An Extraordinary Natural Legacy

An assessment and recommendations for the proposed expansion of Western Australia's conservation reserve system

March 2019

Centre for Conservation Geography

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Acknowledgement of country: The authors acknowledge the Traditional Owners of the lands that are the focus of this report and their continuing connection to these lands. We pay respect to them and their cultures, and to their elders past and present. We acknowledge the inextricable link between natural values and Aboriginal heritage values and that the knowledge of Traditional Owners will be vital for maintaining both.

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Cover photo: 'An ancient landscape' by Hugh Brown.
Image taken in the vicinity of ex Hamersley, one of the focus areas of this report.

CENTRE FOR CONSERVATION GEOGRAPHY

Strategic Tools and Conservation Innovation

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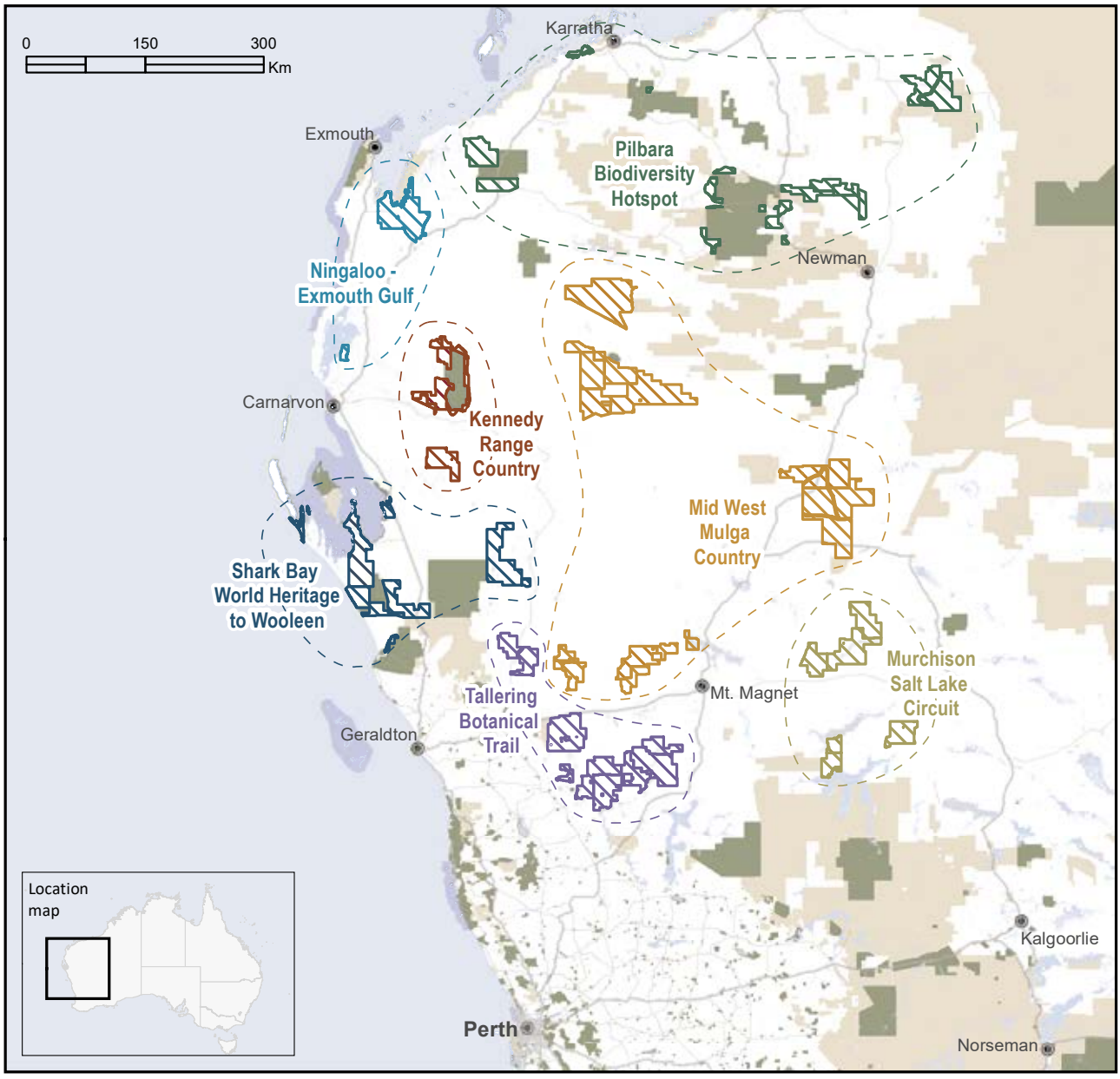
Proposed expansion of Western Australia's conservation reserve system



The proposed parks whose natural values are assessed in this report, and the boundaries of each property 'cluster' which form the basis of this publication's chapters.

CONTENTS

The extraordinary new parks proposed for Western Australia

Two decades ago, in a visionary endeavor to expand the state's parks network and diversify regional economies, the Western Australian government started a program to buy selected leasehold properties, mainly in the Gascoyne and Murchison bioregions.

Their intention was to create a more comprehensive, adequate and representative reserve system and protect rare and unique biodiversity. The parks would also provide new recreational and tourism opportunities in regions with few or no existing reserves.

But the process was never completed and these properties have remained ever since as unallocated Crown land.

It was our privilege to be commissioned by The Pew Charitable Trusts to assess the natural values of some 60 of these properties, across 5 million hectares, and make recommendations about an appropriate future for them. This is the first publication to do so in a comprehensive way.

Western Australia is well known as a biological treasure trove, rich in unique species and ecological communities. Nonetheless, as we delved into databases and scientific publications, we found ourselves amazed by the outstanding nature of these potential new parks.

Some of their values are already well appreciated – the world heritage biodiversity and scenic values of properties at Shark Bay, for example, and wetlands such as Fortescue Marsh and Thundelarra lignum swamp listed by the Australian government as nationally important.

But other values are poorly known or have only recently been appreciated. Discovered only 20 years ago beneath the sandy plains of many Murchison properties are groundwater calcrete 'islands' harboring communities of unique species of water beetles, crustaceans, mites and other invertebrates that never see the light of day. And aboveground, on ancient ironstone ranges with skeletal soils are unique plant communities, often with species found only on those ranges. That's what you get in landscapes as ancient as those of the Yilgarn and Pilbara cratons.

The old infertile soils and low sporadic rainfall mean it can be tough for plants and animals to make a living across much of this country. But innovative adaptation and specialisation across eons of geological stability have produced impressive diversity. These properties include centres of diversity or endemism for stygofauna, lizards, wattles and other plants. They are also rich in cultural heritage.

What can't be quantified or represented on maps are the powerful stories such values represent – the billions of years of geological sculpting, the millions of years of biological evolution, and the tens of thousands of years of human occupation.

Unfortunately, the properties also abound in threatened and at-risk species and ecological communities, which means they need attentive conservation management to retain and recover their values.

If, as recommended in this report, these properties are protected as conservation reserves, Western Australians will be very fortunate in the future to be able to visit these ecological and cultural treasures.

Lucinda Douglass

Carol Booth

The magnificent Gregory's Gap is part of the proposed 'Wanna' Conservation Park, which lies on the northern edge of the poorly protected Gascoyne bioregion. Photo: David Blood (DEC)

1 Introduction

The proposed parks would boost protection of world heritage values at Shark Bay by adding new conservation reserves and connecting existing reserves. This is the entrance to Big Lagoon, Francois Peron National Park. Photo: Anton Blume.

1.1 A far-sighted state project

With their distant horizons and ancient geology, Western Australia's national parks and reserves encourage long-sighted perspectives:

> Deep into the past – landscapes that have been in the making for more than 3 billion years, wildlife with Gondwanan roots, and the everyday and spiritual insignia of the oldest living cultures on Earth.
>
> And far into the future – sites that will provide ongoing generations of Western Australians with experiences that nourish and excite, build regional economies, and maintain Western Australia's unique natural and cultural heritage.

Creating national parks and reserves has turned out to be one of the most far-sighted projects ever undertaken in the state, immensely popular with people – with more than 20 million visits last year –and providing iconic destinations to support the state's primary tourism drawcard: wild nature. From the dramatic gorges of Karijini to Ningaloo's world heritage reef and range, the colourful floral vistas of the Mid West and the towering karri trees of the South West, they provide sanctuary for some of the world's most distinctive, diverse, rare and beautiful plants and animals, landscapes and seascapes.

Building Western Australia's reserve system is an ongoing project, with the first park, the 2000-hectare John Forrest National Park, declared almost 120 years ago, and the 3-million-hectare Great Kimberley Marine Park declared just 2 years ago. Over time, the goals for the reserve system have grown due to a realisation of their many economic, cultural and environmental benefits. Initially, they were mainly for recreation. Now, they are intended to fulfill many objectives – protect representative portions of each ecosystem and provide sanctuary for threatened species, conserve the cultural heritage of the past Indigenous and pastoral inhabitants, support Traditional Owners to maintain their culture and connections to country, provide exciting new places for Western Australians to visit, and expand tourism and economic opportunities.

Tourism icon, Karijini National Park, is the second largest national park in Western Australia. Photo: Tomasz Judkowiak

Getting away from it all, star-gazing, adventuring and relaxing – conservation reserves provide great social as well as environmental benefits.
Photo: Jed Currey

One far-sighted project that will enable Western Australia to make major progress in meeting multiple goals was begun 20 years ago, when the government started strategically acquiring leasehold properties, mostly in regions with few existing reserves. However, most of these properties intended to become the next major expansion of the state's conservation reserve system have stalled on the way to secure conservation tenure. They are currently classified as unallocated Crown land, which stymies realisation of many potential benefits. The next step for the government would be, with the consent and involvement of Traditional Owners, to formally gazette them as reserves (nature reserves, national parks or conservation parks), based on assessments of their natural and cultural values.

This report has been commissioned by The Pew Charitable Trusts to assist in the next phase of decision-making. It provides an assessment of the natural values of these properties – the richness, uniqueness and rarity of the species, ecological communities and other features – and their potential contribution to Western Australia's conservation reserve system.

In the rest of this chapter we outline the history, importance and goals of Western Australia's reserve system and its benefits for nature and people. The importance of reserves is then further illustrated by exemplifying some of the state's extraordinary natural values. We also briefly explain the background to the purchase of the properties and the approach taken in this report.

1.2 Milestones in the creation of Western Australia's reserve system

Western Australia's first national park, John Forrest National Park, with snail hakea (*Hakea cristata*) and grasstrees (*Xanthorrhoea preissii*) in the foreground. Photo: Russell Cumming

Western Australia's first national park – and Australia's second – came in 1900 with 1600 hectares of jarrah forest east of Perth reserved as the Greenmount National Park, later renamed the John Forrest National Park. It wasn't a universally popular move – the local paper described the park as 'an immense area of land now locked up and retarding the progress of the district' after the Lands Minister refused a request in 1909 from the Greenmount Roads Board to excise part of it for settlement (*The Swan Express,* 1909). This and most other parks in the early decades of statehood were created mainly for recreation and scenic appreciation, as the population swelled due to gold rushes and as railroads made travel easier. They often eventuated as 'a matter of someone's personal fancy' (Rundle, 1996).

The state's first reserve for conserving nature had actually been created 6 years earlier, in 1894 – but this 64,000-hectare South Dandalup Nature Reserve was cancelled 17 years later after political pressure from timber millers (Rundle, 1996, Calver and Wardell–Johnson, 2017). Since then, Western Australia's reserve system has been built in fits and starts (Figure 1-1), with different motivations dominating at different times.

A few floral reserves were created during the early decades, mainly to protect novelties like the Albany pitcher plant, but Western Australia's first large national park for nature conservation was 80,000 hectares on the Stirling Range gazetted in 1913 (Rundle, 1996, Craigie et al., 2015). It undoubtedly helped that the floral riches of this area include gastrolobium plants poisonous to livestock. This has been characteristic of reserves, the properties often having little economic worth when gazetted (Brandis, 2008).

During the 1950s and 1960s, with growing public concern for endangered wildlife, nature-focused motivations became more influential in shaping the reserve system (Rundle, 1996). The state's botanical regions were mapped, and government botanist Charles Gardiner said it was imperative that 'adequate reserves representative of various types of natural habitats should be preserved' (*West Australian*, 1954). He persuaded the government to create a series of reserves for floral protection – including Kalbarri, Cape Arid and Jilbadji (Rundle, 1996). Wildflowers were by then already a major tourism attraction (*Beverley Times*, 1966).

Private reserves such as Charles Darwin Reserve, managed by Bush Heritage Australia, complement Western Australia's formal conservation reserve system and play a critical role in the state's conservation efforts. Photo: Kerry Trapnell

Early morning in Hancock Gorge, Karijini National Park. Photo: Stuart Bell

The scenic Cape Arid National Park on Western Australia's south coast is known for its stunningly beautiful beaches, clear blue seas and rocky headlands. Photo: Stephan Ridgway

In 1970 the West Australian Minister for Lands proudly proclaimed that 11.3 million acres (4.6 million hectares) had been 'set aside for posterity', and that this was more than in any other Australian state (*Beverley Times*, 1970).

Momentous changes came in the 1970s. A major milestone was the 1970 appointment of a Minister for Environmental Protection and the 1972 establishment of the Environmental Protection Authority with a mandate to build a state-wide reserve system with an explicit focus on conserving 'representative' examples of nature (Rundle, 1996). An analysis by the Academy of Science found that of 218 'vegetation alliances' (plant communities) in the state, half had no protection in reserves or their protection was precarious (Specht et al., 1974). By the end of the decade, the area in reserves exceeded 10 million hectares (about 4% of the state) (CAPAD, 2017).

Community conservation campaigns became more influential after the 1970 formation of the Western Australian Conservation Council as an umbrella group for small local groups. The council advocated an additional 8 million hectares of conservation reserves (Rundle, 1996). Also important was a growing scientific understanding of the species, ecosystems and ecological processes specific and often unique to this continent, including greater appreciation of the roles of fire, flood and drought, the relationships between birds and plants and the ecological importance of predators. This was accompanied by a growing realisation of the constraints imposed on agriculture by low productivity and natural climate variability, and the massive biodiversity losses being caused by land clearing, invasive species and changes to fire regimes.

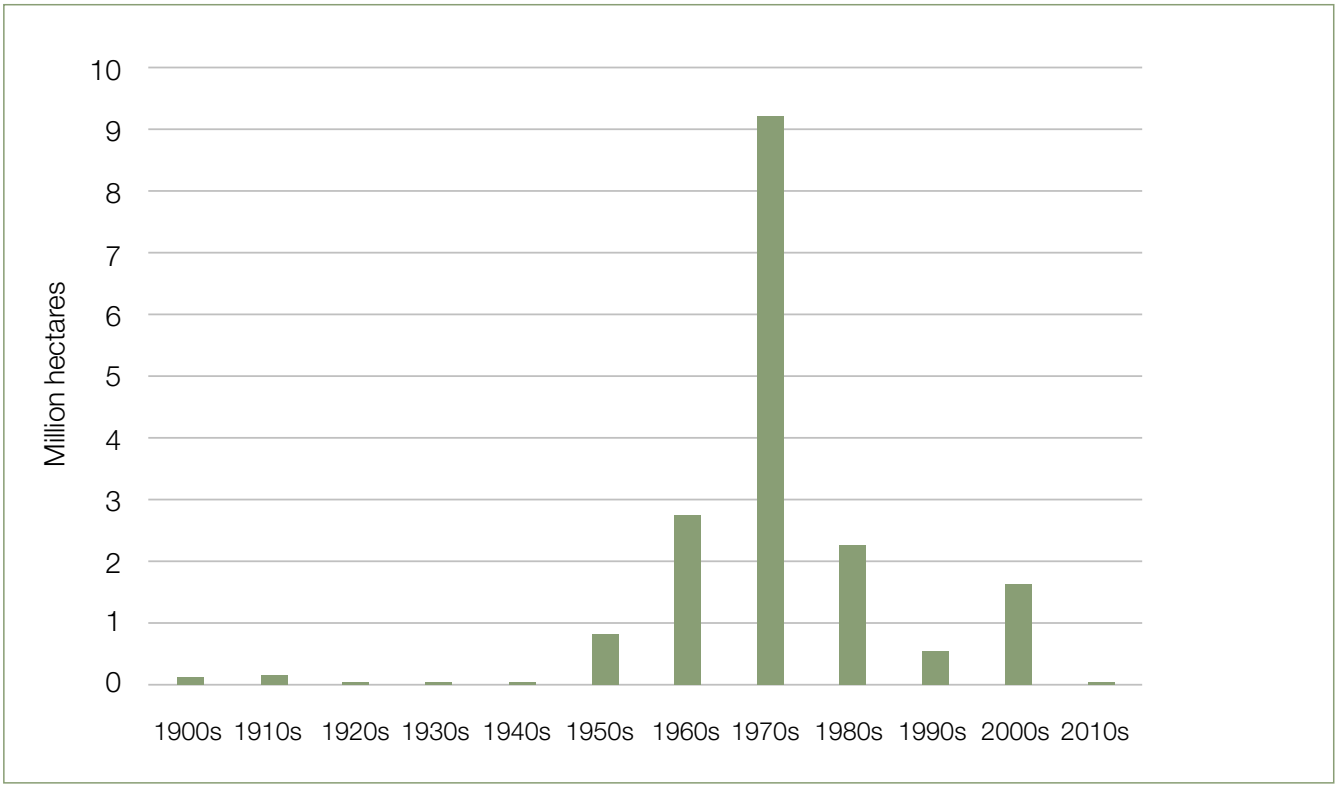
Australia's signing of the 1992 Convention on Biological Diversity led to the first national strategies for protected areas, as well as federal funding to help states buy properties for parks. 'The establishment of a comprehensive system of protected areas is vital if we are to retain our status as a region of megadiversity,' said Prime Minister Paul Keating in 1992 (DEE, nd-b).

Soon after, in response to the collapse of the wool industry, Western Australia embarked on the Gascoyne-Murchison Strategy, which led to the purchase, with federal government contributions, of many of the properties that are the focus of this study.

Another recent development has been the creation of Indigenous protected areas and private reserves. While not part of the state's legislatively declared conservation reserve system, they make a critical contribution to Australia's conservation efforts and are recognised as part of the national reserve system. In the mid-1990s the Indigenous Protected Areas program was established by the federal government to support Traditional Owners to manage their land for conservation as part of the national reserve system. Western Australia's first Indigenous protected area came in 2002 with Paruku. In Western Australia, the recognition that native title can exist over national parks and reserves has led to legal changes recognising customary rights and enabling joint management and joint vesting of parks. Since the early 2000s, close to 2 million hectares has also been protected in private reserves, most managed by the Australian Wildlife Conservancy and Bush Heritage Australia.

Figure 1-1 shows the progressive creation of Western Australia's reserve system since 1900, and Figures 1-2 and 1-3 and Box 1-1 highlight some of the milestones in this history.

Figure 1-1: The gazettal of state-managed conservation reserves, area per decade, in Western Australia

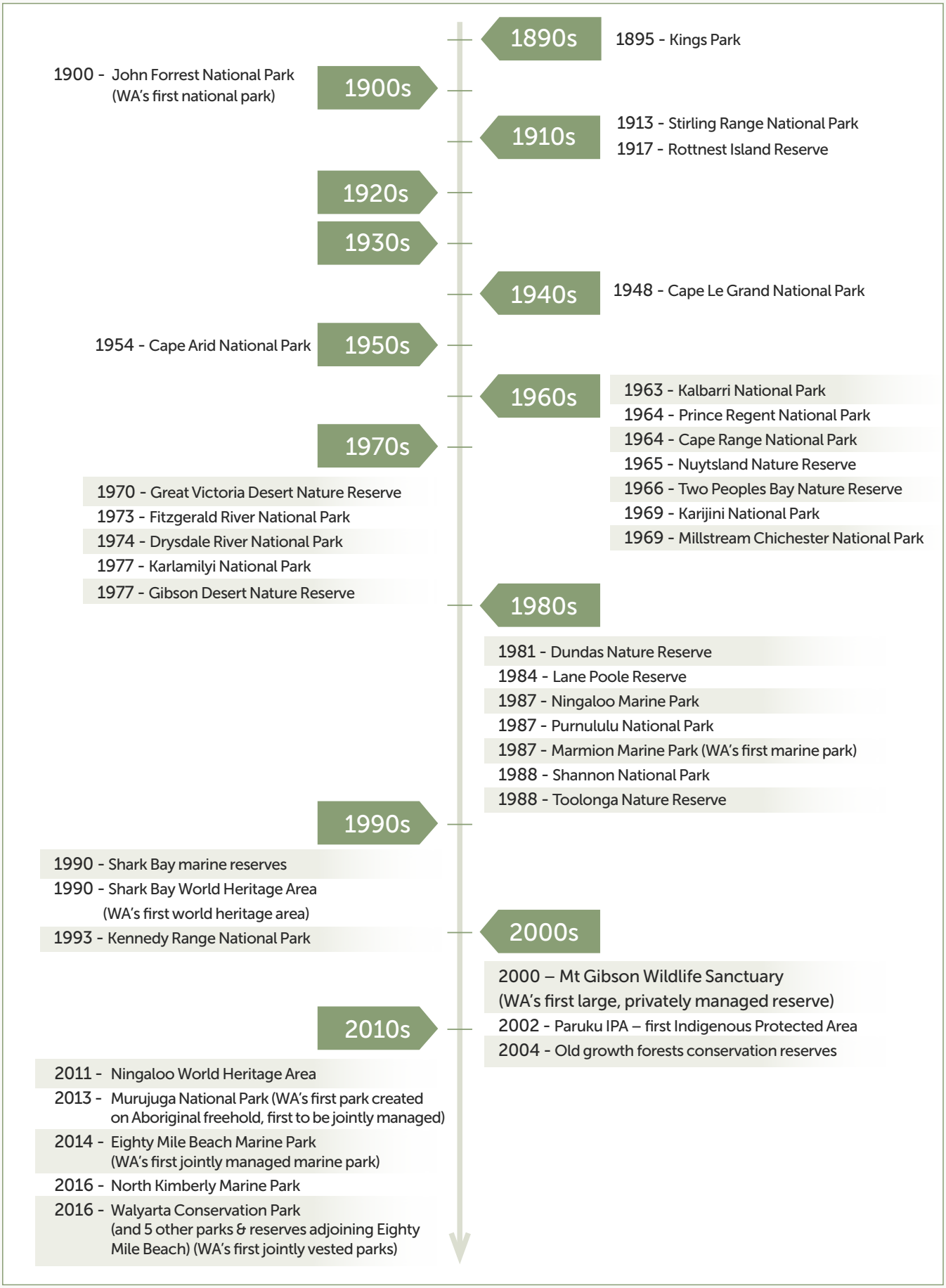


Notes: These state-managed reserves primarily consist of nature reserves, national parks and conservation parks, which are managed by the state government.

Source: CAPAD (2017)

Cape Le Grand National Park, a spectacular coastal park, features wide sandy beaches, botanically rich heathy sandplains and massive rock outcrops. Photo: AGO

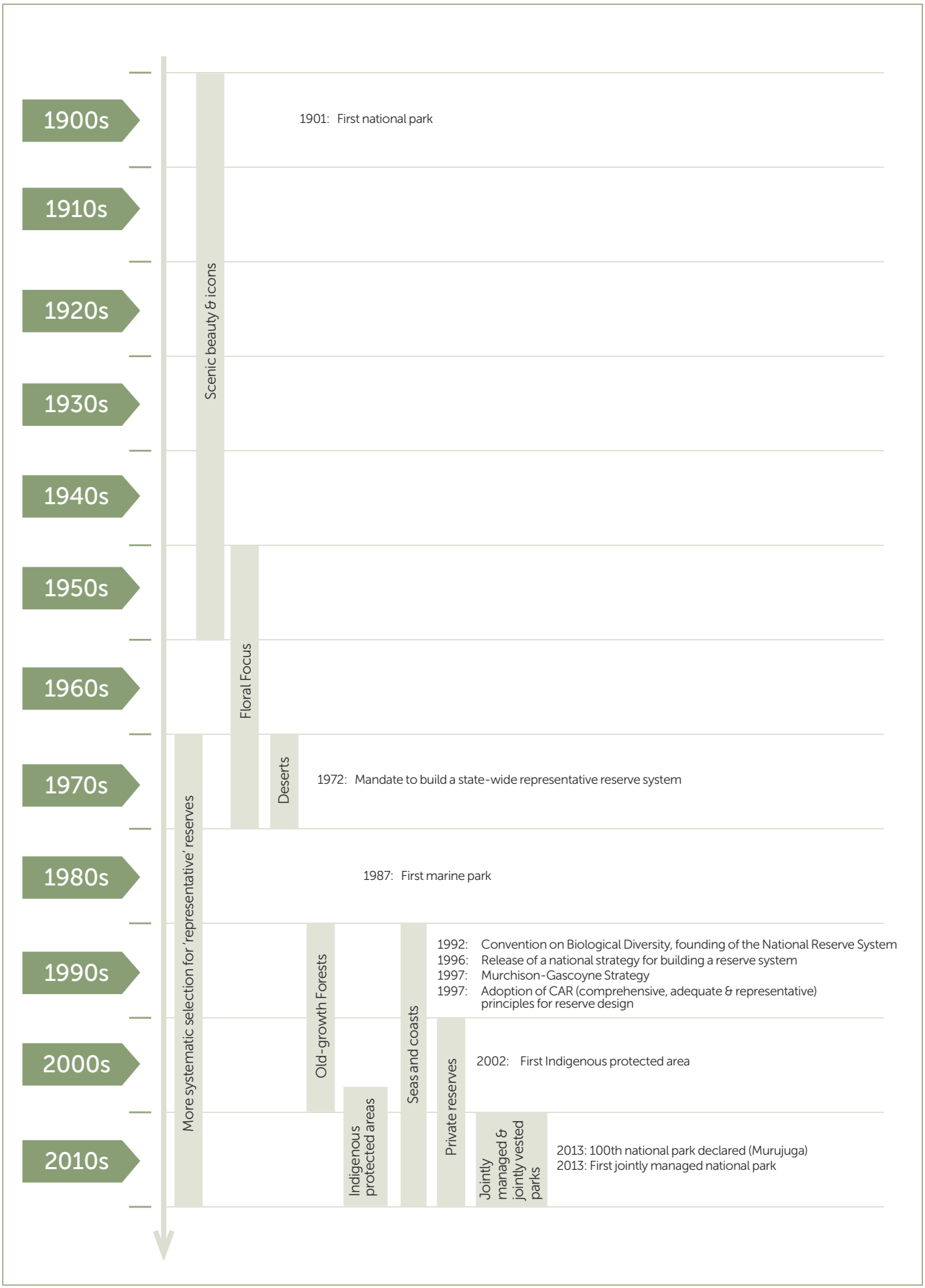
Figure 1-2: Park milestones in the creation of the Western Australian reserve system



Primary source: CAPAD (2017)

Bell Gorge, in the KImberley's King Leopold Ranges Conservation Park, is a tourism drawcard as well as a haven for wildlife. Photo: Glenn Walker

Figure 1-3: Major phases and policy milestones of the creation of Western Australia's reserve system



Box 1-1: Some major phases in the creation of protected areas in Western Australia

Scenery & icons (from the 1870s): Most early reserves were created for their scenic qualities and to provide for recreation. Perth Park (now Kings Park), prized for its panoramic views, was the state's first significant bushland area to be protected, in 1872. In the early 1900s, as the population grew and railroads were established, scenic areas such as Greenmount, Leeuwin-Naturaliste, Beedelup and Warren were protected. Another early focus was icons such as standout geological features or biological novelties. A few floral reserves were created in the early decades of the 1900s mainly to protect novelties like the Albany pitcher plant and the red flowering gum.

Representative examples of nature (from the 1960s): In 1958 an Australian Academy of Science committee started an inquiry into Australia's reserves. The Western Australian subcommittee produced a report with reserve proposals in 1962 that generated public support for a more systematic approach to reserve creation. The Western Australian Cabinet adopted some of the proposals but stalled on others, particularly those opposed by miners. The 630,000-hectare Hamersley Range National Park (now Karijini), one of the academy's recommendations, was created only because the decision apparently bypassed a Mines Department vetting process. The systematic approach to reserve creation was enhanced by the adoption of the CAR (comprehensive, adequate and representative) principles in 1997.

Flora (from the 1950s): The first reserves selected on a more scientific basis were 'strategic botanical province interface reserves' that resulted in the parks known today as Kalbarri and Cape Arid. They were declared largely at the urging of the state government botanist. The Australian Academy of Science published a major analysis in 1974 of gaps in protection of 218 vegetation alliances as a guide for reserve priorities.

Deserts (from the 1970s): Large desert reserves created in the 1970s now comprise the majority of the conservation reserve system – Gibson Desert Nature Reserve, Karlamilyi National Park and Great Victoria Desert Nature Reserve. Large desert areas have also been designated as Indigenous protected areas over the past 2 decades, complementing the government-managed parks.

Seas & coasts (from the 1980s): The state's first wave of marine parks came with the declaration of the suburban Marmion Marine Park and Ningaloo Marine Park in 1987, followed by protection of Shark Bay, Rowley Shoals and Shoalwater Islands in 1990. The creation of the Great Kimberley Marine Park in 2016, as Australia's largest marine park in state waters, has tripled Western Australia's marine parks estate.

Old growth forests (1990s-2000s): Concerns over industrial-scale woodchipping of the South West forests in the 1970s sparked a strong public movement that made forest protection a defining political issue. After the 2001 state election, old growth forest logging was officially ended and the Gallop Government declared 46 new national parks and conservation parks protecting over 500,000 hectares of forest.

Management by Traditional Owners (from the 2000s): A revolution over the past 2 decades in management of lands for conservation has been the increasing involvement of and leadership by Traditional Owners. This has included the declaration of Indigenous protected areas (mainly in the deserts and the Kimberley) and joint management of some parks where native title has been recognised. Indigenous ranger programs, now funded by both state and federal governments, are increasing the capacity of Traditional Owners to manage their lands for conservation while also delivering social, cultural and economic benefits to individuals and broader communities.

Sources: Lines (2006), Rundle (1996), CAPAD (2017), Specht et al. (1974)

Sunset at Joffre Gorge, Karijini National Park. Photo: Pauline Kirby

Coral garden in the world heritage-listed Ningaloo Marine Park.
Photo: Paul and Kelly Wags

Karri trees (*Eucalyptus diversicolor*) at dawn on Heartbreak Trail in Warren National Park, south-west Western Australia. Photo: Simon Neville

Under starry skies at Z Bend Gorge, Kalbarri National Park, Western Australia. Photo: Richard Burges

1.3 The benefits and achievements of Western Australia's conservation reserve system

As occurred with Western Australia's first national park, proposals for new reserves have often been greeted with caution, sometimes opposition – typical for decisions that alter existing land uses. But once implemented, it seems there is no regretting. It is widely accepted that Western Australia would be greatly impoverished in all sorts of ways had the current suite of parks not been created or if they were to be lost. Stirling Range, Ningaloo, Shark Bay, Karijini, Purnululu, old growth forest parks – such parks are core to the Western Australian identity, setting the state apart from the rest of the world by their unique wildlife, deep geological history and cultural significance. They are destinations that define the state's tourism experience and are an important source of regional employment. They are the backdrop to pivotal life experiences – places for learning, adventure and escape. For their Traditional Owners, the parks are home – the source of their identity, wellbeing and, increasingly, economic opportunity.

Currently, about 19 million hectares (7.6% of the state) are protected in the conservation reserve system (in nature reserves, national parks and conservation parks, the most secure forms of conservation tenure) (CCG, 2017).

In the state government's words (DPaW, 2017b), the reserve system is important for four main reasons:

- conserving Western Australia's biodiversity, which is both rich and displays a high level of endemism
- protecting cultural and heritage values and supporting Aboriginal connection to lands and waters through customary activities and joint management
- providing for community wellbeing through provision of ecosystem services, nature appreciation and recreation opportunities
- contributing to state and regional economies through nature-based tourism and sustainable resource use and extraction.

Nature Conservation

> *A well-managed conservation reserve system forms the cornerstone of biodiversity conservation, protecting viable samples of all regional ecosystems and the plants and animals they support. These areas provide the basis for integrated ecosystem management and a landscape-scale approach to conservation that seeks to link reserve and off-reserve conservation efforts to enhance ecosystem resilience and habitat connectivity*

Western Australian government (DPaW, 2017b)

A major conservation goal for Western Australia – one agreed to by all Australian governments – is to create a 'comprehensive, adequate and representative' network of reserves (DPaW, 2017b). This requires protecting the full range of ecological communities in each bioregion ('comprehensive') in areas large enough to be ecologically viable and maintain populations, species and communities ('adequate'), and encompassing the variability of habitat within ecosystems ('representative') (DEE, nd-d). The government does not make explicit what is needed to achieve this, but refers to various national and international commitments – in particular, an area-based bioregional target of 17% and an ecosystem target of 15% (see Box 1-2). The state still has a considerable way to go to meet these targets – about half of Western Australia's bioregions have not met the international benchmark of 17% protection (Figure 1-4) and more than 40% of the state's ecosystems lack the targeted 15% level of protection (Taylor, 2017b).

Western Australian reserves such as Barrow Island Marine Park are important for protecting threatened flatback turtles (*Natator depressus*), which breed only in northern Australia. Photo: Sonny Rutherford

Indigenous cultural heritage and connections

Western Australia's parks are rich in evidence of the many innovative ways in which Aboriginal people have lived in these landscapes for tens of thousands of years – from the middens of everyday discards and the patterns of trees and grasses shaped by deliberate burning, to the rock art and cultural practices that sustain their connections to a highly spiritual and richly storied landscape.

The creation of parks provides opportunities for Indigenous cultures to be maintained and better understood, and for the centrepiece of these cultures, the land itself, to be sustained in return. It requires the meaningful involvement of Traditional Owners in park management. The past decade has seen the emergence of formal joint management arrangements, joint vesting provisions, Aboriginal freehold land being leased to the state as national parks and a state Aboriginal ranger program (DPaW, 2017c). They mark a turning point and significant escalation in the potential of the conservation reserve system to deliver social and economic co-benefits, as well as meet conservation goals.

In addition to managing fire, weeds and feral animals and protecting threatened species, Aboriginal ranger programs generate jobs in remote areas, where they are often hardest to find. They raise education and health standards, connect older generations to younger people, and generate pride and direction in Aboriginal communities (van Bueren et al., 2015).

Other culturally aligned economic opportunities are based on tourism. Seventeen Aboriginal tour operators were licensed to operate in Western Australian parks in 2016–17, almost double that of the previous year (DPaW, 2017c).

Aboriginal rock painting on ex Doolgunna, part of the proposed 'Doolgunna – Mooloogool' National Park. Photo: David Blood (DEC)

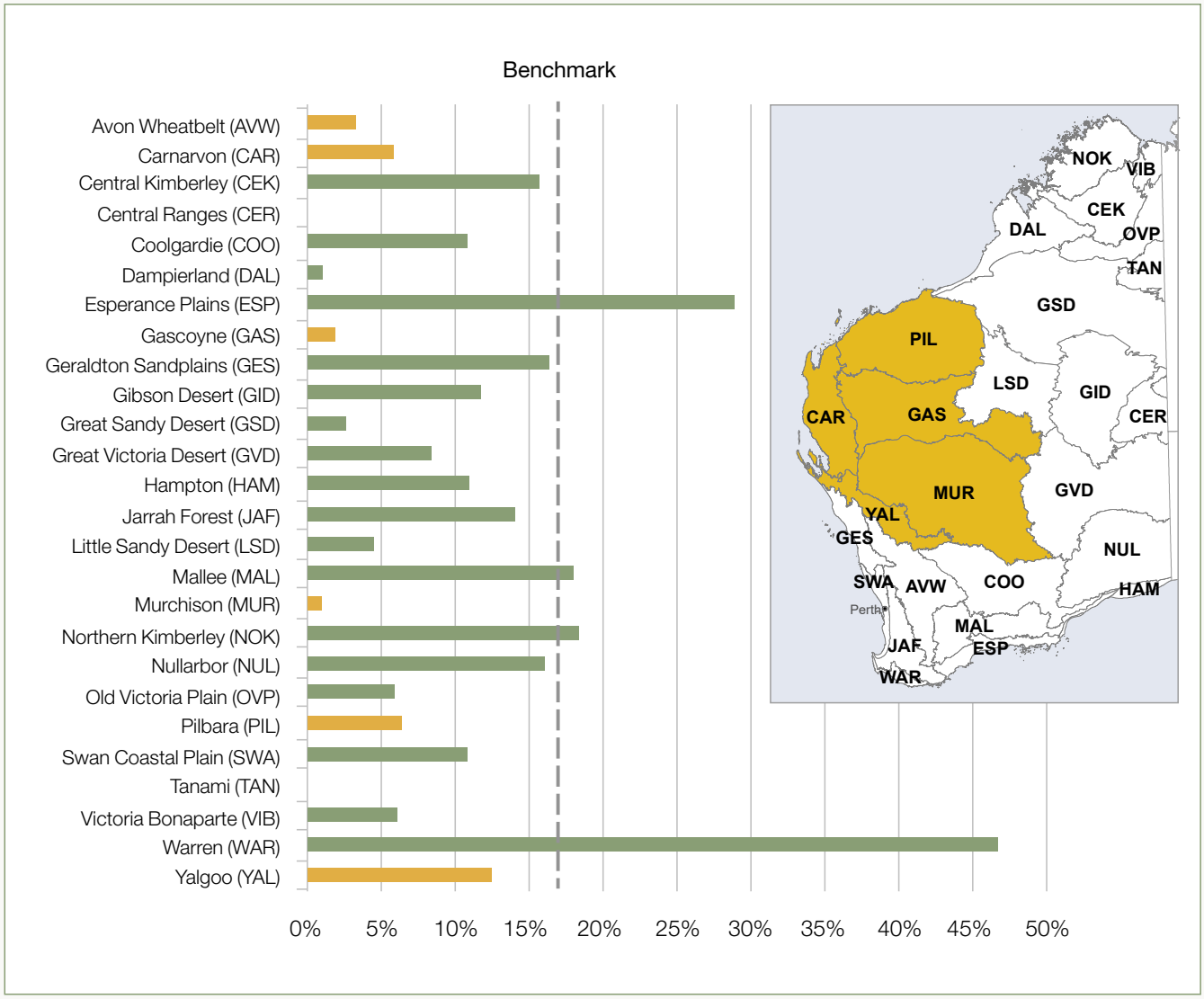
Charmaine Wright of the Nyangumarta Warrarn Ranger group is one of a rapidly growing number of Aboriginal rangers caring for protected areas in Western Australia. Photo: YMAC

Parks and people

In 2016–17, the state's national parks and reserves attracted more than 20 million visits (Figure 1-5), and the visitor satisfaction level exceeded 90% (DPaW, 2017c). This is almost the equivalent of each Western Australian visiting 10 parks a year. Some visit for the dramatic landscapes, natural beauty, rich cultural heritage and unique wildlife. Others visit for adventure, camping under the stars, or escape from everyday life. For some it's a way of life – more than 5000 people volunteered more than 700,000 hours on various projects in support of parks (DPaW, 2017c).

The popularity of parks puts them at the centre of Western Australia's tourism industry. 'Experience Extraordinary' is how Tourism Western Australia brands the state, and most of the highlighted experiences are those to be had in national parks and reserves (Tourism WA, 2018). Of more than 7 million international visitors to Western Australia in the year ending March 2013, about half visited a national or state park (Tourism WA, 2013). Park tourism is particularly important to some regional economies – for example, more than three-quarters of international visitors to the Coral Coast visited a park. Park visitation is growing at a far higher rate than Western Australia's population (Figure 1-5). Providing additional opportunities to visit and stay in natural areas is 'an important objective of Tourism WA' (Tourism WA, 2013).

Figure 1-4: Percentage of each Western Australian bioregion protected in the conservation reserve system



Notes: These reserves are those classified as IUCN I-IV reserves, a classification based on management purposes. Most are national parks, nature reserves and conservation parks managed by the state government. Only the western Australia extent of bioregions is considered. The orange bars represent bioregions relevant to this report, most of which are currently poorly represented in the conservation reserve system. The orange shaded bioregions contain proposed parks and are the focus of this report

Source: CCG (2017).

Box 1-2: Western Australia's conservation reserve goals

To establish and effectively manage a system of comprehensive, adequate and representative conservation reserves in Western Australia to contribute to long-term conservation of biodiversity and the culture and heritage of Aboriginal people.

Western Australia's conservation reserve system objective (DPaW, 2017b)

To achieve the state's goal of a 'comprehensive, adequate and representative' network of reserves, how much land needs to be protected and where should reserves be placed? Various international and national commitments as well as scientific studies provide some guidance.

Australia's main international commitment for a reserve system is specified in what is known as Aichi target 11 – one of 20 targets in the *Strategic Plan for Biodiversity 2011–2020* adopted in 2010 in Aichi, Japan, by signatories to the Convention on Biological Diversity:

By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes.

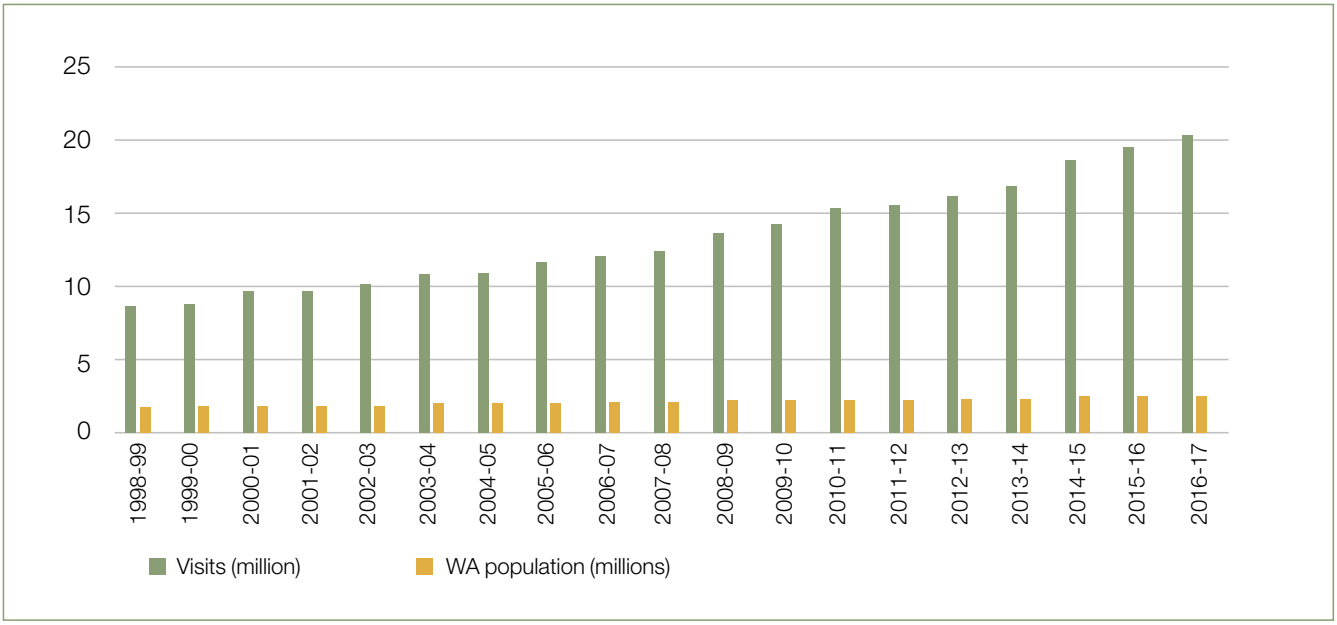
The area-based target of 17% is an interim one – a globally negotiated next step rather than a final scientifically defined endpoint. The 17% target should be applied at an ecologically meaningful scale, to areas with 'distinct assemblages of natural communities and species' (Woodley et al., 2012). The Western Australian government has accepted in various policy statements and management documents that the 17% area target should apply at least to a bioregional level (DPaW, 2017b, DPaW, 2013, DPaW, 2017f). In this study, we apply 17% as a benchmark at bioregional and sub-bioregional levels as one way of assessing the extent to which the proposed new parks will enable progress towards the state's conservation goals (see chapter 2 for more details). In addition, as the Aichi target specifies, the reserves should be ecologically representative, well connected and well managed.

Australia's *Strategy for the National Reserve System 2009–2030* requires protecting examples of at least 80% of all regional ecosystems in each bioregion (by 2015) and each sub-bioregion (by 2025) (NRMMC, 2009). In this study, we document how many sub-bioregional ecosystems are newly protected in each proposed park. The national strategy also requires 'protecting core areas for the long-term survival of threatened ecosystems and threatened species habitats'. A WWF-Australia analysis found that almost two-thirds (63%) of nationally listed threatened species in Western Australia do not have a minimum level (30%) of their habitat protected in reserves, and 9% have no habitat in reserves at all (Taylor, 2017b). In this study, we document the threatened and priority species and ecological communities that are likely to be protected in each of the proposed parks.

Another (long-held) target of Australian governments has been to protect at least 15% of the pre-1750 distribution of each ecosystem in reserves (and more for small ecosystems) (JANIS, 1997). In this study we apply this target as another way of assessing the state's conservation reserve progress. Currently, more than 40% of sub-bioregional ecosystems in Western Australia lack this level of protection in the reserve system (Taylor, 2017b).

The over-riding goal for parks – the long-term viability of nature at all scales – requires not only that all species and other levels of biodiversity be represented in reserves but that reserves be large enough to ensure their persistence over time and the maintenance of ecological processes. No single area target can reflect this because biodiversity is not evenly distributed (Rodrigues and Gaston, 2001). Ecosystems with high diversity or endemism, for example, require a larger proportion of their area to be protected than others. A 2005 review of more than 100 studies of reserve targets found that 'representation, resiliency, and redundancy' could only be achieved with area-based targets averaging 40% (Svancara et al., 2005). Other reviews indicate that protected areas should cover around half the landscape to 'protect nature in all its expressions' (Locke, 2013).

Figure 1-5: Visitors to Western Australia's national parks and reserves compared to population



Sources: ABS (2018), DPaW (2017c)

1.4 The extraordinary nature of Western Australia

Eons of geological stability and geographical isolation have given rise in Western Australia to highly distinctive landscapes and a rich and unique biota. A long lack of glaciation and volcanic eruptions – processes which create new soils and mountains – has seen the soils leached of nutrients and the mountains worn down. As Australia has drifted north after splitting from Gondwana, the climate has dried. Australia as a whole is the flattest of all continents, with the highest proportion of nutrient-poor soils and the most variable and lowest water flows of inhabited continents (Finlayson and McMahon, 1991, Orians and Milewski, 2007). But the stability and isolation have also enabled evolutionary innovation – uninterrupted time for ancient lineages of plants and animals to adapt to the changing environment.

One of the strong ecological themes of Western Australia (and other parts of the Australian Outback) is the astonishing ways in which life has adapted to scarcity and to boom-and-bust conditions – plants that mine infertile soils for scarce nutrients and thrive with fire; birds that travel thousands of kilometres to breed in inland lakes that flood once in a decade; frogs, lizards and mammals that endure heat and long droughts by aestivating, slowing their metabolism, burrowing or obtaining all the moisture they need from food; and crustaceans and beetles that live, very slowly, in lightless caves and calcretes – and how adapting to tough conditions has led to extraordinary diversity and levels of endemism (Woinarski et al., 2014b).

For the richness and uniqueness of its species and ecological communities, Western Australia bears major conservation responsibilities. These have escalated as species and communities have declined due to rapid changes brought about by land clearing, invasive species and altered fire regimes. The state government has listed 428 plants and 249 animals as threatened species and an additional 3197 plants and 213 animals as priority species (Smith and Jones, 2018, DBCA, 2018). Sixty-nine ecological communities are listed as threatened and 391 are listed as priorities (DBCA, 2016, DBCA, 2017a). Ensuring that these species and ecological communities have a future is one reason for Western Australia to give high priority to creating an optimal reserve system.

Some of Western Australia's special places and species

WORLD HERITAGE TREASURES

Three Western Australian sites have been designated world heritage areas for their 'outstanding universal values' – the Ningaloo Coast for its diverse marine life, unique cave fauna and spectacular beauty; Shark Bay for its stromatolites, diverse seagrass beds, rich marine life, refugia for threatened species, unique plant life and natural beauty; and Purnululu National Park for its spectacular geology (UNESCO, 2018). A nomination is being prepared for the Burrup Peninsula (DPaW, 2017c), and other sites are also likely to be worthy of world heritage status.

Western Australia hosts one of the world's largest remaining populations of dugongs (*Dugong dugon*), listed globally as vulnerable. They can be found in Ningaloo Marine Park. Photo: Geoff Taylor

Endemic to Australia, banded stilts (*Cladorhynchus leucocephalus*) sometimes form vast flocks numbering hundreds of thousands on Western Australia's lakes and wetlands. Photo: Keith Wilcox

GLOBALLY AND NATIONALLY SIGNIFICANT WETLANDS

Despite, and because of, the aridity of much of Western Australia, the state has dozens of wetlands formally recognised for their international or national significance. The 12 Ramsar wetlands (those of international importance) include Eighty Mile Beach, which regularly supports more than half a million birds, and Roebuck bay, one of the world's most important migration stopover areas for shorebirds (DBCA, nd-b). The state has more than 120 wetlands and wetland systems (covering more than 2.5 million hectares) designated as nationally important.

PLANTS APLENTY

Western Australia is botanically exceptional, with very high levels of diversity and endemism. Close to 11,500 species (vascular plants) are known, about two-thirds of which are unique to Western Australia. Based on recent rates of discovery the total flora is likely to consist of some 14,000 species, about two-thirds of Australia's estimated total (Beard et al., 2000, Chapman, 2009a, Chapman, 2009b). The renowned South West has more than 7000 species, some 80% of which are found nowhere else (Lambers and Bradshaw, 2016).

Being rooted to one spot – unable to move to food or away from predators or fire – 'makes the plant lifestyle uniquely challenging' (Pate, 2016). Life is extra difficult where soils are infertile and water is scarce. But, perversely, Western Australia's floral riches are probably due in large part to just how tough it is for plants. The long-term stability of Western Australia's landscapes has impoverished the soils, fostered competition for scarce resources, and provided eons for the evolution of multiple solutions to tough conditions, giving rise to habitat specialists and endemic species (Beard et al., 2000, Pate, 2016). The innovations evident in the South West, for example, include different types of roots to 'cope with hot soils, seasonal drying, winter waterlogging, extended droughts and extreme infertility' (Pate, 2016). The variety and severity of impediments foster diversity by making it difficult for any one species to dominate.

About 400 species of orchids occur in south-west Western Australia. These 4 species (clockwise from left) – zebra orchid (*Caladenia cairnsiana*), purple pansy orchid (*Diuris longifolia*), rattle beaks (*Lyperanthus serratus*) and western whispy spider orchid (*Caladenia microchila*) – are found nowhere else. Photo: Keith Wilcox

Some of Western Australia's special places and species

A SONGFUL STATE

Almost 550 species of birds have been recorded in Western Australia, 387 of which breed in the state (Birdlife Australia, nd). Seventeen species (and several subspecies) are unique to Western Australia, including the endangered Carnaby's black-cockatoo, Baudin's cockatoo, noisy scrub-bird and western ground-parrot. One reason for the rich birdlife is the partnership forged over tens of millions of years in Australia between birds and flowering plants such as eucalypts and banksias – nectar in exchange for pollination services. Australia offers far more nectar to birds than any other continent (Low, 2014). Western Australia is important in other avian ways – its wetlands and tidal flats, for example, sustain hundreds of thousands of migratory shorebirds that leave from and arrive in the northwest for their annual round trip of more than 20,000 kilometres to the northern hemisphere summer for breeding (DoE, 2015a).

