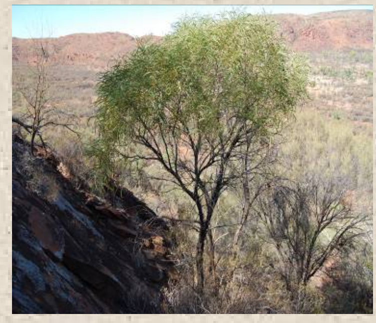
Recovery action implementation for threatened arid acacias

Distribution, monitoring and Indigenous ecological knowledge of *A. peuce*, *A. undoolyana*, *A. pickardii* & *A. latzii*



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Abbreviations

APS	Australian Plant Society, a non-profit, independent, incorporated community organisation with members throughout Australia that encourages the growing, propagating, preservation and conservation of Australian plants
CLC	Central Land Council, a statutory authority representing Aboriginal people in the southern Northern Territory under the *Aboriginal Land Rights (Northern Territory) Act 1976*. It also has functions under the *Native Title Act 1993* and the *Pastoral Land Act 1992*
MCCR	Mac Clark Conservation Reserve
NP	National Park
NRETAS	Department of Natural Resources, Environment, the Arts & Sport of the Northern Territory; includes the Parks and Wildlife Service
NT	Northern Territory
PWSNT	Parks and Wildlife Service, Alice Springs, Northern Territory, a service within NRETAS
SA	South Australia
SA DEH	South Australian Department of Environment & Heritage

Executive Summary

1. The project implemented three key actions from the 'National recovery plan for threatened Acacias and *Ricinocarpos gloria-medii* in central Australia'; specifically to: carry out targeted surveys for additional populations of *Acacia latzii* and *Acacia pickardii* in the NT and SA; carry out population and habitat monitoring at selected sites for these two species, *Acacia peuce* and *Acacia undoolyana*; and engage Indigenous ecologists to provide input into the recovery process.

2. Targeted surveys extended the extent of occurrence of both the northern and southern populations of *Acacia latzii*; in the case of the southern population this involved a large increase. Thirty-three individual stands of *Acacia pickardii* were mapped on Andado Station and knowledge of the species' distribution was refined.

3. Monitoring programs were set-up and the first round of monitoring completed for each of the four Acacia species. The number of monitoring plots established for each species was: *Acacia peuce*, 24; *Acacia latzii*, 5; *Acacia pickardii*, 4; *Acacia undoolyana*, 6.

4. The monitoring program for each species targets the most vulnerable life history stages and is designed to maximise the ability to determine negative trends, to assess the effectiveness of specific management actions and to best use scarce human and financial resources. In most cases monitoring is recommended at intervals of five years.

5. Indigenous ecological knowledge was sought and recorded for each species by working with Traditional Owners and other knowledgeable Indigenous people and by assessing the existing literature and unpublished records of anthropologists, linguists, and ethno-biologists. This assessment also included understanding the significance of each species in Aboriginal mythology.

6. Completion of this project is a significant step in ensuring the recovery of the four threatened Acacia species.

Part 1 Introduction

This report details the findings of a project titled "Implementation of recovery actions for threatened Acacias in central Australia". The project was funded by the Federal Department of Environment, Water, Heritage and the Arts.

The actions carried out during the project stem from those identified in the "National recovery plan for threatened Acacias and *Ricinocarpos gloria-medii* in central Australia" which was adopted by the Federal Minister in 2007. The plan lists nine recovery actions, three of which were undertaken as part of this project. The recovery actions chosen for implementation were those that: were of most urgent need, involved a wide range of stakeholders, and were capable of being completed during the project period.

The three actions undertaken and detailed in this report (together with the relevant page numbers from the National Recovery Plan) are:

Action 1. Carry out targeted surveys for additional populations of Acacia latzii *and* Acacia pickardii *in the NT and SA (pages 43-44).*

Action 3. Carry out population and habitat monitoring at selected sites (pages 45-47).

Action 8. Engage Indigenous ecologists to provide input into the recovery process (pages 53-54).

The work undertaken was restricted to the four *Acacia* species; *Acacia peuce* (Waddy Wood), *Acacia undoolyana* (Undoolya Wattle), *Acacia pickardii* (Bird's Nest Wattle) and *Acacia latzii* (Tjilpi Wattle).

This report details the methodology and results from the implementation of each of the recovery actions in addition to outlining the underlying aims of the work. Emphasis is placed on providing enough detail so that actions can be fully replicated in the future and in developing rationale and cost-effective strategies for ensuring the conservation of each species.

Part 2 Distribution mapping & assessment of habitat variables for *A. latzii* & *A. pickardii*

2.1 Introduction

This section outlines the progress made towards Action 1 from the National Recovery Plan (Nano *et al*. 2007). The outcomes achieved are: 1) the distributions of *A. latzii* and *A. pickardii* have been mapped and 2) the habitat variables of the two species have been assessed.

The recovery of *A. latzii* and *A. pickardii* is currently hampered by knowledge gaps in their distribution and habitat variables. Additional survey work is therefore required to better understand the extent of occurrence and habitat requirements of these species.

Acacia latzii is endemic to the Finke Bioregion, where it is restricted to two areas about 200km apart – one in the Bacon Range south-east of Alice Springs and the other in the Beddome Range along the eastern edge of the NT-SA border. For a long time it was assumed that both the northern and southern populations were very small. However, vegetation surveys in 2001 (Neave *et al*. 2004) revealed the occurrence of outlying stands in both regions, indicating that the species might be more widely distributed than previously thought. Survey and mapping are therefore high priorities for both populations.

In the NT, *A. pickardii* is known from three distinct populations in the Simpson-Strzelecki Dunefields Bioregion. The Andado population is by far the largest, consisting of a densely populated main stand and several smaller outliers. The extent and size of the smaller populations is currently poorly understood. Mapping of the Andado population is a high priority so that impacts associated with disturbance (including mineral exploration) can be minimised and opportunities for off-reserve conservation can be sought. The Allitra Tableland and Numery populations are comparatively small and are not under immediate threat. Mapping of these populations is also warranted, given the overall rarity of the species.

2.2 Methods

2.2.1 Mapping

Acacia latzii

Surveys for additional *A. latzii* populations were conducted by vehicle and on foot on Henbury, New Crown, Umbeara (all in the Northern Territory) and Tieyon (South Australia) stations. Potential habitat was identified from existing geology, topographic and landsystem data layers using ArcGIS 9 (ArcMap version 9.2). In addition, Google Earth™ imagery was used to identify potential occurrences of *A. latzii* based on tree canopy attributes (shape, spacing and colour). Voucher specimens obtained from foot surveys will be lodged with the NT and SA Herbaria. These and other confirmed but non-vouchered records are indicated with a red cross on the generated distribution maps. Populations and individuals viewed with binoculars from the vehicle are indicated with an orange cross to denote a slight chance of misidentification. Search transects, including those with negative results (denoted as 'not sighted') are included on the maps to guide future survey effort.

Acacia pickardii

Acacia pickardii occurs as relatively small discrete stands throughout its range, making it possible to map individual patches. Mapping of this species was carried out for the entire Andado population and for a portion of the Allitra Tableland and Numery populations. Stands were located from existing Herbarium records, Google Earth™ imagery, on ground searches and from the records of other researchers (Peter Latz, Connie Spencer, Bill Low and Tom Newsome pers. comm.). Stand edges were mapped with the use of a GPS. These data were then uploaded into ArcGIS and converted to polygons.

2.2.2 Habitat variables

To gain a clearer understanding of the habitat requirements of each species, a range of environmental variables was measured *in situ* using replicated quadrat-based sampling. These data were supplemented with information derived from existing land unit and land system mapping of areas coinciding with known occurrences. The two data sets were then summarised and combined to form a single habitat description.

2.3 Results & Discussion

2.3.1 Distribution

Acacia latzii

The 2007-8 survey confirmed that the northern *A. latzii* population is confined to the immediate Bacon Range area and does not extend to other nearby hills and ranges (Fig. 2.1). Sampling revealed however, that the extent of occurrence of this population is substantially larger than the original estimate. According to these results, the population has a longitudinal range of 11.5km and a latitudinal range of 28 km, giving an extent of occurrence of c. 320 km^2. The results also demonstrate that this population has a continuous distribution throughout the Bacon Range site, which in turn implies an adequate level of genetic exchange.

Prior to 2008, the southern population was known from a small cluster of records straddling the SE and SW corners of Umbeara and New Crown Stations (NT portion) respectively, and from a single outlier record 36 km to the west on Umbeara Station (Fig. 2.2). The species was thought to be extremely rare in SA. The main population was known from a latitudinal range of c. 10 km and a longitude range of c. 22 km (extent of occurrence of 220km^2). The extent of occurrence of this population has been greatly extended as a result of this 2008 survey. The results show that this species has a continuous distribution from Coglin Creek in the east to the main Tieyon Station access road in the west, representing a longitude range of c. 65 km. The latitude range of this population has additionally been extended (now c. 35km) due to a new record 11 km south of the NT/SA border, again on Tieyon Station. The extent of occurrence of this population is therefore in the order of 2275 km^2. In addition, an outlier population was recently recorded on Mt Cavanagh Station in SA, some 40 km W of the main population (SA DEH unpublished data 2008) (Fig. 2.3). It is possible therefore, that future survey work will further increase the known distribution of this species.

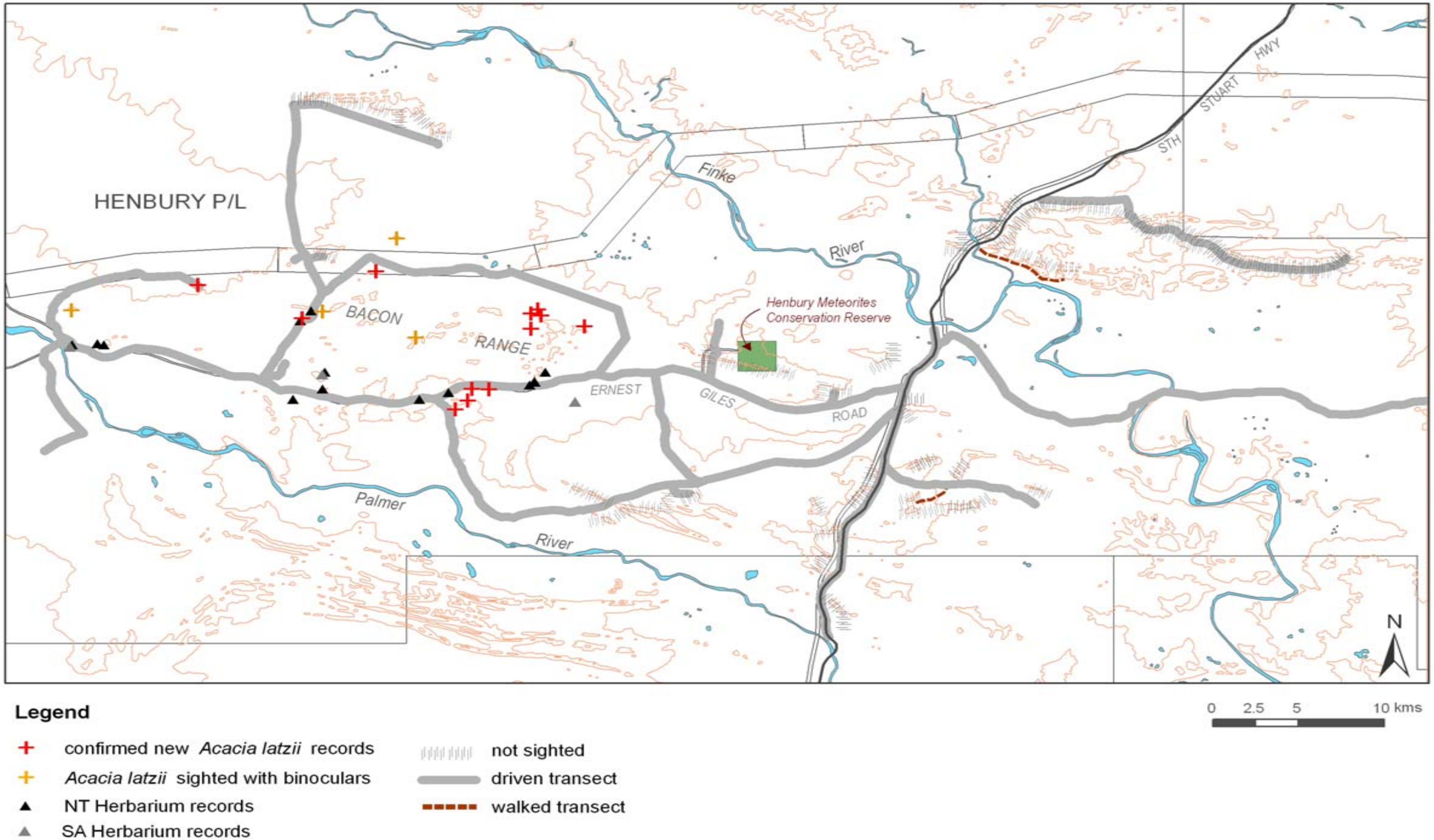

Fig. 2.1 Distribution of *A. latzii* and location of the 2008 survey transects in the Bacon Ranges, NT

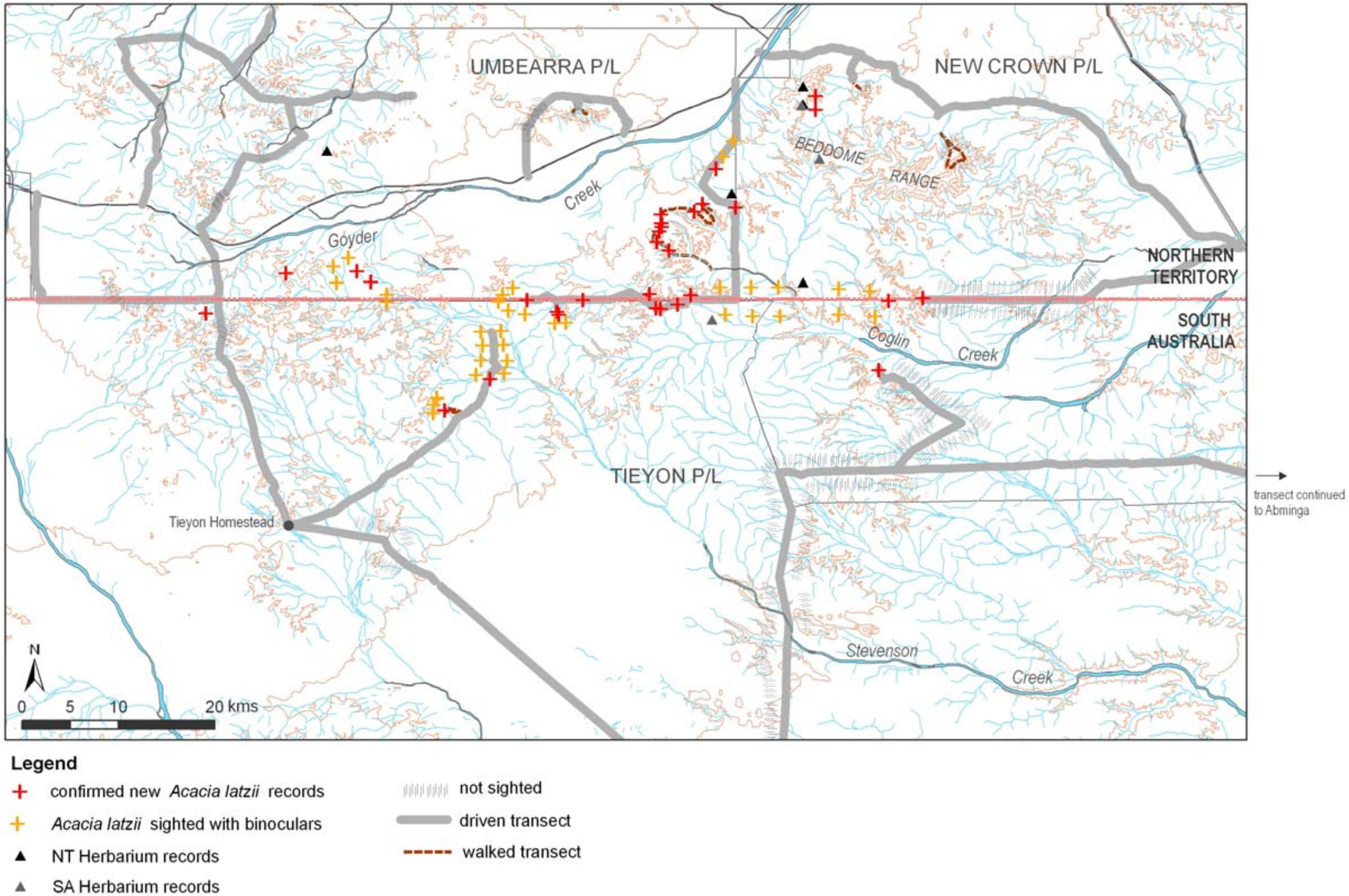

Fig. 2.2 Distribution of *A. latzii* and location of the 2008 survey transects in the Beddome Range area, NT & SA

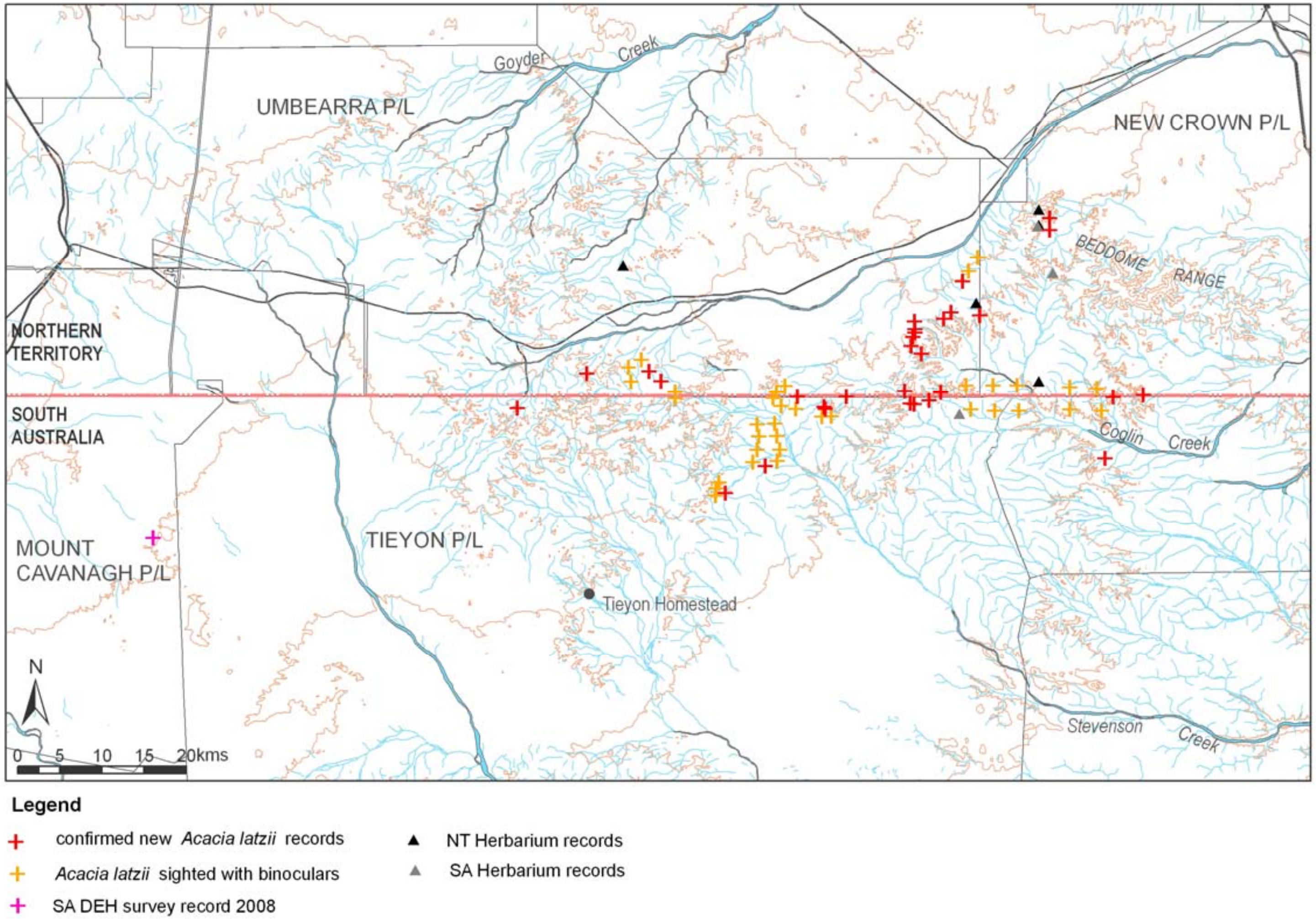

Fig. 2.3 Distribution of the main and western-most outlier (SA DEH record) populations of *A. latzii* in southern NT and northern SA

Acacia pickardii

Acacia pickardii is closely associated with the Wilyunpa land system (Perry *et al*. 1962) throughout its range in the NT. Mapping of this land system is at a scale of 1:100,000 (unit 1.1 Kennedy & Sugars 2001) on Andado Station and 1:1000,000 throughout the rest of the range of *A. pickardii*. Future searches based on the distribution of this land system may therefore result in additional records of *A. pickardii*.

The Andado population comprises four *Acacia pickardii* patches distributed within an area of approximately 220 km^2 (latitudinal extent 16.5 km, longitudinal extent 13.5 km) (Fig. 2.4). The largest concentration of trees is on the summit of Hubbard Hill. This comprises one large and numerous small stands within a 6 km^2 area. To the north, the species occurs as three very small patches within an area of 1.4 km^2 on the Hubbard Hill footslopes; and to the south it occurs as one larger and numerous smaller stands within a 0.75 km^2 area. There are two further occurrences to the NE of Hubbard Hill (i.e. the 'East bore' population). These are of roughly equal size (each less than 1 km^2) and occur about six km apart on the tableland summit. In all, 33 individual stands were mapped for the Andado population.

The Allitra Tableland and Numery populations of *Acacia pickardii* are far more restricted in size and area of extent compared with the Andado population (Fig. 2.4). Three small, closely spaced stands were mapped on the Allitra Tableland, incorporating all but one of the known records. Future searches in this area will likely reveal additional stands. The Numery population occurs as one small stand only which was not mapped for this project. This area has already been searched for additional stands, but future more intensified surveys would be worthwhile given this species' rarity and its highly disjunct distribution.

