

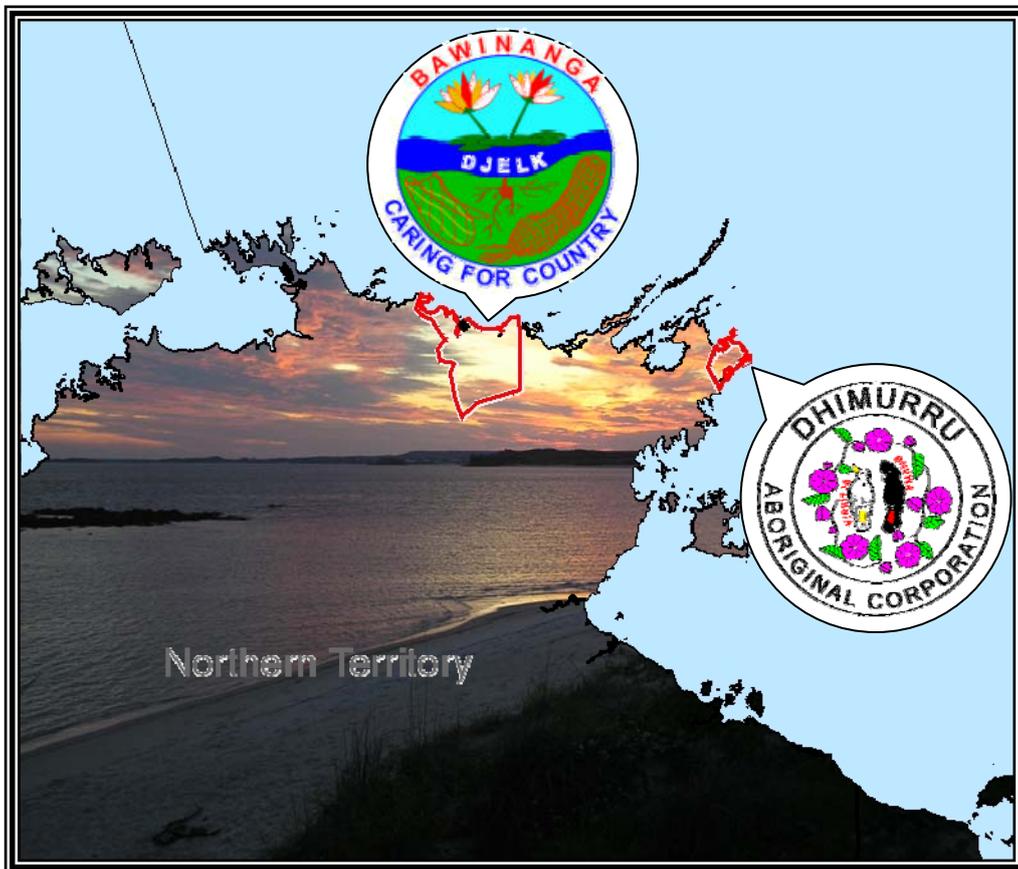
Developing an effective conservation and sustainable use economy: two Arnhem Land case studies

N. Concu

September 2011



Centre for Aboriginal Economic Policy Research
Research School of Social Sciences
The Australian National University

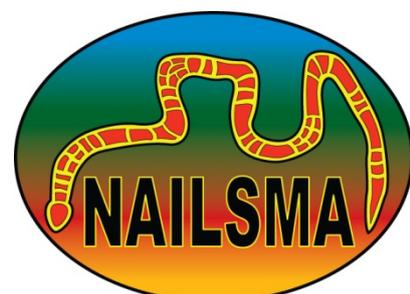


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Foreword

The idea for this project was formed in early discussions with Dr Peter Whitehead and then also with Dr Sue Jackson. All too often community-based Working on Country rangers bid for funds to provide environmental services constrained by program guidelines and realism about availability of financial resources and the need for their equitable distribution. In the brief for this project, I was keen to do two things: First, explore the idea that environmental needs analysis should determine what was needed; and second, explore ways that provision of services to address these environmental management needs might be sustainably sourced from public, private and philanthropic sectors.

Subsequently the research was commissioned and funded under Theme 6 of the Tropical Rivers and Coastal Knowledge (TRaCK) hub as project 6.3 'Developing an effective conservation and sustainable use economy in Arnhem Land: Options for payment for environmental services'.

Initially, this work was to be undertaken in the Maningrida region only, focused on the Mann/Liverpool/Tomkinson and Blyth/Cadell Rivers catchments. This was primarily because a great deal of productive environmental research has been undertaken with the Djelk Rangers and the Bawinanga Aboriginal Corporation for over a decade and there was a typically enthusiastic local response to this project proposal. It was also because TRaCK has a focus on fresh water.

Owing to unforeseen delays, contractual arrangements for this project were only completed in the first half of 2009 and subsequently Dr Nanni Concu, an environmental economist, was recruited to undertake this project, initially funded for 18 months only, 1 July 2009 to 31 December 2010 (subsequently extended to 31 March 2011). Dr Concu was working with the Dhimurru Aboriginal Corporation when recruited and so the nature of the project expanded somewhat as we now expanded its scope to look less at two catchments in central Arnhem Land and more at two Indigenous Protected Areas, Djelk and Dhimurru. This expansion not only added an important comparative perspective to the research, but also provided two very different contexts, the Djelk Indigenous Protected Area is very remote and experiencing little development pressure beyond applications for mineral exploration, the Dhimurru Indigenous Protected Area surrounds a major open cut bauxite extraction and alumina production operation at Gove, including the mining town of Nhulunbuy.

This was to be an innovative 'blue-sky' research project from the outset mainly because this question, on behalf of the natural and cultural environment had not been asked before and we were well aware that we would only get a very preliminary and partial answer at best. The project was also constrained by major data shortcomings that we were aware of and so we committed to using some exploratory instruments, like questionnaires, that we know would be potentially problematic to administer in cross-cultural and political contested circumstances.

While this project has been undertaken by Dr Concu as lead researcher, we were fortunate to be able to recruit a few others on a part-time basis to assist with both research and administrative support including Dr Jennifer Koenig who was coaxed back from maternity leave to assist us on a part-time basis in Maningrida through the Bawinanga Aboriginal Corporation; and then when she left Maningrida, John White, Bill Fogarty and Susie

Russell in Canberra. In May 2011 Dr Concu left Australia to take up a university position in Sardinia and finalisation of this report after peer review was undertaken by Dr Koenig and Geoff Buchanan, a doctoral candidate at the Centre for Aboriginal Economic Policy Research (CAEPR).

It is also pleasing that this project was able to dovetail with the People on Country, Healthy Landscapes and Indigenous Economic Futures project being undertaken at CAEPR, mainly sponsored by the Sidney Myer Fund, the Australian Research Council and the Australian National University: the Djelk and Dhimurru groups are two of our partners on this longer term project and so our research collaborations have been productively enhanced under the Tropical Rivers and Coastal Knowledge hub umbrella.

Of particular practical importance, this project is very much about people working and living on their country, maintaining the environmental and cultural values of that country, and looking for future economic livelihoods using their country sustainably. So at one level, this report can be read as a valuable, but preliminary, environmental business opportunities assessment for the two IPAs, bearing in mind that the Djelk IPA was only declared in September 2009.

At another level though, this report has important economic and political implications. On the economic front, it should be of value to the 40 other declared Indigenous Protected Areas throughout Australia, as well as to countless other less formal community-based Caring for Country initiatives. On the political front, there is a dominant national narrative of scepticism about the biodiversity value of the Indigenous estate and more so of the contributions made by community-based Indigenous rangers. In my view much of the factual information in this report should open up prospects for a more productive focus on what might be economically possible on Aboriginal-owned land in local, regional, national and even global environmental and cultural interests.

Professor Jon Altman
August 2011

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Summary

This is the final report for the research project ‘Developing an effective conservation and sustainable use economy in Arnhem Land: Options for payment for environmental services’. The research was undertaken at the Centre for Aboriginal Economic Policy Research (CAEPR) at the Australian National University (ANU). The Tropical Rivers and Coastal Knowledge (TRaCK) research hub funded the research. This report provides a preliminary assessment of the management needs and costs for two Indigenous Protected Areas (IPAs) in Arnhem Land, as well as a preliminary cost-benefit analysis (CBA) of the social benefits and costs associated with the management of the protected areas. The project commenced in July 2009 and was completed in March 2011.

This report is aimed at helping decision-makers in communities, businesses, non-government organisations and government agencies consider payment for environmental services alongside continued public funding to support economic development in remote Indigenous communities. Crucially, this report highlights the need for better information and alternative economic perspectives in relation to the capacity of payment for environmental services to support the regional economy of Arnhem Land. This information is critical to addressing both opportunities for and barriers to the development of an effective conservation and sustainable use economy in this region and beyond.

The research was carried out in collaboration with two Indigenous Ranger groups in Arnhem Land, the Djelk Rangers (Bawinanga Aboriginal Corporation) in Maningrida and the Dhimurru Rangers (Dhimurru Aboriginal Corporation) in Nhulunbuy. The two groups manage the Djelk IPA and the Dhimurru IPA respectively. The Djelk IPA was declared in 2009. It extends over 6,732 km² stretching from the Central Arnhem Plateau to the Arafura Sea in the Arnhem Coast sub-bioregion ARC-2. The Djelk IPA has outstanding environmental and cultural values for the diversity of its landscapes and languages, and the wealth of community assemblages and species. The Dhimurru IPA was established in 2000. It covers around 920 km² of land and 90 km² of adjacent marine areas in the Gove Peninsula. The IPA contains areas of important cultural and environmental values, hosting a significant representation of Australia's Arnhem Coast sub-bioregion ARC-3. Both IPA's are generally considered to be in near pristine condition.

The two IPAs face quite different environmental management problems. The Djelk Rangers' priorities focus on land and sea management including fire, weed and feral animal control and coastal surveillance. Among the most important issues for the Dhimurru IPA is managing the growing demand for the recreational uses of its environmental and cultural resources. Recreational activities could damage sensitive ecological systems, spread weeds and invasive ants through vehicles movement, disturb native flora and fauna, and damage cultural and sacred sites. The bauxite mine and processing plant adjacent to the Dhimurru IPA also have a serious impact on the integrity of the natural environment and cultural landscape.

Both the Djelk and the Dhimurru rangers finance their management activities mainly through public funding. Djelk's revenues are split between government grants (78%) and fee-for-service earnings (22%). The Djelk Rangers use these finances to employ over 35 Indigenous rangers as well as to cover the operational costs of a range of activities including weed and feral animal control, fire management, and coastal patrols. Four activities—weed control, fire management, customs patrols, and marine debris patrols—generate 85 per cent of Djelk's total expenditure. The major source of Dhimurru's

revenues is public funding (69%), and it is supplemented by Dhimurru's own generated income (20.5%), private contributions (9.2%) and fee-for-service income (1.6%).

Dhimurru's activities have interconnected goals: people management, environmental monitoring, conservation and restoration, and heritage and cultural protection. People management includes issuing general and special access permits to non-Indigenous visitors, checking permit compliance, camp site maintenance, fencing, and rubbish pick-up. It accounts for over 74 per cent of Dhimurru's total expenditure. Weed control and crocodile management account for another 17 per cent of the Dhimurru's expenses.

Public funding and fee-for-service revenues are the cost to society of this provision of environmental services through Indigenous ranger organisations. Both funding streams originate largely from institutional responsibilities of government. A variety of Commonwealth programs such as Working on Country (WoC) and Indigenous Protected Areas (IPAs) are based on this principle. Here the government outsources some of its responsibility to protect the environment by contracting local Indigenous rangers to provide environmental services. In return, Indigenous rangers are required to provide some measure of accountability for their work through management plans, progress reports and financial reports. However, the compensation for this service is calculated on the basis of the government's accounting rule for granting funding and on what the ranger organisations estimate it will cost for them to deliver the service. They are not based on estimates of the benefits that the rangers' activities generate for the Australian public.

Lack of data, methodological limitations, and a short timeframe, severely restricted the quantitative assessment of the demand for environmental services. Therefore it is not possible to contrast the benefits of Indigenous provision of environmental services in the two IPAs with either the social costs or the organisations' private expenditure. As a result, the data presented here is not sufficient to demonstrate in economic terms that the benefits of environmental service provision within the IPAs justify their social cost. Similarly, it was not possible to assess the feasibility of financing Indigenous provision of environmental services in the IPAs on the basis of the benefits it generates at the local and national levels. Further research is necessary to collect more data on such issues over longer time periods. A robust analysis of the costs and benefits of Indigenous provision of environmental services needs to account for temporal and spatial variability, and take into account the fluctuations in environmental, economic and social conditions. Priority should also be given to the collection of basic ecological data. This is necessary to assess the effectiveness of management practices in reaching environmental outcomes.

Acknowledgments

I gratefully acknowledge the Traditional Owners, the Djelk Rangers, and the Dhimurru Rangers who have collaborated with me on this research. I also thank the Tropical Rivers and Coastal Knowledge (TRaCK) research hub for funding this study. I am also grateful to Jennifer Koenig for her invaluable help in the field, to John White for his literature summary, and to Jon Altman, Kat May, Bill Fogarty, Boyd Hunter, Geoff Buchanan, Sue Jackson, Dermot Smyth and external reviewers for their comments on draft versions of this report. Geoff Buchanan and Jennifer Koenig assisted with editing and proofreading this report after review in preparation for public release.

Abbreviations

ABS	Australian Bureau of Statistics
AHA	Animal Health Australia
ALRA	Aboriginal Land Right Act (Northern Territory) 1976
ANRA	Australian Natural Resource Atlas
ANU	Australian National University
AQIS	Australian Quarantine and Inspection Service
BAC	Bawinanga Aboriginal Corporation
CAEPR	Centre for Aboriginal Economic Policy Research
CBA	Cost-Benefit Analysis
CDEP	Community Development Employment Projects
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DOIC	Domestic Offsets Integrity Committee
EPBC Act	Environmental Protection and Biodiversity Conservation Act (Commonwealth)
DLNG	Darwin Liquefied Natural Gas
GHG	Greenhouse Gases
IPAs	Indigenous Protected Areas
MAC	Maningrida Arts and Culture
NAFI	North Australian Fire Information
NAILSMA	North Australian Indigenous Land and Sea Management Alliance
NRETAS	Department of Natural Resources, Environment, The Arts and Sport (Northern Territory)
NT EPA	Northern Territory Environmental Protection Authority
NTER	Northern Territory Emergency Response
NTG	Northern Territory Government
RTA	Rio Tinto Alcan
TRaCK	Tropical Rivers and Coastal Knowledge
UPP	User-Pays Principle
WoC	Working on Country program (Commonwealth)
WALFA	West Arnhem Land Fire Abatement
WONS	Weed Of National Significance

1. Introduction

This report is aimed at helping decision-makers in communities, businesses, non-government organisations and government agencies consider payment for environmental services alongside continued public funding to support economic development in remote Indigenous communities. Crucially, this report highlights the need for better information and alternative economic perspectives in relation to the capacity of payment for environmental services to support the regional economy of Arnhem Land. This information is critical to addressing both opportunities for and barriers to the development of an effective conservation and sustainable use economy in this region and beyond.

This report presents the final results of the Tropical Rivers and Coastal Knowledge (TRaCK) Project 6.3 ‘Developing an effective conservation and sustainable use economy in Arnhem Land: options for payment for environmental services’. This project was developed and supervised by Professor Jon Altman at the Centre for Aboriginal Economic Policy Research (CAEPR) at the Australian National University (ANU). The principal investigator, Dr Nanni Concu (CAEPR), coordinated a team of researchers: Dr Jennifer Koenig (field assistant), Dr John White, and Dr Bill Fogarty. The project started in July 2009 and finished in March 2011.

In this report, two case studies are presented analysing two successful Indigenous ranger organisations in Arnhem Land that provide environmental services: Djelk Rangers (Bawinanga Aboriginal Corporation) and Dhimurru Aboriginal Corporation. Case study analysis combines a hybrid economy model perspective with a cost-benefit analysis (CBA) to provide insights critical to the development of a conservation and sustainable use economy in Arnhem Land. The hybrid economy model (Altman 2001; 2007; 2009; 2011) is used here to identify economic activities and agents and their relations and to analyse the feasibility of this development pathway. This is based in part on the user-pays principle. Under the user-pays principle the direct and indirect beneficiaries of environmental services bear its cost (UN 1996).

The hybrid economy model brings into focus the linkages and interdependencies between the state, market and customary sectors (Altman 2001). The customary sector, also referred to as ‘the third sphere’ (Adaman and Madra 2002), is made up of processes of production and consumption that are not regulated by the state or market exchange. These alternative modes of economic organisation are largely based on cultural continuities (Altman 2001). The customary sector includes subsistence activities such as hunting, fishing and gathering; the manufacturing of tools for subsistence production (spears, baskets, fish traps) and for ceremonies; and habitat management to conserve the productivity of the land. Research shows that in some areas with a small market sector, the customary economy has been remarkably resilient over the course of nearly 25 years, and that subsistence hunting, fishing and gathering represents up to 50 per cent of the livelihood of some individuals and groups (Altman and Whitehead 2003).

The linkages between the state, market and customary sectors shape the economy of remote Indigenous communities. The major characteristics of this hybrid economy can be described as: (i) a significant state sector that provides support for local livelihoods through some forms of welfare and service provision, as well as via grant funding to enterprises such as art centres and Indigenous land and sea management groups; (ii) a spatially heterogeneous market sector—in regions such as mining districts, the market sector heavily dominates the economy, while in other regions it is almost non-existent

because of limited resources, small population size, and limited spending capacity making it difficult for markets to develop; and (iii) a customary sector that varies largely in response to state and market involvement, as well as environmental, socio-economic and cultural factors.

The relatively large dimension of the public sector in Indigenous economies has often meant economic change happens as a consequence of budgetary and political decisions leading to policy change. Recent examples of such change are the radical reform of the Community Development Employment Projects (CDEP) program and the introduction of income management as part of the Northern Territory Emergency Response (NTER) (COAG 2009). Another key example in the context of this report is the Commonwealth Government's Working on Country (WoC) program which has largely replaced CDEP as the main source of wages for Indigenous land and sea management organisations in the Northern Territory. Political and budgetary-driven changes generate both short and long-term changes in the mix of the state, market and customary sectors, as well as bringing about changes in the output composition of these economies. For instance, there is increasing evidence that many Indigenous service providers, in particular Indigenous land and sea management organisations, are experiencing an increase in the demand for jobs (S. Ansell, pers. comm. 2009). In remote areas that have been affected by industrial development, changes in economic conditions have often been sudden and dramatic. Such changes—positive and negative—have included loss of land and livelihood; large inflows of non-Indigenous workers; increased availability of services, facilities and market alternatives; higher spending capacity; and the decline in customary activities.

The user-pays principle states that the user of a natural resource should pay for the full long-term marginal social cost of the use of a public resource (UN 1996; Pearce and Turner 1990:175). This study broadly applies this principle to identify possible mechanisms for generating financial resources to support the provision of environmental services on Indigenous-owned land by Indigenous people. A first step involves identifying direct and indirect beneficiaries of these services—both current and potential. These mechanisms can be designed in several ways: as public funds for supporting the generation of public goods such as biodiversity protection; as fee-for-service contracts through which government agencies outsource environmental service provision to Indigenous providers; or as arrangements for the payment for environmental services (PES) between Indigenous providers and private buyers, such as in the case of markets for carbon credits.

This study investigates development possibilities generated by growing all sectors of the hybrid economy. Mechanisms for purchasing and selling environmental services produced on Indigenous-owned land have the potential to foster a balanced growth of each sector, rather than just produce a change in their relative size or in the output composition. Such mechanisms are based on the user-pays principle and the Indigenous provision of environmental services. This study provides a critical discussion of the potential growth effects and development implications of these mechanisms.

In terms of economic theory, the quantitative condition for environmental services to generate growth is that the net private and public benefits are positive. In other words, the benefit of the environmental services should be larger than the cost of delivery, the opportunity cost, and the direct and indirect costs. This quantitative condition is necessary for a demand for environmental services to emerge. This study identifies actual and potential beneficiaries of environmental service provision on Indigenous land, and

identifies information and data needed to provide a quantitative estimate of demand. This is an exercise in a preliminary cost-benefit analysis (CBA).

This study also looks beyond the economic or financial case for development based on payment for environmental services by also taking political economy into account. In terms of development theory, a condition for sustained development is effective decision-making powers (Hamilton 1999; Hill 2003; Hunt 2008:44). The process of selling and supplying environmental services necessarily entails negotiation in relation to quality, quantity and production processes. Mechanisms developed based on the user-pays principle then need to be assessed by looking at the capacity of the different actors to exercise powers in these negotiating processes. For example: do Indigenous landowners provide these services according to their aspirations, capacities and knowledge or are they forced into negotiation out of poverty and lack of alternatives?

This report focuses on two Indigenous organisations managing Indigenous Protected Areas (IPAs) in Arnhem Land, northern Australia: the Djelk IPA and the Dhimurru IPA. The Commonwealth Government set up the IPA program in 1997 with Nantawarrina IPA in South Australia being the first to be declared in 1998. There are currently over 40 declared IPAs across all Australian states and the Northern Territory. The IPA program ‘seeks to provide a planning and land management framework for Indigenous owned land to be managed as part of the National Reserve System (NRS)’ (Gilligan 2006: 2). Under the IPA program Indigenous landowners and managers can voluntarily declare their lands as an IPA in line with one of the IUCN reserve categories (Gilligan 2006). The program requires and funds community consultation and management planning prior to formal declaration of an IPA. If a formal declaration is made by Indigenous landowners and managers the IPA then receives annual funding through the program to undertake specific works set out in the Plan of Management (Gilligan 2006). Federal and state governments provide further support for IPAs through several funding programs that landowners and managers can make applications to.

The Djelk IPA in central Arnhem Land features two major river systems, the Liverpool-Mann and Cadell-Blyth, the catchments of which encompass the Arnhem Land sandstone plateau, extensive savanna plains and wetlands. The Dhimurru IPA in north-east Arnhem Land has an extensive system of wetlands and monsoonal rainforests linking land to sea. These IPA’s are managed by two of Australia’s largest and most well-established Indigenous Ranger programs on behalf of Traditional Landowners. The Djelk and Dhimurru rangers have both been operating for over 15 years and conduct a myriad of land and sea management activities. They are both highly innovative organisations that are seen as being at the forefront of developing options for a conservation and sustainable use economy in Arnhem Land.

The report is structured as follows. Section two of the report outlines the methodological approaches and related issues. Section three critically examines environmental management within the two IPAs against the current management activities of the two ranger groups. It explores the ways in which the environmental services the ranger groups are providing are financed through their engagement with the state and market sectors. For each of the IPAs in the study, the report contains: (i) a description of the environmental and cultural assets requiring management; (ii) an assessment of existing and emerging impacts on environmental and cultural values; (iii) a description of management activities performed and their outcomes and estimated costs; (iv) an assessment of the gap between

management needs and currently funded management activities; and (v) an analysis of commercial opportunities and demand including a preliminary cost-benefit analysis highlighting gaps in data needed for a further assessment of development options.

Following on from the detailed case studies, section four of the report provides a brief discussion of the institutional and economic barriers to the development of an effective conservation and sustainable use economy based on payment for environmental services. Section five then discusses implications of applying particular economic models and methods to assessing the development of this economy, arguing for the need to move beyond mainstream economic concepts. The report then concludes with some recommendations for future research.

2. Methodological approaches and issues

The research methodology was based on the collection and analysis of primary and secondary data. A review of the literature and informal discussions with experts on issues relating to Indigenous land and sea management provided the secondary data necessary to catalogue the range of environmental and cultural assets requiring management in the case study areas. Primary data were collected through extensive fieldwork which commenced in September 2009 with regular four-week-visits to the field sites. In the field, the research team used a number of different approaches for data collection as outlined below.

During the earlier stages of the fieldwork the research team interviewed senior Indigenous and non-Indigenous staff of the two organisations. These were semi-structured interviews focused on the history of each organisation, the motivations for their land and sea management activities, the types of activities undertaken, their financial and capital needs, and the forms of government support they received. The team then analysed unpublished data and documentation related to the organisations' revenues and cost structures, and contractual arrangements with commercial partners. Both ranger groups have an advanced data collection system to monitor the outputs of their management activities and to report to stakeholders. The Djelk Rangers use CyberTracker™ software on hand-held computers to record events and activities. Dhimurru is switching to the same technology, but still uses a mix of paper forms and hand-held computers. The research team had access to these internal data and contributed to the refinement of the data collection system and the training of the rangers in its use.

Primary data were also collected with the use of two questionnaires designed to survey Indigenous and non-Indigenous residents in and visitors to the IPAs. The questionnaires were primarily aimed at assessing the type of resources residents and visitors utilise in the study areas. The Indigenous residents' questionnaire was administered by senior Indigenous Rangers in face-to-face interviews, and data recorded with the use of a Cyber Tracker™ script the research team had developed in collaboration with the rangers. The questionnaire aimed to collect primary data on the use of environmental resources, and gave the Rangers another opportunity to engage with the Traditional Owners of the IPAs. In the Djelk IPA, thirty senior men and women from several language groups in Maningrida and surrounding outstations within the IPA were interviewed. Around fifty senior men and women were interviewed in the Dhimurru IPA. The visitor questionnaire was developed in leaflet format. For the Djelk IPA it was distributed in Maningrida to local government offices, the Bawinanga Aboriginal Corporation (BAC) offices, the Health Clinic, Maningrida School, the Maningrida art centre, BAC Women's Centre, the

Maningrida Progress Association Motel, the Arnhemland Barramundi Nature Lodge as well as being distributed at community gatherings. The aim was to survey the non-Indigenous residents of Maningrida as well as visitors to the region for business and recreational reasons. Thirty four questionnaires were returned of which 22 were filled in by visitors to the region. The Dhimurru Rangers distributed the questionnaires to the non-Indigenous visitors that purchased an access permit for the Dhimurru IPA—of these, 28 questionnaires were returned. A quantitative assessment of the demand for recreational uses of natural resources was also attempted, but the low number of visitors and responses implies that the analysis does not provide statistically robust results. The low response rate is indicative of the difficulty of conducting research using such instruments in a highly complex social and cultural environment. For example, at the time the surveys were being conducted, the Northern Land Council was in the process of developing a permit system to regulate non-Indigenous access to country outside of Maningrida. There was also discussion of recreational fishing permits being introduced following the High Court's Blue Mud Bay decision (see Morphy and Morphy 2009). As a result, some non-Indigenous residents were wary of completing the surveys and of the data being used to further restrict recreational activities.

The team also used participant observation complemented with an action research approach to gain a better understanding of the ranger organisations' conservation activities, constraints and risks. This methodological approach helped to develop better reporting methodologies to keep track of inputs, outputs and environmental outcomes of the organisations' activities. In turn this helped to refine the rangers' systems of reporting to funding agencies and commercial partners, as well as providing the team with quantitative data for cost estimation. These approaches for primary data collection all have several strengths and weaknesses. Questionnaires, participatory observation, and action research are all quite time consuming. They provided a rich set of qualitative data but, given the short time-frame of the research, reliable complementary quantitative data were much harder to obtain cross-check and calibrate.

Analysis of internal documents relating to the cost and revenue structures of the two ranger groups reveals important information for the estimation of the cost of environmental service delivery. The CBA methodology contrasts the delivery cost with the expected benefits of the environmental services. CBA is used here to attempt to determine whether the benefits of Indigenous provision of environmental services justify the costs of delivery—but in the absence of sufficient data this highlights critical gaps in the data needed for a proper assessment.

CBA has severe limitations. In particular, CBA attempts to reduce everything to the common numeraire (i.e. monetary value), and that is often not possible. Further, the inclusion or exclusion of benefits and costs is often a subjective matter. These limitations are even more relevant when working in a diverse cultural context such as in these case studies. Coupled with these methodological limitations, data limitations and time constraints restricted the ability to make any robust inference and extrapolation. Major data limitations of this study include:

- Data were collected for one year only. A proper assessment of costs of delivery environmental service needs to account for annual fluctuations in environmental and economic conditions;

- Data only include activities that were documented through CyberTracker™ or other reporting systems used. For instance, training, planning, community liaison, and participation in meetings and conferences are not accounted for.
- Some data are underreported in CyberTracker™. For example, the number of staff recorded as being involved in each activity. Often the staff member recording the data in CyberTracker™ only records themselves and not all members of staff present for the job (Ansell & Koenig 2011).

These limitations and data issues severely affect analysis. Throughout the report effort has been made to clearly state the limitations and assumptions relating to the calculation of estimates. Many effects of rangers' activities could not be identified, quantified or valued. As a result estimates of ranger organisations' effort and cost that are presented in the report are often lower bound estimates. Further, the temporal distribution of many benefits and costs could not be determined. Two final caveats are in order. First, results from this analysis are preliminary. Second, as both ranger organisations are parties to contractual arrangements for service delivery, this preliminary analysis is based on information that is commercially sensitive. The use of organisational data and its presentation in this report is done with the prior, informed consent of the ranger organisations.

Importantly, the reliance on existing quantitative data and readily available monetary values in the preliminary CBA highlights the current limitations of this method of analysis and of an adherence to the user-pays principle in assessing the value of environmental services and the potential for further development. The hybrid economy model as applied in this report reveals that other data and alternative methods of measurement will be required to move beyond a mainstream, utilitarian, non-Indigenous economic assessment of value.

3. The study areas

The two Indigenous land and sea management organisations that participated in this research, Djelk Rangers (Bawinanga Aboriginal Corporation) and Dhimurru Aboriginal Corporation, are based and operate in Arnhem Land, in the far north of the Australian continent. Both organisations manage areas of Indigenous-owned land vested in the Arnhem Land Aboriginal Land Trust under the *Aboriginal Land Rights (Northern Territory) Act 1976 (Cth)*. They have a secure system of inalienable land tenure. These areas include two IPAs—the Djelk IPA and the Dhimurru IPA.

3.1 The Djelk Indigenous Protected Area

The Djelk Rangers are a strategic community initiative, established by Traditional Owners as a business unit of Bawinanga Aboriginal Corporation (BAC) in 1991. Initially established to tackle weeds and feral animals in the region, they have since developed their capacity to deal with a broad suite of land and sea management issues. The Djelk IPA was declared in 2009. This terrestrial Djelk IPA extends over 6,732 km² of land, stretching from the Central Arnhem Plateau to the Arafura Sea in the Arnhem Coast sub-bioregion ARC-2 (Figure 1). However, the actual area of Djelk operations covers over 14,000 km² and encompasses neighbouring land estates (to be added to the Djelk IPA following further consultation) as well as sea country between Cuthbert Point to the west and Cape Stewart to the east, and out to sea to a line demarcated by the 15 metre depth contour (Gambold 2009). The Djelk Rangers are awaiting Commonwealth Government approval to declare this sea country as part of their IPA. Whilst referred to herein as the Djelk IPA, it should be noted that all of the reported Djelk Ranger activities and their operational budget extends over the larger land and sea management area.

The region has had a relatively short history of state colonisation. The Djelk IPA surrounds the township of Maningrida which was established as a trading post in 1957 (Altman 2004). Prior to this, Aboriginal people in the region had almost no European intrusion besides occasional patrols and expeditions by explorers (Altman and Branchut 2008). The

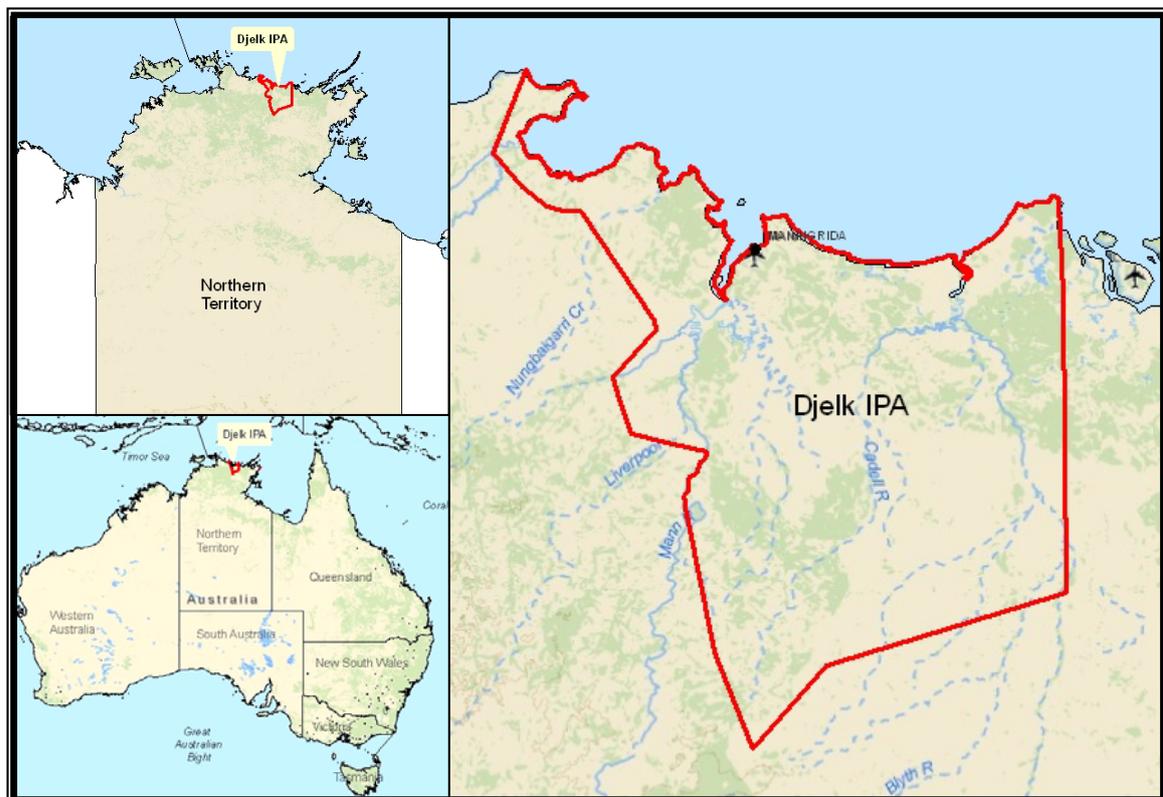


Figure 1: The Djelk Indigenous Protected Area.

pre-colonial mode of living for Aboriginal people in the region was based on the exploitation of naturally available resources for livelihood needs. The formation of the settlement saw many hinterland people from diverse language groups migrate to Maningrida and it quickly became a service centre with a significant Aboriginal population (Altman and Branchut 2008). In the 1970s, there was a major shift in the national approach to Indigenous Australians and general policy changed from assimilation to that of self-determination and land rights (Altman 2000). The outstations movement at this time was particularly strong in Maningrida with many people deciding to move back to small family-based communities on their ancestral lands (Altman 1987).

