CHAPTER 2

THE LAND AND ITS PEOPLE

The environment of Northern Australia can seem an odd mix. While it has an intimate familiarity to local Indigenous people, to those accustomed to temperate Australia, it has a strange character. Fires seem too pervasive and frequent; many of the native trees are at least semi-deciduous (they lose their leaves to save water during the Dry season); there is too much grass, some of it taller than a person; the eucalypts don't have that familiar evocative reassuring smell; even the colours of the bush seem somewhat harder. Parts of the landscape seem decidedly African in flavour, with the boab trees but without the lions. Indeed, the link across the Indian Ocean is explicitly marked: the Kimberley region is named for its resemblance to the landscape in southern Africa of the same name.

Why does the North appear so different, such a mix of familiar Australian and apparently non-Australian natural features? In large part, it is an artefact of settlement history, of where most Australians grew up. The distinctive features and feel of Australia are dominated by the environments that characterise where most people live – coastal southern, eastern and south-western Australia and their agricultural hinterland.

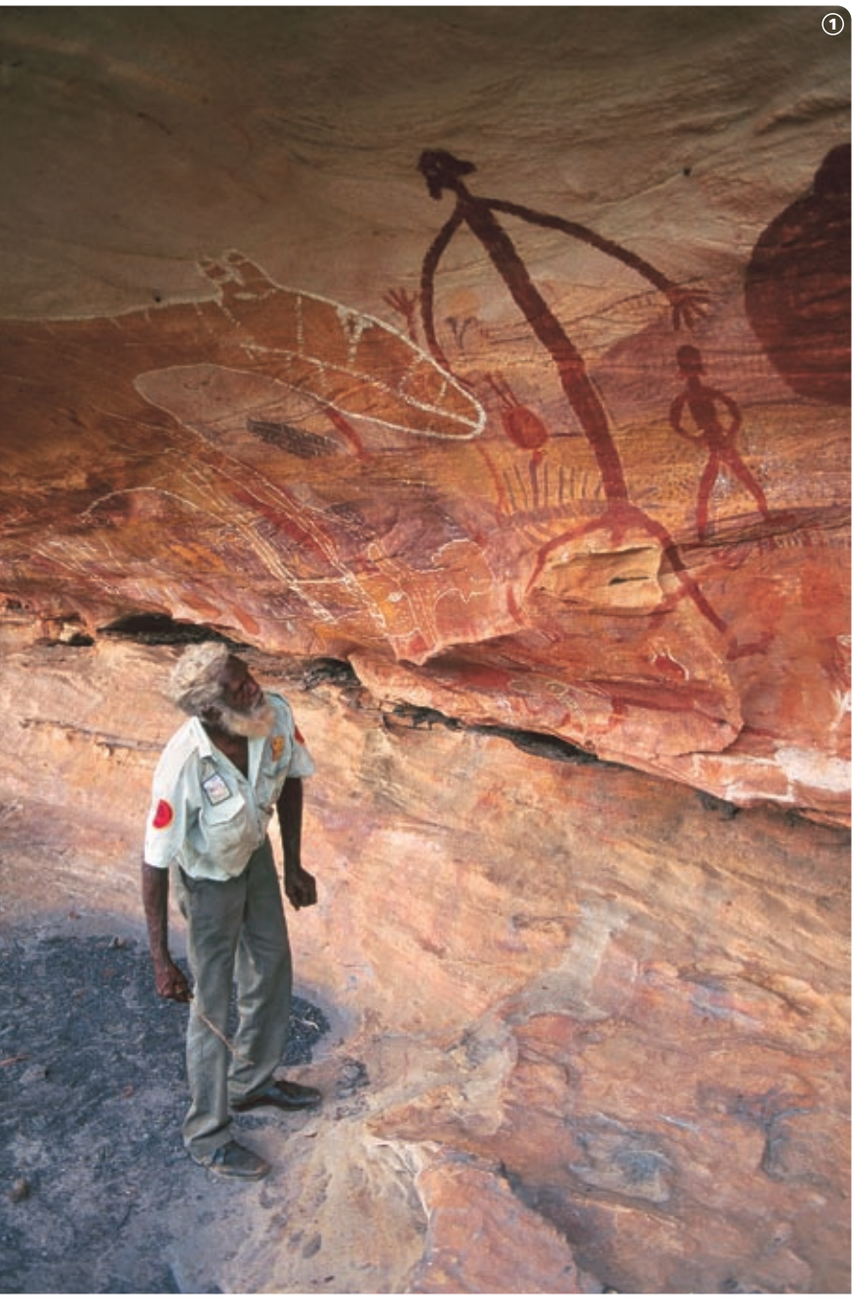
Earlier settlers in southern Australia may have found the native vegetation there strange too but were able to transform it to a more homely fashion, with European plants and animals. That has not been the case in the North; for most Australians, it remains a foreign and unfamiliar landscape, and even its society seems different.

In this chapter we provide an overview of the North's geography and consider how it differs from the rest of Australia. We also introduce its regions, weather, landscape features and people. Finally, we discuss the North's current land tenure and economies, as well as the way in which the land is managed. These facts and figures provide the background necessary to understand the natural values, processes and threats, discussed in the following chapters.

1 Boys fishing, Elin Beach, Hopevale, Cape York Peninsula. *Photo by Kerry Trapnell*

THE PAST: AN ARAFURA INHERITANCE

In part, Northern Australia's legacy now lies submerged. For much of the past three million years, Australia and New Guinea were a single land mass, with a wide plain across what is now the Arafura Sea. The only high ground on the plain were low hills that are now islands



1 Dr Tommy George, Laura, Cape York Peninsula. *Photo by Kerry Trapnell*

fringing the Kimberley coast and Arnhem Land, the islands in Torres Strait and the low hills that fronted the north-western coastline of the Arafura plain (now the Aru Islands of Indonesia).

Major river systems flowed across this plain, arising from both the south and the north. The plain had vast shallow lakes, and embayments fringed with mangroves and salt-marsh. Rainforests were largely confined to the mountains and slopes to the North and to riparian zones and protected gorges in the south, with much of the Arafura plain a savanna, similar to parts of Northern Australia today (Nix and Kalma 1972; Schulmeister 1992).

The eucalypt savannas that now dominate the North probably began developing from 15 million years ago as the continent's climate dried. From three million years ago the dominance of savanna accelerated as the periods of massive global cooling created drier conditions (van der Kaars 1991). This directional change may have been further influenced by the arrival of Aboriginal people and consequential altered fire regimes, some 50,000 years ago (Veevers 2000).

The alternating global warming and cooling episodes of the last three million years repeatedly isolated then reconnected New Guinea and Australia, as the Arafura plain successively submerged and emerged with changing sea levels, as show in Figure 2.1 (Voris 2000). The last glacial maximum was approximately 20,000 years ago. As Earth warmed and ice melted, the land bridge was submerged (approximately 10,500 years ago) and the final connection across Torres Strait eventually flooded (8000 years ago), and Australia was isolated. The modern shoreline of Australia dates from about 6000 years ago (Chapell and Thom 1986; Lees 1992).

One of the features of the Arafura plain before the last sea-level flood was Lake Carpentaria – a giant (~30,000 km^2: Torgersen *et al*. 1988) freshwater lake in the centre of what is now the Gulf of Carpentaria. As the sea waters rose, this lake disappeared. One reminder of this ancient lake is the current fragmented distribution of fish such as the Threadfin and McCulloch's Rainbowfishes, Lorentz's Grunter and the giant Freshwater Anchovy in rivers of Arnhem Land, Cape York and southern New Guinea. These rivers all previously intermingled in Lake Carpentaria.

The rising sea also fragmented the range of many other plants and animals. Comparable environments and species assemblages persist in the Fly River region, Port Moresby and Popondetta areas of southern New Guinea, and across Northern Australia. The connections were especially strong, close and more enduring between Cape York Peninsula and New Guinea. Cape York still harbours most of the species shared between Australia and New Guinea, especially rainforest species (Nix and Kalma 1972).

The consequences of these dramatic shifts in sea level and associated climatic and vegetation changes must have been profound for Aboriginal people. Thousands of generations watched sea levels rise and decline. For much of that time, clan territories could have extended across the Arafura plain. The marshy shores of Lake Carpentaria, now well out to sea, may once have been productive and well-populated lands. The memory of these lost lands is still evident in some coastal Aboriginal cultures.

