CENTRE FOR ABORIGINAL ECONOMIC POLICY RESEARCH

THE AUSTRALIAN NATIONAL UNIVERSITY

# Knowledge Foundations for the Development of Sustainable Wildlife Enterprises in Remote Indigenous Communities of Australia

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

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## ABSTRACT

Sustainable wildlife enterprises in remote Indigenous communities are an important source of economic development and employment whilst providing people with opportunities to continue their close connection with country and to maintain customary wildlife harvesting practices. Critical to the success of wildlife enterprises is recognition of the importance of both Indigenous ecological knowledge and western science in their design and implementation.

This paper analyses the Indigenous ecological knowledge and western science underpinning the northern long-necked turtle and fledgling tarantula spider industries that have been established by the Djelk Rangers in the remote township of Maningrida in central Arnhem Land. The paper addresses issues of complementarity and conflict across both knowledge systems. The paper also examines the formal transmission of knowledge through education and training institutions as a means of developing employment pathways for young Indigenous people to work in wildlife enterprises.

**Keywords:** Indigenous ecological knowledge, traditional knowledge, western science, remote Australia, wildlife industry, natural resource management, Indigenous education, Indigenous training, science education.

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## INTRODUCTION

Whilst more prominence is often given to Indigenous land and sea management activities in remote communities, there is growing importance being placed upon the development of sustainable wildlife enterprises for commercial purposes (Senate Standing Committee on Rural and Regional Affairs and Transport 1998). Wildlife enterprises being developed include production of Australian native foods (CSIRO Sustainable Ecosystems 2009), crocodile hatchlings (Webb, Missi & Cleary 1996) and long-necked turtle hatchlings (Fordham, Hall & Georges 2004). These enterprises are widely seen as an important means of local economic development and Indigenous employment as well as an essential part of the localised hybrid economy. At the same time wildlife enterprises provide Indigenous people with opportunities to continue their close connection with country and maintain customary wildlife harvesting practices (Altman & Cochrane 2003; Bawinanga Aboriginal Corporation (BAC) 2007). Wildlife enterprises established on sound ecological principles have potential to contribute to the maintenance of biodiversity in fragile environments such as those characterising much of northern Australia (Altman & Whitehead 2003; Gillespie, Cooke & Taylor 1998; Webb 2002) and can play a significant role in land management (Altman & Cochrane 2005).

**BAC**: Bawinanga Aboriginal Corporation

To date, the development of commercial wildlife enterprises in remote Indigenous communities has nevertheless been quite limited. There are a broad range of factors influencing the development and success of commercially viable wildlife enterprises. Factors include the requirement of an extensive knowledge base and well-skilled workforce, regulatory controls administered by different layers of government and by Indigenous organisations, public perception of wildlife utilisation, and access to markets (Whitehead 2003; Gorman, Whitehead, Griffiths et. al 2008).

This paper focuses upon the first of these factors, particularly the relative contributions of Indigenous ecological knowledge and western science to the development of wildlife enterprises. In so doing it explores the theoretical and methodological assumptions underpinning the relationships between each knowledge system, and pays particular attention to the complementarity and interdependence of Western and Indigenous contributions to enterprise development. The paper also examines the role of training and education as formal mechanisms in the transmission of knowledge to support the skill base required for an effective wildlife enterprise.

The paper reports on a study undertaken during 2008 of a wildlife enterprise in the remote township of Maningrida in north central Arnhem Land. Whilst the wildlife enterprise is based upon several animal species, this paper restricts itself to the commercial harvesting of two species in particular. These are a well-developed freshwater northern long-necked turtle industry that has been operating for five years, and a fledgling tarantula spider industry which is at its very earliest stages of development.

A second paper will examine the broad range of factors influencing the development of the enterprise and its on-going viability. Particular attention will be paid to institutional barriers to the effectiveness of wildlife enterprises in remote localities. These include regulatory frameworks, changing government policies and programmes, staff training opportunities and organisational constraints as well as external factors such as seasonality and market variability.

The paper draws upon fieldwork undertaken during the second half of 2008 by staff from the Centre for Aboriginal Economic Policy Research (CAEPR) at The Australian National University (ANU) and earlier field work during 2000-2005 by one of the authors. The study is part of a larger Australian Research Council (ARC) funded project on the re-engagement of young people living in remote Indigenous communities in education, training and employment.

**ARC**: Australian Research Council

## SETTING THE SCENE

### THE LOCATION OF THE STUDY

The location of the study is Maningrida township and surrounding region. Maningrida is in north central Arnhem Land, some 550 kilometres east of Darwin at the mouth of the Liverpool River. As at the 2006 Census, Maningrida township had an Indigenous population of slightly more than 1,900 people with about 160 non-Indigenous people also living in the township (Australian Bureau of Statistics (ABS) 2007).[1]

**ABS**: Australian Bureau of Statistics

Surrounding Maningrida is an administrative region of some 10,000 square kilometres, in which about 360 Indigenous people live on 32 outstations (ABS 2007), although this number fluctuates quite widely depending on season and may increase to 600 or so (Fogarty & Paterson 2007).

### THE MANINGRIDA SOCIO-CULTURAL CONTEXT

The Maningrida region is socio-culturally and linguistically diverse. This has been comprehensively described in previous literature (Altman 1982, 1987, 2008; Hiatt 1965; Keen 1994; Meehan 1982).

There are some 14 languages and 15 dialects that are mainly spoken across the region, although some 51 different languages have been identified in total (Handelsmann 1996). The Dhkurridj clan of the Kunbidji people, whose language is Ndjebbana, are recognised as the traditional landowners of the Maningrida township. The other main language groups living in the area include Rembarrnga, Kune, Kunwinjku, Burarra, Dalabon, Djinang and Gurrgoni. Many Indigenous people are fluent in three or four languages. This makes Maningrida one of the most linguistically diverse places per capita in the world. The different languages also provide for a superstructure of social relations within Maningrida region as they serve as a demarcation for geographical and cultural diversity.

Social relations within the region are based upon two overarching moieties: Yirritja and Dhuwa, also referred to as Yirrichinga and Jawonga respectively. These two moieties define spatial relationships to country and the responsibilities each person holds to the land and its flora and fauna. Responsibilities entail ceremonial obligations as well as the transmission of Indigenous knowledge, thus creating a cyclical process of social reproduction.

Local organisation and estate tenure is founded on patrifilial kin groups. Each kin group holds a defined territorial estate and its component sites, as in the case of the Dhkurridj for example, may be both onshore and offshore (Bagshaw 2007). Overall there are more than 100 such clans or groups in the Maningrida region.[2] While there is generally only one clan or group who is the traditional owner for a particular estate, alliances with other clans means that clans share the resources provided by different estates. In this way areas of high usage, for example a floodplain, are shared by neighbouring and affiliated clans, although access is by permission of the owning clan, either explicitly or implicitly granted according to long standing social arrangements.

Despite continual interaction with government and non-government agencies and the private sector, there is a continuing strong customary social organisation. This is reflected not only in maintenance of linguistic diversity but also in formal ceremonial practice, kin-based sharing and strongly held principles of leadership and representation which underpin Indigenous governance. Yet there also exists in the Maningrida region a distinctly inter-cultural form of development that has emerged as a result of the demands of modernity. This has led the Indigenous community to move beyond a sole reliance on the socioeconomic imperatives of customary social reproduction to a greater shared identity with other Indigenous and non-Indigenous peoples in the region. The development of a wildlife enterprise in Maningrida represents an inter-cultural response to this engagement of western and Indigenous cultures.

### THE BAWINANGA ABORIGINAL CORPORATION

The BAC was established in 1974 by the traditional owners of the Maningrida region. BAC has service delivery responsibility to the outstations in this region, although the establishment of Shires in 2008 and current Northern Territory Government policy development in relation to outstations will affect these arrangements. One of the principal goals of BAC is to promote the sustainable economic development of the region's land and sea resources. It is expected that this will lead to the creation of meaningful long-term employment while at the same time strengthening links with traditional Indigenous culture (BAC 2009).

BAC provides a wide range of employment opportunities, not only through its own administrative requirements but also through various enterprises such as the Djelk Land and Sea Rangers, the Wildlife Centre, the Maningrida Arts and Culture Centre, construction industries, and food and retail outlets.

### THE BAC WILDLIFE CENTRE

In 1998 Djelk Rangers commenced the development of a sustainable wildlife enterprise as a natural extension of land management activities. The initial wildlife industries involved the harvest and incubation of saltwater crocodile (*Crocodylus porosus*) and northern long-necked turtle (*Chelodina rugosa*) eggs: subsequent hatchlings being sold to crocodile farms or as pets for the domestic market respectively.

BAC established the Wildlife Centre in 2006 as an enterprise, separate from the Djelk Ranger land and sea management activities, to promote the development of sustainable wildlife industries in the Maningrida region. In 2008 the Centre was staffed by three Indigenous Djelk Wildlife Rangers and a non-Indigenous Wildlife Enterprise Manager with specialist expertise in wildlife management.

At the time of this field work, the Wildlife Centre was responsible for enterprise activities related to three animal species:

- saltwater crocodiles
- northern long-necked turtles, and
- tarantula spiders.

Whilst the crocodile and turtle industries were well-established, the tarantula spider industry was an emergent industry aimed at selling individual spiders to the domestic market and tarantula venom to pharmaceutical companies.

## METHODOLOGY

The study required the collection of information about Indigenous knowledge and western scientific knowledge underpinning the turtle and tarantula spider industries as well as information about the delivery of training and science education in the region.

As a first step in gathering and documenting Indigenous knowledge relevant to the turtle and tarantula spider, the social-cultural context of the Maningrida region was examined, drawing upon existing research literature. This recognises that Indigenous knowledge exists contemporaneously with, and subject to, the intercultural realities of life in the Maningrida region

For the second step in exploring the strength, relevance and availability of Indigenous knowledge surrounding the two species, interviews were conducted with Indigenous people from Maningrida and surrounding outstations. These interviews were held in August and September 2008. Respondents were not chosen randomly, but rather through connections to country within the scope of the enterprise

development, seniority within the socio-cultural fabric of the region and immediate township, as well as through self-selected interest. Overall some 50 persons were interviewed.

**MCEC**: Maningrida Community Education Centre

**CDU**: Charles Darwin University

**NT DET**: Northern Territory Department of Education and Training

This interview information was supplemented by a series of earlier interviews undertaken during the establishment of the turtle industry (during 2000–05) which were recorded and/or where detailed field notes were taken. The purpose of these earlier 35 interviews was to determine key life history information.

A more detailed account of the methodology for the collection of Indigenous knowledge is presented at Appendix 1.

Information on the western science underpinning the turtle and tarantula spider industries was collected through interviews with the specialist scientists and the BAC Wildlife Enterprise Manager.

Information about training provision and the Maningrida Community Education Centre (MCEC) science curriculum was gathered through interviews with senior MCEC staff, MCEC students, Charles Darwin University (CDU) staff, the BAC Training Officer, Northern Territory Department of Education and Training (NT DET) science consultants, Djelk Wildlife Rangers and the BAC Wildlife Enterprise Manager. These interviews occurred during August 2008–February 2009. Many of the same individuals were interviewed during field research in the context of a broader ARC study over 2007–08 (see above).

## KNOWLEDGE FOUNDATIONS FOR DEVELOPING A WILDLIFE ENTERPRISE: INDIGENOUS KNOWLEDGE

Recognition of the potential contribution of Indigenous Knowledge to wildlife industries and land and sea management has increased rapidly over the last several decades, as evidenced by the increased reference to Traditional Ecological Knowledge in the published literature (Brook & McLachlan 2008; Cheveau, Imbeau, Drapeau et al. 2008; Scott 2004). Traditional Ecological Knowledge has been applied to conservation studies of endangered species at both the species level and community level (Fraser, Coon, Prince et al. 2006) and in regard to a wide range of land and sea management practices (Berkes & Davidson-Hunt 2006; Foale 2006; O'Flaherty, Davidson-Hunt & Manseau 2008; Telfer & Garde 2006). The evolution of knowledge systems and their interaction as they are applied to wildlife, land and sea management is a further area of research (Berkes Colding & Folke 2000; Moller, Berkes, Lyver et al. 2004; Murray, Neis & Johnsen 2006; Pierotti & Wildcat 2000).

At an institutional level, the Commonwealth government's Caring for our Country programme and proposed Biodiversity Conservation Strategy 2010-2020 highlighted the importance of ensuring that traditional ecological knowledge is utilised in land, sea and wildlife management. The government identified as a priority 'reversing the ongoing erosion of Indigenous environmental knowledge' in biodiversity conservation (National Biodiversity Strategy Review Task Group 2009) and 'maintain[ing] traditional ecological knowledge', utilising Indigenous knowledge to 'develop a more distinctly Australian approach to biodiversity conservation' (Caring for our Country 2008). Similarly Indigenous Land Councils accorded priority to those land, sea and wildlife management activities which utilised Indigenous knowledge, maintaining the spiritual and physical health of country and linking their young people back to country and culture (e.g. Kimberley Land Council 2009; Northern Land Council 2009).

### DEFINITIONS OF INDIGENOUS KNOWLEDGE AND INDIGENOUS ECOLOGICAL KNOWLEDGE

There are a variety of terms used to identify Indigenous-based knowledge systems. 'Indigenous knowledge', 'traditional ecological knowledge', 'Indigenous ecological knowledge', and 'local ecological knowledge' are

commonly used in the research literature and, less commonly, extended to include reference to Indigenous wisdom in 'traditional ecological knowledge and wisdom'.

From a theoretical perspective, there continues to be considerable debate about the very notion of Indigenous knowledge and whether it can or should be defined. Anthropologists such as Ellen and Harris (1997) define Indigenous knowledge as:

> ...local, orally transmitted, a consequence of practical engagement reinforced by experience, empirical rather than theoretical, repetitive, fluid and negotiable, shared but asymmetrically distributed, largely functional, and embedded in a more encompassing cultural matrix.