BAC was established in the late 1970s as an Outstation Resource Centre, incorporated under Commonwealth law as an independent Indigenous organisation to accept and administer government funds provided for the welfare of Aboriginal people living in the region (Cochrane 2005). Organisationally, it is controlled by an annually-elected Executive representing each of the affiliated regional outstations. Whilst BAC is a commercial enterprise with a current annual turnover exceeding \$30 million, since the early 1990s it has assumed an increasing role in community economic development and advocacy (Gambold 2009). BAC's development charter includes plans for sustainable land and resource management. This business philosophy underpins their sponsorship of the Djelk Ranger program (Gambold 2009).

Today, around 2,100 Aboriginal people reside within the area the Djelk Rangers manage, which includes the boundaries of the IPA (Altman 2008). The large majority of this population (approximately 75%) live within the township of Maningrida. The remaining population live in one of the 34 outstations scattered throughout the region (Gambold 2009)—though people's movement between town and outstations can be quite fluid. The non-Indigenous resident population numbers around 150 individuals, however, many other non-Indigenous people travel to Maningrida for short-term work (e.g. contractors and government staff). The region has a relatively well-developed economy compared to other remote Indigenous communities. The large size of the resident population allows for economies of scale and well-managed Aboriginal organisations that have focused on community economic development, such as BAC, provide a source of significant Indigenous employment (NTG 2009). When compared with similar-sized communities with a predominantly non-Indigenous population Maningrida's economic profile reveals a relatively low number of private enterprises, a low number of job opportunities, a higher rate of unemployment, lower participation in the labour force, and lower median individual income (NTG 2009). Maningrida's economy is hence heavily dependent on both Commonwealth and Northern Territory government funding. As of December 2007, for instance, 84 per cent of Indigenous employment was funded through the Commonwealth Government's Community Development Employment Projects (CDEP) program (NTG 2009).

In addition to public funding and welfare payments, residents in the region receive income from small enterprises. The local art centre, Maningrida Arts and Culture (MAC), specialises in fine and tourist art production and represents over 800 artists from the region (this includes some deceased artists). All artwork produced by artists is bought by MAC and then marketed and resold to a variety of wholesale and retail customers. A range of artefacts are produced and almost all depend on naturally occurring raw materials (e.g. bark paintings, wooden carvings and fibre-craft weavings). In the 2008-2009 financial year, MAC distributed over \$1.5 million to artists in the region (MAC 2009). Three small tourist

enterprises—BAC Tourism, the Maningrida Progress Association motel and the Arnhem Land Barra Fishing Lodge—cater for a limited number of tourists and the growing numbers of working visitors (e.g. government staff, researchers and housing construction workers). Importantly, the local economy is still significantly reliant on customary harvesting of bush resources, as well as customary management activities that maintain the natural productivity of the land (Altman 2001; Altman and Whitehead 2003). Through his extensive research in the Maningrida region over the last 30 years, Altman (2001) termed this observed mix of state support, market engagement, and customary activities a hybrid economy.

Any future development path for the region necessarily involves modifying the character of the hybrid economy. The Commonwealth Government's radical transformation of the CDEP program, for instance, reduces employment opportunities and income streams as well as enterprise development options (Altman & Hinkson 2010). Evidence suggests that income and flexible employment provided in the past by the CDEP scheme has supported people's engagement in the customary sector in terms of hunting, fishing and gathering of bush foods (Altman, Buchanan and Biddle 2006). The remote location, low population, and the high cost of essential goods and services—particularly transportation costs—hinders the development of new commercial enterprises in the region.

Indigenous provision of environmental services in the region is extremely important as it creates a relatively large number of jobs (through the Djelk Ranger program) and also helps to maintain the integrity and productivity of the land. In turn, this supports the sustainable use of natural resources for customary use, and also current and future business opportunities (e.g. art production and wildlife enterprise) based around the commercial use of natural resources. The Djelk Rangers have developed an extensive Plan of Management for the region of the IPA (Gambold 2009). In implementing the plan, senior Traditional Owners guide and control the management of the IPA through an Advisory Committee consisting of representatives of landowning clans. Djelk currently employs 35 Indigenous Rangers, a non-Indigenous Ranger coordinator and a Special Project Officer. The Djelk Rangers are divided into three groups – Sea, Land, and Women Rangers. For the financial year 2009-2010, Djelk Rangers had a budget of around \$2 million, 78 per cent of which was provided by public funding through the Working on Country (WoC), Caring for our Country, and IPA programs—22 per cent was self-generated revenue from fee-for-service contracts with public and private sector clients.

An environmental and cultural asset inventory—as provided in Gambold (2009)—highlights the base upon which a conservation and sustainable use economy in the Maningrida region has been pursued by BAC through, inter alia, the establishment of the Djelk Rangers and the declaration of the Djelk IPA. This inventory is also useful in the identification of opportunities for the further development of this economy.

3.1.1 Environmental assets

The Djelk IPA comprises three major biodiversity-rich landscapes, or bioregions, that are home to iconic species such as saltwater crocodiles, and a rich variety of fauna (DEWHA 2010c). The coastal and marine environments of the Arnhem Coast bioregion are connected to the sandstone uplands of the Arnhem Plateau bioregion and the scattered low hills of the Central Arnhem bioregion through two of the most intact river systems in Australia (Gambold 2009). The Blyth and Liverpool rivers and their tributaries flow through a large, complex system of riparian zones and extend to the coast through

floodplains, fresh and saline wetlands, and mangrove-lined estuaries. The Arnhem Plateau and the coastal and alluvial floodplains associated with the Liverpool and Blyth rivers are sites of high conservation significance at the international, national and territory level (NRETAS 2010). Ward and Harrison (2009) rate the seasonal floodplains associated with these rivers as being of international significance as they support large aggregations of waterbirds and migratory shorebirds, and host numerous threatened species.

These interconnected landscapes contribute to the protection and conservation of important flora and fauna assemblages. The dominant vegetation type is eucalypt woodland and open forest, interspersed with floodplain swamps, coastal vine thickets, monsoon rainforests and, in the southern reaches of the IPA, by sandstone heathlands (Gambold 2009). According to Griffiths et al. (2000), some of these vegetation types have high conservation significance. The sandstone heathland, for instance, has been nominated as a threatened ecological community under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*. The Djelk IPA coastal reaches and the major estuaries host some of the richest mangrove communities in Australia (Duke 1992; Gambold 2009).

Harrison et al. (2009) report 13 threatened plant and animal species of international significance in the IPA. They also record around 43 plant species endemic to the Northern Territory present in the area (Harrison et al. 2009). While significant knowledge gaps do not allow a comprehensive inventory of the invertebrate and non-terrestrial fauna, there are some records for vertebrates in the IPA. The coastal environments, including off-shore islands, beaches, dunes, estuaries and floodplains, support extraordinarily biodiversity-rich habitats. Common species include Egrets, Ibis, Magpie Geese, Long-neck Turtles, Dusky Rats, Water Pythons, Arafuran File Snakes, and Saltwater Crocodiles (Gambold 2009). Mangrove specialists and a large number of waders share these habitats. Islands and beaches are breeding habitats for large colonies of Roseate and Bridled terns. Threatened species of turtles—Green, Olive Ridley, Flatback, and Leatherback—have their nesting sites in remote beaches in the IPA (Gambold 2009:38). Recent research has shown that the area contains a large number of previously undescribed species, such as 46 species of spiders (Gambold 2009: 4).

The woodlands and open forests are also rich in biodiversity, supporting a broad range of bird and reptile species. Species here are predominantly of the generalist types which are common throughout the north Australian tropical savannah woodlands. Birds such as honeyeaters, granivores, hollow-nesting parrots and cockatoos, raptors and kingfishers are common (Gambold 2009:39). Many woodland birds that are rare in other parts of Australia—such as the Red-tailed Black Cockatoo, the Bush Stone-curlew, and the Australian Bustard—are commonly recorded in the IPA. This landscape also hosts a large diversity of reptiles such as skinks, geckos, monitors, dragons and snakes (Gambold 2009:39). Common mammals include insectivorous and fruit-eating bats, and macropods such as wallabies, wallaroos, and euros (Gambold 2009:39). Several exotic mammal species are also common—cattle, Asian water buffalo, pigs and cats.

The sandstone habitat in the Arnhem Plateau has outstanding values for biodiversity conservation (ANRA 2010). The plateau has a complex topography, with crevices, valleys, and caves. As a result, many species live in small populations with limited distributions (Woinarski et al. 2007). It has very high levels of endemic vertebrate and invertebrate species (Watson and Woinarski 2003), and several plant species—this includes at least 15 terrestrial vertebrates, birds (including the White-throated Grass-wren), reptiles (such as

the Oenpelli Python), mammals, and many invertebrates (ANRA 2010; Gambold 2009:40). The rugged nature of this bioregion affords its biota some protection from threatening processes such as intense fires which have affected biodiversity elsewhere.

Djelk IPA has outstanding environmental values in terms of the diversity of its landscapes, and the wealth of community assemblages and species. According to the Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System (see SEWPAC 2011a), the Djelk IPA's contribution to the conservation of the three bioregions within its boundaries (Arnhem Coast, Central Arnhem, and Arnhem Plateau) is deemed to be very significant, significant and moderate respectively (Gambold 2009:18). Ward and Harrison (2009) rate several areas within the IPA as having international conservation significance. Overall, the inclusion of the Djelk IPA within the National Reserve System has significantly improved the representativeness of the international, national, and Northern Territory conservation estates.

3.1.2 Cultural values

The Djelk IPA is a *cultural landscape*: a combined work of nature and humankind expressing a long and intimate relationship between people and their natural environment (UNESCO 2011). Aboriginal people have continuously occupied this region of Arnhem Land for at least the last 40,000 years. Unlike many other Indigenous groups in Australia, Indigenous people here have never lost possession and use of their land. As such, traditional cultural institutions remain robust and are an integral part of community life. In pre-colonial times, this was a region where two distinct cultural blocs met, the Kuninjku/Bininj Kunwok bloc to the west of the region and the Yolngu cultural bloc to the east. Berndt and Berndt (1970) identified the transition from west to east occurring in the region of the Tomkinson Floodplains, a resource-rich wetlands area. While there was mixing between these two cultural blocs at the margin, within each there were a number of distinct language communities. Today there is greater social mixing between linguistic communities, but the region remains linguistically and culturally rich and diverse, with at least 13 major languages spoken (Altman & Branchut 2008).

Throughout the Maningrida region, country is divided into clan estates. The current terrestrial Djelk IPA includes approximately 102 clan estates (Gambold 2009). Each clan estate is associated with numerous sites of cultural significance. Land ownership and the management of natural resources remain governed by customary rights which are passed down from both parents. Whilst land ownership is primarily inherited from one's father, responsibilities for land and resource management can also come from one's mother. Each clan estate covers an area and a suite of resources available to the landowners and their family. The available resources depend on the ecological profile of the land and also on seasonal factors. Such variety provides for complex social interaction around the access and exchange of resources (Gambold 2009).

The long occupation and cultural and artistic heritage of this region of Arnhem Land is reflected in the rich collection of rock art galleries found throughout the Djelk IPA. These pictures painted on rock in the sandstone shelters of the region are among Australia's greatest national treasures. The Djelk Rangers have been collaborating with researchers to undertake a comprehensive survey of rock art and archaeological sites in the IPA (May et al. 2010) The artistic creativity of painting on rock is now continued on bark, which has replaced rock as the preferred medium, and is predominately produced for market exchange (Garde 2004). MAC lists over 800 artists in the region involved in the production

of bark paintings, carvings, fibre crafts and sculptures, and other art work. In 2008-2009, the centre sold around \$2.5 million of artwork (MAC 2009).

3.1.3 Existing and emerging threats to environmental assets and cultural values

Scientific research, monitoring by Djelk Rangers, and the observations of Traditional Owners have identified several threats to the environmental and cultural assets in the IPA. Each of these threats and their associated management goals are covered within the Djelk IPA Plan of Management (Gambold 2009). These include altered fire regimes, feral animals, weeds, impacts on marine resources, and impacts on cultural heritage as outlined in more detail below.

Altered fire regimes

In many parts of Arnhem Land, fire patterns altered following the depopulation of large tracts of country and the cessation of customary landscape burning. Burning intensity also changed with the introduction of large feral herbivores that consume large quantities of biomass and through the spread of weeds (Bowman et al. 2001a). The observed trend is that in areas without fire management, fires occur later, are of greater intensity, and are more extensive in range. Such fires can be a threat to landscape conditions, plant communities, and individual species (Bowman et al. 2001a; 2001b). Late, intense and less frequent fires have been shown to negatively affect vegetation regenerative capacity (Bowman et al. 2001b). Edward and Russell-Smith (2009) also show that altered fire regimes have exceeded the ecological tolerance for a substantial portion of fire-sensitive vegetation types in the Arnhem region.

Feral animals

Feral pigs, buffalo, cattle and cane toads have a negative impact on some biodiversity values (Fordham et al. 2006, Griffiths & Pardon 2002). Water buffalo and pigs occur in significant densities within the Djelk IPA. These two species are associated with most of the environmental damage in the area. They are a vector for weeds, they cause erosion and are implicated in the destruction of wet rainforest patches and the breaching of coastal levees leading to saltwater incursion to wetlands. Both pigs and buffalo also pose a safety issue to land owners. Further, pigs are known to damage important traditional food sources such as yams, and marine and freshwater turtle nests (Fordham et al. 2006).

Surveys on buffalo density and distribution, as well as observation from Djelk Rangers and Traditional Owners, found that over the past decades buffalo numbers have increased (Koenig et al. 2003). The last aerial survey undertaken in the region estimated Buffalo density to be around 0.74 ± 0.08 per km² equal to an approximate population of 3500 animals within the IPA (Koenig et al. 2003). This is a lower bound estimate due to the surveys having only covered a portion of the IPA.

Smaller introduced animals such as cats and cane toads are also known to have a large impact on native fauna. The density of cats within the IPA and the extent of damage they cause is unknown. The cane toad is implicated in the collapse of the northern quoll and yellow-spotted goanna populations (Woinarski et al 2007b). Cane toads spread throughout the IPA around the turn of the millennium and no effective control measure has been found for this pest.

While not recorded in the IPA, several introduced ant species are a potential threat to the biodiversity in the area. Yellow Crazy Ants, Ginger Ants, and Big-headed Ants have been recorded in other regions of Arnhem Land, including Kakadu National Park.

Weeds

According to Griffith et al. (2000), only a small proportion of the weeds recorded in the Northern Territory are recorded in the Djelk IPA. This is a strong indication of the integrity and ecological health of the IPA. There is, however, serious concern about the threat posed by a few invasive species, such as *Mimosa pigra*, Gamba Grass, Perennial Mission Grass, and Annual Mission Grass. *Mimosa pigra* is a woody weed of national significance (WONS). It forms impenetrable thickets restricting human and animal access, impeding hunting, fishing, and the collection of bush food such as turtles, water lilies and water chestnuts. It entangles animals, impedes the establishment of plants, and generally reduces biodiversity (Boustead 2009:13). Five outbreaks are recorded in the IPA, but they have been successfully controlled and contained through constant monitoring and treatment since 1991 when the first outbreaks were detected.

Invasive grasses such as Gamba and the Mission grasses are regarded as major threats to the savanna of northern Australia as they provide fuel for hot wildfires that damage native plants. Other environmental weeds are recorded in the Arnhem Plateau, Arnhem Coast and Central Arnhem bioregions. These remain as yet unrecorded in the Djelk IPA, but pose an adjacent and continuing threat requiring ongoing monitoring.

Threats to marine resources

The Djelk Rangers represent and protect Indigenous rights, interests and resources in sea country. BAC are awaiting formal government endorsement for including marine areas—from the high tide mark to a 15 metre depth contour—in the IPA. The major threats to marine resources in this sea country include illegal foreign and commercial fishing, the presence of marine debris, and the invasion of exotic marine pests, pathogens and diseases.

Illegal commercial fishing impacts on marine resources directly by harvesting greater numbers and more species than that laid out under Fisheries management plans. In addition, there are indirect hazards associated with illegal commercial fishing and the use of drift nets. For example, the Djelk Rangers have documented several instances of crocodiles, marine turtles, marine mammals, seabirds and undersized fish that have been netted and killed accidentally as by catch. Illegally placed commercial nets are common. While recreational fishing impacts are believed to be minimal, severe cultural breaches by recreational fishermen at restricted sites are a frequent occurrence. Foreign fishing vessels are also responsible for illegal fishing activities and have a negative impact on local fish stocks, particularly shark species which are captured for their fins. Illegal foreign fishing vessels also pose a hazard to Australia's environment and primary industries as they can carry marine pests, exotic diseases and parasites. They also represent a threat to Australia's border security.

Marine debris is another source of threat to marine resources. As a result of the prevailing current, the Arnhem Land coastline receives a large volume of inorganic debris such as abandoned or "ghost" nets. Ghost nets are fishing nets that have been accidentally lost, deliberately discarded or abandoned at sea. They are a serious threat to marine wildlife as they trap fish, marine turtles and other animals as well as harbouring disease. Marine turtles and marine mammals are most vulnerable to entanglement in these ghost nets.

Marine debris drifts onto reefs, headlands and beaches, damaging marine and coastal communities (Gambold 2009). Marine debris also represents a potential source of marine and terrestrial pests.

Threats to cultural values

Gambold (2009) lists three major threats to cultural values: (i) loss of cultural heritage through breakdown of intergenerational transfer of knowledge; (ii) inadequate recording of sites of cultural significance; and (iii) damage and destruction of rock art, cultural sites, and culturally significant species caused by feral animals, human activities, intense bushfires, and climate change. These issues are closely linked to processes of depopulation, centralisation and changing lifestyles that in turn are affected by government policies and investments.

Emerging threats

Several mining exploration licences have been granted for areas within the IPA (Gambold 2009). No mining has been undertaken as yet. While the final impact on the environment would depend on the type of mining activity, considerable impacts are to be expected from the operation of any mine, its infrastructure, and its transport network.

The effects of climate change are also likely to have a significant impact on the IPA. Rising sea levels, atmospheric increases in carbon dioxide, increased frequency and severity of cyclones, changes to monsoonal precipitation, and increases in solar radiation are some of the expected effects. All have serious implications for Traditional Owners and present environmental management issues at a landscape scale. For example, increases in carbon dioxide are considered to promote vegetative growth. Coupled with increased ambient temperatures and shifts in seasonal rainfall, this could increase the probability of hot, uncontrolled fires (Gambold 2009).

3.1.4 Rangers' management activities and outcomes

Since 2007, the Djelk Rangers have been routinely collecting data in the field with CyberTracker™ software installed on hand-held computers. The Djelk Rangers pioneered the use of CyberTracker™ by Indigenous ranger groups in northern Australia, developing their own data collection sequences in collaboration with NAILSMA (Ansell & Koenig 2011). The Djelk Rangers record data on all of their land and sea management activities in the field using this technology. The data is used to report back to Landowners as well as to program partners and funding bodies. Whilst an invaluable source of information, the data collected has some limitations and these need to be taken into account during analysis. As the data collection system evolves and the rangers become more proficient with its use, the collection and quality of data increases. Thus, the possibility of comparing some variables from year to year is limited. In addition, some time-consuming activities such as vehicle and equipment maintenance and attendance at meetings and conferences are not usually recorded using this technology and are either under reported or not reported at all.

For this research, a number of assumptions were necessary, particularly in assigning work time and resources to specific tasks. For instance, the time spent on a given activity is calculated as the hours spent in the field plus the travel time. The time spent preparing vehicles, equipment and materials is not included in these calculations. Similarly, as data on the vehicles and equipment used is not recorded, the number of vehicles used is calculated as the minimum number necessary to transport the rangers who participated in

any recorded activity. As a day's work was often multi-purpose, it is assumed that time and resources were allocated equally to each task.

Land and Women Rangers

The major tasks of the Djelk Land and Women Rangers include prescribed burning, fire mitigation, feral animal control, weed survey and control, and the protection of cultural sites. These activities aim to maintain the biodiversity and natural productivity of the land through the use and transfer to younger generations of both Indigenous and non-Indigenous (i.e. western scientific) knowledge (Gambold 2009). Table 1 summarises the activity data for the fiscal year 2009-2010 and outlines the time spent on each activity as a percentage of the total hours worked and the total distance travelled for given activities.

Table 1: The Djelk Land Rangers time allocation and the total distance travelled to undertake operations in the 2009-2010 financial year. Total hours spent on land ranger patrols was 1951 hours.

Activity	# Patrols	% of Total Hours n = 1951 hours	Distance Travelled (km)
Weed Survey & Control	147	43.2	10,115
Feral Animal Control	20	8.1	2,038
Prescribed Burning	136	40.0	20,897
Fire Fighting	11	2.8	1,657
Cultural Site Protection	33	6.0	3,040

Weed treatment has been the most frequent activity of the year, with over 90 days (43.2% of total labour time) dedicated to surveying and treating weed infestations in the IPA and surrounding regions (Table 1). Following the identification of a new outbreak of *Mimosa pigra* in 2008-09 on the Tomkinson River floodplains, the rangers intensified monitoring and treatment in this area. Feral animal-proof fences were constructed around Mimosa infestations to prevent further spread of seed and to date no new infestations have been reported. The rangers also continued to treat and monitor annual and perennial Mission Grass, the most prevalent weed species in the IPA particularly in the township of Maningrida and at all of the outstations. Whilst the actual area treated annually for weeds is relatively small (circa 100 hectares), treatment areas are spread throughout the entire management area requiring extensive travel.

Prescribed burning continues to be a major commitment for the Djelk Rangers. It is the activity that required the most distance travelled, as it involved traversing most of the IPA as well as surrounding areas that fall within Djelk Rangers' management (Table 1). As a result, helicopters are used extensively to conduct aerial burning in conjunction with ground burning from vehicles. Djelk is part of the West Arnhem Land Fire Abatement (WALFA) project, a contractual agreement between the Northern Territory Government, the Northern Land Council (NLC), Traditional Landowners and Darwin Liquefied Natural Gas (DLNG) for the abatement of a minimum 100,000 tonnes of CO₂ equivalent greenhouse gas emissions per annum (see insert on next page). Figure 2 compares fire activities for the last two fire seasons (taken as calendar years).

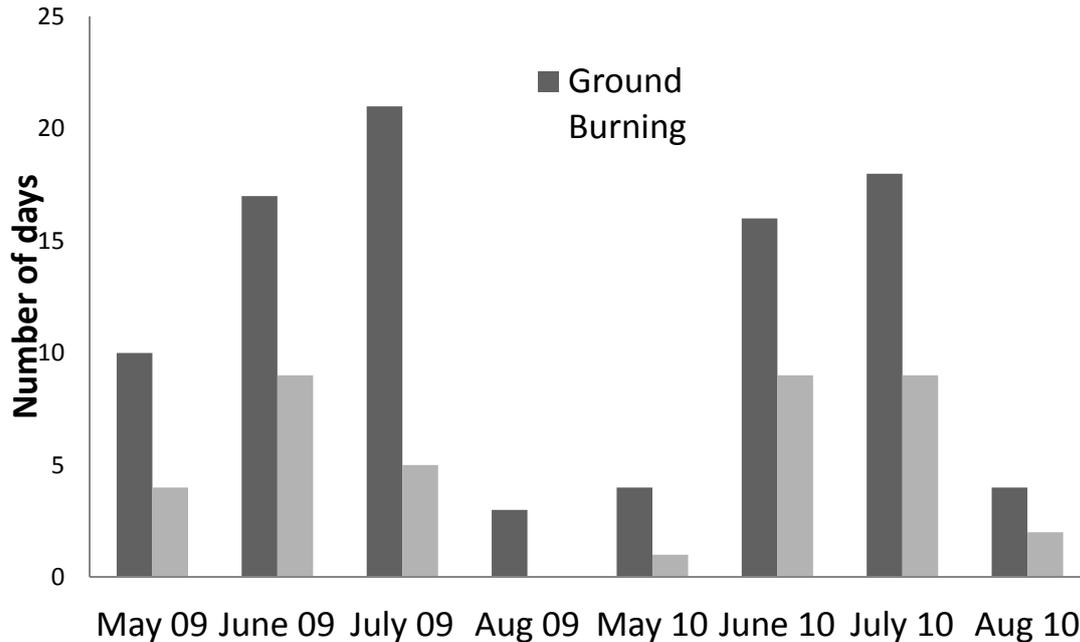


Figure 2: The number of days of prescribed burning undertaken by the Djelk Rangers over two fire seasons in 2009 and 2010.

Compared to the 2009 fire season, prescribed burning started slightly later in 2010 due to seasonal factors related to the end of the wet season. In 2010, the Djelk Rangers decreased the number of days of on-ground prescribed burning and increased the number of days of aerial burning compared to the 2009 fire season (Figure 2). The number of kilometres travelled increased slightly in 2010 as did the hours spent undertaking prescribed burning. This increase was primarily due to increased access to country made possible by greater involvement of and consultations with Landowners. Senior Traditional Landowners continued to take part in burning activities, both on the ground and in the air, providing invaluable knowledge, direction and support to the Djelk Rangers.

Djelk Ranger fire management is nowadays probably one of the most advanced systems for controlled burning in Australia. It is based on traditional knowledge, advanced equipment such as an incendiary machine, a sophisticated data recording system based on CyberTracker™, and effective collaboration between Djelk, Traditional Owners, Bushfires NT, NLC, NAILSMA, neighbouring ranger groups, and North Australian Fire Information (NAFI). The targeted reduction in GHG emissions has been regularly exceeded (Gambold 2009). Djelk Rangers are involved in extending this fire management model to Central Arnhem Land through the Central Arnhem Land Fire Abatement (CALFA) project.

Feral animal control is the third most frequent activity performed by the Djelk Land Rangers (8.1% of total labour time: Table 1). This activity almost exclusively targeted water buffalo at specific sensitive sites identified by Traditional Owners as requiring management. In 2009-2010, the rangers culled 662 buffalo in one area in the upper reaches of the Cadell River using a combination of on-ground and aerial culling. Outstation residents also cull feral animals for their own dietary needs. The last feral animal surveys in the IPA were conducted over a decade ago (Koenig et al. 2003; Griffiths and Pardon 2002). Whilst the current size of the population of feral animals in the IPA is unknown,

results from previous surveys suggest that such large scale culling at key sites is likely to have a significant impact.

In 2009-2010, the Djelk Rangers started intense monitoring and management of cultural sites in the IPA. These activities include recording cultural information from Traditional Owners, assessing management needs, and implementing a management program if needed—such as weed eradication, feral animal protection, and prescribed burning. As at the end of the 2009-2010 financial year, over 20 sites had been documented and mapped.

The Djelk Rangers have established an important partnership with the NT Department of Natural Resources, Environment, The Arts and Sport (NRETAS) and Warddeken Land Management to conduct biodiversity surveys within the Djelk and neighbouring Warddeken IPAs. Since April 2009 an NRETAS ecologist has been based in Maningrida coordinating biodiversity surveys and training rangers in biodiversity monitoring in both IPAs. The goal is to establish a biodiversity baseline for the IPA in order to assess the impact of management activities and establish management priorities.

West Arnhem Land Fire Abatement (WALFA) Agreement

The West Arnhem Land Fire Abatement (WALFA) agreement is an agreement between the Northern Territory Government, Darwin Liquefied Natural Gas, the Northern Land Council and Traditional Owners for the area of the Arnhem Land Plateau including the upper reaches of the Mann and Liverpool Rivers. It is a strategy for offsetting greenhouse gas emissions from the Wickham Point Gas Plant.

Under the WALFA agreement, Darwin Liquefied Natural Gas will provide around \$1 million per year for 17 years to ranger groups within western Arnhem Land to implement a fire management strategy. This strategy is aimed at reducing the incidence of extensive, destructive wildfires in the broader Arnhem Land Plateau region. This will be achieved by reducing annual fuel loads with a mosaic of patchy, early dry-season prescribed burns and fire breaks.

Savanna fires are the greatest source of greenhouse gas emissions in the Northern Territory. Based on estimates for 2004, burning of savannas contributes 41 per cent of the NT's accountable emissions. Limiting wildfires significantly reduces greenhouse gases emissions from that landscape. This abatement and the resultant reduction in emissions provide an effective carbon offset for the Liquefied Natural Gas plant at Wickham Point. The WALFA agreement also seeks to provide appropriate employment opportunities for Aboriginal people by supporting community-based land management programs. It aims to conserve environmental and cultural values of the management area, specifically by protect rainforests and other vulnerable wildlife and cultural heritage including the many rock art sites from the impact of wildfire.

Source: Gambold 2009.

A crude measure of the capital intensity of each activity is given in Figure 3. It is estimated as the ratio between the average hours worked per patrol and the average distance travelled per patrol for each of the different land and sea management activities. It is based on the assumption that the distance travelled gives an indication of the use of capital (boat, car or helicopter). The lower the figure the more capital intensive the activity and the higher the figure the more labour intensive the activity. This measure, albeit rudimentary, serves to highlight management options that are less capital intensive or activities that will create more labour demand. For instance, for the land rangers weed control appears to require more labour than prescribed burning. Of the sea ranger patrols, the AQIS patrols are the most labour intensive. However, these figures must be interpreted with caution as the distance travelled for many of the activities (particularly the sea ranger patrols and prescribed burning) is actually an integral component of the task being performed. For example, with prescribed burning a helicopter traverses large tracts of country and drops flammable incendiaries every 30 seconds. Thus the distance travelled is actually an indication of the amount of work undertaken.

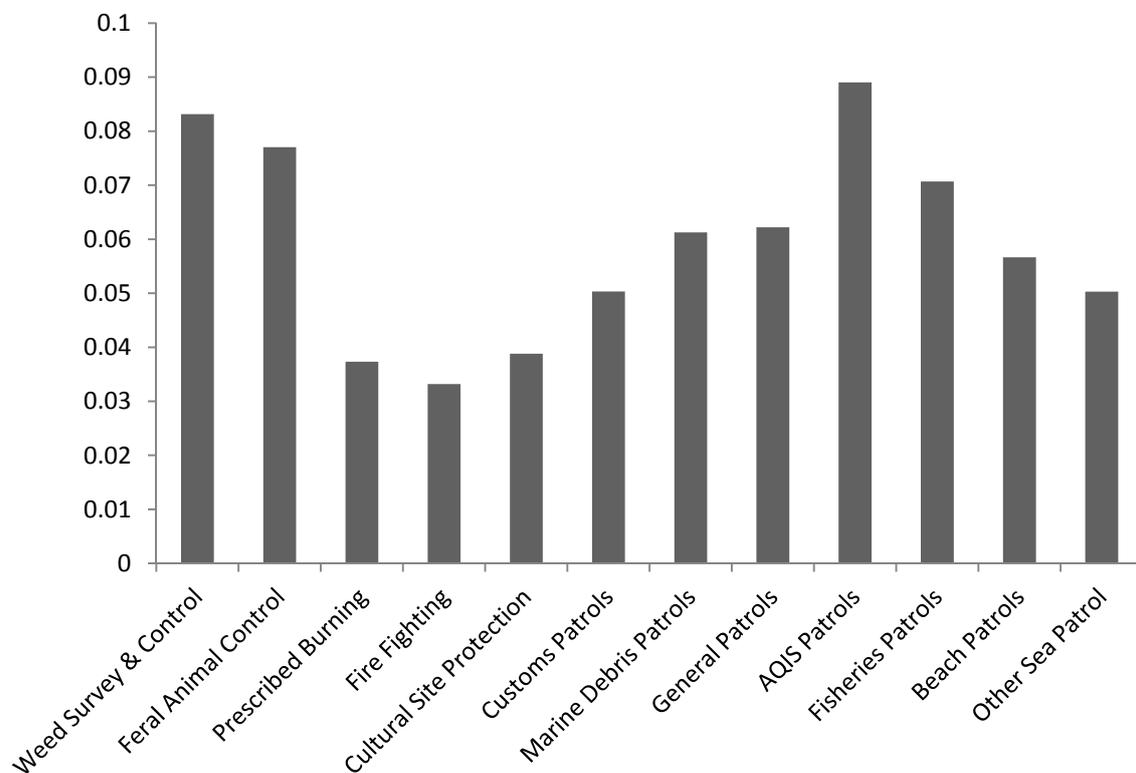


Figure 3: An indication of capital and labour intensity for the main Djelk Ranger activities. Taken as the ratio between the average number of hours per patrol divided by the average distance travelled (in kilometres) per patrol. For this analysis the distance travelled by the sea rangers was converted from nautical miles to km. N.B. For many activities the distance travelled is actually an integral part of the activity and cannot be assumed to be the travel time (e.g. most sea patrols and prescribed burning).