THE NORTHERN LANDSCAPE

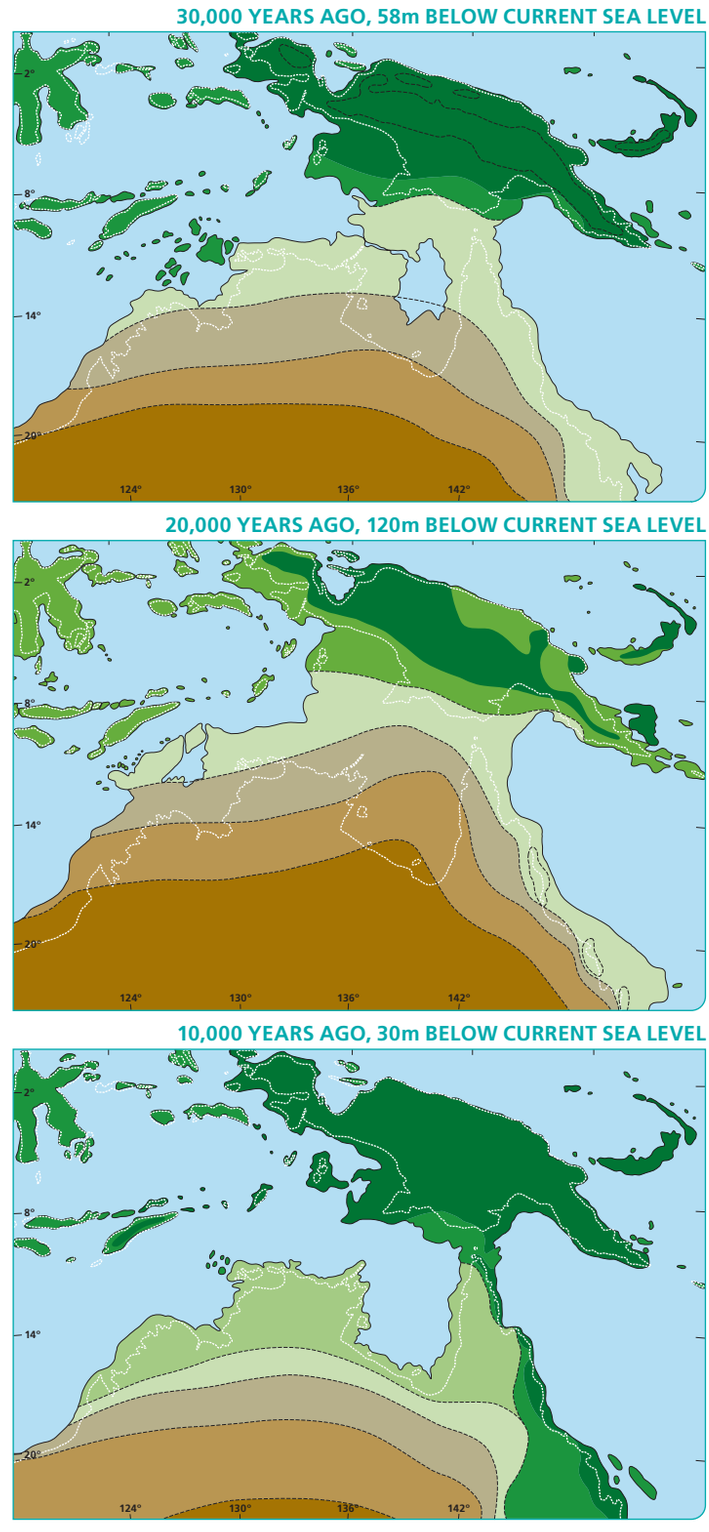
Across Northern Australia there are striking similarities over vast areas of country, in climate, landforms, vegetation and wildlife. Often the similarities dominate the casual observer's perspective. On Cape York Peninsula you can stand on deep red laterite soil and admire the surrounding tall forests of the Darwin Stringybark *Eucalyptus tetrodonta*. Thousands of kilometres away, in Arnhem Land or the north Kimberley, you can be in almost identical stands. The North has a distinctive feel, and is an environmental entity arising from the characteristic features of climate, landforms, vegetation, wildlife and ecological functioning.

CLIMATE

Much of the present character and ecology of the North is defined by a strongly monsoonal climate, a feature it shares with tropical environments in Asia, Africa and South America. The land is exposed to an orderly procession of climatic extremes: an almost rainless Dry season of about 7–8 months, followed by a shorter season of violent storms and torrential rains. Temperatures are high year-round, peaking in the summer Wet season. Cyclones are frequent. It is a harsh climate that shapes the ecology, distribution and abundance of most plant and animal species, and the interactions between them. The climate is also a major constraint on the kinds of land use activities that the North can sustain, and has been a major force shaping Indigenous land management and cultural practice.

There are distinct geographic patterns in climate (Figure 2.2). Annual rainfall decreases away from the coast towards Australia's arid core. Rainfall is highest on the east coast of Cape York Peninsula and the northernmost coastal areas of the Northern Territory and the Kimberley.

FIGURE 2.1 **SHIFTING PATTERN OF NORTHERN AUSTRALIA/NEW GUINEA COASTLINES**



Source: Nix and Kalma 1972.

1 Starcke River, Cape York Peninsula. *Photo by Kerry Trapnell*

SOILS

Much of Northern Australia lies on ancient rocks which arose from different geological episodes over the past three billion years. First, the southern half of Western Australia emerged and this formed the basis of the Australian continental plate. Second, about two billion years ago, an accretion of basement and platform cover formed the western two-thirds of Northern Australia (the western margins of the Gulf Region, Top End and Kimberley). Third, the Cape York basement and uplands emerged at around 500–200 million years ago.

Subsequently, the extensive intervening sediments of the Great Artesian Basin and central lowlands began developing about 300 million years, reached a maximum 135–65 million years ago and continue today. Thus, Northern Australia is home to ancient rocks and ancient landscapes that have been subject to millennia of deep weathering.

From this parent material, thin and infertile soils have developed, leached of nutrients by intense tropical rains over millennia. Only in a few districts are there younger and more fertile soils, developed from volcanic rocks, limestones or floodplain alluvium. The cracking clays on these soils support extensive grasslands, and low, open grassy woodlands. Vast areas across the whole of the North are mantled by red and yellow earths and deep sands that support grassy woodlands or savannas. Equally vast are areas of shallow or skeletal soils, often sandy, that support hummock grassland (spinifex) and heathland.

High rainfall intensities, particularly during the first storms of the Wet season, have great erosive power. Consequently, even in undeveloped, ungrassed landscapes there is continuous loss of soil by sheet wash and very little profile development on slopes greater than three per cent.

LANDFORMS

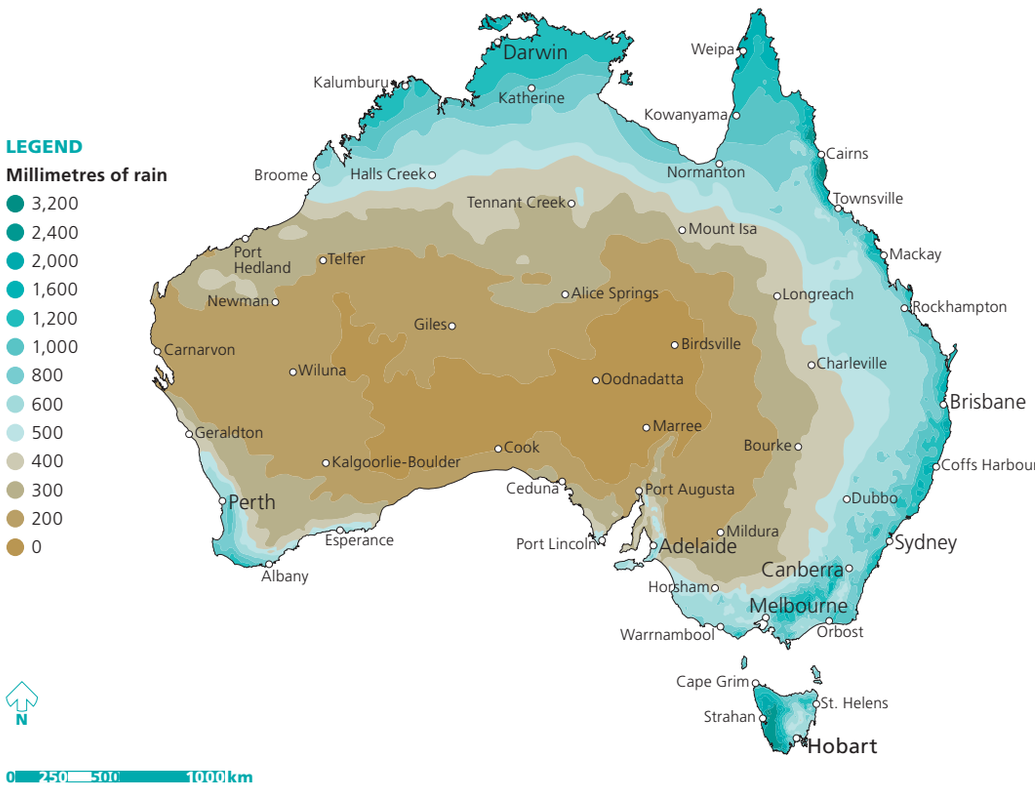
Many visitors to the North see the land as largely featureless – vast expanses of bush on flat lands extending to the horizon. Indeed, much of the North is gently undulating land at low elevation. From the southern Kimberley, east to Cape York Peninsula these landscapes are unbroken by high mountains or ranges, and landscape variation is subtle. A consequence of the region's low topographic relief is that savanna species have been able to disperse across much of the North, unhindered by mountain barriers, for millions of years.