Carnaby's black cockatoo (*Calyptorhynchus latirostris*), listed nationally as endangered, is unique to south-west Western Australia. Photo: Georgina Steytler

Spiny-tailed geckos (*Strophurus spinigerus*), unique to Western Australia, are like other geckoes in lacking eyelids, so need to lick their eyes to keep them moist. Photo: Ken Lawson

LAND OF LIZARDS

Lizard species richness is probably higher in arid Australia than anywhere else in the world (Pianka, 1981). Of the 720 or so species described in Australia (by 2012), more than half occur in Western Australia and more than a quarter are unique to the state (Wilson and Swan, 2013). There are probably dozens yet to describe. Major centres of lizard diversity run from central Australia to the Pilbara and north to the Kimberley (Powney et al., 2010). The Pilbara is particularly rich in geckoes, skinks and dragons, and more than half its rock-dwelling skinks and geckoes are found only there or also in the West Murchison sub-bioregion (Doughty et al., 2011).

The success of reptiles in the Outback – which has largely come about over the last 10 million years with its transformation from forests to deserts – probably has much to do with infertile soils and fire regimes that create a range of habitats, each suited for particular subsets of species (Pianka and Goodyear, 2012). The prickly fortress of spinifex, which thrives in arid areas, is ideal habitat for reptiles.

One of the unique features of Western Australia's faunal emblem, the numbat (*Myrmecobius fasciatus*), is that it feeds almost entirely on termites. Photo: James Evans

MEMORABLE FOR MAMMALS

Australia has an extraordinary and distinctive mammal fauna of ancient lineages. Even by Australian standards, Western Australia has some unusual mammals. The exclusively termite-eating, strictly diurnal, pouchless numbat is the sole member of its family (the Myrmecobiidae) (DPaW, 2017e). The honey-possum – the world's only non-flying exclusively nectar-and-pollen-eating mammal – is also the sole member of its family (Tarsipedidae) with its closest relative in South America (Bradshaw, 2014). This tiny mammal can daily eat its own weight in nectar and pollen and features the largest spermatozoa of any mammal. And the kakarratul and itjaritjari (marsupial moles) – mysterious, blind, dune-tunnelling marsupials that rarely emerge – comprise their very own order (Notoryctemorphia), which may have branched off from other lineages more than 60 million years ago (Benshemesh, 2004, Woinarski et al., 2014a).

Mammal diversity is highest in the north Kimberley, the Pilbara and the South West (How and Cowan, 2006). Although Western Australia, like the rest of Australia, has lost a large number of mammal species, it is also a sanctuary for many surviving species. In particular, Western Australia's islands are refuges from foxes and cats for species such as the boodie, mala, djoongari and greater stick-nest rat (Woinarski et al., 2014a).

RICH IN FISHES

Western Australia has more than 120 described freshwater fish species, with more yet to be found (Morgan et al., 2014). Some of Western Australia's rivers are so poorly known it is still possible to discover fishes new to science. A team of biologists recently discovered 20 new species in Kimberley rivers, all endemic (Shelley, 2016). This added to the 18 endemic species already known from there, making the Kimberley Australia's major centre for fish endemism. The South West also hosts endemic fish – 11 of 14 species known from there, with more to be described – which have ancient lineages unique to the region or are related to fishes in eastern Australia, which became isolated due to aridity and the formation of the Nullarbor Plain (Morgan et al., 2014). One unusual fish in the South West, the salamanderfish, is the only member of its family (Lepidogalaxiidae), a lineage estimated to be about 230 million years old (Morgan et al., 2014). When pools dry out, this fish burrows into the damp bottom sand and aestivates, breathing through its skin and sustained by fat reserves. Three highly unusual fishes occur in the Pilbara – two species of gudgeon and an eel, blind and colourless, living in subterranean waters on Cape Range Peninsula and Barrow Island (Larson et al., 2013, Morgan et al., 2014).

The Kimberley archerfish (*Toxotes kimberleyensis*), unique to the west Kimberley, gains its name from its skillful hunting method of spitting at insects to knock them into the water. Photo: Gunther Schmida

Typical of the Mid West are landscapes like this dominated by mulga. Photo: Simon Nevill

GLOBAL AND NATIONAL BIODIVERSITY HOTSPOTS

Some designations recognise both the exceptional values of Western Australia and the high level of threats. The South West, renowned for wildflowers, is one of just 35 global biodiversity hotspots – places where 'exceptional concentrations of endemic species are undergoing exceptional loss of habitat' (Myers et al., 2000, Conservation International, 2018).

The species unique to the South West include more than 5000 plants and 100 vertebrate animals (Myers et al., 2000, Lambers and Bradshaw, 2016).

In addition, of 15 national biodiversity hotspots, 8 are in Western Australia: Fitzgerald River, Busselton Augusta, Central and Eastern Avon Wheatbelt, Mount Lesueur-Eneabba, Geraldton to Shark Bay sand plains, Carnarvon Basin, Hammersley–Pilbara and North Kimberley (TSSC, 2003).

WONDERS DOWN UNDER

Some of the most surprising animals of Western Australia exist in the perpetual subterranean darkness of aquifers. The recent discoveries of thousands of highly specialised, highly endemic and often ancient invertebrates living in Western Australian calcretes is one of the great unfolding stories of ecology (Halse et al., 2014, Cooper et al., 2002). Western Australia has an exceptionally diverse and endemic array of stygofauna (groundwater animals), perhaps the highest in the world. The Pilbara has one of the highest densities of stygofauna species globally (Eberhard et al., 2005, Halse et al., 2014).

Most stygofauna are crustaceans; others are beetles, worms, snails, water mites and flatworms. Western Australia's tectonic stability has allowed survival of ancient faunal groups – some with Pangaean origins, others Gondwanan. Many species are restricted to a single calcrete or calcrete group (Halse et al., 2014).

Despite the lack of light, limited sources of energy and often low oxygen, groundwater is a very stable habitat – unlike surface waters, particularly in arid areas. Stygofauna are typically colourless and eyeless but have highly developed chemical and touch receptors. With no light for photosynthesis, bacteria and fungi are at the base of the food web. With energy very limited, stygofauna typically have a slower metabolism, lower reproductive rate and longer lifespan than similar animals on the surface (Serov, 2014).

This eyeless, colourless crustacean, *Mangkurtu kutjarra,* occurs in a groundwater calcrete aquifer in the Pilbara, a global hotspot for stygofauna. Photo: Jane McRae, Bennelongia Environmental

1.5 The proposed new parks

> *In an age of diminishing nature, there are few large places left in the world that are still as environmentally intact as the Outback, that offer such a sense of space and allow us to reflect on our fit to the natural world.*
>
> Woinarski et al. (2014b)

The 63 properties whose values we assess in this report were bought (in part or whole) by the state government, with contributions by the federal government, for the purpose of improving Western Australia's reserve system. They cover about 5 million hectares mainly in the Gascoyne, Murchison, Pilbara, Carnarvon and Yalgoo bioregions.

All properties were selected by the government for their high conservation values. They include exceptional places, some of global importance. From bilbies to underground crustaceans to plants known only from a single location, they will help species on the edge of survival and those found nowhere else. They will greatly improve Western Australia's reserve system by including ecosystems with little or no existing protection, in bioregions with few other reserves, and by linking and buffering existing reserves to help them survive future stresses.

All 63 properties were once leasehold properties used for livestock grazing. They were acquired in the following ways:

- purchase through the Gascoyne-Murchison Strategy (43 properties)
- exclusion from the pastoral lease estate through the 2015 state-wide lease renewal process (13 properties)
- opportunistic acquirement through negotiation or surrender (7 properties).

About two-thirds of the properties were bought as part of the Gascoyne-Murchison Strategy, the first in 1998. This strategy was initiated in response to problems besetting the wool industry, due to the lack of financial viability and environmental sustainability of many pastoral properties (Taskforce, 1993). Surveys of rangeland condition since the 1960s have found that less than half the pastoral area is in good condition; in the Murchison and some other regions only about 20% is in good condition (DPaW, 2013). To improve sustainability, one of the major commitments of the Gascoyne-Murchison Strategy was establishment of a conservation reserve system in the region. At the time only 7% of the plant communities there had at least 10% of their extent in reserves (Brandis, 2008).

The magnificent granite rocks on ex Woolgorong, a property acquired by the state in 2005 and intended as a conservation reserve. Photo: Glenn Campbell

Currently, the properties are in a tenure limbo, classified as unallocated Crown land. This tenure provides much weaker legal protections for their natural and cultural values than would apply if they had been transferred, as intended, into the conservation reserve system. For example, there are fewer requirements for assessing the environmental impacts of new projects. As the Department of Parks and Wildlife explained to a parliamentary inquiry into pastoral leases in 2013, under current government policy, there are 'no constraints to exploration and mining activity' on these properties (DPaW, 2013). Even though the Department of Biodiversity, Conservation and Attractions is responsible for managing the properties, there is no requirement to seek their advice on management conditions for exploration on the properties. As a result, some 'poorly managed exploration programs' have caused 'considerable environmental damage' (DPaW, 2013). The tenure limbo also limits the resources and legislative tools available for managing these properties and for realising the full range of potential environmental, cultural, recreational and tourism benefits.

Because the properties were purchased for conservation, with the federal government contributing 50% or more of the funding for most purchases, the former Department of Parks and Wildlife said it was 'inappropriate' for the properties to be retained as unallocated Crown land, without secure tenure and the ability to apply conservation laws (DPaW, 2013). The agreements with the federal government required the co-funded properties to be reserved in a timely manner.

For many properties, Aboriginal custodianship has been recognised by a native title determination; for others, claims for native title rights have yet to be determined. Decisions about the future of most of these properties will need the consent of native title parties. The current laws and policies of the state government enable joint management and joint vesting of the future national parks and reserves. Precedents also exist for 'lease-back' arrangements whereby freehold tenure is granted over recognised Aboriginal land, in exchange for that land being leased back to government for conservation purposes.

Although our focus in this report is primarily natural values, the properties also have high cultural values as Indigenous homelands and from their more recent pastoral histories. They will also greatly expand recreation and tourism options, particularly in regions with few other parks.

Old cattle yards on ex Doolgunna are a reminder of its pastoral past. Photo: David Blood (DEC)

Towering cliffs on ex Carrarang are the most westerly point on the Australian mainland. Photo: Glenn Campbell

1.6 About this report

Permanent rock pools, like this one known as Fish Holes on ex Doolgunna, are important refuges in the arid eastern Gascoyne region.
Photo: David Blood (DEC)

The Centre for Conservation Geography was commissioned by The Pew Charitable Trusts to assess the natural and conservation values of the 63 former pastoral properties acquired by the Western Australian government and to recommend how these values could best be protected as reserves.

In chapter 2 we explain the approach and methods applied for the subsequent 8 chapters. The 63 properties have been grouped into 24 proposed new parks or extensions to existing parks, and chapters 3 to 9 each focus on 1 geographical cluster of proposed parks.

The main values of focus include threatened and priority species and ecological communities, world heritage listings, important wetlands and other aquatic features, key biodiversity areas, important biological areas, plant communities and ecosystems lacking protection in the reserve system and buffering of and connectivity with other reserves and high-value features. We also assess the extent to which the proposed parks will enable Western Australia to meet an international benchmark and national target for reserves and therefore help the state move towards its overall goal of establishing 'a system of comprehensive, adequate and representative conservation reserves'.

Besides the natural values, there are other considerations for the government in deciding the future of these properties. These include the native title status and Indigenous heritage values of each property, which are mostly very high. We only briefly cover these values, for they require specific expertise. Considerations also include mining rights where leases or licences have been granted. We document the current extent of mining activities and provide some recommendations about how they can be addressed.

2 Methods and approach

One hope for the future is that endangered species such as this black-flanked rock-wallaby (*Petrogale lateralis lateralis*) can be reintroduced to conservation reserves such as Kennedy Range National Park, where they were lost to foxes. The species was once widespread in Western Australia south of the Kimberley. There is a slim possibility they survive on properties in the Mid West proposed as conservation reserves. Photo: Sarah Matheson

2.1 Assessment approach

In this report we assess the natural values of 63 former leasehold properties bought by the Western Australian government for conservation but still awaiting gazettal as part of the state's conservation reserve system. For each property, we recommend a tenure and classification appropriate for the ongoing protection of those values, and assess the extent to which reserving these properties will enable Western Australia to make progress on meeting its national and international targets for reserves.

The properties also have cultural values that should be considered in decisions about their future but are not part of the scope of this report. These values, which include Aboriginal and pastoral heritage, are extensive and complex and deserve their own dedicated study. We do, however, provide information about the registered Aboriginal heritage sites on each property, but do not draw any conclusions about their relative importance. These registered sites represent only a part of the properties' cultural values, which can only be fully appreciated through specialist cultural assessments and consultation with the Traditional Owners. Similarly, we provide information about the native title holders and claimants, but have not consulted Traditional Owners about their aspirations for these properties. That is being done by others.

We also consider the geology and mineral prospectivity of each property and mining activity. Although the 63 properties were bought for conservation, some had existing mining activity and other interests have developed during the delay in transferring the properties into the reserve system. We make recommendations for the management of existing and proposed mining activities.

Each of the following 7 chapters (chapters 3 to 9) is structured as follows:

- Natural values for conservation (see section 2.3.1 for methods)
- Importance for achieving Western Australia's conservation reserve goals (see section 2.3.2 for methods)
- Native title and Aboriginal heritage sites (see section 2.3.3 for methods)
- Geology, mineral prospectivity and mining (see section 2.3.4 for methods)
- Recommendations on reserve tenure, reserve classification and mining considerations (see section 2.3.5 for the criteria applied)

In the final chapter (chapter 10) we summarise the combined values of the 24 proposed new or expanded parks, including the most significant natural values of the proposed parks and their combined importance for enabling Western Australia to meet its conservation reserve targets.

2.2 Proposed park clusters and names

We group the properties initially into 7 broad geographical clusters, each of which forms the basis of a chapter. We then further group the properties based on their location and values into 24 proposed new parks or additions to existing parks (Table 2-1).

We refer to each of the former leasehold properties by the former station name with the prefix 'ex'. In some cases, only part of the property was acquired by the Western Australian government, so the 'ex' distinguishes that part of it from the remaining active pastoral property. For example, 'ex Karratha' is the proposed reserve while 'Karratha Station' is an active pastoral lease.

We do not name the proposed new parks, but use their former station names in quote marks – for example, 'Barnong' National Park – to refer to them. For proposed parks consisting of 2 properties we use both names. For those consisting of 3 or more properties, we use the names of the properties at each end of the proposed park. For properties proposed for incorporation into an existing reserve, we use the name of that reserve – for example, 'Kennedy Range National Park expansion'.

The property boundaries data used in this report were sourced from the Department of Biodiversity, Conservation and Attractions (then known as the Department of Parks and Wildlife) in February 2015 and refined since then through personal communication with departmental staff. The boundaries are 99.8% identical to those of more recently published, publicly available data (DBCA, 2017f). Our study includes the properties of the Pilbara, Gascoyne and Mid West Development Regions (DBCA, 2017d), with the exclusion of 2 properties (ex Lorna Glen and ex Earaheedy) that are protected by the Matuwa Kurrara Kurrara Indigenous Protected Area.

Table 2-1: Proposed parks and park clusters

Chapter	Cluster	Label for proposed park	Properties making up the proposed park
3	Shark Bay World Heritage to to Wooleen	'Carrarang' (Edel Land)	ex Carrarang
		'Yaringa – Nanga'	ex Yaringa, ex Nanga (north)
		Zuytdorp Nature Reserve (expansion)	ex Tamala, ex Murchison House (north), ex Nerren Nerren, ex Nanga (south)
		Kalbarri National Park (expansion)	ex Murchison House (south)
		'Muggon – Wooleen'	ex Muggon, ex Wooleen
4	Ningaloo to Exmouth Gulf	'Giralia'	ex Giralia
		'Boologooro'	ex Boologooro
5	Kennedy Range Country	Kennedy Range National Park (expansion)	ex Bidgemia, ex Doorawarrah, ex Jimba Jimba, ex Lyons River, ex Mardathuna, ex Middalya, ex Minnie Creek, ex Mooka, ex Williambury
		'Pimbee'	ex Pimbee
6	Murchison Salt Lake Circuit	'Bulga Downs – Cashmere Downs'	ex Bulga Downs, ex Cashmere Downs
		'Black Range – Kaluwiri'	ex Lake Mason, ex Black Range, ex Kaluwiri
7	Pilbara Biodiversity Hotspot	Karijini National Park (expansion)	ex Hamersley, ex Rocklea, ex Mt Florence, ex Juna Downs, ex Marillana, ex Mulga Downs, ex Hillside, ex Roy Hill
		Millstream Chichester National Park (expansion)	ex Pyramid
		Cane River Conservation Park (expansion)	ex Minnie, ex Nanutarra
		'Meentheena'	ex Meentheena
		'Karratha – Mardie'	ex Karratha, ex Mardie
8	Tallering Botanical Trail	'Barnong'	ex Barnong
		'Kadji Kadji – Burnerbinmah'	ex Burnerbinmah, ex Thundelarra, ex Kadji Kadji, ex Karara, ex Lochada, ex Warriedar
		'Woolgorong'	ex Woolgorong
9	Mid West Mulga Country	'Twin Peaks – Yuin'	ex Twin Peaks, ex Narloo, ex Yuin
		'Noongal – Lakeside'	ex Dalgaranga, ex Noongal, ex Lakeside
		'Mooloogool – Doolgunna'	ex Mooloogool, ex Doolgunna
		Mount Augustus National Park (expansion)	ex Cobra, ex Waldburg, ex Mt Phillip, ex Dalgety Downs
		'Wanna'	ex Wanna

2.3 Methods

2.3.1 Natural values for conservation

In section 2 of each of the following 7 chapters, we review the natural values of each proposed park (see Technical notes 1). Also considered are buffering values – where the properties add value by buffering high-value features such as important wetlands. The level of information available about each property varies considerably. Some properties have not been comprehensively surveyed and not all information has been published, so the value assessments should be regarded as incomplete – particularly for the more eastern properties such as those in the Murchison Salt Lake Circuit and the Mid West Mulga Country clusters.

We list the species and ecological communities recorded on each property that warrant protection in the reserve system due to them having been assessed by the Western Australian government as threatened or at risk. Due to a lack of comprehensive surveys, the status of many species and communities in Western Australia is uncertain. These have been classified by the government as 'priorities' with 3 categories (1 to 3) representing different levels of risk and a fourth category for species that are rare, near threatened or need monitoring. For example, 'priority 1' species are poorly known from one or a few locations which are potentially at risk, with all occurrences very small or on lands not managed for conservation. See Table 2-2 for an explanation of the conservation classes assigned by the government to distinguish different levels of threat or risk to species and ecological communities and their priority for further surveys.

Technical notes 1

Threatened and priority species and ecological communities: These include all categories listed in Table 2-2. Records were obtained from the Species and Communities Branch of the Western Australian Department of Biodiversity, Conservation and Attractions. A 2-kilometre search buffer was applied to pick up species and communities recorded just outside the property boundaries. In some cases, they are likely to also be present (but not recorded) in the proposed park, and species in the vicinity are likely to also benefit from management of the proposed park. Fauna species records date from 1896 to 2017. Historical records were retained if the species is suspected to still occur in the general region. The current status of some of these species on a specific proposed park is uncertain. The ecological communities have a buffer applied by the Department of Biodiversity, Conservation and Attractions to ensure that the boundary is sufficient to pick up any developments with potential to impact groundwater or surface water and consequently the community. The buffers range from 100 to 3500 metres; most are 500 metres. Data sources: plants (DBCA, 2017e), animals (DBCA, 2017d), ecological communities (DBCA, 2017b).

World heritage areas: Australian Government Department of the Environment (DoE, 2015b)

Watercourses and catchments: Australian Hydrological Geospatial Fabric, Bureau of Meteorology (BOM, 2014)

Key biodiversity areas: Birdlife Australia (Birdlife, 2015)

Important wetlands: Directory of Important Wetlands, Australian Government (DIWA, 2014)

Land systems: Department of Primary Industries and Regional Development (DPIRD, 2017c)

Geological heritage (including stromatolites): State register of Geoheritage sites, Department of Mines, Industry Regulation and Safety (DMIRS, 2017)

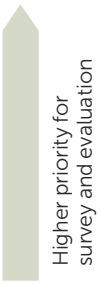
Pristine estuaries: OzEstuaries, Geoscience Australia (Dyall et al., 2004)

Biologically important areas: National Conservation Values Atlas, Australian Government (DEE, 2008b)

Important coastal margin: Australian Register of the National Estate (DEE, 2008a)

Table 2-2: Conservation classes for Western Australian flora, fauna and ecological communities

Conservation class	Description
Threatened	Threatened species are specially protected under the Wildlife Conservation Act 1950 and ranked according to their level of threat using the categories of the ICUN Red List: • **Critically endangered** – considered to be facing an extremely high risk of extinction in the wild. • **Endangered** – considered to be facing a very high risk of extinction in the wild. • **Vulnerable** – considered to be facing a high risk of extinction in the wild. • **Extinct** – there is no reasonable doubt that the last individual has died.
Conservation dependent	Fauna dependent on ongoing conservation intervention to prevent them becoming threatened
International agreement	Migratory birds protected under international agreements such as those with Japan (JAMBA), China (CAMBA) & the Republic of Korea (ROKAMBA)
Specially protected	Other specially protected species, including fauna declared to need special protection actions.
Priority species & ecological communities – may be threatened or near threatened but are data deficient or require monitoring	
Priority 1	Poorly known from 1 or a few locations (for communities generally ≤5 occurrences or a total area of ≤100ha) which are potentially at risk. Mostly outside protected areas.
Priority 2	Poorly known from 1 or a few locations (for communities generally ≤10 occurrences or a total area of ≤200ha) some of which are in protected areas.
Priority 3	Poorly known from several locations or a few widespread occurrences and doesn't appear to be under imminent threat. Or large widespread occurrences that are under threat across much of their range.
Priority 4	Adequately known but rare, near threatened or recently removed from the threatened list. Require regular monitoring.



2.3.2 Importance for achieving Western Australia's conservation reserve goals

In section 3 of each of the following 7 chapters, we analyse the extent to which the proposed parks would enable Western Australia to make progress on national and international targets for conservation reserves (as explained in Box 1.2), and therefore help Western Australia meet its overall goal for the parks network:

> *To establish and effectively manage a system of comprehensive, adequate and representative conservation reserves in Western Australia to contribute to long-term conservation of biodiversity and the culture and heritage of Aboriginal people.*
>
> Department of Parks and Wildlife (2017b)

Our scope is limited to the 'conservation of biodiversity' (subspecies and species, plant communities and ecological communities) and the extent to which the proposed parks would increase the proportion of bioregions, sub-bioregions and sub-bioregional ecosystems protected in Western Australia's conservation reserve system. This system consists mainly of national parks, nature reserves and conservation parks, which are 'created under legislation and generally require parliamentary approval to change them' (DBCA, 2014). The properties assessed in this report encompass parts of 7 of Western Australia's 27 bioregions, 14 of 55 sub-bioregions and 216 sub-bioregional ecosystems.

Although the Western Australian government is yet to clearly specify what is needed to achieve the state's goal of a 'comprehensive, adequate and representative' reserve system, there are national and international commitments that provide some guidance. We assess the extent to which the proposed parks will help Western Australia meet an international 2020 benchmark of 17% for protection of bioregions and sub-bioregions and a national minimum target of 15% for protection of ecosystems (Figure 2-1). As explained in Box 1-2, the 17% benchmark is based on a target in the *Strategic Plan for Biodiversity 2011–2020* under the Convention on Biological Diversity. The 15% target comes from a long-held national target to protect at least 15% of the pre-1750 distribution of each ecosystem in reserves (and more for small ecosystems) (JANIS, 1997).

Figure 2-1: Bioregions, sub-bioregions and the proposed parks

Technical notes 2

Conservation reserve system: Parks making up the 'conservation reserve system' are those that have moderate to high tenure security and are required to be managed primarily to maintain their natural values, as specified for IUCN reserve categories I to IV (Possingham et al., 2006, CCG, 2017). The primary tenures in Western Australia are national parks and conservation parks (managed primarily for ecosystem protection and recreation) and nature reserves (managed primarily for ecosystem protection and science).

Bioregions and sub-bioregions: These are designated in the Interim Biogeographic Regionalisation for Australia version 7 (DEE, nd-a), which are used as the planning framework nationally for assessing gaps in the reserve system and identifying priority regions for new reserves.

Plant communities: These are defined as the existing distribution of the vegetation associations in the pre-European vegetation data (DPIRD, 2017b). This data has been derived from 1:250,000 scale maps resulting in 819 vegetation associations state-wide (Shepherd et al., 2002). Cleared areas were removed by only using remnant vegetation (DPIRD, 2017a), as defined by the extant/remnant vegetation data with query "comments" = 'REMNANT VEGETATION'.

Sub-bioregional ecosystems: These are defined as each unique combination of sub-bioregion and plant community.

Level of protection: We describe plant communities and sub-bioregional ecosystems as 'unprotected' or 'poorly protected' if <0.1% or 0.1–5%, respectively, of their remaining extent is in the conservation reserve system. Two thresholds were applied as minimum targets for protection in the conservation reserve system: 17% for bioregions and sub-bioregions and 15% for plant communities and sub-bioregional ecosystems. For plant communities and sub-bioregional ecosystems, their remant extent was calculated as a percentage of their pre-European extent. Box 1-2 discusses these levels of protection, targets and their potential inadequacy.

Main data sources: Pre-European vegetation (DPIRD, 2017b), remnant vegetation (DPIRD, 2017a), bioregions and sub-bioregions (DEE, nd-a), reserves (CCG, 2017)

2.3.3 Native title and Aboriginal heritage sites

In section 4 of each of the following seven chapters, we provide information from publicly available datasets about the native title status of each property and registered Aboriginal heritage sites (see Technical notes 3 for data sources). Although we discuss natural values and Aboriginal heritage values separately in this report, we acknowledge the inextricable link between them and that the knowledge of Traditional Owners will be vital for maintaining both natural and cultural values. The Aboriginal heritage sites do not comprehensively represent Indigenous heritage values, for there are likely to be many sites of cultural significance that are not publicly recorded or registered.

Because this report is focused primarily on natural values, and because consulting with Traditional Owners is a significant undertaking requiring a dedicated project, the recommendations on park tenure and classification do not take account of cultural values. Such research would provide additional reasons for reserving the properties and for undertaking consultation with Traditional Owners about the future management of properties.

Technical notes 3

Aboriginal heritage sites: We note whether the proposed parks provide full or partial protection for registered Aboriginal heritage sites, with 'partial' meaning 1% to 95% protection and 'full' meaning more than 95% protection. We also note the number of lodged Aboriginal heritage sites, which are applications that have been submitted but not yet registered.

Native title: Three datasets published by the National Native Title Tribunal are used to show native title determinations, outcomes and claims (NNTT, 2018). Claimants are listed together where there are overlapping native title claims by the 1) Mullewa Wadjari Community, 2) Wajarri Yamatji and 3) Widi Mob.

Data sources: Aboriginal heritage (DAA, 2018), native title (NNTT, 2018)

2.3.4 Geology, mineral prospectivity and mining

In section 5 of each of the following 7 chapters, we provide for each property information about the geology, mineral prospectivity and the mining either approved or under application (see Technical notes 4 for data sources).

We calculate the area in each proposed park under granted production and production applications, and granted exploration and exploration applications – for minerals and petroleum (which we refer to as 'oil & gas'). The various lease, licence and permit types, and their classification for our calculations, are shown in the notes below.

Technical notes 4

Spatial overlaps: To deal with spatial overlaps between mining tenements and titles, we give preference in our area calculations to production over exploration then granted over applications.

Tenement and title classification: We classify the variety of leases, licences and permits relevant to this report as either 'exploration' or 'production' in the following ways.

Exploration tenements & titles	Production tenements
Exploration licence	Mining lease
Mineral claim	Mining lease S.A.
Prospecting licence	General purpose lease
Retention licence	Miscellaneous licence
Temporary reserve	Miscellaneous licence S.A.
Petroleum exploration permit*	

*All other lease types are for mineral mining or exploration

For the purposes of this report, these tenements and titles constitute 'mining-related activity'. 'Existing' activity refers to granted tenements and titles and 'proposed' activity refers to applications. To identify areas 'free of existing mining-related activity' areas with only applications for exploration were summed with areas with no overlying tenements or titles. This was done assuming that all production applications would previously have had granted exploration.

Main data sources: Mining tenements, petroleum titles and petroleum title applications were obtained from the Western Australian Department of Mines, Regulation and Safety and Petroleum (DMIRS, 2018b). The Minedex database was used to indicate mines, target commodities, mineral fields and major resource projects (DMIRS, 2018a). Areas where mining is prohibited under section 19 of the Western Australian Mining Act were also viewed (DMIRS, 2018c). Expert advice on the geology and mineral prospectivity of the proposed parks was provided by Susan Belford (Belford, 2017).

2.3.5 Recommendations on reserve tenure, reserve classification and mining interests

All properties considered in this report were acquired by the Western Australian government for inclusion in the state's conservation reserve system. They were each assessed by highly experienced environmental officers for their conservation values, and then set aside (as unallocated Crown land) awaiting gazettal as conservation reserves. There is little question that these 63 properties warrant being added to Western Australia's network of parks and managed for conservation. Instead, when considering the values outlined in this report, the primary questions for each property are:

(1) Should it be a standalone park or combined with other properties or existing parks?

(2) What reserve tenure should it be, and how should that tenure be classified?

(3) How should mining issues be addressed?

The 'recommendations' section in each of the following chapters addresses the above questions. Our basis for recommendations is the natural values of the properties as a whole. The final tenure applied to each property will depend on the decision-making authorities' assessment of their natural values as well as cultural, social and economic considerations. Finer-scale research and analysis within properties may be required to weigh up and balance these various considerations.

Proposed park boundaries

In most cases, the arrangement of these properties into reserves that are most effective for conservation management is obvious. Their location in the landscape and in relation to other reserves would have been important considerations for the government when acquiring the properties. The main factors we consider in proposing park boundaries are:

- park size and shape
- ecological connectivity
- buffering of high-value sites
- efficiency of management
- congruence with native title areas.

In a few cases we recommend incorporating additional public land (unallocated Crown land or timber reserves) into a proposed park to improve its integrity, create a corridor between properties or take advantage of an outstanding conservation opportunity. Where possible, we have drawn upon research regarding these areas, but a thorough assessment of their natural values lies beyond the scope of this report. Further investigation of the values of these areas is warranted.

Reserve tenure

For each proposed park we recommend one of 3 reserve categories provided for under Western Australia's *Conservation and Land Management Act 1984*: national park, nature reserve or conservation park. These tenures are managed by the state government and have sufficient security to constitute what is known as the 'formal reserve system'. They are created under legislation and generally require parliamentary approval to be changed (DBCA, 2014).

There are two main factors considered by the government in a tenure decision: (a) the management objectives for the reserve and (b) the biological, scenic and cultural values of the property. The management objectives are based on protected area categories developed by the International Union for the Conservation of Nature (IUCN) (Dudley, 2008). Two of 6 categories are applicable to the properties assessed in this report:

- IUCN II reserves, which are managed mainly for ecosystem protection and recreation, and are classified by the Western Australian government as either national parks or conservation parks
- IUCN IA reserves, which are managed mainly for ecosystem protection and science, and classified by the Western Australian government as nature reserves.

National parks and conservation parks are distinguished by the significance of their values: those of national parks are considered of international or national significance and those of conservation parks are considered of regional or local significance. The main characteristics of the 3 tenure options are outlined in Table 2-3. In this report, we consider only biological values for the tenure recommendation, not scenic or cultural values.

Table 2-3: Western Australia's reserve categories, purposes and classes

Reserve Category	Typical IUCN Management Category	Typical Classification	Management Objectives	Values
National Park	II	Mostly class A	Established for wildlife and landscape conservation, scientific study, preservation of features of archaeological, historic or scientific interest. Can also be used for enjoyment by the public.	Nationally or internationally significant scenic, natural or cultural values.
Nature Reserve	IA	Class A or unclassified	Established for wildlife and landscape conservation, scientific study and preservation of features of archaeological, historic or scientific interest. Recreation that does not harm natural ecosystems is allowed, but other activities are usually not permitted.	Internationally, nationally or regionally significant natural values.
Conservation Park	II or III	Class A or unclassified	Established for wildlife and landscape conservation, scientific study, preservation of features of archaeological, historic or scientific interest. Can also be used for enjoyment by the public.	Regionally or locally significant conservation and recreational values

Sources: DEC and CCWA (2012), Dudley (2008)

Reserve classification

For each proposed park, we also consider whether it should be classified as Class A or remain unclassified. Class A designation is 'used solely to protect areas of high conservation or high community value' (Department of Regional Development and Lands, n.d.). In this report we do not consider community values (such as cultural, recreational and tourism values). Class A designation provides for greater security because any changes to the purpose or area of a reserve and the approval of any mining leases require the agreement of both houses of parliament. This is also required for approving a mining lease in an unclassified national park.

Class A designation is usually applied by the state government to national parks (because their conservation values are of international or national significance) and can also apply to nature reserves and conservation parks. There are no published criteria for the classification decision, so in this report we recommend that a proposed park be designated Class A if it meets one or both of the following criteria for 'high conservation value':

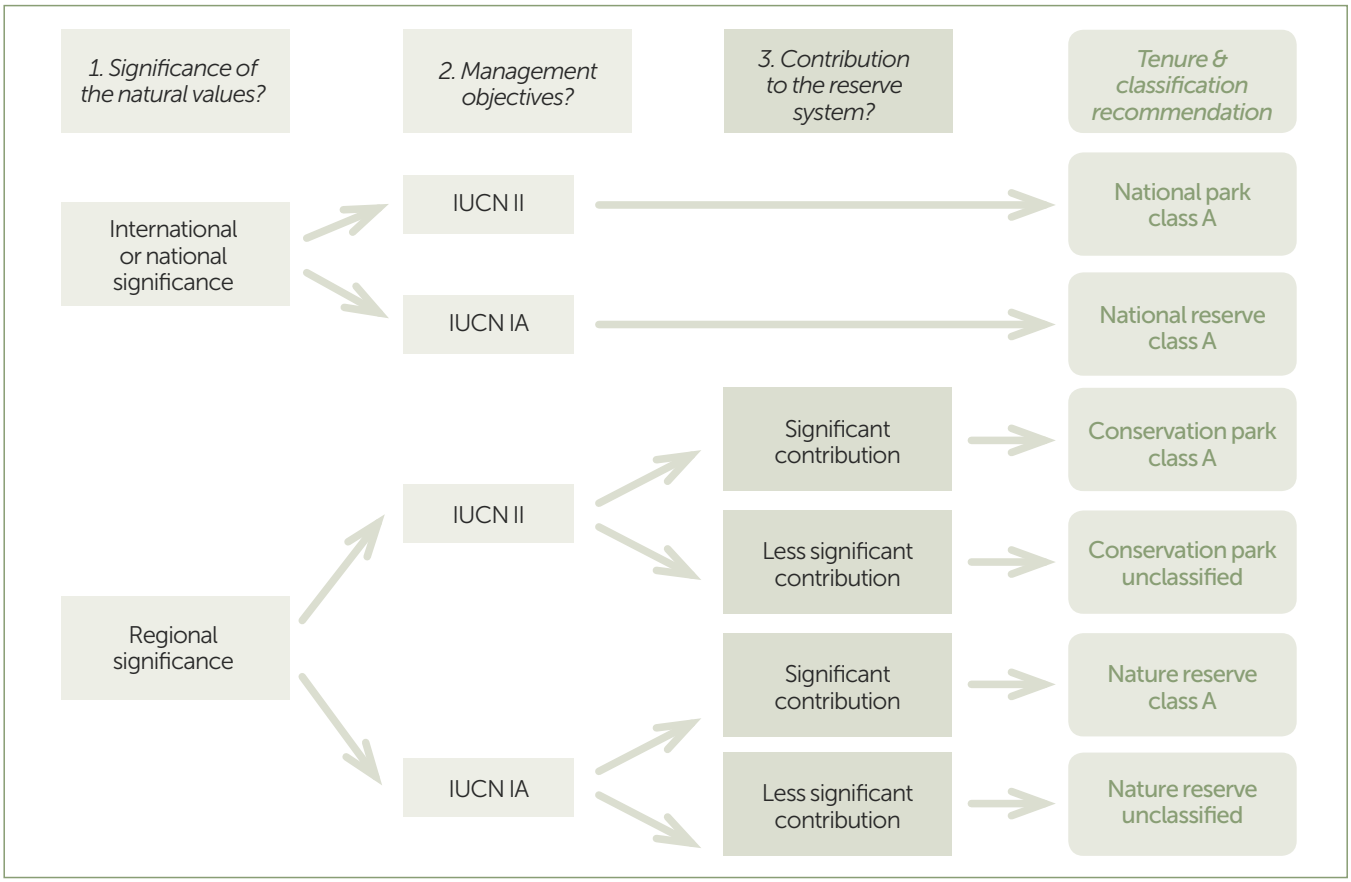
- its natural values are of international or national significance (as defined for the tenure decision)
- it would make a significant bioregional, sub-bioregional or sub-bioregional ecosystem contribution to achieving the state's conservation reserve goals.

These criteria are explained in Box 2-1. Both sets of criteria are for conservation values that are either irreplaceable (for example, habitat for a highly threatened species or an ecosystem found nowhere else) or difficult to replace. Proposed parks that would make a significant bioregional, sub-bioregional or sub-bioregional ecosystem contribution to achieving the state's conservation reserve goals are usually difficult to replace in the reserve system because a low level of existing representation can indicate a lack of properties in suitable condition or existing or potential land uses that limit the availability of new parks. Furthermore, where current levels of protection in the conservation reserve system are low (below the minimum protection target), the highest level of protection should be applied to ensure effective conservaton of at least some of these unique regions and ecosystems.

Approach to reserve tenure and reserve classification recommendations

Figure 2-2 shows the process by which tenure and classification recommendations are made in this report based on expert opinion of 3 considerations: natural values (relevant to both tenure and classification recommendations), management objectives (relevant to the tenure recommendation) and contributions to the reserve system (relevant to the classification recommendation). Each criterion is explained in Box 2-1.

Figure 2-2: Decision flow chart for reserve tenure and reserve classification recommendations



Box 2-1: Criteria for reserve tenure and reserve classification recommendations

1. Natural values

Relevant to tenure and classification recommendations

For the purposes of this report, examples of values of international or national significance include:

- World heritage values (within or adjacent)
- Nationally important wetlands (within or adjacent)
- Important coastal margin on Register of National Estate (within or adjacent)
- Nationallly important for threatened or at-risk biodiversity (species and ecological communities).
- Centres of species richness or endemicity
- Globally or nationally significant geological heritage
- Substantial proportions of key biodiversity areas

For the purposes of this report, examples of values of regional significance include:

- Wetlands of regional significance
- Rivers and creeks and their riparian zones
- Threatened or at-risk species or ecological communities not included above
- Pristine estuaries

2. Management objectives

Relevant to tenure recommendations

These are consistent with protected area categories defined by the World Conservation Union (Dudley, 2008):

- IUCN II: managed mainly for ecosystem protection and recreation
- IUCN IA: managed mainly for ecosystem protection and science

3. Contributions to the state's conservation goals

Relevant to classification recommendations

For the purposes of this report, examples of significant contributions to Western Australia's conservation goals include the following:

- Improved protection for bioregions or sub-bioregions that do not meet the 2020 international benchmark of 17% protection
- Improved protection for sub-bioregional ecosystems that do not meet the national minimum target of 15% for ecosystem protection
- Improved protection for sub-bioregional ecosystems and plant communities with >70% of their remaining extent in the proposed parks

Mining considerations

Although the reserve tenure and reserve classification recommendations in this report are based on the natural values of each proposed park, we also consider mining-related activity for each park and how it should be managed.

Our mining-related recommendations are underpinned by both a consideration of what is needed to maintain the properties' natural values for which they were acquired and our understanding of what is possible under Western Australian legislation. Legal advice was provided by the Environmental Defenders Office regarding the implications of the interaction between reserve tenure, reserve classification and mining tenements and titles (existing and proposed) (EDO, 2018).

Our recommendations for mining tenements and titles depend on their type and status as well as the natural values of the proposed parks and the reserve tenure and reserve classification we are recommending. For exploration applications we recommend they not be granted or be referred to the Environmental Protection Authority for further assessment or be restricted to areas outside the proposed parks. For existing exploration licences, we recommend they be referred to the Environmental Protection Authority for assessment, have conditions applied to safeguard the proposed parks' natural values or that the Minister for Mines not grant permission for continued operations.

Mining lease applications over Class A reserves would require the scrutiny and transparency of the Western Australian parliament as well as assessment by the Minister for Mines. For existing mining-related operations and new proposed activities on existing mining leases, our recommendations include 1 or more of the following: assessment by the Environment Protection Authority at the highest level, negotiations for the voluntary surrender of leases, new conditions to eliminate or minimise environmental impacts, or excision of land from the proposed park to allow for continued operations.

3 Shark Bay World Heritage to Wooleen

The proposed expansion of conservation reserves at world-heritage-listed Shark Bay would help create a 1.2-million-hectare 'Oceans to Outback' corridor stretching from the Shark Bay peninsula to Kalbarri National Park and 200–300 kilometres inland. Photo: Jake Masson

Coastal scenery typical of the proposed 'Yaringa – Nanga' National Park. Photo: Simon Nevill

3.1 At a glance

Proposed parks

Table 3-1: Former leasehold properties acquired for conservation

Property*	Year Acquired	Size (hectares)	Traditional Owners (native title parties)
ex Carrarang	2008	19,000	Malgana (100%)
ex Muggon	1999	183,000	Wajarri Yamatji (100%)
ex Murchison House (north)	2005	38,000	Nanda (100%)
ex Murchison House (south)	2005	9,000	Nanda (100%)
ex Nanga (north)	2000	88,000	Nanda (100%)
ex Nanga (south)	2000	88,000	Malgana (100%)
ex Nerren Nerren	2006	104,000	Nanda (100%)
ex Tamala	2006	56,000	Nanda (100%)
ex Wooleen	2002	9,000	Wajarri Yamatji (100%)
ex Yaringa	2001	19,000	Malgana (100%)

* The current tenure of all properties is unallocated Crown land.

Natural highlights

1.2 million-hectare ocean-to-outback corridor

Outstanding natural beauty – coastal cliffs, shell beaches, wildflower displays

World heritage values; greater protection for globally significant stromatolites

114 threatened and priority species including the endangered loggerhead turtle

10 plant communities and 29 sub-bioregional ecosystems not protected in existing reserves

Botanical transition zone with very high plant diversity & endemism

Progress towards the 2020 international benchmark for protection

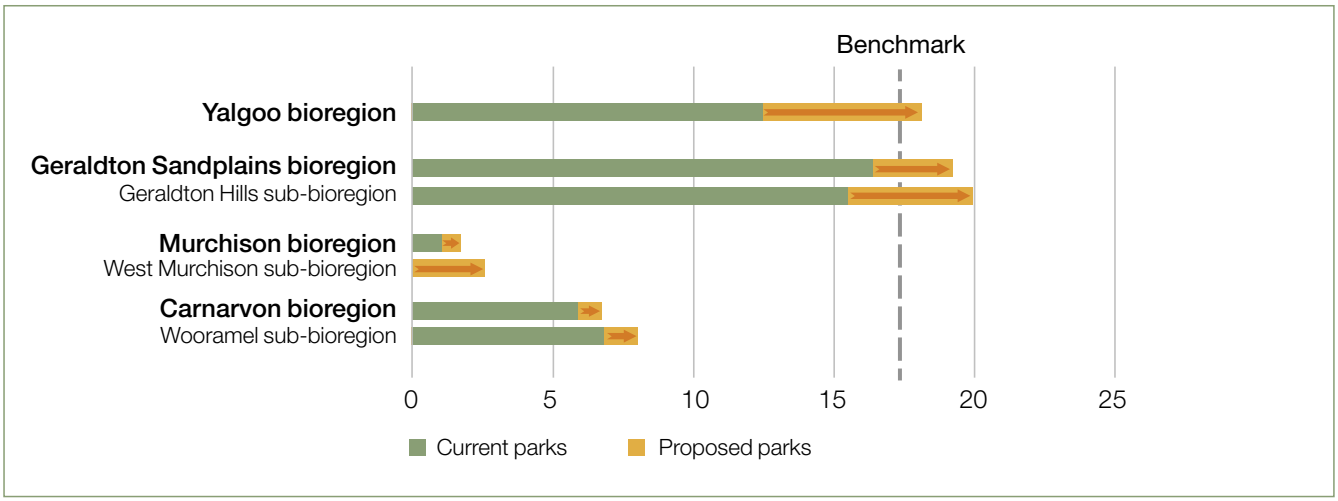


Figure 3-1: The potential increase in protection (% area) due to the proposed parks in bioregions and sub-bioregions where substantial progress can be made towards the international benchmark of 17%.

Reserve recommendations

Table 3-2: Proposed parks and park extensions

Property	Recommended Protection*	Recommended Classification
ex Carrarang	Create a new national park	Class A
ex Yaringa, ex Nanga (north)	Create a new national park	Class A
ex Tamala, ex Murchison House (north), ex Nerren Nerren, ex Nanga (south)	Expand Zuytdorp Nature Reserve	Class A
ex Murchison House (south)	Expand Kalbarri National Park	Class A
ex Muggon, ex Wooleen	Create a new conservation park	Class A

*Section 3.6 also includes recommendations regarding unallocated Crown land south of Toolonga Nature Reserve and ex Nerren Nerren.

Ruddy turnstones (*Arenaria interpres*) fly north each year, as far as the High Arctic, to breed. Their name comes from their habit of flicking stones to uncover prey. Photo: Georgina Steytler

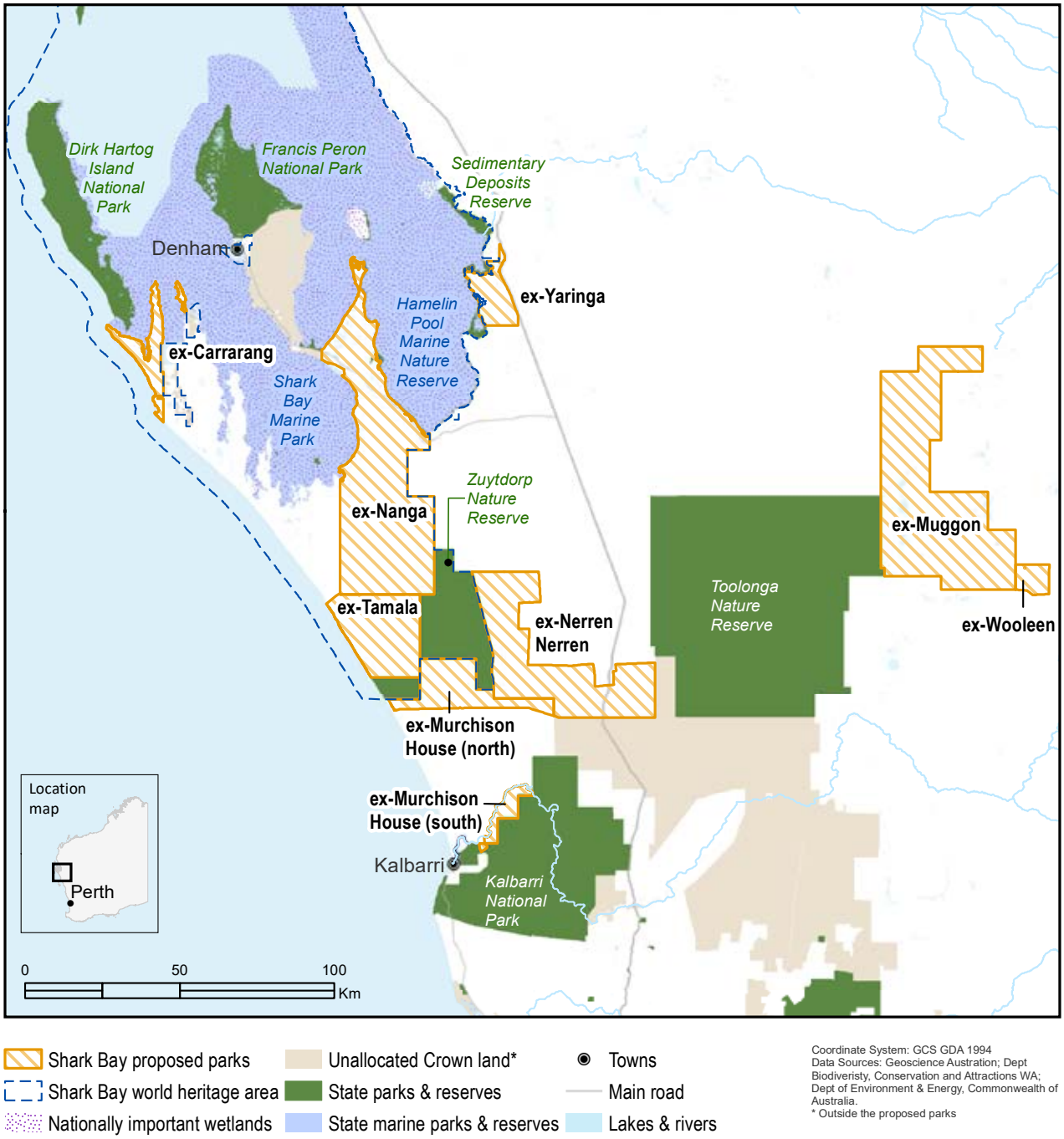


Figure 3-2. The proposed parks of 'Shark Bay World Heritage to Wooleen'

3.2 Natural values for conservation

As recognised by its world heritage status, the Shark Bay area has outstanding natural values. Shark Bay met all 4 criteria for listing on the World Heritage Register of Natural Places, including for its evolutionary history, globally threatened species, superlative natural phenomena and outstanding natural beauty.

Lying in a transition zone between the eucalypt-dominated South West botanical province and the wattle-dominated arid province, the Shark Bay area is botanically diverse, with more than 800 species recorded, and has a high rate of plant endemism (DEC and CCWA, 2012). Animal species diversity is also high with 34 mammals, 245 birds (almost a third of Australia's total) and 120 reptiles and frogs recorded (DEC and CCWA, 2012). Although more than 20 mammal species have disappeared from the mainland area since European settlement, Shark Bay is important for threatened mammals, including 5 nationally endangered species.

The 9 former leasehold properties reviewed here – covering about 600,000 hectares – provide major conservation opportunities, including to protect sites with world heritage values, facilitate management of threats to world heritage values and provide sanctuary for threatened, priority and unique species.

The properties were mostly bought under the Gascoyne-Murchison Strategy by the state government (with contributions from the federal government) to add to the reserve system. Although acquired from 10 to 19 years ago, they remain as unallocated Crown land. As such, they lack the legal protections requiring assessment of the impact of new projects on the natural and cultural values for which they were acquired. Formal responsibility, but not full resourcing, for property management lies with the Department of Biodiversity, Conservation and Attractions.

Three of the properties – ex Carrarang, ex Nanga and ex Tamala (250,000 hectares) – lie within the Shark Bay World Heritage Area, while 3 others – ex Nerren Nerren, ex Murchison House (north) and ex Yaringa (160,000 hectares) – border the world heritage area. The world heritage values of the proposed parks include a floristically diverse botanical transition zone, a nesting site for endangered loggerhead turtles and several sites of outstanding natural beauty (Box 3-1). As recognised by UNESCO, these properties are also important for facilitating management and improving the resilience of world heritage values (UNESCO, nd).

Another major conservation opportunity is to create a large (1.2 million hectares) land-to-sea corridor stretching from the Shark Bay peninsula to Kalbarri and 200–300 kilometres inland. The consolidation of fragmented existing reserves will increase their integrity, facilitate management of threats to both land and sea, and increase the tourism appeal of the area. The 2 inland properties making up the eastern end of the corridor – ex Muggon and ex Wooleen – are an opportunity to protect a chain of wetlands in an arid region with very poor representation in the conservation reserve system.