However such representations of Indigenous knowledge have been heavily critiqued. Milton (1996), for example, sees such definitions as adding to the dichotomy between the two knowledge systems and reinforcing the dominance of technical and western modes of science. As a result, terms such as 'traditional ecological knowledge' may carry with them connotations of a knowledge system which is 'traditional' and hence 'static' and perhaps even 'primitive'. For this reason preference is often given to the term 'Indigenous ecological knowledge' or IEK, and this will be the term generally utilised throughout this paper.

**IEK**: Indigenous ecological knowledge

In the case of Indigenous wildlife, land and sea management, the explicit focus of Indigenous knowledge tends to be more upon the local environment and the inter-relationships between its many components while at the same time acknowledging linkages with the spiritual and cultural dimensions of Indigenous knowledge. Berkes, Colding and Folke (2000) describe traditional ecological knowledge as a

> ...cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. This definition recognises that Traditional Ecological Knowledge is an attribute of societies with historical continuity in resource use practice.

This view of IEK involves a continual state of change as it acquires deeper and more extensive understandings of the local environment and adapts to environmental changes and intercultural interaction.[3]

## COMPLEMENTARITY OF INDIGENOUS ECOLOGICAL KNOWLEDGE AND WESTERN SCIENCE

The challenge for wildlife, land and sea management is to develop a methodology that, in recognising the legitimacy of both Indigenous and western knowledge systems, transforms the dichotomous relation between each. This does not necessarily mean there is a need to identify a separate realm of knowledge, but rather to create the necessary discourses between each (Nygren 1999) and a wildlife, sea and land management methodology which is focused upon the interconnectedness of the two knowledge systems (Ferradas 1998).[4]

In bringing together the potential contributions of IEK and western scientific knowledge to environmental issues, such as population monitoring and sustainable harvesting, Moller, Berkes, Lyver et al. (2004) identify five areas of complementarity. These relate to the type of information gathered and hypotheses generated, such as a focus of IEK on extreme local events and qualitative information, whereas science has more a focus upon averages, general principles and objective information. Taken together these areas enable more complete spatial and temporal understanding, the application of more general scientific principles to local situations, a better understanding of complex systems and a greater community focus.[5]

We need however to acknowledge that the way ecologists tackle problems has changed in recent times—there is a greater appreciation of the impact anomalies have on wild populations and a movement away from traditional null-hypothesis testing to multi-model inferencing (Anderson, Burnham & Thompson 2000). Nevertheless, combining the relative contributions of science and IEK provides a more complete understanding and sometimes less resource-heavy and time-consuming resolution of environmental issues—one more likely

to develop a stronger link between science and the community (Moller et al. 2004). Furthermore, IEK (similar to expert advice from non-Indigenous naturalists) has great potential to provide additional knowledge for input to Bayesian analysis used in modelling population dynamics (McCarthy 2007).[6]

Whilst there are different principles or assumptions underpinning IEK and western scientific knowledge, there are several dimensions where there are meaningful parallels. Both include classification of the various elements that constitute the environment, use of technology and resource management, and the 'web of life' incorporating ecology, evolution and systematics (Dene Cultural Institute 1998).

However there are also assumptions about IEK often made by non-Indigenous people that are not necessarily valid, especially in regard to supporting western conservation and management practices. There has been a call for a 'reality check' on claims made about Indigenous ecological wisdom (Berkes, Colding & Folke 2000), recognition of the tendency towards a 'romantic' view of Indigenous land management (Wohling 2001), and realisation that Indigenous understanding of conservation or wildlife and land management may differ markedly from understandings held by Western scientists and conservation groups (Bradley 2001, Pierotto & Wildcat 2000; Suchet 2001).

Finally, not all Indigenous knowledge is accessible to scientists and other non-Indigenous people involved in wildlife enterprise development, even Indigenous knowledge that might be potentially valuable to the enterprise. Such sacred knowledge or *Mardayin*, which can be loosely translated to a body of 'sacred law' relating to ancestral beings, forms a complex relationship with land ownership and ceremonial obligations. Essentially, it is the responsibility of landowners to look after the *Mardayin* as it forms an ancestral charter to land ownership. As noted by Davis (1997), those responsible for developing wildlife enterprises need therefore to recognise the rights and responsibilities of local estate owners regarding secret and sacred knowledge. This highlights the importance of developing appropriate consultative mechanisms when seeking access to land and permission to collect particular species.

In summary, rather than considering their contributions as being independent of or even in opposition to each other as has been the case in earlier remote development enterprises, both IEK and western scientific knowledge are better considered as changing or evolving as a result of interactions between western scientists and Indigenous peoples. Furthermore, it can be argued that most benefit will arise from intercultural discourse and the resultant interconnectedness of both knowledge systems. However, a cautionary note is warranted. Whilst recognising that IEK can contribute to the development of wildlife management strategies, especially where there is limited knowledge held by western scientists and where it is not possible to apply scientific research methods, there can be significant limitations. These may arise from variations in IEK among individuals, between communities and across species which necessitate rigorous testing of IEK prior to its incorporation into management plans (Gilchrist, Mallory & Merkel 2005).

## INDIGENOUS KNOWLEDGE UNDERPINNING THE BAC WILDLIFE ENTERPRISE

Indigenous knowledge underpinning the BAC wildlife enterprise is embedded in the socio-cultural fabric of the Maningrida region—its spiritual cosmology, social organisation, linguistic features and defined clan estates. As a result, the Indigenous knowledge foundations of the BAC wildlife enterprise have spiritual and cultural dimensions as well as more ecological dimensions associated with the targeted species.

### INDIGENOUS KNOWLEDGE: CULTURAL IMPORTANCE OF TURTLE AND SPIDER

Rock paintings and ceremonial stories about freshwater turtles indicate that Indigenous people have been interacting with *C. rugosa* for many millennia (Chaloupka 1993; Fordham 2007). This high level of interaction is largely due to their harvesting of *C. rugosa* which provides Indigenous people in tropical northern Australia with a seasonal source of protein (Georges & Kennett 1988; Russell-Smith, Lucas, Gapindi et al. 1997).

## THE JOURNEY OF THE TURTLE SPIRITS

*A long time ago, when mainland Australia was connected to islands that now lie off the coast of Northern Australia, ancestral spirits roamed the country. During this time, the turtle spirits embarked on a long inland journey from a region known today as the Goulbourn Islands. After many days of travel the spirits began to argue over who would continue on and who would stay. Everyone agreed that some spirits should remain to manage the land that they had already travelled across. After much discussion, which at times was heated, a compromise was struck. The freshwater turtle spirits would continue travelling inland, while the marine turtle spirits would remain and provide custodianship over the region, which today, is inundated by the Arafura Sea. The freshwater turtle spirits realised that the journey ahead would be arduous and at times dangerous. As such, they would have to place an emphasis on being small and inconspicuous to avoid predation, so they offered the marine turtle spirits half of their fat reserves in exchange for travelling no further.*

*The next stage of the journey crossed over country where water is only seasonally available, causing the legs of some spirits to become so inflamed and their bodies so weak that they could not possibly continue on the expedition. Another discussion was held and it was decided that those spirits (wamarra (northern long-necked turtle)) too weak to travel should remain and survive by storing water under their armpits and burying in the mud to remain cool when waterholes dry. The remaining spirits mustered up the energy to continue inland to the sandstone escarpment. On reaching the large crystal clear permanent billabongs of the escarpment country they realised that they had travelled to where all the local rivers and streams start to flow. As such, it was time for them to go their separate ways and colonise all the rivers of the region.*

This is an extract from Fordham (2007). It is an extremely important story for people of central and western Arnhem Land, as the turtle spirits cross the country of many language groups including Mawng, Kunbarlang, Kunwinjku, Kune and Rembarrnga on their journey inland. Yellow ochre collected from cliff faces abutting the sea is used during ceremonies to signify the exchange of fat reserves from the freshwater to the marine turtle spirits.

Tarantuala spiders (*Selenotholus sp.*) are not harvested for customary or subsistence purposes in the study region. From the interviews undertaken for this project, local Indigenous people seemed to have little interaction with these spiders and, as noted below, the extent to which tarantula spiders are differentiated from other large spiders in the area is open to question.

The moiety for both *C. rugosa* and *Selenotholus sp.* is Yirritja: this was consistent across all language groups consulted in the region. Both *C. rugosa* and *Selenotholus sp.* (as are all species of turtles and spiders) are subject to strong ceremonial obligation, having their own *Bungal*, or song lines and creation story through dance. The *Bungal* for freshwater turtles is an extremely important story for people of central and western Arnhem Land (according to one respondent) because the turtle spirits cross the country of many language groups including Mawng, Kunwinjku, Kune and Rembarrnga on their journey inland (see text box above). A number of respondents noted that the spider has 'a really good show' and that the *Bungal* features a very expressive dance outlining the life cycle of a spider.[7]

**Fig. 1. Artistic representations of turtles and spiders in Indigenous cosmologies**

a.

b.

c.

a. Spider rock art at Baradj. [Photo courtesy of Ian Munro with permission from D. Yibarbuk]
b. Northern long-neck turtle painting, Michael Godjuwarra, 1998.
c. Spider painting, Billy Redford and Marina Murdilnga, 2001.

**Table 1. Indigenous names attributed to *Chelodina rugosa* and *Selenotholus sp.* from language groups interviewed**

| *Language Group* | *Chelodina rugosa* | *Selenotholus sp.* |
|---|---|---|
| Ndjebbana | makeddja | kidjikarrabba[a] |
| Rembarrnga | wamarra | garr |
| Kune | gomdow | garr |
| Kunjwinku | komrdaw | garrum |
| Burrarra | burnda | gardany |
| Dalabon | wamarra | karrh |
| Djinang | barnda | djomborlok |
| Gurrgonni | ngalngi | kidjikarrabba[a] |

**Note:** a. The new name for tarantula spider to be used by scientists for taxonomic purposes.

Artistic representations of turtles and spiders demonstrate their importance in Indigenous cosmologies as well as demonstrating longevity of cultural information. Photographs of some examples are provided at Fig. 1.

## INDIGENOUS KNOWLEDGE: LANGUAGE AND THE DIFFERENTIATION OF SPECIES

Interviewees across language groups were in agreement that no specific Indigenous name was attributed to *Selenotholus sp.* Rather the generic name for 'spider', as per language group, was considered the relevant term. During early field work associated with mapping the distribution of *Selenotholus sp.*, there appeared some confusion as to whether Indigenous people were referring to *Selenotholus sp.*, or to any large spider that lived in the region, such as the golden orb spider.

For the scientist assisting in the development of the tarantula spider industry, this did not mean the rejection of the IEK associated with the tarantula but provided a challenge to 'think and see how they [the Indigenous people] think and see' (Excerpt from interview 2008). Grouping the tarantula with the local orb spider for example could be made on the basis of particular common features such as them being large, their painful bites, the fear held of spiders in general, their burying of eggs underground and possibly on their ability to climb trees. As the scientist explained:

> The morphology that we hold and love and which provides the basis for our taxonomy, doesn't transact with this one at all. We are talking about a functional taxonomy, based upon the lives they live—so it is a different kind of taxonomy, it doesn't fit into a Linnaean system but it is of a different order (Excerpt from interview 2008).

Interviews indicated that the Indigenous people differentiated the tarantula spider from other local spiders, but further anthropological work is required to understand better the basis of such differentiation. As the scientist continued:

> They might recognise that it looks different but whether they place any significance on the difference is another matter... they have their own ethno-taxonomy – this is an animal that lives on the ground, this is an animal that lives in the air – they have a different basis for their taxonomy, there is a divergence, they are coming from an entirely different paradigm than from we are coming from (Excerpt from interview 2008).

This emphasises the importance of an interdisciplinary approach to understanding IEK and in this case local ethno-taxonomy.

Since the field work commenced, the traditional owner for the Gurrgoni country on which the tarantula species was discovered has named the 'new' spider *Dji-djigardapa*. For consistency and for scientific naming purposes, however, the traditional owner agreed the species name be spelt *Kidjikarrabba* which is also the new Ndjebbana name for the species (see Table 1). Prior to the field work the tarantula spider had been referred to as *na-mewaya ka-raya ka-nora* in Ndjebbana and *mut-gu-mewiyi mu-rratji dji-nerre* in Gurrgonni, both meaning 'spider' or 'big spider'.

A similar issue of identifying different species according to the Indigenous name used relates to the long-necked turtle. There was a clear differentiation between turtle species that inhabit the Maningrida region, although this may not be apparent from the name attributed to different species. The sandstone long-necked turtle *Chelodina burrungandjii* is recognised as anatomically different from *C. rugosa* by Rembarrnga and Kunjwinku speaking people (on whose country this species is distributed in the study region) yet there is no distinction in the names applied to each. This demonstrates the importance of scientists understanding that Indigenous knowledge about the species may vary with spatial scale. In this instance there could potentially be problems from a western scientific perspective if the scientist was asking where *wamarra* were found—they would be told in the escarpment as well as on the floodplain.

## INDIGENOUS KNOWLEDGE: DISTRIBUTION AND ABUNDANCE

Respondents were asked about their knowledge of the distribution and abundance of *C. rugosa* and *Selenotholus sp.*, as a key aspect of Indigenous ecological knowledge that might provide insights for the Wildlife Centre in its enterprise development.

All interviewees reported *C. rugosa* on their traditional lands, suggesting the species has a wide distribution, as it is found in floodplain and savannah environments. Furthermore, all respondents indicated that the distribution of *C. rugosa* had not contracted in their lifetime—that is, turtles were still found in the same billabongs as when they were a child. However, in terms of abundance, it had become harder to find turtles at traditional harvest sites. Similarly, respondents tended to indicate a wide distribution of *Selenotholus sp.*, reporting the species existed not only on the floodplain but also in savannah environments and was found in both wet and dry areas. No-one believed that the species distribution had changed during their lifetimes.

