collaboration now occurring between University of New England to test CMI methodology.
Provision of regional assessment of land condition for incorporation in the first report on the sustainability of Australian agriculture by the National Collaborative Project on Indicators for Sustainable Agriculture.	Dry Season Greenness Index developed for regional assessment of land condition in rangelands.
Incorporation of regional rangeland assessment in the National Rangeland Monitoring Program (NRMP) and report on the condition of NT rangeland for NT State of the Environment report (SoE).	VRD Rangeland assessment results will be incorporated into broader reporting on state of NT rangelands. Information will be incorporated into the NRMP. Information is also a valuable dataset to SoE reporting.
PROJECT 3.2	
Preliminary analysis of the distribution of selected invertebrates in relation to variation in rainfall, soil and vegetation along NATT	Invertebrates sampled at all NATT sites on two occasions and a census taken of grasshoppers. Spiders sorted to family. Sorting of ants, beetles and grasshoppers to species progressing.
Completion of sorting and analysis of methodology trials	Manuscript in preparation.
Completion of sorting and analysis of ants from Mitchell grassland grazing trials	Ants identified to species. Preliminary analyses completed.
PROJECT 3.3	
Finalise the collaborative arrangement with the CRC for Weed Management Systems and employ Post Doctoral Fellow to carry out the analysis by December 1996	Collaborative arrangement with CRC for Weed Management Systems unsuccessful. Post-doctoral position jointly funded CRC and CSIRO.
Develop a computer based Geographic Information System of <i>Cryptostegia grandiflora</i> (rubbervine) distribution, soil property distribution, infrastructure and topography in two sub-catchments by June 1997	GIS for Balfes Creek Catchment and Fletcher Creek Catchment operational.
Develop a mechanistic model of <i>Cryptostegia</i> invasion patterns based on dispersal attributes, habitat suitability and climatic patterns by June 1997	Partially achieved. Small area (less than <1 ha) models developed for <i>Cryptostegia</i> habitat suitability.
Using the models developed in 2 and 3, test alternatives for management of <i>Cryptostegia</i> at the sub-catchment (<500,00ha) scale in two areas by December 1997	On track for achievement. Components of milestones 1-4 are complete and available for use, however the target date is more likely to be June 1998.
Integrate the population biology, dispersal systems, habitat quality and climate variability data into the spatial model	Field data collected and algorithms written. On target for achievement. Likely target date is December 1998.
Make a preliminary test of the model to evaluate different weed control strategies for ecological and economic efficacy	On track for a post-1999 target date.
PROJECT 4.1	
Appointment of a half-time information technology facilitator	Information facilitator appointed.
Negotiate data access agreement in collaboration with Bibliographic and Research Database consultants	Part one of report on database complete. Findings being analysed.
Facilitation of Internet access to all Centre staff	Modems and connections to ISPs purchased for members with no Internet access. Project to allow users with limited Internet access to retrieve remote HTML web pages completed
Complete catalogue of modellers, tools and data specifications	Delayed due to staff shortages.
Develop WWW pages through liaison with sub-Program 4 and 5	Development of WWW site for the centre completed.
Implement early version of virtual community	Basis set up in early 1997. Prototype evolved into a series of lists, each dealing with a separate topic Extended virtual community to be publicly accessible late July 1997.
Form a Computer Advisory Group	Computer advisory group yet to be set up. Information facilitator acts as computer support person for staff.
PROJECT 4.2	
Identification of ways to link cultural beliefs with ecological knowledge through a symposium	Achieved. Northern Landscapes Symposium organised by Dr Rose held in December 1996
Completion of a study of frontier culture in northern Australia	Continuing. PhD student carried out studies with pastoralists in central Australia and NT savannas. Also carried out research with Aboriginal pastoralists.
Completion of a study of Aboriginal religion and land-use practice	Publication of book <i>Nourishing Terrains</i> , (1996) by Dr Rose.
Completion of a paper on settler pastoralist values and knowledge systems.	Continuing. Series of investigations and reports on cultural perceptions, land management decisions, communications and knowledge in Aboriginal and Settler communities being collated from a number of CRC related research activities.

