



Australian Government

Land & Water Australia

Sustainable Northern Landscapes and the Nexus with Indigenous Health: Healthy Country, Healthy People



Professor Stephen Garnett and Dr Bev Sithole

Research project number NTU7 of the Social and Institutional
Research Program of Land & Water Australia.

Commenced in July 2003 and completed in June 2007.



Australian Government

Land & Water Australia

Sustainable Northern Landscapes and the Nexus with Indigenous Health: **Healthy Country, Healthy People**



Professor Stephen Garnett and Dr Bev Sithole

June 2007

Acknowledgements

The *Healthy Country, Healthy People* project was undertaken at the behest of Traditional Owners in central Arnhemland in collaboration with a transdisciplinary team of medical, ecological and social researchers.

This project was funded by Land and Water Australia, the Northern Territory Government, the National Health and Medical Research Council, the Australian Institute of Aboriginal and Torres Strait Islander Studies and Pfizer CardioVascular Lipid Research Grants (CVL).

The project was undertaken by researchers from the Institute of Advanced Studies at Charles Darwin University in collaboration with a number of key partners including the traditional owners of west Arnhemland, the Bawinanga Aboriginal Corporation, the Northern Land Council and the Northern Territory Government.

TEAM LEADER Stephen Garnett: April-June 2007

David Bowman: 2003-April 2007

Environmental Group

David Bowman, CDU
Don Franklin, CDU
Owen Price, NRETA
Barry Brook, Uni Adelaide
Aaron Petty, CDU
Grant Williamson, CDU
Louis Elliott, CDU

Health Group

Fay Johnston, CDU
Paul Burgess, CDU
Susan Jacklyn, CDU
Amy-Jo Vickery, CDU
Kerin O'Dea, Uni Melb

Policy Group

Bev Sithole, Consultant
Tess Lea, CDU
Peter Whitehead, NRETA
Stephen Garnett, CDU

Dr Burgess was supported by PhD scholarships, initially from the Centre for Remote Health, and subsequently NHMRC public health scholarship #333416.

We thank all participants and collaborators in this project for their time and expertise. In addition to the researcher team members and participating organisations, the study would not have occurred without the support of the Maningrida Health Board and Community Health Centre, Ian Munroe, Gavan Enever and Victor Rostron.

We also acknowledge the important comments on the health component of the study made by Glenn Albrecht, Ross Bailie and Joseph McDonnell from the Menzies School of Health Research and their assistance with statistical analysis.

Ethical approval was granted by the joint Human Research Ethics Committee of the Northern Territory Department of Health and Community Services, and the Menzies School of Health Research, and also the Human Research Ethics Committee of Charles Darwin University.

The research followed over a year of consultations with Aboriginal people and organisations throughout northern Australia as part of planning a submission for the larger project (Burgess *et al.* 2005). Photographs were provided by researchers in the project. Permission to use photos was granted by the traditional owners.

Contents

Executive Summary	iv
Introduction	1
Research Area	4
Approach	6
Summary of Study Results	7
Healthy Country: Ecosystem Health and ICNRM	7
Grass biomass and composition	7
Fire regimes	9
Weeds and feral animals	13
Interpretation	15
Fire	15
Weeds	16
Feral animals	17
Summary	18
Ethnography	19
Visits to country	19
Ranger programs	20
Interpretation	21
Healthy People: Human Health and ICNRM	23
Interpretation	25
Broader Policy Implications	26
Indigenous Disadvantage	26
Health Policy	27
Indigenous Economic Development	28
Education, Governance and Justice	29
Housing Policy and Outstations	30
Environmental Policy	30
Trans-disciplinary Policy Research	31
Monitoring and Evaluation	32
ICNRM, culture and engagement with country	32
Ecosystem health	35
Cautions Required in Using the Study	36
Synthesis	37
Recommendations	39
References	40



Executive Summary

The *Healthy Country, Healthy People* project has explored the relationship between landscape health and Aboriginal health in northern Australia. Aboriginal people worked with a trans-disciplinary research team to test the assertion that investment in Indigenous Natural and Cultural Resource Management (ICNRM) benefits both people and the environment. The project was designed as a proof of concept and the results have been highly encouraging.

People taking part in customary and contemporary land and sea management practices, particularly those living in traditional homelands, were much healthier, including lower rates of diabetes and lower risks of cardiovascular disease. The landscape where ICNRM is practised was also in better condition according to several measures of landscape health. However, the precursors of ecological decline are present and the ecological health of Indigenous lands may be short-lived without greater external support.

This project set out to test whether there is

- a demonstrable link between continued Indigenous cultural and natural resource management (ICNRM) and biodiversity conservation
- a significant association between participation in ICNRM and indicators of health and wellbeing.

Aboriginal people actively involved in ICNRM were demonstrably healthier than those who weren't. In particular they had low levels of the precursors of cardiovascular disease and diabetes. They also felt good about themselves because they were fulfilling cultural responsibilities, eating good traditional food and avoiding the social tensions of town life.

The Aboriginal lands examined had fire regimes closer to what is believed to be a traditional fire regimes than nearby conservation areas and pastoral lands. This can be attributed partly to the lower fuel loads consisting of a wide range of perennial grasses. Elsewhere the grass layer was dominated by large annual species or weeds. In contrast, feral animals, particularly buffalo, were far more abundant on Aboriginal lands. Tools were developed that can assess ecosystem health at a landscape level.

The research was designed as a proof of concept that investment in ICNRM has ancillary benefits for physical health. The results suggest investment can be justified, though the ideas need testing in other situations. There may also be educational, economic, employment, governance and judicial benefits as well as benefits for mental health. ICNRM can be seen as integrating concept across many policy domains.

There is strong potential for active involvement in ICNRM to be added to the list of headline indicators of success in Indigenous policy. An ICNRM indicator could also be considered as an option to fulfil Indigenous aspirations for a cultural indicator. The research also supports the idea that State of Environment reporting should develop further its assessment of the level of engagement by Indigenous people in environmental reporting.



Introduction

Tropical Australia is grappling with two crises of national significance – the protracted ill health of Indigenous peoples and ecological decline due to wildfires, invasive weeds and feral animals.

The health of Indigenous Australians remains much worse than for other Australians. Although, between 1967 and 2004, life expectancy at birth for Indigenous men in the Northern Territory had risen by eight years (from 52 to 60 years) and 14 years for women (from 54 to 68 years), total Australian life expectancy rose over the same period to 78 years for men and 83 years for women, leaving a gap of about 15 years (Wilson *et al.* 2007).

Nationally, the greatest differences were for those aged between 35 and 54, where the Indigenous death rates were five to six times those for non-Indigenous people (SCRGSP 2007). By way of comparison, in 2001 Canadian First Nations men might expect to live for 70 years and women 76 years (Treasury Board of Canada 2005), eight and ten years longer respectively than Indigenous Australians. Australia is ranked last on a league table of wealthy nations working to improve the health and well-being of aboriginal peoples (NACCHO and Oxfam 2007).

Indigenous Australians suffer a double burden of disease likened to the world's most undeveloped nations. Preventable infectious diseases fomented by poverty and socio-economic disadvantages combine with an increasing burden of physical and mental chronic conditions arising from inactivity, malnutrition and social dysfunction (Altman 1987, ABS and AIHW 2005). The differences between Indigenous and non-Indigenous people are particularly high for chronic diseases. From 2004-05 Indigenous people reported higher rates for asthma, diabetes/high sugar levels and kidney disease, arthritis, back pain/problems and heart and circulatory diseases. Indigenous rates of kidney disease were 10 times the non-Indigenous rate and three times higher diabetes (SCRGSP 2007). Much of the difference can be attributed to underlying socio-economic and environmental conditions (Carson *et al.* 2007).

For Aboriginal people living in remote areas, a key to health appears to be connection to 'country', being lands to which they have a traditional attachment. Despite lower levels of health services, health of Aboriginal people in very remote areas is better than that in remote locations (Scrymgeour 2007). This can be attributed partly to the physical activity and diet of people living in very remote areas: over 20 years ago the health of Aboriginal people in the Kimberley with diabetes improved dramatically when returning to traditional subsistence activities (O'Dea 1984, O'Dea *et al.* 1988). Similar results have been obtained more recently for the dispersed communities around Utopia in eastern Northern Territory (McDermott *et al.* 1998). Little attention, however, has been given to the psychological importance of being on country, even though benefits were identified over 30 years ago (Morice 1976).

Certainly, Indigenous peoples hold the view that they are happier and healthier when they are engaged in cultural and natural resource management (Burgess *et al.* 2005; Burgess and Morrison 2007). Indigenous elders talk about achieving a balance and acting to maintain that balance through continuous, active and spiritual interaction with country. Povinelli (1992) states that, for Aboriginal people, gathering and hunting is a way of attending to, re-enacting and

ensuring the physical and mythical reproduction of the environment, the human body and the social group. The health and productivity of land or sea country is thus dependent on regular human visits; sites must be occupied, used and talked about (Povinelli 1992).

While the poor condition of Indigenous health has been recognised for many decades, Australia's tropical rangelands have been seen as one of the last great regions on earth with a continuous natural environment (Garnett and Crowley 2003, Woinarski 2003a, Woinarski 2003b). And these rangelands do indeed retain secure populations of many species that have disappeared or declined drastically from elsewhere in Australia. However, this apparent security is now being challenged by a variety of factors, and there is increasing evidence that elements of the biota of the north Australian rangelands are in decline (Bowman and Panton 1993, Russell-Smith and Bowman 1992, Russell-Smith *et al.* 1992, 1998, Bowman *et al.* 2001, Franklin 1999, Woinarski *et al.*, 2001, Russell-Smith *et al.* 2002, Woinarski and Fisher 2003, Franklin *et al.* 2005, Woinarski and Catterall 2005). The main terrestrial environmental problems facing Aboriginal landowners in the region are the spread of weeds and feral animals onto Aboriginal lands and the effect of wildfires in areas where traditional fire regimes have been disrupted. In the marine environment illegal fishing, wasted by-catch and marine debris have direct consequences for Aboriginal owners of coastline (Storrs *et al.* 2003).

Aboriginal people consider the environment as unhealthy if not being managed actively by people (Whitehead *et al.* 2000). This is sometimes described as country needing its people, or that country is sad without its people, emphasising the inextricable connection between good health and a healthy environment (Burgess *et al.* 2005; Johnston *et al.* 2006, submitted). Aboriginal people manage their country as part of their cultural responsibilities and, in the Top End of the Northern Territory, many Traditional Owners have continued to practice traditional management of fire, despite a variety of impediments, until the present day (Langton 1998, Yibarbuk *et al.* 2001, Altman and Whitehead 2003, Storrs *et al.* 2003, Cochrane 2005).

Evidence is emerging that there are many ecological benefits deriving from situations where Aboriginal people have been able to maintain or re-invigorate their cultural responsibilities to country (Altman and Whitehead, 2003). Recognition of the potential ecological benefits of active Aboriginal land management has led to a dramatic increase in the number of Aboriginal communities involved formally in Indigenous Cultural and Natural Resource Management (ICNRM) through the Caring for Country program facilitated by the NLC and its partners (Storrs *et al.* 2003, NLC 2006). There is also management that is occurring outside the formal Caring for Country programs, though much of this is under-reported and unrecognised (Sithole *et al.* in press). While the on-ground effort has been constrained by availability of resources and funding, interest and participation in the formal and informal ICNRM in the NT has continued to grow, underlining the value that communities place on the program.

However the assertion that participation in ICNRM has delivered a range of physical, psychological and social benefits to Aboriginal people (Burgess *et al.* 2005; Burgess and Morrison 2007) as well as benefits to landscape health has never been specifically tested. Thus, at the behest of the Traditional Owners of central Arnhemland in the Northern Territory, the *Healthy Country, Healthy People* project was developed as a collaboration between Traditional Owners and a trans-disciplinary group of researchers involving medical, biophysical and social scientists. The Traditional Owners were concerned with the increasing obstacles to fulfilling cultural obligations with respect to land management, the protracted ill health of Indigenous people and the ecological decline evident on some Indigenous lands.

This exploratory research project takes Aboriginal people's testimony as a starting point to investigate the close connections between Aboriginal people, their ancestral lands and the impacts that this may have on the health of landscapes as well as the physical health and well-being of populations. Specific objectives of this research project were

- ▶ To understand Indigenous perspectives with respect to the relationship between health and well-being and involvement in ICNRM
- ▶ To assess the degree to which ICNRM affected environmental variables
- ▶ To document linkages between involvement in ICNRM and human health
- ▶ To initiate a critical evaluation of policy options deriving from the research.

The research was never intended to be definitive. Rather, it was undertaken as a proof of concept to test the assertion that, in some situations at least, investment in ICNRM can have widespread ancillary benefits; as well as describing the defining characteristics of the environment in places where ICNRM is practiced. While recent government investment in the environmental elements of ICNRM (e.g. OIPC 2006, Natt 2007, DEWR 2007) demonstrate an interest by governments at several levels in the concept, the transdisciplinary implications of ICNRM have not previously been explored.



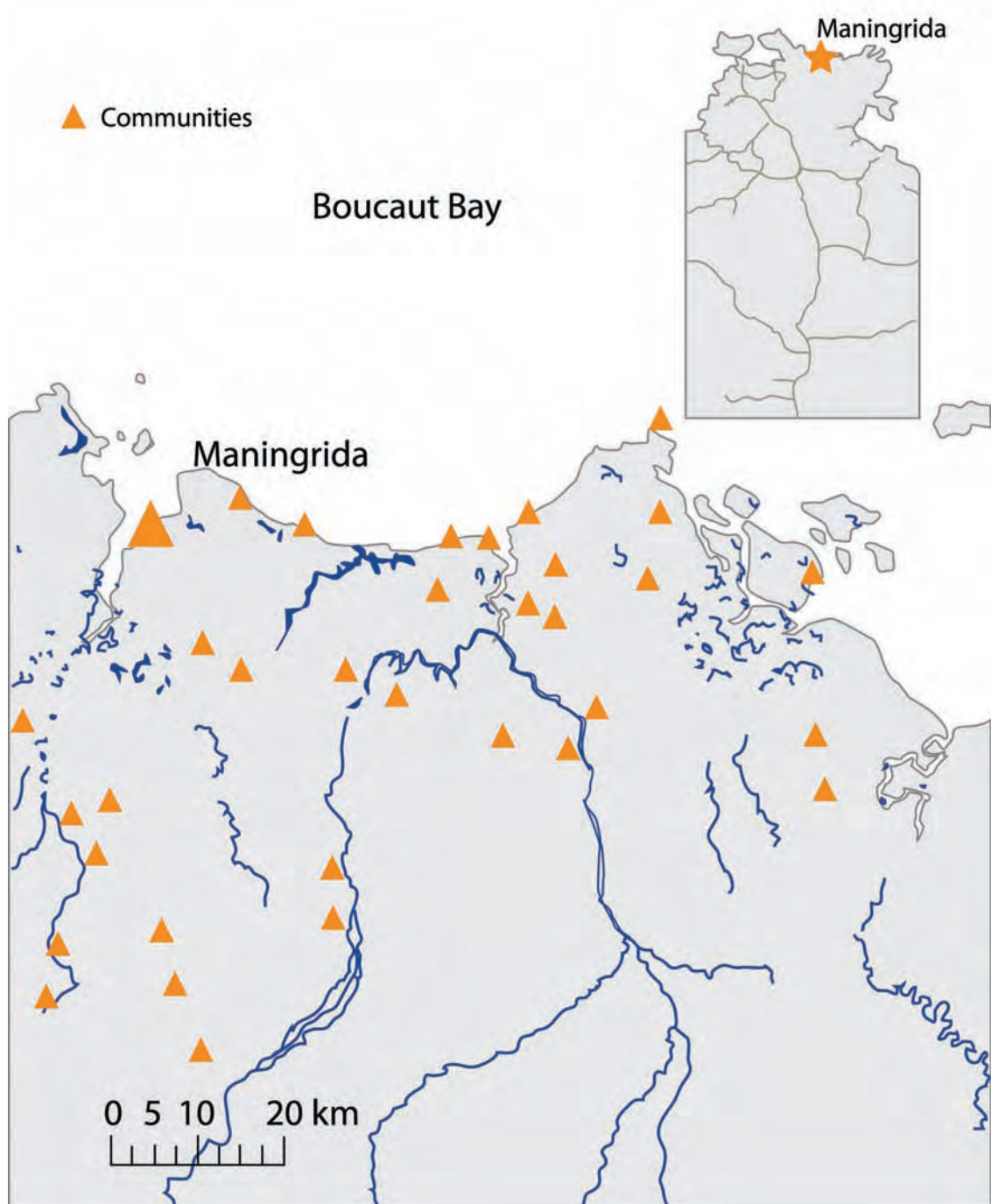
Research Area

Environmental research was carried out across the northern part of the Northern Territory to sample a range of tenures and management regimes. The monsoon usually delivers over 1,000 mm of rain from November to April, but there is rarely significant rain from May to October. The vegetation is almost entirely tropical savanna woodland dominated by a small number of eucalypt species. The under-storey is predominantly grassy, and is often burnt through the dry season. Although the flora and fauna are diverse, there are few large native herbivores. In the last two hundred years, however, cattle *Bos taurus*, horses *Equus caballus*, buffalo *Bubalus bubalis* and pigs *Sus scrofa* have been introduced and today occur in substantial numbers in the wild. Similarly a range of plant species have been introduced, some intentionally as pasture species, and a number of these have substantial wild populations.

