An Australian Government Initiative

Feasibility of Small Scale Commercial Native Plant Harvests by Indigenous Communities

A report for the RIRDC/Land & Water Australia/FWPRDC/MDBC Joint Venture Agroforestry Program

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Foreword

The Indigenous people of Australia have a long and well-documented history of using native plants as an essential component of a vigorous customary economy. Despite this long association and knowledge, and more recently the ownership of large areas of land and their plant populations, few Indigenous people have engaged successfully in commerce based on use of native plants. The few exceptions mostly involve the fabrication of various artefacts and art production, where plant parts are a medium for the creative expression of culture, rather than being valued for their particular properties.

However, there is increasing interest by Indigenous communities and government in exploring options for use of native plants for food, food additives, botanical medicines and many other purposes, to increase Indigenous well-being and self-reliance. This project explores some of those options with the aim of identifying opportunities that might be successfully exploited by Indigenous people in remote locations in northern Australia.

Transplanting industries and practices from elsewhere will not necessarily provide workable solutions for these communities. Indigenous people in remote Australia face many challenges in developing viable resource-based industries, in particular the tyranny of distance, limited infrastructure, lack of capital and few opportunities to raise capital on land held under inalienable title. Education, training and technical support are also constrained.

This project adopted a fundamentally different approach by engaging with Aboriginal people to find out what sort of opportunities they were interested in pursuing and the conditions necessary for them to benefit. This bottom-up approach mostly identified modest (often very modest) proposals for entry to the formal economy, but this feature was viewed positively by all of the Aboriginal groups who engaged with the project. They emphasised the need to succeed with small enterprises carried out and controlled by community members and to advance from there.

This report investigates the basis for plant selection, and presents a number of case studies that explore the social, commercial and ecological implications of small scale selective harvest of native plants. It proposes some principles and practices to guide efforts to develop new Indigenous opportunities and enhance existing commercial uses. The report recommends:

- assessment of the market value of products with authenticated connection with Indigenous harvest and processing
- investigation of overseas markets for botanical medicines linked with Aboriginal practice
- continued government support during enterprise development, to help overcome the difficulties of remote locations
- better matching of government regulation to the scale of native plant use.

For those promoting enterprise development, it is important to consult with the community ‘on country’, to protect Indigenous intellectual property, to recognise that small enterprises may best suit traditional cultural and social needs and environmental constraints (e.g. risk of overharvesting), and enterprises with the best comparative advantage are likely to be those that are actively linked to culture, and are therefore less prone to being overtaken by non-Indigenous imitations.

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This report, a new addition to RIRDC’s diverse range of over 1500 research publications, forms part of our Agroforestry and Farm Forestry R&D program, which aims to integrate sustainable and productive agroforestry within Australian farming systems.

Most of our publications are available for viewing, downloading or purchasing online through our website at www.rirdc.gov.au/reports/Index.htm.

Peter O’Brien
Managing Director
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Abbreviations

CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
EPBCA	*Environmental Protection and Biodiversity Conservation Act 1999*
KCTWM	Key Centre for Tropical Wildlife Management
NLC	Northern Land Council
NTU	Northern Territory University
PWCNT	Parks and Wildlife Commission of the Northern Territory
WIPO	World Intellectual Property Organisation

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Executive summary

Indigenous people in remote Australia face many challenges in developing viable resource-based industries. Transplanting industries and practices from elsewhere will not necessarily provide workable solutions for these communities, which confront the hurdles of distance and scarce access to infrastructure, capital, land and training for new skills.

This research worked with Indigenous communities in the Northern Territory to explore the feasibility of developing small-scale enterprises based on harvesting of plant material in remote Aboriginal communities. The project investigated the basis for selection of plant products and undertook case studies on selective harvests, including evaluation of transport and collection costs, and potential markets. This report presents results of the consultations with communities, and outcomes of the case studies. It provides recommendations for enterprise development to address ecological, social, economic and marketing issues, training and education, as well as recommendations and concerns raised by the aboriginal peoples consulted and involved in the case studies.

Specific objectives of the project were to:

- identify potential market opportunities for plant products suited to harvest in remote communities with limited infrastructure
- examine cultural appropriateness of commercial harvesting of a range of native plants
- assess ecological and other land management implications of potential and existing harvests
- develop community-based strategies for improved realisation of commercial opportunities.

Potential plant products were selected using both "expert" botanical advice (a database of plant uses and botanical advice) and consultation with Indigenous communities as to the products they were most interested in exploring.

The case studies looked at bushfoods, customary foods for sale within communities, live plant trade, arts and craft, as well as novelties and educational items for the tourism market. The case studies and results were:

- Live plant trade with cycads *Cycas arnhemica* – harvest as an ornamental plant market appears biologically, socially and economically feasible. Better information on the size and value of the Australian market is required.
- Bush foods – Kakadu plum *Terminalia ferdinandiana* – Returns for bulk supply to this established bushfood market appear viable for some communities, but there is a risk of local over-harvest which may compromise customary use and have uncertain ecological impacts. Regulation may be best managed by local communities.
- Adding value to bushfoods – Lotus lily *Nelumbo nucifera*– The community chose to market this plant as samples sold with a pamphlet describing the customary use. This case study indicated that remote communities may best maintain a place in the market by connecting customers (e.g. tourists) with elements of traditional culture associated with the plants.
- Bushfoods for sale within communities – long yam *Dioscorea transversa*- There was a strong commitment by aboriginal women in the Nauiyu community to making customary foods more available to their communities for health reasons. The need for wider markets was not seen as important, but cultivation techniques and nursery facilities may assist usage of the plant.
- Harvest of *Bombax ceiba* for carving – Use of this species is part of a well-established trade in carvings, but there was concern about sustainability of harvest and the capacity of the tree to coppice at a rate to meet expected increase in demand. Cut stems produced stems large enough for re-harvest within 20 years, however further work on a more detailed population model for the species is required.

- Analysis of stems cut for dijeridus - customary harvest in contrast to imitation didjeridus – non-customary harvest uses different species, often produces poor instruments and is not sustainable. Better regulation of a permit system is needed. Aggressive promotion of the values of authentic products, coupled with social and public recognition of the impacts on customary use is needed to protect Aboriginal entrepreneurs.
- Trial harvests of a small number of other items favoured by communities indicated that financial returns from wild harvest of bushfoods may be too low to support more than marginal operations. For example, net returns to harvesters were mostly less than $10 h-1, given cost disadvantages (handling and transport) of operating from remote locations. Distributions of harvestable plants in unmodified landscapes are patchy, so that densities sufficient to sustain adequate returns are not available to all communities.

A number of communities expressed interest in various forms of value-adding, including drying and packaging of fruits or seeds, and growing out of plants for the nursery trade. Some of these options present opportunities to market the Aboriginal connection as a key element of the product.

Two options that explicitly exploit the Aboriginal connection and on-site value-adding that were examined in greater detail are:

- presentation of bushfoods as novelty items, intended not so much for consumption as food but rather as examples of customary use, to accompany written stories about the cultural significance of the plant(s), and
- sale of cycads endemic to Aboriginal land and hence unavailable to alternative suppliers through legitimate channels.

Linking species of bushfoods to presentation of Aboriginal culture to the tourist trade, as an adjunct to other tourism-related ventures offers some commercial advantage over competition.

Harvests of woody plants for artefacts (carvings, didjeridus and bark paintings examined during the study) show commercial and customary harvests by Aboriginal people to be presently sustainable, although legal and illegal harvests of stems for ersatz didjeridus may cause local problems.

It is important to communities and government to note that many options depend on pre-existing infrastructure (e.g. the Merrepen Arts Centre and Bawinanga nursery respectively), which is in turn often supported by the Community Development Employment Program (CDEP) scheme resourcing. Criteria used to judge commercial viability need to extend to embrace the legitimacy of a “hybrid” economy in which enterprise of this sort emerges and grows using state support on a number of fronts, including education and training. A constraint in some cases was expensive regulatory requirements (for monitoring harvests) regarded as unwarranted for the small scale of use. It is also important to recognise that in identification of potential enterprises, long and flexible timeframes are required to support community discussion and permit implementation, particularly when dealing with biota of spiritual significance to Aboriginal custodians.

Indigenous people emphasised the need to succeed with small enterprises delivered and controlled by their own community members. Consultation regarding enterprise development should be undertaken “on country” and engage relevant community members. Development is most likely to be successful if it occurs incrementally and involves the community - the community can progressively develop the enterprise as experience is gained. Government assistance in the short to medium term is recommended, as is further research on markets. Management for the risk of local over-harvest may be best undertaken by local indigenous communities in association with customary use, and in consultation with government regulatory authorities. Additional issues and principles outlined in the report, provide guidance in supporting this development process.

1. Introduction

1.1 Socio-economic background

In northern Australia, many Aboriginal people live in remote locations where built and industrial infrastructure is scarce, soils are infertile and highly erodible, and literacy and numeracy levels are low. Options to raise capital are few, given that land, the primary asset held by Aboriginal people, is granted under inalienable title. Systems of Aboriginal land ownership and custodial responsibilities for land and resources constrain mobility and reduce capacity to match labour availability to employment opportunities. Opportunities for Aboriginal people to engage with the market economy are therefore few. Many depend substantially on welfare or “work for the dole” schemes like the Community Development Employment Program (CDEP).

Welfare dependence is regarded by many observers, including some Aboriginal leaders, as a social "poison" that contributes to the perpetuation of the marginal status of Aboriginal Australians (Pearson 1999). This view of the role of welfare is not universal (Martin 2001). The welfare system is also seen to contribute to a vital hybrid economy (Altman 2001) that supports Aboriginal culture and the many direct and indirect contributions of Aboriginal people to the national good (Whitehead 2000; Yibarbuk et al. 2001).

Irrespective of views of the role of welfare and obligations of the state, many also accept that Aboriginal society could benefit from a greater diversity of opportunity to engage with the market economy. Members of many Aboriginal communities and their resource management agencies actively seek opportunities to develop commercial enterprise (e.g. BAC 2001). Motivations and expectations vary, ranging from a search for modest incentives to reconnect people with active management of their country (e.g. www.nlc.org.au/nlcweb/caring_for_country/01_caring_for_country.html), to proposals for privately-funded ventures to provide employment in roles more typical of industrial Australia, as well as varying levels of Aboriginal equity in major developments (e.g. First Management Corporation 1999). Unfortunately, there has been a long history of failure of enterprise based on living resources in northern Australia generally and on Aboriginal land in particular (Woinarski and Dawson 2002).

Despite this history, a Senate Committee inquiring into the commercial use of native wildlife concluded that activities involving wild plants and animals presented important commercial opportunities for Aboriginal people (Senate Rural and Regional Affairs and Transport References Committee 1998). The reasons for this view were several: that there are few obvious alternatives on lands owned by Aboriginal people, that wildlife use and management makes good use of existing skills and interests, that communities already manage a substantial customary economy based in part on wildlife (Altman 1987), and that involvement with wildlife fosters customary connections to land that many are eager to maintain (Martin 1995).

But the fact that the issue was seen to require a Senate inquiry in itself suggests some of the special challenges that confront enterprise development based on native species in remote Australia. An incomplete list of challenges captured in the Committee's observations includes:

- products from native species are often likely to be poorly recognised and lack well established markets, so that costs and risks are increased, whether in establishing new markets or positioning products within existing markets;
- native products often show strong seasonal peaks in availability, compromising establishment of robust markets;
- options for value-adding are likely to be limited by gaps in education, skills and relevant infrastructure at remote harvest sites;
- commercial use may conflict with the maintenance of customary use, in ways that only Aboriginal people are qualified to evaluate; and

- lack of infrastructure and capital, plus complex systems of land and resource ownership and responsibility inhibit large scale collaborations that might be needed to meet market expectations for continuity of supply and consistency of quality.

Given these and other related factors (see Martin 1995), it is obvious that orthodox approaches to identify and explore options for wildlife-based enterprise raise many difficulties for Aboriginal communities. Alternatives to orthodox, entirely market driven developments should be considered. This project considers one such alternative, based on the core assumptions that:

1. Options identified and developed by Aboriginal people themselves are more likely to attract serious Aboriginal engagement.
2. Options based at least in part on positive assessments of "comparative advantage" for remote Aboriginal communities offer greater prospects of success.
3. Rapid change in the mix comprising the present hybrid economy is problematic: capacity to manage substantial entry to the market economy is constrained by prevailing weaknesses in the social and built infrastructure required to manage the demands of such markets.
4. Options involving modest initial investment are most realistic given the substantial risk of failure of new products entering established or developing markets.
5. Developments that make useful contributions to capacity-building may be viewed favourably even if economically marginal.
6. Community members are best placed to realistically match opportunity to local capacity.

We have treated these ideas as axiomatic. We believe that it follows from these axioms that support for communities, families or individuals in enterprise development should be offered incrementally and iteratively, so that activity and capacity build on each other. Within such a framework, details of enterprise are matched to existing skills, interests and infrastructure, but also give considerable weight to the potential of the enterprise to enhance capacity. More ambitious enterprise may follow success and the increase in confidence and capacity that flow from it. Accordingly, this project focuses on options positioned at the modest end of the range of wildlife uses that might be regarded as accessible to remote communities.

1.2 Environmental and resource management background

Failures in resource management are legion: some analysts of past performance and the forces acting on human resource management systems question whether living resources can or will ever be managed sustainably (Ludwig et al. 1993). The history of post-colonial resource use in northern Australia provides no effective counter to such pessimism, because efforts to impose large scale developments have often ignored biophysical constraints and impacts (Woinarski and Dawson 2002), in addition to overriding other local social and cultural concerns (Dale 1996).

Ignorance of the biological systems of tropical Australia and the influences on them has been a factor in promotion of unrealistic expectations. Despite great increases in research effort over the last few decades (Whitehead et al. 2002), gaps in knowledge of individual species and the systems that support them continue to compromise our capacity to understand and appropriately manage the living resources of the northern savannas. Even though exploitation of these environments has mostly been of comparatively low intensity, there is little doubt that substantial damage has already been done, with many species of fauna declining in range and abundance through causes that remain obscure (Franklin 1999).

Nonetheless, for the reasons outlined earlier, contemporary political and socioeconomic pressures on Aboriginal people to use commercially the few resources available to them are likely to prove irresistible. Even those communities rejecting large scale orthodox agroforestry ventures, because they regard environmental impacts as unacceptable, seek more modest and less intrusive alternatives

(e.g. BAC 2001). Moreover, there is a growing realisation that one of the factors contributing to conservation problems is the virtual depopulation of large tracts of country, following the forced or facilitated movement of many Aboriginal people to townships and other settlements. Lands without people are especially vulnerable to the impacts of invasive exotic plants and animals, as well as uncontrolled wildfire (Yibarbuk et al. 2001). Enterprise that provides incentives for people to return to and actively manage country may benefit conservation of natural values in ways embraced by the Australian and international communities, additional to any economic and social return (Whitehead 1999).

However, little effort has been made to understand the values that Aboriginal people particularly seek to maintain in the environments for which they accept responsibility (Whitehead et al. 2000). The assumption that they are the same as those sought by urban Australians is probably invalid, although there is likely to be considerable overlap (Yibarbuk et al. 2001). Many in the orthodox conservation community regard the notion of sustainable development—as embraced by Australian governments (e.g. Anon. 1992)—as oxymoronic (e.g. Lele and Noorgard 1996). In the Aboriginal community, views of good land and resource use practice are also likely to be diverse, but generally give much greater emphasis to the place of humans and their roles in the maintenance of landscapes. Values of land and its resources independent of human interactions with them are meaningless abstractions: country without people and their activity is by definition unhealthy (Whitehead et al. 2000). Consequently, use of native living resources to meet human needs is less likely to confront the aesthetic distaste and automatic rejection that characterises the reaction of some conservation interests (see examples in Senate Rural and Regional Affairs and Transport References Committee 1998).

1.3 Implications for enterprise development

This background illustrates how important it is that proposals for commerce, which involve living resources and originate from outside communities should be realistic and comprehensively consider constraints. For example, they should not create unrealisable commercial expectations nor, if substantial markets exist or can be developed, involve levels or methods of exploitation that may exacerbate existing environmental management problems. However, addressing issues of biodiversity conservation, different cultural norms and their interactions, behaviour of markets, and resource availability and condition in an integrated and rigorous (preferably quantitative) way presents formidable challenges.

For example, quantitative models capable of robust prediction of sustainable levels of harvests of north Australian plants is currently impracticable for most species, given the existing low levels of knowledge of plant demography. Moreover, any harvest has impacts at some level. It is not known how well the change acceptable to regulatory authorities will match levels of change acceptable to Aboriginal landowners for extracting a given level of benefit. It is therefore necessary to adopt conservative “rules of thumb” to identify those plants and modes of harvest that are most likely to sustain harvests at scales that are relevant to the aspiration of Aboriginal land owners and land managers.

1.4 The Project

The central goal of the present project was to examine the feasibility of developing small-scale enterprise based on commercial use of native plants. Specific objectives are to:

1. identify potential market opportunities for plant products suited to harvest in remote communities that possess limited infrastructure;
2. examine the cultural appropriateness of commercial harvesting of a range of native plants;
3. assess the ecological and other land management implications of potential and existing harvests; and
4. develop community-based strategies for improved realisation of commercial opportunities.

As will be obvious from the cultural axioms and the analysis that led to their formulation, in pursuing these objectives, we avoided offering pre-packaged options. Rather we built on interests expressed by various Aboriginal groups in celebrating and exploiting their knowledge of native plants and their uses. We sought to facilitate discussion and consideration rather than to direct decisions about the "best" options. As a corollary, we did not actively seek to exclude options based on pre-conceptions about ecological or commercial sustainability or the capacity of communities to manage particular categories of harvest. Rather we sought and continue to seek to provide information about the relative costs and benefits of potential harvests that communities and individuals could use in decision-making.

This approach and the dialogue it generated permitted us to explore some of the reasons for Aboriginal participants preferring some options over others. Where communities had access to some equipment, infrastructure and supporting institutions, this level of engagement also permitted assessment to extend to include operational trials of some aspects of favoured options.

Within the main report, the commercial, ecological and cultural sustainability of options is assessed using results from seven case studies trialled. Full details of these case studies is provided in the Appendices. This report summarises both the formal assessments of feasibility as well as the less formal experiences that provide insights to the probability of people taking up and then succeeding in small enterprise based on native plants. We have sought to make our information most valuable to Aboriginal communities and their supporting agencies, rather than to maintain commercial interests. In addition, we provide a list of recommendations for further work.

2. Objectives

The agreed objectives and outputs for the project were:

1. Assessment of the cultural appropriateness of commercial harvesting of a range of native plants by Aboriginal people.
2. Identification of potential market opportunities for products suited to harvest in remote communities possessing limited infrastructure.
3. Assessment of the ecological and other land management implications of potential and some existing harvests.
4. Matching of commercial opportunities to cultural, ecological and logistic constraints.
5. Development of community-based strategies for realisation of commercial opportunities.

These objectives are ambitious given a limited budget and constraints on time. But as is clear from the project title, our emphasis is on feasibility rather than a definitive treatment of all available options and methods of addressing them.

3. Methodology

3.1 General overview

The project team has collective experience exceeding 60 years in working with Aboriginal people and their agencies in northern Australia. That experience informed our general approach to the exploration of opportunities. The process varied in detail from one group to another, but invariably had the following features:

- The notion (of using plants to generate income) was introduced to representatives of the community (often people with relevant roles in associations or resource centres), usually with a few examples of possibilities. In most cases community members had previously sought information or made suggestions about the use of plants in commerce, and these guided some of the early interactions. Initial contact was facilitated by members of the project team who had worked previously with the particular community on issues of natural resource management.
- The community members contacted initially were encouraged to discuss the idea more widely, sometimes in formal meetings of relevant associations.
- Contact was renewed after periods invariably exceeding several weeks but sometimes extending over several months, when nominations were sought for Aboriginal people particularly interested in being involved and coordinating contacts and activity.
- Subject to invitations from relevant landowners, project team members then visited towns and outstations for further discussions, often meeting "on country". Such meetings were generally facilitated by the community's nominated coordinators. At these meetings specific options and sites were sometimes agreed for further work, although usually more than one meeting was required before this stage was reached.
- Where interest was sufficient, trial harvests of nominated items were arranged in collaboration with the community nominees. Aboriginal people directed the harvests, including the choice of sites visited. Wherever possible, quantitative surveys of abundance of the relevant plants were also made. Sometimes these surveys involved local people, but were often conducted primarily by the project team.
- During these harvests, participants and the project teams discussed aspects of the trials, including any cultural or ecological concerns about harvest design. Special efforts were made to ensure that people with special custodial or other cultural responsibilities for the species or sites agreed with the proposed uses and methods of harvest.
- When the level of interest warranted, some post-harvest handling and packaging was arranged, invariably involving the full participation of interested Aboriginal people.

3.2 Community involvement

The project ultimately involved, to varying degrees, a substantial number of Aboriginal communities. They included: Bulla Community at Timber Creek; Kalkaringi Community at Victoria River; Kybrook Farm Community at Pine Creek; Larrakia Nation in the Darwin region; communities in the Maningrida region of central Arnhem Land serviced by the Bawinanga Aboriginal Corporation; Nauiyu Nambiyu Community from the Daly River; Pirlangimpi Community at Melville Island; and Yolngu people in north east Arnhemland. The Laynhapuy Homelands Association and the Yirrkala community were involved from the outset and initiated some of the ideas. Other communities have been chosen based on links already established through the Parks and Wildlife Commission of the Northern Territory (PWCNT) and the Northern Land Council (NLC). Familiarity earned through long term working relationships and related levels of trust strongly influenced participation. Nick Smith established connections with a number of communities in Cape York through his work with the Balkanu Cape York Development Corporation.

Levels of participation varied among communities, dependent on the level of prior contact with members of the project team, as well as communication and consultation processes existing within communities.

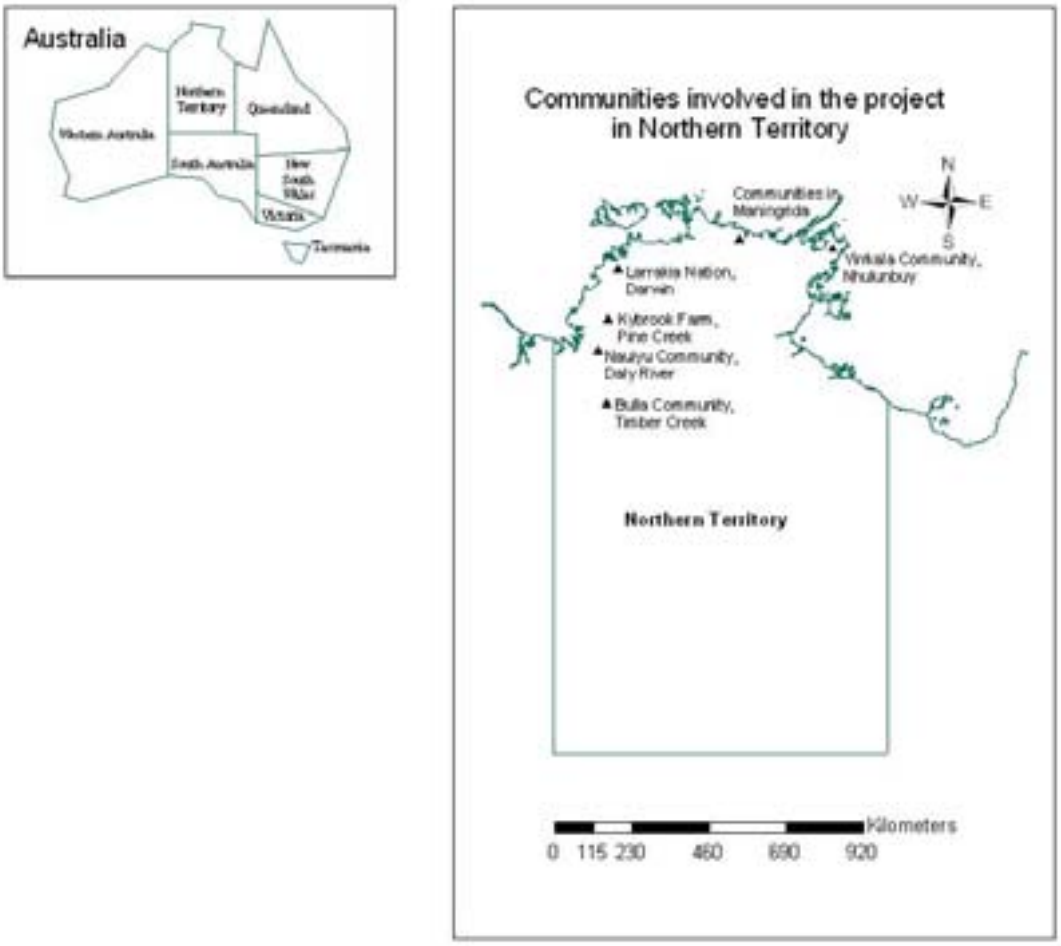

Figure 1: Map of the Northern Territory showing the location of communities participating in the project in various ways

3.3 Initial identification of candidate plants

In addition to options identified by members of the project team and by Aboriginal resource management agencies and individuals, an effort was also made to examine options in a more systematic and structured way. This more formal process involved a review of the existing literature on Aboriginal use of native species and of other information relevant to the assessment of economic and ecological sustainability.

Aboriginal knowledge has been seen as a potential shortcut to identification of high-volume, high-value pharmaceuticals. However, with the emergence of comprehensive and semi-automated screening protocols, dependence on Aboriginal or any other existing knowledge of potential uses has been greatly reduced. We did not seek to apply Aboriginal knowledge to the identification of such products. Rather, our emphasis was on identifying items of more prosaic utility or interest, with which Aboriginal people are familiar, which appeared harvestable at low cost, and yet might offer reasonable financial returns in small to moderate quantities.

For the Northern Territory, plants of potential interest were identified initially by reference to a major ethno-botanical database maintained by the Parks and Wildlife Commission of the Northern Territory (G. Wightman and N. Smith, unpublished). This database (Plant Use database) includes details recorded from some published ethno-botanical sources, plus unpublished observations of Glenn Wightman and Nick Smith. Other sources investigated include Cribb and Cribb (1974), Brock (1988), Dunlop et al. (1995), Hill (1998), Low (1991), Wightman et al. (1992a, b), Yunipingu et al. (1995), and Marrfurra et al. (1995). A haphazard sample of candidates from this database was then filtered loosely through a set of criteria relating to the availability of markets and a range of influences on social, economic and ecological sustainability. Initial filtering was relatively crude (Box 1) and then more detailed assessments were made for higher-ranked plants (Boxes 2 and 3). Application of these criteria was supplemented by input from a number of botanical experts (notably Glenn Wightman, Nick Smith and David Liddle).

To make the initial identification of existing or potential markets, we considered analogues of customary uses listed in the database, compendia of non-timber forest products and similar items (e.g. http://www.fao.org/forestry/foris/index.jsp?start_id=4029), or discussions of natural plant products (e.g. ten Kate and Laird 2000), the arts and crafts industries (e.g. Salmon 2002), and local knowledge.

For many products, indigenous knowledge may be particularly valuable. For example, purveyors of "botanical medicines" (herbal remedies and the like, as distinct from clinically-proven pharmaceuticals) have historically depended on reports of traditional use for assurance regarding efficacy and safety (Laird 2000). Aboriginal culture offers a rich source of such knowledge, which international conventions (the Convention on Biological Diversity) and national legislation (the *Environmental Protection and Biological Diversity Conservation Act 1999*) indicate should benefit those people providing the knowledge.

Although we were careful to reveal only published information on Aboriginal uses that had already entered the public domain, it should be noted that this procedure was criticised by some Aboriginal people who examined our project progress report (Whitehead et al. 2001). In that report we provided some re-analysis of published information that might originally have been obtained (i) without genuinely informed consent, (ii) very often without ensuring understanding of the commercial use that others could make of it, and (iii) without those gathering the information necessarily accepting an obligation to return benefits to the knowledge providers. However, we consider that ignoring published information provides no effective remedy for inequitable use, and argue that application by Aboriginal people, in an effort to retrieve some commercial benefits for Aboriginal land owners and managers, is preferable to entirely abandoning the field to non-Aboriginal interests.

In addition to this re-assessment of documented uses, researchers from the participating institutions and communities jointly identified other candidate species and their uses. In regard to recording of Aboriginal knowledge not previously published, protocols for recording and attribution of additional traditional knowledge collected during this study are those applied by Glenn Wightman (see Yunipingu et al. 1995) and policies, procedures, principles and guidelines relating to ethics in research at Charles Darwin University http://www.cdu.edu.au/research/policies_procedures/ethics.html). Management of such intellectual property to protect indigenous interests is a primary goal of the institutions and individuals involved in these studies. As far as we are aware, this report contains no information that is not available from other sources. We have, at the request of Nick Smith of Balkanu Cape York Development Corporation, removed reference to options identified by Cape York people where there was doubt about prior publication of references to these options. We return to the larger subject of intellectual property and its exploitation later in this report.

Box 1: Preliminary criteria for selection and assessment of target species with potential for commercial use of native plants in northern Australia. The original set of native plant species was selected by Aboriginal people in northern Australia.

Cultural

1. Harvest can be undertaken without significant risk of offence to community members or other Aboriginal groups with special interest in, or responsibility for the species.
2. There are no important age, gender, or other social restrictions on the individuals who may participate in harvesting, packing, handling or distributing the plant or its parts.
3. The species is not restricted to sites to which access may be denied to those who engaged in the enterprise.
4. Relevant landholders have agreed explicitly to the harvest proceeding.
5. Agreement has been reached at least in principle about ownership and appropriate distribution of income.

Logistical

6. Harvest is not excessively constrained by seasonal factors (inaccessibility of sites during flowering or fruiting).
7. Harvest is feasible without highly specialised equipment.
8. The harvested item does not require highly specialised packaging, handling or storage.
9. The item appears capable of being "stockpiled" while awaiting transport to markets.

Economic

10. A significant market exists for this species or similar species.
11. The species offers products sufficiently similar to those for which markets exist to suggest that substitution is possible.
12. Simple models of costs of harvest, handling and transport, and likely prices and volumes suggest that a significant net income is plausible.
13. Distributors have expressed interest in handling products of this type.

Ecological

14. The species is widely distributed, reducing the risk of local over-harvesting.
15. The species is abundant and economically viable harvests appear to involve low risks of adverse impact.
16. Harvest causes minimal damage or methods can be modified to reduce damage to plants or populations.
17. Harvest appears unlikely to impact on other associated or dependent species of flora and fauna.
18. Commercially viable harvests of seeds/other propagating material appear unlikely to compromise recruitment.
19. Information is available to allow construction of basic harvest models.

Legal

20. Licensing under wildlife protection legislation for local, national or international sale appears unlikely to be problematic.
21. Licensing under food quality or consumer protection laws is not required or appears achievable at modest cost.

Box 2: Criteria for more detailed ranking of plant species with regard to commercial opportunity. The scores for individual characteristics were summed to assign each species an index of suitability.

Markets		
No existing markets known		0
At least one significant existing market		1
Multiple significant markets		2
At least one very large market		3
Distributor interest?		
None		0
Minor		1
Substantial		2
Anticipated product unit value		
Low (where no information assumed to be low)		1
Moderate		2
High		3
Potential to establish Aboriginal identity/link		
No potential		0
Limited potential		1
Good potential		3
Established or inherent (e.g. art or traditional implements)		5
Scale of potential supply from Aboriginal lands		
Very limited		0
Limited		1
Substantial		2
Quality of supply from Aboriginal lands		
Unknown		0
Adequate		1
High		2
Seasonality of supply		
Aseasonal		0
Extended availability but clear seasonality		-1
Highly seasonal		-2
Suitability for storage/stockpiling of product		
No capacity		0
Some capacity		1
Readily stored		2
Cost of harvest		
No information		0
Low (easily harvested)		1
Costs moderate		-1
Costs high		-2
Infrastructure requirements for harvest, transport, handling or storage		
Minor		0
Substantial		-1
Major		-2
Regulatory constraints (e.g. CITES listing)		
On harvest	Limited	0
	Substantial	-1
On sale	Limited	0
	Substantial	-1

Box 3: Criteria for more detailed ranking of plants with regard to cultural issues affecting suitability for harvest. The scores for individual characteristics were summed to assign to each species an index of suitability.

Cultural constraints	
No known constraints	0
Possible concerns	-1
Substantial concerns	-2
Recorded uses	
No recorded use	0
At least one recorded use	1
Multiple recorded uses	2
Landholder support	
No agreement	0
Landholder acceptance	1
Strong landholder support	2
Ownership/responsibility	
Ownership/responsibility ambiguous	-1
No relevant information	0
Quality of consultation	
None	0
Substantial but potentially incomplete	1
Comprehensive	2

Box 4: Issues that community representatives were asked to consider during consultations about potential for commercial harvests of native plants

COMMUNITY RESEARCH HOMELANDS HARVESTING PROJECT

These questions are to help you think more about and consider the idea of a small community run and controlled harvesting project. Your community could discuss these questions for each of the plants that (the project team) have suggested can be sold.

- Is your community interested in harvesting and selling the plant which grows in your community through Laynhapuy?
- Is it OK to collect or harvest and sell the plant from a cultural point of view?
- Where does the plant grow?
- Which season does it grow in?
- Can we collect the plant easily?
- Will there be enough to sell?
- Do other Yolgnu have interests in the plant or the land where it grows?
- Who would collect the plant?
- Who would look after the collected plants?
- How would we get it to Laynhapuy?
- Who would handle and distribute the money that comes from the sale of plants?
- Who would make sure not too much is taken?

3.4 Matching market options with community interests

A list of options was identified by the process described above. In the Northern Territory the list was reviewed to varying levels of comprehensiveness by relevant community representatives, land owners, and custodians of knowledge, with the intent to eliminate culturally unacceptable options or to assign priorities to acceptable options, based on the particular local circumstances. The process involved both individual and group consultations, including visits to a number of community resource centres and related outstations. We adopted no *a priori* criteria for determining when consultation was adequate, and consider it likely that informative judgments of the reasons for success or failure of individual projects will be best based on longer-term assessments.

All consultations in the Northern Territory were facilitated by staff of the Centre for Indigenous Natural and Cultural Resource Management (Greg Wearne) and the Caring for Country Unit of the Northern Land Council (Peter Cooke, Robin Knox and Michael Storrs). In Queensland, the Wik, Wik Weya and Kugu communities of Cape York indicated that they did not wish to discuss such issues through group meetings or have consultations filtered through intermediaries. Thus the approach there emphasised direct interaction between the ethno-botanist (Nick Smith) and senior (mostly male) traditional owners with the authority to speak for particular country. Box 4 gives an example of the written material used in initial contacts with the Yirrkala and Cape York communities.

3.5 Assessing commercial sustainability of preferred options

Wherever practicable, those options preferred by participating communities were examined in more detail. The additional information sought included:

- characterisation of existing related markets, including levels of demand and prevailing prices;
- where no similar products were known, assessment of potential markets based on contact with potential retailers or limited survey of potential consumers;
- abundance of the plant and its products in the landscape;
- costs (time and direct expenditures) of harvest of product by Aboriginal people in community settings;
- costs of reaching markets, including handling, packaging and transportation; and
- options for value-adding within communities.

3.5.1 Characterisation of existing markets

Information was gathered on existing markets through websites, approaches to the companies that produce existing bushfood or other plant products, surveying products presently available in retail and wholesale stores, simple questionnaire surveys of potential consumers, and interviews with wholesalers and retailers.

3.5.2 Assessments of potential markets for new products

To provide a preliminary assessment of local demand for the type of products Aboriginal people might produce, we also targeted visitors at the 2001 Merrepen Arts Festival and 2001 Darwin Botanic Gardens Tropical Fair Extravaganza. At these events we offered samples of bushfoods and had examples of the information that might be presented with such foods. We asked those interested in the samples to complete questionnaires which, amongst other things, sought opinions on the quality of the product and price they would pay.

In addition, retailers of bush tucker in the Darwin region were identified by visiting or phoning likely tourist outlets, conducting informal interviews or asking proprietors to fill in a questionnaire. We sought information on:

- who supplied them;
- what the difference was between the retail and wholesale pricing (mark up);
- which products sold and why;
- units sold annually;
- forms of packaging used; and
- interest in additional products of the kind communities may produce.

3.5.3 Availability of the products

Potential availability of products based on native plants was determined by:

- examining available literature and accessing the PWCNT Herbarium database to determine distribution and seasonality;
- talking to Traditional Owners and other Aboriginal informants about seasonality and distribution of plants that offered products for which markets were thought to exist;
- quantitative surveys to determine abundance of adult plants;
- measuring harvest rates achieved by participants in trials.

3.5.4 Costs of harvest

Estimates of the costs (in time and other resources) of wild harvest took account of:

- number of people collecting;
- time required for collection of a measured quantity;
- time of travel to and from the collection site;
- costs of transport to and from harvest site;
- cost of equipment used in harvest;
- costs of minimum post-harvest processing to access markets.

In most cases density or other measure of the abundance of resources at the collection site were also made.

3.5.5 Costs of servicing markets

Where some post-harvest treatment was necessary or desirable, estimates of costs took account of labour, equipment and consumables.

3.5.6 Options for value-adding

The most substantial area of activity involving post-harvest labour and skill to add value is the arts and crafts industry, where customary practice is highly valued. This area has already been subject to considerable attention (Wright 1999; Wright and Morphy 2000) and we did not seek to do more.

Other options for value-adding mostly involved non-customary activity. These were mostly initiated and considered through interactions occurring during the harvest process. None of the proposals for value-adding considered in trial harvests involved technologically demanding or equipment-intensive processing. However, costs of such basic processes as vacuum packing of fruits, potting of harvested live plants and the like were quantified in the same way as harvest costs.

In most cases we considered only costs directly attributable to harvesting or processing activity and made no provision for related overheads. These were often likely to be low, but a full costing would require some additional investigation to take account of the role of administrative and other indirect support.

3.6 Assessing ecological sustainability for preferred options

Review of scientific and Aboriginal and other expert knowledge of the ecology of target species was used to provide preliminary rankings of potential impacts of harvest on the harvested species themselves, as well as their dependent fauna. Criteria used for this preliminary assessment are described in Box 5. Readers will note that there is no provision to evaluate impact of harvests on soil or other physical attributes of affected environments. Consideration of these classes of impacts was considered unnecessary because such effects are less likely with the small scale enterprise under consideration here. Relevant criteria could be readily added if more aggressive harvest methods were under consideration.

In some cases information additional to that available from the literature or from the knowledge and experience of project participants was considered necessary to make reasonable assessments. Methods used to gather additional data varied, but involved one or more of the following:

- transect-based surveys of distribution and abundance (and for woody species, stand structure) of selected species, stratified by major vegetation types;
- field quantification of existing harvests, especially those involving cutting of large woody stems, where evidence of harvest can be readily gathered and assessed;
- in a few cases, initiation of construction of comprehensive population models; and
- design of simple harvest experiments in association with interested communities.

However, it is considered that in most cases sustainability is best assessed over the long term through adaptive management experiments (Walters 1986), in which responses to manipulation are carefully monitored in harvested and unharvested (control) populations. This is particularly the case for harvested species with long generation times, for which long runs of data (much longer than the duration of this study) will be required to build robust predictive models.

Unfortunately, none of the opportunities identified and trialled to date have run long enough to put sufficient items into the marketplace to comprehensively test existing markets, and hence to accurately predict demand over the long term. Gathering information on demand and size of harvests should be an integral part of any ongoing management experiment.

Box 5: Criteria for initial ranking of relative susceptibility of different plant species to harvests of different types. The scores for individual characteristics were summed to assign to each species an index of potential impacts of known or potential harvest modes. Where 2 or more modes of harvest were possible, the impact ranked most detrimental was chosen.

Distribution	
Narrow endemic	-1
Regional	0
Widely distributed in the northern tropics	1
Habitat	
Strongly associated with particular, sparsely available habitat	-1
Strongly associated with widely available habitat	0
Distributed across a number of widely available habitats	1
Abundance	
Rare	-2
Low density	-1
Common	0
Highly abundant	1
Other threats	
Severe and exacerbated by harvest	-2
Substantial and independent of harvest	-1
Minor and independent of harvest	0
Substantial and potentially ameliorated by harvest	1
Impact of harvest on individual plants	
Death (removal) of established reproductively mature plant	-4
Increased probability of mortality of established plant	-3
Substantially reduced recruitment	-3
Slightly reduced recruitment	-2
Slight stress (e.g. leaf removal)	-1
No impact	0
Importance for fauna	
Significant for keystone species	-4
Significant for many species, including culturally significant fauna	-3
Significant for many fauna	-2
Significant for some fauna	-1
Little known significance	0

3.7 Strategies for realising opportunities

The project plan called for an analysis of approaches to assessment and implementation of enterprises based on plant use, to be completed with community representatives at a substantial workshop (Objective 4).

In November 2001 such a workshop was held over three days (6-8 November 2001) at the Merrepen Art Centre at Nauiyu Community in Daly River. About 70 people attended, including Traditional Owners, Aboriginal Rangers, and representatives from the Office of Aboriginal Development, Aboriginal and Torres Strait Islander Commission, Northern Land Council, Territory Health Services, Balkanu Cape York Development Corporation, Greening Australia, NT Area Consultative Committee, Northern Territory University, and Parks and Wildlife Commission of the Northern Territory. Traditional Owners from Nauiyu, Wooliana, Yirrkala, Maningrida, Ramingining, Acacia, Kybrook, Cape York, Darwin, Katherine, Kakadu, and other parts of the Top End attended.

It quickly emerged that most Aboriginal participants wished to focus on more fundamental and general issues about the commercial use of natural resources on Aboriginal land and elsewhere, rather than to develop detailed strategies, which they thought may be premature. Consequently, the workshop was most useful in establishing a set of basic principles that traditional owners and custodians wished to see incorporated in any project involving plant use. Clearly, these will need to be a core element of any generic strategy.

In addition, participants reviewed the conduct of the present project and the methods used. In particular, they identified a number of questions that they considered had not been properly or comprehensively dealt with during the study.

This reaction to some extent compromised the realisation of project objectives, but provided a useful reminder of the seriousness with which many Aboriginal people view methods and motivations for use of both plant resources and knowledge associated with them.

3.8 Communication and review

Full participation of the potential users of research outputs in the study was the most critical feature of the communication strategy, because those same individuals were most likely to be engaged in implementation. However, efforts were also made to communicate results to non-participants in a range of forums. These included:

- participation of project team members in formal conferences such as the Australasian Conference on Tree and Nut Crops in Perth, April 2001;
- incorporation of plant surveys as part of Ranger training camps conducted by the Parks and Wildlife Commission, involving some of the regions' Aboriginal interests (Victoria River Ranger Training Camp, May 2001 and Fish River Ranger Training Camp, NT, September 2001);
- presentation of project objectives, methods and progress to the Women's Land Management Conference hosted by Wagiman women in May 2001;
- Larrakia Nation cultural camp in July 2001;
- Merrepen Arts Festival at the Daly River in June 2001;
- Darwin Botanic Tropical Garden Spectacular in July 2001;
- participation in the International Flora Malesiana Symposium, Royal Botanic Gardens, Sydney, NSW, September 2001; and
- participation in the Asia Pacific Wetland Managers Training Program Indigenous Wetland Managers Study Tour, Darwin, NT.

In both the Merrepen Festival and Darwin Botanic Garden event, attendees were interviewed about their attitude to commercial use of plants by Aboriginal communities and their interest in some products.

4. Results

4.1 Initial identification of candidate plants

The Plants Use Database was searched to identify a sample of species that (i) had well-established uses within Aboriginal communities; (ii) did not involve prohibitions on use by people likely to seek involvement in harvest or handling of products; (iii) were considered likely to occur at abundances permitting operationally plausible harvest in the lands of relevant communities; and (iv) possessed other characteristics that appeared consistent with potential commercial use. For assessing ecological impacts, criteria shown in Box 5 were applied, and for economic and social issues, Boxes 3 and 4 were relevant. An output from that exercise is summarised in Appendix 1. Plants included in this list provided an initial base for early interactions with the Yirrkala, Maningrida and Aurukun communities.

Although we attempted to introduce some rigour by specifying the process explicitly so that it is repeatable when more or better information becomes available, we do not suggest that the results provide more than a crude indication of relative suitability. The ranking emerging from the analysis is best treated as a broad indicator of the relative scope of commercial opportunities available from mostly common plants species in northern Australia, as well as the severity of constraints that are likely to confront the development of any particular option. High rankings indicate readily identifiable (often existing) commercial opportunities constrained by relatively fewer significant marketing, cultural or sustainability obstacles; low rankings suggest limited opportunities encumbered by sometimes substantial difficulties. More generally, plants that are familiar to Aboriginal communities, with established markets for products that are harvestable without causing the death of the plant, rated highly.

It should be noted that there are no particular grounds for the relative weightings of cultural, commercial and ecological criteria applied here. Perhaps the most important value of the analysis is that it equipped team members to approach and interact with community members from a reasonably well-informed position, and to ensure that relevant issues were well-canvassed during consultations.

4.2 Classes of use

The range of species presented in Appendix 1 is large enough to be confident that most potential commercial uses were considered, so that discussions with communities could explore the full range of options and issues raised by harvests of different types and for different purposes or markets. The potential commercial uses identified in examining this list can be conveniently subdivided into several classes:

1. bushfoods (or native foods) for the wider market;
2. traditional foods for sale and consumption within communities;
3. live plant trade;
4. arts and crafts based mostly on woody plants;
5. timber extraction;
6. botanical medicines;
7. volatile oils;
8. novelties or education items directed at the tourist trade; and
9. various complements to other activity.

These options were all considered, in various levels of detail, by all of the communities with whom we interacted. The distribution of plants in Appendix 1 among these categories is in Table 1.

Table 1: Categorisation of uses for 122 haphazardly chosen species considered as sources of potential commercial products (see Appendix 1). Note that at the request of the Balkanu Cape York Development Corporation, details of some options have been removed from the Appendix.

Categories of Plant Product	Number of species
Bush- or native foods	43
Traditional foods for sale and consumption within communities	7
Live plant trade	38
Arts and crafts based mostly on woody plants	7
Timber extraction	8
Botanical medicines	3
Volatile oils	3
Novelties or education items directed at the tourist trade	6
Various complements to other activity	2

4.2.1 Bushfoods

It was inevitable that selection of plants based on an ethnobotanical database would identify many options to use plants as food. Many fruits and nuts (seeds) were identified (41% of 122 species), but a number of other options, including teas and flavourings, also emerged during discussions with communities.

Many fruits raise problems with handling and storage. Nuts may be more readily dried and stored, and many species present in northern Australia have been recognised as having good potential as cash crops (Evans 1999). Extracting kernels locally may often be tedious and labour-intensive, but would reduce transport costs substantially. The potential of native nut crops would appear to justify further investigation.

4.2.2 Traditional foods for sale within communities

A number of communities identified plants that they considered might be cultivated preferentially for sale within communities, even if larger external markets were unavailable. Motivations were not explored in detail, but included: a desire to see money entering the community used to stimulate wider activity within it; and a wish to see fresher, healthier traditional foods available to community members. Cultivation of yams (especially *Dioscorea* species) was often mentioned in this context.

There was also interest in cultivating some plants around communities to provide material for propagation by others (e.g. for sale to plant nurseries or individuals), an option that had been identified earlier by the Daly River community (Leach and Daenardi 1999).

4.2.3 Live plant trade

Markets for native Australian plants for use in domestic gardens and commercial landscaping are large and they support a small but significant industry in northern Australia. Many plants are already used and industry members consider that most options have been thoroughly examined and commercially-rewarding options already been taken up. However, there may be some interest in plants with distributions that are confined to Aboriginal land that offer options to local communities unavailable to the wider industry. These might involve harvest of propagating material from rare plants or harvest of adults of more common plants. Unfortunately, regulatory regimes for rare or endemic plants may constrain commercial use even where methods or quota of use in no way threaten the status of the species in the wild (see Case study 1: Cycads, and Appendix 3.1)

A related option is the harvest of a range of plants with well establish uses (orchids, cycads, grass trees, valuable timbers) from areas scheduled for clearing to accommodate other use.

4.2.4 Arts and crafts

Many plants are traditionally used for the fabrication of utilitarian articles like baskets, strings, or hunting and foraging implements (e.g. spears and digging sticks). Others are used for less utilitarian but culturally significant objects, such as art works (carvings and paintings) and musical instruments (didjeridu and clap-sticks). A substantial industry has developed around the sale of these and a range of derived products to individuals and institutions. Many of the species identified in Appendix 1 are used in this way.

In some cases, the particular plant materials used have changed to allow production in larger numbers than used by communities prior to the emergence of related industry. For example, softer woods of more readily available timbers have sometimes been substituted for carvings, in preference to hardwoods. Communities expressed no particular interest in seeking additional options or substitutions for production reasons, but in one case (Maningrida) sought identification of alternatives that may be more resistant to insect (borer) attack. Many items have been rendered unsaleable by borers (Phillips 2001). The Maningrida community also sought studies of the sustainability of harvests of *Bombax ceiba*, the softwood currently most used for carving.

The Jawoyn are concerned to halt illegal commercial harvesting of *Eucalyptus phoenicea* stems for didjeridu manufacture, and are seeking support to develop management plans to ensure sustainability of harvests of such stems from Aboriginal lands (Forner 1999).

Some have expressed concern at the impact of bark removal (for paintings) on large stems of the dominant *Eucalyptus* species. This issue is being investigated as an extension of the present project (A.D. Griffiths, unpublished data).

4.2.5 Timber extraction

Large scale forestry operations have a rather chequered history in northern Australia, with a number of spectacular failures in the Northern Territory. A Parliamentary review of the use of public funds for this purpose concluded that claims of commercial potential had been systematically exaggerated (Lacey 1979). Aboriginal people have been involved in several major ventures in the Top End, including establishment of plantations of several species at Maningrida and the Tiwi Islands. Early plantations were established without much regard to genuine Aboriginal involvement in decision-

making, and this may in part be influencing contemporary attitudes to forestry. However, views are by no means uniform. Landowners and community representatives in the Maningrida area have in the last few years rejected proposals to develop large plantations (>30,000 ha) of the introduced *Acacia mangium*, while Melville Island people embraced the opportunity (see the National Forest Inventory 2003 for further details). Clearing for establishment of *A. mangium* plantations is now in progress on the Tiwi Islands.