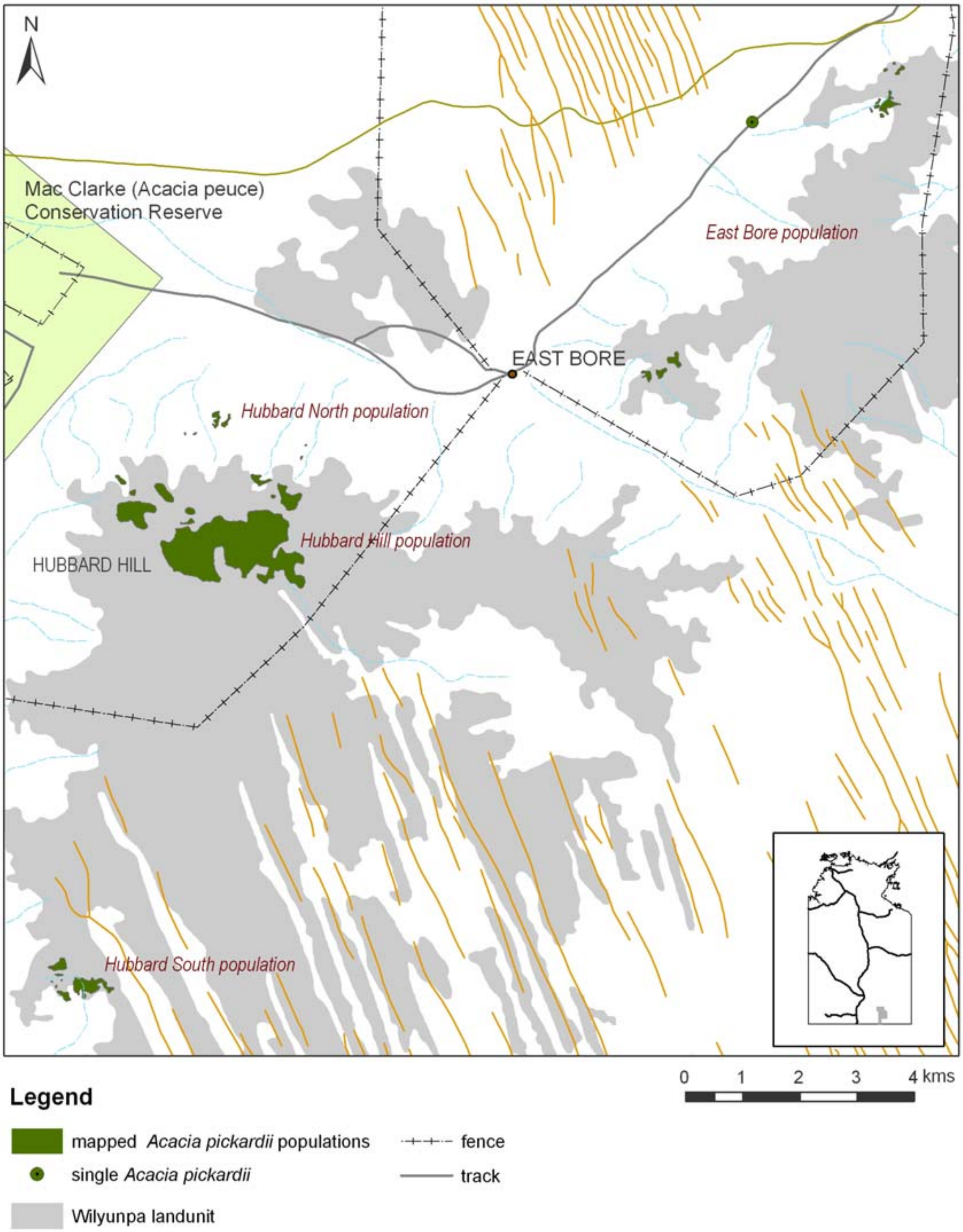

Fig. 2.4 Distribution of *Acacia pickardii* on Andado Station, NT

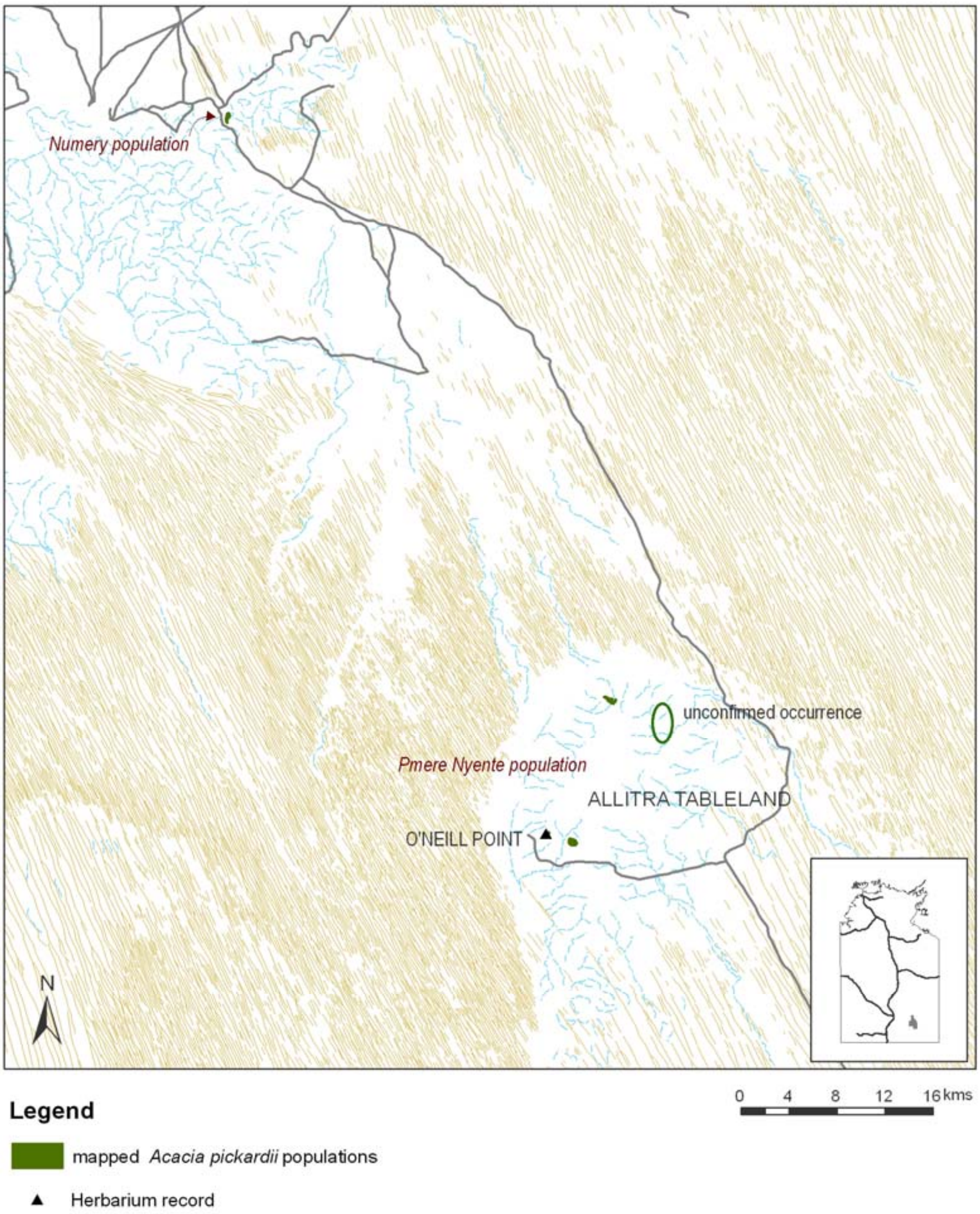

Fig. 2.5 Distribution of *Acacia pickardii* on Numery Station (north) and the Allitra Tableland (south) in the NT

2.3.2 Habitat variables

Acacia latzii

This survey confirmed that despite its highly disjunct distribution, *Acacia latzii* has a high level of habitat specificity. This species is confined to two closely related land systems – Chandler in the north and Rumbulara in the south – giving rise to overlapping habitat parameters for the two populations (Table 2.1). In summary, the habitat of *A. latzii* comprises silcrete-capped mesas and stony low denuded hills derived from shale and siltstone (north and south) and limestone, sandstone and dolomite (north only). This species is often concentrated along minor creeklines and on low-mid hill slope positions. Soils are sandy clay-loams and are often highly alkaline and calcareous at depth. The ground layer is very sparse, comprising mainly short grasses and chenopod low shrubs. The risk of fire incursion is thus usually very low.

Acacia pickardii

Like *Acacia latzii*, *A. pickardii* has both a highly disjunct distribution and a high level of habitat specificity (Table 2.2). Existing records indicate a close association with the Wilyunpa land system which occurs in the south-eastern portion of the NT. This system comprises stony, sparsely vegetated tablelands developed on claystone and silty sandstone (Rumbalara shale) (Perry *et al*. 1962; Kennedy & Sugars 2001). The plateaux have an elevation of up to 45 m and they descend south-eastwards from the north facing escarpments. Soils are mainly texture contrast (duplex) consisting of sand over clay with a rocky surface. They can be slightly acidic to basic. On the summit, the species occurs both in association with, and away from, minor creeklines. Less often, it occurs on erosional footslopes and adjacent sandy plains. Associated shrubs include *Acacia tetragonophylla*, *Acacia aneura*, *Acacia sibirica*. The ground layer is sparse, comprising mainly salt tolerant short grasses and chenopod low shrubs. The risk of fire incursion is very low.

Table 2.1 Summary of habitat attributes for the northern and southern populations of *A. latzii* in the NT. Data sources: NRETAS (unpublished data 2008), Jessop & King (1997), White *et al*. (2000), Perry *et al*. (1962).

Habitat variable	Southern population	Northern population
Geology	Deeply weathered shale and siltstone of lower Cretaceous age	Strongly deformed shale, siltstone, limestone, sandstone and dolomite of lower Palaeozoic age
Geomorphology	Partially dissected erosional weathered landscape	Partially dissected erosional weathered landscape
Land system	Rumbulara	Chandler
Landform	Stony silcrete-capped mesas & low denuded hills	Stony silcrete-capped mesas & low denuded hills
Land form elements	Minor gullies & creeks, low-mid slope (occasional on upper slopes)	Minor gullies & creeks, low-mid slope (rare on upper slopes)
Soil type	Calcareous red earth & Lithosol	Calcareous red earth & Lithosol
Soil upper horizon	Sandy clay loam; pH 6.5; non-calcareous	Sandy loam to sandy clay loam; pH 6-6.5; non-calcareous
Soil lower horizon	Red sandy clay loam; pH 9.0; very highly calcareous	Red sandy clay loam; pH 7-9.0; very highly calcareous
Slope	1-3%	1-7%
Aspect	N,S,E,W	N,S,E,W
Relief	to 30m	to 80m

Table 2.1 continued

Surface stone cover	100% shale surface cover	>90%
Fire History	Mainly long unburnt	Mainly long unburnt
Associated low trees	*Acacia sibirica*	-
Associated shrubs	*Eremophila freelingii, Senna artemisioides* nothosubsp. *coriacea, Atriplex vesicaria*, *Maireana trichoptera, Maireana astrotricha, Maireana georgei*	*Eremophila freelingii, Senna artemisioides* nothosubsp. *coriacea, Atriplex vesicaria, Maireana spongiocarpa, Ptilotus parvifolius, Maireana georgei, Maireana schistocarpa*
Associated ground species	*Aristida contorta, Fibristylis dichtoma*, *Enneapogon cylindricus, Enneapogon polyphyllus, Tripogon loliiformis, Enteropogon ramosus, Sclerolaena diacantha, Solanum ellipticum*, *Anemocarpa saxatilis.*	*Sporobolus actinocladus, Sclerolaena eriacantha, Enneapogon polyphyllus*, *Sporobolus caroli*

Table 2.2 Summary of habitat attributes for the NT populations of *A. pickardii*. Sources: NRETAS (unpublished data 2008), Kennedy & Sugars (2001); White *et al*. (2000), Perry *et al*. (1962).

Habitat variable	
Geology	Mesozoic; Lower Cretaceous; Rumbalara shale; siltstone, claystone
Geomorphology	Partially dissected erosional weathered land surface, duricrusted plateaux
Land system	Wilyunpa (& Middleton)
Landform	Undulating broad tableland summit plains and breakaway slopes
Land form element	Summit stony plain, stony slopes & rises, minor gullies, sandy flats below summit slopes
Soil type	Duplex soils consisting of sand over clay with a rocky surface.
Soil upper horizon	Loamy sand, pH 6.5-7
Soil lower horizon	Fine sandy light clay to light clay, pH 7-8.5, slightly calcareous
Slope	Flat to 3%; breakaway scarps have slopes of 20%
Aspect	None, N, S or W
Relief	to 50m
Surface cover	Sandy veneer and ironstone and quartzite gravel
Fire History	Long unburnt

Table 2.2 continued

Associated low trees	*Acacia tetragonophylla*, *Acacia aneura*, *Acacia sibirica*
Associated shrubs	*Senna artemisioides* nothosubsp. *sturtii, Eremophila obovata* subsp. *obovata, Maireana campanulata Atriplex vesicaria*
Associated ground species	*Sporobolus actinocladus, Sclerolaena lanicuspis, Dactyloctenium radulans, Aristida contorta, Enneapogon polyphyllus, Enneapogon avenaceus, Heliotropium filaginoides*, *Frankenia serpyllifolia*

Part 3 Population and habitat monitoring

3.1 Introduction

3.1.1 Program aims

This section outlines the progress made towards Action 3 from the National Recovery Plan (Nano *et al*. 2007). The outcomes achieved are: 1) the establishment of monitoring sites for *Acacia latzii*, *A. pickardii*, *A. peuce* and *A. undoolyana*; and 2) the completion of the first annual monitoring at these sites.

Effective recovery of the four acacias is currently constrained by knowledge gaps in population dynamics, life history attributes and the magnitude of threatening processes. Thus, there is a need for the systematic collection of population and site data over time to establish size and age-structure trends and to relate them to environmental, biotic and disturbance influences. This monitoring program has five specific aims as detailed below.

1. Audit the current status of key populations.
2. Measure changes (direction and magnitude) in population size and structure through time.
3. Monitor the development of threats through time, with a particular focus on the impacts of fire, weeds, cattle and feral herbivores on recruitment and adult survival.
4. Evaluate and improve the effectiveness of existing conservation measures.
5. Inform future management actions.

3.1.2 Monitoring History

Information relating to past monitoring projects was collated and used in the formulation of this new program. Historically, monitoring effort has been highly variable across the four species in terms of intensity, frequency and duration. Plots have been established in fenced and unfenced situations for three species – *A. peuce*, *A. latzii* and *A. pickardii*, and monitoring for grazing effects is ongoing in the latter two species. Population monitoring programs for *A. peuce* and *A. undoolyana* were established in the NT in the 1980's, but were disbanded prior to their completion. The following outlines in more detail, past and existing monitoring programs for each species.

Acacia peuce

The NT population of *A. peuce* has a long history of monitoring. The first phase began in 1979 with the broad aim of providing baseline data for the management and conservation of the species (Chuk 1982). The program was designed to examine 1) seedling emergence and survival, 2) seedling height growth rates, 3) adult growth rates and 4) flowering and fruiting patterns. Fourteen 25 x 25 m regeneration plots (plots A-N) were established to monitor seedling fate. Every individual less than 20 cm high within each plot was individually labeled and monitored at least annually through to 1996. In addition, 36 adult trees and 10 seedlings were simultaneously monitored for growth rates and fruiting and flowering phenology. As part of the same program, population size and age structure was audited in 1980 (Deveson 1980; Chuck 1982), using 14 circular 50 m radius plots (0.78 ha). None of the plots was permanently marked. The PWSNT took carriage of the monitoring program through to 1996, after which time it was disbanded. The population was again audited in 2001 by the PWSNT, using the same methodology (A. Bowland unpublished data 2001). The regeneration plots and marked trees were likewise re-measured at this time. New seedlings that emerged after the large rainfall events of 2000-2001 were tagged and monitored, but none survived beyond 2004. A Northern Territory species management plan (Anon 2005) was drafted for this population of *A. peuce*. However, only a few of the recommendations have so far been implemented. Under present arrangements, PWSNT ranger staff (East district: Trephina Gorge Office) undertake routine visits to MCCR.

Acacia latzii

In 1993, two small *A. latzii* stands on Henbury pastoral lease were enclosed in rabbit- and cattle-proof fences. Since then, regular monitoring of these and adjacent unfenced plots has been carried out by the Australian Plant Society. Henbury was chosen as the most suitable monitoring location because of its proximity to Alice Springs. Data collected during monitoring include rainfall, flowering, seeding, disturbance and recruitment events. The southern (Beddome Range) population is not subject to any monitoring.

Acacia pickardii

In 1993, four *A. pickardii* monitoring plots were established in the Goyder Lagoon pastoral lease population in South Australia by the SA DEH. This program includes sites inside and outside established rabbit- and cattle-proof fences (Davies 1995). In the Northern Territory, the Biodiversity Unit of NRETAS undertakes routine visits (1-2 times per year) to the Hubbard Hill population on Andado Station to check for obvious problems. No systematic monitoring of that, or any of the remaining NT populations, has yet occurred.

Acacia undoolyana

Three *A. undoolyana* monitoring plots (100 m x 50 m) were established in 1987 at N'Dhala Gorge Nature Park and on the neighbouring Undoolya Station (see Latz *et al*. 1989). The program aimed to audit the population age class structure and to document any site-specific threats. The three plots each had a different fire history. The 'Vee Gorge' plot was long unburnt and supported many large old trees; the 'N'Dhala Ridge' plot was evidently exposed to a patchy burn in the 1920's, and the 'N'Dhala Gorge' plot was burnt in 1975 (Latz *et al*. 1989). Tree height and stem diameter at 1.3 m was measured for every individual in the plot. It was envisaged that subsequent monitoring would take place every five years or so, however this never eventuated. An additional programme was established by PWSNT in 2002 to quantify flowering and fruiting frequency in a single stand (n = 10 individuals) at the N'Dhala Gorge population. Monitoring took place on an irregular basis over a six year period but has now ceased. The results of that work supported field observation (e.g. Latz *et al*. 1989) that sexual reproduction is extremely rare in this species.

3.1.3 Knowledge gaps limiting species recovery

Population size and structure trends

The heightened vulnerability of these four acacias is largely due to their inherent population attributes (i.e. size and structure). Each species is characterised by small, highly fragmented populations that are restricted in area of occurrence and extent. Without systematic monitoring, it is difficult to know if the populations are stable or in decline. Monitoring is also needed to gauge the magnitude of threats associated with human activities and/or stochastic events.

In each of the four acacias, population decline is inferred from observations of 'unhealthy' age-class distributions. There is general consensus that viable populations will comprise a mix of many juveniles, moderate numbers of young adults, and fewer older individuals. Available information suggests a strong deviation from this desirable patterning. Two species – *A. latzii* and *A. pickardii* – are apparently dominated by senescing adults and show little sign of regeneration (Nano *et al*. 2007). Data from the 1980 census (Deveson 1980) of *A. peuce* showed that two of the populations (Andado and Birdsville) may be in decline due to a paucity of juveniles and saplings. *Acacia undoolyana* apparently differs most. Field observation suggests an over-representation of juveniles and saplings and a decline of adults due to fire effects (Latz *et al*. 1989). Each species therefore needs to be systematically audited and then monitored to determine the extent to which they deviate from healthy limits, and if remedial action is necessary to ensure long term viability.

Causes of decline

Keith (1996) identified two principle causes of plant population decline: 1) when the pools of individuals within each life stage are depleted without commensurate replacement within critical time frames, and 2) when the transfer between life stages is interrupted. Disturbance, biotic interactions, and resource constraint can act independently or in concert to initiate decline. The four *Acacia* species are vulnerable to decline because they have slow population dynamics and they potentially face a suite of threats. Currently, the magnitude of threats is thought to be low, but data are lacking.

Existing information suggests that many of the mechanisms of decline identified in the scheme by Keith (1996) may be evident in these species. These are detailed below.

1) **Death of standing plants** from fire, cattle damage, root exposure and lightning strikes.
2) **Disruption of regeneration via**
    a. **Failure of seed germination & emergence** due to inadequate rainfall or loss of safe sites.
    b. **Failure of seedling establishment** due to inadequate rainfall, grass competition, rabbit browsing, cattle trampling or habitat modification.
    c. **Interruption of growth and maturation** through fire or browsing effects.
    d. **Failure of seed bank maintenance** due to seed crop failure or high rates of seed predation.

The following outlines in more detail potential mechanisms of decline for the four species.

<u>1) Death of standing plants</u>

Fire is the most likely cause of standing plant death in each of the four acacias. Species such as *A. peuce* that are killed by fire and have a long primary juvenile period (i.e. the time taken for seedlings to mature and produce their first flowers) are especially vulnerable to decline with an increase in fire frequency. For species facing this 'immaturity risk', decline can be initiated after a single short fire interval if all standing plants are killed and the seed bank is exhausted (Keith 1996). To date, only a small proportion of the Andado *A. peuce* population has been affected by this process. The consequences for that particular stand were, however, catastrophic – most individuals were killed and regeneration was negligible. This stand occurs on a clayey plain that lacks a continuous stony pediment and has high grass biomass following periods of prolonged rainfall. The high grass cover provides fuel connectivity between *A. peuce* habitat and adjacent flammable dune fields. Monitoring of ground fuel loads is needed to guide fire management in this stand.

Data are lacking, but it is likely that *A. latzii* is similar to *A. peuce* in its response to fire. Increased fuel loads via exotic grass invasion and/or altered climate parameters would therefore represent a significant threat to this species. *Acacia undoolyana* is potentially the strongest fire-sprouter of the four species. Importantly though, it may also be vulnerable to decline from too frequent, too hot or badly-timed fire events. Highly flammable *Triodia* grasses occur throughout *A. undoolyana* habitat, making the fire risk for this species comparatively high. Additionally, Buffel Grass has invaded many creek lines adjacent to *A. undoolyana* stands, increasing the level of fuel connectivity and biomass throughout its range. It is also possible that *A. pickardii* has some capacity to resprout after fire given its propensity for clonal growth. Fire is, however, exceptionally rare in *A. pickardii* habitat due to low ground fuel loads, meaning that the fire response of this species is largely irrelevant in terms of its long term persistence.

Lightning strike mortality is listed as a potential threat to *A. peuce* (Anon. 2005). However, lighting incidence data obtained in the last four years by PWSNT show that strike frequency is in fact extremely low and that the current population of lightning affected individuals has accumulated over many years. Lightning impacts are unknown for the remaining three species, but are similarly unlikely to be high.

Cattle grazing may result in plant death in *A. peuce*, *A. latzii* and *A. pickardii*. Observed cattle impacts on *A. peuce* include seedling trampling; ring barking; soil compaction and loss, and root exposure (Chuk 1982; Bowland & Heywood 2002). There are, however, no specific data on the incidence of cattle-induced mortality for any of the species. Monitoring is therefore needed to assess the magnitude of this threat.

<u>2) Disruption of regeneration</u>

a) Seeds to seedlings: failure of seed germination & emergence

One reason for poor recruitment in plant populations is a failure of seed germination in the absence of critical cues. Given the arid context, climate (i.e. low and erratic rainfall) likely acts as the primary constraint on shrub seedling germination and emergence (e.g. see Nano 2005). Climate limits on seedling recruitment may therefore account for an over representation of adults in *A. peuce*, *A. latzii* and *A.*

pickardii populations, but this needs further examination. While seedling recruitment failure is unlikely to act as a major obstacle to population replacement in *A. undoolyana*, data are again lacking.