Sea Rangers

Marine and coastal monitoring and management are key tasks for the Djelk Sea Rangers. They assist with the protection of natural and cultural resources, while providing bio-security and border protection services. In 2009-2010, the sea rangers spent nearly 2,000 hours patrolling approximately 10,000 km² of sea, including islands, up to three nautical miles off the coast of the IPA. Their activities focused on surveillance and marine debris control. The data on patrol type, effort, personnel, and findings is recorded using CyberTracker™. Photographic evidence of non-Indigenous marine activities and impacts is also collected by the sea rangers. Information on time and resources allocated to marine patrols is extrapolated from these data making use of conservative assumptions, consistent with those for terrestrial activities. Table 2 provides the number of coastal patrols undertaken in the year 2009-2010 and the distance covered carrying out the patrols.

Table 2: The Djelk Sea Rangers time allocation and the total distance travelled to undertake operations in the 2009-2010 financial year. Total hours spent on sea ranger patrols was 1845 hours.

Activity	# Patrols	% of Total Hours n = 1845 hours	Distance Travelled (nautical miles)
Customs Patrols	162	56.3	11,149
Marine Debris Patrols	64	19.6	3,191
General Patrols	33	11.4	1,823
AQIS Patrols	19	5.9	655
Fisheries Patrols	7	2.6	367
Beach Patrols	5	0.9	162
Other Sea Patrol	14	3.3	655

Surveillance activities are one part of contracted services the Djelk Sea Rangers provides to several external agencies including Australian Customs and NT Fisheries. In 2009-2010 the Djelk Sea Rangers undertook 112 patrols for the Australian Customs and Border Protection Service (Customs), and travelled over 12,000 nautical miles (Table 2). They sighted and reported 83 commercial fishing boats and 24 recreational fishing boats. The data indicates that the presence of the Djelk Sea Rangers is likely to be a deterrent to illegal activities. Only 2 per cent of the fishing boats monitored by the Djelk Sea Rangers were found to be in breach of the law.

In partnership with NT Fisheries, the Djelk Sea Rangers have greatly improved their enforcement and compliance capacity. Last year the Djelk Sea Rangers provided evidence that led to successful convictions of two fishermen for illegally entering a coastal sacred site and Aboriginal land without a permit. Under the service level agreement with Australian Customs, the patrols between NT Fisheries and Customs are reported on jointly. Each Customs patrol is therefore also a Fisheries Patrol. The Djelk Sea Rangers also conduct some additional patrols for Fisheries that are not required by Customs. In 2009-2010 the Djelk Sea Rangers undertook seven dedicated NT Fisheries patrols covering around 560 nautical miles.

Under another fee-for-service contract, the Djelk Sea Rangers provide bio-security monitoring for the Australian Quarantine Inspection Service (AQIS). This involves patrolling the coast and landing sites, checking debris for marine pests, invertebrates,

vertebrate diseases, and removing marine debris. A total of 64 patrols (17 contracted by AQIS) were performed to monitor marine debris (Table 2). The sea rangers collected over 1,060 items, including household and commercial rubbish, ghost nets, and driftwood. The Rangers removed 32 ghost nets over the season. Samples of the ghost nets are sent to AQIS for identification. The Djelk Sea Rangers are now also part of Ghost Nets Australia—an alliance of Indigenous land and sea management groups and communities that provide support for addressing the problem of ghost nets.

As part of their environmental and cultural protection activities, the Djelk Sea Rangers have installed buoys clearly marking registered sacred sites in the sea. This is aimed at increasing compliance on the part of commercial and recreational fishers so that sacred sites are adequately respected and protected.

Other activities

Over the last 10 years the Djelk Rangers have actively participated in the trialling of several wildlife harvesting enterprises. In collaboration with research organisations and BAC, the Djelk Rangers set up trials to determine sustainable harvest and commercial opportunities of several native plants and animals (Cochrane 2005). These industries were investigated as potential ways to self fund land management activities. Since the Commonwealth Government introduced funding for ranger wages and operations, the two wildlife-based enterprises in Maningrida now function independently of the Djelk Rangers. The BAC Nursery propagates a wide range of local Indigenous plants for landscaping and for sale. The Djelk Wildlife Enterprise is involved in long-neck turtle and crocodile egg harvesting, incubating the eggs and then selling the hatchling for the pet market and to crocodile farms. Recently the Djelk Wildlife Enterprise has expanded its activities to include the operation of BAC's commercial mud crab license as well as the husbandry of tarantula spiders to sell spiderling and harvest venom for the pharmaceutical industry. Being a part of the same parent organisation as the rangers, BAC, both the nursery and the wildlife enterprise exchange some resources and staff time with the rangers on a small scale. Currently, the CDEP program provides the main means of hiring labour for these two enterprises.

BAC manages a tourist facility just outside of Maningrida. The Djelk Rangers are occasionally involved in cultural tours, but overall their involvement in tourism is minimal. BAC established a safari camp for guests to hunt buffalo and pigs. Some current Djelk staff worked as guides prior to becoming rangers, but the enterprise did not prove to be commercially viable (Cochrane 2005).

3.1.5 Management needs and gaps.

The Djelk Rangers have a detailed Plan of Management for their IPA which enshrines the views and wishes of over 100 land-owning groups in the region (see Gambold 2009). During the interviews with Landowners conducted as part of this study, several key themes were highlighted again. In particular, Traditional Owners identified the need to address the impacts of feral animals—especially buffalo—in the region. The issue of feral buffalo management highlights the importance of acknowledging both the livelihood and conservation concerns of Traditional Landowners alongside government and scientific concerns (see, for example, Albrecht et al. 2009). Half of the Traditional Owners interviewed by the research team on the topic stated that they hunt buffalo for their meat supply (14 out of 28); while all of them (28 out of 28) expressed concern about the damage caused by feral animals and expect the Djelk Rangers to do more culling. Buffalo in

particular, threaten the health of floodplains, the sources of native bush foods, and the integrity of cultural sites. Given the importance of buffalo as a resource for landowners, to date the Djelk Rangers only conduct buffalo culls where Landowners identify that they want this to happen. For example, over 650 buffalo were culled in the sensitive spring country of the upper reaches of the Cadell River following Traditional Owner requests and consent. The rangers have been working with research organisations and industry partners to develop a range of feral animal management strategies to present to Traditional Owners. Critically important is obtaining an accurate assessment of the damage caused by buffalo in the region and a survey of feral animal density and abundance in the IPA. Options investigated for the removal of buffalo include widespread aerial culling, a Landowner harvest incentive program, and commercial harvesting for pet meat.

Some Landowners (11 out of 28) expressed their concern about frequent trespassing and illegal fishing activities. The Djelk Rangers do not currently police non-landowner access to country. Given the remoteness of the community and the lack of independent tourists, it is left to individual organisations in Maningrida to educate their staff on protocols for obtaining permission to visit country. Littering is also an issue that frequently emerged during the interviews. While the Djelk Rangers do not currently address this issue directly, they liaise with and support the local council to help deal with littering. The rubbish dispersed in the township often ends up in creeks, beaches, mangroves, and coastal waters, and is then removed by the rangers as marine debris. The Djelk Rangers have also been investigating ways of dealing with people's disposal of their clothing and bedding in the water for cultural reasons.

Finally, the paucity of ecological data for the region presents a serious problem. Insufficient data means that Djelk Rangers have not been able to effectively: (i) assess the outcomes of their own activities; (ii) monitor and evaluate progress; (iii) re-align priorities; (iv) advise and consult with Traditional Owners with the backup of a biodiversity baseline; and (v) promote their achievements. Realising this shortcoming, the Djelk Rangers lobbied successfully for an ecologist to work in the IPA. The recent appointment of the NRETAS ecologist to work with Djelk and Warddeken IPAs is an important first step forward in addressing this issue. The collection of such ecological data and the measurement of management benefits is also important information on which to base payment for environmental services currently and potentially provided by Djelk Rangers—and also in the event that a trading scheme emerges for ecosystem services or biodiversity credits.

3.1.6 Budget and cost structure of the Djelk Rangers.

The Djelk Rangers finance their activities through a mix of government funding and fee-for-service contracts with private and public agencies. As shown in Table 3, revenues for the year 2009-2010 amount to over \$2 million. This is the **cost to society** of the environmental services the Djelk Rangers provide. Government program funds correspond to 78 per cent of the total revenues. These public funds are distinct from fee-for-service payments from other government departments. Government program funds come from three programs: the Indigenous Protected Area (IPA) program (15.2% of total revenues), the Working on Country (WoC) program (54.7%), and the Caring for our Country program (8.1%). WoC funds are principally dedicated to the labour and training costs incurred by the Djelk Rangers and are made up of three categories: WoC Commonwealth, WoC NT, and WoC Flexible.

Table 3: The Djelk Rangers budget for the financial year 2009-2010 (\$).

Revenues	Wages & Training	Operational	Other	Total	%
<i>Public Funding</i>					
Indigenous Protected Area		154,000	161,000	315,000	15.2
WoC Commonwealth	503,000	155,000	150,000	808,000	38.9
WoC NT	115,000			115,000	5.5
WoC Flexible	214,000			214,000	10.3
Caring for our Country			168,000	168,000	8.1
<i>Sub Total</i>	832,000	309,000	479,000	1,620,000	77.9
<i>Fee-for-service</i>					
WALFA			106,000	106,000	5.1
CALFA			10,000	10,000	0.5
Australian Customs			272,000	272,000	13.1
AQIS			11,000	11,000	0.5
NT Fisheries			60,000	60,000	2.9
<i>Sub Total</i>			459,000	459,000	22.1
Total	832,000	309,000	938,000	2,079,000	100

Source: Djelk Rangers Annual Report 2009-2010 (May et al. 2010)

N.B. WALFA and CALFA revenues are for the calendar year 2009.

Figures are un-audited and rounded up to the nearest thousand.

The Djelk Rangers receive around 22 per cent of their total revenues through fee-for-service and fire abatement contracts (Table 3). The Djelk Sea Rangers provide maritime surveillance and bio-security services for Customs, AQIS, and NT Fisheries. Since 2005 Customs has contracted the Djelk Sea Rangers to carry out 72 sea patrols per annum—but as mentioned above, the rangers actually provided 112 Customs patrols. Payments are pro rata, based on the reports and invoices that Djelk submit and vary according to performance. In 2009-2010, the Djelk Rangers received \$272,000 from Customs. AQIS and NT Fisheries paid the Djelk Rangers \$11,000 and \$60,000 respectively, for monitoring of marine debris and illegal foreign fishing vessels (IFFV). Revenues from AQIS decreased substantially compared to the previous financial year, partly as a consequence of AQIS re-directing their resources to the monitoring of other environmental problems (AQIS, pers. comm. 2009).

Through the WALFA project the Djelk Rangers receive payment from the private sector for their contribution of ‘greenhouse-effective fire-management services’ that seek to ‘offset the loss of monsoon forest’ and ‘to some extent the GHG emissions from the [DNLG] plant’ (Whitehead et al. 2009: 301-2). The Djelk Land Rangers carry out fire management and strategic burning as part of this WALFA agreement, and received around \$100,000 in the calendar year 2009. They are also involved in setting up the CALFA project, for which they received \$10,000.

Even though the Djelk Rangers rely heavily on public funding, one should not overlook the importance and innovation of their fee-for-service and offset revenues from the state and market sectors. Many of their contracts predate the Commonwealth Government’s

introduction of the WoC program and the declaration of the Djelk IPA and attest to the recognised quality of work conducted by the rangers. BAC and the Djelk Rangers established the Sea Rangers following Traditional Owner concerns about the influx of Indonesian fishermen. The Djelk Sea Rangers soon became highly successful in detecting and reporting illegal foreign fishing vessels. Following media exposure, this became formally recognised by the Commonwealth Government with the establishment of the service-level agreement. Following the success of the Djelk Rangers, Customs expanded the program to include other Indigenous land and sea management groups. Similarly, other Indigenous organisations and government agencies are looking at the WALFA project as a possible model for fire management and Indigenous engagement and employment.

Public funding and fee-for-service revenues are the financial cost to society of the Djelk Rangers' land and sea management operations. These funding streams originate predominantly from the institutional responsibilities of government for public service provision and the enforcement of regulations. Until recently, there has been limited data to assess whether the benefits of environmental protection and regulation enforcement in the Djelk IPA match their social cost or vice versa. The Djelk Rangers have been instrumental at streamlining the data reporting and information that is delivered back to government through the use of CyberTracker™. Seeing the benefits and accountability that this brings to the ranger groups, the Commonwealth Government has recently invested funds to employ two dedicated CyberTracker™ support officers to work with Indigenous ranger groups.

In terms of the hybrid economy model, the WALFA project can be seen to extend both the market and the customary sector with state backing. In this case, a private commercial organisation is paying for services that are primarily in the customary domain, informed and quantified through western science. The rangers rely on traditional knowledge and customary practices as well as non-Indigenous knowledge and skills to undertake their work. Importantly, the community retains control (governance) over the NRM activities that occur on their lands. It can be argued that an effect of the state's involvement in Indigenous NRM and its development of linkages with the private sector strengthens the customary sector in the Djelk IPA.

The estimations of the **private cost** of the Djelk Rangers' activities are presented in Table 4. These estimations are based on CyberTracker™ data on rangers' participation, duration, and distance covered during each activity and patrol. In order to obtain reliable cost estimates, it is necessary to introduce several hypotheses regarding labour rates per hour, the number of vehicles or boats on patrol, and cost per km or nautical mile. Labour cost is calculated according to the rate AQIS paid rangers in its fee-for-service contract—\$16 per hour. As wage rates vary among rangers, the AQIS rate is taken as the average salary cost per hour. The final labour cost is calculated on the basis of the time spent on the job including travel time. As this excludes the time spent preparing vehicles and equipment, it is a conservative estimate of the labour cost.

Table 4: Estimates of the private cost of the Djelk Rangers activities for the financial year 2009-2010 (\$).

Activity	Low	Medium	High
<i>Land & Women Rangers</i>			
Weed Survey and Control	84,245	96,189	108,133
Feral Animal Control	15,724	17,706	19,688
Prescribed Burning	115,301	134,224	153,148
Cultural Site Protection	10,862	13,664	16,466
Fire Fighting	1,940	2,904	3,869
Sub Total	228,072	264,688	301,304
<i>Sea Rangers</i>			
AQIS Patrols	17,306	20,167	23,027
Customs Patrols	124,306	151,724	179,143
Marine Debris Patrol	42,118	50,419	58,720
Beach Patrols	3,267	3,959	4,650
General Patrols	19,755	24,542	29,330
NT Fisheries Patrols	4,591	5,378	6,164
Sub Total	211,343	256,189	301,034
Total	439,415	520,876	602,338

N.B. These are estimates of the Djelk Rangers' labour and vehicle/boat running costs. They do not include other operational costs (such as materials or equipment), capital cost, and administrative cost. For the weed control activities they include cost of chemicals.

Estimating the operational cost of vehicles and boats also required some assumptions. For vehicles, a low, medium and high cost per kilometre was calculated. The low estimate is based on the approximate rate per km charged for a rental 4WD vehicle in Darwin (\$0.50 per km). This is the lowest bound of our estimates. Rangers' vehicles are generally second hand and travel almost exclusively on unsealed roads in what are often extreme conditions, so it is plausible that the cost per km is higher than \$0.50 per km. Hence the estimates of vehicle costs are given using two more values: a medium (\$1 per km) and a high (\$1.50 per km). Similarly, the cost per nautical mile of the Djelk Rangers' boats is estimated using low, medium and high measures of fuel efficiency. The low measure is based on a fuel consumption rate (1 litre per nautical mile) for a similar boat with a similar engine available in the specialised literature (Russell and Webb 2008). As the Djelk Rangers' boats are old (approx 5 years old) and work in rough conditions, we also used higher fuel consumption rates (medium = 2 litres per nautical mile; high = 3 litres per nautical mile). Finally, the average cost of hiring a helicopter is estimated at \$900 per hour (Djelk, pers. comm. 2010).

Note that these estimates refer only to activities that are recorded through the CyberTracker™ system. Other activities, such as biodiversity monitoring, training, education, conference and workshop participation, and community assistance, are not reported. Hence the total cost presented is only a part of Djelk Rangers' total expenditure. Further, these estimates do not include other operational costs such as expenditure on materials, consumables and equipment. Neither capital costs nor administrative cost are

computed in these estimations. As stated previously, labour costs are likely to be underestimated as the actual number of staff working on each patrol is under recorded with CyberTracker™. Hence, these figures should be considered as lower bound estimates of the total expenditure.

Four activities—weed control, fire management, customs patrols, and marine debris patrols—generate 85 per cent of the overall expenditure (Table 4). The cost of weed control activities ranges from \$80,000 to \$110,000, and it is equivalent to 19 per cent of total expenditure. Weed infestations in the Djelk IPA are concentrated in a number of areas—especially around Maningrida township and at the 34 outstations—and their combined size is estimated to be around 100 hectares. The cost of controlling these infestations is then around \$800–\$1,100 per hectare. In the Djelk management area weed infestations are scattered across 10,000 km² and weed survey and control needs to be undertaken by hand—predominantly by spraying, though cutting and spraying and hand pulling are sometimes necessary. The Djelk rangers have spray units attached to the back of 4WD vehicles as well as 4WD quad bikes and also use backpack spray units to access areas where there is no road access. In the estimates for the Djelk IPA (Table 4), labour accounts for 66 per cent of the total cost. This reflects the nature of the weed infestation which requires weed surveys to be conducted throughout the landscape and followed up with weed control targeted to specific areas so as to minimise damage to native vegetation.

Expenditure associated with fire management, in particular prescribed burning and fire mitigation, ranged from \$115,000 to \$153,000 in the last financial year (Table 4). Djelk Rangers received a significant proportion of this money from their participation in the WALFA project—\$106,000 in 2009-2010. The WALFA project pays for the management of fire over the WALFA region which includes roughly 1,000 km² of the Djelk IPA. Fire management activities throughout the rest of the IPA are funded through other funding streams including the WoC and IPA programs.

The operational and labour costs associated with Customs patrols vary between \$124,000 and \$179,000 (Table 4). In 2009-2010 the Djelk Sea Rangers received \$272,000 from Customs to carry out coastal patrols. Assuming capital and administrative costs of the Customs patrols are 50 per cent of the operational and labour costs, the contracted fee for coastal patrols seems to cover the cost of provision. As a service level agreement, Djelk invoice for the cost of providing the service. Marine debris patrols generate a total expenditure ranging from \$42,000 to \$58,000.

Another source of expenditure is the AQIS patrols. According to the contractual agreement, AQIS pays for two Djelk Rangers and vehicle or boat costs. In the last financial year, Djelk Rangers received \$11,000. The total estimated cost varies between \$17,000 and \$23,000. The gap between revenues and expenditure is largely due to the fact that more than two Rangers are usually involved in the AQIS patrols. However, in order to cut the cost of these patrols, the Djelk Rangers organise them in conjunction with other activities.

The cost structure of each Djelk Rangers' activity is illustrated in Figure 4. It shows the ratio of labour cost over total cost. A ratio higher than 0.5 indicates that labour is the main source of cost. Some activities are more labour or capital intensive than are others. For example, weed control activities are labour intensive with labour accounting for around 66 per cent of the weed control costs, 26 per cent is associated with vehicle use, and 8 per cent with the cost of chemicals. Conversely, the expenditure associated with fire management

activities are capital intensive. Labour cost accounts for only around 35 per cent of the total cost, while operational cost—particularly helicopter hire—accounts for the remaining 65 per cent. Among the Djelk Land Rangers’ activities, feral animal control has the highest labour cost/total cost ratio. Feral animal control, particularly for buffalo, requires large teams of rangers spending large amounts of time sighting animals and then culling. Following Civil Aviation Safety Authority endorsement in 2009, this should become more streamlined with some Djelk Rangers gaining the qualifications necessary to conduct aerial platform shooting by helicopter. Coastal patrols have a similar cost structure, with a ratio labour cost/total cost over 0.6. However, AQIS and NT Fisheries patrols appear to demand more labour in comparison to the other types of patrols. This is possibly related to the nature of these contracted activities that require control of landing sites and the checking, recording and removal or destruction of marine debris.

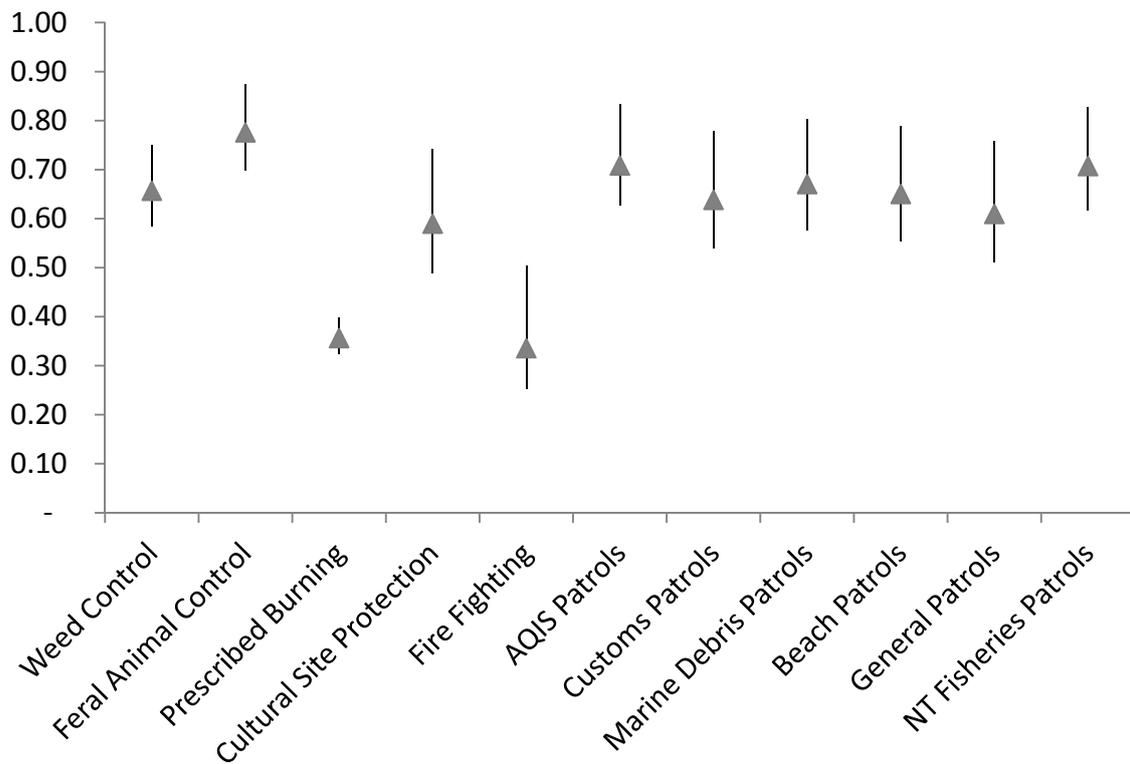


Figure 4: Ratio of labour cost over total estimated cost for the Djelk Rangers based on the estimates of high, medium and low total costs reported in Table 4. The triangle represents the ratio estimated using the medium total cost.

3.1.7 Commercial opportunities and analysis of demand.

The Djelk Rangers can be regarded as receiving payments for environmental services that benefit the local, national and international community. In terms of Djelk’s main sources of revenue, the use of government program funding is generally restricted to specific purposes, while revenue from fee-for-service agreements are directed back into the ranger program and act as important discretionary monies. There are several other potential public and private sector ‘buyers’ of Djelk’s environmental services. Identifying these buyers is a key step in enabling the Djelk Rangers to expand their operations even further, providing

more employment opportunities for Aboriginal people within the region. There are also other potential environmental services for which a demand exists that Djelk could look to supply. Different sources of demand for environmental services are distinguished here as institutional demand, Indigenous direct use, non-Indigenous direct uses, and non-use related demands for conservation.

The institutional demand

The institutional demand for Indigenous NRM services arises from the institutional responsibilities of government agencies and departments. Institutional demand can therefore be seen as largely representing demand from the state sector. As described above, government agencies fulfil some institutional responsibilities by outsourcing monitoring, management and potentially enforcement service provision to the Djelk Rangers. Three examples highlight how institutional demand may expand in the near future.

First, with respect to any mining development in the Djelk IPA, the NT Environmental Protection Authority could contract the Djelk Rangers to provide the environmental monitoring of mining activities and assist with environmental impact assessments. Second, outsourcing could further develop in the field of scientific research through more collaborative work to produce essential scientific data about the environmental values of the Djelk IPA. This research is particularly needed in light of the IPAs national environmental significance and its inclusion within the National Reserve System. Djelk have a long history of collaborating with research organisations and are experienced in working with researchers and collecting research data. The use of CyberTracker™ means that such data can readily, accurately and independently be collected by the rangers. Third, under the Northern Territory Government's Blue Mud Bay settlement proposal it is proposed that sea rangers be provided with fisheries compliance and enforcement powers through an amendment of the Fisheries Act (NTG 2011). This amendment would be supported through appropriate training of sea rangers to fulfil this role.

Indigenous direct use of environmental services

While data is limited, the most recent estimate of the size of the customary sector from research undertaken within the Djelk IPA showed that it represents up to 50 per cent of livelihood for some outstation residents in the region (Altman 2003). The magnitude of a local demand for environmental conservation is uncertain. The local Indigenous population benefits from the use of their land and waters within the Djelk IPA in different ways: as a source of food; as a source of inputs for subsistence production (e.g. hunting and fishing implements); and as a source of materials for art production (which in turn generates cash income). The relationship between benefits from uses of the IPA and its environmental condition is not necessarily positive and linear—that is, in the short term at least, better environmental conditions do not necessarily imply more benefits to users. Take the case of feral animals. As highlighted in the interviews with senior men and women from Maningrida and the outstations in the Djelk IPA, the presence of feral animals may not be entirely negative: buffalo are an important source of food. It could also be argued that, given their size and number, subsistence buffalo hunting is more efficient than hunting for smaller, rarer native species. Hence large-scale buffalo culling could have a negative impact on the welfare of residents. Similar conflicting issues arise when arguing for the protection of cultural values. Some feral animals such as buffalo have nowadays found their place in Aboriginal myths and stories of creation; they have acquired cultural significance (Altman 1982). Again, their total eradication (if possible) may not be deemed culturally appropriate. Such issues highlight the importance of the Djelk IPA Plan of

Management, which enshrines the land and sea management aspirations of Traditional Owners in the region.

Consider also the case of the extraction of materials for art production and how this relates to Djelk's provision of environmental services. Indigenous art production in Maningrida is a very important income stream. Maningrida Arts and Culture (MAC), the local centre for the promotion of Indigenous culture and the marketing of high-quality art, recently reported an annual turn-over of around \$2.5 million (MAC 2009). 60 per cent of MAC total revenues are distributed among the artists (MAC 2009). Art production includes bark painting, carving, fibre crafts, hollow logs, and musical instruments, and is almost entirely based on natural products for media and colours. The sustainability of the art industry in the region depends on the long-term availability and sustainable use of these species from wetlands, floodplains, savannas and monsoon rainforest patches (Koenig et al. 2005). The little data there is suggests that for some species harvested for art production, the impacts of fire, feral animals and weeds are negligible. The harvesting of some tree species is considered sustainable as the trees have evolved strategies (e.g. re-sprouting) for dealing with damage from fire and cyclones and also enabling them to deal with damage from new threats (e.g. feral animals, see Koenig & Griffiths 2011). In a recent study, both fire and feral animal damage were found not to be the main factors influencing tree survival pre and post harvest (Koenig et al. 2011). Other research shows that Indigenous fire management has little effect on species composition, total tree density, or reduction in fine fuel biomass (Bowman and Prior 2004). More data is required though to fully reveal any benefits to the art industry from environmental service provision within the Djelk IPA.

Indigenous residents also use the IPA for recreational, social, cultural, and spiritual purposes. Around 90 per cent of the interviewees (26 out of 28) stated that they travel across their estate to visit family, take part in ceremonies, and for recreational reasons. These uses are primarily dependent on the accessibility of outstations, ceremonial sites and recreational areas, and hence they are dependent primarily on the weather, on the road conditions, and the availability of transport. There is currently no information recorded to determine the benefits that Djelk's environmental services have on the recreational, social and spiritual uses of the IPA. Government regulations create obligations and responsibilities for landowners. The NT Weed Management Act 2001, for instance, declares a general duty of landowners to prevent weed infestation and spreading (NRETAS 2011). Traditional Owners in the Maningrida region initially established the Djelk Rangers as a way for them to be able to tackle new and emerging environmental threats such as weeds. The Djelk Ranger program and the environmental services currently undertaken reflect the direct wishes of the Traditional Owners and works only happen following extensive consultation. The declaration of the Djelk IPA highlights the convergence between NRS priorities for investing in NRM and the aspirations of Traditional Owners. Under the Djelk IPA, Traditional Owners have voluntarily contributed their land to the NRS on the proviso that the Djelk Rangers are funded to conduct a range of activities that are mutually agreed upon to the benefit of Traditional Owners and the wider public.

In addition to the uncertainty about the magnitude of the local demand for environmental services, one should not disregard that the low average income of the Indigenous residents implies a limited capacity to pay. Hence, it is questionable that the local demand is capable of generating sufficient financial resources to pay for the Djelk Rangers' services.

Non-Indigenous direct uses

Other sources of potential demand for Djelk Rangers' services are the non-Indigenous residents and visitors who gain direct benefits from Djelk's provision of environmental services in the IPA. Direct uses include recreation, bio security services for the agricultural industry, commercial harvesting of wildlife for the pet market and the pharmaceutical industry, carbon credits and other potential environmental credits. Recreational use of the IPA on the part of non-Indigenous residents and visitors is quite hard to quantify and mostly limited to areas closest to Maningrida township. Recreational fishing is a particularly popular pastime for many non-indigenous residents and seen as a major benefit of living in Maningrida. In addition, many non-Indigenous residents derive a proportion of their meat consumption from marine species including fish, crab and prawns.

Three small-scale tourism ventures are based in the Maningrida area and cater to different visitor demands, though accommodation is a service common to all three. These ventures are the Arnhemland Barramundi Nature Lodge that provides out-of-town accommodation, food and guided fishing tours; BAC Tourism which offers out-of-town accommodation and cultural and ecological tours; and the Maningrida Progress Association motel that caters mainly for people travelling to Maningrida for work and looking to stay in the township.

BAC Tourism provided cultural tours and accommodation services to 72 tourists with an average stay of 4 days in 2008-2009. Each tourist paid on average \$172 a day. The overall revenue is equivalent to around \$50,000. The visitors' questionnaire distributed by the research team to non-Indigenous residents and visitors in Maningrida provides an estimation of the total cost of a visit to the region. The 22 visitors that completed the questionnaire declared an average stay of 4 days and a daily expenditure per person of \$564. The difference between the BAC figure of \$172 per tourist per day and the amounts reported in the questionnaires may reflect the different tourism operators and services respondents used along with the travel cost of getting to Maningrida. These figures suggest that around 2,000-2,500 visitors per year would be needed to generate roughly a 300 per cent increase in tourism revenues (compared to the 2008-2009 figures). This does not seem like an impossible target when compared with the tourist flow in nearby Kakadu National Park that currently registers around 210,000 visitors per year (SEWPAC 2011b).

This agricultural industry benefits from weed and feral animal control activities. The gross value of Australia's agricultural production totals \$41.8 billion a year (National Farmers' Federation 2011). Feral buffalo and weeds management provide two example of how environmental services provided by Djelk Rangers can and have benefited the agriculture sector. Australia was declared free from bovine tuberculosis in 1992 after a 27-year eradication campaign, however, not all the feral buffalo in Arnhem Land were eradicated and there is the possibility that they could still carry tuberculosis and spread it to domestic cattle. Until 2010, the industry relied on a surveillance system for early detection and eradication (AHA 2011) that partly involved Indigenous rangers through AQIS. Weeds cause loss of production and force farmers to incur treatment costs. Sinden et al. (2004) estimate the total cost of weeds in the agricultural sector to be around 10 per cent of the gross value of Australia's agricultural production. As there is no information on probabilities of tuberculosis outbreaks, weed spreading, and the impact of monitoring and treatment in the Djelk IPA, estimates of the contribution of the Djelk Rangers and Traditional Owners to preventing agricultural losses are speculative. One can only assume that this contribution is positive as the probability of a tuberculosis or other disease (e.g.

foot and mouth disease) outbreak is: (i) positively correlated to the number of feral animals; and (ii) positively correlated to the number of contacts between feral animals and non-quarantined individuals and animals that reach Australia illegally. In each case the culling activities of the Djelk Rangers and Landowners and also their bio security patrols decrease the probability of disease outbreaks. Similarly, the Djelk Rangers' weed control decreases the probability of weeds spreading.

The problem of weeds and feral animals could be looked at from another perspective. Most if not all of the weeds and feral animals that threaten the Djelk IPAs environmental and cultural values were originally introduced in Australia for agricultural purposes—for example, mission grass and buffalo. Particularly striking, is the case of the cane toad, *Bufo marinus*, initially introduced in Queensland to control the sugar cane beetle. The cane toads have spread throughout northern Australia and in the Maningrida region have been responsible for the decline of species with economic and ritual significance. It could be argued that the agricultural sector should pay for the cost incurred by Indigenous communities and the rest of the public. This cost includes loss of biodiversity and damage to cultural values. Hence, the cost of the Djelk Rangers' weed and feral animal control activities could be considered as the lower bound of the payment they should receive in view of the negative externalities of the agricultural sector.