The proposed parks have high habitat diversity, with 41 plant communities and 50 sub-bioregional ecosystems represented. Several ecosystems can only be protected (to the targeted 15% level) in these proposed parks, with 5 ecosystems having more than 85% of their total extent there. The proposed parks will also protect more than 23,000 hectares of 'ecological refugia', areas with high productivity even during the least productive years, which are critical for the resilience of species during times of resource-scarcity (Klein et al., 2009). Together, the properties harbour more than 100 threatened and priority species, including several plant species unique to the area.

The proposed parks will increase representation in the reserve system for the Carnarvon and Murchison bioregions, which are both national priorities for new reserves.

Here, in 5 subsections corresponding with the recommendations in section 3.6 and the map in Figure 3-2, we describe the natural values of these 9 former leasehold properties.

Box 3-1: World heritage values that would be boosted by the proposed new parks

STROMATOLITES OF HAMELIN POOL

World heritage criteria vii, viii, ix

Hamelin Pool contains the world's most diverse and abundant stromatolites, a 'superlative natural phenomenon' and a major reason for the world heritage listing. Protecting ex Nanga (north) to the west of Hamelin Pool and ex Yaringa to its east will facilitate management of potential land-based threats to the stromatolites.

SEAGRASS MEADOWS, ABUNDANT MARINE LIFE, REFUGES

World heritage criteria vii, viii, ix, x

Shark Bay's Wooramel Seagrass Bank is the largest in the world and the richest in seagrass species, enabling dugongs, dolphins, sharks, rays, turtles and fish to thrive in high numbers. Shark Bay is one of the world's most significant strongholds for dugongs. Seagrass meadows are highly susceptible to activities on land that increase sedimentation or nutrient runoff (Orth et al., 2006). The proposed highly protected land-to-sea corridor provides the best chance for maintaining a healthy Wooramel catchment and preventing seagrass decline. Ex Carrarang features an important nesting site for the endangered loggerhead turtle (DPaW, 2017d).

BOTANICAL TRANSITION ZONE

World heritage criteria x

The Shark Bay region is a transition zone between 2 major botanical provinces featuring many plant species at their northern or southern limits as well as species unique to the area. This floristic diversity is most pronounced on ex Nanga and ex Tamala.

HABITATS OF TERRESTRIAL THREATENED SPECIES

World heritage criteria x

The region has high plant and animal diversity, including more than 100 threatened and priority species recorded in the proposed parks. Protection coupled with effective management is critical to building their resilience to climate change.

OUTSTANDING NATURAL BEAUTY

World heritage criteria ix

The region has a great diversity of landscapes and outstanding coastal scenery. The proposed parks include sea cliffs, peninsulas, shell beaches and wildflower vistas that will substantially add to the beauty of the reserve system.

Sources (unless otherwise noted): DEC and CCWA (2012), UNESCO (nd).

3.2.1 Proposed 'Carrarang' (Edel Land) National Park

Former leasehold property: ex Carrarang

Located on the tip of Shark Bay's southern peninsula, ex Carrarang (19,000 hectares) is part of the Shark Bay World Heritage Area and features world heritage values. These include outstanding coastal scenery, such as dramatic coastal cliffs whose colours contrast with those of the dunes and sea and impressive wildflower displays (DEC and CCWA, 2012). The Department of Environment and Conservation and the Conservation Commission of Western Australia recognised its 'botanical importance, landscape features and natural values' in recommending that it be made a national park with Class A status (DEC and CCWA, 2012).

Much of the property consists of coastal dunes. With 2 plant communities represented, its vegetation is a mix of spinifex grasslands and dwarf shrublands, and more than 200 plant species have been recorded there (DEC and CCWA, 2012).

Shelter Bay on ex Carrarang is 1 of just 3 nesting sites in Shark Bay for 1 of the world's largest nesting populations of the nationally endangered loggerhead turtle (DPaW, 2017d) (Box 3-2). The new park would protect 11 threatened and priority animal species – including the Shark Bay boodie, greater stick-nest rat and Shark Bay worm-lizard – and 11 threatened and priority plant species (Table 3-4). Ex Carrarang is part of designated biologically important areas for 3 seabird species: the lesser crested tern, roseate tern and wedge-tailed shearwater (BIAs, 2009).

The cliffs of ex Carrarang, the westerly-most point of the Australian mainland, are a highlight of the proposed 'Carrarang' (Edel Land) National Park. Photo: Glenn Campbell

Box 3-2: Loggerhead turtles

Western Australia hosts what is probably the world's third-largest breeding population of loggerhead turtles, a species listed as nationally endangered. Loggerheads occur around the world in tropical and subtropical waters. Nesting in Western Australia occurs mainly in the Shark Bay and Ningaloo Coast areas. Because there is little or no female-mediated interbreeding between major breeding aggregations, the Western Australian population is unique.

It's not known where young loggerheads go after hatching in Western Australia, but they probably disperse into the Indian Ocean on major currents. Young turtles are thought to use floating natural debris and biota along the current fronts for protection and food. After several years in the open ocean, they may live in coastal waters before returning to their birth region to reproduce.

Like all marine turtles, loggerheads grow only slowly, taking some 10 to 30 years to reach sexual maturity. Females reproduce only when they have sufficient fat stores to fuel breeding migration and egg production. They migrate back and forth between foraging and nesting areas, with intervals of 1 to several years. Shark Bay is a known foraging area for adult loggerheads, which have strong fidelity to both their feeding and breeding grounds.

In Western Australian waters, the major threats to loggerheads are climate change, chemical and terrestrial discharges, and fisheries bycatch. Climate change is expected to cause changes in dispersal, food webs, primary sex ratios, habitat availability, reproductive success and survivorship. Control of egg and hatchling predators such as foxes is important in nesting areas.

Sources: DEE (2017), Limpus (2008).

Young loggerhead turtles (*Caretta caretta*) face many perils but if they reach adulthood, when they are too big for most predators, they can live 50 years or more. The species is endangered in Australia. Photo: James Cordwell

Table 3-3: Summary of conservation values of the proposed 'Carrarang' (EdelLand) National Park

ex Carrarang (19,000 hectares)	
World heritage	Part of the Shark Bay World Heritage Area; world heritage values include coastal scenery and habitat for threatened species, including a nesting site for loggerhead turtles (endangered).
Threatened & priority animals	6 bird, 2 mammal, 3 reptile species.
Threatened & priority plants	11 species.
Plant communities:	2 communities.
Sub-bioregional ecosystems	2 ecosystems.
Biologically important area	Part of the BIA for lesser crested tern *(Sterna bengalensis)*, roseate tern *(Sterna dougallii)*, wedge-tailed shearwater *(Puffinus pacificus)*. The last 2 species breed in the area.

Sources: See technical notes 1 and 2 (chapter 2).

Table 3-4: Threatened and priority species of the proposed 'Carrarang' (EdelLand) National Park

Species	Conservation class
Birds	
Flesh-footed shearwater *(Puffinus carneipes)*	Vulnerable / international agreement
Caspian tern *(Sterna caspia)*	International agreement
Common greenshank (*Tringa nebularia)*	International agreement
Sanderling *(Calidris alba)*	International agreement
Wedge-tailed shearwater *(Puffinus pacificus)*	International agreement
Whimbrel *(Numenius phaeopus)*	International agreement
Mammals	
Boodie (Shark Bay) *(Bettongia lesueur lesueur)*	Conservation dependent
Greater stick-nest rat, wopilkara *(Leporillus conditor)*	Conservation dependent
Reptiles	
Loggerhead turtle *(Caretta caretta)*[A]	Endangered
Shark Bay worm-lizard *(Aprasia haroldi)*	Priority 1
Keeled legless lizard (Shark Bay) *(Pletholax gracilis edelensis)*	Priority 3
Plants	
Eremophila cuneata	Priority 1
Eremophila splendens	Priority 1
Bossiaea calcicole	Priority 2
Carpobrotus sp. Thevenard Island	Priority 2
Lepidium biplicatum	Priority 2
Melaleuca huegelii subsp. *pristicensis*	Priority 2
Stenanthemum divaricatum	Priority 2
Ptilotus alexandri	Priority 3
Thryptomene repens	Priority 3
Lepidium puberulum	Priority 4
Triodia bromoides	Priority 4

Notes: A. Not recorded in the DCBA database, but DPaW (2017d) note that Shelter Bay (ex Carrarang) is one of 3 sites used by about 70% of nesting loggerheads found in Western Australia

Sources: See technical notes 1 (chapter 2).

3.2.2 Proposed 'Yaringa – Nanga' National Park

Former leasehold properties: ex Yaringa, ex Nanga (north)

The world heritage values of these 2 properties (108,000 hectares) – both part of the Shark Bay World Heritage Area – include the outstanding beauty of expansive shell beaches and wildflower displays, globally threatened species and the floral riches of the botanical transition zone.

They also serve a vital buffering function for the stromatolites of Hamelin Pool, one of the main values for which the world heritage area was declared (see Box 3-3) (UNESCO, nd). Ex Yaringa borders the Sedimentary Deposits Reserve of Hamelin Pool, and the 2 properties encompass some 60–70% of the coastline around Hamelin Pool. Living, dead and dormant stromatolites are well developed between the supratidal and subtidal zones on the east coast of Nanga Peninsula (Playford et al., 2013). To maintain the integrity of a world heritage value, it is important to 'include sufficient areas immediately adjacent to the area' to protect it from encroaching threats (DEC and DEWHA, 2008). The proposed park is essential to facilitate management of land-based threats to Hamelin Pool.

The diversity of the proposed park is indicated by the 10 plant communities and 12 sub-bioregional ecosystems represented on the properties, with 2 communities and 1 ecosystem having less than 5% of their extent protected in existing reserves (Tables 3-5 and 3-7). Much of the vegetation consists of diverse shrublands with tree-heath and scrub-heath that includes banksias, grevilleas, wattles, paperbarks and mallees. Management on ex Yaringa would help protect the Salune Land System, a priority ecological community on an adjacent property (Table 3-5).

The 2 properties harbour 22 threatened and priority plant species, including the endangered Beard's mallee (*Eucalyptus beardiana*), a small mallee found mainly in Shark Bay's unique tree-heath community, particularly on ex Nanga (DEC, 2010). There are 11 threatened and priority animal species, including the curlew sandpiper, greater sand plover and malleefowl (all listed as vulnerable) (Table 3-6). The properties are also part of a designated biologically important area for 3 seabird species: the lesser crested tern, roseate tern and wedge-tailed shearwater (BIAs, 2009).

The once-abundant western barred bandicoot (*Perameles bougainville bougainville*), listed nationally as endangered, is now confined to islands at Shark Bay and fenced reserves free of feral cats and foxes. A reintroduction attempt on Heirisson Prong, adjacent to ex Carrarang, failed due to predators penetrating its fence. One hope for the future is that improved control of feral cats and foxes will enable the reintroduction of the bandicoot to the proposed 'Carrarang' National Park. Photo: Ryan Francis Photography

Box 3-3: The stromatolites of Hamelin Pool

These unusual microbe-built structures, which occur for some 100 kilometres around the edge of Hamelin Pool, are a major reason for Shark Bay being declared a world heritage area.

Stromatolites once flourished all over the world, but living examples are now rare. Those in Hamelin Pool are the most diverse and abundant in the world. They are built mostly by cyanobacteria, microbes that evolved more than 3 billion years ago and transformed the planet, making possible the evolution of complex life. They did this by developing the ability to photosynthesise: using energy from light to split water, creating stores of energy from the hydrogen molecule and emitting the oxygen into an atmosphere with almost no free oxygen. This waste product drove the Great Oxidation Event some 2.3 billion years ago, leading eventually to the high-oxygen atmosphere of today. The ability to photosynthesise has evolved just once, and all plants and algae do so using cyanobacteria incorporated into their cells as chloroplasts.

Ironically, the complex life made possible by cyanobacteria now limits their occurrence as stromatolites, for they have been largely grazed and competed out of existence. The reason the Hamelin Pool stromatolite microbes are safe from being eaten by the likes of gastropods (snails and slugs) is the hypersalinity of the water, about double that of the open ocean. This also limits the growth of thallophytic algae that might otherwise occupy the stromatolite niches. The salinity is kept high by restricted water circulation – due to the Faure Sill, a shallow bank of sand and seagrass – and low rainfall and high evaporation. Surprisingly, Hamelin Pool does support many fish, although fewer species than in the open part of Shark Bay, as well as sea snakes and jellyfish.

The stromatolites in Hamelin Pool have grown through accretion – by filamentous algae trapping and binding sand and mud and microbes precipitating calcium carbonate cement. Radiocarbon dating has shown some stromatolites in Hamelin Pool are close to 2000 years old; some may be older. Much remains to be learned about their means of growth and the organisms responsible.

Sources: Canfield et al. (2013), Playford et al. (2013), Shih (2015)

The proposed 'Yaringa – Nanga' National Park would provide greater protection for Hamelin Pool, which contains the world's most diverse and abundant stromatolites. Photo: Ingrid Sieler

Table 3-5: Summary of conservation values of the proposed 'Yaringa – Nanga' National Park

Ex Yaringa (19,000 hectares)	
Threatened & priority plants	6 species.
Threatened & priority animals	8 bird species.
Plant communities	7 communities: 2 with <5% in existing reserves.
Sub-bioregional ecosystems	7 ecosystems: 1 with <5% in existing reserves.
Biologically important area	Part of the BIA for the wedge-tailed shearwater *(Puffinus pacificus)*, which forages and breeds in the area.
Buffering & connectivity	• Borders the world heritage area and provides a buffer for the globally significant stromatolites of Hamelin Pool. • Located 1 km west of Salune Land System, a priority 3 ecological community with a very restricted distribution, so management on ex Yaringa can limit threats such as feral animals & fire to the land system.

Ex Nanga (north) (88,000 hectares)	
World heritage	Part of the Shark Bay World Heritage Area, with world heritage values including coastal scenery (such as shell beaches) of outstanding beauty and being part of the botanical transition zone.
Threatened & priority plants	19 species.
Threatened & priority animals	2 bird, 1 reptile, 1 invertebrate species.
Plant communities	5 communities: 1 with <5% in existing reserves.
Sub-bioregional ecosystems	7 ecosystems.
Biologically important area	Part of the BIA for the roseate tern *(Sterna dougallii)* and wedge-tailed shearwater *(Puffinus pacificus)*, which breeds in the area
Buffering & connectivity	• Located adjacent to the Sedimentary Deposits Reserve of Hamelin Pool, so ex Nanga helps protect the Hamelin Pool ecological community (priority 4) from land-based threats. • A critical link in a land-to-sea corridor from Hamelin Pool to Zuytdorp Nature Reserve.

Both properties (108,000 hectares)	
World heritage	Overlaps the Shark Bay World Heritage Area, with values including the botanical transition zone and coastal scenery of outstanding beauty.
Threatened & priority plants	22 species.
Threatened & priority animals	9 bird, 1 reptile, 1 invertebrate species.
Plant communities	10 communities: 2 with <5% in existing reserves.
Sub-bioregional ecosystems	12 ecosystems: 1 with <5% in existing reserves.
Biologically important area	Part of the BIA for roseate tern (Sterna dougallii) and wedge-tailed shearwater *(Puffinus pacificus)*.
Buffering & connectivity	Adjacent to Hamelin Pool and part of a land-to-sea corridor.

Sources: See technical notes 1 and 2 (chapter 2).

Table 3-6: threatened and priority species of the proposed 'Yaringa – Nanga' National Park

Species	Conservation class	ex Yaringa	ex Yaringa (north)
Birds			
Malleefowl *(Leipoa ocellata)*	Vulnerable	●	●
Curlew sandpiper *(Calidris ferruginea)*	Vulnerable / International agreement	●	
Greater sand plover *(Charadrius leschenaultii leschenaultii)*	Vulnerable / International agreement	●	
Western grasswren *(Amytornis textilis textilis)*	Priority 4		●
Fork-tailed swift *(Apus pacificus)*	International agreement	●	
Glossy ibis *(Plegadis falcinellus)*	International agreement	●	
Rainbow bee-eater *(Merops ornatus)*	International agreement	●	
Ruddy turnstone *(Arenaria interpres)*	International agreement	●	
Sharp-tailed sandpiper (*Calidris acuminata)*	International agreement	●	
Reptiles			
Javelin legless lizard *(Delma concinna major)*	Priority 1		●
Invertebrates			
Shield-backed trapdoor spider *(Idiosoma nigrum)*	Vulnerable		●
Plants			
Eucalyptus beardiana	Endangered		●
Calandrinia operta	Priority 1	●	
Sclerolaena stylosa	Priority 1		●
Acacia drepanophylla	Priority 2	●	●
Acacia sclerosperma subsp. glaucescens	Priority 2	●	
Dasymalla glutinosa	Priority 2		●
Dicrastylis micrantha	Priority 2		●
Grevillea rogersoniana	Priority 2		●
Lepidium biplicatum	Priority 2	●	
Macarthuria intricata	Priority 2		●
Melaleuca huegelii subsp. pristicensis	Priority 2		●
Physopsis chrysophylla	Priority 2		●
Thryptomene caduca	Priority 2		●
Verticordia dichroma var. syntoma	Priority 2		●
Abutilon sp. Hamelin	Priority 3		●
Acacia subrigida	Priority 3		●
Chthonocephalus tomentellus	Priority 3		●
Eremophila occidens	Priority 3		●
Scaevola chrysopogon	Priority 3	●	●
Sondottia glabrata	Priority 3	●	●
Jacksonia dendrospinosa	Priority 4		●
Triodia bromoides	Priority 4		●

Sources: See technical notes 1 (chapter 2).

Table 3-7: The extent of protection (%) in the proposed 'Yaringa – Nanga' National Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Yaringa	ex Yaringa (north)
Little protection (0.1 to 5%) in existing reserves		
VT 209 Shrublands; Acacia sclerosperma & minnieritchie scrub	8.2	
VT 676 Succulent steppe; samphire	<0.1	0.2
Inadequate protection (5 to 15%) in existing reserves		
VT 217 Bare areas; mud flats	0.1	
VT 2081 Shrublands; bowgada and associated spp. scrub		2.4

Source: See technical notes 2 (chapter 2).

Curlew sandpipers (*Calidris ferruginea*) fly to northern Siberia each year to breed. They have recently been listed as critically endangered in Australia due largely to loss of habitat along their migration route as well as in Australia. Photo: Georgina Steytler

3.2.3 Proposed expansion of Zuytdorp Nature Reserve

Former leasehold properties: ex Tamala, ex Murchison House (north), ex Nerren Nerren, ex Nanga (south)

The addition of these 4 properties (286,000 hectares) to the Zuytdorp Nature Reserve (59,000 hectares) will protect world heritage values, including the floral riches of the botanical transition zone and the beauty of the coastal scenery (DEC and CCWA, 2012). The scenic values include the peninsula and shell beach of ex Nanga, and the Zuytdorp Cliffs on the western side of ex Tamala and ex Murchison House, also 'a superlative natural phenomenon' (DEC and DEWHA, 2008) (see Box 3-4).

These properties are botanically rich – with ex Tamala, for example, having more than 300 plant species (DEC and CCWA, 2012) – in part because they are in a transition zone between 2 botanical provinces – the South West (dominated by eucalypts and plants typical of cooler, wetter areas) and the Eremaean (dominated by wattles and plants adapted to more arid regions). This means many plants in the Shark Bay area are at their northern limit (at least 145 species) or their southern limit (at least 39 species). There are also more than 50 endemic plant species in the Shark Bay area (DEC and CCWA, 2012, PWS, nd-c).

With the diversity of this transition zone most pronounced on ex Nanga and ex Tamala, the proposed park features impressive wildflower displays (DEC and CCWA, 2012). It also harbours 47 threatened and priority plant species, 15% of which are not yet described. The threatened species include *Eucalyptus beardiana* (endangered) and 3 spider orchids – Caladenia elegans (critically endangered), *C. barbarella* (endangered) and *C. bryceana subsp. cracens* (endangered) (Table 3-8). Many spider orchids are pollinated through sexual deception, by luring male flower wasps with a species-specific perfume that mimics the sex pheromone of receptive female wasps (Whitehead, 2016).

The diversity of the 4 properties is indicated by the 15 plant communities and 18 sub-bioregional ecosystems found there (Table 3-8). A quarter of the plant communities and half the ecosystems have little or no protection (<5%) in existing reserves (Tables 3-8 and 3-10). Much of the vegetation consists of shrublands with scattered eucalypts, coastal heath, shrub-heath and tree-heath. Shark Bay's tree-heaths are rich, complex communities unique to the area, with many endemic plants (PWS, nd-c). The trees typically grow to no more than 6 metres and some unusually large shrub species grow just as tall.

Another ecological community of note – with world heritage significance as a 'superlative natural phenomenon' – are the coastal birridas (evaporative pans) on ex Nanga and ex Tamala (McKenzie et al., 2000) (see Box 3-4).

Eight threatened and priority animal species have been recorded, including the malleefowl (vulnerable) and the Zuytdorp slider, an almost-limbless burrowing skink found only in the Shark Bay area (Wilson and Swan, 2013).

The proposed reserve expansion will improve protection of other important sites through buffering and management of threats. Protecting ex Tamala and ex Murchison House, for example, is important for limiting threats to the Abrolhos Marine Protected Area.

The low-lying landscapes of the Shark Bay region are botanically rich, with over 800 plant species. This image was captured on Tamala Station Road.
Photo: Lawrence Hillary

Box 3-4: Zuytdorp cliffs and birridas

ZUYTDORP CLIFFS

These dramatic coastal cliffs – 180 km long and up to 260 m high – are 'one of the most remarkable geomorphological features of the Australian coast'. They are thought to have formed when movement along the Zuytdorp Fault (an earthquake) cut through the limestones and overlying calcrete. This fault was probably active during the Pleistocene (125,000 – 10,000 years ago) and perhaps more recently during the early Holocene. Other than a minor earthquake (magnitude 2.9) in 1995, there is little evidence of movement along the fault in modern times.

BIRRIDAS

These conspicuous features of Shark Bay peninsulas and islands are flat-floored claypans, most covered with low samphire shrubs, lying in valleys between sand dunes. Once saline lakes, when sea levels were higher, they are now evaporative pans with a gypsum base that can be up to 5 metres thick. When they fill with water after rain, the dormant eggs of small crustaceans (such as brine shrimps) hatch, attracting migratory shorebirds to feed.

Sources: PWS (nd-a), Playford et al. (2013)

Table 3-8: Summary of conservation values of the proposed additions to Zuytdorp Nature Reserve

ex Murchison House (north) (38,000 hectares)	
Threatened & priority plants	25 species.
Threatened & priority animals	1 bird, 1 reptile, 1 invertebrate species.
Plant communities	7 communities: 1 with 0% representation in existing reserves, 1 other with <5%.
Sub-bioregional ecosystems	8 ecosystems: 1 with 0% representation in existing reserves, 2 others with <5%.
Biologically important area	Part of a BIA for the roseate tern *(Sterna dougallii)* and wedge-tailed shearwater *(Puffinus pacificus)* (this species breeds in the area).
Buffering & connectivity	• Borders the world heritage area, creating a buffer. • Part of the proposed land-to-sea corridor linking ex Nerren Nerren, ex Tamala and Zuytdorp Nature Reserve, and a link between fragmented parts of Zuytdorp Nature Reserve.

ex Nerren Nerren (104,000 hectares)	
Threatened & priority plants	25 species.
Threatened & priority animals	2 bird, 1 reptile species.
Plant communities	7 communities: 1 with 0% representation in existing reserves.
Sub-bioregional ecosystems	9 ecosystems: 2 with 0% representation in existing reserves, 2 others with <5%
Buffering & connectivity	• Borders the world heritage area, creating a buffer • A critical link in the proposed land-to-sea corridor.

ex Tamala (56,000 hectares)	
World heritage	Part of the Shark Bay World Heritage Area, with world heritage values including the botanical transition zone and the high scenic qualities of the coastal landscape.
Threatened & priority plants	7 species.
Threatened & priority animals	2 bird species.
Plant communities	7 communities: 1 with 0% representation in existing reserves, 1 other with <5%.
Sub-bioregional ecosystems	8 ecosystems: 2 with 0% representation in existing reserves, 1 other with <5%.
Buffering & connectivity	A critical link in the proposed land-to-sea corridor.

Table 3-8 (continued)

ex Nanga (south) (88,000 hectares)	
World heritage	Part of the Shark Bay World Heritage Area, with world heritage values including the botanical transition zone.
Threatened & priority plants	9 species.
Threatened & priority animals	3 bird, 1 reptile species .
Plant communities	4 communities.
Sub-bioregional ecosystems	4 ecosystems: 1 with 0% representation in existing reserves.
Biologically important areas	Part of the BIA for for roseate tern *(Sterna dougallii)* and wedge-tailed shearwater *(Puffinus pacificus)* (this species breeds in the area).
Buffering & connectivity	A critical link in the proposed land-to-sea corridor from Hamelin Pool to Zuytdorp Nature Reserve.

All properties (286,000 hectares)	
World heritage	Overlaps with the Shark Bay World Heritage Area; world heritage values include outstanding beauty of coastal scenery & the botanical transition zone.
Threatened & priority plants	47 species.
Threatened & priority animals	5 bird, 2 reptile, 1 invertebrate species.
Plant communities	15 communities: 2 with 0% representation, 2 others with <5%.
Sub-bioregional ecosystems	18 ecosystems: 5 with 0% representation, 4 others with <5%.
Biologically important areas	BIAs for roseate tern and wedge-tailed shearwater.
Buffering & connectivity	Buffers the world heritage property & is part of the proposed land-to-sea corridor.

Sources: See technical notes 1 and 2 (chapter 2).

Everlasting daisies – here on the proposed 'Muggon – Wooleen' Conservation Park – are among the beautiful botanical icons of the Outback.
Photo: Peter Le Scelle

Table 3-9: Threatened and priority species of the proposed additions to Zuytdorp Nature Reserve

Species	Conservation class	ex Murchison House	ex Tamala	ex Nerren Nerren	ex Nanga (south)
Birds					
Atlantic yellow-nosed albatross *(Thalassarche chlororhynchos)*	Vulnerable / international agreement		●		
Malleefowl *(Leipoa ocellata)*	Vulnerable	●	●	●	●
Western grasswren *(Amytornis textilis textilis)*	Priority 4				●
Caspian tern *(Sterna caspia)*	International agreement				●
Rainbow bee-eater *(Merops ornatus)*	International agreement			●	
Reptiles					
Javelin legless lizard *(Delma concinna major)*	Priority 1				●
Zuytdorp slider (*Lerista humphriesi)*	Priority 3	●		●	
Invertebrates					
Shield-backed trapdoor spider *(Idiosoma nigrum)*	Vulnerable	●			
Plants					
Caladenia elegans	Critically endangered	●			
Caladenia barbarella	Endangered	●			
Caladenia bryceana subsp. *cracens*	Endangered	●		●	
Eucalyptus beardiana	Endangered			●	●
Chamelaucium sp. Coolcalalaya	Priority 1	●		●	
Malleostemon nerrenensis	Priority 1			●	
Pileanthus aurantiacus	Priority 1	●			
Thryptomene sp. Carrarang	Priority 1	●			
Verticordia lepidophylla var. quantula	Priority 1	●		●	
Acacia plautella	Priority 2			●	
Anthotroche myoporoides	Priority 2			●	
Arnocrinum drummondii	Priority 2	●			
Beyeria gardneri	Priority 2			●	
Calytrix formosa	Priority 2			●	
Carpobrotus sp. Thevenard Island	Priority 2	●			
Chamelaucium sp. Wongan Hills	Priority 2			●	
Dasymalla glutinosa	Priority 2	●		●	
Dicrastylis linearifolia	Priority 2			●	
Dicrastylis micrantha	Priority 2			●	
Grevillea rogersoniana	Priority 2		●		●
Hemigenia saligna	Priority 2	●			
Lepidium biplicatum	Priority 2	●			
Macarthuria intricata	Priority 2	●			●
Malleostemon pentagonus	Priority 2			●	
Physopsis chrysophylla	Priority 2			●	●
Thryptomene caduca	Priority 2	●			●
Verticordia cooloomia	Priority 2	●			
Verticordia dichroma var. *dichroma*	Priority 2			●	
Verticordia dichroma var. *syntoma*	Priority 2	●	●	●	
Verticordia insignis subsp. *eomagis*	Priority 2		●		

Table 3-9 (continued)

Species	Conservation class	ex Murchison House	ex Tamala	ex Nerren Nerren	ex Nanga (south)
Plants					
Acacia gelasina	Priority 3			●	
Acacia leptospermoides subsp. *obovata*	Priority 3			●	
Calytrix harvestiana	Priority 3	●			
Grevillea stenomera	Priority 3	●	●		●
Malleostemon microphyllus	Priority 3	●			
Melaleuca boeophylla	Priority 3			●	
Scaevola chrysopogon	Priority 3			●	●
Scholtzia sp. Eurardy	Priority 3			●	
Scholtzia sp. Folly Hill	Priority 3	●			
Thryptomene sp. Eagle Gorge	Priority 3		●		
Eucalyptus zopherophloia	Priority 4	●	●		
Jacksonia dendrospinosa	Priority 4		●		●
Jacksonia velutina	Priority 4	●		●	
Lepidium puberulum	Priority 4	●			
Triodia bromoides	Priority 4	●		●	●
Verticordia capillaris	Priority 4	●			
Verticordia polytricha	Priority 4			●	

Sources: See technical notes 1 (chapter 2).

The caspian tern (*Hydroprogne caspia*), the world's largest tern, inhabits coastlines and inland rivers. It is protected under a migratory bird agreement with Japan. Photo: Georgina Steytler

Table 3-10: The extent of protection (%) in the proposed additions to Zuytdorp Nature Reserve for plant communities with inadequate representation in existing reserves

Plant Communities	ex Murchison House	ex Tamala	ex Nerren Nerren	ex Nanga (south)
No protection (<0.1%) in existing reserves				
VT 386 Low woodland; York gum	4.3		0.7	
VT 360 Shrublands; bowgada scrub with scattered mulga		34.5		
Little protection (0.1 to 5%) in existing reserves				
VT 401 Mosaic: Shrublands; scrub-heath on coastal association on yellow sandplain / Shrublands; acacia patchy scrub	23.9			
VT 387 Shrublands; *Melaleuca cardiophylla* thicket		0.8		
Inadequate protection (5 to 15%) in existing reserves				
VT 17 Shrublands; *Acacia rostellifera* thicket				3.0
VT 36 Shrublands; thicket, *acacia-casuarina* alliance			0.7	
VT 365 Shrublands; bowgada & jam scrub with scattered York gum & red mallee			17.6	
VT 402 Shrublands; heath on coastal limestone	2.9	44.1		1.8
VT 406 Shrublands; acacia, casuarina, *Eucalyptus eudesmioides, Banksia ashbyi* & other mixed species thicket			10.0	

Sources: See technical notes 2 (chapter 2).

3.2.4 Proposed expansion of Kalbarri National Park

Former leasehold property: ex Murchison House (south)

Kalbarri National Park, situated on the lower reaches of the Murchison River, features spectacular wildflowers, dramatic sandstone rock formations along the Murchison Gorge, soaring coastal cliffs and vast rolling sandplains (DPaW, 2015a). It is part of the South West Australia global biodiversity hotspot and part of the Geraldton Hills to Shark Bay Sand Plains national biodiversity hotspot.

As part of the transition zone for the South West and Eremaean botanical provinces, Kalbarri National Park has outstanding plant diversity, with more than 1000 species recorded, the third highest for Western Australian parks (DPaW, 2015a). It also has high reptile diversity with 75 species recorded.

Adding the southern block of ex Murchison House (9000 hectares) to Kalbarri (186,000 hectares) would enhance these values and buffer the north-western edge of the park. It would extend the national park to include an additional 30 kilometers of the lower reaches of the Murchison River, where lie many freshwater springs and soaks.

The vegetation is mostly low sheoak woodlands and shrublands of scrub-heath, wattles and paperbarks. The Kalbarri expansion would improve protection for 4 plant communities and 4 sub-bioregional ecosystems, including 1 of each with less than 5% representation in existing reserves (Table 3-11).

The property harbours 19 threatened and priority plant species, including the northern dwarf spider orchid (*Caladenia bryceana* subsp. *cracens*) (endangered), Kalbarri leschenaultia *(Lechenaultia chlorantha)* (endangered) and long-leaved myrtle *(Hypocalymma longifolium)* (vulnerable) (Table 3-12). The long-leaved myrtle, a small shrub, is known only from this property, growing in damp areas on the west-facing slopes of breakaways (TSSC, 2011). There are also 6 threatened and priority animal species recorded on the property, including the golden gudgeon, a fish found only in the rocky pools of the Gascoyne and Murchison rivers, Carnaby's cockatoo (endangered) and malleefowl (vulnerable).

Table 3-11: Summary of conservation values of the proposed addition to Kalbarri National Park

ex Murchison House (south) (9,000 hectares)	
Threatened & priority plants	19 species.
Threatened & priority animals	5 bird species, 1 fish species.
Plant communities	4 communities: 1 with <5% representation in existing reserves.
Sub-bioregional ecosystems	4 ecosystems: 1 with <5% representation in existing reserves.
Buffering & connectivity	Improved integrity of Kalbarri National Park and substantially improved protection for 30 kilometers of the Murchison River, including many freshwater soaks and springs.

Sources: See technical notes 1 and 2 (chapter 2).

Table 3-12: Threatened and priority species of the proposed addition to Kalbarri National Park

Species	Conservation class
Birds	
Carnaby's cockatoo *(Calyptorhynchus latirostris)*	Endangered
Malleefowl *(Leipoa ocellata)*	Vulnerable
Great egret *(Ardea modesta)*	International agreement
Ruddy turnstone *(Arenaria interpres)*	International agreement
Common greenshank *(Tringa nebularia)*	International agreement
Fish	
Golden gudgeon *(Hypseleotris aurea)*	Priority 2
Plants	
Caladenia bryceana subsp. *cracens*	Endangered
Lechenaultia chlorantha	Endangered
Hypocalymma longifolium	Vulnerable
Acanthocarpus parviflorus	Priority 2
Calytrix formosa	Priority 2
Lasiopetalum oldfieldii subsp. *oldfieldii*	Priority 2
Mirbelia corallina	Priority 2
Stenanthemum divaricatum	Priority 2
Verticordia cooloomia	Priority 2
Verticordia dichroma var. syntoma	Priority 2
Angianthus microcephalus	Priority 3
Bossiaea inundata	Priority 3
Calytrix harvestiana	Priority 3
Grevillea stenomera	Priority 3
Malleostemon costatus	Priority 3
Scholtzia sp. Eurardy	Priority 3
Caladenia integra	Priority 4
Stachystemon nematophorus	Priority 4
Verticordia polytricha	Priority 4

Sources: See technical notes 1 (chapter 2).

Carnaby's black-cockatoos (*Calyptorhynchus latirostris*), unique to Western Australia, are endangered mainly due to habitat destruction. They need old eucalypt trees for nesting and eat the seeds of trees such as banksias and hakeas. Photo: Georgina Steytler

Table 3-13: The extent of protection (%) in the proposed addition to Kalbarri National Park for plant communities with inadequate representation in existing reserves

Plant Communities	Murchison House (south)
Little protection (0.1 to 5%) in existing reserves	
VT 387 Shrublands; *Melaleuca cardiophylla* thicket	2.1.2
Inadequate protection (5 to 15%) in existing reserves	
VT 17 Shrublands; *Acacia rostellifera* thicket	0.5

Sources: See technical notes 2 (chapter 2).

3.2.5 Proposed 'Muggon – Wooleen' Conservation Park

Former leasehold properties: ex Muggon, ex Wooleen

These 2 arid properties (with ex Muggon constituting 95% of the 192,000-hectare area) would add to the reserve system an ecologically important chain of wetlands and almost 2 dozen plant communities and ecosystems currently lacking representation in the reserve system. The landscape quality is high – there are few weeds and the area has rehabilitated well since being destocked (Daniel et al., 2009). The landscape is also very diverse, with red sandplains, stony spinifex ridge lands and extensive lake lands and lake systems (Smith et al., 2008).

The area features gently undulating to almost flat sandplains with numerous salt pans, claypans, seasonal saline marshes and seasonal saline lakes (Daniel et al., 2009). The Yarra Yarrak Lake System comprises half the property (Smith et al., 2008). Muggon Lake is a saline 'megascale irregular elongate lake' stretching 10 kilometres, surrounded by salt pans. Mungawolagudgi Claypan to its east is an intermittent freshwater lake, the only regionally significant wetland in the Murchison bioregion (McKenzie et al., 2001). Information about the wetlands is sparse due to the area's remoteness, with 'almost every aspect' of their ecology 'a knowledge gap' (Daniel et al., 2009). However, it is expected that when the lakes fill they would teem with waterbirds, including migratory shorebirds listed under international agreements. Two nearby lakes (Wooleen and Breberle) are listed as nationally significant wetlands in part due to their importance to waterbirds (DIWA, 2014, Daniel et al., 2009).

The diversity of the proposed park is indicated by the 16 plant communities and 18 sub-bioregional ecosystems found there, of which 12 plant communities and 15 ecosystems have little to no representation (<5%) in existing reserves (Tables 3-14 and 3-16). The majority of the vegetation is wattle shrublands and woodlands and succulent shrublands. Ex Woolen would provide the first formal reservation of wattle forests and woodlands in the West Murchison sub-bioregion.

One plant community (a succulent steppe with bowgada scrub) and a land system (Weenyung) are unique to ex Muggon (Smith et al., 2008).

Ex Muggon harbours 10 priority plant species and 7 threatened and priority bird species, including malleefowl (vulnerable) (Table 3-15).

This reserve would form the eastern extent of the proposed land-to-sea corridor extending from Shark Bay. Ex Muggon will complement the adjacent Toolonga Nature Reserve by protecting different types of plant communities and improving the long-term viability of the reserve. East of ex Wooleen is Wooleen Station (a pastoral lease), which is under careful management for environmental remediation and eco-tourism (Taylor, 2017a).

Wolarry Swamp on ex Muggon is part of an extensive paleodrainage system with significant wetlands important for birds, including migratory shorebirds listed under international agreements. Photo: David Blood (DEC)

Part of the remarkable Yarrawolya Breakaway on ex Muggon. Photo: David Blood (DEC)

Ring-tailed dragons (*Ctenophorus caudicinctus*) are denizens of rocky ranges and outcrops, where they bask and wait in ambush for insect prey. The current described species, which occurs across northern and central Australia, probably consists of a few different species. This dragon was photographed on ex Muggon. Photo: Sarah Crews

Table 3-14 Summary of conservation values of the proposed 'Muggon – Wooleen' Conservation Park

Ex Muggon (183,000 hectares)	
Wetlands	Extensive paleodrainage system with significant wetlands, Muggon lake (saline) and Mungawolagudgi Claypan (freshwater).
Threatened & priority plants	10 species.
Threatened & priority animals	7 bird species.
Plant communities	15 communities: 8 with 0% representation in existing reserves, 3 others with <5%.
Sub-bioregional ecosystems	17 ecosystems: 13 with 0% representation in existing reserves, 1 other with <5%.
Buffering & connectivity	• Part of the proposed land-to-sea corridor from Shark Bay to ex Wooleen. • Garry Land System (priority 3), which has an extremely restricted distribution and lies just outside the north-west border, can benefit from effective management of ex Muggon.

Ex Wooleen (9,000 hectares)	
Plant communities	4 communities: 1 with 0% representation in existing reserves, 2 others with <5%.
Sub-bioregional ecosystems	4 ecosystems: 3 with 0% representation in existing reserves, 1 other with <5%.
Buffering & connectivity	The most easterly part of the proposed highly protected land-to-sea Shark Bay to Wooleen corridor.

Both properties (192,000 hectares)	
Wetlands	Muggon lake (saline) and Mungawolagudgi Claypan (freshwater).
Threatened & priority plants	10 species.
Threatened & priority animals	7 bird species.
Plant communities	16 communities: 8 with 0% representation in existing reserves, 4 others with <5%.
Sub-bioregional ecosystems	18 ecosystems: 14 with 0% representation in existing reserves, 1 other with <5%.
Buffering & connectivity	• Part of the proposed land-to-sea corridor from Shark Bay to ex Wooleen • Garry Land System (priority 3) can benefit from effective management of ex Muggon.

Sources: See technical notes 1 and 2 (chapter 2).

Table 3-15: Threatened and priority species of the proposed 'Muggon – Wooleen' Conservation Park (ex Muggon only)

Species	Conservation class
Birds	
Malleefowl *(Leipoa ocellata)*	Vulnerable
Peregrine falcon (Falco peregrinus)	Specially protected
Common greenshank *(Tringa nebularia)*	International agreement
Glossy ibis *(Plegadis falcinellus)*	International agreement
Great egret *(Ardea modesta)*	International agreement
Rainbow bee-eater *(Merops ornatus)*	International agreement
White-winged tern *(Chlidonias leucopterus)*	International agreement
Plants	
Abutilon sp. Pritzelianum	Priority 1
Acacia sp. Muggon Station	Priority 2
Angianthus microcephalus	Priority 2
Bergia auriculata	Priority 2
Dicrastylis linearifolia	Priority 3
Hemigenia tysonii	Priority 3
Prostanthera tysoniana	Priority 3
Psammomoya ephedroides	Priority 3
Ptilotus beardii	Priority 3
Goodenia neogoodenia	Priority 4

Sources: See technical notes 1 (chapter 2).

Table 3-16: The extent of protection (%) in the proposed 'Muggon – Wooleen' Conservation Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Muggon	ex Wooleen
No protection (<0.1%) in existing reserves		
VT 229 Mosaic shrublands, bowgada and associated species scrub / Shrublands, bowgada & grevillea scrub	4.5	
VT 240 Succulent steppe with open scrub, scattered Acacia *sclerosperma* & *bowgada* over saltbush & bluebush	32.4	
VT 261 Succulent steppe with low woodland, snakewood over saltbush & bluebush	30.4	
VT 266 Mosaic – shrublands, bowgada scrub / Succulent steppe, saltbush & bluebush	5.7	
VT 269 Low woodland over scrub; mulga over bowgada scrub	0.6	
VT 327 Shrublands; mulga, bowgada, *Acacia quadrimarginea* & *minnieritchie* scrub	8.6	12.8
VT 340 Succulent steppe with scrub, bowgada scrub over various species	100	
VT 361 Shrublands; *bowgada* & *minnieritchie* scrub with scattered mulga	2.0	
Little protection (0.1 to 5%) in existing reserves		
VT 18 Low woodland; mulga *(Acacia aneura)*	0.1	<0.1
VT 29 Sparse low woodland; mulga, discontinuous in scattered groups		<0.1
VT 202 Shrublands; mulga & *Acacia quadrimarginea* scrub	1.2	
VT 676 Succulent steppe; samphire	0.3	
Inadequate protection (5 to 15%) in existing reserves		
VT 125 Bare areas; salt lakes	<0.1	
VT 162 Shrublands; snakewood scrub	<0.1	
VT 2081 Shrublands; bowgada and associated spp. scrub	6.5	0.2

Sources: See technical notes 2 (chapter 2).

3.3 Importance for achieving Western Australia's conservation reserve goals

The proposed parks will enable Western Australia to make substantial progress on meeting its conservation goals by increasing protection of poorly represented bioregions and providing the first protection for dozens of ecosystems and plant communities.

Bioregional and sub-bioregional protection

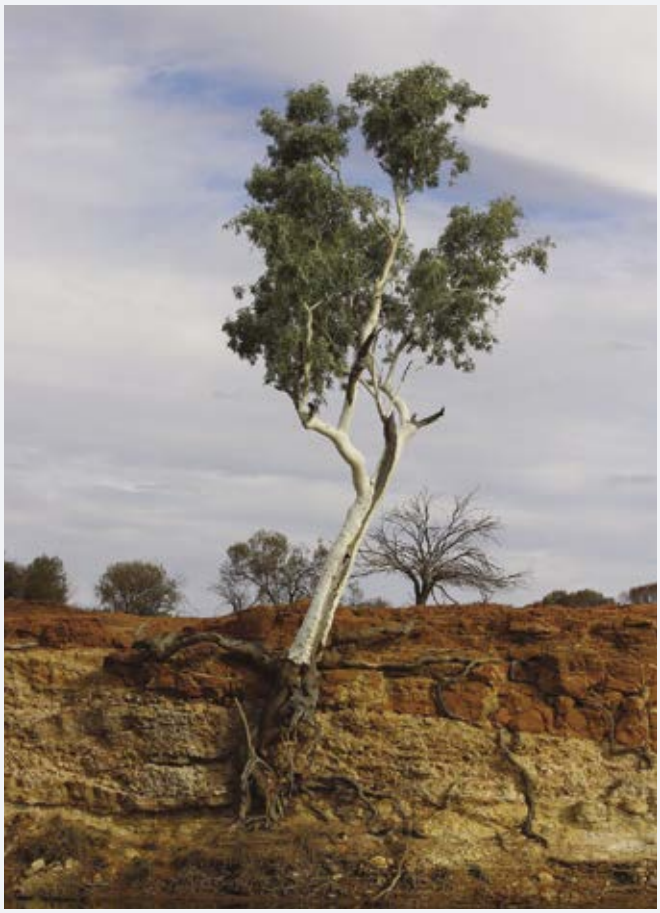
The proposed parks encompass parts of 4 sub-bioregions within 4 different bioregions, one indication of their high diversity. They are particularly important for improving protection of the West Murchison sub-bioregion – taking it from less than 0.1% to 2.6% in reserves (Table 3-17) – and the Murchison (1.1% currently in reserves) and Carnarvon (5.9%) bioregions. The parks would enable the state to achieve the international benchmark of 17% (a standard applicable for large-scale areas, derived from the Aichi Biodiversity Targets under the Convention on Biological Diversity) for 3 regions: the Geraldton Hills sub-bioregion and the Yalgoo and Geraldton Sandplains bioregions (Figure 3-3).

Plant community and ecosystem protection

The proposed parks would improve protection of 41 plant communities and 50 sub-bioregional ecosystems (Table 3-18). This would be the first such protection for 10 plant communities (24% of the total) and 19 sub-bioregional ecosystems (38% of the total) currently lacking representation in the reserve system. Protection of the proposed parks is particularly important for the 18% of ecosystems and 5% of plant communities with more than half of their entire extent on those properties (Table 3-18).

Currently, more than a third of Western Australia's sub-bioregional ecosystems lack a minimum level of protection, based on a long-held national target of 15% of each ecosystem to be in reserves (JANIS, 1997, Taylor, 2017). The proposed parks would enable the minimum reserve target of 15% to be met for an additional:

- 17 sub-bioregional ecosystems (34% of the total ecosystems on the proposed parks)
- 10 plant communities (24% of the total communities on the proposed parks) (Table 3-18).



Protecting a small part of the former pastoral station, ex Coolcalalaya, in a conservation reserve would help achieve an 'Oceans to Outback' corridor by connecting ex Nerren Nerren with Toolonga Nature Reserve. This is a bank of the Murchison River on ex Coolcalalaya. Photo: Leanne Masson

The Shark Bay heath dragon (*Ctenophorus butleri*) has a tiny distribution, being found on Dirk Hartog Island, the Edel Land Peninsula and in isolated patches down to Kalbarri. Photo: David Caloren

Table 3-17: Current and improved protection of bioregions and sub-bioregions (% protected) in Western Australia's conservation reserve system

	Bioregion	Sub-bioregion	Bioregion	Sub-bioregion	Bioregion	Sub-bioregion	Bioregion	Sub-bioregion
	Carnarvon	Wooramel	Geraldton Sandplains	Geraldton Hills	Murchison	West Murchison	Yalgoo	Edel
Current protection	5.89	6.86	16.40	15.49	1.06	0.06	12.53	32.28
Proposed parks	0.86	1.19	2.84	4.53	0.62	2.52	5.57	17.84
New total	6.75	8.05	19.24	20.02	1.68	2.58	18.10	50.12

Sources: See technical notes 2 (chapter 2)

Notes: *Current protection* means the percentage of each bioregion and sub-bioregion protected in the existing conservation reserve system. *Proposed parks* means the percentage of each bioregion and sub-bioregion protected in the proposed parks. *New total* means the percentage of each bioregion and sub-bioregion that would be protected if the proposed parks are declared.

Figure 3-3: Progress towards the 2020 international benchmark (17%) for protection of bioregions and sub-bioregions (% area protected) due to the proposed parks

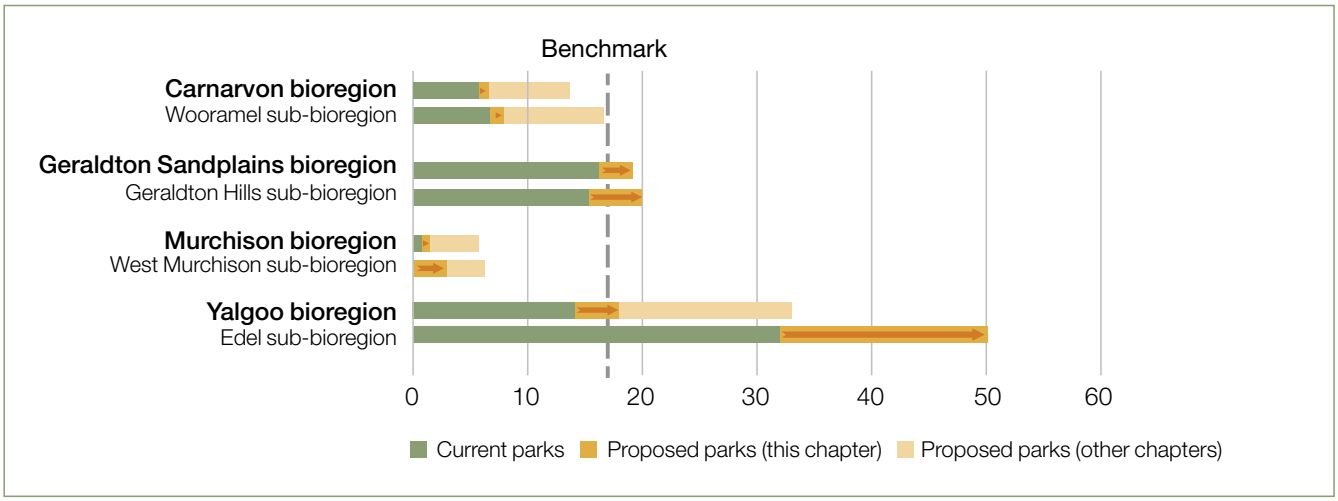


Table 3-18: Numbers of plant communities and sub-bioregional ecosystems in the proposed parks, levels of protection in the existing conservation reserve system and the contribution to protection of particular communities and ecosystems

	Plant Communities (number & percentage)		Ecosystems (number & percentage)	
Improved protection in proposed parks				
Total in proposed parks	41	100%	50	100%
Will achieve 15% target[A]	10	24%	17	34%
Current level of protection in reserve system				
No existing protection (<0.1%)	10	24%	19	38%
Little existing protection (0.1-5%)	7	17%	6	12%
Inadequate protection (5.1-<15%)	9	22%	7	14%
Exceeds 15% protection	15	37%	18	36%
Contribution to protection of particular communities & ecosystems[B]				
Critical (>85% of total extent)	1	2%	5	10%
Very important (50–85% of total extent)	1	2%	4	8%
Important (10–50% of total extent)	15	37%	25	50%

Sources: See technical notes 2 (chapter 2)

Notes: A. This assumes protection in other proposed parks and does not include ecosystems that already have more than 15% of their extent protected in the conservation reserve system. B. This represents the number of communities or ecosystems with a substantial proportion of their total extent in the proposed parks. For example, the proposed parks are 'critical' for ecosystem protection where more than 85% of the entire ecosystem extent occurs within the proposed parks.