Allocation to long lived, drought tolerant adults rather than to rapid population turnover, is a highly successful persistence 'strategy' in arid environments. In itself, therefore, infrequent (relative to the overall life span of the species) seedling recruitment is not necessarily limiting for population persistence, especially where a species is able to reproduce by vegetative means (as is the case for *A. undoolyana* and *A. pickardii*). Problems may arise, however, if already rare recruitment opportunities are 'missed' or become less frequent due to changed climate and habitat parameters. It has been suggested, for example, that surface soil erosion due to pastoral related activities has reduced the recruitment rate of *A. peuce* by bringing about a loss of seedbed sites (Chuck 1982). Monitoring of soil erosion levels and of seedling distribution patterns would help reveal the magnitude of this threat to each of the three species exposed to cattle grazing.

b) Seedlings to juveniles: failure of seedling growth and survival

Seedling establishment failure is another reason for decline in plant populations (Keith 1996). The major cause of seedling death in all plants, but especially in woody arid species, is desiccation. It is expected, moreover, that the transfer from seedlings to juveniles occurs less frequently than that of seeds to seedlings, because in most arid systems, rainfall that is sufficient for germination is quite often inadequate for seedling growth and survival. It is likely, therefore, that seedling drought stress represents the major impediment to recruitment to the juvenile life phase in each of these threatened acacias. Data from the 1980 *A. peuce* survey (Deveson 1980) suggested the existence of an early life stage bottleneck in the Andado and Birdsville populations. In each case, the size class distribution was strongly bimodal with an over-representation of very small and very large individuals, indicating population decline. Post 1980 trends can now be examined by re-establishing the existing Andado regeneration monitoring plots and by establishing new, permanent population monitoring plots. Similarly, population monitoring plots need to be established for the three other threatened acacias to examine the role of early life stage bottlenecks in determining negative population trends.

In each species, survival beyond the seedling phase may be further constrained by introduced forms of disturbance. It is possible, for example, that past high levels of seedling predation by rabbits may in part account for the present-day population structure of *A. peuce*, *A. latzii* and *A. pickardii*. Presently, rabbit numbers are low across most of central Australia, but this may change with time and needs to be carefully monitored. Direct cattle damage (browsing and trampling) might also act to reduce seedling establishment to levels below the climate potential in these three species. Feral herbivores, especially camels, are becoming increasingly prevalent in *A. latzii* habitat, and their effects are poorly known. Future potential limits to seedling growth and survival in all four species include: exotic grass (*viz Cenchrus ciliaris*) invasion – and thus heightened seedling competition and fire risk – and increased desiccation risk associated with climate change.

c) Juveniles to adults: interruption of growth and maturation

Populations can decline via the interruption of maturation and developmental growth (Keith 1996). For these particular shrub species, this may come about via two mechanisms. The first involves the creation of a sapling bottleneck by herbivore browsing. Where this is in operation, individuals become stunted and remain in a subadult phase. Thus, reproductive onset and canopy development are suppressed. Again, the only existing evidence for this process relates to *A. peuce*. In 2001 Bowland & Heywood (2002) compared juvenile height in fenced and unfenced stands, and reported a significant browsing impact on *A. peuce* juvenile development. Although this study was limited by a lack of replication (only one unfenced plot was sampled), it does serve to highlight the potential negative impact of cattle activity on *A. peuce* development. Further sampling and monitoring should be undertaken to properly quantify the magnitude of this threat in each of the three species exposed to cattle grazing (*A. peuce*, *A. latzii* and *A. pickardii*).

The second mechanism involves the death of pre-reproductive stems due to fire. For species that are not necessarily killed by fire, short fire-return intervals can create a sapling bottleneck if they have a long secondary juvenile period (time for basal and root sprouts to become sexually mature) (Keith 1996). This process may be affecting *A. undoolyana*. Various stands have been exposed to fire, some having been burnt in the 1970's and again in 2002. These populations are likely to have low size-class variability, compared to those in fire-protected sites. Size structure data are therefore needed.

d) Mature plants to seeds: seed bank failure

Populations that fail to establish a persistent seed bank may decline in the absence of adequate dispersal. Seed bank failure may arise from infrequent flowering and seed set or from high rates of seed predation. Preliminary work indicates that sexual reproduction in all four acacias is rare and varies greatly according to climatic conditions. In drought, therefore, it is highly unlikely that there would be enough seed produced to satiate predators, meaning that in some years at least, there would be minimal contribution to the seed bank. However, crop failure is unlikely to represent a major threat to any of the species because in each case, individual longevity, rather than seed bank establishment serves as a buffer against decline. Overall therefore, flowering and fruiting monitoring is of low priority. The small, isolated fragments of *A. peuce* are possibly the exception given that they may be experiencing comparatively low pollinator visitation (Vamosi & Vamosi 2005). Comparisons of main and fragment *A. peuce* stands may help determine the threat level associated with low seed set. Seed production monitoring is of medium priority in *A. latzii* given that this species does not reproduce vegetatively; and of low priority for the remaining species given that they readily sprout in response to drought stress and mechanical disturbance.

3.1.4 Monitoring questions

Several monitoring questions emerge from the above assessment of knowledge gaps. These questions fall into four categories: fecundity; population demography; site condition, and effectiveness of management action. Priority questions for each species are listed in Table 3.1. Seed crop monitoring is a medium priority for *A. peuce* fragments but is of a low priority for the remaining species. Issues relating to key population attributes (*viz* size and age structure trends), are a high priority for all four species. Threats associated with exotic grass invasion may develop through time and should be treated as a high monitoring priority for all species. Ground fuel monitoring in relation to native grass species biomass fluctuations is important for *A. undoolyana* and for one *A. peuce* stand. Feral herbivore impacts are a high priority for *A. latzii* and may become a priority with time for *A. pickardii* and *A. peuce*. The Andado stands of *A. peuce* are now fenced, and monitoring of short and long term responses of the population to cattle exclusion is a high priority. Monitoring of cattle exposure effects is a medium priority for *A. pickardii* and *A. latzii*. Feral herbivore and cattle impacts on *A. undoolyana* should remain negligible with time. Monitoring of fire incursion rates and plant fire responses is a high priority for *A. undoolyana* and *A. peuce.*

Table 3.1 Prioritisation of monitoring questions by species.

Threat/Knowledge Gap	Monitoring Question	*A. peuce*	*A. pickardii*	*A. latzii*	*A. undoolyana*
Fecundity	Is seed set occurring?	Medium	Low	Medium	Low
Population Demography	Is the population size stable, increasing or decreasing?	High	High	High	High
	Is there a good mix of juveniles, saplings and adults in the population?	High	High	High	High
	What is the critical life history stage limiting recruitment to the adult population?	High	(?) High	(?) High	(?) High
Site Condition	Are weed impacts increasing at the site?	High	High	High	High
	Are ground fuel loads sufficient to carry a wildfire?	High	Low	Low- Medium	High
	Are feral herbivore impacts increasing at the site?	Medium	Medium	High	NA
	Are cattle impacts increasing at the site?	High	Medium	Medium	NA
	Is soil erosion becoming more pronounced?	High	Low	Low- Medium	Low
Effectiveness of management action	Have site remediation actions been successful?	High	NA	NA	NA
	What are the short & long term responses of the populations to remedial actions?	High	NA	NA	NA
	Is fire management reducing wildfire threats?	NA	NA	NA	High

3.1.5 Monitoring program overview

This monitoring program has been designed to directly address the identified priority questions for the four threatened acacias. Below is an outline of the key components of the program: the level, frequency and overall design.

Monitoring level

The overall approach used in this program equates to 'current status monitoring' (*sensu* Duncan & Coats 2006). Using this method, data collection is focussed at the level of the population rather than the individual. This type of monitoring provides an initial audit of the total population size, the density of each life stage (seedlings, juveniles, subadults and adults), as well as an estimate of habitat condition and threat magnitude at the site. Repeated sampling of permanently marked plots allows managers to document the development of threats over time and to detect population trends which may signify more widespread decline. This monitoring level was deemed appropriate because threats are presently considered minor and populations are apparently stable at the decade scale.

Additional monitoring activities were put in place for *A. peuce* in recognition of this species' status as Endangered in the NT. This essentially involved the re-establishment of three aspects of the demographic monitoring program established in the 1980's (see Chuck 1982):

1. Growth and survival of tagged individuals in the 14 regeneration plots (A-N)
2. Growth and maturation of 10 tagged individuals in the main stand
3. Seed crop production of tagged adults in the main and fragment stands.

While this extra monitoring adds to time and labour costs, it can be justified on the grounds that it provides the best means by which the causality of any decline can be examined, without going to the level of experimentation (Duncan & Coats 2006).

Personnel

This program assumes the availability of two government agency staff. However, it is acknowledged that site visitation frequency is ultimately constrained by staff funding and time availability, both of which can vary greatly according to organisational support. The project is therefore much more likely to succeed with the inclusion of a range of non-government stakeholders (Table 3.2).

Monitoring frequency

Population monitoring is usually undertaken at least annually (Duncan & Coats 2006). This rule of thumb is perhaps 'overkill' for these particular arid species, given that in each case, the threat level is currently relatively low and population dynamics are very slow. For *A. latzii and A. pickardii* a monitoring frequency of once every five years would be adequate under average rainfall conditions. More intensive monitoring of *A. undoolyana* and *A. peuce* is warranted given that these species are presently recovering from fire and cattle effects. With regard to all four species, monitoring frequency and timing needs to be flexible, so that responses to future major rainfall (and hence recruitment) and wildfire events can be measured.

Site selection

A minimum of four sites per species was adopted for this program. Site number and placement varied according to a range of factors including: ease of accessibility; population size and distribution, the level of habitat variation; the number and nature of potential threats, and landholder willingness to provide site access. All of the sites are located in the southern NT (Table 3.2).

Program duration

In each species, population dynamics are extremely slow: recruitment is rare, growth rates are slow and adults are extremely long-lived. Species with this type of life history can exist in non-viable populations without displaying obvious decline. Alternatively, recovery may be occurring, but only over long time scales. Short term monitoring is therefore unlikely to reveal the true picture in terms of population trends in any of the species. This means that monitoring needs to be a long term undertaking. Monitoring frequency is therefore possibly less important than duration in this regard. We therefore recommend a three-phase program that involves continual reappraisal of the effectiveness of the methodology in terms of its ability to reveal population trends and threat development. The progression to the second and third phases will depend on necessity and resources.

Phase 1: 2008-2013
Phase 2: 2014-2018
Phase 3: 2019-2023.

Data storage

Digital site maps, data sheets and data are stored with the NRETAS on the corporate data storage drive at W/Biodiversity/ Threatened_Species_Pavey/monitoring.

Table 3.2 General monitoring program design for the four arid acacias in the NT.

	A. peuce	***A. pickardii***	***A. undoolyana***	***A. latzii***
Site Tenure	MCCR, Andado Station	Andado Station	N'Dhala Gorge NP, Undoolya Station	Henbury Station, Umbeara Station, New Crown Station
Prime responsibility for project	Threatened species officer NRETAS	Threatened species officer NRETAS	Threatened species officer NRETAS	Threatened species officer NRETAS
Recommended stakeholder groups	NRETAS Biodiversity staff, Andado Station leaseholders & managers, PWSNT ranger staff & joint management employees, CLC/Traditional owners, APS	NRETAS Biodiversity staff, Andado & Numery Station leaseholders & managers, PWSNT ranger staff & joint management employees, CLC/Traditional owners, APS	NRETAS Biodiversity staff, Undoolya Station leaseholders & managers, PWSNT ranger staff & joint management employees, CLC/Traditional owners, APS	NRETAS Biodiversity staff, Henbury, Umbeara & New Crown Station leaseholders & managers, CLC/Traditional owners, APS

3.2 Individual species programs

3.2.1 *Acacia peuce*

Site location

Mac Clark Conservation Reserve (MCCR) & Andado Station, NT (Fig. 3.1).

Key monitoring questions

Population Demography

1. Is the population stable, increasing or decreasing in size?
2. Is there a good mix of juveniles, saplings and adults in the population?
3. Do the main and fragment stands exhibit the same trends?
4. Is seedling establishment failure limiting recruitment to the adult population?
5. What is the time to maturity?

Fecundity

6. Do the fragment stands have lower seed set than the main stands?

Site Condition

7. Are weeds increasing?
8. Are ground fuel loads sufficient to carry a wildfire in the northern stand?
9. Are feral herbivore impacts increasing?

Effectiveness of management action

10. Have cattle been completely excluded by fencing?
11. Is soil erosion becoming less pronounced with cattle exclusion?
12. What are the short & long term responses of the population to cattle exclusion?

Methods

Two levels of monitoring intensity were required to address the above questions. The first was current status monitoring, and involved the establishment of permanent sample plots to record population trends, and positive and negative changes in site condition (questions 1-3 and 7-11). The second is demographic monitoring, where the focus is at the level of individual plants. The re-establishment of the existing regeneration plots (A-N) enables the fate of tagged juveniles to be monitored over time which will directly address question 4. Monitoring the growth and development of the 10 tagged saplings will indicate the time to maturity for this species.

A comparison of seed production levels between permanently tagged trees in the main and fragment stands will address question 5.

Current status monitoring

The large size of the Andado population meant that it was not practical to count every individual. Accordingly, a series of permanently marked quadrats was established to enable a subset of individuals to be counted at repeated intervals (Table 3.3, Fig. 3.1). The overall sample design reflected the configuration of the population and the predominant land use and threat. The main stand consists of two aggregated bands (with scattered individuals) within MCCR, 1 km apart. The core area of the main stand was fenced in the 1970s, leaving the edges exposed to cattle grazing. A fragment, comprising three distinct patches approximately 5km to the south of the main stand, was also fenced at this time. All remaining fragments inside and outside the reserve were fenced in 2004. Thus, plot sampling could be stratified across two variables: stand connectivity (main stand/fragment) and degree of cattle exposure (long fenced/recently fenced). Circular sample plots (50 m radius) were used in this, as in the original (1980) and the 2001 surveys, enabling comparison between the three points in time. Plot placement was determined *a priori* from an existing map of the main and fragment stands. It aimed to reflect broad environmental variability (*viz* aspect, runoff/runon position, and distance to drainage) as well as expected variability in density. Where possible, trees with existing number tags were chosen as the centre point of each new plot. This approach reduced the level of plot positioning bias and avoided the need for additional tags/fence posts. In cases where there were no marked trees, the plot centre was usually situated in the middle of the particular patch, and marked with a metal post. Sampling intensity of the four stratification classes ultimately reflected their availability. In all, 26 plots were established. Of these, 10 were in the main stand (7 long fenced, 3 recently fenced) and 16 were in fragments (3 long fenced, 13 recently fenced). Three of the recently fenced fragment samples (24-26) were in the badly fire-damaged northern stand. Certain of the plots incorporated existing regeneration plots. Site variables recorded for each plot were: location details; physical factors (slope, aspect, stone cover etc), and disturbance level and type (cattle, feral herbivores, fire, weeds, soil erosion).

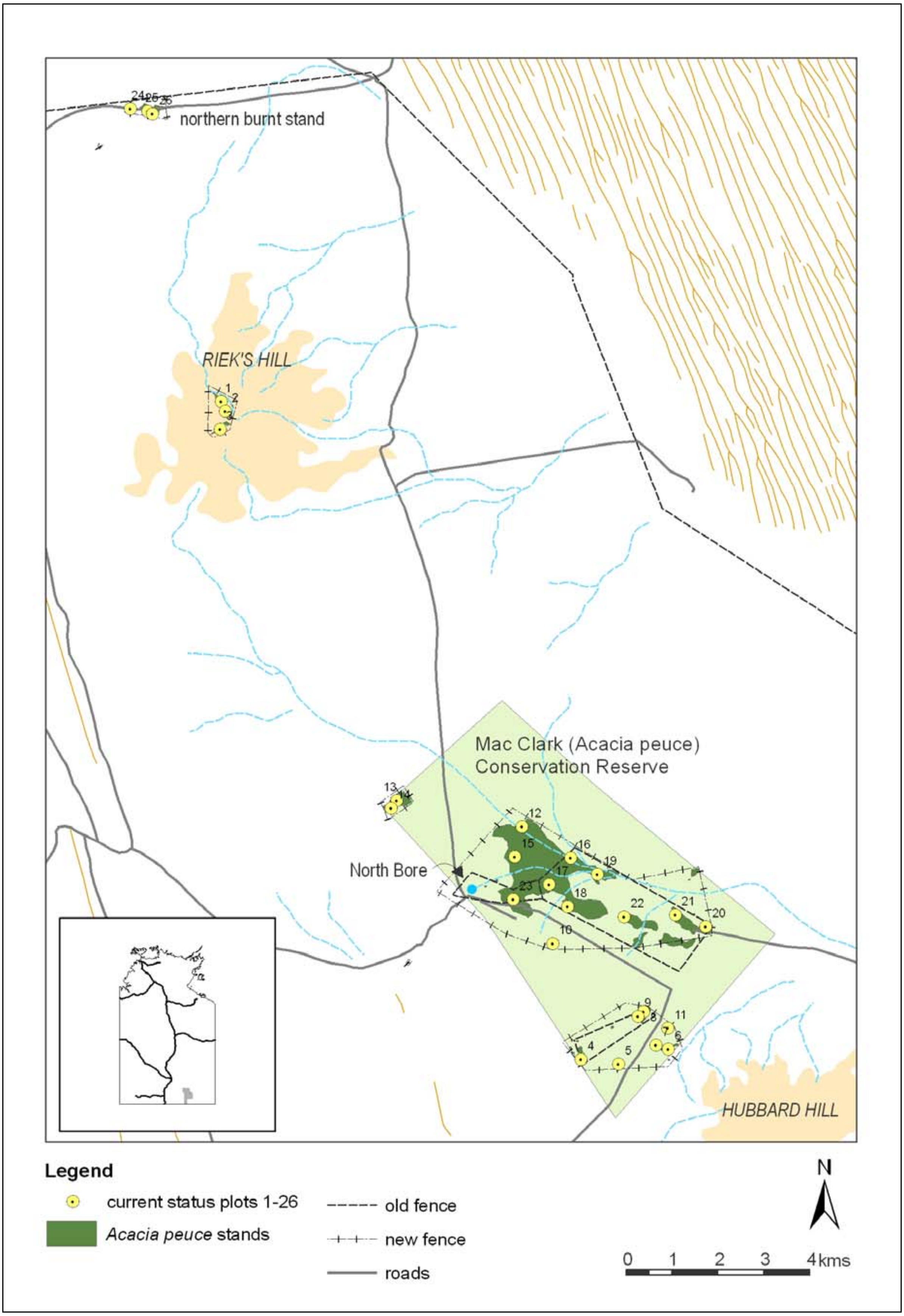

Fig. 3.1 Location of *A. peuce* 2008 monitoring program at Andado Station, NT and distribution of the 0.78 ha permanent sample plots (plots 1-26)

Table 3.3 Site location and distribution of sample sites across the variables 'stand connectivity' and 'grazing exposure'. Sites in bold font are badly fire damaged.

Stand connectivity	Grazing exposure	Site No.	Easting (WGS 84)	Northing (WGS 84)	Marked tree at plot centre	Included regeneration plot
Main Stand	*Long fenced*	16	551755	7222546	14	H
		17	551319	7221974	16	I
		18	551685	7221495	18	J
		19	552271	7222190		G
		20	554411	7221054	7	E
		21	553809	7221309	9	F
		22	552802	7221265		A
	Recently fenced	12	550785	7223233		
		15	550642	7222575	30	
		23	550608	7221655		
						L
Fragment	*Long fenced*	4	552953	7221216	23	
		8	553174	7219206	26	K
		9	553065	7219102	25	
						M
	Recently fenced	1	544880	7232480	36	
		2	544965	7232266	35	
		3	544856	7231876	33	
		5	552675	7218079		
		6	553658	7218387	28	
		7	553415	7218482		
		10	551388	7220691		
		11	553650	7218849		
		13	548324	7223807		N
		14	548207	7223640		
		24	543105	7238840		
		25	543453	7238779		
		26	543548	7238729		

In each plot, the height, stem circumference (breast height over-bark) and reproductive status (abundance of buds, flowers, ripe and immature fruit) of every individual was recorded. Where trees were multi-stemmed, the largest stem was measured.

Tree density (number of individuals ha^{-1}) was averaged over all plots (excluding the badly burnt plots 24, 25, 26) and compared with the results of the 1980 and 2001 surveys. Comparisons were also made between main and fragment stands and long- and recently-fenced stands using two-factor ANOVA on transformed (*ln*) data. To examine structural changes over time, population percentages of five height classes (≤0.3m; 0.31-1.5m, 1.51-5m, 5-10m and >10m) were compared with the results of the 1980 and 2001 surveys. Comparisons were also made on the basis of stand connectivity and fence history.

To test for cattle effects on soil erosion, % cover of sandy surface soil in long- and recently-fenced stands was compared using one-way ANOVA. All stands were checked for evidence of ongoing cattle access.

Demographic monitoring

i. The regeneration monitoring plots (A-N) were re-established as part of this program to help determine if juvenile survival failure limits population replacement (Question 4) and to gain an estimate of seedling growth and maturation rates (Question 5). Each of the 14 regeneration plots was relocated and the position of its SW corner recorded with a GPS (Table 3.4, Fig. 3.2). Where required, fallen corner posts were reassembled, such that the four corners of each quadrat were again permanently marked. Each plot was then searched for remaining tagged individuals. Once located, the status of each individual was recorded as alive or dead. Where a tag could not be found, the individual was scored as 'not found'. Height and reproductive status was also recorded for each individual. A photo point was established for each plot using the SW corner. Seedling survival (percentage of total emergence) was calculated from the regeneration plot data and comparison was made between the 2008 results and the results of the last monitoring session in 1996. Seedling yearly height growth rates were estimated as:

[average seedling height in 2008 – 0.3m (i.e. maximum seedling height at 1979)]/29 years.

Eight sites were identified for the establishment of additional regeneration plots to enable closer monitoring of population trends in fragment stands and badly impacted patches in the main stand (Table 3.4, Fig. 3.2). These new plots should be established following significant rainfall. The plots are distributed as follows:

- +3 in unburnt fragments (O, P,Q) (in current status plots 5, 7, 10)
- +2 in heavily grazed main stand patches (R, S) (in current status plots 12, 15)
- +3 in the burnt stand (T, U, V) (plots 24, 25, 26).

Table 3.4 Location of the established regeneration plots (A-N) and the recommended additional plots.