The commercial utilisation of wildlife (e.g. for the pet market and the pharmaceutical industry) is another source of demand for the environmental services of the Djelk Rangers. As mentioned before, the Djelk Wildlife Enterprise currently commercialises crocodile and long-neck turtle eggs and hatchlings, and it is also looking into other species such as snakes, lizards and spiders for the pet trade and harvesting venom for the pharmaceutical industry. The projected revenue (less royalties) from these activities ranges from \$98,000 to \$122,000 per year (B. Corey pers. comm. 2010). While this enterprise has been judged as successful according to other criteria (see Fordham et al. 2010), its commercial viability relies on BAC and the state underwriting labour (through CDEP), training, maintenance and other costs. If these costs outweigh the revenue generated, then the current financial benefits of the enterprise would be negative.

The emergence of a market for carbon credits presents a clear opportunity for the Djelk Rangers. The WALFA project generates a reduction of well over 100,000 tonnes of CO₂ equivalent each year. The Djelk Rangers contribute a relatively small amount of this figure as only a fraction of the Djelk IPA is included in the WALFA area. The Djelk Rangers still have a large proportion of their IPA available to sell carbon credits to other buyers, most likely through CALFA. In the European market, carbon credits are trading at around €14 (\$19) and price projections to 2020 predict prices will stay at around €20 (\$27) (Carbonpositive 2010). Djelk will have a substantial cost advantage due to the suitability of large areas of the IPA for fire management, the low opportunity cost of this land—for example, its low agricultural potential—and the tenure system and pre-existing relationships with Landowners that give the Djelk Rangers access on their behalf.

This opportunity may come with the expected passage of the Carbon Farming Initiative through the Australian parliament and the likely endorsement of the Savanna Burning methodology by the Domestic Offsets Integrity Committee (DOIC). This would establish a market into which Djelk could trade carbon credits produced through a DOIC certified project. This could potentially include approximately a 10,000 km² area currently managed by the Djelk Rangers within the developing CALFA project. The development of

an Australian market for carbon credits would clearly benefit the Djelk Rangers. With a carbon price projected to float around the \$20 mark, the Djelk Rangers could look forward to raising substantial revenues even in the short term. Importantly, these revenues would be discretionary giving Djelk greater autonomy in its spending, not being tied to government or other third-party priorities.

Current research indicates that the bio-sequestration produced when establishing prescriptive burns to produce carbon abatements under the current savanna burning methodology is much greater than the abatement achieved. This may provide a very significant income stream for land managers in addition to carbon abatement in the future.

Other markets for environmental services, such as for biodiversity credits, do not currently have any capacity to stimulate a demand for the Djelk Rangers' environmental services in the short term.

Non-use values

Non-use values are defined as values or benefits people derive from natural resources independent of any use (Pearce and Turner 1990). They include existence values, bequest values, and option values. There are a few techniques that economists use to provide estimates of non-use values, but these have not been used to estimate such values for the Djelk IPA region. However several studies provide estimates of the values people attach to protecting native vegetation and the different management options for waterways in other Australian regions (Zander et al. 2010; Concu 2007; Hatton-McDonald and Morris 2005). One study estimates values for the Kakadu Conservation Zone, which is in close proximity to the Djelk IPA (Imber et al. 1991). Another assesses people's responses to different management options for three tropical river systems in northern Australia (Zander et al. 2010). While transferring benefit estimates from one study site to another can be misleading (see Rolfe and Bennett 2007:3), it can also give an indication of the importance of the work rangers are carrying out and the value of these services to the wider Australian public. Zander et al. (2010) found that the majority (90%) of Australians in their study were willing to pay substantial amounts of money to maintain cultural and environmental values in tropical river systems in northern Australia.

As mentioned above, around 30 per cent of the Djelk IPA is under mining exploration leases. Mining development would be likely to create serious environmental impacts, and the loss of non-use values. Should mining have an impact on 10 per cent of the leased areas, and using the lower estimates for the value of native vegetation provided by Concu (2007) and Imber et al. (1991), non-use value could range from \$2 million to \$5 million. Such speculative figures need to be compared with the net benefits of the mine project and these are dependent on the type of mineral, its quality, and current market prices. If one assumes that without Indigenous management these values would be lost, it could be argued that the non-use values are an important element in the overall demand for environmental services.

The total benefits of the Djelk Rangers' activities are the sum of the benefits from direct and indirect uses of the environment plus the non-use values (Table 4). As is clearly evident in Table 4, there are significant gaps in the data needed to estimate the benefits derived from the provision of environmental services in the Djelk IPA. In many cases the data is not currently available to identify the actual benefits of Djelk IPA environmental services, nor quantify and estimate their value to the Australian community. In the absence

of this data it could be found that the benefits are negative if the estimated costs of delivery of these environmental services are greater than the generated revenue or benefit achieved. Further, the temporal or intergenerational distribution of these benefits is unknown. Given these gaps in the data, it is not possible then to properly assess the commercial viability of many of the potential enterprises listed in Table 4. It is evident that there is not enough data to establish the feasibility of financing environmental services in the Djelk IPA on the basis of the benefits it generates for the local, national and global community. These results highlight the limits of arguing for the support of Indigenous provision of environmental services from a purely financial, utilitarian, economic-driven, non-Indigenous perspective.

Table 5: Benefits of environmental conservation in the Djelk IPA.

Benefits	Value (\$ per year)	
	<i>Current</i>	<i>Potential/Target</i>
Institutional Demand for environmental services	1,963,000	unknown
Direct Indigenous Use		
- Food Source		unknown
- Material for art production		unknown
- Recreational, social, spiritual		unknown
Direct non-Indigenous Use		
- Recreational	unknown	1,500,000
- Agricultural Industry	100,000	unknown
- Wildlife Enterprises	possibly negative	unknown
- Pharmaceutical Industry	possible negative	unknown
- Environmental markets (carbon credits, biodiversity credits)	1,000,000	unknown
Non-use values (without mine development)		unknown
Non-use values (with mine development)		possibly around 2-5 million

3.2 Dhimurru Indigenous Protected Area

Yolngu people established Dhimurru Aboriginal Corporation and its ranger group in 1992 to monitor and minimise the impact of an increasing non-Indigenous population at Nhulunbuy that followed the establishment of a bauxite mine and processing plant on their traditional lands. Yolngu people run and control the organisation through the Dhimurru Board. It includes representatives of 17 clans with interests in the region. The Yolngu Managing Director, a Senior Cultural Advisor, Yawarrin (men) Rangers, Miyalk (women) Rangers, and a Permit Officer are all responsible for Dhimurru's daily operations. Non-Indigenous staff includes an Executive Officer, three project facilitators, and administrative personnel. Dhimurru currently employs 16 Indigenous and 6 non-Indigenous staff members.

In 2000 Yolngu people declared the Dhimurru IPA and this declaration was recognised by the Commonwealth Government. The IPA covers around 920 km² of land and 90 km² of adjacent marine areas in the Gove Peninsula (Figure 9). This land is held under an inalienable Aboriginal freehold title by the Arnhem Land Aboriginal Land Trust on behalf of the Traditional Aboriginal Owners to whom the land was granted under the *Aboriginal Land Rights (Northern Territory) Act 1976 (Cth)* (ALRA). The IPA contains areas of important cultural and environmental value, hosting a significant representation of Australia's Arnhem Coast sub-bioregion ARC-3, and it is generally considered in near pristine condition (SEWPAC 2011a). The primary focus of Dhimurru's activities is the protection and enhancement of the natural and cultural values of the IPA (Dhimurru 2006, 2008, 2009). Dhimurru fosters "both-ways" management by integrating Yolngu and non-

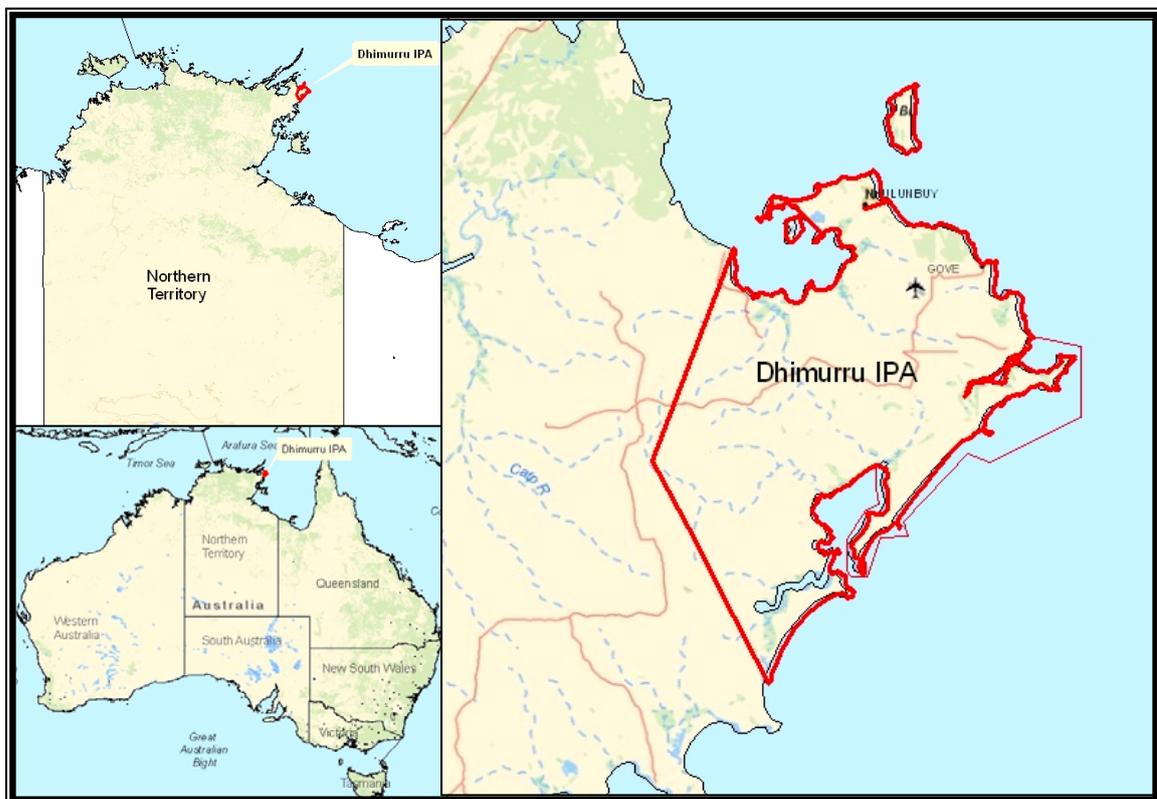


Figure 5: The Dhimurru IPA.

Indigenous sciences. The IPA is also managed according to IUCN Category V Guidelines for Protected Areas (Dudley 2008). Environmental values include high plant diversity, intact faunal assemblages, and significant feeding and nesting sites for threatened species of marine turtles and sea birds (Dhimurru 2008).

The Dhimurru IPA surrounds land leased to Rio Tinto Alcan (RTA) for bauxite mining and processing, and the localities of Nhulunbuy, Yirrkala and Gunyangara. Table 6 summarises selected statistics for these localities. There are significant differences in the demographic composition and economic conditions of these localities. Yirrkala and Gunyangara have a largely Indigenous population with a median household income of around \$1,100 per week (ABS 2006). Nearly 40 per cent of the population at Yirrkala participate in the labour force, while in Gunyangara labour force participation is around 30 per cent of the total population (ABS 2006). Unemployment rates in Yirrkala and Gunyangara are 6 per cent and 4.5 per cent respectively. The large majority of the population in Nhulunbuy is non-Indigenous, and most moved to the town to take advantage of the job opportunities created by the mine. The rate of labour force participation in Nhulunbuy is around 60 per cent, the unemployment rate is around 1.4 per cent, and a total of 49.2 per cent of the labour force is employed in the mining, construction, or manufacturing industries (ABS 2006). Residents in Yirrkala are employed in the public administration sector (27.4%), and health care and social assistance (19%), and only 8.7 per cent of the labour force works in the agricultural, mining, manufacturing and construction sectors (Table 7). In Gunyangara the public administration sector takes a very large share of the labour force (80.3%), and the construction sector occupies around 6.6 per cent of the workforce. No worker from Gunyangara is employed in the mining or manufacturing sectors. As shown in Figure 6, the demographic profiles of the localities also differ. Both Yirrkala and Gunyangara have a larger proportion of residents younger than 35 years while Nhulunbuy has a higher proportion of residents in the age classes above 35 years. In short, several factors contribute to explain why the median household income in Nhulunbuy is equal to \$2,200 per week—double the median household income in the other localities (ABS 2006): Nhulunbuy has a higher labour force participation rate than Yirrkala and Gunyangara; salaries in the mining, construction and manufacturing sector are higher than in other sectors; and workers over 35 years old have on average higher salaries than younger workers.

Table 6: Selected statistics for localities in the Dhimurru IPA.

	<i>Yirrkala</i>	<i>Nhulunbuy</i>	<i>Gunyangara</i>
Population	686	4,111	229
% of population = Indigenous	84.2	5.7	86.8
Median Household Income (per week)	\$1,116	\$2,200	\$1,100
Labour Force Participation	38.8	58.7	28.8
Employment Rate (inclusive of CDEP workers)	94.0	98.6	65.5
Unemployment Rate	6.0	1.4	4.5

Source: ABS 2006 Census

Table 7: Employment by industry in localities in the Dhimurru IPA

Industry	<i>Yirrkala</i>		<i>Nhulunbuy</i>		<i>Gunyangara</i>	
	Total	%	Total	%	Total	%
Agriculture, forestry & fishing	4	1.6	3	0.1	0	0.0
Mining	6	2.4	101	4.2	0	0.0
Manufacturing	0	0.0	701	29.5	0	0.0
Electricity, gas, water & waste services	0	0.0	9	0.4	0	0.0
Construction	12	4.8	357	15.0	4	6.6
Wholesale trade	0	0.0	16	0.7	0	0.0
Retail trade	11	4.4	168	7.1	0	0.0
Accommodation & food services	0	0.0	130	5.5	0	0.0
Transport, postal & warehousing	9	3.6	105	4.4	4	6.6
Information media & telecommunications	0	0.0	21	0.9	0	0.0
Financial & insurance services	0	0.0	15	0.6	0	0.0
Rental, hiring & real estate services	0	0.0	12	0.5	0	0.0
Professional, scientific & technical services	3	1.2	52	2.2	0	0.0
Administrative & support services	0	0.0	90	3.8	0	0.0
Public administration & safety	69	27.4	160	6.7	49	80.3
Education & training	31	12.3	159	6.7	4	6.6
Health care & social assistance	48	19.0	185	7.8	0	0.0
Arts & recreation services	3	1.2	0	0.0	0	0.0
Other services	9	3.6	43	1.8	0	0.0
Inadequately described/Not stated	47	18.7	53	2.2	0	0.0
Total	252	100.0	2380	100.0	61	100.0

Source: ABS 2006 Census

The different distribution of the labour force across industries, and the data on labour force participation, give a cross-section of the economy (excluding the customary sector) of these localities. In Nhulunbuy the market sector is clearly the dominant element of the economy: primary industries, wholesale and retail trade, and the hospitality industry account for 75 per cent of the employment in Nhulunbuy. The public sector clearly dominates the economy of the other two localities, where the public administration, education, health care and social assistance sectors account for over 80 per cent of the employment. Both Yirrkala and Gunyangara have a much smaller labour force than Nhulunbuy. This means that some individuals of working age are not taking part in the economy through salaried labour. Hidden in these figures are the extent to which Yolngu livelihoods are sustained through customary activities and art production for sale.

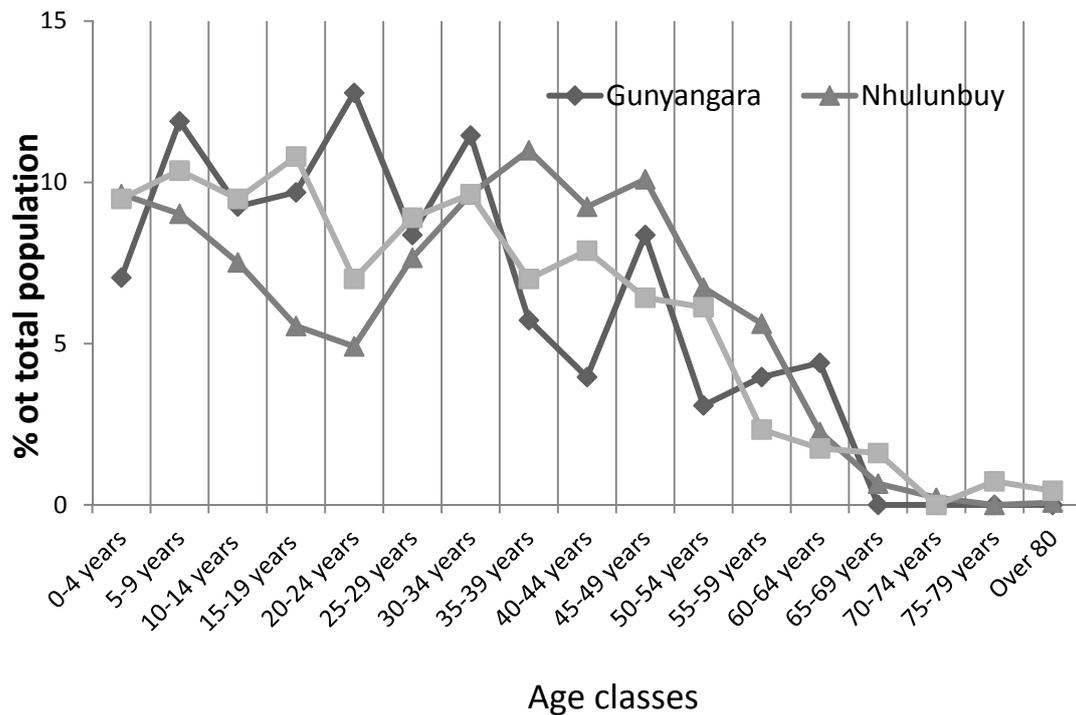


Figure 6: The population distribution in age classes for major localities (Gunyangara, Nhulunbuy and Yirrkala) within the Dhimurru IPA.

Yirrkala hosts one of Australia’s premier art centres. The Buku-Larrnggay Mulka Art Centre was established in 1975 and is now a gallery, museum, art school and multimedia centre. It supports Yolngu artists from Yirrkala and more than 20 homelands in the region. Total annual revenues from art sales at Yirrkala are around \$2 million, 65 per cent of which goes directly to the artists (W. Stubbs, pers. comm. 2011). Some other enterprises have benefited from payments relating to mining impacts on clan lands. The Rirratjngu clan, for instance, set up the Bunuwal group in 2008 to develop Yolngu capacity to build commercial enterprises, including property development (East Arnhem Shire 2010). The Gumatj clan has similarly set up several enterprises, the most recent of which is a timber mill for furniture building and construction material that uses stringy bark harvested in Gumatj land (Pearson and Helms 2011).

The Indigenous tourism industry revolves around the Garma Festival. Garma is the showcase of Yolngu culture and a celebration of the Yolngu cultural inheritance. The festival takes place at Gulkula in the Dhimurru IPA every year in August and has been running since 1998. It provides a national platform for Indigenous people from the region and beyond to highlight Indigenous issues. On average about 1,500 Indigenous and non-Indigenous people attend the festival each year. In Nhulunbuy two non-Indigenous run hotels cater for the all-year-round movement of people visiting the town for business. No data is available on visitor numbers and length of stay.

This mix of state, market and customary activities is bound to change according to political and budgetary developments, market trends in the mining sectors, and cultural/social shifts in the communities. The role of Indigenous provision of environmental services in this mix

is clearly linked to existing environmental and cultural assets, their conditions, actual and potential threats, and the capacity of the Indigenous Rangers to provide the necessary conservation services.

3.2.1 Environmental assets.

The Dhimurru IPA has outstanding environmental values including high plant diversity, intact faunal assemblages, and a unique geological system of quaternary dunes that is the largest in the Northern Territory. The Dhimurru IPA also hosts significant feeding and nesting sites for sea birds and threatened species of sea turtles (Dhimurru 2008). For management purposes, Dhimurru identifies five major areas: northern beaches; Yarrapay; southern coastal and inland waterways; Manydjarrarrnga-Nanydjaka; and coastal waters and islands. Within these areas, the Traditional Landowners have designated several sites that can be accessed by non-Indigenous people for recreational purposes by purchasing an access permit.

Northern beaches

This management area includes several beaches and inlets, recreational areas and cultural sites in and around Nhulunbuy. Long stretches of white sand are interspersed with mangrove vegetation in the proximity of creeks and estuaries. Paperbark, pandanus and monsoon vine thickets are found in the freshwater swamps beyond the sand dunes, where abundant bird and animal life used to support the local Indigenous population prior to the establishment of Nhulunbuy. The Nhulun-Roy Marika lookout dominates the town, and it is an important cultural site. Just outside of town, Banambarrnga has camping facilities for visitors to enjoy the beaches, the spectacular cliffs, and the wildlife. Their proximity to the township means that these sites are very popular with visitors and residents. Fishing and beach-related pastimes are the most common activities.

Yarrapay

The management area of Yarrapay is located in the eastern part of the IPA, around 40 km from Nhulunbuy. Here the bauxite shelf meets the ocean water of the Gulf of Carpentaria creating spectacular rock outcrops contrasted with rainforest and vine thickets, and interspersed with small beaches where marine turtles nest. The prevalent vegetation type is eucalypt open forest. Stone arrangements recording Yolngu contact with Macassan fishermen in the 1800s can be seen at Wurrwurrwuy, a rare archaeological site listed in the NT Heritage register. The area is accessible all year round, and it is popular among Indigenous and non-Indigenous people for fishing and camping and among Yolngu for collecting materials for art production and for manufacturing fishing implements.

Southern coastal and inland waterways

Several freshwater pools and creeks in the eastern reaches of the IPA are popular sites for recreation, hunting, and collecting food and materials for art production. The vegetation here is dominated by thick tropical eucalypt woodland and mangroves. This is the habitat of the Gove Crow butterfly, an endangered species endemic to this area that researchers recommend be regarded as “near threatened” or “conservation dependent” (Braby 2010). For conservation and cultural reasons, Dhimurru limits the daily number of visitors that can access the Ganami and the Gapuru recreational sites in this area. Visitors need to obtain a special permit before being allowed in these sites.

Manydjarrarrnga-Nanydjaka

This area is a long peninsula on the south eastern reaches of the Dhimurru IPA. It has a large expanse of quaternary dune fields, with complex vegetation communities including dune grassland and shrubland, monsoon vine forest, mangroves, pandanus swamp, melaleuca woodlands, eucalypt open forest and spectacular granite outcrops (NRETAS and Dhimurru 2009). Limestone outcrops intersperse the long sandy beaches, creating a landscape of outstanding beauty. This is an important nesting site for migratory sea birds and threatened marine turtle species—Green, Olive Ridley, Hawksbill, and Loggerhead. The area has always been a popular hunting, fishing and food gathering site for the Yolngu. Archaeological evidence suggests that pre-contact Indigenous owners sourced foods from this rich ecological zone. Fish, shellfish, crabs, swamp fowls, mammals, reptiles, tubers, spike rush and cycad nuts were amongst available dry season foods with a greater dependence on marine life, fruits and berries throughout the wet (Dhimurru 1999: 19-20). Today Yolngu still harvest resources from Manydjarrarrnga-Nanydjaka—marine turtles and their eggs and trevally are particularly sought after (Dhimurru 1999:13). Two flora and fauna surveys commissioned by Dhimurru in 1994 and 2009 document the wealth of this area. Preliminary analysis of the data collected in 2009 indicates that Manydjarrarrnga-Nanydjaka still remains in relatively pristine condition notwithstanding the increased number of feral animals and cane toads (NRETAS and Dhimurru 2009). Access to this area is restricted and visitors need to obtain a special permit.

The coastal waters and islands

The Dhimurru IPA is the only IPA in Australia that formally includes coastal waters. This is recognition of the ecological, cultural and economic importance of its marine resources. The marine part of the Dhimurru IPA includes islands, rocky and coral reefs, inlets, bays, estuaries, mudflats, and sea grass meadows. Dugongs, marine turtles, dolphins and crocodiles are known to feed in these waters. The IUCN lists the dugong as a species vulnerable to extinction (IUCN 2010).

3.2.2 Cultural Assets

The Dhimurru IPA is a landscape of considerable cultural significance. It contains a rich variety of tangible and intangible cultural and heritage values. The Dhimurru IPA Cultural Heritage Management Plan lists several categories of cultural features (Dhimurru 2009:8):

- Sacred places, i.e. places that are significant according to Indigenous traditions, myths, and philosophies
- Ancestral burial places
- Places with historical family associations
- Places of significance resulting from the Macassan contact period
- Places of historic significance associated with the Mission period
- Stone arrangements and artefacts from the time of the Macassan contact
- Shell middens illustrating the use of natural resources and responses to changing environmental conditions
- Grinding surfaces for natural resources processing
- Ancient deposits of cultural materials.

It is not possible here to give a detailed account of the wealth of these cultural and heritage features spread all over the IPA. In Manydjarrarrnga-Nanydjaka area, for instance, well over 50 sacred sites have been registered. Creator beings (the Whale, Lightning Sea Snake, Stingray, Crocodile, and Dog) bestowed Manydjarrarrnga-Nanydjaka to the Lamamirri

Stone arrangements at Wurrwurrwuy

The Macassans sailed to the Arnhem Land shores for hundreds of years until the early 1900s and are an important part of Yolngu maritime history. They arrived annually to harvest the sea cucumber (trepane, bech-de-mer, or dharripa), turtle shell and pearls to sell to Chinese traders. They arrived in praus in the monsoon winds around November and returned on the southwest trade winds a few months later. Yolngu had a very good trading relationship with them, and some of Yolngu family members sailed back to Macassar with the fleet. Their descendants now live in Macassar (in present day Indonesia). Some words of Macassan origin exist in the Yolngu language today. This is an important story that is represented in the Wurrwurrwuy stone pictures.

The stone pictures are located on the bauxite shelf at Garanhan (Macassar Beach), one of Dhimurru recreation areas. Dhimurru is protecting this site and developing further interpretive material so visitors can learn about our history with the Macassans. The stone arrangements or 'pictures' depict aspects of Macassan material culture, including sailing vessels and dwellings. Aspects of Yolngu culture are also depicted at Wurrwurrwuy. These stone pictures outline a record of economic and social contact between the Yolngu and Macassans that continued for several centuries.

Wurrwurrwuy is inscribed on the Northern Territory Heritage Register under the Northern Territory Heritage Conservation Act 1991. This site is also under consideration for inclusion on the National Heritage List.

Source: Dhimurru 2009.

descendants and the Gumatj people. A senior Gumatj elder, Yäma Mununggiritj tells of some of the events:

There is the sea and the land, which Whale gave us, and he is there now. You can see where Whale has been where the water is spurted out and the rock where he left his image. Here the Lightning Snake too comes out and rests his head on the rock. He makes lightning and thunder and has given to us landowners a gift of special white clay. Whale creates for us shellfish and turtle at another place (Dhimurru 1999:25).

The best archaeological records of Indigenous contact with Macassan traders in all north-eastern Arnhem Land is located at Wurrwurrwuy (see insert on next page), in the Yarrapay area. Stone arrangements or "pictures" depict Macassan boats, houses, and other elements of their material culture, represented in outline form by small to medium sized laterite rocks. These stone arrangements were probably made at the end of the 19th century (Dhimurru 2009:33). Wurrwurrwuy was listed in the Northern Territory Heritage Register in 2007.

Nhulun is a registered sacred site in the hill of Nhulunbuy (also known as Mt Saunders). The Ancestor Wuyal, known as the Sugarbag Man, named the place in the course of its creation journey. Wilkinson et al. (2009) give an account of this journey, and the profound connections it created all through the area surrounding the town and the mineral processing facilities.

Nhulun was desecrated in 1969 during the early mine construction (Dhimurru 2009).

4.2.3 Threats

Human activities—mining and industrial development, recreational uses, commercial and recreational fishing—are the most significant threats to the integrity of environmental and cultural values of the Dhimurru IPA. Marine debris, weeds, feral animals and altered fire regimes are also causes for some concern.

Threats to terrestrial resources and cultural values

Amongst the threats to environmental and cultural values is the increased use of the IPA for recreation purposes by the growing non-Indigenous population. Recreational activities have a range of impacts: (i) Direct impacts of vehicles on sensitive ecological systems such as dunes and beaches; (ii) indirect impacts of vehicles through spreading of weeds and invasive ants. Hoffman and Saul (2010), for instance, maintain that Yellow Crazy ants—an invasive ant species found in the Dhimurru IPA that could have significant environmental impacts—could have been spread in the IPA only by vehicles; (iii) disturbance of native flora and fauna. Kennett et al. (2004) identify four-wheel driving along beaches as a significant threat to turtle nesting and hatcheries; (iv) killing of wildlife, lighting of fires, littering and vandalism. Episodes of damage to interpretative signs, fences and bollards are regrettably recurrent (Dhimurru pers. comm. 2010); and (v) damage to cultural sites and entering significant sacred sites causing offence to Traditional Landowners. Reports and evidence of off-track traffic is growing. Traditional Owners have complained that motorbikes have left tracks in sacred sites, and are disturbing traditional activities and ceremonies.

The Dhimurru IPA surrounds land leased for bauxite mining and processing. Strip mining and bauxite processing radically alter ecological features and flows, and have repercussions beyond the boundaries of the leased area. The soil deprived of the vegetation cover is easily washed away and eroded, and water flows change as a consequence. Such alterations also have a serious impact on the integrity of the cultural landscape and the tangible and intangible relics of the local culture. Shell middens and other cultural landmarks, for instance, have been destroyed by the mining activities (Dhimurru pers. comm. 2010). Industrial accidents have also been reported, affecting the soil and the water in the bay adjacent to the processing plant (RTA 2008; ABC 2010a; 2010b).

Feral animals such as water buffalo and pigs are a key concern because of their impacts on wetlands and fresh water pools, and, in the case of feral pigs, increased turtle nest predation. Buffalo also pose a human safety concern as they can be quite aggressive, are not deterred by human presence, and are known to dwell in close proximity to the urban areas. There is little data, however, on feral animal densities, population size and distribution. Weeds are also a threat to the cultural and environmental integrity of the IPA. Mission grass is the most common weed in the Dhimurru IPA. It is concentrated around communities and areas of relatively intense vehicle traffic. Garden weeds are also common in Gayngaru, the lagoon on the eastern side of Nhulunbuy, and in Nhulun. Weeds displace native vegetation, and could cause intense fires.

Yellow Crazy ants are an invasive ant species introduced in the area probably during the Second World War. They have spread across the Dhimurru IPA to at least 50 locations (Hoffman and Saul 2010). The Yellow Crazy ant poses a significant threat to biodiversity as the ants have the potential to displace native fauna (Gerlach 2004, O'Dowd et al. 2003, Hill et al. 2003). The Yellow Crazy ant is known to kill invertebrates, reptiles, hatchling birds and small mammals. On Christmas Island, a number of species of endemic fauna, including land crabs, mammals, birds and reptiles, are at risk either directly through predation or indirectly through habitat alteration or resource depletion due to the introduction of these ants (O'Dowd et al. 2003). Yellow Crazy ants could potentially spread across the whole of Northern Australia. However, there is no quantitative data on the impacts that this species has on Indigenous livelihoods or on biodiversity values of the IPA, or on the potential risk to the agricultural sector.

Fire management is carried out by Traditional Landowners, while the Dhimurru Rangers do some opportunistic burning. Wildfires do not often affect the IPA region, as the eastern winds carry moisture that reduces the risk of intense, uncontrolled fires.

Threats to marine resources and cultural values

Yolngu Traditional Owners are particularly concerned about declining numbers of fish and marine mammals. The major causes are thought to be commercial fishing, illegal fishing by domestic and international operators, recreational fishing, marine pollution associated with the operation of the bauxite processing facilities, and marine debris. Yolngu are observing lower numbers of barramundi and mud crabs in creeks, rivers and bays (Dhimurru 2006). This evidence questions the claims that commercial fishing in the region is sustainable. There are also strong concerns that prawn trawling and long line fishing are causing damage to marine ecosystems and are affecting marine turtles, notwithstanding the introduction of turtle excluder devices. Research, however, shows that the unintentional capture of turtles has radically decreased since the use of turtle excluder devices in nets in 2000 (CSIRO 2006). Illegal fishing and intrusion of fishing vessels outside their permitted fishing zones has also been observed (Dhimurru 2006).

Indigenous concerns over marine debris have also been growing. Plastic rubbish and ghost nets have significant impacts on marine species through ingestion, entrapment and strangulation (Gunn et al. 2010). These ghost nets can get entangled in rocky reefs and can trap and kill fish, dolphins, sea turtles, sharks, dugongs and other marine life. The circular current in the Gulf of Carpentaria keeps these ghost nets roaming and “ghost fishing” until they are washed ashore. By trapping marine species, ghost nets have direct economic consequences for the Indigenous people who depend on marine resources for their livelihoods. Moreover, plastic debris causes increased mortality in marine species when ingested, and litter beaches and rocky shores, affecting the recreational use of these areas.