However, there are substantial areas of far more complex landforms. These areas provide much of the dramatic attraction to visitors, and harbour many of Northern Australia's most distinctive endemic plant and animal species. The spectacular ranges and escarpments of the Kimberley, the Ord-Victoria uplands in the southwest of the Top End, Arnhem Land and the uplands of the western Gulf country in Queensland are examples. The ruggedness of these features is notable on a national scale (Figure 2.3): the Kimberley has a more rugged topography, with more cliff lines, than any other part of Australia.

This concentration of cliffs, escarpments and rocky areas has favoured a proliferation of distinctive rock-dwelling mammals (Freeland *et al*. 1988) and other animals and plants (e.g. Woinarski *et al*. 2006a). It has also provided the necessary environment for the development of the richest rock art galleries in the world.

However, these spectacular landscapes are of modest elevations (few peaks exceed 900 m) and while they do have orographic effects on regional rainfall they do not modify the underlying seasonally wet-dry climate. Only mountains in the far north-east are high enough to intercept the easterly trade winds and generate orographic rainfall in the winter Dry season (e.g. the McIlwraith Range on the east coast of Cape York Peninsula).

FIGURE 2.2 **AVERAGE ANNUAL RAINFALL**



Source: Based on a standard 30-year climatology (1961–1990), Bureau of Meteorology.

ENVIRONMENTS

One feature of the vegetation across the North is the widespread distributions of many savanna plants. These species evolved and spread because they had few climatic or other isolating barriers. In contrast, rainforest and some heathland species have faced long periods of isolation, persisting in patches of particular soil, geology or landform, physically isolated in a sea of savanna. Consequently, many locally endemic species have evolved in habitats such as rainforests and on isolated sandstone escarpments.

The following sections describe some of the key species and vegetation types of the North.

Savanna

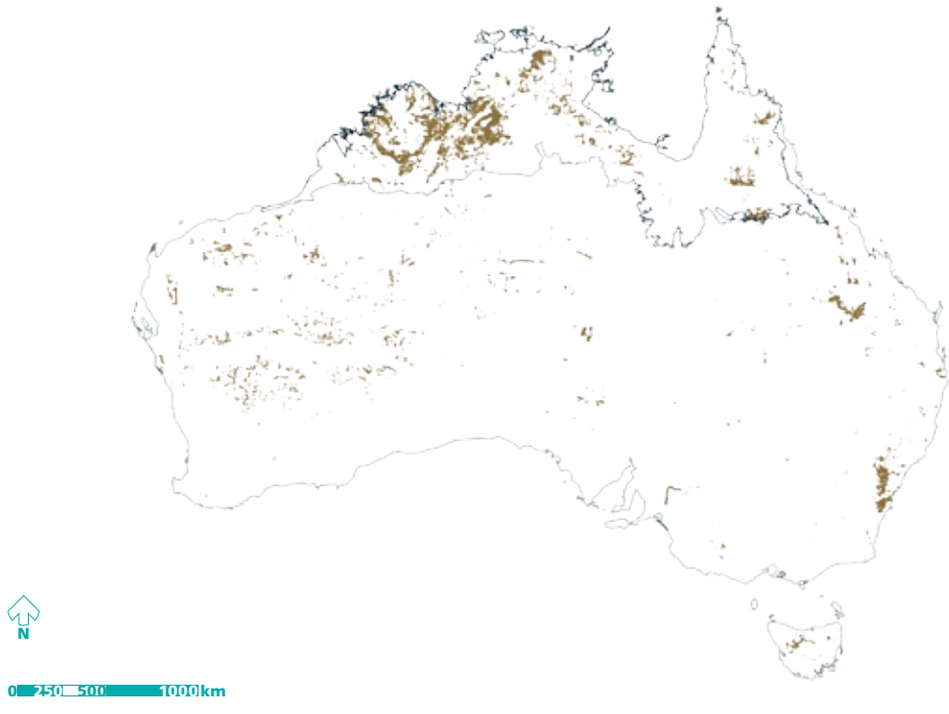
One of the results of the monsoonal climate and relatively infertile soils is the dominance of a single broad vegetation type – savanna – from the Kimberley to Cape York, covering more than 1.5 million square kilometres (Figure 2.4).

Savanna is the result of highly seasonal rains and the regular fires of the long Dry season. The grasses include annuals and perennials, and both types have short, intense growing periods during the Wet season, then either die or dry off to the roots during the Dry. Many grasses respond positively to fire, resprouting rapidly after burning.

Eucalypts are the dominant trees in the Australian savannas. These are tolerant of the annual drought and usually highly resilient to burning, at least when mature. Paperbarks *Melaleuca* species, Cypress-pines *Callitris intratropica*, Cooktown Ironwood *Erythrophleum chlorostachys* and a few other tree species also dominate some savanna areas. The density of tree cover varies widely through the savannas from little or none on regularly flooded areas, to denser forests on some of the higher rainfall areas, such as on the Tiwi Islands and the west coast of Cape York Peninsula.

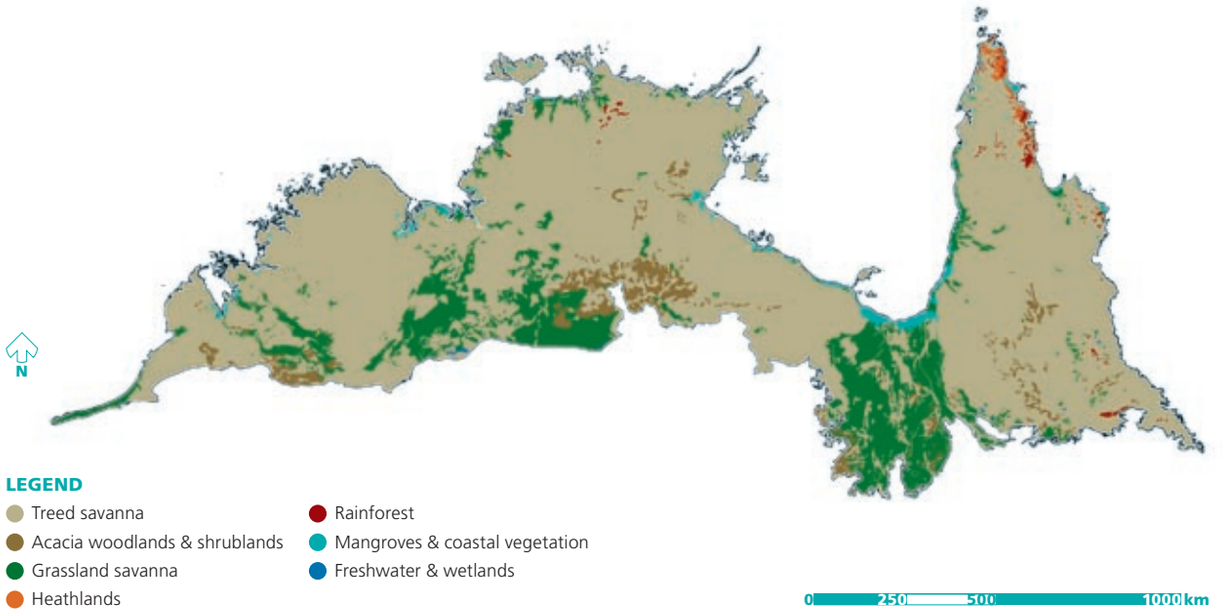
FIGURE 2.3 **OCCURRENCE OF CLIFFS & TOPOGRAPHIC RELIEF IN AUSTRALIA**

Note that relief is defined as the difference in elevation between divides and valley bottoms for sample circular areas of 25 km².