Plot	Easting	Northing	Stand type, fence history
Original 1979 plots			
A	552779	7221258	Main, long fenced
B	553253	7221139	Main, long fenced
C	553826	7220736	Main, long fenced
D	553999	7220691	Main, long fenced
E	554397	7221049	Main, long fenced
F	553788	7221302	Main, long fenced
G	552277	7222203	Main, long fenced
H	551737	7222528	Main, long fenced
I	551319	7221974	Main, long fenced
J	551685	7221495	Main, long fenced
K	553170	7219194	Fragment, long fenced
L	551954	7218153	Fragment, long fenced
M	544867	7232478	Fragment, recently fenced
N	548326	7223837	Fragment, recently fenced
Recommended additional plots			
O	552675	7218079	Fragment, recently fenced
P	553415	7218482	Fragment, recently fenced
Q	551388	7220691	Fragment, recently fenced
R	550785	7223233	Main, recently fenced
S	550642	7222575	Main, recently fenced
T	543105	7238840	Fragment, recently fenced, burnt
U	543453	7238779	Fragment, recently fenced, burnt
V	543548	7238729	Fragment, recently fenced, burnt

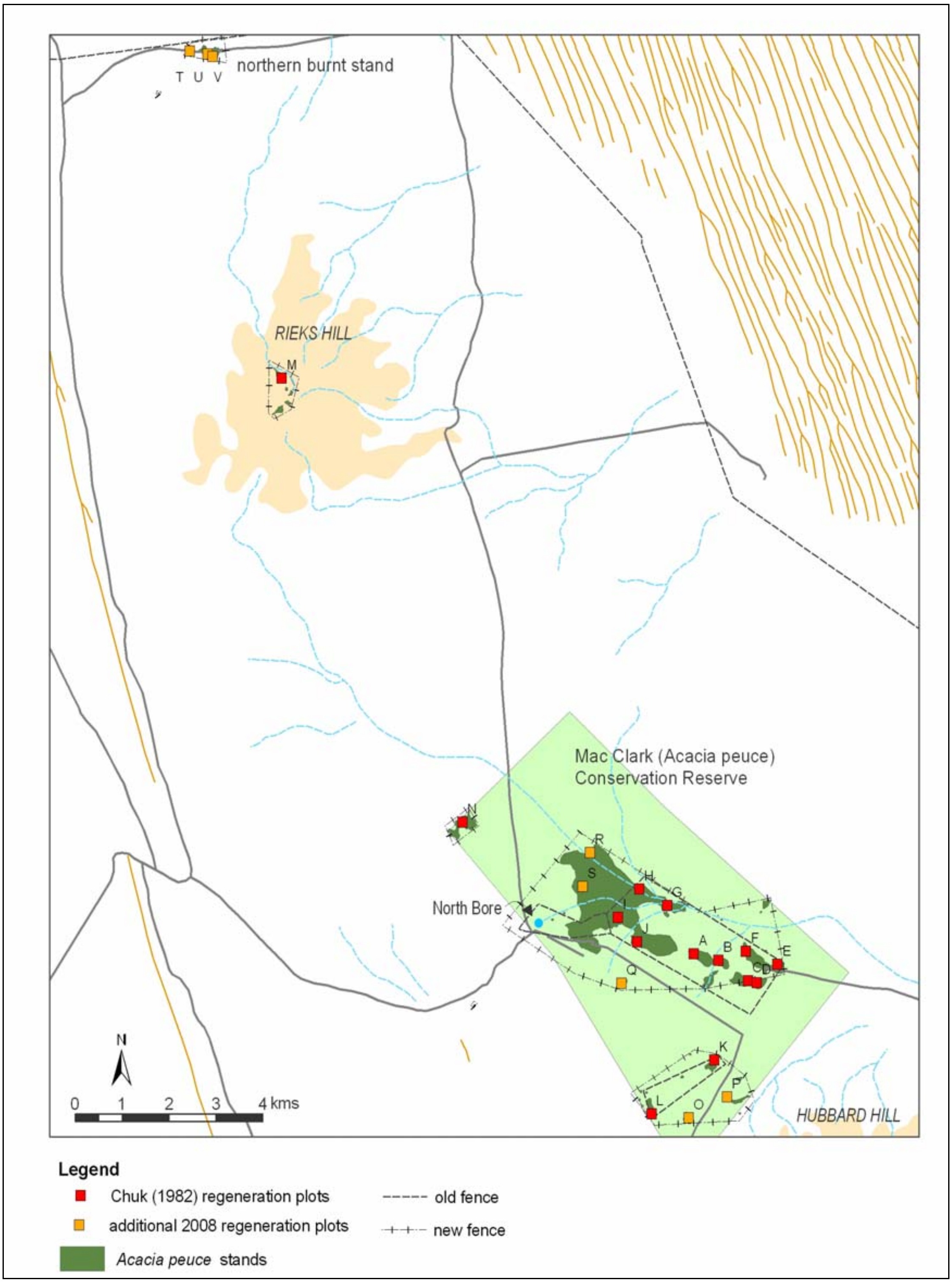

Fig. 3.2 Location of original (1979) 25 x 25m *A. peuce* regeneration plots (A-N) and the recommended additional plots (O-V) at Andado Station, NT

ii. The reproductive status of the 10 tagged main stand saplings was recorded in 2008 but time constraints meant that height measurements were not obtained for that year. Height data are available up to 2002. Accordingly, sapling growth rate was calculated as:

[**average height (2002) – average height (1983)]/19 years.**

iii. Fecundity was compared between main and fragment stands with one factor ANOVA using fruit and flower abundance scores for 14 tagged trees (seven from the main and seven from fragment stands) (Table 3.5, Fig. 3.3). Ten of the data points used for this comparison were obtained between 1983 and 1996, and one from 2008.

Table 3.5 Location and stand type of tagged adult trees for *A. peuce* fruiting and flowering monitoring on Andado Station, NT.

Stand Type	Tree No.	Easting	Northing
Fragment	23	552953	7221216
	25	553293	7221176
	26	553831	7220726
	28	554413	7221076
	33	553905	7221121
	35	551808	7222531
	36	551928	7218201
Main stand	2	553051	7219101
	3	553158	7219211
	4	553648	7218384
	7	550638	7222581
	9	544838	7231881
	14	544998	7232241
	30	544858	7232481

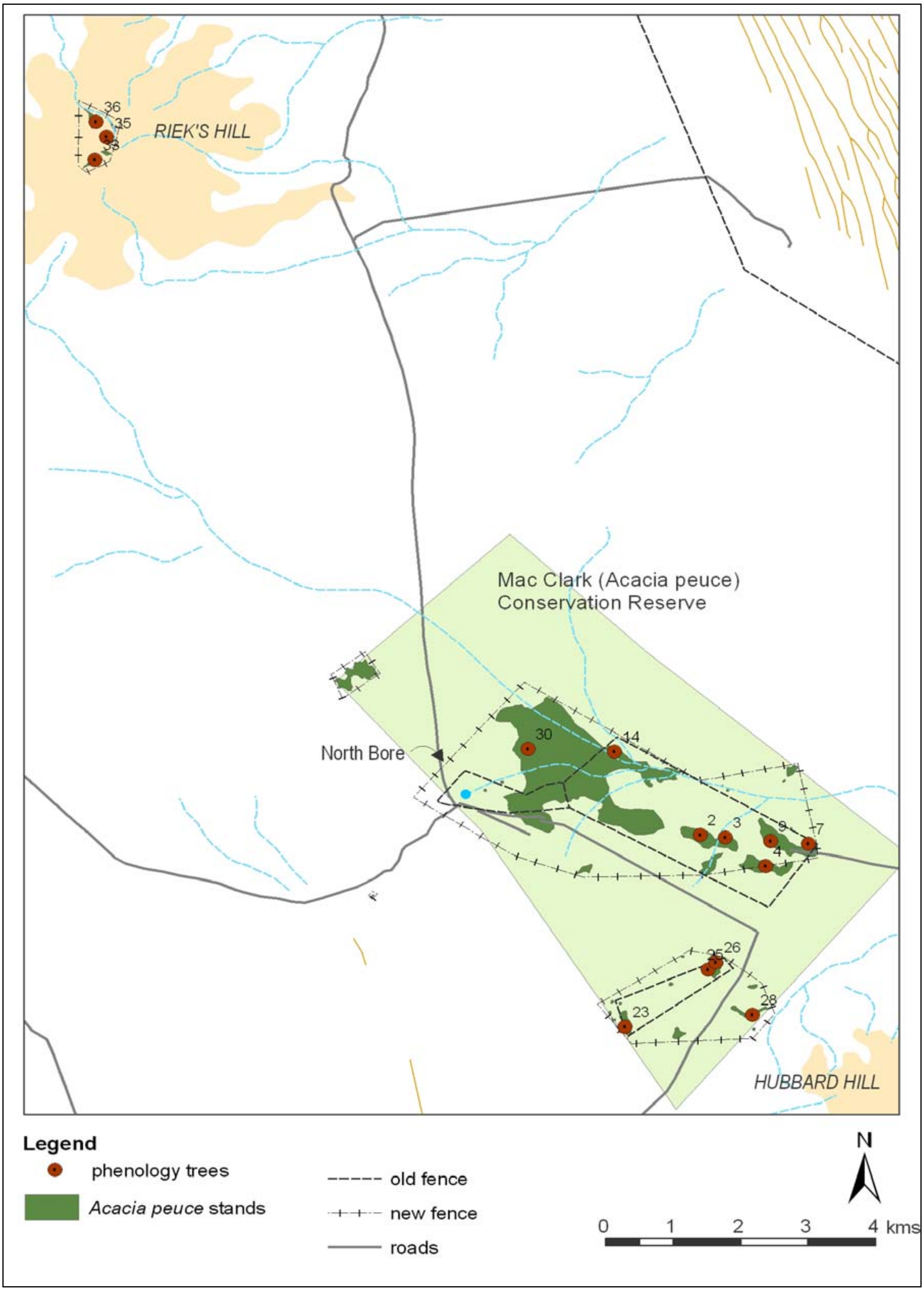

Fig. 3.3 Location of 14 permanently tagged *A. peuce* trees for seed crop monitoring of main and fragment stands at Andado Station, NT

Results and Discussion

Population size

<u>Total population</u>

In 2008 there was an average of 40.2 individuals (all size classes, plots 1-23) per plot which equates to approximately 52 individuals ha^{-1}. This figure is consistent with the estimate obtained from the 2001 survey (55 individuals ha^{-1}, A. Bowland unpublished data 2001). Both estimates in turn vary markedly from the 1980 estimate of 23 individuals ha^{-1} (Deveson 1980). These data imply that the population size increased dramatically between 1980 and 2001, and is currently stable. Despite the fact that plot placement and sample size varied with each survey, we expect that the detected positive size trend is real given the small extent and the relative uniformity of the main population. Plot placement should therefore not have had a major influence on the result. Further, the method produced very similar results in the 2001 and 2008 surveys – a period involving no major recruitment or mortality events – providing additional proof of its accuracy. The slightly higher density figure obtained in the 2001 *vs* the 2008 survey most likely reflects the inclusion of numerous lightly timbered fragment stands in the latter (see below).

Data from the regeneration plots (see below) indicate that the jump in population size between 1980 and 2001 was almost entirely due to the 1975-1983 recruitment pulse, rather than to continuous recruitment over the two decades. This episode overlapped with the largest and most prolonged series of above average rainfall events in recorded history (1973-1979). This seven year period included two years of more than three times the yearly average (c.150 mm), as well as a further three years with more than 250mm in total. Given the rarity of such events, we can expect that population recruitment may occur as infrequently as once or twice per century. Long term monitoring is therefore essential if we are to gain an accurate picture of population size dynamics of this species.

Importantly, the results also demonstrated a positive trend in the number of mature individuals in the Andado population. In 1980, the density of adults >5m tall was 6.8 ha^{-1}, compared with 10.4 ha^{-1} in 2001 and 10.7 ha^{-1} in 2008. These data indicate that the species does not meet IUCN Endangered criterion B1b(v) (i.e. decline of mature individuals). Again though, caution is warranted and the issue should be re-examined once data from the newly established permanent plots are obtained.

Main *vs* fragment stands

Density varied according to stand connectivity ($F_{1,19} = 4.961$, $P<0.05$), with fragments having significantly fewer individuals ha^{-1} (average 30.97 ha^{-1}) than the main stand (average 78.46 ha^{-1}). The lower density of the fragment stands is most likely reflective of the inherent environmental variability across the Andado site. Specifically, the main stand occurs in an area of microrelief, whereas many of the fragments are situated on slight rises or hill slopes, meaning their development may be limited by moisture constraints. The small size and lower density of the fragments means that they are inherently more vulnerable to decline from stochastic events, disturbance and climate change compared to the main stand. Negative size trends in the fragment subpopulations would heighten the overall extinction risk of this species in the NT. Comparative population size monitoring of main versus fragment stands should therefore continue as part of the management of this species.

Long *vs* recently-fenced stands

Recently fenced stands had a lower density (average 39.7 ha^{-1}) than the long fenced stands (average 78.46 ha^{-1}) ($F_{1,19} = 4.766$, $P<0.05$). There were no interactive effects of stand connectivity and grazing exposure on density ($F_{1,19} = 0.109$, $P>0.05$). At present it is not possible to disentangle cause and correlation in relation to the difference in density between long- and recently-fenced sites. For example, the higher density of the long-fenced stands may in fact have little to do with the variable grazing intensity, and may instead simply reflect the fact that the best developed stands were originally selected for preservation. Long term monitoring (incorporating major recruitment events) is needed to track comparative density changes over time and to relate any such changes to cattle exclusion measures. If for example, density differences between long- and recently-fenced stands become reduced with time, we can then relate the positive changes to cattle exclusion.

Population structure

Total population

Repeated sampling of the Andado *A. peuce* population has revealed an important shift in population structure over the 1980-2008 period (Fig. 3.4). In 1980, the population was dominated by seedlings ≤ 0.3m (50.81%, 11.4 ha^{-1}) and adult trees >5m (30.49%, 6.8 ha^{-1}) and was markedly deficient in the mid-age classes (e.g. 0.31-1.5m at 2.9 ha^{-1}). The patterning suggested that the population was non-viable because seedlings were apparently not progressing to later life phases. However, by 2001, individuals in the height classes 0.31-1.5m and 1.51-3m were dominant (50.2 %, 27.6 ha^{-1} and 17.75%, 9.76 ha^{-1}) whereas the abundance of seedlings (7.5%) and mature trees (19%) was proportionately reduced. The same pattern was apparent in 2008, with the 0.31-1.5m and 1.51-3m height classes comprising a similarly high proportion (49.1% and 19.3%) of the standing population. Thus, the results demonstrate that a high proportion of the 1979-1983 seedling cohort survived and is now established. The same pattern was apparent from the comparison of stem width measurements between 1980 and 2008. Overall, we can conclude that the Andado population is not constrained by a seedling bottleneck and is therefore not in decline from juvenile establishment failure as was previously reported (see Deveson 1980, Chuck 1980).

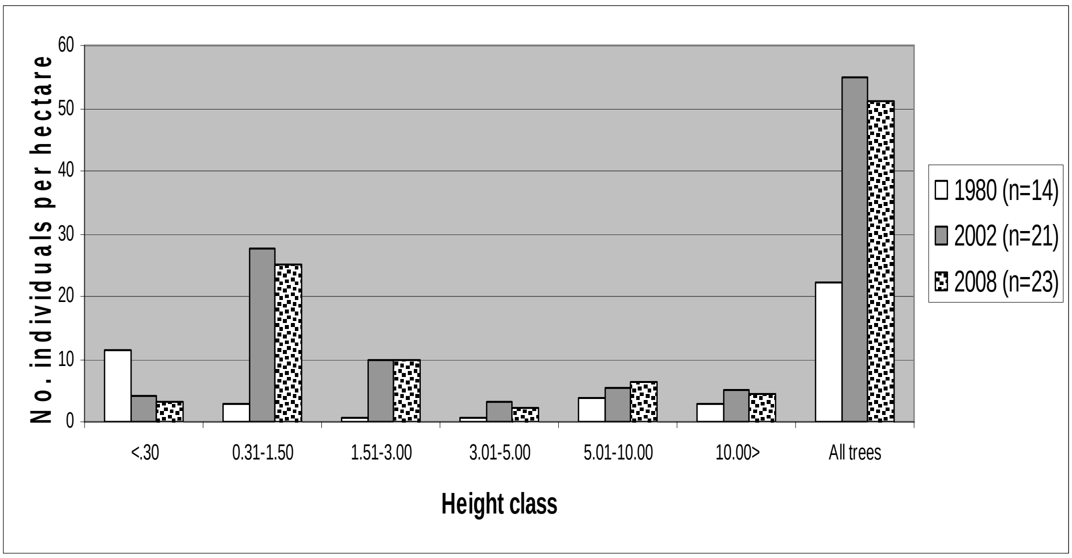

Fig. 3.4 Height class densities in the *A. peuce* population in 1980, 2001 and 2008, Andado Station, NT. (n) is number of plots used in each survey

Main *vs* fragment stands

In 2008 there was a dominance of individuals in the 0.31-1.5m height class in both the main (50.3%) and fragment (48.5%) stands, indicating successful recruitment across the entire population (Fig. 3.5). There was however, some variability with regard to the remaining height classes. Most notably, fragment stands had proportionately fewer individuals in the 1.51-3m class (9.9% v 24.2%). Again, this result most likely reflects variability in moisture supply, with establishing individuals in the main stand having greater access to soil moisture and hence a faster rate of growth. This means that maturation and stand replacement may occur at a much slower rate in the fragment stands, again adding to their already-heightened vulnerability.

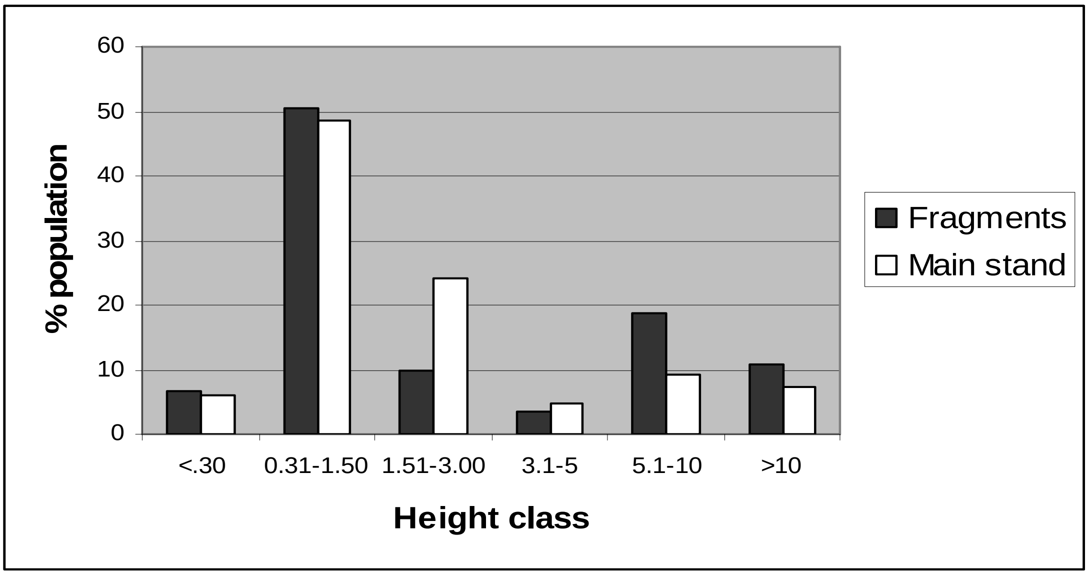

Fig. 3.5 Height class distribution of main and fragment *A. peuce* stands in 2008, Andado Station, NT

Long *vs* recently-fenced stands

Population structure was similar in long- and recently-fenced stands. Both stand types had a high proportion of individuals in the 0.31-1.5m class (51.1% and 45.2%) and in the 1.51-3m class (19.8% and 18.5%). Likewise, the proportion of small plants (<0.3m) did not vary according to grazing history (6.3% and 6.2%). This result suggests that there has not been a uniformly negative browsing effect on growth and development in unfenced stands. This is probably due to selective rather than uniform cattle use of the site given that certain recently fenced plots (e.g. 12, 14 and 15) are clearly far worse affected than others. Fencing history may therefore be an unsuitable measure of grazing exposure. Alternate variables such as understorey palatability, may instead correlate more with cattle impact gradients on *A. peuce* but this needs further examination.

Seedling survival and growth

<u>All regeneration plots</u>

Seedling survival data from the 1979 regeneration plots (A-N) provide further evidence that the population is replacing itself, albeit at a very slow rate. In 1996 seedling survival (No. remaining/total emergence, averaged across plots A-N) was 63.8% and this high survival rate carried through to 2008 at which point it was 60.8%. The average survival rate between 2008 and 1996 was as high as 95% (Fig. 3.6). Combined, these data demonstrate that once *A. peuce* seedlings progress beyond early establishment, survival rates are thereafter high. Adequate rainfall for seedling establishment is therefore the critical factor for population replacement in this species.

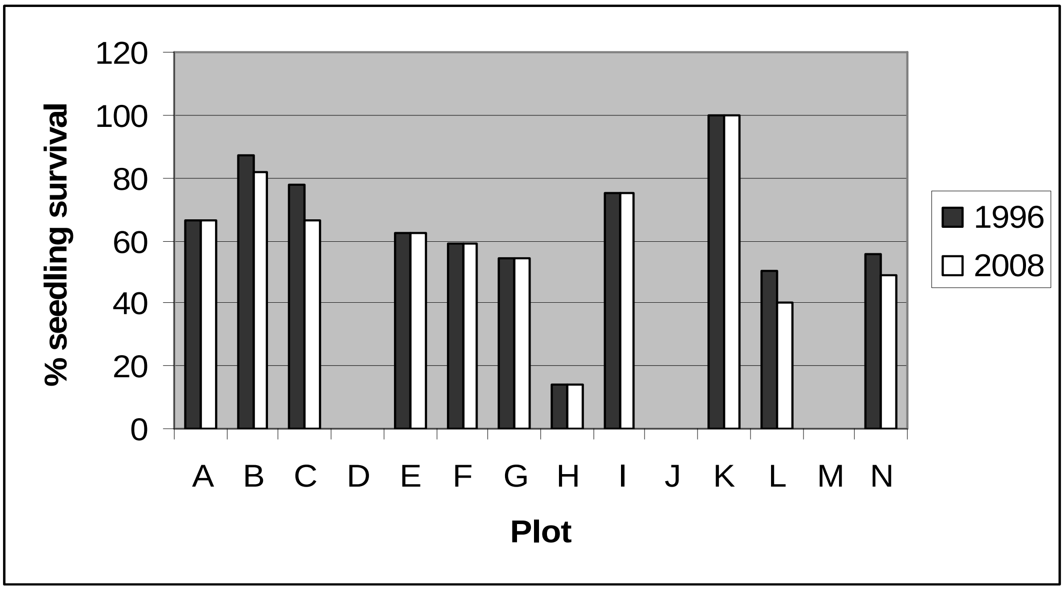

Fig. 3.6 Survival of *A. peuce* seedlings in the regeneration plots A-N in 1996 and 2008, Andado Station, NT

The height data emphasise the exceedingly slow rate of seedling growth in this species. When monitoring commenced (1979) all seedlings were <0.3m in height. At 2008, the average height of tagged plants was 82 cm (± 4 cm). This represents a minimum height increase of 52 cm which equates to a growth rate of c. 2 cm year^{-1} for this life phase. Other data show that height growth rates increase substantially once individuals progress beyond 80 cm. Height growth data for ten small main stand plants (average initial height 79.5 cm) over a 19 year period reveals a growth rate of c. 13 cm year^{-1}. When last monitored (2002) the average height of the 10 individuals was 3.4 m. Importantly, even by this stage none were reproductively mature. Combined, these data emphasise the extremely long time periods required for *A. peuce* maturation. Management must therefore take account of the slow life cycle of this species.