Floodplain and savannah woodland billabongs were identified as important habitat for *C. rugosa*. Interviewees with access to both floodplain and savannah billabongs noted that the former had greater turtle abundance, based on harvest success. More specifically, respondents noted that billabongs which are seasonally dry and are vegetated with water chestnut (*Eleocharis dulcis*) and paperbark trees (*Melaleuca sp.*), and possibly water lilies (*Nymphaea sp.*), support the highest density of turtles. All respondents reported high numbers of *Selenotholus sp.* in savannah (occurring in woodlands and regions of low relief) as well as floodplain environments.[8] Spiders in floodplains could be found 'hiding' underground on floodplains during the wet season, when their habitat is inundated. However, if the region experienced severe flooding, they moved to higher ground, where they existed under logs, and in hollows and termite nests.

In early interviews (those conducted during 2000–02) respondents did not identify a decline in turtle numbers in their present lifetime. In 2008, four of the five respondents identified a decline in turtle harvest success and, in turn, abundance. The general consensus was that, firstly, pigs eat turtles and their rooting makes it harder to find turtles, and that, secondly, buffalo tramp on turtles when they are aestivating. The largest damage was thought to occur at ephemeral billabongs with *E. dulcis* and *Melaleuca sp.* The

**Fig. 2. Customary harvesting of *C. rugosa* in the Maningrida region**

Source: Fordham 2007.

remaining respondent identified no reduction of turtle abundance in recent times, although there had been a decline in the extent of turtle harvesting by outstation people. This suggests that, despite significant feral pig and buffalo impacts on the turtle population, these predatory pressures were compensated for by the reduced level of harvesting and that the turtle population may have responded positively and quickly to harvest reduction. In previous years (2003–05) cane toads had been blamed for a general reduction in harvest success (D. Fordham unpublished data), however any impact by cane toads is likely to swamped by other threatening processes (Fordham, Georges & Brook 2008). Similarly, there was some concern that pig and buffalo damage to floodplain areas may threaten the persistence of *Selenotholus sp.* The impact of cane toads on tarantula spiders was raised but more in the context of the overall impact on local fauna and associated food chains.

### INDIGENOUS KNOWLEDGE: LIFE CYCLE OF THE SPECIES

Respondents had a good understanding of the life cycle of *C. rugosa*. There was a general consensus that:

- turtles breed during the wet season, when the billabongs fill with water
- turtles move between billabongs during the wet season in response to intensive flooding
- turtles aestivate under the mud when billabongs recede
- aestivation coincides with a period of elevated mortality, owing to predation by pigs, birds (eagles and jabirus) and dingoes, and
- turtle eggs hatch at the onset of the following wet season. Interestingly, there was no information given regarding nesting, though goannas were identified as an egg predator. Earlier surveys concluded that *C. rugosa* eggs were not targeted as a food source, and there was much confusion as to where the turtle nests (D. Fordham unpublished data).

Information regarding the life cycle of *Selenotholus sp.* was generally sparse. However, there were some key points of consensus around the breeding cycle. Most respondents agreed that the spiders breed underground during the 'build up' or Gornmal season (see seasonal cycle)—the female and male make separate, but connected burrows, spinning webs at their entrance after pairing. The majority of respondents thought the young hatch and stay in and around the mother until the end of the wet season. No information was forthcoming on periods of high mortality; birds were considered the major predator and no threat to the species from human interaction was reported.

### INDIGENOUS KNOWLEDGE: CUSTOMARY USE

*C. rugosa* are harvested for food, though one respondent indicated that the turtle carapace was once also commonly used as a plate.

Turtle harvesting is primarily viewed as 'women's business'. Harvesters target aestivating turtles during the late dry season when ephemeral waters have receded. The characteristic mound and breathing hole of the aestivating turtle are used to locate the turtle. A digging stick (the wooden digging stick has now been replaced by a steel bar) is used to determine the exact location of the turtle and for excavation (see Fig. 2). The angle of the late afternoon sun improves harvest success by facilitating the observation of tell-tale signs of an aestivating turtle. Billabong vegetation is often burnt to make finding the breathing holes easier. Less commonly practiced harvest techniques include looking for the tracks of turtles that exit the billabong to aestivate, and (during the wet season) muddling in shallow creeks which extend from ephemeral billabongs. *C. rugosa* in permanent waterways are sometimes caught using fishing-line, while targeting fish.

## Table 2. Seasonal calendar, Maningrida region, Northern Territory

| Gregorian period | Language | Terms | Colloquial term | Weather characteristics | Major customary activity | Major land and sea management activities (Djelk) |
|---|---|---|---|---|---|---|
| November–December | Kuninjku<br>Burarra<br>Kune | *Gunumeleng*<br>*Gornmol*<br>*Duludu* | Build up | Heat<br>Humidity<br>Storm build up | Hunting bird life<br>Burning<br>Turtle hunting | Fire management<br>Customs surveillance & AQIS monitoring<br>Turtle animal husbandry |
| January–March | Kuninjku<br>Burarra<br>Kune | *Gudjewg*<br>*Jemberr*<br>*Gadjagdung* | Wet season | Heavy rain<br>Strong winds<br>Cyclones | Hunting macropods<br>Pandanus & bark Harvest | Weed control<br>Customs surveillance Customs surveillance & AQIS monitoring.<br>Crocodile egg harvesting & husbandry<br>Turtle egg harvesting & husbandry |
| April–May | Kuninjku<br>Burarra<br>Kune | *Banggerreng*<br>*Barra*<br>*Ganirringgan* | Knock 'em down | Storms & associated flattening of spear grass | Fishing<br>Hunting mammals | Burning & weed control<br>Customs surveillance & AQIS monitoring<br>Crocodile egg husbandry & crocodile trapping Turtle egg harvesting & husbandry |
| May–June | Kuninjku<br>Burarra<br>Kune | *Yekke*<br>*Mu-dawarr*<br>*Yegerr* | Early dry Season | Mists<br>Less humidity | Fishing<br>Hunting birds & buffalo | Burning & weed control<br>Customs surveillance & AQIS monitoring<br>Turtle egg harvesting & husbandry.<br>Crocodile husbandry |
| July–September | Kuninjku<br>Burarra<br>Kune | *Wurrgeng*<br>*Rarranyjarr*<br>*Wurrgeng* | Dry season | Dry days<br>Cooler temperatures<br>Cold nights | Fishing<br>Hunting mammals/ buffalo<br>Peak ceremonial<br>Painting & weaving | Burning<br>Feral animal control.<br>Customs surveillance & AQIS monitoring<br>Turtle husbandry<br>Spider collection |
| September–October | Kuninjku<br>Burarra<br>Kune | *Gurrung*<br>*Warlirr*<br>*Walirr* | Late dry Season | Hot clear days | Bird life<br>Turtle hunting<br>Peak ceremonial<br>Burning | Weed & feral animal control.<br>Customs surveillance & AQIS monitoring<br>Turtle husbandry<br>Spider husbandry |

Notes: a. For full discussion of customary harvest intensity and quantification see Altman 1982: 228–40.

Surplus harvested turtles are often placed in a deep pit dug into the ground in a shady location, the hole is covered in bark from a paper-bark tree (*Melaleuca sp.*)—here they remain in semi-torpor until they are eaten, or the onset of the wet season, whichever comes first.

Respondents identified areas (spatial population refugia)[9] where turtles could not be harvested, reflecting harvesting techniques—which prevent the harvest of turtles in permanent waterholes—and also cultural beliefs. They also identified temporal refugia which occur when billabongs are not able to be harvested in a particular year owing to extreme rainfall, ceremonial commitments and customary law.

As we have already noted, there was no customary use of *Selenotholus sp.* identified.

### INDIGENOUS KNOWLEDGE: ACCESS ISSUES

Most Indigenous traditional owners agreed that access to country required prior negotiation with the relevant landholders before collection or study of either species occurred. However, traditional owners with familial connections to the employees of the Wildlife Centre agreed that these workers could act as their proxy and negotiate permission where appropriate. The extent of required consultation varied: those who required extensive consultation were particularly concerned with royalty entitlements and benefit sharing arrangements.

Custodianship of the species is also an important consideration when granting access. One traditional owner referred to the fact that he is one of the keepers of the spider *Mardayin*, which brings with it important responsibilities requiring consultation about the potential impact (e.g., on the spider population) of any use of spiders in commercial or educational development. *Mardayin* ceremony does not preclude the collection of a species provided other permission protocols have been fulfilled, although the need to consult with the *Junggay* (or ceremony 'boss') during such times was noted.

### INDIGENOUS KNOWLEDGE: INDIGENOUS SEASONAL CYCLES

Much of the Indigenous cosmology of the region is directly correlated with the cyclical Indigenous calendar. While Indigenous calendars do not correlate directly with the Gregorian calendar, it is possible to draw some general comparisons and break the seasons into distinct periods as shown in Table 2.

Understanding the seasonal cycle as recorded by Indigenous people of the region is necessary for understanding IEK and its inclusion in BAC's wildlife enterprise developments. Indigenous knowledge of the breeding habits, migratory patterns and locations of species being considered for enterprise development can often be plotted against the seasonal calendar. This is of particular importance when considering species about which western science knows very little, as it allows scientists to complement or test their developing knowledge base with the existing knowledge held by Indigenous people of the region. The seasonal calendar also highlights periods of substantial land and sea management activity and therefore assists in planning additional activities required for new wildlife industries. In the Indigenous calendar for the Maningrida region we have included both customary activities and the major activities undertaken by Djelk Rangers, the latter being important in allocating Ranger resources to the wildlife enterprise.

## KNOWLEDGE FOUNDATIONS FOR DEVELOPING A WILDLIFE INDUSTRY: WESTERN SCIENCE

The role for western science in supporting wildlife industries is twofold. Firstly, it can provide the necessary evidence to show that, at a general level, it is possible to exploit wildlife for commercial purposes without long-term impacts on wildlife survival. Greater scientific discourse in legitimating the practice of wildlife harvesting can therefore answer claims that wildlife harvesting can never be sustainable or, where it might be sustainable, that it either must have a conservation benefit or not be used at all for commercial purposes, even by Indigenous Australians (e.g. Australian Conservation Foundation 2006; Irwin 2009; Kangaroo Protection Co-operative 1998). Secondly, it can help identify those species most suitable for wildlife harvesting and the necessary conditions for their long-term persistence given the impact of harvesting.

### THE SCIENTIFIC BASIS FOR ESTABLISHING WILDLIFE INDUSTRIES

#### The need for scientific discourse

There is growing global appreciation of the socioeconomic and environmental benefits of indigenous wildlife use (Altman 2003; Altman & Cochrane 2005; Altman, Bek & Roach 1996; Freeman 1993; Gray, Altman & Halasz 2005;) and broad acceptance that protectionism alone rarely meets conservation goals (du Toit, Walker & Campbell 2004; Getz, Fortmann, Cumming et al. 1999). However, emotionality, subjectivity and political opportunism, rather than rigorous scientific discourse, still continue to have a significant influence on government decision-making in Australia, constraining Indigenous resource access (Altman & Whitehead 2003; Webb 2002). Although overexploitation by Indigenous and non-Indigenous people is directly responsible for the precarious conservation status of many species (Baum et al. 2003; Jackson et al. 2001; Milner-Gulland & Bennett 2003), if appropriate management practices are implemented, resource utilisation can potentially be sustainable (Brook & Whitehead 2005; Fordham, Georges & Brook 2008; Jones, Andriahajaina, Hockley et al. 2005; Taylor, Laake, McLoughlin et al. 2005). Sustainable exploitation by definition demands that the harvest regime does not threaten population persistence, allowing a stable population size over the long term (Convention on Biological Diversity 2006).[10]

#### Differential impact of harvesting on species

Organisms display differential vulnerabilities to harvesting pressures (Fordham, Georges & Brook 2007; Stevens, Bonfil, Dulvy et al. 2000) and thus commercial harvests of wildlife are appropriate in some, but not all, circumstances (Webb 2002). The important point is that sustainability, or otherwise, determines whether an animal is harvested, not the charismatic appeal of certain animals, nor the life stages per se that are being targeted (Bonner 1993a, 1993b). Highly fecund, fast growing, early maturing species with flexible diets and habitats are better equipped to compensate for harvests than those species that mature late, experience high levels of survival and have long generation times (Fordham, Georges & Brook 2007, 2009). Harvesting species with 'slower', less flexible life history traits may be sustainable if harvests target life stages that contribute relatively little to population growth (Kokko 2001), such as eggs and juveniles (Gaillard, Festa-Bianchet & Yoccoz 1998). Harvesting life stages that contribute heavily to population growth will be sustainable only if highly regulated adaptive management practices are in place. However, even tightly regulated harvest regimes may threaten stocks if harvesting is considered in isolation (see below). Temporal and spatial population refugia can potentially promote population persistence among harvested stock (McCullough 1996).

### Complex modelling to determine sustainability and ensure long-term persistence

There is a growing recognition that human impacts such as habitat degradation, over-exploitation, introduction of invasive species and climate change do not occur in isolation but usually interact and self-reinforce. There is also recognition that human-induced ecosystem shifts may be rapid, large, and sometimes irreversible—once thresholds are crossed, hysteresis[11] will mean it is impossible to restore former interrelationships (Brook, Sodhi & Bradshaw 2008). Failure to recognise that human impacts are often synergistic, can lead to optimistic population projections, resulting in a threat to population persistence (Bradshaw, Sodhi & Brook 2009). Consequently, policy makers and resource managers urgently need new mechanisms for informed decision-making (Zimmer 2007), including multi-species model systems that simultaneously consider changes in climate, land use, harvest pressure and invasive species and their interactions (Fordham & Brook 2009).