Currently exploitation of timber for building materials is limited. A few small-scale operations exist in the Darwin region and in Cape York to satisfy demands for hardwood flooring or low volume furniture manufacture. In the past, overseas developers have proposed harvest of some slow growing hardwoods for veneers (P. Fitzgerald, PWCNT, pers. comm.) but these ventures, in common with so many others, have collapsed.

However, interest has been expressed in "salvage" of stems from areas proposed for tree clearing for other uses. Examples include clearing for plantation development on the Tiwi Islands, mining operations on Cape York and, more generally, clearing for roads or tracks. Obviously such operations could not form the basis for long-term, continuing industry and would require intensive pre-clearing survey to determine materials available and prior approaches to would-be markets with information on quantities and qualities available. Nonetheless, experience gained through salvage operations may provide the information and develop the skills needed to design and construct longer-term operations based on small-scale sustainable timber extraction.

4.2.6 Botanical "medicines"

Alternative approaches to the maintenance of human health and treatment of minor ailments have become popular in Australia and many other affluent nations, to the extent that there are now large industries providing products and services (Laird 2000). Examples include natural medicines such as Ginseng, and St. John's Wort. Their popularity is at least in part derived from preferences for natural products and styles of treatment rather than the synthetic remedies and more aggressive interventions characteristic of modern medicine.

Our limited desk-top survey was striking for the proportion of plants that Aboriginal people traditionally employed as remedies for ailments such as gastro-intestinal upset, respiratory problems, skin conditions, pain relief and the treatment of wounds (Appendix 1). Users of alternative therapies may particularly value connections to traditional use (e.g. Olsen 2000). Interest was expressed, particularly by Aboriginal people in Cape York, in exploration of options relating to a number of plants with aromatic properties.

4.2.7 Volatile (essential) oils

Essential oils are volatile, aromatic substances obtained from plants, often by processes of steam distillation. They are used as flavourings and fragrances in food, soap, perfumes and lotions. As noted above, some of these substances are thought to have medicinal properties.

Australian species are already important in the marketplace, with both *Eucalyptus* and *Melaleuca* species being used in large quantities here and overseas (Boland et al. 1991). Indeed, China has come to dominate production of many oils through establishment of large plantations and production of large quantities at lower cost than other locations. Brophy and Moran (1996) have examined the potential for new products from a number of genera found in the Australian tropics. Not included in their examination was a recent entrant to the market, the oil of the native pine, *Callitris intratropica*, which has been marketed as Australian Blue Cypress Oil "the Essence of Sydney 2000 (Olympic Games)" (Olsen 2000). A number of other north Australian species have oils that would appear to have some commercial potential (Brophy and Moran 1996).

There was interest in exploration of potential uses for other species from some Cape York people but further research has been delayed because of concern by Traditional Owners about intellectual property rights (see below).

4.2.8 Novelties and educational items

As noted later in this report, there are often significant obstacles, associated with remoteness and infrastructure limitations, constraining Aboriginal entry to larger markets. Small, remote and weakly serviced communities suffer cost penalties that compromise effective competition with other larger-scale producers. However, some industries, such as arts and crafts, clearly derive their strength from links to a unique culture. Whilst few other industries are likely to enjoy such benefits, there may be options that benefit from other connections to the lives of Aboriginal people. Alternative therapies, volatile oils, bushfoods (but see also Cherikoff 2000) and some elements of the plant nursery trade are among the possibilities.

In addition, some communities have expressed interest in marketing small quantities of some plant items, including fruits, packaged with details of their significance to Aboriginal culture and accompanied by associated traditional stories (see, for example, Case study 3). These items would not be intended so much for consumption as a complement to and reminder of other experiences, especially indigenous tourism. Emphasis would be placed on those items that are conspicuous in the landscape or are the particular focus of some tourism experiences (e.g. bush tucker walks).

4.2.9 Complements to other activity

We noted early in this report that the success of enterprises in Aboriginal communities may be judged by criteria that go well beyond the strictly economic. In addition, some enterprises may be assessed not only on their internal economics, but also by their contribution to the quality and economic success of other activities. In this context, some communities have expressed interest in plantings of relevant species to support tourism. For example, availability of some fruits may vary markedly seasonally and from year to year. Well-chosen and well-maintained plantings may be useful to ensure that tourists have reliable access to bush-tucker items. Sustainability of the use of natural stands of plants used for weaving or carving may be improved if additional plantings are made. Cultivated stands may be used to provide additional income through sales of propagation materials to visitors or commercial interests. Community members report frequent requests for propagation material for bush tucker plants.

It will also be obvious from Appendix 1 that many perishable items are highly seasonal in their availability. If Aboriginal communities are to develop relationships with buyers and provide year-round options for employment, it may be necessary to develop a range of products of similar types but with different seasonal schedules, to extend continuity and duration of supply.

4.2.10 Overview

This brief review, using readily available information, indicates that there are many plants available to north Australian Aboriginal communities that offer at least some potential for commercial use. Although the ecological knowledge base is often weak, lack of relevant ecological information is rarely likely to be the dominant constraint on achievement of sustainability. Monitoring systems can be designed relatively simply to provide information needed to improve management capability and ensure sustainable practice, if regulatory frameworks are also robust. Robust frameworks will not only be capable of encouraging acceptable practice, but will avoid arbitrary constraints that are not based genuinely on issues of sustainability.

Inadequate knowledge of potential markets is of much greater significance. Poor information on potential demand and price, and the elasticity of price with variation in supply and demand, present much greater risks to communities contemplating significant financial and social investment. Decisions leading to major and inflexible commitments to commercially marginal enterprise are likely to greatly increase pressure to challenge ecological limits, irrespective of the quality of information available.

4.3 Matching ranked options with community interests

The interests identified by Aboriginal people at two different communities are summarised in Tables 2 and 3, and compared collectively with our *a priori* rankings (Appendix 1) in Table 4. There is an undeniable mismatch between the overall ranking of options and the expressed interests of many communities (Table 4). There are also marked differences in the range of options currently considered by different communities, suggesting that both the criteria they applied and the manner in which options were ranked, differed among those groups. There are many potential explanations for the mismatch between our ranking and community preferences, but the most significant appear to be:

- greater community interest in highly familiar plants with well-established local uses rather than those that may offer a commercial market involving unfamiliar uses;
- well-established local enterprise based on particular plants (e.g. use of Bombax ceiba for art manufacture in Maningrida);
- a desire to engage in enterprise that also makes non-commercial contributions to community well-being: for example, cultivation of traditional products considered important for health (e.g. yams) to replace "imported" alternatives;
- the personal biases of researchers who deliberately or otherwise emphasise certain options so that the community position is not a fully-informed one;
- influence of community advisers who also bring personal interests (but also a great deal of relevant experience) to bear;
- regional differences in abundance and frequency and forms of traditional use of native plants;
- variation in the local availability of infrastructure suitable for supporting enterprise based on plants (e.g. plant nursery facilities and reliable water or power supplies);
- different views put by different segments of the community interacting with researchers (e.g. information predominantly provided by women in the Daly River community); and
- generally poor quality of information available to make "objective" assessments, particularly with regard to economic returns and markets.

More generally, it is likely that our analysis did not comprehensively encompass or adequately weight social and cultural criteria. While these issues were included in the ranking scheme, their influence on overall ranking of options was potentially small given the large number of criteria invoked (Boxes 2, 3 and 5). This result highlights the difficulty of identifying generic approaches or strategies for the identification and development of options.

Table 2: Species and options for commercial use of interest to individual homeland groups in East Arnhem Land.

Plant species proposed for use in the Yolngu Homelands

Common name (Rirratjunu name)	Scientific name	Yolngu community expressing interest
Billygoat plum (Mamanbu)	*Terminalia ferdinandiana, T. carpentariae*	Baniyala*, Dhuruputjpi*, Gurrumuru, Gangan
Black plum (Wanapu)	*Pouteria serica*	Baniyala, Gangan
Cheeky yam (Djitama)	*Dioscorea bulbifera*	Baniyala*, Dhuruputjpi, Gurrumurru, Gangan, Wandawuy
Cheesefruit (Gurrungurr)	*Morinda citrifolia*	Baniyala*; Gurrumurru*, Gangan
Cycad (Nathu)	*Cycas orientis*	Dhuruputjpi*, Gurrumuru*, Wandawuy*
Green plum (Dhurrpinda)	*Buchanania obovata*	Dhuruputjpi*, Gurrumurru, Gangan
Indian almond (Matpana)	*Terminalia catappa*	Baniyala*, Dhuruputjpi*, Gangan, Wandawuy*
Long yam (Manmuna)	*Dioscorea transversa*	Baniyala*, Dhuruputjpi*, Gurrumurru*, Gangan, Wandawuy*
Native fig (Djin'pu)	*Ficus superba*	Gangan
Native grape (Lingarr)	*Ampleocissus acetosa*	Baniyala
Native nutmeg (Ganmurru)	*Myristica insipida*	Wandawuy
Nut tree (Gutu)	*Terminalia grandiflora*	Dhuruputjpi*, Gurrumurru, Gangan
Red apple (Larrani)	*Syzygium fibrosum, S. suborbiculare*	Baniyala*, Dhuruputjpi, Gurrumurru, Gangan, Wandawuy
White apple (Larrani)	*Syzygium eucalyptoides*	Baniyala*
White currant (Gumbu)	*Flugea virosa*	Dhuruputjpi, Gurrumurru, Wandawuy

* indicates an interest by community elder(s) in cultivation or planting around the community

Table 3: List of species identified by the Daly River community as suitable for commercial and community use. Species marked * were also identified under an ACIAR project in 1999.

Species	Description	Potential use/product
*Acacia auriculiformis**	hardy, fast-growing large tree	use in revegetation and mixed agroforestry plantings
*Antidesma ghesaembilla**	slow growing tree	harvest of fruit
*Brachylstelma gabriflorum**	perennial producing small, disc-shaped tuber	edible yam
Cochlospermum fraseri	tree	edible flowers
*Cucumis melo**	small climber or shrub	edible fruit
*Dioscorea transversa**	climbing plant	edible yam
*Flacourtia territorialis**	shrub	edible fruit
*Flueggia virosa**	small, spreading shrub	edible fruit
Grewia asiatica	tree (exotic)	edible fruit
*Gyrocarpus americanus**	tree	artefact manufacture, rehabilitation
*Haemodorum coccineum**	tree	tubers used for dye; replanting in areas of high fibre-craft production
*Marsdenia viridiflora**	climber	edible fruit
Nelumbo nucifera	water lily	edible fruit/seed
*Pandanus spiralis**	palm	revegetation of wetter sites
*Piliostigma malabaricum**	tree	harvest of leaves as seasoning, flavouring
*Sesbania formosa**	tree	rehabilitation, pulp production
*Solanum echinatum**	small annual shrub	edible fruit
*Sterculia quadrifida**	large, deciduous tree	edible seeds, potential for use in agroforestry mixed plantings
*Syzygium suborbiculare**	tree	edible fruit, some potential in plantations
*Vitex glabrata**	perennial sedge	edible fruit

Table 4: Comparison of the plant-use options currently under active consideration by communities and a ranking of potential use based on a wide range of criteria (Appendix 1). The range of rankings was from 1 (high) to 21 (low).

Species	Community or region	Use	*a priori* Rank
Acacia auriculiformis	Daly River	use in revegetation and mixed agroforestry plantings	7
Ampleocissus acetosa	Yirrkala	wild harvest of fruit	14
Antidesma ghesaembilla	Daly River	harvest of fruit	12
Bombax ceiba	Maningrida	artifact manufacture	1
Brachystelma glabriflorum	Daly River	wild harvest of seeds and subsequent cultivation as landscaping/garden plant	21
Buchanania obovata	*Yirrkala*	*wild harvest of fruit as "filler"*	*9*
Cochlospermum fraseri	Daly River	fresh or dried flowers as garnish or novelty	9
Cucumis melo	Daly River	small climber or shrub, edible fruit	15
Cycas arnhemica	Maningrida	landscaping and garden plants	5
Cycas orientis	Yirrkala	landscaping and garden plants	6
Dioscorea transversa and *D. bulbifera*	Daly River Yirrkala	cultivation as vegetable	15
Ficus superba	Yirrkala	wild harvest of fruit	20
Flacourtia territorialis	Daly River	edible fruit	16
Flueggia virosa	Daly River, Yirrkala	edible fruit	17
Grewia asiatica	Daly River	wild harvest of fruit	15
Gyrocarpus americanus	Daly River	artefact manufacture, rehabilitation	11
Haemodorum coccineum	Daly River	tubers used for dye; replanting in areas of high fibre-craft production	4
Marsdenia viridiflora	Daly River	climber, edible fruit	14

Species	Community or region	Use	*a priori* Rank
Morinda citrifolia	Yirrkala	wild harvest of fruit for juice	8
Myristica insipida	Yirrkala	wild harvest of seed (nut)	10
Nelumbo nucifera	Daly River	wild harvest of flowers and seed	3
Pandanus spiralis	Daly River	revegetation of wetter sites	4
Piliostigma malabaricum	Daly River	harvest of leaves as seasoning, flavouring	13
Pouteria serica	Yirrkala	wild harvest of edible fruit	16
Sesbania formosa	Daly River	rehabilitation, pulp production	11
Solanum echinatum	Daly River	wild harvest of edible fruit	16
Sterculia quadrifida	Daly River	wild harvest of edible seeds, potential for use in agroforestry mixed plantings	12
Syzygium eucalyptoides	Yirrkala	wild harvest of edible fruit	13
Syzygium fibrosum	Yirrkala	edible fruit	13
Syzygium suborbiculare	Daly River, Yirrkala	edible fruit, some potential in plantations	12
Terminalia catappa	Yirrkala	seed for kernels (nuts)	15
Terminalia ferdinandiana	Larrakia, Maningrida, Yirrkala	wild harvest of fruit	3
Terminalia grandiflora	Yirrkala	wild harvest of seeds (nut)	15
Vitex glabrata	Daly River	edible fruit	16

Note: The match between these rankings and currently preferred options is poor (see text for discussion). Communities are interested in pursuing many options for species given a low *a priori* ranking by researchers. Note that a number of options being considered by Cape York communities have been omitted from this summary at the request of the Balkanu Cape York Development Corporation.

4.4 Assessing commercial sustainability of preferred options

Our most detailed assessments of the economic performance of the options identified by participating Aboriginal groups and their agencies are in the Case Studies set out in some detail in Appendix 3. We have also summarised the major outcomes from those studies below. We do not suggest that these assessments are complete, in that we have not sought to develop full business models nor plans. A much more extended study involving a greater range of expertise would have been necessary to achieve that desirable end. Rather, we consider that we have done enough to indicate whether the different proposals have prospect of reasonable returns on investment in time and other costs.

However, perhaps the most important outcomes from the trials are yet to be manifest. Trials have often advanced sufficiently to provide new information about costs and related issues, but they have yet to result in substantial quantities of product entering markets. Given that some of the items produced are novel, it is only by entering markets that a robust estimate of demand and price will be available. Industry and academic participants are committed to the next phase of the project, which will continue for about 2 years after the submission of this report. The Northern Territory Government has entered into a formal agreement with the Northern Territory University to pursue development of options.

4.4.1 Case study 1: Cycads

This trial examined a wild harvest of stems of *Cycas arnhemica*, a plant endemic to central Arnhem Land, and hence a resource existing entirely on Aboriginal land. Cycads are valued as decorative plants in pots, in domestic gardens and in larger landscape features.

Prices paid for individual stems of other cycad species exceed AUS$1000 in some markets, but prices commanded for this species are unknown. Approaches to potential buyers returned offers of about $1.00 cm^{-1} of stem or $100 for a relatively large specimen, up to an order of magnitude lower than retail prices. This result is not unexpected, but it will be necessary to test the market before a realistic assessment of price can be made. The total market for large stems for domestic use can be expected to be relatively small and it may be necessary to access overseas markets to achieve optimal returns.

The average size of stems extracted in this trial was 27 cm. Non-wage costs (vehicle equipment use) of extracting stems was $4 per plant. Average time devoted to each plant (digging, temporary storage, loading and transport) was 2.4 h. Establishing them in a nursery generated fixed costs of about $3.90 per plant, and required investment of time of around 1.5 h. Transport to markets in Darwin has been estimated at $7.00 per plant. Subsequent trials suggest that plants may experience substantial deterioration in condition during shipment in containers. It may be necessary to examine other potentially more expensive options. At the prices so far offered by wholesalers, the return on labour to provide a stem established in a nursery would be about $3.10 h^{-1}, less than a third of CDEP (work for the dole) rates ($10 h^{-1}). However, we consider that in a fully commercial operation, effort required would be reduced to about half that recorded in this trial.

A substantial additional cost has been imposed by a requirement for the harvesting group to establish a very elaborate monitoring scheme. The scheme has been dictated by the listing of *C. arnhemica* on Appendix 2 of CITES. This imposes special obligations on the national and local management authorities. Cost of compliance with this scheme, assuming a harvest of 300 plants p.a. over 5 years, is $16.50 per plant. Even with optimistic assumptions about increased harvest efficiency, meeting this cost reduces returns to a clearly unsustainable rate of about $1-2 h^{-1}.

The perversity of this situation is exacerbated by the fact that the monitoring scheme is poorly calculated to provide information on the status of the regional cycad population (it samples a very

small area very intensively and records data on growth that is not needed for a regional assessment). The harvest is quantitatively trivial and probably requires no special monitoring system, let alone a scheme designed to return information relevant to cycad demography rather than condition of the harvest site.

4.4.2 Case study 2: Kakadu plum

The fruit of the Kakadu plum *Terminalia ferdinandiana* has been in demand for some years as an additive to jams and sauces and as an element of some restaurant meals (Woods 1995). In the recent past, buyers have been able to meet their needs at a price of around \$10.00 kg^{-1}. However, recent increases in demand and the entry of Coles-Myer into the market through an arrangement with Robins Australian Foods has seen a proposed increase in price to \$20 kg^{-1}. We estimate that harvesters in good sites can pick about 1 kg h^{-1}, suggesting that reasonable returns on effort may be achieved.

However, costs of transport from remote collection sites are potentially as high as \$5-8 kg^{-1}, and accessing the higher price may depend on arrangements to stockpile fruit, which will in turn require infrastructure (e.g. reliable power and refrigeration) that is unavailable at many remote sites.

Reasonable returns also depend on access to relatively high density sites, so that search for, and travel time between, fruiting trees does not add significantly to costs. Such sites are not uniformly distributed in the landscape and will be readily identified and heavily exploited close to settlements and major centres like Darwin. Returns on effort will reduce rapidly if different groups seek to use the same sites.

4.4.3 Case study 3: Lotus lily

The lotus lily *Nelumbo nucifera* is widely distributed across Asia and northern Australia. It grows in permanent and semi-permanent wetlands and produces conspicuous capsules containing numbers of large seeds. The seed are used in Asia and by Aboriginal people for food. Prices that might be paid for fresh product in Australia are unknown, but the dried seeds imported from Asia sell in Darwin for about \$10 kg^{-1}.

Rate of collection of experienced harvesters was about 0.8 kg h^{-1}. Costs of getting seeds to market may be substantial, depending on harvest sites. Like many other native food products, distribution in accessible parts of the landscape is highly clumped (on the few wetlands remaining at the end of the dry season), so there is a risk of over-harvest: competition between groups using the same sites could greatly reduce average returns.

A Daly River community has collaborated in the design of a pamphlet telling the story of the lotus lily from an Aboriginal perspective, to accompany a package containing a small sample of dried lotus lily seed and directed to the tourists who are attracted to the local Art Centre. Interviews suggest that \$10 per item would be regarded as a reasonable price. At this price participants appear able to achieve a ten-fold increase in return on effort, although total volumes are likely to be small and represent a small increment on community income. Risks of over-harvest and decline in average returns on labour are greatly reduced if the “value-adding” strategy is adopted in preference to supply as a food.

4.4.4 Case study 4: Long yam

The long yam *Dioscorea transversa* is an important food item for coastal people of the Top End. The yams are tubers of a vine that grows among monsoon vine thicket vegetation in a range of situations. We did not identify the long yam as a candidate for commercial use, but a number of Aboriginal groups were interested in making the plant more available to members of their communities. This interest was one expression of a wider concern about the health effects of diets dominated by refined, store-bought food.

A great deal of labour is required to locate and extract yams, even by the most skilled. Harvesters were able to take about 0.45 kg h^{-1}, or 0.30 kg h^{-1} if travel time to and from harvest sites was included. We were able to get no indication from bushfood interests of a reasonable price, but yams of various sorts of Asian origin are available in Darwin at about \$10 kg^{-1}. The return on effort is perhaps too low to realistically use wild harvest to satisfy even within-community demands at prices that are likely to be acceptable to harvesters. The relatively low return for effort on long yams is consistent with Altman's (1987) calculations of the imputed value of women's often labour intensive food gathering activities, compared with hunting of larger animals done mostly by men.

Segments of the tuber shoot readily and cultivation from seed also appears feasible. It may be possible to develop low cost ways of cultivating yams in the plant nurseries that many communities operate at varying levels. This prospect warrants further investigation, which is presently being advanced.

4.4.5 Case study 5: *Bombax ceiba* and its use as carving wood

The large tree *Bombax ceiba* is relatively common in monsoon forests and thickets, especially in coastal areas. Customary use includes construction of canoes and the species has more recently (in the last 20+ years) been used for the production of sculptures for commercial sale from the Central Arnhem Land town of Maningrida. Sale of carvings has become a thriving regional industry.

Much has been written about the economics of the arts and crafts industry and we did not engage in further examination of these issues. Rather we responded to a request from the Bawinanga Aboriginal Corporation, which was concerned about the sustainability of use of this species, given ongoing growth in sales of carvings.

We found that a relatively small proportion of the total regional population had been cut over more than 2 decades, and that most cut stems resprouted. While the rate of regrowth of coppices and other recruitment to the population is unmeasured, the harvests appear likely to remain within sustainable limits. In 21 years some 4600 trees have been cut and in the year 2000/2001, the harvest took about 1.8% of the region's population of adult trees. It appears that cut stems may recover to harvestable size in 20 years or less.

We conclude that it is unlikely that, with prudent management, the continued commercial growth of the carving enterprise will be constrained by depletion of this important resource. However, further measures of regrowth and plant recruitment is advisable.

4.4.6 Case study 6: Miscellaneous

Here we very briefly examined options involving two species (*Grewia asiatica* and *Ocimum tenuiflorum*) proposed for limited use in connection with other (tourism) enterprise. The *Grewia* (Wild plum) would be presented as an example of bush food and linked to regional history, especially the role of Chinese miners in introduction of the plant. The *Ocimum* (bush tea) was proposed to be used in a similar way but sold in small quantities for making "bush tea".

Neither option is likely to be commercially attractive in isolation because the sums involved are too small to justify investment in mechanisms for distribution and sale. They perhaps have the potential to generate good returns on effort if linked to existing tourism operations. These items provide good options for diversifying existing operations and filling gaps in a seasonal calendar of bushfood availability.

4.4.7 Case study 7: Didjeridu harvest

There is no doubt that sales of didjeridu offer opportunities for commercially viable enterprise. Indeed, the industry has been sufficiently attractive to bring many non-indigenous people into the market (see Taylor 2003). It is the interaction between commercial success and ecological and cultural sustainability that we examine in the case study, focusing on the tree *Eucalyptus phoenicea* (refer to Appendix 3.7).

4.5 Assessing ecological sustainability for preferred options

4.5.1 Case study 1: Cycads

The area of 8,600 ha harvested in this trial contains several million cycads. At the proposed rate of extraction of 300 stems p.a., each harvested plot could be rested for more than 5,000 years before being re-harvested. The present harvest is self-evidently sustainable.

It is probable that a very much larger harvest could be sustained without significant impact on the regional population, and this may ultimately require information of the sort demanded by the regulatory agency. Work is currently being done on congeners which will result in detailed population models (Liddle, 2004). These could be applied to manage *C. arnhemica* harvests while detailed demographic information is gathered from the monitoring plots. Constraints on a sustainable enterprise are unlikely to derive from the health of the resource, which is large and well managed (protected from hot fires) by the local community.

4.5.2 Case study 2: Kakadu plum

A huge resource is available over much of the Top End and beyond, producing many thousands of tonnes of fruit. Present commercial demand of about 5 tonnes represents no threat to the species as a whole. However, the trees are not uniformly distributed through the landscape, and there will be a tendency to focus harvest on accessible “clumps” of trees. The potential for local over-harvest will require management. Maintaining customary use while managing commercial use to inhibit over-harvest may present considerable challenges for communities on whose lands particularly favourable patches are located. We did not actively investigate mechanisms by which this might be achieved or get suggestions from participants, but consider some options later in this report. Management authorities (Parks and Wildlife Commission) have imposed no requirements to monitor the resource on harvesters receiving permits to sell Kakadu plum.

4.5.3 Case study 3: Lotus lily

Like many other native foods, distribution of lotus lily is highly clumped (on the few wetlands remaining at the end of the dry season). The traditional owner of the lands on which we conducted trial harvests recognised the risk of over-harvest if they sought to service markets seeking large quantities for food. This led to a suggestion to sell the connection of Aboriginal culture to the fruit, rather than large quantities of the fruit itself. The community has collaborated in the design of a

pamphlet telling the story of the lotus lily from an Aboriginal perspective, to accompany a package containing a small sample of dried lotus lily seed and directed to the tourists who are attracted to the local Art Centre. Volumes required for this communal use are likely to be small and ecologically insignificant.

4.5.4 Case study 4: Long yam

As with the other items we have considered in detail, the distribution of yams is patchy and confined to well recognised sites, creating the potential for local over-harvest. We have suggested that effort required to harvest long yam is too great to be used to satisfy commercial demands even within communities, and proposed that cultivation be attempted. Taking the stock of tubers and seed required to provide for propagation is unlikely to threaten the status of the wild populations. However, should the practice of seeking wild stock for cultivation become established, it will be desirable to vary sources to ensure that accessible sites are not excessively used.

4.5.5 Case study 5: *Bombax ceiba* and its use as carving wood

We have calculated that the number of adult trees cut over the last 21 years is equivalent to about 19% of the present adult population. *Bombax ceiba* coppices readily and is a relatively fast-growing tree, so all we have suggested is that present rates of use pose little threat to the status of the population as a whole (Griffiths et al. 2003). The location of many of its preferred habitats means that some local populations will probably never be cut. As a corollary, some patches have been and will continue to be cut at considerably higher rates, presenting a risk of local over-harvest. There is strong incentive to cut at accessible sites, because harvesters are otherwise required to carry logs (often on their shoulders) for considerable distances.

Whilst most cut trees will ultimately recover through re-sprouting, the dynamics of regularly cut populations are poorly understood, and some caution is warranted. Local custodians have recognised this difficulty and are already making decisions to avoid further cutting in highly accessible sites that have previously been heavily used.

In order to better understand the demography of the species and the demands that the arts trade is placing on it, the users (Maningrida Arts and Culture) are implementing systems to better identify the type of wood used in carvings and trends in use of all species. Together with long-term monitoring of stands in harvested and unharvested jungles, these initiatives will provide the information needed to develop population models capable of predicting impacts of prevailing and projected harvest regimes. The necessary monitoring regimes and associated institutional arrangements are being developed as part of a PhD project supported by the Australian Research Council (Koenig et al. in press).

It is notable that the need for this work was identified by the community and that some senior traditional landowners have emphasised their obligation to ensure that the trees are “looked after” on the land for which they are responsible. Regulatory authorities have sought no monitoring of this form of use.

4.5.6 Case study 6: Miscellaneous

Both wild plum and bush tea occur at moderate densities in relatively small patches. In common with most other bushfood items, there is considerable risk of local over-harvest. For the exotic wild plum, this does not present a conservation problem. However, if substantial markets developed for bush tea (as distinct from the novelty market we discuss here), then it would be wise to consider cultivation.

4.5.7 Case study 7: Didjeridu harvest

Customary harvesters are highly selective and take a small number of stems from any single location. If existing patterns of less discriminating commercial cutting are maintained, then usage of *Eucalyptus phoenicea* in the Katherine region is probably unsustainable. Many tens of thousands of stems are being cut, often involving clearing of most stems at a local level. The species itself is not at risk, but over-cut sites will suffer ecological change detrimental to wildlife and other values. The principal requirement is for better regulation and greater market recognition of authentic items produced within a collaborative management framework. This will require collaboration between the Parks and Wildlife Commission, Northern Land Council, Jawoyn Association and affected landowners.

4.6 Cultural sustainability

4.6.1 Case study 1: Cycads

At Maningrida, no objections to harvest of cycads for sale have been raised by participants in trials or others with whom the ideas have been discussed. The harvest is so modest that access to cycads for customary use is in no way threatened and so presents no special management problems. The reticence of the Yolngu to become involved in harvest of a similar endemic species does not necessarily represent concerns about the project, but rather a determination to follow due customary process. This experience highlights the important role of customary management systems and the obligation to match timetables to the demands of those systems.

4.6.2 Case study 2: Kakadu plum

There appear to be no unique cultural concerns about sale of this fruit taken in wild harvest. However, there is some risk that intense local harvest could compromise customary use. Returns on effort are likely to be sufficient to encourage some harvesters to persist with collection at very accessible sites after fruit volumes have been reduced by prior harvest and so greatly reduce fruit and seed availability for other users. Long term impacts on local recruitment of new trees might also be anticipated, which would also affect customary use.

4.6.3 Case study 3: Lotus lily

A senior traditional owner at the experimental harvest site has raised concerns about the risk of over-harvest. This concern may relate to direct detrimental effects on customary use or concerns about the longer-term condition of the resource. The concern resulted in a shift of emphasis to lower volume use. That shift had the additional benefit of engaging some members of the community in promoting understanding of the significance of the plant and recording customary knowledge. Total incomes from the proposed use as tourist items are small, but the proposed use fits well with the community's general emphasis on presenting Aboriginal culture through mediums that are accessible to non-Aboriginal people.

This trial is presently on hold while the Northern Land Council ensures that all relevant traditional owners at potential harvest sites are properly consulted and all necessary permissions have been obtained.

4.6.4 Case study 4: Long yam

Increasing access to this food among Aboriginal people was seen as perhaps the most important reason for considering commercial harvest. Thus it may be seen to foster rather than threaten cultural interests. Widespread over-harvest appears improbable given the likely limited return on effort, but if focussed at a few accessible sites may intrude on customary use, which appears to be very important to older woman in particular. Emphasis on cultivation will reduce potential for conflict with customary use.

4.6.5 Case study 5: *Bombax ceiba* as carving wood

A number of traditional owners and custodians expressed their commitment to maintain populations of *Bombax ceiba*. A failure to manage harvests and consequent over-cutting would cause considerable concern. Locals recognised the risk and had taken steps to improve management and monitoring prior to this project. Sale of carvings and other arts and crafts dependent on plants as the medium has been an important expression of culture in the region and evidence of its valuation by the wider Australian society. This tangible recognition has in turn helped sustain the culture. Developing management and monitoring regimes that respect local interest and provide an appropriate level of local control would be consistent with the significance of this activity to the maintenance of culture.

4.6.6 Case study 6: Miscellaneous

Both wild plum and bush tea involve low volume options that should not conflict strongly with customary use. In common with the *Nelumbo* (lotus lily) example, they celebrate Aboriginal culture and promote wider appreciation of its values.

4.6.7 Case study 7: Didjeridu harvest

The history of the didjeridu industry presents a particularly compelling example of the difficulties faced by Aboriginal entrepreneurs and craftsmen in protecting and servicing a market that grows rapidly. Many, perhaps most, didjeridus entering markets are probably now made by non-Aboriginal people, often using stems obtained illegally (without permits) or stolen from Aboriginal land. This situation reduces incentives for young people to develop skills and knowledge and so may damage culture. There is an important role for Aboriginal Arts and Crafts Centres to aggressively promote recognition of the cultural significance of items such as the didjeridu and the role of the consumer in helping to promote sustainable practice by seeking authentic items produced within a sound management framework.

4.7 Strategies for realising opportunities

It had been anticipated that the development and review of strategies for the realisation of commercial opportunities would occur in conjunction with workshops organised as an element of this project. However, it quickly became apparent that Aboriginal participants wished to gain experience with individual projects before discussing more comprehensive initiatives. Rather than strategies, the major workshop involving a number of communities from the Top End and Cape York produced statements of principles and a series of questions that Aboriginal people considered important in reaching decisions about commercial use of plants.

Important issues and suggested guidelines for enterprise development were:

- planning for developments should always be carried out “on country”;
- traditional land owners (as distinct from other residents) must be involved at all stages;
- benefits should be shared equitably among traditional owners and those working directly on enterprises;
- developments must be designed to respect plants, sites and culture;
- community leaders should provide cultural and operational guidance;
- steps should be taken to involve more young people in all aspects of such projects;
- opportunities for people of all ages to work together on country provided by such projects should be exploited to encourage inter-generational transfer of cultural and biological knowledge;
- communities seeking involvement should identify and pursue sources of support to establish nurseries on communities; and
- training and accreditation should run in conjunction with business development.

Questions that require answers to facilitate and foster developments included:

- How can intellectual property be protected so that ideas and knowledge are not abrogated and exploited by others?
- Can systems of authentication be developed to verify production by Aboriginal people and how much benefit will such certification bring in the marketplace?
- Will a coordinated and cooperative approach to marketing and harvest be feasible and produce benefits for Aboriginal people?
- How can permit and product tracking systems be designed to ensure sustainability?

It is reassuring that the issues raised by Aboriginal participants at the workshops are similar in range and emphasis to those identified during the implementation of trial harvests. These issues and questions and their implications for strategies for enterprise development are considered further in the Discussion (Section 5).

In addition to these more generic issues, participants made suggestions about the additional options to which they would give some priority. These included:

- dried and fresh flowers, fruit and leaves for incorporation in floral arrangements
- herbs for use as flavouring and potpourri
- insect repellents based on customary practice
- additional fresh bushfoods, especially fruits, for sale in local community stores
- extension of perspectives to include animal products.

4.8 Communication and review

The primary communication tool employed in this project is the active participation of Aboriginal people and their agencies in all facets of the work. In addition, summaries such as the case studies were circulated to individuals for comment prior to inclusion in this report. The report as a whole has also been circulated to those same groups and includes responses to queries or concerns raised by them.

Discussions during planning and implementation of trial harvests influenced the direction of some projects and interpretation of results. The November 2001 workshop in Nauiyu also exposed all aspects of the project to scrutiny from a large number of Aboriginal people, and resulted in considerable feedback about the outcomes (summarised above).

However, the workshop also raised some fundamental issues that require further discussion. The Key Centre for Tropical Wildlife Management and its partners have an ongoing commitment to active and relevant communication with Aboriginal people. As a tangible expression of this commitment, research in this area has specifically identified a Memorandum of Understanding between the Northern Territory Government and the Northern Territory University (now Charles Darwin University). We will be working collectively to produce material relevant to many of the queries raised by Aboriginal people and to maintain communication during the trial harvests initiated as part of the project, and beyond.

5. Discussion

This project sought to examine the feasibility of small-scale enterprise by Aboriginal communities using native plants. Our initial approach was to use a desktop analysis to identify candidate species based on criteria that we thought informative with regard to ecological, commercial, and social sustainability. This process was intended explicitly to confront the question of feasibility by identifying a group of species and options for their use that were matched to the physical, ecological and cultural landscape of northern Australia. The results of this initial exercise are in Appendix 1.

However, it quickly became apparent that Aboriginal participants in the project brought to bear a somewhat different set of criteria. Their preferences were apparently more strongly informed by social considerations than were ours, which weighted different sets of ecological, economic and cultural criteria approximately equally. Thus the congruence between our *a priori* rankings and the options emerging from early consultations was poor (Table 4 and Figure 2). This mismatch was probably to be expected. Nonetheless, it was an important result because it reinforced the need for ongoing consultation to allow the project team to better understand community perspectives, and for the utility of the information and analysis available from the research group to be better appreciated by Aboriginal participants.

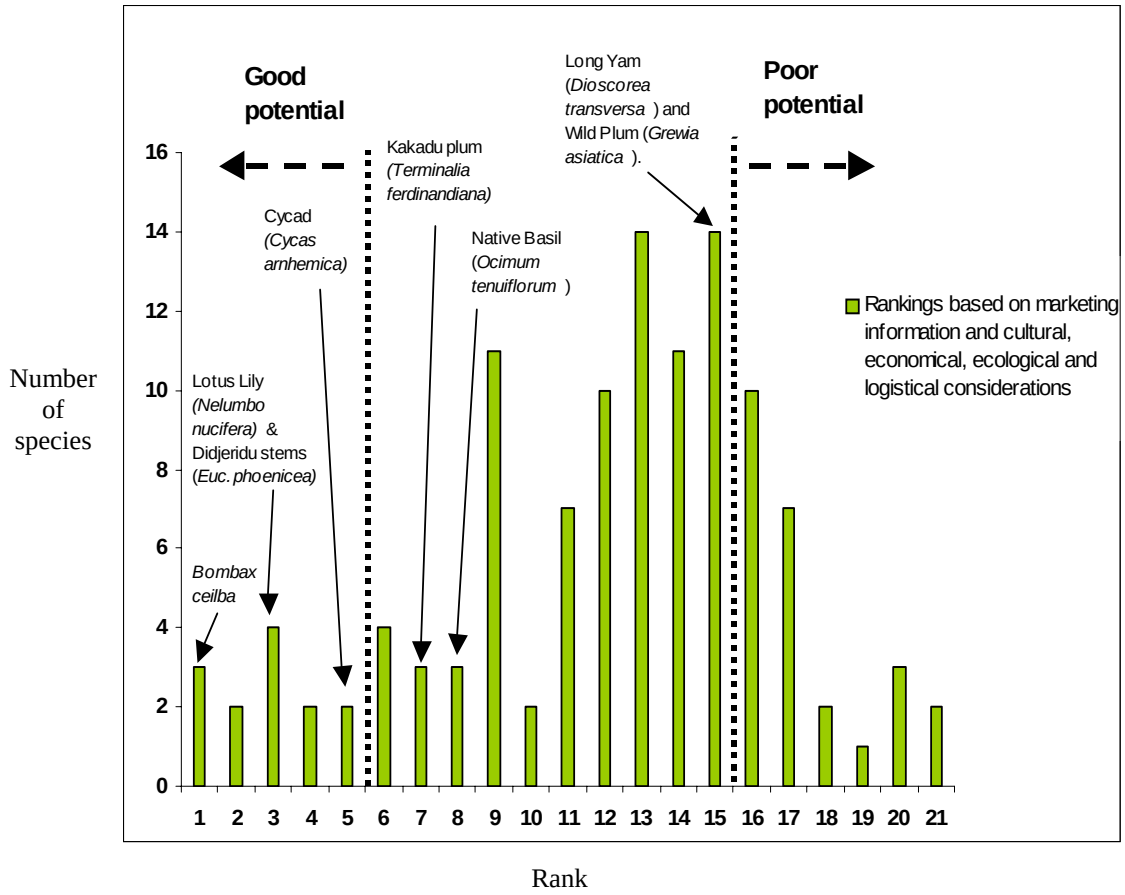

Figure 2: Number of species given each *a priori* ranking of overall "suitability" based on initial desktop exercise (see Appendix 1). Rank 1 has the highest *a priori* potential and rank 21 the least. Positions of species examined in case studies are shown.

It is also important to note that while the congruence between *a priori* assessments and community preferences was poor overall, there was sufficient agreement for a number of species (those ranked 6 or above in Table 4) to allow agreement about harvest trials. In regard to those community priorities that we had previously ranked very low (e.g. long yam), we were mindful of the operational axioms (see Section 1 Introduction) on which the project was built. Hence our willingness to follow the lead given by the Aboriginal participants.

5.1 Categories of use

The range of options identified by our *a priori* analysis and Aboriginal participants could be conveniently summarised in eight categories. Our trial harvests deals with five of the categories and the issues raised by Aboriginal participation in them are dealt with under the discussion of those trials (sections 4.4–4.6 and Appendix 3). Here we consider some issues associated with those categories that we have not explored through the experience of a trial harvest: namely timber extraction, botanical medicines and volatile oils.

5.1.1 Timber extraction

During the project no opportunities presented for engagement in this activity. Two possibilities mooted included salvage from lands being cleared for *Acacia mangium* plantations on Melville Island and from lands scheduled for strip mining for bauxite on Cape York. Rates of land clearing are accelerating in northern Australia and trees are mostly chained and burned. Potentially valuable timbers include ironwood *Erythrophleum chlorostachys*, which is abundant over much of northern Australia and is used for furniture and floorings. It is likely that Aboriginal groups will from time to time seek support to develop options for salvaging timbers, perhaps supplemented by selective logging. However the long history of failure in forestry-related industries (Lacey 1979; Woinarski and Dawson 2002) may discourage some groups from entering this area again.

Perhaps more important, exploiting such options requires a substantial investment in equipment (trucks, portable mills, storage and drying facilities) that few groups will be in a position to make, or even wish to consider early in the development of enterprise based on plants.

A more detailed study of potential markets, volumes and quality of timber is desirable, and some relevant work has been done under an ACIAR funded project in Cape York ('Enhanced resource use planning for tropical woodland agro-ecosystems' ACIAR Project No. LWR2/96/163).

5.1.2 Botanical “medicines”

Botanical medicines are generally produced directly from whole plant material. As a consequence they contain many compounds. The high cost of determining in a scientifically rigorous way the individual and collective actions of many different compounds, taken simultaneously, has meant that the mode of action of these “medicines” is often poorly understood. Rather than being treated by regulators as medicines with well understood clinical effects, they are often lumped with dietary supplements. Traditional use is accepted in many regulatory systems as evidence of the safety and efficacy of such plant preparations (Laird 2000).

Should Aboriginal people seek to introduce a botanical medicine based strongly on traditional application, they should be in a strong position to influence the decisions of regulators and hence access to markets. However, if a use is already documented, as is the case for many plants and plant extracts (e.g. Anon. 1988), then other entrepreneurs might also use that information to seek approval to market a related product. As far as we have been able to ascertain, there would be no obligation to compensate Aboriginal people for the use of information that was instrumental in achieving

registration. Indeed, it might often be difficult for the providers of relevant information to be identified, except where they were recognised as authors on relevant ethno-biological literature (e.g. Lindsay et al. 2001).

Exceptions to this general situation might arise if material was sourced from Commonwealth lands. Regulations under the *Environmental Protection and Biodiversity Conservation Act 1999* have been drafted (but not yet ratified) to give effect to benefit sharing arrangements. Agreements must contain reasonable arrangements, including protection, recognition and valuing of, any Indigenous knowledge provided by the access provider. States or Territories are yet to enact similar provisions.

The botanical medicines market is a large and expanding one (Laird 2000). Although we did not identify a particular candidate for entry to this market, it would be surprising if the long-term occupants of a mega-diverse continent with many unique plants had not developed uses that would be attractive to elements of this market. Unfortunately, a detailed investigation of the potential was beyond the scope of this project. However, we believe that a thorough exploration of the options should be a high priority for future research. That research should also examine the mechanisms that may be available to Aboriginal people to protect knowledge of commercial value or perhaps more immediately, ways of extracting commercial benefits from use of the knowledge in partnerships with others seeking to enter these markets.

Should legal protection prove problematic, there are incentives for large corporations to be able to demonstrate that they have acted ethically and sought to engage Indigenous peoples in enterprise that derives at least in part from their knowledge. Markets for such products appear to have a great deal to do with image and a rejection of hard-edged, technologically-driven, aggressively interventionist approaches to medicine. Corporations embroiled in battles with Indigenous people over recognition of knowledge and associated claims may struggle to present an image matching the expectations of the consumers of such products. Moreover, consumers may particularly value evidence that botanical medicines are produced under the guidance or at least with the cooperation of the Indigenous developers of the product. Explicit connections with Indigenous groups may therefore be commercially valuable. This possible market advantage also warrants more comprehensive examination as an element of research on potential Australian products.

5.1.3 Volatile oils

Interest in volatile oils came chiefly from people in Cape York, who identified a number of options. Tentative arrangements were made to explore options, including initial determination of the active constituents of these oils. However, arrangements with the third parties needed to provide the necessary expertise were stalled by concerns about the management of intellectual property and difficulties in identifying sources of funding. Markets for many of the potential products based on volatile oils share features with botanical medicines. Connection with traditional uses may have value in the market, and this angle ought also to be examined in future research connected with the botanical medicines trade.

5.2 Trial harvests (Case studies)

Our trial harvests covered the remaining categories of use, namely bushfoods, traditional foods for sale and consumption within communities, live plant trade, arts and craft, novelties and educational items directed to the tourism market, and various complements to other activities. We have indicated that the species and uses which we examined in trial harvests were not necessarily those that would have been chosen had commercial viability been a principle determinant. In addition, most trials have yet to be completed, in that significant quantities of product have not entered markets. Nonetheless,

the process of developing and implementing the trial harvests raised issues that are critical for understanding opportunities and constraints. Some of the most important are:

1. At prices considered plausible, supplying items in bulk by wild harvest often generates relatively low rates of return on effort. Achievable rates of return for supply of bushfoods may be less than CDEP wages. Additional costs associated with isolation and limited infrastructure depress returns.
2. Exceptions to the generally poor returns arise where price is influenced by a connection of products to traditional Aboriginal practice and lands, and the bushfood is an additive rather than bulk ingredient, so that it represents a relatively small proportion of the total cost of production. Returns on harvest of Kakadu plum appear to have benefited from such a process following the decision of Coles-Myer to actively promote a line of Australian native foods some of which contain Kakadu plum.
3. Many community leaders are more interested in supplying food for consumption by their members than satisfying larger markets. This appeared to strongly influence choices of favoured items.
4. Value-adding within communities is an important issue, especially to supply items of interest to the tourist trade, and can greatly increase returns on effort. As a general principle, a direct connection with an ancient culture with profound knowledge of the use of Australian plants may itself be a marketable commodity which Aboriginal entrepreneurs may seek to exploit, in preference to acting as anonymous suppliers of bulk products.
5. Focus on widespread and abundant species reduces risks of widespread overharvest. Species or populations will not be significantly impacted at regional and larger scales. However, relatively "clumped" distributions of most species creates risk of localised impacts. Thus management problems will be expressed and require resolution at relatively fine (local) spatial scales. Centralised management and compliance regimes are incapable of dealing effectively with these issues.
6. Many groups wish to match their initiatives closely to local conditions and issues. Supplies may often be small, risks of irregular supply are increased and difficulties arise in maintaining market interest when small groups seek to enter into markets individually. The desirability of cooperative ventures was discussed but ideas were not advanced significantly. The roles of existing Aboriginal organisations in coordinating and facilitating such activity also requires consideration.
7. The engagement of relevant community members in the trials set in train a sequence of important checks and balances. For example, traditional land owners, even if they were not directly involved in the trials themselves, raised issues to which we and other participants were obliged to respond. On at least two occasions these were issues of sustainability and risk of over-harvest. Customary approaches to resource management may have the potential to complement, reinforce or perhaps replace some formal statutory requirements.
8. Regulatory requirements from Government are complex and difficult to understand, even to those who have been exposed to the mix of processes that shape them. To those less in tune with bureaucratic process, they may appear without a logical purpose. Apparently arbitrary decisions about the forms of use and species that require monitoring, and a resultant uncoupling of costs from threats to sustainability, invite non-compliance.
9. Social benefits unconnected to income generation may derive from and be an advantage of these ventures. These include engagement of children in activity on country, facilitating transmission of customary knowledge, a significant and hence respected “regulatory” role for traditional land owners and resource custodians, and the more general benefits of engagement in meaningful employment where reward, albeit potentially modest, is directly dependent on effort and skill.

Several of these points raise issues that are fundamentally important to the process by which Aboriginal people in remote Australia might enter further into the market economy. The key questions can be paraphrased as:

- What criteria should be used to determine the "value" or success of individual Aboriginal enterprises in the north Australian context?
- How should use of plants be managed and monitored to ensure ecological sustainability?
- How might Aboriginal culture and its values be connected to and add value to other marketable commodities?
- How can constraints of scale and seasonality or other irregularity of supply (and hence incomes) be overcome?

We deal with these issues below.

5.3 Criteria for success?

We have used our simple analyses to estimate the returns that Aboriginal participants might expect to gain from various uses. We have suggested that returns at least equivalent to hourly rates on "work for the dole" schemes may be necessary to provide incentives to engage in this activity. This suggestion should perhaps be scrutinised.

Altman (2001) argues that it is unreasonable to expect Aboriginal people in remote northern Australia to choose and remain entirely within one of the market, customary or welfare sectors. He promotes the notion of a "hybrid" of these different elements as a necessary and indeed desirable condition for many communities well into the future.

We interpret this proposition to mean that not only should movement of individuals between these elements be expected, but hybrid activities dependent on more than one element should also be accepted or indeed promoted. For example, participation in the Kakadu plum harvest may provide the cash needed by individuals or groups to run a vehicle, that is also used for many other activities (fire management, hunting and collection of other plant foods) carried out in conjunction with the harvest or separately. Depriving participants in commercial harvest of access to CDEP or other income used to meet basic needs (full CDEP amounts to $224 per week) would also deprive them of the option to take more diverse roles and to be active in managing larger areas of country. For example, under schemes of CDEP support, rangers working with the Bawinanga Aboriginal Corporation detected and controlled outbreaks of Mimosa pigra, a thorny shrub that renders grasslands unusable by stock or larger wildlife. At nearby Gunbalunyah, failure to detect similar problems early and react immediately has required subsequent expenditures of several million dollars of Federal and Territory funds to bring a major infestation under control.

Aboriginal people who are actively engaged in maintaining land to favour wildlife are already providing other conservation management services that are clearly valued by the national and international communities (Yibarbuk et al. 2001). Thoughtful use of commercial opportunities linked to maintenance of basic support can contribute to expansion of that role to provide a range of national benefits (Whitehead 2000). Provided that basic support is maintained, Aboriginal people can cope with the cost disadvantages of operating in remote areas, supply useful commercial products, and connect with the market economy.