Main *vs* fragment stands

Three plots are situated in fragment stands. One of these (K) has only ever had one seedling, and this was alive in the 2008 census. The two remaining fragment plots (L and N), initially supported relatively high seedling numbers (10 and 74), but now exhibit below average seedling (now juvenile) survival (40% and 49%). While the sample size is too small to draw firm conclusions, the results do imply that low seedling survival rates may be the cause of the comparatively low density of fragment stands. Height data from the regeneration plots confirm that fragment juveniles are smaller than those in the main stand. In 2008 average height of fragment stand seedlings (K, L & N) was 61 cm (± 5 cm), while that of main stand seedlings was 91 cm (± 6 cm). Browsing impacts on growth cannot be considered in any detail given that only one plot with seedlings (N) was situated outside the fence areas. It is interesting to note however, that individuals in this plot are on average shorter (62 ± 5.5 cm) than those in the long fenced stands (89 ± 5.4 cm). This stand was heavily impacted by cattle in the past – adults have bark and root damage and many of the tagged juveniles show a clear browse response (i.e. multi-stemmed growth). The recovery of this stand therefore needs to be monitored.

Flowering and fruiting

Analysis of flowering and fruiting patterns using data from 11 site visits revealed a strong (though non significant) trend towards higher fecundity in main versus fragment trees (Fig. 3.7). Lower fecundity in the fragment stands may result from a combination of heightened resource constraint and lower pollination visitation but details are lacking. Further work is needed to determine if low seed set represents a real threat to the fragment stands. Comparative seed bank studies and ongoing monitoring should shed further light on this issue.

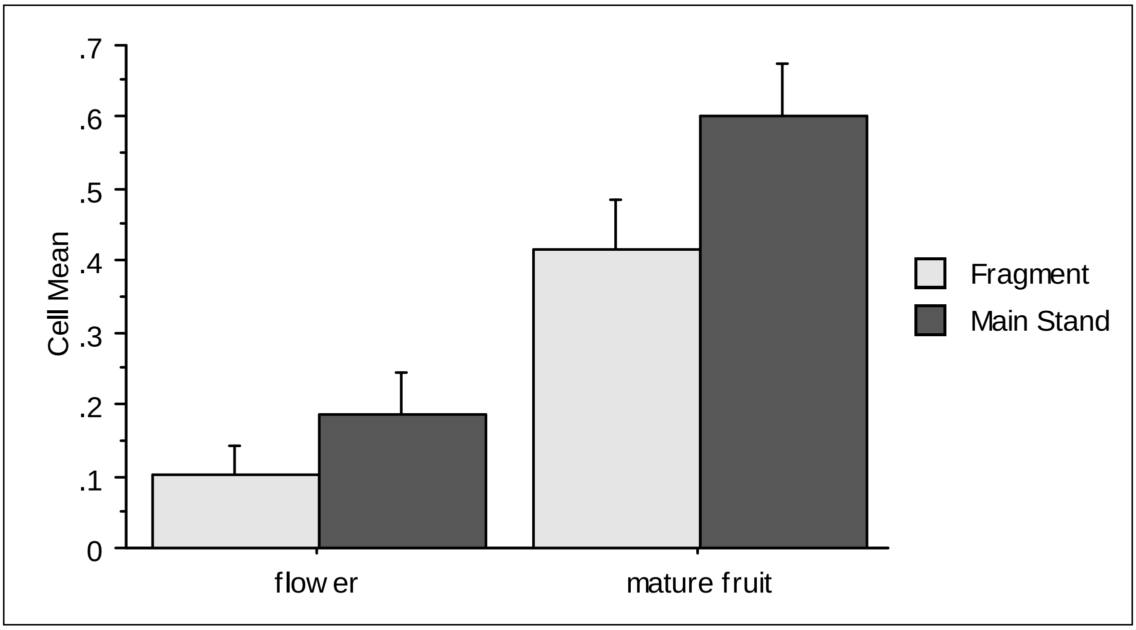

Fig. 3.7 Mean abundance score of flowers and ripe fruit in main and fragment *A. peuce* stands over 11 site visits, Andado Station, NT

Habitat condition

Remarkably, the Andado site is essentially free of weeds at present. Threats associated with exotic grass invasion (altered fire regimes, seedling competition etc) are therefore not of current concern for *A. peuce*. Ongoing site monitoring should continue however, to ensure that this threat does not develop over time. Increased mining activity in the direct vicinity of the stand could increase the likelihood of Buffel Grass invasion in particular. Feral animal impacts are likewise negligible at present. Rabbit and camel impacts may also increase with time and should therefore be monitored periodically. Due to the protracted drought conditions, ground fuel loads are very low, meaning that the fire threat is presently negligible. Possibly the greatest immediate threat to *A. peuce* is the loss of sandy surface mounds in heavily grazed patches. Long fenced sites had a significantly higher cover of sandy surface soil than recently fenced sites ($F_{1, 24} = 9.4$, $P < 0.05$) suggesting that cattle grazing has accelerated soil erosion. Field observation revealed that young *A. peuce* plants are closely associated with the sandy mounds, and are largely absent from areas of exposed stony clay. This suggests that this species has high microsite specificity in relation to its regeneration niche. The continued loss of surface soil may therefore result in reduced recruitment through a reduction in seed bed availability. This potential threat should therefore be carefully monitored.

Effectiveness of management action

During 2007, live and recently dead cattle were recorded at three stands (Riecks Hill, northern burnt stand and plot N). The North Paddock site showed signs of quite high cattle use and individual trees had recent damage. Fences therefore need to be regularly checked and maintained to ensure their efficacy. Ongoing cattle access will hamper assessment of site and population responses to this management action.

Highest priority fragment

In 2001, the northern burnt stand comprised c. 200 fire killed and only nine live individuals. The 2008 survey (plots 24, 25 & 26) revealed that while the nine individuals were still present, there had been no additional recruitment over that period. The live population is presently skewed towards the smaller size classes. Four individuals are in the 0.31-1.5m height class, two are in the 1.51-3m class, two are in the 3.1-5m class and a single individual is >5m. Only two of the nine are reproductively mature. This means that there is presently only minimal contribution to the seed bank and that future recruitment opportunities may therefore be missed. Each of the nine living plants is badly damaged by cattle (browsing effects, root exposure, bark damage etc) and two have abnormal leaf growth, possibly in response to insect attack. The overall condition of the population is therefore currently very poor. Thus, while the population size is presently stable, the long term viability of this stand is clearly in doubt. The NT population therefore likely meets IUCN endangered criterion B1b(iv) (continuing decline in the number of subpopulations). The fate of the nine remaining plants should be carefully monitored over the next few decades. Close attention should also be paid to recruitment dynamics in this population.

Future monitoring procedure

Comparison of the 1980, 2001 and 2008 data confirmed that *A. peuce* population dynamics are extremely slow. There has essentially been no change in population size or structure between 2001 and 2008, indicating that the population is currently stable. Threats associated with exotic plant and animal species are presently negligible and any dramatic changes will be recorded by NRETAS staff during routine visits to the site. Accordingly, current status monitoring may be carried out as infrequently as once every five years without the loss of information. More intensive monitoring of the badly burnt northern stand is, however, warranted and these should be assessed every two years. Information on juvenile and sapling survival, growth and maturation rates will help determine the time period required for population replacement. As such, it would be useful to monitor the regeneration plots and tagged saplings every two years. Regular monitoring of seed set in fragment stands may also prove informative and could likewise been done every two years or as regularly as possible. Fuel loads should be monitored following substantial rainfall and fire management action taken if required. Likewise, new seedling recruitment monitoring should take place following the next major rainfall event. Fences should be checked at every possible occasion. Table 3.6 summarises the recommended program for *A. peuce* monitoring.

Table 3.6 Recommended monitoring procedure for *A. peuce* on Andado Station, NT.

Monitoring questions	Monitoring action	Monitoring frequency
Is the population increasing, decreasing or stable? Do the main and fragment stands exhibit similar trends? Is there a positive population response to fencing?	Resample population size and structure in the 26 permanent 'current status' plots	Every five years
Are juveniles progressing to the sapling stage?	Record height growth and survival of tagged individuals in the regeneration plots (A-N)	Every two years
Are saplings maturing? How long does it take for the population to replace itself?	Record height growth and reproductive status of the 10 tagged saplings in the main stand	Every two years
Are threats increasing or decreasing?	Record surface soil cover as well as weed, feral animal, cattle and fire impacts in the 26 permanent 'current status' plots	Every five years
Is fire a threat to any of the stands?	Monitor ground fuel biomass levels following rainfall	As required
Are the badly disturbed/isolated fragments viable?	Compare flowering and seed set in the 14 permanently marked fragment and main stand adults	Every two years
	Monitor the fate of the nine remaining plants in the burnt stand	Every two years
	Following the next major rainfall period, record and follow the fate of any new seedlings in the original and newly established regeneration plots (A-U)	At least annually for the first 5 years following seedling emergence
Is fencing excluding cattle?	Check fence integrity	At least annually

3.2.2 *Acacia latzii*

Site locations

Bacon Range (Henbury Station) and Beddome Range (New Crown & Umbeara Stations), NT (Figs. 3.8 & 3.9).

Key monitoring questions

Population Demography

1. Is the population stable, increasing or decreasing in size?
2. Is there a good mix of juveniles, saplings and adults in the population?
3. Do the southern and northern populations exhibit the same trends?

Site Condition

4. Are weeds becoming more prominent?
5. Are ground fuel loads sufficient to carry a wildfire?
6. Are grazing impacts increasing?
7. Are feral herbivore impacts increasing?

Methodology

Five permanently marked plots were established to enable monitoring of site condition and *A. latzii* population size and age-structure trends over time. Three of the five plots were located in the northern (Henbury) population, and the remaining two in the southern population along the New Crown-Umbeara boundary (Figs. 3.8 & 3.9). Sampling intensity and plot location were foremost constrained by accessibility. The southern population is especially remote, being approximately five hours from Alice Springs and having 4WD only access. It would be beneficial to establish additional plots in this population if time and resources permit.

Initial survey work revealed little variation in environmental setting – the species being largely limited to lower hill slope positions associated with minor drainage in both populations. Further, there was no opportunity to stratify sampling across grazing intensity or fire exposure, meaning that it will be difficult to infer causality from the data if population decline is detected. This program should nevertheless reveal size and structure trends in both (north and south) populations and more intensive monitoring can be undertaken in the future if declines become apparent. Further, the established APS program on Henbury should provide insight into grazing impacts, albeit on a localised scale.

Plot size and shape were kept consistent (50 m radius circular plots) with the *A. peuce* programme so that direct between-species density comparisons could be made. In each case, plot centres were marked with a labelled metal picket and their location recorded with a GPS (Table 3.7). In certain plots, individuals were mainly concentrated along drainage lines in a linear formation, meaning that large areas of the plot were unpopulated. Mostly though, individuals occurred throughout, meaning that the decision to use circular plots was justifiable, though perhaps not ideal. Individuals were scored for the seven variables listed below.

i. Age/size class (senescent adult, adult >3m, subadult 1.51-3m, juvenile 0.3-1.5m, or seedling <0.3m).

ii. Reproductive status (fruiting/flowering/sterile).

iii. Situated in drainage line (yes/no).

iv. Root exposure from cattle (yes/no).

v. Camel branch breakage (yes/no).

vi. Bark damage (yes/no).

vii. Browsed foliage (yes/no).

The site attributes recorded for this program were essentially the same as those recorded for *A. peuce*. These included site physical variables (% rockiness, slope, aspect) as well as weed, cattle, feral herbivore and fire impacts.

Table 3.7 Location of *A. latzii* monitoring plots in the southern and northern NT populations

Population	**Site No.**	**Easting**	**Northing**
Southern	1	426995	7133700
(New Crown & Umbeara Stations)	2	425128	7137689
Northern	3	295772	7277799
(Henbury Station)	4	291828	7286557
	5	288244	7283774

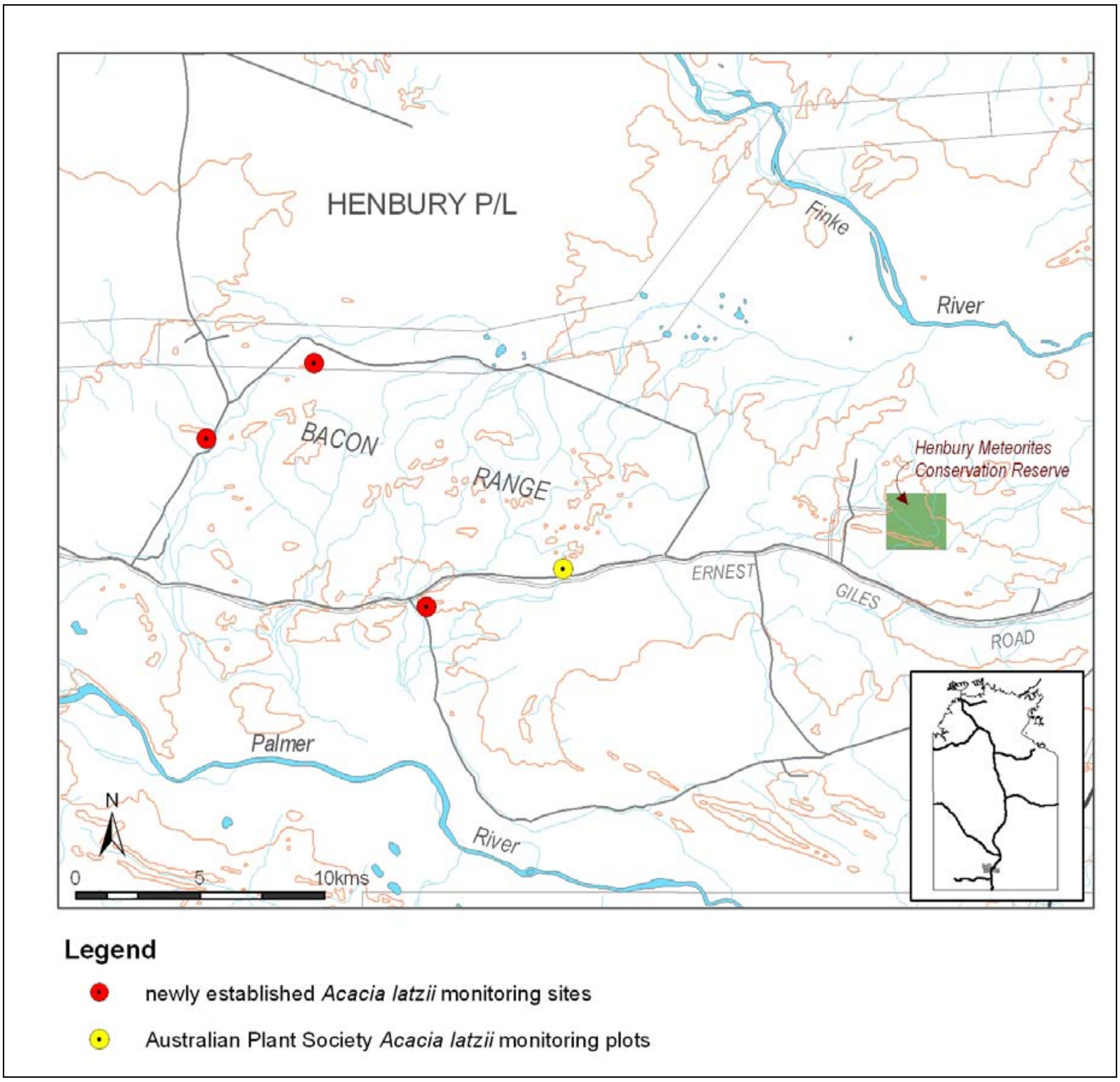

Fig. 3.8 Location of the newly established (2008) *A. latzii* monitoring plots and the Australian Plant Society monitoring plots in the Bacon Range population, Henbury Station, NT

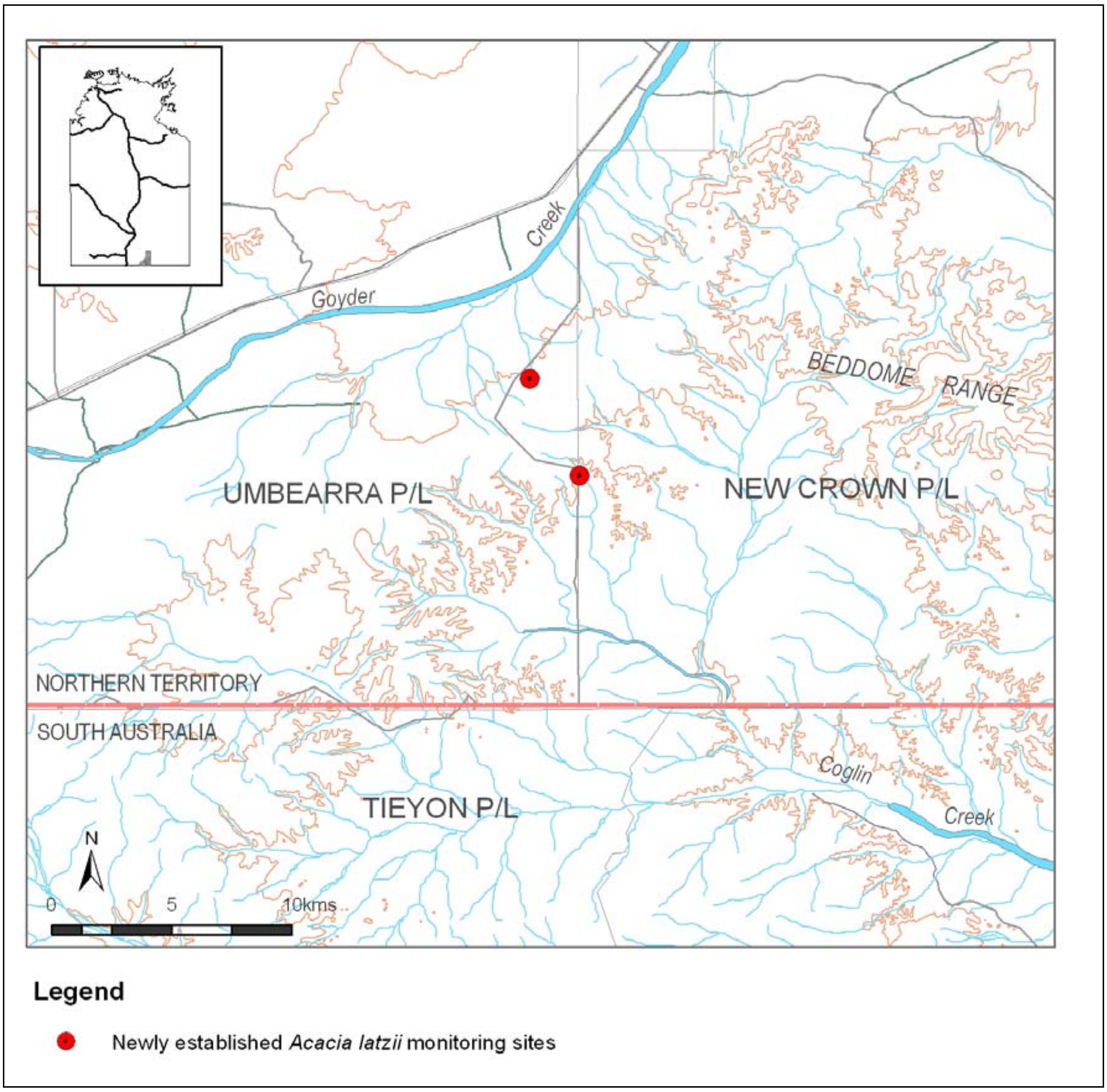

Fig. 3.9 Location of the 2008 *A. latzii* monitoring plots in the Beddome Range population, New Crown and Umbeara Stations, NT

Results and discussion

Population size

The 2008 survey recorded an average of 21.8 individuals (all size classes, plots 1-5) per plot which equates to approximately 28 individuals ha^{-1}. The average density of mature individuals was 24 ha^{-1}. These figures differ quite markedly from those obtained for *A. peuce*. Specifically, the total population density in *A. latzii* is approximately half that of *A. peuce*, while the density of mature *A. latzii* is more than twice that of *A. peuce.* The two species therefore exhibit quite contrasting patterns in terms of their localised abundance and their population structure (see below). These data suggest therefore, that the *A. peuce* population is less vulnerable to decline than *A. latzii.* Importantly, *A. latzii* has a much less restricted area of extent in the NT, meaning that its extinction risk is spread over a greater area.

The northern and southern *A. latzii* populations varied little in terms of their overall density (29 ha^{-1} vs 27 ha^{-1}), and the density of mature individuals (both 24 ha^{-1}). This suggested that the two face similar environmental, disturbance and life history constraints and should therefore be treated as a single management unit.

Population structure

This study confirmed that the *A. latzii* population is presently greatly skewed towards the older age classes (Fig. 3.10). Very old plants (characterised by many dead branches) comprised the bulk of the population (58.7%) followed by 'younger' adults (26%), sub-adults (9.2%), juveniles (4.6%) then seedlings (0.9%). The density of juveniles and seedlings was correspondingly very low (1 ha^{-1} and <1 ha^{-1} respectively). This patterning strongly suggests that the population is declining as a result of recruitment failure. Alternatively, the situation could be dramatically altered if suitable recruitment conditions arise prior to the loss of the older age classes. Mortality and recruitment rates therefore need to be closely monitored over a long time frame to test for these divergent outcomes.

The results show that the northern and southern stands have essentially the same structure, suggesting that they are equally prone to decline. There was, however, some variability in that the northern population had higher adult density and lower old/senescent adult density compared to the southern stand (Fig. 3.11). Interestingly, the former had a high density of (apparently) fire killed individuals while none were recorded in the southern stand. This result highlights two issues. First, it suggests that the northern stand may be more fire prone than the southern stand. Second, the result implies that fire has an extremely long lasting impact on *A. latzii* population structure, again because of the slow population dynamics of this species.