To sum up, there is strong scientific support for the establishment of wildlife enterprises. Rigorous population modelling, based on a combination of strong experimental studies and more general IEK and western scientific knowledge, addresses the major issue of impact of wildlife harvesting upon the sustainability of targeted wildlife populations. As a result, in many instances it is possible to identify appropriate species and the necessary conditions for developing an ecologically sustainable wildlife enterprise. Whilst data availability will always be a limiting factor to achieving scientifically robust model predictions on wildlife sustainability, IEK has the potential to strengthen model forecasts.

## SCIENTIFIC KNOWLEDGE UNDERPINNING THE TURTLE AND TARANTULA INDUSTRIES

In the case of the northern long-necked turtle wildlife industries, there was a well-developed body of scientific knowledge about the physiology and life cycle of *C. rugosa* prior to the development of the industry (Kennett 1999; Kennett & Christian 1994; Kennett, Christian & Pritchard 1993). Ecological principles of population maintenance at a general level and technical aspects of animal husbandry for reptiles were also available. The challenge for the scientific community in developing the turtle enterprise was therefore one of applying this scientific knowledge at a species level and at a fine spatial scale to the populations of *C. rugosa* living in the Maningrida region, and with regard to industry specific requirements.

During 2000–06 the major scientific effort addressed such critical issues as:

- optimal conditions for egg incubation and survival of hatchlings
- interaction of indigenous harvesting and pig predation upon turtle populations, and
- capacity of turtle populations to respond to commercial and customary harvesting.

In 2009-2010 scientific research will focus upon strategies to control the high level of pig predation at billabongs which restricts turtle population growth. Research will also investigate the complex relationship between forecasted changes in the local climatology and turtle habitat suitability at ephemeral billabongs used for turtle harvesting. This ongoing research will be used to refine and update the existing biological processes underpinning the wildlife enterprise, following the notion of adaptive monitoring and an adaptive management type framework (Lindenmayer & McCarthy 2006; Lindenmayer, Hobbs, Montague-Drake et al. 2008; Walters & Holling 1990; Whelan 2002). It is crucial that scientific research to support such a wildlife industry is ongoing and does not cease once the first domestic sales are secured.

There is a less developed body of scientific knowledge about *Selenotholus sp.* available on which to build a tarantula wildlife industry (R. Raven pers. comm. 2008). The challenge for the scientific community therefore is quite different from that for the turtle wildlife industry. The research is much more directed to building up basic knowledge about the tarantula spider including:

- taxonomic or morphological differences between spiders to differentiate species
- morphological adaptations for mating and breeding in general, and
- juvenile development and impacts on population growth.

Although this research is extremely difficult, it is not as critical to developing the tarantula industry as it might be to the turtle industry. This is largely because the impact of harvesting egg-bearing tarantulas on the sustainability of tarantula populations is insignificant, at least under present conditions, and both egg incubation and husbandry are more straightforward than in the case of the turtle industry. The reported density of tarantulas in the area of the Maningrida region where harvesting is proposed is extremely high, and the general spider population the highest observed by the researchers anywhere in Australia (R. Raven pers. comm. 2008). Nevertheless, part of the scientific research will be population monitoring to ensure sustainability as part of industry development. In the early stage of industry development the immediate concern is to establish effective animal husbandry techniques and conditions for the growth of spiderlings—and so more focused on work practices in the animal handling facility than on .extensive scientific investigation.

To sum up, in both cases (but more so in relation to *C. rugosa*) industry development has been and continues to be one of adaptive management. This involves a structured process of 'learning by doing', but 'doing' based upon rigorous field experimentation. It not only requires close collaboration with stakeholders, but also recognises the importance of a well-designed experimental basis to build upon existing scientific knowledge that may be incomplete and insufficient for industry development.

## COMBINING KNOWLEDGE SYSTEMS FOR THE SUCCESSFUL DEVELOPMENT OF THE WILDLIFE ENTERPRISE

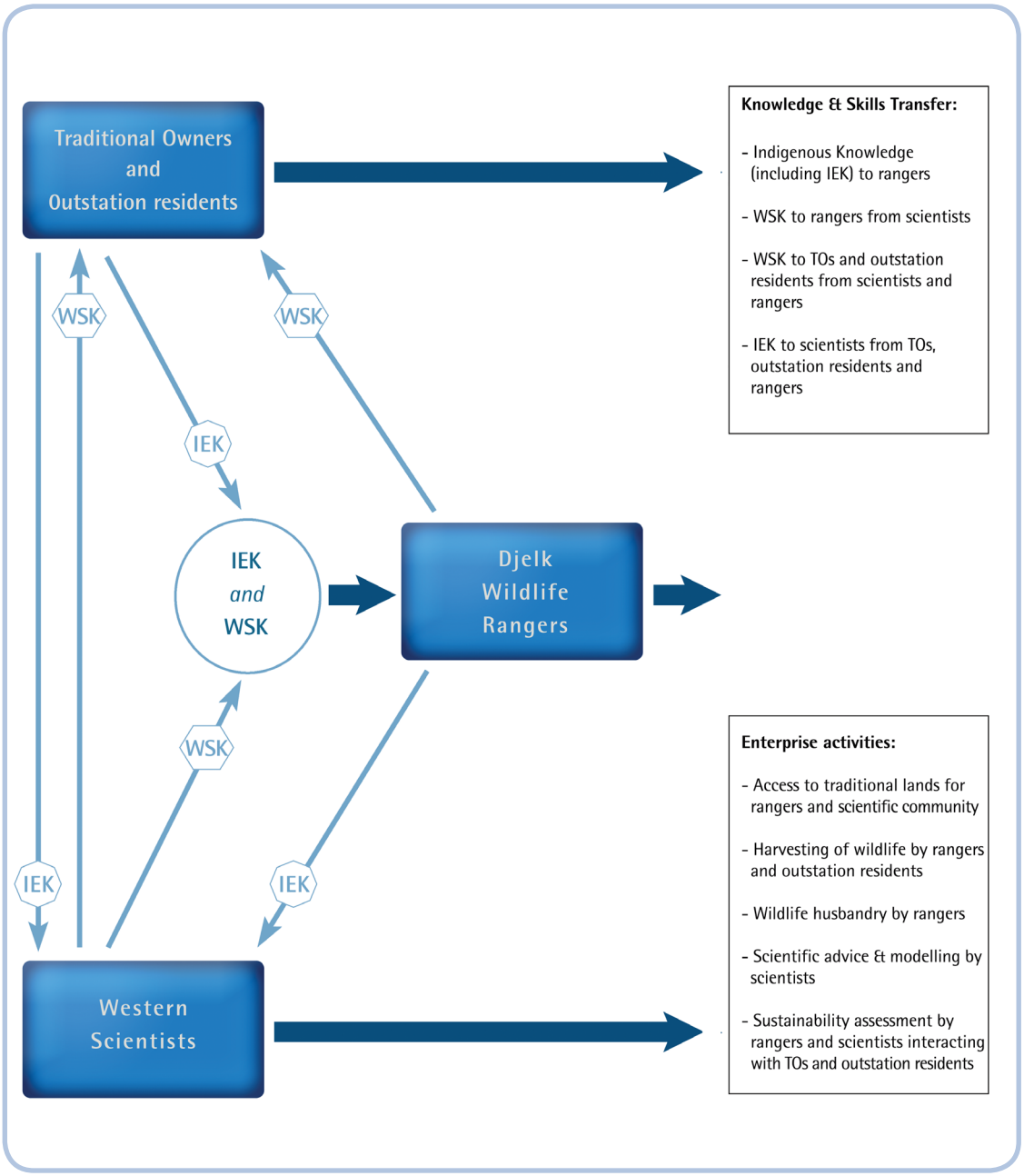
The development of the turtle and spider wildlife industries has been dependent upon the contributions of both western scientific knowledge and IEK. The extensive periods of fieldwork and the building of trusting personal relationships provided opportunities for the Wildlife Enterprise Manager and scientists to gain a deep understanding of many aspects of IEK to complement their existing scientific knowledge. This included both knowledge about the cultural and ceremonial importance of the species, and knowledge of their ecology and life cycle.

The Wildlife Enterprise Manager as a principal scientist drew upon the knowledge of local outstation residents about long-necked turtles (and other wildlife), such as:

- time of year when breeding occurs
- turtle population numbers over time in particular billabongs, and
- local habitat information.

In this way he was able to supplement his more generalised scientific knowledge of reptile ecology.

**Fig. 3. The transmission of Indigenous ecological knowledge (IEK) and western scientific knowledge (WSK) between key agencies in the BAC Wildlife Centre Enterprise**




In the case of the tarantula spiders, where little scientifically based information was available, the scientists gained much knowledge from working alongside traditional owners and outstation residents. This included providing new insights into the life of spiders such as:

- the spider life cycle and their behaviour during the wet season
- reproductive cycle and 'husbandry' of young, and
- spider habitats—in burrows, ground and trees.

**Table 3. The major tasks for a sustainable turtle wildlife enterprise and associated western scientific knowledge and Indigenous ecological knowledge**

| Major task | Relevant western scientific knowledge | Relevant Indigenous ecological knowledge |
|---|---|---|
| Identification and access to traditional lands | Maps of the topography of the region | Cultural practices & beliefs of traditional owners |
| Collection of individuals from wild | Ecology of savannah billabongs and wetlands etc.<br>Life cycle and physiology of *C. rugosa*<br>Animal trapping & handling techniques | Species distribution and species abundance<br>Knowledge of C. rugosa biology<br>Harvesting regimes<br>Harvest techniques |
| Wildlife husbandry | Facility management<br>Measurement and description of captive turtles, including record keeping and trend analysis<br>Incubation techniques<br>Hatchling husbandry | |
| Maintaining sustainable wildlife populations | Ecological principles of population maintenance<br>Understanding past and future variability within landscapes using historical records and forward projections of regional climates<br>Captive breeding and release programs | Long-term and short-term knowledge of environmental impacts<br>Wildlife refugia<br>Spatial and temporal rotations of harvesting<br>Spatial and temporal understanding of variability within landscape (year to year changes) |

Those developing the two industries acknowledged the legitimacy of both forms of knowledge—as evidenced by Fig. 3—and have combined elements of each in undertaking the major tasks involved in establishing a viable enterprise. As might be expected, this has occurred to a much greater degree in the case of the turtle industry which is now a well-established business enterprise.

The major tasks underpinning a sustainable turtle industry, and relevant western scientific knowledge and IEK that has been used for developing processes and procedures for the industry, are identified in Table 3 and illustrated in Figure 3.

**Fig. 4. Djelk Rangers harvesting *C. rugosa* using turtle traps**

Source: Fordham 2007.

This shows that the contributions of western scientific knowledge are drawn from broad scale ecological studies and utilise a range of data sources and techniques that have been derived from a variety of situations. This contrasts to the much more localised Indigenous knowledge about the species—of which little was known by the scientists at the start of the wildlife enterprise development. Two quite different examples illustrate how these forms of knowledge interact.

- In gaining access to billabongs for harvesting turtles, potential billabongs were firstly identified using maps and satellite imagery: the list of candidate sites was refined after consultation with Djelk Rangers, and permission sought after establishing personal relationships with traditional owners and taking account of cultural practices and beliefs.
- Collection of turtles required an understanding of the ecology of savannah, wetlands and billabongs gained from the scientific literature and discussions with outstation residents about localised distribution, abundance and seasonal harvesting regimes (Fig. 4).

**Table 4. Tasks for a sustainable spider wildlife industry and associated western scientific knowledge and Indigenous ecological knowledge**

| Task | Relevant western scientific knowledge | Relevant Indigenous ecological knowledge |
|---|---|---|
| Access to traditional lands | | Cultural practices & beliefs of traditional owners |
| Collection of individuals from wild | Ecology of floodplains | Knowledge of species abundance<br>Spatial & temporal understanding of variability within landscape |
| | Life cycle & physiology of spiders<br>Animal trapping & handling techniques | Traditional ecological knowledge of species biology |
| Wildlife husbandry | Facility management<br>Measurement & description of captive spiders; record keeping & trend analysis<br>Incubation techniques<br>Hatchling husbandry | |
| Extraction of venom | Venom milking techniques | |

The process of utilising western scientific knowledge and IEK for the fledgling spider industry differed significantly in that there was quite limited knowledge about the *Selenotholus sp.*, either from western science or from the Indigenous community. As a result there has been a much greater dependency on the scientists and Indigenous people jointly developing basic information about the species than was the case for the turtle industry. The major tasks for a sustainable spider wildlife industry and associated western scientific knowledge and IEK are contained at Table 4.

A final example of the interaction of knowledge systems highlights the challenges faced when developing a wildlife industry requiring animal husbandry or, more simply, rearing young in captivity. As one of the scientists explained:

> Only by understanding how they [the Indigenous young rangers] think and see can we make the rearing procedures flow smoothly.... the students would not recognise that this is an animal that we have removed from the wild—we have disconnected it totally from its environment and it now needs our attention—so that the rearing issue is a big thing, a cultural thing. Therefore the animals such as spiders that need on-site or off-site captivated attention is a very new concept in terms of their culture (Excerpt from interview 2008).

The research and development approach adopted for these two wildlife industries has respected the legitimacy of the knowledge systems of each partner and recognised that each is continually evolving due to the two-way interaction that accompanies collaboration. Two-way interaction or learning assumes that

each enterprise partner is able to operate across the two knowledge systems. The extent to which this is the case is an area requiring greater scrutiny but during the course of this research:

- The Wildlife Enterprise Manager claimed that the Rangers could move with ease between both forms of knowledge, commencing from their Indigenous knowledge base and incorporating scientific knowledge. Interviews with one of these Rangers confirmed this, as did discussions with their former MCEC teacher.
- The scientists also felt that they could operate within the cultural context of much of the IEK they acquired—and which provided additional meaning to their overall knowledge base.