The primary location for the health research was the coastal Aboriginal community of Maningrida, a settlement originally established in 1957 as a government trading post. The regional population of approximately 2,600 includes those living in Maningrida as well as numerous dispersed 'outstations' or 'homelands' where smaller family groupings of 10-100 people live on their traditionally owned lands or 'country'. The main settlement has many government services including a health centre and school. Those on outstations are supported by Bawinanga Aboriginal Corporation, first established in 1974, which also runs a number of enterprises in the town.

The people living in Maningrida come from many different cultural and linguistic groups. The distinct spatial clustering of houses reflects this diversity and areas within the town are usually named after the language commonly spoken by their residents. There is considerable movement of individuals to and from outstations, and to more distant towns and settlements. Strong cultural traditions remain intact, including the complex system of kinship relations that define many aspects of day to day life such as roles, responsibilities and potential marriage partners (Berndt and Berndt 1970, Keen 1991). Individual identity is strongly determined by connection to country. Land is usually inherited through paternal descent, but individuals also have links and responsibilities to their mother's country (Rose 1996).

Like many large Aboriginal settlements throughout northern Australia, the region is marked by socio-economic disadvantage and population health is poor. Most cash income is derived from government. This is augmented by traditional cultural activities including traditional harvest and sale of art works using harvested materials (Altman 2001). These are marketed nationally and internationally through the community-based Maningrida Arts & Culture. More recently, a ranger program, the Djelk Rangers, has been initiated under the auspices of Bawinanga Aboriginal Corporation. The rangers' roles include land management and actions which enable commercial exploitation of wildlife on Aboriginal lands (e.g. safari hunting, fishing tours, and crocodile egg harvesting for crocodile skin farms). The rangers also fulfil their cultural responsibilities to country through active environmental management, as do others both in Maningrida and on outstations.





Approach

This research project was trans-disciplinary involving people from a mix of disciplinary backgrounds including Traditional Owners, biophysical scientists (ecologists), social scientists (anthropologists, political scientists), medical practitioners and policy analysts. These researchers were divided into three groups to tackle different objectives of the study. Within the study, groups were formed to study health, landscape and ecology and policy. These groups were interlinked. For example, the work of the anthropologists was important to inform the other study components and underline the valuation by Aboriginal people of ICNRM activities. The policy group reviewed the results from the study to draw out the policy implications of this study. Methods to gather data varied depending on the component of the research project.

The landscape and ecology team appraised the landscape health under differing management regimes using tools appropriate to an extensive, sparsely-populated landscape. Monitoring of fire frequency was undertaken using satellite imagery that can be downloaded free from the internet. Abundance of feral animals was monitored using an efficient field design built on the tracking skills that are still held in Arnhemland communities. Grass composition was assessed based on field surveys targeting the cover of the invasive native annual grass *Sarga* and the ratio of annual to perennial grasses, while remote sensing was used to monitor weeds (mimosa, gamba grass).

Data for the ethnographic component were gathered in a number of ways including continuous observation and general conversations. Subsequently the themes from discussions and observations were summarised and reviewed by participants at a later feedback visit to ensure they reflected the ideas that had originally been expressed. Additionally, 13 semi-structured interviews were recorded with 11 women and two men aged from 22 to 51 years. The interviews were typically made while traveling to and from traditional lands as these activities facilitated conversations about country.

In collaboration with expert Indigenous and non-Indigenous informants over a two year period, a health measurement scale quantifying participation in ICNRM was developed, piloted and successfully validated using psychometric methods. This scale was incorporated into a program of preventive health assessments aimed at the early detection and intervention for chronic diseases responsible for premature death and disability. A representative sample of 301 adults aged between 15 and 54 years participated in the program. Increasing levels of ICNRM participation were strongly associated with primary residence in decentralised homelands. Our measurement of ICNRM may not be transferable to other communities who may define ICNRM differently. This study used community derived definitions of ICNRM so it is not a health evaluation of formal ranger programs, even though the role of ranger programs appears to overlap with community derived definitions and practices of ICNRM as described previously.

The fourth team comprising policy analysts and social scientists considered the results to draw out the key findings and the policy implications in consultation with the research groups. They also considered policy implications for areas not directly covered by research including employment, education, justice and governance.

Summary of Study Results

Healthy Country: Ecosystem Health and ICNRM

The health of the northern Australian savannas is a key component of a national conservation strategy and a source of concern given recent evidence of biodiversity loss and human-induced changes to vegetation. Aboriginal communal property is a major tenure class with potential to make a key contribution to biodiversity conservation in the region both because it is widespread and because traditional land management skills are associated with the successful maintenance of biodiversity. The goal of the landscape ecology component of the project was to assess, on a broad scale, the ecological impact of Aboriginal activity on country. The study was restricted to two vegetation types, lowland savanna and floodplains. We conducted the following studies:

- 1 a broad-scale survey of grass biomass and composition (Bowman *et al.* 2007);
- 2 a comparison of ecosystem health indices relating to fire, the grass-layer, weeds and feral herbivores across six tenure groups, including two owned and managed traditionally (Franklin *et al.* submitted);
- 3 a more intensive analysis of fire patterns across these six tenure groups (Petty & Bowman submitted); and
- 4 a comparison of fire frequency and grass composition in the closely and sparsely settled savannas within 100 km of Darwin (Elliott *et al.* submitted).

The work was carried out on four tenure types:

- 1 two managed by Aboriginal owners – Oenpelli and Maningrida;
- 2 two national parks – Mary River [proposed] and Kakadu, the latter jointly managed with Traditional Owners;
- 3 a cluster of pastoral leases in the Mary River area; and
- 4 a military training area (Mt Bundy).

Grass biomass and composition

The key finding is that grass biomass and the abundance of annual spear-grasses (*Sarga ex Sorghum*) in the tall-grass savannas of the north are greater under European than Aboriginal management, whereas perennial grasses are less frequent under European management. This was demonstrated most clearly in the broad-scale survey (Table 1), and evidence of a similar trend was also found in the comparison of six tenures (Figure 1). This difference appears to be related to fire management.

Table 1

Median (with 95 % confidence bounds) of bootstrapped model-averaged predictions of fuel type in *Eucalyptus tetradonta* savannas amongst regions in north-western Australia with contrasting land management.

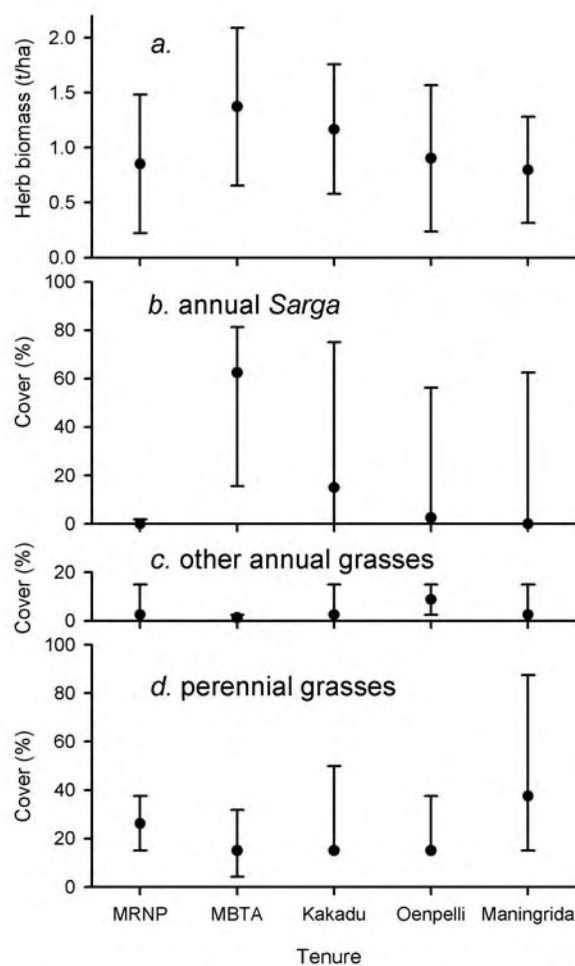
Region	Fuel load (t/ha)	% likelihood of Sarga occurrence	Sarga biomass (t/ha)	Perennial grass biomass (t/ha)
Arnhemland	1.14 (1.12-1.17)	51 (47-55)	0.67 (0.66-0.68)	0.46 (0.44-0.48)
Darwin	2.21 (2.11-2.32)	89 (88-91)	0.88 (0.87-0.89)	0.37 (0.35-0.39)
Gulf of Carpentaria	1.64 (1.59-1.68)	0 (0-0)	0 (0-0)	1.26 (1.20-1.31)
Kimberley	1.30 (1.27-1.33)	43 (39-47)	0.54 (0.53-0.54)	0.81 (0.77-0.84)

Figure 1

Biomass and composition of the herb-layer in *Eucalyptus miniata*/ *E. tetradonta* lowland savannas across five tenures in the Northern Territory.

Herb biomass (a) data are mean $\pm$ standard deviation. Grass cover data (b, c, d) are median $\pm$ 25th – 75th percentile. Sample sizes are: MRNP – 16; MBTA – 8; Kakadu – 29; Oenpelli – 28; Maningrida – 39. (From Franklin *et al.* submitted)

MRNP = Mary River National Park; MBTA = Mount Bundy (military) Training Area; KNP = Kakadu National Park.



Fire regimes

There is considerable variation in the frequency and timing of fire across the six tenure study areas (Figure 2). European tenures varied greatly in fire frequencies (Figure 3) but were consistently burnt earlier in the dry season than the two Aboriginal tenures (Figure 4), the latter having intermediate fire frequencies. Fire frequencies were particularly high in Kakadu National Park and particularly early in the Mt Bundy military training area.

Figure 2

The six tenures study area in northern Australia, showing: (A) the Fire History Index (no. of years burnt out of 4); and (B) the percentage of these fires that occurred before August 1.

The eastern two-thirds of the study area (showing as mostly cream in Fig. 2B) is Aboriginal land.

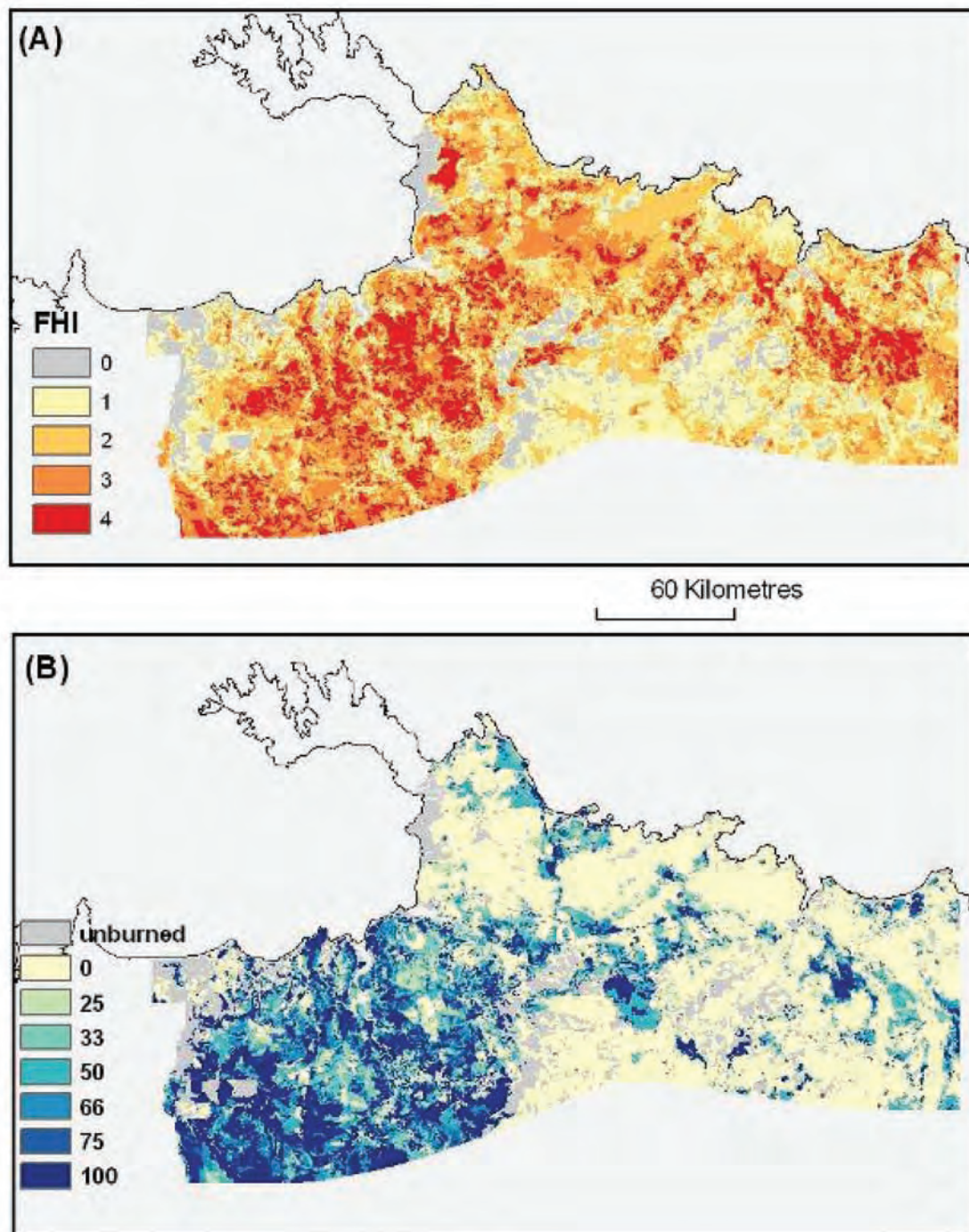


Figure 3

Distribution of fire frequencies (number of years burnt) across six tenure units and two land systems in the Northern Territory for the four years 2002 - 2005.

MRNP = Mary River National Park; **MBTA** = Mount Bundy (military) Training Area; **KNP** = Kakadu National Park. Numbers in brackets after tenure unit names are the mean number of years burnt (of four) per pixel. (From Franklin *et al.* submitted)