A carpet of winter wildflowers just off the North West Coastal Highway on ex Nerren Nerren. Photo: David Mackenzie

3.4 Native title and Aboriginal heritage sites

The Shark Bay area has been occupied by Indigenous people for at least 30,000 years (DEC and CCWA, 2012). The proposed parks show extensive evidence of this history, including 29 registered Aboriginal heritage sites and 10 lodged sites. Six of the registered sites would be entirely protected and the other 23 partially so (Table 3-19).

The properties proposed for parks can be considered in 3 groups that correspond to native title claims and determinations:

- the coastal properties – ex Carrarang, ex Yaringa and ex Nanga (north) – are part of the Malgana Shark Bay people's country
- the botanical transition properties – ex Murchison House, ex Nerren Nerren, ex Tamala and ex Nanga (south) – are part of the Nanda people's country
- the inland wetland properties – ex Muggon and ex Wooleen – are part of Wajarri Yamatji country.

Native title parties will play a key role in determining whether the proposal for these parks is implemented.

Thirty-one species of reptile have been recorded in the general vicinity of the Muggon wetlands. Photo: Harry Everett (DEC)

Table 3-19: Native title status and Aboriginal heritage sites in the proposed parks

Native title party, claimed or determined (percentage of property)	Registered Aboriginal heritage sites
Proposed 'Carrarang' National Park	
ex Carrarang	
Malgana, determined non-exclusive (100%)	12 sites that would be partially protected including a burial site with skeletal remains at Heirisson Prong, historical man-made structures at Crayfish Bay and Wilimia, an artefacts scatter and midden sites at Heirisson Prong, Cormorant Bay, Pearlers Camp, Crayfish Bay, Zuytdorp Point and Wilimia and a camp at False Entrance.
Proposed 'Yaringa – Nanga' National Park	
ex Yaringa	
Malgana, determined non-exclusive (100%)	6 sites (1 would be fully protected, 5 partially), including a camp, artefact scatter and 2 quarries.
ex Nanga (north)	
Malgana, determined non-exclusive (100%)	No registered sites
Proposed expansion of Zuytdorp Nature Reserve	
ex Nanga (south)	
Nanda determined non-exclusive (100%)	No registered sites
ex Murchison House (north)	
Nanda, determined non-exclusive (100%)	3 sites that would be fully protected, including a camp, midden and artefacts scatter at Kelly's Soak.
ex Nerren Nerren	
Nanda, determined non-exclusive (100%)	No registered sites
ex Tamala	
Nanda, determined non-exclusive (100%)	1 site: an artefacts scatter at Bookah Spring Cave
Proposed expansion of Kalbarri National Park	
ex Murchison House (south)	
Nanda, determined exclusive (13%), determined non-exclusive (87%)	7 sites (3 that would be fully protected, 4 partially) including the Bettie Crossing Soak, the mythological Beemarra site, Woonana Pool, Goonerburrallager Pool, Menarra Stone Arrangement, Birrugada Pool, Bettie Crossing Soak and Nats Flat. These sites are along the river on the border of ex Murchison House (south). They are associated with the important dreamtime story whereby the serpent Beemarra swam down the Murchison River to the ocean, became scared by the waves, then fled back to the river creating sandstone tunnels and freshwater where she rested (KVC, 2018).
Proposed 'Muggon – Wooleen' conservation Park	
ex Muggon	
Wajari Yamatji determined exclusive (35%), determined non-exclusive (59%), claim application (6%)	No registered sites
ex Wooleen	
Wajarri Yamatji, determined non-exclusive (100%)	1 site that would be fully protected: a mythological site

Sources: See technical notes 3 (chapter 2), data current to January 2019.

3.5 Geology, prospectivity and mining

The near-surface geology of the Shark Bay area consists mostly of Pleistocene Tamala limestone and Peron sandstone. Most of the surface is covered by sand dunes systems probably ranging in age from late Pleistocene to early Holocene (Playford et al., 2013). The overall prospectivity of, and mining activity within, the proposed parks of Shark Bay are low.

The following information about the geology, prospectivity and mining activity on each property comes from the following sources: Belford (2017) and (DMIRS 2018a, 2018b) as described in technical notes 4. The extent of proposed and existing mining-related activity is summarised in Tables 3-20, 3-21 and 3-22.

Proposed 'Carrarang' (Edel Land) National Park

Ex Carrarang

The surface geology comprises Quaternary deposits of shoreline and coastal calcareous eolian deposits (limestones). There is low prospectivity for industrial minerals. There are no known mineral deposits.

Mining activity: The miscellaneous lease L 09/6 (for a road or pipeline) covers 22 hectares (0.1%) and expires in 2025. It is associated with a large evaporative salt mine east of ex Carrarang, which has operated since the 1980s on land excised from the world heritage area.

Areas without mining activity: 99.9% of ex Carrarang is free of existing or proposed mining-related activities.

Proposed 'Yaringa – Nanga' National Park

Ex Yaringa

The surface geology includes Quaternary shoreline and coastal calcareous eolian limestone and Cretaceous marine limestone, marl and greensand. There is some prospectivity for industrial minerals. There are no known mineral deposits.

Mining activity: Two applications for exploration licences have been lodged in the past year. Half of E 09/2282 spans 17% of ex Yaringa and 30% of E 09/2313 spans 7% of ex Yaringa.

Areas without mining activity: 100% of ex Yaringa is free of existing mining-related activities. Applications for exploration covering 24% of the property are currently being considered.

Ex Yaringa

The surface geology comprises Cenozoic deposits of Quaternary shoreline and coastal calcareous eolian deposits (limestones) and older quartzose eolian and alluvial deposits. Ex Nanga (north) has low prospectivity, and all known deposits lie beyond the property.

Mining activity: A small part (7%) of an area covered by a recently approved exploration licence extends across 0.5% of ex Nanga (north). It is associated with a heavy mineral sand mine that sits outside the property. Small shell mines operate outside ex Nanga (north) off its north-west coast inside L'Haridon Bight.

Areas without mining activity: 99.5% of ex Nanga (north) is free of existing or proposed mining-related activities.

Proposed Zuytdorp Nature Reserve extension

Ex Nanga (south)

The surface geology comprises Cenozoic deposits of Quaternary shoreline and coastal calcareous eolian deposits (limestones) and older quartzose eolian and alluvial deposits. Proven deposits of heavy mineral sands to the east of ex Nanga (south) imply high prospectivity but there are no known mineral deposits on the property.

Mining activity: Four exploration licence applications (E 09/942-4, E 09/957) overlap 60% of ex Nanga (south). These applications are still pending despite being submitted in 1998 by a company which appears to have been delisted since 2002. The Coburn Heavy Mineral Sands Project (leases M 09/111-2 and M 09/102-6) has operated since 2003 outside the eastern border of ex Nanga (south), outside the world heritage area, targeting minerals such as zircon, ilmenite, and titanium.

Areas without mining activity: 100% of ex Nanga (south) is free of existing mining-related activities. Applications for exploration covering 60% of the property are currently being considered.

Ex Murchison House (north)

This property is underlain with Cenozoic deposits of Quaternary shoreline and coastal calcareous eolian deposits (limestones) and older quartzose eolian and alluvial deposits. Mineral prospectivity is low. There are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Murchison House (north) is free of existing or proposed mining-related activities.

Ex Nerren Nerren

The surface geology comprises Cenozoic deposits of quartzose eolian and alluvial material. This property may be prospective for heavy mineral sands along old strandlines, but there are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Nerren Nerren is free of existing or proposed mining-related activities.

Ex Tamala

The surface geology comprises Quaternary shoreline and coastal calcareous eolian deposits (limestones) and older quartzose eolian and alluvial deposits. There is potential prospectivity for heavy minerals sands. There are no known mineral deposits.

Mining activity: Three old mining exploration applications (E 09/942-3 & E 09/957) that overlap with ex Nanga (south) extend over the northern end of ex Tamala.

Areas without mining activity: 100% of ex Tamala is free of existing mining-related activities. Applications for exploration covering 23% of the property are currently being considered.

Proposed Kalbarri National Park extension

Ex Murchison House (south)

This property is underlain predominantly by Ordivician sandstone, lesser siltstone and carbonate (red beds) and a small area of Cretaceous, marine to coastal limestone, shale and radiolarian siltstone. Mineral prospectivity is low. There are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Murchison House (south) is free of existing or proposed mining-related activities.

Proposed 'Muggon – Wooleen' Conservation Park

Ex Muggon

The geology of this area is complex. Two major fault lines run north-south through the western part of the property and bound areas of Permian continental and coastal sandstone, siltstone and coal measures, and much older Mesoproterozoic sedimentary rocks. To the east of these faults the area is predominantly underlain by Carboniferous continental and marine, glacially influenced siliciclastic deposits.

The prospectivity of the area is varied. The Permian rocks are prospective for coal. The Talisker Coal prospect lies just west of ex Muggon. There is an outcrop prospective for barite but otherwise there are no known mineral deposits.

Mining activity: Three exploration licences and 1 application for exploration span 12% of ex Muggon. The 3 licences cover 20,000 hectares (11% of the property) and entirely overlay the largest lake wetland system of ex Muggon. The application covers 2500 hectares (1.5%). An oil & gas exploration application lodged in September 2013 covers the northern third of the property (SSTP EPA- 0111). Negotiations with native title parties have halted (NNTT, 2015).

Areas without mining activity: 90% of ex Muggon is free of existing mining-related activities. Applications for exploration covering 40% of the property are currently being considered.

Ex Wooleen

The area is underlain by Neoproterozic sandstone, siltstone, conglomerate, dolomite and basalt, and Archean gneiss. This gneiss is part of a complex of the oldest rocks in Australia. Mineral prospectivity is low. There are no known mineral deposits.

Mining activity: Two exploration leases granted in 2018 cover the central and northern half of the property. An exploration application made in February 2018 covers 13% in the southern part of the property.

Areas without mining activity: 50% of ex Wooleen is free of existing mining-related activities. Applications for exploration covering 35% of the property are currently being considered.

Blue pincushion (*Brunonia australis)* is one of the flowers adding colour to the landscapes of ex Muggon. Photo: David Blood (DEC)

Table 3-20: Existing mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed 'Muggon – Wooleen' Conservation Park				
ex Muggon	11%	-	11%	-
ex Wooleen	52%	-	52%	-
All properties	13%	-	13%	-
Proposed 'Yaringa – Nanga' National Park				
ex Nanga (north)	<1%	-	<1%	-
All properties	<1%	-	<1%	-

Note: Where mining tenements and titles overlap, only one value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

Table 3-21: Applications for mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed 'Muggon – Wooleen' Conservation Park				
ex Muggon	1%	29%	31%	-
ex Wooleen	14%	-	14%	-
All properties	2%	28%	30%	-
Proposed 'Yaringa – Nanga' National Park				
ex Yaringa	24%	-	24%	-
All properties	4%	-	4%	-
Proposed Zuytdorp Nature Reserve expansion				
ex Nanga (south)	60%	-	60%	-
ex Tamala	23%	-	23%	-
All properties	23%	-	23%	-

Note: Where mining tenements and titles overlap, only one value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

Tourism operator, Darren Capewell of Wula Gura Nyinda Eco Adventures, takes a break on ex Carrarang. Photo: Glen Campbell

Table 3-22: Proposed park areas (%) free of existing mining-related activity

	No mineral Mining	No oil & gas mining	Combined
Proposed 'Carrarang' (Edel Land) National Park			
ex Carrarang	100%	100%	100%
Proposed Kalbarri National Park expansion			
ex Murchison House (south)	100%	100%	100%
Proposed 'Muggon – Wooleen' Conservation Park			
ex Muggon	89%	100%	89%
ex Wooleen	48%	100%	48%
All properties	87%	100%	87%
Proposed 'Yaringa – Nanga' National Park			
ex Nanga (north)	100%	100%	100%
ex Yaringa	100%	100%	100%
All properties	100%	100%	100%
Proposed Zuytdorp Nature Reserve expansionk			
ex Murchison House (north)	100%	100%	100%
ex Nanga (south)	100%	100%	100%
ex Nerren Nerren	100%	100%	100%
ex Tamala	100%	100%	100%
All properties	100%	100%	100%

3.6 Recommendations

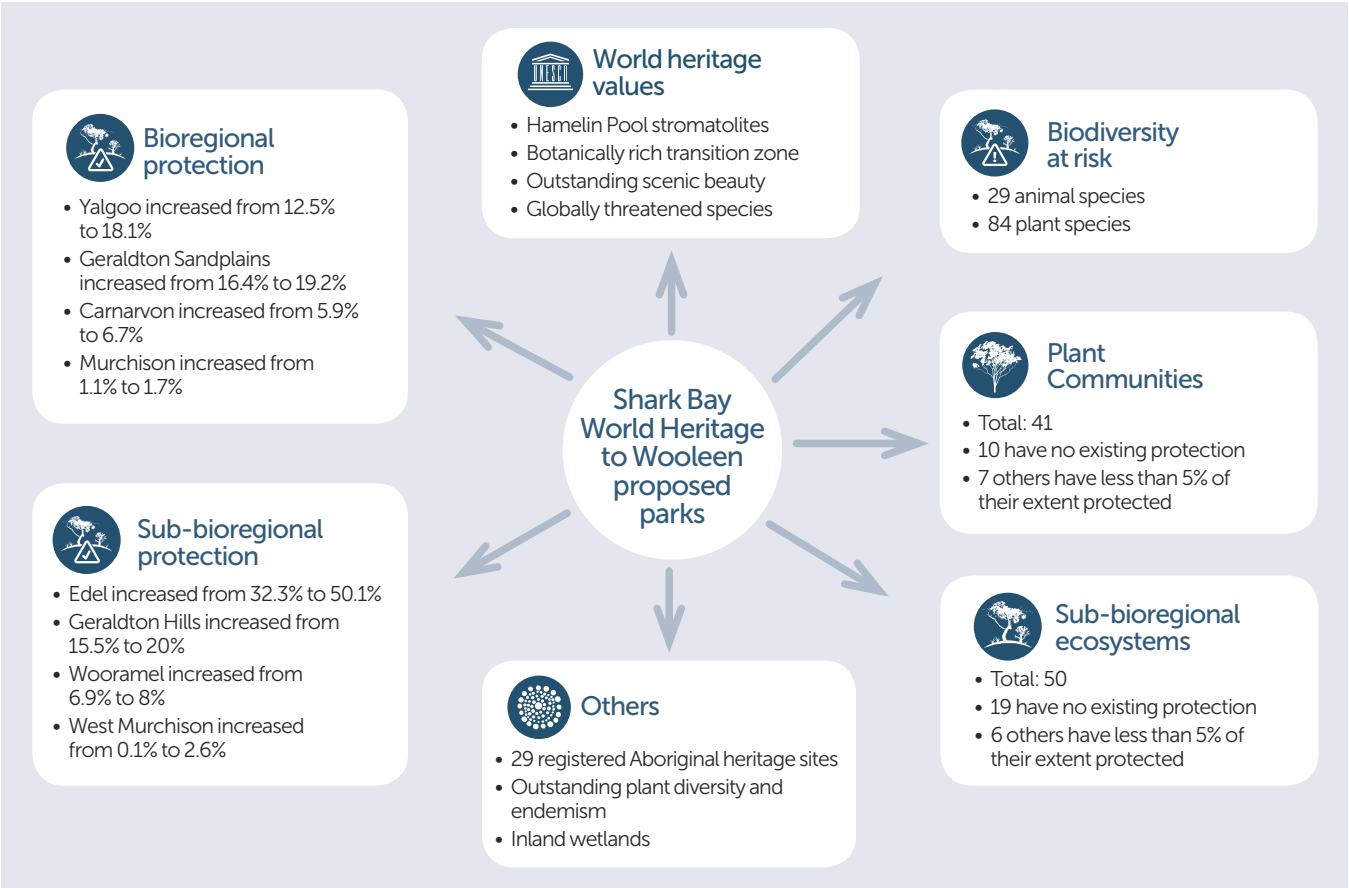
The proposals to create 3 new parks and expand 2 existing parks would add 613,000 hectares to the conservation reserve system, increasing the protection of world heritage values such as the stromatolites of Hamelin Pool, the floristically rich botanical transition zone, an important nesting site for the globally threatened loggerhead turtle, and the outstanding beauty of coastal scenery (see Figure 3-4). With the inclusion of additional parcels of unallocated Crown land, they would create a highly protected land-to-sea corridor, consolidating fragmented reserves and facilitating management of landscape-scale threats. They would protect 10 plant communities and 19 sub-bioregional ecosystems lacking representation in the current reserve system, as well as 5 ecosystems with more than 85% of their total extent encompassed by the parks. More than 100 threatened and priority species would be protected – 84 plant species and 29 animal species. The parks would increase protection of 4 bioregions and 4 sub-bioregions, and enable Western Australia to achieve the international benchmark for protection (17%) for the Yalgoo and Geraldton Sandplains bioregions and the Geraldton Hills sub-bioregion.

The proposed parks are mostly consistent with the intention of the Western Australian government as registered in the Australian government's 2016 Collaborative Australian Protected Areas Database (CAPAD, 2017).

Apart from a small part of 1 property, the proposed parks are all either determined or claimed as native title. They have substantial cultural values and would protect 29 registered Aboriginal heritage sites. The proposed configuration of new parks could facilitate joint management agreements with single Traditional Owner groups in the following way:

'Carrarang' (Edel Land) National Park, ' Yaringa – Nanga' National Park	Malgana people
Expanded Zuytdorp Nature Reserve, expanded Kalbarri National Park	Nanda people
'Muggon – Wooleen' Conservation Park	Wajarri Yamatji people

Figure 3-4: Some combined values of the proposed new parks



Recommendation 3-1

Declare ex Carrarang a Class A national park, incorporating the adjacent 40 metre strip of unallocated Crown land to the high-water mark.

Conservation considerations

The world heritage status and the nationally and internationally significant natural values of this 19,000-hectare property warrant high level protection. Its declaration as a Class A national park would be consistent with recommendations by the Department of Environment and Conservation and the Conservation Commission of Western Australia (DEC and CCWA, 2012, table 3). The Shark Bay management plan proposes that it be named the Edel Land National Park (DEC and CCWA, 2012). Also consistent with the management plan is the proposal here to include the 40 metre strip of unallocated Crown land from the high-water mark to the property boundary.

The world heritage values of ex Carrarang include an important nesting site for loggerhead turtles (endangered) and the outstanding beauty of its coast and wildflower blooms. The new park would protect 11 threatened and priority animal species – including the Shark Bay boodie, greater stick-nest rat and Shark Bay worm-lizard – and 11 threatened and priority plant species. It is part of a biologically important area (designated by the federal government) for certain seabird species that forage and breed in the area.

The native title party of this proposed park is the Malgana Shark Bay People, whose consent would be required for any change in tenure. Twelve registered Aboriginal heritage sites would be protected.

Mining considerations

Currently, 99.9% of ex Carrarang is free of existing or proposed mining-related activity. The miscellaneous lease L 09/6 (for a road or pipeline) covers just 22 hectares (0.1%) of the proposed park and expires in 2025. Measures could be taken to allow this lease to continue if required.

Recommendation 3-2

Declare ex Yaringa and ex Nanga (north) a Class A national park, incorporating the adjacent 40 metre strip of unallocated Crown land to the high-water mark.

Conservation considerations

Bordering Hamelin Pool and protecting much of its surrounding coastline, this proposed park serves a vital buffering function for the Shark Bay stromatolites, one of the most important features of the world heritage area. Other world heritage values include the outstanding beauty of the coastal scenery, the high plant diversity and endemism of the botanical transition zone (on ex Nanga), as well as threatened species. The properties harbour 22 threatened and priority plant species, including an endangered eucalypt (Beard's mallee), and 11 threatened and priority animal species, including curlew sandpiper, greater sand plover and malleefowl (all listed as vulnerable). The properties are part of biologically important areas for several seabird species. They would add 108,000 hectares to Western Australia's conservation reserve system.

The world heritage status and internationally and nationally significant values of this proposed park – particularly the buffering of Hamelin Pool, the high plant endemism and richness and 8 threatened and priority-1 species – warrant a very high level of protection. Although the 2012 Shark Bay management plan recommended that ex Nanga become a conservation park (DEC and CCWA, 2012, table 3), the values are consistent instead with Class A national park status. The proposed park would also make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. In particular, the park would add 0.9% of the Wooramel sub-bioregion (with less than 7% in existing reserves) and 0.7% of the Carnarvon bioregion (with less than 6% in existing reserves) to the reserve system.

The native title party of this proposed park is the Malgana Shark Bay people, whose consent would be required for any change in tenure. Six registered Aboriginal heritage sites would be protected. The southern part of ex Nanga, whose native title claimants are the Nanda people, could be incorporated into Zuytdorp Nature Reserve.

Mining considerations

These properties have low prospectivity and 99.6% of their area is free of existing mining-relating activities. The only granted mining tenement, a new exploration licence, covers part (0.4%) of ex Nanga (north). Upon declaration of the Class A national park, written consent of the Minister for Mines and Petroleum would be required for the exploration activities to continue. This consent, and consent for 2 recent exploration licence applications on ex Yaringa, should, in the public interest, not be granted.

Recommendation 3-4

Incorporate ex Tamala, ex Murchison House (north), ex Nerren Nerren, ex Nanga (south) and the adjacent 40 metre strip of unallocated Crown land to high-water mark into Zuytdorp Nature Reserve. Classify the entire nature reserve as Class A.

Conservation considerations

This proposal for ex Tamala, ex Murchison House (north) and the 40 metre strip of unallocated Crown land is consistent with recommendations in the 2012 Shark Bay management plan (DEC and CCWA, 2012, table 3). The values of ex Nerren Nerren and ex Nanga (south) warrant a similar level of protection. The properties would add 286,000 hectares to the conservation reserve system.

Ex Tamala and ex Nanga (south) are both part of the Shark Bay World Heritage Area, while ex Murchison House (north) and ex Nerren Nerren border the world heritage area. Their world heritage values include the high plant diversity and endemism of the botanical transition zone with its impressive wildflower blooms, and the beauty of coastal scenery such as the Zuytdorp Cliffs and shell beaches. The properties harbour 47 threatened and priority plant species – include an endangered eucalypt and 3 endangered or critically endangered spider orchids – as well as 8 threatened and priority animal species. They are part of the proposed wildlife corridor that would enable landscape-scale management and adaptation of species to climate and habitat changes.

The values of these properties – including the high plant diversity and endemism in the botanical transition zone, the large number of threatened and priority plant species, and the overlap with the Shark Bay World Heritage Area – are of national and international significance, warranting protection as a Class A national park. The proposed park would also make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. In particular, the park would add 4.1% of the Geraldton Hills sub-bioregion and 4.5% of the Yalgoo bioregion to the reserve system, enabling Western Australia to meet the 17% international benchmark for both, and protect 9 sub-bioregional ecosystems with little to no current representation in the reserve system. Given the significant natural values of both the existing reserve and the proposed expansion, the entire nature reserve should be afforded Class A status. This is consistent with a proposal by the Department of Environment and Conservation and the Conservation Commission of Western Australia in 2012 (DEC and CCWA, 2012).

The native title party of this proposed park is the Nanda people, whose consent would be required for any changes to tenure. Three registered Aboriginal heritage sites would be protected.

Mining considerations

These properties have low prospectivity and no existing mining-related activity. Four applications for exploration licences, spanning 65,000 hectares, were lodged in 1998 over parts of ex Nanga (south) and ex Tamala by a company that delisted in 2002. Given these properties are within the world heritage area and that 20 years has passed, they should not be granted.

Recommendation 3-5

Incorporate Murchison House (south) into Kalbarri National Park.

Conservation considerations

This proposed 9000-hectare addition to Kalbarri National Park would enhance the values of the park – adding to its diversity and extending protection along 30 kilometres of the lower reaches of the Murchison River. This property is part of the transition zone for south-west and arid zone plants, and has high botanical diversity, including 19 threatened and priority plant species. It also harbours 6 threatened and priority animal species, including Carnaby's cockatoo (endangered) and malleefowl (vulnerable). It would protect 1 plant community and 1 sub-bioregional ecosystem with little representation in existing reserves.

The nationally significant values of this property, including several threatened species, warrant extending the Class A status of the existing national park to this northern addition.

The native title party of this land is the Nanda people, whose consent would be required for any extension to the park. The park expansion would enable protection of an additional 7 registered Aboriginal heritage sites.

Mining considerations

This property has low prospectivity and no existing or proposed mining-related activity.

Recommendation 3-6

> Protect the large area of unallocated Crown land south of and between Toolonga Nature Reserve and ex Nerren Nerren as a conservation reserve.

Conservation considerations

This recommendation is consistent with the 2015 *Kalbarri National Park Management Plan*, which proposed the declaration of unallocated Crown land north-west of Kalbarri National Park as conservation reserves (DPaW, 2015a). With the gazettal of the region's former leasehold properties as protected areas and the potential to create a major wildlife corridor linking these properties with existing parks, this area should be assessed and designated an appropriate conservation tenure and classification.

Recommendation 3-7

> Declare ex Muggon and ex Wooleen a Class A conservation park.

Conservation considerations

This proposed conservation park would protect a chain of diverse wetlands, including salt pans, freshwater claypans, seasonal saline marshes and seasonal saline lakes, which are likely to be important for waterbirds and shorebirds. The specific values require further investigation, and potentially a revision of these recommendations if new and important information comes to light. The park would protect 17 threatened and priority species and constitute the eastern part of the proposed land-to-sea protected corridor from Shark Bay.

The natural values of these properties – including the wetlands, a threatened bird species (malleefowl), unique ecosystems, priority plant species (1 priority-1 and 5 priority-2 species) – are of regional significance, warranting protection as a conservation park.

The proposed park would make a significant contribution to Western Australia's conservation reserve system, warranting Class A status. In particular, the proposed park would add 2.5% of the West Murchison sub-bioregion (with less than 1% in existing reserves) and 0.6% of the Murchison bioregion (with just over 1% in existing reserves) to the reserve system, and protect 15 sub-bioregional ecosystems with little to no current representation in the reserve system. It is the only location where 1 plant community (a succulent steppe with bowgada scrub) and the Weenyung land system (both unique to ex Muggon) can be protected.

The native title holders of this proposed park are the Wajarri Yamatji people, whose consent would be required for any change in tenure. One registered Aboriginal heritage site would be protected.

Mining considerations

The majority of this area – 87% or 167,000 hectares – is free of existing mining-related activity. Applications for exploration, which cover 30% or 58,000 hectares, are currently being considered.

The oil & gas exploration permit application (STP-EPA-0111) covers almost all of the Weenyung land system while the mineral exploration licence (E 09/2220) covers almost all of the plant community 340 (a succulent steppe with bowgada scrub). Given that these natural features are not found elsewhere, it is critical that the Minister for Mines requires current and future activities to be assessed by the Environmental Protection Authority at the highest level and, if consent is granted, that conditions are applied to ensure these features are not placed at risk.

Three exploration licences – covering 25,000 hectares in south-west ex Muggon – overlay the largest series of lakes on this property. Given these features were a key reason for the acquisition of the property for conservation, and given mining activities are generally inconsistent with maintaining the natural values of wetlands, a similar procedure of assessment by the Environmental Protection Authority and subsequent application of precautionary conditions should be mandated by the Minister for Mines.

Any future granting of mining leases or changes to the purpose of the reserve should be fully considered and open to scrutiny through its classification as a Class A reserve.

4 Ningaloo to Exmouth Gulf

Protecting ex Giralia (shown in the foreground) as a national park is important for the health of Exmouth Gulf (in the background), one of Australia's most significant coastal environments, bordering the Ningaloo Coast World Heritage Area. Photo: Renae Boyd

Thorny devils (*Moloch horridus*) – ant eaters that grow 20 centimetres long and can live 20 years – are common on ex Giralia. Photo: Peter Le Scelle

4.1 At a glance

Proposed Ningaloo to Exmouth Gulf parks

Table 4-1: Former leasehold properties acquired for conservation

Property	Year Acquired	Size (hectares)	Traditional Owners (native title parties)
ex Boologooro	2001	15,000	Gnulli (100%)
ex Giralia	2002	232,000	Gnulli (99%), Thalanyji (1%)

Natural highlights

Greater protection for 2 nationally important wetlands including the world's largest inland mangrove community

A priority-1 ecological community, the Yarcowie Land System

23 threatened and priority species including bilbies and grey falcons

World class fossil sites including 100-million-year-old shark teeth

Greater protection for dozens of shorebird species, including 25 threatened and priority species

13 ecosystems and 7 plant communities with no protection in existing reserves

Progress towards the 2020 international benchmark for protection

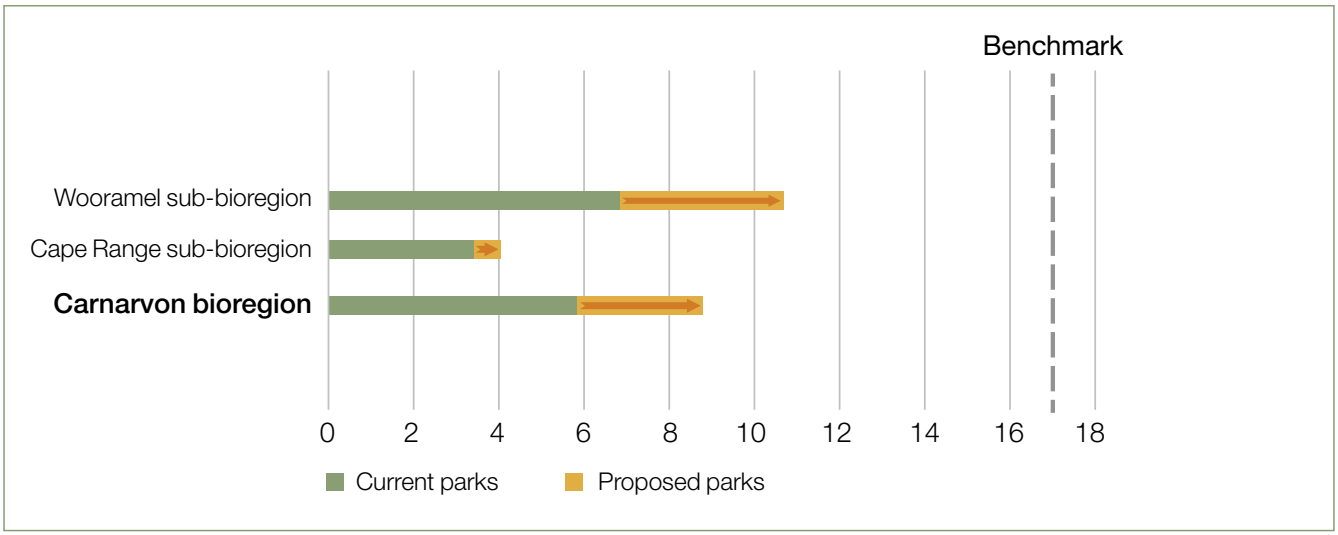


Figure 4-1: The potential increase in protection (% area) due to the proposed parks in bioregions and sub-bioregions where substantial progress can be made towards the international benchmark of 17%.

Reserve recommendations

Table 4-1: Proposed parks

Property	Recommended Protection	Recommended Classification
ex Giralia	Create a new national park	Class A
ex Boologooro	Create a new nature reserve	Class A

Weighing less than a box of matches, the red-necked stint (*Calidris ruficollis*) flies annually from Australia to Siberia to breed and then back again for the summer. Photo: Georgina Steytler

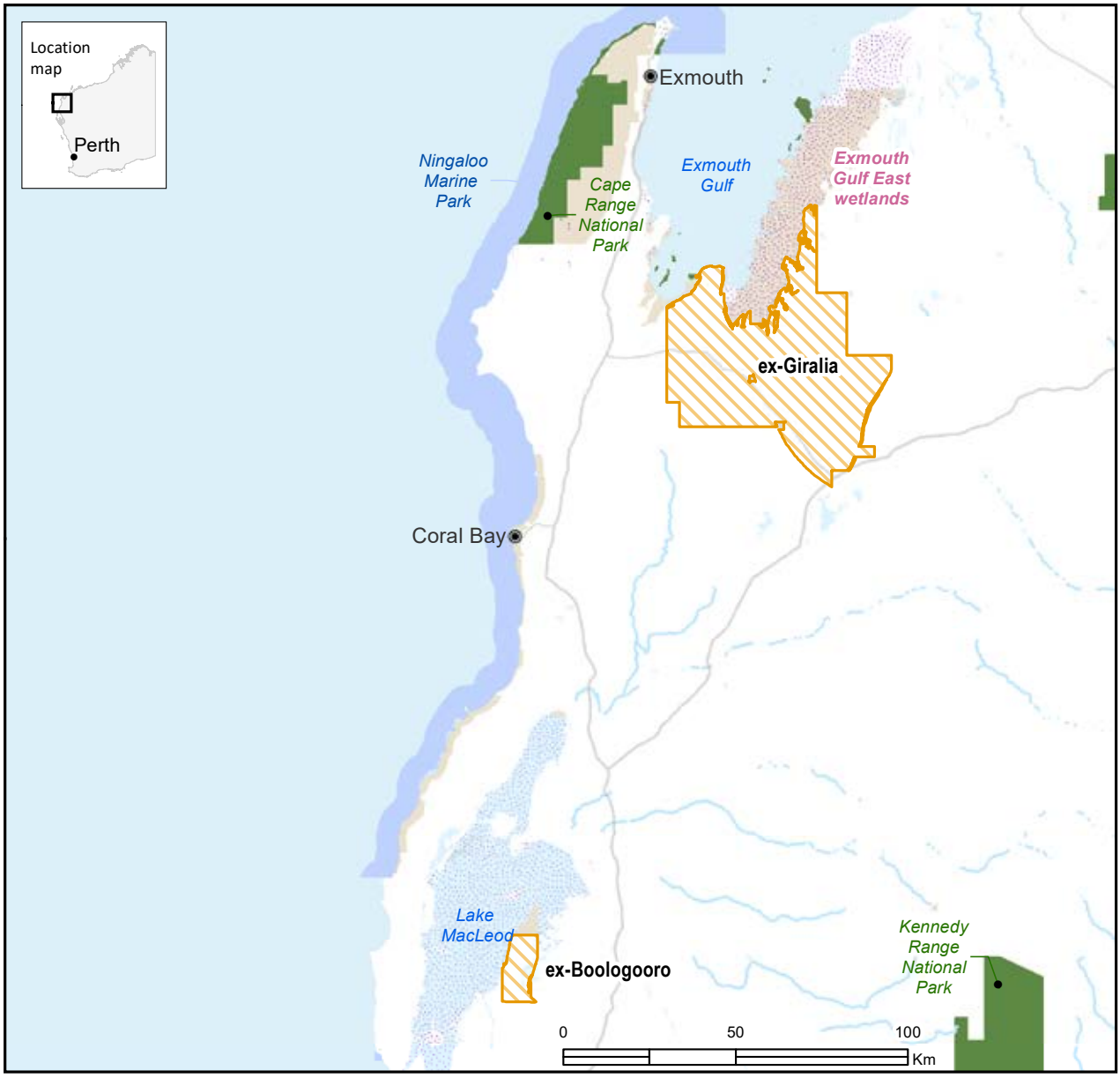


Figure 4-2: The proposed parks of 'Ningaloo to Exmouth Gulf'

4.2 Natural values for conservation

The 2 proposed conservation reserves lie near the Ningaloo Coast World Heritage Area. Their primary values lie with their proximity to 2 exceptional wetlands – Exmouth Gulf East and Lake MacLeod – each designated as nationally important and each highly productive for shorebirds and many other species and important for maintaining the health of coastal and marine habitats.

These properties were bought under the Gascoyne-Murchison Strategy by the state government (with contributions from the federal government) to add to the conservation reserve system. Although acquired more than 15 years ago, they remain as unallocated Crown land. As such, they lack the legal protections requiring assessment of the impact of new projects on the natural and cultural values for which they were acquired. Formal responsibility, but not full resourcing, for property management lies with the Department of Biodiversity, Conservation and Attractions.

The proposed parks offer the opportunity to protect a listed priority-1 ecological community, 5 threatened and priority plant species, 18 threatened and priority animal species as well as dozens of shorebird species (including more than 20 threatened and priority species) that use the wetlands. They are also biologically important areas for 2 seabird species.

The parks would add 247,000 hectares to the conservation reserve system, increasing representation of the inadequately protected Wooramel sub-bioregion and Carnarvon bioregion. They would protect 6 plant communities and 9 sub-bioregional ecosystems with no representation in existing reserves.

Here, in 2 subsections corresponding with the recommendations in section 4.6 and the map shown in Figure 4-2, we describe the natural values of these 2 former leasehold properties acquired for conservation.

4.2.1 Proposed 'Giralia' National Park

Former leasehold property: ex Giralia

Ex Giralia is a 232,000-hectare property on the eastern edge of Exmouth Gulf. About half of the property consists of sandplains and sand dunes, while the rest is predominantly limestone plains and hills, undulating stony plains and saline mudflats. The vegetation consists largely of spinifex, saltbush and bluebush, wattles, scattered eucalypts, and mangroves on the shoreline (Mitchell et al., 1988).

Protection of ex Giralia is important for the health of Exmouth Gulf, one of Australia's most significant coastal environments, bordering the Ningaloo Coast World Heritage Area. The gulf's eastern shore (Exmouth Gulf East) is a nationally important wetland (designated by the Australian government) and a key biodiversity area (designated by Birdlife Australia) (DEE, 2008b, DEWHA, 2008b, Birdlife, 2015). Ex Giralia shares 70 kilometres of its northern border with this wetland.

Currently, just 1% of the Exmouth Gulf East wetland is protected in reserves – in Tent Island Nature Reserve and the Burnside and Simpson Island Reserve. The proposed national park would double the protected wetland area. In addition, we endorse government reports recommending a high level of protection for the unallocated Crown land along the eastern shore of Exmouth Gulf, to the north of ex Giralia (EPA, 2008, Fig 4-2). Incorporating this into the proposed park would add about 100,000 hectares of extremely high-value wetland, values recognised by the Environmental Protection Authority and in a former recommendation by the Western Australian government to include it in the Ningaloo Coast World Heritage Area (EPA, 2008).

The Exmouth Gulf East wetland is described in its listing as a nationally important wetland as an 'outstanding example of tidal wetland systems of low coast of north-west Australia, with well- developed tidal creeks, extensive mangrove swamps and broad saline coastal flats' (DIWA, 2014). It includes one of the largest discrete areas of mangroves in Western Australia and mudflats that are up to 4 kilometres wide (at Giralia Bay).

The wetland provides extensive habitat for shorebirds and seabirds, including several threatened species. It is a migration stop-over for shorebirds. The mangroves and extensive seagrass beds in the Gulf provide nursery and feeding areas for marine fishes and crustaceans. The seagrass beds support a major dugong population (at least 1000 individuals) and a rich diversity of invertebrates and fish.

The proposed park would also protect about a third of the Yarcowie Land System, a listed priority-1 ecological community with a very restricted distribution threatened by overgrazing (Table 4-3) (DBCA, 2017a). This community consists of tussock grasslands or grassy shrublands on gilgaied soils on nearly flat plains.

Most of the 10 sub-bioregional ecosystems and 10 plant communities found on ex Giralia have little existing protection in the reserve system: 50% have no representation and 80% have less than 5% (Table 4-3). Five threatened and priority plant species have been recorded on the property (Table 4-4). Ex Giralia contains the entire extent of 1 ecosystem and is therefore the only location for its protection.

Ex Giralia is very important for threatened and priority animal species with 18 recorded there, including the night parrot (recorded there in 1967), bilby (vulnerable), grey falcon (vulnerable), lesser sand plover (endangered) and 4 other migratory shorebird species listed as vulnerable – eastern curlew, bar-tailed godwit, eastern curlew and greater sand plover (Table 4-4). The property is also part of the biologically important area for the wedge-tailed shearwater (BIAs, 2009).

Ex Giralia's ocean frontage exemplifies the complex and globally significant geomorphology of the Ningaloo coast. In the Giralia Range you can walk on ancient sea floors and find 100-million-year-old shark teeth weathering in the rock (WAM, 2017). Ex Giralia features world class fossil sites from the Cretaceous period (68-66 million years ago). It has one of the world's richest deposits of ammonites (an extinct cephalopod), and other fossils include the teeth of extinct sharks and bones of dinosaurs (WAM, 2017, Dans, 2010). The stratigraphy of Cape Range shows evidence of the collision of the Australian continent with Indonesia (Carter, 1987).

The bilby (*Macrotis lagotis*) (vulnerable) is one of 23 threatened and priority species recorded on ex Giralia. The species' inveterate digging habits benefit many other species, marking it as an 'ecosystem engineer'. Photo: Kathie Atkinson

The world's largest migratory shorebird, the eastern curlew (*Numenius madagascariensis*), has recently been listed in Australia as critically endangered. About three-quarters of the global population spend part of the year in Australia and fly annually to Russia and north-east China to breed.
Photo: Georgina Steytler

Table 4-3: Summary of conservation values of the proposed 'Giralia' National Park

ex Giralia (232,000 hectares)	
Important wetland	The property includes part of the Exmouth Gulf East wetland, listed as a wetland of national importance. Management of ex Giralia is essential for protecting its habitats including mangroves and seagrass beds.
Threatened & priority plants	5 species.
Threatened & priority animals	15 bird, 3 mammal, 1 reptile species.
Priority ecological community	38% of the tussock grasslands or grassy tall or low shrublands of the Yarcowie Land System (priority 1).
Plant communities	10 communities: 5 with 0% representation in existing reserves, 3 others with <5%.
Sub-bioregional ecosystems	10 ecosystems: 6 with 0% representation in existing reserves, 3 others with <5%. Only location for the protection of plant community 267 in the Cape Range sub-bioregion.
Biologically important area	Part of the BIA for the wedge-tailed shearwater (Puffinus pacificus) which forages and breeds in the area.
Buffering	Protection for the nationally important coastal margin in Exmouth Gulf and Venn Creek and the Exmouth Gulf Key Biodiversity Area.

Sources: See technical notes 1 and 2 (chapter 2).

Table 4-4: Threatened and priority species and ecological communities of the proposed 'Giralia' National Park

Species	Conservation class
Birds	
Night parrot *(Pezoporus occidentalis)*[A]	Critically endangered
Lesser sand plover *(Charadrius mongolus)*	Endangered / international agreement
Bar-tailed godwit *(Limosa lapponica baueri & L.l. menzbieri)*	Vulnerable / international agreement
Eastern curlew *(Numenius madagascariensis)*	Vulnerable / international agreement
Greater sand plover *(Charadrius leschenaultii leschenaultii)*	Vulnerable / international agreement
Grey falcon *(Falco hypoleucos)*	Vulnerable
Red knot *(Calidris canutus piersmai & C.c rogersi)*	Vulnerable / international agreement
Common greenshank *(Tringa nebularia)*	International agreement
Great egret *(Ardea modesta)*	International agreement
Pacific golden plover *(Pluvialis fulva)*	International agreement
Red-necked stint *(Calidris ruficollis)*	International agreement
Roseate tern *(Sterna dougallii)*	International agreement
Ruddy turnstone *(Arenaria interpres)*	International agreement
Whimbrel *(Numenius phaeopus)*	International agreement
Mammals	
Bilby *(Macrotis lagotis)*	Vulnerable
Brush-tailed mulgara *(Dasycercus blythi)*	Priority 4
Lakeland Downs mouse, kerakenga *(Leggadina lakedownensis)*	Priority 4
Reptiles	
Hermite Island worm-lizard *(Aprasia rostrata)*	Priority 3
Plants	
Sclerolaena stylosa	Priority 1
Acacia startii	Priority 2
Corchorus congener	Priority 2
Crinum flaccidum	Priority 3
Eremophila youngii subsp. *lepidota*	Priority 4
Ecological communities	
Tussock grasslands or grassy tall or low shrublands of the Yarcowie Land System (Carnarvon Basin)	Priority 1

Note: A. The most recent record for the night parrot on Giralia was 1967.

Sources: See technical notes 1 (chapter 2).

Table 4-5: The extent of protection (%) in the proposed 'Giralia' National Park for plant communities with inadequate protection in existing reserves

Plant communities with little to no protection in existing reserves	ex Giralia
No protection (<0.1%) in existing reserves	
VT 267 Succulent steppe with open scrub; scattered *Acacia sclerosperma* & *A. victoriae* over saltbush & bluebush	9.4
VT 658 Shrublands; *Acacia sclerosperma* & snakewood scrub (also with some waterwood)	22.1
VT 670 Hummock grasslands, shrub steppe; scattered shrubs over *Triodia basedowii*	9.9
VT 1322 Shrublands; *Acacia sclerosperma, A. victoriae* & snakewood scrub	1.5
VT 2675 Hummock grasslands, low tree & shrub steppe; scattered eucalypts, kanji over Triodia pungens & T. basedowii	38.8
Little protection (0.1 to 5%) in existing reserves	
VT 98 Hummock grasslands, shrub steppe; kanji over soft spinifex & *Triodia basedowii*	1.9
VT 676 Succulent steppe; samphire	0.2
VT 680 Hummock grasslands, shrub steppe; *Acacia bivenosa* over *Triodia basedowii*	23.9
Inadequate protection (5 to 15%) in existing reserves	
VT 127 Bare areas; mud flats	0.15

Sources: See technical notes 2 (chapter 2).

4.2.2 Proposed 'Boologooro' Nature Reserve

Former leasehold property: ex Boologooro

Ex Boologooro is a 15,000-hectare property on the eastern shore of Lake MacLeod, a large (220,000 hectare) salt lake inland from the Ningaloo Coast World Heritage Area. The property consists of saline and sandy plains vegetated mainly with low shrublands of samphire, bluebush and saltbush (DAFWA, 2017). Three of the 4 plant communities there have less than 5% protection in existing reserves and 3 of the 4 sub-bioregional ecosystems have no representation in existing reserves (Table 4-6, Table 4-8).

Lake MacLeod is a nationally important wetland that also has internationally significant values likely to warrant listing as a Ramsar wetland of international importance (Bertzeletos et al., 2012, Kavazos et al., 2017). Lake MacLeod is recognised as an 'outstanding example of a major coastal lake' with a 'unique assemblage of wetland types' (DIWA, 2014). Once a bay of the Indian Ocean, it became separated from the sea by sand dunes (at its southern end) and a fall in sea level. It now features, across about 6000 hectares, permanent shallow saline wetlands and inland mangrove swamps that are fed by seawater driven by tidal action about 20 kilometres through underground limestone channels and rising in sinkholes on the western side of the lake. This sort of wetland – a 'closed sabkha system that is permanently inundated' – is unique (Kavazos et al., 2017). Freshwater also enters the lake – from the Lyndon River, Minilya River and Cardabia Creek catchments and, in times of major flood, the Gascoyne River. The white mangroves (*Avicennia marina*) fringing the lake are the world's largest inland mangrove community, a relic of when these shores were coastal (mangrove seeds are dispersed by seawater) (Ellison and Simmonds, 2003).

More than 100,000 birds have been counted at a time on Lake MacLeod, and 70 species have been recorded, including several that breed there (Johnson, 2011). The lake is particularly important – of national and international significance to migratory as well as resident shorebirds – as a stopover, wintering and drought refuge area (Johnson, 2011, Bertzeletos et al., 2012) (see Box 4-1). Of the 25 species listed under international agreements, 7 are listed as threatened (see Table 4-7). The western part of ex Boologooro is part of a biologically important area for the fairy tern (Sterna nereis) (listed nationally as vulnerable), which breeds on the shores of Lake McLeod (BIAs, 2009).

Managing ex Boologooro as a nature reserve will help protect the values of Lake MacLeod. These values are at risk from invasive animals, weeds, mining and increased sedimentation due to grazing and erosion in the catchments of the rivers and creeks running into the lake (Kendrick and McKenzie, 2001, Johnson, 2011). Lake ecosystems are among the most vulnerable and difficult of natural systems to restore (Johnson, 2011).

Box 4-1: The importance of Lake MacLeod for shorebirds

Thirty-seven species of shorebirds have been recorded at Lake MacLeod, of which 28 are trans-equatorial migrants that travel along the East Asia–Australasian Flyway to breed in the northern hemisphere and 9 are nomadic Australian residents that move around the continent in response to rainfall. Seven of the migratory species have recently been listed as threatened primarily due to destruction of wetlands along their flyway (see Table 4-7).

Surveys between 1990 and 2006 showed that Lake MacLeod hosts 'significant' populations of at least 10 shorebird species – high enough to meet the Ramsar wetland criteria for international importance. Three species – red knot (vulnerable), red-necked stint and curlew sandpiper (vulnerable) – have occurred in internationally significant numbers (more than 1% of their flyway populations). The maximum number of curlew sandpipers recorded equalled 31% of the entire flyway population. Significant numbers (more than 1% of their national population) of 5 Australian residents – common greenshank, black-winged stilt, banded stilt, red-necked avocet and red-capped plover – have also occurred there. The lake appears to be a particularly important drought refuge for banded stilts (endemic to Australia). The maximum number recorded equalled 47% of their entire population. The lake is also internationally significant as a staging site for at least 2 more species – sharp-tailed sandpiper and greater sand plover (vulnerable).

The importance of Lake MacLeod for shorebirds has been boosted by the decline in wetlands elsewhere in Australia. Curlew sandpiper numbers on Victorian wetlands, for example, declined by 80% from the 1980s to mid-2000s.

Source: Bertzeletos et al. (2012)

The greater sand plover (*Charadrius leschenaultia*), recently listed in Australia as vulnerable, flies annually to central Asia to breed. It has suffered habitat loss on its migratory pathway and in Australia. Photo: Georgina Steytler

Table 4-6: Summary of conservation values of the proposed 'Boologooro' Nature Reserve

ex Boologooro	
Buffering	Effective management on ex Boologooro of feral animals, weeds and sedimentation is important for protecting the values of Lake MacLeod, a nationally important wetland with internationally significant values as a habitat for migratory and residential shorebirds.
Threatened & priority animals	25 threatened & priority shorebird species have been recorded at Lake MacLeod.
Plant communities	4 communities: 1 with 0% representation in existing reserves, 2 others with <5%.
Sub-bioregional ecosystems	4 ecosystems: 3 with 0% representation in existing reserves.
Biologically important area	The western part of ex Boologooro is part of a BIA for the fairy tern (Sterna nereis) (listed nationally as vulnerable), which breeds on the shores of Lake MacLeod.

Sources: See technical notes 1 and 2 (chapter 2).

Table 4-7: Threatened and priority birds of Lake Macleod (bordering the proposed 'Boologooro' Nature Reserve)

Species	Conservation class
Birds	
Lesser sand plover *(Charadrius mongolus)*	Endangered / International agreement
Bar-tailed godwit *(Limosa lapponica)*	Vulnerable / International agreement
Curlew sandpiper *(Calidris ferruginea)*	Vulnerable / International agreement
Eastern curlew *(Numenius madagascariensis)*	Vulnerable / International agreement
Great knot *(Calidris tenuirostriss)*	Vulnerable / International agreement
Greater sand plover *(Charadrius leschenaultia)*	Vulnerable / International agreement
Red knot *(Calidris canutus)*	Vulnerable / International agreement
Grey-tailed tattler *(Tringa brevipes)*	Priority 4 / International agreement
Asian dowitcher *(Limnodromus semipalmatus)*	International agreement
Black-tailed godwit *(Limosa limosa)*	International agreement
Broad-billed sandpiper *(Limicola falcinellus)*	International agreement
Common sandpiper *(Actitis hypoleucos)*	International agreement
Grey plover *(Pluvialis squatarola)*	International agreement
Little curlew *(Numenius minutus)*	International agreement
Long-toed stint *(Calidris subminuta)*	International agreement
Marsh sandpiper *(Tringa stagnatilis)*	International agreement
Oriental plover *(Charadrius veredus)*	International agreement
Pacific golden plover *(Pluvialis fulva)*	International agreement
Pectoral sandpiper *(Calidris melanotos)*	International agreement
Red-necked phalarope *(Phalaropus lobatus)*	International agreement
Red-necked stint *(Calidris ruficollis)*	International agreement
Ruddy turnstone *(Arenaria interpres)*	International agreement
Sharp-tailed sandpiper *(Calidris acuminata)*	International agreement
Terek sandpiper *(Xenus cinereus)*	International agreement
Wood sandpiper *(Tringa glareola)*	International agreement

Source: Bertzeletos et al. (2012)

The whimbrel (*Numenius phaeopus*) spends summer in Australia and breeds in the tundra of Siberia and Alaska. Photo: Georgina Steytler

Table 4-8: The extent of protection (%) in the proposed 'Boologooro' Nature Reserve for plant communities with inadequate representation in existing reserves

Plant communities with little to no protection in existing reserves	ex Boologooro
No protection (<0.1%) in existing reserves	
VT 325 Succulent steppe; saltbush & samphire	20.1
Little (0.1 to 5%) protection in existing reserves	
VT 308 Mosaic: Shrublands; Acacia sclerosperma sparse scrub / Succulent steppe; saltbush & bluebush	0.3
VT 676 Succulent steppe; samphire	0.1
Inadequate (5 to 15%) protection in existing reserves	
VT 125 Bare areas; salt lakes	<0.1

Source: See technical notes 2 (chapter 2).