However there were instances where there was a conflict between Indigenous knowledge and scientific knowledge. This strongly suggests the need to test the accuracy of information against existing western scientific knowledge or IEK from other sources, a point made by several critics of the ready acceptance of IEK in supporting scientific research and development activities (Gilchrist, Mallory & Merkel 2005). Where such conflict arises, for local Indigenous people interacting with scientists, this may lead to a change in IEK in the face of contemporary ecological knowledge. Similarly, it may lead to a re-analysis of existing western scientific knowledge for the scientists as they test their existing knowledge against local knowledge. Two contrasting examples of this were found in IEK related to tarantula behaviour which conflicted with existing scientific knowledge—in relation to tarantulas climbing into trees, and female and male burrows being connected.

In the first instance, the notion of a very large spider that was adapted to living in water and climbing high into trees was inconceivable for the scientist, especially taking into account their vulnerability to predators such as birds when in such exposed situations. For the scientist this required quite a shift in thinking about the behaviour patterns of the spider and the need to test this IEK with fresh observations. In the latter instance, the scientific evidence was more solid, resulting in the need for the Indigenous people to adapt their ecological knowledge to incorporate the idea that male and female burrows were highly unlikely to be connected, if for no other reason than these spiders are highly predatory and hence would not share a habitat (R. Raven pers. comm. 2009).

In summarising the major contributions of each form of knowledge there is a temptation to differentiate the value that might be attached to each. Too often such a question seems to suggest a hierarchy in terms of the legitimacy of the two knowledge systems. Interviews with each of the stakeholders in this wildlife enterprise indicate that this has not been the case. The scientists accepted the legitimacy of IEK and examined the extent to which particular pieces of it could add value to the scientific knowledge required for the task. Similarly, Djelk Rangers assimilated western scientific concepts to their own understanding of the local environment. As this demonstrates, knowledge does not remain static during the research and development process. Both western scientific knowledge and IEK can change in the normal process of gaining more information from the respective scientific and Indigenous communities.

## KNOWLEDGE TRANSMISSION: EDUCATION AND TRAINING PATHWAYS TO SUPPORT WILDLIFE ENTERPRISES

The intergenerational transmission of Indigenous knowledge of northern long-necked turtles and tarantula spiders through story-telling, painting, close observation, customary pursuits and ceremony is a significant component in developing the necessary understandings to underpin a wildlife enterprise. Similarly, field work out on country provides the opportunity for transmission of Indigenous knowledge, and IEK in particular, between Indigenous outstation residents and scientists. Field work also provides opportunities for experiential learning and transmission of western scientific knowledge between scientists and Indigenous outstation residents and Djelk Rangers.

Equally important is the transmission of western scientific knowledge through formal education and training.

Formal training of Djelk Rangers and the education of Indigenous secondary school students in skills and knowledge that are necessary for the effective operation of a viable wildlife enterprise is critical. Without a skilled workforce, the viability of the enterprise remains at risk. This is particularly important for long-term viability, which will depend upon an emerging group of well-trained young people to replace staff moving to other occupations, or to enable expansion of the enterprise. Whilst the principal role of formal training and education relates to the transmission of western knowledge (in this case science), they also have the potential to provide opportunities for the transmission of Indigenous knowledge, at least to a limited extent.

**MCEETYA**: Ministerial Council for Education, Employment, Training and Youth Affairs

To address the need for a skilled Indigenous workforce in remote Australia, the Ministerial Council for Education, Employment, Training and Youth Affairs (MCEETYA) called for the development of training and education strategies that:

- were of high quality and culturally appropriate
- focused upon the capacities and potential of Indigenous students
- adopted pedagogies which led to high expectations and outcomes, and
- were underpinned by curricula which were 'significant' to Indigenous students and young adults (MCEETYA 2006).

Similarly, NT DET identified the development of training, employment and career pathways as a particular priority for young Indigenous people living in remote communities. As a result, there is a strong expectation that system and school personnel will work more closely with external providers, such as the BAC and the Djelk Rangers, to effectively 'case manage' students into post-school opportunities (NT DET 2006).

The application of these government priorities to Indigenous young people living in remote locations has been reviewed by Fordham and Schwab (2007) in terms of the extensive range of CAEPR research undertaken over recent years.

To examine the extent to which education and training providers in the Maningrida region met the MCEETYA call for 'innovative strategies', this research focused upon the two major avenues through which students and young adults could gain the necessary knowledge and skills for employment as Djelk Wildlife Rangers:

- certificate-level training related to land, sea and wildlife management, and
- the senior secondary science curriculum at the MCEC.

## TRAINING: INTERCULTURAL TRANSMISSION OF KNOWLEDGE FOR A SKILLED WORKFORCE

Training of Djelk Rangers responsible for the development of the wildlife industries, as well as land and sea management, has differed across time. During the mid-1990s, the focus was upon short courses. In 1997, formal certificate-level training commenced, with Certificate IV in Resource Management and Certificate I in Land Management Skills offered from CDU.

Certificate-level training was offered by CDU through to 2001 before changing the courses to include a greater emphasis upon the application of Indigenous knowledge to resource management. These Certificate I and II courses in Natural Resource Management were delivered during 2003–05, together

## REVERSE CULTURAL AWARENESS TRAINING: AN EXAMPLE

Using the crocodile industry as an example, Rangers had to write an academic style article explaining the processes involved in crocodile egg harvesting:

- The aim was to help Rangers understand how scientists go about their analyses, how scientists think and what comprises western science
- Rangers found this assignment too difficult due to low literacy levels
- This assignment was adjusted to writing a readable scientifically-based article for the local paper
- This new assignment had the added advantage of 'publicising' the work of the Rangers and building their self-esteem
- The exercise developed the Rangers' perspective on how westerners think, and this was extended to considering the role of universities, graduation ceremonies, use of gowns etc. which had parallels in their own Indigenous culture.

The key to success was in finding the right context. For example, in planning an assignment related to marketing a wildlife enterprise, there is a need to develop Rangers' understanding of how business people think.

with a Certificate IV course which focused more upon administration, planning and assessment. Recently, the Djelk Rangers employed by the Wildlife Centre have acquired specialist skills though their secondary schooling (see next section), complemented by short training courses, rather than through formal certificate-level training.

### AN INNOVATIVE TRAINING STRATEGY: COMMUNITY ENGAGEMENT AND TWO-WAY LEARNING

The Certificates I and II in Natural Resource Management, delivered on country during 2003–05, aimed at improving the Djelk Rangers' capacity in land management and sustainable harvesting activities. These certificate courses used a two-way training approach, drawing upon both IEK and western science, and employed a high level of community engagement. The courses:

- recognised the important contribution of Indigenous knowledge to effective land and sea management
- viewed training as an opportunity for intergenerational cultural transmission of Indigenous knowledge
- prepared Indigenous students to engage in western science discourse and engage with western institutions through a process of 'reverse cultural awareness training' (see text box, above), and
- developed greater cultural awareness and appreciation of Indigenous knowledge among trainers.

To quote the course coordinator, at the very start of the course:

> It was clear from the start that the potential students had a wealth of knowledge already and that the educational process would in effect be something of a two-way exchange. Staff had skills, particularly in language and literacy development. The students had a vast knowledge and skills in natural and cultural management… it was clear that the [training] process was going to be more of a cultural exchange than it was about skills transfer (excerpt from interview 2008).

During the course, the training staff questioned the very nature of their own knowledge system, especially its assumed rational underpinning, and became more aware of the cultural basis of much of their own western knowledge and understandings.

> In a setting where culture becomes the cornerstone of the pedagogical process, it is impossible not to catch at least a glimpse of the cultural constructedness of your own position (Williams 2008).

Initially the Djelk Rangers were the sole focus of this training but later the training was adapted for adolescent students on outstations as well as the Rangers. This resulted in the Rangers not only being 'students' and increasing their land management skills but also being role models for the young adolescents on the outstations, presenting them with potential career pathways. In this way, the program sought to engage young people living on outstations in education and training and help them develop realistic and meaningful job aspirations.

The Djelk Ranger 'on country' training model used in 2003–05 not only utilised the skills of the training provider (CDU) but also provided the opportunity for the transmission or 'teaching' of relevant IEK by traditional owners living on country. Yet their involvement generally remained limited to discussions about their country and sites of special significance, in particular preparing sites for visitors in terms of calling to ancestors and welcoming visitors to country, rather than transmission of IEK related specifically to land management and sustainable harvesting.

### TRAINING IN WESTERN SCIENCE

The certificate courses were the principal means by which western scientific knowledge was transmitted to the Djelk Rangers, providing a solid foundation for the development of land, sea and wildlife management practices. Course units were available dealing with plant and animal identification, mapping and plant and animal surveys, development of land and aquatic management practices, and feral weed and animal control. These courses of study were directly relevant to the tasks undertaken by the Djelk Rangers and their work responsibilities.

Overall, the delivery of the Natural Resource Management Certificate was an innovative strategy. It involved traditional owners, Djelk Rangers, young adults and secondary-age students living on outstations, training providers and science specialists exchanging knowledge, both IEK and western scientific knowledge (see Appendix 2 for more detail on the aims and organisational arrangements for this course).

### THE EFFECTIVENESS OF TRAINING DELIVERY

Courses in Natural Resource Management delivered by CDU were particularly relevant for Djelk Rangers involved in sustainable harvest projects. In total some 25 men and 6 women were enrolled across Certificate levels I–IV, with the large majority enrolled in Certificate I (skills-based and requiring much lower levels of literacy and numeracy). Some 15 Djelk Rangers graduated with Certificate I or II levels in Natural Resource Management over 2003–05. Generally retention rates for this course were higher than with other courses, with the core group of 15 Rangers who graduated attending regularly—other students were less regular due to work commitments and ceremony obligations. No Rangers completed Certificate level IV due to work demands and their high level of responsibilities within the Djelk Rangers.

The effectiveness of the course was positively influenced by the following factors.

- The curriculum and teaching strategies were negotiated: the Rangers shared responsibility in shaping their own education and ensuring that the training directly related to their work responsibilities.
- Engagement with the Rangers necessarily included engagement with the wider Indigenous community, with a visible and active presence in the community being an important aspect of both legitimising the programme and developing a broader understanding of the role of the Rangers within the community and with landowners.
- Training was conceived as part of an overall research and development strategy to support employment, which broadened its scope from mere land management skills training to assisting Rangers successfully engage with researchers and resource managers (Williams 2008).

### CONSTRAINTS UPON EFFECTIVE TRAINING DELIVERY

Programmes such as these certificate courses are subject to a range of external factors which limit their effectiveness. An assessment of the effectiveness of training and employment projects in Maningrida, including these types of courses, by Fogarty and Paterson (2007) identified the following limiting factors impacting upon young adult participation and achievement:

- inability to regularly commit to work and training because of competing ceremonial priorities and commitments
- the need to move to an outstation and discontinue their training and work due to family problems or work-related conflicts
- substance abuse and poor physical health
- crowded and noisy living conditions which make it difficult to present to work on time, and be mentally ready for work
- insufficient literacy to cope with the training
- personal issues such as child minding, and
- choosing alternative employment.

Administrative requirements for employment and training programmes were found to be resource-intensive and limited the extent to which certificate courses could be delivered in remote areas. A huge resource commitment was required by the BAC training coordinator and the CDU course coordinator to maintain effective delivery of the Natural Resource Management Certificate. As a result, once the BAC coordinator left the position, there was insufficient local administrative support to maintain the course. Since 2005 there has been no certificate training of male Djelk Rangers and none is currently planned.[12]

The discontinuation of the certificate courses in Natural Resource Management has resulted in little formal skill development among the current group of Djelk Wildlife Rangers in the area of wildlife management and tasks associated with the wildlife enterprise. For this group, the development of relevant skills has largely been dependent on their secondary science education and experiential learning whilst on field work or when working in the animal handling facility. This contrasts to the important role played by the Natural Resource Management Certificate courses in the early stages of the development of the turtle industry as well as the crocodile industry being operated by the Djelk Rangers. It therefore represents an opportunity missed, especially in regard to ensuring effective workforce succession and extending the scope of the Djelk wildlife enterprise.

## 'CONTEMPORARY ISSUES AND SCIENCE' & 'COMMUNITY STUDIES (SCIENCE)' COURSES OF STUDY, MCEC, 2004–08

**Course commencement:** 2004 for Community Studies (Science) (CS); 2005 for Contemporary Issues in Science (CI)

**Student enrolments:** Since 2004 a large number of students have enrolled in the courses. However, only eight students have continued studying CI for the entire school year and seven students in CS.

Topics: The topics covered in the MCEC curriculum since 2004 have included:

- tarantula spider diversity and abundance
- tarantula spider collection, husbandry and milking of venom
- community attitudes to crocodile hunting and crocodile tourism
- funding of Maningrida sea rangers' patrols of foreign fishing vessels
- crocodile egg collecting
- buffalo disease monitoring
- global warming
- bio-prospecting
- health implications of Maningrida camp dogs
- long neck turtle protection and harvesting of turtle eggs
- local weeds.

**Student completion:** There are no accurate figures readily available on the number of students who enrolled in CI or CS at the start of the school year but who did not complete the course.

All eight students enrolled in CI throughout the school year successfully completed the course.

Four of the seven students enrolled in CS throughout the school year completed the course, one of whom took two years. Of the three not completing the course but who were enrolled throughout the 2008 school year, one student was also enrolled for the 2007 school year.

**Student outcomes:** Knowledge and skills developed included:

- better understanding of ecosystems and the environment
- critical thinking, especially in regard to environmental and community issues
- computer literacy
- written skills
- work readiness skills.

**Employment outcomes:** As at end 2008, all eight students who completed CI were employed, with two being employed as Djelk Rangers in the Wildlife Centre and one other having been employed previously as a Ranger.

Three of the four students who completed CS were employed, one with the Sea Rangers. The fourth student left school at end of 2008.