The arts and crafts industries are important examples of highly successful activities that generate significant incomes but continue to be supported in various ways by the state and other organisations. The work is important and esteemed although the hourly rate of return may often be much lower than CDEP or other less skilled paid work (Altman 1987). The continued growth of the arts and crafts industry may ultimately see the need for that support to be reduced or eliminated, but that point has

yet to be reached. Other enterprise based on commercial use of wildlife will require similar support for its establishment and during its development (see BAC 2001 for examples).

Experience with these sorts of operations and the links to the market economy may stimulate interest and ultimately equip Aboriginal participants and their organisations to establish other enterprise that is less dependent on links to CDEP or other support, or becomes a more vigorous component of the hybrid economy. Thus participation may be warranted even at relatively low rates of return. Pulling the CDEP plug could forestall this sort of capacity-building and actually extend or increase dependency. Indeed, it is possible to make a case that the CDEP scheme is a realistic and relatively low cost subvention in regions that may always struggle to achieve economic viability, due to the failure of markets or gaps in markets. Opportunity cost of such subvention is low, being mainly equivalent to unemployment benefits that would be payable in any event.

That subvention and its linkage to various forms of enterprise may also be seen as a contribution to education and training. Older people with English as a second or third language and who have had little formal schooling may have highly developed skills relevant to management and use of plant populations, but require supplementary skills to apply that knowledge to a commercially viable operation. Seeking to coerce such people into a formal classroom would be insulting and foolish, but "on the job" exposure to ideas and methods with their peers may be an effective way of achieving at least some forms of business training. A project structured to enhance the number of people receiving training may not perform well in a strictly commercial sense, but if it provides people with the skills to take up other opportunities, is likely to be a invaluable long term investment.

We argue that success of enterprise of the sort we have considered cannot be meaningfully assessed in isolation, but must be connected to the social context and long term social policy objectives.

5.4 Management for sustainability

An important general theme which emerges from the case studies affects the design of management systems for sustainability. In all cases the species harvested are at least regionally abundant. At the species level, the harvest quanta - present and projected - range from trivial to minor and so do not threaten the species conservation status or the dynamics of target populations at the regional and larger scales. But in most cases, including the most widespread and abundant of potential targets, that is Kakadu plum, there is a significant risk of local over-harvest at accessible or otherwise highly favourable sites.

Unless managed well, local over-harvest has the potential to cause acute localised reduction in the harvested population and so affect other organisms dependent on it. This may also reduce the commercial viability of harvest operations by forcing harvesters into less favourable (e.g. more distant) sites. Customary users of the harvested item who lack the means to travel to more distant sites may find their access restricted.

It is therefore in everyone's interest to implement management systems capable of dealing with localised impacts. Logically, those management systems should also be localised and depend, as far as possible, on local knowledge and authority for their design and implementation. The global regulatory sledge-hammer brought to bear on a trivial cycad harvest (Appendix 2: Case study 1) is a vivid illustration of the problems that arise when generic prescriptions are substituted for locally relevant solutions. The cycad harvest is arguably the use least in need of tight regulation. Populations are huge, demand is relatively low and likely to stay that way, conflicts with customary use are minor, the harvest site is inaccessible, entry to the site requires permits, no other legal sources of large stems exist, and the local residents who benefit from the harvest have every incentive to exclude competitors. Despite this favourable management situation, the initiative is saddled with compliance requirements so onerous that they severely compromise commercial viability.

It is clearly desirable that means be found to match statutory authority to local authority and capacity. Only in this way, will it be possible to manage at the fine spatial scales at which problems will be manifest. Centralised bureaucracies in sparsely populated northern Australia cannot conceivably achieve this level of management intervention. In any event, highly intrusive formal schemes are likely to be unacceptable to Aboriginal landholders. Useful control and monitoring is likely to be most productively accomplished by delegation of legislated powers to local people, to be exercised within jointly determined guidelines.

5.5 Overcoming constraints of scale

The trials on which we engaged mostly involved relatively small groups of people with a particular idea they wished to pursue. This observation may appear superficially consistent with the pronouncements from the Federal Government (e.g. http://www.minister.immi.gov.au/atsia/media/media02/r02009.htm) regarding desirability of a shift from an emphasis on community as the focus of Government policy towards individuals and families. However, the capacity of those small groups to pursue these opportunities was, and for the foreseeable future will continue to be, dependent on access to basic resources such as vehicles, buildings and other infrastructure provided by others. Such requirements are most often met by regional Resource Centres or, in the case of these trials, by the Project. Vehicles needed for the most basic and modest of operations but capable of operating effectively in remote settings are expensive to purchase and to maintain, and hence beyond the means of most small groups.

Even if it were feasible for small operators to access capital, the small scale of ventures and other factors such as seasonality of supply and income, would make it impossible, at least early in enterprise development, to service that capital at the group or individual level. There is a clear and essential role for integration of activities across groups to provide infrastructure and other support. This role is currently filled by agencies like Bawinanga Aboriginal Corporation and, at larger scales, by Caring for Country or similar groups within Land Councils. Most importantly, these organisations provide their support within a framework that emphasises building skills and experience. They seek incremental improvements in capacity to take full control of such operations and reduce dependence on others over time. As we have indicated below (see section 5.7 Cultural sustainability), it is neither logical nor helpful to celebrate the picturesque in Aboriginal culture but then ignore inconvenient social corollaries, or to deny educational, economic and operational realities in favour of an ideological emphasis on individuality. In addition to Commonwealth Government and other institutional support, the potential for Aboriginal people to create cooperatives to develop access to economies of scale and control quality and continuity of supply, should be seriously investigated. Drawing on existing structures to support such integration appears likely to be the most effective option.

5.6 Comparative advantage and Indigenous people

We have discussed the numerous cost disadvantages encountered by Aboriginal people seeking to meet market demands from remote locations. But we have less comprehensively considered the advantages that might contribute to the success of Aboriginal enterprises. There are at least two kinds: those that offer practical advantage to Aboriginal people in accessing resources, maintaining them and harvesting them efficiently, and those that derive from external interest in Aboriginal culture.

5.6.1 Practical advantages

Practical advantages available to Aboriginal people in Northern Australia include:

1. In the Top End and other parts of the Northern Territory, access to large areas of land that is relatively intact structurally, so that wild harvest of plants is at least plausible.
2. An associated access to aesthetically attractive environments free of industrial and agricultural pollutants (clean and green).
3. Control over populations of unique endemic plants that are less available or entirely unavailable to potential competitors.
4. A detailed knowledge of country and the resources it supports.
5. A detailed knowledge of local plants, their phenology (eg. timing of fruiting), and impacts on their abundance and condition.
6. An ability to operate in remote sites with minimum infrastructure and minimum cost.
7. Systems of land ownership and access rights that may be useful for resource management, in commercial as well as customary settings.

5.6.2 Marketing advantages

Potential advantages in markets based on native plants include:

1. Knowledge of the utility of different plants as food, for implements, and as medicine. Highly developed and long standing customary knowledge may increase the credibility in some markets or connection with Aboriginal culture may be a primary motivation.
2. Beliefs and narratives about many plants that are of interest to the wider Australian and international communities.
3. Employment of plants or parts of plants in important expressions of culture and especially in the creation of works of art and in crafting implements.
4. Suppliers of customary foods to Aboriginal communities.

Advantages arising from the relatively intact state of north Australian environments apply to many sites outside Aboriginal land. This may be an important feature of natural products from north Australian generally, but is not exclusive to Aboriginal people.

However, Aboriginal lands (e.g. Arnhem Land) are home to a large number of plants with restricted distributions. The sandstone flora of the escarpments provides important examples. Some plants can be obtained nowhere else. Aboriginal landowners have important knowledge of how to maintain both endemic and more widespread common plants (especially through the use of fire) that may position them to maintain better populations of these species than outside Aboriginal lands (Price and Bowman 1994; Bowman et al. 2001), irrespective of apparent structural intactness. Intimate knowledge of the flowering and fruiting schedules of native plants will position Aboriginal harvesters to minimise time spent seeking out and completing harvest. Detailed knowledge of country and an ability to operate effectively across diverse landscapes with a minimum of logistical support offer similar efficiencies. All else being equal, Aboriginal harvesters working on their own lands should be able to operate more cost-effectively than hired teams engaged on similar tasks. However, it is unlikely that these advantages will, on their own, outweigh the considerable disadvantages of operating from remote locations with limited infrastructure.

The thriving arts industry is an area where the commercial benefits of society's interest in Aboriginal culture are most striking. Whilst the natural materials no doubt contribute to the aesthetic appeal of artworks and elaborate handicrafts, most of the value is added and derives from the quality of the human input. A larger proportion of the population is able to contribute to and benefit from the production of artworks than is the case in the wider Australian society, because access to aspects of Aboriginal culture is valued in addition to the artistic merit of the work.

There is reason to believe that similar benefits may be available in other areas. In the Kakadu plum case study (Case study 2: Appendix 3.2), we alluded to the initiative taken by Coles and Robins Australian Foods to enter into arrangements with Aboriginal suppliers of raw materials for incorporation in a range of relatively "up-market" products. The connection with Aboriginal people is made explicit on the labelling and is clearly seen as a marketing advantage, which probably has two components. First, being seen to contribute to Aboriginal enterprise through the arrangement, and second an implied authentication of wild origin and "naturalness" that is valued by the particular consumers likely to seek out such products.

The idea of the Nauiyu women to market their stories of bushfoods and their significance to Aboriginal culture taps a similar interest in the Australian bush and the manner in which Aboriginal people connect with it. The reaction to their tourism novelties will provide an interesting test of the level of interest in clearly authentic but relatively ephemeral representations of Aboriginal culture. Like the arts and crafts industries, the plant provides a medium for a message about culture rather than itself being the primary focus.

That principle might also be extended to include the sale of cycads. Large specimens will probably be quite old and hence present a strong connection with their place of origin and the custodians of that place. In presenting these unique products, that connection might be celebrated in stories about the way place has been maintained to foster an abundance of these special plants, as well as their cultural significance. Pots carrying designs significant to the local people might reinforce the authenticity of that connection and add considerable value. Trials of these ideas are proposed.

This sort of value-adding could not be legitimately duplicated by non-Aboriginal people and so will clearly set these products apart in the market place. Whether the increments in price achieved justify the additional effort in purely commercial terms will emerge over the longer term. However, we suggest that whenever Aboriginal suppliers have a measure of control over presentation to the market, there should be additional effort to connect to a particular Aboriginal group, as a mode of authentication. Even if these efforts do not bring great increases in price, they may be sufficient to reduce competition from the ersatz (imitation), and the long-term weakening of the market that would result. We consider this issue further, in discussions of intellectual property (section 5.8).

5.6.3 Supply of customary foods

At the commencement of this project, we did not anticipate the level of interest shown by Aboriginal people in supplying "healthier" customary foods to their own and other Aboriginal communities. Costs of conventional foods in many Aboriginal settlements are extraordinarily high and choice limited, exacerbating problems experienced by low income families. It is reasonable to expect that Aboriginal suppliers would be in a better position to predict and respond to demand for customary foods than non-Aboriginal people. Costs of supplying some native fruits and vegetables (yams) locally will clearly be lower than placing them in other markets, often great distances from harvest sites. Programs for local supply offer opportunities for enterprise and improved choice for consumers: they will bring additional benefits in keeping funds within the community and contributing to other local commercial activity.

5.7 Cultural sustainability

During trial harvests on traditional lands and in a range of discussions, Aboriginal participants identified a number of significant social issues for wild harvests. Most were dealt with individually in other parts of this report and associated documents. Here we discuss some of the more significant ones.

Mostly, participants in our trials saw no particular difficulty with a range of commercial use, provided that appropriate processes were followed, all relevant permissions were given, and arrangements for distributing proceeds from the activity were clear and agreed.

Indigenous governance of resources is based on customary land stewardship and additional culturally-defined property rights. Only the relevant Aboriginal people are in a position to make judgements about acceptable practice on lands in which they have an interest. It is important that all those involved in development of enterprise provide opportunities (and in particular, time) for the necessary consultations and consideration. Traditional land owners have a key decision-making role and would normally be expected to share in the benefits from enterprise on their lands (see workshop summary in Appendix 2).

Enthusiasm for development of enterprise on Aboriginal lands is in part driven by a desire to provide genuine employment opportunities. Gathering of plant foods is mostly regarded as an appropriate activity for women. Uses biased towards bushfoods may not be effective in engaging men. Men are perhaps more likely to seek involvement in commercial activities that are less linked to customary practice, such as cycad harvest.

An issue that arose repeatedly, related to the need to maintain and even strengthen customary use. For the reasons previously mentioned, managing the interaction between customary use and commercial harvests may present some difficult challenges. Intense harvest of highly accessible sites for commerce may deprive those not involved in commercial activity of customary access. The solution to these sorts of local problems will lie with individual communities. For more common species, an appropriate approach will be to designate "approved" harvest areas and nominate other areas as protected for customary harvest. If such local solutions are to be effective, it will be important that statutory regulatory regimes and the actions of regulatory agencies strengthen local capacity to influence behaviour, rather than disable customary authority.

However, this solution may not be practicable for some attractive items that occur at low densities. They may be regarded as entirely unsuitable candidates for commercialisation, regardless of market valuation, unless their abundance can be increased by cultivation or other measures, or market opportunities can be met with access to small volumes. Plants falling into this category include *Ficus* (fig) species, native grape *Ampelocissus acetosa*, and some bush apples (*Syzygium* species).

Local control over choices and their subsequent management is the most significant general point to emerge from this project, particularly with regard to the interaction between culture and sustainability. Management regimes that conflict with local practice and authority will contribute to failure in one or more of the elements of sustainability. Moreover, they will work against the strengthening of culture that many participants in the project sought.

We have argued elsewhere that one of the advantages that might favour Aboriginal entrepreneurs is public interest in their culture. It is unreasonable on the one hand to celebrate and to market aspects of that robust culture and special relationships with place and wildlife, but at the same time expect the culture to be so malleable as to immediately adjust to the demands of a modern market economy and the practices of centralised bureaucracies. To foster the hybrid economy and enhance the success of its engagement with markets, it may be necessary to also build hybrid institutional arrangements. Hybrid institutions and their participants will actively embrace customary practice and seek to match statutory and policy regimes to its critical elements (Altman and Cochrane 2002; Altman and Whitehead 2003).

5.8 Intellectual property

Traditional knowledge is increasingly recognised as a valuable source of information for the achievement of sustainable development. It can play a role in the social and economic organisation of nations and in promoting a sense of national cohesion and identity (WIPO 2001). In discussions organised within the framework of the Convention on Biological Diversity, it has been argued that biodiversity and the traditional knowledge to use it sustainably are a comparative advantage for countries that are biodiversity rich. Australia is a mega-diverse country and northern Australia a hotspot for biodiversity conservation (Woinarski and Braithwaite 1990). Federal legislation (the *Environmental Protection and Biodiversity Conservation Act 1999*) provides as one of its principle objects, that Australia will "promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge" (Section 3). The Commonwealth has drafted regulations that provide for benefit-sharing agreements for access to biological resources on Commonwealth land that include "protection for, recognition of and valuing of any indigenous knowledge given by the access provider". States and Territories have yet to enact similar legislation. Parties to the CBD have recently agreed on a set of (voluntary) guidelines for managing access to biological (genetic) resources and benefit sharing.

Many Aboriginal people and their organisations have embraced the notion that their knowledge is valuable and those seeking to use it should at the very least acknowledge their application of it. Indeed, most consider it mandatory that users share the commercial or other benefits of its application with the knowledge custodians. At the same time there is concern about the reluctance of the young to learn from their elders. Knowledge and skills are being lost and many older Aboriginal people seek assistance to record their knowledge in written and other records, so that it will not be lost forever. Participants in this project are involved in documenting traditional knowledge of plants and animals and their uses, invariably at the request of senior knowledge custodians (see, for example, Lindsay et al. 2001). Although protected by copyright, there is no legal barrier to its application (as distinct from reproduction) by others once it is in the public domain, nor obligation to compensate for use.

This set of conflicting aspirations creates a confused and difficult environment for those seeking either to document that knowledge or, as here, to use accounts of its application to illustrate options for Aboriginal people to apply knowledge and skills to commercial activity. So sensitive is the issue that we have been (mildly) rebuked for inclusion of the Table at Appendix 1, even though we were careful to include only material that had already appeared in print in one form or another. Further, other reviewers of draft content have suggested that it is against the interests of our stakeholders to publish any of the information presented here. Clearly we do not accept that position.

The apparent seriousness with which a number of Governments are taking the issue has persuaded some Aboriginal people that the safest course is to withhold access to both knowledge and resources until a comprehensive and rigorous legal framework is established. However, the tortuous progress of these and related issues through the World Intellectual Property Organisation and commentaries from powerful voices like relevant US agencies (WIPO 2001) suggest to us that agreement on provisions that will provide strong protection will be problematic and are, at best, some years off.

Consequently, we argue that Aboriginal people and their organisations may be better served, in developing enterprise over the short to medium term, by seeking options that are protected from misuse or abrogation; that is they enter markets that presently value a genuine connection with Aboriginal culture. By providing evidence of the Aboriginal connection and its significance as an integral part of the product, they can reinforce the dependence of the market on authentication and inhibit the entry of the imitation. Failure to take such action has seen much of the Top End didjeridu market dominated by "instruments" made of everything from PVC pipe to bamboo decorated with daisies.

We do not argue that efforts to achieve improved legislation and policy should cease, but rather that opportunities that genuinely link culture and product can be taken up now. Risk can be minimised by thoughtful systems of authentication; these do not need to be centralised to be effective. The arts and crafts industries have developed modes of authentication that have proved highly effective and add value to the works, although problems remain.

5.9 Strategies for realising opportunities

Participants in the Project and the trial harvests considered that it was inappropriate to develop detailed statements of strategy or tactics for Aboriginal enterprise involving commercial use of plants at this time. This caution arises because some communities have had little or no exposure to the ideas and even those involved in the trial harvests have yet to gain full experience of all the issues likely to arise during development and operation of such an enterprise.

We were also sensitised to the difficulties of proposing 'one-size-fits-all' solutions, given the relative poor match of our "objective" assessments to the interests expresses by Aboriginal communities and individuals.

Nonetheless, we provide a broad statement that we consider captures the most significant issues and gives at least partial responses to them. We acknowledge that these statements could not be said to have the full support of all stakeholders; indeed, it should be recognised that they represent primarily the views of the project team.

Many of these issues and responses have already been recognised and are being implemented by active resource management agencies working with Aboriginal people in enterprise development. However, they may be of some additional value to those with less direct experience and to those with an interest in commercial use of plants in partnership with Aboriginal people.

5.9.1 Context

Commercial

1. Cost structures are inherently adverse
2. Capital is limited and capacity to raise capital on assets is constrained
3. Business skills are in short supply
4. Infrastructure to support commerce is limited
5. Existing enterprise is most often dependent on other non-commercial support
6. Global and national markets for novel plant products are poorly understood and require exploration and/or development
7. Local markets are small
8. Failure of enterprise in Aboriginal communities has been frequent
9. Comparative advantage is confined to uses involving clear expressions of culture and access to plants limited in availability or entirely unavailable to other users

Resource availability

10. Plant communities are often diverse and relatively intact, including some species found nowhere else
11. Useful plants are often widespread and abundant
12. Distributions are often spatially clumped

Ecological

13. Many species are highly resilient to those levels of harvest tested, but some items of greater market value (e.g. cycads) are much less so
14. Product availability is often highly seasonal
15. Supply is variable from year to year
16. Quality of wild product may be variable
17. Risk of general, widespread over-harvest is low, but may be pronounced at the local level
18. Management regimes promoting sustainability will be technically straightforward for most uses, and will be effective provided community support is achieved and regulators match requirements to local conditions, capability, and customary practice

Social

19. Culture remains strong in many north Australian locations
20. Knowledge of plant ecology and uses of plants for food and medicine remains strong
21. Conflict between commercial and customary use is likely at some sites
22. Few objections to plant use are likely provided all interests are consulted and involved in decision-making
23. Customary rights and obligations for resource management differ from assumptions underpinning statutory regimes
24. Distribution of income from enterprise will require consideration of customary practice as well as normal commercial practice
25. Formal education may be limited
26. English may be 2nd or 3rd language
27. Literacy and numeracy are not universal
28. Expectation that enterprise developments will directly address key social problems
29. Expectation that local people will determine options and control implementation

Legal and policy settings

30. Limited or no protection for traditional knowledge or uses deriving from it
31. Developments on Aboriginal land require informed consent which in turn demands detailed and comprehensive consultation
32. Government approaches to novel (non-forestry) use of native plant species are invariably cautious and variable across jurisdictions
33. Claims of state ownership conflict with customary law and practice
34. Regulatory regimes influenced by poorly-informed conservation categorisations may impose arbitrary constraints

5.9.2 Implications

1. Orthodox approaches to identifying and exploring options for wildlife-based enterprise raise many difficulties for Aboriginal communities.
2. Rapid change in the mix comprising the present hybrid economy is problematic: capacity to manage substantial and rapid entry to the market economy is constrained by weaknesses in the social and built infrastructure, which is needed to manage the demands of markets.
3. Critical constraints will rarely involve inadequate knowledge, skills or capacity to ensure biological sustainability, rather, they will derive from poor understanding of markets and social considerations.
4. Criteria for useful or successful enterprise should extend beyond the narrowly commercial to consider social implications, especially building capacity through experience
5. Ideas for novel plant use originating in Aboriginal communities and based on customary practice and traditional knowledge enjoy little or no legal protection, and so can be displaced from markets by imitators less constrained by geographic, social and other limitations.
6. Options offering durable "comparative advantage" for remote Aboriginal communities will most often involve close links to culture that cannot be easily imitated or abrogated by others; access to plants unavailable outside Aboriginal lands; and the attraction of products grown in “clean and green” remote lands free of pollution.
7. Enterprises that draw heavily on customary skills and knowledge are most likely to capture this comparative advantage, as has happened with the arts and crafts market.
8. Local markets for novel products are limited and likely to be slow to develop, suggesting that initial focus on the few existing substantial markets or on products that can be linked closely to existing markets is the “best-bet” strategy.
9. Exploiting areas of comparative advantage despite numerous commercial constraints may be facilitated by linkage to such business infrastructure (eg. arts and crafts) as is already available.
10. Large overseas markets for products of the sort that Aboriginal groups might develop and fill (e.g. botanical medicines) are poorly understood and investment risky until the necessary research has been completed.
11. Options involving modest initial investment are most realistic given the substantial risk of failure of new products.
12. “Scaling up” of enterprise is constrained by the small size of individual groups, short (seasonal) periods of resource availability and variation in resource availability and may be best overcome by Aboriginal groups forming cooperatives.
13. Developments that make significant contributions to capacity-building are especially valuable and building this social benefit into enterprise will be considered mandatory by most communities.
14. Capacity-building will require time. Support for communities, families or individuals in enterprise development should be offered incrementally and iteratively, so that activity and capacity reinforce each other.
15. An incremental strategy will in turn require creative use of existing social welfare and commercial programs to maintain support while additional markets, skills and infrastructure are developed.
16. More ambitious and independent enterprise may follow modest initial success and the increase in confidence and capacity that flows from it.
17. An initial focus on options positioned at the modest end of the range of plant uses that are feasible in remote communities will minimise the risk of more debilitating failure.
18. Management of resource use to achieve sustainability is most needed at small spatial (local) scales and a key issue will be management of conflict between commercial and customary use, so management regimes will most logically involve local people and a large measure of local control.
19. Developing co-management arrangements that devolve statutory power to local groups should also be seen as an important capacity-building measure.

5.9.3 Responses (Key recommendations for realising enterprise)

Selection of options

1. Look for comparative advantage, including uses that are buffered from abrogation by non-Aboriginal groups
2. Embrace other options principally if they build relevant skills and experience
3. Promote uses that can be productively linked to other activity and enterprise
4. Expand assessment beyond strictly commercial to include (*inter alia*) a contribution to capacity building
5. Consider the role of the selected use as a platform for additional future activity (incrementalism)

Operational

6. Consult widely and comprehensively to elicit ideas and concerns, including work "on country"
7. Ensure that all relevant "rights-holders" and especially traditional land owners are involved in deliberations
8. Clarify the objectives and expectations of all participants early in the process, including the non-commercial expectations
9. Avoid creating excessive expectations
10. Apply local knowledge and traditional skills to design of harvests and monitoring systems, as well as formal technical information
11. Clarify and document benefit-sharing arrangements early in the process
12. Determine and document statutory regulatory requirements prior to initiation of harvests
13. Involve CDEP coordinators and other administrators in project development so that productive linkages and optimal use of available infrastructure can be achieved
14. Design linked training and education programs as integral parts of enterprises
15. Identify individuals who are prepared and equipped to act as local "champions" for chosen projects
16. Build processes for certifying authenticity of origin into all developments
17. Be realistic about timelines
18. Where possible, conduct pilot projects before committing significant capital or other resources

Strategic

19. Promote research into markets that exploit comparative advantage for Aboriginal enterprise, especially relating to traditional knowledge
20. Build relationships with regulators so management frameworks can be adjusted to local circumstances and the demands of sustainability
21. Investigate feasibility of developing cooperatives to improve continuity of supply and diversity of offerings to markets, especially for bushfoods

6. Recommendations

We consider that significant engagement of Aboriginal people in enterprise based on native plants will require additional support from Government. Constraints inherent in remoteness, diseconomies of scale, lack of infrastructure and capital, and social disadvantage are likely to be overcome only if assistance is provided to realise the few comparative advantages available, mostly relating to consumer interest in Aboriginal culture. A range of recommendations and their context are discussed in previous sections (especially 5.1 and 5.9).

Specifically, we recommend that:

1. Markets for botanical medicines derived from species present on Aboriginal land and linked to Aboriginal practice, be systematically investigated with respect to Asia, Europe and the US.
2. The market value of a direct, demonstrable and authenticated connection of Aboriginal people with the harvest and processing of native plant products be examined.
3. The commercial value of Aboriginal knowledge and documentation of long-standing customary use of botanical medicines, foods and food additives be determined by reference to the registration processes of Australia and nations with major markets.
4. Benefit-sharing arrangements of the type for which draft regulations have been prepared by the Commonwealth Government (under the *Environmental Protection and Biodiversity Conservation Act 1999*) be adopted by the Northern Territory and other north Australian jurisdictions.
5. Regulatory requirements at the Federal and State/Territory levels be better matched to scale of use and its implications for sustainability rather than being based on often arbitrary categorisations.

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Appendix 1: Australian native plants - potential commercial use

A haphazard sample of north Australian native plants from an ethno-botanical and plant use database (Plant Use Database), together with a preliminary assessment of the potential for commercial use. Ranks in the final column are based on a crude index derived from criteria of the type shown in Boxes 1 and 4. Higher rankings (1 being highest) represent more favourable assessment and lower indicate that some significant difficulties are anticipated in achieving sustainable commercial use. It should be noted that our reference here to cultural constraints refers to unusually strong and widely-held concerns about use of a particular species. In all cases access to resources will require the agreement and support of relevant groups or individuals. The matrix used to derive the ranking is available from the authors on request. Note that 19 species in which Cape York people had a particular interest have been omitted at the request of the Balkanu Cape York Development Corporation. Thus the total number of species shown here does not tally with the summary of the analysis provided elsewhere in this report.

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Abrus precatorius, crab's eye vine. Slender perennial twining vine to 10m. Coastal monsoon vine thickets, monsoon forest associated with lowland freshwater streams	Seeds used to make decorative ornaments and necklaces	May be small niche market but there is no quantitative information. Toxicity of seeds may limit suitability.	Costs of collecting should be low but returns are also likely to be low unless incorporated into substantial artifacts.	No impacts on fauna anticipated. Some risk of local over-harvest if significant demand develops.	No recorded constraints	Collection of seed appears feasible. Availability highly seasonal. Toxicity of seeds a problem.	S: no cultural objections to harvest. W: markets and prices uncertain, seeds toxic O: easy to store and transport; establish Aboriginal connection T: demand and prices unpredictable (limited precedent),	9
Acacia auriculiformis, black wattle. Large spreading tree 10-20 m in height. Coastal monsoon vine thickets and monsoon forests.	Wood used by Aboriginal people for spearthrowers, axe handles, many medicinal uses.	Some demand for seed for rehabilitation and erosion control. Used overseas for pulpwood, but in Top End has been recently replaced by exotics.	Costs of seed collection are high and returns at current prices generally regarded as inadequate.	A very common and fast growing tree. Well -managed wild harvests unlikely to have significant impact.	No recorded constraints regarding seed. Some clans are against extraction of whole plants	Availability of seed seasonal (late dry). No access problems.	S: no cultural objections to harvest; established uses W: relatively poor returns O: complement to other community activities; T: limited demand and hence likely to be marginal.	7
Acacia producta. Small shrub 0.5-1m high. Open forest and woodland on sandy soils, sandstone country.	Attractive plant with potential for cultivation. A showy shrub for gardens and rockeries. Known to Aboriginal people as food source for fauna but not used.	Potentially a small market through nurseries.	No relevant information available.	Populations not large and restricted in distribution; however, risk of over-harvest is minimal unless demand is extraordinarily high. Source of food for fauna in harsh environments.	No constraints known	Collection of seed appears feasible but returns unknown. Availability seasonal. Requires plant nursery facilities for reasonable prospects of adequate returns to communities. Substantial costs of transport to markets.	S: Aboriginal and Arnhem Land link; no cultural objections to use; limited ecological impact W: limited local market O: easy to store and transport; established Aboriginal connection T: demand and prices unpredictable (limited precedent); success likely to be followed by others entering market at lower prices	15

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Acacia sericoflora. Slender, commonly single stemmed shrub 3-4 metres high with angular, hairy whitish young branchlets. Found on sandstone country beside permanent fresh water in deep sand.	Attractive plant that may have potential cultivated. A showy shrub for gardens and rockeries. Used by Aboriginal people for spear shafts.	Potentially a small market through nurseries.	No relevant information available	Populations not large and restricted in distribution; however, risk of over-harvest minimal unless demand extraordinary. Reduction in density undesirable.	No constraints known	Collection of seed appears feasible but time taken and returns unknown. Availability seasonal. Requires plant nursery facilities for reasonable prospects of adequate returns to communities. Substantial costs of transport to markets.	S: Aboriginal and Arnhem Land link; no cultural objections to cultivation; limited ecological impact of harvest W: limited local market; success likely to be followed by others entering market at lower prices O: easy to store and transport; establish Aboriginal connection T: demand and prices unpredictable (limited precedent), entry of others with lower price structures to markets.	16
Acacia simsii, Sim's wattle. Small shrub 2-3 m high. Tall coastal open forest in sandy soil.	Attractive plant that may have potential cultivated. Known to Aboriginal people but no uses documented.	Potentially a small plant nursery market.	No relevant information available	No relevant information available	No constraints known	Collection of seed appears feasible but returns unknown. Availability seasonal	S: Aboriginal and Arnhem Land link; no cultural objections to harvest; limited ecological impact; W: limited local market; O: easy to store and transport T: demand and prices unpredictable (limited precedent), success likely to be followed by others entering market at lower prices	15
Acacia sublanata, spiny wattle. Sparse to sprawling shrub 1-2m with prickly foliage and hairy stems. Open forests in red earth to lateritic soils, sandstone country in shrubby woodland.	Attractive plant that may have potential cultivated. An interesting garden and rockery shrub. Named by Aboriginal people and recognised as food for fauna.	Potentially a small plant nursery market.	No relevant information available	Nectar source in harsh environment. Reduction in density undesirable.	No constraints known	Collection of seed appears feasible but returns unknown. Availability seasonal	S: no cultural objections to cultivation; limited ecological impact of harvest W: limited local market; O: easy to store and transport T: demand and prices unpredictable (limited precedent), entry of others with lower cost structures to market	15

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Acacia yirrkallensis, dwarf wattle. Small much branched shrub 0.5-1m high. Tall coastal open forest and sandstone country.	Attractive plant that may have potential cultivated. Endemic to eastern Arnhem Land. Named by aboriginal people and recognised as a source of pollen for bees	Potentially a small plant nursery market.	No relevant information available	Nectar source in harsh environment	No constraints known	Collection of seed appears feasible but returns unknown. Availability seasonal	S: Aboriginal and Arnhem Land link; no cultural objections to harvest; limited ecological impact of harvest W: limited local market O: easy to store and transport; establish Aboriginal connection T: demand and prices unpredictable (limited precedent), entry of others with lower cost structures to market	13
Adansonia gregorii, baobab. Native, large tree with swollen trunk that attracts considerable tourist interest	Many: wood is used to carve coolamons; old dried fruit for carvings; inside portion of seeds eaten; current investigations of potential to use tubers as vegetables	Carvings, fruit for jams/ chutneys/ snacks, tourism;	Market most likely price sensitive; processing labour intensive and hence costly	The tree is slow growing and this will inhibit the use of trees; substantial use of seeds is unlikely to cause problems (populations limited by fire)	No recorded constraints; interesting range of traditional use	Most confined to remote sites with limited infrastructure	S: locally abundant and no cultural obstacles to use; W: existing market limited; O: small potential for niche market linking Kimberley /Western NT tourism; T: demand and prices unpredictable (limited precedent)	9
Adenanthera pavonina, red bean tree. Moderate sized spreading tree to 10m. Coastal monsoon vine thickets, monsoon forest fringing black soil floodplains.	Aboriginal people use seed to make ornaments; young leaves edible; kernels of seeds edible after roasting. Timber used for building and cabinet making in India	Potential for small niche markets for (1) seed for cultivation (2) as snack food (3) timber for cabinet-making. No established markets in Australia	Wild harvest laborious but no special storage necessary. Better if value added (e.g. necklaces) packaged and sold through community; or used in local nursery.	Impacts on fauna thought unlikely; minor harvests of seed should not threaten status of harvested species. Timber use would require careful management.	No recorded constraints	Seasonal availability of relatively sparsely distributed resource. Costs of wild seed harvest high.	S: no cultural objections to harvest recorded, easy to store and harvest W: low returns from non-timber uses O: value adding at community in artefacts or nursery trade T: demand unpredictable	9

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Albizia lebbeck. A large spreading tree 10-15m high. Uncommon in coastal vine thickets, on stabilised dunes or low lateritic ridges above the beach. Wood is hardy, strong and durable.	Attractive plant that may have potential cultivated. Cultivated from seed, very hardy and fast growing; an excellent shade or shelter tree.	May be a small market through nurseries for this species.	No relevant information available	n/a - if plant cultivated this will enhance wildlife	No recorded constraints	Cultivation appears feasible but relatively uncommon plant in restricted range of habitats. Access likely to be a problem.	S: fast growing, good attributes W: limited local market O: low maintenance T: demand and prices unpredictable (limited precedent),	17
Allosyncarpia ternata. A large spreading tree 15-30m high with broad dense evergreen crown. May be cultivated from fresh seed, in well-drained soils, slow growing.	Important source of honey; wood used to make fighting sticks. Timber considered suitable for building and furniture.	Attractive plant that may have potential cultivated. May be a small market for seed from nurseries.	No relevant information available	Limited seed harvest unlikely to have significant impact. Populations fire limited.	Important tree to Aboriginal people for shade and shelter but no known constraints associated with seed collection.	Collection of seed appears feasible but returns unknown. Availability seasonal. Access a problem in remote rugged terrain.	S: no cultural objections to harvest W: limited local market O: easy to store and transport as saplings; establish Aboriginal connection T: demand and prices unpredictable (limited precedent),	13
Ampelocissus acetosa, native grape. Semi-prostrate shrub or scrambling climber. Common on open forest, woodland and shrubland, monsoon vine thickets and sandstone	Berries are eaten raw, tap root (tuber) eaten after roasting; leaves to wrap meat for cooking.	Fruit for jams/ chutneys; fruit raw for snacks	Market limited to jams; returns may be too low for labour intensive wild harvesting.	Fauna unlikely to be affected by wild harvest of fruit - records of blue tongue lizards eating fruit. Pigs eat tubers.	No recorded constraints	Abundant in a variety of habitats; fruit may be fragile and difficult to store and transport; availability seasonal	S: widely distributed, no cultural objections to harvest recorded W: fruit fragile; no previous commercial use; O: potential for niche market if able to collect in large quantities; T: demand and prices unpredictable (limited precedent)	14

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Antidesma ghesaembilla, black currant. Native, spreading shrub or small tree 2-10m high. Open forest and woodland, coastal monsoon vine thickets.	Berries eaten raw; early Australian settlers made jam from berries; Aboriginal people use fruit for cordial and as a dye; timber light and hard and used for digging sticks and spear heads.	Fruit for jams/ chutneys/ snacks; wood may have some potential for artefacts.	Depending on density of trees and access - large quantities needed for production of jams unless used as quantitatively minor component.	Animals eat fruit, (possums, wallabies, dingoes, pigs, emu), so wild harvest may have some impact on fauna.	No recorded constraints	Found in a variety of habitats, sometimes at high densities; fruits in wet season, potentially constraining access; handling and transport of fruit may cause damage	S: many different habitats and uses; W: fruit fragile; no established market; seasonality and storage problems; intense harvests may compromise use by community and availability for fauna O: potential for niche market if able to collect insufficient quantity; T: demand and prices unpredictable (limited precedent)	12
Aponogeton elongatus, water yam. Native aquatic plant found around billabongs	The round hairy yam at the base of the stem is roasted, peeled and eaten. The roots are crushed on mortars and eaten	No current indications of interest but may have potential with bushfood/ restaurant industry;	Cost of harvest unknown	Relatively common; risk of over-harvest minimal unless demand unexpectedly large.	No recorded constraints	Best harvested at the beginning of the wet season when the tubers are large. Some access problems and difficulties with strong seasonality of supply. Achievable storage periods unknown.	S: no cultural objections to harvest recorded, can be stored without refrigeration; W: markets and prices uncertain; O: may have small niche restaurant potential; T: demand and prices unpredictable (limited precedent)	13
Austrodolichos errabundas, yam. Low vine or climber growing in open forest.	Perennial tuber roasted in coals, cleaned and softened and fibre is chewed to remove carbohydrates and nutrients	Perhaps some potential for the bushfood / restaurant industry. May be an acquired taste.	Wild harvest laborious; supply probably limited unless cultivated	Distribution patchy and repeated harvest may deplete local populations	No recorded constraints; significant wild harvest may compromise availability for community	Locating tubers requires skill; distribution patchy	S: can be stored without refrigeration W: markets and prices uncertain O: niche in restaurant trade; sale in community where cultivation may improve access T: demand and prices unpredictable (limited precedent)	15

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Bambusa arnhemica, native bamboo. Planting spreading plant 10-15m high. Along banks and fringes of freshwater streams and associated monsoon forest, also coastal monsoon vine thickets	Aboriginal people use bamboos as spear shafts, didgeridoos and to carry water; Asian community around Darwin harvests for shoots for human consumption.	Specialised markets exist for bamboo shoots. Limited markets for bamboo poles for variety of uses.	Product has competed successfully with imported and locally cultivated product.	Impacts on development and persistence of clumps unknown: studies currently underway.	No recorded constraints.	Harvest after first rains, compromising access to some sites; feasibility has been demonstrated around Darwin and markets established.	S: no cultural objections to harvest, easy to harvest, store and transport W: Aboriginal people do not recognise bamboo as a food source O: there is a demand and the harvesting is regulated for sustainability T: demand unpredictable	6
Bombax ceiba, red flowered kapok. Erect tree 10-20m high with large woody thorns on trunks and branches. Coastal monsoon vine thickets	A number of uses including the wood for carvings and didgeridus, bark for twine and trunk for dugout canoes.	Existing markets for carvings.	Stem is minor part of value of product. Returns are currently adequate to encourage many members of communities to participate in artefact trade.	Studies at the Maningrida community, where species is widely used, suggest that harvests are sustainable.	Large trees have special significance to Aboriginal landowners. Harvest of smaller trees acceptable	Narrow distribution and difficulties of access inhibit use of all parts of population, but sufficient stems exist to meet community needs in accessible areas.	S: no cultural objections to harvest of small stems; established trade; W: durability of products sometimes in question; continued expansion of trade could lead to over-harvest; O: expansion of range of products; development of treatment methods to improve durability of products; T: market resistance to Bombax products due to borer problems	1
Boronia lanuginosa. Erect multi-stemmed shrub to 0.5 m with woolly hairs on young shoots. Endemic to Top End sandstone country and spinifex shrubland.	Infusions in water used to treat aches and pains and on chest to treat colds. Attractive plant that may have potential cultivated (from seed or cuttings).	Perhaps some potential as botanical medicine. Decorative plants sold through nurseries.	No relevant information available	Determination of potential ecological impacts would need further investigation.	None known	Cultivation appears feasible but relatively uncommon plant in restricted range of habitats. Access may be a problem.	S: strong Aboriginal connection W: time factor in cultivating O: member of suite of Arnhem Land plants with strong Aboriginal identity T: demand and prices unpredictable (limited precedent),	12

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Bossiaea bossiaeoides. Slender leafless shrub 1-2m high with smooth, flattened, broadly winged blue-green branches and yellow pea flowers. Open forest and woodland.	Unusual, decorative plant that may have potential cultivated for gardens and rockeries. Named by Aboriginals and known as calendar plant (when in flower, bees are producing honey).	May be a small market through nurseries for this species.	No relevant information available	Fruit/flowers eaten by emu.	No recorded constraints.	Collection of seed appears feasible but returns unknown. Availability seasonal	S: Aboriginal connection W: no established market; productive use requires plant nursery facilities O: member of suite of "Aboriginal" native plants T: demand and prices unpredictable (limited precedent)	12
Brachychiton diversifolius, kurrajong. Native tree 7-15m high, semi-deciduous. Open forest and woodland.	Many: seeds eaten after roasting; ground into flour to make damper; wood used to make spears and as firesticks; inner bark is rolled into a very strong string used for nets and dilly bags; tap roots of young plants are eaten raw or cooked; gum is chewed.	Seed in the restaurant industry as flavouring; wider sales as snack, Seed for nursery trade, either sold to larger concerns or grown by communities.	Costs of harvest of seed from wild uncertain, but likely to be high; many pods out of reach from ground	Tree common; although some native fauna may eat seed from pods, considered unlikely that well-designed wild harvest will have significant impact on fauna or species itself	No recorded constraints; irritant hairs in pod may constrain willingness to handle in quantity	No specific obstacles; seasonal availability combined with labour intensive harvest may constrain supply; post harvest handling and storage feasible in remote communities. Seed availability and hence incomes seasonal.	S: no cultural objections to harvest recorded; seed can be stored readily; W: markets and prices uncertain; to harvest in quantity a problem; O: principally as snack food, readily stored; T: demand and prices unpredictable (limited precedent)	8
Brachychiton paradoxum, native peanut. Small straggly tree 2-3 m high but may reach 6 metres. Found in open forest and woodland, sandstone country and escarpment plateau	Many: seeds eaten after roasting and grinding; tap root cooked and eaten; wood to make fire sticks; string and rope made from bark.	Seed for restaurant industry as flavouring; wider sale as snack	Costs of harvest from wild uncertain but likely to be high; pods within easy reach of ground	Tree is common; and although some native fauna might eat seed from pods, considered unlikely that wild harvest will have significant impact.	No recorded constraints; irritant hairs in pod may constrain willingness to handle in quantity	Seasonally availability combined with labour intensive harvest may constrain supply; more easily gathered than congeners; post-harvest handling and storage feasible in remote communities	S: no cultural objections to harvest recorded, can be stored readily; W : markets and prices uncertain; likely costs of harvest O: unique snack food; T: demand and prices unpredictable (limited precedent)	9

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Buchanania arborescens, Blumes. Erect slender tree 10-15m high. Monsoon forest associated with permanent freshwater streams in sandstone country, coastal monsoon vine thickets above the beach	Many: fruit eaten raw; many medicinal uses; bark and wood for cultural purposes Cultivated from fresh seed, grows in well-grained soils, A handsome shade tree	Good potential for jams/chutneys; niche markets as a snack food. Seed for nursery trade, either sold to larger concerns or grown by communities.	Less common than some other fruit trees with similar products, reducing range of situations in which harvest offers adequate returns No information on price and demand. Returns on seed collection effort unknown.	Tree is relatively common and fruit plentiful; wild harvest may have some effects on native fauna. Seed and fruit harvest would require management to reduce potential of local impact.	No recorded constraints	Seasonality of peak availability (late dry/transition); drying or freezing may be necessary to provide continuous supply of fruit; many sites are accessible when fruit is abundant. Collection of seed is feasible but time taken and returns unknown.	S: no cultural objections to harvest recorded, fruit can be stored readily; trees are usually small simplifying fruit gathering; W: markets and prices uncertain; harvest laborious O: snack food or in jam, can be stored easily; T: demand and prices unpredictable (limited precedent)	14
Buchanania obovata, green plum. Small to moderate size tree 4-10m. Common understorey tree in open forest and woodland, sandstone country.	Many: fruit eaten raw; numerous medicinal uses; wood used to make woomeras.	Good potential for jams/chutneys; niche markets as a snack food	Less common than some other fruit trees with similar products; reducing range of situations in which harvest offers adequate returns	Tree is common and widespread and fruit plentiful; wild harvest may have some effect on native fauna.	No recorded constraints	Seasonality of peak availability (late dry/transition); drying or freezing may be necessary to provide continuous supply; many sites are accessible when fruit is abundant	S: no cultural objections to harvest recorded, fruit can be stored readily; trees are usually small and it is easy to gather fruit; W: markets and prices uncertain O: has opportunity as snack food, or jam, can be stored easily; T: demand and prices unpredictable (limited precedent)	9
Callitris intratropica, Cyprus pine. Tall straight trees 15-18m high forming cone-shaped crown. Open forest and woodland in sandstone or lowland country, common on slopes and ridges protected from fire.	Many traditional uses. Wood is used for woomeras, paddles and a number of medicinal purposes. Cypress oil named as scent of Sydney 2000.	Markets exist for cypress oil and wood.	Process is time and energy consuming and cost unknown. Might be able to combine the use of the wood for timber with use of the foliage for oil.	Cypress forests are relatively species poor. Well-managed harvests would not necessarily compromise other values.	No recorded constraints although some groups are against extraction of whole plants	Laborious and time consuming process but returns are good	S: product is sought after and returns reasonable; W: time consuming process; O: easy to store; T: demand and prices unpredictable (limited precedent),	6

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Calophyllum inophyllum, beauty leaf. Large spreading tree, 15-20m high with dense foliage and broad crown. Coastal dunes and cliffs. Found in eastern Arnhem Land and off shore islands, also Darwin foreshore	Named but not used by Aboriginal people. Attractive plant and outstanding shade tree that may have potential cultivated for sale of seedlings.	May be a small market for seed from nurseries.	No relevant information available	Prolific seed producer and germination rates high. Sustainable seed collection regimes can be designed.	No recorded constraints.	Collection of seed appears feasible but returns unknown. Availability seasonal	S: endemic and unique W: time factor in cultivating O: easy to cultivate; T: demand and prices unpredictable (limited precedent),	13
Calytrix exstipulata, turkey bush. Erect bush 1-4 m high. Common understorey in open forest, woodland and sparse shrubland extending to drier regions.	Used by Aboriginal people to make boomerangs, clap sticks and woomeras. An attractive ornamental suited to gardens, rockeries and street medians	Seed for nursery trade, either sold to larger concerns or grown by communities.	No information on price and demand. Returns on seed collection effort unknown.	Widespread, locally abundant plant. Seed harvest would require management to reduce potential for local impact.	No recorded constraints	Collection of seed is feasible, but highly seasonal.	S: no cultural objections to harvest W: markets and prices uncertain, harvest laborious O: easy to store and transport T: demand and prices unpredictable	12
Calytrix megaphylla. Slender small shrub 0.5-1m high. Found on the sandstone escarpment country and in mixed shrubby woodland.	Attractive plant that may have potential cultivated. Endemic to the escarpment region of Kakadu and western Arnhem Land	May be a small market through nurseries	No relevant information available	Unlikely small scale harvest of seed will have ecological impacts	Not known constraints recorded.	Collection of seed appears feasible but returns unknown. Availability seasonal	S: endemic to Aboriginal lands W: limited local market O: established Aboriginal connection; one of a suite of Arnhem Land plants for which particular “brand” might be developed. T: demand and prices unpredictable (limited precedent)	13

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Carallia brachiata, Carallia. Small to medium sized tree, generally 5-10m high. Found in coastal monsoon vine thickets, monsoon forests	Fruit are eaten raw; wood is used for axe handles, spear throwers and fighting sticks.	Some potential for jams/chutneys; niche markets as a snack food; artifact manufacture	May have commercial economic potential	Patchily distributed, creating risk of local over-harvest; fruit eaten by native animals such as birds, possums, fish, turtles and wallabies; substantial wild harvest may have some impact on local fauna	No recorded constraints	Patchy distribution and some sites difficult to access; seasonality of availability (late dry)	S: no cultural objections to harvest, trees small and seed harvest straightforward W: markets and prices uncertain O: use snack food, or jam as complement to other fruit harvests T: demand and prices unpredictable (limited precedent)	12
Carpentaria acuminata. Tall slender, single stemmed feather palm 15-30m high with a trunk 12-15cm diameter. Moister coastal vine thickets, dense monsoon forests associated with permanent fresh water.	The young central shoot is eaten raw or slightly cooked (like cabbage); fronds are used for carrying water; wood is sometimes used to make fighting sticks	May have some potential with niche restaurant markets	Easy to harvest and store	Harvest often kills plant; considerable potential for local overharvest	No recorded constraints	Common within most of its range; many accessible sites; readily cultivated	S: no cultural objections to harvest recorded, easy to harvest W: markets and prices uncertain; demand small O: some novelty value T: demand and prices unpredictable (limited precedent)	13
Cochlospermum fraseri, yellow kapok. Slender shrub or small tree to 6m high. Common understorey plant in open forest and woodland, wide variety of well drained soils, and sandstone country	Roots of young plants eaten roasted; flowers eaten raw or cooked; young stems used for fire sticks; bark used to make string; many Aboriginal medicinal uses	Small niche market for fresh and dried flowers; possible domestic market if packaged properly.	Wild harvest will be viable in those areas where trees in abundance although returns uncertain	Effects of reduced seeding following harvest of flowers uncertain; effects may be minimised by rotating areas/individuals harvested	Flower used to decorate body during ceremony but no cultural constraints in picking the leaves.	Distribution patchy and harvests laborious; seasonality of availability offset by some extent by potential to dry	S: no cultural objections to harvest recorded, trees are small and it is easy to gather flowers; W: markets and prices uncertain O: niche market as addition to salads and jams, or as tea T: demand and prices unpredictable (limited precedent)	9