3.2.4 Dhimurru’s activities and outcomes

Dhimurru is moving rapidly towards the use of Cyber Tracker™ and hand-held computers to collect data on activities and patrols. The data we present here are based on Dhimurru’s current system of patrol reporting based on paper forms. These data provide information on the number of rangers taking part in the patrol, the location, and the activities performed. The data cover the terrestrial activities—the reporting system for sea patrols is still under development. It should also be noted that while the rangers are organised into three teams—Land, Sea, and Women—the activities are usually of such scale that they require the teams to work together. For instance, the Land Rangers are responsible for the maintenance of camping sites, and often carry out this activity with the help of the other teams. Similarly, the Sea Rangers organise, coordinate, and carry out beach clean-ups and marine debris collections with the other teams. Further, the reporting systems cover a fraction of the activities that are part of the Dhimurru Rangers’ responsibility. Training, community education, participation in conferences and meetings, representing, liaising and engaging with Traditional Landowners and the community at large, and ceremonial responsibilities are not formally recorded.

Data analysis required some assumptions to assign work time and resources to specific tasks. For instance, the time spent on a given activity is calculated as the hours spent in the field plus the travel time. It does not include the time required preparing vehicles, equipment and materials. Similarly, as data on vehicle and equipment used are not

recorded, the number of vehicles used is calculated as the minimum number necessary to move the Rangers participating in the recorded activity. Further, as patrols are often multi-purpose, it is assumed that patrol time and resources are allocated equally to each task. In the financial year 2009-2010, the Dhimurru Rangers carried out 474 patrols corresponding to an average of 40 patrols per months. These patrols covered approximately 40,000 km. Dhimurru's activities have interconnected goals: people management; environmental monitoring; conservation and restoration; and heritage and cultural protection. Table 8 records the activities performed and their incidence in the total number of patrols.

Table 8: The time allocation and distance travelled for each activity of the Dhimurru Rangers. The total number of hours spent on all activities was 1406 hours.

Activity	# Patrols	% of Total Hours	Distance Travelled (km)
Buffalo culling	1	0.2	20
Ants monitoring	5	1.6	563
Track maintenance	10	2.3	1,996
Ghost nets	17	4.5	4,774
Fencing	31	10.4	3,441
Signs & maintenance	44	13.9	6,318
Crocodile traps	190	9.5	13,123
Prescribed burning	2	0.3	394
Marine Debris	8	1.3	1,410
AQIS & Mosquito monitoring	15	4.9	668
Camping area maintenance	21	6.2	4,792
Weed check/treatment	35	9.6	3,709
Rubbish pickup	83	15.4	7,677
Permit checks	305	20.0	23,301

People Management

Dhimurru has a permit system to manage the impact of visitors. Under the provisions of the ALRA, access to destinations that the Traditional Landowners have designated as 'recreational areas' is conditional on purchasing and holding an access permit. Only areas designated as recreational areas are accessible to non-Indigenous visitors through a Dhimurru access permit. Dhimurru issues general and special access permits. Special access permits are required for areas that are considered particularly sensitive to the impacts of visitors, and access is restricted to a limited number of people per day. In 2009-2010 Dhimurru issued around 4,900 general permits and 150 special permits. As shown in Table 8, over 20% of Dhimurru Rangers' work time was allocated to performing permit and compliance checks. There is usually a high level of compliance among visitors. The rangers reported five incidents of breached permit conditions over the year.

People management also includes installing signs and sign maintenance, fencing, rubbish pick-ups, and campsite and track maintenance. Overall these activities kept the rangers occupied for 23 per cent of their work time. Limits on use and access prevent conflict with local Indigenous communities and also have important environmental and cultural outputs. Limiting access protects sites of cultural and environmental significance by avoiding damage caused by vehicle movements (including weed and ant spreading, fire scars, bush

and tree damage, opening of new tracks, disturbance of fauna, and damage to nesting sites) as well as by inappropriate behaviour (vandalism, killing of wildlife).

Environmental management

Alongside these preventive activities, the Dhimurru Rangers carry out environmental management and conservation. This includes: crocodile trapping, tagging and relocating (13% of total work time). The Dhimurru Rangers work in collaboration with Northern Territory Parks and Wildlife Rangers to set and monitor crocodile traps around the communities in the Dhimurru IPA. Trapped crocodiles are tagged and relocated according to the requests of the Traditional Landowners. In 2009-2010, 27 crocodiles were trapped and relocated. The Dhimurru Rangers and NT Parks and Wildlife Rangers also collaborate in weeds monitoring, treatment and eradication. The prevalent weed is perennial mission grass. Two infestations covering a combined area of less than three hectares were treated. Continuous weed monitoring across the IPA allows the Dhimurru Rangers to detect infestations early and to act quickly to eradicate and contain new infestations. Some coffee bush has also been reported and treated in disturbed soil within the mine lease.

The Dhimurru Rangers continue to monitor the IPA for Yellow Crazy Ant infestations. A Yellow Crazy Ant monitoring and eradication program in the Dhimurru IPA started in 2004 in collaboration with CSIRO, RTA, and the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPAC). The project has successfully eradicated Yellow Crazy Ants from 21 sites covering 246 hectares within the IPA and the mine lease. Ecological monitoring has recorded full recovery at 17 sites within the 12 months following treatment (Hoffman, unpublished data). In recognition of these achievements, Dhimurru—in partnership with CSIRO and RTA—won three national environmental awards in 2010: the NAIDOC (National Aboriginal and Islander Day Observance Committee) Caring for Country Award; the Banksia 2010 Indigenous Award - Caring for Country; and the Banksia 2010 Origin Gold Banksia Award.

AQIS contracts Dhimurru to collect samples of mosquito larvae and weeds, and to monitor marine debris. In 2009-2010, the Dhimurru Rangers carried out 15 patrols (2% of total). Collected samples are sent to AQIS for analysis.

Buffalo culling and fire management are minor undertakings of the Dhimurru Rangers. These activities are mostly carried out by Traditional Landowners, and the rangers perform them opportunistically.

From May to September, the Dhimurru Rangers are busy with cleaning up marine debris and host nets carried by the south-easterly winds onto beaches. These activities are usually organised with the help of volunteers. Over a ton of rubbish was collected from just 4 km of beach in Manydjarrarrnga-Nanydjaka in 2009-10. Amongst the 7,737 individual items that were picked up and recorded, 13 ghost nets were collected. The nets contained an entangled Hawksbill Turtle and a sea snake, both found dead. The total number of ghost nets collected in the season was 66, the largest measuring 55 metres in length.

In Figure 7, a measure of the labour intensity of selected activities undertaken by the rangers is given. This is calculated as the ratio between the average hours worked per patrol divided by the average distance travelled per patrol. It is based on the assumption that the distance travelled gives an indication of the use of capital assets. As these ratios are calculated on the basis of estimated averages, this measure of labour intensity should

be treated with caution. Figure 7 shows that permit check patrols are relatively low labour intensity, as they require extensive travelling but little labour is involved. Similarly, most of the effort required for crocodile trapping is monitoring the traps, which requires little labour but considerable travelling. Camp site maintenance, fencing and weed treatment have higher rates of labour intensity. Ghost net related activities also have relatively low labour intensity, as they require travelling long distances.

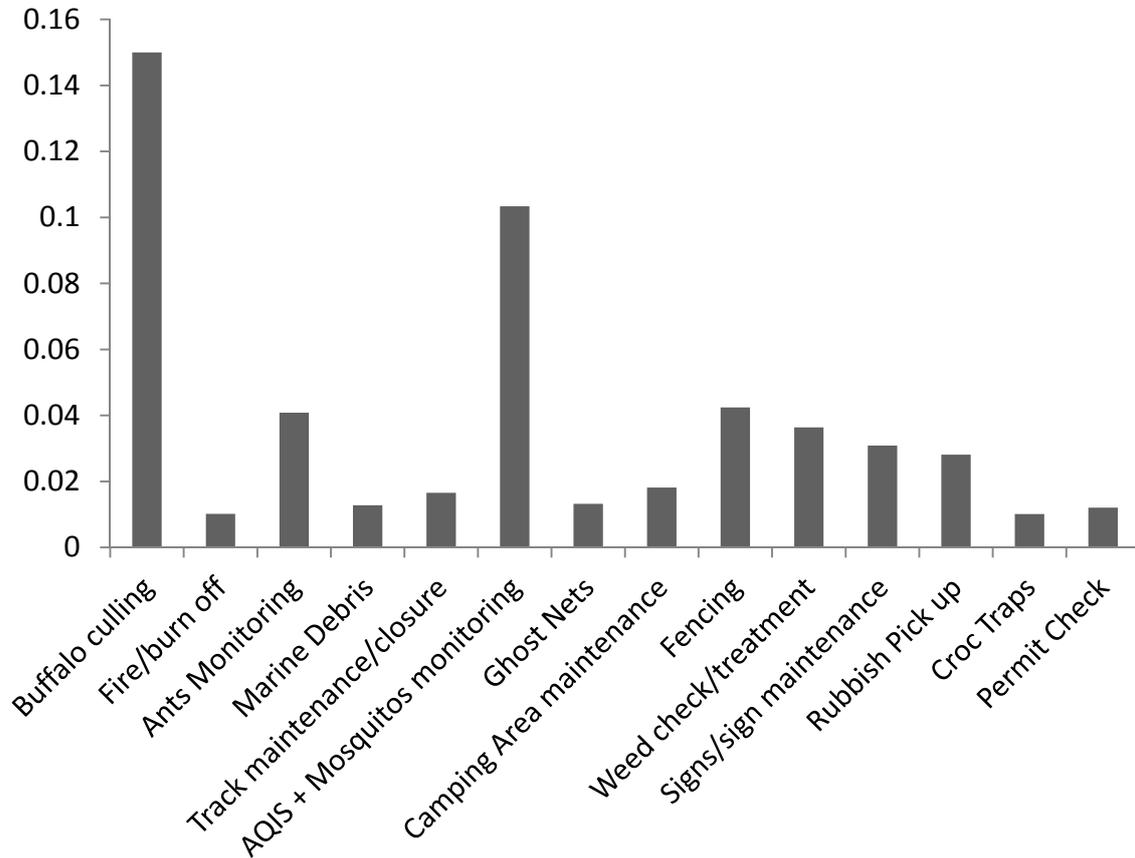


Figure 7: An indication of the capital and labour intensity of the main Dhimurru Rangers activities. Taken as the ratio between the average number of hours per patrol divided by the average distance travelled per patrol.

3.2.5 Management needs and gaps.

The majority of the Traditional Landowners interviewed by the Dhimurru Senior Cultural Advisor and the TRaCK team expressed concern about damage to cultural sites. They would like Dhimurru to provide more cultural site maintenance. As most of the interviewees did not state any concern about environmental problems such as weeds or feral animals, it could be inferred that they are principally concerned about the impact of human activities on cultural sites. Since the interviews took place, the Dhimurru Rangers have undertaken cultural mapping of the IPA in order to improve the management of cultural sites.

The Traditional Landowners within the Dhimurru IPA have emphasised the cultural and environmental importance of marine resources (Dhimurru 2006). Dhimurru's data collection system currently underreports the effort of rangers in the marine part of the IPA.

There are an increasing number of non-Indigenous users of marine resources within the IPA for Dhimurru Rangers to monitor and manage. The resolution of marine tenure issues following the High Court Decision on the Blue Mud Bay case is likely to lead to extra responsibilities for the Dhimurru Rangers (see Morphy and Morphy 2009; NTG 2011).

Lack of data on Indigenous and non-Indigenous use of the recreational areas is of concern. This information would allow estimation of the impacts of human activities and assessment of the optimal number of visitors per area. The Dhimurru Rangers could then better manage visitor flows. This information would also be necessary in order to further develop sustainable tourism in the area.

3.2.6 Budget and cost structure of the Dhimurru Rangers.

Table 9 summarises Dhimurru's major revenue sources for the financial year 2009-2010. Public funding from the Commonwealth and Northern Territory governments makes up almost 69 per cent of Dhimurru's budget. These are mainly government contributions received through the IPA program (15.4% of total revenues), the WoC program (35.4%), and the Caring for our Country program (17.2%). WoC funds cover labour and training costs of the Dhimurru Rangers. As shown in Table 7, Dhimurru earns around \$1.8 million per year from these programs. As shown in Table 7, the importance of fee-for-service revenue is minimal (1.6%). AQIS contracts the Dhimurru Rangers to carry out weed, mosquito and marine debris monitoring. AQIS pays for up to two rangers per day plus vehicle costs. In 2009-2010, AQIS activities generated \$19,000 or 0.7 per cent of total revenue. Also CSIRO contracts Dhimurru to carry out Yellow Crazy Ant monitoring, and Dhimurru receives around \$17,000 per year from this contract. The Dhimurru Rangers also earned around \$7,000 from the Carpentaria Ghost Net program to carry out ghost net clean-up and monitoring. These public funds and fee-for-service payments are the **social cost** of the Dhimurru Rangers' environmental services.

Private sector contributions include those from RTA and correspond to 9.2 per cent of Dhimurru's 2009-2010 revenue. RTA had contracted Dhimurru to carry out some ethno-ecological monitoring in the bay adjacent to the RTA bauxite refinery and shipping facilities, on the north-west border of the Dhimurru IPA. The Dhimurru Rangers received around \$40,000 per year. This contract expired in 2009, and has not been renewed. According to RTA the 2008 global financial crisis forced them to rescind the contract (Dhimurru, pers. comm., 2010). Another important source of funding is the income Dhimurru generates directly through the sale of permits, merchandise, visitor guides and assets and through vehicle leasing. This direct income is equivalent to 20.5 per cent of total revenues.

Estimations of the private costs of carrying out the Dhimurru Rangers' activities are obtained making several assumptions about time allocation, hourly wages and vehicle cost per km. Labour cost is calculated according to the rate AQIS pays for rangers in its fee-for-service contract which is \$16 per hour. The final labour cost is calculated on the basis of the time spent on the job including travel time, and time spent preparing vehicles and equipment. Vehicle cost per km is calculated assuming a low, medium and high cost measure. As for the Djelk Rangers, the low estimate is based on the approximate rate per km charged for a rental 4WD vehicle in Darwin (\$0.5 per km). This is the lower bound of our estimates. The Dhimurru Rangers' vehicles often travel on unsealed roads in what are often extreme conditions, so it is plausible that the cost per km is higher. Hence estimates of vehicle costs are given using two more values: medium (\$1 per km); and high

(\$1.5 per km). These estimates are conservative as they do not include operational costs such as expenditure on materials, consumables and equipment. In addition, neither capital costs nor administrative costs are included. Further, these estimates cover only a fraction of the range of activities the Dhimurru Rangers routinely carry out. Estimates of costs per activity are reported in Table 10.

Table 9: The Dhimurru Rangers operational budget for the financial year 2009-2010 (\$).

Revenues	Wages & Training	Operational	Other	Total	%
<i>Public Funding</i>					
Indigenous Protected Area		870,640		870,640	36.4
WoC	615,299			615,299	25.7
Caring for our Country			382,216	382,216	16.0
<i>Sub Total</i>				1,868,155	78.2
<i>Fee-for-service</i>					
AQIS			13,299	13,299	0.6
<i>Sub Total</i>				13,299	0.6
<i>Private Contributions</i>					
RTA			141,848	141,848	5.9
Royalties			4,079	4,079	0.2
Other contributions & prizes			16,777	16,777	0.7
<i>Sub Total</i>				162,704	6.8
<i>Dhimurru Generated Income</i>					
Permit			164,517	164,517	6.9
Visitor's Guides			2,527	2,527	0.1
Merchandise			801	801	0.0
Vehicle Leasing			101,341	101,341	4.2
Asset Sales			35,490	35,490	1.5
Interest received			22,691	22,691	0.9
Other revenues			18,435	18,435	0.8
<i>Sub Total</i>				345,802	14.5
Total	615,299	870,640	904,021	2,389,960	

People management accounts for 74 per cent of the total expenditure. Fencing and sign maintenance both make up around 9 per cent of total expenditure, while camp site maintenance, track maintenance, and rubbish pick-up respectively make up around 5, 2 and 6 per cent of Dhimurru's total expenditure. Considering that these five activities also require material and equipment, it could be argued that their weight in the total expenditure is even higher. Permit and compliance patrols alone account for 40 per cent of the total cost. The importance of these patrols cannot be disregarded. Patrols deter vandalism, culturally inappropriate behaviour, breaches of permit conditions, and access to restricted areas. However, it is hard to quantify their effects on the conditions of the IPA's cultural and environmental assets.

Table 10: Estimates of the private costs of Dhimurru Rangers activities for the financial year 2009-2010 (\$).

Activity	Low	Medium	High
Buffalo culling	225.0	230.0	235.0
Fire/burn off	1,092.3	1,158.0	1,223.7
Ants monitoring	6,536.3	6,766.0	6,995.7
Marine Debris	4,235.0	4,473.3	4,711.7
Track maintenance/closure	10,783.0	11,160.0	11,537.0
AQIS + Mosquito monitoring	14,228.4	14,376.8	14,525.2
Ghost Nets	20,803.9	21,998.5	23,193.1
Camping Area maintenance	25,001.2	26,381.7	27,762.2
Fencing	51,033.9	51,878.5	52,723.1
Weed check/treatment	29,717.7	30,835.4	31,953.1
Signs/sign maintenance	48,557.3	50,496.5	52,435.8
Rubbish Pick up	35,853.1	37,454.8	39,056.5
Croc Traps	60,033.4	63,968.9	67,904.3
Permit Check	215,931.7	223,002.7	230,073.7
Total	524,032	544,181	564,330

N.B. These are estimates of the Dhimurru Rangers' labour and vehicle/boat running costs. They do not include other operational costs (such as materials or equipment), capital cost, and administrative cost.

The activities the Dhimurru Rangers carry out in collaboration with NT Parks and Wildlife (weed control and crocodile management) have a total cost of around \$99,000 equivalent to 17 per cent of Dhimurru's total expenditure. Ghost net pick-up and marine debris monitoring and removal account for around 5 per cent of the total expenditure.

In Figure 14 the cost structure of the Dhimurru Rangers' activities are shown. The Figure illustrates the ratio of labour cost over total cost for selected activities. A ratio higher than 0.5 indicates that labour is the main cost. Overall, labour cost is high across all the activities, indicating that Dhimurru's activities do not require huge investments in capital. AQIS contracted activities and fencing have the highest labour cost/total cost ratio. AQIS contracted mosquito monitoring is carried out in proximity of the communities, and hence it does not require long journeys. Ghost nets and marine activities, on the contrary, have a low labour cost/total cost ratio as they involve travelling to the distant recreational areas in Manydjarrarrnga-Nanydjaka. Monitoring crocodile traps also has a low labour cost/total cost ratio—it involves travelling but requires minimal labour.

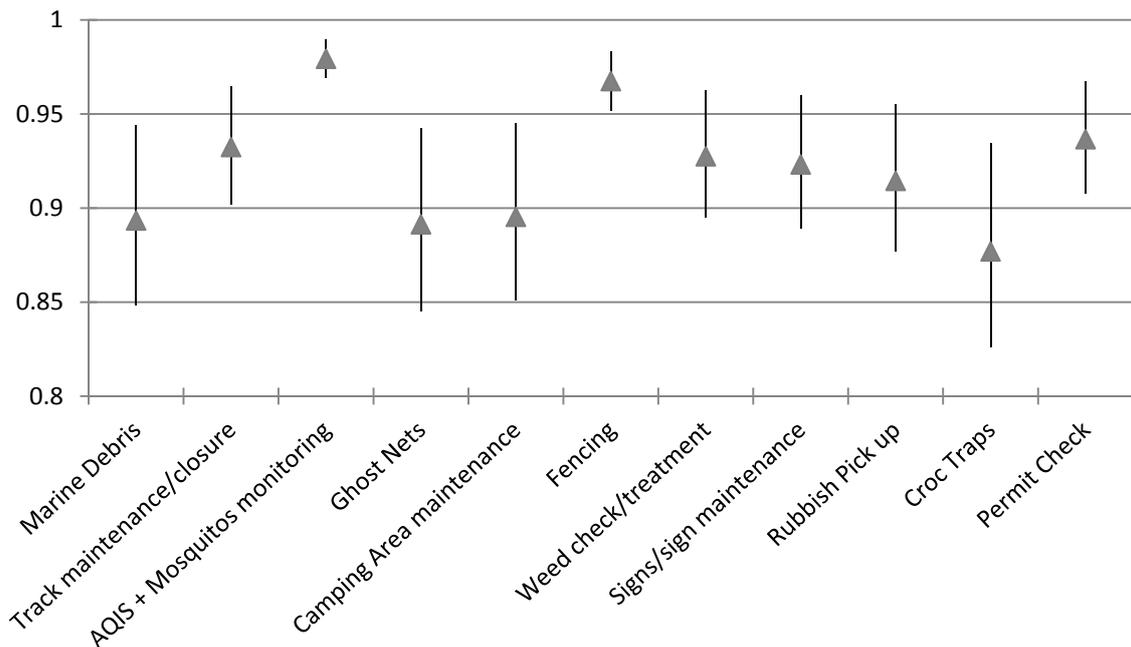


Figure 8: Ratio of labour cost over total estimated cost for selected Dhimurru Ranger activities based on the estimates of high, medium and low total costs reported in Table 10. The triangle represents the ratio estimated using the medium total cost.

3.2.7 Commercial opportunities and analysis of demand.

There are several opportunities for Dhimurru and the community at large to tap into additional local, regional and national demand. As with the Djelk case study, these demands are classified as institutional demand, Indigenous direct use, non-Indigenous direct use, and non-use related demand for environmental services.

The institutional demand

The institutional responsibilities of government agencies and departments are the sources of the institutional demand for environmental services. To date, Indigenous rangers have had limited involvement in the enforcement of regulations. Ongoing Yolngu concerns about the condition of marine resources coupled with the changes in the marine tenure system and management that are likely to follow from the Blue Mud Bay case have strengthened the case for greater Dhimurru participation in Fisheries management and potentially also in the supply of border security services to Customs.

Environmental monitoring and rehabilitation relating to mining and other industrial activities is an opportunity for Dhimurru to gain payment for environmental services. To date Dhimurru's provision of these services has been limited and, as noted above, vulnerable to global market conditions. The RTA bauxite mine, processing plant and power station within the boundaries of the Dhimurru IPA poses serious environmental risks. The relationship between Dhimurru and the mining company has occasionally resulted in joint monitoring projects. Without the official endorsement and sanction from government authorities, these projects have always relied on the company's goodwill,

resources, and market position. Environmental monitoring falls within the responsibility of the Northern Territory Environmental Protection Authority (NT EPA) and the NT Department of Resources. The role of the Department of Resources is the enforcement of compliance issues, and as such the Department conducts mine audits and inspections to ensure compliance with relevant standards. The NT EPA's role is limited to investigating accidents in the RTA plants. These public agencies and Dhimurru could both benefit from outsourcing environmental monitoring in the IPA.

Indigenous direct use of environmental services

Yolngu use their land and sea country within the Dhimurru IPA to extract food resources, inputs for subsistence production (e.g. hunting and fishing implements), and materials for art production. It is also used for recreational, spiritual and ceremonial purposes. Nearly 90 per cent of the Traditional Owners who were interviewed stated turtles, fish, mussels and crabs are the main resources extracted from their estate. Only one interviewee reported catching some wallabies. Food resources are mainly extracted from the marine rather than the terrestrial environments. From a utilitarian perspective, this may explain why the condition of the marine estate is a major concern to Traditional Owners. The terrestrial environments are important sources of material for art production and ceremonial tools, as well as curative plants. Logs for *yidaki* (didgeridoos) and bark are the most common resources extracted from the bush. Recreational and ceremonial uses of the marine and terrestrial landscapes are also common. All interviewees reported visiting the bush for at least one or other of these purposes.

Lack of data on the impacts of visitors, industrial development, weeds, and feral animals on the landscape, species and communities limits any assessment of the demand for environmental services from the local communities. Surveys recently conducted by NRETAS in Manydjarrarrnga-Nanydjaka could not conclusively identify any adverse effects attributable to feral animals, weeds, visitors, and fires (NRETAS and Dhimurru 2009). Yolngu residents' demand for environmental services is therefore considered undetermined.

As shown in Table 5, the low median household income in the communities with a prevalent Indigenous population suggests that there is also a limited capacity to pay for environmental services. In other words, it is unlikely that a local Indigenous demand for environmental services would be capable of providing sufficient financial resources for some of the services the Dhimurru Rangers provide.

Non-Indigenous direct uses

Non-Indigenous direct uses of the Dhimurru IPA are essentially for recreational purposes. No other direct use such as commercial harvesting of wildlife or carbon trading has emerged so far. This is due partly to the environmental conditions in the area. The region is much wetter than Central and Western Arnhem Land and limits Dhimurru's ability to generate carbon credits from fire management. The recreational demand originates from the resident non-Indigenous population and from tourists visiting the IPA. The tourism industry revolves mainly around the Garma Festival. There is also an all-year movement of people who visit the area for business. These visitors usually find accommodation at one of the two non-Indigenous run hotels in Nhulunbuy.

The visitor survey conducted by Dhimurru and the TRaCK research team provides some useful insights into the magnitude of the recreational demand of non-Indigenous residents

and tourists. 17 residents and 11 tourists took part in the survey. Tourists are mostly from interstate. The recreational areas in close proximity to Nhulunbuy are the most popular areas to visit among both residents and tourists. Residents visit the town beaches at least once a fortnight and over 70 per cent of the tourists surveyed visited these recreational areas. The northern beaches are the second most visited area: Ngumuy is the most popular among residents; and Garanhan is the most popular among tourists. Fishing and camping are the most common activities among residents, while for tourists the main attraction is the Garma festival and Indigenous cultural experiences. Residents rated their overall recreational experience in the Dhimurru IPA as good, while tourists rated their experience as excellent. The major causes for dissatisfaction among tourists are access roads, lack of information on native flora and fauna, conditions of camping areas, and lack or poor condition of toilet facilities. The residents' major concerns regard the lack of information on native flora and fauna, the condition of boat ramps, the lack or poor conditions of toilet facilities, and the general cleanliness of recreational areas. This list of concerns gives an indication of the areas where Dhimurru could improve recreational services.

In terms of cost of the recreational experience, tourists declared an average expenditure of \$545 per day per person. The length of their stay was up to one week for 54 per cent of the tourists, up to two weeks for 9 per cent, and less than one month for 27 per cent, while the remaining 10 per cent stayed in the area for more than a month. The average cost of visiting the IPA declared by residents was equal to \$84 per person per day. If one considers the residents' declared expenditure per day, the frequency of their visits to the Dhimurru IPA, and the fact that Dhimurru issues around 3,000 annual permits per year, it could be estimated that the demand for recreational services from non-Indigenous residents has a total value of around \$6,500,000. This is a conservative estimate as the visits to recreational sites may last more than one day, and the number of annual permits underestimates the number of users as they include family members and exclude permits valid only for two months.

Albeit limited, this information gives some indication of the potential for further tourism development and for raising revenues from the recreational demand. As the Traditional Owners are concerned about the impact of people on cultural resources, tourism development could focus on interstate and overseas visitors, as they seem to be more interested in the cultural element of the recreational experience than non-Indigenous residents. The impact of tourists could also be reduced by extending the tourist season rather than concentrating it around the Garma Festival. Assuming that the cost of the recreational experience less travel cost is around \$150 per day (see section 4.1.6), and the average length of stay is one week, 2,000-2,500 tourists per year could double the Dhimurru budget. This corresponds to 1 per cent of the total number of tourists per year in Kakadu National Park. There are some trade-offs to consider. These flows of tourists come on top of the existing pressure on the resources caused by non-Indigenous residents. Hence, tourism development should consider mitigating measures. Further, non-Indigenous residents may be crowded-out. That is, the quality of their recreational experience would suffer from increased tourist flows, and possibly lead to increased non-compliance—for example, refusal to purchase a permit. Similarly, tapping into the demand for recreational use from the non-Indigenous residents needs to take into consideration that any price increase could have some undesirable non-compliance effects. Even with an inelastic demand, residents could decrease their demand for permits but still use the resources unless appropriate enforcement and compliance measures were taken.

Non-use values

In section 4.1.7, non-use values were defined as values or benefits people derive from natural resources independent of any use that people might make of these resource. They include existence value, bequest value, and option value. There is insufficient data to quantify the non-use values of the Dhimurru IPA. One example of non-use value of an environmental service provided by Dhimurru relates to their efforts in marine turtle conservation. The economic literature provides some estimates regarding the non-use value estimates for marine turtles. One study provides a simple equation to attempt the transfer of the benefit estimates of the non-use value of marine turtles to other contexts (Richardson and Loomis 2009). Using this equation and interpreting its results with extreme caution, it is possible to estimate the benefits households receive from avoiding the loss of marine turtles as a species. The estimation gives a value of around \$10 per year per household. Aggregating to the Northern Territory, it gives an annual value of around \$1 million. It could be argued that as iconic species, benefits from the conservation of marine turtles should be aggregated over the entire Australian population. In this case, the benefits of avoiding the loss of marine turtles could be said to be around \$100 million. As there is no data on the contribution of Dhimurru environmental services to the conservation of marine turtles, it is not possible to assign Dhimurru's share of the estimated benefits. Table 11 summarises the findings of this preliminary analysis of social benefits generated in the Dhimurru IPA.

Table 11: Benefit of environmental conservation in the Dhimurru IPA.

Benefits	Value (\$ per year)	
	<i>Current</i>	<i>Potential/Target</i>
Institutional Demand for environmental services	\$1,868,155	unknown
Direct Indigenous Use		
- Food Source		unknown
- Material for art production		unknown
- Recreational, social, spiritual		unknown
Direct non-Indigenous Use		
- Residents	\$6,500,000	unknown
- Visitors	unknown	\$2,500,000
Non-use values		unknown

4. Barriers to development of payment for environmental services

The evidence, albeit limited, on current Indigenous provision of environmental services, their outcomes, and the potential for trading these services indicate that there are several obstacles to balanced growth in the state, market, and customary sectors of remote Indigenous economies.

4.1 Mismatch between Indigenous environmental services and non-Indigenous demand for these services

This report has highlighted several examples of a mismatch between the demand for environmental services and Indigenous interests. For example, buffalo culling is one of the main non-Indigenous conservation concerns and is also a concern expressed by many Landowners within the Djelk IPA (Gambold 2009). Such concern is based on the impacts feral buffalo have on the ecological integrity of ecosystems, their potential to transmit diseases to domestic animals, and human safety (Albrecht et al. 2009). However, not all Indigenous people within Arnhem Land express the same concerns. Indeed, in some areas buffalo have been incorporated into Indigenous culture and cosmology and are an important and reliable component of people's diets. They have a direct use and cultural significance that has the potential to create conflict between conservation concerns and the Indigenous dietary needs and cultural values.

Tourism development is another example of a possible mismatch. Both Djelk and Dhimurru IPAs have outstanding environmental and cultural features that make them attractive tourist destinations. However, notwithstanding over 40 years of industrial development within the borders of the Dhimurru IPA and a large non-Indigenous population, the importance of the tourism sector to the economy of Nhulunbuy, Yirrkala, and Gunyangara is negligible (see Table 6). Similarly, in the Djelk IPA the tourism industry has had limited impact so far to the economy. Whilst there are infrastructure constraints linked to the remoteness of these areas, it is generally the Landowners in both IPAs who have made the decision against large-scale tourism. Traditional Owners in both IPAs are wary of increased numbers of non-Indigenous recreational users of their resources and are also concerned about the conditions of cultural sites, trespassing, and unauthorised access, particularly of sacred sites. Hence Traditional Owners may see tourism development as a threat rather than an opportunity.

During informal talks with AQIS officers, it emerged that some Indigenous ranger groups in Northern Australia are not always willing to take up weed and insect monitoring, but are usually eager to participate in marine debris patrols. Financial incentives alone are not enough to motivate some ranger groups to undertake AQIS activities. As in the previous examples, there can be a mismatch between the services sought by non-Indigenous agencies and the services that Indigenous land and sea rangers are willing and able to provide.

4.2 Lack of institutional demand

Outsourcing environmental service provision may include that Indigenous rangers are trained and acquire enforcement powers. This is particularly likely in the case in terms of fisheries activities of sea rangers. The Dhimurru Rangers have requested to be appointed honorary conservation officers as per the Sect 93a of the Territory Parks and Wildlife Conservation Act, and hence gain the powers to obtain a person's name and address, and to

issue an infringement notice or equivalent. Legally, an honorary conservation officer would have the powers and duties of a member of the police force, such as the power to question a person suspected of permit infringement (Australasian Legal Information Institute 2011). So far, there has been little progress on Dhimurru's request for several reasons: lack of a structured training pathway; little or no definition of skills and competencies required; and the need to negotiate by-laws before implementing an infringement regime (Dhimurru, pers. comm. 2011).

Dhimurru has also requested to be included in Custom's Indigenous rangers program for coastal surveillance. Djelk Sea Rangers joined this program as a pilot scheme to assess the capacity of Indigenous rangers to conduct regular patrols of remote coastal areas. To date Customs have not accepted the request of the Dhimurru Rangers.

4.3 Lack of legal framework for environmental service markets

Currently there are no legal frameworks to establish or regulate a market for environmental services. Until such a framework is established, any trading of environmental services is reliant upon voluntary exchanges or provisional, piecemeal arrangements. The WALFA project, the only existing carbon trading scheme in Indigenous Australia, provides an important model of a successful voluntary exchange facilitated by government. As mentioned previously, WALFA is based upon a partnership between the Northern Territory Government, Darwin Liquefied Natural Gas, the Northern Land Council and the ranger groups (including Djelk Rangers) involved in managing fire in the WALFA area. This project was borne out of long-term collaboration between Indigenous ranger groups and research scientists, DLNG's corporate social responsibility, and judicious use of the Northern Territory Government's planning and approval processes directing the DLNG towards offsetting environmental impacts through WALFA.