Source: Maps derived from all cliff lines shown on 1:100,000 topographic maps. Data collated by John Stein.

FIGURE 2.4 **BROAD VEGETATION TYPES OF NORTHERN AUSTRALIA**



Rainforests

In areas where surface or near surface water is available during the Dry season, and on unusual soils, or in locations that provide protection from fire, the development of non-savanna vegetation types occurs.

Rainforests cover around one million hectares of the wet-dry Northern Australia, including about 7000 hectares in the Kimberley and 268,000 hectares in the Northern Territory.[1] This is less than 1% of the land area, but these rich and fragmented forests support a disproportionate amount of the biological diversity of the North. Various types of rainforest are recognised in the North, including littoral rainforest (on coasts), vine thickets or 'dry' rainforest on rocky outcrops, and riparian or gallery forest along rivers. The largest contiguous area of well-developed tropical rainforest occurs in the McIlwraith Range–Iron Range area on the east coast of Cape York Peninsula. There, the coastal ranges induce more rainfall and cloud drip during the Dry season, conducive to the development of extensive rainforest areas. Elsewhere in the North, rainforest is restricted to tens of thousands of small and discontinuous patches, mostly smaller than 200 hectares in size (McKenzie *et al*. 1991; Russell-Smith *et al*. 1992). These patches are usually in moister areas such as at springs or along perennial rivers, or in areas protected from regular fires, such as gorges and rocky slopes in sandstone country.

WHAT IS A TROPICAL SAVANNA?

Tropical savannas are found, or were found, in parts of Australia, Africa, South and Central America, India and South-East Asia.

Tropical savannas comprise a distinctive landscape typically with a tall dense grass layer with or without trees, that occurs throughout the world's tropics. Tropical savannas can be almost treeless grasslands or denser woodlands ('tropical savanna woodland') – as long as the canopy cover of the trees is not so dense that it shades out the grass.

Mangroves

Mangroves – the forests of the sea – cover approximately 1.5 million hectares of Northern Australia. Small areas of mangrove ecosystems are found on nearly all parts of the northern coast. In a smaller number of areas in protected estuaries and bays, large and complex forests have formed with several mangrove tree species. Apart from fishers, mangroves are often overlooked by residents and visitors to the North because they tend to have

1 In the Wet Tropics around Cairns are another 835,000 hectares of rainforest.

TERMITES OF THE TROPICAL SAVANNAS

Northern Australia is a big country shaped by a small insect – the termite. In many places the very look of northern savannas owes much to the mounds built by this social insect. Indeed these landscapes have given rise to one of the most diverse range of termite mounds in the world: from the enormous buttressed 'cathedrals' of spinifex termites, to the remarkably aligned 'magnetic' mounds and miniature cities of columns built by various *Amitermes* species. Even more termite species – around three quarters of those found in Northern Australia – are hidden from view, building nests within trees or underground. As far as we can tell, most of these species are endemic to Australia.

In part, the termites' remarkable success in the seasonally-dry tropics is due to this mechanism of surviving harsh, dry conditions in the humid micro-climates of their nests, a luxury afforded to few other animals. Given that these nests appear to provide stable internal conditions for termites in a wide range of environments, it is perhaps not surprising that many nests appear to be shaped by those different environments. This is seen in *Amitermes laurenis:* in well-drained habitats it builds small dome-shaped mounds, yet in seasonally flooded flats it constructs huge mounds aligned along a north-south axis, often hundreds of times larger. Studies on this species and *A. meridionalis,* which also builds oriented mounds, suggest that such mounds are an adaptation to the seasonally waterlogged conditions: the high surface-area shape oriented north-south creates a stable environment for living above the ground in flooded habitats where migrating to an underground refuge is impossible (Jacklyn 1992).

Termites can be extremely abundant in certain areas. Savanna habitat covered in the large nests of spinifex termites, *Nasutitermes triodiae,* may support a few hundred tonnes of termite per square kilometre – far greater than the typical biomass of cattle in a similar-sized area. This abundance is no doubt partly due to the fact that termites consume a widely available resource most other animals cannot exploit: cellulose. By virtue of symbiotic bacteria or protozoa in their gut, termites can digest the cellulose and lignin present in a wide range of wood and grass, living or dead, as well as the plant material in litter and soil – with individual species specialising on particular sources of cellulose.

The underground activity of termites assists in recycling nutrients otherwise locked up in wood and dead grass. Such insect-driven nutrient cycling may be more important in Australia than it is in other tropical savannas like those of Africa, where large herbivores are more significant (Andersen and Lonsdale 1990).

Peter Jacklyn

dense populations of both mosquitoes and saltwater crocodiles. However, these forests are exceptionally productive, are vital nurseries for fish, and support many specialised species that live only in mangroves.

Salt-marsh flats

On coastlines with little elevation and low rainfall, extensive salt-marsh flats occur behind a coastal band of mangroves. These distinctive, wide, white and brown flats of salt and dried mud receive only occasional tides. Because they are not regularly flushed, salt accumulates and the areas are too saline for even mangroves to survive. Some highly tolerant shrubs and herbs can survive on some parts of the flats. These ecosystems form spectacular landscapes when seen from the air in places such as the estuaries of the southern Gulf Country coast and Cambridge Gulf in the Kimberley.

Tropical heathlands

Tropical heathlands replace savannas in a few districts on substrates with poor water-holding capacity and low fertility. These low shrublands have a high diversity of plant species within small areas. This vegetation type is most extensive and diverse in some coastal areas in the north-east of Cape York Peninsula and in some rocky escarpment areas, such as in the stone country of Arnhem Land, where heathlands occur on skeletal or infertile soils.

Freshwaters

Between Broome and Cooktown are more than 60 major rivers and hundreds of smaller streams flowing directly into the sea. Combined, these rivers and their tributaries extend over one million kilometres and carry nearly two-thirds of Australia's freshwater.

River flows in the North are extremely variable. Flows vary within a year, between the Wet and Dry seasons, and between different years. This is ecologically important, because floods, including extreme floods, drive the natural productivity of many wetland, estuarine and marine systems.

Most rivers, even the larger ones, are ephemeral in most years, shrinking to non-flowing pools in the Dry. Aquifer-fed streams such as the Daly River in the Top End, the Gregory River in the Gulf, and the Jardine River on Cape York Peninsula,

continue to have significant flows even at the end of the Dry season. Such aquifer-fed perennial rivers are especially important for many terrestrial and aquatic species.

Extensive floodplains in the near-coastal lowlands adjacent to some of the largest northern rivers form some of Australia's largest and most diverse wetlands. These include permanent or semi-permanent billabongs and waterholes along major rivers, and extensive ephemeral wetlands that fill seasonally or during major floods. Examples include the Kakadu wetlands (recognised as of international significance through Ramsar and World Heritage listing) and the Southern Gulf Aggregation. The latter is Australia's largest wetland area and forms when several southern Gulf Country rivers merge in major floods to create a single, vast wetland of around two million hectares.

BIODIVERSITY

Northern Australia supports an abundance of plant and animal life. Many are endemic, occurring nowhere else in the world. Many form spectacular features, such as the dense aggregations of Magpie Geese and other waterfowl that congregate on the northern floodplains. Many are characteristic icons such as the boabs of the Kimberley and eastern Top End, or the saltwater crocodiles that inhabit many northern coasts and waterways.