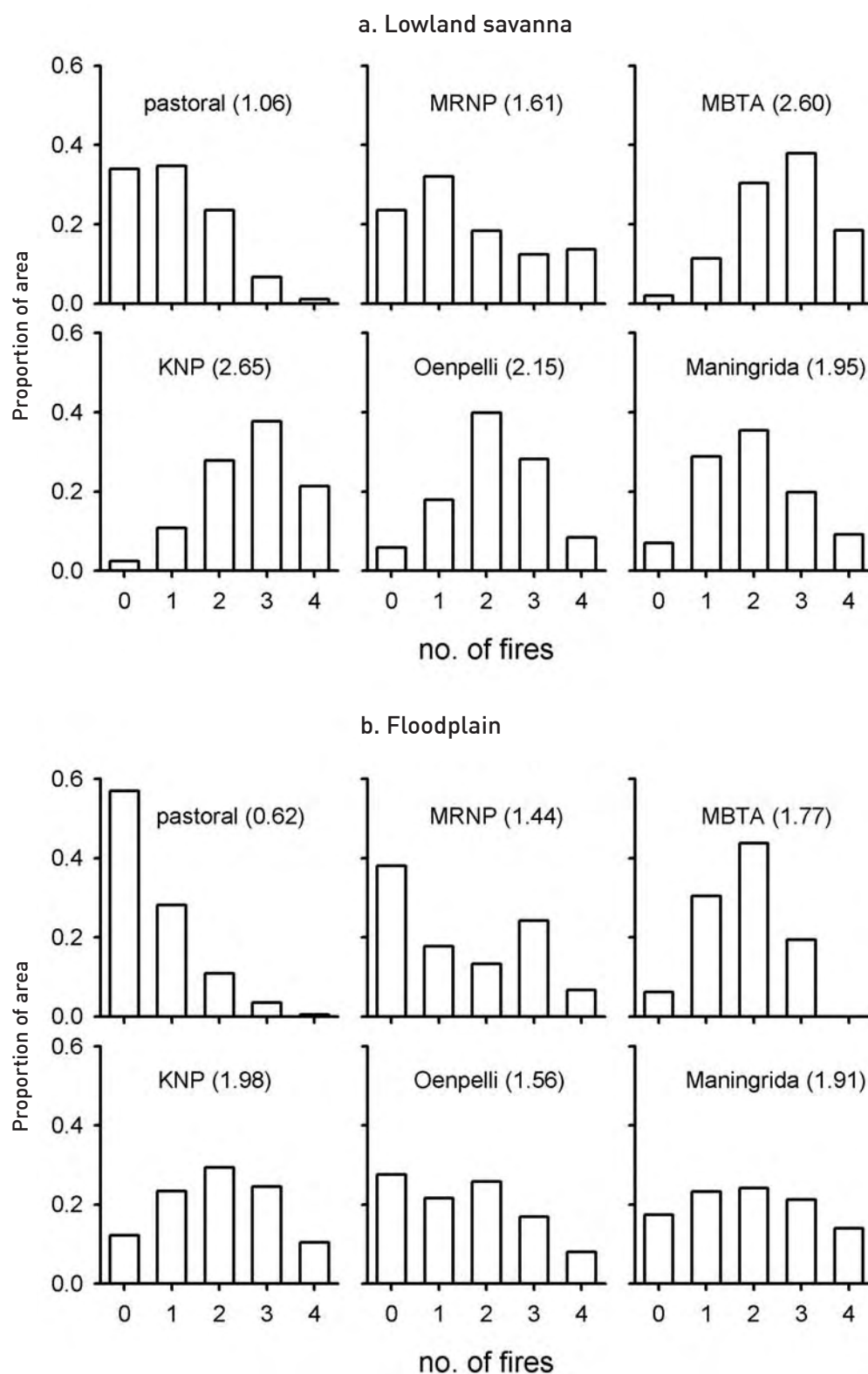
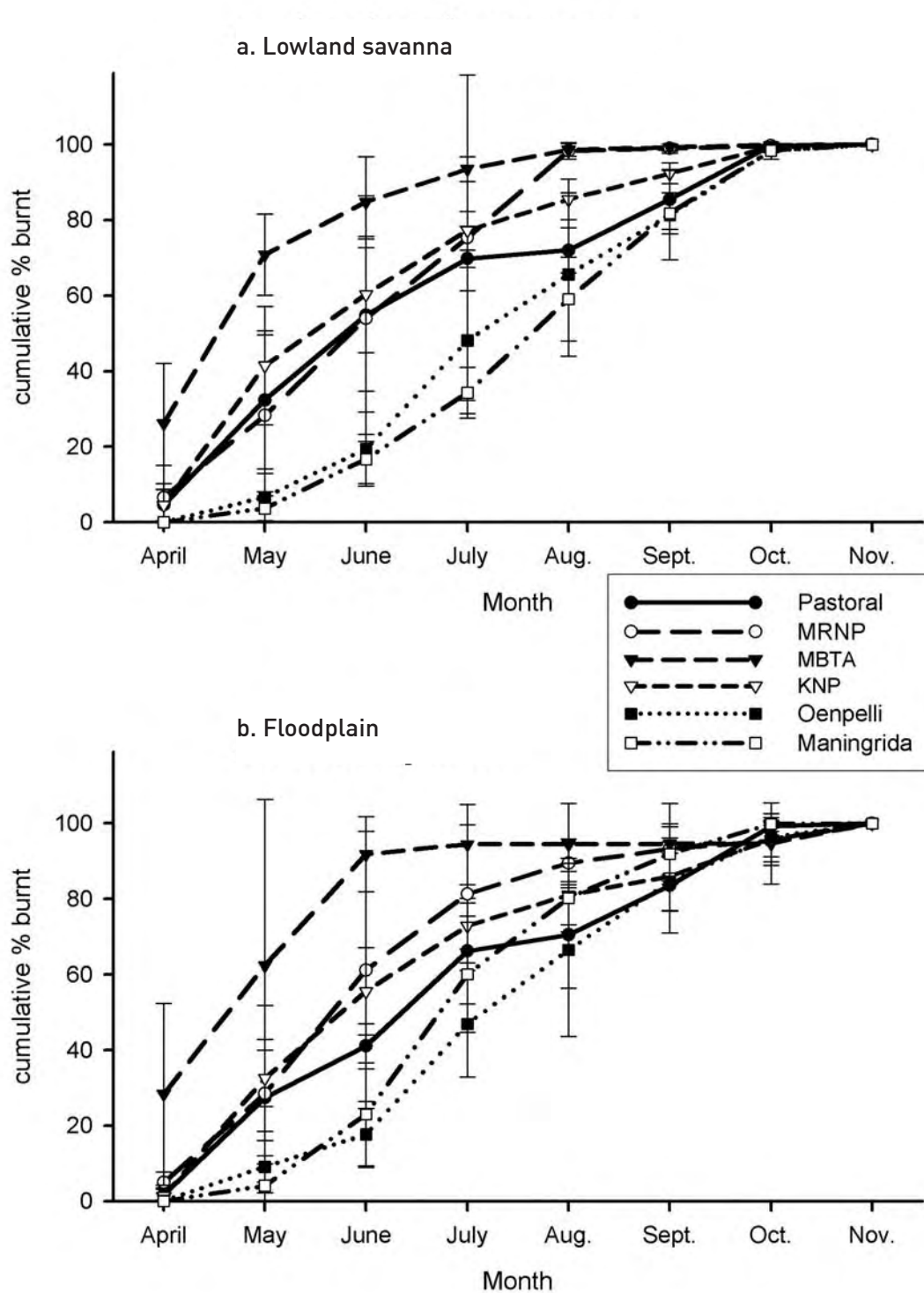


Figure 4

Season of fire across six tenures in the Northern Territory illustrated by the cumulative area burnt as a percentage of all area burnt in a year.

Error bars are standard deviations, expressing variation among the four years (2002-2005) of the study.
(From Franklin *et al.* submitted)

MRNP = Mary River National Park; MBTA = Mount Bundy (military) Training Area; KNP = Kakadu National Park.



In the Darwin area, there was an abrupt transition in fire frequencies 500 m from settlement, with more distant areas burnt almost twice as frequently (Figure 5). Further from settlement, the frequency of fire was higher in the second half of the dry season (Figure 6) and in areas dominated by annual grasses (Figure 7). These results reflect fire suppression and pro-active early dry-season burning in the vicinity of settlements, but little success in managing late dry season wildfires in areas not immediately adjacent to settlements.

Figure 5
The relationship between the Fire Activity Index (mean and standard deviation) and distance from settlement in the greater Darwin region.
Sites have been aggregated into five distance classes of equal size (n=20). (From Elliott *et al.* submitted)

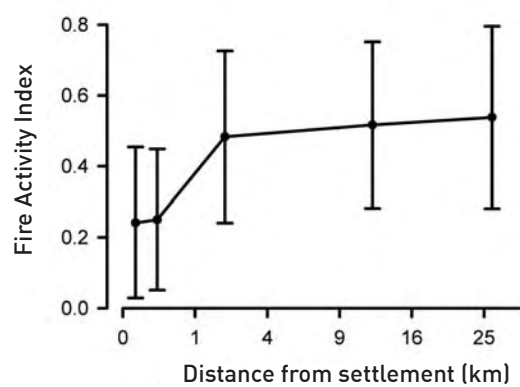


Figure 6
Frequency of fire by season at sites less than 500 m (n=40) and greater than 500 m (n=60) from settlement in the greater Darwin region.
Data are means $\pm$ s.e. 'Early' is May or June; 'mid' is July or August; and 'late' is September to November. (From Elliott *et al.* submitted)

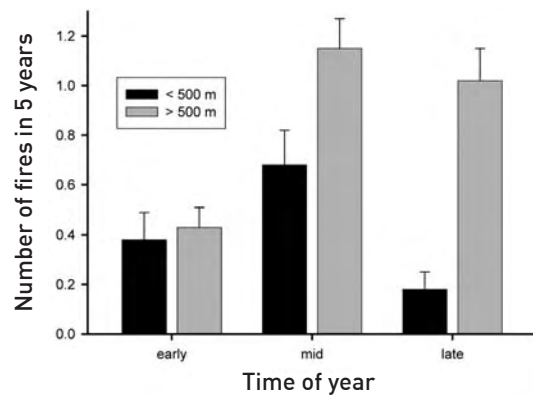
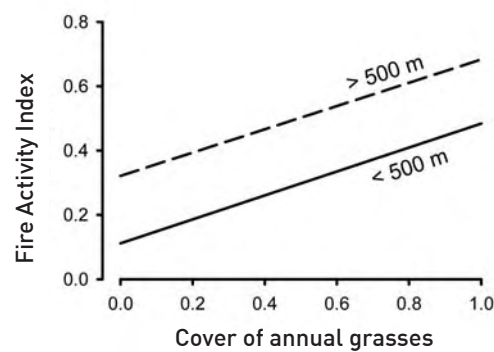


Figure 7
Relationship between the cover of annual grasses and the Fire Activity Index modelled independently for two classes of distance from settlement in the greater Darwin region.
(From Elliott *et al.* submitted)



This difference appears to be related to fire management. European tenures varied greatly in fire frequencies but were consistently burnt earlier in the dry season than the two Aboriginal tenures. The latter had intermediate fire frequencies. Fire frequencies were particularly high in Kakadu National Park and particularly early in the military training area. By contrast, although the Aboriginal lowland savannas tended to be burnt later in the dry season, the lower fire frequencies were lower. Pastoral properties showed the lowest fire frequencies overall, probably as a result of decreased fuel loads from grazing and the incentive to retain unburnt pasture. In summary, the practice of burning as early as possible in the dry season to mitigate against high intensity fires later that is practised on non-Indigenous controlled areas, does not reflect contemporary Aboriginal practice in sites where traditional fire regimes have been maintained.

The results support the suggestion that the patch-burning characteristic of traditional Aboriginal fire management prevents the establishment of a grass-fire cycle that promotes annual over perennial grasses, but this may not be possible once that shift has occurred. Aboriginal land offers a unique opportunity for the conservation of biodiversity through the maintenance of traditional fire regimes. But without financial support, traditional practices may not be sustained, both because of the costs involved in getting out on country and because weeds and feral animals will alter fire regimes.

Weeds and feral animals

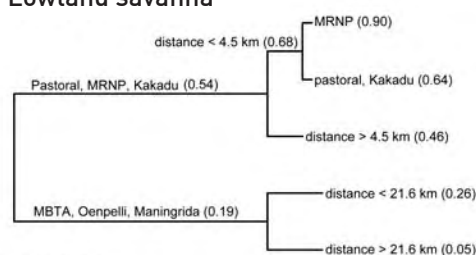
Weeds were more frequent in the European tenures (Figure 8). Feral animals were most abundant in the Aboriginal tenures (Figure 9). In particular, Asian Water Buffalo were prevalent in the Maningrida area and feral horses in the Oenpelli area, whereas the abundance of feral pigs was only slightly elevated in Aboriginal tenures. These data reflect: **a)** an association of weeds with disturbance and development, and their possible eastward expansion from the agricultural districts near Darwin; **b)** a major shift in the population centre for Asian Water Buffalo from Kakadu westwards following their near eradication from the Darwin and Kakadu areas during the Brucellosis (BTEC) campaign of the late 1980s; **c)** the difficulty experienced across all tenures in controlling feral pigs; and **d)** the likely juxtaposition of habitats that suit feral horses in the Oenpelli area.

Figure 8

Regression tree analyses of a weed index with tenure and distance from roads as explanatory variables across six tenures in the coastal north of the Northern Territory.

Bracketed numbers are mean weed index values for the group. Horizontal lines are proportional to the deviance explained, comparable within but not between trees. Sample sizes (no. of 10 x 10 km cells) are: lowland savanna — 271; floodplain — 88. (From Franklin *et al.* submitted)

a. Lowland savanna



b. Floodplain

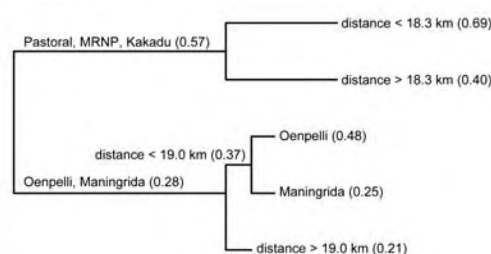
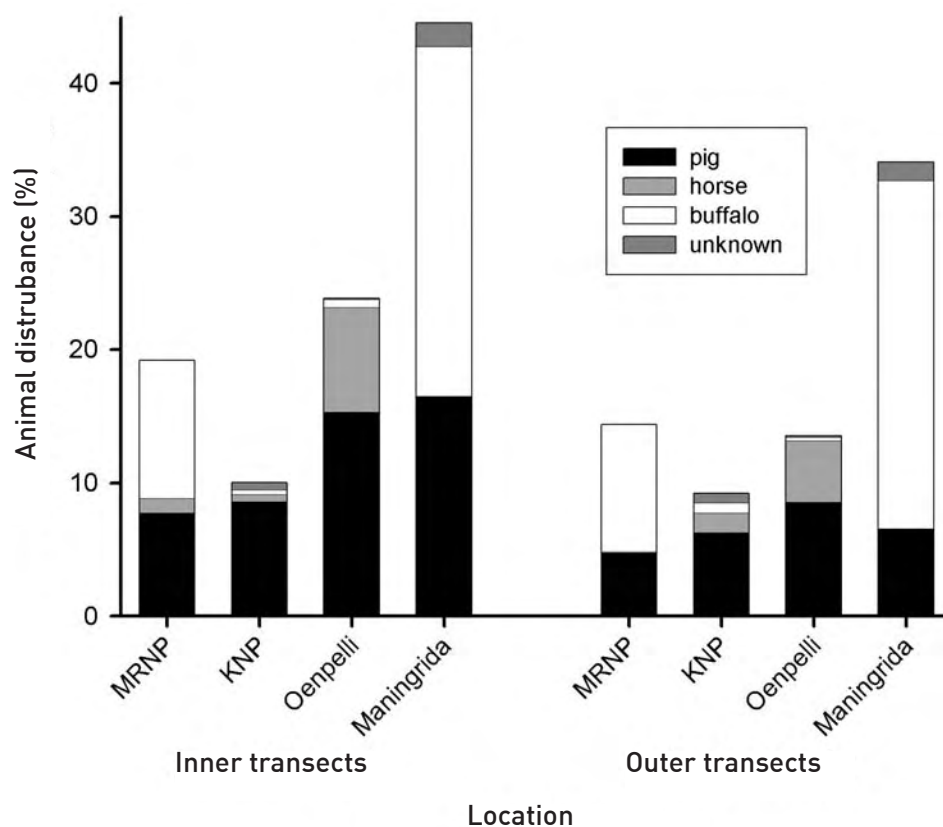


Figure 9

Frequency of animal disturbance on wetlands (inner transects) and adjacent vegetation (outer transects) summarised by tenure and species for four tenures in the coastal north of the Northern Territory.

MRNP = Mary River National Park; KNP = Kakadu National Park. (From Franklin *et al.* submitted)



Interpretation

Fire

Aboriginal fire has been an integral part of Australian savanna management for thousands of years (Preece 2002). Loss of Aboriginal fire regimes has been proposed as a critical factor in the increasingly rapid population declines of mammals and some birds in the Australian tropical savanna (Woinarski *et al.* 2001; Pardon *et al.* 2003, Franklin *et al.* 2005, Garnett *et al.* in press) as well as the decline of some plant species and communities (Russell-Smith *et al.* 1998, 2002, Bowman *et al.* 2001, 2007).

Traditionally, fires were lit for much of the year as people travelled through the landscape (Russell-Smith 2002). It is thought that each fire added to a progressive network of burns, breaking up the fuel layer so that no fire travelled far, and leaving patches of unburnt country that served as temporary refugia for fire-sensitive species. While there is still much to be learned about the scale of fire mosaics needed in a healthy savanna landscape (Parr and Andersen 2006), it is believed that, under Aboriginal management, fires were usually moderate in intensity, canopies and fire sensitive vegetation were protected and soils maintained, at least in comparison to many contemporary regimes (Russell-Smith 2002, Williams *et al.* 2002, Russell-Smith *et al.* 2003a).



Cyrus: Being on country means that traditional burning can resume, bush tucker eaten and that education takes place.

Recreating Aboriginal fires regimes where they have been lost has proved to be extremely difficult. Even where there has been a concerted effort to shift the burning patterns to include more preventative fires in the early-dry season, which are presumed to be relatively cool, patchy and localised, and fewer in the late-dry season when hotter temperatures, drier fuels and stronger winds make for hotter, less patchy and more extensive fires (Press 1987), land managers relate tales of failure; where, in the course of a week or ten days the country had dried out, the fuel has cured from not supporting fire to a single dropped match causing fires of phenomenal scale. Significant factors have changed: population concentration (Whitehead 1999, Whitehead *et al.* 2003); the increase in prevalence of tall grasses, both native and exotic (Rossiter *et al.* 2004, Bowman 2007); the spread of large grazing herbivores; and possibly carbon-dioxide fertilisation (Archer *et al.* 1995). Currently up to one quarter of northern Australia is burnt in fires of considerable extent and intensity every year. In regions where few people manage the landscape and there is relatively little pastoralism, around 50% of the country is burnt each year (Russell-Smith *et al.* 2003a).

This study has corroborated evidence, such as that of Yibarbuk *et al.* (2001), that the parts of Arnhemland visited are among the few places in Australia where Aboriginal fire regimes have been maintained. The evidence suggests that ecosystems will change if traditional burning skills are lost and the fire regime changes. Re-establishment of such fire regimes will be extremely difficult, with consequences for biodiversity and landscape health.

Weeds

European settlement brought to insular Australia numerous vigorous exotic plant species. In Australia as a whole there are at least 2,700 such species of which 370 are legally declared as noxious species by States and Territories. The top 20 individually cover between 0.2 and 12.4% of the continent, with an estimated \$4 billion cost to industry (Sinden *et al.* 2004). The annual cost of weeds to the livestock industry (loss of production, control measures) Australia-wide has been estimated as \$315-345 million, with a further \$112 million cost to public authorities (Sinden *et al.* 2004). Data for the tropical savannas are less readily available, though as an indication of the problem, over 5% of the flora of the Kimberley in Western Australia (108 spp.), 5% of the Northern Territory flora (230 spp.) and 13% of the Queensland flora (1220 spp.) are exotic (Csurhes and Edwards 1998, Dunlop *et al.* 1995, Wheeler *et al.* 1992). Of the 622 naturalised species in the Australian rangelands as a whole, 26% are considered a threat to biodiversity (Martin *et al.* 2006). Most of the \$25 million spent on rangeland weed control by the Australian government since 1996, and the \$56 million on projects with a weed management component, was spent in the tropics (Martin and van Klinken 2006). Uncosted in these estimates are the changes that have occurred in the structure of the native vegetation which, in some places, is considered a worse problem for landscape health than exotic weeds.