In summary, of the 12 male graduates who have completed the CI or CS, 11 have employment. One other student who graduated before the ranger program started has just completed a Power and Water apprenticeship.

## SCIENCE EDUCATION: THE CREATION OF AN EMPLOYMENT PATHWAY TO WILDLIFE MANAGEMENT

With NT DET calling for the development of training, employment and career pathways as a particular priority, schools are faced with two decisions. The first is to identify such pathways in regions of low employment opportunity, and the second is to decide upon the extent to which the curriculum should be oriented towards such priorities.

Over the years, senior MCEC staff identified the following three potential employment pathways for MCEC students:

- Djelk Ranger land, sea and wildlife management
- health services through the local health centre, and
- youth and recreation services.[13]

**TER**: Tertiary Entrance Rank

To address the first employment pathway, MCEC adapted its senior secondary science curriculum to include courses and topics significant to local Indigenous students and which related closely to Djelk Ranger activities. Since 2004, the two courses offered have been 'Contemporary Issues and Science', oriented to a Tertiary Entrance Rank (TER) score, and 'Community Studies (Science)', which does not lead to a TER score.

The courses aim to develop understanding of the ways in which western scientific knowledge is acquired, constructed, and applied. Both courses are highly flexible in terms of course content, do not have pre-requisites and assessment is based upon a variety of individual and collaborative activities. In 2008 both courses were offered at Stage 2 (or Year 12) level. There was no Stage 1 (Year 11) science-related course and in the case of 'bridging students' (equivalent to Year 10), science-related content was integrated with other courses.

The curricula underpinning both courses have several unique features. The first is that the curricula utilise 'teaching' resources well beyond those provided by the school. Central to the delivery of 'Contemporary Issues and Science' and 'Community Studies (Science)' is the involvement of the land, sea and wildlife Djelk Rangers, who have assisted in transmission of knowledge, skill development and gaining access to country. Equally important has been the involvement of external agencies beyond the Maningrida community such as the Queensland Museum and Crocodylus Park in the Northern Territory, that have assisted in transmission of specialist knowledge and skill development.

The second unique feature is that both courses include topics of study which are 'real' issues that are being or will soon be addressed by the Maningrida community. Students directly participated in social and scientific research of priority to groups such as the Maningrida Aboriginal Council and the Djelk Rangers or to residents living in town or on outstations.

### SENIOR SCIENCE AT MCEC

The more detailed examination of the MCEC senior science curricula provided here will particularly highlight those elements that are unique to the two senior science courses and that have contributed to the educational achievements at the Maningrida school. A summary of the MCEC senior science curriculum is included in the text box, above.

**Fig. 5. Students investigating the tarantula spider of the Maningrida region**

a.

b.

a. Collecting tarantula spiders (MCEC 2008).

b. Learning to 'milk' tarantula venom (MCEC 2008).

## 'CONTEMPORARY ISSUES AND SCIENCE': MAJOR TOPICS, 2008

**The scientific investigation of the tarantula spider of the Maningrida region** as part of a research program with the Djelk Rangers and the Queensland Museum to increase understanding of tarantula life cycles, distribution and ecology prior to establishing the commercial sale of tarantulas;

**Saltwater crocodile egg harvesting**, which provided students opportunity to understand their lifecycle and the scientific basis of egg collection, incubation and husbandry, to examine tourism and commercial aspects of crocodile enterprises, and to learn about the place of saltwater crocodiles in Indigenous culture;

**Pig disease monitoring**, which enabled students to learn of the distribution of pigs over time in the Top End, the environmental impact of pigs, monitoring techniques for exotic diseases and the impact on the local economy; and

**Bio-prospecting**, which included issues such as bio-technology, potential products and their development, legal processes and government regulatory frameworks, economic benefits, community perspectives and those of traditional owners.

### Responsive and culturally appropriate

An essential component for educational success is responsiveness in school leadership and teaching to the social and cultural context of Indigenous students in remote communities such as Maningrida. Schwab (2001) highlighted the importance of a secondary school possessing a clearly articulated vision for addressing the needs of Indigenous students, especially those at risk of leaving school early. Fundamental to achieving this vision is a respect for Indigenous culture.

Interviews with MCEC senior and teaching staff supported the view that the senior science curriculum was responsive to the cultural needs of students. This was evident in the curriculum documents scoping 'Contemporary Issues and Science' which directly acknowledged the value of Indigenous culture in student learning and included Indigenous knowledge as a Key Idea in the curriculum (MCEC 2008). It was also evident in the school staff's level of understanding of ceremonial and family obligations, and issues related to access to country for field work. The school's emphasis upon bilingual education was a further indication of the value it placed upon cultural context.

### Capacities and potential of Indigenous students

The task for MCEC was to develop a course of senior science study that challenged students to reach their potential and attain a standard of competency in science no students had previously attained. This was achieved by operating the senior science course at two levels—a TER course and a non-TER course. This resulted in the first MCEC male students graduating with a TER score in 2005. At the same time 'Community Studies (Science)' provided the opportunity for less able students, particularly those with low literacy skills, to continue their studies through to Year 12 completion. As the senior science teacher explained:

> The biggest difficulty is literacy in terms of getting assessment outcomes—but when practically based, this becomes less of an issue. Like all workplace environments you learn most when you are doing the job (Excerpt from interview 2008).

The capacity of students and young adults for science-related activities such as land, sea and wildlife management was articulated by one specialist scientist describing a group of Stage 2 students and several ex-students who were involved in the tarantula spider research programme:

> The young people from Maningrida are so capable, thinking all around the issues, a very bright bunch and very tuned in (not just thinking about their own little issues) and that is the perfect situation to get feedback and set up a model at least for eastern Australia of how they can contribute to research. Their engagement in the technology is strong – a tuned-in smart bunch (Excerpt from interview 2008).

A limitation on all Indigenous students reaching their potential through science has been the restriction of the course to male students only. This has been largely due to perceived cultural difficulties associated with acceptance of female students by male students in the class, and by the male Djelk Rangers involved in course delivery, especially when out on country. The school's description of the course as 'the Rangers course' (or 'Young Men Rangers') emphasised that the course was, until 2009, focused on male Djelk Rangers, which is seen as having a higher profile in the community than the smaller female Djelk Ranger group. As a result, the course may well have become an educational equivalent of 'men's business'.

Yet the school recognised the academic strength of the female student cohort, particularly those entering senior school and in 2009, for the first time, enrolled both male and female students in 'Contemporary Issues and Science' and 'Community Studies (Science)'.

### Pedagogies, high expectations, and outcomes

As already noted, a unique feature of the MCEC science curriculum was the integral role played by agencies such as the Djelk Rangers and scientists from the Queensland Museum and Crocodylus Park. Their involvement not only legitimated expected course outcomes but also defined those outcomes in terms of 'cutting edge' science that could underpin the most up-to-date land and wildlife management practices, as illustrated in Fig. 5). Furthermore, their involvement reinforced the importance of those outcomes for future employment. Students interviewed were impressed by the opportunity to work alongside both the Djelk Rangers and the staff of the Queensland Museum and exhibited great pride in displaying their work during field work for this paper.

Through participation of such high-profile organisations, the 'Contemporary Issues and Science' and 'Community Studies (Science)' courses attained a higher profile in the school curriculum than might have been expected. This in turn led to improved self-esteem among students and raised the expected level of performance.

### Curriculum relevance

Creating a curriculum which is relevant or 'significant' for Indigenous students living in remote communities involves making learning relevant or meaningful in both contemporary Western and Indigenous cultural contexts. This is achieved by drawing upon knowledge and experiences that go beyond the classroom and by accepting multiple ways of knowing and different cultural perspectives on issues (MCEETYA 2006).

Since its inception at MCEC the major theme of the 'Contemporary Issues and Science' and 'Community Studies (Science)' has been 'the local environment'. The 2008 Scoping Statement for 'Contemporary Issues and Science' provides the rationale for the curriculum:

> The scope selected is intended to give the students following this program background knowledge about the local environment. There is also a great deal of understanding students will receive about cultural and scientific knowledge. Students will learn the importance of informed decision making and the various opinions of the public and themselves. It is relevant and motivating for students to integrate their cultural knowledge into the decision making processes.... Students will learn the value of science in developing knowledge and understanding of the local environment (MCEC 2008).

Key Ideas and Intended Student Learning identified in the 2008 Scoping Statement were centred on topics of study that had direct relevance to the local Indigenous community and the work of the Djelk Rangers. These topics are summarised in the text box, above.

Each of these major topics took the student out of the usual textbook and classroom setting, included reference to Indigenous knowledge and application within a cultural context as appropriate, and was directly relevant to the ongoing operation of the Djelk Rangers and the Wildlife Centre. At the same time, the expected student learning outcomes were not diminished and had to meet Senior Secondary Assessment Board of South Australia approval, which held responsibility for course accreditation.

### The effectiveness of the senior science curriculum

Against a background of no Indigenous student graduating with a tertiary accredited Year 12 Certificate at MCEC until the introduction of this senior science curriculum, the total of eight students completing 'Contemporary Issues and Science' since 2005 is a measure of its effectiveness. Another four students have graduated from 'Community Studies (Science)' since 2004. Unfortunately it is not possible to calculate the actual course completion rates for the two courses as initial enrolment information is not readily available. From anecdotal information, it would appear that completion rates are not high, in keeping with the very low attendance rates for the school.

The MCEC senior science teacher identified the following learning outcomes that had been achieved by students completing the course:

- better understanding of ecosystems and the environment
- critical thinking, especially in regard to environmental and community issues
- computer literacy
- oral and written skills
- work readiness skills, and
- confidence (Excerpt from interview 2008).

There is strong support for both courses being seen as providing a pathway to employment, although not necessarily into Ranger work. All eight students who completed 'Contemporary Issues and Science' were employed, with two employed as Djelk Rangers in the Wildlife Centre and one other employed previously as a Ranger. Three of the four students who completed 'Community Studies (Science)' were employed, one with the Sea Rangers. No employment information was available about the fourth student.

By their close association with the Djelk Rangers and staff of the Queensland Museum and Crocodylus Park, students completing the courses developed work readiness skills to assist in working in a western cultural setting. Finally, by incorporating aspects of Indigenous knowledge and culture, being 'out on country' and meeting with traditional owners, there was potential for these courses to be mechanisms for ensuring the continuing vitality of the Indigenous culture and of Indigenous communities.

## CONSTRAINTS UPON EFFECTIVE COURSE DELIVERY

### Low literacy skills

The amount of time required to teach units was very high, due to low levels of literacy of students. For all students studying these courses, English was their second language. This resulted in fewer topics being taught than might be the case for students in other schools. For the staff, it raised the question of how much assistance should be given to students when writing assignments. By giving assistance, literacy skills were improved and students could reach a level suitable for employment. However, it was generally agreed that students completing TER courses would still require 'bridging courses' if intending to pursue higher education studies.

### Student attendance

Staff noted that cultural responsibilities and participation in customary activities and ceremonies over the dry season have an extremely negative impact on school attendance. Very few senior students attended school between August and October. Senior staff also raised the possibility that the 2008 attendance rates were particularly poor due to a strong reaction to the Northern Territory Emergency Intervention.

The effect of irregular and prolonged student absence on teachers, students and curricular options is substantial in the following ways:

- Lesson preparation by teachers to cater for an unreliable number of students becomes devalued, is often largely unproductive and reduces teacher motivation. This is exacerbated when students return to school and, not being independent learners, require significant amounts of teacher attention.
- Such regular disruptions to student learning have a particularly negative impact on literacy attainment and the maintenance of literacy skills for the many students with extremely low English literacy levels. After lengthy absences of several weeks or more, students are often not sufficiently motivated to continue in courses requiring longer periods of study and to catch up on work already covered. They tend to 'drop out' of those courses, or even schooling in general.
- Development of curricula based upon 'blocks' of time (e.g. a week or fortnight) for a specific topic could result in the student missing an entire topic (or more) of study. This is more likely to occur in courses such as 'Contemporary Issues and Science'.
- Curricula involving the participation of other agencies or requiring extensive planning—as is the case with field work out on country—are less likely to be developed when student attendance is uncertain.

To address competing but legitimate pressures upon student achievement, at the time of this research the school was examining how best to timetable courses which took account of the major ceremonial periods in the Maningrida region. This included consideration of again requesting NT DET permission to change the school year to locate the 'long break' in the dry season, a time of most ceremonial activity. In this way, the high value placed on Indigenous culture could be maintained whilst providing students maximum opportunity to attend school.[14]

### Lack of science in earlier years

The study of science and the environment prior to Stage 2 (Year 12) was very restricted, with no Stage 1 science-related course in 2008 and only a very limited teaching of science in middle school or Year 10. To overcome lack of prior formal scientific knowledge, skills and understandings, a different style of teaching was required; one which was more highly individualised, time-consuming and based upon 'scaffolding' the learning outcomes (Van Der Stuyf 2002). Furthermore, the effect of low literacy skills spilled over into the lack of science literacy—that is, the ability to recognise and use necessary science terminology that might be expected of Stage 2 students.