Much of Northern Australia is recognised as being of outstanding national or international significance for biodiversity. For example, the North Kimberley and Einasleigh and Desert Uplands (in north-central Queensland) are listed among the nation's 15 recently recognised biodiversity hotspots, and Cape York Peninsula and the sandstone plateau of western Arnhem

1 Termite mounds, open savanna country, Cape York Peninsula
Photo by Kerry Trapnell

BOABS & BAOBABS

The huge, gouty, swollen trunk capped with a wide, branching canopy is a distinctive feature of baobabs. The single Australian species *Adansonia gibbosa* (formerly *A. gregorii*) is known throughout the Kimberley of WA and the Victoria River district of the Northern Territory by the contraction to Boab. Although sometimes erroneously termed bottle-trees, they are not related to the bottle-trees (*Brachychiton* species) of inland north-eastern Australia. Madagascar, with six species of baobabs, is the centre of diversity while but a single species occurs throughout a vast area of Africa. Given that baobabs are highly valued sources of shelter, food, fibre and medicines by Indigenous people, some argue that their extensive distribution has been due to human activity. This common usage has led to much speculation on the origins of the single Australian species.

Could the Baobab have been brought to Australia by the first people out of Africa who skirted the then low sea-level shorelines around the Indian Ocean some 50–60,000 years ago? Or, much later, introduction by Austronesian voyages some 1500 years ago, or later still by Arab traders? Or, could some of the large seed pods have floated across from either Africa or Madagascar, like the giant eggs of the now extinct elephant birds of Madagascar, that have been washed up on the beaches of south-western Australia? Or, are the baobabs yet another example of divergence from a common origin after the break up of the ancient Gondwanan super-continent?

Earlier studies of their physical features and floral structures indicated that the closest relationship of our Australian baobab was with a subgroup of the Madagascan species. However, a more recent and very comprehensive set of genetic analyses places the Australian species closest to the single African species (Baum *et al.* 1998). This close genetic relationship effectively rules out the ancient Gondwanan connection and divergent evolution. But, until more detailed genetic analyses can tell us how long ago the African and Australian species diverged, the jury is out on a possible human introduction.

Early explorers noted Aboriginal usage of the boab's fruits, seeds, bark and pith, and the correlation between good camp sites and boab distribution. This should not be interpreted as evidence of direct cultivation, but simply as a combination of discarded fruit and seeds together with favourable sites in valleys for boab establishment. The absence of boabs from favourable sites and climate much further east, where they flourish when introduced, remains a puzzle.

Baobabs are at the centre of myths and legends in Africa and Madagascar and are widely believed to live for thousands of years. So far, the oldest baobab dated was around one thousand years old. In Australia, very old baobabs may be surrounded by a mini-forest of their own seedlings. Old trees resist fire, but young trees may be killed by fire (Bowman 1997). Long-term survival of boabs in north-western Australia will depend on appropriate fire management strategies.

Henry Nix

Land are even richer (Abrahams *et al*. 1995; Mackey *et al*. 2001; Woinarski *et al*. 2006a).

The plants of Northern Australia comprise a hybrid assemblage, including not only many characteristic Australian endemic families, but also some groups whose distribution is centred mostly in the tropics of other continents (Bowman *et al*. 1988). Many species are also shared with New Guinea, particularly so for species found on Cape York Peninsula, in rainforests and in savannas (Nix and Kalma 1972). Other coastal species are shared with Indonesia, or more widely across tropical coastal areas (Woinarski *et al*. 2000a). Ignoring the actual species composition, the broad vegetation structure in Northern Australia may appear almost identical to climatically similar areas of Africa, India or South America.

Many plant species occur widely and commonly across Northern Australia (Clarkson and Kenneally 1988). But others are very rare and/or narrowly restricted. Some parts of Northern Australia have notably high species richness or endemism. The Kimberley supports about 2000 species of native plants (Wheeler *et al*. 1992), of which about 300 are endemic (Beard *et al*. 2000); Cape York Peninsula supports about 3000 species of native plants including at least 260 endemic species (Abrahams *et al*. 1995; Neldner and Clarkson 1995); and the appreciably smaller (~30,000 km^2) plateau of western Arnhem Land includes at least 170 endemic plant species (Woinarski *et al*. 2006a).

Native invertebrates (such as insects, spiders and centipedes) are relatively little studied in Australia compared with other animal groups, and particularly so in Northern Australia. Thousands of species remain scientifically undescribed and unnamed. For most species little or nothing is known of their habitat, distribution or ecology. However, everywhere on land they constitute the great bulk of species diversity. In Northern Australia, two insect groups, ants and termites, stand out as being abundant and of particular ecological significance, and are showcased in the accompanying text boxes. By national standards, Northern Australia also supports a high diversity of many other invertebrate groups, including moths and butterflies (where the tally from Northern Australia comprises more than 65% of all Australian species), and grasshoppers. For example, Kakadu

DARWIN WOOLLYBUTT

Eucalypts are the predominant tree species in Northern Australia's savannas, and the Darwin Woollybutt *Eucalyptus miniata* is one of the most common and widespread, occurring from the Kimberley to Burketown in Queensland. It occurs in monsoonal areas with annual rainfall of 600–1500 mm. Its preference for the well-drained sandy or sandy loam soils that are widespread across Northern Australia allows this species to extend across a large swathe of the savannas. Darwin Woollybutt is an evergreen tree, which typically grows to about 15–25 m in height. The limbs and upper trunk are smooth and white but the lower trunk has fibrous bark; and it is this characteristic that gives this species its common name.

Like many savanna species, the Woollybutt's reproductive cycle is closely attuned to seasonal patterns, commencing with the development of flower buds in the early Dry season and finishing with seed released from gumnuts at the onset of the Wet season rains. This cycle, completed in only nine months, contrasts with eucalypts from temperate Australia, which take several years to go from flowering to seeding. Between April and July, the Woollybutts provide a vibrant flowering display with large, bright orange flowers throughout the canopy. The massive gum nuts (up to 6x5 cm) contain one of the largest seeds of all the eucalypts. The nectar-rich flowers and large gum nut seeds offer valuable food for birds, bats and insects, such as the native bees. Black Cockatoos are commonly seen using their strong beaks to strip gum nuts from trees and gouge out the seed.

Most eucalypts in southern Australia require heat from fires to open their seed capsules, resulting in a mass release of seeds. By contrast, the seeds of the Darwin Woollybutt are released from the gum nuts as soon as they ripen, so each year there are a small number of seeds released and no seeds are stored in the canopy from year to year. The seeds that fall to the ground either germinate soon after the early Wet season rains, or decay – so there are no seeds stored in the soil from year to year. The seedlings quickly develop a lignotuber and a deep root system that helps them survive the Dry season and provides some ability to regenerate after fire. Despite this survival mechanism, new seedlings are rare because the period of flowering and seed production coincides with frequent fire. Even the relatively cool fires of the early Dry season can kill flowers and the developing seeds, and hot fires can also reduce the amount of flowering in the following years. Seedlings that are burnt in their first year are unlikely to survive, and a fire-free interval of two or three years is probably needed for seedling establishment.

Flower of Darwin Woollybutt. *Photo by Glenn Walker*

Woollybutt seedlings that do survive to about half a metre are highly resistant to fire or other stresses due to their ability to resprout from a well-developed lignotuber. Frequent fires in the savannas maintain the seedlings in the suppressed woody sprout layer. It is not known how long a fire-free period is required for the sprout to develop into a tree. The high level of fire resistance is also a characteristic of the adult trees and tree survival is high even in sites with annual fire, although survival does decrease with hotter fires. Fire damage and death is often the result of fire entering the trunk or limbs which have been hollowed by termites. One study in Kakadu showed that more than 80% of Woollybutt trees had hollow trunks. Although the hollows contribute to the vulnerability of the individual to fire effects, they provide nest sites for savanna animals and the hollow limbs are highly valued by didgeridoo makers. These values add to the importance of this ubiquitous and marvellous inhabitant of our tropical savannas.

SA Setterfield

1 Waterbirds, Aurukun Wetlands, Cape York Peninsula
Photo by Kerry Trapnell

National Park alone is known to support 161 grasshopper species (Andersen *et al*. 2000).

The vertebrate species – birds, mammals, reptiles, frogs and freshwater fish – of Northern Australia are diverse, often highly abundant, and include many spectacular species. The distribution of individual species largely mirrors the distribution of vegetation. Most species that use savannas (e.g. Frill-necked Lizard, Blue-winged Kookaburra, Black Kite, Black Flying-Fox) are widespread across the North. Animal species that depend on rainforests, heathlands and rocky escarpments typically have more restricted ranges in the scattered patches of these habitats. In these habitats many localised species have evolved due to their long separation and isolation from other areas of similar habitat. This contrasts with most species using savanna which have been able to find connected habitats right across the North. The rainforests of the east coast of Cape York Peninsula are particularly rich in such endemic species; the magnificent Riflebird, Palm Cockatoo, Eclectus Parrot and Green Python are examples. Rocky environments also support a distinctive fauna, including Rock Pigeons, Rock Wallabies, Rock Possums and Rock Rats). Mangroves likewise support a distinctive fauna, including species such as the Red-headed Honeyeater and Mangrove Monitor.