4.3 Importance for achieving Western Australia's conservation reserve goals

The protection of these parks will help the Western Australian government meet or almost meet several targets for ecosystem and landscape protection.

Bioregional and sub-bioregional protection

The proposed parks encompass parts of both Carnarvon sub-bioregions, neither of which is adequately protected in Western Australia's reserve system. Protection of Wooramel would increase by 55% to 10.7% of the sub-bioregion and protection of Cape Range would increase by 21% to 4.1% of the sub-bioregion (Table 4-9). This would enable Western Australia to make good progress to achieving the 2020 international benchmark for Wooramel, but additional reserves in the Carnarvon bioregion should remain a high priority (Figure 4-3).

Ecosystem and plant community protection

The proposed parks would improve protection of 14 sub-bioregional ecosystems and 13 plant communities (Table 4-10). This would be the first such protection for 9 sub-bioregional ecosystems (64% of the total) and 6 plant communities (46%) lacking representation in the conservation reserve system (Table 4-10). Ex Giralia is the only option for protecting 1 ecosystem which is unique to the property.

Currently, more than a third of Western Australia's sub-bioregional ecosystems lack a minimum level of protection, based on a long-held national target of 15% of each ecosystem to be in reserves (JANIS, 1997, Taylor, 2017). The proposed parks would enable the minimum reserve target of 15% to be met for an additional:

- 5 sub-bioregional ecosystems (36% of the total ecosystems on the proposed parks)
- 4 plant communities (31% of the total communities on the proposed parks) (Table 4-10).

Table 4-9: Current and improved protection of bioregions and sub-bioregions (% protected) in Western Australia's conservation reserve system'Boologooro' Nature Reserve

	Bioregion	Sub-bioregion	
	Carnarvon	Wooramel	Cape Range
Current protection	5.89	6.86	3.44
Proposed parks	2.93	3.84	0.63
New total	8.82	10.70	4.07

Source: See technical notes 2 (chapter 2)

Notes: *Current protection* means the percentage of each bioregion and sub-bioregion protected in the existing conservation reserve system. *Proposed parks* means the percentage of each bioregion and sub-bioregion protected in the proposed parks. *New total* means the percentage of each bioregion and sub-bioregion that would be protected if the proposed parks are declared.

Figure 4-3: Progress towards the 2020 international benchmark (17%) for protection of bioregions and sub-bioregions (% area protected) due to the proposed parks

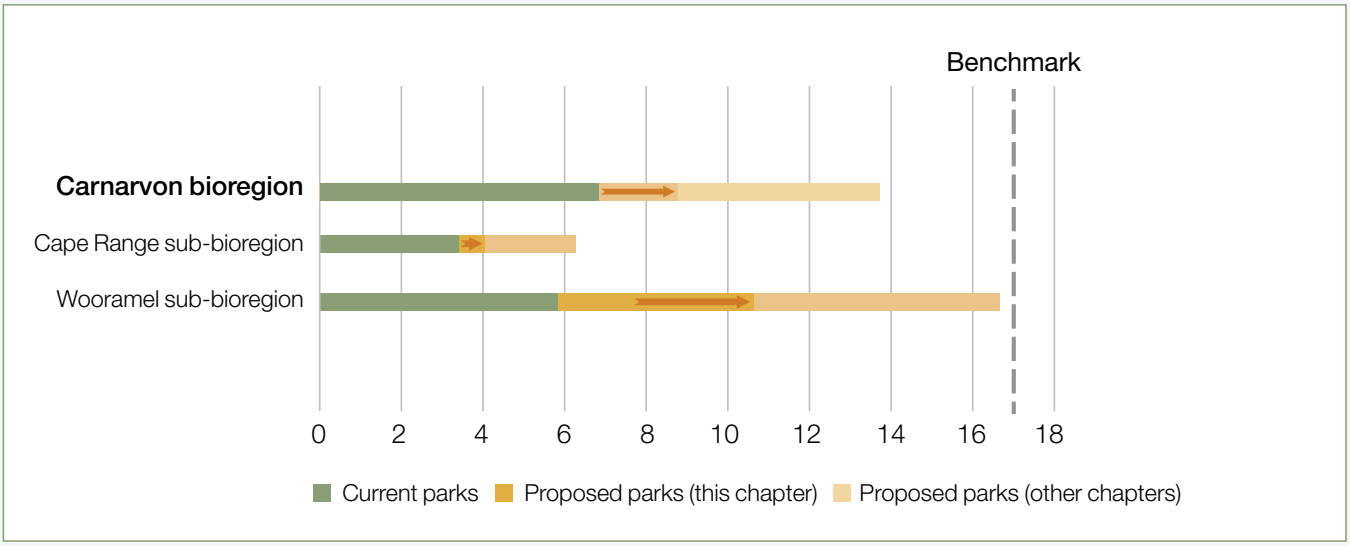


Table 4-10: Numbers of plant communities and sub-bioregional ecosystems in the proposed parks, levels of protection in the existing conservation reserve system and the contribution to protection of particular communities and ecosystems

	Plant communities (number & percentage)		Ecosystems (number & percentage)	
Improved protection in proposed parks				
Total in proposed parks	13	100%	14	100%
Will achieve 15% target[A]	4	31%	5	36%
Current level of protection in reserve system				
No existing protection (<0.1%)	6	46%	9	64%
Little existing protection (0.1-5%)	4	31%	3	21%
Inadequate protection (5.1-<15%)	2	15%	1	7%
Exceeds 15% protection	1	18%	1	7%
Contribution to protection of particular communities & ecosystems[B]				
Critical (>85% of total extent)	0	0%	1	7%
Very important (50–85% of total extent)	0	0%	0	0%
Important (10–50% of total extent) 4	3	1%	6	43%

Sources: See technical notes 2 (chapter 2)

Notes: A. This assumes protection in other proposed parks and does not include ecosystems that already have more than 15% of their extent protected in the conservation reserve system. B. This represents the number of communities or ecosystems with a substantial proportion of their total extent in the proposed parks. For example, the proposed parks are 'critical' for ecosystem protection where more than 85% of the entire ecosystem extent occurs within those proposed parks.

Dingoes (*Canis lupus dingo*) arrived in Australia probably about 3500 years ago. Although predators themselves, they are thought to benefit some threatened species by suppressing the abundance or activities of feral cats and foxes. Photo: Gary Meredith

Grey plovers (*Pluvialis squatarola*) fly annually to the Siberian tundra to breed. Almost all in Australia are females, the males presumably spending the non-breeding season further north. Photo: Georgina Steytler

4.4 Native title and Aboriginal heritage sites

Both properties lie within the Gnulli native title claim application area (Table 4-11). The proposed parks would protect 6 registered Aboriginal heritage sites and another 2 locations which may become future registered sites if more information becomes available.

Beyond these registered heritage sites and the significance of the broader landscapes to Traditional Owners, native title parties will continue to play a key role in determining whether the proposal for these properties to become parks is implemented.

Table 4-11: Native title status and Aboriginal heritage sites in the proposed parks

Native title party, claimed or determined (percentage of property)	Registered Aboriginal heritage sites
Proposed 'Giralia' National Park	
ex Giralia	
Gnulli, claim application (100%)	6 sites (4 that would be fully protected, 2 partially): all artefact scatters
Proposed 'Boologooro' nature reserve	
ex Boologooro	
Gnulli, claim application (100%)	No registered sites

Sources: See technical notes 3 (chapter 2), data current to November 2018.

4.5 Geology, prospectivity and mining

The Ningaloo Coast lies on the western edge of the Australian continent, originating from successive break-ups of the supercontinents Pangaea and Gondwana 180 to 50 million years ago (DEWHA, 2010). The Carnarvon Basin (which encompasses the Ningaloo area) formed as the Indian and Australian tectonic plates separated. Over millions of years, this basin filled with thousands of metres of sedimentary rock. For much of that time, the current coastal area was covered by shallow seas. Uplift has occurred intermittently since the late Cretaceous period. The Ningaloo region is underlain by about 10 kilometres of marine sedimentary rocks (from the Permian to Cretaceous periods). Above this bedrock are limestone rocks (from the Palaeogene, 60–20 million years ago) formed from silt, mud and the skeletal remains of billions of marine organisms. As sea levels rose and fell, the limestones were overlain by and interbedded with various marine sediments.

The following information on geology, prospectivity and mining activity on each property comes from the following sources: Belford (2017), DMIRS (2018b) and DMIRS (2018a). The extent of proposed and existing mining-related activity is summarised in Tables 4-12 to 4-14.

Proposed 'Giralia' National Park

This property is dominated by limestone and sandstone in the east, and has a mixed geology in the west. There is generally low mineral prospectivity, but there may be some prospect for industrial mineral mining. There are no known mineral deposits.

Mining activity: Two applications for exploration licences in the north-east of ex Giralia (covering 5% of the property) were submitted in July 2017 (E 08/2929, E 08/2934). They overlay the nationally important wetlands of Exmouth Gulf. A temporary minerals reserve overlaps the same north-eastern tip of ex Giralia. This is held by the Minister for Mines and Petroleum and covers the lease area of the Yannarie solar salt facility project, which did not proceed following strong public opposition. Two other applications for exploration licences cover about 10% of ex Giralia – E 08/2991 in the west (submitted in May 2018) and E 08/2940 in the east (submitted in August 2017).

Areas without mining activity: 92% of ex Giralia is free of existing mining-related activities. Applications for exploration covering 12% of the property are currently being considered.

Proposed 'Boologooro' Nature Reserve

This property is underlain with limestone and sandstone deposits from the Miocene and Quaternary periods. It has low mineral prospectivity. There are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities. Adjacent to ex Boologooro, a large evaporative salt mine (for salt and gypsum) operates on a production lease (ML 245SA) over the majority of Lake MacLeod. This mine currently uses only a small percentage of its total lease area.

Areas without mining activity: 100% of ex Boologooro is free of existing or proposed mining-related activities.

Common greenshanks (*Tringa nebularia*) fly annually to Siberia to breed. Like other migratory shorebirds, they have lost habitat along their migratory pathway and in Australia. Photo: Georgina Steytler

Table 4-12: Existing mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed 'Giralia' National Park				
ex Giralia	8%	-	8%	-

Note: Where mining tenements and titles overlap, only 1 value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

Table 4-13: Applications for mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed 'Giralia' National Park				
ex Giralia	12%	-	12%	-

Note: Where mining tenements and titles overlap, only 1 value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

Table 4-14: Proposed park areas (%) free of existing mining-related activity

	No mineral Mining	No oil & gas mining	Combined
Proposed 'Boologooro' Nature Reserve			
ex Boologooro	100%	100%	100%
Proposed 'Giralia' National Park			
ex Giralia	92%	100%	92%

Ex Giralia was a pastoral station from 1888 until its purchase by government for conservation purposes in 2002. Photo: Pepe Clarke

4.6 Recommendations

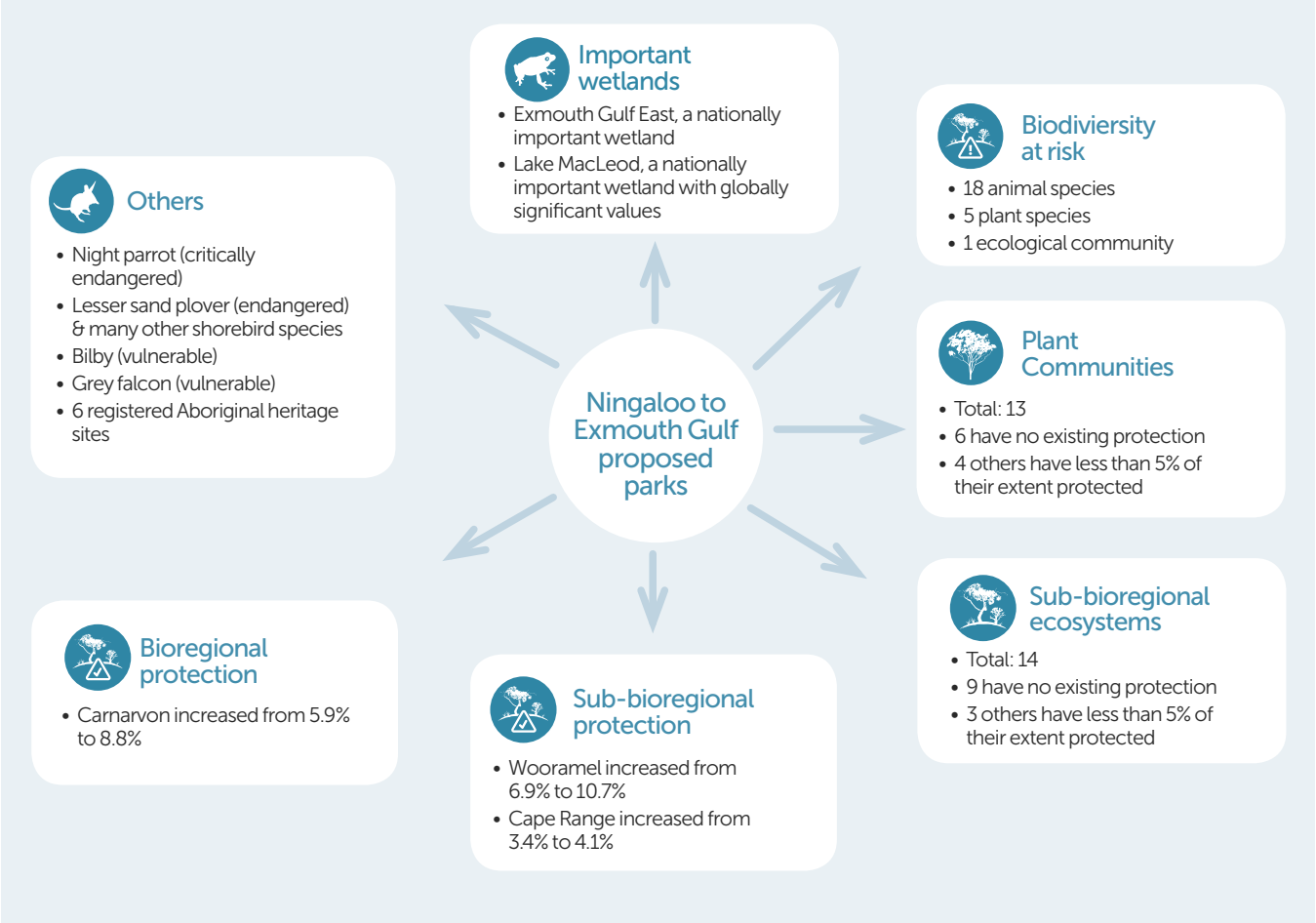
The proposals to create 2 new parks would add 247,000 hectares to the reserve system in the vicinity of the Ningaloo world heritage coastline. This is consistent with the intention of the Western Australian government as registered in the 2016 Collaborative Australian Protected Areas Database (CAPAD, 2017).

The parks would help protect 2 large wetland areas, each designated as nationally important and each highly productive for wildlife, including many threatened and priority shorebird species. Effective management of these properties (water quality, sedimentation, weeds, feral animals) is essential to maintain the health of these important wetlands.

The proposed parks also offer the opportunity to protect a listed priority-1 ecological community, 6 plant communities and 9 sub-bioregional ecosystems lacking any representation in the current reserve system, and 23 threatened and priority species (see Figure 4-4). They would substantially increase the extent of the poorly protected Wooramel sub-bioregion and Carnarvon bioregion in reserves.

The proposed parks are in the Gnulli native title claim application area. They would protect 6 registered Aboriginal heritage sites.

Figure 4-4: Some combined values of the proposed new parks



Recommendation 4-1

Declare ex Giralia as a Class A national park. Incorporate the adjacent Exmouth Gulf East wetland, which is currently unallocated Crown land, into the park.

Conservation considerations

Ex Giralia (232,000 hectares) and adjacent unallocated Crown land provide a major opportunity to add to the protection of one of Australia's most significant coastal environments, as reflected in the world heritage listing of the nearby Ningaloo Coast. The reservation of these areas would protect the nationally important wetland, key biodiversity area and estuaries of East Exmouth Gulf. The adjacent unallocated Crown land, about 100,000 hectares extending west and north of ex Giralia, has been recognised by the Western Australian government and the Environmental Protection Authority as one of the most important environmental assets in the state, requiring the highest level of protection.

The high biodiversity values of ex Giralia include 18 threatened and priority animal species, 5 threatened and priority plant species and a listed priority-1 ecological community. The mudflats are used as a migration stop-over by shorebirds and the mangroves serve as a nursery for fishes and crustaceans. The health of the productive seagrass beds, which support a large dugong population, relies on effective management of ex Giralia.

The values of ex Giralia – particularly the nationally important wetland, the priority-1 ecological community, 9 threatened and priority-1 species, and its importance for shorebirds listed under international agreements – are of national and international significance, warranting protection in a Class A national park. The proposed park would also make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. In particular, the proposed park would add 3.8% of the Wooramel sub-bioregion (with less than 7% in existing reserves) and 2.8% of the Carnarvon bioregion (with less than 6% in existing reserves) to the reserve system, and protect 9 sub-bioregional ecosystems with little to no current representation in the reserve system. Ex Giralia contains the entire extent of 1 ecosystem and is therefore the only option for its protection.

The native title claimants are the Gnulli native title claim group, whose consent would be needed for the park. Six registered Aboriginal heritage sites would be protected.

Mining considerations

Currently, 92% of ex Giralia is free of existing mining-related activities. Mineral exploration is generally not compatible with maintaining the values of fragile and important wetland areas and rare ecosystems. Strong public opposition to industrial salt operations in the area has previously resulted in the refusal of a large project.

An existing exploration licence (E 08/2929) and one application (E 08/2934) span the most fragile mangrove and nationally important wetland areas of Exmouth Gulf. Another application (E 08/2991) overlays the Yarcowie Land System, a poorly known priority-1 ecological community, and spans most of an ecosystem unique to ex Giralia.

The 4 exploration licence applications that are pending for Giralia and any future applications should be refused on public interest grounds due to likely adverse impacts on the fragile ecology and unique coastal attributes of Exmouth Gulf and ex Giralia. The existing exploration licence would require ministerial consent for activities to proceed. This consent should also not be granted on public interest grounds.

Samphire communities, which receive little protection in existing reserves, occur among the mangroves of Exmouth Gulf on the shores of ex Giralia. Photo: Renae Boyd

Recommendation 4-2

Declare ex Boologooro as a Class A nature reserve.

Conservation considerations

The designation of ex Boologooro (15,000 hectares) as a nature reserve would help protect the adjacent Lake MacLeod, a nationally important wetland with internationally significant values. This 'unique assemblage of wetland types' includes saline wetlands that are very important feeding and breeding sites for waterbirds, including for 25 internationally protected migratory bird species, some of which are threatened. The property is also part of a biologically important area for the threatened fairy tern. The lake features the world's largest inland mangrove community.

The values of ex Boologooro – particularly the adjacent nationally important wetland and its importance for migratory shorebirds listed under international agreements, some of which are also threatened – are of national and international significance, warranting protection in a Class A reserve. Maintaining the park's values requires science-based management, warranting declaration as a nature reserve. The proposed park would also make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. It would add 0.6% of the Cape Range sub-bioregion (with less than 4% in existing reserves) to the reserve system and protect 3 sub-bioregional ecosystems and 1 plant community with no current representation in the reserve system.

The native title claimants for ex Boologooro are the Gnulli native title claim group, whose consent would be needed for the reserve.

Mining considerations

Currently, 100% of ex Boologooro is free of existing or proposed mining-related activity. Mining is not compatible with maintaining the values of fragile and important wetland areas such as Lake MacLeod. Given the risk that mining activities would pose to the values of the property and adjacent wetlands, any future applications for exploration licences or mining lease should not be granted.

The mangrove systems on the eastern margins of Exmouth Gulf are areas of high primary productivity important for sustaining the health and diversity of Exmouth Gulf and the nearby Ningaloo Reef. Photo: Pepe Clarke

Lake MacLeod is Australia's westernmost lake and a nationally important wetland that also has values likely to warrant listing as a Ramsar wetland of international importance. It would be afforded greater protection through the creation of the 'Boologooro' Nature Reserve.
Photo: Gnaraloo Wilderness Foundation

5 Kennedy Range Country

A flowering native bush tomato on the road to Sunrise View lookout, Kennedy Range National Park. Photo: Michael Pelusey

The proposed additions of former leasehold properties to Kennedy Range National Park would more than double the park area and substantially improve landscape connectivity. Photo: Simon Nevill

5.1 At a glance

Proposed parks

Table 5-1: Former leasehold properties acquired for conservation

Property*	Year Acquired	Size (hectares)	Traditional Owners (native title parties)
ex Bidgemia	1999	7,000	Gnulli (100%)
ex Doorawarrah	2012	15,000	Gnulli (100%)
ex Jimba Jimba	1999	6,000	Gnulli (100%)
ex Lyons River	1999	11,000	Gnulli (100%)
ex Mardathuna	1999	32,000	Gnulli (100%)
ex Middalya	1999	14,000	Gnulli (96%), Thudgari (3%)
ex Minnie Creek	2001	7,000	Gnulli (100%)
ex Mooka	2000	80,000	Gnulli (100%)
ex Pimbee	1998	99,000	Gnulli (95%), Malgana (5%)
ex Williambury	1999	21,000	Gnulli (95%), Thudgari (4%), Thiin-Mah Warriyangka, Tharrkari, Jiwarli (1%)

* The current tenure of all properties is unallocated Crown land.

Natural highlights

18 priority species and ecological communities including plants unique to Kennedy Range

5 plant communities and 13 ecosystems with no protection in existing reserves

Kennedy Range National Park would more than double in area

Scenic beauty, remoteness and naturalness

Springs and soaks fringed with river red gums and paperbarks

Marine fossils revealing geological evolution

Progress towards the 2020 international benchmark for protection

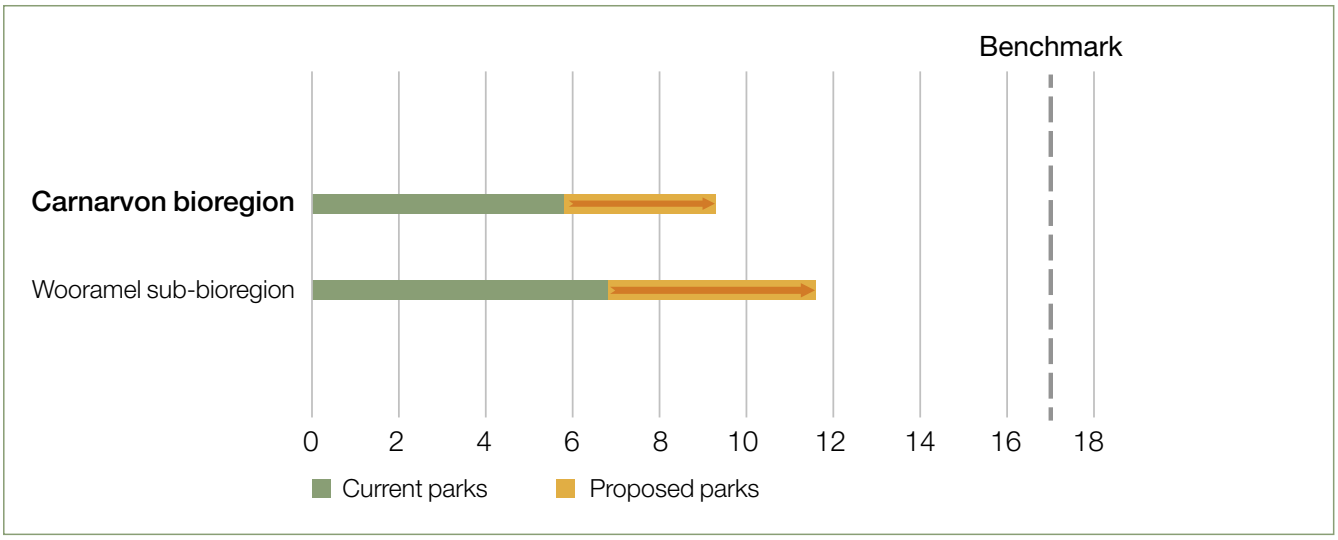


Figure 5-1: The potential increase in protection (% area) due to the proposed parks in bioregions and sub-bioregions where substantial progress can be made towards the international benchmark of 17%.

Reserve recommendations

Table 5-2: Proposed parks

Property	Recommended Protection	Recommended Classification
ex Bidgemia, ex Doorawarrah, ex Jimba Jimba, ex Lyons River, ex Mardathuna, ex Middalya, ex Minnie Creek, ex Mooka, ex Williambury	Expand Kennedy Range National Park	Class A
ex Pimbee	Create a new conservation park	Class A

Australia's only bee-eater, the rainbow bee-eater (*Merops ornatus*) migrates north for winter into northern Australia, New Guinea and southern Indonesia. Here they huddle for warmth in the early morning. Photo: Gary Meredith

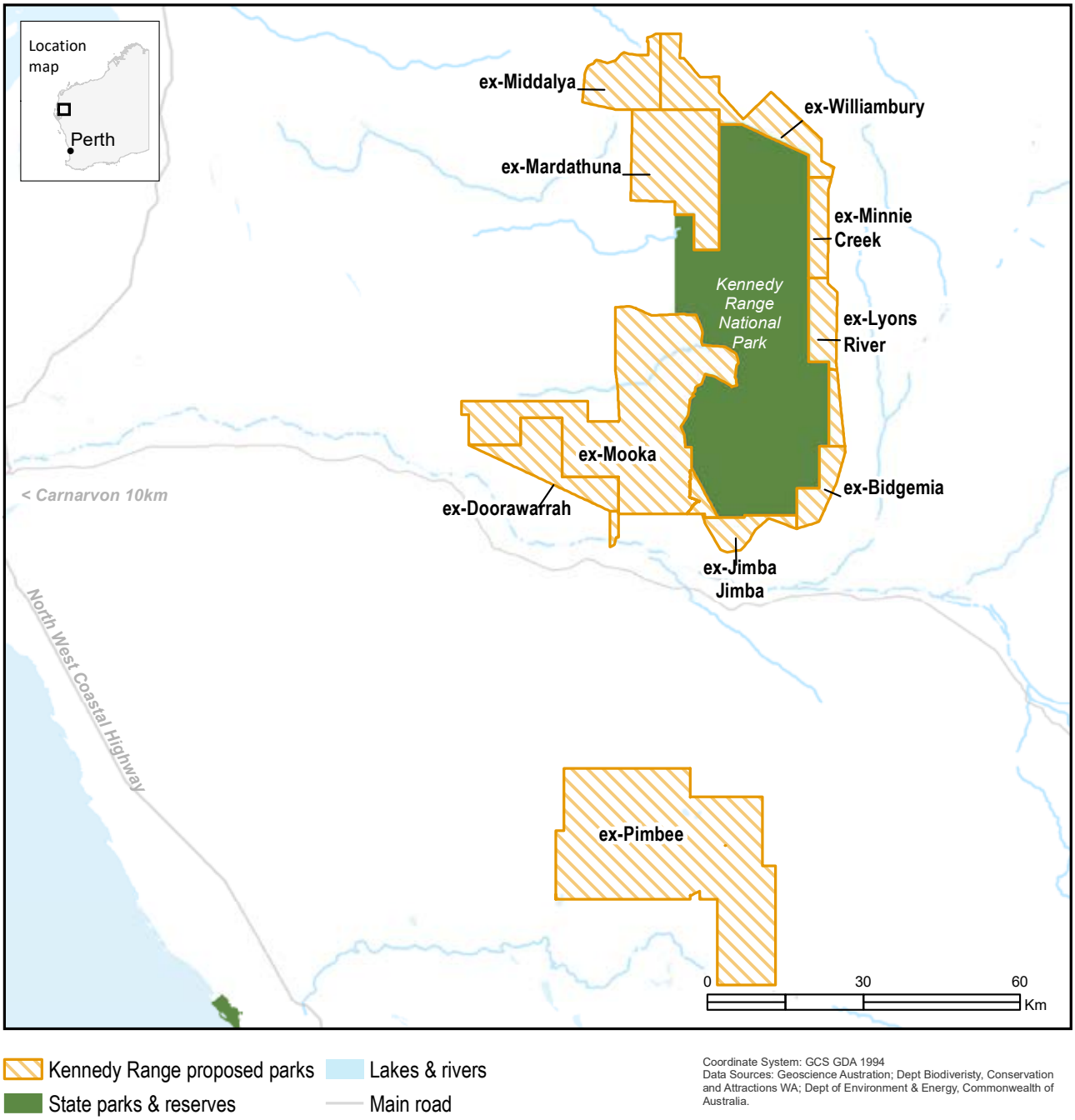


Figure 5-2: The proposed parks of 'Kennedy Range Country'

5.2 Natural values for conservation

Kennedy Range Country is characterised by red sandy plains and stony plains with wattle shrublands and woodlands, and the range itself – a weathered sandstone plateau rising 100 metres above the plains.

The new park areas would add 292,000 hectares to the conservaton reserve system, 9 as additions to Kennedy Range National Park and 1 as a new conservation park. These offer the opportunity to substantially improve protection of the range – by capturing its northern extent and buffering it on all sides – and adding to the reserve system 8 plant communities and 13 sub-bioregional ecosystems lacking representation in existing reserves. The parks would also protect 2 listed priority ecological communities and 17 priority species. They would increase protection of the Wooramel sub-bioregion (a national priority due to its low level of protection) by 70%.

The properties were mostly bought under the Gascoyne-Murchison Strategy by the state government (with contributions from the federal government) to add to the reserve system. Although acquired up to 20 years ago, they remain as unallocated Crown land. As such, they lack the legal protections requiring assessment of the impact of new projects on the natural and cultural values for which they were acquired. Six of the properties – ex Bidgemia, ex Jimba Jimba, ex Lyons River, ex Mardathuna, ex Williambury and ex Middalya – are managed under section 33(2) of the Conservation and Land Management Act (formally under CEO management by order of the Governor). Responsibility for, but not full resourcing of, property management lies with the Department of Biodiversity, Conservation and Attractions.

Here, in 2 subsections corresponding with the recommendations in section 5.6 and the map in Figure 5-2, we describe the natural values of these 10 former leasehold properties acquired for conservation.

5.2.1 Proposed additions to Kennedy Range National Park

Former leasehold properties: ex Bidgemia, ex Doorawarrah, ex Jimba Jimba, ex Lyons River, ex Mardathuna, ex Middalya, ex Minnie Creek, ex Mooka, ex Williambury

Kennedy Range is a weathered sandstone plateau, 12 to 25 kilometres wide and about 80 kilometres long, rising about 100 metres from the surrounding plain. It is an isolated remnant of an ancient land surface with 'outstanding geology' that can help 'unravel Australia's recent geological evolution' (DEC, 2008). As revealed by marine fossils (mostly fossilised burrows), the area was once a marine shelf and fringing shoreline. Sand and silt were deposited and compressed over millions of years to form beds of sandstone and siltstone. The range was probably created by uplift about 20 million years ago and then eroded away (DEC, 2008). Arid conditions during the Pliocene and Pleistocene led to the establishment of dunefields over the range and surrounding areas.

The top of the Kennedy Range plateau is mostly a sandy plain of large red sand dunes and wide swales with spinifex grasses and shrubs. The eastern escarpment has dramatic sandstone cliffs dissected by steep canyons, which turn into waterfalls after rain. This escarpment and its steep footslopes support tall shrublands of mulga and other wattles. The western slopes, with tall wattle shrublands and stony footslopes, are lower and less steep.

The addition of parts of 9 former pastoral leases (193,000 hectares) to Kennedy Range National Park (142,000 hectares) would more than double the park area and substantially improve landscape connectivity by capturing the northern extent of the range and creating a buffer around the range. They would add to the scenic beauty and 'qualities of remoteness and naturalness not readily available elsewhere' in the Carnarvon bioregion (DEC, 2008).

The proposed additions include plant communities and sub-bioregional ecosystems poorly protected in existing reserves. Four of the 14 plant communities and 7 of the 14 ecosystems have no existing protection in the reserve system (Tables 5-3 and 5-5). Ex Mooka

includes an extensive part of the Yalbalgo land system (dunes and broad swales with wattles, shrubs and spinifex), not currently represented in the reserve system.

Springs and soaks are an important value, particularly those on ex Mooka. Mooka Spring and its associated creek are a regionally significant aquatic system and part of a listed priority ecological community, springs of the western Kennedy Range (Table 5-3) (DEC, 2008, DBCA, 2017a). The springs are fringed with a forest community of tall river gums and cadjeputs. They support rich invertebrate communities, including species mostly not found elsewhere in the region.

Another priority ecological community, represented on 4 properties, is the spinifex-dominated plant assemblages of the sand dunes on top of the plateau (Table 5-3).

Over 400 native plant species have been recorded across the park and proposed extension, including species unique to the area and at least 80 annual wildflower species (DEC, 2008). The plants are mainly arid species, including daisies, fanflowers, hibiscuses, mulla mullas, peas, poverty bushes and wattles. The major challenge for park managers is controlling feral goats, which can severely damage plants and springs through overgrazing and trampling (DEC, 2008). Nine priority plant species have been recorded on the proposed park additions, including an undescribed pea (*Tephrosia*) and myrtle (*Calytrix*) recorded only on Kennedy Range (Table 5-4).

More than 150 native vertebrate animal species have been recorded in the park and proposed additions (33 reptiles, 103 birds and 20 mammals). A skink, *Lerista kennedyensis*, is unique to the area. One major opportunity that the proposed park extension could help realise in the future is the reintroduction of several mammals lost from the Kennedy Range such as the western pebble-mound mouse, Shark Bay mouse, western barred bandicoot, greater stick-nest rat, bilby, chuditch, black-flanked rock-wallaby and banded hare-wallaby (DEC, 2008). This would require more-effective control of feral animals, particularly cats and goats.

The view from Kennedy Range overlooking ex Mooka, which, if added to the park, would protect freshwater springs of regional significance.
Photo: Renae Boyd

Table 5-3. Summary of the conservation values of the proposed additions to Kennedy Range National Park

ex Williambury (21,000 hectares)	
Threatened & priority plants	2 species.
Priority ecological community	Plant assemblages (spinifex dominated) of sand dune mesa topping the Kennedy Range National Park (priority 4).
Plant communities	7 communities: 1 with 0% representation in existing reserves, 3 others with <5%.
Sub-bioregional ecosystems	7 ecosystems: 2 with 0% representation in existing reserves, 3 others with <5%.
Buffering & connectivity	Extension to north-eastern Kennedy Range National Park.

ex Bidgemia (7,000 hectares)	
Plant communities	3 communities: 1 with <5% representation in existing reserves.
Sub-bioregional ecosystems	3 ecosystems: 1 with <5% representation in existing reserves.
Buffering & connectivity	Extension to eastern Kennedy Range National Park.

Lyons River (11,000 hectares)	
Threatened & priority plants	6 species
Threatened & priority animals	2 species.
Priority ecological communities	1 community: plant assemblages (spinifex dominated) of sand dune mesa topping the Kennedy Range National Park (priority 4).
Plant communities	5 communities: 2 with <5% representation in existing reserves.
Sub-bioregional ecosystems	5 ecosystems: 2 with <5% representation in existing reserves.
Buffering & connectivity	Extension to eastern Kennedy Range National Park.

ex Minnie Creek (7,000 hectares)	
Threatened & priority plants	2 species.
Priority ecological communities	1 community: plant assemblages (spinifex dominated) of sand dune mesa topping the Kennedy Range National Park (priority 4).
Plant communities	4 communities: 1 with <5% representation in existing reserves.
Sub-bioregional ecosystems	4 ecosystems: 1 with <5% representation in existing reserves.
Buffering & connectivity	Extension to eastern Kennedy Range National Park.

ex Jimba Jimba (6,000 hectares)	
Plant communities	3 communities: 1 with <5% representation in existing reserves.
Sub-bioregional ecosystems	3 ecosystems: 1with <5% representation in existing reserves.
Buffering & connectivity	Extension to southern Kennedy Range National Park.

ex Mooka (80,000 hectares)	
Threatened & priority plants	3 species.
Threatened & priority animals	3 species.
Priority ecological communities	1 community: Springs of the western Kennedy Ranges; the Mooka spring and associated creek are an ecological community of 'regional significance' (priority 4).
Plant communities	9 communities: 2 with 0% representation in existing reserves, 4 others with <5%.
Sub-bioregional ecosystems	9 ecosystems: 4 with 0% representation in existing reserves, 3 others with <5%.
Buffering & connectivity	Extension to south-western Kennedy Range National Park.

Table 5-3. (continued)

ex Doorawarrah (15,000 hectares)	
Threatened & priority animals	1 species.
Plant communities	3 communities: 2 with 0% representation in existing reserves, 1 other with <5%.
Sub-bioregional ecosystems	3 ecosystems: all with 0% representation in existing reserves.
Buffering & connectivity	Extension to south-western Kennedy Range National Park.

ex Mardathuna (32,000 hectares)	
Threatened & priority animals	1 species.
Priority ecological communities	1 community: Plant assemblages (spinifex dominated) of sand dune mesa topping the Kennedy Range National Park, a priority ecological community (priority 4).
Plant communities	3 communities: 1 with 0% representation in existing reserves, 1 other with <5%.
Sub-bioregional ecosystems	3 ecosystems: 1 with <5% representation in existing reserves.
Buffering & connectivity	• extension to north-western Kennedy Range National Park • springs of the Western Kennedy Ranges ecological community (priority 4) is on the border, so would benefit from improved protection of ex Mardathuna

ex Middalya (14,000 hectares)	
Plant communities	3 communities: 1 with <5% representation in existing reserves.
Sub-bioregional ecosystems	3 ecosystems: 1 with 0% representation in existing reserves, 1 other with <5%
Buffering & connectivity	Extension to north-western Kennedy Range National Park

All properties (193,000 hectares)	
Threatened & priority plants	9 species.
Threatened & priority animals	4 bird, 1 mammal species.
Priority ecological communities	2 communities: Plant assemblages of sand dune mesa topping Kennedy Range (priority 4) and springs of the western Kennedy Ranges (priority 4).
Plant communities	14 communities: 4 with 0% representation in existing reserves, 5 others with <5%.
Sub-bioregional ecosystems	14 ecosystems: 7 with 0% representation in existing reserves, 4 others with <5%.
Buffering & connectivity	Capturing the northern extent of the range and creating a buffer around the range.

Sources: See technical notes 1 and 2 (chapter 2).

Eucalypts line the banks of the Wooramel River, which runs through the proposed 'Pimbee' Conservation Park. Photo: Matt Clive

Calandrinia wilsonii, listed as a priority species, was described only in 2018 and is known from just 3 localities. It inhabits sites just above the waterline of salt lakes or saline river floodplains. Photo: Fred and Jean Hort

Table 5-4: Threatened and priority species and ecological communities of the proposed additions to Kennedy Range National Park

Species	Conservation class	ex Williambury	ex Doorawarrah	ex Lyons River	ex Minnie Creek	ex Mooka	ex Mardathuna
Birds							
Peregrine falcon *(Falco peregrinus)*	Specially protected			●		●	
Common greenshank *(Tringa nebularia)*	International agreement					●	
Great egret *(Ardea modesta)*	International agreement		●				
Rainbow bee-eater *(Merops ornatus)*	International agreement					●	●
Mammals							
Western pebble-mound mouse, ngadji *(Pseudomys chapmani)*	Priority 4		●				
Plants							
Tephrosia sp. Kennedy Range	Priority 1	●		●	●		
Calytrix sp. Kennedy Range	Priority 2			●			
Omphacomeria acerba	Priority 2			●			
Solanum pycnotrichum	Priority 2			●			
Acacia atopa	Priority 3					●	
Calothamnus borealis subsp. *cinereus*	Priority 3	●		●	●		
Gymnanthera cunninghamii	Priority 3					●	
Ptilotus luteolus	Priority 3			●			
Goodenia neogoodenia	Priority 4					●	
Ecological Communities							
Plant assemblages (spinifex dominated) of sand dune mesa topping the Kennedy Range National Park	Priority 4	●		●	●		●
Springs of the western Kennedy Ranges	Priority 4					●	●[A]

Notes: A. This community is located within 2 kilometres of the boundary of ex Mardathuna, so management on this property is important to buffer threats to the springs community.

Sources: See technical notes 1 (chapter 2).

Table 5-5: The extent of protection in the proposed additions to Kennedy Range National Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Williambury	ex Bidgemia	ex Lyons River	ex Minnie Creek	ex Jimba Jimba	ex Mooka	ex Doorawarrah	Ex Mardathuna	ex Middalya
No protection (0%) in existing reserves									
VT 303 Sparse succulent steppe; bluebush with very sparse snakewood shrubs	0.4								
VT 307 Low woodland; bowgada & *Acacia subtressarogona*						9.9	2.9		
VT 320 Shrublands; bowgada & *Acacia victoriae* scrub						0.8			
VT 321 Mosaic: Shrublands; *Acacia sclerosperma* & bowgada scrub / Succulent steppe; saltbush & bluebush							0.1		
Little protection (0.1 to 5%) in existing reserves									
VT 160 Shrublands; snakewood & *Acacia victoriae* scrub	0.1		0.1			<0.1		<0.1	0.1
VT 182 Low woodland; mulga & bowgada *(Acacia ramulosa)*						<0.1			
VT 244 Shrublands; *Acacia sclerosperma* & *A. victoriae* scrub	<0.1								
VT 264 Low woodland; *Acacia victoriae* & snakewood	<0.1	0.3	0.4	0.1	0.4	1.5			
VT 308 Mosaic: Shrublands; *Acacia sclerosperma* sparse scrub / Succulent steppe; saltbush & bluebush						0.2	0.3		
Inadequate protection (5 to 15%) in existing reserves									
VT 162 Shrublands; snakewood scrub	1.9	0.8	0.4	0.3	0.5	3.7		4.7	2.4
VT 2081 Shrublands; bowgada and associated spp. scrub		0.1	0.2	0.1	<0.1				

Source: See technical notes 2 (chapter 2).

This is a bumper wildflower season on ex Pimbee (near its western boundary), with Prince of Wales feather (*Ptilotus polystachys*) and cotton bush (*Ptilotus obovatus*) dominating the foreground. Photo: DEC

5.2.2 Proposed 'Pimbee' Conservation Park

Former leasehold property: ex Pimbee

Ex Pimbee is a 99,000-hectare property some 50 kilometres south of Kennedy Range National Park. It consists largely of red sand dunes and swales with wattle shrublands and low woodlands, scattered shrubs, and a prominent grass layer of mainly wanderrie grasses (Payne et al., 1987).

Wooramel River passes through the south-east corner of the property, and there is a series of small claypan lakes in the central part that fill after rain.

Ex Pimbee is important for protecting plant communities and sub-bioregional ecosystems inadequately represented in the reserve system. Four of the 9 plant communities and 6 of the 9 ecosystems on ex Pimbee have no protection in existing reserves. The park would provide the first protection for the stony and alluvial plains, dunes, claypans and tall wattle shrublands of the Yagina land system (about half of which occurs on ex Pimbee) and sand dunes with gidgee woodland and sandy swales of the Yalbalgo land system (Payne et al., 1987).

Three priority plant species have been recorded on ex Pimbee (Table 5-5). One of these, *Calandrinia rubrisabulosa*, grows only on red sand dunes. With pink flowers, it is one of the plants adding colour to these landscapes after rain (Obbens, 2014) (see Box 5-1).

Box 5-1: *Calandrinia* – colourful dry-country succulents

Often adding bright splashes of colour to arid landscapes after rain are carpets of parakeelya flowers (members of the genus *Calandrinia*). These small herbs with fleshy leaves typically emerge only after rain, often becoming superabundant. They reproduce rapidly, with their showy, nectar-containing flowers attracting a variety of insect pollinators. The rest of the time they exist only as tiny seeds on the ground, remaining dormant through the dry years.

With more than 70 species, *Calandrinia* has more species than any other genus of succulent plants in Australia. Succulence is unusual in this country. Storing water in leaves or stems would seem an ideal strategy for plants in dry places, but even though Australia is the driest vegetated continent, it is the only warm continent with no native large stem-succulents. Yet introduced succulents (cactuses) have thrived in many parts of Australia. Perhaps plants with the evolutionary capacity for stem-succulence have not made it (by natural means) to Australia or they were outcompeted if they did.

Genetic works shows that *Calandrinia* has been in Australia a long time, probably entering via South America and Antarctica around the time Australia split from Antarctica some 33 million years ago. They then probably evolved in Western Australia, where the majority of species are found, before moving east and south.

Sources: Hancock et al. (2018), Holtum et al. (2016), Holtum et al. (2017)

Parakeelyas are most diverse in Western Australia. Shown here are *Calandrinia primuliflora* (left), C. *polyandra* (middle), C. translucens (top right) and *C. lehmannii* (lower right). Photos: Fred and Jean Hort

Table 5-6: Summary of conservation values of the proposed 'Pimbee' Conservation Park

ex Pimbee (9,000 hectares)	
Threatened & priority plants	3 species.
Threatened & priority animals	1 species.
Plant communities	9 communities: 4 with 0% representation in existing reserves, 2 others with <5%.
Sub-bioregional ecosystems	9 ecosystems: 6 with 0% representation in existing reserves.

Sources: See technical notes 1 and 2 (chapter 2).

Table 5-7: Priority species of the proposed 'Pimbee' Conservation Park

Species	Conservation class
Birds	
Rainbow bee-eater *(Merops ornatus)*	International agreement
Plants	
Acacia atopa	Priority 3
Calandrinia rubrisabulosa	Priority 3
Eremophila petrophila subsp. *densa*	Priority 3

Sources: See technical notes 1 (chapter 2).

Table 5-8: The extent of protection (%) in the proposed 'Pimbee' Conservation Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Pimbee
No protection (<0.1%) in existing reserves	
VT 184 Shrublands; mulga & bowgada scrub	2.5
VT 283 Shrublands; Acacia sclerosperma, bowgada & A. victoriae scrub	14.2
VT 342 Mosaic: Low woodland; waterwood/shrublands; Acacia sclerosperma & bowgada scrub	20.3
VT 349 Mosaic: Shrublands; bowgada scrub with scattered mulga/Shrublands; bowgada & grevillea scrub	0.3
Little protection (0.1 to 5%) in existing reserves	
VT 676 Succulent steppe; samphire	<0.1
VT 1271 Bare areas; claypans	0.1
Inadequate protection (5 to 15%) in existing reserves	
VT 2081 Shrublands; bowgada and associated spp. scrub	0.9

Source: See technical notes 2 (chapter 2).

5.3 Importance for achieving Western Australia's conservation reserve goals

The 2 proposed parks are part of the Wooramel sub-bioregion in the Carnarvon bioregion. They will enable the Western Australian government to make substantial progress towards meeting the state's conservation goals.

Bioregional and sub-bioregional protection

With only 6.9% of its area in the conservation reserve system, Wooramel sub-bioregion is a national priority for new reserves. The proposed park will increase protection of Wooramel by 70% to 11.7% of the sub-bioregon, which represents substantial progress towards the 2020 international benchmark of 17% (Table 5-9, Figure 5-3).

Ecosystem and plant community protection

The proposed parks would improve protection of 22 plant communities and 22 sub-bioregional ecosystems (Table 5-10). They would be the first such protection for 8 plant communities (36% of the total in the proposed parks) and 13 sub-bioregional ecosystems (58% of the total) currently lacking representation in the conservation reserve system.

Currently, more than a third of Western Australia's sub-regional ecosystems lack a minimum level of protection, based on a long-held national target of 15% of each ecosystem to be in reserves (JANIS, 1997, Taylor, 2017). The proposed parks would enable the minimum reserve target of 15% to be met for an additional:

- 1 sub-bioregional ecosystem (6% of the total ecosystems on the proposed parks)
- 2 plant communities (9% of the total communities on the proposed parks) (Table 5-10).

Table 5-9: Current and improved protection of bioregions and sub-bioregions (% protected) in Western Australia's conservation reserve system

	Bioregion	Sub-bioregion
	Carnarvon	Wooramel
Current protection	5.89	6.86
Proposed parks	3.46	4.81
New total	9.35	11.67

Source: See technical notes 2 (chapter 2).

Notes: *Current protection* means the percentage of each bioregion and sub-bioregion protected in the existing conservation reserve system. *Proposed parks* means the percentage of each bioregion and sub-bioregion protected in the proposed parks. *New total* means the percentage of each bioregion and sub-bioregion that would be protected if the proposed parks are declared.

Figure 5-3: Progress towards the 2020 international benchmark (17%) for protection of bioregions and sub-bioregions (% area protected) due to the proposed parks

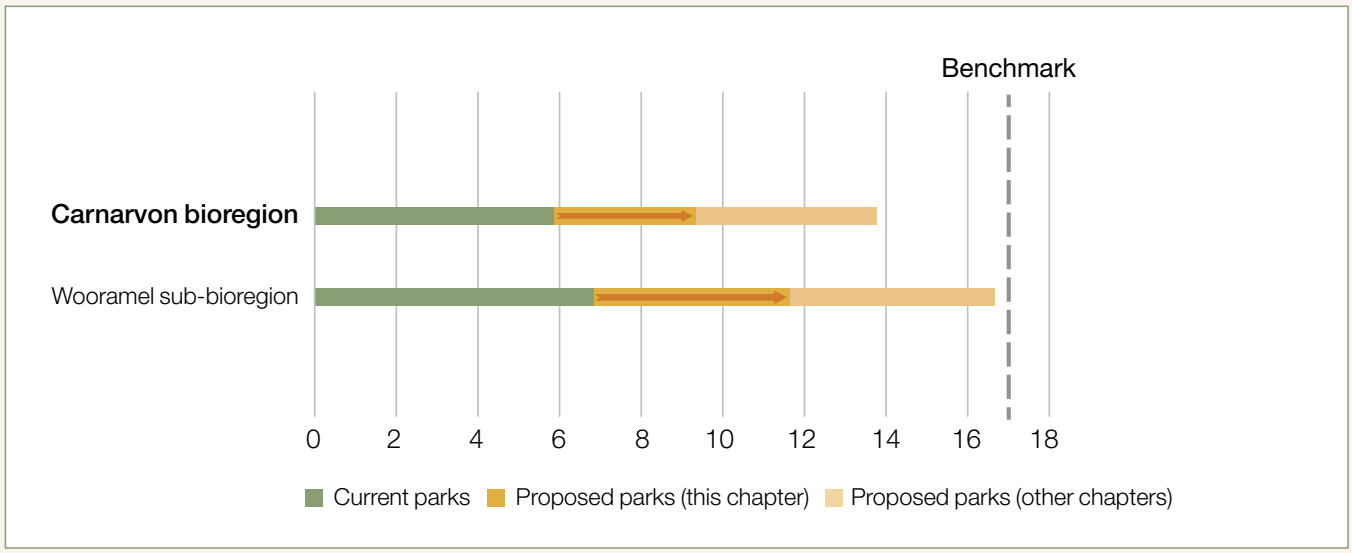


Table 5-10: Numbers of plant communities and sub-bioregional ecosystems in the proposed parks, levels of protection in the existing conservation reserve system and the contribution to protection of particular communities and ecosystems

	Plant communities (number & percentage)		Ecosystems (number & percentage)	
Improved protection in proposed parks				
Total in proposed parks	22	100%	22	100%
Will achieve 15% target[A]	1	6%	2	9%
Current level of protection in reserve system				
No existing protection (<0.1%)	8	36%	13	59%
Little existing protection (0.1-5%)	7	32%	4	18%
Inadequate protection (5.1-<15%)	2	9%	1	6%
Exceeds 15% protection	5	23%	4	18%
Contribution to protection of particular communities & ecosystems[B]				
Critical (>85% of total extent)	0	0%	0	0%
Very important (50–85% of total extent)	0	0%	0	0%
Important (10-50% of total extent)	5	23%	5	23%

Sources: See technical notes 2 (chapter 2)

Notes: A. This assumes protection in other proposed parks and does not include ecosystems that already have more than 15% of their extent protected in the conservation reserve system. B. This represents the number of communities or ecosystems with a substantial proportion of their total extent in the proposed parks. For example, the proposed parks are 'critical' for ecosystem protection where more than 85% of the entire ecosystem extent occurs within those proposed parks.