The principal exotic woody weed likely to affect Arnhemland is prickly mimosa, *Mimosa pigra*, which forms dense impenetrable woody thickets in grasslands and wetlands. Many millions of hectares have now been invaded, reducing native plant diversity and abundance, and changing or reducing the fauna assemblages present (Braithwaite *et al.* 1989, Whitehead *et al.* 1990).

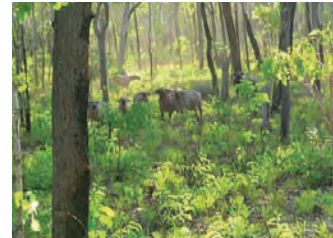
Across the broader landscape, changes in grass composition are critical to landscape health. Nearly all introduced pasture grasses and legumes were considered desirable to the grazing industry when introduced (Eyles *et al.* 1985), but they have spread rapidly and aggressively with permanent irreversible effects on Australia's rangelands and its wildlife (Rossiter *et al.* 2003, Cook and Dias 2006). A retrospective review of the fate of over 450 introduced pasture species found that only 4 were useful and did not become weeds whereas 60 became weeds and 17 were both useful and considered weeds (Lonsdale 1994). Several are likely to be particularly damaging. In semi-humid savannas, gamba grass, *Andropogon gayensis*, a vigorous African perennial species, has been promoted widely for use in pastures but readily invades intact ecosystems, creating a fuel load 10 times that typical of non-invaded environments. Not only are native understorey species smothered, but woody mid-storey and canopy species may be lost as a result of increased fire intensity (Rossiter *et al.*, 2003). This species, already widespread, has an ecological envelope that could allow it to spread across all northern tropical Australia, especially where ground has been disturbed by stock and feral animals (Setterfield *et al.* 2005). The slightly smaller and less well-studied mission grass, *Pennisetum polystachion*, is likely to have similar effects.

Native annual grasses, particularly the annual sorghums, *Sarga* spp. also promote and are promoted by intense fires (Cook *et al.* 1998; Bowman *et al.* 2004, 2007) and disappear when fires are avoided (Russell-Smith *et al.* 2003). Although the fuel loads of the native annuals are lower than those of the exotic African grasses, they are still high and the structure of their stems is such that they generate fires hot enough to damage trees (Bowman and Wilson 1998, Andersen *et al.* 2003) as well as replacing a diverse perennial grass sward with a monoculture (Russell-Smith *et al.* 2003).

This study has shown that areas under Aboriginal management are remarkably weed free compared to those under other tenures, particularly pastoral lands. Also the native grass sward is dominated by a diverse range of perennial grasses rather than a few vigorous annual species. This result may be an historical artifact of isolation, in the case of exotic weeds, in combination with the maintenance of traditional fire regimes. Sustaining this element of landscape health will require vigilance to detect exotics and substantial effort to remove those that arrive.

Feral animals

Many exotic animals have been introduced, deliberately or accidentally, into Australia's tropical savannas. Some of these are now amongst the region's most widespread and abundant species, and have substantially changed the dynamics and composition of the landscapes they inhabit. The study concentrated on horse, Asian water buffalo and pigs. These large herbivores contribute substantially to total grazing pressure on tropical landscapes (Fisher *et al.* 2004). With cattle on the extensive pastoral estate and feral herbivores on other tenures, a remarkably small proportion of the Australian tropical rangelands is free from the impacts of recently-introduced herbivorous mammals.



Buffalo near Ji-bena

Buffalo affect both the long term structure of the savanna (Werner 2005, Werner *et al.* 2006) and the composition of grasslands, their wallowing channels causing salt water intrusion into large areas of seasonal freshwater swamps (Skeat *et al.* 1996). They also spread weeds (Lonsdale 1993). The elimination of buffalo from large parts of their range to control disease during the 1980s allowed some relief from their impact, but populations are now recovering rapidly (Anonymous 1999). No attempt was ever made to control buffalo in Arnhemland and this study corroborates reports of high levels of abundance there (Koenig *et al.* 2003, Gorman *et al.* 2007). The ecological impact of feral pigs is surprisingly little known given the visibility of their activities. They are known to turn over large areas of freshwater wetland each year, and their varied diet includes frogs, earthworms, plant tubers, and the eggs of turtles (Pavlov 1995). By eating turtles and their eggs they compete directly with traditional human use. They also reduce seed availability for birds by eating critical grass species (Crowley *et al.* 2004). They are also dangerous; in the ethnographic studies (below) women talked of the presence of feral pigs and buffalo being a disincentive to be on country.

The study did not look at the prevalence of smaller feral animals such as cats, cane toads and ants, all of which can have substantial impacts on biodiversity (Abbott 2002, Watson and Woinarski 2004, Griffiths and McKay 2005). The first two are likely to be, or soon will be, widespread on all tenures but outbreaks of exotic ants are sufficiently well confined to warrant attempts at eradication (Hoffmann and O'Connor 2004). In the context of this discussion, eradication of an outbreak of exotic ants in Arnhemland is being carried out by the Dhimirru Aboriginal ranger group in association with CSIRO (CSIRO 2004).

In this study, the major difference in feral animal occurrence was the prevalence of buffalo on Aboriginal tenures. This has implications for ongoing landscape health since not only are buffalo likely to affect landscape function through creation of wallows and overgrazing but they are also

likely to promote the spread of weeds. They will affect fire regimes both by consuming fuel and, when seeds arrive, by spreading exotic grasses. However, while virtual eradication was achieved in Kakadu and areas to the west in the 1980s through helicopter shooting and other means, the application of such technology in Arnhemland may not be appropriate. This is because buffalo harvesting represents one of the few potential sources of income for people in Arnhemland and is also a significant source of meat (Brook *et al.* 2006).

Summary

There is mounting ecological evidence that Indigenous people living a more traditional lifestyle where they continue to practice fire management have country with a superior abundance and diversity of animal and plant foods (Whitehead *et al.* 2003). Supporting Aboriginal people to be on and manage their lands has been argued to be a relatively low cost option when compared with managing large national parks (Altman and Whitehead 2003). However, maintenance of landscape health on Aboriginal lands will only be possible under three conditions: people are actively and frequently engaged with their land, the fuels are present and have not been destroyed by feral animals but that the fuel load has not been inflated through the proliferation of large native or exotic grasses. Currently some parts of the Aboriginal tenures have active engagement and fuel loads that are relatively unchanged. However there are large numbers of feral animals, particularly buffalo. While these will already have caused change, this may not be irrevocable if appropriate control is undertaken before exotic grasses arrive. But such control may need to be designed in a way that does not compromise future economic options for Aboriginal people.



Landscape in central Arnhem Land

Ethnography

Visits to Country

The ethnographic research revealed several major and often overlapping themes relating to Aboriginal perceptions of the nexus of people with land and how this affects the well-being of both. These included:

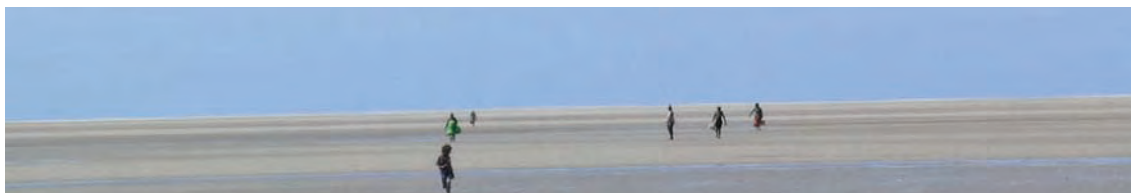
- ▶ The stresses and constraints of living in large settlements compared to living on traditionally-owned country;
- ▶ Detailed ecological knowledge including the use of natural resources and fire;
- ▶ An inherent understanding of the link between physical health and the procuring and eating of bush foods;
- ▶ Identity, culture and spirituality; and
- ▶ Concern for younger people.

Interviewees from towns were torn between the demands of urbanised and traditional lifestyles and how these tensions had a manifest impact on many people's sense of well-being. Many are unable to live on their land, or indeed regularly visit their land, because they lacked transport and needed to be in town for welfare payments, medicines and store items such as sugar, flour and tobacco. Yet town was described as 'boring' and as making people 'homesick and lazy'. In contrast, on country, people felt 'fitter and happier' because they got their 'energy back' and avoided 'stress and humbug' (Aboriginal English for unreasonable/incessant demands from relatives). Frequent funerals, overcrowding, violence and substance abuse are considered major stressors in remote Aboriginal settlements (ABS 2002).

Returning to country, even for brief visits, allowed people to gather traditional foods. Interviewees had detailed knowledge of their country, the seasons and the availability and location of resources. Most food was eaten once procured, but some was always saved for sharing with relatives back in town, thus fulfilling social obligations. Wood, fibre, dyes for arts and crafts were also frequently collected, primarily to earn cash via the Aboriginal art market.

Interviewees frequently lit fires to aid the hunting of animals such as turtles, clear land to make walking easier, or to promote new green grass shoots to attract game. Landscape burning is considered fundamental to Aboriginal subsistence (Yibarbuk *et al.* 2001). For example, women will burn a swamp to find turtles and men use fire to create habitats to attract game (Russell-Smith *et al.* 1997, Murphy and Bowman 2006). But burning also is a tangible way people can 'humanise' a landscape, literally signalling that they are on their land by putting up columns of smoke that can be read by nearby Aboriginal groups. In the longer term the burnt patches indicate that others understand the country is being looked after (Head 1994). Rose (1996) identified the skilful use of fire as one of two key land management resources used by Aboriginal people throughout Australia, second only to the intimate, detailed long-term knowledge of local country.

Collection of wild foods entailed hard physical work, such as chopping, digging, and walking. Bush harvesting greatly exceeded Australia's physical activity recommendation for adults of half an hour of moderate activity each day (DHA 1999). Interviewees were also well aware that their traditional foods are far healthier than the typical urbanised diet that is so rich in sugars and fat.



Aboriginal people on country in central Arnhem Land

A key motivation to hunt and gather was not simply to get sustenance but to deal with issues of Aboriginal culture and identity. The gathering of traditional food reinforced identity, harvesting and eating being linked to specific places, stories and ceremonial events, as it is throughout the world [Kuhnlein and Receveur 1996]. The interviewees felt that being on country allowed them to fulfil their obligation to care for land as well as fulfil the needs of the land itself for human engagement. Interviewees called out loud to introduce the ethnographic researcher to the deceased 'old people' and spirits of the country to explain her purpose in visiting their country for fear that dangerous supernatural forces are not disturbed and the visitor harmed (Rose 1996). Overall active management of land was central to the identity of the Traditional Owners interviewed and people spoke of their sadness when unable to fulfil their cultural and spiritual obligations.

Adult Aboriginal people were deeply concerned about the loss of understanding and respect for traditional culture by the younger generations. Returning to country was understood by adults as a powerful way to educate and deepen respect for their traditional culture. They were afraid that young people would lose their culture, their skills and eventually their country.

Ranger programs

Customary obligations to country overlap with the aspirations and activities of formal ranger programs. Indeed, the cultural obligations to country were the primary driver in the initiation of the ranger movement (NLC 2006) so that, unlike conventional ranger programs which might be expected to concentrate on natural resource management, cultural management often has primacy in ICNRM. At an early stage in this project a community driven evaluation of Aboriginal land and sea management was supported as a complementary activity. While reporting separately (Sithole *et al.* in press), many of the conclusions are pertinent to the ethnographic work undertaken here and are summarised.

Ranger groups are seen as a mechanism to complement individual, family or clan obligations to look after country. In some areas of the Top End, ranger groups are managing areas that are uninhabited, or areas that would otherwise be inaccessible to the individual Traditional Owners. Rangers have access to transport and can extend the scope of land and sea management activities being undertaken. Most Traditional Owners were happy that Aboriginal people are involved in 'looking after country'. Traditional Owners get respect from their peers for being involved. Many rangers and Traditional Owners acknowledged that seeing others get involved in land and sea management in spite of all the problems and challenges spurred them to also get involved. Those Traditional Owners already involved felt very happy to be involved in Aboriginal land and sea management and achieve 3 key objectives spontaneously,

"you stay on country, look after your country and, most importantly, make something of yourself"

However, as Altman and Whitehead (2003) observe, for many Traditional Owners who have had their connections to country eroded by colonial processes, the reoccupation of country is either not viable or not desired.

One of the most acknowledged benefits of land and sea management as articulated by Aboriginal people is the sense of self worth and pride reported by rangers and Traditional Owners involved in the program. Traditional Owners explained in various ways their excitement, their enjoyment (satisfaction) and the pride derived from being involved in land and sea management. Being a ranger or being involved in land management creates opportunities for Traditional Owners to be on country, see country and reconnect with country. Many Traditional Owners observed that countrymen respect those involved in the program and feel good knowing that country was being looked after. Some Traditional Owners indicate that the benefit of being involved is so great that many would continue in the program even if there were no CDEP or salary. Some Traditional Owners have left paid employment to get involved in Aboriginal land and sea management and feel very strongly about doing ranger work. Rangers are aware of the value of the work they are doing and distinguish between value at a personal level, at a community/clan level, regional level and for the country. Similarly, most elders expressed great pride in what the groups were achieving, in what the groups were representing and most importantly, they were proud of the way rangers were challenging stereotypes of Aboriginal people in many areas where the rangers are demonstrating action, leadership, knowledge and innovation. In many communities, ranger work or involvement in Aboriginal land and sea management was seen as the new hope for young people who now have something to look forward to.

As with the interviewees, Traditional Owners and rangers observed that undertaking land management was time away from 'humbag', as well as from violence and the temptation for alcohol and drugs. Many Traditional Owners and rangers also indicated that they became fit and healthy when they are on country because they were swimming and eating bush tucker. They also spent time away from smoking as they often run out of cigarettes while doing land and sea management. Some ranger groups collected bush tucker for family and other countrymen.

Interpretation

The Aboriginal views expressed during this study about the interconnectedness between people and country, and how this promotes the well-being of both land and the people are consistent with previous accounts from Aboriginal people and other ethnographic studies. The interconnectedness of spiritual life, responsibility for country, use of country and individual autonomy and well-being have been repeatedly explained to non-Aboriginal people from early colonisation to the present (Berndt and Berndt 1970, Rose 1992, Keen 1988, Anderson 1995, Rose 1996). This relationship includes 'Caring for Country' or exercising cultural obligations that are felt to lead to health improvements for landscapes and the physical health and social well-being of the populations living there (Rose 1992, Povinelli 1993, Burgess *et al.* 2005, Burgess and Morrison 2007). Responsibilities include:

- Burning (cleansing for ceremony and for hunting);
- 'Let the country know we are there' - using resources, hunting and fishing;
- Protecting the integrity of the country through respect;
- Protecting and enhancing species diversity;
- Protecting sacred areas;
- Providing a new generation and teaching them on country; and
- Learning and performing ceremonies.

Connection to land is achieved through very specific localised knowledge of a region's natural history that is coupled with complex layers of past personal and family experiences, and deeper connection to the past and therefore to Aboriginal identity via traditional stories and beliefs (Rose 1996). This nexus between land and people is ongoing through hunting and gathering and simply being on country, and is particularly strong in remote and very remote Australia where 43% of Indigenous people live on their homelands/traditional country and 90% recognise an area as their traditional country (SCRGSP 2005).

Overall, Aboriginal informants in both the ethnographic study and in the ranger group evaluation support the idea that the majority of benefits from ICNRM, both health benefits and benefits to landscape health, derive primarily from the sense of well-being that comes from maintaining or re-establishing cultural connections to country as well as the more obvious influences of better diet and more exercise.



Matthew Ryan, a Djelk Ranger

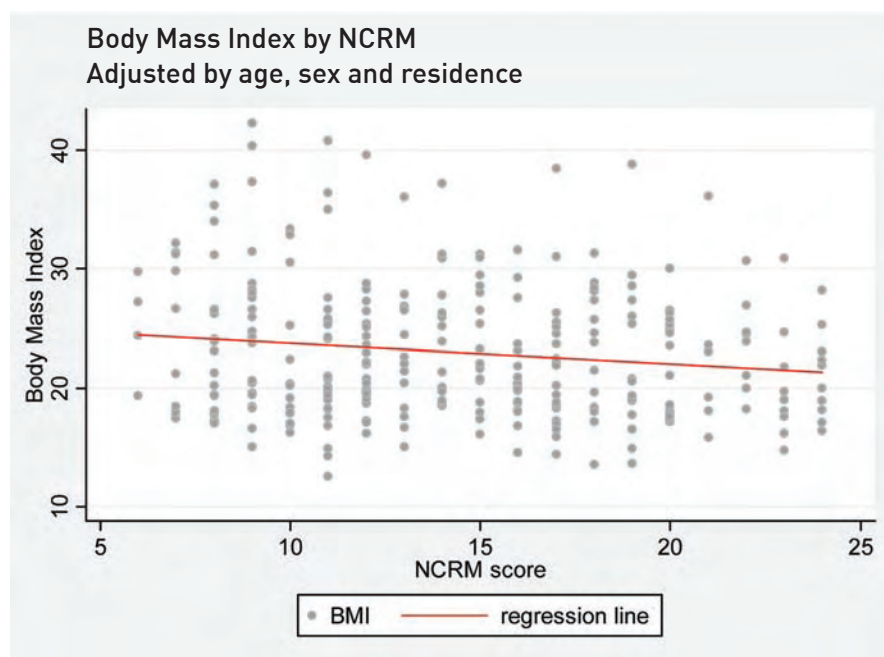
Healthy People: Human Health and ICNRM

In this cross-sectional study, increasing self-reported participation in ICNRM was associated with a range of health benefits across a broad range of risk factors and disease endpoints when adjusting for age, sex and primary place of residence. Increasing participation in ICNRM is associated with a more nutritious diet and greater levels of physical activity, although smoking prevalence exceeds 70% in this population regardless of ICNRM participation.