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Cucumis melo, wild cucumber. Small climber or shrub. Found in open forest and woodland on well-drained soils.	Fruit are eaten raw and have a pleasant crispy and sweet taste.	Small niche market with restaurants	Sparse distribution may compromise economically viable harvest	Unknown	No recorded constraints; very popular with Aboriginal children, creating competition for product	Sparsely distributed over large areas; no access difficulties	S: no cultural objections to harvest recorded, easy to gather fruit W: markets and prices uncertain, may not be large enough quantities O: has opportunity in fruit salads/ jams T: demand and prices unpredictable (limited precedent)	15
Cycas angulata, cycad. Large palm like plant 3-10m high, dark grey trunk 40-85cm diameter, male and female plants. Open woodland often near streams, sandy or lateritic soil.	Treated seed ground into a damper by Aboriginal people. Fronds used for decoration in floral arrangements, whole plant for commercial and domestic gardens.	There is a market for this species as a large ornamental plant	Harvest of whole plants is feasible at moderate cost, but post-harvest care to bring to saleable condition not yet costed	Harvest requires careful monitoring to measure impact on population	Cycad has some cultural significance with some Aboriginal clans	Slow growing so entry to market dependent on harvest off established plants. These require extended post-harvest care in plant nursery. Overseas sales require detailed management plan.	S: no cultural objections to harvest of fronds, endemic W: limited local market, long time to recover from extraction, O: easy to store and transport; establish Aboriginal connection T: demand and prices unpredictable (limited precedent),	6
Cycas arenicola, cycad. Large palm like plant. Occurs on sandy soil on scree in the upper reaches of the East Alligator and Liverpool Rivers, Northern NT.	Seed made into a damper by Aboriginal people. Fronds for decoration in floral arrangements, whole plant for commercial and domestic gardens.	Small market for fronds and whole plant for commercial and domestic gardens	Harvest of whole plants is feasible at moderate cost, but post-harvest care to bring to saleable condition not yet costed	Harvest requires careful monitoring to measure impact on population	Cycad has special cultural significance (used in ceremony) with some Aboriginal clans	Slow growing so entry to market dependent on harvest off established plants. These require extended post-harvest care in plant nursery. Overseas sales require detailed management plan.	S: no cultural objections to harvest of fronds, endemic to Aboriginal land W: limited local market, competition with local species O: established Aboriginal connection; overseas market for large plants T: demand and prices unpredictable (limited precedent)	5

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Cycas armstrongii, cycad. Palm like plant 1-3m high, 17-30cm diameter, male and female plants. Isolated limestone outcrops, sandstone country, on stony slopes, well-drained sandy sites.	Treated seed ground into flour by Aboriginal people. Fronds for decoration in floral arrangements. Whole plant for commercial and domestic gardens	Fronds are in demand by florists, but most collect themselves. Limited market for whole plants.	Harvest is feasible at moderate cost, but post-harvest care to bring whole plants to saleable condition not yet determined	Research to date indicates that if fronds are harvested conservatively, impact on plants is minor. Harvest of whole plants requires careful management.	Cultural significance for some Aboriginal clans, but generally no objection to harvest of fronds, and interest from some communities in harvesting whole plants	Slow growing so early entry to market dependent on harvest of established plants, requiring extended post-harvest care in plant nursery. Overseas sales require detailed management plan. Delivery of fronds from remote sites problematic.	S: no cultural objections to harvest of fronds; agreement that whole plants may be harvested W: limited local market and storage time for fronds, long period between extraction and sale of whole plant O: significant local market, potential greater overseas T: demand and prices unpredictable (limited precedent)	9
Cycas arnhemica, cycad. Large palm like plant 1-10m high with 30-50cm diameter trunk. From well-drained sandy soil to boggy clays, open woodland to monsoon forests. Experimental harvest permitted with permit.	Treated seed ground into flour by Aboriginal people. Fronds for decoration in floral arrangements. Whole plant for commercial and domestic gardens.	Some demand as ornamental plant. Endemic to central Arnhem Land and Groote Eylandt, giving an Aboriginal identity	Harvest of whole plants is feasible at moderate cost, but post-harvest care to bring to saleable condition not yet costed	Harvest would need to be monitored to measure impact on population	Cycad has some cultural significance with some Aboriginal clans, but interest in harvest of whole plants in relevant areas.	Slow growing so early entry to market dependent on harvest off established plants. These require extended post-harvest care in plant nursery. Overseas sales require detailed management plan. Delivery of fronds from remote sites problematic	S: no cultural objections to harvest of fronds, endemic and different appearance to species presently on market; one of a suite of Arnhem Land plants. W: long time to recover from extraction O: established Aboriginal connection; significant local market, potential greater overseas T: demand and prices unpredictable (limited precedent),	5
Cycas calcicola, cycad. Palm like plant 2 - 5m tall. Abundant around Daly River basin and north along Finniss Range from Katherine River to the north of Litchfield Park.	Treated seed ground into flour by Aboriginal people. Fronds for decoration in floral arrangements. Whole plant for commercial and domestic gardens.	Fronds are in demand by florists, but most collect themselves. Limited market for whole plants.	Selling of fronds is economically viable and selling of whole plant may also be, depending on time taken to recover after extraction.	Research to date indicates that if fronds are harvested conservatively, impact on plants is minor. Whole plant harvest requires careful management.	Cultural significance with some Aboriginal clans but generally there is no objection to harvest of fronds.	Logistically feasible - limited local market Experimental harvest allowed with permit.	S: no cultural objections to harvest of fronds and plants W: limited local market and storage time for fronds, long period between extraction and sale of whole plant O: unusually attractive plant may be in greater demand than alternatives T: demand and prices unpredictable (limited precedent).	1

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Cycas orientis, cycad. Large palm like plant 1-10m high with 30-50cm diameter trunk. From well-drained sandy soil to boggy clays, open woodland to monsoon forests. Experimental harvest permitted with permit.	Fronds for decoration in floral arrangements, seed made into a damper by Aboriginal people, whole plant for commercial and domestic gardens	Demand as ornamental plant. Endemic to central-Arnhem Land and Groote Eylandt, giving an Aboriginal identity	Depending on how long they take to recover from extraction	Harvest would need to be monitored to measure impact on population	Cycad has some cultural significance with some Aboriginal clans	Depending on density if plants harvested from the wild or speed of growth if cultivated	S: no cultural objections to harvest of fronds, endemic W: limited local market, recover time after adult harvest O: established Aboriginal connection T: demand and prices unpredictable (limited precedent),	6
Cymbidium canaliculatum, tree orchid. An epiphytic orchid. Usually in open woodlands on Eucalyptus foelscheana, E. bleeseri.	Attractive for domestic gardens. Aboriginal people eat the leaves raw or cooked, for medicinal purposes and the juices as fixatives for ochres in paintings.	May be a small market through nurseries for this species.	Depending on price offered by nurseries	No relevant information available	Not cultural objection to cultivation, whole plant removal may not be culturally acceptable in some areas	Depending on density if plants harvested from the wild or speed of growth if cultivated	S: no cultural objections to harvest; easy to store and transport W: limited local market, competing with more colourful exotic cultivars O: salvage from areas subject to clearing T: demand and prices unpredictable.	16
Dendrobium affine, tree orchid. An epiphytic orchid generally 20-30 cm.	Attractive for domestic gardens. Aboriginal people eat the pseudobulbs baked.	May be a small market through nurseries for this species.	No relevant information	No relevant information	Not cultural objection to cultivation, whole plant removal may not be culturally acceptable in some areas	Depending on density if plants harvested from the wild or speed of growth if cultivated	S: no cultural objections to harvest W: limited local market, competing with more colourful domesticated varieties O: easy to store and transport T: demand and prices unpredictable	16

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Dendrobium canaliculatum, tree orchid. An epiphytic orchid generally 20-30 cm high, forming short, thick, fleshy pseudobulbs 3-10 cm long attached to the host plant.	Aboriginal people eat the pseudobulbs baked. Attractive plant for domestic gardens.	May be a small market through nurseries.	No relevant information	Overharvest likely if demand significant. Would require careful management.	No objection to cultivation, whole plant removal may not be acceptable in some areas.	Densities not high and harvests may be most feasible as complement to other resource management activity.	S: no cultural objections to harvest W: limited local market, competing with more colourful cultivars O: complement to other land management activity T: demand and prices unpredictable (limited precedent); risk of overharvest	16
Dillenia alata, red beech. Small to moderate size tree to 10m with dense round evergreen crown. Found in coastal monsoon forest.	Many: seeds eaten raw; wood used to make canoes; leaves used as external dressing on wounds to reduce swelling; attractive plant that may have potential cultivated.	Potential for domestic and residential gardens. Potential as botanical medicine not investigated.	No relevant information.	Modest harvest of seed or leaf unlikely to cause severe problems.	No objection to cultivation, whole plant removal may not be acceptable in some areas.	Small scale seed and leaf collection feasible	S: no cultural objections to cultivation W: use as garden plant must compete with established nurseries O: supplement other nursery activity in communities T: demand and prices unpredictable (limited precedent)	15
Dioscorea bulbifera, cheeky yam. A climbing plant found in monsoon vine forests.	Somewhat toxic; round hairy tuber cooked until soft, skin is peeled to remove the hairs and flesh grated and soaked in running water overnight	Small niche market with restaurants; supply to communities	Market small; viability compromised by laborious harvest; and complex preparation	Unknown, but patchy distribution; substantial wild harvest	No recorded constraints	Locating tubers requires considerable skill; complex preparation limits markets; regulatory constraints (toxicity if poorly prepared); method of cultivation untested	S: no cultural objections to harvest recorded; valued within Aboriginal communities; complements other bush food experiences W: markets and prices uncertain, laborious to harvest and prepare, O: cultivation; novelty appeal in restaurants; complement to other bushfood experiences T: demand and prices unpredictable (limited precedent), processing time significant; mild toxicity if poorly prepared	15

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Dioscorea transversa, long yam. A climbing plant which is found in monsoon vine forests	Eaten raw or cooked, roasted or boiled	Market with restaurants, communities and other domestic consumers	Time consuming and laborious wild harvest, may have potential cultivated	No impact known; substantial wild harvest may cause local depletion	Commonly used as food source during large ceremonies; important food item in communities, a number of which have expressed interest in cultivation	Locating tubers requires skill; laborious extraction especially in rocky areas; costs high; sites may be difficult to access; local depletion may lead to increased costs of extraction; methods of cultivation untested	S: no cultural objections to harvest; valued in Aboriginal communities W: markets and prices uncertain, harvest and preparation laborious; O: clutivation; niche in restaurant trade; complement to other bushfood experiences T: demand and prices unpredictable (limited precedent)	15
Elaeocarpus arnhemicus, blue plum. Evergreen tree 5-15m. Coastal monsoon vine thickets, monsoon forest associated with permanent freshwater streams	Ripe fruit edible; wood used for making canoes.	Fruit for jams, chutneys. Potential for sale of seed to nursery market.	Difficulties in providing high volumes given restricted range of habitat occupied. No reliable information presently available regarding nursery trade.	A number of native bird and animals eat fruit and wild harvest may have some impact depending on intensity of harvest: Confined to small, often fragmented habitat types, increasing potential for local over-harvest	No recorded constraints	Wild harvests laborious and returns uncertain; storage may be a problem although potential to dry fruit could be explored; seasonality of availability; germination often difficult	S: no cultural objections to harvest recorded W: markets and prices uncertain; difficulties in providing volume; fruit fragile O: gourmet bushfood market, perhaps as complement to other products T: demand and prices unpredictable (limited precedent)	12
Eleocharis dulcis, water chestnut. Perennial sedge found around billabongs and on floodplains.	Eaten fresh or roasted.	Potential in restaurants or for domestic consumption via gourmet wholesalers	Easy to prepare and store. Wild harvest (extraction from glutinous swamp soils) may be laborious.	Eaten by many native fauna and dry season staple for magpie geese. Densities are often very high and impact is likely to be highly localised	No recorded constraints	Wild harvest may be laborious in floodplain habitats where the species is most abundant; storage may be a problem; cultivation may be an option to meet small novelty market	S: no cultural objections to harvest recorded W: markets and prices uncertain, needs storage facilities; harvest laborious O: gourmet bushfood niche; or as novelty for tourists; complement to other activity T: demand and prices unpredictable; competition with larger cultivars in mainstream markets	7

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Erythrophleum chlorostachys, ironwood. Tree 12-18m with dense crown. Common and widespread in open forest and woodland in sandstone and lowland country.	Important wood for Aboriginal people: spears, woomeras, digging sticks, number of medicinal uses.	May be a niche commercial market for timber for building and heavy furniture. Strong, durable and resistant to termites.	No relevant information.	Harvest of relatively slow-growing tree would require careful management	No recorded constraints although some groups are against extraction of whole plants	Logging and milling demand substantial infrastructure; previous experience with forestry operations in remote sites suggest difficult to maintain economic operations	S: no cultural objections to harvest; some established uses W: constraints on extraction rates; lack of information on growth rates O: easy to store T: demand and prices unpredictable (limited precedent)	14
Eucalyptus arnhemensis. Evergreen tree 5-15m. Occurs in savannas, generally on elevated sandstone.	Timber sometimes used for posts and fencing; attractive plant that may have potential cultivated.	Potential for domestic and residential gardens.	No relevant information	Impact of regulated seed harvest expected to be minor.	No cultural objection to cultivation, whole plant removal may not be culturally acceptable in some areas	Collection of seed feasible but returns unknown. Seasonal. Requires plant nursery facilities for adequate returns to communities. Substantial costs of transport to markets.	S: no cultural objections to cultivation W: competing with established nurseries O: supplement other nursery activity in communities T: demand and prices unpredictable (limited precedent)	15
Eucalyptus jensenii, ironbark. Tree 7-12m with small to moderate dense crown. Open woodland on hills and rocky ridges.	Aboriginal people use for digging stick and clap sticks.	Timber is hard and durable, being used for fence posts and yards. May be a commercial market for the wood.	Oil yield is low.	Harvest for timber would require careful management.	No recorded constraints although some groups are against extraction of whole plants	Relatively sparsely distributed, compromising harvest. Logging and milling demand substantial infrastructure. Previous forestry experience in remote sites suggests difficult to maintain economic operations	S: no cultural objections to harvest W: preferred (hilly) habitat complicates extraction O: exploit interest in native timbers; salvage when land cleared for other purposes T: demand and prices unpredictable (limited precedent)	16

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Eucalyptus miniata, woollybutt. Erect tree 10-20 m with tall trunk and spreading crown. Often associated with E. tetrodonta and dominant in communities in sandstone and lowland country	Hollow stems used for didgeridoos, a number of medicinal properties.	Large market for didgeridus although there is also much competition for this market.	Obtaining stem for didjeridu is minor part of total product value. Returns more strongly dependent on quality and authenticity of decoration.	Harvest of stems requires careful management. Preliminary analysis indicates that in some areas, stems of dimensions used for didjeridus are critical to dynamics of forests	Important part of local (Top End) culture, with eastern and central Arnhem Land people regarding themselves as originators or instrument	Harvest is straightforward and stems can be taken from a wide range of environments.	S: widespread and easily harvested and transported; no cultural objections to harvest; strong links to Aboriginal culture W: competition from ersatz products; no authentication protocol O: strengthening of recognition of authentic products T: over-harvesting and over-supply with "fake" products.	3
Eucalyptus phoenicea. Slender, often multi-stemmed tree 7-10m high with light open crown. Found predominantly on rocky slopes in shallow sandy or skeletal soils	Hollow stems used for didjeridus. Also used for firewood.	Large market for didgeridoos although there is also much competition for this market.	Obtaining stem is minor part of total product value. Returns more strongly dependent on quality and authenticity of decoration.	Harvest of stems requires careful management. Preliminary research indicates that in some areas, stems of dimensions used for didjeridus are heavily harvested by illegal operators.	Important part of local (Top End) culture, with eastern and central Arnhem Land people regarding themselves as originators or instrument	Harvest is straightforward and stems can be taken from a wide range of environments.	S: widespread & easily harvested & transported; no cultural objections to harvest; strong links to culture W: competition from ersatz products; no authentication protocol O: strengthening of recognition of authentic products T: overharvest & over-supply of "fakes" damaging image	3
Eucalyptus tetrodonta, stringybark. Erect tall tree 10-30m tall. Found in association with E. miniata and is dominant in eucalypt communities in sandstone and lowland country	Many: Aboriginal people use the wood for canoes, spears, digging and fighting sticks, didgeridoos; some medicinal uses. Bark used for painting.	Large market for didgeridus although there is also much competition for this market. Well established market for paintings.	Obtaining stem is minor part of total product value. Returns more strongly dependent on quality and authenticity of fabrication and decoration.	Preliminary research indicates that stems of dimensions used for didjeridus are critical to dynamics of forests Taking barks for painting may kill tree. Harvest will require careful management.	Didjeridus are important part of local (Top End) culture, with eastern and central Arnhem Land peoples regarding themselves as originators or instrument. No cultural objection to use of species.	Harvest is straightforward and stems can be taken from a wide range of environments.	S: widespread and easily harvested; no cultural objections to harvest; strong links to Aboriginal culture. W: competition from ersatz products; no authentication protocols O: established markets for authentic product T: overharvesting and over-supply with "fake" products damaging image	3

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Exocarpos latifolus, native cherry. Shrub or small tree 3-5m. Widespread in coastal monsoon vine thickets. In low land or sandstone country, open forest, woodland, shrubland	Wood used to make woomeras and yam sticks; fruit is considered toxic but the swollen peduncle at the base of the fruit is eaten when red; inner bark and leaves used as medicinal wash.	Potential as botanical medicine	Laborious and time consuming wild harvest	Not enough known about faunal dependence on fruit to be able to predict impacts of harvest.	Fruit and bark used by some Aboriginal people to prevent pregnancy so there may be cultural constraints	Seasonal fruiting; unsuitability for cultivation (root parasite)	S: a number of traditional uses W: no particular market identified O: component of larger botanical (traditional) medicine market T: active components not well described	17
Ficus superba, wild fig. Found in North East Arnhem Land and Groote Island	Many: fruit eaten; bark used for arm bands, chest bands and for making string.	Market interest as ingredient for jams, or as a dried fruit product.	Wild harvest of fruit is labour intensive, returns are likely to be low for sale as a raw product	Tree abundant in some areas but restricted in distribution; intense local harvest may have ecological impacts; fruit used by many birds.	No recorded constraints	Mostly confined to remote sites with limited infrastructure where storage may be a problem	S: good flavour suited for jam products or dried figs W: labour intensive harvest, difficult to handle and store, returns on raw product low O: existing market interest; complement to other activity T: demand and prices unpredictable	20
Flacourtia territorialis, bush cherry. Plants are found along rivers, spings and billabongs	Fruit is eaten when ripe	Bushfoods	Laborious and time consuming wild harvest	Fruit are eaten by emu, possum, dingo and birds, but over harvesting given likely levels of demand appears improbable	No recorded constraints	Fruit spoils easily; wild harvest laborious.	S: fruits have good flavour and abundant in some areas, no cultural obstacles to harvest W: no established interest O: component of jams and sauces; complement to other bushfood harvests T: demand and prices unpredictable	16
Flueggea virosa, white currant. Small spreading shrub, found mainly in coastal monsoon vine forests and thickets, stabilised dunes.	Many: fruit eaten; wood used for fire-sticks; infusion from leaves used for medicinal purposes	Market interest as ingredient for jams chutneys and sauces; perhaps some options as novelty item; botanical medicine.	Labour intensive harvest; returns on raw product likely to be low	Restricted to monsoon forests and thickets; intense harvest may have local ecological impacts although shrub may be locally abundant and fruit plentiful; consumed by range of fauna	No recorded constraints	Fruit spoils easily; wild harvest laborious.	S: locally abundant, can produce fruit in large quantities and no cultural obstacles W: no well established market O: component of jams and sauces; complement to other bushfood harvests T: demand and prices unpredictable	17

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Grevillea formosa, Mt Brockman grevillea. Prostrate spreading shrub to 50cm, stems trailing 2-3m. Sandstone escarpment, on plateau and ledges on shallow sandy pockets.	No known Aboriginal uses. Attractive plant that may have potential cultivated. Grow from seed or tip cuttings, full sun in sandy soils, fast growing.	Outstanding showy ground cover plant that may have potential for domestic and residential gardens.	Margins weak in nursery industry, reducing options for remote communities.	Limited impact from well managed initial seed collection.	No known objection to cultivation.	Requirement for nursery facilities; transport costs from remote communities high.	S: no cultural objections to cultivation; evocative associations with Kakadu W: must compete with established nurseries O: component of wider Arnhem Land nursery offerings T: demand and prices unpredictable	13
Grevillea parallela. Slender tree 3-7m with silvery pendulous foliage. Open forest and woodland in sandy or lateritic soils, extending to sparse savanna woodland plains	Named by Aboriginal people but not used. Attractive plant that may have potential cultivated.	A slender attractive tree for parks, gardens, streets and landscaping.	Margins weak in nursery industry, reducing options for remote communities.	Limited impacts from well-managed seed collection.	No known objection to cultivation	Requirement for nursery facilities; transport costs from remote communities high.	S: no cultural objections to cultivation W: competition with established nurseries; no strong connection with Aboriginal culture or evocative locations O: component of wider Arnhem Land nursery offerings T: demand and prices unpredictable	14
Grevillea pungens, flame grevillea. Small shrub 1-25m high with spreading arching branches. Open forest and woodland on sandy soil, coastal woodland on sand dunes.	Named by Aboriginal people and noted as producing distinctive “cheeky” honey. Attractive plant that may have potential cultivated.	Potential market for domestic and residential gardens.	Margins weak in nursery industry, reducing options for remote communities.	Limited impacts from well-managed seed collections	No known objection to cultivation	Requirement for nursery facilities; transport costs from remote communities high.	S: no cultural objections to cultivation W: competition with established nurseries O: component of wider Arnhem Land nursery offerings T: demand and prices unpredictable	17
Grewia asiatica, wild plum. Exotic shrub found in coastal monsoon vine thickets, drier vine thickets,	Many: wood use for fire sticks; bark used to make string; dried leaves and fruit makes substitute for tea; fruit eaten as snack.	Ingredient for jams, dried fruit product.	Good size, tasty fruit that may have market potential, sometimes occur in dense patches which facilitates harvest	A variety of native fauna eat fruit; exotic plant	No recorded constraints	Seasonality of availability. Perishable item but can be dried for storag;	S: Tasty fruit and good size, readily dried and collected W: labour intensive harvest O: some apparent market interest; complement to other activity T: demand and prices unpredictable	15

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Gyrocarpus americanus, stinkwood. Tree 6-12m with thick trunk. Coastal vine thickets, drier thickets on sandstone hills or rock outcrops or open woodland or sparse savanna woodland	Many: wood light and soft and used to make coolamons and other wood craft, young stems used to make fish spears, some medicinal and ceremonial uses	There may be a market for the wood for crafts or furniture	Stem density relatively low, increasing costs of extraction in quantity	Harvest of trees requires careful management to ensure sustainability.	Tree is of cultural significance but there is no known objection to its harvest	The tree is large, abundant and found in a variety of habitats, offering a range of harvest options. Use of timber would require milling facilities. Carting timber will require reliable equipment.	S: widespread and easily harvested and transported; no known cultural objections to harvest; strong links to local Aboriginal culture W: competition from other softwoods for craft or furniture; O: complement to other activity T: demand and prices unpredictable	11
Haemordium coccineum. Perennial native herb to 1m which has rootstock as a bulb. In open woodland and forest on gravelly or shallow lateritic soils, woodland in sandstone country	Flowers and roots used to produce purple-red dyes for baskets and bags, dry stems used for fighting sticks, medicinal properties	Dye valued by those making baskets and bags - a small market. There may be a larger non-traditional demand for a natural dye	Wild harvest is probably not economic but there may be potential to cultivate this species	Harvest requires death of plant. Risk of over-harvest to meet commercial demands.	No known objection to wild harvest or cultivation.	Risk of depletion of wild stocks near settlements to meet demands of crafts industry. Cultivation near settlements may be required to improve economics of harvest.	S: no cultural objections to cultivation or wild harvest W: market limited; competing with artificial dyes O: cultivation and sale of dye to complement craft industry T: market demand and prices unpredictable	4
Hibiscus menzeliae. An erect shrub 1.5-3m with prickly hairy leaves. Sandstone country.	No described uses. Attractive plant that may have potential cultivated.	Potential for residential gardens.	Margins weak in nursery industry, reducing options for remote communities.	Modest seed harvest unlikely to have significant impact on species itself or dependent fauna	No recorded constraints	Requires nursery facilities and expertise	S: no cultural objections to cultivation W: competing with established nurseries O: complement to existing uses of established nursery T: demand and prices unpredictable	14
Hibiscus sabdariffa, wild rosella. Exotic plant bearing fruit used in jams and other flavouring.	Used by non-Aboriginal people for jams.	Use of fruit in jams or for other flavouring. Some novelty value.	Cost of collection likely to be high. Products unlikely to command high prices.	No significant impact (exotic)	No known constraints	Diffusely distributed. Seasonal availability. Short life unprocessed.	S: no cultural objections to cultivation W: limited market; no connection to Aboriginal culture O: complement other harvests T: demand and prices unpredictable	11

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Horsfieldia australiana. nutmeg. Tree 10-15m with dense spreading crown. Dense monsoon forest associated with freshwater streams, in sub-coastal lowland or sandstone.	Kernel has a coconut-like taste eaten raw. Fruit are regarded as good for stomach complaints. Garden plant, cultivated from fresh seeds, grows in deep well-drained soils.	Kernel may have some potential in the restaurant industry or as snack food. Fruit as botanical medicine. Seed for nursery trade, either sold to larger concerns or grown by communities.	Wild harvest may be laborious and returns on raw product low. Cultivation possible. No information on price and demand. Returns on seed collection effort unknown.	Although widespread and locally abundant, restricted to narrow range of habitats. Some risk from localised intense harvest, but can be managed.	No recorded constraints	Relatively abundant in monsoon forests; harvest laborious. Fruiting occurs in wet season, constraining access. Collection of seed appears feasible but returns unknown.	S: fruit easy to store and no cultural obstacles; connected with Aboriginal traditional use W: laborious harvest, mostly of fallen fruit O: complement to other bushfood activity; use as novelty item T: demand and prices unpredictable	10
Ipomoea abrupta, yam. Woody vine with bulbous roots found in coastal monsoon vine thickets and stabilised sites above beach level	Roots eaten raw or roasted; stems are used as string	Yams as bushfood; potential to supply native fine food caterers, especially restaurants.	Labour intensive harvest, prices of raw product not expected to be high	Restricted to narrow range of habitats; substantial wild harvest may cause local depletion	No recorded constraints	Difficult to locate; time consuming to extract; good storage capability; cultivation may be possible.	S: good tasting yams, good storage characteristics W: difficult to locate, time-consuming to extract O: complement to other bushfood harvests, especially other root crops T: wild harvest may not be a viable option; cultivation unproven	15
Marsdenia viridiflora, bush banana. Climber, native perennial evergreen, around 0.5m. Semi-decidious coastal monsoon vine forest and thicket and occasionally vine thicket on rock outcrops in inland areas.	The fruits, roots, leaf and flowers are all eaten. The fruit are eaten fresh when young. Infusion from leaves used as skin wash.	Fruit, leaves and flowers in bushfoods markets. Botanical medicine.	No information on costs of collection or likely prices.	Fruit likely to be consumed by a range of fauna so intensive local harvest may cause some problems.	No known cultural constraints effecting wild harvest or cultivation	Narrow window of opportunity to take fruit (regarded as inedible when mature). Limited distribution may constrain wild harvest. Cultivation methods unproven.	S: young fruit tasty and can be stored for some time; strong Aboriginal connection W: plants may not be in high enough density for reasonable harvest O: complement to other bushfood harvests and tourism activities T: demand and prices unpredictable	14

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Melaleuca cajuputi, paperbark. Tree 10-30m. Common on banks of streams & around billabongs & persistent seasonal swamps	Wood used for many purposes by Aboriginal people including canoes; medicinal values in leaves; bark used for preparing food, shelters.	Existing small market among gourmet wholesalers for bark used for food wrapping.	Easy to collect and store	No impact on fauna, no impact on the tree unless live bark is damaged.	No recorded constraints	Widely distributed and abundant and bark easy to collect and store	S: no cultural objections to harvest recorded, easy to store and harvest W: small specialised markets O: complement to wider involvement in bushfood supply T: demand unpredictable	2
Melaleuca dealbata, paperbark. Tree 10-30m. On banks of streams and around billabongs.	Wood used for a number of purposes by Aboriginal people including canoes and medicinal; bark used for preparing food, shelters	Existing small market among gourmet wholesalers for bark used for food wrapping.	Easy to collect and store	No impact on fauna, no impact on the tree unless live bark is damaged	No recorded constraints	Widely distributed and abundant and bark easy to collect and store	S: no cultural objections to harvest recorded, easy to store and harvest W: small specialised markets O: complement to wider involvement in bushfood supply T: demand unpredictable	2
Mimusops elengi. Erect evergreen tree 10-15 m with tall trunk and dense crown. Coastal monsoon vine thickets and old stabilised dunes, lateritic cliffs above beaches	Fruit eaten raw.	Fruit for jams, chutneys or dried as snack.	Berries are fairly large but time-consuming to harvest due to large size of some trees and relatively low density of fruit.	Restricted to narrow range of habitats; substantial wild harvest may cause local depletion.	No recorded constraints	Perishable item; seasonality of availability; potential for drying may offset these difficulties.	S: Tasty fruit of good size; may be dried W: labour intensive to harvest O: treat as low volume complement to other bushfood supply T: demand and prices unpredictable	16
Morinda citrifolia, cheesefruit. Rain forests, riparian vegetation and coastal habitats on sandy soils.	Many: medicinal uses to treat coughs, colds, congestion and asthma; fruit eaten.	Juice extracted for natural health drink, skin care products. Much sought after for health-promoting properties. Existing market overseas, Australian skin care company in joint arrangement with an Arnhem Land community to	Prices for juice good (>$35 litre-1) but volumes available from wild harvest relatively small. Supplementary plantings may be necessary to provide adequate supply.	Use of fruit unlikely to cause special problems, plant is common in Northern coastal areas of the NT.	No recorded constraints	Juice can be extracted by press; patchily distributed and small plantations around communities may be plausible to provide reasonable quantities	S: existing and growing markets W: perishable product; patchily distributed O: important component of wider bushfood supply activity T: current interest may be fleeting fad	8

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
		develop a facial product utilising the Morinda fruit.						
Myristica insipida, native nutmeg. Large spreading tree 10-20m high. Coastal vine thickets, monsoon forests.	Kernel is ground and used as a nutmeg spice, wood used for woomeras and digging stick, other medicinal properties.	Bushfood supply as spice, flavouring or snack. Novelty for tourism industry.	Depending on density of trees and price for product.	Not known.	No cultural objection	Harvesting laborious and quantities limited	S: no cultural objections to harvest, returns are high W: wild harvest will be time consuming and limited in quantity O: easy to store T: monitoring of population necessary	10
Nauclea orientalis, Leichhardt tree. Large tree 10-25m. On banks of streams and in associated monsoon forest in lowland or sandstone country, coastal vine thickets and swampy sites	Many: fruit is edible but bitter tasting; infusion of fruit in water used to treat gastro-intestinal problems; infusion from bark used as fish poison; trunk used for canoes and paddles	Large fruit as ingredient for jams, dried fruit. Traditional use as medicine may indicate potential for use as botanical medicine.	Fruit crops large and relatively easy to harvest, reducing costs.	Many native fauna eat the fruit and these have roles in seed dispersal within and between rainforests; intense harvests within parches may inhibit use by dispersers	No recorded constraints	Trees occur at relatively low densities in many sites, increasing potential for overharvest. Trees readily cultivated.	S: Good size, easily collected fruit; tree is ecologically and culturally important with strong associations with Aboriginal culture W: no established market O: test options for complement to other bushfood and botanical medicine ventures T: demand and prices unpredictable	14
Nelumbo nucifera, red lily. Perennial aquatic herb common across tropical north Australia in billabongs and swamps	Many: seed heads are eaten raw or roasted; roasted roots treat constipation; leaves used in food preparation; other medicinal properties	Bushfoods: Seeds have good nutty flavour; may be ground to flour, used as a dried nut product, or used for making sauces. Roots are roasted and eaten, new shoots eaten raw. Botanical medicine.	labour intensive bringing low prices in raw form; some potential as a higher value packaged novelty item linked to wetland and indigenous tourism.	Abundant and prolific producer of seed; unlikely that wild harvest will have negative ecological effects; populations appear more likely to be limited by climatic and hence hydrological variation.	Whole plant has ceremonial significance for women of some Aboriginal groups, but this does not appear to affect willingness to consider sustainable use	Seed may be collected over much of dry season; access often difficult; sporadic failure to develop (probably related to hydrological variation)	S: tasty nutty flavour, dries easily and stores well W: abundance variable from year to year O: number of options in bushfoods supply, perhaps as part of wider offerings T: cheaper imported seed	3

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Nymphaea macrosperma, water lily. Widespread across north Australia, found in billabongs, swamps and slow moving waterways in water up to 2 metres deep	Seeds, tuber and flower stem are eaten; tubers and seed heads used to treat different gastro-intestinal complaints.	Bushfoods: Flower stem has a fresh crisp taste similar to celery. Botanical medicines: use of tubers and flower heads.	Costs of collection and transport of flower stems substantial but price likely to be relatively low.	Wide spread, but little is known of population ecology; important food for some waterbirds. Harvests of the scale to satisfy local niche markets unlikely to cause more than highly localised problems.	No recorded constraints	Difficult to supply fresh stems from remote locations.	S: locally abundant, no cultural barriers, fresh stem provides a unique dining experience W: costs of delivering fresh stems to customer's doorstep O: develop as complement to wider bushfood offerings T: demand and prices unpredictable	11
Ocimum tenuiflorum, bush tea. Annual forb which occurs throughout the Northern Territory.	Leaves are used to make pleasant tea, which is thought to have strengthening properties.	Bushfoods: already sold as tea in Darwin. Botanical medicines: as beneficial herbal tea	In some areas occurs in sufficient density for efficient harvest. Existing prices appear congruent with cost of wild harvest. Cultivation could be considered.	Well-designed leaf harvests appear unlikely to threaten status of plant or other species.	No known cultural constraints.	Distribution and abundance not described sufficiently to determine favourable harvest sites. Facilities for sun or other forms of drying. Cool, dry storage areas: refrigerated storage probably best.	S: no cultural barriers, established uses, connection to Aboriginal culture and beneficial traditional use W: many other competing herbal teas O: opportunity for value adding in community (drying and packing); T: demand and prices unpredictable	8
Pandanus spiralis Tree to 10m with prickly leaves, found over broad range of habitats: often associated with wetter sites	Variety of uses: leaves are used to make dilly bags; seeds are eaten roasted or raw; roots are used to make a grey green dye; roots are made to extract sugar bag; fleshy pith is eaten; a range of medicinal uses	Useful in revegetation of wetter sites and erosion control in drainage lines. Arts and crafts: used to make range of saleable items. Cultivation may reduce prospect of over-exploitation near settlements	Cultivation of this species in a nursery situation may be economically viable	At levels of seed harvest likely to be required for proposed uses, impacts are likely to be negligible.	No known cultural constraints on wild harvest or cultivation	Plant nursery facilities required, with associated requirement for reliable water supply and pumps.	S: no cultural objections to cultivation or wild harvest; readily cultivated W: market limited; possible competition with nurseries O: mainly to meet needs of communities rather than external buyers T: low prices and sporadic demand	4

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Passiflora foetida, wild passionfruit. Exotic perennial climber found in monsoon vine forests, thickets, open forests and woodlands.	Although recognised as introduced, a number of uses are recorded. Pulp of fruit eaten. Leaves or fruit pulp used to treat skin infections	Bushfoods: Pulp of ripe orange fruit	Market limited and processing labour intensive, health concerns as unripe fruit skin highly toxic	Exotic plant treated as a weed in many areas	No known cultural constraints.	Difficult to collect; highly perishable Skin of green fruit is considered toxic	S: ripe fruit taste similar to cultivated passionfruit W: skin of green fruit considered toxic; as exotic, association with traditional culture weak. O: complements other activity T: low prices & limited interest	14
Piliostigma malabaricum, sweet and sour leaf. Run on areas in Eucalypt forest or stream margins	Leaf is eaten or chewed for its sweet and sour taste, burnt bark is added to chewing tobacco	Bushfoods: Leaf as a native flavouring in cooking.	Harvesting is simple but laborious; not highly abundant and somewhat restricted in habitats occupied	Fruits eaten by birds and nectar by native bees. Use of leaves unlikely to cause negative ecological affects provided individual trees are not over-harvested	No recorded constraints	Leaves can be dried for storage and transportation; seasonal availability because best flavour is with new growth	S: leaves can be dried and stored, overcoming seasonaility issues, association with Aboriginal culture W: distribution sparse. O: element of wider bushfoods supply enterprise T: prices and demand uncertain	13
Pouteria sericea, wild prune. Small bushy tree, widespread in monsoon vine forests and thickets.	Fruit is eaten raw; timber is used to make spear throwers and axe handles.	Bushfoods: regarded as one of the tastier native fruits in the Top End. Live plant trade: some potential for use in domestic gardens etc	Individual trees offer low yields; trees do not occur at high densities, so harvest laborious and supplies tenuous	Use of fruit unlikely to cause major negative ecological affects provided individual trees are not overharvested.	No recorded constraints	Perishable fruit would need to be frozen or dried; harvest labour intensive; drying might be considered	S: well-regarded taste W: low yield, harvest time-consuming O: complement to other bushfood supply activities; cultivation to increase supplies T: prices and demand uncertain but significant demand may straing acapacity to supply.	16

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Regelia punicea. Slender sprawling shrub or small tree 2-3m with hairy branchlets. Escarpment country.	Wood is used for digging and fighting sticks; a delicate ornamental suited to gardens and rockeries.	Live plant trade: residential gardens.	Margins in live plant trade tight and remote sites unlikely to compete unless premium for suite of "Arnhem Land" plants can be established.	Source of nectar: native bees nest in this tree. Collection of seed for cultivation can be managed to avoid impacts.	No cultural objection to cultivation, whole plant removal may not be culturally acceptable in some areas	Requirement for nursery facilities and reliable water supply.	S: no cultural objections to cultivation; member of suite of plants associated with evocative landscape and active Aboriginal culture W: competing with established nurseries with lower cost structures O: complement to other live plant supply activity where Aboriginal association can be promoted T: demand and prices unpredictable	12
Santalum album, sandalwood. Shrub or small tree to 3m. Uncommon in coastal / near coastal vine thickets	Fruits are eaten, also used to treat skin ailments. Wood used in Asia for incense sticks.	Timber: for incense sticks	Previous proposals to exploit commercially have failed due to limited supplies	Some risks of over-harvest if all specimens encountered were taken. Harvest would require careful management	No recorded constraints although some groups against extraction of whole plants	Previous surveys indicate that populations are small and trees scattered.	S: no cultural objections to harvest W: populations small and scattered, limiting scope O: easy to store T: demand and prices unpredictable	13
Schefflera actinophylla, umbrella tree. Slender, multi-stemmed tree, 10-20 m. Moister coastal monsoon vine thickets, dense monsoon forest associated with permanent streams	Named by Aboriginal people and recognised as food for animals, but no recorded uses. Attractive plant for cultivation.	Live plant trade: residential gardens or pot plant.	Margins in live plant trade are tight and higher costs in remote areas work against effective competition for plants that have no special Aboriginal connection.	Many birds feed on flowers and fruit. Conservative seed harvest unlikely to cause significant detriment.	No known objection to cultivation.	Depending on density if plants harvested from the wild or speed of growth if cultivated	S: no cultural objections to cultivation W: competing with established nurseries O: complement to other live plant offerings T: limited interest given ready availability of similar plants from existing sources	17
Sesbania formosa, white dragon tree. Endemic to northern Australia. Erect slender tree 10-15m. On fringes of coastal floodplains on black soils; along banks of permanent and	Timber used to make fire sticks, coolamons and woomeras. Bark is burnt to make black paint.	Revegetation and use in agroforestry. Fast growing with light soft wood which may be useful for pulp.	No relevant information	Selective, small scale wild harvest of seed should have minimal ecological impact	No recorded constraints.	Relatively sparsely distributed, compromising commercial harvest except for high value products. Logging and milling demand substantial	S: no cultural objections to harvest W: no established markets O: most immediately useful within communities for land management activity T: demand and prices unpredictable	11

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		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
seasonal lowland freshwater streams, and in monsoon forests						infrastructure; previous experience with forestry operations in remote sites suggest difficult to maintain economic operations		
Solanum echinatum, little plum. Semi-prostrate shrub located on sandstone country in the Top end.	Fruit eaten by some Aboriginal peoples, but considered poisonous by others.	Fruit has pleasant taste. However, ambiguity over potential for some mild toxicity	No present market	Fruit eaten by many animals; well-managed use of fruit unlikely to cause negative ecological affects	No recorded constraints	Mostly confined to remote sites; sparsely distributed and labour intensive to harvest.	S: association with Aboriginal culture W: ambiguity over safety O: no present markets T: regarding toxicity of fruit	16
Stemodia lythrifolia. Erect multi-branched perennial herb 0.3-1m high. Open woodland and sparse woodland.	Leaves and stems used in ash to treat skin ailments, as well as respiratory congestion and headache. .	Botanical medicines	No present information	Reported to be used by rock kangaroos to treat skin conditions. Conservative harvests of leaves and small stems are unlikely to compromise status of populations	No recorded constraints	Relatively sparsely distributed	S: no cultural objections to harvest; well-established Aboriginal use W: no established market O: component of suite of species justifying investigation as botanical medicines T: demand and price uncertain	11
Sterculia quadrifida, bush peanut. Tree 5-10m tree. Coastal monsoon vine thickets, stabilised sand dunes monsoon forest associated with permanent water	Many: seeds eaten; string made from inner bark; inner bark in water or breast milk used to treat sore eyes and ears; wood for fire sticks; stems used to make pipes. Cultivated from fresh seed, adapts to a variety of well-drained soils, hardy and fast growing.	Bushfoods: seeds Botanical medicines: bark Arts and crafts: string	No information on price and demand. Costs of seed collection unknown.	Populations not large and restricted in distribution. Seed harvest will require careful management if demand substantial. Harvesting bark may damage plants and conflict with other uses.	No recorded constraints	Sparse distribution and size of tree makes harvesting difficult; yields from individual trees small. Availability seasonal.	S: nut has well-regarde flavour W: limited yield per tree; laborious harvest, thinly distributed; processing time ;likely to be significant O: seed harvest as complement to other bushfoods supply; investigate options for botanical medicine in greater detail T: inability to provide sufficient supplies to maintain interest.	12

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Syzygium eucalyptoides ssp. bleeseri, white apple Small tree, found in open forests and woodlands	Fruit eaten raw. Sweet tasting, small fruit. Regarded as better tasting than red apple.	Bushfoods: edible fruit, but no present market interest	No relevant information.	No marked detriment expected, provided harvest is not highly concentrated.	No recorded constraints	Occurs at relatively low densities, adding to cost of harvest; fruiting may be sporadic; difficulties getting raw fruit to buyers	S: well-regarded flavour and no cultural obstacles W: trees occur at relatively low densities O: component of wider bushfoods supply (for salads or other novelty/specialised use) T: maintaining adequate supply	13
Syzygium eucalyptoides ssp. eucalyptoides, white apple. Small tree found in open forest and woodland..	Fruit eaten raw. Small fruit, pleasant taste.	Bushfoods: edible fruit, but no present market interest	No relevent information	No marked effects expected, provided harvest is not highly concentrated.	No recorded constraints.	Sparsely distributed, fruit sparse; fruiting may be sporadic; difficulties getting raw fruit to buyers	S: pleasant tasting and no cultural obstacles W: little is known about likely yield O: complement to other products to fill seasonal gaps T: maintaining adequate supply	13
Syzygium fibrosum, small red apple. Shrub or small tree, dense monsoon forest	Fruit eaten	Bushfoods: raw fruit or use in jams	No relevant information	No marked effects expected, provided harvest is not highly concentrated.	No recorded constraints. Significant harvest may conflict with community use.	Fruits are damaged easily during handling; difficulties getting raw fruit to buyers. Vailability seasonal.	S: pleasant tasting and no cultural obstacles W: little is known about likely yield O: perhaps a complement to other products to fill seasonal gaps T: maintaining reliable supply	13
Syzygium suborbiculare, large red apple. Medium sized tree found in open forests and woodlands also margins of monsoon vine forests.	Many: apple is eaten; juice from cooked fruit is taken to treat coughs, colds and congestion; fruit pulp is applied to sore ears; infusion from leaves and bark to treat stomach pains	Bushfoods: In salads or jams. Botanical medicines:	No relevant information presently available	No marked effects expected, provided harvest is not highly concentrated.	No recorded constraints, although significant commercial harvest may conflict with community use.	Abundant in many areas. Fruits are damaged easily during handling; difficulties getting raw fruit to buyers. Availability seasonal.	S: large fruit of interesting character W: fruit is in demand in communities and may be taken for immediate use rather than to satisfy market O: perhaps a complement to other products to fill seasonal gaps T: maintaining relaible supply; competition with community use	12

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Tacca leontopetaloide, Tacca. Stemless herb, located in coastal regions in open vegetation and monsoon vine forests	Fruit eaten, seeds discarded; roots are used to treat diarrhoea although they require careful preparation	Bushfoods: use of small fruit; in jam or as a flavouring for other cooking. Used overseas for arrowroot	Labour intensive to harvest, returns likely to be low	Collection of fruits unlikely to cause negative ecological effects, in this widely distributed, fast growing herb	No recorded constraints	Highly perishable fruit, difficult to handle and store in remote areas.	S: locally abundant, easy to extract fruit from plant W: small fruit containing mostly seeds, little flesh, storage problems O: seasonal complement to other bushfood supply, principally as novelty for tourists T: widely distributed in Asia and any high volume use likely to be more easily satisfied from that source	11
Tamarindus indica, tamarind. Exotic tree probably introduced to northern Australia by Macassans in 17th Century	Fruit is eaten raw, flavouring; concoction from pulp and seeds are used for coughs, colds and congestion.	Fruit has strong spicy taste, widely used as a flavouring for cooking	Limited Australian market interest, more easily satisfied from other sources	Exotic	No recorded constraints	Fruit/seeds readily collected. Ability to dry and store overcomes seasonality issues.	S: readily collected and stored; uses well established W: exotic so limited Aboriginal connection O: complement to other bushfood supply activity T: limited markets more easily satisfied by others	9
Terminalia catappa, Indian almond. A large tree found on beaches.	Pulp of fruit is eaten; kernel is extracted from the large woody stone and eaten; trunks are used to make dug out canoes; planted as a shade tree.	Bushfoods: Kernel has a strong almond taste and is high in protein, potential as a nut product.	No relevant information on price, but commercial use proposed for Pacific Island forms.	Well-managed use of fruit or seed unlikely to cause negative ecological affect	No restrictions have been recorded	Collection of seeds requires minimum effort as they can be picked from the ground; labour intensive to crack fruit, more information is needed on densities.	S: kernel high in protein & tasty - similar to almond. W: very difficult to extract kernel, requiiring design of a device for extraction O: complement to other activity to test potential demand and returns T: no method developed to extract kernel efficiently.	15

Species	Documented Uses	Factors Influencing commercial options					Summary of strengths, weaknesses, opportunities and threats	Ranking (Range 1-21)
		Markets	**Economic**	**Ecological**	**Cultural**	**Logistical**		
Terminalia ferdinandiana. Kakadu plum. Small spreading deciduous tree with well known fruit. Widespread in Top End.	Fruit is eaten raw; preparation from inner red bark is used to treat sores, boils, ringworm and leprosy.	Bushfoods: Fruit used in jams, chutney and sauces, and as a dried fruit. Presently substantial market demand for raw fruit, delivered frozen C	Established price $9-12 kg-1. Reasonable returns on labour are achievable at this price in high density stands.	Kangaroos, wallabies possums and emus eat the fruit. Provided only single harvest, extended fruiting period will maintain availability for fauna.	No restrictions have been recorded Community members often confine harvesting to times when access is most convenient (dry after fire)	Freezing large volumes and getting to market in frozen form expensive and demands considerable infrastructure; naturally dried fruit might be a better alternative.	S: substantial existing market, demand growing and presently exceeding supply W: perishable; costs of transport to markets O: important component of diverse bushfood supply activity T: plantation based production 5 to 10years is likely and more profitable near larger settlements rather than in remote communities.	7
Terminalia grandiflora Slender tree 7-15m with narrow crown and pendulous branches. Common in open forest and woodland extending to dry regions on a wide range of well-drained soils.	Fruit is cracked and kernel eaten; wood is used to make woomeras, spearheads, fighting sticks and digging sticks.	Bushfoods: Use of kernel	No relevant information but known to be very labour intensive to extract seed.	Use of fruit/seed unlikely to cause negative ecological affect at small volumes.	No restrictions have been recorded	Both collection of nuts and removal of kernel are likely to be labour intensive; more information is needed on densities.	S: kernel is high in protein and is good tasting; W: very difficult to extract kernel, perhaps requiring design of mechanical device for extraction; O: component of wider bushfood supply activity T: limited demand; no method is achieved to extract kernel efficiently.	15
Vitex glabrata, bush currant. Moderate sized spreading tree 7-12m high with rounded crown. Coastal monsoon vine thickets, open forests and woodlands mostly by small streams	Fruits eaten, sometimes being dried and stored for later use. Fruit used in some ceremonies. May be cultivated from seed or cuttings. Hardy tree for parks and coastal planting.	Bushfoods: Edible fresh or dried fruit. Laive plants trade: Seed for nursery trade, either sold to or grown by communities.	No information on price and demand. Returns on fruit or seed collection effort unknown.	Important food for emu and other fauna. Populations not large and restricted in distribution; risk of over-harvest unless carefully managed.	No recorded constraints	Collection of fruit and seed appear feasible but returns on effort unknown. Availability seasonal but offset by ability to dry fruit.	S: no cultural objections to harvest; fruit may be dried for storage; established Aboriginal connection W: markets and prices uncertain O: complement to other bushfood supply activity T: demand and prices unpredictable; difficulty in supplying significant demand	16

Appendix 2: Proceedings of commercial plants products workshop held at Nauiyu Nambiyu Community, September 2001

Commercial Plant Products Workshop

Nauiyu (Daly River)
November 2001

Parks and Wildlife Commission of the Northern Territory and the Key Centre for Tropical Wildlife Management

Commercial Daly River Plants Products Workshop

Nauiyu (Daly River), November 2001

A commercial plant products workshop was held at Nauiyu on the Daly River on the 6th, 7th and 8th of November, 2001.