PROJECT 4.2 (CONTINUED)	
A preliminary paper on the identification of the issues in environmental change and historical land use patterns in the Pine Creek area, NT.	Continuing. Original focus expanded. Field trips conducted, both to Pine Creek and to outlying areas, documenting the landscapes of different groups (Settler, Indigenous, Chinese) and collecting information on environmental change. Major community awareness project completed.
Appointment of Post-Doctoral Fellow in Aboriginal knowledge.	Post-Doctoral Fellow to be appointed. Survey planned to identify management/research/extension needs.
Review and adoption of methodologies for non-market resource valuation.	Assessment taking place as part of expanded work regarding current national projects.
Participation in determination of non-market values associated with timber clearing.	Continuing through environmental valuation in the Desert Uplands of Queensland.
Completion of a preliminary report on non-market survey pilot study.	Continuing through environmental valuation in the Desert Uplands of Queensland and commencing in NT.
PROJECT 4.3	
Undertake workshops to establish relationships between economics and ecology	In progress. Preliminary workshops undertaken with researchers from Sub-Programs 1-3. Conceptual models necessary for defining sustainable savanna development being developed.
Complete a case study relating pastoral production to biodiversity value	Work initiated. Other work linked to Desert Uplands Case Study.
Review best practice for sustainability in pastoral production, rubber vine management and nature based tourism interpretation sites	Research activities initiated and in progress in association with QDPI, QDNR, Savannah Guides Ltd.
Contribute to review of best practice management for northern defence sites	In progress.
Preliminary assessment of economic sensitivity to intensity of resource use in pastoral, mining and tourism industries	Number of activities in progress
Comparison and deployment to stakeholders of grazing management model packages. M Quirk, W Holmes, J Scanlan, G McKeon	Ongoing, through W. Holmes grazing management packages, Dynama, Breedcow etc. in association with other packages.
Complete a biophysical framework to integrate resource information for pastoral property management planning	Work in progress by QDPI.
Complete inventory of non-government initiatives in conservation land management associated with nature based tourism (T Nevard)	In progress.
Complete first year of survey of tourist 'propensity to pay' and demand for conservation land management (T Nevard)	In progress.
Complete first stage of audit of tourism resources and tourists in tropical savannas (N Black)	Preliminary report on tourism flows completed for north-west Queensland.
Complete review of savanna fire management (G Calvert)	Literature review completed.
Preliminary assessment of conservation status of desert upland fauna (A Kutt)	Literature review completed
Complete a review of priorities for mining (R Hynes)	Joint venture consultancy begun between CRC & Management International in progress.
Application to savannas of indicators arising from National Collaborative Project on Indicators for Sustainable Agriculture (A Cowie)	In development.
PROJECT 4.4	
Completion of a social, economic and ecological profile of the savannas (G Crough)	Information on key issues associated with land resources, tenure and management completed.
Review of existing socio-economic model systems and their adaptation to the savannas (G Crough, G Kirby)	Regional economist being appointed.
Analysis of services infrastructure of savanna towns (C Macgregor)	19 representative towns surveyed; six identified for in-depth study.
Establishment of a social and economics researchers' network across the CRC (G Kirby, R Hynes)	In progress.
Completion of a study on linkage between dry season grazing management and Aboriginal community decision making (J Monaghan)	Completed. Arrangements in place for two new complementary investigations.
Preliminary assessment of the social value of the NT reserve system (G Kirby)	In progress with work to be accelerated by new regional economist.
Have evaluated the feasibility and scope of land use case studies. (G Kirby, R Hynes)	Completed. Case studies accelerated, progress rapid.
PROJECT 5.1	
Development of new units within existing coursework MSc programs at NTU & JCU.	Achieved. Units available to both NTU and JCU MSc students. Information packages on these courses available to training providers. Further units under development.
Commence specialist short courses.	Short courses being developed for delivery in 1997/1998. Number of NTU and JCU MSc units available, or being modified, for two-week block delivery and available as stand alone short courses.
Complete curriculum development for key areas based on needs analysis.	Accreditation document completed for the Certificate 1 in land management. Input continuing into suite of courses (Certificate IV through to degree and postgraduate) in resource management offered by FATSIS. Curriculum for Masters courses being developed.
Develop comprehensive understanding of local knowledge systems	A major collaborative project commenced in 1997, researching the ways in which stakeholders acquire information and reach decisions relating to land management.
Review postgraduate programs based on client feedback.	Data and feedback from students and employers being collected and collated on regular basis. Review of Masters programs scheduled for 1998.
Develop a full MSc program in tropical savanna management	Significant progress made. Range of options available to students to increase.
Establish distance and multimedia education activities based on results of needs analysis	Number of units and courses will be completed in multimedia format (CD ROM) by end of 1997/early 1998. Plans for further multimedia development over next three years.
Recover costs of Centre educational activities	Mechanisms are currently under discussion and negotiation. Overseas markets also being explored.