Nevertheless, risk factors for developing diabetes and cardiovascular disease showed significant inverse associations with ICNRM participation. This included the body mass index (BMI), a measure of appropriate body weight for a person's height (Figure 10). An elevated BMI (> 25) is associated with greater risk for cardiovascular disease and the development of diabetes (Wang and Hoy 2004).

Figure 10

The association between ICNRM and Body Mass Index (BMI). Linear regression adjusted for age, sex and primary place of residence. (From P.Burgess and F.Johnston)



Similarly, the population prevalence of Non-Insulin Dependent Diabetes Mellitus (NIDDM) displayed a significant inverse association with increasing ICNRM participation (NIDDM; Figure 11). NIDDM is associated with increased cardiovascular risk, kidney failure, blindness, ulcers and limb amputations. It is the greatest single cause of preventable Indigenous hospital admissions (ABS and AIHW 2005).

Increasing participation in ICNRM also had a significant inverse association with risk factors implicated in the development of NIDDM and cardiovascular disease. These included blood pressure, the presence of abdominal obesity, the presence of an elevated albumin-creatinine ratio (a urinary marker of cardiovascular and kidney disease risk) and glycosylated haemoglobin (a blood marker of diabetic and cardiovascular risk).

Finally, cardiovascular risk (CHD risk: an estimated risk of a heart attack occurring), calculated using the Framingham equations based on traditional risk factors of blood pressure, diabetes, smoking and elevated cholesterol (Anderson *et al.* 1991), displayed an inverse association with ICNRM involvement (Figure 12) but the sample lacked the necessary statistical power for the association to be significant beyond the 90% confidence interval.

Figure 11

The association between ICNRM participation and Non-Insulin Dependent Diabetes Mellitus (NIDDM)
Logistic regression adjusted for age, sex and primary place of residence. (From P.Burgess and F.Johnston)

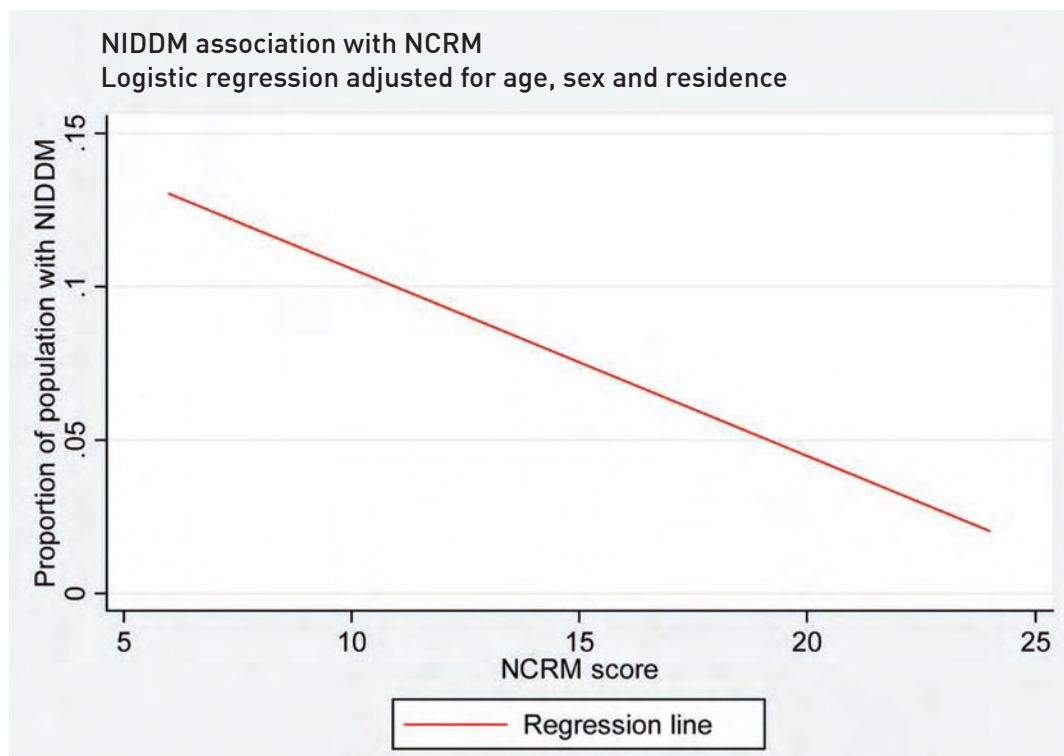
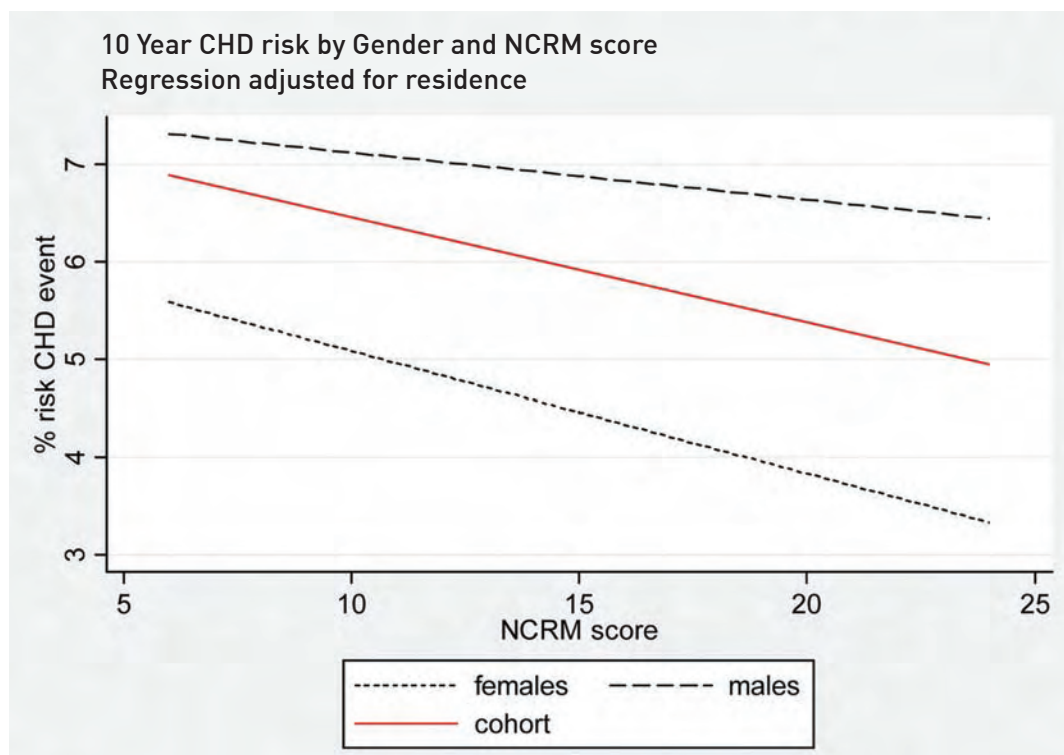


Figure 12

The association between ICNRM and 10 year risk of Coronary Heart Disease (CHD) for adults aged 30 to 54.
Linear regressions adjusted for primary place of residence. (From P.Burgess and F.Johnston)



Interpretation

Cardiovascular disease and diabetes account for 40% of excess Indigenous mortality and more than 21,800 potentially preventable hospital admissions each year (ABS and AIHW 2005). While a lower proportion of Indigenous people in remote areas reported one or more long term health conditions compared to those in non-remote areas, those living in remote areas reported significantly higher rates of diabetes/high sugar levels (9%), heart and circulatory diseases (14%), and kidney disease (3%). Diabetes/high sugar levels affected the activities of 20% of Indigenous people compared to 12% for non-Indigenous people (SCRGSP 2007). Chronic disease has a major effect on the functionality of Aboriginal societies and prophylactic interventions that will reduce the level will have a profound impact.

This exploratory study was supportive of Indigenous assertions of health gains linked to ICNRM but was, by design, unable to determine the causal direction of these associations. However, most chronic diseases have a long asymptomatic course before clinical presentation and diseases such as diabetes may improve markedly upon reinvigoration of ICNRM activities (O'Dea 1984). Ultimately this issue can only be resolved by following large groups of people over time to unravel the causal direction of ICNRM participation and health outcomes.

Nevertheless, the evidence is sufficient to support the proof of concept that investment in ICNRM appears to be an important strategy for the prevention of chronic diseases and their complications. Even from a narrow economic perspective, investment in ICNRM would result in substantial direct savings from health care costs saved and reduced individual and social impacts (Baker *et al.* 2005).



Leila Nimbadja gathering bush orchids: Being on country opens new economic opportunities, including bush tucker, bush products, artefacts and art



Broader Policy Implications

Many programs that have been successful in remote area communities such as 'ranger programs', art centres, and outstation resource centres have arisen organically through creative use of government programs such as working for welfare payments, rather than being the specific objective of a government program. However, there remains a remarkable paucity of evaluation of the efficacy of various Aboriginal programs or policy initiatives. Policy debate often reflects broader political agendas about Aboriginal issues but, without good evidence, it is difficult to advance these debates. Results from this project are relevant for several areas of policy and these are considered in the sections below.

Indigenous Disadvantage

In 2000 the Council for Aboriginal Reconciliation put forward the proposition that 'Aboriginal and Torres Strait Islander peoples should enjoy a similar standard of living to that of other Australians, without losing their cultural identity' (CAR 2000). In response, the Council of Australian Governments (COAG) commissioned the Steering Committee for the Review of Government Service Provision to produce a regular report against key indicators of Indigenous disadvantage for which there have now been two reports (SCRGSP 2005, 2007). There are 12 headline indicators:

- ▶ Life expectancy at birth;
- ▶ Disability and chronic disease;
- ▶ Years 10 and 12 retention and attainment;
- ▶ Post secondary education — participation and attainment;
- ▶ Labour force participation and unemployment (including CDEP and long term unemployment data);
- ▶ Household and individual income;
- ▶ Home ownership;
- ▶ Suicide and self-harm;
- ▶ Substantiated child abuse and neglect;
- ▶ Deaths from homicide and hospitalisations for assault;
- ▶ Family and community violence; and
- ▶ Imprisonment and juvenile detention rates.

The research reported here has direct relevance to the first two but potentially has relevance to all twelve. Ways in which these indicators might incorporate the concepts raised by this research are considered below.

In 2004 COAG also agreed to a National Framework of Principles for Government Service Delivery to Indigenous Australians (COAG 2004). Under the framework, the Commonwealth has developed a bilateral agreement with the Northern Territory government which now includes a schedule *Healthy Country, Healthy People: Supporting Indigenous Engagement in the Sustainable Management of Land and Seas* (OIPC 2006). This schedule establishes the principal that ICNRM is a legitimate area for government investment and identifies the following scopes for sustainable Indigenous management of land and seas:

- ▶ Natural and cultural resource management including biodiversity conservation;
- ▶ Land and sea monitoring and reporting for border protection, including assisting in the identification and reporting of domestic and foreign illegal fishing;
- ▶ Active participation in the sustainable economic use of land and sea in industry sectors such as mining, pastoralism, forestry, tourism, fisheries, aquaculture, horticulture, wildlife utilisation and the commercial provision of environmental services; and
- ▶ Practical maintenance of Indigenous knowledge, culture and heritage.

The scope includes acknowledgement of the cultural importance of environmental management and its potential for economic use of resources. It does not acknowledge, however, that investment in ICNRM may have the ancillary benefits for health explored here.

Health Policy

The first two headline indicators of Indigenous disadvantage identified by SCRGSP (2007), *Life expectancy at birth* and *Disability and chronic disease*, fall within the broad ambit of health policy. Despite over twenty years of medical research, the health gains for Aboriginal people have been smaller than might have been expected. The standard biomedical models need reappraisal (NHMRC 2002). Burgess, *et al.* (2005) argued that natural and cultural resource management provide a culturally appropriate vehicle for health promotion and disease prevention, through the associated improvements in diet, physical activity, autonomy and social and spiritual connection to land. They postulated that, for Aboriginal people, health is not just the physical well-being of the individual, but the social, emotional, and cultural well-being of the whole community. Aboriginal health is holistic, encompassing mental health and physical, cultural and spiritual health. Land and engagement with land is central to that well-being. Crucially, Aboriginal people believe that when the harmony of these interrelations is disrupted, their health will suffer.

In this respect the National Aboriginal and Torres Strait Islander Health Strategy: Framework for Action by Governments (NATSIHC 2003) recognises that improvement of Indigenous health status must include attention to physical, spiritual, cultural, emotional and social well-being, community capacity and governance. While it understandably has a major focus on health service provision, a key component of the framework is the promotion of health, through non-health sector strategies. These include education, employment, transport, food and nutrition, custodial health, aged and disability services, recreation and exercise. Clearly, initiatives such as increased employment opportunities through ranger programs, educational programs that support elders to teach young people about country and the practical support of those choosing to live on their homelands, all fit with this key component of the framework. Although no specific funding has been allocated for this, it is intended to 'guide all Australian governments in a coordinated, collaborative and multi-sectoral approach to achieving Aboriginal and Torres Strait Islander health gain over the next decade' (Anderson 2004).

Presently the health needs of Indigenous Australians are largely met through the funding and delivery of mainstream health services, with services specially targeting Aboriginal and Torres Strait Islander people complementing these mainstream services (DHAC 2000). This project looks at the nexus between health and ICNRM and concludes that the health outcomes associated with ICNRM may help prevent or delay significant causes of premature disease and death, delivering significant economic savings in health care expenditure. ICNRM can be considered a legitimate health promoting activity and is consistent with the Ottawa Charter on Health Promotion (WHO 1986) and with the Be Active Australia policy (DHAC 2005). Physical activity, particularly communal physical activity as part of participation in organised sport, arts or community group activities, is one of the key indicators of functional and resilient families and communities (SCRGSP 2007). However, the traditional health promotion 'lifestyle messages' of increasing physical activity and improving nutrition have achieved little impact on the burden of chronic diseases in remote Indigenous communities. Initiatives like the \$1.1 billion package to promote better health among Australians (COAG 2006) are likely to deliver little benefit to remote Indigenous communities. A reconsideration of how these messages are articulated and facilitated is suggested by this project. Involvement in ICNRM appears to deliver the opportunities for activity and improved nutrition while also contributing to environmental improvements. This suggests that involvement in ICNRM constitutes a substantial reservoir of community strengths from which improved primary and secondary prevention outcomes could be obtained.

The ethnographic research also raises issues relating to health research policy. The findings from this project support the need for Indigenous-voiced health promoting activities to be taken seriously and investigated. Indigenous health research in Australia has traditionally focussed on the documentation of excess morbidity and mortality rates in Indigenous populations. While these statistics continue to demand urgent action to redress pervasive health inequalities, this approach, while furthering knowledge, "has not contributed in a significant or systematic way to improved health outcomes for Indigenous and Torres Strait Islander populations" (NHMRC 2002). Indigenous commentators have demanded a change in focus of research activity to 'what works' including a focus on social and cultural determinants of health, factors contributing to resilience and prevention of disease, coupled with an awareness that innovative solutions may come from outside the confines of the health sector (NHMRC 2002).

In doing so, Indigenous Australians have invoked key principles also articulated in several World Health Organisation conceptual frameworks for the promotion of health and the care and prevention of chronic conditions. Addressing social disadvantages requires the creation of healthy public policy across a range of sectors with a focus on community control and participation in the policy process (WHO 1986, 2005, NHMRC 2002).

Indigenous Economic Development

Ever since the Indigenous disadvantage was raised at COAG in 2000, economic development has been identified as central to improving the well-being of Indigenous Australians (SCRGSP 2005, 2007). The fourth schedule to the bilateral agreement *Boosting Indigenous Employment and Economic Development* (OIPC 2006), the Northern Territory Indigenous Economic Development Strategy (Northern Territory Government 2005), identifies cultural and natural resources management as a key sector for development in the next 15 years because of the links between ICNRM and enterprise development on country. As part of this policy the Commonwealth Government aims to move as many people currently employed under the Community Development Employment Projects (CDEP) Program into full time positions (DEWR 2005).

ICNRM is the fastest growing movement in remote areas of the Top End (Storrs *et al.* 2003; Sithole *et al.* in press). The number of CDEP positions for ICNRM currently exceeds 350 and is growing, signalling the importance of ICNRM to Indigenous and remote areas employment policy (Storrs *et al.* 2003). However, there is a perception among some Aboriginal people engaged in ranger programs supported by CDEP that their efforts are undervalued. Aboriginal leaders are increasingly critical of the 'welfare mentality' that has developed since the recognition of citizenship rights in 1967. Social security benefits are known in Aboriginal English as 'sit down money'; they are widely recognised as sapping economic enterprise and a work ethic that had developed in the pastoral industries (Pearson 2001). Recent investments will ensure that the number of full time funded positions for ICNRM does increase but more investment is needed to strengthen the participation of Aboriginal communities in the remote economies and recognise ICNRM as a viable and important employment opportunity. ICNRM is clearly central in Aboriginal culture and potentially represents a successful contemporary model of employment through caring for country programs and indigenous ranger activities.