4.4 Insufficient scientific and economic data on Indigenous provision of environmental services

The lack of data on the environmental, social or economic benefits that rangers' activities are generating locally, nationally and internationally potentially limits groups' ability to gain more support for Indigenous provision of environmental services. Similarly, there is currently no quantitative estimate of the institutional demand for these environmental services, nor of the use and non-use benefits generated by Indigenous NRM. Insufficient data also prevents any estimation of the cost effectiveness and efficiency of the public expenditure on Indigenous NRM. All of these issues highlight the importance of efforts, such as those within Djelk and Dhimurru rangers, that aim to increase accountability to funding bodies, industry partners and Landowners. The use of CyberTracker™ to record and report on management activities and the employment of Northern Territory Government staff to work with and train the rangers in both Djelk and Dhimurru IPAs to undertake environmental and biodiversity monitoring and management are significant steps taken towards this long-term task.

5. Implications and discussion

The two case studies presented in this report provide important lessons for developing an effective conservation and sustainable use economy in Arnhem Land. The necessary condition for developing effective conservation and sustainable use economies in remote

Indigenous communities is the convergence of Indigenous and non-Indigenous interests and aspirations. Only this convergence creates a matching demand and supply of environmental services. When such a convergence is not reached, any attempt to promote development based on the provision of environmental services is either stalled or imposed on one of the parties. That is, the market, state and customary sectors do not grow harmoniously, but one or more of the sectors grow at the expense of the other(s). When convergence occurs, as in the case of the two IPAs in this study and the WALFA project, the customary, state, and market sectors do work and grow together.

The first step to solve conflicts involves recognising that Indigenous notions of conservation may encompass ecological processes as well as social relationships, ecological and human interrelations, and power dynamics. The IPA program embodies this holistic approach to caring for country. IPAs are areas of Indigenous-owned land or sea where Traditional Owners have entered into a voluntary agreement with the Australian Government to promote biodiversity and cultural resource conservation (SEWPAC 2010). The second step requires recognising that Indigenous notions of development may not produce growth in the conventional Western economic sense. That is, the preferred development path by Traditional Owners may not be driven by financial motives or generate financial outcomes. Effective exercise of Indigenous decision making could instead lead to forms of development and empowerment without conventional economic growth. The IPA program again is an example of this, whereby Traditional Landowners are not paid for declaring an IPA on their land. Rather, funding is provided to manage the IPA in accordance with an agreed upon plan of management developed in consultation with Traditional Owners.

This in turn entails questioning the appropriateness of a focus on quantifiable measures of benefits and costs as the criteria for decision making. The *economics* of Indigenous provision of environmental services is linked to the biophysical and ecological effects of ranger activities, as well as their consequences for human welfare. It is not sufficient to claim that Indigenous provision of environmental services has—or does not have—some biophysical effects. It is necessary to provide evidence of the impacts these services have on consumption, production, investment opportunities, and so on. This evidence, however, could tip the benefit-cost scale on either side. Arguing for the support of Indigenous provision of environmental services from a utilitarian, non-Indigenous perspective could actually hinder the development cause of Indigenous communities. Also, the application of this perspective could pose serious equity issues. First, it legitimises only the demands of those citizens who can afford to pay. Second, it could create a precedent and lead governments to apply the same principles for any service to Indigenous (and other) communities.

A critical point to be acknowledged in any economic analysis is that many of the environmental threats affecting the two IPAs originated from outside their borders—that is, Traditional Owners within the IPAs bear the cost of negative externalities. Young et al. (1991: 190) argued that ‘this argument ... should carry considerable weight’ when looking for government to pay for land management on Indigenous land that is only required due to impacts caused by non-Indigenous people. Promoting development based on addressing these threats within the IPAs is equivalent to arguing for economic growth based on remediation expenditure. In other words, it adopts the mainstream economic view that expenditure on remediation and restoration is a measure of economic progress. This purely

economic concept disregards the decline of environmental and cultural resources and the local and national impacts on people's wellbeing.

Much more attention needs to be placed on the institutional arrangements and the configuration of power networks supporting the state, market and customary sectors, rather than on their relative size and contributions to the hybrid economy (Adaman and Madra 2002). In turn, this would highlight the issues of power in market transactions, Indigenous dependence on governments and their vulnerability to shifting policy priorities, and the motivations of Traditional Owners in caring for country. For instance, one of the benefits of schemes such as the WALFA project is the increased independence from government funding that they afford to Indigenous ranger groups (see Pagiola et al. 2008). In short, the market and customary sectors allegedly grow at the expense of the state contributions to the economy—although the state plays a significant role in providing the legislative, policy and regulatory environment within which this growth occurs. Independence from government funding comes at the cost of relying on governments to set up the framework that identifies buyers and then to lead the negotiation for the market transaction. In the absence of government pressure, potential buyers may participate voluntarily in these markets for philanthropic reasons, motives of corporate responsibility, and scientific needs. When other business priorities emerge, these agents can easily withdraw from the market, as in the case of the Dhimurru Rangers' contracts with AQIS and RTA. Hence, the Traditional Owners' ability to negotiate in environmental service markets needs government backing. When this is lacking, contracts are bound to be short-term, driven by the buyers' needs, with minimal consideration of Indigenous interests and cultural priorities. Without a policy framework that forces agents to find buyers and request environmental services buyers are located on the short-side of the market and able to exercise market power. This situation is unlikely to lead to sustained improvement in the socio-economic conditions of Indigenous communities.

A policy framework may not be in itself sufficient for Indigenous providers to gain power in the market for environmental services. There is no guarantee that Indigenous landowners end up in the short side of the market, or that they can successfully compete with other environmental service providers. As a policy framework for environmental service provision creates a demand that in turn creates a supply, it is plausible that new agents would enter the market. Local Indigenous service providers may have some cost advantages—location, Indigenous knowledge, etc—but they may be outcompeted in areas such as technology adoption and marketing. Further, it is hard to predict the form these markets will take. For instance, without international coordination, creating a market in one country may drive potential buyers to move their investment to other countries. The resulting market could be a monopsony, where one or very few firms have some market power over the price they pay for environmental services. In short, the possible scenarios resulting from the creation of markets for environmental services are multiple. The final outcome for Indigenous land and sea managers can only be assessed empirically once such markets are established. Of course strong government regulation may favour Indigenous providers. As labour markets are regulated to protect the workers—the weaker party in labour contractual arrangements—so should the regulation for environmental service markets protect Indigenous landowners. A clear legal framework for trading carbon credits and biodiversity services is needed to ensure that Indigenous landowners are not the losers in market exchanges.

With or without a policy framework, however, the private demand for environmental services may tie Indigenous development to global markets. Hence they subject local Indigenous economies to the volatility of resource prices and international trade, over which Indigenous landowners have little control—and possibly limited opportunities for hedging—as is the case of Dhimurru’s contractual relationship with RTA. Also, one should not disregard the potential adverse effects of exposing Indigenous providers to markets. Market exchange can be realised only for environmental and cultural elements that can be commodified. This risks the conflation of a set of systemic cultural and environmental complexities into commercialised elements, with potentially detrimental effects on the system (Kosoy and Corbera 2010; Norgaard 2010), and a shrinking of the customary sector. However, some Indigenous landowners may want to embrace market exchange as a way of producing financial and cultural benefits (Comaroff and Comaroff 2009:9-10). Effective Indigenous empowerment is a key factor in ensuring Indigenous interests are not overlooked.

As Indigenous Australians may have different sets of incentives and cultural demands, one should not expect Indigenous landowners to automatically embrace non-Indigenous notions of environmental conservation. Monetary incentives may not be enough to ensure the delivery of contracted service, the undertaking of conservation work, or changes in management practices. Contracted activities have to guarantee a degree of autonomy in their implementation, so that they can fit around other cultural and environmental responsibilities, such as is the case with the WALFA scheme and Customs programs. The activities required for the generation of the contracted environmental services need to match Indigenous management practices. Whenever this match does not occur, and when conflicting cultural priorities are apparent, effective Indigenous empowerment is required to ensure Indigenous and non-Indigenous interests converge.

6. Further research

Future research should aim to collect data across different areas and land tenure systems, and for longer time periods. There are now over 40 IPAs in Australia. They span many biogeographic regions, catchments, and ecosystems. They provide a good representation of Australia’s environments. Some IPAs have been established under the ALRA, others on the basis of native title claims, and hence differ in history, size, and regulatory regimes. A robust analysis of the costs and benefits of Indigenous provision of environmental services needs to account for such variety. Data should also cover a long-term time frame and take into account the fluctuations in environmental, economic and social conditions.

Research should look at quantifying and/or understanding the role of informal provision of environmental services by Indigenous landowners. While the data presented here is mostly based on the formal activities of rangers, Traditional Owners also perform environmental services as part of their customary activities, including the fulfilment of cultural responsibilities. These activities are largely unreported.

It is also necessary to better understand Indigenous and non-Indigenous values and aspirations driving the supply and demand of environmental services, and to identify areas of match and mismatch. Indigenous and non-Indigenous land managers, for instance, may be both driven by a sense of stewardship rather than financial motivations. Identifying common values would help to promote shared understandings and to develop inclusive

principles of environmental management that could be used to resolve conflict between Indigenous and non-Indigenous conservation priorities.

Priority should also be given to the collection of basic ecological data. This is necessary to assess the effectiveness of actions in reaching the agreed environmental targets.

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TRaCK
Tropical Rivers and Coastal Knowledge



DHIMURRU
ABORIGINAL CORPORATION

VISITOR SURVEY

The Dhimurru Rangers invite all visitors to provide feedback to improve the recreational experience in the Indigenous Protected Area.



CENTRE FOR ABORIGINAL ECONOMIC POLICY RESEARCH



ANU
THE AUSTRALIAN NATIONAL UNIVERSITY

Dear Visitor/Resident,
Dhimurru Aboriginal Corporation (DAC) and the Centre for
Aboriginal Economic Policy Research (CAEPR) at the Australian
National university (ANU) invite you to take part in this survey.
Please read this sheet carefully and keep the attached copy
throughout the period of research (May-Dec 2010).

This survey is part of CAEPR "*People on Country, Healthy
Landscapes, and Indigenous Economic Futures*" research project.
This questionnaire aims to gain a better understanding of some
of the benefits related to recreational activities in Indigenous
Protected Areas (IPAs). We would like to get information about
the recreational activities you undertake, or a planning to
undertake, in the IPA. Your answers will be very useful in
understanding how to improve environmental management and
visitor services.

The project is funded by the Tropical Rives and Coastal
Knowledge research hub, and the Australian Rivers Institute.

Participation is completely voluntary, and you may withdraw
from the research at any time. By completing the questionnaire
you consent to the use of the information you provide. This
information will be stored at CAEPR, and made public only in
aggregate form in articles, books or reports, with no data linked
to participants' names. If you have any questions or concerns
about any part of this research, please contact Dr. Nanni Concu
at CAEPR (nanni.concu@anu.edu.au or 02 61258499).
If you have serious concerns regarding the way the research is
conducted please contact ANU Human Research Ethiucs
committee at the address below:

Secretary, Human Research Ethics Committee
Research Office
The Australian National University
ACT 0200 Australia
Phone: 61-2 61257945
E-mail: Human.Ethics.Officer@anu.edu.au

Thanks!

Dr. Nanni Concu
(project coordinator)

1. Did you know that Dhimurru IPA is a nationally recognized protected area and part of Australia's National Reserve System?
 - Yes No

2. Are you a Nhulunbuy resident?
 - Yes (**GO TO QUESTION 9**) No

3. Have you visited the Dhimurru IPA before?
 - Yes No

4. Where do you come from?
 - Darwin
 - Northern Territory. *Town:* _____
 - Interstate. *State* ___ *Town:* _____
 - Overseas. *Country:* _____

5. Which form of transport did/will you use to get to Nhulunbuy/Dhimurru IPA (tick as many as appropriate)?
 - Car/bus with Tour Operator
 - Private car
 - Hired car
 - Airplane
 - Boat
 - Other: _____

6. Which o the following best describes the type of group you are travelling with?
 - Alone
 - With and/or friends
 - Part of a commercial tour
 - Part of a club or organisation
 - Part of a school group
 - Other: _____

7. How many days have spent/will you spend overall in the Dhimurru IPA?

- 1 day
- 2 days
- Weekend
- More than one week
- 2 weeks
- More than 2 weeks but less than 1 month
- More than 1 month

8. Which recreational areas have you visited/will you visit?

- | | | |
|---|--|--------------------------------------|
| <input type="checkbox"/> Town Beaches | <input type="checkbox"/> Macassan Beach | <input type="checkbox"/> The Giddies |
| <input type="checkbox"/> East Woody and
East Woody
Island | <input type="checkbox"/> Turtle Beach | <input type="checkbox"/> Wathawuy |
| <input type="checkbox"/> Nhulun Lookout | <input type="checkbox"/> Little Bondi
Beach | <input type="checkbox"/> Gapuru |
| <input type="checkbox"/> Rainbow Cliff | <input type="checkbox"/> Rocky Point | <input type="checkbox"/> Wonga Creek |
| <input type="checkbox"/> Daliwoi | <input type="checkbox"/> Cape Arnhem | <input type="checkbox"/> Cato River |

SKIP to Question 10

9. How often do you visit the Dhimurru IPA?

	Every day	More than once a week	Every week end	More than once a fortnight	Once a fortnight	Once or twice per month	Less than once a month	Once every 1 or 2 months	Rarely	Never
Town Beaches										
East Woody and East Woody Island										
Nhulun Lookout										
Rainbow Cliff										
Daliwoi										
Macassan Beach										
Turtle Beach										
Little Bondi Beach										
Rocky Point										
Cape Arnhem										
The Giddies										
Wathawuy										
Gapuru										
Scout Camp										
Wonga Creek										
Cato River										

10. What are the main activities/reasons for you to visit the Dhimurru IPA?

- Fishing
- Camping
- Aboriginal arts and crafts
- Bushwalking
- Visiting family/friends
- The Garma Festival
- Cultural experience
- Sighseeing
- Bird watching
- Business Work
- Other: _____

11. Which of these descriptions fits you best?

- Full/part-time student
- Full-time employed
- Part-time employed
- Unemployed
- Home duties
- Retired

12. Please provide an estimate of the cost to you (travel costs, permits, etc.) of a visit to a recreational area in the Dhimurru IPA (on average per day per person).

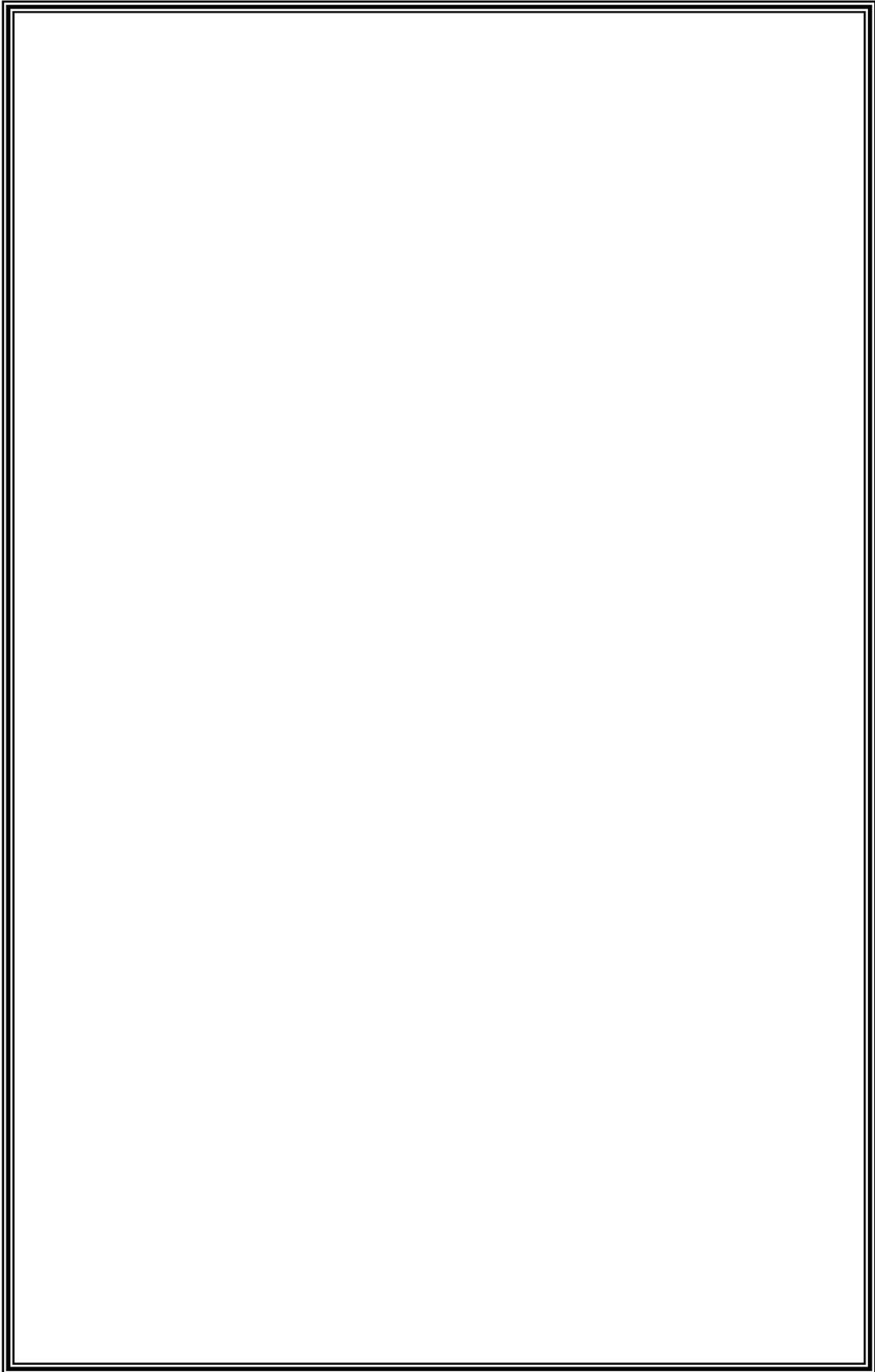
- | | |
|--|--|
| <input type="checkbox"/> \$0 - \$50 | <input type="checkbox"/> \$551 - \$600 |
| <input type="checkbox"/> \$51 - \$100 | <input type="checkbox"/> \$601 - \$650 |
| <input type="checkbox"/> \$101 - \$150 | <input type="checkbox"/> \$651 - \$700 |
| <input type="checkbox"/> \$151 - \$200 | <input type="checkbox"/> \$701 - \$750 |
| <input type="checkbox"/> \$201 - \$250 | <input type="checkbox"/> \$751 - \$800 |
| <input type="checkbox"/> \$251 - \$300 | <input type="checkbox"/> \$801 - \$850 |
| <input type="checkbox"/> \$301 - \$350 | <input type="checkbox"/> \$851 - \$900 |
| <input type="checkbox"/> \$351 - \$400 | <input type="checkbox"/> \$901 - \$1,000 |
| <input type="checkbox"/> \$401 - \$450 | <input type="checkbox"/> \$1,001 - \$1,500 |
| <input type="checkbox"/> \$451 - \$500 | <input type="checkbox"/> \$1,501 - \$2,000 |
| <input type="checkbox"/> \$501 - \$550 | <input type="checkbox"/> Over \$2,000 |

13. How would you rate your overall recreational experience in the Dhimurru IPA?

Excellent	Good	Average	Not Good	Poor
<input type="checkbox"/>				

Comments: _____

14. In your opinion, how important are these factors for your recreational experience when you visit a conservation area in Australia?			
16. Do you have any comments or suggestions for Traditional Owners and Rangers of the Dhimurru IPA?			
	Very Important	Average	Not Important
Information about the area			
Information about Culture and Heritage			
Information about plants and animals			
Contact with staff			
Access Roads			
Camping areas			
Boat Ramps			
Toilets			
Parking areas			
Cleanliness/lack of litter			
Other: _____			
<p>Thanks for your cooperation and your contribution to improving our management practices.</p> <p>15. How would you rate the Dhimurru IPA in relation to there factors?</p> <p>For more information about Dhimurru Aboriginal Corporation, go to www.dhimurru.com.au.</p> <p>For further information about the People on Country research project please visit: www.anu.edu.au/caep/country/.</p> <p>Information about Aboriginal Culture and Heritage If you have any further comments please contact Dr. Nanni Concub in CAEPR (nanni.concu@anu.edu.au or 02 61258499) Contact with staff</p>			
	Very Important	Average	Not Important
Information about the area			
Information about Culture and Heritage			
Information about plants and animals			
Contact with staff			
Access Roads			
Camping areas			
Boat Ramps			
Toilets			
Parking areas			
Cleanliness/lack of litter			
Other: _____			





Dhimurru IPA Topic Guide

Prepared by John M. White

Introduction

The Dhimurru Indigenous Protected Area (IPA) was formally declared in 2000, comprising just over 1,000 square kilometres of land, 300 kilometres of coastline and 90 square kilometres of marine estate in north-east Arnhem Land. The land and sea country managed by the Dhimurru Land Management Aboriginal Corporation ('Dhimurru') provide significant breeding habitats for seabirds and several threatened species of marine turtles. The IPA region remains in a relatively pristine condition with wildfire and the presence of feral animals being less significant issues than in other areas of Arnhem Land. The main environmental threats to the region's biodiversity and water quality are the presence and related activities of the Rio Tinto Alcan Gove mine, and non-Indigenous (*Ngapaki*) visitors. Marine debris ('ghost nets') is a significant threat to marine life, particularly for marine turtles.

Dhimurru was established in 1992 in response to Yolngu Traditional Owner concerns about the activities of increasing numbers of *Ngapaki* associated with the bauxite mine near Yirrkala. Dhimurru manages an access permit system to control and manage visitor access to land and sacred sites, and to mitigate potential environmental damage. The permit system also enables Nhulunbuy residents and tourists to visit designated areas for recreational activities. Dhimurru's activities have mainly been directed towards the management of visitors, including the closure of certain tracks and campsites and the demarcation of preferred ones; however Dhimurru is also involved in the rehabilitation of damaged sites. Dhimurru has become increasingly involved in collaboration with research projects such as the turtle recovery and ghost net removal, marine debris removal, bandicoot surveys, crocodile and crazy ant management, and management of the Gove Crow butterfly. These collaborative activities reflect Dhimurru's 'both ways' approach that incorporates both Yolngu and western intellectual traditions and practices in policy formation, governance and management activities. Dhimurru rangers also monitor and control weed infestations and the presence of feral animals in the IPA. The 2006 sea country program has extended Dhimurru's area of management and the Sea Country Team is active in participating in collaborative research, management and monitoring work. Dhimurru represents the continuous stewardship of the land and sea country within the IPA by Yolngu traditional owners and its management activities reflects the aspirations of Yolngu landowners.

Preliminary findings from the Tropical River and Coastal Knowledge (TRaCK) research project indicate: the need for more scientific research in order to create baseline data against which the impact of Indigenous land management activities can be assessed; that Indigenous land managers should improve their ability to monitor and report on the environmental outcomes of their activities so that potential environmental service purchasers can be confident that the activities they fund are having quantifiable effects;

and, that a sustainable use economy needs a proper framework that creates markets for environmental services. In view of these findings, this topic guide includes literature that relates to a range of environmental and cultural assets within the IPA and environmental threats. In doing so, the topic guide seeks to determine what the relevant research suggests Indigenous land managers do to improve the environmental outcomes of their activities, and a range of policy implications for Indigenous land managers. This guide also provides a general overview of a diverse body of science and social science literature that relate to the Dhimurru IPA. In contrast with the Djelk IPA, concerns about fire and feral animal management, and sustainable natural resource use are not significant issues for Dhimurru, and this is reflected in the literature.

The literature in this topic guide is reviewed thematically with sections on:

- environmental and cultural assets,
- environmental threats (including sub-sections on feral animals, fire and general assessments), and
- management and policy implications.

A brief introduction to each theme draws out key issues and/or areas of agreement in the literature, while short summaries are provided for each reference. Many of the documents are available online; however some are only available in printed form and can either be obtained from libraries or by contacting CAEPR.

Environmental and cultural assets

Environmental assets

This section includes three studies that describe environmental assets within the IPA, including studies that describe the region's significant biodiversity and that examine the distribution and ethnozoology of frogs. This body of literature demonstrates that the Dhimurru IPA is notable because of the region's high plant diversity and intactness of plant and animal communities.

Biodiversity Conservation Division, NRETAS & Dhimurru Land Management Aboriginal Corporation (2009). Biodiversity re-survey at Cape Arnhem Peninsula, February 2009. Draft version.

In 1994, Dhimurru Land Management staff were involved in a systematic fauna survey on the Cape Arnhem Peninsula, which reported that the region was in a relatively pristine condition. The 2009 report provides a follow-up survey 14 years later in order to update information about biodiversity and to assess potential changes. Comparisons were made between the 1994 and 2009 data.

Boll, V. (2004) The distribution and ethnozoology of frogs (and toad) in north-eastern Arnhem Land (Australia). *Anthropozoologica*, 39:61-72.

This paper is based on field research conducted in the IPA region during 2002 and is concerned with the occurrence, distribution and ethnozoology of frogs and toads. The author worked with Dhalwangu people to determine a range of local traditions, beliefs, and

nomenclature relating to amphibians. The research identified seven different species of frogs and many Cane toads, and each specimen was identified by both their scientific and Dhay'yi names. In addition, local co-researchers also provided comments and shared traditional knowledge about each specimen. The paper describes the arrival of Cane toads in 2000 and discusses both scientific and Yolngu concerns about their proliferation in this region. However, no direct evidence is provided that demonstrates Cane toads are responsible for a loss in vertebrate biodiversity in the region. The limited number of species found during this research is attributed to seasonally dry conditions and the author recommends that wet season surveys need to be conducted to compile a more comprehensive list. Importantly, the paper includes some detailed stories about frogs by older informants that demonstrate the incorporation of frogs into the moiety system as well as local cosmological, ritual and totemic systems.

http://www.mnhn.fr/museum/front/medias/publication/10619_061_072.pdf

Department of Natural Resources, Environment, The Arts and Sport (NRETA). (2005) Northern Territory Bioregions: Assessment of Key Biodiversity Values and Threats, Northern Territory Parks and Conservation Masterplan. Darwin: Northern Territory Government.

This report draws upon and summarises a wealth of existing data to provide a bioregional summary for each of 12 bioregions within the Northern Territory, and an addition 13 that are shared with neighbouring states. The report groups the Dhimurru IPA region under a broader biogeographic region termed the 'Arnhem Coast'. It provides a general description of the bioregion, a summary of land tenure, reservation, use and details of protected areas. The report describes broad vegetation types, as well as significant and threatened plant and animal species. It also identifies general management issues, including fire management and the status of significant exotic plants and animals in the bioregion.

http://www.nt.gov.au/nreta/parks/masterplan/publications/pdf/bioregions_assessment.pdf

Cultural assets

A large body of ethnographic research has been conducted with Yolngu people in northern Arnhem Land. A selection from this literature is included for further reading at the end of this section. Keen's (2004) *Aboriginal Economy and Society: Australia at the Threshold of Colonisation* provides an excellent general overview of Yolngu ecology, technology, seasonal mobility, identities (including language varieties, patri-groups, patri-moieties and subsections), kinship and marriage, cosmology and quasi-technology, governance, and economy (including production, distribution, consumption, exchange and trade). The following three references by Berndt (1964), Wilkinson et al (2009) and Yunupingu (2006) provide valuable information on the significance of land and sea country within the Dhimurru IPA.

Berndt, R. M. 1964. The Gove dispute: the question of Australian Aboriginal land and the preservation of sacred sites. *Anthropological Forum*, 2:258-95.

This paper provides a valuable record of sites of cultural heritage within the IPA prior to the establishment of the Gove bauxite mine. Berndt's fieldwork aimed to identify Yolngu

sites of significance in and around the proposed mine and Weapons Research Establishment leases in order to demonstrate the religious and cultural heritage value of certain sites to Yolngu people. It also gives an excellent background to the 'Gove dispute' that resulted in the famous Yolngu bark petition against the Commonwealth's excision of land for the mining lease. Not surprisingly, the paper is couched in a more general discussion of issues relating to the development of land rights and compensatory frameworks for Indigenous communities. The research involved the production of six detailed maps of land and sea country within the present IPA and the identification of 317 sites of significance. Where possible (or relevant), each site's name, significance and moiety affiliation are listed. The mapping also shows 'inviolate' areas that Yolngu believe should not be disturbed by the proposed mining activities, as well as specific areas of clan ownership. Berndt noted that Yolngu associated the majority of sites with the various beings that created the natural environment, and argued that the destruction of these sites entailed the destruction of religious and cultural heritage.

Wilkinson, M., Dr Marika, R. & Williams, N. 2009. This place already has a name. In: Koch, H. J. & Hercus, L. A. (eds.) Aboriginal Placenames: Naming and Re-naming the Australian Landscape. Aboriginal History Monograph 19. Canberra: Department of History, The Australian National University.

This paper is significant because it examines the origin and meaning of Yolngu placenames in the IPA region and includes a detailed story relating to the ancestral being Wuyal and the hill of Nhulunbuy. It also includes a map that approximates the location of sites associated with Wuyal's movements and a linguistic discussion of Yolngu placenames. The paper is framed around the dispute over the appearance of English road signs and place names on the Gove peninsula between 1963 and 1984. It provides an elaborated historical background to Yolngu-non Indigenous relations and 'naming events', and a discussion of the 1968 bark petition to recognise the Yolngu name 'Nhulunbuy' over the English name 'Gove'. Importantly, the bark petition sent to the Commonwealth Parliament included the image of Wuyal to invoke the ancestral authority of the name Nhulunbuy.

Yunupingu, D. 2006 [1985]. Ganbulapula: The Story of the Land around the Old Dhupuma College. Yirrkala, NT: Yirrkala Literacy Resources Development Unit.

This educational booklet provides a detailed story of the ancestral being Ganbulapula and the land around Yirrkala. Importantly, the booklet provides four maps detailing areas and sites of significance within the present IPA, some of which illustrate the paths of other ancestral beings, or the extent of Dhuwa and Yirritja related sites. The booklet also includes a painting of country near Daliwuy Bay that shows several ancestral beings. The story of Ganbulapula is written in Gumatj Matha with an accompanying English translation.

Further reading:

Berndt, R.M. (1952) *Djanggalawul: An Aboriginal Religious Cult of North-Eastern Arnhem Land*. London: Routledge

Berndt, R. M. (1976) *Love Songs of Arnhem Land*. Melbourne: Thomas Nelson.

Keen, I. (1994) *Knowledge and Secrecy in an Aboriginal Religion*. Melbourne: Oxford University Press.

Magowan, F. (2007) *Melodies of Mourning: Music and Emotion in Northern Australia*. World Anthropology Series. Perth: University of Western Australia Press.

Morphy, H. (1984) *Journey to the Crocodile Nest*. Canberra: Australian Institute of Aboriginal Studies.

Morphy, H. (1991) *Ancestral Connections: Art and an Aboriginal System of Knowledge*. Chicago: The University of Chicago Press.

Thomson, D. (1949) *Economic Structure and the Ceremonial Exchange Cycle in Arnhem Land*. Melbourne: Macmillan.

Warner, W. L. (1958) *A Black Civilization: A Social Study of an Australian Tribe* (2nd ed.). New York: Harper & Row.

Williams, N. (1986) *The Yolngu and their Land: A System of Land Tenure and the Fight for its Recognition*. Canberra: Australian Institute of Aboriginal Studies.

Environmental Threats

This section includes one paper that identifies potential threats to the Gove Crow butterfly and two papers that address the significant threat of marine debris and ‘ghost nets’ within the IPA.

Braby, M. (2010) Conservation status and management of the Gove Crow *Euploea alcathoe enastri* (Lepidoptera: Nymphalidae), a threatened tropical butterfly from the indigenous Aboriginal lands of north-eastern Arnhem Land, Australia. *Journal of Insect Conservation*, 14:535-54.

This study involved surveys carried out between 2006 and 2008 to determine the spatial distribution and habitat, and the extent and severity of threatening processes for the Gove Crow (*Euploea alcathoe enastri*) butterfly within the Dhimurru IPA region. The surveys involved identifying suitable habitat patches by drawing on scientific, geographic and Indigenous knowledge and on-the-ground visual searches for the presence of the butterfly within these patches. The results and analysis demonstrate that the subspecies had a limited geographical range and is endemic to an area of approximately 6,700km² on the Gove peninsula. The study identified two main threats to the species’ conservation: habitat modification through an altered fire regime and weed infestation, and habitat disturbance by feral animals. It identified that there were concerns that traditional knowledge and land management practices amongst Indigenous custodians was not being passed down to the younger generation. It also found that potential increases in the presence of Asian water buffalo and feral pigs, and predation by Yellow Crazy Ants posed significant threats to the conservation of the butterfly. The study recommends that the species should be regarded as ‘Near Threatened’ or ‘Conservation Dependent’ because conservation management may be necessary.

While acknowledging that the region remains in a relatively pristine condition, the paper urges that continued management incorporating both scientific and Indigenous knowledge is required for the successful maintenance of biodiversity and cultural heritage in this region.

<http://www.springerlink.com/content/85251713125020u8/fulltext.pdf>

Gunn, R., Hardesty, B. D. & Butler, J. (2010) Tackling ‘ghost nets’: Local solutions to a global issue in northern Australia. *Ecological Management & Restoration*, 11:88-98.