The workshop was organised by the Key Centre for Tropical Wildlife and the Parks and Wildlife Commission, it was held at the Merrepen Art Centre and the Leadership Centre in Nauiyu.

About 70 people attended the workshop, and included people from Nauiyu, Wooliana, Yirrkala, Maningrida, Ramingining, Acacia, Kybrook, Cape York, Darwin, Katherine, Kakadu and other parts of the Top End.

The main aim of the workshop was to bring together people from different communities who had been working on the commercial plant products project with Glenn Wightman, Julian Gorman and Honorlea Massarella from the Parks and Wildlife Commission and the Key Centre for Tropical Wildlife Management. We wanted to discuss the project and to look for directions for the future and ways to improve our research in the next stages of the plant products project.

The project has been going for three years and is due to finish its first stage at the end of this year. The project has been looking at ways that Aboriginal communities can be involved in commercial plant products businesses, and how communities can make more money from small businesses based on plant products. Value adding on communities appears to be the best way to make small plant product businesses work. This allows communities to maintain control over the business and the plant products, and to be involved in the sharing of the profits from the business

During the workshop a range of issues where raised by people, these are shown on the following pages. A list of people who attended the workshop is also included, along with contact details for people and organisations that may be able to help set up and run small community based businesses based on plant products.

The workshop

Tuesday, 6th November 2001

- All participants arrive at Nauiyu, introduction of all people present.
- Late afternoon, welcome on behalf of MalakMalak by Biddy Lindsay, field inspection of **Yilik,** Red lily plants, outline of project, initial discussions re workshop outcomes.

Wednesday 7th November 2001

- Morning: outline of project so far by Glenn Wightman and Julian Gorman, split into groups to look at different aspects of plant commercialisation, harvest, preparation, packaging, sale.
- Afternoon: presentation on business planning by Mike Harrison, discussion of permits, intellectual property, labeling, etc.

Thursday, 8th November 2001

- Morning: discussion of major points raised so far during workshop, outline of major outcomes, future directions, etc.
- Afternoon: pack up and depart.

During the workshop a number of important issues were raised. Some of these issues need to be discussed and researched further before they can be resolved. For example:

- Intellectual property rights, how to protect indigenous knowledge from exploitation by other people;
- Permits for harvesting plant products, can the system be improved by Aboriginal involvement;
- Authenticity labeling, can products be labeled to show they are really made by Aboriginal groups;
- A co-operative or co-ordinated approach to marketing and harvest: is it practical or possible;
- Can we code products and track harvests to ensure the industry is sustainable?

Some aspects of the project that were considered to be good and should be continued were also raised.

- Planning should continue to be done on country;
- Traditional land owners need to be involved at all stages;
- Benefits should be returned equitably to traditional owners and those who work on the project;
- Respect for plants, sites and culture is very important;
- Elders at communities provide cultural and biological direction to the project.

Things that should be considered with future projects:

- Involve more young people in all aspects of the commercial plant project;
- Further encourage the transfer of cultural and biological knowledge during commercial plant projects;
- Seek funding sources for help in starting and running community nurseries;
- Produce a contact list so that everyone can keep in touch with each other (see last two pages).

Other commercial plant opportunities that were raised during the workshop included:

- Floral art products – dried and fresh flowers, fruit and leaves that can be used by florists for making flower arrangements,
- Essential oils from plants,
- Herbs for use as flavouring and smell, for example in pot-pouri,
- Insect repellents from traditional sources such as cypress pine,
- Bush cucumber, especially on Wagiman country,
- Animals, for food resources, e.g., farming Bandicoots for meat,

What next?

The project funding from the Rural Industries Research and Development Corporation (RIRDC) stops at the end of this year. We have applied for more funding from RIRDC to continue the project next year looking at more species in more communities. We hope to hear whether we have got the funding by the middle of next year.

We will produce a final report for the project by the end of this year, we also hope to make a video of the workshop to send to everyone.

The Key Centre for Tropical Wildlife Management (NTU), the Parks and Wildlife Commission and the Centre for Indigenous Natural and Cultural Resource Management (NTU) are keen to continue working with communities on the commercial plants products project. We hope that we can continue with the project even if we don't get extra money from RIRDC.

Thanks

We would like to thank everyone who came to the workshop for your ideas and support.

- Special thanks to **traditional owners**, Biddy Lindsay, Albert Muyung, and other MalakMalak people for letting us have the workshop on their country.
- The staff of **Merrepen Arts** where supportive and helpful throughout, particularly Patricia Marrfurra, Meng Hoeschle and Amanda Grossett.
- Jo Moloney from the Caring for Country Unit at the **Northern Land Council** helped organise and facilitate the workshop.
- The **Office of Aboriginal Development** supported the workshop financially, and Bill Ivory assisted in organising things.
- The **Northern Territory Employment and Training Authority** provided funding for the workshop.
- Rob and Marie Prosser from the **Leadership Centre** and Gary and Rhonda Higgins from **Mango Farm** provided excellent accommodation.

Parks and Wildlife Commission of the Northern Territory and
the Key Centre for Tropical Wildlife Management

Who to talk to about a commercial plant project?
Below are the people to talk to about different aspects of setting up a small business based on a plant product. Almost all of the people were at the workshop. If they cannot help you themselves they will be able to put you in contact with the right person.

What plant might be good for a small business on our country?
Glenn Wightman, PWCNT, phone 8999 4513.
Julian Gorman, KCTWM, phone 8946 6574.
Joe Morrison, Indigenous Land Management Facilitator, 8999 4547

How do we begin a small business selling plant products?
Jo Moloney, Northern Land Council, 8920 5100.
Glenn James, Northern Land Council, 8920 5100.

Where do we get advice about growing plants?
Lesley Alford, Greening Australia, 8981 1344.

What about health concerns if we want to sell food plants?
Ken O'Brien, Territory Health Services, 8999 2400.

Can we get help or training to run a small business?
Bill Ivory, Office of Aboriginal Development, 8924 4225.
Rod Murray, NT Area Consultative Committee, 8941 6933.

Can we get start up money or loans to begin?
Michelle Adams, ATSIC, 8944 5602.

How do we get a permit for selling plant stuff?
Dave Lawson, PWCNT, 8999 4561.
Bernard Higgins, Northern Land Council, 8920 5100

Can we look after our intellectual property?
MaryAnn Bin-Sallik and Lorraine Williams, CINCRM, 8946 6440.

Appendix 3: Trial commercial harvests of native plants by Aboriginal communities in the Top End of the Northern Territory: Case studies

Appendix 3.1. Case study 1: Cycads

Appendix 3.2: Case study 2: Kakadu plum

Appendix 3.3: Case study 3: Lotus lily

Appendix 3.4: Case study 4: Long yam

Appendix 3.5: Case study 5: *Bombax ceiba*

Appendix 3.6: Case study 6: Miscellaneous

Appendix 3.7: Case study 7: *Eucalyptus phoenicia* and didjeridu fabrication

Appendix 3.1 Case study 1: Cycads

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Introduction

This study was conducted as part of the project "Feasibility of local, small scale harvests for indigenous communities". As a part of the larger project, a team comprising David Bowman, Julian Gorman, Tony Griffiths, Honorlea Masarella, Nick Smith, Greg Wearne, Peter Whitehead, and Glenn Wightman undertook a desktop analysis to identify those plants that appeared to offer some commercial opportunity that Aboriginal communities may be in a position to exploit. Criteria used to identify options are given in chapter 3 of the main report.

This *a priori* selection included two species of cycads endemic to Arnhem Land: *Cycas orientis* found in eastern Arnhem Land, and *C. arnhemica* which is confined to central Arnhem Land.

Because they were ranked high in our initial assessments, uses of cycads were raised as options with a number of communities, and seriously pursued in two of them. However, only one species, *C. arnhemica*, was ultimately harvested in a trial comprising part of the larger program. This report summarises that trial. Additional detail is available from the Key Centre for Tropical Wildlife Management.

Background

Cycads are slow growing, dioecious plants that show tuberous or columnar growth forms. The tuberous stems are either short or subterranean and are often branched. Columnar types may reach a height of up to 10 m and are seldom branched. Although cycads are considered woody plants, their stems have only a thin layer of wood, which surrounds a large pith or marrow. There are 11 species of cycad recognised in the Northern Territory, all of which show the columnar growth form (PWCNT 1997a).

Toxins are present in the leaves and the seed of all Northern Territory cycads. Cattle that eat cycad leaves may die and consumption of seeds may be harmful to humans unless they are thoroughly treated to remove toxins. Northern Territory primary production authorities have promoted cycad eradication in the past (e.g. Wesley-Smith 1973). Although eradication is no longer actively promoted, the threat to cattle means that many pastoralists still seek ways to reduce or eliminate them.

Aboriginal people have used cycads for a variety of purposes in the past and continue to do so today (Jones 1993). Cycad seeds are rich in starch, and exudates from the leaves and sporophylls may be used for medicinal purposes. Cycads are culturally significant in other ways. On Melville Island, the cycad is used in important ceremonies (Whiting 1963) and in the Borroloola district the Karawa people use the cycad in initiation and other rituals (Harvey 1945).

In the Northern Territory, there is a considerable demand for cycad leaves, harvested commercially by non-Indigenous people for incorporation in floral arrangements (D. Liddle, PWCNT, pers comm). Live cycads are popular decorative plants and are now proving increasingly popular with collectors and home gardeners for display, as well as with local councils and developers for parks and housing complexes (e.g. Krempin 1990). Current suppliers of Australian native cycad species mainly rely on salvage harvest of plants from areas being cleared of native vegetation in Queensland and Western Australia. There are also large and lucrative overseas markets (Osborne 1995). It is the market for live plants that our trial harvest was designed to examine.

Three options are available for entry to this market: growing stock from seed, salvage harvesting, and harvesting of established plants from the wild explicitly for trade. Cycads are slow growing, even under careful cultivation, so large investments in nursery infrastructure and time are needed before entering markets based on growing plants from seed. It is improbable that Aboriginal communities

will be able to compete effectively against well-established nurseries close to major settlements, where operational costs are lower. However, those same communities may have a comparative advantage in accessing relatively advanced plants from the very large populations of some species that grow only on their lands. There is a number of species endemic to Aboriginal lands for which no other permits for harvest of seed or adults have been issued, so that Aboriginal communities may offer the only legal source of supply.

Regulatory issues

All Northern Territory cycads are listed under Appendix 2 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Appendix 2 of CITES lists species that are not necessarily threatened with extinction, but in which trade is controlled in order to avoid utilisation incompatible with their survival. This imposes a number of obligations on Australia, which are effected through the Federal *Environmental Protection and Biodiversity Conservation Act 1999*. In brief, species like cycads can only be traded internationally if they are obtained under an approved management plan that meets specified standards regarding impacts on wild populations and systems, as well as arrangements for monitoring those impacts.

The Parks and Wildlife Commission of the Northern Territory has produced a management plan for cycads, which provides chiefly for seed and leaf harvest, but also makes special provisions for limited harvests of adult stems (PWCNT 1997a). Provisions for using adult stems relate primarily to "salvage" operations, where land is being cleared for other purposes. However the plan, as modified in 2000 with approval from the Federal Minister for Environment and Heritage, also allows for experimental non-salvage harvest of *Cycas angulata, C. armstrongii, C. arnhemica, C. orientis* and *C. calcicola*, limited to 500 plants of each species within the life of the 2000 amendment.

This project employed that provision to investigate the feasibility of a harvest of adult and juvenile plants of a species endemic to central Arnhem Land (*C. arnhemica*). The work was done under permits obtained from the Parks and Wildlife Commission NT by the Bawinanga Aboriginal Corporation at Maningrida, central Arnhem Land. The trial was carried out around Gamardi by members of the region's land management team (Djelk Rangers), residents of Gamardi outstation (where large populations of the cycad are present), and staff of the Bawinanga Aboriginal Corporation nursery.

Objectives

Objectives of the trial harvest were to:

1. On behalf of the Aboriginal participants, record details of the trial to determine:
    a. density, population size and distribution of *Cycas arnhemica* in a relevant site;
    b. post-harvest growth and survival of harvested plants under nursery conditions; and
    c. cultural acceptability, and economic and operational feasibility of commercial harvest of cycad stems from the wild.
2. On behalf of the management authority, establish monitoring arrangements capable of determining the effects of two different live-stem harvest regimes on the population dynamics (survival, growth and recruitment) of Cycas arnhemica remaining in harvested sites.

Methodology

There were four phases to the experimental harvests:

- establishing experimental plots and assessment of pre-harvest conditions;
- conducting the harvest;
- nursery trials of a range of post-harvest treatments; and
- post-harvest assessment of harvest sites

Characterising harvest and control plots

Three sites were chosen within the extensive area occupied by substantial populations of *Cycas arnhemica*, from which harvest was logistically convenient. Within each site, 9 quadrats (20 × 20 m) were chosen randomly and allocated randomly to 1 of 3 treatments, resulting in 3 replicates of each treatment:

1. no harvest of *Cycas arnhemica* stems (control); or
2. harvest of all adult (>0.5 m and <1.0 m in stem length) *Cycas arnhemica* stems; or
3. harvest of all intermediate (>0.05 m and <0.5 m in stem length) *Cycas arnhemica* stems.

In each quadrat environmental attributes recorded included habitat structure (e.g. basal area of woody plants, canopy cover of the upper stratum, landscape position, patch size and distance from closest permanent water), disturbance (fire, pigs, weeds), soil texture/colour and woody vegetation composition.

Monitoring protocol

The management authority required a comprehensive monitoring system to assess impacts, which was focused at the level of individual plants within small, permanently marked quadrats. All cycads in all quadrats were measured (diameter (mm), height (mm)) irrespective of size, and reproductive status recorded. All adult plants were identified with stainless steel tags attached with stainless steel wire. All plants with little or no stem were marked with stainless steel tags attached to a stainless steel spike driven into the ground close to the individual plant. All plants were to be re-measured at 12-monthly intervals. These data also provided a measure of cycad density within the various size classes.

Although not designed explicitly for this purpose, data on cycad density gathered in these quadrats provided a basis for at least crude estimates of the *C. arnhemica* local (10 km radius of outstation) and regional populations. To do this we ran aerial transects in a fixed wing aircraft over the area with significant cycad populations. Transects were separated by l km and subdivided into approximately 1 km segments by flying at or near a ground speed of 180 km h^{-1} for 20 seconds. The aircraft flew at 100 m above ground level over an area of approximately 86 km^2 surrounding the site of the trial harvest (Figure 1).

The cells within which harvests occurred and for which we consequently had an estimate of density, were identified and used as a reference to assign, by visual comparison, a relative density score to all other cells. Cells containing *C. arnhemica* at densities equivalent to or greater than known cells were assigned a score of 3; those with densities about 50% of those of measured cells were assigned a score of 2; those with densities 10% or less of those of measured cells a score of 1. If no cycads were detected, a score of 0 was assigned.

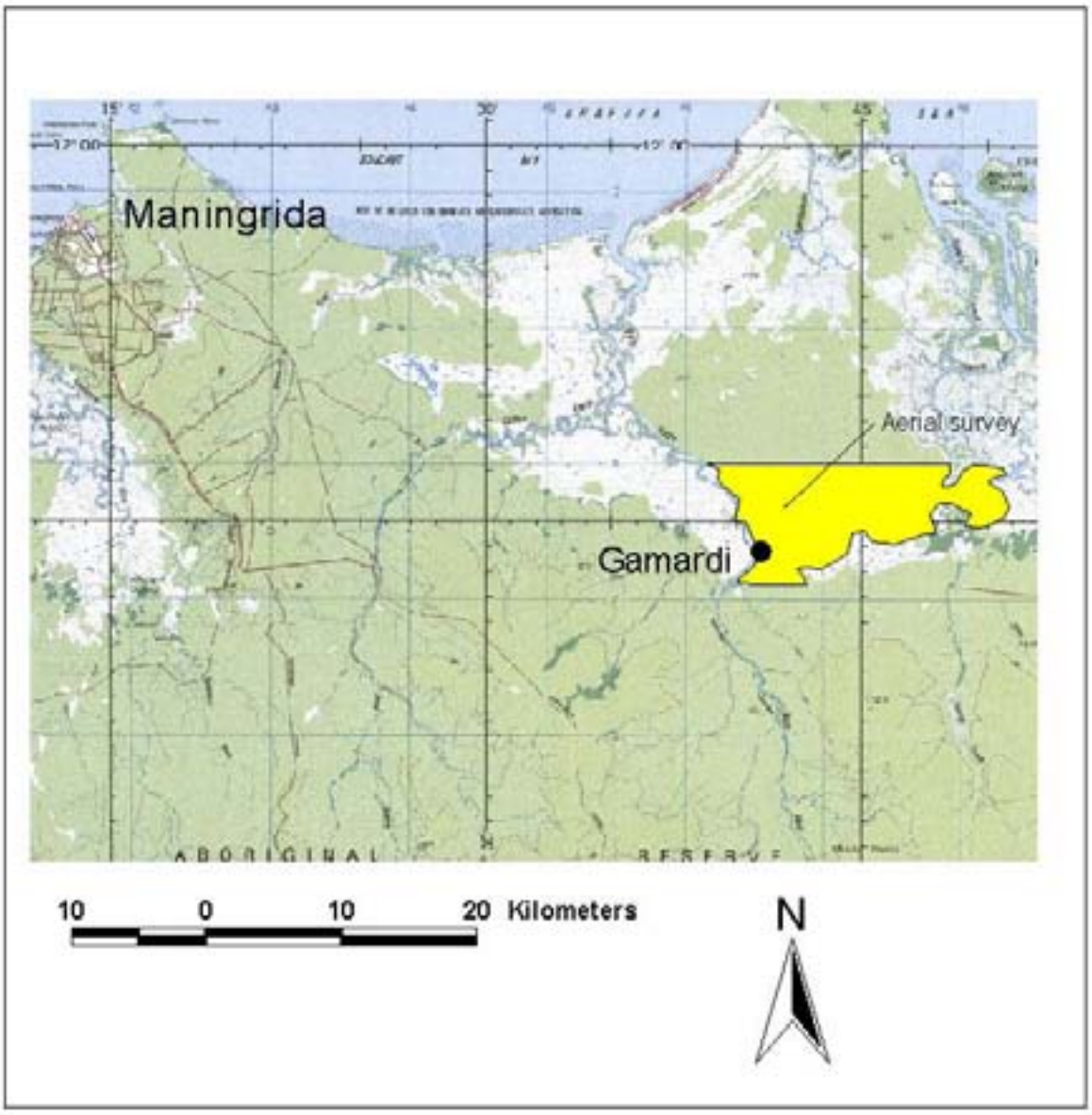

Figure 1: Map showing position of Gamardi community and area surveyed from the air to estimate size of the cycad population.

Harvest process

Traditional Owners from Gamardi Outstation and Djelk Rangers removed plants using shovels, picks and by hand (see Figure 2a). Harvesters worked in groups of 2 or 3. It should be noted that the number of persons involved exceeded requirements for commercial harvest. Additional community members were engaged to enhance opportunities for participation in, and understanding of, the project.

Harvesters carefully removed the soil to expose the basal bulb of the cycad and roots were cut approximately 15 cm below the bulb. All soil was returned to the excavated hole following removal of the plant (see Figure 2b).

All of the plants removed (previously tagged and measured) were placed in the shade prior to transport to the BAC Nursery at Maningrida within 3 days of removal. Transport between the Outstation and the BAC Nursery was done with particular care to avoid any damage to the plants. Initial harvests took place in July and September of 2001 and were repeated in 2002. Figures provided here are from the 2001 harvest.

Post-harvest treatment

All cycads received the same basic preparation. Fronds were cut, roots were trimmed and the bulb washed in a weak solution of bleach (42 g L^{-1} sodium hypochlorite). The basic soil mixture used consisted of a 10:1:1 proportion of locally obtained sand (large grained river sand from Mann River, 50 km west of Maningrida): Cocopeat (fibrous mulch derived from coconut husks): and perlite respectively.

The influences of other treatments on re-establishment of harvested cycads were also examined. These included: pre-potting application of fungicide and/or root growth hormone, and delayed potting. The delayed potting treatment involved storing trimmed, washed cycads in a dry shed and then potting them into the same soil mixture after 2 months. The delayed potting treatment was intended to simulate conditions which would be encountered during transport to an overseas market by ship e.g. to meet entry requirements for the US. To gain entry, plants must be transported free of soil.

The various categories of treatment were:

Intermediate stems

1. control	fertiliser only
2. fungicide	fertiliser + fungicide
3. root hormone	fertiliser + root hormone
4. comprehensive	fertiliser + fungicide + root hormone
5 delayed	delay (2 months) + fertiliser

Adult stems

5. control	fertiliser only
6. delayed	delay (2 months) + fertiliser

Placement of potted plants within the available nursery space was randomised with respect to size at harvest (intermediate, adult) and post-harvest treatment. Post-potting, all plants were watered twice daily and weeded fortnightly. Condition of all plants was recorded at 2-month intervals. This segment of the experimental harvest will be concluded in 2004.

Figure 2a. Extraction of cycads by Traditional Owners of the Gamardi Community and the Djelk Rangers

Figure 2b: Harvest site after completion of work and refilling of holes.

Figure 2c: Measuring cycads in quadrats as part of the monitoring program.

Markets

To assess the wholesale potential of cycad species in the tropical north of Australia, 54 north Australian nurseries were selected from the Internet Yellow Pages search engine (restricted to Queensland north of Brisbane and Northern Territory, excluding smaller business) and faxed a summary of the project. They were asked to fill in a short questionnaire indicating interest or otherwise in purchasing wild harvested plants in the future and, if interested, the sizes and numbers required and the price they would be willing to pay.

In addition, the web and other sources were searched for details of current retail prices of cycads at nurseries both in Australian and internationally.

Labour costs

Labour costs are calculated and reported in a number of analyses. In the case of members of the project team they are based on actual salaries with overheads in the nature of salary (superannuation, workers compensation, payroll tax etc). In the case of Aboriginal participants, they are mostly based on a Community Development Employment Program (CDEP) rate in 2001 of 4.6 hr/day at $10 /hr, plus a CDEP top-up ($50 d^{-1}) as an extra incentive associated with this project, plus 12% on-costs. For non-CDEP participants only the $50 top-up payment was made.

Results

Harvest sites and local population size

The mean density of cycads calculated from quadrats was 1356 $\pm$ 501 (SD) ha^{-1} (n=27) and ranged from 550 to 2250 ha^{-1}. This estimate is based on samples taken to assess the impact of harvest. It was therefore taken only from areas which contained significant numbers of *C. arnhemica*, and consequently does not represent an unbiased estimate of the average regional density of cycads.

There was no variation in density among harvested sites ($F_{2,26}$=2.3, P=0.12). The percentage of cycads harvested from individual quadrats ranged from 4.4% to 25% of the total number of cycads present. Variation in proportion harvested was attributable to treatment type, the size structure of the cycad population within the quadrat, as well as variation in density.

There was little variation in physical and vegetation structural features of harvested sites that warrant mention here. These details will be reported elsewhere.

We derived a crude estimate of the area's cycad population by assigning aerial survey cells to relative density classes based on a comparison with our harvested sites. Results are shown in Table 1. Using the estimated midpoints of those cells, a very crude estimate of the local population is more than 5 million cycads. This estimate is clearly a very preliminary one. It includes all age classes, including seedlings within the 86 km^2 area closest to the Gamardi outstation. It should be noted that there are additional significant regional populations of *Cycas arnhemica* in another 200-300 km^2 of open forest in very inaccessible areas.

Table 1: Frequencies of assignments of 1 km^2 aerial survey cells to density classes relative to the average measured densities within harvested cells

Score	Midpoint density (000's cycads km^{-2})	Number of cells
3	135.6	24
2	67.8	23
1	13.6	19
0	0	20
Total		**86**

Harvest costs

Extraction of 112 cycads from land close to Gamardi required 33.5 person days over four and a half days (or 3.3 cycads per person per day). This figure takes into account all aspects of the extraction process such as training, consultation, transport to local base camp and lunch breaks. Given more experience and training we would expected this extraction rate to increase. The actual time to dig plants from the ground ranged from 5 to 20 minutes for 5-50 cm size class and 10 to 30 minutes for the 50-100 cm size class. The actual costs included $1520 in labour from Gamardi residents,$864 in labour for Djelk Rangers, $1254 in labour for our Research Associate and $400 in vehicle use (at $1.00 km^{-1}). These costs averaged $36 for each plant extracted.

Costs of post-harvest treatment

Potting and treatment costs for initial establishment in the nursery were $437 in equipment and consumables (bags, fertiliser, other chemicals). Full nursery (including ongoing operational) costs will not be readily estimated until time to recovery is better known, but we estimated total labour involved in initial potting, weeding and watering to require approximately 21 person days, totalling $2040 (CDEP plus top-up wages).

The total cost of collection and initial establishment in the nursery was $6515 or about $58 for each harvested plant. These costs are likely to be somewhat higher than would be incurred in a genuinely commercial harvest. Based on observations made during the harvest we estimate that labour inputs could be halved in a full commercial operation, and that estimate has been used in subsequent assessments of the potential returns to the community.

Monitoring costs

The total cost of establishing the quadrats for monitoring effects of the harvest was $11650. Equipment including stainless-steel tags, wire and pegs was $3216. Stainless steel is needed to persist in fire and resist longer-term loss through rust. Transport and accommodation costs for the research team was $3020 and salaries $3265. Djelk Rangers put 20 days (4 people for 5 days) into establishment of the monitoring scheme. The cost of this work was approximately $2150 (including overheads) based on the CDEP plus top-up regime.

Re-measurement costs to meet the ongoing requirements of the management authority are estimated at $2614 pa ($1360 in transport and accommodation and $1254 in salaries). Over a period of 5 years, the cost of monitoring, excluding the establishment cost, will be approximately $13070. Total costs, including establishment, over this 5 year period will be $24,720. It is worth noting in passing that the original requirement was for monitoring at 4-monthly intervals, which would have tripled the recurring cost. The frequency of monitoring was reduced after objection from the participants.

Post-harvest maintenance

A total of 112 cycads was harvested in the initial trial. In 6 months following harvest:

- 29 showed no signs of recovery;
- 83 resprouted to produce at least one flush of leaves (although the first set of fronds to appear are often small and/or deformed, and the second set apparently normal).

Anecdotal reports indicate that apparently full recovery following such treatment may exceed 12 months, so at the time of writing it is too early to provide a comprehensive analysis of post-harvest vigour and mortality. However, results to date are encouraging and it appears that the great majority of stems will resume growth. Full details will be provided in other papers.

Costs in labour of maintaining the harvested cycads in the nursery over 12 months is estimated at 72 hours. No separate provision has been made for costs of water nor other overheads.

Markets

Eleven (20%) of nurseries surveyed returned the questionnaire and of these, one expressed no interest in the product. In the aggregate there appears to be demand for all stages of growth from seedling to adult. Five nurseries were interested only in buying seedlings, often in large quantities. Those interested in plants offered $1.50 to $3.00 per seedling, $20-25 for a caudex of 50 cm, and $50-100 for a caudex of 100 cm. As most of the respondents are unlikely to have seen a mature *Cycas arnhemica* plant, their responses are likely to be based on knowledge of other cycad species. Retail prices for common and exotic varieties of cycads (such as *Cycas revoluta*) are often about an order of magnitude greater than suggested in the completed questionnaire (Table 2). For example, Price Palms Plantation proposed $1 cm^{-1} in their response to us, but sell *C. revoluta* for $10 cm^{-1} (http://www.ppp.com.au/).

One respondent (K-Palms) exports various species of cycad trunks in containers and also by airfreight to Europe, USA, NZ and Asia. K-Palms have been in business for the last 27 years dealing in seeds of cycads, palms and succulents, germinated seeds and seedlings and larger plants. Most of their products are exported. They expressed considerable interest in this Arnhem Land species and suggested that there was potential to sell them into Asia.

Table 2: Cycad prices at some Australian nurseries, in December 2001

Australian Nursery	Cycad species	Price (excluding delivery)	Source
K-Palms Nursery and Seed	*Cycas media*	A$130 for 60 cm caudex A$260 for 1.5 m caudex A$120 m^{-1} in lots of 100 trunks	K Palms website: http://www.kpalms.com/
	Cycas revoluta	A$15 – A$30 for bulbs 5-15 cm in diameter	K Palms website
	Cycas taitungensis	A$20 – A$40 for bulbs 5-15 cm in diameter	K Palms website
Utopia Palms and Cycads	*Cycas bougainvillensis*	A$300 for 30 cm caudex (100 lb bag)	http://www.utopiapalmsandcycads.com/default.htm
	Cycas seemanii	A$20 for 20 cm caudex	
	Cycas pectinata	A$275 for 30 cm caudex	
	Cycas wadei	A$90 for 200 ml caudex	
Price Palm Plantations	*Cycas revoluta*	A$500 for a 50 cm caudex; A$1000 for 100 cm caudex	http://www.ppp.com.au/index.html
Grasstrees Australia	*Macrozamia riedlei*	A$30 for 5-10 cm bulb A$270+ for 60-70cm bulb	Pamphlet by Grasstrees Australia
Allora Gardens Nursery, Darwin	*Cycas thouarsii* *Cycas revoluta* *Cycas armstrongii* *Zamia fischeri*	Prices ranges from A$9 for *C. revoluta* in a 12cm pot to $290 for a large double header *C. armstrongii*	Phone enquiries
Ironstone Lagoon, Darwin	*Cycas thouarsii* *Cycas revoluta* *Zamia fisheri*	$45 for *C. revoluta* and *C. thouarsii* in 25 cm diameter pots. No caudex, just fronds.	Phone enquiries
Bunnings, Darwin	*Cycas. thouarsii* *Cycas revoluta* *Zamia fisheri*	*C. revoluta* from $14 for seedlings in a 12 cm diameter pot to $82 for larger ones with 15cm of caudex; *C. thousarsii* from $35 for no caudex and 30cm fronds to $80 with a 18 cm caudex	Phone enquiries

Discussion

Ecological sustainability

In some nations the single most serious threat to the status of cycad populations is the popularity of wild cycads for ornamental use, and the illegal collection of wild plants to satisfy that demand (Osborne 1995). It is argued that low rates of growth, restricted distributions, often small population sizes, and susceptibility to a number of anthropogenic threats additional to harvest, render members of this group of plants particularly vulnerable to decline. This general argument has been used to justify the CITES Appendix 2 listing of all north Australian species of the genus *Cycas*, even though there is no evidence for the majority of species that they are under threat, or that international trade has in any way influenced their present status. For example, the species ultimately harvested in this study (*Cycas arnhemica*) exceeded densities of 2000 plants ha^{-1} over large areas, and the local population within a 10 km of the outstation at Gamardi is estimated to exceed 5 million plants.

We do not suggest that our population estimate should be used as a basis for setting large harvest quotas. A more rigorous estimate, together with better understanding of population dynamics would be required to justify harvests that approach a substantial proportion of a maximum sustainable yield. We do suggest, however, that the triviality of the current harvest in population terms be recognised and that this recognition influence monitoring schemes requirements.

To assess the ecological sustainability of a substantial harvest, there are at least four areas that might warrant consideration:

- effects of removal of some plants on dynamics of the unharvested population;
- effects on fauna dependent on the cycad for food or shelter and any flow on effects (e.g. through impacts on pollinators or seed dispersers);
- physical damage such as soil erosion or degradation resulting from the extraction of plants; and
- effects of physical disturbance on associated flora and fauna.

In this case study, significant impacts on the dynamics of the cycad population as a whole can be discounted, given the tiny fraction of the population and its habitat subject to harvest. At the population level it will not be possible to meaningfully measure the effects of harvests constrained to 300 stems pa from a total area slightly in excess of 1 ha, from a local population in the millions spread over 8600 ha. For example, in a system of harvest rotation it would not be necessary to return to the same site (in this case a 20 × 20 m quadrat) for 5,000+ years, which under any reasonable assessment might be thought to allow ample time for recovery of even the slowest growing plants.

The particular monitoring system required by the management authority will, however, allow very local effects to be determined over the long term and will provide important insights to the demography of this species, which could ultimately used to derive harvest simulation models employable for robust design of more intense harvests.

The average density of cycads sampled in the harvest area was 1356 ha^{-1} and it ranged from 550 to 2250 ha^{-1}. The harvest intensity averaged 121 stems ha^{-1}, so that reductions in density due to harvest were well within the range of natural variation within the area occupied by the population. Significant effects on fauna can be dismissed, even at the local scale. Harvest intensity is so low that it will not measurably reduce the resources available to fauna over relevant areas.

Neither seed dispersal nor pollination biology has been studied in *Cycas arnhemica*. However, given the slight reductions in density involved under this harvest regime, significant indirect effects on their reproductive success or the status of their pollen and seed vectors appear very unlikely.

Physical disturbance associated with the harvest involves digging up to 16 holes about 30 cm deep and up to 50 cm in diameter within a 20 × 20 m quadrat. Soil is replaced and in most cases the volume of subterranean plant tissue extracted with the stem is a few litres or less, so that no appreciable depression is created, and care is taken to ensure that holes are not linked by areas of disturbance. In the flat sites preferentially used, significant erosion is highly improbable. Similarly, the small area of disturbance means that significant impacts on other flora are improbable (Figures 2a-2c).

There is a risk of introduction of weeds or fungi on implements, clothes and vehicles. The region is relatively free of sources of weed seed or other propagules (Griffiths et al. 2000; Yibarbuk et al. 2001), reducing the probability of significant dispersal. There is no record of *Phytophthora* related dieback in the region, although it has been found several hundred km to the east near Nhulunbuy. However, it will be desirable that outstations and nursery which may provide foci for weed establishment and dispersal be maintained in a weed-free condition so that risks are minimised. A commercially viable harvest could provide an important source of funds and incentives to achieve high standards of weed control and other monitoring of threats to ecological integrity at outstations, which would be of wider conservation benefit in this bio-diverse area of Australia.

Commercial sustainability

Despite the enormous populations at this site and others, commercial access by the local people has been severely restricted. Harvests may not exceed 500 stems and an extraordinarily detailed and labour intensive monitoring system was imposed for this study. The monitoring system sought by the management authority, being based on intensive sampling of a small number of small quadrats (and hence achieving a sampling intensity of less than 0.01% of cycad habitat close to the Gamardi outstation), is clearly not well designed to return useful information on the status of the regional population, which should arguably be the focus and concern of the management authorities (the Parks and Wildlife Commission locally and Environment Australia nationally).

If maintained over the long term, the monitoring plots will, however, provide insights to the local dynamics of populations and information on the time required for recovery from localised harvests. However, with total harvests constrained at most to 500 stems pa from a regional population spread over at least 30,000 ha, the supply of plants will not be compromised in any way by the current harvest strategy. This should in itself be sufficient reassurance that a harvest of the order currently authorised is likely to be sustainable, and argues against application of an expensive monitoring system that will consume a substantial proportion of the potential income. A requirement to accurately measure and individually tag all stems (as distinct from recording numbers in broad size classes) is particularly time consuming and clearly unnecessary to determine population outcomes. Imposition of arbitrary and demonstrably unnecessary costs is not likely to be the most effective way to seriously engage local people in useful monitoring of the impacts of their activities or the condition of their country.

In this trial, the basic cost in equipment and consumables for potting was about $3.90 per plant. Additional costs of transport from nursery to market are estimated at about $7 per plant. Thus, after unavoidable costs of materials and transport totalling $10.90 are met, sales to wholesalers at the prices mooted to date ($30.00) are likely to return a net of about $19.10 per plant to cover the cost of labour and compliance.

Our estimate of the total effort required to harvest, transport, treat, pot and maintain in the nursery averaged 3.9 person hours per plant. We have argued that this is probably substantially higher than would be required in a fully commercial operation. However, even if the effort is reduced to half this figure, the return to Aboriginal participants in such harvests, in the absence of a compliance cost is no more than $10 h^{-1}, or about the CDEP wage. Such returns are still probably adequate (while

noting that we have included no administrative overheads) to provide an incentive to make the effort involved in such harvests and their management.

However, the fixed costs imposed by the monitoring scheme were about $16.50 per plant (based on annual harvests of 300 plants p.a. over 5 years). After meeting costs of compliance, the amount remaining to reward harvesters for their effort is about $1.00 h^{-1}. We are hopeful that prices actually paid for this unique plant will be considerably better than the understandably conservative initial offers of wholesalers. However, it is clear that the cost of compliance presents a major obstacle to the reasonable development of this and other, related opportunities.

There are several potential responses to this unsatisfactory situation. They include:

1. Cease harvest of smaller plants and concentrate on larger, more valuable stems. Access to larger stems than are presently available from other sources is the principal rationale for a wild harvest and the feature that will distinguish an Aboriginal enterprise from other operations. In the absence of compelling argument, restricting harvest of small stems is perverse.
2. Reduce the costs of the monitoring regime. As argued earlier, the particular design and costs of the monitoring system cannot be justified by the tiny harvest currently permitted. It is designed to return demographic information that will, over the long term, be of universal value for management of cycads in northern Australia. The monitoring work in this study was research paid for by the project ie largely Government funded. However for a commercial situation we question why costs of basic, public-good research should be shifted from Government to some of the nation's most disadvantaged people, particularly when they are unnecessarily constrained to an unrealistically small and otherwise restricted harvest.
3. Retain the present monitoring scheme but increase the harvest conducted under its umbrella. The summary above demonstrates that losses of plants to harvest as presently structured are likely to be negligible compared to natural or other anthropogenic sources of mortality. Aboriginal owners of the harvested lands are confident that if more cycads are required, this can be achieved through a shift in burning regimes to more comprehensively protect the site from hotter fires (Terry Gunadilla, pers comm.). However, there is presently no incentive for the land managers to incur this cost. A substantial increase in the approved harvest (e.g. to 1000 stems pa, including access to larger stems) will not threaten sustainability, but improve returns and incentives by reducing the significance of fixed (mainly compliance) costs. It may be necessary to consider methods of directly accessing overseas markets to sell this amount of product.
4. Develop a more relevant monitoring scheme that increases sampling intensity (in the sense of sampling a larger proportion of the population of interest) at the expense of the detailed measures of individual stems.

Some combination of these changes will probably emerge from reviews of the trials.

Communities may also wish to consider some forms of value-adding, perhaps including supply of pots decorated with traditional designs, and/or sale with information about the significance of the cycad to Aboriginal culture. An interesting option, directly deriving from wild harvest of larger, more valuable stems, is the opportunity to provide very detailed certification regarding provenance: to link a valuable individual product to place, landowner and culture in a way that is likely to be attractive to some elements of the market.

Cultural sustainability

The cycad is spiritually significant to all 13 clans in the Yolngu language group of eastern Arnhem Land, but is of special significance to the Wangurri Clan (Dhangatji Mununggurr and Melngathu Wunungmurra, Yolgnu, pers. Comm.). This has meant that elders have wished to extend time available to discuss the idea of removing cycads from their land.

Wangurri clan members presently live at three Homeland Centres, Muthamulwuy, Dhalinybuy and Buymarrwuy. The Laynhapuy Aboriginal Homelands Association supports the majority but not all of the homeland centres in the Yolngu language group. The Wangurri clan has some of its areas supported by Laynhapuy Aboriginal Homelands Association and others by the Gumatj Association. Involvement of different centres means that discussions amongst Aboriginal elders inevitably entangle local community politics with shared cultural concerns.

As part of this study project team members made two trips to homelands in eastern Arnhem Land to discuss the idea of cycad harvesting with elders. During the first trip in February 2000 a number of different ideas were discussed, including but not focusing particularly on cycads. The second trip in June 2001 dealt more specifically with the potential for cycad harvest. During this trip the Laynhapuy managed homelands (Buymarrwuy, Garrthalala, Gangan, Dhuruputjpi and Yilparra homelands) were visited. All Homelands elders gave a consistent response: namely that the Wangurri Clan must make the final decision because the cycad was of special significance to them and they have special responsibility for it.

Elders had agreed to meet at a forthcoming Laynhapuy Homeland Association Board (scheduled for July 2001) with a member of project team and talk more about the appropriateness of harvesting cycads. Although this meeting took place in July, not all the Aboriginal representatives were present and the discussion on cycad harvesting was therefore postponed.

Bawurr, a senior man from Dhalinybuy Homeland, which is supported by the Gumatj Association, is also chairman of the Dhimurru Land Management and Aboriginal Corporation. His homeland is on land of the Wangurri Clan and therefore spiritually connected to the cycad. However, because the site receives services from the Gumatj Association, Bawurr was not automatically invited to the Board meeting of the Laynhapuy Aboriginal Homelands Association. A member of the project team therefore contacted him separately and discussed the idea. His initial response was positive but he also indicated a need to discuss the issue further with his family and Dhimurru staff.

Until the elders of these clans make an informed decision, the project cannot become involved in testing the feasibility of such an enterprise on their lands. The people apparently remain interested. Representatives from the Yolngu clans participated in a workshop to discuss this project at the Daly River in November 2001 and intended to take the idea of harvesting cycads further during 2002.

Like the Wangurri Clans of east Arnhem Land, people of central Arnhem Land also have cultural affiliations with the cycad. These clans in central Arnhem Land have had considerable experience in sustainable utilisation and perhaps as a result more readily became involved. Harvests of cycads had been raised in meetings of local people as early as 1995, so there had been more opportunity for discussion and resolution of issues through the Bawinanga Aboriginal Corporation, which employs the Djelk Rangers and services all of the region's outstations.

The Gamardi outstation, where the trial harvest of *Cycas arnhemica* was conducted, raised a number of issues regarding the use of the plants by non-aboriginal people. While they were enthusiastic in their involvement in the trial, a number of community members were concerned about the potential for people to eat the toxic seeds as they were ignorant of the "proper way" to prepare them. In response to this concern, a member of the regional community has prepared a detailed written summary of the potential dangers of eating the seed and the correct way to prepare the seed for

human consumption. This material may be incorporated in the documentation to accompany plants sold. While it is improbable that many non-Aboriginal buyers will attempt to consume seeds, the concern is a particularly graphic illustration of the obligations that the 'owners' of the plant accept. That responsibility extends to the safety of other people, both Aboriginal and non-Aboriginal.

Some readers may wonder why we have given a good deal of information about the interaction that led to the present trial. We consider that this brief history of the project team's interactions with participants in a proposal to harvest a small number of cycads, gives some indication of the extent of potential negotiations necessary to ensure that agreements are based on genuinely informed consent. These processes are probably no more nor less labyrinthine than those of other cultures, including white Australia. However, they are poorly understood by outsiders. Decision-makers in formal resource management institutions, whilst making every effort to comply with legal strictures and notions of natural justice in contexts they understand, may blunder in failing to recognise and respect customary practice and indigenous systems of governance. Such errors are likely to be significant sources of failure in well-intentioned attempts to foster enterprise, as well as in delivery of other services. One solution to such difficulties is to seek arrangements that devolve authority for most day to day decision-making to local people, within broad guidelines to ensure that statutory responsibilities for resource security are met.

This is not to say that good communication and time will settle all differences of opinion with regard to commercial use of native plants and animals in Aboriginal communities. Such contested issues need to be resolved in the Indigenous domain. People may choose to defer to "owners" of species, but when differences cannot be readily resolved, choose to press ahead with their own clan-based or wider regional priorities.

Implications of the trial

Cycads have commercially been regarded as one of the products of higher unit value that might conceivably offer favourable opportunities to Aboriginal people in northern Australia. There is a demonstrable demand that could be filled without significant ecological risk. Estimates of potential returns are crude, but suggest that under reasonable regulatory and other conditions, harvest could provide adequate returns to communities and hence some incentive to actively manage sites to protect their natural values, including cycad populations.

However, the essentially arbitrary international and national assignment of these plants to categories of special concern militates against successful enterprise. Monitoring requirements initially imposed were so onerous that meeting them was likely to consume much of the potential return to the Aboriginal harvesters yet contribute no immediate advice on the impacts of their harvest activity. Those requirements appear to provide basic information on cycad demography that is of wider application and interest and therefore might more reasonably be regarded as the province of Government.

Imposition of an over-prescribed monitoring scheme, despite the in-principle support of the management authorities (PWCNT 1997b), is a good example of all-too-common regulatory disincentives for good conservation practice. People seeking to earn a modest return from demonstrably sustainable use of a native plant on their lands are saddled with onerous administrative constraints. Such costs would not be levied if for example, they chose to destroy large parts of the population to foster a cattle grazing enterprise (Whitehead 2000).

The perversity of prevailing negative attitudes to harvests from the wild becomes even more apparent when alternatives are considered. For example, basing cycad production on artificial culture from seed would be treated entirely differently under the existing Management Plan (PWCNT 1997a). Up to 25% of all seeds could be taken, apparently on the grounds that few seeds will establish in the wild and that population dynamics (including seedling establishment and persistence) are likely to be

density-dependent (i.e. that average success rates of one or more size/age classes will increase at lower densities so the prior removal of much seed becomes irrelevant). No information has been produced to justify this assumption, which must apply if such a level of seed harvest is to be sustainable.

Moreover, no account is taken of the long-term environmental costs of growing out seedlings to plants of saleable size under artificial conditions. Environmental costs over at least several years will include substantial use of plastics for regular re-potting, water use from surface impoundments or ground waters, application of fertilisers and pesticides, use of electrical power, and establishment of infrastructure on land totally cleared of its native vegetation. To clear one hectare of land for a nursery and associated tracks on the Gamardi site would require destruction of about the same number of cycads as are presently proposed for harvest over 5 years.

Conservationists have long recognised that *in situ* conservation of viable wild populations in their natural places is greatly preferred over artificial maintenance in specially protected places. It is time to recognise the potential contribution of systems of "*in situ* production" of native species to conservation, and to reconsider attitudes to wild harvests. Aboriginal people are willing to collaborate in novel ways to contribute to the nation's conservation goals. But that willingness should not be abused by either completely denying opportunities for economic advancement based on native species or, more cynically and destructively, saddling Aboriginal enterprise with ongoing compliance costs of a sort not met by promoters of "*ex situ* production" and use of exotic species that require the immediate or longer term destruction of entire natural systems.

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Appendix 3.2: Case Study 2: Kakadu plum

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Introduction

This study was conducted as part of the project "Feasibility of local, small scale harvests for indigenous communities". As a part of this larger project, a team comprising David Bowman, Julian Gorman, Tony Griffiths, Honorlea Masarella, Nick Smith, Greg Wearne, Peter Whitehead, and Glenn Wightman undertook a desktop analysis to identify those plants that appeared to offer some commercial opportunity that Aboriginal communities may be in a position to exploit. Criteria used to identify options are given in chapter 3 of the main report.

Our *a priori* selections of plants that offer opportunities to Aboriginal communities identified Kakadu plum *Terminalia ferdinandiana* as one of a number of potentially significant bushfood items. There are established markets for the fruit, which is used for customary purposes by most Top End Aboriginal communities, and the species is very common in large parts of the north Australian landscape. Wild harvests of Kakadu plum and some other plant products were initiated to examine the feasibility of selling raw products to gourmet bushfood companies for processing.

Background

The Kakadu plum *Terminalia ferdinandiana* (family Combretaceae) is restricted to the Top End of the Northern Territory and the Kimberley region of Western Australia (Dunlop et al. 1995). It is a small to moderate sized semi-deciduous tree which flowers at the end of the dry season (September-November) and fruits from the middle of the wet season to the early dry (January-June). It occurs in open woodland and produces smooth fleshy ovoid drupes, 1.5-2.5 cm long and with a short beak. The fruits are yellow green when ripe (Brock 1988). Other species of *Terminalia* produce very similar fruit: namely *T. carpentariae, T. prostrata* and *T. latipies.* Fruits of *T. ferdinandiana* have been found to contain extremely high levels of vitamin C: samples contained 3150 milligrams per 100 grams, 60 times the vitamin C content of oranges (Low 1991).

The fruit, fresh or frozen, is in considerable demand from bushfood wholesalers in Darwin and elsewhere in Australia (Juleigh Robins and Rob Cross, pers. comm.) and the Australian native food industry identified *Terminalia ferdinandiana* as one of thirteen plants warranting commercial development (Flecher 1999). Fruits are added to jams and chutneys based primarily on other fruit and used fresh by the restaurant industry as a garnish or flavouring in a range of dishes. The fruit has been incorporated in cosmetics (see http://www.litya.com/).

In addition to eating the fruit as snacks, Aboriginal people also eat the pale, tasteless gum that oozes from the trunk of the trees.

Regulatory issues

The *Territory Parks and Wildlife Conservation Act 2000* specifies that collectors taking native plant products for commerce must obtain a permit (Sections 55-57). If property in that wildlife is vested in the Territory (e.g. plants on public and leasehold land), they must also pay royalties (Section 116). The royalty for *T. ferdinandiana* fruit is \$1.00 kg^{-1} (*Territory Wildlife Regulations*). On Aboriginal land, traditional owners wishing to use plants commercially also require a permit, but are not subject to royalties. Owners of Aboriginal or other freehold land may allow others to harvest from their lands under permits issued to the land owner.