Another area of economic policy directly relevant for this discussion is the development of ICNRM based enterprises based on country. Many Aboriginal people involved in ICNRM are also involved in enterprise projects that have been established. Livelihoods that marry economic independence with culturally appropriate jobs and lifestyles demand the development of enterprises that realise social goals, such as integrating employment for community members, building a skill-base and providing essential services in remote regions, while sustainably exploiting natural resources (Altman and Cochrane 2003, Altman and Whitehead 2003, Bowman and Davies in press). Though the potential for profitable enterprises varies from community to community, the level of interest and involvement in ICNRM based enterprises is growing and needs to be supported. Critically, a balance needs to be found between wildlife-based enterprise and animals rights based agendas embedded in conservation legislation.

Education, Governance and Justice

This research did not explore explicitly the potential educational, governance and legal benefits that might derive from ICNRM. However other research suggests that they may be considerable. For instance, experience in Canada suggests that junior ranger programs can be successful in engaging young Indigenous people in activities on country and other meaningful pursuits when other approaches have failed (Schwab 2006). Also Sithole *et al.* (in press) found that there was motivation among those involved in ranger activities to increase levels of numeracy and literacy. They found that the ranger program had improved adult numeracy and literacy levels in most of the remote communities they visited. Numeracy and literacy training was offered as part of a suite of courses delivered to rangers and becoming literate and numerate had opened new opportunities for many people in the communities, with benefits flowing to families and others not involved in the ranger program.

Sithole *et al.* (in press) also commented that institutional structures for ICNRM combining customary authority and knowledge, statutory land ownership and management roles with techniques drawn from western knowledge provide Traditional Owners with mechanisms for promoting partnerships, advocacy, creating linkages between stakeholders, facilitating research and coordinating activities on country. Ranger groups and associated networks make it easier to coordinate support for land and sea management. Though ranger groups were constituted primarily as structures focusing on environmental concerns, they are also seen as development nodes. The ranger group has, in some communities, become the focal point of interactions with external interest groups and offers a functional and legitimate institutional base from which to develop environmental and related programs in Aboriginal communities.

Many of the participants in the ethnographic research as well as the ranger evaluation commented on the benefits of being away from the tensions and temptations of townships. Nothing was quantified but a legitimate area of research would be to test the extent to which involvement in ICNRM is associated with abstinence from substance abuse and avoidance of negative interactions with the law. There is a tendency among policy makers to assume that remote communities are equivalent to very remote outstations but Aboriginal informants were adamant that there are major differences, with involvement in ICNRM allowing participants to benefit from those differences.

Housing Policy and Outstations

One of the most contentious questions to arise from this research is the extent to which ICNRM relies on ongoing support for outstations. Famously described as ‘cultural museums’ by Senator Amanda Vanstone, and portrayed in terms that suggest complete policy failure, the reality is much more complex (Altman 2006). This research did not compare health outcomes between people on outstations and those in communities. It was deliberately designed to test activity not location. However, the expense and difficulty in reaching many outstations effectively means that active and continuous land management does require residency in outstations. This in turn has implications for housing policy, a key national indicator and one of the principal schedules under the bilateral agreement between the Northern Territory and Commonwealth governments.

If ICNRM is supported as legitimate employment then many of the underlying issues relating to outstations are no longer as difficult: there are many non-Indigenous people living in very remote areas undertaking tasks that are considered legitimate. They face difficulties but are supported in terms of, for example, salary, distance education and tax incentives. Having an income allows purchase of a vehicle and fuel and access to supplies. However a model where CDEP is the only income for rangers can de-legitimise ICNRM while making outstation residence harder because there is so little endogenous income.

Environmental Policy

The *Healthy Country, Healthy People* schedule of the Bilateral Agreement is a measure of the extent to which ICNRM has become a feature of conservation policy in the Northern Territory. The schedule commits to supporting “the effective engagement of Indigenous people in the decision making and management process in this area, including taking a more focused and coordinated approach to the implementation of existing, and development of new policies, legislation and programs” (OIPC 2006). Further, there is a recommendation that the schedule “must take full account of Indigenous aspirations, priorities and preferences”.

There are many examples that illustrate the extent to which the concept has already been institutionalised.

The Integrated Natural Resource Management plan for the Northern Territory *Sustaining Our Resources – People, Country and Enterprises* underlines the role of all stakeholders in achieving the objectives of the plan and recognises the importance of continuing to involve Traditional Owners.

The *Northern Territory Government’s Parks and Reserves (Framework for the Future) Act 2003* establishes joint management arrangements between the Northern Territory Government and Traditional Owners, acknowledging the role of Indigenous knowledge and culture in Parks management.

At a Commonwealth level the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBCA) recognises the role of Traditional Owners and promotes their involvement in ICNRM. The principal objectives of the Commonwealth Biodiversity Strategy focus on the recognition of Indigenous Knowledge and practices, its application and sustainable use. The main elements of this law are to:

- ▶ Promote a cooperative approach to the protection and management of natural resources;
- ▶ Recognise the role of Indigenous people in conservation and sustainable use of biodiversity; and
- ▶ Promote the use of Indigenous knowledge and practices in biodiversity.

Despite the existence of an appropriate institutional framework, Whitehead (2002) finds that Traditional Owners continue to be recipients of services rather than active partners in developing and implementing improved natural resource management and conservation practice (Whitehead 2002, Lane, 2002).

The trend towards developing policies and processes to facilitate or strengthen the participation of Traditional Owners in ICNRM through investment by government mirrors trends in other parts of the world where advocacy to recognise and integrate Indigenous knowledge and practices in ICNRM policy have been increasing. However, government recognition of the role of Aboriginal people in ICNRM needs to be adequately supported and government funding streams dedicated to ICNRM needs to be institutionalised.

The level of engagement by Aboriginal people in ICNRM is well documented and this study presents further evidence that there is much interest and participation by Traditional Owners to participate in cultural natural resources management either formally through Aboriginal ranger groups or as family groups and individuals. For the latter, homelands are a setting that is very strongly associated with ICNRM. A substantial amount of management requires that people live on the land. Because transport and road infrastructure is limited, this effectively this means people living on outstations. The expansion of ICNRM activities in remote Indigenous communities despite highly constrained resourcing demonstrates the viability and cost effectiveness of the program.

Trans-disciplinary Policy Research

Most research is segregated into disciplines with little reference to the perspectives of others. Policies designed to improve Aboriginal health have not even begun to integrate these perspectives, underscoring the inherent western view that human health is largely decoupled from the natural environment. This study brought together Traditional Owners and researchers from multiple disciplines to respond to Indigenous requests to investigate 'what works' with a focus on cultural and social drivers of improved health and ecological outcomes and supports the need for further research in this area. Further studies with more robust methods are required to replicate or refute these findings and to clarify the causal direction of the association.

What is more difficult to explain is why the fundamental importance of the nexus between Aboriginal well-being and their land that is espoused by Aborigines and anthropologists has not already been effectively integrated into policy aimed at improving Aboriginal well-being. This is despite recognition of Aboriginal legal rights to land and natural resources throughout remote areas of Australia. We suspect there are several reasons for this apparently counter-intuitive situation. First, the testimony of Aboriginal people is a difficult basis on which to develop policy, particularly in land management and medical settings where quantitative

evidence is often given much higher weighting than 'hearsay'. Thus the rich and moving anthropological literature, such of that by Rose (1996), is largely discounted from specific policy debates. The presentation of Aboriginal testimony by non-indigenous people (such as is the case here) is open to criticism of bias or selective reporting. In any case, Aboriginal testimony is also open to conflicting interpretations. Culturally specific issues of 'health', 'well-being', 'place' and 'identity' are culturally complex topics and difficult subjects to discuss without the appropriate context and experience. This problem is compounded given that much testimony is provided in limited English given the acute difficulty in finding appropriate interpreters to assist interviews. Secondly, it is very difficult to operationalise the testimony into specific policy settings or interventions, particularly those that cut across separate administrative sectors such as health care and land management.

Nevertheless, there is a strong case both to attempt the trans-disciplinary research needed to understand the relationship between healthy country and healthy people and to develop the policies and performance indicators that might be derived from such research.

Monitoring and Evaluation

ICNRM, culture and engagement with country

In measuring progress towards removing Indigenous disadvantage, the SCRGSP (2007) assessed strategic change indicators against seven criteria:

- ▶ Relevance to priority outcomes;
- ▶ Sensitive to policy interventions and changes in policy settings;
- ▶ Actions in the strategic areas for action result in positive outcomes over time in the headline indicators;
- ▶ Meaningful to stakeholders and principally to the Indigenous community;
- ▶ Supported by strong logic or empirical evidence;
- ▶ Unambiguous and clear in meaning and interpretation; and
- ▶ The existence of, or ease of developing, supporting data sets.

However, while there was widespread agreement that a cultural indicator was needed, none could be agreed that met these criteria.

There is also widespread agreement in the importance of land to Indigenous people. Even though nearly 40% of Indigenous adults living in non-remote areas did not recognise an area as their homelands in 2004-5, up by 50% over the previous decade (SCRGSP 2007), indicators relating to the relationship with land were universally considered important among Indigenous people. The importance of land to Indigenous people is also recognised at the highest levels of government:

"We recognise that communal interest in and spiritual attachment to land is fundamental to Indigenous culture." (Howard 2005)

"I recognise ... the spiritual importance of connectedness to country and of indigenous languages. And with others I celebrate the way indigenous culture is now so central to Australia's cultural expression to the world." (Howard 2007)

However, measures of connectedness to country are confined to considerations of access and identification, even though this information was missing for people in remote and very remote areas in the most recent survey. Thus, neither the health of culture nor the degree to which Indigenous people are actively fulfilling responsibilities to country are being measured in the national survey despite Indigenous and Prime Ministerial affirmation of its importance.

Similarly, the National Aboriginal and Torres Strait Islander Social Survey (NATSISS) aims to 'provide broad information across key areas of social concern and explore the extent of participation in society and the barriers to that participation'. The ethnographic information obtained here, and available in other anthropological literature, suggests that the definitions of 'key areas of social concern' and 'society' are not necessarily defined from an Indigenous perspective. The cultural indicators in NATSISS (ABS 2002) are:

- ▀ Identification with clan, tribal or language group'
- ▀ Attendance at cultural events'
- ▀ Participation in/payment for cultural activities;
- ▀ Main language spoken at home;
- ▀ Difficulty communicating with service providers;
- ▀ Whether speaks an Indigenous language;
- ▀ Recognition of homelands/traditional country; and
- ▀ Access to homelands/traditional country.

All these indicators are effectively passive indicators. The evidence here suggests that, even if people are living on or near country, identify strongly with traditional country and speak traditional languages fluently, there is a strong stratification across Indigenous society among those actively involved in the management of country and those who, for a variety of reasons, are not.

At the same time there is consensus among key stakeholders in ICNRM that frameworks must be developed which capture the multiple benefits derived from ranger programs and other similar initiatives. Yet some stakeholders in ICNRM have reported on environmental outcomes and have not known what to do with other outcomes (Sithole et al. 2007). Although outcomes deriving from ICNRM need to be considered at multiple levels - at the program level, at the group level and at the level of the communities, looking at what people say about the program and looking too at what individuals get out of the program - it is the specific benefits derived by individuals that might be the target of such an indicator.

To an extent the need for effective indicators of ICNRM activity is being considered under the *Healthy Country, Healthy People* Schedule to the overarching agreement on Indigenous Affairs where monitoring and evaluation will be developed for some or all of the following features (OIPC 2006):

- ▀ Levels of Indigenous engagement, including qualitative information on the development of land and sea management plans, governance arrangements for Indigenous groups and the experiences of Indigenous people working in this area;
- ▀ The biodiversity conservation, resource security and border protection outcomes being achieved by Indigenous people, including through the Indigenous Protected Areas program;
- ▀ CDEP contribution to Indigenous land and sea management activities and the transition of people from CDEP to independent seasonal, part-time or full-time work;

- ▶ Numbers of Indigenous people engaged in both accredited and non-accredited natural and cultural resource management training activities, as well as literacy and numeracy, administration and business and other types of training provided by government agencies linked to employment pathways;
- ▶ Levels and types of employment for Indigenous people engaged in land and sea management;
- ▶ Delivery of small business advice and support programs for Indigenous people seeking to explore economic development opportunities associated with this area;
- ▶ Consideration, and take-up of these economic development opportunities, including the numbers of business plans developed and start-ups, with ongoing analysis of the reasons for success and failure;
- ▶ Numbers of young people and women engaged in land and sea management activities and qualitative information on the maintenance and passing on of traditional knowledge as appropriate;
- ▶ Levels of natural resource management grant funding being used by Indigenous groups to support land and sea management activities;
- ▶ The administrative burden placed on Indigenous groups by funding arrangements and reporting requirements for Indigenous groups, including Indigenous land and sea rangers, accessing government support in this area;
- ▶ Ownership of intellectual property by Indigenous people (pre-existing and gained through proposed processes) is recognised as an important issue, particularly access to and ownership of data collected as a result of processes stemming from the implementation of this schedule;
- ▶ Related social, physical and mental health benefits; and
- ▶ Specific actions and new approaches taken by agencies to directly support delivery of the schedule, together with resource impact assessments.

Building on these measures and the research reported here, engagement in ICNRM could be used to form the basis of a response to a demand for a cultural indicator. It can be assessed against the SCRGSP criteria in Table 2.

Measurement of engagement in ICNRM at a national level would achieve four desirable outcomes:

- ▶ Go some way towards satisfying Indigenous aspirations for a national measure of cultural health, especially that linked to land. Even though the complex interconnectedness of country, identity and spirituality has been argued by a leading Aboriginal health professional as fundamental to understanding Aboriginal health in Australia today (Anderson 1995), current indicators lack reference to any Aboriginal concept of health;
- ▶ Allow comparative analysis with other policy measures aiming to overcome Indigenous disadvantage;
- ▶ Draw on the many non-environmental benefits being derived from ICNRM; and
- ▶ Reinforce local policy initiatives aiming to increase involvement in ICNRM.

Table 2

Potential for engagement in ICNRM as a strategic change indicator for Overcoming Indigenous Disadvantage.

Criteria for selection as an indicator	Potential for use of ICNRM engagement
Relevance to priority outcomes disease	At least: Life expectancy at birth; and Disability and chronic
Sensitive to policy interventions and changes in policy settings	Sensitive to policies that might support ICNRM and outstation residency
Actions in the strategic areas for action result in positive outcomes over time in the headline indicators	Relevant to at least: Life expectancy at birth; and Disability and chronic disease
Meaningful to stakeholders and principally to the Indigenous community	Indigenous people in this survey self-reported activity effectively
Supported by strong logic or empirical evidence	Proof of concept tested here corroborating existing data
Clear and unambiguous in meaning and interpretation appropriately	Self-reporting undertaken here could be adapted
The existence of, or ease of developing, supporting data sets	This data has not been collected. Could readily be added to NATSISS surveys

Ecosystem Health

National State of the Environment reporting considers the condition, pressures and associated responses against eight themes (ASEC 2006):

- Biodiversity
- Coasts and oceans
- Land
- Natural and cultural heritage
- Atmosphere
- Human settlements
- Inland waters
- Australian Antarctic Territory.

The research reported here has particular relevance to policies aimed at improving the environmental indicators relating to biodiversity, land, coasts, and inland waters and some relevance to all but the last. The tools developed to assess landscape health through remote sensing and techniques that can be applied easily by those practicing ICNRM have the potential to feed directly into State of the Environment reporting.

However, all numerical indicators needed for SOE reporting currently refer to physical entities on non-Indigenous measures of pressure and response. For the first time, however, SOE reporting in 2006 considered environmental management by Indigenous people (Brown *et al.* 2006). Although the reporting is at this stage a set of case studies and no quantitative measures of involvement have been developed, it provides a precedent into which the environmental indicators being developed under the *Healthy Country, Healthy People* Schedule to the bilateral agreement can feed.

Cautions Required in Using the Study

Establishing the causal link between ICNRM and health requires further research following populations over time. This was always intended to be an exploratory study. These preliminary findings, while supportive of Indigenous assertions of health gains linked to ICNRM, need to be viewed within the study limitations. More robust studies are required to support these findings. A cross-sectional study cannot determine if ICNRM prevents chronic diseases or if chronic diseases preclude ICNRM participation. Two points may favour the former. First, many chronic diseases have a long asymptomatic course prior to clinical presentation. Second, chronic diseases such as diabetes may improve markedly upon reinvigoration of ICNRM activities (O'Dea *et al.* 1988). Ultimately this issue can only be resolved by following large groups of people over time to unravel the causal direction of ICNRM participation and health outcomes.

Our measurement of ICNRM may not be transferable to other communities who may define ICNRM differently. This study used community derived definitions of ICNRM so it is not a health evaluation of formal ranger programs, even though the role of ranger programs appears to overlap with community derived definitions and practices of ICNRM as described previously.

The landscape health research was also designed to examine broad trends and also requires testing. There is a danger that enthusiasm to support ICNRM may occur too broadly before the circumstances under which it delivers health, environmental or other benefits are fully understood. Should this occur, inevitable failures and instances of poor performance may undermine faith in the concept because the research will not have been done to identify the causes of failure. The ranger evaluation (Sithole *et al.* 2007), in which much of the evaluation was undertaken by the rangers themselves, demonstrated that only some ranger groups were successful, stable or secure. Investments in ICNRM must be managed adaptively so that failure is documented and seen as an opportunity to learn. A substantial proportion of investment should be used to build capacity.