MCEC recognised the need to develop a more comprehensive science curriculum, particularly if students were to be provided the option of a strong pathway to employment in land, sea and wildlife management. The school developed—with the Djelk

Rangers—a series of 'on country' activities to be undertaken as part of the 2009 middle-school science curriculum. Small experiential activities with the Rangers, combined with classroom activities, were seen as sound preparation for more detailed study of science in the senior school. Whilst these activities might be considered as constituting a junior ranger programme, the curriculum would not appear to have the necessary pedagogical foundations that characterise effective junior ranger programmes (Schwab 2006). Staffing constraints did not allow a proposed inclusion of a Stage 1 'Contemporary Issues and Science' course or Stage 1 Community Studies (Science) for 2009.[15]

## SOME CONCLUDING REFLECTIONS

The study set out to explore the knowledge foundations underpinning a wildlife enterprise and the transmission of that knowledge to those directly involved in the enterprise. As such the study required a multi-disciplinary approach, drawing upon specialists in anthropology, science, wildlife management, education and training and programme evaluation. The study highlighted the dependence of viable wildlife enterprises in remote regions upon both IEK and western science. This not only related to enterprise development but also its ongoing operation. The study identified the intergenerational transmission of IEK and the role experiential learning on country plays in the two-way transmission of western scientific knowledge and IEK between scientists and Indigenous people involved in the enterprise. The study also demonstrated the important links between education, training and the continuing viability of wildlife enterprises. Just as wildlife enterprises are dependent on recognising the important contributions of both IEK and western scientific knowledge, so too successful training and education delivery is dependent upon recognising the legitimacy of both forms of knowledge. To maximise the benefits that can accrue from each knowledge system in the development of wildlife enterprises, the two-way learning of IEK and western science, whilst on country or in a wildlife handling facility needs also to be reflected in the delivery of education and training by schools and training institutions.

### VALUING THE IMPORTANCE OF INDIGENOUS ECOLOGICAL KNOWLEDGE

The development of the BAC wildlife enterprise was dependent on the acquisition and appreciation of a rich source of IEK. The importance of recognising and acknowledging the valuable contribution of IEK to land, sea and wildlife management, and using that knowledge as in the case of this wildlife enterprise, cannot be underestimated, as indicated by Aboriginal leaders:

Aboriginal leaders from across the savannahs perceive that the preservation of knowledge and the development of mechanisms that perpetuate this knowledge are of highest priority (Tropical Savannas CRC 2008).

The value accorded IEK by the scientists in the current study:

- enabled strong personal relationships to be established between the scientific community and Indigenous town and outstation communities
- facilitated access to country
- provided localised ecological and species-specific information which otherwise could not have been obtained from existing scientific literature, and
- provided an opportunity for this knowledge to be transferred (or reinforced) to younger Djelk Rangers from traditional owners or other Indigenous community members.

Most importantly, valuing IEK and building it into the 'business' model of the wildlife enterprise engaged the local community and promoted a strong sense of community ownership of the enterprise.

## VALUING THE IMPORTANCE OF A STRONG SCIENTIFIC BASIS

The successful development of wildlife industries in remote areas is at a very early stage in Australia. Often little is documented about the local species, especially in regard to collection of individuals from the wild, optimal conditions for egg incubation where applicable, and for animal husbandry. Acknowledging the need to build a strong scientific base as a precursor to commercial activity is of paramount importance. Yet this may be time-consuming and require resources at a level beyond that available through either the Indigenous sponsoring organisation or from government. If a strong scientific basis is not valued and resourced then wildlife industries will not be viable. In brief, wildlife industries are not a quick-fix solution for a local Indigenous economy.

Furthermore, the development of sustainable wildlife industries is not without its critics. For this reason a valuable and necessary scientific outcome of wildlife industry development is the ability to demonstrate sustainability of species through population modelling. The rigorous population modelling underlying the turtle industry is species-specific and takes account of customary harvesting, commercial harvesting, predation, invasive species, availability of temporal and spatial refugia, and climatic change. Again, as in the case of developing the above wildlife handling and husbandry procedures, this is time consuming and requires adequate resourcing. However it has enabled the turtle industry to withstand the level of scrutiny which wildlife harvesting and associated industries attract.

## THE INTEGRATION OF INDIGENOUS ECOLOGICAL KNOWLEDGE WITH WESTERN SCIENCE

The question of the extent to which IEK and western scientific knowledge has been integrated to produce a new body of knowledge to underpin the wildlife enterprise may be raised. The possibility of a paradigm shift occurring with an accompanying development of a new knowledge system has been raised, based on the large number of scientific publications now drawing upon IEK in conservation and land management research (e.g. Brook & McLachlan 2008).

In this case the extent to which the integration of IEK with western scientific knowledge could possibly lead to such a 'paradigm shift' is unclear. Gaps in existing scientific knowledge were filled by knowledge about the local ecology and species held by the Indigenous communities. Issues and new research questions were raised through interaction with Indigenous communities that required further scientific analysis. The application of existing scientific knowledge to local conditions was tested against local Indigenous knowledge. There was certainly greater understanding by scientists of the cultural and spiritual dimensions of IEK and their incorporation into Indigenous land and wildlife management practices. It was not simply a matter of the scientists reducing IEK to a scientific positivist framework and ignoring its much more holistic dimensions. However the extent to which this integration of elements of IEK with western scientific knowledge could lead to the development of a new and conceptually different knowledge system remains a question that warrants much more investigation. It may well be that over time as the scientists (and the Djelk Rangers) move more easily between both IEK and western scientific knowledge a quite different conceptualisation of the science underpinning wildlife enterprises will evolve. Such scientific knowledge would be one derived from the 'interconnectedness' of the two knowledge systems.

## THE CONSISTENCY OF BOTH FORMS OF KNOWLEDGE

In general there was widespread consistency in ecological information derived from Indigenous people on country and either already established or predicted scientific information held by scientists. This accords with the findings of Telfer and Garde (2006) with regard to the consistency between scientific knowledge and Indigenous knowledge about the rock kangaroo ecology in western Arnhem Land.

Importantly Telfer and Garde (2006) found that Indigenous knowledge of the rock wallaby extended beyond that reported in the scientific literature. There were similar instances in the current study, especially

in regard to scientific knowledge about the abundance and distribution of the local tarantula spider. There were also several instances where there were inconsistencies of ecological knowledge between Indigenous knowledge and western science. As already noted, the concept of a tarantula spider climbing a tree certainly challenged the beliefs of the scientists. The adaptation of tarantula spiders to periods of living under water in the wet season was another example. Such instances led the scientists to re-examine their understanding of the ecology of the species and in the case of the tarantula led to its identification as a new species. Conversely Indigenous people were challenged by new knowledge arising from the study, in this case in regard to the breeding habits of the tarantula spider and the nesting sites of turtles. Both relate to aspects of the life-cycle which are not clearly visible, a finding similar to that of Foale (2006) in marine resource management among Melanesian indigenous fishers.

### LANGUAGE AND TAXONOMY

The study identified differences between the basis for Indigenous naming of the turtle and spider species and western scientific naming, suggesting an Indigenous taxonomy that differs with the scientific (Linnaean) taxonomy. Differences between Indigenous and scientific taxa were reported by Foale (1998) in regard to Solomon Islands fish taxonomy and other marine vertebrates and invertebrates. Some scientific species corresponded to more than one Indigenous taxon and the differentiation of taxa was more common for those species that were important to the subsistence economy. As Foale noted, the detailed naming system of the more commonly exploited fishes indicated a greater depth of knowledge of their biology and behaviour. The underlying complexity of the Indigenous naming system used in regard to the rock wallabies of western Arnhem Land was similarly noted by Telfer and Garde (2006). Ens et al. (2009) reported that whilst Rangers suggested that there was only one word for frogs of the Arnhem Plateau, senior people used other words to describe different frogs when depicted in art, at ceremony, in the bush or in general discussion. Taken together these studies highlight the importance of understanding the language used by Indigenous people to identify species if a more detailed analysis of IEK is to be obtained. For the current study, the findings indicate the need for a multi-disciplinary approach to understanding the bases of Indigenous taxonomy, especially in regard to the tarantula spider, and the implications that may have on the development of wildlife management practices.

### INDIGENOUS KNOWLEDGE, INTELLECTUAL PROPERTY, PATENTS AND PUBLICATION RIGHTS

The integration of Indigenous ecological knowledge with western science to develop the harvesting, animal husbandry and population monitoring techniques to underpin a sustainable wildlife industry raises the question of intellectual ownership. Whilst this is somewhat clearer with regard to the proposed extraction and sale of tarantula venom and has been well canvassed under the label of bioprospecting (e.g. Davis 1998; O'Bryan 2004), the situation is far less clear in regard to the intellectual property rights associated with the direct sale of wildlife into the domestic market. These property rights relate to the knowledge underpinning the collection, breeding and animal husbandry of wildlife such as turtle hatchlings and spiderlings. Partnership or contractual arrangements between scientific institutions and local Indigenous organisations need to specify the extent to which techniques developed during the course of the establishment of a wildlife industry that have been reliant upon Indigenous knowledge or access to Indigenous land can be treated as 'commercial-in-confidence'. Such arrangements could address the wider application of those techniques to other locations or to other species which may, in the future, constitute market competition. Yet such considerations are generally not at the forefront of wildlife enterprise development, which often commence from more ad hoc arrangements between Indigenous organisations and scientific institutions as partners with seed funding from government. We suggest that there are critical issues surrounding intellectual property and publication rights in the development of wildlife industries that warrant further attention.

## TWO-WAY LEARNING AS THE BASIS OF KNOWLEDGE TRANSMISSION

There were close parallels between the exchange of knowledge that underpinned the every-day operation of the wildlife enterprise and the more formal delivery of training and education. Both involved the two-way transmission of IEK and western scientific knowledge, leading in both cases to a more comprehensive set of skills and knowledge base among participants. Both were focused upon issues that were significant to the Djelk Rangers and Indigenous residents on outstations and students. They were also significant to the scientists, trainers and teachers. Importantly, both involved 'on country' experiential learning.

## INDIGENOUS KNOWLEDGE AND THE SCHOOL CURRICULUM

The potential role of the MCEC incorporating Indigenous knowledge into the school curriculum was raised during interviews. Whilst this is consistent with the Indigenous education policy as agreed by government, there remains some debate as to how this might be accomplished. Recent analyses of the manner of inclusion of Indigenous knowledge into science textbooks in the secondary school highlight the difficulties of treating Indigenous knowledge within the science curriculum (Cobern & Loving 2001; Ninnes 2000).

Whilst there is scope for inclusion of IEK into the science curriculum (or more generally into the school curriculum) and there is a priority given to 'two-way education', NT DET staff reported that this does not occur to any marked degree across Northern Territory secondary schooling. IEK tended to be treated within a western scientific framework rather than promoting the legitimacy of a plurality of knowledge systems. Furthermore, research suggests that curricular interventions which have tried to be inclusive of Indigenous perspectives have generally presented Indigenous knowledge and representations of Indigenous society and culture as complete and unchanging (see Sillitoe 1998). However, this should not preclude the continuation of such efforts. Indeed, further development of curricula aimed at 'on country' learning has a critical role to play in the development of Indigenous knowledge based curricula.

## THE DEVELOPMENT OF EDUCATION AND EMPLOYMENT PATHWAYS

Effective employment pathways require the establishment of strong partnerships between secondary schools, training providers and employers. MCEETYA (2006) recognised this. Yet there was little evidence of such a partnership operating on the ground in Maningrida, despite recognition that Ranger employment was a priority for all those involved in the teaching of relevant courses. Relationships tended to be more dependent upon particular staff from the Djelk Rangers and the school taking the opportunity to work together rather than a more formal relationship between MCEC and the Djelk Rangers. The need to formalise such partnerships and address resourcing issues remains a priority.

Junior ranger programmes, involving secondary school students, have been seen as a way forward in promoting an employment pathway. However a research priority is articulating a solid pedagogical foundation for a junior ranger learning programme that will develop the skills and understandings necessary for future employment in land, sea and wildlife management. Such a learning programme could involve customary skills and knowledge, life skills and ranger skills, delivered both within the classroom and out on country and utilise the specialist knowledge of teachers, rangers and other specialists, and the Indigenous community including traditional owners (see Schwab 2006). The important point is that successful education and employment pathways cannot be founded solely on existing approaches to secondary school curricula.

The development of a strong educational pathway leading to skilled secondary school graduates is even more problematic without significant changes to the institutional setting. Strategies to reduce student absenteeism during the dry season, corresponding to times of intense ceremonial activity, are of high priority and have been canvassed earlier in this paper. Whilst the focus on literacy remains the highest educational priority, sufficient staffing resources are required to provide a science-related curriculum

across all of the high school and senior secondary school years if priority is to be accorded to land, sea and wildlife management as potential employment options.

## THE NEXT STEP ...

This study has identified the importance of IEK to the development of the turtle and tarantula spider industries. We have highlighted a number spheres where IEK could potentially contribute to better assessing the ecological viability of prospective wildlife industries. These include strengthening species distribution and demographic models. The next challenge is to directly establish how important the contributions from IEK are to these predictive tools, techniques which are key to the successful management of harvested populations and thus the development of wildlife industries.

Quantifying the contribution of IEK to ecological models will very much be dependent upon a multi-disciplinary approach to gathering Indigenous knowledge about the ecology of the species. Quantifying the contribution of IEK will also inevitably require statistical approaches that are generally associated with western science concepts. With this in mind, a novel method would be to use a Bayesian statistical framework to determine whether incorporating key aspects of IEK provides more ecologically realistic models that could be applied when, for example, predicting species range and abundance under different harvest scenarios. This recognition of established IEK, including those aspects outlined in this paper, would avoid starting at a 'null view point'. It would seem logical that if expert knowledge from scientists and naturalists can provide effective prior information to strengthen model output (Choy, O'Leary & Mengersen 2009), there is enormous scope to better incorporate IEK into ecological modelling and, in turn, the development of scientific processes necessary for the effective operation of a wildlife industry.

# NOTES

1. These population numbers are the actual counts enumerated by the 2006 census. The ABS does not produce estimated resident populations for Maningrida and its region and hence these population numbers represent an undercount of the residential population. When applying the Northern Territory-wide undercount of 19% for the 2006 census, Altman (2008) suggest a regional population of about 3000 people, of whom some 2800 are Indigenous people. This compares to 2435 people enumerated by the 2006 Census.

2. During the 1960s and 1970s anthropologists engaged in much debate over the delineation of terms such as clan, hoard or band. For a discussion of this see Keen 1994. The term clan is contestable and in some ways simplistic and misleading. Through memetic linguistic adaptation, however, it is a term that is readily used by the people of the region.