This paper discusses the Carpentaria Ghost Net Programme (CGNP) that has been developed to address the problem of ‘ghost nets’ (discarded fishing nets) along Australia’s northern Gulf coast. The project integrated a large network of Indigenous ranger groups (including Dhimurru) with government agencies and other stakeholders to resolve the problem of ghost nets. The paper shows that since 1993, concerns have been growing amongst Indigenous communities on the Gulf coast about increases in marine debris, particularly ghost nets. It demonstrates the negative environmental and economic effects of ghost nets, including the problem of ‘ghost fishing’ in which ocean currents lock derelict nets into a cyclical movement with damaging consequences for marine life. Two primary species of conservation importance at risk from ghost nets are the endemic Flatback Turtle and the Narrow Sawfish, although a large array of benthic and pelagic species are also at risk from marine debris habitat degradation. The paper describes the development of the CGNP in partnership with Indigenous ranger groups, and the physical, environmental, social achievements and benefits to date.

<http://onlinelibrary.wiley.com/doi/10.1111/j.1442-8903.2010.00525.x/pdf>

White, D. (2005) Marine Debris in Northern Australian Waters: Report to the Department of Environment and Heritage. Sydney: World Wildlife Fund.

This study involved beach surveys to collect and determine the composition and source of all anthropogenic marine debris at a number of sites in the Northern Territory and northern Queensland. The research involved the participation of Dhimurru staff, and a brief discussion of Dhimurru’s Turtle Recover Program is included in the introduction. The results and discussion demonstrate that marine debris is an ongoing problem in northern Australia, and that the greatest threat posed is the entanglement of threatened marine life (including marine turtles) in derelict fishing nets. The results also show that the nets responsible for the deaths of marine turtles were identified as originating from foreign fishing vessels operating in northern Australian waters. The paper concludes that while local initiatives and monitoring are important, more targeted solutions need to be devised that address the problem of ghost nets and the fishing industry in northern Australian waters.

<http://www.environment.gov.au/coasts/publications/pubs/marine-debris-northern2005.pdf>

Management Implications

This section includes two management plans that have been developed by Dhimurru to assist in building both their management capacity and partnerships with management agencies, marine industries and other stakeholders. The remaining papers discuss Dhimurru's collaboration with researchers and management agencies through specific programs. A preliminary appraisal of this literature suggests that Dhimurru's model of 'two ways' collaboration, governance and management activities has been highly successful, and that Dhimurru's expanding operations is necessary for managing the IPA's environmental and cultural assets.

Dhimurru Aboriginal Corporation (2006) *Yolnuwu Monuk Gapu Wana Sea Country Plan: A Yolngu Vision and Plan for Sea Country Management in North-east Arnhem Land, Northern Territory*. Nhulunbuy, NT: Dhimurru Aboriginal Corporation.

This plan presents Dhimurru's further vision for Yolngu management of sea country within the IPA and aims to build on its marine management capacity through the development of partnerships with marine industries and management agencies. The plan explains what sea country means to Yolngu custodians and how Yolngu guardianship and custodial responsibilities are undertaken. It also explains Dhimurru's role in the sea country planning process, as well as future management concerns and priorities. The plan seeks to inform other stakeholders of Yolngu aims in order to facilitate open and transparent working partnerships. These aims include recognition of Yolngu custodianship of sea country, the development of sound rules and culturally appropriate protocols for the use of sea country and the development of real partnerships that build upon Dhimurru's capacity to manage sea country in an ecologically and economically sustainable manner.

<http://www.dhimurru.com.au/Downloads/DhimurruSeaCountryPlan.pdf>

Dhimurru Aboriginal Corporation (2009) *Dhimurru Indigenous Protected Area Cultural Heritage Management Plan 2009 to 2015*. Prepared for Dhimurru by Daryl Guse (Earth Sea Heritage Surveys) and with revisions from Dhimurru Staff. Nhulunbuy, NT: Dhimurru Aboriginal Corporation.

This plan builds upon the 2006 sea country plan to outline Dhimurru's overall IPA management plan. It includes a detailed background to the environmental and cultural context of the IPA, a discussion of the IPA in relation to heritage management principles and the cultural significance of the IPA to Yolngu people. The plan discusses a range of management issues and heritage conservation management policy considerations, with specific emphasis on sacred sites and sites of archaeological significance, and sites of Yolngu historical significance. The plan outlines the cultural heritage management priorities and activities for Dhimurru and addresses issues relating to training and capacity building, knowledge gaps, information management, knowledge sharing and public education.

<http://www.dhimurru.com.au/Downloads/Dhimurru%20CHMP%20090406.pdf>

Kennett, R., Munungurritj, N. & Yunupingu, D. (2004) Migration patterns of marine turtles in the Gulf of Carpentaria, northern Australia: implications for Aboriginal management. *Wildlife Research*, 31:241-8.

This study used satellite telemetry to track the migration routes of 20 green turtles departing from a nesting beach approximately 45 kilometres south of Nhulunbuy. The results show that all of the tracked turtles remained within the Gulf of Carpentaria, suggesting that the foraging habitat for adults of this population may be confined to the Gulf region. The paper argues that Indigenous people play a critical role in conserving and managing marine turtles and that the development of a Gulf of Carpentaria marine turtle management strategy is an urgent priority.

http://www.publish.csiro.au/?act=view_file&file_id=WR03002.pdf

Kennett, R., Robinson, C. J., Kiessling, I., Yunupingu, D., Mununguritj N. & Yunupingu, D. (2004) Indigenous initiatives for co-management of Miyapunu/Sea Turtle. *Ecological Management & Restoration*, 5:159-66.

This paper discusses how Yolngu have responded to threats on marine Turtle populations in north-east Arnhem Land. It focuses specifically on Yolngu concerns over Marine Turtle populations and habitats, demonstrating that Yolngu strategies attempt to balance and adapt Indigenous and scientific knowledge, and facilitate cooperation amongst a range of stakeholders. The paper shows that marine debris is the primary concern, and that ongoing resources required to clean up debris is substantial. Increasing numbers of four wheel drive vehicles visiting the region was identified as another significant threat to turtle hatcheries. The paper also discusses Dhimurru's 'two-way' co-management approach to research and management, and asserts that ongoing partnerships are critical for the long-term sustainability of marine resources and species.

<http://onlinelibrary.wiley.com/doi/10.1111/j.1442-8903.2004.00204.x/pdf>

Marika, R., Yunupingu, Y., Marika-Mununggiritj, R. & Muller, S. (2009) Leaching the poison - The importance of process and partnership in working with Yolngu. *Journal of Rural Studies*, 25:404-13.

This paper provides a Yolngu perspective on the 2007 Northern Territory Emergency Response to demonstrate a specific Indigenous experience of being governed from a distance. It draws upon potent Yolngu metaphors from north-east Arnhem Land (including likening government impositions on Indigenous people in remote areas to the cycad nut that has poison within its flesh) to render Yolngu perspectives and law visible. The paper provides a valuable discussion of the importance of metaphor in Yolngu discourse, and the distinctly different decision-making processes of Yolngu and non-Indigenous people. In doing so, the authors set out Yolngu concerns about governance and decision-making and provides guidance on how bureaucrats, policy makers and researchers can best work with Indigenous people.

<http://www.sciencedirect.com/science/issue/5977-2009-999749995-1489126>

Muller, S. (2008) Community-Based Management of Saltwater Country, Northern Australia. *Development*, 51:139-43.

This paper examines the role of the Dhimurru Sea Country Plan in asserting self-defined, community-based management strategies that are based on local objectives and concerns.

The author argues that the plan is an example of 'post-development in practice' because Yolngu have established control as participants in the development process. The paper demonstrates that Yolngu have been able to articulate their own ideals through management planning in a manner that is accessible by government agencies and other stakeholders

<http://www.palgrave-journals.com/development/journal/v51/n1/pdf/1100465a.pdf>

Muller, S., Power, E., Suchet-Pearson, S., Wright, S. & Lloyd, K. (2009) "Quarantine matters!": quotidian relationships around quarantine in Australia's northern borderlands. *Environment and Planning*, 41:780-95.

This paper examines the work of the Australian Quarantine and Inspection Service (AQIS), through the Northern Australia Quarantine Strategy (NAQS), to investigate the making and remaking of borders in daily life. The paper argues that border spaces and relationships are constantly being negotiated by a range of stakeholders and that borders do not exist as easily identifiable lines. The research also involved interviews with three Yolngu ranger groups in north-east Arnhem Land (including Dhimurru) to examine their experiences of working with the NAQS. Importantly, the paper demonstrates the critical role that Indigenous ranger groups play in Australia's border protection.

<http://www.envplan.com/epa/fulltext/a41/a40196.pdf>

Puig, J., Huchery, C., Collier, N., Garnett, S. & Concu, N. (2009) Scenario modelling as a tool to explore climate change adaptation for remote indigenous communities. *IOP Conference Series: Earth and Environmental Science*, 6.

This paper examines the utility of scenario modelling in assessing the potential impacts of climate change on Indigenous communities in the Northern Territory. Rather than making predictions on these changes, the author's approach asks 'what if?' and discusses how Indigenous communities might adapt to future climate change impacts. The paper includes a brief background to and discussion of Dhimurru's involvement in the research.

<http://iopscience.iop.org/1755-1315/6/57/572034>

Robinson, C. & Mununggurritj, N. (2001) Sustainable Balance: a Yolngu framework for cross-cultural collaborative management. In BAKER, R., DAVIES, J. & YOUNG, E. (eds.) *Working on Country: Contemporary Indigenous Management of Australia's Lands and Coastal Regions*. Melbourne: Oxford University Press.

This paper examines Dhimurru's innovative model of collaborative management and provides a valuable background to the organisation's formation and organisation. It shows that through Dhimurru, Yolngu have maintained and exercised their traditional rights, and have conserved the cultural and ecological values of the present IPA. The paper also discusses Dhimurru's involvement in cross-cultural management of Cape Arnhem, and a range of challenges faced by Dhimurru's management initiatives.

Smyth D. (2007) Dhimurru Indigenous Protected Area: Sole management with partners. In BAUMAN, T. & SMYTH, D. (eds.) *Indigenous Partnerships in Protected Area Management in Australia: Three Case Studies*. Canberra: AIATSIS.

This paper examines the location, history, and cultural and natural values of the Dhimurru IPA, and the organisations involved in Dhimurru IPA partnerships. It discusses the 'two-ways' management of the IPA and outlines a range of successes and challenges faced by the organisation. The paper demonstrates that Dhimurru is a valuable example of protected area management because Yolngu have taken on sole management responsibility, while negotiating fruitful partnerships with government agencies and other stakeholders.

Verschuuren, B., Marika, M. & Wise, P. (2007) Power on this land; managing sacred sites at Dhimurru Indigenous Protected Area, Northeast Arnhem Land, Australia. In Papayannis, T. & Mallarach, J. M. (eds.) *Proceedings of the Second Workshop of the Delos Initiative. Ouranoupolis, Greece, Gland, Switzerland. Athens: Med-INA, Gland: IUCN.*

This paper examines Dhimurru's experience with managing sites of cultural heritage significance. It provides a general explanation of the relationship between *Rom* (law), *Manikay* (song/ceremony) and *Miny'tji* (art) in Yolngu cultural connections with country. The paper outlines a range of natural, cultural and spiritual values that Dhimurru has taken upon itself to maintain and protect, and a discussion of land rights at Nhulun lookout. It also discusses paintings of Muruwirri (Lonely Rock) and Dhambaliya (Bremmer Channel) to demonstrate the cultural significance of sacred sites in the marine environment (sea country). The authors detail a range of pressures and impacts on the IPA's natural, cultural and spiritual values, citing non-Yolngu human disturbance and visitor management as primary concerns. The paper also includes sections on conservation perspectives and sustainability, and the incorporation of traditional and scientific knowledge in management practices and activities. The paper concludes by making a number of conclusions and recommendations on how the Dhimurru experience might inform other indigenous groups and policy makers to deal with the preservation and management of sacred sites.

<http://www.iucn.org/what/tpas/livelihoods/resources/publications/?uPubsID=4006>

Appendix C: Djelk IPA topic guide

Djelk IPA Topic Guide

Prepared by John M. White

Introduction

In September 2009 the Djelk Indigenous Protected Area (IPA) was declared, covering more than 673,200 hectares of land and sea country between the Arnhem Land plateau and the Arafuran Sea. The area comprises internationally renowned wetlands, monsoon rainforests, tropical savannas, rivers, estuaries and islands. A total of 13 threatened species have been identified, while the seasonal floodplains and coastal areas support significant aggregations of waterbirds and shorebirds. The Internationally Significant biodiversity in the region has come under increasing threat from feral animals, noxious weed infestations and fire, and there are concerns that climate change will result in future salt water inundation of low-lying and freshwater habitats.

After many years of consultation, the traditional owners of the region decided to declare the Djelk IPA as a formal commitment to manage their land and sea country in accordance with international standards. As part of the National Reserve Estate, the Djelk IPA meets the International Union of the Conservation of Nature (IUCN) definition of a Managed Resource Protected Area and has been declared as a Category VI Indigenous Protected Area. Under this Category, the Djelk IPA should be managed according to the principles stated in Schedule 8 of the Australian Government Environmental Protection and Biodiversity Conservation (EPBC) Regulations of 2000. In accordance with EPBC principles, the IPA is to be managed primarily for the sustainable use of natural ecosystems, while protecting and maintaining biodiversity and other natural values.

Aboriginal people have led a dynamic lifestyle on their clan estates in this region of the Northern Territory for at least 40,000 years and continue to live on-country according to their traditional laws and customs. Today, approximately 800 people reside on the 34 outstations in the Djelk IPA. The region is serviced by the township of Maningrida that has a population of about 1700 residents. The Bawinanga Aboriginal Corporation (BAC) was established at Maningrida as an Outstation Resource Centre in the 1970s and has grown into a highly successful Indigenous enterprise. The BAC sponsors the Djelk Ranger Program and a range of interrelated commercial ventures including the Djelk Wildlife Enterprise and the BAC Tourism Enterprise.

The Djelk Rangers represent the continuous stewardship of the land within the IPA by Aboriginal people, and the rangers work with individual landowners to keep the land and sea country healthy, and their cultural and social values strong. Ranger activities include promoting sustainable natural resource use, wildlife management and mitigation, feral animal and weed control, protecting sites of cultural significance and maintaining the continuity of traditional knowledge and skills. Since 2002 the Djelk Rangers expanded their area of management to include stewardship over sea country, and carry out a range of activities including protecting natural and cultural resources. Sea country work also includes monitoring dugong and turtle habitats, monitoring and reporting fishing vessels to

Northern Territory Fisheries and undertaking Illegal Foreign Fishing Vessel (IFFV) patrols for the Australian Customs Service, as well as a range of other fee-for-service activities.

This topic guide provides a general overview of a diverse body of science and social science literature that relates to the Djelk IPA. A significant volume of literature relates to differences in fire management practices between Indigenous and non-Indigenous managed regions in Arnhem Land. A preliminary review of this literature suggests that customary Aboriginal landscape burning has positive implications for the internationally-valued biodiversity of the Djelk IPA. Another significant theme relates to the threats posed by feral buffalo, particularly to the wetlands that provide habitats for a number of threatened or endemic species, and aggregations of species. A review of the relevant literature suggests that reducing feral buffalo and pig populations is a high management priority in the IPA. Key issues that emerge from this topic guide are that more scientific research needs to be undertaken to identify management implications of threatened and endemic species, to quantify and qualify environmental threats (for example, cane toads and exotic weeds) and to suggest possible targets for Indigenous land managers.

Preliminary findings from the Tropical River and Coastal Knowledge (TRaCK) research project indicate: the need for more scientific research in order to create baseline data against which the impact of Indigenous land management activities can be assessed; that Indigenous land managers should improve their ability to monitor and report on the environmental outcomes of their activities so that potential environmental service purchasers can be confident that the activities they fund are having quantifiable effects; and, that a sustainable use economy needs a proper framework that creates markets for environmental services. In view of these findings, this topic guide includes literature that relates to the range of environmental and cultural assets within the IPA, sustainability issues relating to natural resource use and environmental threats. In doing so, the topic guide seeks to determine what the relevant research suggests Indigenous land managers do to improve the environmental outcomes of their activities, and a range of policy implications for Indigenous land managers.

The literature in this topic guide is reviewed thematically with sections on:

- environmental and cultural assets,
- natural resource use,
- environmental threats (including sub-sections on feral animals, fire and general assessments), and
- management and policy implications.

A brief introduction to each theme draws out key issues and/or areas of agreement in the literature, while short summaries are provided for each reference. Many of the documents are available online; however some are only available in printed form and can either be obtained from libraries or by contacting CAEPR.

Environmental and Cultural Assets

This section includes two studies that describe environmental features in the Djelk IPA. Both studies demonstrate the region's conservation significance, high biodiversity and other natural values. This section also includes ethnographic studies of Aboriginal

economies, social systems, cosmologies and cultural practices within the IPA region. This body of research demonstrates the richness of Aboriginal culture and language diversity in the region.

Altman, J. (1987) *Hunter-gatherers today: an Aboriginal economy in north Australia*. Canberra: Australian Institute of Aboriginal Studies.

This book is based on field research conducted in 1979 into the economy of eastern Gunwinggu people in north-central Arnhem Land. The research involved a combination of ethnographic and quantitative data-collection methods and was primarily focussed on Momega outstation in the Maningrida hinterland. The book is significant because it is the first Australian study that focuses entirely on an Indigenous micro economy, and also provides rich ethnographic insights relating to the 'outstations movement'. It includes a brief historical background, sections on social organisation, dietary analysis, expenditure patterns, time allocation, production, distribution, consumption and ceremonial and market exchange. The analysis clearly illustrates that the local economy of the outstations is different from the service provision centre at Maningrida, and that the character of the outstation economy is hybrid, involving a mix of customary, market and state activity.

Berndt, R. & Berndt, C. (1970) *Man, land and myth in north Australia: the Gunwinggu people*. East Lansing, MI: Michigan State University Press.

This book is the result of ethnographic fieldwork conducted between 1945 and 1968 with Gunwinggu-speaking people in northern Arnhem Land. As the title suggests, this book is chiefly concerned with the interrelationships between Gunwinggu people (man), their country (land) and their cosmology (myth). The book describes the Gunwinggu orientation towards sustainable utilisation of the natural environment as being inseparable from the organisation of social relations, cosmology and ancestral law. The book is significant because it provides a complex, detailed and descriptive ethnography of Gunwinggu life in historical context.

Griffiths, A. D., Bowman, D. M. J. S., Cowie, I. & Fensham, R (2000) *Vegetation of the Maningrida Region, North-Central Arnhem Land*. Darwin: Key Centre for Tropical Wildlife Management. Northern Territory University.

This technical report provides a general description of vegetation diversity in the Maningrida region. It identifies species of conservation significance and maps the distribution of habitat types based on vegetation and geomorphology. The fieldwork was conducted over an area of 8,500 km² during March and April 2000 and involved field observations and sampling (in association with the BAC), satellite imagery and aerial photography. The survey identified a number of alien plant species and reported that distribution was low in comparison with other regions in the Northern Territory. The appendices provide a list of a large number of plant species of interest and twenty species of conservation significance.

Harrison, L., Mcguire, L., Ward, S., Fisher, A., Pavey, C., Fegan, M. & Lynch, B. (2009). *An inventory of sites of international and national significance for biodiversity values in the Northern Territory*. Darwin: Department of Natural Resources, Environment, The Arts and Sport.

This report involved identifying and collating data and information on sites of outstanding conservation significance in the Northern Territory. Criteria for selection of sites included a local concentration of threatened or endemic species, large aggregations of wildlife, and wetland or botanical values. The overall project produced a centralised database and 67 detailed information papers on the various sites. Site number 17 was the Maningrida coastal habitats (pp 210-213) and the case study includes a brief description of the location, tenure and land use, significance rating, ecological values, management issues and information, condition, current conservation initiatives, flora and other environmental values.

<http://www.nt.gov.au/nreta/environment/conservation/reports.html>

Taylor, L. (1987) *The same but different': Social reproduction innovation in the art of the Kunwinjku of western Arnhem Land*. Unpublished PhD thesis. Canberra: The Australian National University.

This thesis is an important contribution to anthropological understandings of Kunwinjku art in western Arnhem Land. It includes an historical analysis of the development of the market for Kunwinjku paintings and an outline of Kunwinjku social organisation. The main focus of the analysis is on the meanings encoded in Kunwinjku bark paintings and the relationship between the production of art and the Kunwinjku social system.

Natural Resource Use

This section includes literature that relates to the environmental and economic sustainability of the BAC and the Maningrida Arts and Culture (MAC) enterprise. Several papers demonstrate the benefits of drawing on both scientific and Indigenous knowledge systems in the development and monitoring of commercial enterprise. Another prominent theme is the need for more adequate policy design and institutional and legal frameworks to encourage sustainable economic development in this region.

Altman, J., Roach, L. M. & Liddle, L. (1997) *Utilisation of native wildlife by Indigenous Australians: commercial considerations*. CAEPR Discussion Paper No. 135. Canberra: Centre for Aboriginal Economic Policy Research, The Australian National University.

This paper assesses the potential impacts of commercial wildlife harvesting by Indigenous people on the Australian environment, drawing on data relating to commercial and subsistence utilisation, and species sustainability. The paper provides a brief historical background and includes a discussion of enterprise development, joint ventures, royalties and marketing. The adequacy of existing regulatory regimes for the maintenance of biodiversity is discussed, and the authors make a number of policy recommendations in light of their findings.

<http://caepr.anu.edu.au/Publications/DP/1997DP135.php>

Fordham, A., Fogarty, W., Corey, B. & Fordham, D.

(2010) *Knowledge foundations for the development of sustainable wildlife enterprises in remote Indigenous communities of Australia and the Viability of wildlife enterprises in remote Indigenous communities in Australia: A case study.* CAEPR Working Paper No. 62. Canberra: Centre for Aboriginal Economic Policy Research, The Australian National University.

This paper examines the BAC Wildlife Centre and Wildlife Enterprise in terms of an existing nexus between scientific and Indigenous ecological knowledge. The paper gives a background to the BAC's enterprise activities and provides a discussion of the Maningrida socio-cultural context. It includes an examination of both Indigenous ecological knowledge and science in the development, management and implementation of wildlife harvesting enterprises. The paper also discusses issues relating to training and science education as a method for developing employment opportunities for young Aboriginal people to work in wildlife enterprises. The authors provide a range of proposed strategies and recommendations for development through 'two ways' education and the creation of pathways to employment, and the integration of Indigenous ecological knowledge with western science.

<http://caepr.anu.edu.au/Publications/WP/2010WP62.php>

Fordham, A., Fogarty, W. & Fordham, D. (2010) *The viability of wildlife enterprises in remote Indigenous communities of Australia: A case study,* CAEPR Working Paper No. 63. Canberra: Centre for Aboriginal Economic Policy Research, The Australian National University.

This paper examines the viability of the BAC's wildlife harvesting for commercial sale enterprises, including existing harvests of saltwater crocodiles and northern long-necked turtles, and an emergent tarantula spider industry. It includes a background to, and discussion of the Djelk Ranger programme and the BAC Wildlife Centre and Wildlife Enterprise activities. The paper then examines a range of factors that influence the development of a successful wildlife enterprise, including collaboration and valuing both scientific and Indigenous knowledge. The paper also discusses a range of external and organisational factors that influence the viability of the wildlife enterprises, including regulatory frameworks, government policies and programmes, seasonality and market variability, illegal wildlife harvesting and organisational issues. The paper suggests that such enterprises can be commercially viable and independent of government funding if these factors and issues can adequately be addressed.

<http://caepr.anu.edu.au/Publications/WP/2010WP63.php>

Forner, J. (2007) *The globalisation of the Didjeridu and the implications for small scale community based producers in remote northern Australia.* *The International Journal of Environmental, Cultural, Economic and Social Sustainability*, 2:137-47.

This paper provides a discussion of the implications of the increasingly globalised market for Didjeridus for small scale community producers. The study region is in Jawoyn country, south east of Katherine in the Northern Territory, near the settlements of Beswick and Barunga. The paper provides a background to the globalisation of the Didjeridu, its origin and traditional use and illustrates the difference between customary and commercial production techniques. The paper also includes a discussion of relevant legislation relating to the harvesting of timber for didjeridu production. Through an examination of market

research, the author suggests that a large market exists but regulations are required to ensure that ethical and environmental values are maintained while servicing this market. The paper acknowledges that most didjeridu entering the market are produced by non-Aboriginal people using stems that are regularly acquired without permit or stolen from Aboriginal land. A consequence of this lack of regulation is that it is difficult for Aboriginal producers to compete in the market while maintaining cultural and environmental standards. The paper argues that this is a disincentive for young Aboriginal men to learn appropriate harvesting and production skills, which constitutes a loss of cultural knowledge.

Gorman, J., Griffiths, A. D. & Whitehead, P. J. (2006) An analysis of the use of plant products for commerce in remote Aboriginal communities of northern Australia. *Economic Botany*, 60:362-73.

This study sought to use a range of ecological, marketing, cultural and logistical criteria to derive a ranking of the commercial potential of a variety of native plant species. It consulted with six Aboriginal communities (including the BAC) to determine their priorities and preferred style of enterprise development and conducted trials to test the viability of these desired approaches. The research demonstrates the interaction between commercial and subsistence harvesting, and that value-adding to raw product can have significant economic, ecological, cultural and social benefits. The results suggest that ecological sustainability, working with familiar products in a small-scale, community-based enterprise and ownership of ideas at all stages of enterprise development were key priorities for the Aboriginal participants. Furthermore, the paper shows that plant products that already have an existing market have better economic potential than products that are unfamiliar to the market. The paper recommends that substantial public investment in developing these opportunities in remote Aboriginal communities is justified by the potential social and economic benefits.

<http://www.springerlink.com/content/0013-0001/60/4/>

Gorman, J.T. & Whitehead, P.J. (2006) Small-scale commercial plant harvests by Indigenous communities. Canberra: Joint Venture Agro-forestry Program.

This research investigates the feasibility of small-scale commercial plant harvests by Indigenous communities and draws on a number of case studies including the BAC's wild-harvested live plant trade of Cycads. In the case of the BAC's operations, the study reports that harvests of cycad stems for commercial sale are economically, socio-culturally and biologically feasible, however the success of the enterprise is impeded by unnecessary and costly regulatory requirements. The report recommends a reconsideration of monitoring regimes by the relevant authorities if the BAC's live plant trade is to be feasible in the long term.

<https://rirdc.infoservices.com.au/downloads/04-149.pdf>

Gorman, J., Griffiths, A. D., Whitehead, P. J. & Petheram, L. (2008) Production from marginal lands: Indigenous commercial use of wild animals in northern Australia. *International Journal of Sustainable Development and World Ecology*, 15:240-50.

This study involved the collation of a database of animal species utilized by Aboriginal people in the Northern Territory for subsistence or commercial purposes, consultation with Indigenous communities and a description of three case studies to identify obstacles constraining wildlife-based enterprise development. The study found that a lack of infrastructure and adequate training, a lack of market information and knowledge dissemination, and adverse public perceptions were significant issues affecting the progress of commercial wildlife harvesting enterprises. The study recommends that more appropriate and flexible government policy and regulation is required if these enterprises are to benefit Indigenous livelihoods.

<http://dx.doi.org/10.3843/SusDev.15.3:7>

Gorman, J., Pearson, D. & Whitehead, P. J. (2008) Assisting Australian Indigenous resource management and sustainable utilization of species through the use of GIS and environmental modelling techniques. *Journal of Environmental Management*, 86:104-13.

This study used a Geographic Information System (GIS) to predict the probability of species abundance for *Cycas arnhemica* and *Brachychiton diversifolus* in the Maningrida region. These species were chosen because they are currently being 'wild harvested' in commercial trials for use as carving wood and for the sale of decorative plants. The main aim of the study was to test a relatively easy and inexpensive method for assessing the distribution and abundance of species for sustainable management. The results and analysis suggest that this type of methodology predicts trends in species distribution that are consistent with on-site sampling.

http://www.sciencedirect.com/science?_ob=PublicationURL&_tockey=%23TOC%236871%232008%23999139998%23673168%23FLA%23&_cdi=6871&_pubType=J&_auth=y&_acct=C000028338&_version=1&_urlVersion=0&_userid=554534&md5=5a96631f35ea0ed67997ecdff8ce9c06

Griffiths, A. D. & Philips, A. (2003) Harvest of *Bombax ceiba* for the Aboriginal arts industry, central Arnhem Land, Australia. *Biological Conservation*, 113:295-305.

This study combined information from field surveys, a regional rainforest inventory and sales figures to assess the current harvest of *Bombax ceiba* used for sculptures by Maningrida artists. The paper includes a discussion of the significance of Indigenous customary and commercial harvesting and gives a background to the Aboriginal arts industry at Maningrida. It demonstrates that *Bombax ceiba* is a high demand species that occurs in sporadic patches of rainforest in the Northern Territory and Aboriginal people use the tree for a range of customary and commercial purposes. Despite this high demand, the results suggest that the current level of harvesting is sustainable and the regional population of *Bombax ceiba* is secure. The paper recommends that future monitoring of harvest sustainability is a management priority and that both scientific and Aboriginal knowledge need to be incorporated into natural resource management decisions.

http://www.sciencedirect.com/science?_ob=PublicationURL&_tockey=%23TOC%235798%232003%23998869997%23433893%23FLA%23&_cdi=5798&_pubType=J&_auth=y&_acct=C000028338&_version=1&_urlVersion=0&_userid=554534&md5=4d7e36ee672f264de0bb84453432d94f

Griffiths, A. D., Schult, H. J. & Gorman, J. (2005) Wild harvest of *Cycas arnhemica*: impact on survival, recruitment and growth in Arnhem Land, northern Australia. *Australian Journal of Botany*, 53:771-9.

This study involved an experimental harvest of *Cycas arnhemica* near Maningrida to assess the effect of wild harvest and other factors including fire frequency and feral animal disturbance on survival, recruitment and stem growth. The results suggest that small-scale commercial harvesting of *Cycas arnhemica* will have little impact on wild populations if only juvenile stems are taken and harvested locations are allowed to recuperate for 15-40 years.

<http://www.publish.csiro.au/nid/66/issue/1050.htm>

Griffiths, A. D., Schult, H. J., Gorman, J. & Whitehead, P. J. (2004) Trial harvest of the Arnhem Land cycad *Cycas arnhemica*: an ecological and economic assessment for a remote Aboriginal community. Report to Bawinanga Aboriginal Corporation. Darwin: Key Centre for Tropical Wildlife Management, Charles Darwin University.

This report draws on the same experimental wild harvest of *Cycas arnhemica* and includes data on the economic costs of the harvest and the survival of harvested plants under a range of treatments at a nursery run by the BAC. The report found that the cost of production was relatively low and the availability of subsidised labour through CDEP, ease of harvest, abundant supply of Cycad juvenile stems and low mortality in the nursery led the authors to conclude that wild harvest is an environmentally sustainable and economically viable option. However the study also found that the annual cost of compliance and monitoring of the *Cycas arnhemica* population is a significant economic disadvantage that is currently burdening the community. The authors recommend that either the costs of the monitoring regime need to be reduced, or that the unrealistically small harvest quota must be increased under the present scheme. The authors argue that the monitoring scheme in its present design shifts the responsibility of basic public research from the government onto Aboriginal people who are constrained to an unrealistically small harvest quota.

Koenig, J. (2007) "Too many trees!": Indigenous woodcarving and harvest sustainability. Unpublished PhD thesis. Darwin: Charles Darwin University.

This PhD thesis draws on both scientific and social science approaches to examine the socio-cultural, economic and ecological determinants of Indigenous woodcarving and harvest sustainability in the Maningrida region. Through an analysis of long term art sales, the thesis demonstrates that the local woodcarving industry has expanded rapidly in the last twenty years, both in terms of the number of woodcarvers and the number of carvings produced for sale. The research shows that while Aboriginal artists engage in a range of economic activities, woodcarving for commercial sale was the predominant means of generating cash income. The thesis also reports that most woodcarving was produced in outstation communities, rather than in the service township at Maningrida. The scientific component of the research demonstrates that current levels of harvesting *Bombax ceiba* and *Brachychiton diversifolius* for woodcarving are ecologically sustainable.

Koenig, J., Altman, J., Griffiths, A. D. & Kohen, A. (2006) Twenty years of Aboriginal woodcarving in Arnhem Land: using art sales records to examine the changing dynamics of sculpture production. *Forest, Trees and Livelihoods*, 17:43-60.

This paper draws on the Maningrida community art centre's sales records for the last twenty years to examine changes in woodcarving production, harvesting and the demographic characteristics of the principle sculpture producers over time, and examines elements of individual artist production. The study found that the production of sculpture has grown rapidly in the last two decades and has become a significant component of arts production in the Maningrida region. The paper demonstrates that arts production is an important way for Aboriginal people to engage with the market economy and to earn greater income than welfare benefits in a region where there are very few other commercial opportunities. The study also found that, for a range of reasons, there are a growing number of women engaging in woodcarving in what was formally a male dominated activity; that artists are taking up woodcarving at a younger age; and, that arts production in the region is dominated by Kuninjku-speaking people. The paper argues that the combination of demographic changes and increases in market demand for sculptural works have led to the rapid growth of the carving industry at Maningrida.

Philips, A. (2001) Aboriginal artifact production in the Maningrida region: harvest sustainability and pest control in the carving wood industry. Unpublished M.A. thesis. Darwin: Northern Territory University.