The final caution is that control of ICNRM needs to remain with the Aboriginal practitioners. Provision of outside funds risks driving agendas away from Aboriginal aspirations. Increased funding will require increased capacity to manage and account for the expenditure of those funds; capacity which is rarely available in remote communities where the ICNRM occurs. The policies that govern fund accountability also, perversely, contain the seeds of policy failure. The reason is that ICNRM is qualitatively different to non-Indigenous environmental management because there are different motivations for involvement. One key aspect of designing new programmes will be in marrying the competing objectives of ICNRM. There is ample evidence that ICNRM is a cultural activity with cultural objectives. Whether objectives concerning landscape or human health are also met is at least partly a by-product of cultural activity. But funding agencies commonly measure success in terms of area of weed sprayed, land burnt, documents delivered or even meetings attended. Financial reporting can sometimes be the only reporting undertaken, because rigorous systems are needed to account for expenditure of public funds. Multiple accounting stances that need to be aligned before a return on investment can be calculated. Where an Indigenous manager might think a project was enormously successful because particular clan lands had been visited, songs sung and country burnt in accordance with traditional custom, a western manager may fret that the primary use of the project vehicle appeared to be to reach favoured hunting and fishing sites and there was no deliverable trip report. Yet the outcome on the ground may have a close correspondence with the objectives desired by all parties. Negotiation on the scope and metrics of return on investment is therefore essential.



Synthesis

The Aboriginal views expressed during this study about the interconnectedness between people and country, and how this promotes the well-being of both land and the people, are consistent with previous accounts from Aboriginal people and other ethnographic studies. To date, however, there has been very little attempt to understand Aboriginal participation in ICNRM in an integrated way. Existing assessments of ICNRM tend to focus a particular sector. Most reports emphasise the biophysical benefits rather than any cultural, social, political, economic or health benefits. Traditional focus on the environmental benefits in turn has tended to render other benefits invisible even when Aboriginal people were underlining them. Even now other benefits tend to be grouped within employment (Sithole et al. in press). The need for an integrated assessment framework is clearly evident and underlined by the proof of concept presented here. Cross-disciplinary research has revealed the strong interactions among social and other ICNRM related benefits thus suggesting a need for closer collaboration among sectors to strengthen the areas of complementarity among agencies.

The health of the Northern Australian savannas is a key component of the national conservation strategy and a source of concern given recent evidence of biodiversity loss and human induced changes to vegetation. Aboriginal land tenure is a major tenure class with potential to make a key contribution to biodiversity conservation in the region both because it is widespread and because traditional land management skills are associated with the successful maintenance of biodiversity. A major driver of biodiversity loss is thought to be the decline of traditional Aboriginal fire management.

Anthropologists have clearly and repeatedly articulated the close connection between ICNRM and health yet there has been little integration of this research in official health policy. There is an expectation that Indigenous health initiatives be associated with improved outcomes in areas responsible for the greatest burden of disease and death. Results from this study indicate that higher levels of ICNRM participation are associated with better outcomes across an array of risk factors linked to diabetes and cardiovascular risk. While the findings are supportive of Indigenous assertions of health gains linked to ICNRM, they need to be viewed within the study limitations. Further studies with more robust methods are required to replicate or refute the findings and clarify the causal direction of the association. Nevertheless the signals are sufficiently strong to justify both the recent investments to support Indigenous resource managers and further investment in the future.

Healthy Country, Healthy People is a unifying concept for development and conservation and addresses the key pillars of sustainable development as defined by the ESD and the WSSD. This project underlines that there are significant ecological, health benefits to be derived from ICNRM and emphasises that there are likely to have been other benefits which were not the focus of this study. The results provide a positive message for Aboriginal people involved in ICNRM and is important justification for further adequate or co-investment in ICNRM. Almost certainly, health

benefits derived from ICNRM have the potential to deliver significant economic savings in terms of health care and related costs for Aboriginal people that have been avoided or reduced through prevention of chronic diseases or at least a delay in their occurrence. There is a need to review current investments to ensure that their scale is congruent with the seriousness of both the environmental and human problems confronted in remote and regional north Australia, and the anticipated benefits of this integrated approach.

This project underlines a range of significant benefits derived from ICNRM and provides justification for increased investment and co-investment. Importantly, outcomes are not always necessarily or exclusively environmental. Agencies that have traditionally dismissed ICNRM as a domain of environmental agencies need to recognise and embrace the opportunities being presented and invest in the program.

Recommendations

The following recommendations are derived from the research:

- ▶ Consolidate and institutionalise the new investments in ICNRM which this research demonstrates are likely to provide benefits in multiple policy domains;
- ▶ Ensure additional investments incorporate adequate capacity building in management, using a process in which both successes and failures are used for learning;
- ▶ Quantify other ancillary benefits of ICNRM to expand the proof of concept beyond physical health and the environment. In particular, describe the impact of engagement in ICNRM on educational, economic, employment, governance and judicial indicators as well as mental health. This would help determine whether involvement in ICNRM can be considered an integrative force in Indigenous policy;
- ▶ Obtain a deeper understanding of the relationship between residence on outstations and ICNRM and its ancillary benefits, particularly a comparison between investment in ICNRM in very remote areas and other types of policy delivery; and
- ▶ Develop national indicators for involvement in ICNRM that can be reported alongside those that measure Indigenous disadvantage and the State of the Environment.

References

- Abbott, I. 2002. Origin and spread of the cat, *Felis catus*, on mainland Australia, with a discussion of the magnitude of its early impact on native fauna. *Wildlife Research* 29:51-74.
- Altman, J. 2001. *Sustainable development options on Aboriginal land: the hybrid economy in the 21st Century*. CAEPR Discussion Paper 226/2001. Australian National University, Canberra.
- Altman, J. 1987. *Hunter Gatherers Today: An Aboriginal economy in north Australia*. Australian Institute of Aboriginal Studies, Canberra.
- Altman, J.C. 2006. *In search of an outstations policy for Indigenous Australians*. CAEPR Working Paper 34/2006. Australian National University, Canberra.
- Altman J. and Cochrane M. 2003. *Sustainable development in the indigenous owned savannas: innovative institutional design for cooperative wildlife management*. CAEPR Discussion Paper 247, Australian National University, Canberra.
- Altman, J. C. and Whitehead, P. J. 2003. *Caring for country and sustainable Indigenous development: Opportunities, constraints and innovation*. CAEPR Working Paper 20/2003, Australian National University, Canberra.
- Andersen, A.N., Cook, G.D. and Williams, R.J. eds. 2003. *Fire in Tropical Savannas. The Kapalga Experiment*. Springer, New York.
- Anderson, K.M., Wilson, P.W.F., Odell, P.M. and Kannel, W.B. 1991. An updated coronary risk factor profile: a statement for health professionals. *Circulation* 83:356-362.
- Anderson, I.P.S. 2004. Recent developments in national Aboriginal and Torres Strait Islander health strategy. *Australian and New Zealand Health Policy* 1:3 doi:10.1186/1743-8462-1-3.
- Anderson, P. 1995. *Priorities in Aboriginal Health Aboriginal Health: Social and cultural transitions*. Darwin, Charles Darwin University.
- Anonymous 1999. *Kakadu National Park Plan of Management, Kakadu Board of Management and Parks Australia*. Commonwealth of Australia, Jabiru.
- Archer, S. and Schimel, D.S. 1995. Mechanisms of shrubland expansion: land use, climate or CO₂. *Climatic Change* 29:91-99.
- ABS (Australian Bureau of Statistics) 2002. National Aboriginal and Torres Strait Islander Social Survey, 2002. Catalog number 4714.0.
- ABS and AIHW (Australian Bureau of Statistics & Australian Institute of Health and Welfare) 2005. *The health and welfare of Australia's Aboriginal and Torres Strait Islander Peoples, in ABS Catalogue No. 4704.0*. Australian Bureau of Statistics & Australian Institute of Health and Welfare, Canberra.
- ASEC (Australian State of the Environment Committee) 2006. *Australia State of the Environment 2006: Independent report to the Australian Government Minister for the Environment and Heritage*. Department of Environment and Heritage, Canberra.
- Baker, P.R., Hoy, W.E. and Thomas, R.E. 2005. Cost-effectiveness analysis of a kidney and cardiovascular disease treatment program in an Australian Aboriginal population. *Advances in Chronic Kidney Disease* 12: 22-31.
- Berndt, R. M. and Berndt, C. H. 1970. *Man, land and myth: the Gunwinngu people*. Ure Smith, Sydney.

- Bowman, D.M.J.S. and Davies, J. in press. Indigenous Land Use. in P.A. and B.Wilson ed. *Ecology: An Australian Perspective* (Second Edition). Oxford University Press, Oxford.
- Bowman D.M.J.S., Franklin D, Price O.F. and Brook B.M. 2007. Land management affects grass biomass in the *Eucalyptus tetrodonta* savannas of monsoonal Australia. *Austral Ecology* 32:446-452.
- Bowman, D.M.J.S. and Panton, W.J. 1993. Decline of *Callitris intratropica* R.T. Baker & H.G. Smith in the Northern Territory: implications for pre- and post-European colonization fire regimes. *Journal of Biogeography* 20: 373-81.
- Bowman, D.M.J.S., Price, O., Whitehead, P.J. and Walsh, A. 2001. The 'wilderness effect' and the decline of *Callitris intratropica* on the Arnhemland Plateau, northern Australia. *Australian Journal of Botany* 49:1-8.
- Bowman, D.M.J.S., Walsh, A. and Prior, L.D. 2004. Landscape analysis of Aboriginal fire management in Central Arnhemland, north Australia. *Journal of Biogeography* 31: 207-23.
- Bowman, D.M.J.S. and Wilson, B.A. 1988. Fuel characteristics of coastal monsoon forests, Northern Territory, Australia. *Journal of Biogeography* 15: 807-17.
- Braithwaite, R.W., Lonsdale, W.M. and Estbergs, J.A. 1989. Alien vegetation and native biota in tropical Australia: the impact of *Mimosa pigra*. *Biological Conservation* 48:189-210.
- Burgess, C. P., Johnston, F. H., Bowman, D. M. and Whitehead, P. J. 2005. Healthy country: healthy people? Exploring the health benefits of indigenous natural resource management. *Australian and New Zealand Journal of Public Health* 29: 117-22.
- Burgess, C. and Morrison, J. 2007. Country. pp.177-202. in Carson, B., Dunbar, T., Chenhall, R. and Baillie, R. eds. *Social Determinants of Indigenous Health*. Allen and Unwin, Sydney.
- Brook, B., Bowman, D., Bradshaw, C., Campbell, B. and Whitehead, P. 2006. Managing an endangered Asian bovid in an Australian national park: the role and limitations of ecological-economic models in decision-making. *Environmental Management* 38:463-469.
- Brown, R. and Creaser, P. (eds), Kerins, S. Lennon, J. and Liddy, M. 2006. *Indigenous involvement in environmental and heritage management', case studies prepared for the 2006 Australian State of the Environment Committee*. Department of the Environment and Heritage, Canberra.
- Carson, B., Dunbar, T., Chenhall, R. and Baillie, R. 2007. *Social Determinants of Indigenous Health*. Allen and Unwin, Sydney.
- Cochrane, M.J. 2005. *The Djelk ranger program: An outsider's perspective*. CAEPR working paper number 27/2005, Australian National University, Canberra.
- DHAC (Department of Health and Aged Care) 2000. *Health and Aged Care Portfolio Submission to the Commonwealth Grants Commission's Inquiry into Indigenous Funding*. Commonwealth Grants Commission, Canberra.
- Cook, G.D. and Dias, L. 2006. Turner Review No. 12: It was no accident: deliberate plant introductions by Australian government agencies during the 20th Century. *Australian Journal of Botany* 54: 601-625.
- Cook G.D., Ronce, O. and Williams, R.J. 1998. Suppress thy neighbour: the paradox of a successful grass that is highly flammable, but harmed by fire. pp. 71-74. in R. Weber ed. *Proceedings of the 13th Conference on Fire and Forest Meteorology*. International Association of Wildland Fire, Lorne.
- CAR (Council for Aboriginal Reconciliation) 2000. *National Strategies to Advance Reconciliation*. Council for Aboriginal Reconciliation, Sydney.
- COAG (Council of Australian Governments) 2004. *National Framework of Principles for Government Service Delivery to Indigenous Australians*. Accessed 4 June 2007 at http://www.coag.gov.au/meetings/250604/attachments_b.pdf
- COAG 2006. *Better Health for All Australians*. Accessed 4 June 2007 at <http://www.coag.gov.au/meetings/100206/index.htm#health>

- Crowley, G.M., Garnett, S.T. and Shephard, S. 2004. *Management guidelines for golden-shouldered parrot conservation*. Queensland Parks and Wildlife Service, Brisbane.
- CSIRO (Commonwealth Scientific and Industrial Research Organisation) 2004. Yellow crazy ant eradication begins in Arnhemland. *CSIRO Media release* PR04 123.
- Csurhes, S. and Edwards, R. 1998. *Potential Environmental Weeds in Australia: Candidate Species for Preventative Control*. Department of Environment and Heritage, Canberra.
- DEWR (Department of Employment and Workplace Relations) 2005. *Building on Success CDEP - Future Directions*. Commonwealth Government, Canberra.
- DEWR (Department of Environment and Water Resources) 2007. *Working on Country Programme*. Press release. Accessed 4 June 2007 at <http://www.environment.gov.au/indigenous/workingoncountry/index.html>
- DHA (Department of Health and Ageing) 1999. *National Physical Activity Guidelines for Adults*. Canberra, Australian Government.
- DHAC (Department of Health and Aged Care) 2005. *Be Active Australia: A Framework for Health Sector Action for Physical Activity 2005-2010*. DHAC, Canberra.
- Dunlop, C.R., Leach, G.J. and Cowie, I.D. 1995. *Flora of the Darwin region*. Conservation Commission of the Northern Territory, Darwin.
- Elliott, L.P., Franklin, D.C. and Bowman, D.M.J.S. submitted. Grass, settlement and fire frequency in *Eucalyptus miniata* savannas of the Darwin region of northern Australia. *International Journal of Wildland Fire*.
- Eyles, A.G., Cameron, D.G. and Hacker, J.B. 1985. *Pasture research in northern Australia - its history, achievements and future emphasis*. CSIRO Division of Tropical Crops and Pastures, Brisbane.
- Fisher, A., Hunt, L.P., James, C., Landsberg, J., Phelps, D.G., Smyth, A. and Watson, A. 2004. *Review of total grazing pressure management issues and priorities for biodiversity conservation in rangelands: a resource to aid NRM planning*. Desert Knowledge CRC and Tropical Savannas CRC, Alice Springs.
- Franklin, D.C. 1999. Evidence of disarray amongst granivorous bird assemblages in the savannas of northern Australia, a region of sparse human settlement. *Biological Conservation* 90:53-68.
- Franklin, D.C., Whitehead, P.J., Pardon, G., Matthews, J., McMahon, P. and McIntyre, D. 2005. Geographic patterns and correlates of the decline of granivorous birds in northern Australia. *Wildlife Research* 32:399-408.
- Franklin, D.C., Petty, A.M., Williamson, G.J., Brook, B.W. and Bowman, D.M.J.S. submitted. Monitoring contrasting land management in the savanna landscapes of northern Australia. *Environmental Management*.
- Garnett, S.T. and Crowley, G.M.. 2003. Cape York Peninsula. pp. 220-229 in Mittermeier, R.A., Mittermeier, C.G., Gil, P.R., Pilgrim, J. and Fonesca, G. eds. *Wilderness: Earth's Last Wild Places*. Cemex, Mexico City.
- Garnett, S.T., Woinarski, J.C.Z., Crowley, G.M. and Kutt, A.S. (in press). Biodiversity conservation in Australian tropical rangelands. In *Can Rangelands be Wildlands?: Wildlife and Livestock in Semi-arid ecosystems*. Edited by: Johan du Toit, Richard Kock and James Deutsch. Blackwell Scientific, London.
- Gorman, J., Saalfield, K. and Griffiths, A.D. 2007. Population estimate of feral buffalo and cattle on the Arafura Swamp, central Arnhemland. *Northern Territory Naturalist*.
- Griffiths, A.D. and McKay, J.L. 2005. *Monitoring the impact of cane toads on goanna species in Kakadu National Park, Kakadu National Park*. Department of Environment and Heritage, Jabiru.
- Head, L. 1994. Landscapes socialised by fire: post-contact changes in Aboriginal fire use in northern Australia, and implications for prehistory. *Archaeology in Oceania* 29:172-181.