Once taken under a valid permit, ownership of the harvested item passes to the permit holder. The Parks and Wildlife Commission requires no permit for movement of wild harvested native plants into other jurisdictions, but those jurisdictions may seek evidence that the material was obtained lawfully. Ongoing commercial use would ultimately be regulated through a management plan made under the *Territory Parks and Wildlife Conservation Act 2000*. The principal test to be satisfied in such a plan

would be that use dependent on wild populations is clearly sustainable (Section 32). Legal provisions are similar in other States.

Terminalia ferdinandiana is not listed as threatened under relevant Territory, State or Federal legislation. The species is not listed under the Convention on International Trade in Endangered Species (CITES).

Movement of fruit in the Northern Territory is subject to the provisions of the *Plant Diseases Control Act 2000*. At the time of writing there were no special provisions in place. However, other State and Territory jurisdictions may impose an array of requirements for the transport of fruit across their borders, which may be varied from time to time. Harvesters wishing to supply interstate markets should seek advice from the Department of Business, Industry and Resource Development about requirements.

Objectives

Objectives of the trial harvest and associated studies were to:

1. Determine the effort required to harvest *T. ferdinandiana* fruit at favourable sites.
2. Estimate costs of collection, including transport and handling.
3. Examine sources of variation in collection rate, including
    - densities of trees
    - time (season) of collection
4. Describe variation in densities of *T. ferdinandiana* in the landscape and hence availability and distribution of favourable sites.
5. Relate costs and effort incurred in harvest and handling to wholesale and retail prices.

Methods

Harvest trials were conducted with the assistance of people from the Larrakia Nation. The Association selected participants and coordinated their activity. Larrakia people also identified suitable harvest sites in the Darwin region. The trials extended over the fruiting seasons of 2000 and 2001.

Measures of the availability of harvestable Kakadu plum trees in the wider landscape were done on Aboriginal land south of the Maningrida Township in central Arnhem Land. Djelk Rangers supported by the Bawinanga Aboriginal Corporation, the project team and a group of botanists from the Brisbane and Darwin Herbaria conducted a broad scale vegetation survey for preparation of a vegetation map (Griffiths et al. 2000) as well as these quantitative surveys for Kakadu plum.

Characterising harvest plots

Darwin Region

Harvests were trialed only in the Darwin region in the fruiting seasons of 2000 and 2001, and were conducted in all of the months of March to June. Descriptions of harvest sites were confined to measures of Kakadu plum stem density and stand structure. At each site, the number of trees greater than 2 metres in total height was recorded in each of 2 transects of 100 m x 10 m. Diameter at breast height (cm) was measured for each tree, the presence or absence of fruit noted, and positions along the transect were recorded.

As there was no specific proposal to use these sites for regular commercial harvest, no formal monitoring protocol or paired unharvested "control" sites were established.

Maningrida Region

In order to determine the average density of Kakadu plum in the Maningrida region, we walked a pair of east-west transects of 500 m at 5 km intervals along the road running south from Maningrida to the edge of the Arnhem Land escarpment. Lengths and separations of transects were measured with a hip chain. Members of each transect pair were parallel and separated by 100 m. There was a total of 15 pairs, or a total of 15 km of transects.

Within each transect we recorded the occurrence of Kakadu plum trees of any height as well as their distance from the transect origin (also measured from the hip chain). Tree height (m), diameter at breast height (cm), and presence of fruit were also recorded for those individuals greater than 2 m in height. Individuals less than 2 m in height are highly unlikely to produce significant amounts of fruit and therefore only their presence was recorded.

Monitoring protocol

See above.

Harvest process

At each site, pickers harvested for a predetermined time and recorded the number of trees from which they harvested. They picked by hand without ladders, and shook the trees to drop ripe fruit and/or focused on fruit within reach from the ground. They used no destructive methods or equipment to reach inaccessible fruit. They sought to remove as much fruit as practicable from each tree before moving to the next. Harvest times reported are those during which participants were actively picking and include no rest periods or other breaks. The weight of fruit collected was measured (nearest gram) on site using a Pesola spring balance.

We used these data to determine an average rate of collection per harvester for each sampling occasion. Variation in rate of collection was related to numbers of trees harvested (and hence the fruit available per tree) and tree density (average for transect) at the site of collection.

Post-harvest treatment

Post-harvest treatment in these trials was confined to refrigerated storage.

Markets

Demand for the product was assessed by:

1. Contacting a number of retail outlets for details of sales of products containing Kakadu plum, compared with other bushfood-derived items.
2. Seeking indications of the total volumes of raw product sought by a number of wholesalers and retailers.
3. Collating data held by the Parks and Wildlife Commission on permits issued and royalties paid by harvesters and landholders in the Northern Territory.

Labour costs

Labour costs were calculated and reported in a number of analyses. In the case of members of the researcher group they are based on actual salaries with overheads in the nature of salary (superannuation, workers compensation, payroll tax etc). In the case of Aboriginal participants, they are mostly based on CDEP rates plus a CDEP top-up ($50 d^{-1}) plus 12% overheads, or in cases where the participant was in receipt of a full salary, that salary and typical overheads.

Statistics

We used the SAS system (SAS Institute Inc. 1999). Rates of harvest and similar phenomena were related to tree densities, season and other variables by generalised linear modelling (PROC GLM). Correlation coefficients are Pearson product-moment.

Results

Characterising harvest sites

Darwin Region

Harvesters sought out sites at which high densities of fruiting trees were known to occur. Thus the trials probably represent an optimal situation for achieving relatively high rates of harvest at low cost. Densities at these sites averaged 272 stems ha^{-1}, so that harvesters were required to move very short distances and there was no time lost in search. Additional trees were usually easily visible from a tree just harvested.

However, it should be noted that not all trees were in fruit at the time of harvest (Table 2), which straddled the peak fruiting time. It is not known whether some trees failed to fruit at all or were fruiting out of synchrony with the bulk of the population.

Table 1: Details of tree density at sites at sites of small-scale harvests of fruit of *Terminalia ferdinandiana* in the Darwin Region. Densities were assessed at each site by counting each stem within 2 transects 100 m in length and 10 m wide (0.1 ha each).

Transect	Date	Trees > 2m in transect	Density (trees ha^{-1})
1a	26-Jun-00	11	110
1b	26-Jun-00	13	130
2a	10-May-00	15	150
2b	10-May-00	9	90
3a	10-May-00	15	150
3b	10-May-00	44	440
4a	10-May-00	36	360
4b	10-May-00	25	250
5	29-Mar-01	54	540
6	29-Mar-01	22	220
7	24-Apr-01	22	220
8	24-Apr-01	63	630
9	16-May-01	36	360
10	16-May-01	17	170
Mean $\pm$ SD		27.2 $\pm$ 16.9	272 $\pm$ 169

Maningrida Region

The wild harvest conducted by the Larrakia people was in sites particularly chosen for their unusually high densities of fruiting trees. The more extensive survey conducted in the Maningrida region provided a better understanding of the distribution of the species in the wider landscape. The following broad patterns were evident with regard to availability of *T. ferdinandiana* for harvest at Maningrida:

(a) The species is widespread and moderately abundant in the region. Mean density of plants over 2 m in height over all transects was 14.4 trees ha^{-1} ($\pm$ 24.3 SD, n=30).
(b) Distribution in the landscape is patchy at a number of scales. There were two clearly identifiable regions where abundance was notably higher. Along a narrow coastal strip, where density over two relevant 500 m transects was 82 trees ha^{-1}. Another favourable region occurred some 40 km inland on clay soils, where mean density over contiguous transects (excluding 2 transects in swampland) was 31.3 trees ha^{-1} ($\pm$ 19.2 SD, n=6).

Within these long transects there were a few sites with small patches of highly clumped trees at densities that approached those from which harvests were taken near Darwin. For example, dividing our Maningrida transect samples into 100 m cells returned 8 of 150 units that exceeded the minimum

number of trees recorded (9) in the 100 m transects at the harvested Darwin sites. Denser clumps sufficiently large to provide for efficient harvest were encountered mostly in the coastal region.

Harvest

On average, relatively inexperienced pickers, operating in a non-destructive manner, were able to take fruits of Kakadu plum at a rate of 1.0 kg h^{-1} at sites they identified as favourable (Tables 2 and 3). In these trials there was no relationship between the density of fruit bearing trees in a 100 m transect running through the site and the rate of harvest per person (r=-0.25, P=0.48, n=10). However, the rate of harvest did vary significantly with the average amount of harvestable fruit per tree found at that site ($F_{1,8}$=5.59, P=0.047; Table 3). The amount of fruit per tree varied significantly among months ($F_{3,6}$=8.30, P=0.015; month as factor with 4 levels), being greater in May/June.

Table 2: Density of fruiting trees and details of collecting teams and trees from which fruit were taken during a number of trail harvests by Larrakia people near Darwin.

Transect	Date	Fruiting trees (%)	Density of fruiting trees (trees ha^{-1})	Persons collecting	Trees harvested
1a	26-Jun-00	36	39.6	5	20
1b	26-Jun-00	38	49.4	5	20
2a	10-May-00	13	19.5	5	20
2b	10-May-00	22	19.8	5	20
3a	10-May-00	33	49.5	5	25
3b	10-May-00	31	136.4	5	25
4a	10-May-00	22	79.2	4	25
4b	10-May-00	40	100.0	4	25
5	29-Mar-01	87	369.8	4	~80
6	29-Mar-01	82	180.4	4	~40
7	24-Apr-01	100	220.0	4	~40
8	24-Apr-01	52	327.6	4	~85
9	16-May-01	22	79.2	5	25
10	16-May-01	53	90.1	4	15

Table 3: Rate of harvesting of fruit of *Terminalia ferdinandiana* from trees > 2m in height in sites of different density near Darwin.

Transect	Fruit collected (kg h^{-1}) by team	Collected per person (kg h^{-1})	Density of fruiting trees (stems ha^{-1})	Mean harvestable fruit per tree (kg)
1	8	1.6	44.5	0.4
2	3.1	0.62	19.7	0.15
3	4.2	0.84	93.0	0.16
4	7.46	1.86	89.6	0.29
5	0.978	0.33	369.8	0.012
6	0.74	0.61	180.4	0.019
7	2.283	1.71	220.0	0.057
8	2.519	0.945	327.6	0.03
9	1.737	0.695	79.2	0.069
10	1.617	0.809	90.1	0.108
Mean $\pm$ SD	3.36 $\pm$ 2.56	1.00 $\pm$ 0.53	151.4 $\pm$ 119.8	0.130 $\pm$ 0.127

Taken together, these results suggest that the rate of collection was limited by the physical requirement to access and remove fruits from individual trees (handling time), rather than moving between trees (search or travel time). Sparsity of ripe fruit on individual trees was associated with lower rates of collection, even if large number of trees were in fruit at the site.

There is unlikely to be significant gain in seeking out and focusing on sites with densities higher than the range encountered in these trials, but substantial gain in focusing on timing of harvests to coincide with peak of fruit availability and ripeness, or situations in which trees bear unusually well or unusually synchronously.

Harvest costs

Based on the costs of running a vehicle in these remote sites over poor roads ($1.00 km^{-1}: estimate provided by Bawinanga Aboriginal Corporation based on long experience), the total cost of moving a day's harvest by a group of 3 harvesters (say 25 kg) to Maningrida from an outstation 50 km away would average $0.04 kg^{-1} km^{-1}, or about $4.00 kg^{-1}.

Monitoring costs

We have not sought to cost an appropriate monitoring system. Given the wide distribution of the species at densities that are unlikely to be attractive to harvesters from wild populations, wild harvest is unlikely to put the species at special risk. However, sustained harvest of a large proportion of the fruit from particularly accessible high density sites could result in long term change in populations. Simple monitoring programs recording stand structure and recruitment at harvested and unharvested control sites (paired by soil types and other relevant environmental attributes) could be established at relatively modest cost and are therefore unlikely to strongly influence economic viability of harvest operations. Any evidence of detriment could be linked to an immediate response such as the planting of additional trees maintained in nurseries.

Post-harvest maintenance, processing and delivery

Costs of getting harvest teams to sites near Darwin and returning them and product were relatively minor as all sites were within 15 km of the Larrakia Nation Office. Average costs have been estimated at $15.00 per trip by road (at $0.50 km^{-1}) for an average harvest of 25 kg d^{-1} by a team of 3. Transport costs in this region will average about $0.6 kg^{-1}.

Transport and handling costs have not been calculated in detail for all other potential harvest sites, but costs of air freighting fresh or frozen fruit to markets in Darwin from Maningrida has been calculated at $3.45 kg^{-1} (including packing). Road freight would often be impossible in the coastal regions where Kakadu plum is most common because roads are often cut at the time of maximum fruit availability (late wet/early dry season). Unit costs of transport could be reduced somewhat if fruit were frozen and stockpiled at outstations and economies of scale achieved in moving larger loads, but exercising these options would require additional infrastructure (e.g. reliable power) that is unlikely to be available at many outstations in the foreseeable future. If larger quantities could be stockpiled in Maningrida and packed to maintain condition (cooled and bruising avoided) then movement by barge could be arranged at much lower cost (a few cents kg^{-1}). Sun-drying may be another option to allow stockpiling and so reduce costs, and this possibility should be investigated further. It is presently unclear whether a sun-dried product would be acceptable to the market.

A major buyer of Kakadu plum has designed and is trialing a device for removal of seeds. This is similar to those devices used for olives, and they propose to test it on Kakadu plum soon. The seed of a typical Kakadu plum represents approximately 75% of its wet weight. Such processing done on site therefore has the potential to greatly reduce storage and transport costs.

The major buyers of Kakadu plum are located in southern Australia, and at least one of them has offered a more attractive price (see below) for product delivered refrigerated to Melbourne. They have quoted costs of $0.33 kg^{-1} for transport from Darwin to Melbourne in refrigerated trucks.

Markets

Demand

All retail outlets contacted confirmed that products containing Kakadu plum were among the more popular items. Substantial and continuing demand was confirmed by buyers of raw product who collectively estimated a total demand of 10-12 tonne in late 2000 (Keith Milliken, unpublished data). This estimate preceded the bushfoods promotion of Coles-Myer, involving a collaboration with Robins Australian Foods, which might be expected to increase demand. A considerably lower estimate of present (in 2002) national demand of 3.5 tonnes with the potential to rise considerably (to 5 tonnes in the short term) was provided by Street Ryan Consultants (Mike Harrison, pers. comm.), who are familiar with the Coles-Robins Australian Foods initiative and its likely requirements.

Quantities of Kakadu plum fruit for which the Parks and Wildlife Commission have issued permits in the Northern Territory are shown at Figure 1. Several features are noteworthy. First, the quantities for which permits are sought are erratically variable. The source of this year to year variation is not understood given continuing high demand. Second, the amount paid in royalties is consistently lower than amounts for which permits were sought, suggesting either that most harvests occurred on private (including Aboriginal) land, or realised harvests failed to meet expectations. Third, if the permits sought do indicate demand, then they are broadly consistent with the estimates of buyers cited above. It should be noted that there is a number of obvious errors in the data provided, compromising the usefulness of more detailed analysis. We were unable to obtain equivalent figures for Western Australia.

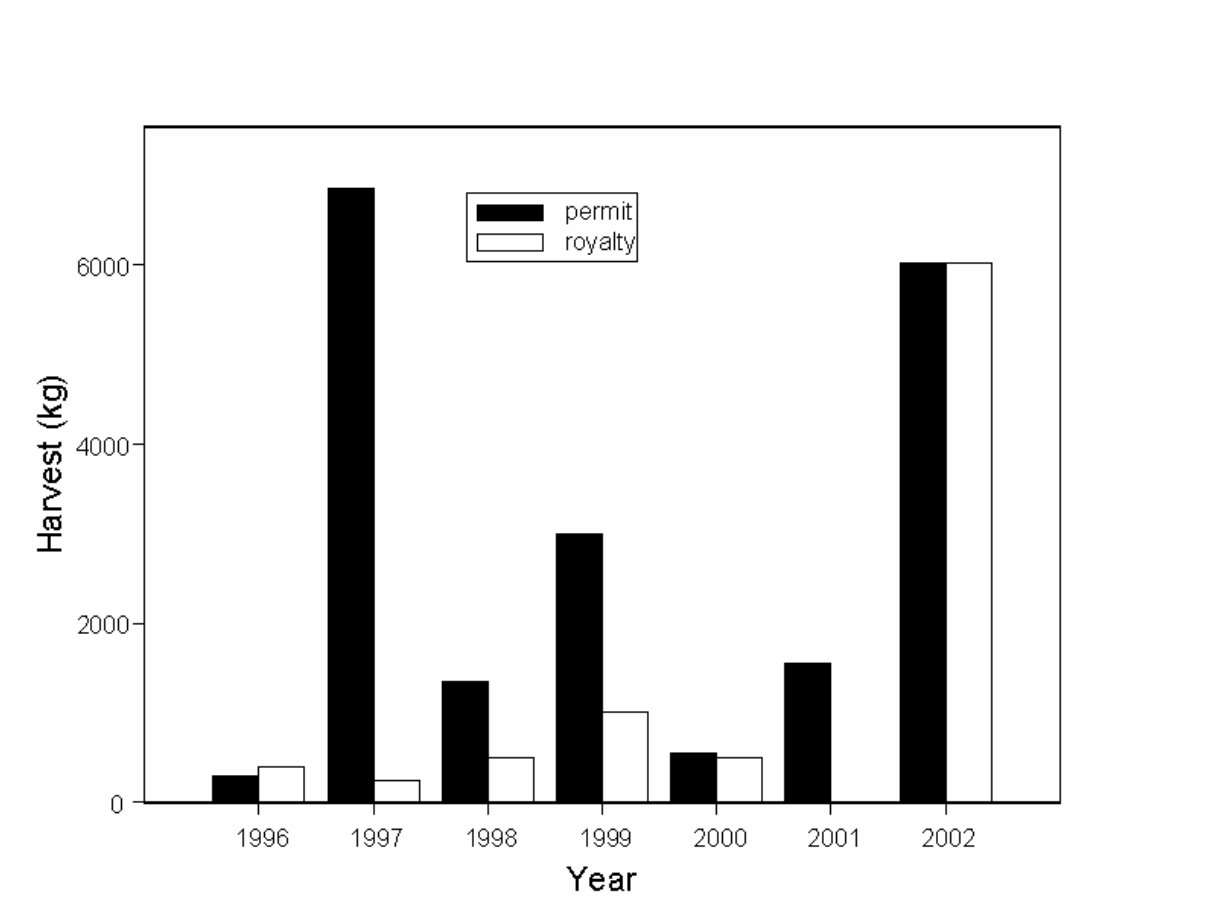

Figure 1: Variation in the weight of Kakadu plum fruit for which permits were sought and royalties paid from 1996. Data were provided by the Permits Section of the Parks and Wildlife Commission.

Price

In late 2000, the prevailing wholesale price of Kakadu plum was \$9-12 kg^{-1} (Keith Milliken, unpublished data). Robins Australian Foods, who are one of the major buyers and processors, has recently entered into an arrangement for distribution of their products through Coles stores, and have increased the wholesale price they offer to \$20 kg^{-1}, delivered frozen or chilled in Melbourne.

Discussion

Ecological sustainability

At a conservative estimate, the population of Kakadu plum trees over 2 m in northern Australia exceeds a few hundred million. Over much of their distribution they are protected in parks and reserves (Fig. 2). Woods (1995) regarded 15 kg a season from a mature tree as being at the lower end of production. Our gross under-estimate of annual fruit production - conservative because it is based on a one-off snapshot of fruit readily harvestable from the ground - is 130 g per tree (Table 3). Even using this under-estimate, annual fruit production greatly exceeds tens of thousands of tonnes. Present commercial demand is measured in, at most, tens of tonnes. Subsistence or other non-commercial harvest is likely to be substantial, but if the entire Aboriginal population of the Top End region consumed 20 kg each (an improbably large intake), total annual consumption (estimated at 300 tonne) would still represent an insignificant proportion of total production. There appears to be little risk of widespread, uniform over-harvest of fruit in the foreseeable future, unless grossly destructive harvest methods are used. As far as we have been able to ascertain, there have been no reports of destructive forms of harvest.

Localised problems are more likely, especially near larger population centres and perhaps along roads, if prices are maintained at projected levels. However, local impacts could be readily detected and corrected by simple monitoring systems and remedial plantings respectively, if there was evidence that recruitment had been compromised by intensive harvest of fruit. However, severe problems are unlikely even at the local level because the extended period of fruiting and ripening means that repeated harvest, often at very low returns on effort, would be necessary to intercept all or even most fruit (and hence seed) production from individual trees

Commercial sustainability

Labour requirements

Individual harvesters picked fruit at about 1 kg h^{-1} in favourable sites. This rate of harvest appears to be achievable over a considerable range of tree densities, including sites with densities as low as 90 trees ha^{-1}. Such sites are relatively common in the landscape, while denser aggregations are patchily distributed. At high densities, trees are separated by only a few meters, so that the next “target” tree is readily located and little or no time is lost in searching.

Rates of collection and average returns are likely to be much less attractive at substantially lower densities, because time will be used in locating and moving between widely-spaced trees, and then returning the picked crop to centrally-placed vehicles. Rates of collection may be substantially improved in the “best” months, when trees are most heavily laden with fruit, although it appears that this time may vary somewhat from site to site and year to year (below). Small groups of harvesters will often need to exploit sub-optimal standing crops if they are to extend the picking season over more than a few weeks.

Our estimates of effort take no account of the time spent travelling from a base to the collection site. In remote sites with a relatively small number of high density stands of Kakadu plum, as occur in the Maningrida region, it is probable that time spent positioning harvesters (most of whom possess no vehicles) and moving between sites may represent a substantial addition (up to around 50%) to time actually spent picking fruit.

We also have no measure of year-to-year variation in fruit availability. Fruiting phenology may be affected by weather conditions and fire (Willams 1997). Kakadu plum is more fire sensitive than many other savanna trees, and late dry season fire effects on flowering obviously have the potential

to damage subsequent fruit production. Thus it can be anticipated that fruit availability and hence incomes may vary substantially from year to year. Protection of favoured harvest sites from fire may help to reduce risk and degree of fluctuation.

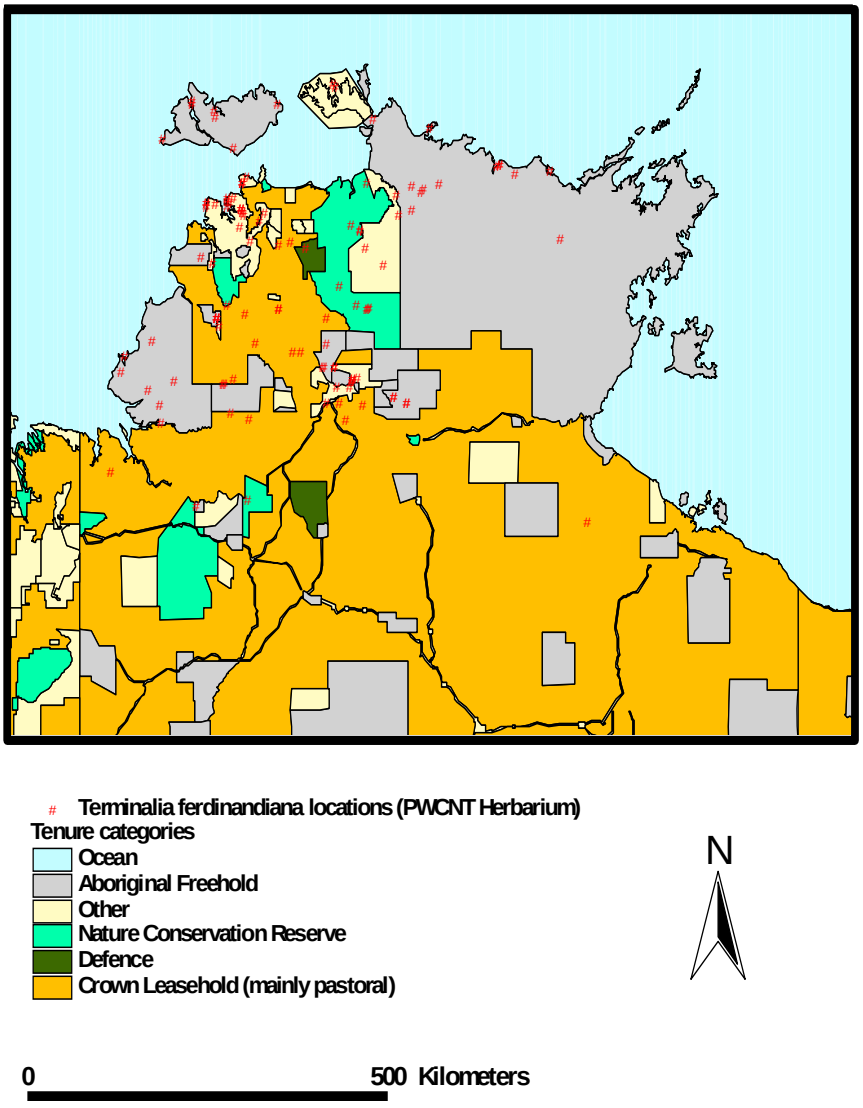

Figure 2: Location of records of Kakadu plum *Terminalia ferdinandiana* distribution in relation to land tenure in the Northern Territory. Many regions are poorly sampled. Distribution extends into Western Australia as far west as Broome.

Costs

We have estimated an average direct cost (in fuel and vehicle running) of transporting pickers and crop to and from good harvest sites in remote, sparsely populated areas at about \$4 kg^{-1}. This figure will obviously vary greatly in different locations. Close to Darwin, in the relatively smaller number of good sites, costs of transport averaged about \$0.60 kg^{-1}. Readily accessible, low cost sites such as those close to Darwin are most likely to suffer over-harvest, and unless located on private lands that can be protected from illegal harvest, will be rapidly exploited when wholesale prices are attractive.

Transport from Maningrida by air (roads to Darwin are cut by flooding at the time of maximum fruit availability in most years) has been quoted at \$3.45 kg^{-1}. Excluding costs of handling in Darwin and transport interstate, non-labour costs will therefore range from about \$1-8 kg^{-1} depending on the distance from major centres. Major buyers of Kakadu plum have suggested that refrigerated road transport in bulk can be arranged from Darwin to Melbourne at a price of \$0.33 per kg. Achieving these rates would probably require stockpiling of produce in Darwin, which would generate additional storage and handling costs. In the absence of figures on volumes, we have arbitrarily estimated a total storage, handling and shipping cost of \$1 kg^{-1} to get Kakadu plum to Melbourne. This figure would be greatly reduced if some processing (de-seeding) was done in Darwin or communities.

Prices and net returns

At the time these trials were initiated, the average price offered was about \$10 kg^{-1}. At remote sites net return on time spent actually harvesting was therefore equivalent to about \$2 h^{-1}. However, the Robins Australian Foods / Coles initiative appears to be a response to or to have stimulated greater demand and improved prices, now said to be about \$20 kg^{-1} landed in Melbourne. We estimate that at this price, net returns of at least \$10 kg^{-1} are achievable at good (high density sites) in remote areas and could be considerably better at sites closer to Darwin. Careful timing of harvests matched to the maximum standing crop of fruit could increase these returns substantially. This sort of return would appear to be sufficient to justify the harvest effort and be attractive to some Aboriginal communities.

However, this conclusion applies to the relatively small areas that support Kakadu plum trees at much higher than average densities. For example, at Maningrida the best sites are likely to be confined to the lands of a few clans rather than necessarily presenting commercial opportunities to a large proportion of the regional community. It is likely that local people will already have a much more comprehensive knowledge of local concentrations of trees than was revealed by our broad-scale surveys, and some further work should be done to identify these clumps and to compare their densities, size and potential total yield with those sites shown to be capable of supporting high rates of harvest. To open opportunities to a wider range of participants and to maximise returns may require supplementation of Kakadu plum populations, perhaps around outstations, by direct seeding or other means.

The recent acute change in price perhaps raises some concerns about volatility of demand and pricing, and its sensitivity to the marketing decisions of a small number of major players. However, it is probable that costs of acquiring and using Kakadu plum is a small part of the total cost of producing and distributing the foods in which it is used, chiefly as an additive rather than a bulk ingredient. This may tend to stabilise prices, especially if processors and retailers see a significant market advantage in maintaining access to a wild-harvested “natural” product sourced from pristine lands by Aboriginal people with a long association with the plant.

Cultural sustainability

There are no specific cultural issues raised in the literature that would conflict directly with commercial harvest of the fruit of *T. ferdinandiana*. Aboriginal people with whom we explored the options expressed no such reservations. However, general concerns were raised about the potential for commercial harvest to reduce access for community members, and especially children, to this and other wild foods. This is a possibility if accessible sites are targeted for intense commercial harvest, especially if methods are developed to allow communities to harvest regularly and stockpile product pending transport to buyers. On Aboriginal land, the solution to this problem will lie with individual clans or communities and their management of the harvest.

Other issues have arisen in regard to intellectual property. For example, the project team was approached by a private company seeking documentation of customary use of Kakadu plum. That

information was to ultimately form part of a submission to the US Food and Drug Administration (FDA) seeking approval of Kakadu plum as a food additive. We have not explored the issues in detail, but it appears that customary knowledge may be useful for seeking exemption from some requirements for pre-market approvals. Criteria for such exemption include a determination that such use is "generally recognised as safe" (GRAS). Information that reduces the high costs of compliance with FDA requirements is clearly of considerable commercial value.

We declined involvement on the grounds that the arrangement offered no or few returns to the Aboriginal providers of the knowledge and that, more importantly, we had no means to determine who should receive those returns. This is likely to be a recurring problem in respect of those plants that are widely distributed and commonly used by different Aboriginal groups. There are presently no legal mechanisms to ensure that use of such knowledge provides returns to Aboriginal people, nor to specify distribution. Recently enacted Commonwealth legislation (regulations under the *Environmental Protection and Biodiversity Conservation Act 1999*) provides for benefit-sharing contracts for uses occurring on Commonwealth lands, but does not touch the more abstract issue of intellectual property and its application.

We can offer no universal solution to such dilemmas, but as noted elsewhere, consider that legislative remedies are likely to be constrained in their reach and come too late to prevent non-Indigenous others making "unauthorised" use of Aboriginal intellectual property. Whilst improved legal frameworks are being developed, options that exploit market interest in Aboriginal culture and green connections may offer more immediate returns to Aboriginal people.

The Coles-Myer/Robins Australian Foods proposal is an example of a process through which Aboriginal people may secure a stake in the future of the bushfoods industry. Here Aboriginal communities are encouraged to become suppliers of raw product through establishment of a company owned by Indigenous people and contracted to supply Robins Australian Foods. It is proposed that Aboriginal suppliers receive payment for product at the established price. An associated organisation made up of Aboriginal community associations will receive a levy of 5% of the value of raw product supplied by the Aboriginal participants and others. The disposition of these funds will be decided by the Board of that organisation. An additional payment on each processed item sold will be used to fund associated research.

The arrangement appears to be designed to connect the products to Aboriginal culture whilst ensuring that supply is not entirely dependent on Aboriginal participation. There may also be an ethically-based, public good, dimension through which a major Australian company wishes to be seen to be contributing to enterprise development in disadvantaged Aboriginal communities. However, it is not clear whether the proponents of the scheme seek an exclusive arrangement with the Aboriginal groups who join them, or whether they will be free to pursue other arrangements as well. Relationships between mainstream suppliers of agricultural produce and major supermarket chains have not always been comfortable, with many suppliers complaining that they are frequently forced to accept prices below the cost of production.

Whatever the motivation or detail of the arrangement, the fact that a major retailer has sought to engage so directly with Aboriginal people in itself supports the notion that this connection has market value, which Aboriginal people may wish to exploit in other enterprise.

Implications of the trial

Kakadu plum is one of relatively few bushfood species that has achieved sufficient recognition to lead to the establishment of a significant market. Existing demands, however, appear to present no threat to the status of Kakadu plum populations in the north Australian landscape, although local over-exploitation may be possible if excessive removals of fruit and seeds inhibit recruitment. However, such change in fruit harvest will be easily detected and effective responses can probably be made at relatively low cost.

Our simple and admittedly incomplete calculations indicate that at prices that have recently become available, even remote Aboriginal communities might be able to profitably exploit markets for this species by wild harvest. The area over which harvest meets costs and offers meaningful net returns to pickers will be increased if such work can be linked to CDEP programs (see main report for a discussion of the role of CDEP).

The robustness of this conclusion is dependent to some extent on the good will of major buyers and the strength of commitment to source supply from Aboriginal communities. Supplies of fruit available close to major centres like Darwin can be collected at much lower cost. In the absence of a genuine commitment to remote community involvement, pressures on buyers to maintain prices may be reduced, at least in the short term, by concentrating on the more accessible resource. This problem will be exacerbated when existing and proposed Kakadu plum plantations begin to produce. Remote Aboriginal communities seeking to establish similar plantations will be disadvantaged by transport costs just as they are in wild harvests.

Whether working as wild harvesters or plantation operators, they will be able to compete with non-Aboriginal or other Aboriginal groups operating close to major centres only if “branding” is achieved. Premium prices may be available for well-recognised Indigenous producers from areas that are viewed as cleaner and greener, specifically because they are isolated from major population centres.

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Appendix 3.3: Case Study 3: Lotus lily

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Introduction

This study was conducted as part of the project "Feasibility of local, small scale harvests for indigenous communities". As a part of the larger project, a team comprising David Bowman, Julian Gorman, Tony Griffiths, Honorlea Masarella, Nick Smith, Greg Wearne, Peter Whitehead, and Glenn Wightman undertook a desktop analysis to identify those plants that appeared to offer some commercial opportunity that Aboriginal communities may be in a position to exploit. Criteria used to identify options are given in chapter 3 of the main report.

Our *a priori* selections of plants that may offer opportunities to Aboriginal communities include a relatively high ranking for lotus lily *Nelumbo nucifera*, based primarily on availability, established use and easy collection and storage. This option was independently suggested by people from the Daly River community, initially for sale as a bush food item.

Lotus lily is an important source of food for the Aboriginal people in this area, and is abundant in billabongs close to the settlement. Images of lotus lily feature strongly in art from the region, which is sold from the local Merrepen Art Centre. In the process of investigating the species' utility as a commercial bushfood, it was suggested that stories about the significance of the plant may be of interest to tourists visiting the Arts Centre. It was proposed that interest in bushfood and Aboriginal culture might be satisfied simultaneously if a bushfood item was packaged and presented in an appropriate way. This report briefly explores options for sale for consumption as well as a novelty or educational product.

Background

The lotus lily is a perennial aquatic herb, which grows in permanent and semi-permanent lagoons and billabongs from submerged creeping rootstock (Brock 1988). The large rounded, dark green leaves (20-90 cm wide) are held above the water on stiff prickly stems. The deep pink showy flowers with a yellow centre are also large (15-25 cm wide) and are carried above the water on stalks up to 2 m tall. The seeds are approximately 2 cm in length and are carried in a spongy capsule. The plants fruit from May to August and produce large tubers beneath the soil.

The natural distribution of the species includes the Top End of the Northern Territory, tropical Queensland, and widely across Asia, as far north as Japan and southern Russia. In India, China and Japan it is planted in temple gardens as a sacred plant (Low 1991).

In northern Australia *Nelumbo nucifera* occupies freshwater wetland habitats that are inundated for all or most of the year (Cowie et al. 2000). It is often one of the most abundant and conspicuous elements of the freshwater aquatic flora. In years favourable to the vegetative growth of the species (prolonged wet seasons but with lower than average total falls so that water levels do not rise rapidly) its emergent parts may become so dense that users of wetland waterways seek its removal as a "weed".

The Ngan'gikurunggurr name is Miwulngini. Aboriginal people eat the roasted tubers, the raw or soaked seeds, and the inner leaf stalk. In addition to being consumed unprocessed, the seeds may also be ground into flour or roasted (Lindsay et al. 2001). The tubers are sweet tasting and fibrous. The root may also be used to treat constipation (Marrfurra et al. 1995).

Regulatory issues

The *Territory Parks and Wildlife Conservation Act 2000* specifies that collectors taking native plant products for commerce must do so under permit (Sections 55-57). If property in that wildlife is vested in the Territory (e.g. plants on public and leasehold land), they must also pay royalties (Section 116). No royalty is presently specified for *Nelumbo nucifera* or its parts under the *Territory Wildlife Regulations*. The Minister for Parks and Wildlife may, however, declare a royalty on any wildlife (including plants) taken under a permit. Given the range of items for which royalties have been fixed in regulations, it seems likely that royalties would be levied on *Nelumbo* taken from public land, should significant commercial usage develop.

On Aboriginal land, traditional owners wishing to use plants commercially also require a permit, but are not subject to royalties. Owners of Aboriginal or other freehold land may allow others to harvest from their lands under permits issued to the land owner (often a land trust).

Once taken under a valid permit, ownership of the harvested item passes to the permit holder. The Parks and Wildlife Commission requires no permit for movement of wild harvested native plants into other jurisdictions, but those jurisdictions may seek evidence that the material was obtained lawfully. Ongoing commercial use would ultimately be regulated through a management plan made under the *Territory Parks and Wildlife Conservation Act 2000*. The principal test to be satisfied in such a plan would be that use dependent on wild populations is clearly sustainable (Section 32). Legal provisions are similar in other States.

Nelumbo nucifera is not listed as threatened under relevant Territory, State or Federal legislation. The species is not listed under the Convention on International Trade in Endangered Species (CITES).

Movement of fruit in the Northern Territory is subject to the provisions of the *Plant Diseases Control Act 2000*. At the time of writing there were no special provisions in place. However, other State and Territory jurisdictions may impose an array of requirements for the transport of fruit across their borders, which may be varied from time to time. Harvesters in the Northern Territory wishing to supply interstate markets should seek advice from the Department of Business, Industry and Resource Development about requirements.

Objectives

Objectives of the trial harvest were to:

1. Determine the effort required to harvest *Nelumbo nucifera* at favourable sites.
2. Estimate costs of collection, including transport and handling.
3. Examine sources of variation in collection rate.
4. Relate costs and effort incurred in harvest and handling to wholesale (raw product) and retail prices (value added product).

Methodology

We conducted wild harvests of lily seeds with the traditional owners of the Daly River area in the dry season of 2000. Aboriginal women and children usually harvest lotus lily towards the end of the dry season. The trial harvests were done by women from the Nauiyu community, including Patricia Marrfurra, her mother Molly Akanburra and grandmother Mercia Wawul, Kitty Kamarrama, and Mabel Kanintyanyu. Harvesters chose the most appropriate areas for collection, while members of the project team observed and measured the times taken in collection and processing.

Characterising harvest and control plots

Given the predictable distribution of *Nelumbo* in permanent and semi-permanent wetlands, no particular effort was made to characterise harvest sites, beyond recording the density of seed pods (the items harvested in these trials). Similarly, because there are presently no proposals for significant commercial harvest and these trials were very modest, we made no attempt to establish control sites.

Density of *Nelumbo* was indexed by running short transects through the area to be harvested, recording numbers of flowers and pods encountered. Only mature pods were included in counts. It was not practicable to count the number of individual *Nelumbo* plants in these inundated sites.

Monitoring protocol

No control sites were formally established. However, the transect method used to assess abundance could be modified relatively simply for long-term monitoring of the impacts of seed harvest, or return for unit effort (kg h^{-1}) by harvesters could be used as an index of abundance. Both methods assume that continuity of seed production is an adequate index of population status. It is probable that methods that gave a more direct measure of the abundance of plants would be preferred to assess very long-term trends.

Harvest process

Sites suitable for harvest were chosen by traditional owners. The criteria they used included the potential for substantial harvest and use of areas which would raise no cultural issues regarding the presence of non-Aboriginal observers and extraction of the fruit for commerce. All participants were experienced in harvesting resources from wetlands for food for themselves and families.

All of the trial harvests were conducted in a large billabong, called Red lily Billabong, close to the community. The first took place in mid-August, which is relatively early in the dry season and at the beginning of the fruiting season for lotus lily. This somewhat compromised harvest. Closer to the end of the dry the abundance and accessibility of lotus lily seed increases.

The second trial harvest was done towards the end of the dry season in October 2000, when lotus lily seed was approaching peak abundance. The third and forth trial harvests were conducted at the start of the wet season in November 2000 when lotus lily seeds were at peak density. There was some spatial overlap in sections of the billabong that were harvested. In some areas previously harvested, pods that had been immature at the time of previous harvests were taken.

Harvesters waded into the billabong and pods with mature receptacles were cut from the stems. At the time we harvested, many fruit were green with the flesh overlying and kernel and the kernel itself being quite soft. A proportion of fruit was slightly brown to black. As receptacles dried later in the season, the integument over the kernel became completely black and harder to remove, while the kernel also became much harder and very brittle.

The weight of fruit collected before shelling was measured on site to the nearest gram, using a Pesola spring balance.

Post harvest treatment

Harvesters returned to the perimeter of the billabong to remove seeds from pods. This was done by breaking the capsules apart with fingers. Pods were discarded and seeds stored in cloth bags.
A number of treatments was examined in a very superficial way to look at the potential to extend the life of lotus lily seed before obvious deterioration occurred. These included sun drying, oven drying, freezing, and vacuum packaging. Sun drying was done by exposing seeds on racks (one layer or more) for 2-3 days during the late dry season. Oven drying was done at the Darwin Herbarium in a Thermoline Dehydrating Oven at 47^{o}C for 19 hours. The vacuum packaging machine used was a small Foodsaver (by Tilia) Compact II machine intended for domestic use. Bags were heat sealed after air was withdrawn from (VacLoc) bags.

In addition, representatives of the Merrepen Arts Centre and local women collaborated with the project team to design a pamphlet to accompany lotus lily seed. They wrote a brief description of use and significance and chose designs and other images to accompany the text.

Markets

Bushfood wholesalers

Samples of raw (untreated) lotus seeds were sent to Robins Australian Foods (Juleigh Robins) and Australian Gourmet Wildfoods (Rob Cross). Neither had used this plant product previously but both were willing to consider options and indicate interest or otherwise for use in their industry sector.

Retail Outlets

Managers of a number of retail outlets were interviewed to record their views of the potential to sell bushfood products incorporating information about customary use and other aspects of Aboriginal culture connected to the item. These included Murrawidi Gallery at the Bowali Visitors Centre (in Kakadu National Park), Raintree Art Gallery (Darwin), Darwin Airport, Muk Muk Trading (Darwin) and Nitmiluk Visitors Centre (Nitmiluk National Park in Katherine). Information sought included:

1. What native plant products do you presently sell?
2. What are the most popular items?
3. What is the % mark up on original price?
4. Do you know on average what customers spend?
5. Does the purchaser want evidence of authenticity?
6. Would you be interested in buying bush foods products directly from communities or individuals for the tourist market?
7. What recommendations would you give for marketing the product?
8. Would inconsistency of supply be a problem?
9. What reservations would you have, if any?
10. Are their any other products that you would be interested in from Aboriginal Communities?

Only Murrawidi Gallery was selling bushfood products at the time of survey. Pamphlets intended to accompany bushfood samples (Figure 1) had not been printed at the time of these interviews.

Consumer Survey

To examine potential consumer demand for some bushfood products we compiled a simple questionnaire to get some measure of public opinion. Questionnaires were distributed to visitors at two Top End events, the Merrepen Arts Festival, which is held annually in the Nauiyu Community at

Daly River (in June), and the Gardens Fair which is also an annual event and is held at the Darwin Botanic Gardens (in August).

At each event the intent of the project was briefly explained and samples of wild bush food were offered. At the Merrepen Arts Festival, samples of *Nelumbo nucifera* (lotus lily) and *Grewia asiatica* (bush plum) were supplied as examples while at the Botanic Gardens Fair samples of *Ocimum tenuiflorum* (native basil tea), *Grewia asiatica* and *Boab adamsonia* were available.

Drafts of information pamphlets designed by the community for *Nelumbo nucifera*, *Grewia asiatica* and *Vitex glabrata* were shown as examples to gauge interest in the concept and the content. Pamphlets were packed with a small sample of the native bushfood product which had been sun dried and vacuum packed as well as some cultural, geographic and botanical information.

We did not seek information on markets for lotus lily seed receptacles and stalks which might be used as inclusions in flower arrangements.

Results

Characterising harvest sites

The average density of receptacles measured on 3 October 2000 on 6 transects ranging from 40 to 57 m in length was 0.53 $\pm$ 0.21 (SD) capsules m^{-2}. Water depth varied from 30 to 100 cm. Large numbers of flowers were present in October (approximately one third the density of the standing crop of pods), indicating that fruit production was continuing.

Monitoring protocol

Not applicable to this trial.

Harvest process

The average rate of harvest of *Nelumbo* fruits during these four trial harvests was 0.62 $\pm$ 0.32 kg h^{-1} (Table 1). Exclusion of figures for the unproductively early (August) harvest increased the average to 0.80 $\pm$ 0.11 kg h^{-1}, the figure we use in all subsequent analysis and discussion. We have included in these estimates the time required to remove seeds from the pods, but not time spent travelling to the site. The average fruit weight was 2.0 g unpeeled and 1.0 gram peeled (estimated from 3470 seeds weighing 6.94 kg).

Table 1: Wild harvests of *Nelumbo nucifera* at the Red lily Billabong, Daly River. The site is about 10 min travelling time from the harvesters' settlement. Harvest rate calculations exclude travelling time.

Date	Fresh or dried pods	No. collecting	Collection and husking time (min)	No. pods collected	Weight of seed (kg)	Rate of seed collection (kg h^{-1})
15-Aug-00	Fresh	5	45	50	0.5	0.13
15-Aug-00	Dried	3	35	50	0.4	0.22
03-Oct-00	Fresh	3	75	150	2.5	0.66
03-Oct-00	Fresh	4	70	170	3.5	0.75
03-Oct-00	Fresh	5	65	230	4.1	0.76
21-Nov-00	Fresh	4	75	210	4.5	0.90
28-Nov-00	Fresh	5	90	289	6.9	0.91
Mean $\pm$ SD						**0.62 $\pm$ 0.32**

The major non-labour item of cost we were able to measure was transport of harvesters to and from harvest sites. In these trials suitable sites were only a few km distant from residences of the harvesters. Costs calculated at \$0.50 km^{-1} averaged \$1.20 kg^{-1}.Additional costs of possibly \$0.50 kg^{-1} would be incurred in getting crops to a Melbourne market, including packing and transport.

Markets

Bushfood wholesalers

We received no response from Robins Australian Foods but Australian Gourmet Wildfoods (Rob Cross) indicated they might be interested in using lotus lily. He was unable to suggest a price for locally produced fruits. Lotus lily seeds imported from Asia are sold in Darwin and elsewhere in Australia for use in Asian cooking, at prices less than \$10 kg^{-1} wet.

Interviews with retail outlets

All proprietors felt that there is potential for niche products within the tourist market that provide authentic connections to Aboriginal culture. A summary of the major points arising in the interviews includes:

- the most common consumer purchase price range was \$15 - 20
- mark-ups from the wholesale price are 80 - 100%
- seasonality of fruiting and inability to supply all year round was not a big issue, provided availability included the peak mid-year tourist season
- all were interested in trialing products in their stores
- recommended wholesale prices were \$10 per item

This small group of retailers volunteered the view that authenticity and means of certifying it (labelling) were important issues for consumers. Two of their number also suggested that tourists would be more interested in purchase if they were convinced that the proceeds reached Aboriginal communities. Providing information in languages other than English was mentioned as an important option in the tourist market these retailers serviced.

Consumer survey

A total of 148 questionnaires were completed, 36 at the Merrepen Arts Festival in Daly River and 112 at the Botanic Gardens Gardening Fair in Darwin.

A summary of responses extracted from completed questionnaires includes the following major points:

- all international and interstate visitors and 98% of local visitors questioned were interested in buying bushfood products such as the ones being sampled;
- 7% of all people questioned considered the authenticity issue to be very important, while 91% thought it was important and 2% thought it was not important.
- 53% thought the product sample shown was valued somewhere between $10 and $15 (28% thought in the region of $5, 7% at $20, and 12% were undecided).

The population from which these samples were drawn cannot be considered random. The Merrepen sample is likely to be dominated by people with an interest in Aboriginal culture and hence to value stories of Aboriginal culture more highly than a randomly selected group. Similarly, visitors to the Garden Fair are likely to value information on plants more highly than average. Nonetheless, the responses do indicate that a substantial market exists at somewhere between $10 and $15 per pack.

Post-harvest treatment

Collection and shelling of receptacles was timed during four harvests. On average a receptacles required 2.1 $\pm$ 0.3 min to collect and removing the fruit required an additional 1.0 $\pm$ 0.2 min (Table 1).

Fresh seed that was not actively dried deteriorated within a few months, even with our modest vacuum packing. Sun drying or drying in a commercial drier and then vacuum packing extended the period over which seeds could be stored without obvious deterioration to several months. It is likely that well-dried seeds will remain stable in storage for very long periods, but are very hard and would require treatment (e.g. soaking in water) before any form of consumptive use. Seed frozen when fresh deteriorated rapidly on defrosting.

Discussion

Lotus lily seed was a product that we initially ranked as offering some opportunities in the bushfood market, provided it could be harvested at reasonable cost. However, we did not comprehensively consider its potential value as a novelty of particular interest to tourists. Additional possibilities were developed during the trial harvests and the associated interactions with members of the community.

The potential to package a small and durable sample of lotus lily seed, with information on its significance to Aboriginal people and the manner in which it is used by them (Figure 1), is an interesting one. Like some other options identified by the Daly River community (e.g. long yam: Appendix 3.4: Case Study 4), the proposal perhaps says as much about determination of community members to maintain culture as about a desire to establish a profitable commercial enterprise. By effectively selling interesting and educational material and relegating the bushfood item to a “prop”

to support stories about Aboriginal culture, the community is accessing a market that values a genuine connection with Aboriginal society. Such markets cannot be so easily exploited by non-Aboriginal interests in the way that the bushfood market itself can. They escape some of the disadvantages of distance and isolation by exploiting a comparative advantage that in part derives from remoteness.