3. The evolving nature of IEK from an Indigenous perspective is highlighted by the Dene Cultural Institute (1998) that describes IEK in the following way, which also picks up on the knowledge-practice-belief complex identified by Berkes (1999):

   > Traditional environmental knowledge is a body of knowledge and beliefs transmitted through oral tradition and first-hand observation. It includes a system of classification, a set of empirical observations about the local environment, and a system of self-management that governs resource use. Ecological aspects are closely tied to social and spiritual aspects of the knowledge system. The quantity and quality of traditional environmental knowledge varies among community members, depending on gender, age, social status, intellectual capability, and profession (hunter, spiritual leader, healer, etc.). With its roots firmly in the past traditional environmental knowledge is both cumulative and dynamic, building upon the experience of earlier generations and adapting to the new technological and socioeconomic changes of the present.

4. As Merlan (1998: 223) states we should:

   > ... cut across radical dichotomies between traditionality and (presumably) non- or post traditionality, between persistence and change; to assume neither is more fundamental than the other and to begin in the middle where both are relevant, rather than with notions of separateness and distinctiveness.

5. The five areas of complementarity are:

   - information gathering: science collects data over large areas but within relatively short time-series whereas IEK tends to record data from the immediate locality over a much longer period of time. Using both sources of information provides a more complete spatial and temporal understanding;
   - identifying averages and extremes: science focuses on statistical averages for particular types of events whereas IEK is more concerned with extreme events, variations and unusual patterns. Combining both enables an examination of the application of more general principles to local situations;
   - quantitative and qualitative information: science places greater emphasis upon the collection of information about the specific issue, while IEK is more concerned with collecting qualitative information about the whole. Combining both leads to better understanding of complex systems;

- hypotheses and testing: science provides the tools for testing hypotheses and IEK is better able to generate more locally relevant hypotheses within shorter time frames; and
- objectivity complementing subjectivity: science has a more objective focus and IEK a more subjective and community focus (after , Moller, Berkes, Lyver et al. (2004).

Such complementarity of each knowledge system in addressing environmental issues is also highlighted by Pierotti and Wildcat (2000).

6. Bayesian methods are a statistical approach whereby prior knowledge and new data are combined using a model to produce posterior knowledge (McCarthy 2007). Bayesian methods may utilise both objective data and subjective evidence such as beliefs held by experts in a specialist field of research or people such as Indigenous traditional owners who hold specialist Indigenous knowledge.
7. An anthropological recording of the *Bungal* is archived in the BAC cultural research office, but is yet to be translated into Standard Australian English.
8. This appears contrary to western scientific knowledge of expected distribution and warrants further investigation to verify whether the tarantula spider's range does extend to savannah woodlands or whether the distribution of another similar large spider is being reported.
9. Refugia are regions of favourable habitat in which species or groups of species persist during periods during which most of the original geographic range becomes uninhabitable. This may include regions where a species retracts for short periods of time when large parts of their preferred habitats become uninhabitable because of drought or other effects (temporal refugia). It may also refer to regions where the species have permanently retracted because of long-lasting environmental changes (spatial refugia) (see Morton, Short & Barker 1995).
10. See Cooney (2007) for a review of the definitions that have been applied to the concept of sustainable use.
11. Hysteresis refers to the situation where the state of an ecological system may be determined in part by its history as well as more immediate environmental disturbances that impinge on the system. As a result it may not be possible for an ecological system to be restored to an earlier state. For this reason, and at a more general level, a system with hysteresis is often referred to as having 'memory' and it is not possible to predict the output of a system at a particular point in time without knowing its history or more precisely the history of its inputs. See Ludwig, Walker & Holling (1997) for the application of the concept of hysteresis to ecological systems.
12. Batchelor Institute of Indigenous Tertiary Education delivered Certificate II and III training in Conservation and Land Management to eight female Rangers during 2008.
13. These priorities were being reviewed in September 2009 by the newly appointed school executive.
14. NT DET has recently agreed to this change to the structure of the school year.
15. The inclusion of science in the middle school in 2010 was under consideration by the newly appointed school executive in September 2009, as was the inclusion of a VET in Schools programme which would include certificate training in Conservation and Land Management for post-Year 10 students.

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# APPENDIX 1. METHODOLOGY USED TO GATHER INDIGENOUS ECOLOGICAL KNOWLEDGE

This study required the collection of Indigenous Ecological Knowledge (IEK) specific to the northern long-necked turtle (*Chelodina rugosa*) and a species of tarantula spider (*Selenotholus sp.*). Representations of Indigenous knowledge surrounding these two species should be seen as existing contemporaneously and subject to the intercultural realities of life in the Maningrida region. As a first step in gathering and documenting the IEK of the turtle and tarantula spider, the social-cultural context of the Maningrida region was examined.

For the second step in exploring the strength, relevance and availability of IEK surrounding the two species, a series of interviews were conducted with Indigenous people from Maningrida and surrounding outstations. Respondents were not chosen randomly, but rather through connections to country within the scope of the enterprise development, seniority within the socio-cultural fabric of the region and immediate township, as well as through self selected interest. This is consistent with critical appraisals of methodologies used in the past for gathering IEK that have called for targeting of individuals that have greater knowledge of the species under examination rather than adopting a more random sampling methodology (Gilchrist, Mallory & Merkel 2005; Huntington 2000).

Information was gathered in situ during August and September 2008 using a standardised question format or interview schedule, see below. A standardised set of questions was developed to ensure the required information was sought. However, the interviews are best described as semi-directive interviews, allowing the respondents to 'converse' with the researchers and follow more closely their own train of thought rather than be limited by a tight interview schedule as typically occurs in social science research.

Five recorded interviews relating to Indigenous knowledge of long-necked turtles were undertaken during this period by the Wildlife Centre Coordinator, Mr Ben Corey. This interview information was supplemented by a series of earlier interviews undertaken by Damien Fordham during the establishment of the turtle enterprise (during 2000–05) which were recorded and/or where detailed field notes were taken. The purpose of these earlier interviews (n = 35) were to determine key life history information.

Nine recorded interviews with nine different respondents relating to Indigenous Knowledge of tarantula spiders were undertaken by Bill Fogarty, who supplemented these nine interviews with less formal interviews of another 30 people in more casual settings, with detailed field notes taken. One of the interviews was specifically conducted with staff of the BAC Wildlife enterprise development as a training exercise, where the method of semi-formal anthropological interview was demonstrated with the staff acting as respondents. As well as identifying IEK held by Wildlife Centre staff, it also increased their awareness of interview techniques which, in turn, would assist them during future consultations and information gathering.

In the case of the tarantula-related interviews, all interviews were conducted in conjunction with Indigenous collaborators and interpreters, with both male and female collaborators participating at different times. As an impetus and visual aid to each of the interviews, a live specimen of *Selenotholus sp.* was procured from the BAC Wildlife Centre enterprise. Due to the widespread knowledge of *C. rugosa* across the region, the display of a specimen of this species was not necessary.

A summary of IEK outcomes from the interviews are given at Table A1.

We recognise the caution that documenting IEK is time consuming and is best achieved over a lengthy period of time (Huntington 2000), longer than the 2 month period allotted for the more standardised interviews in the current study, especially as was the case in regard to the tarantula species. Whilst this is

true, the collaborative nature of the on-going research associated with the development of the tarantula industry will provide the opportunity to gather further information about the IEK of the tarantula spiders of the Maningrida region. We should point out however that there has been considerable anecdotal information gathered already by the scientists (and the Wildlife Centre Coordinator) responsible for developing the tarantula spider industry arising from their collaboration with Indigenous peoples living on country. This is less of an issue in regard to the long-necked turtle IEK as extensive information was gathered and documented by Damien Fordham from key informants over a five year period. Finally, the collaborative approach to the research, involving both Djelk Rangers and traditional owners, together with the researchers' extensive experience working in the Maningrida region, increased the willingness of the Indigenous respondents to share IEK with the researchers, a potential methodological problem that has been noted elsewhere (Huntington 2000).

Interviews were conducted within the ethical parameters of the larger project, as per the Australian Research Council and The Australian National University ethics clearance process.

## SEMI-DIRECTIVE INTERVIEW FRAMEWORK

**Aim:** To establish aspects of indigenous ecological knowledge important to wildlife enterprise development

### Species Distribution

(i) Where on the landscape is the species' found i.e., establishing its range?

(ii) What defines where the species is located? Note that this includes environmental factors (i.e., rainfall; temperature; and edaphic conditions), species interactions (i.e., food and habitat availability) and human-induced impacts (i.e., introduction of invasive species).

(iii) Is the species found in the same place as it was when you were a child? This tries to gauge temporal distribution shifts in response to natural and human-induced environmental shifts.

### Abundance

(i) Where are the animals found in highest densities and what are the key characteristics of this habitat?

(ii) Do population numbers change in response to seasonality? This is common in the wet dry tropics and reflects annual depressions in population abundance (i.e., periods of low survival) and recruitment pulses. The former normally coincides with the dry season and the later with wet season—though I would expect the opposite with the floodplain spiders

(iii) Has there been long-term temporal change in the animal's abundance? Used to determine whether we are dealing with a declining, increasing or stable population. This background information is important for understanding the impact of the harvest.

### Life history of the species

Necessary information to ensure that the harvest is sustainable.

(i) When do they breed?

(ii) Where do they breed?

(iii) How do they breed i.e., eggs, live bearers etc.

(iv) When do hatchlings/juveniles enter the population?

(v) Is there a period of high mortality i.e., for turtles it is when the billabong dries out at the end of the dry season?

(vi) What species' (including humans) preys upon them?

(vii) Do they move across the landscape and if so when i.e., good to know about dispersal between populations?

### Traditional harvest regimes

(i) Do you collect and eat these particular animals?

- Nutritional value
- Medicinal value
- Traditional uses

(ii) When and how do you collect these animals?

(iii) Did your parents ever eat this animal or use it for medicinal/traditional purposes?

(iv) Do you eat/use these animals immediately or do you have techniques to store the food source for utilisation at a later date i.e., when people were still walking over country, turtles would be dug up out of the ground and then reburied in a pit, providing food for the return journey. This gives us an understanding of any animal husbandry techniques.

(v) I suggest asking about cultural stories – as they can provide a good insight into the ecology of the species

### Transference of information

(i) How did you learn about these animals and from whom i.e., who are the custodians of the knowledge?

(ii) Is the above information passed on to the following generation and if so how and by whom?

(iii) Cultural role of the species (i.e. totem, ceremonies, etc.)

(iv) Are there sites, times of the year when the animal can not be utilised. This is important because it can provide population refugia, promoting sustainability.

### Access issues:

(i) Do you currently allow people to come onto your country to collect wildlife? If so, who are they?

(ii) If at this stage you do not have people coming onto your country for collecting wildlife as part of a wildlife industry:

(a) Would you agree to allowing people onto your country to harvest wildlife as part of a wildlife industry?

- If so, who would you allow i.e., Rangers, family
- Are there any aspects of wildlife harvesting you would wish to do yourself, or join in with others doing it?

(iii) What are the preconditions for people being allowed entry to your country?

- Having a clan member with them
- Having specific cultural understandings i.e., meeting with TO's and discussing the cultural landscape

.

**Table A1. Summary of IEK information for each of the two species gathered during semi-directive interviews and field work**

| Indigenous Knowledge | *C. rugosa* | *Selenotholus sp.* |
|---|---|---|
| *Cultural Importance* | | |
| Ceremonial obligations | ✓ | ✓ |
| Artistic representation | ✓ | ✓ |
| Dance | ✓ | ✓ |
| Food source | ✓ | N |
| Regular interaction | ✓ | N |
| *Species identification* | ✓ | ? |
| *Species distribution* | | |
| Range | ✓ | ✓ |
| Distribution over time | ✓ | × |
| *Species abundance* | | |
| Density of species | ✓ | ✓ |
| Change over time | ? | × |
| Habitat | ✓ | ✓ |
| Seasonal effects | ✓ | ✓ |
| *Life cycle* | | |
| Time of breeding | ✓ | ✓ |
| Location of breeding | × | ✓ |
| Pre-adult development | ✓ | × |
| Mortality | ✓ | × |
| Predators | ✓ | ✓ |
| *Intergenerational transfer* | | |
| Customary activity | ✓ | ✓ |
| Ceremonies: dance, art, songlines | ✓ | ✓ |
| Sacred Law | ✓ | ✓ |

Key: ✓ - respondents generally provided consistent information
N – respondents agreed does not occur
× – no or little knowledge held by respondents
? - conflicting or uncertain information provided by respondents

# APPENDIX 2. THE NATURAL RESOURCE MANAGEMENT CERTIFICATE: AIMS AND ORGANISATIONAL ARRANGEMENTS

## THE 2003–05 DJELK RANGER 'ON COUNTRY' TRAINING MODEL

### Aim

To engage young people living on outstations as well as increasing the land and sea management skills of Djelk Rangers

### Organisational arrangements

- BAC training officer was responsible for all the 'on-the ground' organisation of the Djelk Rangers and, through them, liaising with the outstations and traditional owners. The officer was also responsible for workplace assessments.
- The School of Applied Indigenous Knowledge Systems (CDU) was responsible for course delivery related to engagement of Indigenous people with western science thinking.
- The Conservation and Land Management School (CDU) was responsible for any specialist scientific training and assessments.
- MCEC through the outstation schooling program incorporated aspects of the course into their school curriculum.
- Traditional owners were responsible for training 'on country'.

Typically each short course and visit to an outstation would:

- be of about 1 week's duration
- involve 12 students (generally 14 year olds or thereabouts)
- involve 8 Rangers who were often associated with the region in which the outstation was located
- be at Certificate I level and oriented to topics such as plant harvest, animal harvest and/or sites of cultural significance depending on the country—plant harvest being associated with inland areas and animal harvest closer to the sea, and
- include literacy, numeracy and computer training.