This Master of Tropical Environmental Management research was a response to concerns amongst members of the Maningrida community regarding issues of sustainability and pest control in the carving wood industry. The thesis shows that wood borer infestation (*Sinoxylon anale* and *Minthea sp.*) in stands of *Bombax ceiba* trees is impacting on the expansion of the MAC enterprise. The research involved surveying vine-thickets in floodplain and coastal habitats to determine the density, distribution and stand structure of *Bombax ceiba*, and investigated the infestation rate of MAC wood carvings. The results show that 24 percent of carvings surveyed were infested with wood borer and the thesis recommended that management options include treating timber or carvings with pesticides, or selecting borer resistant species with suitable carving properties. The study concluded that while current levels of *Bombax ceiba* harvesting in the Maningrida region is sustainable, further development of the MAC industry could threaten sustainability in the future.

Environmental Threats

A significant body of research has focused on environmental threats in the IPA, particularly the ecological impacts of feral animals (Asian water buffalo, feral cattle and pigs) and fire. As a consequence, this section is divided into two main subsections, feral animals and fire, with a third subsection (general assessments) that includes a report on the risks of climate change, and discussions of threat mitigation through Indigenous involvement in natural resource management. The literature appears to be in agreement that the reduction of feral buffalo and pig populations in the IPA is a high management priority, and that ecological damage caused by feral animals is a possible cause of exotic weed infestation. Another general point of congruence is that low intensity, coordinated

Aboriginal landscape burning practices are preferable over late-dry season fuel reduction burns for maintaining biodiversity and other natural values. The literature also demonstrates the potential environmental, economic, social and cultural benefits of increased Indigenous involvement in natural resource management.

Feral Animals

Albrecht, G. A., McMahon, C. R., Bowman, D. M. J. S. & Bradshaw, C. J. A. (2009) Convergence of culture, ecology and ethics: management of feral swamp buffalo in northern Australia. *Journal of Agricultural and Environmental Ethics*, 22:361-78.

This paper provides an elaborated historical background on the introduction of Asian swamp buffalo into Northern Australia and the changing relationship between people and buffalo since the early nineteenth century. The authors are a team of interdisciplinary researchers who have drawn upon archival sources, field research and interviews to gain an understanding of the diverse value orientations of various stakeholders in relation to buffalo exploitation and management. The paper argues for the possibility of convergence in these values and ethical orientations over time through transdisciplinary and transcultural agreement. The paper also examines shifting Aboriginal relationships with buffalo in Arnhem Land from the incorporation of the introduced species into the Rainbow Serpent dreaming. The authors conclude that while buffalo are a culturally significant animal, they are now viewed as destructive to country and Aboriginal people see the need to manage buffalo numbers in order to minimise harmful ecological and human welfare impacts.

<http://www.springerlink.com/content/1187-7863/22/4/>

Bowman, D. M. J. S. & Robinson, C. J. (2002) The getting of Nganabbaru: observations and reflections on Aboriginal buffalo hunting in northern Australia. *Australian Geographer*, 33:191-206.

This study of Aboriginal buffalo hunting is based on field research in the Cadell River region of North-central Arnhem Land. It examines the search efficiency, hunting effort, meat off-take and shot efficiency of a group of Aboriginal buffalo hunters. The article covers a broad range of existing literature on buffalo hunting and land management practices, including a brief history of Indigenous and non-Indigenous buffalo hunting, the Brucellosis and Tuberculosis Eradication Campaign (BTEC) of the 1980s and a range of cross-cultural perspectives on feral Buffalo. The results are also couched in a more general historical discussion of the relationship between Aboriginal hunting practices and the decline of marsupial megafauna. The article argues that studies of contemporary Aboriginal hunting of buffalos ('megaherbivores') offer little for understanding Pleistocene megafauna extinctions. The article concludes that more interdisciplinary research is required to develop sustainable and culturally appropriate programs for the management of feral Buffalos on Aboriginal land.

<http://www.informaworld.com/smpp/title~db=all~content=g713403273>

Fordham, D. A., Georges, A. & Brook, B. W. (2007) Demographic response of snake-necked turtle correlates with Indigenous harvest and feral pig predation in tropical northern Australia. *Journal of Animal Ecology*, 76:1231-43.

This study examines the demography of snake-necked turtles (*Chelodina rugosa*) across six waterholes and three seasons that are subject to varying levels of Indigenous harvest and feral pig predation. In contrast to many species of turtles, snake-necked turtles are fast-growing, early maturing and reproduce quickly. These qualities, the paper argues, give turtle populations the capacity for a compensatory demographic response to population threats. The conclusions suggest that snake-necked turtle populations may be able to endure occasional or sustained adult harvesting without necessarily threatening population viability.

<http://onlinelibrary.wiley.com/doi/10.1111/jae.2007.76.issue-6/issuetoc>

Fordham, D. A., Georges, A. & Brook, B. W. (2008) Indigenous harvest, exotic pig predation and local persistence of long-lived vertebrates: managing a tropical freshwater turtle for sustainability and conservation. *Journal of Applied Ecology*, 45:52-62.

Building on the previous (2007) study, this paper provides important implications for the management of snake-necked turtle populations. The research shows that pig-related turtle mortality exceeds levels that can be compensated by increased hatchling survival. The study also shows that, in the absence of pigs, compensatory demographic responses by turtle populations were adequate to allow sustainable Indigenous harvesting of up to 20 percent of sub adult and adult turtles without threatening populations. The paper suggests that fencing wetlands to exclude predators, hatchling supplementation to offset losses from predation and periodic culling of pigs are workable management strategies for ensuring ongoing sustainable turtle harvesting.

<http://onlinelibrary.wiley.com/doi/10.1111/jpe.2008.45.issue-1/issuetoc>

Gorman, J., Saalfield, K. & Griffiths, A. D. (2007) Population estimate of Asian Water Buffalo and wild cattle in the Arafura Swamp, central Arnhem Land. *Northern Territory Naturalist*, 19:1-8.

This paper presents the results of an aerial survey of Asian Water Buffalo and wild cattle covering 3,089 km² of wetlands in central Arnhem Land in September 2005. The paper reports that 812 individuals were observed and estimates that the survey area had a total population of 5,187 Asian Water Buffalo and 4,333 wild cattle. The paper also provides a general background on the adverse environmental impacts of Buffalo, and the cultural and economic significance of the species to Aboriginal people. It argues that management options are limited in remote and inaccessible regions because of the expense in controlling their numbers. The paper suggests that support and encouragement should be provided to Aboriginal communities to create sustainable enterprises based on the harvest of feral pests.

Griffiths, A. D. & Pardon, L. G. (2002) *Feral animal abundance and spatial extent of damage from the Gumadir River catchment, western Arnhem Land*. Technical Report No. 2. Darwin: Key Centre for Tropical Wildlife Management, Charles Darwin University.

This study involved an aerial survey of the abundance of feral animals and kangaroo species in the Gumadir River catchment of western Arnhem Land. It found that the sandstone plateau had a relatively high density of feral buffalo and a diverse kangaroo population, while the lowland region had few buffalo or kangaroos but a large feral pig population. The survey was combined with an assessment of feral animal damage, which reported that the wetlands had been significantly degraded by the presence of feral pigs. It found that almost all habitats in the study region had been affected by significant feral animal damage and habitat degradation. The report recommends that buffalo populations on the plateau should be annually culled by twenty percent for at least ten years to limit the extent of habitat damage while enabling a small herd to persist for sustainable Indigenous harvesting. Significantly, this study engaged with local Aboriginal traditional landowners to assist in assessing the 'acceptability' of feral animal impact. The study suggests that incorporating Aboriginal perspectives on environmental damage in habitat mapping and assessment can provide guidelines for future management practices in order to protect ecological, economic and cultural values.

Koenig, J., Griffiths, A. D., Godjuwa, C. & Campion, O. (2003) Aerial survey of vertebrates in the Mann River district, central Arnhem Land, September 2000. *Northern Territory Naturalist*, 17:7-19.

This study reports the results of an aerial survey of large vertebrate fauna in the Mann River district of Arnhem Land in September 2000. The survey identified 747 individuals from eight species, of which four species were native and four were feral. The paper shows that the majority of individuals were feral animals (92 percent), of which 78 percent were buffalo. The paper argues that ongoing monitoring of feral animal populations in the region is critical to maintaining acceptable population densities and that aerial surveying is a cost effective method of doing so.

Fire

Bowman, D. M. J. S., Garde, M. & Saulwick, A. (2001) Kunj-ken makka man-wurrk. Fire is for kangaroos: interpreting Aboriginal accounts of landscape burning in Central Arnhem Land. IN ANDERSON, A., LILLEY, I. & O'CONNOR, S. (Eds.) *Histories of Old Ages. Essays in Honour of Rhys Jones*. Canberra: Pandanus Books, Research School of Pacific and Asian Studies, The Australian National University.

This paper provides a general discussion of Rhys Jones' 1969 'fire-stick farming' hypothesis in relation to Aboriginal accounts of landscape burning in Central Arnhem Land. The main theme that emerges from the interviews is that the Aboriginal participants consider the landscape to be under threat from the cessation of customary landscape burning practices. Through an interpretation of the participant's accounts, the paper discusses landscape burning as customary economic practice, and as having significant implications for land management. The paper concludes that the knowledge gained from customary landscape burning practices (including having more frequent and less intense burns) can have positive implications for future land management in Central Arnhem Land, and elsewhere in Australia.

Bowman, D. M. J. S., Price, O., Walsh, A. & Whitehead, P. J. (2001) The 'wilderness effect' and the decline of *Callitris intratropica* on the Arnhem Land Plateau, northern Australia. *Australian Journal of Botany*, 49:665-72.

This study used aerial surveying to assess the distribution of living and dead *Callitris intratropica* trees on the Arnhem Land Plateau in order to assess the effects of Aboriginal landscape burning. The paper shows that *Callitris intratropica* is an important indicator of landscape change on the Plateau following the cessation of customary landscape burning. It found clear differences between the unoccupied western side of the Plateau and the eastern side, where Aboriginal people continue to live on country. The paper uses the term the 'wilderness effect' to describe transitions in the fire regime following the depopulation of the western side by Aboriginal people in the last 50 years. It shows that less frequent, hotter burns substantially affect the tree's ability to regenerate on the western side of the Plateau.

<http://www.publish.csiro.au/nid/66/issue/475.htm>

Bowman, D. M. J. S. & Prior, L. D. (2004) Impact of Aboriginal landscape burning on woody vegetation in *Eucalyptus tetrodonta* savanna in Arnhem Land, northern Australia. *Journal of Biogeography*, 31:807-17.

This article similarly examines the impact of Aboriginal landscape burning by comparing regions of the Arnhem Land savanna that have either been continually managed by Aboriginal people, or have been uninhabited for the last 50 years. The researchers tested the hypothesis that landscape burning increased the abundance of tree species and tree density in the mid layer of *Eucalyptus tetrodonta* savanna. The results indicate that Aboriginal landscape burning has a significant impact on vegetation structure, but little effect on species composition, total tree density or reduction in fine fuel biomass (grass). Landscape burning, the article reports, reduces canopy height and the density of mid-layer saplings and trees with edible fruit. The authors argue that this is consistent with ethnographic and historical accounts that Indigenous fire management strongly influenced vegetation structure at the time of European settlement.

<http://onlinelibrary.wiley.com/doi/10.1111/jbi.2004.31.issue-5/issuetoc>

Bowman, D. M. J. S., Walsh, A. & Prior, L. D. (2004) Landscape analysis of Aboriginal fire management in Central Arnhem Land, north Australia. *Journal of Biogeography*, 31:207-23.

This study used geographical information system and global positioning system technologies to map the spatial and temporal pattern of landscape burning in Central Arnhem Land. The general hypothesis is that the break down of Aboriginal landscape burning practices in the late 19th century (that were replaced by more indiscriminate and frequent burning by Europeans) resulted in a build up of flammable grass species that produced a severe grass-fire cycle. The results suggest that conventional non-Indigenous land management regimes that involve landscape burning early in the dry season establish a positive feedback cycle between fire frequency and flammable grass fuels. By contrast, areas of landscape that have been subjected to Aboriginal burning practices late in the dry season were characterized by a fine-grained mosaic of burnt and unburnt areas. The article concludes that the incorporation of Aboriginal knowledge into fire management practices is critically important to maintaining biodiversity.

<http://onlinelibrary.wiley.com/doi/10.1111/jbi.2004.31.issue-2/issuetoc>

Edwards, A. C. & Russell-Smith, J. R. S.

(2009) Ecological thresholds and the status of fire-sensitive vegetation in western Arnhem Land, northern Australia: implications for management. *International Journal of Wildland Fire*, 18:127-46.

This study draws on a compilation of 16 year Landsat-based fire mapping, associated vegetation structural mapping and an aerial survey of fire-sensitive *Callitris intratropica* tree distribution to examine the condition of fire-sensitive vegetation in western Arnhem Land. This paper is significant because it provides a baseline against which current and future fire management regimes can be assessed. The paper also argues that applying critical threshold criteria is an extremely valuable method for producing landscape-scale ecological assessments that inform management practices. The results of this study show that burning regimes in the past 16 years have significantly exceeded ecological tolerances for a substantial proportion of fire-sensitive vegetation types. The paper concludes that the reinstatement of effective fire management in the western Arnhem Land Fire Area (WALFA) through the development of economically sustainable bases for Indigenous fire management is critical to conserving the region's internationally valued biodiversity.

<http://www.publish.csiro.au/nid/115/issue/5043.htm>

Murphy, B. & Bowman, D. M. J. S.

(2007) The interdependence of fire, grass, kangaroos and Australian Aborigines: a case study from central Arnhem Land, northern Australia. *Journal of Biogeography*, 34:237-50.

This study examined the distribution and abundance of Kangaroo scats in burnt and unburnt areas to determine the interaction between burning and habitat type on the abundance of kangaroos. The study also examined the isotopic composition of scats to indicate variations in the diets of kangaroos in burnt and unburnt areas. The study was focussed on the Korlorrbirrahda outstation region in central Arnhem Land that has had a continuous history of Aboriginal occupation since European colonisation. The results demonstrate that there is clear evidence that Aboriginal landscape burning affects the distribution of kangaroos. The paper shows that kangaroos move away from burnt dry, rocky habitats to burnt moist habitats because of the increased abundance of nitrogen rich grasses. This study is significant because it provides evidence of the 'ecological logic' of landscape burning: that the interaction between Aboriginal landscape burning, kangaroos and vegetation results in the increased abundance of kangaroos.

<http://onlinelibrary.wiley.com/doi/10.1111/jbi.2007.34.issue-2/issuetoc>

Petty, A. M. & Bowman, D. M. J. S.

(2007) A satellite analysis of contrasting fire patterns in Aboriginal- and European-managed lands in tropical north Australia. *Fire Ecology*, 3:32-47.

This study used satellite imagery to compare and contrast fire frequency and fire seasonality across three land management regimes in northern coastal Arnhem Land, between the Mary River in the west and the Blythe River in the east. The management styles included pastoral properties, centralised fire management (park rangers and military land managers) and decentralised Aboriginal landscape burning.

The discussion shows that each management style is characterised by different paradigms, with pastoralists aiming to improve cattle yield by protecting and improving pasture with fire, while park rangers and military land managers carry out landscape burning for hazard reduction purposes. In contrast, Aboriginal landscape burning is carried out by small, widely dispersed communities. The study demonstrates that Aboriginal landscape burning had an even distribution throughout the dry season in contrast to the significant bias towards early dry season burning on all non-Indigenous controlled land. This paper is important because it clearly illustrates the impact of different management paradigms on fire frequency and fire seasonality.

<http://fireecology.net/Journal/Volume03/Issue01/toc.html>

Price, O., Edwards, A. C. & Russell-Smith, J. R. S. (2007) The efficacy of permanent firebreaks and aerial prescribed burning in western Arnhem Land, Northern Territory, Australia. *International Journal of Wildland Fire*, 16:295-307.

This study investigated the effectiveness of a range of different natural and imposed types of firebreaks and how effectiveness varied with firebreak size and seasonality. This paper is significant because it provides the first probabilistic estimate that firebreaks will not always work to contain fires in this region. It notes that there is growing evidence that the contemporary fire management regime (following the decline of Indigenous landscape burning) is negatively impacting on fire-sensitive vegetation and fauna in Western Arnhem Land. The paper suggests that the ideal method for managing both fire and biodiversity in the region involves the creation of patchy burns across the landscape rather than Aerial Prescribed Burning, which relies heavily on firebreaks for containment purposes. The study recommends that the reinstatement of customary Aboriginal fire regimes would reduce the reliance on ineffective firebreaks during late dry-season fires.

<http://www.publish.csiro.au/nid/115/issue/3790.htm>

Russell-Smith, J. R. S., Lucas, D., Gapindi, M., Gunbunuka, B., Kapirigi, N., Namingum, G., Lucas, K., Giuliani, P. & Chaloupka, G. (1997) Aboriginal resource utilisation and fire management practice in western Arnhem Land, monsoonal northern Australia: Notes for prehistory, Lessons for the future. *Human Ecology*, 25:159-95.

This paper examines the relationship between proliferation and utilisation of customary resources and landscape burning practices for Aboriginal people in the near-coastal region of western Arnhem Land. While the geographic focus of the study is situated within Kakadu National Park, the general discussion has implications for the Djelk IPA region. The data shows that, prior to European colonisation, burning in the early dry season was the norm and was applied purposefully and systematically over much of the landscape of near-coastal northern Australia. The implications of this paper is that a return to low-intensity, progressive and systematic burning (particularly in the early-mid dry season) is a high priority for conservation and biodiversity management.

<http://www.jstor.org/stable/i412693>

Telfer, W. R. & Bowman, D. M. J. S. (2006) Diet of four rock-dwelling macropods in the Australian monsoon tropics. *Austral Ecology*, 31:817-27.

This study used macroscopic analysis of the content of scats (faecal pellets) and an analysis of carbon isotope ratios using mass spectrometry to determine the diet of four rock-dwelling macropods in western Arnhem Land. It demonstrates that the four species (the black wallaroo *Macropus bernardus*, common wallaroo *Macropus robustus*, short-eared rock-wallaby *Petrogale brachyotis* and the nabarlek *Petrogale concinna*) ate different diets across the landscape and according to season. It recommends that further research needs to be undertaken to determine whether the black wallaroo is restricted to foraging on plants that are endemic to the Arnhem Land Plateau; and that more research is required to understand the implications of fire on the diet of these four species, particularly during the dry season when food sources are limited.

Telfer, W. R., Griffiths, A. D. & Bowman, D. M. J. S. (2006) Scats can be used to monitor the cryptic rock-dwelling macropods of the Australian wet-dry tropics. *Australian Journal of Zoology*, 54:325-34.

This paper is an elaborated discussion of the methods used in the previous study. It illustrates the utility of using scats to demonstrate the presence and habitat preferences of rock-dwelling macropod species. The authors argue that their methodology is an efficient and cost-effective way to study the habitat use of elusive species.

<http://www.publish.csiro.au/nid/91/issue/1437.htm>

Whitehead, P. J., Purdon, P., Russell-Smith, J. R. S., Cooke, P. M. & Sutton, S. (2008) The management of climate change through prescribed savanna burning: emerging contributions of Indigenous people in north Australia. *Public Administration and Development*, 28:374-85.

This paper provides an extensive discussion of Aboriginal people's involvement in the West Arnhem Land Fire Abatement Project (WALFA) following Australia's commitment to cut greenhouse gas emissions (GHGE). The authors cover a broad range of management and governance issues and challenges, and argue that policies need to be designed to adequately recognise the potential contributions and unique needs of remote communities to contribute to GHGE mitigation. The paper demonstrates that Indigenous engagement with the WALFA initiative is an opportunity to develop enterprise and generate employment based on land management. In doing so, it recommends that new institutional and legal structures need to be developed to realise the potential ecological, economic, social and cultural benefits of Aboriginal participation, through land management, in global carbon markets.

<http://onlinelibrary.wiley.com/doi/10.1002/pad.v28:5/issuetoc>

General Assessments

Green, D., Jackson, S. & Morrison, J. (2009) Risks from Climate Change to Indigenous Communities in the Tropical North of Australia. Canberra: Department of Climate Change.

This study considers the biodiversity, health, infrastructure, education and livelihood impacts of climate change for Indigenous communities in the tropical north of Australia.

The study includes climate change projections, a detailed discussion of each impact category and eight case studies of communities at risk. It provides a description of the Maningrida community, a range of concerns about climate change, a list of current socio-economic constraints, a discussion of community responses to previous natural hazards (including the impacts of Cyclone Monica in 2006), the responses from a number of community representatives to climate change projections and a discussion of the level of community knowledge about the risks of climate change. The study found that there is a critical need for engagement with Indigenous communities to communicate the risks of climate change and to develop collaborative activities and partnerships with Indigenous institutions. It identifies that climate change will elevate health risks and compound problems associated with limited infrastructure and overcrowded living conditions in present circumstances. The study concludes with a range of overarching issues and recommendations across each impact category.

<http://www.climatechange.gov.au/publications/adaptation/risks-from-climate-change-to-indigenous-communities.aspx>

Russell-Smith, J. R. S. & Bowman, D. M. J. S. (1992) Conservation of monsoon rainforest isolates in the Northern Territory, Australia. *Biological Conservation*, 59:51-63.

This paper draws on geographically comprehensive survey data of the reservation status and condition of 16 monsoon rainforest isolates in the 'Top End' of the Northern Territory. Through an assessment of the data, the results show that one-third of the 1220 sites were severely disturbed by fire, 22 percent were infested with weeds, and 20 percent were severely disturbed by feral cattle and Asian water buffalo, while 10 percent were disturbed by feral pigs, 7 percent by storm damage and 5 percent by flood damage. The negative impacts of each of these threats are shown to apply equally across Aboriginal land, Crown land (including pastoral leasehold), and national parks and reserves. In view of the results and a review of the relevant literature, it argues that controlled, low-intensity landscape burning should commence early in the dry season as soon as grasses begin to dry out. The impacts of feral buffalo, cattle and pigs are also discussed, showing that each species are severely damaging vegetation in fragile rainforest habitats and that feral animal disturbance is a significant cause of exotic weed infestation. The paper concludes that active fire and feral animal management on a landscape scale is vital for the conservation of significant rainforest isolates and biodiversity in the region.

http://www.sciencedirect.com/science?_ob=PublicationURL&_tokey=%23TOC%235798%231992%23999409998%23438358%23FLP%23&_cdi=5798&_pubType=J&_auth=y&_acct=C000028338&_version=1&_urlVersion=0&_userid=554534&md5=4932241939b2a38e3a5d0d82e422ddea

Whitehead, P. J., Bowman, D. M. J. S., Preece, N., Fraser, F. & Cook, P. (2003) Customary use of fire by Indigenous peoples in northern Australia: its contemporary role in savanna management. *International Journal of Wildland Fire*, 12:415-25.

This paper draws on a range of previous studies to examine the potential environmental, economic and socio-cultural benefits of Indigenous fire management regimes in the tropical savanna. It includes a description of contemporary Aboriginal practices,

objectives, motivations and cultural significance in relation to customary landscape burning. The paper investigates the compatibility of Aboriginal landscape burning practices with biodiversity conservation management regimes and the objectives of other land users. Customary practice is discussed in relation to biodiversity, contemporary conservation problems and ecological science. The paper also discusses the future role of Aboriginal land managers in fire management regimes and recommends that policies and management frameworks urgently need to be developed to realise the range of potential benefits.

<http://www.publish.csiro.au/nid/115/issue/744.htm>

Yibarbuk, D. M., Whitehead, P. J., Russell-Smith, J. R. S., Jackson, D., Godjuwa, C., Fisher, A., Cooke, P., Choquenot, D. & Bowman, D. M. J. S. (2001) Fire ecology and Aboriginal land management in central Arnhem Land, northern Australia: a tradition of ecosystem management. *Journal of Biogeography*, 28:325-43.

This study provides an ecological assessment of Dukaladjarranj (a clan estate in north-central Arnhem Land) and examined fire behaviour and Aboriginal fire management practices in the region. Importantly, it involved mapping the natural resources of the estate drawing on both traditional and ecological perspectives. The study also incorporated a range of data-gathering methodologies, including aerial surveys, and ethnographic information was gathered from senior custodians detailing customary fire management practices. In comparison to other parts of the Arnhem Land savanna, the results demonstrate that continuous and coordinated Aboriginal landscape burning in the estate has suppressed the accumulation of fuels, greatly reduced wildfire risk and has maintained diverse habitats for native fauna. The paper recommends that the maintenance of biodiversity on the Arnhem Land plateau requires cooperative initiatives that incorporate Indigenous customary knowledge of landscape burning. Furthermore, it shows that such programs have significant potential economic, social and cultural benefits for Aboriginal communities.

<http://www.jstor.org/stable/i325530>

Management and policy implications

This section includes literature that draw on information relating to the IPA to argue for more appropriate policy to be developed to address the unique challenges faced by Aboriginal people in remote contexts. The papers deal with interrelated themes of economic development, existing regulatory frameworks and health, as well as new challenges and potential opportunities for Aboriginal communities in the future. Other papers address more general topics relating to Indigenous land managers, policy-makers and researchers.

Altman, J. C. (2001) *Indigenous communities and business: three perspectives, 1998-2000*. CAEPR Working Paper No 9. Canberra: Centre for Aboriginal Economic Policy Research, The Australian National University.

This publication includes three previously unpublished papers that are concerned with issues of Indigenous engagement with business. The first paper is an overview of Indigenous, governmental and industry perspectives on business engagement with Aboriginal communities. It explores possible future possibilities, opportunities and strategies, as well as a range of existing and future challenges for Indigenous business development. The second paper is similar in scope and emphasises the lack of existing understanding about Indigenous economies and the role of Indigenous business in Aboriginal communities. The final paper addresses a range of issues relating to the development potential of Indigenous economies and the role of business in Indigenous economic development.

<http://caepr.anu.edu.au/Publications/WP/2000WP9.php>

Altman, J. C. (2001) *Sustainable development options on Aboriginal Land: The hybrid economy in the twenty-first century*. CAEPR Discussion Paper No. 226. Canberra: Centre for Aboriginal Economic Policy Research, The Australian National University.

This paper develops the conceptual model of the hybrid economy to describe the market, state and customary components of Indigenous economies in remote and regional Australia. It argues that a significant impediment to economic development is that Indigenous customary economic activity has been largely unrecognised, unquantified and poorly understood by policy-makers. The paper suggests that a hybrid intellectual framework (combining science, social sciences and Indigenous knowledge systems) is required to understand the reality and legitimacy of Indigenous hybrid economies. The paper also provides some examples of how this approach may enhance sustainable development on Aboriginal land in the future.

<http://caepr.anu.edu.au/Publications/DP/2001DP226.php>

Altman, J. C. & Branchut, V. (2008) *Fresh water in the Maningrida region's hybrid economy: Intercultural contestation over values and property rights*. CAEPR Working Paper No. 46. Canberra: Centre for Aboriginal Economic Policy Research, The Australian National University.

This report examines fresh water governance arrangements in the Maningrida region. The report includes a detailed discussion of water in the regional hybrid economy, including a historical analysis of the political economy of water, and sections on water administration and the cultural significance of water. The paper also discusses contestations over water property rights and water governance, and makes a number of recommendations for the amelioration of potential cross-cultural water conflicts. The paper concludes by urging for a new intercultural water governance paradigm in this region.

http://dspace-prod1.anu.edu.au/bitstream/1885/41042/2/2003_DP247.pdf

Altman J. & Cochrane, M. (2003) *Innovative institutional design for sustainable wildlife management in the Indigenous-owned savanna*. CAEPR Discussion Paper No. 247. Canberra: Centre for Aboriginal Economic Policy Research, The Australian National University.

This paper is based on empirical evidence on cooperative wildlife management and institutional hybridity in the Northern Territory savanna. A case study of the Bawinanga Aboriginal Corporation's (BAC) wildlife management activities demonstrates that collaborations between scientists and Aboriginal people living on country can produce positive outcomes for both the environment, and Indigenous interests. The paper also discusses a range of issues relating to governance and sustainable development, and proposes a set of challenges for policy, science and Indigenous hybrid institutions.

<http://caepr.anu.edu.au/Publications/DP/2003DP247.php>

Altman J. & Cochrane, M. (2005) Sustainable development in the indigenous-owned savanna: innovative institutional design for cooperative wildlife management. *Wildlife Research*, 32:473-480.

This is a revised version of the author's (2003) CAEPR discussion paper. It includes a table and discussion of the links between the BAC, Djelk community rangers and natural resource users in the Maningrida region.

<http://www.publish.csiro.au/nid/145/issue/1025.htm>

Altman, J. & Johnson, V. (2000) *The CDEP in town and country Arnhem Land: Bawinanga Aboriginal Corporation*. CAEPR Discussion Paper No. 209. Canberra: Centre for Aboriginal Economic Policy Research, The Australian National University.

This paper examines the Community Development and Employment Projects (CDEP) scheme administered by BAC in the township of Maningrida and at outstations located in the regional hinterland. The research assesses the economic, social and cultural benefits generated by the scheme in both 'town' and 'country' contexts. The results suggest that the positives of the scheme outweigh the negatives and that 'active' welfare (in the form of CDEP scheme participation) has been an important option for Aboriginal people. The paper also identifies a number of policy issues and makes a range of recommendations for how the scheme might be improved.

<http://caepr.anu.edu.au/Publications/DP/2000DP209.php>

Burgess, C. P., Johnston, F. H., Bowman, D. M. J. S. & 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.

This paper draws on a range of science and social science literature to examine the health benefits of Indigenous Natural Resource Management (NRM). It provides an extensive discussion of the social and physical determinants of poor health outcomes for Aboriginal people in northern Australia, the connections between health and people's relationship with country, and a brief history of Indigenous NRM. The benefits of the 'NRM-health nexus' are discussed in terms of individual and personal autonomy, social cohesion and governance. In conclusion, the paper argues that investing in Indigenous NRM has the potential to provide pathways to sustainable economic development and biodiversity

conservation, while improving the physical, psychological and social health of Aboriginal people living in remote northern Australia.

<http://search.informit.com.au/documentSummary;dn=200505069;res=APAFT>

Carter, J. L. (2001) Collaborative ecological research with Indigenous Australians: the trepang project. *Faculty of Science. Darwin, Charles Darwin University.*

This PhD thesis is the result of extensive collaborative ecological field research with community rangers and traditional owners living in Maningrida and the Cobourg Peninsula. The core of the thesis is an analysis of participatory research with Aboriginal people, while the study of ecological aspects of trepang is presented separately in the appendices. Thus the main emphasis of the body chapters is in the development of collaborative research protocols, methods and processes with the aim of enhancing community participation in the project and offering more equitable research partnerships. The thesis advocates for an 'intercultural research' paradigm that incorporates both western scientific and Indigenous customary knowledge in research design and involves dialectal learning between different knowledge systems and traditions. The 'trepang project' recommends further research needs to be conducted to assess the vulnerability of the trepang fishery stock size and to develop robust sustainable management strategies.

Cochrane, M. (2005) *The Djelk Ranger Program: An Outsider's Perspective. CAEPR Working Paper No. 27. Canberra: Centre for Aboriginal Economic Policy Research, The Australian National University.*

This paper examines a range of BAC activities that were observed by the author in 2003, with an emphasis on the Djelk Ranger Program (including men, women and junior rangers). These activities included weed, feral animal and fire management, sustainable wildlife harvesting, the provision of community services and commercial activities. The paper also discusses the operation of the Maningrida Community Education Centre (CEC), and future projects that include the training and deployment of sea rangers and the development of aquaculture (the most viable being a trepang hatchery). The paper concludes with a discussion of the potential declaration of an Indigenous Protected Area (IPA) in the region. Overall, the author asserts that the operation of the BAC and the Djelk Ranger Program has positive current and future benefits for ecological management, social and cultural wellbeing and sustainable economic development.

<http://caepr.anu.edu.au/Publications/WP/2005WP27.php>

Fogarty, W. & Ryan, M. (2007) Monday in Maningrida, in Altman, J. & Hinkson, M. (eds.) *Coercive Reconciliation: Stabilise, Normalise, Exit Aboriginal Australia. Melbourne: Arena Publications.*

This chapter discusses the successful operation of, and management challenges for the BAC in the context of policies developed under the Northern Territory Emergency Response (NTER). It includes a detailed discussion of local governance structures, the Djelk ranger program, and the potential implications of NTER policies. The author argues that the NTER has undermined the existing development base and has usurped local development aspirations. The paper recommends that prudence should be given by policy makers to ensure that successful existing programs, local authority structures and development goals are not damaged by hastily conceived policies.

Williams, R. J., Carter, J., Duff, G. A., Woinarski, J. C. Z., Cook, G. D. & Farrer, S. L. (2005) Carbon accounting, land management, science and policy uncertainty in Australian savanna landscapes: Introduction and overview. *Australian Journal of Botany*, 53:583-8.

This paper provides a general background to the biophysical context of Australian savannas and includes a discussion of human populations, land use regimes and natural resource management. It also discusses the relationship between savannas and Aboriginal involvement in natural resource management as a both a challenge for the emerging carbon economy, and as having potential environmental, economic and social benefits. In doing so, the authors argue that scientific investigations into carbon stocks in Australian savannas are vital for informing sustainable natural resource management in both the present context, and under future climate change scenarios. The paper recommends that appropriate policy needs to be developed to address these present and future challenges. <http://www.publish.csiro.au/nid/66/issue/1049.htm>