Figure 1: Example of pamphlet produced as an element of these trials. The pamphlet will accompany small samples of dried seed of lotus lily *Nelumbo nucifera*.

Moreover, the process of producing and reviewing the information to be made available to non-Aboriginal people can also become part of a process for conserving knowledge and ensuring that it is passed on to children. Older Aboriginal people consider traditional biological knowledge as highly valuable and think it critically important to pass this knowledge on to future generations (Lindsay et al. 2001). Confirmation that customary knowledge is valued by others outside Aboriginal communities may promote greater appreciation of its value within the community.

Ecological sustainability

Subsistence harvest of the type presently practiced in the billabongs of the Daly River region has been demonstrably sustainable. However, there is some potential for unsustainable practice to become an issue, if large additional quantities of bushfoods are collected for commercial purposes, especially when the distribution of the resource is highly clumped and the potential exists for the whole of all local sites to be harvested. This risk exists in smaller, isolated wetlands over much of non-coastal northern Australia. In coastal regions, lotus lily is much more abundant on larger floodplains and there the risk of over-harvest is much reduced.

Risk of over-harvest also depends on price and demand. Given continued access to supplies of lotus lily seed from overseas, at prices for raw product low enough to reduce incentives to harvest from the wild, conditions providing strong incentive to over-harvest in northern Australia seem improbable in

the mid-term future. Confining harvests to quantities to be sold as part of a more elaborate (value-added) product greatly reduces the prospect of even local over-harvest. Risk of over-harvest was specifically raised by a traditional owner of the site on which these trial harvests took place and her concerns were in part responsible for a switch from harvest for sale as a raw product to a product requiring lower volumes and involving value-adding in the community.

Although there have been no quantitative studies explicitly directed at understanding variation in the abundance of lotus lily in north Australian wetlands, there is evidence of considerable changes in relative cover from year to year (P. Whitehead, unpublished data). Cover appears greater in years with lower than average rainfalls and slower filling of billabongs and swamps during the wet season, although it is unclear whether this is caused by greater vegetative growth of a similar number of plants, or the recruitment of more plants to the population.

These variations will not usually compromise collection of the small amount of seed that the Daly River women are proposing (see below), but does make assessing whether harvest causes change much more difficult. Long runs of data will be required to separate "natural" from harvest-related variation. Rather than consider elaborate monitoring systems that will most likely reveal very little (there is a low probability of impact), it may be more sensible to consider locally designed and implemented harvest management systems that rotate access to different sites, and reduce the probability of harvest-related detriment by "resting" sites from time to time.

It should also be noted that some sites will be "protected" from harvest by phenomena unrelated to harvest management regimes. Harvest involves some discomfort and risk. Wetlands supporting these plants often remained inundated at the time of harvest. Entering the water attracts leeches. Some exposed to these waters develop "swimmers' itch", caused by cercaria from schistosome parasites that normally infect birds. While they do not successfully establish in human hosts, they can cause discomfort where they penetrate the skin. There is a risk of exposure to leptospirosis, a debilitating and sometimes fatal disease (Johnston, 2003). The prickly stems of lotus lily can cause abrasions and cuts that also irritate the skin. There is a risk of encounter with estuarine crocodiles *Crocodylus porosus* that can cause problems a good deal larger than irritation, although harvesters familiar with local conditions reduce this risk by identifying and avoiding places with large and potentially dangerous animals. The presence of large estuarine crocodiles in many parts of the coastal and sub-coastal Northern Territory will effectively prevent harvest or require that boats be used at many sites, especially close to major rivers and floodplains.

We consider approaches to harvest management to reduce risks of local over-harvest of patchily distributed resources in more detail in chapter 5 in the main report.

Commercial sustainability

Supply of raw product

Those consuming fresh fruit (relatively green at the time of collection) agreed that they were pleasantly flavoured and similar enough to well-known and established nut crops to be attractive to many people. However, wild harvest in bulk to supply markets for consumption in this way is likely to be unrewarding in financial terms. At a rate of harvest of 0.8 kg h^{-1}, prices exceeding \$14 kg^{-1} would be necessary to provide a net return of \$10 h^{-1}. Supplying in bulk might also lead to problems of over-harvest. Although lotus lily is a very common plant in favourable sites, permanent and semi-permanent wetlands occupy a tiny fraction of the landscape. Repeated harvests of accessible sites may reduce potential returns as stock is depleted and greater effort is required to extract a sizeable harvest.

There would appear to be little commercial potential to produce *Nelumbo* seed in cultivation to satisfy bulk markets for consumption. Costs of duplicating wetland conditions that favour lotus lily are likely to be too high.

Tourist Pack

Lotus lily seed is one of a number of items that local people at Nauiyu consider could be packaged with information about customary use and significance. At the Nauiyu workshop conducted as part of this project in November 2001, we took the opportunity to examine the costs and returns from a modest supplement to the local Art Centre offerings to the tourist trade (Table 3).

The Merrepen Arts and Culture Centre sells painting, carvings and other artefacts made by Aboriginal people from the Daly River region and surrounds. The Centre attracts approximately 800 visitors spread throughout the dry season and about 1500 additional visitors come to the annual Merrepen Arts Festival. We estimated, based on advice from the Arts Centre management in regard to tourist interests and buying patterns, that about 500 samples of lotus lily could be sold. The Arts Centre has suggested that they would sell the bushfood products and handle funds for those providing them for 10% of gross sales. A price of $10.00 (excluding GST) per item was estimated from the information provided by visitors to the Darwin Botanic Gardens Fair and at the Merrepen Arts Festival of 2001.

The opportunity represented by packaging of lotus lily for tourists is clearly a very modest one, achieving gross returns of only a few thousand dollars annually. In terms of the annual turnover of the Merrepen Arts Centre, the additional income is minor. Nonetheless, the idea is significant because it highlights the very great differences in returns on effort (a 10-fold improvement over supply of raw product as food) when communities are able to add value by connecting a product to their culture, rather than simply selling their labour as anonymous harvesters. The arts market with which they have sought to associate this product is perhaps the most significant existing example of this cultural value-adding.

Table 3: Breakdown of costs associated with wild harvest and packaging of *Nelumbo nucifera* at Nauiyu Daly River. Sales at the Merrepen Arts Centre of 500 units p.a., each containing 10 g of dried seeds is assumed. This will require collection of 10 kg of seed (wet weight). It should be noted that these calculations do not include costs of holding and selling stock.

Setup costs	**Number**	**Unit Price ($)**	**Total ($)**
Collection bags	10	4	40
Vacuum Packaging Machine	1	275	275
Sun Dryers	2	50	100
Pamphlet design and layout			522
Total			937
Assume replacement over 3 years			312 pa
Operating costs			
Vacuum packaging bags	3 rolls	12.33	37
Zip lock bags	500	0.17	83.50
Printing pamphlets	500	0.99	495
Colour film and dye			112.50
Transport to and from harvest site			12
Total - annual production of 500 items			740
Estimated gross annual income			
500 @ $10 each			5,000
Estimated net annual income			
		10% commission to Arts Centre	-500
		depreciation of equipment	-312
		production costs	-740
Net			$3448
Estimated labour requirements			
		12.5 h collection and extraction	
		30.0 h drying and packaging	
Average return per hour			**$81.13**

Our modest surveys indicate sufficient interest in material of this type from retailers elsewhere in the Top End to suggest that a considerably larger market might be available. There are also many more plant products that could be treated in a similar way.

We consider the broader issues of value-adding in more detail in the main report.

Cultural sustainability

Our activities at the Nauiyu Community were determined to a large extent by the interests of the region's older women. Harvests of plants and plant products from wetlands are traditionally a woman's activity and Aboriginal men are unlikely to seek involvement in collection. None of the senior women involved expressed any reservations about harvesting these items or in providing information about their significance to Aboriginal culture.

There is presently no reason to believe that demand from the wider community will compromise access for continuing customary use of lotus lily. As we have noted, much larger markets would need to develop before impacts on wild populations would move beyond the negligible and hence compete with subsistence use.

Implications of the trial

The proposal to use bushfoods as an adjunct to tourism, based around an Arts and Cultural Centre, is an interesting one. By linking the plant to culture, the volumes of material required to achieve useful returns are reduced and so threats of over-exploitation are reduced. The celebration of Aboriginal knowledge that is at the heart of this proposal may have benefits additional to employment and income, especially in promoting a positive valuation of customary knowledge among the young. The products might also be used to promote interest in additional activities like bush tucker tours that may bring in much greater incomes.

Indeed, the returns from this proposal are perhaps too modest to be considered useful if implemented in isolation. The proposal will offer much more if it can be linked to an expanded range of products and treated as part of a larger "promotion" of Aboriginal culture, including, if offered at Centre's outside Naiuyu, as advertising for the Merrepen Arts Centre. Ideas for elaboration of the material included with lotus lily seeds include images of significant works from the gallery and use of a portion of the pamphlet as a postcard, encouraging buyers to advise others of the existence of the Centre.

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Appendix 3.4: Case Study 4: Long yam

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Introduction

This study was conducted as part of the project "Feasibility of local, small scale harvests for indigenous communities". As a part of the larger project, a team comprising David Bowman, Julian Gorman, Tony Griffiths, Honorlea Masarella, Nick Smith, Greg Wearne, Peter Whitehead, and Glenn Wightman undertook a desktop analysis to identify those plants that appeared to offer some commercial opportunity that Aboriginal communities may be in a position to exploit. Criteria used to identify options are given in chapter 3 of the main report.

Our *a priori* selections of plants that may offer opportunities to Aboriginal communities did not identify long yam as a bushfood item with particular promise for conventional markets. However, this species is widely used and highly regarded as a significant food by many Top End and Cape York Aboriginal communities, and is common in the north Australian landscape. A number of Aboriginal people sought support to investigate its commercial utility, often for sale within communities rather than into larger markets. The community with the greatest interest was the Nauiyu community on the Daly River, about 110 km south west of Darwin. The yam remains a major source of food for the Malak Malak and Matngala people (Lindsay et al. 2001) who are the traditional owners of land around the Daly River

Background

The true yams, genus *Dioscorea*, are restricted to higher rainfall areas of the wet-dry tropics and therefore not available to many inland Aboriginal clans. For coastal Aboriginal groups, yams are a staple component of their diet. A number of different types of yam are eaten, but the long yam *Dioscorea transversa* and the round or cheeky yam *D. bulbifera* are probably the most common in the landscape and also most consumed in northern Australia.

The emergent vine of the long yam has shiny leaves with five or seven prominent veins. The yam, a subterranean tuber, is often found deep in the soil. Large specimens commonly reach 50 cm in length and occasionally reach 100 cm. Even large specimens remain relatively slender (several cm in diameter). The flesh is white or pale grey. The northern form of the long yam is often found in sandy soil in coastal open forests and has enormous tubers and sprouts small bulbils from above ground stems. The emergent vine sprouts soon after the first wet season rains and grows rapidly throughout the wet season. The tuber also increases in size during the wet and is ready for harvesting at the beginning of the following dry season and later in the cooler months of the year.

Long yam is usually collected by women using a long digging stick. First the vine is located, and the stem carefully followed and soil excavated using the digging stick until the tuber is revealed. Tubers become progressively more difficult to locate further into the dry season as the stem of the vine tends to dry and break off. Extraction is especially difficult and laborious in rocky or hard soil. In rocky soils tubers may ultimately prove impossible to retrieve, because they are found to be wedged between rocks too large to move.

The tuber is most commonly boiled or roasted on coals prior to consumption (Low 1991), though it is often peeled and eaten without any cooking.

Regulatory issues

The *Territory Parks and Wildlife Conservation Act 2000* specifies that collectors taking native plant products for commerce must obtain a permit (Sections 55-57). If property in that wildlife is vested in the Territory (e.g. plants on public and leasehold land), they must also pay royalties (Section 116). No royalty has been specified in the *Territory Wildlife Regulations* for commercially harvested long yam or any other tuber from a native plant. The Minister for Parks and Wildlife may, however,

declare a royalty on any wildlife (including plants) taken under a permit. Given the range of items for which royalties have been fixed in regulations, it seems likely that royalties would be levied on yams taken from public land should significant commercial usage develop.

On Aboriginal land, traditional owners wishing to use plants commercially also require a permit, but are not subject to royalties. Owners of Aboriginal or other freehold land may allow others to harvest from their lands under permits issued to the land owner.

Once taken under a valid permit, ownership of the harvested item passes to the permit holder. The Parks and Wildlife Commission requires no permit for movement of wild harvested native plants into other jurisdictions, but those jurisdictions may seek evidence that the material was obtained lawfully.

Australian *Dioscorea* species are not listed as threatened under relevant Territory, State or Federal legislation. They are not listed under the Convention on International Trade in Endangered Species (CITES).

Movement of fruit and other plant material in the Northern Territory is subject to the provisions of the *Plant Diseases Control Act 2000*. At the time of writing there were no special provisions in place that would affect long yam. However, other State and Territory jurisdictions may impose an array of requirements for the transport of plant materials across their borders, which may be varied from time to time. Harvesters wishing to supply interstate markets should seek advice from the Department of Business, Industry and Regional Development about requirements.

Objectives

Objectives of the trial harvest of long yam were to:

1. Determine the effort required to harvest *Dioscorea transversa* at favourable sites.
2. Estimate costs of collection, including transport and handling.
3. Examine sources of variation in collection rate, including densities of plants and soil types.
4. Relate costs and effort incurred in harvest and handling to wholesale and retail prices.

Methods

In the dry season of 2000 we conducted four wild harvests of long yam with the Traditional Owners of the Daly River area. Aboriginal women from the Nauiyu community at Daly River did the harvesting. They chose the most appropriate area for collection of the yams and extracted them. We observed the procedure and measured the times taken to find and dig the yams. Although seemingly done with little effort, the ability to identify and follow the vine to the tuber requires both patience and expertise. We did not attempt to emulate the skills of the harvesters.

Characterising harvest and control plots

Quantitative surveys were problematic because the terrain was mostly broken and considerable experience and skill is needed to identify senescent vines of the target species. Primarily because of the difficulty of reliably identifying *Dioscorea* stems, we did not attempt quantitative surveys.

In each quadrat harvested, soil types were recorded as they were thought likely to influence harvest times.

Monitoring protocol

Not attempted

Harvest process

Harvests took place in June and August of 2000. Sites suitable for harvest were chosen by traditional owners. The criteria they used for choice of sites included the potential for good harvest and areas which would raise no cultural issues regarding the presence of non-Aboriginal observers and extraction of the yams for commerce. All participants were experienced in finding and extracting yams and continue this practice to provide food for themselves and their families.

Yams were weighed to the nearest gram on return to the laboratory using a Pesola spring balance.

Post-harvest treatment

Yams were stored in cloth bags after harvest. There was no treatment aside from washing to remove excess soil.

Cultivation

The potential for growing yams from pieces of the tuber was crudely examined at Nauiyu community. Tubers that had been collected during some of the wild harvests were left in a cool dark place until they started to sprout. They were then cut into approximately 4 x 2 x 3 cm sections and placed at various levels in 200 litre drums containing soils consisting of large-grained Daly River sand, local loam, and Cocopeat (fibrous mulch derived from coconut husk) with a small amount of fertiliser. Holes were made in the sides of drums for drainage. Drums were left in the open and received only natural rainfall.

Seed collected from adult plants germinated readily. Experimental trials regarding growth from seed were proposed for the 2002/2003 wet season.

Markets

We made no serious attempts to determine wider interest in the product. Potential buyers were unfamiliar with the item, and despite a considerable effort to extract specimens, the amount of material available did not permit a comprehensive offering of samples. We sent small samples to bushfood users in Darwin and Victoria to get a preliminary indication of interest regarding use in the restaurant trade.

Results

Characteristics of harvest sites

Details of harvest sites are given in Table 1. All sites selected were on well drained loamy soils containing large quantities of rock and pebbles down to the depths at which tubers were found. Soil moisture levels were rated as low at the time of harvest.

Harvest

Yams varied in size from approximately 0.05 to 1 m in length. Effort to extract a small tuber was often equivalent to that required for a much larger specimen. This occurred because the dimensions of the senescent stem gave few clues to the size of the tuber, which was probably more dependent on the number of seasons the tuber had been growing.

The average rate of harvest of long yam during these four trial harvests was 0.42 kg h^{-1} (Table 1). This figure includes only time spent in the act of locating a particular stem and extracting the tuber. Inclusion of travel time to and from settlements reduced this figure to about 0.30 kg h^{-1}.

Table 1: Observations of wild harvest of *Dioscorea transversa* at four different sites in the Daly River region. Four harvesters participated in each trial. The figures used to calculate harvest rate exclude travelling time from residence to harvest site, but include searching time at the site. A total of 190 km was travelled moving harvesters to and from sites.

Date	Travel (1) and on-site search time (2) (min)	Weight collected (kg)	Time required (min)	Time to collect 1 kg (min)	Individual harvest rate (kg h^{-1})	Vegetation and Soil Type
Jun-00	(1) 20 min (2) 5 min	2.25	95	42	0.36	Small thicket with rocky, sandy loam soils
Jun-00	(1) 25 min (2) 15 min	4.65	120	25.8	0.58	Not recorded
Jun-00	(1) 20 min (2) 15 min	3	105	35	0.43	Rocky ridge with sandy loam soil & pebbles
Aug-00	(1) 60 min (2) 30 min	2.5	120	48	0.31	Rocky ridge, loamy soil containing much pebble and rock

Harvest costs

The major contributor to costs that we were able to measure was transport to and from harvest sites. In these trials suitable sites were a few km to up to 35 km distant from residences of the harvesters. Travel costs calculated at \$0.50 km^{-1} averaged \$7.66 kg^{-1}. Additional costs of several cents kg^{-1} would be incurred in getting crops to markets outside settlements.

Monitoring costs

Not applicable to this trial.

Post-harvest maintenance and delivery

The tubers appear likely to be susceptible to deterioration (e.g. through fungal attack) if stored for a significant time. We have no reason to assume that they would require any more complex management than other commercial root vegetables and that storage in cool, dry places would be the general prescription. We did not attempt any formal trials of storage methods.

All drums in which tuber segments were planted had emergent shoots in the 2001/2002 wet season. Tuber growth has not been measured, but the prolonged survival of the plants without artificial irrigation is encouraging.

Long yam also grow from seed very successfully (Ross McDonald, NTU Horticulture, pers. comm.).

Markets

Robins Australian Foods indicated no interest in long yam. Australian Gourmet Wildfood thought there was some potential in the restaurant trade and sought additional samples. Wholesalers were unfamiliar with these yams and were unable to suggest a reasonable price. However, it was suggested that prices of more than \$10.00 kg^{-1} were unlikely, because there are Asian yams which are superficially similar and sell at about this price in local supermarkets in Darwin. Those provided with samples indicated that they saw no special features that would render the yams especially attractive to a wider market. We made no attempt to determine the prices that members of Aboriginal communities may be willing to pay.

Discussion

We did not initially consider yams of any sort as being particularly strong candidates for commercial use. However, we under-estimated the esteem in which foods of this sort were held by some Aboriginal people, especially those women and older men who retained close connections to their traditional lands. They particularly wished to explore the opportunities to make these customary foods more available to members of their communities. Some were unconcerned if wider markets did not exist.

Motivations were not explored in detail, but they included a desire to see money entering the community being used to stimulate wider activity within it, and a wish to see fresher, healthier customary foods available to younger community members. In addition to interest in wild harvest, cultivation of yams (especially *Dioscorea* species) was most often mentioned in this context.

Thus the focus of our trials on wild harvest had two purposes. First, to explore the potential for women to develop a small enterprise based on taking tubers from the wild for sale as food, and second, to also use this experience to better understand the availability of stock for initiating cultivation within communities, and the costs of providing this stock.

Ecological sustainability

The yam species of interest are widely distributed in the landscape and are relatively common in favourable habitats, often associated with the margins of monsoon forests and “dry” jungles or monsoon vine thickets on fire protected sites (Russell-Smith et al. 1997). Aboriginal land

management is often focused on protecting such sites from late dry season fires by burning early around the margins. Poor fire management can result in burning of the emergent parts of the plants, obscuring their position and making harvest even more difficult. Economic returns from yam harvest may increase incentives to protect such sites, which are of great conservation value (Price et al. 1999).

The patchy distribution of yams at exploitable densities increases their potential vulnerability to over-exploitation. However, the labour involved in extraction and the likely commercial return is such that the number of people likely to be interested in such activity is small: only those strongly motivated to promote return to use of customary foods in communities are likely to seek involvement.

Moreover, many harvesters routinely replace the top of the tuber in the hole from which it was excavated in order to promote re-growth for the next season. The high rate of resprouting of tuber segments we observed confirms that this strategy is likely to be effective. The harvesters involved in these trials invariably adopted this practice.

Under prevailing conditions and any reasonable projection of future demand, wild harvest appears likely to be too limited to threaten populations or habitats. If larger markets develop, they are likely to be better satisfied by cultivation than wild harvest.

Economic sustainability

At the rates of harvest we observed, a price of at least \$25 kg^{-1} is required to meet travel and reasonable labour costs. Any significant return on effort would require a substantially higher price. Long yams harvested in these trials were often on rocky slopes in the open sun, so that the work was very taxing. As we have indicated, even if rates of harvest can be improved by selection of sites with more easily excavated soils than were used in these trials, wild harvest is likely to be particularly unrewarding in strictly financial terms. Prices of the order we have estimated to be necessary to meet costs are unlikely to be realised, at least in the short term, because the long yam is not well-known among existing bush food retail companies and restaurants, and there is competition from superficially similar yam like products from Asia.

The effort that older women devoted to this task is testament to the esteem in which they held the product, and perhaps also to their views of the social and cultural benefits of engaging in this sort of activity with other members of the community.

Even if direct sale of yams for consumption is problematic, it may be that wild harvest can provide tubers for cultivation at an acceptable cost. Small pieces sprouted readily and produced apparently healthy plants with minimum additional care. It will be necessary to compare the relative growth rates of stock grown from seed and tubers and the cost of seed collection to determine whether wild harvest of tubers is the better way to source material for cultivation.

The crude trials of cultivation of long yam we initiated provide no basis for conclusions about feasibility or cost of cultivation, but were sufficiently encouraging to suggest that closer examination is warranted. Under especially favourable conditions in the wild, individual long yam tubers may be up to 100 cm in length and weigh several kg. There may be potential to produce large specimens in cultivation to satisfy a local market within communities, especially for older people. However, as we have argued, it may be difficult to establish a significant non-Aboriginal market. Cultivation of long yam for local consumption might be better treated as a supplementary application of nursery infrastructure and training in horticulture, developed initially to satisfy other commercial objectives (e.g. cycads and other garden and landscaping plants). Under these circumstances it may be possible to produce relatively small quantities for local use at an acceptable price.

More comprehensive trials will be undertaken in the future.

Cultural sustainability

Our activities at the Nauiyu Community were determined to a large extent by the interests of the region's older women. Yam harvest is traditionally a woman's activity and Aboriginal men are unlikely to seek involvement in collection, although one male Cape York elder has sought support to develop a yam garden. An important motivation for exploring commercial options involving yams was to increase their availability to Aboriginal people. Therefore any arrangement to supply wider markets should not conflict with this goal.

There is presently no reason to believe that demand from the wider community will compromise access for Aboriginal people to continue customary use. If larger markets were to be developed, then it is probable that they could only be supplied by cultivation. Under these circumstances, access by Aboriginal people would be enhanced rather than compromised.

Some *Dioscorea* yams contain low levels of toxins/secondary compounds that affect taste or produce mild distress in humans if consumed in significant quantities. *Dioscorea bulbifera* gains its common name (cheeky yam) from these characteristics. The "cheekier" varieties require treatment prior to consumption, sometimes involving grating or cutting the flesh and cooking slowly in hot ash, then leaching out the toxin by leaving in running water, then cooking again and placing in water over night (Lindsay et al, 2001). Whilst long yam is generally regarded as benign and is often eaten raw, it may be that offerings to a wider market would require some caution.

Implications of the trial

The strong commitment to making customary foods more available to community members is an issue that we did not clearly identify at the commencement of this project. The interest in yams is a clear expression of that commitment, which justifies greater effort to explore options for cultivation, especially in those communities where nursery facilities have already been developed or are proposed.

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Appendix 3.5: Case Study 5: Bombax ceiba

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Introduction

This case study differs from the others in that it does not involve implementation of a trial to extend the use of a native plant into commerce. Rather, we report studies of a well-established use, namely the harvest of stems of the monsoon forest tree *Bombax ceiba*. Stems are taken for use in production of carvings for the arts trade. Bawinanga Aboriginal Corporation had expressed concern that the potential for increase in demand would threaten the status of regional bombax populations and compromise the sustainability of this regionally significant industry. This report therefore focuses on issues of sustainability and the factors that might influence it, rather than market and related issues.

Background

The Arts and Crafts Industry

The production of Aboriginal art and crafts, relying in part on the wild harvest of plant products, is a well established industry in northern Australia. The economy of many remote Aboriginal communities consists of a varying mix of subsistence activity, social welfare, a 'work for the dole' scheme (CDEP), formal employment and art and craft production. Few people rely on any one of these sectors for their sole income: their economy is a hybrid, often highly dependent on transfer payments from the state (Altman and Taylor 1987).

The production of art is significant to local and regional Aboriginal economies in remote areas of Australia because it is often the only means for Aboriginal people to increase cash incomes (Altman and Taylor 1987). Recent estimates suggest over 4,500 Aboriginal artists in over 39 remote community art centres are producing commercial art for local and overseas markets (Wright 1999).

The value of the industry as a whole is difficult to estimate, but it is likely that community art centres in the Top End of the Northern Territory turn over $5-6 million annually (S. Congreve, ANKAA, pers. com.). Many of the art and craft items produced at Aboriginal outstations and remote communities are derived from native plants (i.e. all bark paintings, wooden sculpture, weaving, some pigments and dyes). Emphasis on use of plants harvested from the wild is particularly evident in central arid and northern tropical regions of Australia. The continued supply of the exploited species represents significant capital to the community (both commercial and social) and is a critical component in the continued success of the industry. Increasing demand for particular items and development of new industries may place new pressures on local populations of these species.

Wild harvest of plants for indigenous art and craft is significant in many countries, particularly South America, Africa and South East Asia (Runk 2001). In Australia, there are potentially hundreds of plant species used by Aboriginal people in the production of commercial art. Few attempts have been made in Australia to assess the size and potential impact of harvest of native species by indigenous people, for subsistence or commercial use (Bomford and Caughley 1996). No previous assessments of harvests have occurred in the area of art production. The highly dispersed nature of the use and diversity of products and species in use makes it a relatively intractable area for research. However, continuing market growth and demand for Aboriginal art and craft (up to 15% over the last two years: Wright and Morphy 2000) has increased interest in the management of species that are particularly significant for the trade.

This study focuses on one plant species *Bombax ceiba*, which is in high demand for sculpture in the Maningrida region of central Arnhem Land. Maningrida is a remote community that has developed a thriving local indigenous arts industry, employing over 300 people who produce a diverse range of Aboriginal art and crafts. Turnover has grown from $50,000 in 1977 to approximately $600,000 in 1998/99 (Altman 1999), and this growth is typical of other community art centres in northern Australia (Wright 1999).

Bombax ceiba

Bombax ceiba is a tall erect deciduous tree with distinctive woody thorns on the trunk and branches (Brock 1988). Within Australia, *B. ceiba* occurs mainly in wetter and fire protected sites, growing to 20 m tall with stems up to 100 cm diameter. The species is relatively common within coastal and riparian monsoon rainforest patches, and vine-thickets on rock outcrops in open woodland across the Top End of the Northern Territory, Western Australia and Queensland (Liddle et al. 1994, Brock 1988). Aboriginal people in the region use the tree *Bombax ceiba* for a range of purposes: the trunk for making canoes, the bark for making twine and the tap roots of young plants for food (Brock 1988). *Bombax ceiba* is also found in Papua New Guinea, South-east Asia, China, India, and the Indonesian Archipelago (Wightman and Andrews 1989). Despite the cultural and potential economic importance of *B. ceiba*, little baseline data exists on its ecology and population dynamics.

Specifically, this study attempts to estimate the population size and density of *Bombax ceiba* in the Maningrida region, document harvest practices and estimate harvest rates and their value. Direct field observations as well as analysis of sales of objects thought to contain the species were used to estimate harvest rates. A preliminary assessment of the sustainability of the current offtake is made. The current management of the species by the Aboriginal landowners is discussed for the Maningrida region and northern Australia more generally.

Regulatory issues

The *Territory Parks and Wildlife Conservation Act 2000* specifies that collectors taking native plant products for commerce must obtain a permit (Sections 55-57). If property in that wildlife is vested in the Territory (e.g. plants on public and leasehold land), they must also pay royalties (Section 116). Royalties have been specified for *B. ceiba* seed at \$10.00 kg^{-1} (*Territory Wildlife Regulations*), but not for whole plants or timber. On Aboriginal land, traditional owners wishing to use plants commercially also require a permit, but are not subject to royalties. Owners of Aboriginal or other freehold land may allow others to harvest from their lands under permits issued to the land owner. Many Aboriginal people do not seek or obtain permits to use timber taken from their own land for arts and crafts intended for sale. No particular attempt appears to have been made to enforce these provisions although the Parks and Wildlife commission has raised the issue with some arts centres.

Once taken under a valid permit, ownership of the harvested item passes to the permit holder. The Parks and Wildlife Commission requires no permit for movement of wild harvested native plants into other jurisdictions, but those jurisdictions may seek evidence that the material was obtained lawfully. Ongoing commercial use would ultimately be regulated through a management plan made under the *Territory Parks and Wildlife Conservation Act 2000*. The principal test to be satisfied in such a plan would be that use dependent on wild populations is clearly sustainable (Section 32). Legal provisions are similar in other States.

Bombax ceiba is not listed as threatened under relevant Territory, State or Federal legislation. The species is not listed under the Convention on International Trade in Endangered Species (CITES).

Objectives

The objectives of the project were to:

1. Measure availability of *Bombax ceiba* stems in the Maningrida region.
2. Determine contemporary usage of *B. ceiba* in the region.
3. Assess likely changes in demand for *B. ceiba* stems.
4. Analyse implications of these observations for status of *B. ceiba* in the region and the sustainability of arts and crafts production based on the species.

Methodology

Site description

The study was conducted over a four-week period during October and November 2000 in the Maningrida region (latitude 12.055 S, longitude 134.230 E), 500 km east of Darwin in north-central Arnhem, Australia (Figure 1). The study area encompasses approximately 5,000 km^2. The landscape is dominated by the Arnhem Land escarpment to the south, extensive wetland systems, and gently undulating lowland plains (Griffiths et al. 2000). The dominant vegetation type is *Eucalyptus* savanna, interspersed by extensive wetlands and monsoon rainforest patches that are most common in a coastal/subcoastal belt. The mean annual Maningrida rainfall is 1,245 mm, of which 92.6% falls between December and April inclusive (Maningrida Airport, Bureau Meteorology 2000). The Aboriginal population in the Maningrida region live in the main township of Maningrida or the 32 outstations (small cluster of dwellings with limited infrastructure) spread throughout the region.

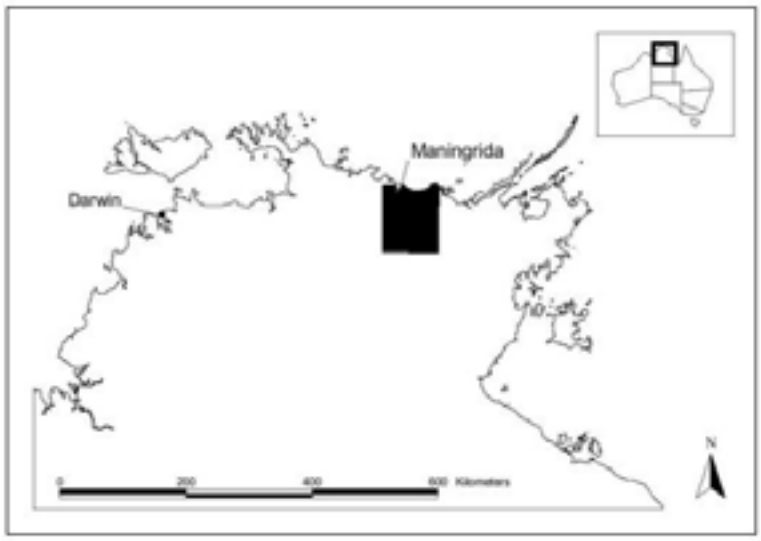

Figure 1: Location of the study area in north-central Arnhem Land

Field- based sampling of *Bombax ceiba*

Eighteen monsoon rainforest patches were sampled within a 62 km radius of Maningrida. Five main types of monsoon vine-thickets occur within the Maningrida region and have been classified in this study according to Russell-Smith (1991): coastal, floodplain, spring and riverine types occurring in lowland areas, and *Allosyncarpia* forests that occupy seasonally dry substrates in dissected sandstone terrain, notably the margins of the Arnhem Land escarpment. This project was restricted to the coastal and floodplain vine thickets, where the region's largest populations of *Bombax ceiba* are located. The size and location of each of the rainforest patches in the Maningrida region were mapped using aerial photography in the 1980's (Russell-Smith 1991). Additionally Russell-Smith (1991) thoroughly sampled the flora of 32 rainforest patches in the study area, and from these data we drew inferences about the distribution and abundance of *B. ceiba*. These data were used in combination with our new observations to estimate the total regional population *B. ceiba*.

At each patch, we sampled *B. ceiba* density and population structure using 10 m wide strip-transects, the initial starting point randomly selected and subsequent transects placed 50 m apart and running roughly parallel. Each transect was positioned to provide a cross-section through the entire rainforest patch, including ecotones, because *B. ceiba* commonly occurs in both the rainforest proper and ecotone habitats. Sampling intensity of rainforest patch area ranged from 0.6% in larger patches (e.g. 78 ha) to 33% in smaller patches (e.g. 0.5 ha), with an average intensity of 16%. Because transect length was influenced by the size and configuration of jungle patches, we used the ratio method (Caughley and Sinclair 1994) to calculate densities. Two measures of the density of *B. ceiba* were determined for each transect: total stems and number of adult trees (DBH >10 cm; A.D. Griffiths, unpublished data) by the transect area. Stem density and its variance was calculated separately for each patch from the patch's transect densities.

In each strip-transect, the stem diameter or diameter-at-breast height (DBH) of every individual *Bombax ceiba* was measured in cm using a diameter tape or forestry callipers, as well as the distance from the start of the transect (m). These data were recorded for all unharvested and harvested stems. In addition, evidence of regrowth of harvested stems was recorded as the number of coppiced stems and their DBH.

The patch-specific harvest rate of *Bombax ceiba* was estimated for each sampled rainforest patch as the proportion of stems cut from the total number of stems within all transects in that patch. The total regional population was calculated using the mean density of *B. ceiba*, the probability of occurrence of *B. ceiba* with a patch of a given type, and total area of rainforest within the study area (Russell-Smith 1992).

The availability (number and size within a 10 km radius) and distance of rainforest patches containing *B. ceiba* to outstation communities was calculated for each occupied outstation in the region and tabulated using Arcview® 3.2a (ESRI 1998). Due to the relatively large number of outstations many patches within 10 km buffers overlapped. The distance of harvested patches to the nearest outstation was measured as well. The relationship between the distance (km) of each patch to the nearest outstation and the harvest proportion (arcsine transformed) of total and adult populations was examined by Pearson correlation.

Value and size of *Bombax ceiba* harvest

The size and value of the harvest of *Bombax ceiba* was estimated using records of sales of wooden sculpture by Maningrida Arts and Culture between 1998 and 2000. In consultation with the some Aboriginal artists we sub-sampled the current stock (n = 70 carvings) in October 2000 to estimate the proportion of sculptures likely to be sourced from *B. ceiba*. The wood is distinctly lighter than most other species used in carvings, however some error is possible through confusion with other tree species.

To estimate the number of stems used, we have assumed that one carving was produced from each stem, as indicated by Aboriginal artists during interviews. Some wastage occurs (i.e. unused section of the stem being discarded) but this is quantitatively insignificant.

Results

Population size

Fourteen out of 18 surveyed vine-thicket patches (or 15% of total number of patches in the study area), contained *B. ceiba*. *Bombax ceiba* had been harvested in 10 patches. In one of these patches, harvested stems were only found outside the transects, elsewhere, nine transects contained harvested stems. The average density of *B. ceiba* from the 14 patches sampled was 105.1 (± 12.3) stems ha^{-1} (Table 1).

Table 1: Summary of field-based surveys of *Bombax ceiba* in monsoon thicket patches in the Maningrida region.

Patch	Density (± se)	Area of patch (ha^{-1})	Total harvest rate (%)	Adult harvest rate (%)	Sampling intensity (%)
1	135.0 ± 32.3	2.3	8	17	17.4
2	107.5 ± 12.5	60.1	10	11	0.7
3	208.1 ± 97.3	0.6	0	0	30.4
4	67.5 ± 18.9	42.0	0	0	1.0
5	44.0 ± 14.4	77.8	22	40	0.6
6	75.7 ± 56.4	1.7	0	0	26.9
7	59.1 ± 26.3	35.0	10	20	1.6
8	88.6 ± 52.7	1.1	0	0	32.7
9	183.3 ± 31.5	0.7	9	22	16.4
10	143.5 ± 53.4	0.8	0	0	26.3
11	159.5 ± 65.7	2.1	3	10	12.4
12	63.9 ± 21.9	2.7	12	67	21.7
13	133.3 ± 49.7	4.5	5	24	19.4
14	234.0 ± 45.8	1.0	5	60	27.4

Using existing spatial data from the Maningrida region, we estimate that rainforest patches in the study area cover a total area of 1215 ha, comprising 95 individual patches with a mean patch size of 12.8 ha. *Bombax ceiba* occurred in 60% of these rainforest patches in the study area (Russell-Smith 1991). Using these figures, we estimate the total population of *B. ceiba* in the Maningrida region as 76,615 (± 8,985 SE) stems. Adult density (trees DBH >10 cm) was estimated at a mean of 43.4 stems ha^{-1} or a regional population of 31,600 (± 3,841) stems.

Harvesting methods and rates

The basic technique employed by Aboriginal artists for harvesting *Bombax ceiba* involves either driving or walking to a rainforest patch, where a suitable stem is selected and felled by cutting approximately 50 cm from the ground using an axe (Figure 2). The trunk is the main part of the tree used for carving, smaller branches usually being discarded. The trunk is usually transported immediately to the artist's home (either a nearby outstation or Maningrida township). We did not attempt to document the number of stems cut per trip by artists, but anecdotal evidence suggest this is quite small (i.e. 1-5 stems).

Figure 2: Example of harvested *Bombax ceiba* showing multiple coppicing

A total of 54 harvested stems were recorded in our survey: 31 within transects and a further 23 outside transects. Observations suggest the majority of stems were harvested either from within the patch ecotone or less than 40 m into the patch. However, four stems were harvested 61-70 m and two trees were harvested 91 and 100 m from the jungle edge. The smallest and largest harvested *B. ceiba* had a stem diameter of 7 cm and 62 cm, respectively. For *B. ceiba* occurring within transects, the majority (83.3%) of harvested stems ranged in size between 10 and 40 cm (Figure 3). As a proportion of each size class, both the 20-30 cm and 30-40 cm size classes were the most heavily harvested.

Coppicing was recorded from 80% of all harvested *B. ceiba* stems (both within and outside transects). One tree was freshly cut the day before our survey and therefore had no opportunity for re-growth. Another two trees showed evidence of re-coppicing from a second harvest. The diameter of coppiced stems (re-growth from the original trunk) ranged from 0.5 cm (indicating a recent harvest) to 27 cm (indicating a greater time from harvest). The average diameter of the coppiced stems was 10.73 cm (± 2.35). Coppicing of harvested stems was clearly recognised by Aboriginal artists as an important feature of the tree they were using.

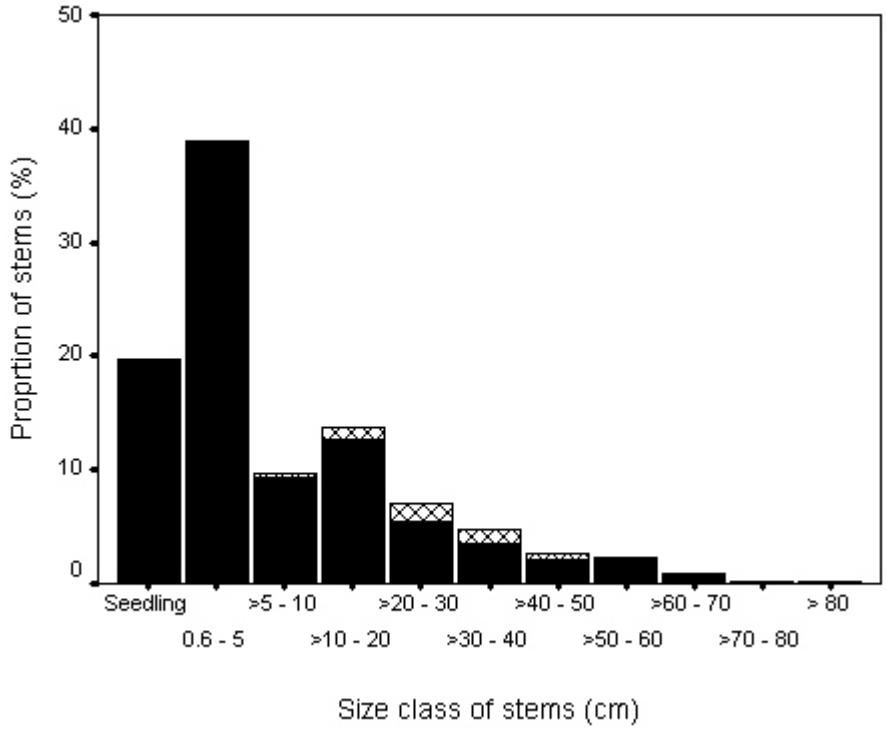

Figure 3: The frequency distribution of *Bombax ceiba* size classes of harvested (hatched) and unharvested (solid black) stems collected from within transects (n = 594)

Ten of 14 sampled patches had been harvested for *B. ceiba*. The proportion of the total population *B. ceiba* that had been harvested from transects ranged from 3 to 22%, or 10% to 67% of the adult population (> 10 cm DBH) (Table 1). Overall this represents a mean harvest rate of 6% and 19% for total and adult populations, respectively. All of the rainforest patches where *B. ceiba* was harvested were located within 10 km of outstations, and there was significant positive correlation between the distance to the nearest outstation and the proportion of harvested stems in transects (r^2= 0.56, P=0.03) (Figure 4). This may be taken to suggest that a greater proportion of harvesting is done distant from outstations, however the relatively small sample size and large number of potentially confounding factors limits the interpretation of this result.

All rainforest patches surveyed (n=18) and 91.93 % of remaining unsampled patches within the Maningrida region lie within a 10 km radius of at least one outstation. A large proportion of the 30 outstation communities have up to 10 patches within a 10 km radius and most of these occur close to the coastal and floodplain environments.

Using these data (regional population size, probability of occurrence in available rainforest patches and harvest rates) we were able to approximate the harvest of *Bombax ceiba* over the last 20 years in the Maningrida region. Using the estimated harvest rate of 6% for the total population we estimate 4,596 stems have been harvested. Using the adult population harvest rate of 19% generates an estimate of 6,008 stems harvested. We take these estimates to represent the cumulative harvest effort for carving wood since 1981, when the first carving was produced by Crusoe Kuningbal (now deceased) and sold by Maningrida Arts and Culture (Jon Altman pers. observation). The estimate will of course also include trees cut for other purposes (see introduction) but we take these uses to be quantitatively minor compared with the use for commercial art and crafts.

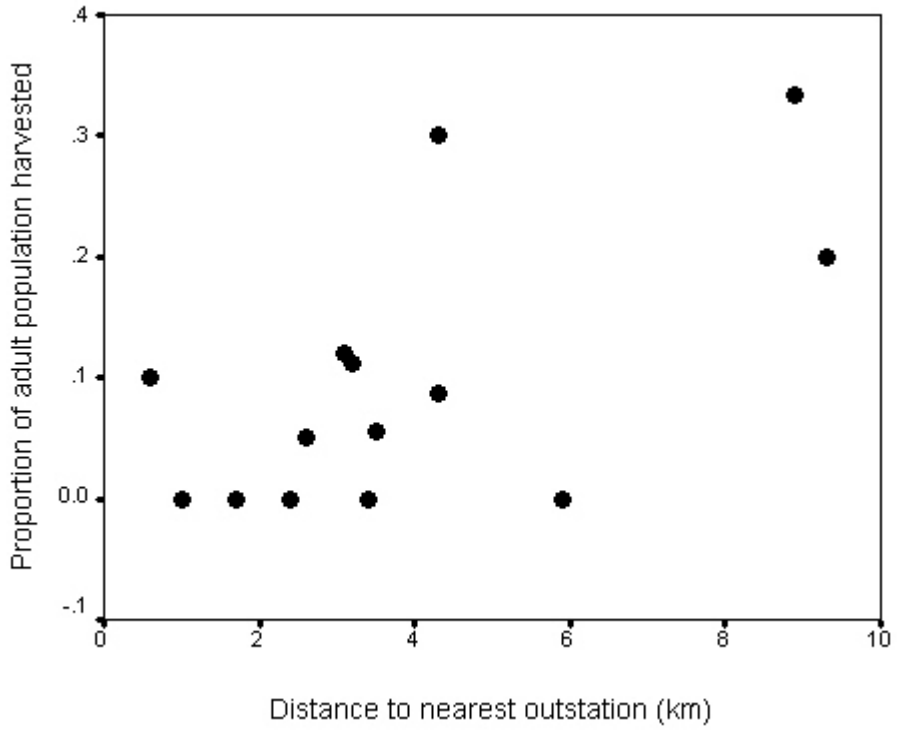

Figure 4: The relationship between the proportions of adult *Bombax ceiba* population that had been harvested in transects from each rainforest patch and the distance (km) to the nearest outstation

Size and value of harvest from sales figures

The sale of wooden sculptures accounts for a large proportion of items marketed by Maningrida Arts and Culture (MAC). In the 1998-99 financial year 466 sculptures were produced by Aboriginal artists, and this increased to 948 items in the following year (MAC 1999, 2000). These items sold for a net profit of AU$63,413 and AU$175,097 in 1998-99 and 1999-2000 financial years, respectively. Average sale price was approximately $260 per sculpture and markets included major Australian galleries, small galleries and tourist shops, local sales and public institutions and private collectors. To estimate the number of *Bombax ceiba* used from sales figures we have used a ratio of 1:1 for stems to sculptures produced. Interviews with Aboriginal artists suggested that they usually produced one carving per stem. Some wastage may occur (i.e. discard of whole stems) but this is unlikely to be significant. Preliminary assessment of stock held at MAC gallery in October 2000 suggests at least 50% is likely to be sourced from *B. ceiba*. Using these data, the number of *B. ceiba* harvested in 1998-99 financial year can be estimated to be about 210 stems, and 474 in the 1999-2000 financial year. These estimates represent 0.6 and 1.8% of total adult stems in the Maningrida region for both financial years, respectively.

Validating the harvest estimates

With this information on current and past production from sales figures, we are in a position to attempt another estimate of the cumulative harvest over the last 20 years, independent of the field-based estimates of cumulative harvest to this level. We derived an estimate of present annual turnover from the mean of the last three years and assumed a linear rise from a base of that harvested in 1980.

We then used this simple model to predict the total production of *B. ceiba* between 1980 and 2001. This resulted in an estimate of a cumulative total harvest of *Bombax ceiba* stems of 5,004. This figure lies between the two field-based estimates, increasing confidence that a working estimate of about 3000-6000 stems harvested since 1981 as being reasonably robust. However, we would caution against use of a linear model to predict future use because there have been some marked recent increases in total incomes from sales. A more comprehensive analysis of sales figures is currently being developed.

Discussion

Population size and current harvest

The results of this study have a demonstrated a number of important points relating to the wild harvest of the rainforest tree *Bombax ceiba*. The first relates to relatively high level of usage of *B. ceiba* by Aboriginal artists throughout the Maningrida region. Few studies in Australia have documented the size of wild harvest of native species by Aboriginal people, and we have shown both a widely distributed and, in places, relatively high level of harvest of this tree.

The second point relates to the importance of this harvest to the economy of Maningrida. That contribution to the incomes and social status of the local people also appears to be sustainable. The harvest in the 2000-2001 financial year represents 1.8% of the adult population. Without any replacement, the existing rate of harvest could be sustained for at least a further 60 years. However, the capacity of the majority of *Bombax ceiba* to coppice following harvest (80% of cut trees) means that a much smaller proportion of the standing adult population is actually lost from the regional population each year. We observed re-coppicing trees that had produced new stems suitable for use, apparently in less than 20 years.

Nonetheless, the management of *B. ceiba* in individual patches may still be an issue when harvest rates are relatively higher, and artists and landowners need to aware of the implications of over-harvesting in the particular patches they depend on. We will be working with land owners to better understand the dynamics of the *B. ceiba* population and to provide tools for ongoing assessment of the status of this resource.

Monitoring

We have shown here that the population of *Bombax ceiba* is capable of sustaining harvest at existing rates well into the future. However, the status of populations and their management does need to be monitored because future demand, based on trends in sales figures, is likely to increase. In conjunction with the project team, the management group of Maningrida Arts and Culture has implemented a program to monitor future harvests. This scheme seeks to document use of *B. ceiba* by working with artists presenting new sculptures to identify the species used. This program also aims to document harvest of at least 12 other native species that are utilised at varying levels for sculpture (Philips 2001).

Monitoring in Aboriginal communities can also occur independent of such structured schemes by also acknowledging the role of senior custodians of land and resources. The abundance and health of large *B. ceiba* are actively monitored by the custodians of traditional land. David Angaraidja (Traditional Owner, Ji-benna outstation) expresses the connection and responsibility felt for *B. ceiba* on his lands:

> "Bulamana (*Bombax ceiba*) tree is like family. The young one grows and is looked after by parent tree. They grow in a group, together. If person wants to cut tree for carving or canoe, they must ask me first. I look after the land and the Bulamana."