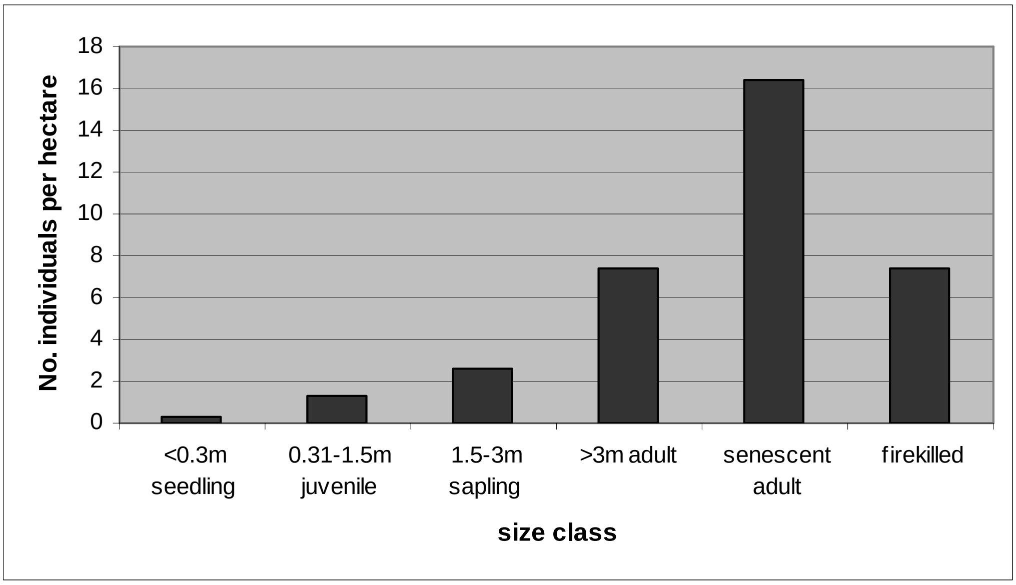

Fig. 3.10 Height class distribution of *A. latzii* (southern & northern NT populations combined)

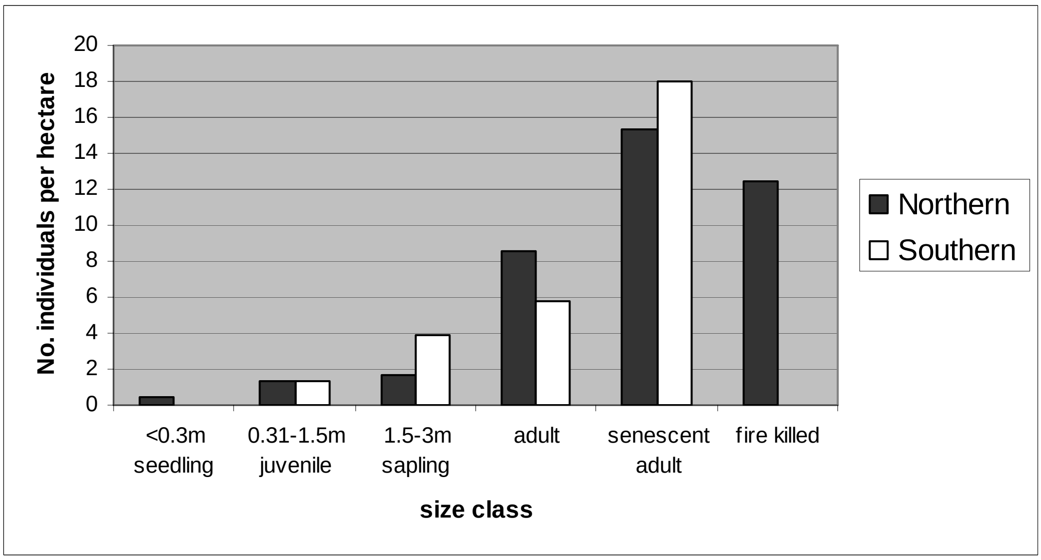

Fig. 3.11 Comparison of height class distributions between the northern and southern NT *A. latzii* populations

Site condition

Each of the five *A. latzii* monitoring plots is presently free of weeds. While this represents a small sample size, our field observations indicate that the result is reflective of the broader situation for this species. Threats associated with exotic grass invasion are therefore presently low for *A. latzii*. Again, though, ongoing monitoring is necessary, given that a high proportion of individuals occur in drainage lines, and this is a preferred habitat for invasive species such as Buffel Grass and Couch Grass. Currently the area including and immediately surrounding the southern population is notably free of Buffel Grass in particular. This most likely reflects the fact that cattle grazing is negligible in the southern stands due to an absence of water points. The situation may therefore change in the future with increased pastoral development.

Direct cattle and feral herbivore impacts on *A. latzii* are presently minimal. Camel and donkey sign was, however, quite common in both populations indicating that these species are using *A. latzii* habitat. None of the plots had recent rabbit sign, but many inactive warrens were noted throughout the broader habitat area. Neither population is currently threatened by fire, again due to exceedingly low herbage cover under the present drought conditions. The situation could rapidly change however, and therefore should be treated as a high priority issue following periods of high rainfall. Soil erosion is presently minimal at all sites.

Future monitoring procedure

Presently, *Acacia latzii* is threatened due to poor seedling recruitment and its small population size and the low number of locations where it occurs. It is not possible to determine whether the current population structure is the result of environmental constraint (i.e. low rainfall) or external threatening process, but the former seems most likely. This 2008 audit has confirmed that threat levels are presently low. Further, the exceedingly low proportion of seedlings and juveniles means that rapid changes in population size and structure is highly unlikely. Intensive, regular monitoring of this species therefore seems unwarranted. Current status monitoring should again be undertaken in five years time.

3.2.3 *Acacia pickardii*

Site location

Hubbard Hill, Andado Station, NT (Fig. 3.12).

Key monitoring questions

Population Demography

1. Is the population stable, increasing or decreasing in size?
2. Is there a good mix of juveniles, saplings and adults in the population?

Site condition

3. Are weeds becoming more prominent in *A. pickardii* habitat?
4. Are negative cattle and feral herbivore impacts increasing?
5. Are ground fuel loads sufficient to carry a wildfire?

Methodology

Acacia pickardii is vulnerable in the NT primarily as a consequence of its inherent population attributes i.e. its small size and low number of subpopulations. Projections for decline are based on field observation that suggests that the population is aging in the absence of adequate recruitment. Cattle, rabbit and fire impacts are recognised as potential threats to *A. pickardii* though all are presently at low intensity. Accordingly, this monitoring programme simply seeks to audit the current status of the population and to document population and threat level trends over time.

Four plots were established in the Hubbard Hill population on Andado Station (Fig. 3.12). Additional plots will be established on this same property in the East Bore stand if proposed road construction associated with mineral exploration goes ahead. Plot size and shape were kept consistent (50 m radius circular plots) with the *A. peuce* and *A. latzii* programmes, and again, plot centres were marked with a labelled metal picket and their location recorded with a GPS (Table 3.8).

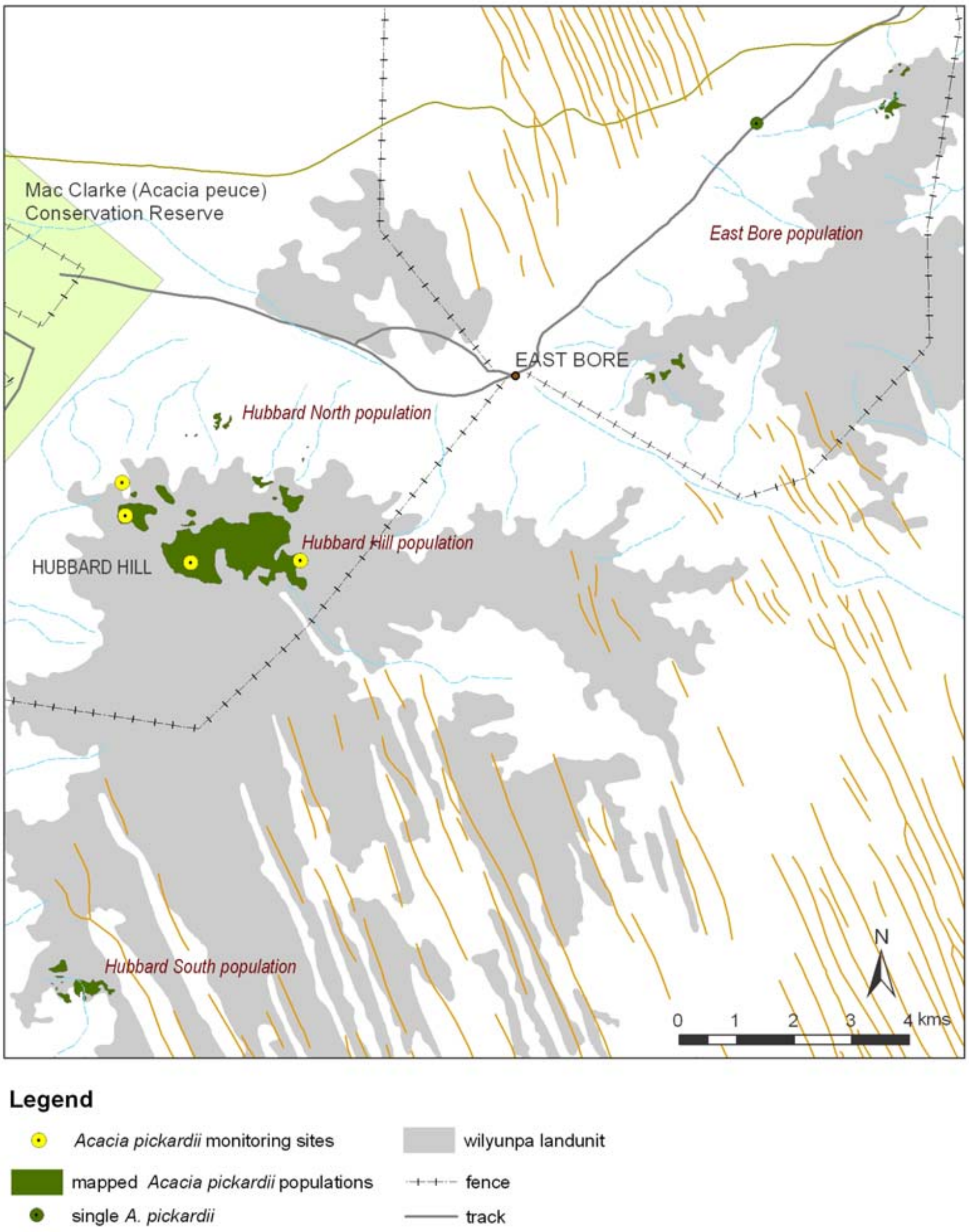

Fig. 3.12 Location of the four *A. pickardii* monitoring plots established in 2008 on Hubbard Hill, Andado Station, NT

Table 3.8 Location of *A. pickardii* monitoring plots on Hubbard Hill, Andado Station, NT.

Site No.	Easting	Northing
1	555161	7216791
2	556183	7215979
3	555114	7217372
4	557912	7216005

Individuals were scored for the following variables:

1. Height class (>3m, 1.51-3m, 0.3-1.5m, or <0.3m)
2. Reproductive status (fruiting/flowering/sterile)
3. Root exposure from cattle (yes/no)
4. Camel stem breakage (yes/no)
5. Herbivore bark damage (yes/no)
6. Browsed foliage (yes/no).

Multi-stemmed trees were converted to a single measurement by averaging stem height. A stem was treated as a discrete individual if it occurred more than one meter from any other plant.

The site attributes recorded for this program were essentially the same as those recorded for the preceding species. These included site physical variables (% rockiness, slope, aspect) as well as weed, cattle, feral herbivore and fire impacts.

Results & Discussion

Population size

This 2008 survey recorded an average of 329 'individuals' (all size classes) per plot which equates to 421 ha^{-1}. The result is quite staggering when compared with the figures obtained for *A. peuce* and *A. latzii* and would suggest that this species does not meet IUCN criterion C2i (no subpopulation estimated to contain more than 1000 mature individuals). However, in the absence of information on population genetics and root suckering patterns, it is impossible to know how many individuals may have been given multiple scores. Therefore despite our application of the '1 m separation rule of thumb', we acknowledge that this figure may be a gross over-estimate of individual plant density, and should therefore be treated with some caution. Certainly though, stem density is currently very high, suggesting a healthy, stable population.

Population structure

The results show that in 2008 the Andado *A. pickardii* population was dominated by small plants in the height class 0.31-1.5m (Fig. 3.13). Importantly though, most individuals in this height class were also clearly very old and seemed as likely to be reproductively mature as the plants in the next height class. Further, none of the plants exhibited a browsing response which would otherwise account for their low stature. Instead, it seems most likely that there are inherent environmental constraints on *A. pickardii* height growth in the Andado population. Thus, the result should not be interpreted as evidence for a high proportion of younger plants (and thus a positive trend) in this population.

A comparison of the size structure of NT and the South Australian populations (data derived from Davies 1995) adds weight to this supposition. Apart from the far greater abundance of the height class 0.31-1.5m in the former, the two populations differ markedly in terms of their relative abundance of >3m tall plants – as little as 2% of the NT population was more than 3m tall (Fig. 3.13). The SA data set includes individuals from both fenced and unfenced sites, meaning that differences do not relate to cattle or feral herbivore impacts. It is possible that the differences are a product of differing sample times given that the data for the SA population was obtained in 1993. This seems unlikely though, given the slow dynamics of the system. Overall therefore, we expect that the NT population is dominated by old (albeit short) plants and we stress that great care needs to be exercised when inferring population trends from structural patterns in this species.

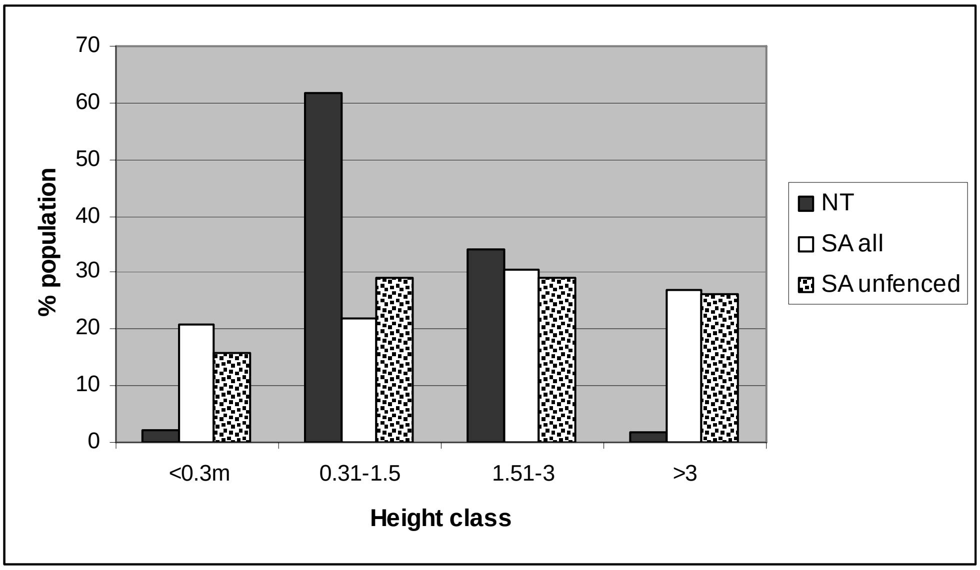

Fig. 3.13 Comparison of age structure in the SA and NT *A. pickardii* populations

Site condition

Each of the four *A. pickardii* monitoring plots is presently free of weeds, indicating that threats posed by Buffel Grass such as heightened fire and seedling competition are presently negligible for this species. Importantly, the situation may change in the near future with increased mineral exploration in the area, and should therefore be monitored. This is particularly the case if new roads are constructed close to existing stands as is likely to occur during mineral exploration currently taking place in the vicinity of Hubbard Hill. Direct cattle and feral herbivore impacts on *A. pickardii* are presently minimal. Cattle sign was present at two plots though there were no obvious effects on tree condition. None of the plots had recent rabbit sign, nor are any threatened by fire due to exceedingly low herbage cover in this habitat. Soil erosion is presently minimal at all sites.

Future monitoring procedure

Presently, the threat level at the Hubbard Hill *Acacia pickardii* is low and the population size and structure are not suggestive of rapid decline. Further, the exceedingly low proportion of seedlings and juveniles means that rapid changes in population size and structure is highly unlikely. Intensive, regular monitoring of this species, therefore seems unwarranted. Current status monitoring should therefore be undertaken on a five yearly basis.

3.2.4 *Acacia undoolyana*

Site locations

N'Dhala Gorge Nature Park and Undoolya Station, NT (Fig. 3.14).

Key monitoring questions

Population Demography

2. Is the population stable, increasing or decreasing in size?
3. Is there a good mix of juveniles, saplings and adults in the population?
4. Is fire causing a sapling bottleneck in the population?

Site condition

5. Are weeds becoming more prominent in *A. undoolyana* habitat?
6. Are ground fuel loads sufficient to carry a wildfire?

Effectiveness of management action

7. Is fire management reducing the wildfire threat?

Methodology

This program is primarily concerned with fire effects on *A. undoolyana* population structure. Specifically, it seeks to 1) determine if the population is currently dominated by saplings due to fire effects and 2) measure population changes over time and evaluate the efficacy of fire management practice. Six permanently marked plots were established to enable repeated sampling of *A. undoolyana* population size and age-structure and site condition (Fig. 3.14). Sampling was stratified across three fire histories and two land tenures (Table 3.9).

Unfortunately, the three original (1987) plots were not permanently marked, meaning that they could not be precisely located and re-established for use in this program. Some continuity was achieved by placing the new plots in two of the three original subpopulations and by using the same quadrat dimensions (100m x 50m). Plots 1, 3-6 had their long axis running parallel to the hill contours, while plot 2 was oriented with its long axis parallel to the hill slope. As in the original program, tree height and stem size (DBH @1.3m) data were obtained for every individual in the quadrat. Multi-stemmed trees were converted to a single measurement by averaging diameters. A stem was treated as a discrete individual if it occurred more than one meter from any other stem.

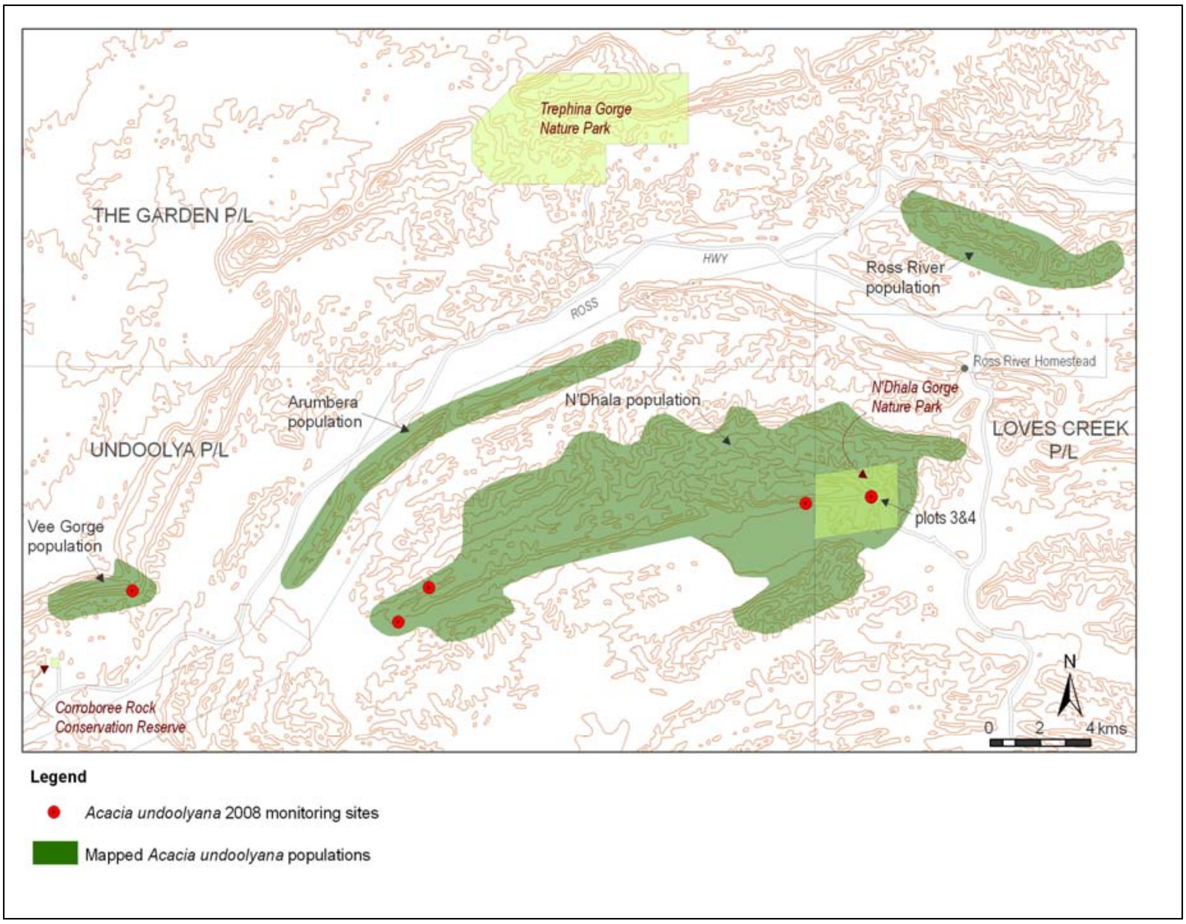

Fig. 3.14 Location of the six *A. undoolyana* monitoring plots established in 2008 at N'Dhala Gorge Nature Park and on Undoolya Station

Table 3.9 Location, fire history and land tenure of the six *A. undoolyana* monitoring plots established in 2008.

Fire age	Population	Tenure	Site No.	Easting (WGS 84)	Northing (WGS 84)
Long unburnt (>100 yrs)	N'Dhala Ridge (east)	Undoolya Stn	1	442687	7385742
	N'Dhala Gorge Nature Park	Conservation Reserve	4	444851	7386247
1975	Vee Gorge	Undoolya Stn	2	422455	7382901
	N'Dhala Gorge Nature Park	Conservation Reserve	3	444784	7386128
1975 + 2000	N'Dhala Ridge (west)	Undoolya Stn	5	431494	7383219
	N'Dhala Ridge (west)	Undoolya Stn	6	430572	7382141

Every live individual was additionally scored for reproductive status (abundance of flowers, buds, mature and immature fruit). Individuals were grouped into five life classes based on the height and stem size data as detailed below.

1. Large adults = stem DBH > 10 cm.
2. Smaller adults = stem DBH 5-10 cm.
3. Saplings = stem DBH < 5 cm, height >1.5 m.
4. Juveniles & small sprouts = stem DBH < 5 cm, height 0.31-1.5 m.
5. Seedlings = stem DBH < 5 cm, height <0.31 m.

To provide an estimate of post fire survival and of the pre-fire population structure in the 2002 burn plots, individuals were classified into one of nine categories as outlined below.

1. Fire killed adult (pre fire stem width >5 cm).
2. Resprouting adult (pre fire stem width >5 cm).
3. Fire killed sapling (pre fire stem width < 5 cm, height >1.5 m).
4. Resprouting sapling (pre fire stem width < 5 cm, height >1.5 m).
5. Fire killed juvenile (pre fire stem width < 5 cm, height 0.31-1.5 m).
6. Resprouting juvenile (pre fire stem width < 5 cm, height 0.31-1.5 m).
7. Post fire sapling recruit (no pre fire stem, height >1.5 m).
8. Post fire juvenile recruit (no pre fire stem, height 0.31-1.5 m).
9. Post fire seedling recruit (no pre-fire stem, height < 0.31 m).