Although found in most parts of Australia, peregrine falcons (*Falco peregrinus*) occur in low densities. Their home range may be up to 50 square kilometres. The species is listed as 'specially protected' in Western Australia (a species in need of special protection). Photo: Keith Wilcox

5.4 Native title and Aboriginal heritage sites

The 'Kennedy Range Country' properties are almost all within the native title claim application area of the Gnulli native title claim group. Claimants over other, far smaller, parts of these properties are the Thudgari, Thiin-Mah Warriyangka, Tharrkari, Jiwarli and Malgana claim groups.

The whole of Kennedy Range is a sacred site, and 187 specific Aboriginal heritage sites have been recorded in and around the national park (DEC, 2008). The properties proposed for addition to the park would protect 9 registered Aboriginal heritage sites (5 partially) (Table 5-11). Nominations for an additional 4 sites have been lodged.

Beyond these registered heritage sites and the significance of the broader landscapes to Traditional Owners, native title parties will continue to play a key role in determining whether the proposal for these properties to become parks is implemented.

Table 5-11: Summary of native title and registered Aboriginal heritage sites of the proposed parks

Native title party, claimed or determined (percentage of property)	Registered Aboriginal heritage sites
Proposed extension to Kennedy Range National Park	
ex Bidgemia	
Gnulli, claim application (100%)	1 site that would be partially protected: Kennedy Range
ex Doorawarrah	
Gnulli, claim application (100%)	No registered sites
ex Jimba Jimba	
Gnulli, claim application (100%)	1 site that would be partially protected: Kennedy Range
ex Lyons River	
Gnulli, claim application (100%)	3 sites (2 would be fully protected, 1 partially) including 3 engraving sites
ex Mardathuna	
Gnulli, claim application (100%)	2 sites (both partially protected) including Kennedy Range and artefact scatter on Watermelon Creek
ex Middalya	
Gnulli, claim application (96%), Thudgari, claim application (3%)	1 site that would be partially protected: Kennedy Range
ex Minnie Creek	
Gnulli, claim application (100%)	1 site that would be partially protected: Kennedy Range
ex Mooka	
Gnulli, claim application (100%)	3 sites (1 that would be fully protected) including Kennedy Range and artefacts scatter on Venny Peak and Bullwolya spring
ex Williambury	
Gnulli, claim application (95%), Thudgari, claim application (4%), Thiin-Mah Warriyangka, Tharrkari, Jiwarli, claim application (1%)	3 sites (2 would be fully protected, 1 partially) including Kennedy Range and artefacts scatter on Merlinleigh Basin
Proposed extension to Kennedy Range National Park	
ex Pimbee	
Gnulli, claim application (95%), Malgana, claim application (5%)	No registered sites

Sources: See technical notes 3 (chapter 2), data current to November 2018.

5.5 Geology, prospectivity and mining

The Kennedy Range consists largely of siltstone, sandstone and limestone deposits. Mineral prospectivity is generally low, except on parts of ex Mooka where there are small deposits of opalite chalcedonic gemstone known as Mookite. An oil & gas exploration permit (EP 481) overlaps Kennedy Range National Park and 7 of the proposed park additions, targeting conventional reservoirs and shale and tight gas formations (New Standard Energy, 2012). Reportedly, this permit was to be voluntarily surrendered when it expired in August 2018 due to technical issues (Black, 2016). However, the public record shows it will now expire in August 2020 and is pending renewal. Share market reports indicate that no accessible gas reserves have been found.

The following information on the geology, prospectivity and mining activity comes from the following sources: Belford (2017) and DMIRS (2018a). The extent of mining-related activity is summarised in Tables 5-12 and 5-13.

Proposed extension to Kennedy Range National Park

Ex Williambury

The western half of this property is underlain by Permian continental and marine sandstone and siltstone, minor limestone and the eastern half is underlain by Cenozoic quartzose eolian and alluvial deposits. The mineral prospectivity is low. There are no known mineral deposits.

Mining activity: Ex Williambury is largely overlapped by the oil & gas exploration permit EP 481, but falls outside the area considered to be most prospective for shale and tight gas (New Standard Energy, 2012).

Areas without mining activity: 25% of ex Williambury is free of existing or proposed mining-related activities.

Ex Bidgemia

This property has a substratum consisting of Permian sandstone, siltstone and minor limestone. Mineral prospectivity is low, and there are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Bidgemia is free of existing or proposed mining-related activities.

Ex Lyons River

The western part of this property is underlain by Permian continental and marine sandstone and siltstone and minor limestone, and the eastern half is underlain by Permian marine and lesser continental siltstone, shale and sandstone. The mineral prospectivity is low. There are no known mineral deposits.

Mining activity: The north-western 28% of the property covers 1% of the edge of the oil & gas exploration permit EP 481, but is outside the area considered to be most prospective for shale and tight gas (New Standard Energy, 2012).

Areas without mining activity: 72% of ex Lyons River is free of existing or proposed mining-related activities.

Ex Minnie Creek

This property has Eocene coastal sandstone in the north, Permian continental and marine sandstone, siltstone and minor limestone in the west, and Permian siltstone, shale and sandstone in the east. Mineral prospectivity is low. There are no known mineral deposits.

Mining activity: The western half of ex Minnie Creek is on the edge of the oil & gas exploration permit EP 481, but outside the area considered to be most prospective for shale and tight gas (New Standard Energy, 2012).

Areas without mining activity: 45% of ex Minnie Creek is free of existing or proposed mining-related activities.

Ex Jimba Jimba

This property is underlain by Permian continental and marine sandstone and siltstone and minor limestone. Mineral prospectivity is low and there are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Jimba Jimba is free of existing or proposed mining-related activities.

Ex Mooka

The western part of this property is underlain by Cenozonic quartzose aeolian and alluvial deposits and the central part is dominated by cretaceous marine to coastal siltstone, shale and radiolarian siltstone. Parts of the radiolarian siltstone are silicified and occasionally form mookite, an opalite chalcedonic gemstone. Otherwise, the property has low prospectivity.

Mining activity: The north-east part of this property, which borders the Kennedy Range National Park, is overlapped by the oil & gas exploration permit EP 481 and is among the areas considered to be prospective for tight and shale gas reserves. Three active mining leases (M 09/109, M 09/86, M 09/18) in the south-east of ex Mooka (near the border with ex Jimba Jimba) for mooka chalcedony or mookite cover 60 hectares in total and consist of small open-pit mines, with relatively small footprints. Two active exploration licences (E 09/1617, E

09/1582) covering 430 hectares also overlap ex Mooka in the south-east. They are held by a company that specialises in mining opalites.

Areas without mining activity: 80% of ex Mooka is free of existing or proposed mining-related activities.

Ex Doorawarrah
This property has a surface geology of Cenozoic quartzose eolian and alluvial deposits. The mineral prospectivity is low and there are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Doorawarrah is free of existing or proposed mining-related activities.

Ex Mardathuna
This property is predominantly underlain by Permian, continental and marine sandstone and siltstone, minor limestone. A lesser part along the eastern margin is underlain by Cenozoic quartzose eolian and alluvial deposits. The property has low mineral prospectivity and there are no known mineral deposits.

Mining activity: Ex Mardathuna is entirely covered by the oil & gas exploration permit EP 481 and falls within the area considered to be most prospective for tight and shale gas reserves.

Areas without mining activity: 0% of ex Mardathuna is free of existing mining-related activities.

Ex Middalya
The property is underlain by Permian continental and marine sandstone and siltstone, minor limestone. The mineral prospectivity is low and there are no known mineral deposits.

Mining activity: The southern half of ex Middalya is covered by the oil & gas exploration permit EP 481 and the north-west corner is covered by the adjacent oil & gas exploration permit EP 482, which is part of the same project.

Areas without mining activity: 30% of ex Middalya is free of existing or proposed mining-related activities.

Proposed 'Pimbee' Conservation Park

Ex Pimbee
This property has a surface geology of predominantly Cenozoic inland eolian and alluvial deposits, generally quartzose, and lesser Cenozoic alluvial and lacustrine inset-valley and valley-fill deposits. It is underlain in the western part by Cretaceous marine to coastal siltstone, shale, and radiolarian siltstone, and in the eastern part by Permian continental and coastal sandstone, siltstone, and coal measures. These Permian sedimentary rocks are exposed in a locality where the Wooramel River cuts through the block. The eastern part of the property is moderately prospective for coal. There are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Pimbee is free of existing or proposed mining-related activities.

One hope for the future is that locally extinct species such as the black-flanked rock-wallaby (*Petrogale lateralis lateralis*) can be reintroduced to Kennedy Range National Park. This will require rigorous control of foxes and goats. Photo: Sarah Matheson

Table 5-12: Existing mining-related activity in the proposed parks (% area affected)

		Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed Kennedy Range National Park expansion					
ex Lyons River	-	28%28%	-		
ex Mardathuna	-	100%	100%	-	
ex Middalya	-	71%71%	-		
ex Minnie Creek	-	55%55%	-		
ex Mooka	<1%	20%20%	-		
ex Williambury	-	75%75%	-		
All properties	<1%	42%42%	-		

Note: Where mining tenements and titles overlap, only 1 value has been calculated, with priority given first to production over exploration, then to existing activities over applications. This is the only table relevant to mining activity because there are no mining applications for the proposed parks.

Source: See technical notes 4 (chapter 2).

Table 5-13: Proposed park areas (%) free of existing mining-related activity

	No mineral Mining	No oil & gas mining	Combined
Proposed Kennedy Range National Park expansion			
ex Bidgemia	100%	100%	100%
ex Doorawarrah	100%	100%	100%
ex Jimba Jimba	100%	100%	100%
ex Lyons River	100%	72%	72%
ex Mardathuna	100%	0%	0%
ex Middalya	100%	29%	29%
ex Minnie Creek	100%	45%	45%
ex Mooka	99%	80%	80%
ex Williambury	100%	25%	25%
All properties	100%	58%	58%
Proposed 'Pimbee' Conservation Park			
ex Pimbee	100%	100%	100%

Source: See technical notes 4 (chapter 2)

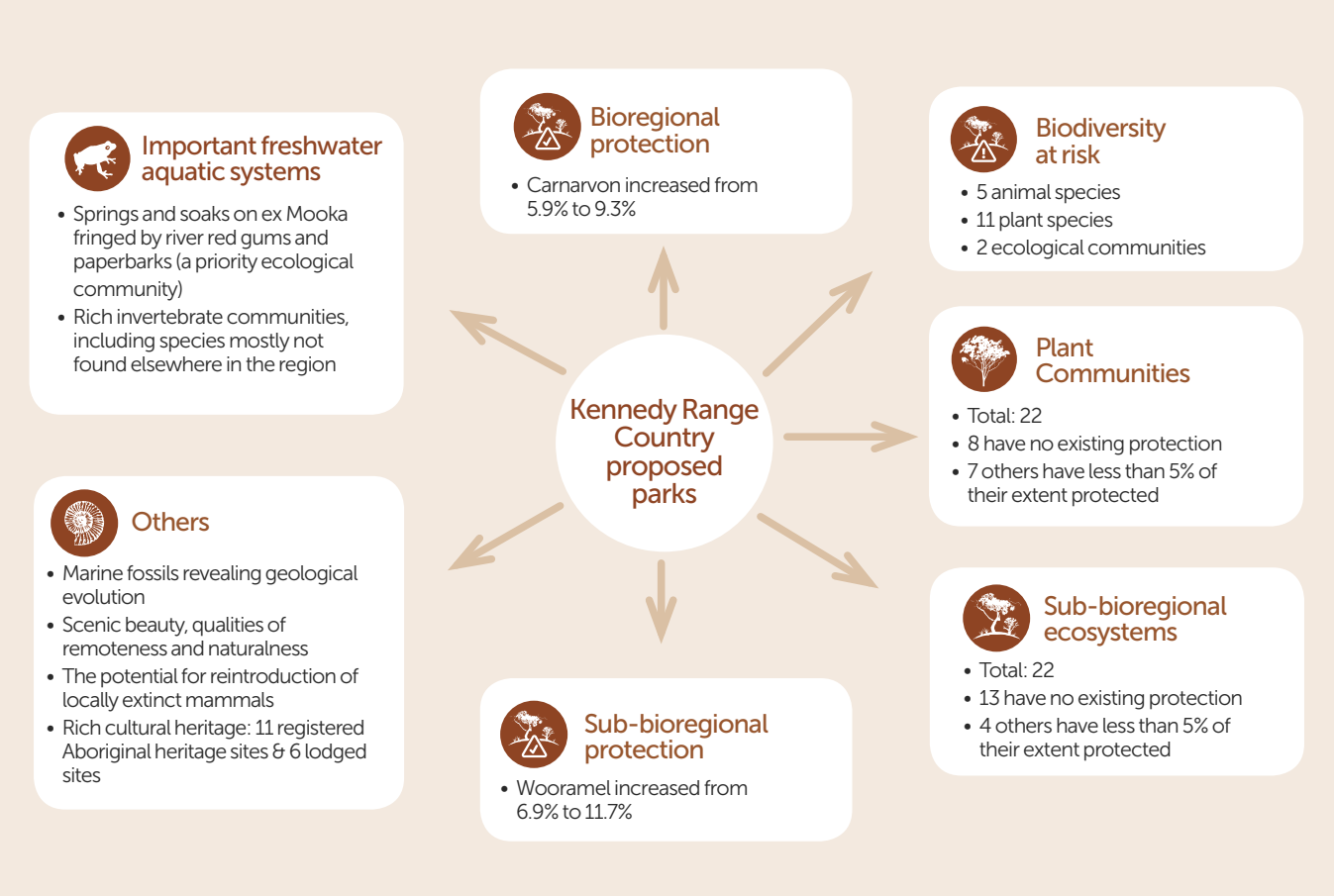
5.6 Recommendations

The following recommendations would add 292,000 hectares to the conservation reserve system. The proposed parks offer the opportunity to protect 2 listed priority ecological communities, 8 plant communities and 13 sub-bioregional ecosystems with no current representation in the reserve system, as well 16 priority species (Figure 5-4). They would substantially improve protection of the Wooramel sub-bioregion (by 70%) and the Carnarvon bioregion (by 57%), both with less than 7% currently in reserves.

These proposals are consistent with the intentions of the Western Australian government to expand Kennedy Range National Park and create a new park from ex Pimbee (DEC, 2008, CAPAD, 2017).

All properties are subject to native title claims. Kennedy Range National Park and the proposed additions have substantial cultural values. These would protect 11 registered Aboriginal heritage sites.

Figure 5-4: Some combined values of the proposed new parks



Recommendation 5-1

Incorporate ex Bidgemia, ex Doorawarrah, ex Jimba Jimba, ex Lyons River, ex Mardathuna, ex Middalya, ex Minnie Creek, ex Mooka and ex Williambury into the Class A reserve, Kennedy Range National Park.

Conservation considerations

The addition of these properties (193,000 hectares) to Kennedy Range National Park (142,000 hectares) will more than double the area of the park, helping to protect and add to the values of that park. The properties will capture the northern extent of Kennedy Range and buffer the existing park on all sides. They will add regionally important springs and soaks with invertebrates not found elsewhere in the region and spinifex-dominated plant assemblages on top of the range, both of which are listed as priority ecological communities. Of 14 plant communities represented on the properties, 9 have little to no protection in existing reserves. The properties harbour 9 priority plant species and 5 priority animal species. The expanded national park could be an ideal location to reintroduce threatened mammals lost from the area.

This recommendation to expand Kennedy Range National Park is aligned with the intention of the Western Australian government 'to add the area to the public conservation estate (nominally as national park)' (DEC, 2008).

Dawson's burrowing bee (*Amegilla dawsoni*) is one of Australia's largest bees and unique to Western Australia. Although a solitary species, females often build their nesting burrow, provisioned with nectar and pollen, within aggregations of several thousand bees on arid claypans. This is a male feeding on a camel bush (*Trichodesma zeylanicum*) at Kennedy Range
Photo: Marc Newman

The high conservation values of the existing national park have been recognised through its Class A reserve classification. This classification should also apply to the park additions, both for consistency and for their significant contribution to the conservation reserve system. In particular, they would add 3.2% of the Wooramel sub-bioregion (with less than 7% in existing reserves) and 2.3% of the Carnarvon bioregion (with less than 6% in existing reserves) to the reserve system, and protect 11 sub-bioregional ecosystems with little to no current representation in the reserve system.

The native title parties of this proposed park are the Gnulli claim group, with the exception of a small part of 2 properties, whose parties are the Thudgari, Thiin-Mah Warriyangka, Tharrkari and Jiwarli. Eleven registered Aboriginal heritage sites would be protected.

Mining considerations

The proposed additions to Kennedy Range National Park have relatively low mineral prospectivity. Almost 60% of the area is free of existing mining-related activity. A small area (less than 100 hectares) could be excluded from the future park to allow existing low-impact opal mining to continue, but with conditions and management that safeguard the important Mooka Springs and Mooka Creek.

The oil & gas exploration permit (EP 481) overlapping Kennedy Range was set to expire in August 2018, with share market reports indicating no success in accessing gas reserves. Despite a report that the permit would be voluntarily surrendered (Black, 2016), the public record now shows it will expire in August 2020 and is pending renewal. Mining is not compatible with conserving the values of the Kennedy Range National Park including its tourism potential. Therefore, the lease should not be renewed. If this recommendation is accepted, 99.7% of the proposed park expansion would be free of mining-related activity.

Recommendation 5-2

Declare ex Pimbee a Class A conservation park.

Conservation considerations

This proposed conservation park would add 99,000 hectares to the reserve system. It includes part of the Wooramel River and features claypan lakes. It is important for the protection of 4 plant communities lacking protection in existing reserves as well as 3 listed priority plant species and 1 priority animal species.

The values of ex Pimbee – including its shrublands and red sand dunes with their colourful dryland succulents, the Wooramel River, claypan wetlands, 3 priority-3 plant species, and the Yagina and Yalbalgo land systems – are of regional significance, warranting protection in a conservation park. The proposed park would make a significant contribution to Western Australia's conservation reserve system, warranting Class A status.

In particular, it would add 1.6% of the Wooramel sub-bioregion (with less than 7% in existing reserves) and 1.2% of the Carnarvon bioregion (with less than 6% in existing reserves) to the reserve system, and protect 6 sub-bioregional ecosystems with little to no current representation in the reserve system.

The values of this proposed park require further investigation, and potentially a revision of these recommendations if new and important information comes to light.

The native title parties of this proposed park are the Gnulli and Malgana, whose consent would be needed for any tenure changes.

Mining considerations

Ex Pimbee has low prospectivity and no existing or proposed mining-related activity.

Kennedy Range is an isolated remnant of an ancient land surface. Its many marine fossils reveal it was once a marine shelf and fringing shoreline.
Photo: Lawrence Hillary

6 Pilbara Biodiversity Hotspot

The iconic Karijini National Park would expand by almost half under current proposals, protecting even more spectacular scenery, incised gorges and rare plants and animals. Photo: Tomasz Judkowiak

6.1 At a glance

Proposed parks

Table 6-1: Former leasehold properties acquired for conservation

Property*	Year Acquired	Size (hectares)	Traditional Owners (native title parties)
ex Hamersley	2015	31,000	Eastern Guruma (100%)
ex Hillside	2015	34,000	Nyiyaparli (100%)
ex Juna Downs	2015	54,000	Banjima (100%)
ex Karratha	2015	15,000	Yaburara & Mardudhunera (88%), Yindjibarndi/ Ngarluma (12%)
ex Mardie	2008	3,000	Yaburara & Mardudhunera (100%)
ex Marillana	2015	75,000	Banjima (61%), Nyiyaparli (39%)
ex Meentheena	1999	217,000	Njamal (100%)
ex Mt Florence	2000	13,000	Banjima (69%), Yindjibarndi (31%)
ex Mt Minnie	1999	110,000	No current claimants
ex Mulga Downs	2015	42,000	Banjima (10%), Nyiyaparli (64%), Palyku (17%)
ex Nanutarra	1999	70,000	Puutu Kunti Kurrama & Pinikura (15%), Thalanyji (85%)
ex Pyramid	2015	3,000	Yindjibarndi/Ngarluma (100%)
ex Rocklea	2015	24,000	Eastern Guruma (5%), Yinhawangka (95%)
ex Roy Hill	2015	29,000	Nyiyaparli (100%)

* The current tenure of all properties is unallocated Crown land.

Natural highlights

A national biodiversity hotspot including for night parrots and northern quolls

91 threatened and priority species including bilbies

Nationally important Fortescue Marsh wetland

A centre of diversity for reptiles and stygofauna

High plant diversity and endemism

Ancient rock landscapes with 2.7-billion-year-old stromatolite fossils

Progress towards the 2020 international benchmark for protection

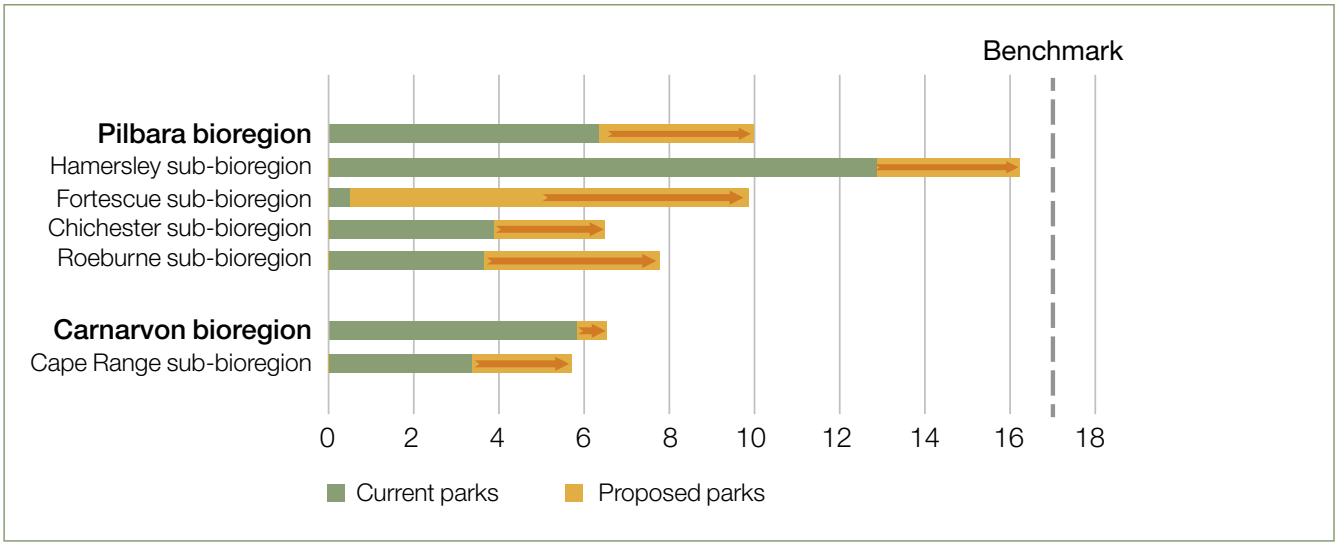


Figure 6-1: The potential increase in protection (% area) due to the proposed parks in bioregions and sub-bioregions where substantial progress can be made towards the international benchmark of 17%.

Reserve recommendations

Table 6-2: Proposed parks and park extensions

Property	Recommended Protection	Recommended Classification
ex Hamersley, ex Rocklea, ex Mt Florence, ex Juna Downs, ex Marillana, ex Mulga Downs, ex Hillside, ex Roy Hill	Expand Karijini National Park	Class A
ex Pyramid	Expand Millstream Chichester National Park	Class A
ex Minnie, ex Nanutarra	Expand Cane River Conservation Park	Class A
ex Meentheena	Create a new national park*	Class A
ex Karratha, ex Mardie	Create a new national park*	Class A

*The recommendation for these parks include additional parcels of unallocated Crown land.

Iron-rich rock formations, grey-green expanses of spinifex and scattered gnarled eucalypts comprise the quintessential landscape of the Pilbara, a biodiverse region with just 6% of its area protected in conservation reserves. Photo: Nicholas Dufty

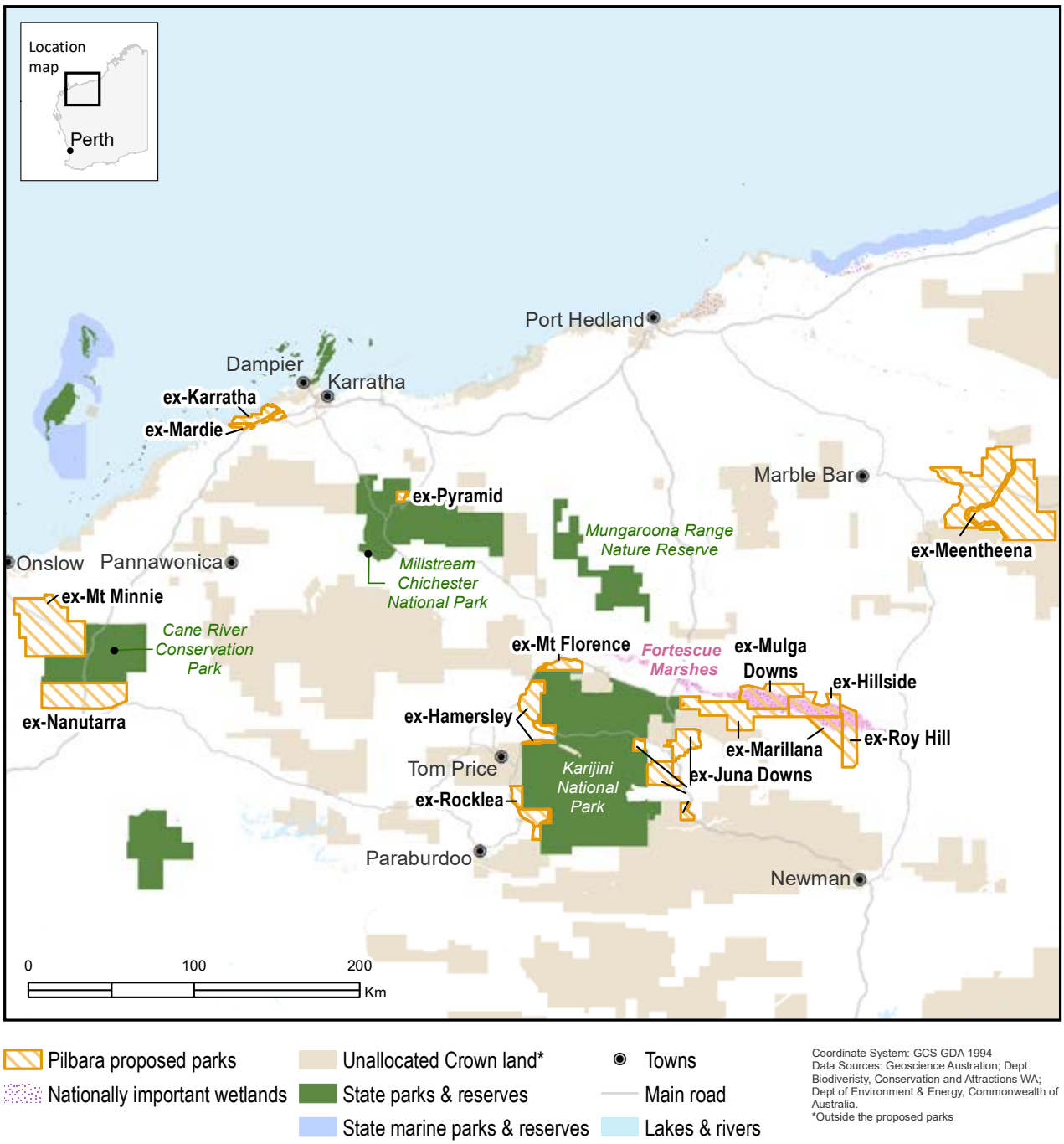


Figure 6-2: Proposed parks of the 'Pilbara Biodiversity Hotspot'

The areas proposed for inclusion in Karijini National Park harbour the Pilbara olive python (*Liasis olivaceus barroni*) (vulnerable), whose preferred habitat is in the ranges in deep gorges and around water holes. Photo: Mike Brown

6.2 Natural values for conservation

The Pilbara is a highly distinctive bioregion, featuring rugged rocky ranges of great antiquity with incised gorges, rolling hills, granitic and alluvial plains, and intermittently flowing rivers. It is defined by the Pilbara Craton, a major granite and greenstone terrace with some of the oldest exposed rocks on Earth, up to 3.7 billion years old. This is overlain by iron-rich sedimentary rocks of the Fortescue and Hamersley Basins (Stewart, 2009, Pepper et al., 2013). The vegetation is largely low wattle woodlands and snappy gums over spinifex and other grasses (Bastin and ACRIS Management Committee, 2008).

The Pilbara is one of Australia's 'centres of biological endemism', with many unique plants and animals (Cracraft, 1991, Thackway and Cresswell, 1995). This is recognised in its designation by the federal government as 1 of 15 'national biodiversity hotspots' – areas with very high natural values, including unique species, which are at risk unless there is 'active conservation management' (TSSC, 2003).

Among its many special attributes, the Pilbara has the highest reptile diversity in Western Australia – among the highest in the world – and the greatest number of gecko species in Australia (EPA, 2014, Powney et al., 2010). It is also a bastion for several highly threatened animals, including the night parrot, northern quoll (see Box 6-2) and bilby (see Box 6-4).

The region is globally significant for the diversity of stygofauna (animals inhabiting groundwater) and troglofaunal (animals inhabiting caves). Conservative estimates are that the Pilbara supports more than 500 species of stygofauna and 600 species of troglofauna, but there are likely to be many more than this (Halse et al., 2014, Eberhard et al., 2005). Most of these subterranean species are unique to the region. The Pilbara is also rich in terrestrial invertebrates – for example, there are at least 375 species of ground spiders and 429 beetle species (Durrant et al., 2010, EPA, 2014).

The Pilbara is also botanically rich, with some 1700 recorded plant species (van Leeuwen, 2012). The number of known species has increased by more than half over the past 25 years. New species are continually being discovered, often during biological surveys for mining and infrastructure assessments. Many have yet to be described and properly surveyed. At least 150 are of conservation significance (EPA, 2014).

Many of the Pilbara's natural values are highly threatened. Twelve of the 41 mammal species that once occurred in the Pilbara are now regionally extinct (Gibson and McKenzie, 2009). Mining, overgrazing, altered fire regimes, weeds and feral animals have altered the vegetation, degraded soils and caused biodiversity declines. Just over three-quarters (77%) of the area has mining tenements, down from 92% in 2014 during the mining boom (EPA, 2014, DMIRS, 2018a).

The proposed parks provide an opportunity to increase protection for nature in a region with very high ecological significance, high threats and low levels of protection in the reserve system. Only 6.4% of the Pilbara bioregion is currently in the conservation reserve system, leaving the majority of ecosystems, ecological communities and threatened species inadequately protected and vulnerable to mining and other threats. As acknowledged by the Environmental Protection Authority, this level of protection is 'well below the 17 per cent recognised internationally for biodiversity protection' (EPA, 2014).

Most of the properties reviewed here were acquired as part of the 2015 exclusion of areas of conservation significance from the pastoral leasehold estate. Although they were bought for the purpose of expanding Western Australia's reserve system and helping the state to meet its conservation targets, they remain as unallocated Crown land. As such, they lack the legal protections requiring assessment of the impact of new projects on the natural and cultural values for which they were acquired. Formal responsibility, but not full resourcing, for property management lies with the Department of Biodiversity, Conservation and Attractions.

Due to mining projects, parts of 3 properties earmarked for expanding Karijini National Park have already been excluded from the areas available for conservation. This is despite those areas having extremely high values, including dozens of threatened and priority ecological communities and species (see Box 6-1).

Here, in 5 subsections corresponding with the recommendations in section 6.6 and the map in Figure 6-2, we describe the natural values of the proposed 2 new parks and 3 park expansions.

6.2.1 Proposed expansion of Karijini National Park

Former leasehold properties: ex Hamersley, ex Rocklea, ex Mt Florence, ex Juna Downs, ex Marillana, ex Mulga Downs, ex Hillside, ex Roy Hill.

Karijini National Park, located on the Hamersley Range, is Western Australia's second largest national park (627,000 hectares) and a tourism icon renowned for spectacular scenery (DCLM, 1999). Adding the 8 properties listed above to Karijini National Park would increase its extent by 301,000 hectares (a 48% increase).

The Hamersley Range and the Fortescue Marsh (which lies in the Fortescue Valley between the Hamersley and Chichester ranges) are critical areas for conserving the Pilbara's rich and unique flora, fauna and ecological communities. Western Australia's Environmental Protection Authority has recommended these properties be afforded the greatest possible protection for their high values and to counter the impacts of extensive mining (EPA, 2014).

The protection of ex Hamersley, ex Rocklea and ex Juna Downs, in particular, can help redress some losses of Karijini's natural values due to historic excisions from the national park for iron ore mining, including 4800 hectares at Marandoo and 8000 hectares for a rail corridor (DCLM, 1999). However, the proposed additions have been compromised due to the exclusion of more than 56,000 hectares on the Hamersley, Rocklea and Juna Downs leasehold properties from transfer to the conservation estate. The excluded areas have very high natural values (Box 6-1). Opportunities to protect and manage these areas for conservation remain open (see Recommendation 6-1).

The 8 properties encompass part of 2 sub-bioregions in the Pilbara bioregion – Hamersley and Fortescue. The latter in particular is very poorly protected, with just 0.5% in conservation reserves. The expansion of Karijini would increase the protection of Fortescue 18-fold to 9.4% and take protection of Hamersley from 12.9 to 15.5% (see section 6.3 for more information).

The biological diversity of the 8 properties is indicated by the 12 sub-bioregional ecosystems and 10 plant communities found there (Table 6-3). The majority of these – 7 ecosystems and 6 plant communities – have little or no protection (<5%) in the existing reserve system (Table 6-3, Table 6-5). The vegetation ranges from spinifex grasslands and samphire shrublands to mulga and snappy gum woodlands.

As with the Pilbara in general, the proposed new park area features high reptile and plant diversity. Three reptiles are listed as threatened and priority species, including the Pilbara olive python (vulnerable), whose preferred habitat is deep gorges and water holes of ranges within the Pilbara region (DEWHA, 2008a).

Gorges such as this hidden garden of Circular Pool in Dales Gorge, Karijini National Park, dominated by *Adiantum capillus-veneris* and *Ficus brachypoda*, are refuges for wildlife. For example, a small damselfly found here, *Nosoticta liveringa*, has otherwise been found only hundreds of kilometres away, in the Kimberley. Photo: Neomyrtus

The 17 other threatened and priority animal species recorded for these properties include the night parrot (critically endangered) northern quoll (endangered), grey falcon (vulnerable), ghost bat (vulnerable) and Pilbara leaf-nosed bat (vulnerable) (Table 6-4). Of the 54 threatened and priority plant species recorded, many are unique to the new or expanded park area and more than a quarter are yet to be scientifically described (Table 6-4).

There are 4 listed priority-1 ecological communities on these properties. Ex Juna Downs contains the only occurrences of 2 priority communities: the coolibah-lignum flats subtypes 1 and 2 (DBCA, 2017c). Although these communities – consisting of coolibah woodlands over lignum thickets on red clays in run-on zones – have not yet been sufficiently surveyed to designate them as threatened, their distribution is highly restricted and they are likely to be under threat, including from dewatering and grazing (DBCA, 2017c). Another priority ecological community is the Brockman iron cracking clay communities on Hamersley Range, a rare grassland dominated by a Mitchell grass, *Astrebla lappacea*. Ex Hamersley contains 18% of this community, but most of it is on the part of the Hamersley pastoral leasehold property excluded from the conservation purchase (see Box 6-1).

The fourth priority ecological community is Fortescue Marsh, an ephemeral wetland (inundated only episodically) in the valley east of Karijini National Park. It is the terminus of the Upper Fortescue River, with surface flows blocked by the Goodiadarri Hills (Pinder et al., 2017). About two-thirds of the wetland area is encompassed by ex Hillside, ex Marillana, ex Mulga Downs and ex Roy Hill. This ecological centrepiece of the Fortescue sub-bioregion – the largest wetland in the Pilbara – is recognised as a wetland of national importance. It also has values of international importance and is considered a potential Ramsar site (Pinder et al., 2017). It is a highly diverse ecosystem with samphire shrublands, fringing mulga woodlands (on the northern side), and groundwater-dependent riparian communities (DBCA, 2017a).

When the Fortescue Marsh floods, as it does about once or twice a decade, it can occupy over a thousand square kilometres and attract over a quarter of a million waterbirds – of more than 60 species – and support major breeding events (CALM, 2005, Trainor et al., 2016). The wetland's importance for waterbirds has been recognised in its designation as a 'key biodiversity area' (Birdlife International, nd).

Fortescue Marsh is also important for other species of high conservation value (EPA, 2013). There have been 2 recent sightings of the critically endangered night parrot and there are also bilbies (vulnerable, see Box 6-4) and northern quolls (endangered) (Davis and Metcalf, 2008, EPA, 2013, DPaW, 2017a) (Table 6-4). The wetland area is dominated by samphires, which include many endemic plants and species new to science (DBCA, 2017a). The area is underlain by 'an ancient and complex array of alluvial aquifers and groundwater systems', which provide saline habitats for stygofauna, many yet to be described (Halse et al., 2014, EPA, 2014). Most of the stygofauna and many other invertebrates in the area have a very restricted distribution (DBCA, 2017a).

The expansion of Karijini National Park is important not only for the values of the proposed additions but also for the buffering of high-value features of the existing park. Inclusion of ex Hamersley, for example, will help protect Hamersley Gorge, a nationally important wetland, by providing a buffer zone to the south and west. The proposed additions will also create a mountains-to-marshes corridor to the east of Karijini.

The Pilbara has exceptionally high stygofauna diversity and endemism, supporting more than 500 species. Most of these groundwater-dwelling species are unique to the region. Clockwise from top left are the isopod *Pilbarusphreotoicus platyarthricus*, the polychaete *Namanereis pilbarensis* and the isopod *Kagalana tonde*. Photos: Jane McRae, Bennelongia Environmental

Box 6-1: Excision of 3 Pilbara conservation properties

In the lead-up to the renewal of Western Australian pastoral leases on 1 July 2015, 165,000 hectares of Hamersley Station, Rocklea Station and Juna Downs Station were designated 'lands of interest' by the then Department of Parks and Wildlife due to their high recorded numbers of threatened and priority plants, animals and ecological communities. They were earmarked to be added to Karijini National Park and subject to agreements under section 8A of the Conservation and Land Management Act 1984, which allows for a conservation management agreement over tenure not held by government.

However, for reasons not yet made public, on 1 July 2015, only 66% of these 'lands of interest' were excluded from the pastoral estate to become unallocated Crown land. The management agreements were not renewed, and the excluded areas, covering more than 56,000 hectares, remain part of the Hammersley, Rocklea and Juna Downs pastoral stations (see Figure 6-3). Mining tenements cover their entire area.

The natural values of the excluded areas are high, including:

- 64% of the threatened ecological community 'Themeda grasslands on cracking clays' (listed as vulnerable)
- 48% of the priority-1 ecological community 'Brockman Iron cracking clay communities of the Hamersley Range'
- 12 threatened and priority animal species, including the endangered northern quoll
- 23 threatened and priority plant species.

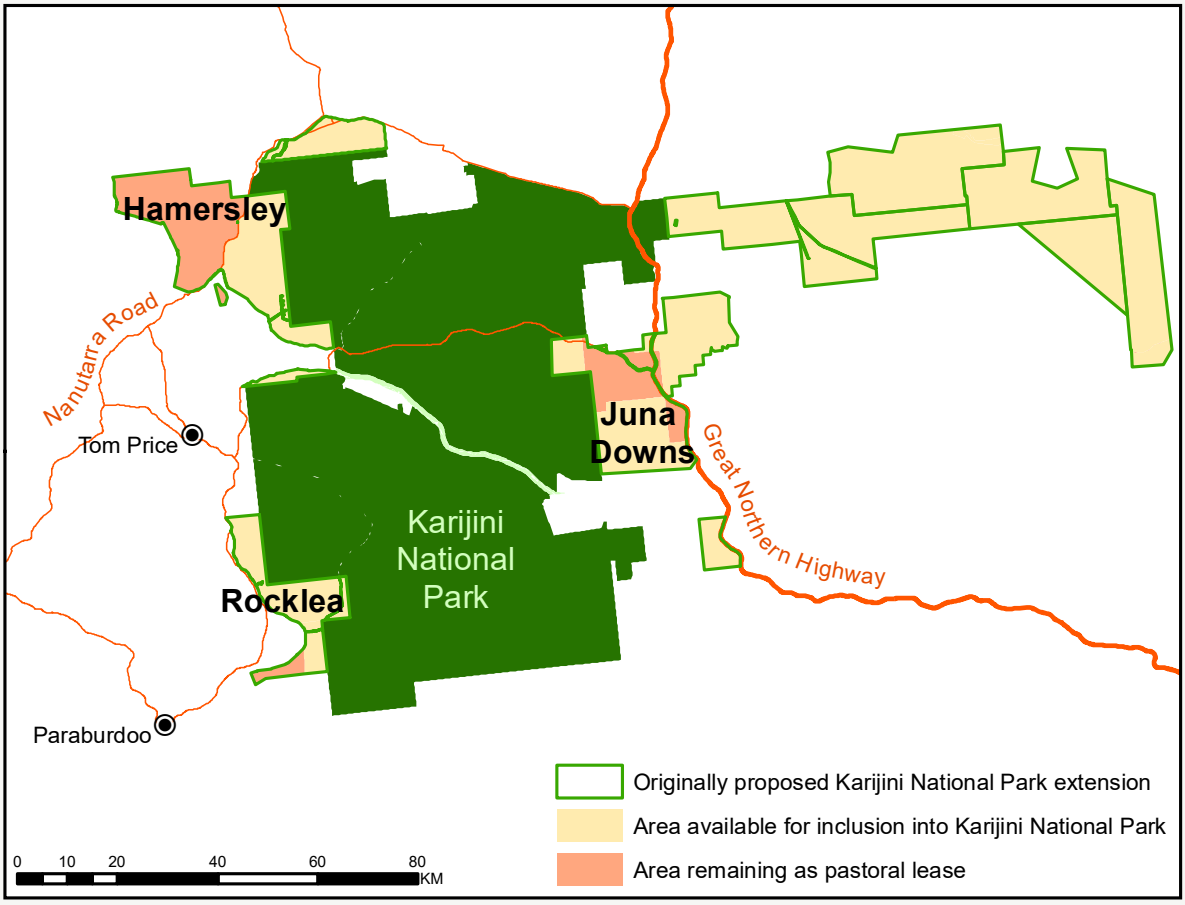


Figure 6-3: Areas of ex Hamersley, ex Rocklea and ex Juna Downs not currently available for incorporation into Karijini National Park (areas in pink).

Table 6-3: Summary of conservation values of the proposed additions to Karijini National Park

ex Hamersley (31,000 hectares)	
Threatened & priority plants	17 species.
Threatened & priority animals	1 bird, 5 mammal, 1 reptile species.
Priority ecological communities	1 priority community: Brockman Iron cracking clay communities on Hamersley Range (priority 1) (8600 hectares, 24% of total extent).
Plant communities	5 communities: 3 with <5% representation in existing reserves.
Sub-bioregional ecosystems	5 ecosystems: 1 with 0% representation in existing reserves.
Buffering & connectivity	Western expansion of Karijini National Park; improved protection for Hamersley Gorge.

ex Rocklea (24,000 hectares)	
Threatened & priority plants	9 species.
Threatened & priority animals	2 bird, 2 mammal species.
Plant communities	3 communities: 1 with <5% representation in existing reserves.
Sub-bioregional ecosystems	3 ecosystems.
Buffering & connectivity	Western expansion of Karijini National Park.

ex Mt Florence (13,000 hectares)	
Threatened & priority plants	4 species.
Threatened & priority animals	1 bird, 2 mammal species.
Plant communities	2 communities.
Sub-bioregional ecosystems	3 ecosystems: 2 with <5% representation in existing reserves.
Buffering & connectivity	Northern expansion of Karijini National Park.

ex Juna Downs (54,000 hectares)	
Threatened & priority plants	5 species.
Threatened & priority animals	2 bird, 4 mammal species.
Priority ecological communities	2 communities (with no current protection in the reserve system): • Coolibah-lignum flats (subtype 1): coolibah and mulga woodland over lignum and tussock grasses on clay plains (Coondewanna and Wanamunna flats and Mt Bruce Flats) (priority 1) (36% of total extent) • Coolibah-lignum flats (subtype 2): coolibah woodlands over lignum over swamp wanderrie (Lake Robinson) (priority 1) (36% of total extent).
Plant communities	2 communities: 1 with <5% representation in existing reserves.
Sub-bioregional ecosystems	2 ecosystems.
Buffering & connectivity	Northern expansion of Karijini National Park.

ex Marillana (75,000 hectares)	
Threatened & priority plants	12 species.
Threatened & priority animals	6 bird, 4 mammal, 2 reptile species.
Priority ecological communities	1 priority community: Fortescue Marsh (Marsh Land System) (priority 1).
Plant communities	5 communities: 2 with <5% representation in existing reserves.
Sub-bioregional ecosystems	6 ecosystems: 2 with 0% representation in existing reserves, 3 others with <5%.
Nationally important wetland	Fortescue Marshes; may also qualify as a wetland of international significance.
Key biodiversity area	Fortescue Marshes KBA, meets 3 criteria: (A1) globally threatened species, (A3) biome-restricted species, (A4) congregations of ≥1% of the global population of ≥1 species.
Buffering & connectivity	• eastern expansion of Karijini National Park • a critical link in a mountains-to-marshes corridor from Hamersley Range to Fortescue Marsh.

Table 6-3 (continued)

ex Mulga Downs (42,000 hectares)	
Threatened & priority plants	9 species.
Threatened & priority animals	4 bird, 2 mammal species.
Priority ecological communities	1 priority community: Fortescue Marsh (Marsh Land System) (priority 1).
Plant communities	3 communities: 1 with 0 % representation in existing reserves, 2 others with <5%.
Sub-bioregional ecosystems	3 ecosystems: 2 with 0% representation in existing reserves, 1 other with <5%.
Nationally important wetland	Fortescue Marshes; may also qualify as a wetland of international significance.
Key biodiversity area	Fortescue Marshes KBA, meets 3 criteria: (A1) globally threatened species, (A3) biome-restricted species, (A4) congregations of ≥1% of the global population of ≥1 species.
Buffering & connectivity	• eastern expansion of Karijini National Park • a critical link in a mountains-to-marshes corridor from Hamersley Range to Fortescue Marsh.

ex Hillside (34,000 hectares)	
Threatened & priority plants	11 species.
Threatened & priority animals	6 bird, 2 mammal, 1 reptile species.
Priority ecological communities	1 priority community: Fortescue Marsh (Marsh Land System) (priority 1).
Plant communities	3 communities: 1 with 0 % representation in existing reserves, 2 others with <5%.
Sub-bioregional ecosystems	3 ecosystems: 2 with 0% representation in existing reserves, 1 other with <5%.
Nationally important wetland	Fortescue Marshes; may also qualify as a wetland of international significance.
Key biodiversity area	Fortescue Marshes KBA, meets 3 criteria: (A1) globally threatened species, (A3) biome-restricted species, (A4) congregations of ≥1% of the global population of ≥1 species.
Buffering & connectivity	• eastern expansion of Karijini National Park • a critical link in a mountains-to-marshes corridor from Hamersley Range to Fortescue Marsh.

ex Roy Hill (29,000 hectares)	
Threatened & priority plants	7 species.
Threatened & priority animals	1 mammal, 2 bird species.
Priority ecological communities	1 priority community: Fortescue Marsh (Marsh Land System) (priority 1).
Plant communities	2 communities: 2 with <5% representation in existing reserves.
Sub-bioregional ecosystems	2 ecosystems: 1 with 0% representation in existing reserves, 1 other with <5%.
Nationally important wetland	Fortescue Marshes; may also qualify as a wetland of international significance.
Key biodiversity area	Fortescue Marshes KBA, meets 3 criteria: (A1) globally threatened species, (A3) biome-restricted species, (A4) congregations of ≥1% of the global population of ≥1 species.
Buffering & connectivity	• eastern expansion of Karijini National Park • a critical link in a mountains-to-marshes corridor from Hamersley Range to Fortescue Marsh.

All properties (301,000 hectares)	
Threatened & priority plants	54 species.
Threatened & priority animals	10 bird, 7 mammal, 3 reptile species.
Priority ecological communities	4 priority-1 communities: 24% of the the Brockman clay community, 36% of both Coolibah-Lignum subtype communities and 61% of the Fortescue Marsh community.
Plant communities	10 communities: 1 with 0% representation in existing reserves, 5 others with <5% representation.
Sub-bioregional ecosystems	12 ecosystems: 4 with 0% representation in reserves, 3 others with <5% representation. Very important to the protection of 1 currently unprotected ecosystem, with 80% of its entire extent.
Nationally important wetland	Fortescue Marshes.
Key biodiversity area	Fortescue Marshes KBA.
Buffering & connectivity	• expansion of Karijini National Park and buffering of important sites in the park. • a critical link in a mountains-to-marshes corridor from Hamersley Range to Fortescue Marsh.

Sources: See technical notes 1 and 2 (chapter 2).