Other issues relating to sustainability

The economic success of the sculpture industry is chiefly dependent on a continuing and accessible supply of high quality wood. Nonetheless, some post-harvest issues could also have substantial impact on the economic viability of this production sector. Stock loss is common owing to insect pests and splitting resulting from poor choice of species and inadequate curing. The tropical environment at Maningrida is conducive to wood borer and up to $20,000 of stock was lost during 1998/9 from this pest alone. While preliminary research by Philips (2001) has provided a range of strategies to address the borer issue, significant further research is needed to advise community art centres about the most durable and otherwise appropriate wood species for sculpture.

Indigenous arts production utilises many skills that are highly valued within the community as well as by the market. The carving market is relatively new with the first carving being sold at Maningrida in 1980 and demand for such items increasing rapidly in recent years. Given the growth of sculpture sales in the past decade and the very rapid growth more recently, it remains unclear whether there are established Indigenous processes able to ensure sustainable use of native species in face of growing market pressures.

It is important to recognise that the arts industry as currently constituted, as part of a hybrid domestic economy, is one of the few areas where Aboriginal people demonstrate a clear comparative advantage and where there has been sustained participation by several generations. It is likely that the growth of this industry will generate benefits to Australia, both directly in terms of welfare dollars that might be saved (an opportunity cost argument) and less directly in terms of the social and cultural benefits to Aboriginal communities of having a vibrant arts industry.

There is enormous national and international interest in the Aboriginal arts industry, yet there may also be some consumer resistance to arts product if there was any suggestion that harvesting was placing some species at risk. The marketing of Aboriginal art has generated significant positive externalities (spin-off benefits) to the Australian and Northern Territory tourism industries. Focused efforts to ensure sustainability of resource use associated with the arts is important to also sustain the considerable economic and cultural benefits for Australia (Altman 2003).

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Appendix 3.6: Case Study 6: Miscellaneous

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Introduction

In addition to the plant products detailed in the five previous case studies a number of other possibilities either ranked well or suggested by Aboriginal participants. These included fruit of *Syzygium* spp. (bush apples), leaves of *Piliostigma malabaricum*, flowers of the native kapok *Cochlospermum fraseri,* the wild plum (*Grewia asiatica*), and bush tea leaf (*Ocimum tenuiflorum*). These were not pursued comprehensively, but in the case of the wild plum and bush tea, some information was gathered on harvest effort (albeit limited) and participants developed proposals for their use in trade associated with tourism. These are reported here for the sake of completeness.

Background

Wild plum (*Grewia asiatica*)

Grewia asiatica (Tiliaceae) is a non-native shrub that grows to about 3 m. It is thought to have been introduced by Chinese miners during the 19th Century, and consequently has no MalakMalak or Matngala name (Lindsay et al 2001). It is found in Darwin, Arnhem Land and the Melville Islands (Brock 1988) and it is very common in some areas around the Daly River, especially Wooliana (Lindsay et al 2001).

It occurs in coastal monsoon vine thickets, on stabilised dunes or low laterite cliffs above beaches, open forest on sandy lateritic soil; and in drier vine thickets on sandstone hills (Brock 1988). The flowers are yellowish and about 1 cm in diameter with numerous stamens. The fruit is reddish-black when ripe, 1-4 lobed, globular and 0.8-1.3 cm in diameter and occurs in clusters. Flowering occurs from September until January and fruiting from October until January.

Our *a priori* selections of plants that may offer opportunities to Aboriginal communities (Appendix 1) include a relatively low ranking for *Grewia asiatica* (17), based primarily on the fact that harvest seemed likely to be labour intensive and demand and price were unpredictable. The ranking was based on wild harvest and the supply of significant quantities of raw product as the target. We did not consider the prospect of using the item as an adjunct to tourist ventures.

Although introduced and obviously less deeply associated with Aboriginal culture than native species, the wild plum is well-regarded by Aboriginal children in and around the Daly River region, and has consequently entered customary use.

Bush tea leaf (*Ocimum tenuiflorum*)

Ocimum tenuiflorum (Lamiaceae) is a herb or small shrub to 80 cm high. The opposite leaves are narrowly ovate to 4 cm long and 1 cm wide. When crushed they have a strong aniseed smell. The small pink or pale purple flowers are borne on spikes at the tips of the stems and branches. The fruit are papery, brown capsules to 1 cm in diameter, containing 3-6 small black seeds. *Ocimum* species are well known in non-Indigenous society as Basil, and another common name for *Ocimum tenuiflorum* is native basil.

Bush tea occurs in creek-lines and drainage depressions, often with native bauhinia and Gutta-percha trees. It is distributed in the southern inland of the Top End of the Northern Territory from about Katherine to Elliott. It also occurs in Western Australia, Queensland and south-east Asia (Darwin Herbarium records).

Aboriginal people in other parts of the Top End also use this species to make bush tea, and consider it to have strong medicinal qualities for the treatment of colds and congestion.

Very limited wild harvest trials were done in the Timber Creek area with Wardaman people, who are the Traditional Owners of that country. Yarlarrg is the Wardaman name for *Ocimum tenuiflorum*.

Our *a priori* selections of plants that may offer opportunities to Aboriginal communities (Appendix 1) include a relatively high ranking for *Ocimum tenuiflorum*, based on the cultural connection, ease of collection, and ease of post-harvest handling and storage.

Regulatory issues

Grewia asiatica is an exotic plant and therefore its use is effectively unregulated from a conservation or land management perspective. Use of *Ocimum tenuiflorum* as a native species is subject to relevant statutes.

The *Territory Parks and Wildlife Conservation Act 2000* specifies that collectors taking native plant products for commerce must do so under permit (Sections 55-57). If property in that wildlife is vested in the Territory (e.g. plants on public and leasehold land), they must also pay royalties (Section 116). No royalty is presently specified for *Ocimum tenuiflorum* or its parts under the *Territory Wildlife Regulations*. The Minister for Parks and Wildlife may, however, declare a royalty on any wildlife (including plants) taken under a permit. Given the range of items for which royalties have been fixed in regulations, it seems likely that royalties would be levied on *Ocimum* taken from public land, should significant commercial usage develop.

On Aboriginal land, traditional owners wishing to use plants commercially also require a permit, but are not subject to royalties. Owners of Aboriginal or other freehold land may allow others to harvest from their lands under permits issued to the land owner (often a land trust).

Once taken under a valid permit, ownership of the harvested item passes to the permit holder. The Parks and Wildlife Commission requires no permit for movement of wild harvested native plants into other jurisdictions, but those jurisdictions may seek evidence that the material was obtained lawfully. Ongoing commercial use would ultimately be regulated through a management plan made under the *Territory Parks and Wildlife Conservation Act 2000*. The principal test to be satisfied in such a plan would be that use dependent on wild populations is clearly sustainable (Section 32). Legal provisions are similar in other States.

Ocimum tenuiflorum is not listed as threatened under relevant Territory, State or Federal legislation. The species is not listed under the Convention on International Trade in Endangered Species (CITES).

Movement of plants in the Northern Territory is subject to the provisions of the *Plant Diseases Control Act 2000*. At the time of writing there were no special provisions in place. However, other State and Territory jurisdictions may impose an array of requirements for the transport of plants across their borders, which may be varied from time to time. Harvesters in the Northern Territory wishing to supply interstate markets should seek advice from the Department of Business, Industry and Regional Development about requirements.

Objectives

Objectives of the trial harvest were to:

1. Determine the effort required to harvest fruits and leaf at favourable sites.
2. Estimate costs of collection, including transport and handling.
3. Relate costs and effort incurred in harvest and handling to wholesale (raw product) and retail prices (value added product).

Methods

Distribution and Abundance

Grewia asiatica

We are yet to estimate abundance of *Grewia asiatica* on MalakMalak country. There are at least 3 large patches (approximately 2 ha) that women of the Daly River community use regularly.

Ocimum tenuiflorum

Within its NT range (between Katherine and Elliot), this species appears to favour black soils, often being found along creek-lines and in drainage depressions. Patches harvested were on pastoral leases, and plants also appeared to be most common where there was evidence of soil disturbance. Although the general distribution of this plant is well understood, there have been no measures of abundance.

Harvest process

Sites suitable for harvest were chosen by traditional owners. The criteria they used included the potential for substantial harvest, and use of areas which would raise no cultural issues regarding the presence of non-Aboriginal observers and extraction of the leaf for commerce.

Grewia asiatica

Our wild harvest was restricted to the dry season of 2000. Four women took part: Molly Akanburru, Mercia Wawul, Patricia Marrfurra and Kitty Kamarrama.

The wild plum shrubs were mostly less than 3 m tall, so harvesters took accessible ripe fruit without use of ladders or other implements. Shrubs were close to each other, so little time was used in within-patch travel of search.

Both the trial harvests for the *Grewia* were done at patches within 20 km of the Nauiyu Community. The trial harvests took place at the end of the dry season in November and December. It appeared that this was somewhat later than the time of peak fruit availability.

Ocimum tenuiflorum

The sites of harvest were chosen by the Wardaman people and were on land that is leased for grazing. The herb is ready to pick towards the end of the wet season until the middle of the dry season. In areas that are grazed this plant will be consumed by cattle as the more succulent grasses disappear.

Three Aboriginal ladies took part in the harvests: Jessie Brown, Lily Gin.gina and Queenie Morgan. The harvest process was simply a matter walking among the low plants plucking green foliage. Once at a patch, there was little time required to search or travel between plants.

Post harvest treatment

A number of dehydrating treatments were examined in a very superficial way to look at the potential to extend the life of *Grewia asiatica* fruit before obvious deterioration occurred. These included sun drying and oven drying, and vacuum packaging. Sun drying was done by leaving fruit exposed on racks (one layer or more) for 2-3 days during the late dry season. Oven drying was done in a Thermoline dehydrating oven at the Darwin Herbarium. The vacuum packaging machine used was a small domestic Foodsaver (by Tilia) Compact II which had a teflon-coated heat seal bar for creating a strong, wide seal on the VacLoc bags.

In addition, representatives of the Merrepen Arts Centre and local women collaborated with the project team to design a pamphlet to accompany *Grewia asiatica* fruit. They wrote a brief description of use and significance and chose designs and other images to accompany the text.

The *Ocimum tenuiflorum* was similarly sun dried or dried in the dehydrating oven at the Darwin Herbarium.

Markets

Bushfood wholesalers

Robins Australian Foods already use *Ocimum tenuiflorum* in one of their products as a flavouring and refer to it as native thyme. Samples of dried *Grewia asiatica* were supplied to Australian Gourmet Wildfoods (Rob Cross) who indicated some interest, but we gained no information on potential price.

Retailer and consumer interest

To examine potential consumer demand for some bushfood products we compiled a simple questionnaire to get some measure of public opinion. Questionnaires were distributed to visitors at two Top End events, the Merrepen Arts Festival, which is held annually in the Nauiyu Community at Daly River (in June), and the Gardens Fair which is also an annual event and is held at the Darwin Botanic Gardens (in August).

At each event the intent of the project was briefly explained and samples of wild bush food were offered. At the Merrepen Arts Festival, samples of *Nelumbo nucifera* (lotus lily) and *Grewia asiatica* (bush plum) were supplied as examples while at the Botanic Gardens Fair samples of *Ocimum tenuiflorum* (native basil tea), *Grewia asiatica* and *Boab adamsonia* were available.

Drafts of information pamphlets designed by the community for *Nelumbo nucifera*, *Grewia asiatica* and *Vitex glabrata* were shown as examples to gauge interest in the concept and the content. Pamphlets were packed with a small sample of the native bushfood product which had been sun dried and vacuum packed as well as some cultural, geographic and botanical information.

Results

Harvest

Grewia asiatica

The average rate of harvest of *Grewia asiatica* fruit during these two trial harvests was 0.40 kg h^{-1} wet weight and 0.21 kg h^{-1} dry weight (Table 1). It must be stressed that both of these trials were done outside the peak period of fruiting and therefore this harvest rate is lower than achievable under optimal conditions.

Table 1: Wild harvests of *Grewia asiatica* at 2 sites in the Daly River area. The sites were approximately 25 and 10 minutes travelling time from the harvesters' settlement. Harvest rate calculations exclude travelling time.

	Date	Distance travelled (km)	Collection time (min)	Wet (dry) weight of fruit (kg)	No. collecting	Fruit collected p.p. kg h^{-1}-wet (dry) weight
Site 1	21-Nov -00	20	60	1.59 (0.87)	4	0.4 (0.22)
Site 2	07- Dec -00	10	15	0.4 (0.2)	4	0.4 (0.2)

Ocimum tenuiflorum

The average rate of harvest of *Ocimum tenuiflorum* during these two collections was 0.109 kg h^{-1} dry weight which is 0.315 kg h^{-1} wet weight (Table 2). It must be stressed that this collection took place near the end of the growing season. Additional trials should be done through the full length of the growing season of this species before we can make judgements about potential returns from wild harvest.

Table 2: Wild harvests of *Ocimum tenuiflorum* at 2 sites by the Wardaman people at Timber Creek. Calculations of harvest rate exclude travelling time.

	Date	Wet (dry) weight (kg)	Harvest Time (min)	No. collecting	Rate of harvest by wet (dry) weight (kg h^{-1})
Site 1	31-Apr-01	0.203 (0.07)	25.2	2	0.242 (0.085)
Site 2	31-Apr-01	0.580 (0.20)	30	3	0.387 (0.133)

Post-harvest treatment

Both items are proposed for use as an adjuncts to tourist interest. Both would be packed with information on the use of the item by Aboriginal people. In the case of *Grewia asiatica* there would also be discussion of the unusual history of this plant and its association with Chinese miners who also made important contributions to north Australian society.

Each *Grewia* sample would consist of approximately 10 grams of dried fruit, so 500 tourist packs (the estimated annual demand) would require approximately 9.5 kg of fresh fruit. At a rate 0.40 kg h^{-1} this would take a total of 23.8 hours to collect.

With 10 grams of dried *Ocimum* in a tourist pack (tea bags contain on average 2 gm), a total of about 14.6 kg of (wet) leaf would be required for 500 samples. This amount of material would require about 46 h of wild harvest.

Markets

Consumer reaction to taste of dried *Grewia* at the venues where we made the product available was generally positive, although we neither sought nor gained information on willingness to pay. As was reported for other items such as *Nelumbo* seed (see Appendix 3.3: Case Study 3), many consumers considered that $10 was a reasonable price for a small sample packed as a novelty and accompanied by printed information.

Ocimum tenuiflorum is currently being used by some of the gourmet food wholesalers. According to surveys done in 2001 there may be local demand for 50 -100 kg per annum at $100 kg^{-1} (see Whitehead et al. 2001). We assumed that a sample sufficient to make “tea” for several people would attract a price of $10 when packed with information about the origin of the product and its cultural significance.

Discussion

Both of these items were identified as novelties that could be offered to tourists to enhance their experience of northern Australia. As a consequence demand is uncertain but would certainly be lower than if attempts were made to supply as foods for more general consumption, but returns are likely to be greater because supplemented by provision of information on the plants and their use.

In other cases we have emphasised the connection with Aboriginal culture as a dominant source of potential interest. In both of these instances, the potential appeal is somewhat different.

Grewia asiatica, as an introduced plant, has a lesser association with Aboriginal culture, but is linked to another culture important in north Australian history. Chinese attracted by gold mining and their descendants continue to be influential in north Australian society. The information provided with samples of the plum will highlight that historical link.

In the case of the native basil *Ocimum tenuiflorum*, the link with Aboriginal people is long and significant, but in addition, plants of this type are familiar to wider national and international audiences. The conjunction of long established Aboriginal customary use and use of related plants as a food seasoning appears likely to be attractive. The proposal to offer sufficient product to allow preparation of a “billy” of bush tea links well with the sorts of opportunities and experiences that appear to attract many tourists to northern Australia.

Wild plum

Ecological sustainability

Although the wild plum is not a native species, it has been naturalised long enough to be adopted into the region's customary economy. The species does not appear to be particularly invasive, so there is no particular argument to favour its elimination from the landscape.

Although we lack quantitative information about abundance, it is highly unlikely that wild harvest of the type we are proposing would affect the recruitment of new individuals or significantly constrain its further spread. There is a risk that purchasers discarding seeds might encourage additional dispersal of the species to new sites, which would be unwelcome in many quarters. Materials distributed with the item should highlight the need to dispose of seeds in ways that will not promote establishment of new populations.

We consider approaches to harvest management to reduce risks of local over-harvest of patchily distributed resources in more detail in the main report.

Economic sustainability

Supply of raw product

Wild harvest in bulk to supply markets is likely to be unrewarding in financial terms. At a rate of harvest of 0.21 kg h^{-1} for the dried wild plum fruit, prices exceeding \$50 kg^{-1} would be necessary to provide a net return of \$10 h^{-1}. Such prices are unrealistic. Maintaining a bulk supply might also present challenges given limited distribution and modest abundance where it does occur. If supplemental planting were to be attempted to maintain supply, such effort might be better devoted to native species that are unlikely to present weed problems in the future.

Tourist Pack

Grewia asiatica is one of a number of items that local people at Nauiyu consider could be packaged with information about customary use and significance. A very simple analysis of costs and returns from a modest supplement to the local Art Centre offerings for the tourist trade is illustrated in Table 3.

The Merrepen Arts and Culture Centre sells painting, carvings and other artefacts made by Aboriginal people from the Daly River region and surrounds. The Centre attracts approximately 800 visitors spread throughout the dry season and about 1500 additional visitors come to the annual Merrepen Arts Festival. We estimated, based on advice from the Arts Centre management in regard to tourist interests and buying patterns, that about 500 samples of wild plum could be sold. The Arts Centre has suggested that they would sell the bushfood products and handle funds for those providing them for 10% of gross income.

This simple costing indicates a return of somewhere in the region of \$64 h^{-1} for wild harvest and value adding of this plant product. The actual wild harvest, drying, vacuum packing and packaging of this product could take place over about a week or slightly longer. The seasonal, short term nature of such projects are attractive to the women in the Nauiyu Community because they can be matched to other related activity and also allow time for cultural and other social obligations.

Table 3: Breakdown of costs associated with wild harvest and packaging of *Grewia asiatica* at Nauiyu, Daly River. Sales at the Merrepen Arts Centre of 500 units p.a., each containing 10 g of dried seeds is assumed. This will require collection of 9.5 kg of fruit (wet weight).

Setup costs	**Number**	**Unit Price ($)**	**Total ($)**
Collection bags	10	4	40
Vacuum Packaging Machine	1	275	275
Sun Dryers	2	50	100
Pamphlet design and layout			522
Total			937
Assume replacement over 3 years			312 pa
Operating costs			
Vacuum packaging bags	3 rolls	12.33	37
Zip lock bags	500	0.17	83.50
Printing pamphlets	500	0.99	495
Colour film and dye			112.50
Transport to and from harvest site			12
Total - annual production of 500 items			740
Estimated gross annual income			
500 @ $10 each			5,000
Estimated net annual income			
		10% commission to Arts Centre	-500
		depreciation of equipment	-312
		production costs	-740
Earnings			$3448
Estimated labour requirements			
		23.8 h collection and extraction	
		30.0 h drying and packaging	
		Average return per hour	**approx $64**

Wild basil

Wild basil was ranked high in our initial appraisal based on its cultural connection, ease of harvest and ease of preparation. Although our assessment is very preliminary, and we need more quantitative information on density and distribution as well as more trials of wild harvest, it seems likely that there may be some potential for wild harvest and processing of this plant product.

Aboriginal people in many parts of the Top End use this species to make bush tea, and consider it to have strong medicinal qualities for the treatment of colds and congestion. The leaves contain eugonol and other alkaloids that are apparently beneficial in the treatment of these symptoms.

Ecological sustainability

This species has a patchy distribution, but is abundant in favourable sites. During the trial harvest we gained the impression that it was doing well in areas disturbed by cattle. In these habitats we believe that the plant behaves as an annual, and as we are not removing seeds, harvesting a modest proportion of the leaf mass is likely to have relatively little impact on the dynamics of populations. More aggressive harvesting involving the cutting of stems, particularly if done before flowering and seeding, could have a substantial effect.

It is probable that the species could be readily cultivated (as it is overseas) if the demand was found to be substantial.

Economic sustainability

Supply of raw product

Wild harvest in bulk to supply markets of the dried leaf may provide returns that justify the harvest and handling effort. At a rate of harvest of 0.109 kg h^{-1}, and price at about \$100 kg^{-1} (dried), gross returns of over \$10 h^{-1} are possible. However, given the relatively patchy distribution of the plant, local overharvest at accessible sites is probable and returns will fall substantially if harvesters need to travel significant distances.

Tourist Pack

Ocimum tenuiflorum is one of a number of items that local Wardaman people consider could be packaged with information about customary use and significance. A very crude estimate of costs and returns to provide a modest income from sales of such items, perhaps from Gregory National Park, is illustrated in Table 4.

The opportunity represented by packaging of wild plum and wild basil for tourists is clearly a very modest one, each product achieving gross returns of only a few thousand dollars annually. However, these species, like many others, provide opportunities during different parts of the calendar. In combination with other initiatives, they could be of significant cumulative benefit to small groups in the community that has expressed interest.

Table 4: Breakdown of costs associated with wild harvest and packaging of *Ocimum tenuiflorum* 500 units p.a., each containing 3 g of dried leaf is assumed. This will require collection of 15 kg (dry weight) and 43.5 kg (wet weight) of leaf.

Setup costs	**Number**	**Unit Price ($)**	**Total ($)**
Collection bags	10	4	40
Vacuum Packaging Machine	1	275	275
Sun Dryers	2	50	100
Pamphlet design and layout			522
Total			937
Assume replacement over 3 years			312 pa
Operating costs			
Vacuum packaging bags	3 rolls	12.33	37
Zip lock bags	500	0.17	83.50
Printing pamphlets	500	0.99	495
Colour film and dye			112.50
Transport to and from harvest site			12
Total - annual production of 500 items			740
Estimated gross annual income			
500 @ $10 each			5,000
Estimated net annual income			
	10% commission to Arts Centre		-500
	depreciation of equipment		-312
	production costs		-740
Earnings			$3448
Estimated labour requirements			
	46 h collection and extraction		
	30.0 h drying and packaging		
	Average return per hour		**$45.37**

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Appendix 3.7: Case Study 7: Didjeridus

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Introduction

Our *a priori* ranking of the potential for commercial use the tree *Eucalyptus phoenicea* was among the highest, based on established patterns of use by Aboriginal people and the existence of substantial and apparently robust markets. We became engaged in study of this species through the Jawoyn Association, who were concerned that patterns of harvest for didjeridu were shifting from the customary towards the unsustainable non-customary. This brief report summarises more extensive ongoing studies (e.g. Forner 1999) that are funded predominantly from other sources. We include that work here because we consider that the use of this species provides a particularly compelling example of the difficulties facing Aboriginal entrepreneurs and suppliers of product when their initiatives are not protected by regulatory or market-based strategies to inhibit intrusion of non-Indigenous competitors.

Background

The didjeridu is a distinctive wind instrument used by Aboriginal people in a variety of spiritual and secular situations. The instrument's geographic origins are described by Moyle (1981) as north of the "Broome-Ingham Line", which delineates roughly the Northern third of Australia, including the Kimberley region in Western Australia, the Arnhem Land region in the Northern Territory and the Cape York region of Queensland. It is only in recent history (the last century) that the didjeridu's use has spread to Aboriginal groups in Central and Southern Australia (Horton 1994, Nuenfeldt 1997).

The instrument's wider uses may have evolved from an origin as an emu decoy, the instrument's characteristic drone being used to attract emu's and other large birds, in much the same way as contemporary hunters use a duck whistle (Moyle 1981). Today the didjeridu is played, often accompanied by singers and clap-sticks (lengths of wood struck together to produce a 'clap'), in ceremonies such as funerals and corroborees, or in other secular or recreational situations.

There are many Aboriginal names for the instrument in different language groups. However the most common terminology used today, "didjeridu" or "didgeridoo", is non-Aboriginal. This word is believed to have been derived from the sound that the instrument produces when played.

Traditionally the didjeridu is made from termite-hollowed branches or stems of eucalypts, or sometimes from bamboo. There are also differences in production methods between different Aboriginal groups, including species used and the characteristics of stems chosen. This report examines the Jawoyn form of the didjeridu and focuses on instruments made from *Eucalyptus phoenicea*.

Eucalyptus phoenicea (scarlet gum) is a small tree to around 12 metres with a slender trunk. Bark is yellow to yellow-brown, flecked, flaky and fibrous on the trunk, smooth and white or cream on upper branches. Trees are often multi-stemmed. The adult leaves are lance-shaped with a long thin point, grey-green, 8-12 x 1.2-2 cm and have a flattened stalk. The bright orange flowers are borne in spherical heads of 12 to 20 flowers. Flowering is extended over a substantial period and a wide range of birds and insects find the flowers attractive. In the inland Top End, the species is abundant on rocky hills and other well-drained sites with often skeletal soils (Dunlop et al. 1995).

In common with many other eucalypt species in northern Australia, a large proportion of stems are piped by termites (Braithwaite et al. 1985). Forner (1999) found that more than 90% of stems were hollow in the Yinberrie Hills area. Abundant hollow stems, that are often of the dimensions required for didjeridu, provide particularly favourable conditions for harvest for didjeridu fabrication. Both customary harvests and legal and illegal commercial harvest occur in the region (Forner 1999).

Regulatory issues

The *Territory Parks and Wildlife Conservation Act 2000* specifies that collectors taking native plant products for commerce must do so under permit (Sections 55-57). If property in that wildlife is vested in the Territory (e.g. plants on public and leasehold land), they must also pay royalties (Section 116). No royalty is presently specified for *Eucalyptus phoenicea* or its parts under the *Territory Wildlife Regulations*. However, the regulations specify a generic royalty of $1 per "stick" (of any species) taken for "didgeridoo".

On Aboriginal land, traditional owners wishing to use plants commercially also require a permit, but are not subject to royalties. Owners of Aboriginal or other freehold land may allow others to harvest from their lands under permits issued to the land owner (often a land trust).

Once taken under a valid permit, ownership of the harvested item passes to the permit holder. The Parks and Wildlife Commission requires no permit for movement of wild harvested native plants into other jurisdictions, but those jurisdictions may seek evidence that the material was obtained lawfully. Ongoing commercial use would ultimately be regulated through a management plan made under the *Territory Parks and Wildlife Conservation Act 2000*. The principal test to be satisfied in such a plan would be that use dependent on wild populations is clearly sustainable (Section 32). Legal provisions are similar in other States.

Eucalyptus phoenicea is not listed as threatened under relevant Territory, State or Federal legislation. The species is not listed under the Convention on International Trade in Endangered Species (CITES). Regulations under the *Environmental Protection and Biodiversity Conservation Act 1999* specify that any object made from bark, wood or timber is exempt from permit requirements for export from Australia. Thus international purchasers of didjeridus may take their instruments home without impediment and manufacturers may export without needing to demonstrate to Federal authorities that their operations are sustainable. Reliance is placed on State controls.

Movement of plants in the Northern Territory is subject to the provisions of the *Plant Diseases Control Act 2000*. At the time of writing there were no special provisions in place regarding movement of timber products. However, other State and Territory jurisdictions may impose an array of requirements for the transport of plants across their borders, which may be varied from time to time. Harvesters in the Northern Territory wishing to supply interstate markets should seek advice from the Department of Business, Industry and Regional Development about requirements.

Objectives

Objectives of this and related studies were to:

1. Determine the features of stems harvested for didjeridu on Jawoyn lands.
2. Determine the availability of the resource on some Jawoyn lands.
3. Establish arrangements for monitoring of impacts and propose improved management regimes for sustainable harvest for didjeridu.

Methods

Distribution and Abundance

Methods for this component of the study are described in full in Forner (1999). The site was the Yinberrie Hills region of the Northern Territory. The Yinberrie Hills are bounded by the Fergusson River to the north and the Edith River to the south, and occupy approximately 1,000 km^2. The landscape is dominated by rolling and undulating hills and a complex drainage network of mostly ephemeral or seasonal creek lines. The surface is comprised of skeletal sandy soils and angular rocks and cobbles up to a meter in diameter (Bowman et al. 1991).

A vegetation map was prepared using a combination of remote sensing and thematic coverages of geology and topography. Quadrats were placed at equal intervals along randomly placed transects intersecting the various vegetation types. Within each quadrat of 20 x 20 m, all woody stems above 2 m were measured (height and circumference at breast height) and a full list of all woody species present was made. Environmental descriptions included estimates of grass cover, soil type and an index of rockiness. Slope and aspect were also recorded.

The floristic and structural data were used to validate and refine the classification. Vegetation maps were in turn used to extrapolate variation in density and total abundance of stems across the landscape.

Harvest process

A few observations of customary harvest were made as an element of Forner's (1999) study. In addition, a few non-Indigenous commercial harvesters were interviewed. Features of harvest were also inferred from observations of cut stems located during floristic and environmental surveys.

More systematic observations of customary harvest were made during subsequent work to establish experimental harvest sites in the region. These observations involved craftsmen from the Barunga, Beswick and Manyallaluk communities, who chose the study sites and conducted the harvest. Eight sites were selected (3 at Beswick, 2 at Manyallaluk and 3 at Barunga). At each site a 1 ha plot was delineated and all trees were tagged. Each plot had a paired control of the same size.

In establishing the experimental plots, stems were cut on the basis of customary criteria as well as following less discriminating commercial practice. The availability of suitable limbs on each tree was assessed on the criteria that experienced observers considered were applied by non-customary commercial harvesters (basically the removal of all stems of approximately appropriate diameter with some evidence of a hollow). Features of customary selections were recorded separately from the non-customary harvest.

In the course of this work, Jawoyn craftsmen provided information on the important features of didjeridu sticks that influenced their choice and methods of harvest, and contrasted this with what they knew of commercial harvest. Observations were made on methods of search for suitable trees, the time devoted to the selection process, the methods used to conduct the harvest and the resulting yields. Discussions regarding the "ideal" characteristics of a didjeridu were also recorded.

For each harvested limb the length, diameter at both ends and hollow diameter at both ends was measured and a count of imperfections (cracks, holes) was made. The limb's shape was also categorised into one of the following classes, ranked in order of complexity of shape:

1. Straight (little or no bend)
2. Slight bend ($<10^o$)
3. Distinct bend ($>10^o$)
4. Multiple bends (more than one significant bend)
5. Sharp bends or branched.

Markets

We did not examine markets. Rather, the focus was on understanding the capacity to service a market that appears to be making heavy demands on the available resource and which is assumed likely to remain robust. Present demand and interest can be gauged by entering "didjeridu" or one of the more common spellings to an internet search engine. For example, a May 2002 search on www.google.com on the word "didgeridoo" resulted in 75,200 hits.

Results

Distribution and abundance

Forner (1999) identified 3 vegetation types with significant densities of scarlet gum. Mean densities varied from 2.0 stems per quadrat in low Ironwood (*Erythrophleum chlorstachys*) open woodland, to 4.6 stems per quadrat (115 ha^{-1}) in scarlet gum (*Eucalyptus phoenicea / E. latifolia*) low open woodland. Regional populations of scarlet gum stems within 2 km of the tracks and roads in his study site were estimated at about 0.92 million. Clearly the species is abundant in the region.

Harvest

Scale of harvest

In quadrats located randomly within 2 km of roads and tracks, Forner (1999) found that 21% of *Eucalyptus phoenicea* stems encountered had been previously cut (Table 1). The nature and position of cuts plus the high proportion of stems cut indicated that stems had been taken by commercial rather than customary harvesters. If these figures are assumed to be indicative of regional exploitation close to roads, then the cumulative harvest of stems is about 190,000 from these Jawoyn lands for which no large scale commercial harvests have been authorised. The period over which this cumulative harvest was accrued is unknown but is likely to exceed several years.

A smaller proportion of *Eucalyptus tintinnans* are taken (Table 1), and observations outside the quadrats suggest that large trees are more often felled to remove upper branches than occurs with *E. phoenicea*.

Permits issued by the Parks and Wildlife Commission over the last few years are in Figure 1. It is notable that the number of stems apparently cut in the area of the study site alone is greatly in excess of the total authorised harvest, which averages about 1300 per year. The field estimate of stems cut (190,000) comes entirely from Aboriginal land. In the 7-year period covered in Figure 1, permits issued for Aboriginal freehold land totalled 350 stems. An Aboriginal art retailer, based in Darwin, estimated that a shop-front store, combined with an internet site, sold approximately 10,000 didjeridus in a single year. There would appear to be a large illegal harvest.

Table 1: Proportions of trees within quadrats placed randomly within 2 km of tracks or roads that had been cut. In addition to scarlet gum, a few salmon gum (*Eucalyptus tintinnans*) were also cut for didjeridus.

Species	Number of trees sampled	Number of trees cut	% of surveyed population cut	% of trees showing regrowth
Eucalyptus phoenicea	295	61	21%	55%
Eucalyptus tintinnans	51	2	4%	50%

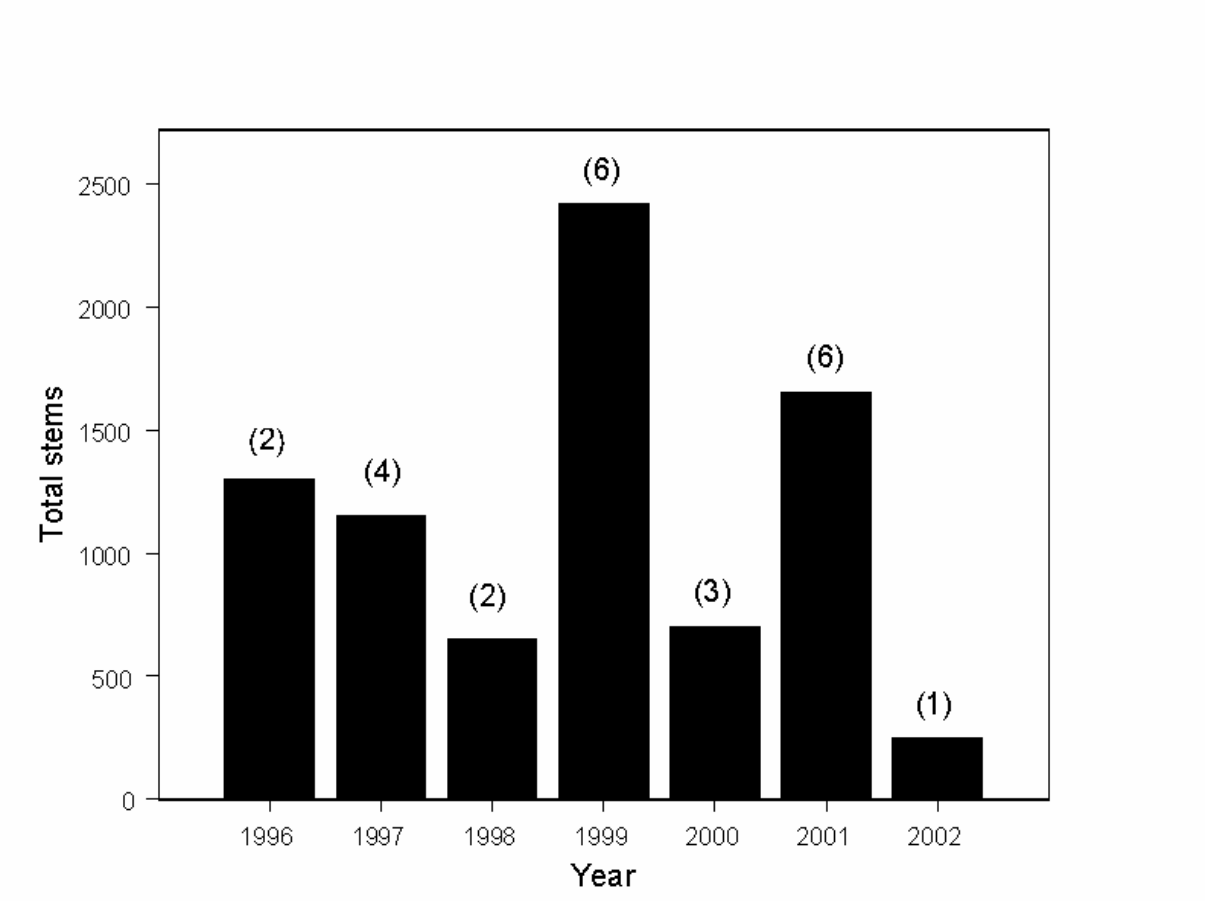

Figure 1: The number of stems of *Eucalyptus phoenicea* for which permits were issued for didjeridu crafting in the Northern Territory over the period 1996 to 2002. The figures in parenthesis over bars is the number of permits. In addition, permits were issued in 1999 for 20 *E. tintinnans* stems. The figures for 2002 are incomplete as they represent only part of the year. (Information provided by the Permits Section of the Parks and Wildlife Commission of the Northern Territory.)

Customary harvest

Didjeridu harvest, fabrication and playing is traditionally a male activity and only Aboriginal men were engaged in the harvests. Results reported here include summaries of information provided about practice as well as quantitative summaries of the features of harvested stems.

Men often proceed on foot to areas known to contain the preferred species, although four-wheel drive vehicles are used if available. Harvesting frequency, duration and yield are extremely variable. Harvests may be initiated opportunistically or planned substantially in advance. Frequency of harvesting ranges from once or twice a month, to several times a week. Many harvesters indicate that they would like to harvest more frequently, but availability of vehicles is limiting. The nearest stands of scarlet gum are 5-10 km from the three participating communities and other favourable sites are often 50-100 km distant from communities. Without a vehicle, a harvesting trip can involve a great deal of effort. Walking to harvest sites is becoming less common as many trees within easy walking distance have already been checked and most suitable “sticks” harvested.

If a vehicle is available a group or family will often combine many activities with the travel associated with a didjeridu harvest. These activities may include collecting bush tucker, land management activities such as burning, collecting materials for baskets, as well as harvesting wood for the didjeridus and other artefacts. On other occasions a group of men will make a trip with the sole purpose of collecting materials for didjeridus.

Once a favourable site is reached, harvesters search on foot. They walk in small groups or individually, often spreading out as the harvest progresses. They may be required to walk considerable distances (several km) to encounter stems considered suitable.

During searches, smaller relatively straight branches and the stems of younger trees are visually assessed for shape. The length of the stick is checked for scars, cracks or nodes and if it appears acceptable, a small axe or tomahawk is used to chip away a section of bark. The exposed wood is then tapped with the fingernail, producing a sound which experienced harvesters use to differentiate suitable hollows from poorly developed hollows or an absence of hollows. This “knock-knock” test is the most important part of the selection process and the most difficult for the inexperienced. The choice of stems for customary use is an exacting process and a small proportion of stems are selected as suitable.

Sticks rated suitable are cut by axe or tomahawk, the bark is skinned (usually with a sharp hatchet) and the hollow cavity washed out with water. Care is taken not to cut the tree too close to the ground, so it has maximum probability for recovery (resprouting) (Table 1). The majority of cuts by traditional harvesters are between knee and head height, the height at which an axe is swung.

The most common reason for discarding stems after a cut is an unfavourable dimension of the hollow, rendering the stem unsuitable for creation of a good musical instrument. Generally younger harvesters make more mistakes and select some unsuitable stems, but after the first or second axe swing the mistake is revealed and cutting discontinued.

Jawoyn harvest yields are generally limited to the number of limbs that the harvester can carry. Two to four didjeridus in a one to two hour search and harvest is common. Using a rope to drag the limbs away, the maximum harvest in one excursion on foot from a vehicle is five to six limbs. Commercial scale harvesting using quadcycles or even helicopters to reach otherwise inaccessible sites can easily yield many times these numbers (Forner 1999).

Young Aboriginal men learn where, when and how to find and cut didjeridus from elder craftsmen. However in some communities this knowledge is slowly being lost, as fewer young men pursue traditional activities.

Didjeridu Morphology

Table 2: Summary of the morphology of 55 Jawoyn didjeridus in comparison to 374 commercial didjeridus. Outside and hollow diameters were measured at both ends of the harvested stems. Values of shape parameters were assigned as shown in the text, with very straight stems ranked one and stems with bends ranked higher according to degree and number of bends, to a maximum of 5 for branched stems.

Attribute	Harvest type	Mean	St.Dev.	Min	Max
Length (cm)	Jawoyn	131.4	11.0	105.0	152.0
	Commercial	137.6	16.7	94	200
Outside Diameter 1 (cm)	Jawoyn	7.45	1.18	4.9	10.1
	Commercial	8.89	1.89	5.1	15.9
Hollow Diameter 1 (cm)	Jawoyn	3.73	0.69	2.3	5.5
	Commercial	2.90	1.69	0	8.3
Outside Diameter 2 (cm)	Jawoyn	6.46	1.12	4.6	9.5
	Commercial	7.77	1.79	4.6	17.6
Hollow Diameter 2 (cm)	Jawoyn	3.03	0.84	1.0	5.0
	Commercial	2.18	1.57	0	7.3
Shape (1-5)	Jawoyn	1.7	0.5	1.0	3.0
	Commercial	1.89	0.7	1	4
Scars (count)	Jawoyn	1.0	1.3	0	6.0
	Commercial	1.81	2.55	0	16

From the eight harvest sites (totalling 8 ha), a total of 43 individual tree limbs were selected by traditional craftsmen as limbs that could be used to construct didjeridus. These limbs were measured, as were an additional 12 limbs cut outside the 8 experimental plots. From the same 8 harvest sites an additional 374 tree limbs were selected as commercially viable didjeridus.

Table 2 shows the generic characteristics of Jawoyn and "commercial" didjeridus. A Barunga harvester stated that the ideal length of a didjeridu was up to his chest. From the ground to his chest measured 128cm. The average length of the Jawoyn didjeridu's was 131.4 cm, with a standard deviation of 11 cm. The average diameter of a Jawoyn mouthpiece (Diameter 2) was 6.4 cm, with an average hollow diameter of 3.03 cm (Hollow diameter 2). Stems selected on traditional criteria were consistently less variable than less discriminating "commercial" harvest. For example, a commercial didjeridu has a larger mouthpiece diameter (7.77 cm), but slightly smaller hollow diameter (2.18cm). The willingness to accept narrow, less developed hollows reflects the commercial harvester's access to mechanical tools which can be used to widen hollows – Jawoyn craftsmen generally do not have such tools.

Discussion

Jawoyn didjeridu craftsmen use several species of eucalypts. However, the scarlet gum is by far the most commonly used. Its small size, propensity to produce multiple stems and high rates of piping, make it an excellent species for didjeridus compared to taller, larger, single stemmed trees. Multiple stems and branches, at an accessible height, increase the crop of potential didjeridus. Harvesters can collect materials without felling the entire tree. Usually, smaller branches or stems can be cut, with the main trunk or additional stems left standing.

Eucalyptus phoenicea is a hard and durable wood. Traditional harvesters note that didjeridus made from other species are more likely to split or crack as the wood dries. They also note that the proportion of suitable hollows is very high in *E. phoenicea*. This is consistent with observations by Forner (1999) who observed that 99% of *E. phoenicea* stems of diameter at breast height (DBH) greater than 5cm were piped (Katherine region). Fox and Clark (1972) and Braithwaite et al. (1985) observed similar proportions of piping in several other eucalypt species.

Scarlet gum grows in shallow, sandy soil on sandstone, on the Arnhem Land escarpment and on rocky granite hills (Brock 1993). Within this range the Jawoyn follow some general "rules" about the type of "country" which produces the best didjeridus. Often the largest proportion of stems with suitable hollows are found on the driest and most rock covered land in an area, particularly on "jump ups" (ridges). However, traditional harvesters warn that it is important to check all stems for hollows before cutting regardless of the site from which they are taken.

Characteristics that make the species attractive to Indigenous harvesters – high density in accessible sites, high proportion of favourable stems, durability of product – are obviously also attractive to non-Indigenous commercial harvesters. Commercial harvesters have clearly taken large numbers of stems of this species, probably in the many tens of thousands.

Ecological sustainability

Customary harvest, whether for personal use or sale, is a highly selective process (Table 2), requiring harvesters to search large areas and resulting in low average intensity of harvest. Jawoyn craftsmen took only 43 stems from 8 ha that were thoroughly searched and contained a total of about 657 scarlet gum trees. Moreover, it is probable that the proportion of stems taken was higher than usual given that harvesters were cutting many stems to establish experimental plots. Selective customary harvest at the intensity that we observed in less artificial situations appears likely to be sustainable, especially given that harvest does not usually result in the death of the tree.

The same could not be said of what is known of non-Indigenous commercial harvest. At randomly selected sites in the Yinberrie Hills (i.e. selected without regard to the presence of cutting or otherwise), an average of 21% of stems had been taken. That this level of cutting was observed on average over a large area is indicative of the intensity of cutting at the local scale. At some sites, local

harvest has involved the cutting of all stems over quite substantial areas, clearly causing ecological change. However, it must be acknowledged that the period over which these harvests have been accumulated is unclear. Many of the cut stems have resprouted, but not enough is known of growth rates to use the size of resprouting stems to estimate the age of cuts and rates of recovery from harvest.

Our experimental harvest using observed commercial criteria resulted in an additional 222 trees being taken from the 657 individuals in the 8 ha area. Commercial harvesters are often able to secure multiple didjeridus from a single tree. In the case of the simulated commercial harvest 373 didjeridu stems were selected from the 222 harvested trees, bringing the harvest to about 40% of trees in the experimental plots.

Significant depletion of stems of *Eucalyptus phoenicea* is unwelcome from a number of perspectives. In addition to compromising the status of the resource, loss of hollows is likely to deprive small fauna of shelter (e.g. Tidemann et al. 1992), and the prolonged period of profuse flowering for which this species is noted provides an important source of food for nectarivorous fauna (e.g. Woinarski et al. 2000).

The most appropriate response to issues raised by high intensity commercial harvesting is presently undetermined: both the Jawoyn Association and the Northern Territory Government are seeking to improve management of the resource through improved permit systems. Proposals involve the issuing of permits (tags) to Aboriginal land owners so that they authorise harvest and control the number of stems cut on their lands. However, the Northern land Council, which has a statutory role (see *Aboriginal Land Rights (Northern Territory) Act 1976*, Section 23) to advise Aboriginal landowners on resource management and other issues affecting their land, is reluctant to concede that Northern Territory legislation of this sort applies on Aboriginal land.

Commercial sustainability

The didjeridu presently has a diverse following and demand is high. A number of Aboriginal craftsmen presently gain access to this market by providing high value products that are culturally authentic and genuine musical instruments. Many Cultural Centres associated with Aboriginal communities also treat didjeridus as works of art, providing details of the craftsmen and the significance of the instrument and associated decoration, which serve to authenticate the object. The market for such products has been sustained over long periods and given trends in other segments of the arts and crafts industries (see Case Study 5, this volume), appear likely to be remain strong.

However, there appears to be a larger market of cheaper ersatz (imitation) didjeridus, many of which are made of inferior materials and function poorly as musical instruments. It is unclear whether these inferior products damage markets for genuine items or perhaps enhance the status of authenticated items by providing clear differentiation in the marketplace.

However, it does appear that the large volumes of these items may compromise access of Jawoyn craftsman to the materials they need to create authentic objects. Many Aboriginal craftsmen are angry at "greedy" harvesters who "steal" sticks from the land without consideration of the environmental consequences or of the cultural origins of the didjeridu. After less than a decade of commercial-scale harvesting, both customary and commercial didjeridu manufacturers have noticed that finding stands of suitable trees is becoming more difficult. It is feared that the commercial imperative to take advantage of a presently strong market, especially by those with no particular connection or obligation for the integrity of the product or land, may be leading to an over-exploitation of the resource.

Describing some harvest practice as theft is not to overstate the case. Staff of the Jawoyn Association and the Parks and Wildlife Commission confirm that approvals have never been sought nor granted

in some heavily cut areas of Aboriginal land. Not only has cultural property been misappropriated, but physical property is also being stolen. Costs to customary harvesters seeking to operate sustainably are being increased by depletion of the resource in reasonable proximity to their communities.

Cultural sustainability

The practice of Jawoyn didjeridu craftsmen is built around provision of a durable product that complies with well-defined standards. The authenticity and quality of the product is an important part of the appeal in the markets in which they operate. Maintenance of that authenticity is dependent on transmission of knowledge and skills to younger members of the community. There is concern that this process is faltering due to lack of interest from younger people. In commercial terms there is probably little incentive to meet exacting standards when better incomes may be achievable from production of a larger number of lesser products for an undiscriminating segment of the market.

In the long term, sustaining the higher end of the market may depend on more active differentiation of the authentic and imitation, so that prices that reflect the additional effort and connection to culture are accepted by consumers. Individual arts and craft centres can contribute to this process by providing high quality background and certification materials. There is also a role for wider publicity regarding the link between authenticity and sustainability, perhaps organised by groups like the Association of Northern, Kimberley and Arnhem Aboriginal Artists (www.ankaa@octa4.net.au).

Implications of Study

The manufacture and sale of didjeridus is a striking example of non-Indigenous appropriation of an Aboriginal cultural icon. The didjeridu has captured great public interest, which has contributed to an ongoing demand for supply of instruments and artworks. In many cases this demand was not or could not be met by Aboriginal craftsmen and artists alone. Consequently, a predominantly commercial and non-Indigenous didjeridu production system has also emerged.

It is difficult to imagine an object that is more closely and uniquely linked to Aboriginal culture than the didjeridu. Yet that link has not meant that Aboriginal people have exclusive access to markets developed around the instrument. The didjeridu example is particularly important because it illustrates the challenges faced by Aboriginal people in maintaining an advantage in markets, once demand becomes sufficiently large and robust to sustain a diversity of product and encourage the entry of a diversity of suppliers.

Aboriginal entrepreneurs need to be realistic about the size and durability of markets in which authenticity of origin and quality are valued sufficiently to inhibit the entry of imitators. They will need strategies in place to protect those markets and maintain prices to overcome the commercial disadvantages of low volumes, high cost structures and remoteness from markets. Aggressive promotion of the values of authentic products and public recognition of the social and cultural impacts of less discriminating purchasing decisions should be included among those strategies.

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