PROJECT 5.2

Develop recommendations for exploitation of the Internet by March 1997	Achieved.
Establish the CRC WWW pages, in collaboration with Project 4.1, to provide basic information to staff, stakeholders and the public about the CRC by November 1997	Achieved. Updated Web site finished in June 1996.
Develop publicity display material for the Centre	Nine-panel portable display produced.
Establish an effective system for internal communications between all CRC staff and special interest groups	Ongoing. Email lists under development. Newsletters distributed to all staff and interest groups over the savannas.
Prepare a number of mass media stories to publicise the CRC	On hold while Centre develops communications policy and strategy.
Complete internal review of centre outcomes and identify opportunities for development of communication products	Ongoing.
Produce multi-media extension materials in best-practice for weed on savanna ecology and weed management packages.	Ongoing. CIMM unit at JCU producing multi-media CD ROM units.
Conduct group workshops for pastoralists on best-practice management for sustainable beef production	In progress.
Complete communication strategy for Centre by December 1997	On target. Communication coordinator will be developing strategy.

LIST OF ABBREVIATIONS AND ACRONYMS

ACIAR	Australian Centre for International Agricultural Research
AgWA	Agriculture West Australia
AHC	Australian Heritage Commission
AMLC	Australian Meat & Livestock Corporation
ANU	Australian National University
APA	Australian Postgraduate Award
ARC	Australian Research Council
AVHRR	Advanced Very High Resolution Radiometer
BRS	Bureau of Resource Sciences
CIRM	Centre for Integrated Resource Management
CINCRM	Centre for Indigneous Natural & Cultural Resource Management
CIMM	Centre for Interactive Multimedia
CMI	Carbon Management Index
COSSA	CSIRO Office of Space Science & Applications
CSIRO L&A	Commonwealth Scientific Industrial Research Organisation, Land & Water
CSIRO MIS	Commonwealth Scientific Industrial Research Organisation, Mathematics & Information Sciences
CSIRO TAG	Commonwealth Scientific Industrial Research Organisation, Tropical Agriculture
CSIRO W & E	Commonwealth Scientific Industrial Research Organisation, Wildlife and Ecology
CYLC	Cape York Land Council
CYPLUS	Cape York Peninsula Land Use Study
DEST	Department of Environment Sport and Territories
DPIE	Department of Environment Sport and Territories
DUBDSC	Desert Uplands Build-Up and Development Strategy Committee
ERIN	Environmental REsource Information Network
ERISS	Environmental Research Institution of the Supervising Scientist
FATSIS	Faculty for Aboriginal And Torres Strait Islander Study
GLADA	Gulf Local Authorities Development Association Inc
GCTE	Global Change and Terrestrial Ecosystems (IGBP project)
GIS	Geographic Information System
GRASP	Grass Production Model (pasture growth model)
GRDC	Grains Research and Development Corporation
HTML	Hyper Text Mark-Up Language
IGBP	International Geo Biosphere Program
ISP	Internet Service Provider
IUCN	International Union for Conservation of Nature and Natural Resources
ILC	Indigenous Land Council
JCU	James Cook University
KLC	Kimberley Land Council

LCD	Local Consensus Data
LWRRDC	Land and Water Resource Research and Development Corporation
MRC	Meat Research Corporation
NABRC	North Australian Beef Research Council
NARU	North Australian Research Unit
NASA	National Aeronautics and Space Administration
NATT	North Australian Tropical Transect
NCPISA	National Collaborative Project on Indicators for Sustainable Agriculture
NGO	Non-Government Organisation
NLC	Northern Land Council
NLP	National Landcare Program
NOAA	National Oceanic and Atmospheric Administration
NRIC	National Resource Information Centre
NRMP	National Rangeland Monitoring Program
NTBC	Northern Territory Bushfire Council
NTDLPE	Northern Territory Department of Lands, Planning and Environment
NTDME	Northern Territory Department of Mines and Energy
NTDPIF	Northern Territory Department of Primary Industry and Fisheries
NT PAWA	Northern Territory Power and Water Authority
NTTC	Northern Territory Tourist Commission
NTU	Northern Territory University
PAN	Parks Australia North
PWCNT	Parks and Wildlife Commission of the Northern Territory
PMP	Property Management Planning
QCC	Queensland Conservation Council
QCU	Queensland Cattlemens' Union
QDNR	Queensland Department of Natural Resources
QDPI	Queensland Department of Primary Industries
QFS	Queensland Fire Service
QTC	Queensland Tourist Commission
RIRDC	Rural Industries Research and Development Corporation
SADENR	South Australian Department of Environment and Natural Resources
SPAEG	Scientific Program Advisory and Evaluation Group
TCC	Townsville City Council
TWRC	Tropical Weed Research Centre
UCQ	University of Central Queensland
UGA	United Graziers Association
VRD	Victoria River District
WA CALM	Western Australian Department of Conservation and Land Management
WWF	World Wide Fund for Nature