Table 6-4: Threatened and priority species and ecological communities of the proposed additions to Karajini National Park

Species	Conservation class	ex Hamersley	ex Rocklea	ex Mt Florence	ex Juna Downs	ex Marillana	ex Mulga Downs	ex Roy Hill	ex Hillside
Birds									
Night parrot *(Pezoporus occidentalis)*	Critically endangered						●		
Grey falcon *(Falco hypoleucos)*	Vulnerable					●			●
Striated grasswren *(Amytornis striatus striatus)*	Priority 4					●			
Peregrine falcon *(Falco peregrinus)*	Specially protected				●	●	●		●
Common greenshank *(Tringa nebularia)*	International agreement								●
Fork-tailed swift *(Apus pacificus)*	International agreement					●			
Great egret *(Ardea modesta)*	International agreement		●					●	●
Gull-billed tern (*Gelochelidon nilotica)*	International agreement					●			
Rainbow bee-eater *(Merops ornatus)*	International agreement	●	●	●	●	●	●	●	●
Wood sandpiper *(Tringa glareola)*	International agreement								●
Mammals									
Northern quoll *(Dasyurus hallucatus)*	Endangered	●	●	●	●	●	●		●
Bilby, dalgyte, ninu *(Macrotis lagotis)*[A]	Vulnerable	#						#	
Ghost bat *(Macroderma gigas)*	Vulnerable				●	●			
Pilbara leaf-nosed bat *(Rhinonicteris aurantia)*	Vulnerable		●	●	●	●			
Spectacled hare-wallaby (mainland) (*Lagorchestes conspicillatus*)[B]	Priority 3	●							
Lakeland Downs mouse, kerakenga *(Leggadina lakedownensis)*	Priority 4	●							
Western pebble-mound mouse, ngadji *(Pseudomys chapmani)*	Priority 4	●			●	●			●
Reptiles									
Pilbara olive python *(Liasis olivaceus barroni)*	Vulnerable					●			●
Spotted ctenotus (*Ctenotus uber johnstonei)*	Priority 2					●			
Lined soil-crevice skink *(Notoscincus butleri)*	Priority 4	●							
Plants									
Barbula ehrenbergii	Priority 1			●					
Calotis squamigera	Priority 1	●							●
Eremophila spongiocarpa	Priority 1					●	●		●
Helichrysum oligochaetum	Priority 1							●	
Josephinia sp. *Marandoo*	Priority 1	●							
Myriocephalus scalpellus	Priority 1							●	
Nicotiana heterantha	Priority 1						●	●	●
Samolus sp. Fortescue Marsh	Priority 1					●			●
Tecticornia globulifera	Priority 1						●	●	●
Tecticornia sp. Christmas Creek	Priority 1						●	●	●
Triodia sp. Karijini	Priority 1				●				
Vittadinia sp. Coondewanna Flats	Priority 1				●				
Adiantum capillus-veneris	Priority 2			●					
Aristida lazaridis	Priority 2				●				
Eremophila pusilliflora	Priority 2		●			●			
Euphorbia australis var. glabra	Priority 2								●
Euphorbia inappendiculata var. inappendiculata	Priority 2	●							

Table 6-4 (continued)

Species	Conservation class	ex Hamersley	ex Rocklea	ex Mt Florence	ex Juna Downs	ex Marillana	ex Mulga Downs	ex Roy Hill	ex Hillside
Plants									
Gompholobium karijini	Priority 2			●					
Hibiscus sp. Gurinbiddy Range	Priority 2		●						
Oxalis sp. Pilbara	Priority 2				●				
Scaevola sp. Hamersley Range basalts	Priority 2		●						
Teucrium pilbaranum	Priority 2				●				
Acacia daweana	Priority 3	●							
Acacia effusa	Priority 3	●							
Aristida jerichoensis var. subspinulifera	Priority 3				●				
Astrebla lappacea	Priority 3	●							
Atriplex flabelliformis	Priority 3					●			●
Calotis latiuscula	Priority 3	●							
Dampiera anonyma	Priority 3	●	●						
Dysphania congestiflora	Priority 3					●	●		
Eremophila magnifica subsp. *velutina*	Priority 3	●			●				
Glycine falcata	Priority 3	●			●				
Goodenia lyrata	Priority 3				●				
Goodenia sp. East Pilbara	Priority 3		●						
Grevillea saxicola	Priority 3		●						
Iotasperma sessilifolium	Priority 3				●				
Oldenlandia sp. Hamersley Station	Priority 3	●							
Rhagodia sp. Hamersley	Priority 3				●				
Rostellularia adscendens var. latifolia	Priority 3		●						
Sida sp. Barlee Range	Priority 3					●			
Solanum kentrocaule	Priority 3		●						
Swainsona thompsoniana	Priority 3	●							
Tecticornia medusa	Priority 3						●		●
Themeda sp. Hamersley Station	Priority 3	●			●	●	●		
Triodia sp. Mt Ella	Priority 3				●				
Triodia sp. Robe River	Priority 3	●							
Whiteochloa capillipes	Priority 3	●							
Acacia bromilowiana	Priority 4				●				
Eremophila magnifica subsp. *magnifica*	Priority 4	●				●			
Eremophila youngii subsp. *lepidota*	Priority 4						●	●	●
Goodenia nuda	Priority 4	●		●	●	●	●	●	●
Lepidium catapycnon	Priority 4					●			
Ptilotus mollis	Priority 4		●						
Rhynchosia bungarensis	Priority 4					●			
Ecological communities									
Brockman iron cracking clay communities of Hamersley Range	Priority 1	●							
Coolibah-lignum flats (subtype 1)	Priority 1				●				
Coolibah-lignum flats (subtype 2)	Priority 1				●				
Fortescue Marsh	Priority 1					●	●	●	●

Sources: See technical notes 1 (chapter 2).
Notes: A. Although the bilby is not recorded in the DBCA database for these properties, DPaW (2017a) shows records on or very close to 2 properties. There are other records, including recent records, around the Fortescue Marshes.
B. The status of the spectacled hare wallaby here is uncertain, for most or all Pilbara populations are thought to be extinct.

Black-winged stilts (*Himantopus himantopus*) feed in shallow water, seizing insects on or near the surface. Photo: Glenn Walker

Table 6-5: The extent of protection (%) in the proposed additions to Karijini National Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Hamersley	ex Rocklea	ex Mt Florence	ex Juna Downs	ex Marillana	ex Mulga Downs	ex Roy Hill	ex Hillside
No protection (<0.1%) in existing reserves								
VT 562 Mosaic: Low woodland; mulga in valleys / Hummock grasslands, open low tree-steppe; snappy gum over *Triodia wiseana*					2.9	0.4		
Little protection (0.1 to 5%) in existing reserves								
VT 18 Low woodland; mulga	0.1		0.2					
VT 29 Sparse low woodland; mulga, discontinuous in scattered groups	<0.1			0.4	0.1	0.2	0.3	
VT 175 Short bunch grassland - savanna/grass plain (Pilbara)	1.4							
VT 181 Shrublands; mulga & snakewood scrub		0.1						
VT 676 Succulent steppe; samphire				0.7	1.4	0.9	0.4	
Inadequate protection (5 to 15%) in existing reserves								
VT 82 Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*	0.3	<0.1	0.5	0.2				0.2
VT 111 Hummock grasslands, shrub steppe; *Eucalyptus gamophylla* over hard spinifex				3.2				0.9

Source: See technical notes 2 (chapter 2).

6.2.2 Proposed extension to Millstream Chichester National Park

Former leasehold property: ex Pyramid

Millstream Chichester National Park (about 238,000 hectares) lies on the Chichester Plateau north of the Fortescue Valley about 150 kilometres north-west of Karijini National Park. It is a rugged, rocky area with spinifex grasslands and perennial and intermittent waters fed by run-off from the Hamersley Range flowing via the Fortescue River into an underground aquifer.

Ex Pyramid (3000 hectares) is enclosed on 3 sides by Millstream Chichester. Its incorporation into the national park would improve the park's integrity as well as increase habitat for 4 threatened and priority species (Table 6-6, Table 6-7). This includes the northern quoll (endangered) (see Box 6-2).

Box 6-2: Northern quolls in the Pilbara

The northern quoll – the largest native mammalian predator across much of northern Australia – is now restricted to a few fragmented populations and listed as nationally endangered. Of the 4 main genetic lineages – in Queensland, Northern Territory, Kimberley and Pilbara – the Pilbara population is the only one not yet invaded by cane toads, the primary cause of the species' decline. Cane toads are projected to colonise the Pilbara between 2026 and 2064. Other threats include feral cats, foxes, altered fire regimes, overgrazing, weed invasion, and mining and infrastructure developments.

The Pilbara population retains healthy genetic diversity (with no evidence of a population bottleneck) and is genetically distinct from the Kimberley population, separated by about 500 kilometres of the Great Sandy Desert.

In the Pilbara, quolls mostly inhabit rocky areas, which provide dens and safety from fire and cats. They are opportunistic omnivores – preying on insects, spiders, snails, other invertebrates and small mammals, birds, reptiles and frogs, and also eating carrion and fruit.

Research in and around Millstream Chichester National Park has shown limited overlap in habitat use by quolls and feral cats, with cats favouring open habitats (recently burnt areas, spinifex grasslands and open shrublands). This may be due to quolls avoiding cats. During a radio-tracking study in the western Pilbara, 8 of 10 quolls that died (25% of the total tracked) were killed or thought to be killed by cats. Two were killed by dingoes, but the potential for dingoes to suppress cat activity and therefore benefit quolls may outweigh their predatory impact on quolls.

Sources: Dunlop (2017), Hernandez-Santin et al. (2016)

Spinifex country and tabletop hills in the vicinity of ex Pyramid, a 3000-hectare proposed extension to Millstream Chichester National Park. Photo: Christabell Mitchell (DEC)

The Pilbara – not yet invaded by cane toads – is one of the last strongholds for the endangered northern quoll (*Dasyurus hallucatus*).

Australian fairy terns (*Sternula nereis nereis*), listed nationally as vulnerable, are thought to be declining due to habitat disturbance and predation. They typically nest above the high-tide mark on sandy beaches, spits and ridges. Photo: Georgina Steytler

Table 6-6: Summary of conservation values of the proposed addition to Millstream Chichester National Park

Ex Pyramid (3,000 hectares)	
Threatened & priority plants	1 species.
Threatened & priority animals	2 mammal, 1 reptile species.
Plant communities	3 communities, 2 with <5% representation in existing reserves.
Sub-bioregional ecosystems	5 ecosystems, 3 with <5% representation in existing reserves.
Buffering & connectivity	Improved integrity of Millstream Chichester National Park.

Sources: See technical notes 1 and 2 (chapter 2).

Table 6-7: Threatened and priority species of the proposed addition to Millstream Chichester National Park

Species	Conservation class
Mammals	
Northern quoll *(Dasyurus hallucatus)*	Endangered
Western pebble-mound mouse, ngadji *(Pseudomys chapmani)*	Priority 4
Reptiles	
Lined soil-crevice skink *(Notoscincus butleri)*	Priority 4
Eremophila petrophila subsp. *densa*	Priority 3
Plants	
Swainsona thompsoniana	Priority 3

Sources: See technical notes 1 (chapter 2).

Table 6-8: The extent of protection (%) in the proposed addition to Millstream Chichester National Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Pimbee
Little protection (0.1 to 5%) in existing reserves	
VT 93 Hummock grasslands, shrub steppe; kanji over soft spinifex	<0.1
VT 589 Mosaic: Short bunch grassland / Hummock grasslands, grass steppe; soft spinifex	0.2

Sources: See technical notes 2 (chapter 2).

6.2.3 Proposed expansion of Cane River Conservation Park

Former leasehold properties: ex Mt Minnie, ex Nanutarra

Cane River Conservation Park – formerly a pastoral lease – was declared in 2000 in recognition of its plant and geological associations not found elsewhere in the region (Hill and Edwardes, 2000). It features alluvial plains, and sandstone ranges and granite outcrops (including the Parry Range and Mt Minnie) with spinifex grasslands and trees including snakewood, bloodwoods, river red gums and cajeputs (a paperbark).

Incorporating ex Mt Minnie and ex Nanutarra (180,000 hectares) into Cane River Conservation Park would more than double its area and improve protection on its north-west and southern borders. Conservation management on these properties would also contribute to healthier catchments for Cane River (to the north) and Ashburton River (to the south) (Table 6-9).

The diversity of the 2 properties is indicated by 12 sub-bioregional ecosystems and 11 plant communities found there. The majority of these – 7 of the ecosystems and 8 of the plant communities – have little or no protection (<5%) in the existing reserve system (Table 6-8, Table 6-10). The vegetation on these properties, dominated by wattles and spinifex, is mostly intact, with few weed species.

As is typical of the Pilbara, the Cane River park and proposed additions are rich in stygofauna and vertebrate animals. Reptiles are particularly abundant and rich, with 80 species recorded in the park (Bush Blitz 2011). A 2011 survey found 645 plant and animal species, more than half of which had not been recorded previously in the park, including more than 60 invertebrates new to science (Bush Blitz, 2011). The area has an unusually high diversity of plants for an arid region, with 331 species recorded during the survey. The 2 properties proposed for incorporation harbour 4 priority plant species (Table 6-10).

The sun sets on Central Parry Range, ex Nanutara – part of the proposed extension to Cane River Conservation Park. Photo: Neomyrtus

Table 6-9: Summary of conservation values of the proposed additions to Cane River Conservation Park

ex Mt Minnie (110,000 hectares)	
Threatened & priority plants	3 species
Threatened & priority animals	1 bird, 1 mammal species.
Plant communities	6 communities, 2 with 0% representation in existing reserves, 3 others with <5%.
Sub-bioregional ecosystems	6 ecosystems, 2 with 0% representation in existing reserves, 2 others with <5%.
Buffering & connectivity	• expansion of Cane River Conservation Park • maintenance of a healthy catchment for the Ashburton and Cane rivers.

ex Nanutarra (70,000 hectares)	
Threatened & priority plants	1 species.
Threatened & priority animals	1 mammal species.
Plant communities	7 communities: 4 with <5% representation in existing reserves.
Sub-bioregional ecosystems	7 ecosystems: 2 with 0% representation in existing reserves, 1 other with <5%. Very important for the protection of 2 ecosystems, with 84% of of 1 and 54% of the other represented.
Buffering & connectivity	• expansion of Cane River Conservation Park • maintenance of a healthy catchment for the Ashburton and Cane rivers.

Both properties (180,000 hectares)	
Threatened & priority plants	4 species.
Threatened & priority animals	1 mammal, 1 bird species.
Plant communities	11 communities: 2 with 0% representation in existing reserves, 6 others with <5%.
Sub-bioregional ecosystems	12 ecosystems: 4 with 0% representation in existing reserves, 3 others with <5%. Very important for the protection of 2 ecosystems.
Buffering & connectivity	• expansion of Cane River Conservation Park • maintenance of a healthy catchment for the Ashburton and Cane rivers.

Sources: See technical notes 1 and 2 (chapter 2).

Table 6-10: Threatened and priority species of the proposed additions to Cane River Conservation Park

Species	Conservation class	ex Mt Minnie	ex Nanutarra
Birds			
Rainbow bee-eater *(Merops ornatus)*	International agreement	●	
Mammals			
Western pebble-mound mouse, ngadji *(Pseudomys chapmani)*	Priority 4	●	●
Plants			
Abutilon sp. Onslow	Priority 1	●	
Solanum pycnotrichum	Priority 2		●
Eremophila forrestii subsp. *viridis*	Priority 3	●	
Triumfetta echinata	Priority 3	●	

Sources: See technical notes 1 (chapter 2).

The Australian bustard (*Ardeotis australis*) is an Outback nomad, turning up after rain or fire to feed. They are now scarce in the south but remain widespread in northern Australia. Photo: David Mackenzie

Table 6-11: The extent of protection (%) in the proposed additions to Cane River Conservation Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Mt Minnie	ex Nanutarra
No protection (<0.1%) in existing reserves		
VT 608 Mosaic: Shrublands; *Acacia victoriae* & snakewood scrub patches / Short bunch grassland - savanna /grass plain (Pilbara)	0.7	
VT 670 Hummock grasslands, shrub steppe; scattered shrubs over *Triodia basedowii*	1.8	
Little protection (0.1 to 5%) in existing reserves		
VT 98 Hummock grasslands; shrub steppe, kanji over soft spinifex & *Triodia basedowii*	16.0	
VT 103 Hummock grasslands, shrub steppe; snakewood over soft spinifex & *Triodia wiseana*		3.0
VT 152 Hummock grasslands, grass steppe; soft & hard spinifex soft spinifex	0.1	1.7
VT 264 Low woodland; *Acacia victoriae* & snakewood	0.6	
VT 605 Hummock grasslands; shrub steppe, *Acacia pachycarpa* & waterwood over soft spinifex	0.2	
VT 646 Hummock grasslands; shrub steppe, snakewood over *Triodia basedowii*		24.5

Sources: See technical notes 2 (chapter 2).

6.2.4 Proposed 'Meentheena' National Park

Former leasehold property: ex Meentheena

This 216,000-hectare property lies in the Chichester Ranges and is dissected by the Nullagine River. It is geologically complex, indicating 'a high level of biogeographic diversity' (CALM, 1998). It is country of spinifex grasslands with snappy gums and kanjis and other wattles.

Most ecosystems and plant communities occurring on ex Meentheena lack protection – 4 of the 5 plant communities and 4 of the 5 sub-bioregional ecosystems have less than 5% of their extent represented in the reserve system (Table 6-12, Table 6-14).

The new park would protect several highly threatened animal species, including the night parrot (critically endangered), northern quoll (endangered, see Box 6-2), ghost bat (vulnerable), bilby (vulnerable, see Box 6-4) and grey falcon (vulnerable) (Table 6-13). It also harbours 5 priority animal species and 2 priority plants.

One outstanding feature of ex Meentheena are fossil stromatolites in the bluff overlooking the Nullagine River, a valuable part of Western Australia's geological heritage and internationally significant for what they reveal about the evolution of early life (Carter, 1987) (see Box 6-3).

The proposed park is in the poorly protected Chichester sub-bioregion and would increase by two-thirds the extent of Chichester in the reserve system (see section 6.3).

For many decades, the night parrot (*Pezoporus occidentalis*), critically endangered in Western Australia, was thought likely to be extinct. However, in 2013 photos confirmed its survival in Queensland, and photos in 2017 also confirmed it survives in Western Australia. This elusive seed-eating parrot inhabits arid and semi-arid spinifex grasslands and shrublands of samphire, bluebush and saltbush. Painting: John Gould

Box 6-3: Fossil stromatolites – evidence of early life on Earth

Stromatolites are structures created by the layering of microbes, particularly cyanobacteria (single-celled photosynthesising microbes), with trapped sediments, and range in size from no bigger than a finger to larger than a house. They include the earliest fossilised evidence of life on Earth. Western Australia has a plethora of stromatolites, both fossil and living, making it an important area for investigating the origins of life.

Living stromatolites are found mainly in habitats difficult for other organisms – like hot springs, saline lakes and sea bays with restricted water circulation. Hamelin Pool in Shark Bay (see chapter 3), an example of the latter, contains the world's best examples of living stromatolites.

Because of Western Australia's vast expanses of ancient rocks, fossil stromatolites are abundant. They include the oldest convincing evidence of life on Earth, at a site in the eastern Pilbara, where cyanobacteria grew probably in a hot spring some 3.5 billion years ago.

Ex Meentheena features exceptionally well-preserved stromatolite fossils that are about 2.7 billion years old. They are thought to have grown in a giant shallow lake system and may have been able to metabolise arsenic.

The global significance of these stromatolites has been recognised by their listing on the Western Australian geological heritage register (DMIRS, 2017).

Sources: Awramik and Buchheim (2009), Carter (1987), Djokic et al. (2017), DMIRS (nd)

Box 6-4: Bilbies in the Pilbara

The Pilbara is one of the last few regions in which bilbies survive after having been lost from more than 95% of their historical range across Australia, mainly due to feral cats, foxes and altered fire regimes. They occur approximately east of a line extending south of Karratha. The known Pilbara populations are small, isolated and highly vulnerable. There have been losses in recent times probably due to fires destroying food sources and exposing them to predators. Fire management must be a high priority.

Bilbies live solitarily on plains of cracking clay, soil or sand (good for burrowing) in spinifex or tussock grasslands and in low shrublands usually dominated by wattles. In the Pilbara they tend to be associated with particular wattle species whose root systems are inhabited by the grubs of cossid moths, which are a favoured food. For example, on ex Meentheena bilbies are associated with stands of *Acacia bivenosa* and on Hillside with *Acacia trachycarpa*. They also eat other invertebrates such as spiders and termites as well as grass and sedge seeds and bulbs.

Bilbies are inveterate diggers – for food and shelter – and may construct a new burrow on average every 2 to 3 weeks. More than a dozen burrows may be in regular use at a time. Up to 4.5 metres long, sometimes spiralling, these burrows are also popular with other animals. A camera trap study at Matuwa (previously Lorna Glen Station), where bilbies have been reintroduced, found 20 other species using bilby burrows in some way. Brush-tailed mulgara and spinifex hopping mice occupied them permanently while echidnas and sand goannas used them as temporary shelters. It is for this reason that bilbies are known as 'ecosystem engineers'.

Sources: DPaW (2017a), Hofstede and Dziminski (2017), Woinarski et al. (2014a)

Snappy gums and spinifex grow on the stony plateau of Millstream Chichester National Park. Photo: Liam Byrne Photography

Table 6-12: Summary of conservation values of the proposed 'Meentheena' National Park

ex Meentheena (216,000 hectares)	
Threatened & priority plants	2 species.
Threatened & priority animals	4 bird, 6 mammal, 1 reptile species.
Plant communities	5 communities: 3 with 0% representation in existing reserves, 1 other with <5%.
Sub-bioregional ecosystems	5 ecosystems: 3 with 0% representation in existing reserves, 1 other with <5%.
Geological feature	2.7 billion-year-old stromatolite fossils in the bluff along the Nullagine River.
Buffering & connectivity	Improved protection of Nullagine River.

Sources: See technical notes 1 and 2 (chapter 2).

Table 6-13: Threatened and priority species of the proposed 'Meentheena' National Park

Species	Conservation class
Birds	
Night parrot *(Pezoporus occidentalis)*	Critically endangered
Grey falcon (Falco hypoleucos)	Vulnerable
Great egret *(Ardea modesta)*	International agreement
Rainbow bee-eater *(Merops ornatus)*	International agreement
Mammals	
Northern quoll (Dasyurus hallucatus)	Endangered
Bilby, dalgyte, ninu (*Macrotis lagotis)*	Vulnerable
Ghost bat *(Macroderma gigas)*	Vulnerable
Pilbara leaf-nosed bat (*Rhinonicteris aurantia)*	Vulnerable
Lakeland Downs mouse, kerakenga *(Leggadina lakedownensis)*	Priority 4
Western pebble-mound mouse, ngadji *(Pseudomys chapmani)*	Priority 4
Reptiles	
Pin-striped finesnout ctenotus *(Ctenotus nigrilineatus)*	Priority 1
Plants	
Eragrostis crateriformis	Priority 3
Heliotropium murinum	Priority 3

Sources: See technical notes 1 (chapter 2).

Table 6-14: The extent of protection (%) in the proposed 'Meentheena' National Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Meentheena
No protection (<0.1%) in existing reserves	
VT 171 Hummock grasslands; low tree steppe; snappy gum over soft spinifex & *Triodia brizioides*	10.9
VT 177 Hummock grasslands; sparse shrub steppe; Acacia bivenosa over hard spinifex, *Triodia brizioides*	0.8
VT 192 Hummock grasslands; shrub steppe; kanji over *Triodia pulchella* & *T. brizioides* on basalt	9.1
Little protection (0.1 to 5%) in existing reserves	
VT 93 Hummock grasslands, shrub steppe; kanji over soft spinifex	1.5
Inadequate protection (5 to 15%) in existing reserves	
VT 173 Hummock grasslands, shrub steppe; kanji over soft spinifex & *Triodia wiseana* on basalt	6.1

Sources: See technical notes 2 (chapter 2).

6.2.5 Proposed 'Karratha – Mardie' National Park

Former leasehold properties: ex Mardie, ex Karratha

This proposed new park (18,000 hectares) would substantially enhance protection of the coastal margin from Cape Preston to Cape Keraudren, and provide a new reserve on a coast with little existing protection. The properties lie within the Roebourne sub-bioregion, and would increase the extent protected in the conservation reserve system from 3.7% to 4.6% (see section 6.3).

The diversity of the proposed park is indicated by the 7 sub-bioregional ecosystems and 7 plant communities found there. Four ecosystems and 3 plant communities have less than 5% representation in existing reserves (Table 6-15).

The new park would protect 2 listed priority ecological communities (Table 6-15). The horseflat land system of the Roebourne (priority 3) consists of extensive, weakly gilgaied clay plains dominated by tussock grasslands (DBCA, 2017a). Threats include grazing, weed invasion and fragmentation. The coastal dune native tussock grassland community dominated by *Whiteochloa airoides* (priority 3) occurs on the landward side of dunes with grasses and scattered low shrubs (DBCA, 2017a). Threats include weed invasion and raw material extraction.

The proposed park has records for 13 threatened and priority animal species, including 3 threatened migratory shorebirds – the bar-tailed godwit, curlew sandpiper and great knot (all listed as vulnerable) – and the ghost bat (vulnerable) and 5 priority plant species (Table 6-16). It is also part of 'biologically important areas' for certain seabird species that forage and breed in the area (Table 6-15).

Ex Karratha is part of the 'Dampier Archipelago' National Heritage listing, recognised for its natural beauty, Aboriginal significance and ancient rock art. The list recognises places of outstanding heritage value to the nation.

Bar-tailed godwits (*Limosa lapponica*) fly annually from Australia to Scandinavia, northern Asia or Alaska to breed. They have been recorded flying 11,000 kilometres non-stop for 8 days at an average speed of more than 50 kilometres an hour. They lose about half their body weight on such a flight, highlighting the importance of protecting productive feeding sites in Australia. Photo: Georgina Steytler

Table 6-15: Summary of conservation values of the proposed 'Karratha – Mardie' National Park

ex Mardie (3,000 hectares)	
Priority ecological community	Horseflat Land System of the Roebourne Plains (priority 3) (5% of total extent).
Plant communities	3 communities: 1 with <5% representation in existing reserves.
Sub-bioregional ecosystems	3 ecosystems: 2 with 0% representation in the existing reserve system.
Biologically important areas	BIAs for the roseate tern *(Sterna dougallii)*, fairy tern *(Sterna nereis)* and wedge-tailed shearwater *(Puffinus pacificus)*, which forage and breed in the area.
Buffering & connectivity	Improved protection of the coastal margin.

ex Karratha (15,000 hectares)	
Threatened & priority plants	5 species.
Threatened & priority animals	11 bird, 1 mammal, 1 reptile species.
Priority ecological communities	2 priority communities: • Horseflat Land System of the Roebourne Plains (priority 3) (21% of total extent) • coastal dune tussock grassland dominated by Whiteochloa airoides (priority 3) (52% of total extent).
Plant communities	7 communities: 3 with <5% representation in existing reserves.
Sub-bioregional ecosystems	7 ecosystems, 4 with 0% representation in the existing reserve system, 1 other with <5%.
Biologically important areas	BIAs for the roseate tern *(Sterna dougallii)*, fairy tern (Sterna nereis) and wedge-tailed shearwater *(Puffinus pacificus)*, which forage and breed in the area.
National heritage	Part of the listed Dampier Archipelago area, recognised for its natural beauty, Indigenous significance and rock art.
Buffering & connectivity	Improved protection for the coastal margin (including 2 estuaries and coastal flats) including the pristine estuaries at the mouth of the Yanyare and Maitland Rivers (with Charraowie Pool).

Both properties (18,000 hectares)	
Threatened & priority plants	5 species.
Threatened & priority animals	11 bird, 1 mammal, 1 reptile species.
Priority ecological communities	2 priority communities: Horseflat Land System of the Roebourne Plains (priority 3) (26% of total extent) and coastal dune tussock grassland dominated by Whiteochloa airoides (priority 3) (52% of total extent).
Plant communities	7 communities: 3 with <5% representation in existing reserves.
Sub-bioregional ecosystems	7 ecosystems, 4 with 0% representation in the existing reserve system, 1 other with <5%.
Biologically important areas	BIAs for the roseate tern, fairy tern & wedge-tailed shearwater.
National heritage	Improved protection for a small section of the national heritage-listed Dampier Archipelago
Buffering & connectivity	Improved protection for the coastal margin.

Sources: See technical notes 1 and 2 (chapter 2).

Great knots (*Calidris tenuirostris*) fly annually to eastern Siberia to breed. They have recently been listed in Australia as critically endangered, mainly due to destruction of tidal flats on their migratory route. Photo: Georgina Steytler

Table 6-16: Threatened and priority species and ecological communities of the proposed 'Karratha – Mardie' National Park

Species	Conservation class	ex Karratha	ex Mardie
Birds			
Bar-tailed godwit *(Limosa lapponica baueri & L.l. menzbieri)*	Vulnerable / International agreement	●	
Curlew sandpiper *(Calidris ferruginea)*	Vulnerable / International agreement	●	
Great knot *(Calidris tenuirostris)*	Vulnerable / International agreement	●	
Peregrine falcon *(Falco peregrinus)*	Specially protected	●	
Common greenshank *(Tringa nebularia)*	International agreement	●	
Common tern *(Sterna hirundo)*	International agreement	●	
Fork-tailed swift *(Apus pacificus)*	International agreement	●	
Great egret *(Ardea modesta)*	International agreement	●	
Oriental pratincole *(Glareola maldivarum)*	International agreement	●	
Rainbow bee-eater *(Merops ornatus)*	International agreement	●	
Ruddy turnstone *(Arenaria interpres interpres)*	International agreement	●	
Mammals			
Ghost bat *(Macroderma gigas)*	Vulnerable	●	
Reptiles			
Green turtle *(Chelonia mydas)*[A]	Vulnerable	●	
Plants			
Goodenia pallida	Priority 1	●	
Atriplex lindleyi subsp. conduplicata	Priority 3	●	
Gomphrena cucullata	Priority 3	●	
Gomphrena leptophylla	Priority 3	●	
Oldenlandia sp. *Hamersley Station*	Priority 3	●	
Ecological communities			
Coastal dune tussock grassland dominated by *Whiteochloa airoides*	Priority 3	●	
Horseflat Land System of the Roebourne Plains	Priority 3	●	●

Sources: See technical notes 1 (chapter 2).
Notes: A. Recorded within 1 kilometre of ex Karratha

Table 6-17: The extent of protection (%) in the proposed 'Karratha – Mardie' National Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Karratha	ex Mardie
Little protection (0.1 to 5%) protection in existing reserves		
VT 175 Short bunch grassland - savanna/grass plain (Pilbara)	1.6	0.4
VT 589 Mosaic: Short bunch grassland - savanna / grass plain (Pilbara) / Hummock grasslands, grass steppe; soft spinifex	0.1	
VT 641 Medium woodland; coolibah & river gum	0.8	
Inadequate protection (5 to 15%) in existing reserves		
VT 117 Hummock grasslands, grass steppe; soft spinifex	0.1	
VT 127 Bare areas; mud flats	0.5	<0.1

Sources: See technical notes 2 (chapter 2).

The Pilbara has been designated by the federal government as a national biodiversity hotspot (1 or just 15 such sites nationally) – areas with very high natural values, including unique species, which are at risk unless there is active conservation management. Photo: Richard Goodwin

6.3 Importance for achieving Western Australia's conservation reserve goals

Despite the Pilbara's ecological significance, the bioregion is poorly protected, with just 6.4% in the conservation reserve system (in 3 nature reserves, 3 national parks and 1 conservation park). The Pilbara is considered a national priority for new reserves (NRMMC, 2009). The proposed parks will enable the Western Australian government to make substantial progress towards meeting the state's conservation goals.

Bioregional and sub-bioregional protection

The proposed parks encompass parts of the Pilbara's 4 sub-bioregions, none of which are adequately protected in WA's existing reserve system, particularly Fortescue (with only 0.5% in reserves), Roebourne (3.7%) and Chichester (3.9%). The new parks would substantially improve protection of each sub-bioregion and increase protection of the entire bioregion by more than 60% to just over 10% (Table 6-18).

These gains would see Western Australia make good progress to achieving the 2020 international benchmark of 17% (a standard applicable for large-scale areas, derived from the Aichi Biodiversity Targets under the Convention on Biological Diversity). The additional protection of the Hamersley sub-bioregion would bring it very close to the benchmark while the other sub-bioregions would still remain below 10% protection (Figure 6-4). This means additional reserves should remain a high priority in the Pilbara. The proposed parks also improve protection of the poorly protected Cape Range sub-bioregion in the Carnarvon bioregion.

Ecosystem and plant community protection

The proposed parks would improve protection of 31 plant communities and 38 sub-bioregional ecosystems (Table 6-19). This would be the first such protection for 6 plant communities (19% of the total) and 15 sub-bioregional ecosystems (40% of the total) currently lacking representation in the conservation reserve system.

Protection of the proposed parks is particularly important for 3 ecosystems with the majority of their extent on those properties (Table 6-19). These include 80% of an ecosystem in the proposed extension to Karijini National Park and 84% of an ecosystem in the proposed extension to Cane River Conservation Park.

Currently, more than a third of Western Australia's sub-bioregional ecosystems lack a minimum level of protection, based on a long-held national target of 15% of each ecosystem to be in reserves (JANIS, 1997, Taylor, 2017). The proposed parks would enable the minimum reserve target of 15% to be met for an additional:

- 5 sub-bioregional ecosystems (13% of the total ecosystems on the proposed parks)
- 2 plant communities (6% of the total communities on the proposed parks) (Table 6-19).

Table 6-18: Current and improved protection of bioregions and sub-bioregions (% protected) in Western Australia's conservation reserve system

	Bioregion	Sub-bioregion				Bioregion	Sub-bioregion
	Pilbara	Hamersley	Chichester	Roebourne	Fortescue	Carnarvon	Cape Range
Existing protection	6.38	12.88	3.95	3.71	0.55	5.89	3.44
Proposed parks	3.62	3.30	2.60	4.13	9.36	0.65	2.29
New total	10.10	16.18	6.55	7.84	9.91	6.54	5.73

Source: See technical notes 2 (chapter 2).

Notes: *Existing protection* means the percentage of each bioregion and sub-bioregion protected in the existing conservation reserve system. *Proposed parks* means the percentage of each bioregion and sub-bioregion protected in the proposed parks. *New total* means the percentage of each bioregion and sub-bioregion that would be protected if the proposed parks are declared.

Figure 6-4: Progress towards the 2020 international benchmark (17%) for protection of bioregions and sub-bioregions (% area protected) due to the proposed parks

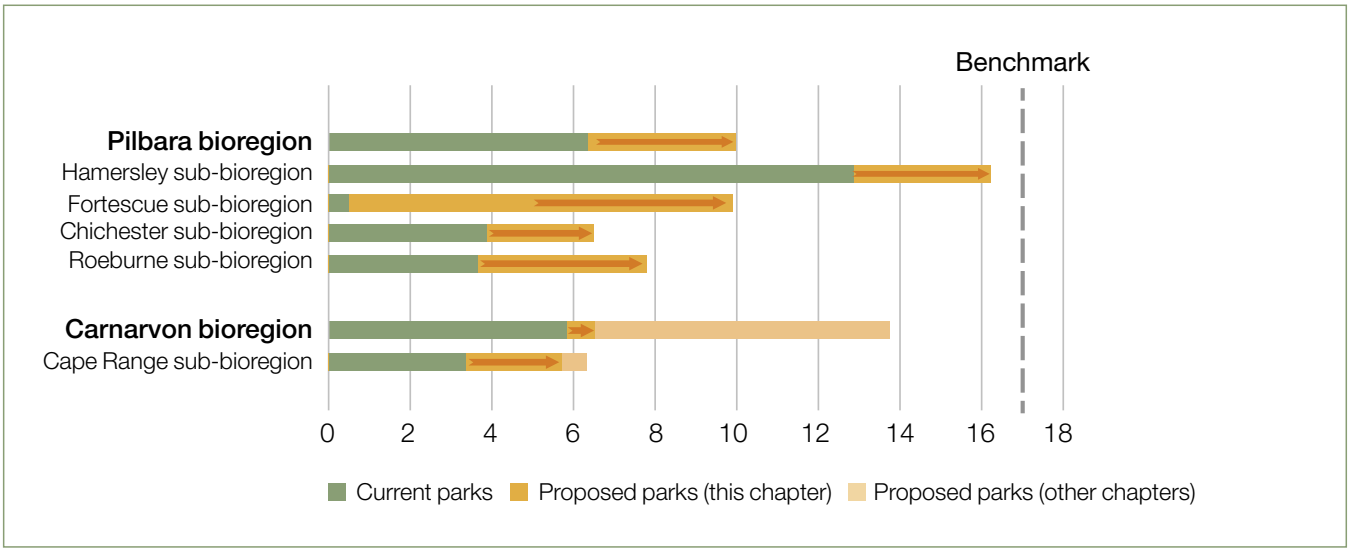


Table 6-19: Numbers of plant communities and sub-bioregional ecosystems in the proposed parks, levels of protection in the existing conservation reserve system and the contribution to protection of particular communities and ecosystems

	Plant communities (number & percentage)		Ecosystems (number & percentage)	
Improved protection in proposed parks				
Total in proposed parks	31	100%	38	100%
Will achieve 15% target[A]	2	6%	5	13%
Current level of protection in reserve system				
No existing protection (<0.1%)	6	19%	15	39%
Little existing protection (0.1-5%)	14	45%	9	24%
Inadequate protection (5.1-<15%)	5	16%	7	18%
Exceeds 15% protection	6	19%	7	18%
Contribution to protection of particular communities & ecosystems[B]				
Critical (>85% of total extent)	-	-	-	-
Very important (50–85% of total extent)	-	-	3	8%
Important (10–50% of total extent)	4	13%	9	24%

Sources: See technical notes 2 (chapter 2).

Notes: A. This assumes protection in other proposed parks and does not include ecosystems that already have more than 15% of their extent protected in the conservation reserve system. B. This represents the number of communities or ecosystems with a substantial proportion of their total extent in the proposed parks. For example, the proposed parks are 'critical' for ecosystem protection where more than 85% of the entire ecosystem extent occurs within those proposed parks

6.4 Native title and Aboriginal heritage sites

The Pilbara has a long history as the country of Indigenous Australians, and is very rich in cultural heritage. There are 13 native title claimant groups for the proposed parks: Eastern Guruma, Yinhawangka, Yindjibarndi, Banjima, Nyiyaparli, Palyku, Ngarluma/Yindjibarndi, Thalanyji, Puutu Kunti Kurrama & Pinikura, Njamal, Yaburara & Mardudhunera. Sixty registered Aboriginal heritage sites would be entirely protected and an additional 37 partially so (Table 6-20). Another 94 nominations have been lodged.

Table 6-20: Native title status and registered Aboriginal heritage sites for the proposed parks

Native title party, claimed or determined (percentage of property)	Registered Aboriginal heritage sites
Proposed additions to Karijini National Park	
ex Hamersley	
Eastern Guruma, determined, non-exclusive (100%)	18 sites (15 that would be fully protected, 3 partially) including the Hamersley burial tree (historical site, modified tree, skeletal material and burial site), Mt Stevenson South (ceremonial and mythological site), multiple scar trees and other artefacts
ex Rocklea	
Yinhawangka, determined, non-exclusive (95%) Eastern Guruma, determined, non-exclusive (5%)	1 site that would be partially protected: an engraving site with artefact scatter at Bellary Creek
ex Mt Florence	
Banjima, determined, non-exclusive (69%) Yindjibarndi, determined, exclusive (29.5%) Yindjibarndi, determined, non-exclusive (1.5%)	3 sites (1 would be fully protected, 2 partially), including Hamersley Gorge Engraving (an artefacts / scatter, engraving, man-made structure, painting site) and Rio Tinto Gorge (an artefacts / scatter, rockshelter, arch deposit site)
ex Juna Downs	
Banjima, determined non-exclusive (100%)	10 sites (4 would be fully protected, 6 partially), including the entire extent of the Mt Bruce sacred site (a ceremonial site restricted to men), Mt Windell (a mythological site), Bardulanha (a ceremonial site), Gundawuna, Mt Meharry (a man-made structure & mythological site), Packsaddle Burial (an artefacts / scatter, man-made structure, rockshelter, skeletal material / burial site). Other sites include grinding patches, rockshelters, camps, man-made structures, and artifacts.
ex Marillana	
Banjima, determined, non-exclusive (61%) Nyiyaparli, determined, non-exclusive (39%)	1 site that would be fully protected, artefacts
ex Mulga Downs	
Banjima, determined, non-exclusive (10%) Nyiyaparli, determined, non-exclusive (64%) Palyku, claimed (17%)	16 sites that would be fully protected, including rockshelters, arch deposit, scar tree, grinding patches/grove site, artefact scatter
ex Hillside	
Nyiyaparli, determined, non-exclusive (100%)	2 sites that would be fully protected, artefacts and an arch deposit
ex Roy Hill	
Nyiyaparli, determined, non-exclusive (100%)	No registered sites
Proposed addition to Millstream Chichester National Park	
ex Pyramid	
Ngarluma/Yindjibarndi, determined, non-exclusive (100%)	No registered sites

Table 6-20 (continued)

Native title party, claimed or determined (percentage of property)	Registered or lodged Aboriginal heritage sites
Proposed addition to Cane River Conservation Park	
ex Mt Minnie	
No current claimants	6 sites (3 would be fully protected, 3 partially), including a rockshelter, arch deposit site, quarry and artefact scatter at 97 Mile Knoll, a camp site and various artefact scatters.
ex Nanutarra	
Thalanyji, determined, non-exclusive (85%) Puutu Kunti Kurrama & Pinikura, determined, non-exclusive (15%)	5 sites that would be partially protected, including an artefact scatter and 4 grinding patches/grooves.
Proposed 'Meentheena' National Park	
ex Meentheena	
Njamal, claim (100%)	6 sites (3 would be fully protected & 3 partially), including 4 engraving sites in the Ripon Hills and Willina Well, a water source at Widgerina rockhole, an artefact scatter
Proposed 'Karratha – Mardie' National Park	
ex Mardie	
Yaburara & Mardudhunera, determined, non-exclusive (100%)	No registered sites
ex Karratha	
Yaburara & Mardudhunera, determined, non-exclusive (88%) Yindjibarndi/Ngarluma, determined, non-exclusive (12%)	29 sites (15 would be fully protected & 14 partially), including Yukulyum Spring (ceremonial, historical, mythological, hunting place, water source), Noorea Soak (grinding patches / grooves, camp, hunting place, sater source), Maitland Mouth 1 (artefacts / scatter, engraving, grinding patches / grooves, midden / scatter site, 2 middens, 3 engraving sites, other artefact scatter, repository/cache sites and shell sites.

Sources: See technical notes 3 (chapter 2), data current to November 2018.

The Chichester Range, which peaks at 370 metres, had its orgins in 100 million years of volcanic activity more than 2.6 billion years ago that buried the older granite-greenstone terrain in molten rock. The present landscape is the result of long periods of weathering and erosion. Photo: Michael Pelusey

6.5 Geology, prospectivity and mining

The Pilbara is geologically ancient and distinctive. The region coincides largely with the Pilbara Craton, one of Australia's major geological blocks, with landscapes of hard rock laid down up to 3.7 billion years ago, some of the oldest rocks on the planet (McKenzie et al., 2009). The Pilbara's geology can be clearly distinguished in satellite photos from that of surrounding areas (Pepper et al., 2013). Its standout features include the plateaus of the iron-rich Hamersley Ranges and balsitic Chichester Ranges, and the Fortescue River valley dissecting the Hamersley Basin with deeply incised gorges. The deep history of the Pilbara region is revealed in features such as a 3.4 billion-year-old fossilized stromatolite reef, immense glacial scarring and palaeochannels that reflect much wetter times in the past (Pepper et al., 2013). The banded iron formations of the Hamersley Range Gorges are important for understanding the early earth's atmosphere and interesting for geology enthusiasts (Carter, 1987).

The following summary of the geology, prospectivity and mining activity on each proposed park comes from the following sources: Belford (2017) and DMIRS (2018a). The extent of proposed and existing mining-related activity is summarised in Tables 6-21, 6-22 and 6-23.

Proposed extension to Karijini National Park

The 8 properties proposed for addition to Karijini National Park are all part of the Neoarchean/Paleoproterozoic Hamersley Group, comprising dolomite, banded iron formation and shale. They are highly prospective for iron. The properties comprising the Fortescue Marsh have a surface geology of Cenozoic alluvial and lacustrine inset-valley and valley-fill deposits of the Fortescue trough. There are known deposits of iron ore.

Mining activity: These properties have a lot of mining activity and most of the area is overlain by mining leases, exploration licences or applications for these.

Areas without mining activity: 28% of the proposed extension to Karijini National Park is free of existing mining-related activities. Applications for exploration covering 8% of the area are currently being considered. Areas with no existing or proposed mineral tenements include a 40,000-hectare contiguous section of ex Roy Hill, ex Marillana and ex Hillside (Fortescue Marsh) and another 15,000-hectare contiguous section of ex Marillana and ex Mulga Downs (Fortescue Marsh). Rocklea has the least mining-related activity with 10% (2500 hectares) free of existing or proposed mining-related activity directly adjacent to Karijini National Park. Applications for exploration covering 87% (20,000 hectares) of ex Rocklea are currently being considered.

Proposed extension to Millstream Chichester National Park

Ex Pyramid is underlain by Archean rocks of the Fortescue Group (sandstone, dacite, rhyolite). The mineral prospectivity is low and there are no known mineral deposits.

Mining activity: An exploration licence (E 47/3816) granted in July 2018 covers all of ex Pyramid.

Areas without mining activity: 0% of ex Pyramid is free of existing mining-related activities.

Proposed extension to Cane River Conservation Park

Ex Mt Minnie

The majority of ex Mt Minnie is underlain by Cenozoic deposits of quartzose eolian and alluvial material bounded to the east by Cretaceous continental to coastal sandstone and conglomerate. A short distance to the south of this block are the Manyingee and Bennett Well uranium deposits. The strike of these deposits extends into ex Minnie and is highly prospective for uranium. Active exploration programs are in progress. In the south-east corner, this block is underlain by Palaoproterozoic sedimentary rocks. Regional indications are that these are prospective for copper and other base metals. There are known deposits of construction materials.

Mining activity: Exploration licences cover 20% (20,000 hectares) of the property, and applications cover another 4% (4000 hectares). Two small mining leases span a total of 200 hectares. There are 5 miscellaneous licences and 1 application associated with a road for mining-related activities.

Areas without mining activity: 80% of ex Mt Minnie is free of existing mining-related activities. Applications for exploration covering 4% of the property are currently being considered.

Ex Nanutarra

The western two-thirds of ex Nanutarra is underlain by minor Cretaceous continental to coastal sandstone and conglomerate that abuts Paleoproterozoic sedimentary rocks and granite to the east. These rocks host the Boolaloo copper deposit. This area is highly prospective for base metals. The eastern third of the block is underlain by Mezoproterozoic Edmund Group rocks (sandstone, siltstone, mudstone, dolomite and chert), and Paleoproterozoic Wyloo Groop rocks (shale, sandstone and conglomerate). There are known deposits of base metals and small deposits of construction materials present.

Mining activity: A small 40-hectare mining lease covers 0.1% of ex Nanutarra and is adjoined by a 20-hectare related miscellaneous licence for a bore, a pipeline, a road and taking water. An exploration licence covers 7% of the property (5000 hectares). There are 6 applications for exploration in the western part of the property and 2 licence applications for a road.

Areas without mining activity: 93% of ex Nanutarra is free of existing mining-related activities. Applications for exploration covering 34% of the property are currently being considered.

Proposed 'Meentheena' National Park

The majority of ex Meentheena is underlain by Archean Fortescue Group rocks, passing upwards through 5 formations from basalt; sandstone, dacite, rhyolite; basalt; and basalt, sandstone, carbonate rocks and shale, chert, basalt. A thin sliver of Archean Pilbara Supergroup rocks (basalt, komatiite, dacite, rhyolite) lie between the Fortescue Group and Archean granite which is located along the western margin of the block. The Pilbara Supergroup basalts host the Lennons Find base metal occurrence along this contact. Numerous known gold occurrences also lie along this western contact of the basalt with the granite. This margin is considered highly prospective for gold and base metals. A small occurrence of an industrial mineral, most likely barite, is located in the centre of the parcel. Known occurrences of barite extend along the western margin. Another sliver of Pilbara Supergroup rocks wraps around the western boundary of another Archean granite that extends northwards across the southernmost margin of the eastern block. The Pilbara Supergroup rocks are highly prospective for gold and base metals. There are known deposits of gold, base metals, construction materials and fluorite.

Mining activity: Two mining leases cover 0.3% of ex Meentheena: M 45/411 (1 hectare) is in the central west among known gold deposits, and M 45/368 (700 hectares) is in the south-west, where previous mines have extracted base metals. Granted exploration licences cover 60% of ex Meentheena.

Areas without mining activity: 40% of ex Meentheena is free of existing mining-related activities. Applications for exploration covering 32% of the property are currently being considered.

Proposed 'Meentheena' National Park

The majority of ex Meentheena is underlain by Archean Fortescue Group rocks, passing upwards through 5 formations from basalt; sandstone, dacite, rhyolite; basalt; and basalt, sandstone, carbonate rocks and shale, chert, basalt. A thin sliver of Archean Pilbara Supergroup rocks (basalt, komatiite, dacite, rhyolite) lie between the Fortescue Group and Archean granite which is located along the western margin of the block. The Pilbara Supergroup basalts host the Lennons Find base metal occurrence along this contact. Numerous known gold occurrences also lie along this western contact of the basalt with the granite. This margin is considered highly prospective for gold and base metals. A small occurrence of an industrial mineral, most likely barite, is located in the centre of the parcel. Known occurrences of barite extend along the western margin. Another sliver of Pilbara Supergroup rocks wraps around the western boundary of another Archean granite that extends northwards across the southernmost margin of the eastern block. The Pilbara Supergroup rocks are highly prospective for gold and base metals. There are known deposits of gold, base metals, construction materials and fluorite.

Mining activity: Two mining leases cover 0.3% of ex Meentheena: M 45/411 (1 hectare) is in the central west among known gold deposits, and M 45/368 (700 hectares) is in the south-west, where previous mines have extracted base metals. Granted exploration licences cover 60% of ex Meentheena.

Areas without mining activity: 40% of ex Meentheena is free of existing mining-related activities. Applications for exploration covering 32% of the property are currently being considered.

Proposed 'Karratha – Mardie' National Park

Ex Karratha and ex Mardie are predominantly underlain by Archean granite, which forms the western edge of the Pilbara Craton and is abutted by a strip of Quaternary shoreline and coastal calcareous eolian limestone deposits. The mineral prospectivity of this block is low. There are known deposits of construction materials in ex Karratha and no known deposits in ex Mardie.

Mining activity: Ex Karratha and ex Mardie have numerous tenements, including 7 exploration licences, 3 mining leases, 2 miscellaneous licences and 10 applications for exploration.

Areas without mining activity: 12% of the proposed 'Karratha-Mardie' National Park is free of existing mining-related activities. Applications for exploration covering 12% of the property are currently being considered. An exemption from mining under section 19 of the Mining 1978 (DMIRS, 2018c) exists over part of ex Karratha in the north-east (S19 153) corresponding with a temporary reserve and applications for exploration.