Total species richness in Northern Australia is high for most vertebrate groups. About 460 bird species (appreciably more than half of the Australian tally) have been recorded in Northern Australia; along with about 110 native mammal species (about one-third of the Australian tally) and approximately 40% of Australia's reptiles. About 225 freshwater fish (more than 75% of the Australian tally) are known in the North. Indeed, more native fish species may be found in one waterhole in Kakadu than are known in the entire Murray-Darling system.

SO MANY ANTS!

Ants are the dominant faunal group in terms of biomass, energy flow and ecosystem function throughout Australia's tropical savanna landscapes. They contribute up to 30% of the total biomass of the savanna fauna, and play key roles in soil structure, nutrient cycling, invertebrate biodiversity, seed dynamics and plant growth.

Ant diversity, productivity and behavioural dominance in Australian savannas are exceptional by world standards. The total savanna fauna comprises about 1500 species (Andersen 2000), with more than 100 species routinely occurring within less than one hectare (Andersen 1992). These are among the most diverse ant communities on Earth.

Savanna ant communities have a characteristic functional group signature, similar to that occurring throughout arid Australia (Andersen 1993a). Typically, communities are dominated numerically and functionally by highly active and aggressive species of *Iridomyrmex*, led by the familiar meat ants *I. sanguineus* and *I. reburrus* (Andersen and Patel 1994). Communities also feature a rich array of taxa whose high degree of morphological, behavioural, physiological or chemical specialisation are indicative of a long evolutionary history of association with behaviourally dominant ants. For example, species of the highly thermophilic genus *Melophorus* (furnace ants) restrict their foraging to the hottest part of the day, at which time they have exclusive access to food resources. The shield ants of the genus *Meranoplus* have highly developed protective morphology accompanied by remarkable defensive behaviour: when harassed they retract their antennae into deep grooves in their head, tuck their legs under a dorsal shield, and lie motionless in a foetal position. There is also a wide range of specialist seed harvester ants, with up to 20 occurring at a single site, each specialising on a different set of seeds (Andersen *et al.* 2000a).

Species of *Iridomyrmex* and their associated highly specialised taxa become less abundant with increasing vegetation cover, and are absent altogether from patches of rainforest. The most common ants in rainforest are broadly adapted and opportunistic species of *Monomorium*, *Pheidole*, *Paratrechina* and *Tetramorium*. However, rainforest ant communities also include a range of specialist forest species, most of which originated in the humid tropics of North Queensland (Reichel and Andersen 1996). The latter include the notorious Green Tree Ant *Oecophylla smaragdina*, a highly aggressive, leaf-nesting species that occurs also throughout the South-East Asian region. Many other specialist rainforest species are also arboreal, a very uncommon feature in savanna landscapes, where ant activity on vegetation is dominated by ground-nesting species (Majer 1990).

Green tree ants are found across the North. *Photo by Kerry Trapnell*

Changes in fire management can cause a rapid shift in ant functional group composition, changing the balance between 'sun-loving' *Iridomyrmex* and associated specialists on one hand, and the generalists of denser vegetation on the other (Andersen 1991). Indeed, there is a continuum from *Iridomyrmex*-dominated systems of annually burnt savanna at one end, to *Oecophylla*-dominated forests in the long-term absence of fire at the other (Andersen *et al.* 2006).

Ant communities are also highly sensitive to disturbances associated with other land management activities, such as grazing and mining (Majer 1984; Andersen 1993b; Woinarski *et al.* 2002; Hoffmann 2000). For example, impacts of emissions from the copper smelter at Mt Isa in north-western Queensland could be detected on ant communities up to 35 kilometres away (Hoffmann *et al.* 2000). Such sensitivity to disturbance, combined with their ecological dominance and ease of sampling, make ants valuable bioindicators for environmental monitoring (Andersen and Majer 2004).

Alan Andersen

1 Painting Up, Banjo Paterson and Griffith Patrick Kowanyama, Cape York Peninsula. *Photo by Kerry Trapnell*

2 The cattle industry has driven much of the economic development of Northern Australia. *Photo by Mark Ziembicki*

PEOPLE OF NORTHERN AUSTRALIA

Indigenous ownership and management

With more than 50,000 years of continuous settlement by Aboriginal peoples, Northern Australia is the home of more than 130 language groups. From the Kaanju and Wuthathi on Cape York Peninsula in the east, to the Bunuba and Bardi in the west, there are thousands of clan estates within these language groups.

Clan estates were, and in many places remain, the foundations of a continent-scale, regionally distinct, social and economic life. Country was managed according to specific laws and customs. This management shaped and created many of the characteristics of the North that we see today. Particular vegetation types were favoured or reduced by management decisions, such as when and how to burn. Different species responded in varying ways to fire regimes, hunting pressures and other practices.

Indigenous people today comprise a major component of the population and landownership of Northern Australia, more so than most other parts of Australia. In many areas, Indigenous people retain intricate environmental knowledge and skills in land management. The future of Northern Australian environments is inexorably and intricately tied to their future.

Changes in customary land management

With the colonisation of Northern Australia in the nineteenth century, the patterns of Indigenous settlement and land management changed across the North, often very rapidly. On more fertile and accessible lands, pastoralism rapidly changed the management of country, even if the Traditional Owners remained physically present. Even in areas that have never been permanently settled by Europeans, the disrupted cultural, economic and social situations meant that people often left their country, or were removed, and customary practices were altered.

Recent studies suggest that the maintenance of customary practices may be a key factor in retaining biodiversity and environmental health in the North, and the ecological connections and processes that maintain these values (e.g. Yibarbuk *et al*. 2000; Bowman *et al*. 2001b).

Changes arising from colonial settlement – many of which continue today – have had serious impacts on Indigenous land management practices. This is compounded by the fact that there are now fewer people dispersed across and managing the landscape than at any previous time in the 50,000 or so years of human presence in Northern Australia.

Early European and Asian settlement

Since at least the early eighteenth century, there was regular communication between the Indonesian islands and the North, especially in the Top End where the Maccassan people came every year to fish for trepang (sea-cucumber) (Macknight 1976). In the 19th century, European settlers moved into the North. The first serious forays by Europeans into the inland of the North began in the mid-1800s onwards. Settlement was much later than in southern and eastern Australia. Some of the more isolated areas taken up by economic development, such as the central Kimberley, were only first leased to pastoralists in the 20th century. Only the parts of the country most inhospitable to cattle (such as parts of Arnhem Land, Cape York Peninsula and the north Kimberley) were not given over to pastoralists.

The gold rush

The search for two different resources – gold and other minerals, and well-watered grazing lands for sheep and cattle – drove the great bulk of the European invasion and settlement. From the 1870s onwards, a series of gold rushes occurred, notably in Halls Creek in the Kimberley, Pine Creek in the Top End, Croydon in the Gulf Country, and the Palmer River Goldfields and other districts in southern and central Cape York Peninsula. Some of these fields were short lived and were abandoned within a couple of decades, leaving ghost towns, overgrown mine workings and weeds. Other gold fields, such as the Pine Creek district, have remained periodically active to the present day. Through the twentieth century, a broader range of minerals were exploited in fields throughout the North.

Cattle grazing

The first stock were brought to Northern Australia in the isolated and short-lived settlements of the northern coast of what is now the Northern Territory, including Port Essington in 1842. More enduringly, pastoral properties were taken up in central and western Queensland in the 1850s, and pastoralism spread progressively westward over the next few decades. The savannas provided the allure of relatively rapid returns from country where abundant grazing was available without any clearing. However, resistance from Aboriginal landowners, social isolation, poor-quality feed, diseases of people and stock, and long distances from markets, all combined to make the development of the pastoral industry relatively slow and spasmodic. By 1910, the current extent of pastoral country had largely been reached. Since then, pastoralism has intensified in most regions, depending largely on market prices.

One important change was the introduction of *Bos indicus* cattle (Brahmans and related tropical breeds) in the 1950s. These cattle gradually replaced the *Bos taurus* (European breeds, such as Herefords and shorthorns), which struggled with tropical conditions. This change in stock has led to increased profitability and more intensive grazing in many regions.