- Hoffmann, B.D., and O'Connor, S. 2004. Eradication of two exotic ants from Kakadu National Park. *Ecological Management and Restoration* 5:98-105.
- Howard, J. 2005. *Interview with ABC Lateline*. Accessed 4 June 2007 at <http://www.abc.net.au/lateline/content/2005/s1380537.htm>
- Howard, J. 2007. *Address to 'Their Spirit Still Shines'*. Commemorating the 40th Anniversary of the 1967 Referendum Old Parliament House, Canberra. Accessed 4 June 2007 at <http://www.pm.gov.au/media/Speech/2007/Speech24341.cfm>
- Johnston, F., Bowman, D., Jacklyn, S. and Vickery A. 2006. Aboriginal testimony about health and place. (conference abstract) *International Geographical Union*. Brisbane. July 2006.
- Johnston, F.H., Jacklyn, S.P, Vickery, A.J. and Bowman, D.M.J.S. submitted. Ecohealth and Aboriginal testimony of the nexus between human health and place. *Medical Journal of Ecohealth*.
- Keen, I. 1988. *Being black: Aboriginal Cultures in 'settled' Australia*. Aboriginal Studies Press, Canberra.
- Koenig, J., Griffiths, A.D., Godjuwa, C., and Campion, O. 2003. Aerial Survey of vertebrates in the Mann River district, central Arnhemland, September 2000. *Northern Territory Naturalist* 17:7-19.
- Kuhnlein, H. V. and Receveur, O. 1996. Dietary change and traditional food systems of indigenous peoples. *Annual Review of Nutrition* 16:417-442.
- Lane M.B. 2002. Buying back and caring for country: Institutional arrangements and possibilities for Indigenous land management in Australia. *Society and Natural Resources* 15:827-846.
- Langton, M. 1998. *Burning questions : emerging environmental issues for indigenous peoples in northern Australia*. Northern Territory University, Darwin.
- Lonsdale, W.M. 1993. Rates of spread of an invading species: *Mimosa pigra* in northern Australia. *Journal of Ecology* 81: 513-521.
- Lonsdale, W.M. 1994. Inviting trouble: Introduced pasture species in northern Australia. *Australian Journal of Ecology* 19:345-354.
- McDermott, R., O'Dea, K., Rowley, K., Knight, S., Burgess, P. 1998. Beneficial impact of the Homelands Movement on health outcomes in central Australian Aborigines. *Australia and New Zealand Journal of Public Health* 22:653-658.
- Martin, T.G., Campbell, S.D. and Grounds, S. 2006. Weeds of Australian rangelands. *Rangeland Journal* 28:3-26.
- Martin, T.G. and van Klinken, R.D. 2006. Value for money? Investment in weed management in Australian rangelands. *Rangeland Journal* 28:63-75.
- Morice, R.D. 1976. Woman Dancing Dreaming: psychosocial benefits of the Aboriginal outstation movement. *Medical Journal of Australia* 2: 939-942.
- Murphy, B.P. and Bowman, D.M.J.S. 2006. The interdependence of fire, grass, kangaroos and Australian Aborigines: a case study from central Arnhemland, northern Australia. *Journal of Biogeography* 34: 237-250.
- NACCHO (National Aboriginal Community Controlled Health Organisation) and Oxfam (2007) *Close the Gap: Solutions to the Indigenous health crisis facing Australia*. Oxfam Australia, Carlton.
- NATSIHC (National Aboriginal and Torres Strait Islander Health Council) 2003. *National Strategic Framework for Aboriginal and Torres Strait Islander Health: Framework for Action by Governments*. NATSIHC, Canberra.
- NHMRC (National Health and Medical Research Council) 2002. *Report to the Aboriginal and Torres Strait Islander Research Agenda Working Group (RAWG): Final report of community consultations on the RAWG road map Canberra*.

- Natt, C. 2007. *Marine Ranger Groups Fight Illegal Fishers*. Press Release. Accessed 4 June 2007 at <http://www.nt.gov.au/dcm/ocm/media/index.cfm?fuseaction=viewRelease&id=2569&d=5>
- NLC (Northern Land Council) 2006. *Celebrating ten years of Caring for Country: A Northern Land Council initiative*. 2006. Darwin: Northern Land Council.
- NTG (Northern Territory Government) 2005. *Indigenous Economic Development Strategy*. Accessed 4 June 2007 at <http://www.nt.gov.au/cdsca/ied/docs/pop.pdf>
- O'Dea, K. 1984. Marked improvement in carbohydrate and lipid metabolism in diabetic Australian aborigines after temporary reversion to traditional lifestyle. *Diabetes* 33: 596-603.
- O'Dea, K., White, N.G. and Sinclair, A.J. 1988. An investigation of nutrition-related risk factors in an isolated Aboriginal community in northern Australia: advantages of a traditionally-orientated life-style. *Medical Journal of Australia* 148:177-80.
- OIPC (Office of Indigenous Policy Coordination) 2006. *Bilateral agreements*. Accessed 4 June 2007 at http://oipc.gov.au/bilateral_agreements/default.asp
- Pardon, G. L., Brook, B. W., Griffiths, A. D. and Braithwaite, R. W. (2003). Determinants of survival for the northern brown bandicoot under a landscape-scale fire experiment. *Journal of Animal Ecology* 72:106-115.
- Parr, C.L., and Andersen, A.N. 2006. Patch Mosaic Burning for Biodiversity Conservation: a Critique of the Pyrodiversity Paradigm. *Conservation Biology* 20: 1610-1619.
- Pavlov, P.M. 1995 Pig, *Sus scrofa*. Pp. 715-717 in Strahan, R. ed. *The Mammals of Australia*. Reed Books, Sydney.
- Pearson, N. 2001. *On the human right to misery, mass incarceration and early death*. Dr Charles Perkins Memorial Oration, The University of Sydney.
- Petty A.M. and Bowman D.J.M.S. submitted. A landsat and MODIS analysis of contrasting fire patterns in Aboriginal – and park managed lands in tropical north Australia. *Journal of Environmental Management*.
- Povinelli, E., 1993. *Labor's Lot. The Power, History, and culture of Aboriginal action*. University of Chicago Press.
- Preece, N. 2002. Aboriginal fires in monsoonal Australia from historical accounts, *Journal of Biogeography* 29:321-336.
- Press, A.J. 1987. Fire management in Kakadu National Park: the ecological basis for the active use of fire. *Search* 18:244-248.
- Rose, D. 1996. *Nourishing Terrains: Australian Aboriginal Views of Landscape and Wilderness*. Australian Heritage Commission, Canberra.
- Rose, D. 1992. *Dingo makes us human: life and land in an Australian Aboriginal culture*. Cambridge University Press, Cambridge.
- Rossiter, N.A., Setterfield, S.A., Douglas, M.D., Hutley, L.B. 2003. Testing the grass-fire cycle: alien grass invasion in the tropical savannas of northern Australia. *Diversity and Distributions* 9:169-176.
- Russell-Smith, J. 2002. *Pre-contact Aboriginal, and contemporary fire regimes of the savanna landscapes of northern Australia: patterns, changes and ecological processes*. Department of Environment and Heritage, Canberra.
- Russell-Smith, J. and Bowman, D.M.J.S. 1992. Conservation of monsoon rainforest isolates in the Northern Territory, Australia. *Biological Conservation* 59:51-63.
- Russell-Smith, J., Lucas, D., Gapindi, M., Gunbunuka, B., Kapiirigi, N., Namingam, G., Lucas, K., Giuliani, P., and Chalupouka, G. 1997. Aboriginal resource utilisation and fire management practice in western Arnhemland, monsoonal northern Australia. Notes for prehistory, lessons for the future. *Human Ecology* 25:159-196.

- Russell-Smith, J., McKenzie, N.L. and Woinarski, J.C.Z. 1992. Conserving vulnerable habitat in northern and north-western Australia: the rainforest archipelago. pp. 63-68 in Moffatt, I. and Webb, A. eds., *Conservation and Development Issues in Northern Australia*. North Australian Research Unit, Darwin.
- Russell-Smith, J., Ryan, P.G. and Cheal, D.C. 2002. Fire regimes and the conservation of sandstone heath in monsoonal northern Australia: frequency, interval, patchiness. *Biological Conservation*, 104:91-106.
- Russell-Smith, J., Ryan, P. G., Klessa, D., Waight, G. and Harwood, R. 1998. Fire regimes, fire-sensitive vegetation and fire management of the sandstone Arnhem Plateau, monsoonal northern Australia. *Journal of Applied Ecology* 35:829-846.
- Russell-Smith, J., Whitehead, P.J., Cook, G.D. and Hoare, J.L. 2003b. Response of *Eucalyptus*-dominated savanna to frequent fires: lessons from Munmarlary, 1973-1996. *Ecological Monographs* 73:349-376.
- Russell-Smith, J., Yates, C., Edwards, A., Allan, G.E., Cook, G.D., Cooke, P., Craig, R., Heath, B. and Smith, R. 2003a. Contemporary fire regimes of northern Australia, 1997-2001: change since Aboriginal occupancy, challenges for sustainable management. *International Journal of Wildland Fire* 12:283-297.
- Schwab, R.G. 2006. *Kids, skidoos and caribou: The Junior Canadian Ranger program as a model for re-engaging Indigenous Australian youth in remote areas*. CAEPR Discussion Paper 281/2006, Australian National University, Canberra.
- SCRGSP (Steering Committee for the Review of Government Service Provision) 2005. *Overcoming Indigenous Disadvantage: Key Indicators 2005*. Productivity Commission, Melbourne.
- SCRGSP (Steering Committee for the Review of Government Service Provision) 2007. *Overcoming Indigenous Disadvantage: Key Indicators 2007*. Productivity Commission, Melbourne.
- Scrymgeour, D. 2007. Town or country: which is best for Australia's Indigenous peoples? *Medical Journal of Australia* 186: 532-533.
- Setterfield, S.A., Douglas, M.M., Hutley, L.B., and Welch, M.A. 2005. Effects of canopy cover and ground disturbance on establishment of an invasive grass in an Australian savanna. *Biotropica* 37:25-31.
- Sinden, J., Jones, R., Hester, S., Odom, D., Kalisch, C., James, R. and Cacho, O. 2004. The economic impact of weeds in Australia. *CRC for Australian Weed Management Technical Series* 8:1-55.
- Sithole, B., O'Leary, P. and Hunter-Xenie, H. 2007. *Articulating Northern Territory Government's aspirations for outputs and outcomes from Indigenous NRM*. CSIRO, Darwin.
- Sithole B. and the Aboriginal land and sea management review group. In press. *Aboriginal land and sea management, a community driven evaluation*. CSIRO, Darwin.
- Skeat, A.J., East, T.J. and Corbett, L.K. 1996. Impact of feral water buffalo. Pp.155-177 in Finlayson, C. M. and von Oertzen, I. eds. *Landscape and Vegetation Ecology of the Kakadu Region, Northern Australia*. Kluwer Academic Publishers, Dordrecht.
- Storrs M., Cooke P. and Josif P.J. 2003. Caring for Country: the rapidly developing formalized structure for Aboriginal natural resource management in the northern land council region of the Northern territory. *Proceedings of the National Landcare Conference: 28 April -1 May 2003*. Darwin, Australia.
- Treasury Board of Canada 2005. *Canada's Performance 2005; the Government of Canada's Contribution*. Treasury Board of Canada, Ottawa.
- Wang, Z. and Hoy, W. 2004. Waist circumference, body mass index, hip circumference and waist-to-hip ratio as predictors of cardiovascular disease in Aboriginal people. *European Journal of Clinical Nutrition* 58:888-893.
- Watson, M. and Woinarski, J.C.Z. 2004. *Vertebrate monitoring and resampling in Kakadu National Park*, 2003. Parks Australia North and Parks and Wildlife Commission of the Northern Territory, Darwin.

- Werner, P.A. 2005. Impact of feral water buffalo and fire on growth and survival of mature savanna trees: an experimental field study in Kakadu National Park, northern Australia, *Austral Ecology* 30:625-647.
- Werner, P.A., Cowie, I.D. and Cusack, J.S. 2006. Juvenile tree growth and demography in response to feral water buffalo in savannas of northern Australia: an experimental field study in Kakadu National Park. *Australian Journal of Botany* 54:283-296.
- Wheeler, J.R., Rye, B.L., Koch, B.L. and Wilson, A.J.G. Eds. 1992. *Flora of the Kimberley Region of Western Australia*. Department of Conservation and Land Management, Perth.
- Whitehead, P.J., Wilson, B.A. and Bowman, D.M.J.S. 1990. Conservation of coastal wetlands of the Northern Territory of Australia: The Mary River Floodplain. *Biological Conservation* 52:85-111.
- Whitehead, P.J., Woinarski, J.C.Z., Jacklyn, P., Fell, D. and Williams, D. 2000. *Defining and measuring the health of savanna landscape: an Australian perspective*. Tropical Savannas CRC, Darwin.
- Whitehead, P.J. 2002. *Inquiry on Capacity Building in Indigenous Communities*. A submission to the House of Representatives Standing Committee on Aboriginal and Torres Strait Islander Affairs. Parliament House, Canberra.
- Whitehead, P.J. 1999. Is it time to fill the north's empty landscapes? *Savanna Links* Sep/Oct 1999:6-7.
- Whitehead, P. J., Bowman, D. M., Preece, N., Frazer, F. and Cooke, P. 2003. Customary use of fire by indigenous peoples in northern Australia: its contemporary role in savanna management. *International Journal of Wildlife Fire* 12:415-425.
- Whitehead, P.J., Woinarski, J.C.Z., Franklin, D. and Price, O. 2003. Landscape ecology, wildlife management and conservation in northern Australia: linking policy, practice and capability in regional planning. pp. 227-259 in Storch, I. and Bissonette, J. A. *Landscape Ecology and Resource Management: Linking Theory with Practice*. Island Press, Washington.
- Williams, R.J., Griffin, A.J. and Allen, G.E. 2002. Fire regimes and biodiversity in the savannas of north Australia. pp. 281-304 in Bradstock, R. A., Williams, J. and Gill, A. M. eds. *Flammable Australia: Fire Regimes and Biodiversity of a Continent*. Cambridge University Press, Cambridge.
- Wilson, T., Condon, J. and Barnes, T. 2007, Northern Territory Indigenous life expectancy improvements, 1967-2004. *Australian and New Zealand Journal of Public Health* 31: 184-188.
- Woinarski, J.C.Z. 2003a. Arnhemland. pp. 230-237 in Mittermeier, R.A., Mittermeier, C.G., Gil, P.R., Pilgrim, J. and Fonsca, G. eds. *Wilderness: Earth's Last Wild Places*. Cemex, Mexico City.
- Woinarski, J.C.Z. 2003b. Kimberley. pp. 238-245 in Mittermeier, R.A., Mittermeier, C.G., Gil, P.R., Pilgrim, J. and Fonsca, G. eds. *Wilderness: Earth's Last Wild Places*. Cemex, Mexico City.
- Woinarski, J.C.Z. and Catterall, C.P. 2005. Historical changes in the bird fauna at Coomoooolaroo, northeastern Australia, from the early years of pastoral settlement (1873) to 1999. *Biological Conservation* 116:379-401.
- Woinarski, J.C.Z. and Fisher, A. 2003. Conservation and the maintenance of biodiversity in the rangelands. *The Rangeland Journal* 25:157-171.
- Woinarski, J.C.Z., Milne, D. J. and Wanganeen, G. 2001. Changes in mammal populations in relatively intact landscapes of Akkad National Park, Northern Territory, Australia. *Austral Ecology* 26:360-370.
- WHO (World Health Organisation) 1986. *Ottawa Charter for Health Promotion in First International Conference on Health Promotion*. World Health Organisation, Ottawa.
- WHO 2005. Preventing chronic diseases: a vital investment: WHO global report. World Health Organisation, Geneva.
- Yibarbuk, D., Whitehead, P.J., Russell-Smith, J., Jackson, D., Godjuwa, C., Fisher, A., Cooke, P., Choquenot, D. and Bowman, D.M.J.S. 2001. Fire ecology and Aboriginal land management in central Arnhemland, northern Australia: a tradition of ecosystem management. *Journal of Biogeography* 28:325-343.

Sustainable Northern Landscapes and the Nexus with Indigenous Health: Healthy Country, Healthy People

Front cover image: Patchy burn

Front cover inset top: Matthew Ryan, Djelk Ranger

Front cover inset bottom: Ranger assisting ecologist measuring fuel loads

For enquiries: Professor Stephen Garnett

School for Environmental Research
Charles Darwin University Darwin NT 0909 Australia

Phone +61 8 8946 7115

Email stephen.garnett@cdu.edu.au

Website www.cdu.edu.au

Land & Water Australia

GPO Box 2182, Canberra ACT 2601
L1, The Phoenix, 86 Northbourne Ave, Braddon ACT

Phone +61 2 6263 6000

Email landandwateraustralia@lwa.gov.au

Website www.lwa.gov.au

© June 2008. Charles Darwin University and Land & Water Australia

Disclaimer

Permission for the non-commercial, general use of this material is permitted, provided due acknowledgment is given to its source and the material remains unaltered.

To the extent permitted by law, the Commonwealth of Australia, Land & Water Australia (including its employees and consultants), Charles Darwin University and the authors, do not assume liability of any kind whatsoever resulting from any person's use or reliance upon the content of this publication.

Citation

Garnett, S.T. and Sithole, B. 2007. *Sustainable Northern Landscapes and the Nexus with Indigenous Health: Healthy Country, Healthy People*. Land and Water Australia, Canberra.

Product code PN20681

Print ISBN 978-1-921253-99-7

Designed by Mariana Rollgejser

Printed by Union Offset Printers



Australian Government

Land & Water Australia

Sustainable Northern Landscapes and the Nexus with Indigenous Health: Healthy Country, Healthy People

GPO Box 2182, Canberra ACT 2601

The Phoenix Building

Level 1, 86 Northbourne Ave, Braddon ACT

Phone 02 6263 6000

Email landandwateraustralia@lwa.gov.au

Website <http://www.lwa.gov.au>