Recorded site attributes were: aspect; slope; % rock cover; rock size class distribution (% outcrop, boulders, stones); % spinifex (*Triodia*) cover; % Buffel Grass cover, and *A. undoolyana* canopy structure and % cover.

Results & Discussion

Population size

In 1987 the *A. undoolyana* population was estimated to contain 279 individuals ha^{-1} (n=3). The 2008 survey (n = 6) produced a remarkably similar estimate of 280 individuals ha^{-1}, indicating that there had been no change in population density over the 21 year period. Although the two surveys were limited by a small sample size, they both took account of the known range of fire histories, meaning that stand variability should be largely accounted for. We can therefore assume that this represents a fairly accurate density estimate for the species in areas where it occurs as the canopy dominant.

It is difficult to speculate on temporal trends in mature plant density because we currently do not know when this species becomes reproductively mature. Assuming a correlation between reproductive maturity and stem width, the data do suggest a slight increase in adult density over the 21 year period, based on an arbitrary threshold value of 5 cm DBH. Specifically, in 1987 the average density of larger plants (>5 cm) was 101 ha^{-1} and in 2008 it was 117 ha^{-1}. The result alludes to a positive recovery trend from the 1975 fires, in spite of the repeated (possibly more localised) fire event in 2002. It must be stressed however, that the time-to-maturity in this species needs to be quantified before any weight can be placed on this result.

Population structure

The 2008 census showed that the *A. undoolyana* population is presently dominated by juveniles/small resprouts (<5 cm stem diameter, 0.3-1.5m stem height) and ‘young adults’ in the 5-10 cm stem class (Fig. 3.15). This confirms that the population comprises relatively few large/old trees, adding weight to the idea that fire is having a negative impact on this species. Importantly though, the results do not necessarily signify population decline, in view of the comparatively high density of trees in the 5-10 cm stem class. Much therefore depends on the reproductive status of this smaller class (i.e. whether or not it is contributing to the seed bank) and on the incidence of fire over the next few decades.

A comparison of stem size data from 1987 and 2008 suggests that there has been an increase in the relative abundance of 5-10 cm stems and a decrease in stems >10 cm in recent history (Fig. 3.16). While the increased density of 5-10 cm stems can be readily accounted for (i.e. the progression of saplings to the early adult life phase), the simultaneous ‘loss’ of larger trees is less easily explained. Certainly, fire could not have caused the decline in larger trees without affecting the density of smaller ones given that both size classes are more or less equally prone to stem kill. Instead we suggest that the pattern is most likely a consequence of the low sample size and the fact that the 1987 and 2008 Vee Gorge samples had different fire histories – the former being long undisturbed and the latter having being burnt in the mid 1970s.

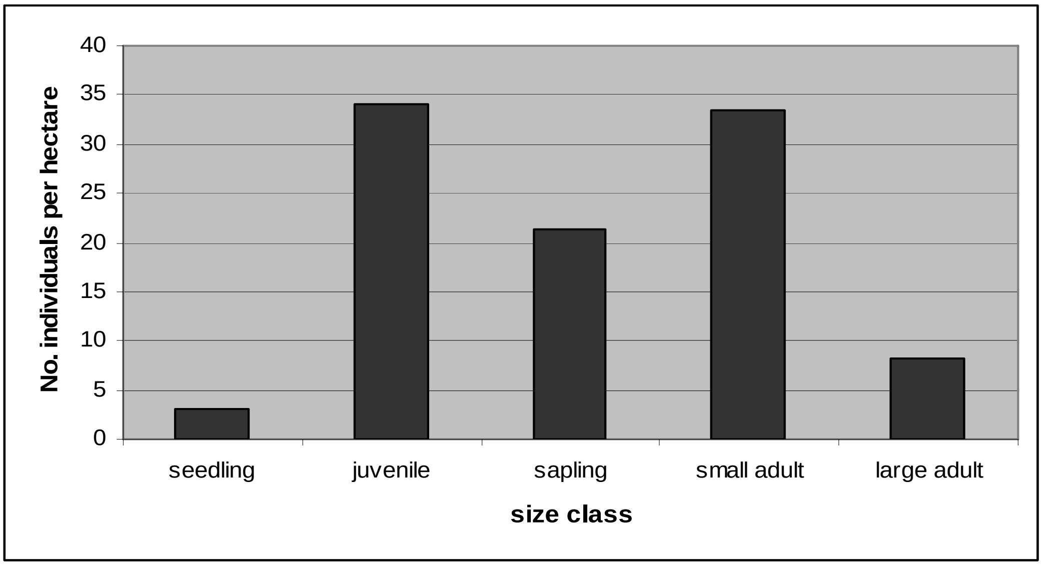

Fig. 3.15 Life class distribution of the *A. undoolyana* population in 2008

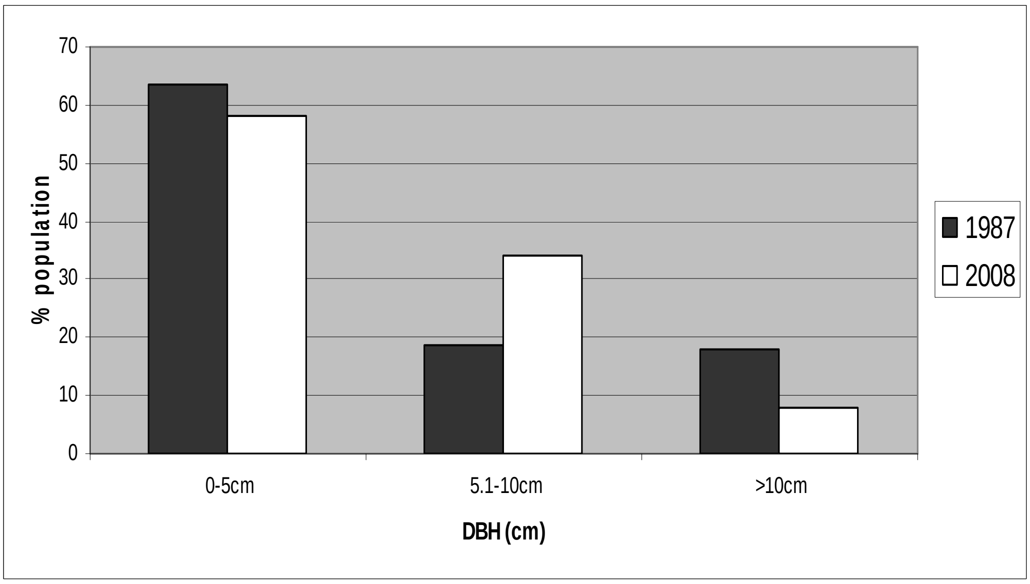

Fig. 3.16 Comparison of stem size distribution in *A. undoolyana* between 1987 and 2008

Site condition

Fire effects

This study demonstrated that *Acacia undoolyana* has moderately high fire survivorship (c. 54%) and that resprouting ability in this species increases slightly with stem size (juveniles 48%, saplings 55% and adults 64%). In the present context therefore (i.e. long fire free intervals), it is unlikely that the species is threatened by a fire-driven decline in standing plant and seed bank density.

There is also little evidence of a population-wide sapling bottleneck in *A. undoolyana* due to fire effects. Where this process is in operation, species have a low proportion of adults in their population because fire repeatedly causes stem kill prior to sapling maturation. According to our estimates, the population is presently dominated by plants with a stem size >5 cm, which we assume are reproductively mature. Overall, therefore, we report that *A. undoolyana* is not under immediate threat of decline from negative fire effects.

Importantly, this and the previous (1987) study serve to emphasise that fire effects are highly variable (both spatially and temporally) across the population. Uneven fire exposure has resulted in a high degree of structural variation among stands, indicating that the risk of decline is non-uniform across this species' range. In long unburnt stands (> 70 years), the size class distribution is quite even, with a near equal abundance of medium and large trees (29% and 25%) and a slight dominance of juveniles (46%) (Fig. 3.17). This contrasts markedly with patterning in fire affected stands. In the 1987 survey, the 1975 burn (12 years post fire) population was dominated (95%) by the smallest stem size class (< 0.5 cm) which had a density of 290 ha^{-1}. The density of individuals in the classes 5.1-10 cm and >10 cm was, by comparison, extremely low (12 ha^{-1} and 2 ha^{-1}). These data show that the burnt population remained almost devoid of mature plants 12 years on from the fire. Similarly, sites burnt in 1975 and again in 2002, comprised only juveniles and small basal stems sprouts (average height 1.14m), more than six years post fire (Fig. 3.17). Other data suggest that recovery time may be in the order of at least three decades – in 2008 (33 years post fire), the 1975 burn population (plots 2 & 3) had a high proportion (52%) of 'adult' trees though the density of large (>10 cm) trees still remained very low. Thus, the effects of fire exposure on *A. undoolyana* population structure are extremely long lasting, most likely due to life history constraints and climate limits on post fire woody growth. This means that increased fire exposure (> once every 30 years) could initiate decline in this species. Currently, though, fire intervals exceed this threshold and the present threat level is therefore minimal.

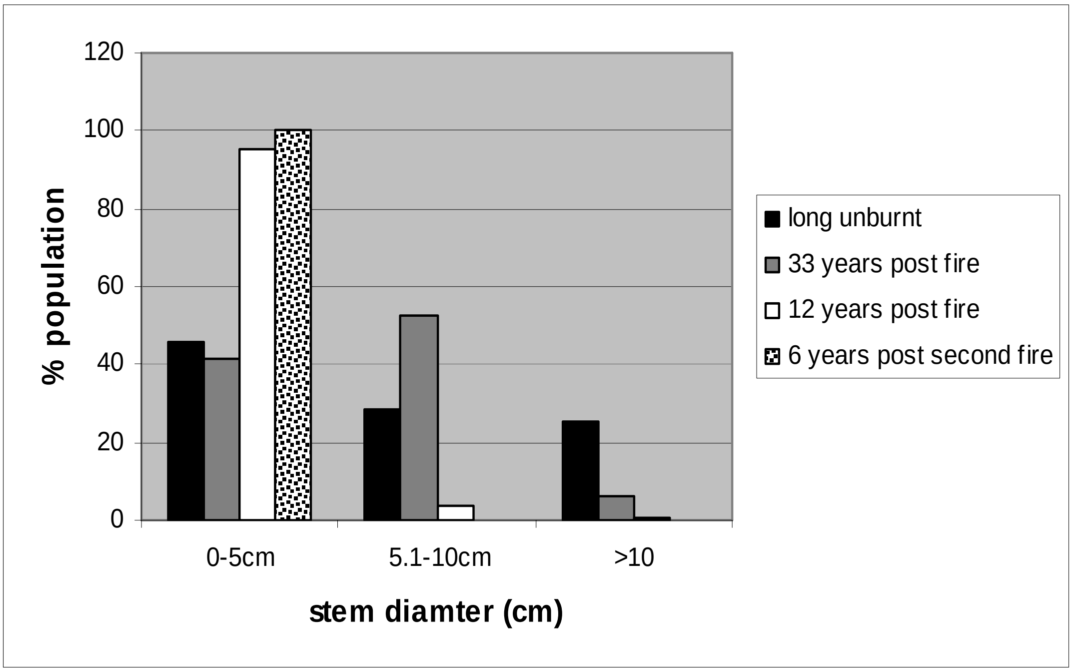

Fig. 3.17 Average size class distribution of *A. undoolyana* stands in relation to time-since-fire. Long unburnt = plots 1 & 4 of 2008 survey and Vee Gorge & N'Dhala Ridge plots of 1987 survey; 33 years post fire = plots 2 & 3 of 2008 survey; 12 years post fire = N'Dhala Gorge plot, 1987 survey; and 6 years post fire = plots 5 & 6 of 2008 survey

<u>Invasive grasses</u>

Buffel Grass was recorded in low abundance (2% cover) in one of the six 2008 monitoring plots (plot 4). Couch Grass was absent from all plots. Threats associated with exotic grass invasion are therefore presently low but should nonetheless be monitored over time. Stands in the immediate N'Dhala Gorge area are perhaps most susceptible given the higher level of disturbance associated with vehicle-based tourist visitation and the high abundance of Buffel Grass along the creekline.

Effectiveness of management

Current management practice aims to reduce the incidence of fire exposure in *A. undoolyana*. Several fire breaks were established at strategic points prior to the 2002 wildfires but unfortunately most ultimately proved ineffective in protecting the targeted stands. This has lead to a shift towards the use of wider and non linear breaks (G. Horne pers. comm. 2008). The efficacy of this latter approach can be gauged by recording future fire incidence in the established plots and with the use of remote sensing and ground survey technique following future wildfire events.

Future monitoring procedure

The combined results of the 1987 and 2008 population audits emphasise the slow population dynamics and the overall low extinction risk of *A. undoolyana*. Accordingly, it would be sufficient to carry out future population audits on a five yearly basis, or in response to the next major wildfire event (Table 3.10). The outstanding issue for this species is the timing of maturation in relation to fire cycles. Based on available information we assume that fire free intervals are on average long enough to allow post-fire recruits and stem sprouts to mature. This assumption does however, require testing. Attempts should therefore be made to quantify the primary (juvenile) and secondary juvenile (stem sprouts) periods for this species through the establishment of a demographic monitoring programme in the 2002 burnt plots. A sample (at least 20) of juveniles and fire sprouts from plots 5 & 6 should therefore be individually tagged and their growth and development monitored to the point at which they mature. Visitation should occur annually during the September-December period when the species is known to flower and fruit or after significant rainfall.

Table 3.10 Monitoring procedure for *A. undoolyana*.

Monitoring questions	Monitoring action	Monitoring frequency
Is the overall population stable, increasing or declining?	Resample population size and structure in the 6 permanent plots	Every five years and after all significant rainfall events
How long does this species take to mature from seed and from stem sprouts?	Tag 20 juveniles and 20 basal sprouts in plots 5 & 6. Record reproductive status and height and stem width	Every two years and after all significant rainfall events until they are mature
Are site threats increasing or decreasing?	Record Buffel Grass cover in the 6 permanent current status plots	Every five years
Are certain populations more prone to fire than others?	Monitor ground fuel levels in the 6 permanent plots	Every five years and after all significant rainfall events
Is management reducing the incidence of fire incursion?	Monitor fire exposure in the frequency of 6 permanent plots	Every five years and after all significant wildfire events

Part 4 Indigenous Knowledge of Threatened Acacias

4.1 Introduction

This project aims to draw together Indigenous Knowledge of four threatened *Acacia* species occurring in the southern region of the Northern Territory - *Acacia peuce, Acacia latzii, Acacia pickardii,* and *Acacia undoolyana*. Specifically, this work sought to:

i) research any information on these species previously documented by anthropologists, linguists, and ethno-biologists;

ii) work with traditional owners and other knowledgeable informants to record current Indigenous ecological knowledge (IEK) relating to these species; and

iii) determine how IEK can be incorporated into recovery actions for these four species, in consultation with Aboriginal knowledge-holders.

The information sought for these acacias included knowledge of their ecology, phenology, distribution, Indigenous use-values (e.g. medicinal, food, artefact production) and potential threatening processes. Also important in this context are the mythological values of these species. This mythological importance seems to influence the willingness of Aboriginal people to be involved in current research and future management programs.

While this project focused primarily on information relating to the Northern Territory (NT) populations of these acacias, some information has also been included for the Queensland populations of *A. peuce,* and the South Australian populations of *A. pickardii* and *A. latzii*.

4.2 Methodology

We undertook an extensive search of the available literature to locate Aboriginal cultural information recorded about any of the four *acacia* species. It became apparent quite early on however, that while a relatively large body of data was available for *A. peuce,* Indigenous knowledge of the other three species either did not exist or it was not easily accessible. One reason for this is that only one of the four species (*A. peuce*) had been scientifically described prior to the 1970s, and by this time, cultural knowledge was generally dwindling. Even for *A. peuce*, the bulk of the recorded information relates to its mythological significance, rather than to any Indigenous use, or to 'ecological' knowledge. In fact, we were unable to locate any reliable evidence to support the view that *A. peuce* timber was used by Aboriginal people to make clubs or waddies – as its common name, 'waddy wood', suggests. This probable misnomer is discussed further below.

In addition to the literature survey, discussions were held with relevant non-Indigenous language and culture scholars of the Arandic and Karnic language regions where populations of the four study species occur.

Traditional owners for the geographically-relevant NT estates[1] (also referred to as 'countries' within this report, as per common anthropological usage) were identified for the study by the Central Land Council (CLC). Although we consulted with as many of these traditional owners as possible, the limited project time frame necessitated that we focussed on people recognised as being the most knowledgeable in the area of Aboriginal plant knowledge. Most of these consultations, designed to canvass the extent of contemporary knowledge of the species concerned, took place in the field, but we carried out some in Alice Springs or on remote communities.

Owing to a lack of available time, and to other factors, we were unable to undertake an extended field trip to the region of Andado Station, where populations of *A. peuce* and *A. pickardii* occur. We were however, able to hold detailed discussions with the Lower *Arrernte* traditional owners of this area at *Apatula* (Finke Community), and to visit the Mac Clark (*Acacia peuce*) Conservation Reserve (MCCR) with Eastern *Arrernte* people.

Consultations held with *Arrernte* people for this study revealed that no traditional IEK exists in a contemporary context for any of the focus species. Traditional owners of the N'Dhala Gorge area have recently been made familiar with the distribution of *A. undoolyana*, but *A. pickardii* was not known to Eastern *Arrernte* informants at all. While no knowledge of the ecology of *A. latzii* was recorded, our main *Pertame* informant, Christobel Swan, did suggest a plausible *Arrernte* name for this species.

Even though we did not record any IEK for any of these species during the project, all of the *Arrernte* people involved in the field research expressed a strong desire to be involved in their ongoing management.

4.3 Distribution of species in relation to Aboriginal language groups

All NT populations of the four threatened acacia species, and the South Australian population of *A. latzii,* occur within the *Arrernte* language region, which embraces several recognised dialects[1]. Populations of *A. peuce* and *A. pickardii* occurring outside of the NT fall within the Karnic language region, encompassing the Aboriginal languages of the Lake Eyre basin.

Acacia undoolyana has the most restricted distribution of all the study species, being confined within the traditional estate boundaries of the Eastern *Arrernte Pwenye* descent group (CLC Anthropology Unit). The main stand of *A. undoolyana* occurs inside N'Dhala Gorge [*Apmere Irlwentye*], a significant men's site to the east of Alice Springs.

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[1] These include Eastern Arrernte, Central Arrernte, Western Arrernte, Akarre, Akityerre, Tyurretye Arrernte, *Pertame* (Southern Arrernte), and Lower Arrernte.

[2] In the classic Arandic model of land tenure, connections to country are organised according to *anyenhenge* sections or estates which are identified by a significant dreaming or totemic tract. Each estate is identified as having a "main place" or principal site as its focus, which is central to the cultural geography, and from which the estate will often take its name.

The distribution of *A. latzii* overlaps with two Arandic language groups. One population stretches across the *Pertame* lands of the *Inteyerre* estate group, from the Bacon range on the Henbury pastoral lease to the estate held by the *Irbmangkara* (Running Waters) group. In the south of its range, *A. latzii* occurs on the Umbearra, New Crown and Tieyon (SA) pastoral leases, within Lower *Arrernte* traditional lands. The main three Lower *Arrernte* estates supporting *A. latzii* populations are *Arleywernpe* (Charlotte Waters), *Atwetyerre* (Old Crown), and *Irreye* (Mt Dare) (CLC Anthropology Unit).

Acacia peuce is restricted to Lower *Arrernte* country within the NT, specifically the *Pmer Ulperre* (Andado) estate (CLC Anthropology Unit). The Queensland populations of this species fall within the traditional boundaries of the *Pitta-Pitta* (Boulia) and *Yarluyandi* (Birdsville) language groups.

The largest of the three NT populations of *A. pickardii* is also confined to the Lower *Arrernte Pmer Ulperre* (Andado) estate, whereas those occurring on Nummery station and the Pmere Nyente Aboriginal Land Trust (ALT) occur within the boundaries of the Eastern *Arrernte Uleralkwe* estate. In South Australia, *A. pickardii* occurs on the traditional country of the *Ngamini* (Mt Gason area) and *Yawarawarrka* (Lake Etamunbanie area) language groups (Tindale 1974; Luise Hercus, pers.comm.).

Eastern *Arrernte* is the most robust language population of relevance to this report, comprising an estimated 2,000 active speakers (Henderson and Dobson, 1994). The Lower *Arrernte* language (*Arrernt Imarnt* is the name preferred by its speakers) is no longer spoken, and most Aboriginal people living in this region now speak Luritja and/or *Antikirrinya,* as well as English (Breen, unpublished). *Pertame* is no longer spoken regularly, and is being incorporated into *Luritja* and Western Arrarnta (NAILSMA, 2006). According to the National Indigenous Languages Survey Report

(NILS), the *Pitta-pitta, Yarluyandi, Yawarawarrka* and *Ngamini* languages are no longer spoken (AIATSIS 2005).

4.4 Information collected for each of the four species

The following section summarises information on the four focus species of this study. This information is organised into three sections for each of the species:

i) existing information on these species as previously documented by anthropologists, linguists, and ethno-biologists;

ii) descriptions of attempts to record current Indigenous ecological knowledge (IEK) from traditional owners and other knowledgeable informants; and

iii) discussion of Aboriginal involvement in future recovery actions for these species, in consultation with knowledge-holders.

4.4.1 Waddy wood, *Acacia peuce*

i) Previously Documented IEK

Indigenous names

Two Lower *Arrernte* names for *A. peuce* are listed in the unpublished *Arrernt Imarnt* (Lower *Arrernte*) dictionary – *arripar* and *irrkep* (Breen, unpublished). *Arripar* is also cited in Latz (1995) as the Lower *Arrernte* name for this species. Both Breen and Latz sourced this name from T.G.H. Strehlow's *Songs of Central Australia.* Following current Lower *Arrernte* orthography, Strehlow's '*arepara*' is now spelt *arripar.*

The other name listed by Breen, *irrkep*, is also the *Arrernte* name for the desert oak, *Allocasuarina decaisneana,* and is the name that both of Strehlow's informants, senior Lower *Arrernte* men, *Injola* [*Inyurla*] Tom Bagot and Fred *Kngietnema* [*Kngirtneme*], provided to him when he travelled to Andado in 1955. Strehlow did not record *arepara* as the name for *A. peuce* in his 1955 diary (see Strehlow 1955a). He and his informants also continued to use *irkapa* when referring to *A. peuce* in the transcription and translation of songs and stories recorded for the Andado region (Strehlow, 1955b). The name *arepara* appears to initially have been applied to this species in *Songs of Central Australia*, published in 1971. Strehlow's informant for this name goes unrecorded, as he did not return to Andado after his initial trip in 1955[2].