Development of the North

While gold, other minerals and the search for pastures drove most of the new settlers, the North has also been punctuated by endeavours to establish major centres of agriculture. Notable examples include attempts to establish sugar cane in the Daly River of the Northern Territory in the 1870s, and the Ord River scheme commencing in the late 1960s. Many of these attempts failed – often at great expense to those involved – due to the harshness and caprice of the monsoonal climate (Bauer 1977; Taylor and Tulloch 1985) and limited areas of fertile soils. In Northern Australia, cropping and horticulture have been established only in small areas on the Ord, the Daly River, around Darwin and in parts of the Gulf Country.

TABLE 2.1 **REGIONAL STATISTICS OF FOUR REGIONS**

Note that for simplicity, we have excluded the areas of central-north Queensland in the study area, such as the Einasleigh Uplands.

	Kimberley[a]	Top End[b]	Gulf[b]	Cape York[b,c]
Area (km²)	300,000	440,000	425,000	137,700
Population (approx. % Indigenous)	34,900 (in 2004) (47% in 2001)	160,000 (30%)	50,000 (25%)	18,000 (60%)
Major towns (population)	• Broome (12,000) • Kununurra (6000) • Derby (5000) • Halls Creek (3600) • Fitzroy Crossing (1150) • Wyndham (1000)	• Darwin (78,000) • Katherine (16,500) • Nhulunby (4000) • Jabiru (1700) • Borroloola (1500)	• Mt. Isa (22,000) • Charters Towers (11,000) • Cloncurry (2500) • Normanton (2500) • Hughenden (1500) • Doomadgee (1200) • Karumba (700)	• Mareeba (6900) • Thursday Island (2500) • Weipa (2200) • Cooktown (1400) • Kowanyama (1200) • Lockhart River (800) • Bamaga (750)
Major economic sectors by gross domestic product (GDP) **contribution**	• Government services • Defence • Mining • Tourism • Pearling • Cattle • Horticulture	• Government services • Defence • Mining • Tourism • Cattle • Fishing	• Mining • Government services • Tourism • Commercial & recreational fishing • Cattle	• Mining (50% of formal economy) • Government services • Tourism • Cattle • Fishing
Employment by sectors	• Government services • Tourism • Cattle • Mining • Pearling • Horticulture	• Government services • Defence • Tourism • Cattle • Mining	• Government services • Tourism • Mining • Cattle • Commercial fishing	• Community services • Public administration & defence • Mining • Cattle • Fishing
Land tenure	• 20% Aboriginal land • 7% Conservation • <1% Cropping/ Horticulture • 2% Defence • 69% Pastoral lease • <1% Production forestry • <1% Urban/ Peri-urban • 1% Wetlands/Rivers/ Coastal waters	• 39% Aboriginal land • 11% Conservation • <1% Cropping/ Horticulture • 2% Defence • 47% Pastoral lease • <1% Mining • <1% Urban/ Peri-urban • <1% Wetlands/ Rivers/Coastal waters	• 7% Aboriginal land • 6% Conservation • <1% Cropping/Horticulture • <1% Defence • 83% Pastoral lease • <1% Mining • 2% Production forestry • <1% Urban/Peri-urban • <1% Wetlands/Rivers/Coastal waters	

Population estimates from latest available Australian Bureau of Statistics figures (www.abs.gov.au)

a Kimberley Appropriate Economy Roundtable Proceedings, Australian Conservation Foundation 2006

b Australian Bureau of Statistics

c Cape York Peninsula Development Association website: www.the-cape.info accessed February 2007

Data on land tenure provided by relevant state and territory government departments of Western Australia, Northern Territory and Queensland. Note that statistics are for current tenure and may not reflect actual current usage, or past usage, such as previous mining tenures.

1 Shelburne Bay Sand Country, Cape York Peninsula. *Photo by Kerry Trapnell*

For many Europeans, the North was a place to chase wealth, and then leave for their real home country in southern Australia or overseas, and relatively few people (mostly pastoralists) sought to establish long-term roots in the North. This resulted in an unsettled European population that was slow to understand how the northern country really worked.

This trend has been exacerbated by persistent myths of the North as an area of great natural resources and wealth; of the North becoming the 'food-bowl of Asia'; of the need to 'populate the North' as a buffer to invasion by our Asian neighbours. Along with these myths come proposals for large 'nation-building' projects such as the Ord River dam. These myths and the big projects they spawn have proved a graveyard for the dreams and money of governments and individuals. Strangely, the myths have usually ignored real development possibilities, such as the incremental improvement of the more profitable tourism and pastoral industries.

REGIONS OF THE NORTH

While there are obvious similarities in environments, landform and climate across the North, there are also some notable regional differences, in part arising from political segmentation and development history.

The North can be usefully divided into four regions – the Kimberley, Top End, Gulf Country and Cape York Peninsula (Figure 1.1, Chapter 1). Each region is briefly described below, and Table 2.1 gives some of the vital statistics for the areas.

The Kimberley

Rugged ranges and escarpments dominate the northern and central Kimberley. Here flat-topped mesas, vertical cliffs and rocky screes provide distinctive habitats, with fire refuges for rainforests and protected overhangs for rock art. In the southern and south-western inland areas,

IRONWOOD

The Ironwood is a fire sensitive tree found across the North. *Photo by John Woinarski*

Eucalypts give the Northern Australian woodlands and open forests their dominant species and much of their ecological character. But there are foreign elements amongst these distinctively Australian trees. Perhaps the most notable of these is Cooktown Ironwood. Although this is an endemic Australian tree, its affinities lie elsewhere: the nine other species in the genus *Erythrophleum* are restricted to tropical regions of Africa, Madagascar, continental Asia and Malesia. It provides an example of the ecological melting pot that is Northern Australia.

Ironwood *Erythrophleum chlorostachys* is widespread across Northern Australia: indeed one of its most pervasive trees. European settlers marked it early: its foliage was poisonous to stock, but its wood was hard (one of the densest timbers of any Australian tree), termite-resistant and durable, and much sought during the early decades of European settlement. Around more intensively settled areas, timber harvesters quickly exhausted the resource of large ironwood trees.

Although Ironwood is common and widespread, there are few large trees. It brings unusual ecological traits to this highly dynamic environment: it is long-lived, slow-growing and fire-sensitive. It may take 300–500 years for ironwoods to become large trees (Cook *et al.* 2005). In the current regime of frequent fires, there is little chance of ironwood saplings reaching maturity; and even large trees are now vulnerable to the increasingly intense fires. Ironwood survives in these landscapes largely in a sub-optimal, waiting state. Although it can reproduce by seed, it can also reproduce vegetatively (from root-suckers and lignotubers), and it may stay for many decades in a persistent cycle of growth, fire, loss of stem and leaves, then regeneration from root-stock. Unfortunately, we don't yet know for how long ironwood can maintain this enforced immaturity: the cycles are unlikely to be endless. Where fires are frequent, ironwood may be evident only as a low carpet of suppressed suckers. Large ironwood trees may be present only in the diminishingly small areas in which fire is absent, infrequent and/or mild. Given the opportunity of substantially reduced fire frequency and/or intensity, ironwood could become the dominant tree across much of Northern Australia. Such an opportunity is unlikely to materialise under current management regimes; and the problem for ironwood, and other (typically less conspicuous) species that share its ecological characteristics, is that the unburnt or infrequently burnt refugia are becoming sparser, and there is no respite from the fires across the rest of the landscape.

John Woinarski

the Kimberley meets the Great Sandy Desert and, at these margins, the country is flatter, more arid, and dominated by low woodlands of eucalypts, pindan wattles and grasslands.

The Kimberley is sparsely settled with less than 35,000 people occupying 300,000 square kilometres and, as elsewhere in the North, most people live in the few towns. Large areas in the North and Central Kimberley remain highly isolated from towns and roads. They have very few residents and are rarely visited.

The Top End

The Top End refers to the part of the Northern Territory north of about 18°S – the large square block extending northwards in the centre of Northern Australia. The region has an exceptional diversity of country. The dominant landform are plains and low hills with vast areas of savanna of eucalypts and grass. There are also extensive grasslands in the Victoria River District and on coastal floodplains, mangrove forests such as those around Darwin Harbour, numerous rainforest patches, and the spectacular 'stone country' (the plateau and gorge country such as in Kakadu, Litchfield National Park and western Arnhem Land).

Largely because of Darwin (78,000 people), the Top End has the highest population of any of the four big Northern regions. There is now a small but growing intensively settled area around Darwin, but elsewhere populations are again largely based on towns and mining camps, with a sparse population on country at cattle stations and on Aboriginal homeland outstations. Large parts of Arnhem Land and the south-west of the region remain very isolated, with few residents.

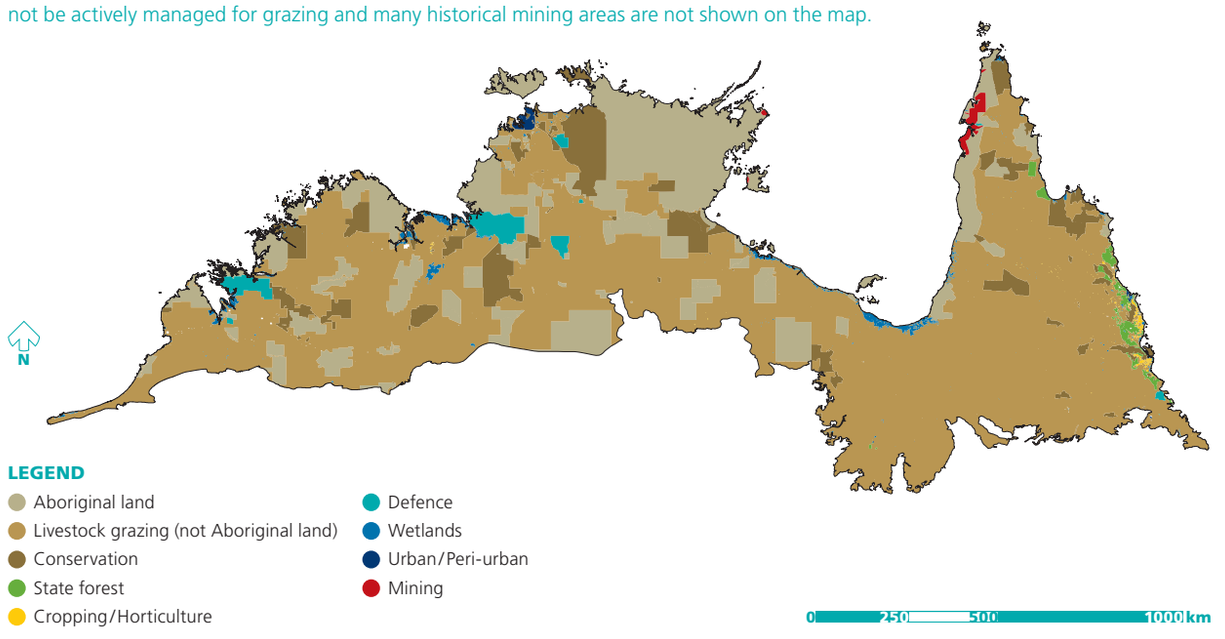
The Gulf Country

The dominating feature of the Gulf Country is the great plain that sweeps around the southern part of the Gulf of Carpentaria. This huge alluvial plain is bordered by the Mt Isa Uplands and the Gulf Fall Uplands and the Barkly Tableland in the west, and by the Einasleigh Uplands to the east. During big Wet season floods, lands bordering the southern Gulf coast are inundated and form the largest wetlands in Australia.

Much of the coastal plain is good quality cattle country and is managed closely for beef production. The highly mineralised belt of the Mt Isa Uplands has produced the long

FIGURE 2.5 **MAP OF LAND TENURES ACROSS THE NORTH**

Note that current tenure does not always correspond with actual current use or past use. For example some pastoral leases may not be actively managed for grazing and many historical mining areas are not shown on the map.



Source: Prepared by Jane Edwards, databases from National Land and Water Resources Audit.

productive mines and small city of Mt Isa, as well as other mines in the mineralised belt that extends north-west into the Northern Territory.

Cape York Peninsula

The Cape has an exceptional diversity of country. In the east the Great Dividing Range form a mosaic of hill country with rainforest, savanna, mangroves and heathlands. In the west are vast low-lying savannas and seasonal wetlands, an extension of the coastal plain of the Gulf Country.

The Cape is one of the most sparsely populated large regions on Earth. Its small population is concentrated in a few towns, including the mine and mining town at Weipa, which is the dominant industry in dollar terms on the Cape.

CURRENT LAND USE AND ECONOMIES

Land tenure and use

The dominant land tenures in Northern Australia are pastoral freehold and leasehold lands (comprising about 70% of the total area) and Aboriginal-owned lands (about 20%). Smaller areas are devoted to conservation reserves (6%), military training (1%) and other uses. These figures can be interpreted variably, as some lands have mixed uses, such as Aboriginal lands jointly managed for conservation, or Aboriginal lands run as pastoral enterprises.

The pastoral and Indigenous lands occur throughout most parts of the North. Conservation reserves are scattered across all regions, though are largely absent from the southern Gulf Region in Queensland and the west Kimberley. The small amounts of non-Indigenous freehold land are mostly associated with towns or agricultural areas near Darwin and Kununurra.

Not shown in Figure 2.5 are operational mines. Currently, mines and mining exploration takes up small areas in distinct mining provinces across the North – mostly in the scattered diamond fields of the Kimberley, uranium and gold around Pine Creek and Jabiru in the Northern Territory, bauxite strip mining in eastern Arnhem Land and the west coast of Cape York Peninsula, strip mining for manganese on Groote Eylandt, and a range of metals, phosphate and diamonds from the large north-west mining province in Queensland that extends from Mt Isa into the Gulf hinterland of the Northern Territory.

1 View from Gunlom Falls, Kakadu National Park, Top End. *Photo by Glenn Walker*

2 Kids cooling off, Kakadu National Park, Top End. *Photo by Glenn Walker*

Economies

The economy of the North is dominated by sectors that depend on natural resources and the provision of government services. However, the main economic drivers of Northern Australia do not mirror land tenure. Precise figures are hard to obtain because the North covers three state jurisdictions; however, government services (including health, education, defence and quarantine) are the largest sectors of economic activity. Importantly, these services involve a continuing and significant transfer of funds by governments from southern Australia to northern regions.

The largest industry sectors in the North are:

- Mining (with sales of minerals worth $2464 million from the Northern Territory in 2004–05);
- Tourism ($1161 million in the Northern Territory in 2003–04); and
- Cattle (more than $1000 million from Northern Australia and central Queensland in 2003).

Relative job numbers do not closely mirror the size of these sectors (Figure 2.6). Government

service industries, tourism and pastoralism provide more employment than mining. This composition of different sectors is also very different from the rest of Australia. In Northern Australia there is a lower proportion of jobs in manufacturing and financial services, but a higher proportion in government services and defence, mining, agriculture and fishing.

In addition, many Aboriginal communities have hybrid economies that provide income from a range of government and non-government sources, including sales of artwork, employment and training schemes, provision of services such as quarantine and land-management work, seasonal work on cattle stations, and collection of food and other needs from the bush and sea.

Distribution of people across the North has changed dramatically since European settlement. In 1850, Indigenous people and the first European settlers were highly dispersed across the country. Since then, people have become more concentrated in population centres.

Currently, there are around 250,000 people in the Kimberley, Top End, Gulf Country, Cape York Peninsula and central-north Queensland outside the Wet Tropics. The great majority of people live in towns; others live in smaller towns or mining settlements; and relatively few people live and work in the country. The sparsity of people in the broader landscape represents a major problem for the North, for example in providing for active management of fire, weeds and feral animals.

CONCLUSION

This chapter provided a brief introduction to the landscape, history and economy of Northern Australia. It is a distinctive land, marked by a climate more related to tropical areas on other continents than to the rest of Australia. Its environments include an idiosyncratic mix of typically Australian and tropical elements, with a distinctive legacy of long-term connections with New Guinea. Its current social and economic features are unlike those of most of the rest of Australia.

In the following chapters we delve more deeply into some of these features. We draw out the manner in which the ecology of Northern Australia works, its conservation values and management challenges. The following chapter describes in more detail the ecological underpinning of the North – how the land operates to sustain its biodiversity and natural resources.

FIGURE 2.6 **EMPLOYMENT BY SECTOR**

Source: ABARE, Northern Australia Regional Outlook paper, November 2006, www.abare.gov.au/publications.