Mr. Brownie Doolan, one of the last Lower *Arrernte* speakers, provided Breen with the name *irrkep* for *A. peuce* during research for the Lower *Arrernte* dictionary. Breen asked Mr Doolan if he was familiar with the name *arripar,* but he was not.

The account in the Flora of Australia (2001 Vol. 11A, pp. 365-6) series adds further confusion to the matter by listing the 'Arunta' name for *A. peuce* as *aratara,* but providing no reference. This work also lists *arripar* as the Lower *Arrernte* name, which is likely to have been sourced from Latz (1995). The Draft Plan of Management for the Mac Clark (*Acacia peuce*) Conservation Reserve (MCCR) lists *irrekepe* as the Lower *Arrernte* name for this species (Anon. 1995, p. 18).

The *Pitta-Pitta* name for this species is uncertain. The Flora of Australia lists *kurriyapari* as the *Pitta-Pita* name for *A. peuce,* but this name applies in practice only to a single, large waddy tree located at the northern end of Boulia. A plaque on this tree states that '*kooree-yuppiree*' is a sacred tree that marked a corroboree ground for the local *Pitta-Pitta* people and other neighbouring groups (Fig. 4.1). The meaning of this name is 'red ochre - father' (*kurri - yapari*) in the *Pitta-Pitta* language (Breen, pers.comm), which seems to confirm that this was indeed an important ceremonial tree. The tree stands on the ceremonial ground on which the present Boulia township is now located (Deveson 1980, p. 6).

Acacia peuce trees located near Birdsville are called *kungkarriya* in both the *Yarluyandi* and adjacent *Mithik*a languages (Breen pers.comm.). All recorded Aboriginal language names for *A. peuce* are listed in Table 4.1.

[2] There is a possibility that Strehlow was given the name *Arepara* by other Lower *Arrernte* informants such as Mick McLean in the late 1960's. Another theory is that the tree is given this name only in reference to ceremony.

Fig. 4.1 The *Acacia peuce* tree - *kooree-yuppiree* [*Kurriyapari*], marking the corroboree ground at Boulia. (Photo from Deveson 1980)

Table 4.1 Recorded Aboriginal language names for *Acacia peuce*.

	Name	**Location**
Lower *Arrernte*	*irrkep, arripar* (?)	Andado/MCCR
Yarluyandi	*kungkarriya*	Birdsville
Mithika	*kungkarriya*	Birdsville (north of)
Pitta-Pitta	?	Boulia
Pitta-Pitta sacred tree	*Kurriyapari*	Boulia township

Indigenous uses

<u>Use of timber</u>

Numerous sources refer to Aboriginal people using the timber of *A. peuce* to make clubs. The *Mac Clark (Acacia peuce) Conservation Reserve Draft Plan of Management* (Anon. 1995, p. iii) claims that the 'extremely hard wood [of *A. peuce*] was prized for making waddies, or digging tools, and was thought to be traded over large distances'. We were not able to determine where this information originated, as it was unsourced in the document. Latz (1995, p.113) also writes that, 'as the name implies, the hard heavy wood is used for the production of clubs', but personal communication with Peter Latz revealed that this reference was uncorroborated. Similar information also appears in Flora of Australia (2001 Vol 11A, p. 366), but as the information there was sourced directly from Latz 1995, it offers no new perspective.

Chuck (1982, p. 13) states that there is in fact no direct evidence to suggest that any of the populations of *A. peuce* were used for this purpose:

> ‘Although *Acacia peuce* has been referred to as ‘waddy wood’ little is known about the significance of the timber of this species to the Aborigines. Being hard and dense it would have been admirably suited for the making of waddies but several other more widespread acacias also share this characteristic.’

T.G.H. Strehlow did not record any information regarding the resource value of the trees on Andado. Smith (1995) disputes the generalised claim that the timber of the Andado population was utilised. Based on archaeological surveys both within the MCCR and surrounding area, he stated that ‘none of the archaeological remains in the area indicate direct exploitation of the timber of *Acacia peuce*’, and suggested that the trees were too important totemically to have been so used. Smith was also unable to find any implements made from the wood of *A. peuce* in the collections of the South Australian and Queensland Museums.

Similarly, we found no evidence to confirm that timber from the Boulia population of *A. peuce* was used by *Pitta-Pitta* people. Seminal Australian ethnographer W.E. Roth describes the weapons of western Queensland Aboriginal people in detail, including the tree and animal species from which materials were sourced for their manufacture. He makes no mention of the use of *A. peuce* in the production of fighting implements in the Boulia district. For instance, ‘nulla nulla’ clubs (*Pitta-Pitta* name ‘*mor-ro’*) in this region were recorded as being made from gidyea wood (Roth 1984 Vol 1, p. 32).

The word *wadi* originates from the *Dharruk* language of the Sydney region and means a war club or piece of wood used as a club (Dixon *et al* 2006, p. 181). Dixon defines ‘waddy wood’ as ‘any of several trees yielding a hard wood, especially the rare *Acacia peuce*’ suggesting that this name could have been applied to any plant species with hard wood, not necessarily those that were actually used by Aboriginal people for making waddies. Another species with the common name waddy wood is *Pittosporum bicolour* (Webster's Revised Unabridged Dictionary, 1913).

Food

We were unable to find any record of the seeds of *A. peuce* being utilised as a food source by Aboriginal people, in spite of the fact that is has 'exceptionally large seeds' for an Acacia (Pedley 1987).

Latz (1995, pp. 49-50) reports that about 50 per cent of the Acacias occurring in central Australia supply seed that was or is still eaten by Aboriginal people – the remainder of the species being either too rare, too difficult to harvest, or less commonly, too poisonous. A number of factors are likely to have made the seeds of *A. peuce* unsuitable as a food resource: the timing of seed ripening in relation to ephemeral occupation of the area by the Lower *Arrernte*; generally consistently low seed production; and the difficulties in harvesting posed by the height of the trees. The fact that these trees are important in Lower *Arrernte* mythology may have also restricted harvest activities, which for many acacia species involves breaking off limbs laden with seeds (Latz 1995).

Significance of *Acacia peuce* in Aboriginal mythology

It is clear from documentary evidence that both *A. peuce* and the Andado region throughout which it is distributed are of immense religious significance to Lower *Arrernte* people (see for example Strehlow 1955, 1955b, 1970, 1971; Anon 1991; Knight 1996). The *Arrernte* name for the MCCR and surrounding area is *Akerre*, originally recorded as *Okira* by Spencer and Gillen (1899 [1968]), and *Akara* by Strehlow, who noted that this area is one of 'three great Lower *Arrernte* ceremonial sites in the Simpson Desert' (1970, p. 95).

Archaeological research has uncovered evidence of several ceremonial- and camp-sites located in the *Akerre* area (Smith, 1995). Not surprisingly, many of the main natural features in the *Akerre* area represent the travels and activities of ancestral beings and still bear *Arrernte* names. For example Rieks Hill, named *Akar Intjota,* is a site of major totemic significance associated with the Two Eagles (*Irrety*) dreaming (see below). East Bore, Casuarina Swamp and the surrounding hills, including Hubbard Hill are known as *Ilmeltye* (Fig. 4.2).

Two major *Altyerr* (dreamings) have been documented in association with the MCCR and broader *Akerre* area. The first is the story of the Two Eagles and their battle with an avenging party of 'Tankga men', and the second concerns the travels of the *Urrempele* (western quoll, *Dasyurus geoffroii*) ancestors from Port Augusta. All of the trees in the MCCR represent Tangka men, and the lone sentinel tree at Casuarina Dam is an *Urrempele* ancestor (Fig. 4.3) (Strehlow 1955, 1955b; Hercus pers. comm.).

Fig. 4.3 *Wangkangurru* and Lower *Arrernte* men with linguist Luise Hercus at the *Urrempele* ancestor tree at Casuarina Dam in 1996 (Photo courtesy of Luise Hercus).

ii) Current Indigenous ecological knowledge of *Acacia peuce*

In September 2008, we undertook consultations with senior Lower *Arrernte* elders Mr Darryle Allen (Fig. 4.4) and Mr Brownie Doolan Pwerrerl (Fig. 4.5) and their families, at *Apatula*. Allen family members are the traditional owners for the area surrounding and incorporating the MCCR. We also visited the MCCR with Eastern *Arrernte* people during September 2008 on the return trip from the Allitra Tableland (Figs. 4.6 & 4.7).

Names for Acacia peuce *in current use by Aboriginal people*

Consultations with Lower *Arrernte* people confirmed that *irrkep* is the name in current use by *Arrernte* people for *A. peuce*. None of the people we spoke to had heard the alternative name for this species, *arripar*.

It is noteworthy that one of the two recorded *Arrernt Imarnt* names for *A. peuce* is the same as for the desert oak. Common names in use for *A. peuce* also reflect the similarity of this species to casuarinas. These include 'belah' in the Boulia district, and 'casuarine trees', which is how the stand of trees on Andado was described by Allen Drover, one of the senior Eastern *Arrernte* men who accompanied us on the September 2008 field trip.

Current knowledge of Indigenous uses and ecology

All of our personal enquiries confirmed the major dreaming significance to *Arrernte* people of *A. peuce.* For this reason, Mr Darryle Allen believes that the trees would not have been utilised for their timber, nor that their seeds were eaten in pre-European times. It is very unfortunate, therefore, that trees from the Andado population were cut down for fence posts, yards and house-building by Europeans in the past.

Enquiries into Indigenous ecological knowledge of the trees yielded little information.

Mythological significance

Brownie, Jeffery and Richard Doolan confirmed that the trees within the MCCR represent the avenging party of Tankga men, and that the lone sentinel tree near Casuarina Dam is associated with the *Ilpenty* (love songs) of the *Urrempele*. Casuarina Dam is known as *Irrkep Anyente* (one casuarina tree) to the Lower *Arrernte* (see Fig. 4.4).

Fig. 4.4 Darryle Allen and family, traditional owners of the *Akerre* area, *Apatula* Community, September 2008

Fig. 4.5 Discussions at *Apatula*, September 2008 between Jason Gibson, and Brownie Doolan, sons Michael and Jeffrey Doolan, and nephew Richard Doolan

Fig. 4.6 Agnes Abbot and Michael Hayes examining *irrkep* seed pods at MCCR, September 2008

Fig. 4.7 Eastern *Arrernte* men viewing the *Tangka* Men trees at *Akerre,* September 2008

iii) Aboriginal involvement in the management of *Acacia peuce* and the MCCR

Due to the significance of the area, people expressed a strong desire to be involved in any future management of *A. peuce* and the Akerre area as a whole. While pleased that all of the trees have now been fenced off, they would like to see the area of the reserve increased to encompass the entire Akerre locality.

People felt very strongly that the name '*Akerre*' should appear on any signage associated with the MCCR. They would also like to see the erection of interpretation signs explaining how *A. peuce* is of great importance to Lower *Arrernte* people.

4.4.2 Tjilpi wattle, *Acacia latzii*

i) Previously Documented IEK

The most comprehensive and readily accessible source on central Australian Aboriginal plant names and uses, Latz (1995), includes no entry for *A. latzii*. Nor does any information appear on this species in available relevant linguistic references. A partial word list only has been published for the *Pertame* language (Swan 1993). This contains names for a small number of important or commonly used plant species, including only two acacias – *A. aneura* (*tetye*) and *A. kempeana* (*tnyeme*). Eleven *Acacia* species are listed in the Arrernt Imarnt Dictionary (Breen unpublished), but neither *A. latzii* nor *A. calcicola*, a closely allied species, are among these. Enquiry of language and ethnobiology specialists revealed that attempts to record a name for this species from some of the last speakers of this language were unsuccessful (Peter Latz and Gavan Breen, pers.comm).

The lower Finke and Henbury regions were common places of visitation for T.G.H. Strehlow, and his collected works contain much information pertaining to them. Distilling relevant botanical information from his collection is an arduous task, and was accordingly attempted only for *A. peuce,* and to as lesser degree *A. pickardii*. We recommend however, that work of this nature is undertaken in the not-too-distant future to determine whether reference is made to a species resembling *A. latzii* in materials relevant to its distribution.

ii) Current knowledge of *Acacia latzii*

Given that *A. latzii* has been recorded as unfamiliar to senior Lower *Arrernte* informants in the past (Breen and Latz pers.comm.), we decided to concentrate our efforts on attempting to record *Pertame* knowledge of this species during this project. The population of *A. latzii* on Henbury Pastoral Lease was visited in June 2008 with two senior *Pertame* people, Stanley Swan and his sister Christobel Swan (Figs. 4.8 & 4.9), along with two of Christobel's grandchildren. The Swans are members if the *Inteyerre* estate group, commonly known as the 'Henbury mob'. Stanley has a long work history in the Finke River area, and Christobel is regarded as an authority on *Pertame* language and plant use.

Two sites where *A. latzii* occurs, both on low hills along the Giles Road, were accessed during this trip. As we approached the first group of trees, Christobel seemed to recognise them straight away and remarked, 'I know this tree. It's a cousin to the gidgee tree'. She also said that she remembered her old people talking about the tree, and recalled a *Pertame* name that she is quite sure relates to this species: *tyenhang* (pronounced 'tjenung'). She did not know of any current uses for the trees, or if they were used by the old people in the early days. Stanley did not recognise the tree, though once becoming familiar with it, he was able to easily identify the species from a considerable distance as we drove along the Giles Road.

Given that *A. latzii* is similar in appearance to *A. calicola*, it would have been advantageous to inspect specimens of the latter species with Christobel, but this was not possible. As a consequence, we are uncertain as to whether the name *tyenhang* also applies to *A. calcicola.* The Western *Arrarnta* name for *A. calcicola* recorded in Latz (1995) is *irrakwetye,* which does not bear any resemblance to the name Christobel gave for *A. latzii*. No other *Arrernte* names for *A. calcicola* are listed in this resource.

During the field trip, we made a short audio recording of Christobel talking about the trees in *Pertame*. The English translation of this recording is as follows:

‘This woman came to ask about the name of this plant. It grows around Henbury and over the Lower Southern *Arrernte* side and down that way. We used to hear them [the old people] talk about the name of the tree…This tree is named *Tyenhang.* So we are wanting to teach the children about this plant. People want to talk to us about plant names so we can teach the *Pertame* language names of these plants.

We didn’t take much notice of the elders when they talked about these plants. In the early days when the old people were around we didn’t take much notice of what they talked about. We didn’t listen to what they said because we were too young. They used to talk about these plants and now we don’t even know what they used them for. They used to tell us in the early days about the name of this plant.’

Christobel and Stanley were perplexed that the common name for *A. latzii* is ‘Tjilpi wattle’, given that *tjilpi* is a *Pitjantjatjarra/Yunkunyjatjarra/Luritja* word and this species is restricted to *Arrernte* country. Although it was explained that this tree was named after Peter Latz who was the first non-Aboriginal person to identify *A. latzii* as a distinct species (*Tjilpi*, meaning old man, is his nickname), they thought it made more sense for the tree to be properly described with an *Arrernte* name, i.e. *Tyenhang.*

According to Latz (1995), the wood of *A. calcicola* is used for artefacts and as firewood, while the leaves are burnt to produce ash for chewing with tobacco. It is likely that *A. latzii* was used for similar purposes in areas where it is locally common.

The anthropological information provided by CLC identified numerous people with traditional links to, and knowledge of, the Lower *Arrernte* and *Pertame* country where *A. latzii* occurs. Unfortunately we had the opportunity to consult with only a small number of traditional owners during this project, and it is acknowledged that further Indigenous knowledge of this species could remain undocumented.

Fig. 4.8 Christobel Swan inspecting an *Acacia latzii,* or *Tyenhang,* Henbury Station

Fig. 4.9 Stanley Swan (left), Simon Abbott (CLC) and Christobel Swan at the Henbury population of *A. latzii*

iii) Aboriginal involvement in the management of *Acacia latzii*

Christobel Swan expressed considerable interest in being involved in future monitoring and management of *A. latzii* populations on Henbury Pastoral lease. She thinks that there would be a number of other *Pertame* people, including young people, who would also be keen to participate.

4.4.3 Birds nest wattle, *Acacia pickardii*

i) Previously documented IEK

As was the case for *A. latzii*, no documented IEK could be located for *A. pickardii* from relevant linguistic or ethnobiological sources for the *Arrernte* region. Nor did consultations with linguists Gavan Breen and Luise Hercus regarding the Karnic language region yield any results. Luise Hercus (pers.comm.) told us that she has travelled the relevant section of the Birdsville track many times over the past 40 years with the most senior *Wangkangurru* and *Yarluyandi* people, and that no one has ever mentioned *A. pickardii's* existence to her. Breen recorded some of the *Ngamini* language during the late sixties and early seventies, working one elderly couple who were the last speakers of this language. Breen informed us that recording the name of a rare and obscure species such as *A. pickardii* was not a priority at that time. In fact, it is likely that both of these old people had died before *A. pickardii* was formally described.

Peter Latz informed us that he travelled to the Allitra Tableland with senior *Arrernte* people in the 1980s, but made no attempt to obtain a name for this species at the time. He suggested however that this region still offers the best opportunity to determine whether this species was known to people, because of the coincidence of a stand of trees with a significant men's site in this area.

To our knowledge, there has not been any previous attempt to record language names and IEK of *A. pickardii* from either Lower *Arrernte* or Eastern *Arrernte* people.

ii) Current knowledge of *Acacia pickardii*

A field trip was undertaken in September 2008 to visit the populations of *A. pickardii* occurring on Nummery station and the *Pmere Nyente* Aboriginal Land Trust. Ten Eastern *Arrernte* traditional owners accompanied us on this trip. These included Allen Drover, Ernie Williams, Bobby Hayes, Michael Hayes (Fig. 4.10), Agnes Abbot, Jane Young, and Virginia Rontji (Fig. 4.11). Both the men and the women inspected the population of *A. pickardii* on Numery, but only the men were able to access the Allitra Tableland population due to the significance of this area as a men's site.

We initially stopped at the population on Numery and walked onto the hill where *A. pickardii* occurs. People were very surprised to see this tree growing on their traditional country, stating that it was literally a 'stranger' to them. Allen Drover, a man aged in his 60s, told us that he had never seen the tree before. Everyone commented on the tree's spikey leaves and thought it looked quite similar to dead finish, *Acacia tetragonophylla,* but acknowledged that it was clearly a different tree. Although the population here is visible from the main Numery road when travelling from the south, Aggie Abbott commented that she had never seen the tree before, in spite of driving up and down the Numery road many, many times during her life. She said, 'seems like it came out of nowhere'. Ernie Williams remarked of the populations on the Allitra Tableland, that 'I've been here before but I never noticed that tree – it's only new to me, but it's been here for a while I reckon!'

Fig. 4.10 Eastern Arrernte men (Allen Drover, Ernie Williams, Bobby Hayes, Michael Hayes) inspecting *Acacia pickardii* on Numery Pastoral Lease

We asked the group of traditional owners if they could identify specific threats to the populations of *A. pickardii* on Numery and *Pmere Nyente* ALT. The men told us that fire in the country where the trees grow is very rare because there is not much ground cover. We could not find any evidence of rabbits near the trees, but there was a lot of camel sign throughout the area, and a small number of animals were observed. People thought that the trees are far too spikey for camels to eat, though they agreed that camels might rub themselves on them, but did not think that this is a big concern. Overall they thought that the *A. pickardii* trees in this region do not require any particular management action.

Fig. 4.11 Aggie Abbott, Virginia Rontji and Jane Young discussing *Acacia pickardii* with Simon Abbott

iii) Aboriginal involvement in the management of *Acacia pickardii*

People involved in this field trip expressed interest in any future involvement in survey and monitoring work for this species. However, due to the significance of the Allitra Tableland, only men could be involved in any such programs in this area. Women could participate in potential surveys for other populations on Numery Station or elsewhere.

3.4.4 Undoolya wattle, *Acacia undoolyana*

i) Previously Documented IEK

No entry for *A. undoolyana* exists in the Eastern and Central *Arrernte* to English Dictionary (Henderson and Dobson 1994), which contains what is possibly the most comprehensive Indigenous ecological knowledge text corpus for any central Australian Aboriginal language. There have been numerous unsuccessful attempts to record language names and other Indigenous knowledge of *A. undoolyana* over the past 20 years. More recently, projects to document cultural knowledge (including

Indigenous plant knowledge) for the National Parks of the East MacDonnell Ranges have been conducted as part of the new joint management arrangements, and in preparation of a joint plan of management for these parks. Traditional owners involved in these projects have been consulted often about this species, including its traditional uses and ecology, but no information has been obtained (D. Scopell and P. Donohoe pers. comm.). While many people are now familiar with the plant and its distribution, this has come about due to increased involvement in survey and burning programs over the past 10 years, rather than to the passing on to them of knowledge from their elders.

It is difficult to imagine that people living in this area traditionally did not know the plant at all, and it is more likely that the knowledge has been lost in recent times. Current anthropological information indicates that *A. undoolyana* is restricted to the traditional country of a single estate group, which suggests it would have been known to only a small number of people. The occurrence of *A. undoolyana* in the ranges, and the overlap between a men's site and the main stand of this species at N'Dhala Gorge, would have further reduced exposure to this species - even today women are not permitted to venture into the gorge proper, where the species is most common.

Whether or not *A. undoolyana* featured in dreaming stories for this area is not known. The unlikely value of *A. undoolyana* as a resource species (seeding is low and unpredictable, similar to the other three rare acacias) would have been another factor in any knowledge being lost as time went on.

ii) Current knowledge of *Acacia undoolyana*

We visited the N'Dhala Gorge area – *Ilwentye* - with two senior Eastern *Arrernte* women during this project, Therese Ryder and Veronica Dobson. Both of these women are experts in the area of traditional Eastern *Arrernte* plant use, and Therese's family are the *apmerekartweye* (traditional owners) for N'Dhala Gorge (Fig 4.12).

While both Therese Ryder and Veronica Dobson were familiar with *A. undoolyana,* neither of them knew an Eastern *Arrernte* name for the species, or of any IEK relating to it. Both women have only become aware of the plant's existence relatively recently, through visiting N'Dhala Gorge as part of the joint management program, and by seeing it in Alice Springs, where it is being planted in public and private gardens. Therese Ryder is quite fascinated by the fact that the tree occurs only on her family's traditional country, but is also a little perplexed as to why people are so interested in it. She told us that her uncle held detailed knowledge of the *Ilwentye* area and would likely have known *A. undoolyana*, but he died some years ago.

Fig. 4.12 Theresa Nano, Veronica Dobson & Therese Rhyder discussing *A. undoolyana*

iii) Aboriginal involvement in the management of *Acacia undoolyana*

Therese Ryder informed us that Eastern *Arrernte* people with traditional links to N'Dhala Gorge are very interested in ranger work, and involvement in plant and animal surveys on their country.

Discussions with some of the traditional owners for the Loves Creek area has revealed that they are also very interested in future work on this species (Agnes Abbott and Jane Young pers. comm.).

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