Table 6-21: Existing mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed Cane River Conservation Park				
ex Mt Minnie	20%	-	20%	<1%
ex Nanutarra	7%	-	7%	-
All properties	15%	-	15%	<1%
Proposed Karijini National Park expansion				
ex Hamersley	68%	-	68%	6%
ex Hillside	62%	-	62%	22%
ex Juna Downs	58%	-	58%	20%
ex Marillana	52%	-	52%	5%
ex Mt Florence	56%	-	56%	9%
ex Mulga Downs	43%	-	43%	31%
ex Rocklea	-	-	-	3%
ex Roy Hill	39%	-	39%	<1%
All properties	49%	-	49%	13%
Proposed 'Karratha – Mardie' National Park				
ex Karratha	84%	-	84%	3%
ex Mardie	100%	-	100%	-
All properties	86%	-	86%	3%
Proposed 'Meentheena' National Park				
ex Meentheena	60%	-	60%	<1%
Proposed Millstream National Park expansion				
ex Pyramid	99%	-	99%	-

Note: Where mining tenements and titles overlap, only 1 value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

The proposed parks provide an opportunity to increase protection for nature in a region with very high ecological significance, high threats and low levels of protection in existing reserves. Photo: Liam Byrne

Gull-billed terns (*Gelochelidon nilotica*) are mainly a bird of the Outback, often appearing in large flocks on temporary flood waters. They are protected under a migratory bird agreement with China. Photo: Georgina Steytler

Wood sandpipers (*Tringa glareola)* breed mainly in Scandinavia, the Baltic countries and Russia. In Australia they inhabit shallow freshwater wetlands, typically with emergent reeds and grass. Photo: Keith Wilcox

Table 6-22: Applications for mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed Cane River Conservation Park				
ex Mt Minnie	4%	-	4%	-
ex Nanutarra	34%	-	34%	<1%
All properties	15%	-	15%	-
Proposed Karijini National Park expansion				
ex Hamersley	6%	-	6%	18%
ex Hillside	-	-	-	3%
ex Juna Downs	3%	-	3%	18%
ex Marillana	-	-	-	14%
ex Mt Florence	-	-	-	13%
ex Mulga Downs	-	-	-	-
ex Rocklea	87%	-	87%	-
ex Roy Hill	-	-	-	-
All properties	8%	-	8%	9%
Proposed 'Karratha – Mardie' National Park				
ex Karratha	13%	-	13%	-
ex Mardie	<1%	-	<1%	-
All properties	11%	-	11%	-
Proposed 'Meentheena' National Park				
ex Meentheena	32%	-	32%	-
Proposed Millstream National Park expansion				
ex Pyramid	<1%	-	<1%	-

Note: Where mining tenements and titles overlap, only 1 value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

Table 6-23: Proposed park areas (%) free of existing mining-related activity

	No mineral mining	No oil & gas mining	Combined
Proposed Cane River Conservation Park			
ex Mt Minnie	79%	100%	79%
ex Nanutarra	93%	100%	93%
All properties	85%	100%	85%
Proposed Karijini National Park expansion			
ex Hamersley	8%	100%	8%
ex Hillside	13%	100%	13%
ex Juna Downs	4%	100%	4%
ex Marillana	29%	100%	29%
ex Mt Florence	23%	100%	23%
ex Mulga Downs	25%	100%	25%
ex Rocklea	97%	100%	97%
ex Roy Hill	60%	100%	60%
All properties	28%	100%	28%
Proposed 'Karratha – Mardie' National Park			
ex Karratha	13%	100%	13%
ex Mardie	<1%	100%	<1%
All properties	11%	100%	11%
Proposed 'Meentheena' National Park			
ex Meentheena	40%	100%	40%
Proposed Millstream National Park expansion			
ex Pyramid	<1%	100%	<1%

Source: See technical notes 4 (chapter 2).

Although a bastion for threatened species, the Pilbara has also lost some of its original fauna – 12 of 41 mammals are regionally extinct. Mining, overgrazing, altered fire regimes, weeds and feral animals have altered the vegetation, degraded soils and caused biodiversity declines. Over three-quarters of the area has mining tenements. Photo: Jessica Wyld

6.6 Recommendations

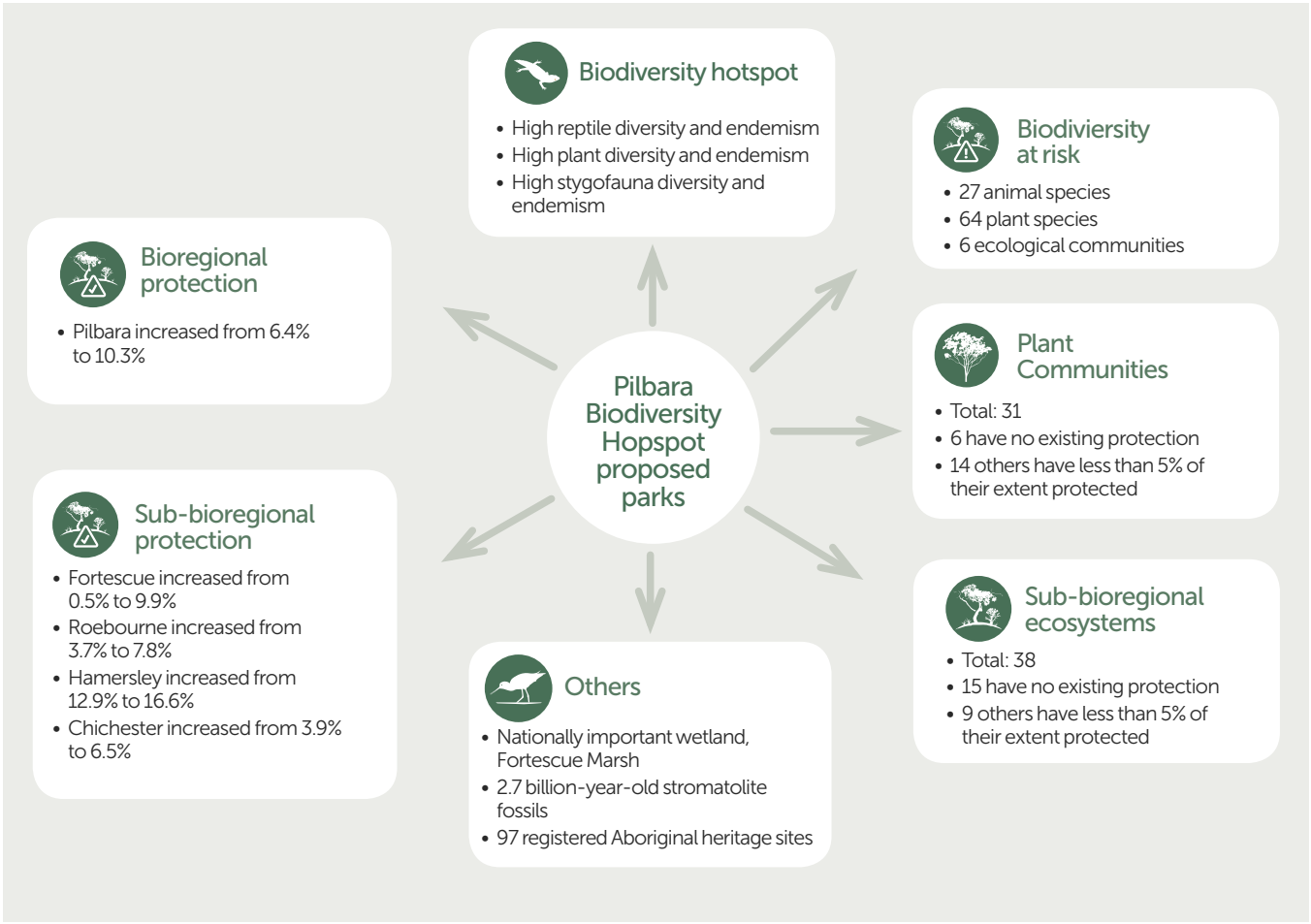
The proposals to expand 3 existing reserves and create 2 new reserves would enhance protection of the iconic Karijini National Park, the nationally important Fortescue Marsh wetland, more than 90 threatened and priority species, 6 priority ecological communities, and 20 plant communities and 24 sub-bioregional ecosystems with less than 5% representation in existing reserves (Figure 6-5). They would increase protection of the Pilbara bioregion and 4 sub-bioregions, none of which currently meet the 17% international benchmark for protection.

The recommendations should be considered within the context of the Environmental Protection Authority's advice to the Minister for the Environment in 2014 regarding 'Cumulative environmental impacts of development in the Pilbara region' (EPA 2014):

> *There is a lack of a comprehensive, adequate and representative reserve system in the Pilbara. Currently only six per cent of the Pilbara biogeographic region is held in the conservation reserve system, well below the 17 per cent international target for biodiversity protection.*

Coupled with the EPA's observations that 'the rate of development approval in the region is unprecedented' and that, despite more than 60 years of mining in the Pilbara, 'there is limited evidence that proponents have successfully rehabilitated any areas that have been subject to large-scale mining', it is clear that this expansion of the conservation reserve system is needed. It would partly redress the significant lack of balance between conservation (6% in the conservation reserve system) and mining (57% under granted mining tenements and another 20% under applications) in the Pilbara.

Figure 6-5: Some combined values of the proposed parks



Recommendation 6-1

Incorporate ex Hamersley, ex Rocklea, ex Mt Florence, ex Juna Downs, ex Marillana, ex Mulga Downs, ex Hillside and ex Roy Hill into Karijini National Park with Class A protection. Seek to re-establish protective agreements, in partnership with leaseholders, on Rocklea, Juna Downs and Hamersley stations over areas previously intended for inclusion in Karijini.

Conservation considerations

The national and international significance of the natural values of these 8 properties warrant the protection and management afforded by declaration as a Class A national park. This is not only consistent with the tenure and classification of the existing national park, but also with the recommendation by the Environmental Protection Authority (EPA 2014):

> *That the proposed 2015 pastoral lease exclusion areas within the Pilbara, identified for management by the Department of Parks and Wildlife, be afforded the highest possible level of conservation tenure.*

The properties harbor more than 70 threatened and priority species – 54 plant species and 20 animal species, including the night parrot (critically endangered), northern quoll (endangered), bilby (vulnerable), ghost bat (vulnerable), Pilbara leaf-nosed bat (vulnerable) and grey falcon (vulnerable). Of the 10 plant communities on these properties, 6 have little to no protection in existing reserves.

The proposed park extension provides the only opportunity for protecting the Fortescue Marsh, a priority-1 ecological community, nationally significant wetland and key biodiversity area which can support more than a quarter of a million waterbirds. It would also improve protection for 3 other priority-1 ecological communities – Brockman Iron cracking clay communities of the Hamersley Range and 2 coolibah-lignum flats communities.

The proposed extension would add 300,000 hectares to Karijini, increasing the park area by 48%. The properties would make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. In particular, they would add 9.4% of the Fortescue sub-bioregion (with less than 1% in existing reserves) and 1.7% of the Pilbara bioregion (with less than 7% in existing reserves) to the reserve system, and protect 7 sub-bioregional ecosystems with little to no representation in the conservation reserve system. It is particulary important for 1 ecosystem with 80% of its extent in the proposed park addition.

We recommend that the government seeks to establish management partnerships and protective agreements over 56,000 hectares of land with high natural values on 3 adjoining pastoral leases (Hamersley Station, Rocklea Station and Juna Downs Station). As discussed in Box 6-1, this land was earmarked for conservation but not included in the exclusion of land from the leasehold estate when Western Australia's pastoral leases were collectively renewed on 1 July 2015.

The native title parties over the proposed extension areas are the Eastern Guruma, Yinhawangka, Banjima, Yindjibarndi, Nyiyaparli and Palyku peoples, whose consent would be required for any tenure change. The park extension would protect 51 registered Aboriginal heritage sites.

Mining considerations

Just over a quarter of the proposed park additions are free of existing mining-related activities. Granted exploration licences cover half of the proposed park area. The activities permitted under these licences should be referred to the Environmental Protection Authority for environmental assessment to ensure that they are consistent with maintaining the natural values for which the properties were acquired. Current applications for exploration licences (which cover 8% of the area) and future applications should not be granted.

Existing mining leases and licences for mining infrastructure, which cover 13% of the area, would ideally be voluntarily surrendered; otherwise, they should have conditions applied to ensure that operations are consistent with maintaining the values of the park. This is especially important where these leases overlap threatened species locations and priority ecological communities. For example, 2 mineral leases (ML 249SA, ML 281SA) on ex Juna Downs overlap the priority-1 Coolibah woodlands over lignum wetland communities, which have a very restricted distribution and are vulnerable to disturbance (DBCA, 2017a). Any further applications for operations on these existing leases should be referred to the Environmental Protection Authority for assessment.

Recommendation 6-2

Incorporate ex Pyramid into Millstream Chichester National Park.

Conservation considerations

Ex Pyramid, enclosed on 3 sides by Millstream Chichester National Park, would make a small (3000 hectares) but important contribution to the integrity of the national park. It would also protect the habitat of threatened and priority species including the northern quoll (endangered). It would protect 3 plant communities with less than 5% representation in existing reserves.

The native title parties for this area are the Ngarluma and Yindjibarndi peoples, whose consent would be required for any tenure change.

Mining considerations

The mineral prospectivity on ex Pyramid is low. An exploration licence over all of ex Pyramid was granted in July 2018. Upon declaration of this area as a park, before any written consent is provided by the Minister for Mines for a continuation of exploration activities, it should be referred to the Environmental Protection Authority for environmental assessment.

Recommendation 6-3

Incorporate ex Mt Minnie and ex Nanutarra into Cane River Conservation Park. Classify the additions as Class A reserves, and review the classification of the existing conservation park.

Conservation considerations

Ex Mt Minnie and ex Nanutarra would enhance protection of Cane River Conservation Park, extending it by 180,000 hectares. These properties have unusually high plant diversity for an arid region, and are also rich in groundwater animals (stygofauna) and vertebrate animals. They harbour 6 priority species. Of the 11 plant communities on the properties, 8 have little to no protection in existing reserves. The expansion would help maintain catchment health for the Cane and Ashburton rivers. The specific values of the proposed park areas require further investigation, and potentially a revision of these recommendations if new and important information comes to light.

While Cane River Conservation Park is currently not classified as a Class A reserve, the proposed 160,000-hectare expansion alone would make a significant contribution to Western Australia's conservation reserve system, warranting Class A protection. We recommend that the classification of the existing park be reconsidered to better reflect the likely value of this conservation reserve.

In particular, the proposed park additions would add 3.1% of the Roebourne sub-bioregion (with less than 4% in existing reserves) to the reserve system, and protect 7 sub-bioregional ecosystems with little to no current representation in the reserve system. It is particulary important for 2 ecosystems with 84% and 54% of their total extent on the properties.

The native title parties for these proposed park additions are the Thalanyji, Puutu Kunti Kurrama and Pinikura peoples, whose consent will be required for the proposed park addition. The new park area would protect 11 registered Aboriginal heritage sites.

Mining considerations

The proposed park additions are 85% free of existing mining-related activities. Exploration licences cover 15% of the area and applications for exploration licences cover another 15%. There are also 2 licence applications for a mining access road. One exploration licence (E 08/2387) and 5 exploration licence applications overlay almost the entire extent of 2 ecosystems currently unprotected in the conservation reserve system.

Any exploration licence applications over any part of the expanded Cane River Conservation Park should be subject to a thorough environmental assessment by the Environmental Protection Authority, with the potential for the Minister to refuse to grant the licence on public interest grounds if activities place the values of the park at risk. If the granting of mining leases is to be considered in future, at a minimum, ministerial conditions should be applied to ensure that operations are consistent with maintaining the values of the park.

The Pilbara is outstandingly rich in reptiles, including geckoes, with more species than any other region in Australia. This is *Gehyra punctata*, a rock-dwelling gecko endemic to Western Australia. Photo: Michael Sale

Recommendation 6-4

Declare ex Meentheena as a Class A national park. Incorporate the unallocated Crown land surrounding ex Meentheena into the park, subject to an assessment confirming its conservation value.

Conservation considerations

This proposed reserve would be the only national park in the north-east Pilbara. It harbours several threatened species, including the night parrot (critically endangered), northern quoll (endangered), ghost bat (vulnerable), bilby (vulnerable) and grey falcon (vulnerable), and also features well preserved 2.7-billion-year-old fossil stromatolites. Four of its 5 plant communities have little or no protection in existing reserves.

The values of this proposed park – particularly the 7 threatened and priority-1 species and the 2.7 billion-year-old fossil stromatolites – are of national significance, warranting protection in a Class A national park. The proposed park of 216,000 hectares would make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. In particular, it would add 2.6% of the Chichester sub-bioregion (with less than 4% in existing reserves) and 1.2% of the Pilbara bioregion (with less than 7% in existing reserves) to the conservation reserve system, and protect 4 sub-bioregional ecosystems with little to no representation in existing reserves.

The native title parties for this property are Njamal people, whose consent will be required for any tenure change. Six registered Aboriginal heritage sites would be protected.

Mining considerations

The proposed park area is 40% (86,000 hectares) free of existing mining-related activities. As the risk to threatened species from further exploration is considerable, additional exploration licenses should not be granted. This includes an exploration licence application (E 45/5117) that overlaps the occurrence of significant stromalite fossils. Exporation licences (spanning 60% of the property) should have conditions applied to ensure that operations are consistent with maintaining the values of the park. The mining lease (M 45/368) near the south-western border of ex Meentheena (700 hectares, 0.3% of the property) could be excised from the future park. Any further approvals for operations should be referred to the Environmental Protection Authority for assessment.

Recommendation 6-5

Declare ex Karratha and ex Mardie as a Class A national park. Incorporate the parcels of unallocated Crown land to the west of these properties into the park, subject to an assessment confirming their conservation value.

Conservation considerations

This proposed park would increase protection of the highly significant coastal margin of the Pilbara, where few reserves exist. The properties harbour 18 threatened and priority species, including the ghost bat (vulnerable) and 3 threatened migratory shorebirds – the bar-tailed godwit, curlew sandpiper, great knot (each vulnerable). The proposed park would protect 2 listed priority-3 ecological communities: the Horseflat Land System of the Roebourne Plains and a coastal dune tussock grassland. Of the 7 plant communities on the properties, 3 have less than 5% protection in existing reserves.

The values of this proposed park – particularly the 6 threatened and priority-1 species, the priority ecological communities, significant coastal margin and overlap with the area covered by the 'Dampier Archipelago' national heritage listing – are of national significance, warranting protection in a Class A national park. The proposed park of 18,000 hectares would make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. In particular, it would add 0.9% of the Roebourne sub-bioregion (with less than 4% in existing reserves) to the reserve system, and protect 5 sub-bioregional ecosystems with little to no representation in existing reserves.

The native title parties for this proposed park are the Yaburara, Mardudhunera, Yindjibarndi and Ngarluma peoples, whose consent would be required for the new park. Ex Karratha is rich in Aboriginal heritage sites, particularly around the Maitland and the Yanyare rivers. Twenty-nine registered sites would be protected.

Mining considerations

The proposed park is 12% free of existing mining-related activities. This consists of a small strip (200 hectares) of ex Karratha adjoining a 2000-hectare area under applications for exploration. These should be denied on public interest grounds.

It is recommended the properties be classified as a Class A reserve to provide the only protection for the Horseflat Land System and the coastal dune native tussock grassland, both priority-3 ecological communities with a very restricted range. The pristine estuaries of the Yanyare River and Maitland River would also be protected.

The eastern section of the proposed park has interim protection under section 19 of the Mining Act 1978, which covers much of the national heritage-listed Dampier Archipelago.

Given their values, these 2 properties should be afforded a high level of protection. However, all of ex Mardie and 84% of ex Karratha are overlain by exploration licences. An additional 3% has mining leases and infrastructure licences. Activities allowed under these tenements should have conditions applied to ensure that operations are consistent with maintaining the values of the park. Any further approvals for operations should be referred to the Environmental Protection Authority for assessment.

The Pilbara is botanically rich, with some 1700 recorded plant species, many with tiny distributions in the rocky ranges. The number of known species has increased by more than half over the past 25 years. Photo: Liam Byrne

7 Murchison Salt Lake Circuit

One of the great Australian nomads is the banded stilt (*Cladorhynchus leucocephalus*). In ways mysterious to us, they know when rain has fallen hundreds or thousands of kilometres away, perhaps offering them a rare chance to breed. Photo: Amanda Keesing

7.1 At a glance

Proposed parks

Table 7-1: Former leasehold properties acquired for conservation

Property*	Year Acquired	Size (hectares)	Traditional Owners (native title parties)
ex Black Range	2000	80,000	No current claimants
ex Bulga Downs (east)	2002	84,000	Wutha (8%)
ex Bulga Downs (west)	2002	29,000	Wutha (100%)
ex Cashmere Downs	2002	52,000	Wutha (73%)
ex Kaluwiri	2003	103,000	Tjiwarl (100%)
ex Lake Mason	2000	149,000	Tjiwarl (15%)

* The current tenure of all properties is unallocated Crown land.

Natural highlights

Greater protection for salt lakes important for breeding of banded stilts and other waterbirds

3 unique priority-1 vegetation communities associated with banded ironstone ranges

3 unique priority-1 groundwater communities, part of a globally significant archipelago of calcrete communities

26 threatened and priority species including malleefowl

7 plant communities and 16 ecosystems with no protection in existing reserves

Corridors linking vast wetlands including Lake Barlee, Western Australia's second largest lake

Progress towards the 2020 international benchmark for protection

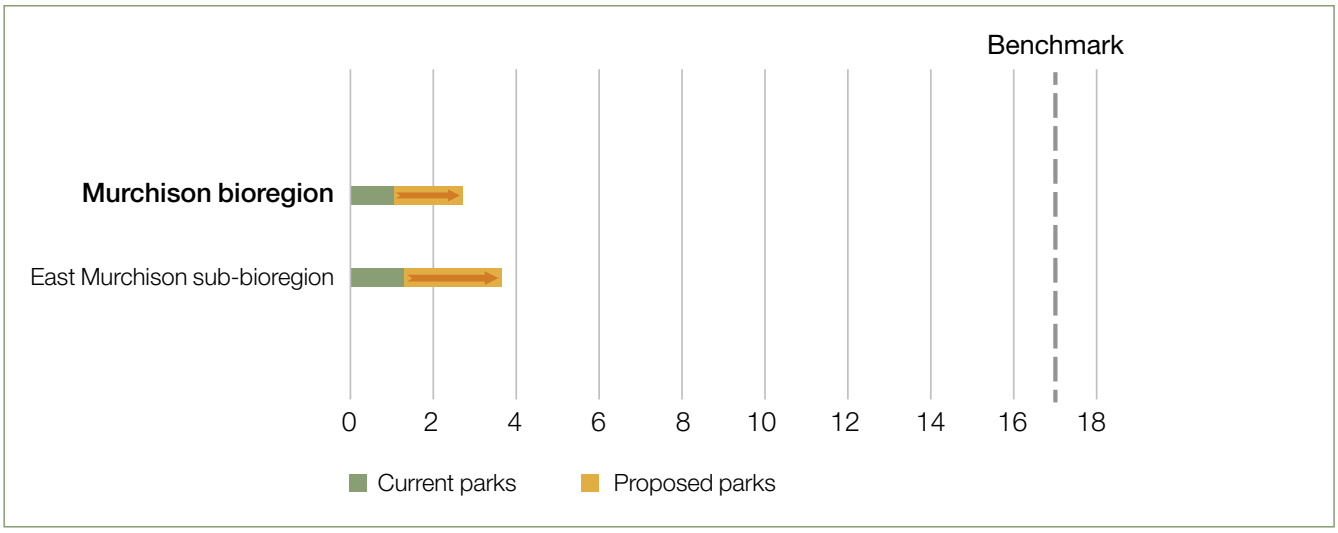


Figure 7-1: The potential increase in protection (% area) due to the proposed parks in bioregions and sub-bioregions where substantial progress can be made towards the international benchmark of 17%.

Reserve recommendations

Table 7-2: Proposed parks

Property	Recommended Protection	Recommended Classification
ex Bulga Downs, ex Cashmere Downs	Create a new national park	Class A
ex Lake Mason, ex Black Range, ex Kaluwiri	Create a new national park	Class A

Claypan dragons (*Ctenophorus salinarum*), endemic to Western Australia, inhabit chenopod shrublands around salt lakes and claypans and in adjacent sandy heaths. Photo: Fred and Jean Hort

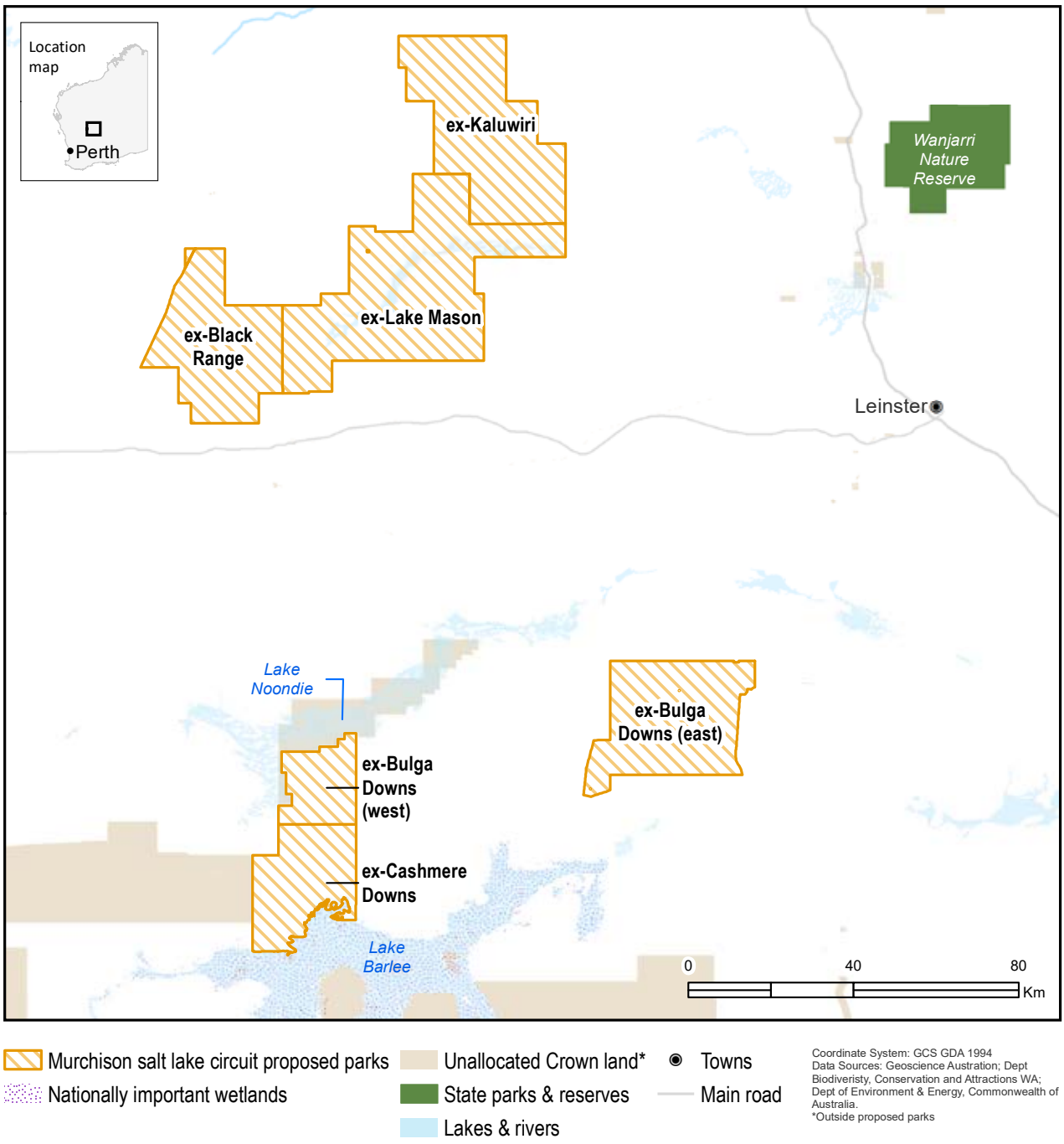


Figure 7-2: Proposed parks of the 'Murchison Salt Lake Circuit'

7.2 Natural values for conservation

In this arid country of vast flat or undulating sandplains occasionally broken by granite and greenstone hills, ridges and domes, water has an especially powerful ecological significance. The salt lakes that fill every decade or so become breeding sites for waterbirds that may travel thousands of kilometres to feed on hyper-abundant crustaceans. And below ground, in permanent waters, are other invertebrates, including potentially dozens of unique species. The wetlands and aquifers reflect the deep history of that region in their association with ancient dry river valleys that functioned as rivers during much wetter times millions of years ago. Another link to the deep past are the low eroded hills featuring banded ironstone formations, which support distinctive ecological communities. The vegetation on the plains is dominated by mulga woodlands often rich in ephemeral species, as well as spinifex grasslands, saltbush shrublands and samphire shrublands (Cowan, 2001).

The 5 properties reviewed here were bought under the Gascoyne-Murchison Strategy by the state government (with contributions from the federal government) to add to the reserve system. Although acquired more than 15 years ago, they remain as unallocated Crown land. As such, they lack the legal protections requiring assessment of the impact of new projects on the natural and cultural values for which they were acquired. Formal responsibility, but not full resourcing, for property management lies with the Department of Biodiversity, Conservation and Attractions.

The proposal to create 2 new national parks offers substantial conservation benefits, including the opportunity to help protect and link 2 ecologically important salt lakes, 3 unique calcrete invertebrate communities, 3 banded ironstone plant communities, and 7 plant communities and 11 ecosystems currently lacking any representation in the reserve system. The proposed parks are also important for protecting rare species such as malleefowl. Adding almost half a million hectares to the reserve system would double protection of the East Murchison sub-bioregion, from less than 2% to almost 4%.

In this chapter, across 2 subsections corresponding with the recommendations in section 7.6 and the map in Figure 7-2, we describe the natural values of these 5 former leasehold properties acquired for conservation.

Although not formally considered rare or endangered, the kultarr (*Antechinomys laniger*) is infrequently encountered. It has been recorded on ex Lake Mason. Photo: Michael Sale

7.2.1 Proposed 'Cashmere – Bulga Downs' National Park

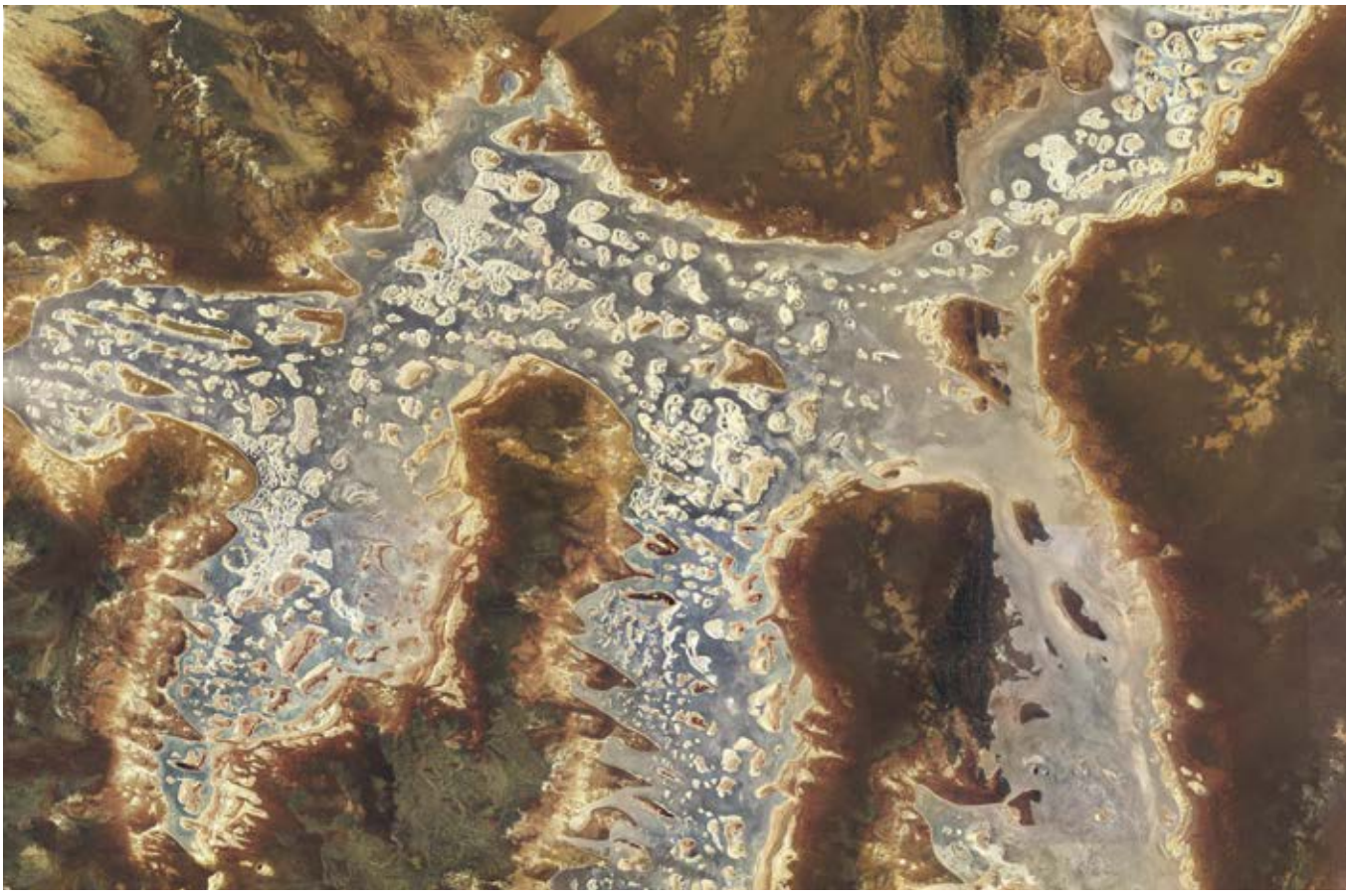
Former leasehold properties: ex Cashmere Downs, ex Bulga Downs (west), ex Bulga Downs (east).

This proposed national park would add 165,000 hectares to the poorly protected East Murchison sub-bioregion. The area between the eastern and western ex Bulga Downs properties is still an active pastoral lease, as is Cashmere Downs Station directly to the east of ex Cashmere Downs (CALM, 2006).

The properties consist mainly of gently undulating sandplains with small breakaways and granite hills, domes and tor fields (CALM, 2006). The eastern property has some different land systems, notably a banded ironstone ridge and hills with permanent springs. The vegetation consists largely of woodlands and shrublands of mulga, other wattles and red mallee, and spinifex grasslands and samphire shrublands. Most of the plant communities and sub-bioregional ecosystems on the proposed park lack protection in the reserve system – 8 of the 13 plant communities and 11 of the 15 ecosystems have no current representation (Table 7-3, Table 7-5).

Ex Cashmere Downs and ex Bulga Downs (west) span the area between 2 large, ecologically important salt lakes – Barlee and Noondie. These lakes mark once-major river systems, representing probably the 'oldest surviving geomorphological features on the Yilgarn Craton' (Anand and Butt, 2010). In Australia, the salt lake fauna is highly regionalised – due to past climatic events linking and dividing the regions – but little is known ecologically of Western Australia's inland salt lakes (Timms, 2007).

With an area of almost 200,000 hectares, Lake Barlee is the second-largest lake in Western Australia. Its catchment area is about 1.8 million hectares, but it receives enough water to fill the lake only every decade or so, after which water may persist for 6 to 9 months (BirdLife International, 2018b, DEC, 2012). The evaporation rate in the area (about 3000 mm) exceeds the average annual rainfall (about 250 mm) more than 10-fold.



Lake Barlee, Western Australia's second-largest lake, has been designated by Birdlife International as a key biodiversity area due to its importance for waterbirds. ©Image Landsat / Copernicus, Google Earth

When it fills, Barlee becomes an important breeding site for waterbirds and shorebirds. The significance of the lake is reflected in its listing as a nationally important wetland by the Australian government and as a key biodiversity area by Birdlife International (BirdLife International, 2018b, DIWA, 2014) (Table 7-3). It also meets 3 criteria for international significance (DIWA, 2014). Of 15 waterbird and shorebird species recorded at the lake, 6 are known to breed there – black swan, Australian shelduck, pink-eared duck, red-capped plover, black-winged stilt and banded stilt – and other species breed in peripheral claypans.

Barlee is particularly significant for the banded stilt – as one of only a few dozen known breeding locations, and the site of the largest breeding event recorded for the species, with 179,000 nests counted in 1980 (Pedler et al., 2014, Burbidge and Fuller, 1982) (see Box 7-1). What draws waterbirds and shorebirds to Lake Barlee are the invertebrates that breed in its waters. Most of the 11 invertebrate species recorded in the lake are crustaceans that hatch from eggs lying dormant in the salt crust (DIWA, 2014).

To the north is another vast salt lake, Lake Noondie, bordered by Bulga Downs (west), also an important breeding site for banded stilts, as well as other birds. Drilling for groundwater has revealed the palaeodrainage channel (the course of an ancient river incised into Archean basement rock) lying down to 130 metres below the lake surface (Salt Lake Potash Ltd, 2018). The whole of Lake Noondie is a registered Aboriginal Heritage Site (DAA, 2018) (section 7.4).

The proposed park is important for protecting a listed priority-1 ecological community associated with the banded iron formation of the Mount Forrest – Mount Richardson Range, much of which occurs on Bulga Downs (east). A survey in 2006 recorded 114 plant taxa in 7 plant communities (Meissner et al., 2009a). As is typical of ironstone communities, these differ from communities on nearby ironstone ranges (see Box 7-2). Four priority plant species were found, including the priority-1 probable ironstone endemic, *Beyeria lapidicola*. Seven priority plant species have been recorded on Bulga Downs (east) (Table 7-4).

It is likely that the properties, with their diversity of habitats, support up to 27 mammal species (CALM, 2006). Six species – almost 20% of the original mammal fauna – are thought to have been lost from the region, including the globally extinct inland boodie, a mound of which was recorded on Mount Richardson (DBCA, 2017d). The area is rich in reptiles and frogs, with up to 76 species likely to occur there, including 20 skink species (CALM 2006). The properties harbour 4 priority animal species, including the malleefowl (vulnerable) (Table 7-4).

Western toadlets (*Pseudophryne occidentalis*) are well adapted to intermittent rain. They emerge only after rain and lay their eggs in shallow burrows. The eggs undergo partial development, then wait for rising waters to flood the burrows before hatching, enabling the tadpoles to swim out. Photo: Fred and Jean Hort

Box 7-1: Banded stilts – desert nomads epitomising adaptation to unpredictable events

Within a week of a big storm transforming a salt-encrusted desert pan into a lake, thousands of banded stilts may arrive from the coast hundreds or thousands of kilometres away, having flown up to a thousand kilometres a night. How they know that rain has fallen is a mystery. At the lake, they feast on 'brine shrimp soup' – a rich banquet of crustaceans whose eggs lie dormant in the salt crust for years between rains – and within a few days, the stilts lay their eggs in a scrape on the ground. The 3 to 5 eggs they lay weigh the equivalent of up to 80% of their body mass. If the lake does not dry up and if they survive predators, the chicks hatch and fledge in about 85 days.

Between 1930 and 2010 just 30 breeding events for banded stilts were recorded (opportunistically). Fewer than a third resulted in chicks fledging, the rest failing due to salt lakes drying up or massive predation of chicks by silver gulls. In several cases, on lakes in southern Australia, seagulls ate the majority of chicks, leading to the listing of banded stilts as threatened in South Australia.

Two researchers who chanced across a massive breeding event on Lake Barlee in 1980 counted 179,000 nests, in densities as high as 18 a square metre, on 3 islands in the lake. There were massive losses, with an estimated 255,000 addled eggs and dead chicks.

The big breeding events are all precipitated by large inland rains. Recent research has shown that small numbers of banded stilts breed in response to almost any inundation of a salt lake. But many have to abandon their eggs or chicks as the lake dries up. They have only a 30% chance of the eggs hatching and a much lower probability of chicks fledging.

Adding to the difficulties for banded stilts, several lakes they use for breeding are under threat from mining – for example, potash mining is being planned for Lakes Disappointment, Mackay, Dora, Auld and others in the Little Sandy Desert and Great Sandy Desert. Lake Noondie and Lake Barlee have also been announced as potential sites for potash mining.

Sources: Burbidge and Fuller (1982), Pedler et al. (2017a), Pedler et al. (2017b), Salt Lake Potash Ltd (2018)

Banded stilts (*Cladorhynchus leucocephalus*) are great travelers who turn up at inland salt lakes soon after rain to feast on crustaceans and breed. Photo: Georgina Steytler

The banded iron formation of Windarling Range, south of ex Cashmere Downs, harbours specialised and restricted plants such as *Tetratheca paynterae*, which grows only in the crevices of such outcrops. Conservation of these unique plants is challenging due to the mineral values of ironstone ranges. Photo: Robin Chapple

Box 7-2: Banded ironstone plant communities

On the Yilgarn Plateau, from near the boundary of the Southwest Australian Floristic Region, a series of ironstone ranges extend inland for over 750 kilometres. They rise barely more than 200 metres above the surrounding plains.

These small ancient ranges consist largely of banded iron formation, which has alternating fine layers of shales, siltstones, cherts (a form of quartz) and sediments rich in iron oxides. They are thought to have formed 2.5 to 3.7 billion years ago, in sea water, as a result of fluctuating oxygen levels. Oxygen released by photosynthesizing cyanobacteria combined with dissolved iron to form iron oxides, which precipitated and formed an iron-rich layer on the ocean floor.

Ironstone outcrops are challenging habitats for plants. They typically have skeletal, acidic, nutrient-impoverished and metal-enriched soils with low water-holding capacity, hard substrates, very high UV irradiation, wind exposure and high temperatures. But they often harbour diverse and unique plant communities and endemic or unusual species. Surveys on 24 ranges have recorded more than 900 plant species, of which 44 are specialist ironstone species, as well as 134 floral communities.

Species diversity and endemism on ironstone ranges decline with increasing aridity. The more southwestern ranges bordering the Southwest Australian Floristic Region have several hotspots of endemism and specialist ironstone plants, and probably acted as refugia during climatic oscillations, while the more inland ranges have been too dry to support many specialist ironstone species or have lost them during previous more arid periods. Even so, say the researchers (Gibson et al 2012) who conducted the surveys, all ranges have surprisingly high beta diversity (the rate of change between the ranges), which means the vegetation composition on each range is unique. This, combined with concepts of irreplaceability, implies 'that a comprehensive reserve network would require the inclusion of part of all the ranges in the formal conservation reserve system'. Currently, ironstone ranges are poorly represented in reserves.

A 5-fold increase in the price of iron ore between 2000 and 2008 led to mines being developed in the ironstone ranges of the Yilgarn Craton, putting several ironstone plant communities at risk. With the Pilbara producing about 95% of Australia's iron ore (DSD 2017), the banded ironstone formations of the southern rangelands contribute very little to Australia's output.

Sources: Gibson et al. (2012), Gibson et al. (2015)

Table 7-3: Summary of conservation values of the proposed 'Cashmere – Bulga Downs' National Park

ex Bulga Downs (east) (84,000 hectares)	
Threatened & priority plants	7 species.
Threatened & priority animals	3 bird, 1 mammal species.
Priority ecological communities	Mount Forrest - Mt Richardson (Bulga Downs) vegetation complex (banded ironstone formation) (priority 1) (41% of community extent).
Plant communities	4 communities: 1 with 0% representation in existing reserves, 2 others with <5%.
Sub-bioregional ecosystems	4 ecosystems: 2 with 0% representation in existing reserves, 2 others with <5%. Very important for 1 ecosystem with no current protection, with 58% of its extent

ex Bulga Downs (west) (29,000 hectares)	
Plant communities	6 communities: 2 with 0% representation in existing reserves, 3 others with <5%.
Sub-bioregional ecosystems	6 ecosystems: 3 with 0% representation in existing reserves, 3 others with <5%.
Buffering and connectivity	Borders the ecologically important Noondie Lake, and is part of a corridor linking Noondie to Lake Barlee.

ex Cashmere Downs (52,000 hectares)	
Important wetland	Borders Lake Barlee, Western Australia's second largest lake, a nationally important wetland and key biodiversity area, and an important site for banded stilt breeding.
Plant communities	10 communities: 4 with 0% representation in existing reserves, 4 others with <5%.
Sub-bioregional ecosystems	10 ecosystems: 6 with 0% representation in existing reserves, 4 others with <5%.
Buffering and connectivity	Borders Lake Barlee, and is part of a corridor linking Barlee to Lake Noondie.

All properties (165,000 hectares)	
Important wetlands	Borders 2 large salt lakes: Lake Barlee (a wetland of national importance) and Lake Noondie.
Threatened & priority plants	7 species.
Threatened & priority animals	4 species.
Priority ecological communities	Mount Forrest - Mt Richardson (Bulga Downs) vegetation complex (banded ironstone formation) (priority 1) (41% of community extent).
Plant communities	13 communities: 8 with 0% representation in existing reserves, 5 others with <5%.
Sub-bioregional ecosystems	15 ecosystems: 11 with 0% representation in existing reserves, 4 others with <5%. Very important for 1 ecosystem with no current protection (58% of its extent).
Buffering and connectivity	Land corridor linking 2 ecologically important lake systems: Barlee and Noondie

Sources: See technical notes 1 and 2 (chapter 2).

This undescribed herb with succulent leaves, *Anacampseros* sp. Eremaean, is known from just 4 populations, including 1 on ex Lake Mason. It flowers only in the evening, opening for just a few hours. Photo: Fred and Jean Hort

The song of rufous whistlers (*Pachycephala rufiventris*) is one of the most beautiful sounds of the Australian Outback. Photo: Keith Wilcox

Red-capped plovers (*Charadrius ruficapillus*) often breed around inland salt lakes after rain, including at Lake Barlee. They lay 2 to 3 eggs in a shallow scrape on the ground. Photo: Ryan Francis

Table 7-4: Threatened and priority species and ecological communities of the proposed 'Cashmere – Bulga Downs' National Park

Species / ecological community	Conservation class	ex Bulga Downs (east)	ex Bulga Downs (west)	ex Cashmere Downs
Birds				
Malleefowl (*Leipoa ocellata*)	Vulnerable	●		
Peregrine falcon (*Falco peregrinus*)	Specially protected	●		
Rainbow bee-eater (*Merops ornatus)*	International agreement	●		
Mammals				
Long-tailed dunnart (*Sminthopsis longicaudata*)	Priority 4	●		
Plants				
Aluta teres	Priority 1	●		
Beyeria lapidicola	Priority 1			
Jacksonia lanicarpa	Priority 1	●		
Eremophila dendritica	Priority 2	●		
Labichea eremaea	Priority 3	●		
Micromyrtus serrulata	Priority 3	●		
Phyllanthus baeckeoides	Priority 3	●		
Ecological communities				
Mount Forrest - Mt Richardson (Bulga Downs) vegetation complex (banded ironstone formation)	Priority 1	●		

Note: No threatened or priority species or ecological communities have been recorded for Bulga Downs (west) or Cashmere Downs.
Sources: See technical notes 1 (chapter 2).

Table 7-5: The extent of protection (%) in the proposed 'Cashmere – Bulga Downs' National Park for plant communities with inadequate representation in existing reserves

Plant communities	ex Bulga Downs (east)	ex Bulga Downs (west)	ex Cashmere Downs
No protection (<0.1%) in existing reserves			
VT 207 Hummock grasslands, shrub steppe; red mallee over hard spinifex	0.3		
VT 411 Succulent steppe with open scrub; scattered bowgada & jam over saltbush			5.3
VT 485 Hummock grassland, mixed sandplain - scattered low trees over sparse dwarf shrubs with spinifex; red mallee over mixed dwarf shrubs with *Triodia basedowii*			2.5
VT 533 Low woodland; mulga & cypress pine		5.3	7.9
VT 865 Hummock grassland, mixed sandplain - scattered low trees over sparse dwarf shrubs with spinifex; red mallee over mixed dwarf shrubs with Triodia scariosa & T. sp.		21.5	24.0
Little protection (0.1 to 5%) in existing reserves			
VT 18 Low woodland; mulga (*Acacia aneura*)	0.3	<0.1	<0.1
VT 202 Shrublands; mulga & *Acacia quadrimarginea scrub*	2.5		1.8
VT 389 Succulent steppe with open low woodland; mulga over saltbush		0.1	0.4
VT 420 Shrublands; bowgada & jam scrub			0.1
VT 676 Succulent steppe; samphire	0.1		
Inadequate protection (5 to 15%) in existing reserves			
VT 125 Bare areas; salt lakes		0.1	
VT 483 Hummock grasslands, mixed sandplain - open mallee over sparse dwarf shrubs with spinifex; red mallee mallee & mixed sparse dwarf shrubs over *Triodia basedowii*	1.6		

Source: See technical notes 2 (chapter 2).

7.2.2 Proposed 'Black Range – Kaluwiri' National Park

Former leasehold properties: ex Black Range, ex Lake Mason, ex Kaluwiri

This proposed park would make a substantial contribution to conservation by protecting an extensive salt lake system and 4 listed priority ecological communities as well as adding 332,000 hectares of the poorly protected East Murchison sub-bioregion to the reserve system.

The landscape consists of gently undulating sandplains and wash plains with breakaways and low hills in the west and north, and salt lakes in the centre. The largest of these – Lake Mason (45 kilometres long and almost 2 kilometres wide) – is an important habitat for waterbirds when it fills after rains. The vegetation consists mainly of spinifex grasslands, with large areas also of mulga and mallee woodlands and saltbushes and samphires around the lake. Three of the 7 plant communities and 4 of 7 sub-bioregional ecosystems on this proposed park lack protection in the existing reserve system (Table 7-6, Table 7-8).

A recent survey of ex Lake Mason and ex Black Range recorded 58 reptile species (indicating an overall richness of about 65 species), 18 mammals (almost the entire number known for the Murchison bioregion), 73 birds (taking the total for the properties to 122 species) and 385 plants (taking the total flora to 467 species) (Cowan et al., 2017). Of these, 2 birds (including the malleefowl), 2 mammals and 15 plants are threatened and priority species (Table 7-7).

The desert mouse (*Pseudomys desertor*), recorded on ex Lake Mason, inhabits a wide variety of habitats including on sand plains and sand dunes and around salt lakes. It is active at night and eats mainly leaves.
Photo: Ryan Francis

Beneath the lake system on ex Lake Mason lie calcretes (limestone aquifers) that contain 2 listed priority-1 ecological communities (81% and 99% of their total extent) (Table 7-6). These communities – each likely consisting of several animal species unique to a single calcrete – have been isolated for millions of years from other aquatic communities. They are part of an archipelago of groundwater communities in the Yilgarn region, which together contain the most diverse water beetle assemblages in the world and also, by global standards, a highly diverse crustacean fauna (Box 7-3). Groundwater is heavily exploited by mining in the Yilgarn region. With each of the approximately 200 major calcretes in the region likely to contain unique species, mining that leads to groundwater drawdown below the calcrete level (about 10 metres) could put several species at risk of extinction (Cooper et al., 2008).

The values of ex Lake Mason also include 2 priority-1 ecological communities associated with banded ironstone formations (Table 7-6). Both communities – the Montague Range and the Lake Mason vegetation complexes – occur within the Gum Creek Greenstone belt. A survey of the Montague Range ecological community (the southeast part of which is on ex Lake Mason) recorded 104 taxa, including 5 priority species, and 6 plant communities (Thompson and Sheehy, 2011b). A survey of the Lake Mason ecological community (partly on ex Lake Mason) recorded 134 taxa, including 7 priority species, and 6 plant communities (Thompson and Sheehy, 2011a). Ex Lake Mason contains 79% of the entire extent of this community.

The ironstone ranges of Western Australia are like islands, with plant communities that have a different structure and composition from those of the surrounding plains (Box 7-2). They are typically diverse (with a high species turnover) and often have unique species (Gibson et al., 2010). The high demand for iron ore makes their conservation challenging (Gibson et al., 2010). Their distribution is very restricted and the removal of even a small proportion of plants may dramatically impact on the genetic differentiation and diversity of populations (Butcher et al., 2009).

Box 7-3: A globally significant subterranean island fauna

Twenty years ago, a unique and highly diverse subterranean group of animals was discovered on the Yilgarn plateau. They live in hundreds of groundwater 'islands' – within thin limestone formations known as calcretes that formed by precipitation from groundwater along ancient palaeodrainage channels (rivers that mostly stopped flowing in the Palaeocene). The entire northern Yilgarn region 'resembles a subterranean archipelago' with more than 200 major calcrete bodies (some bigger than 100 square kilometres) and hundreds of smaller calcrete bodies, which are separated from other calcretes by fine alluvial deposits.

The animals living in these calcretes include water beetles, many types of crustaceans (such as amphipods, copepods, ostracods, oniscids), worms, mites, centipedes and springtails. Only a small proportion of these calcrete animals have yet been identified.

A study of water beetles (including from wells on ex Lake Mason) identified over 100 new species from 47 major isolated calcretes. They make up the world's largest and most diverse collection (by a factor of 10) of subterranean water beetles. Each species was restricted to a single calcrete and molecular-clock analyses suggested there has been no gene flow between the calcretes for 5–10 million years. A similar pattern was found for amphipods and isopods.

A 2010 study using DNA barcoding to distinguish species found at least a dozen species in a single calcrete, which suggests the diversity of species is even 'richer than previously anticipated'.

It is likely that each calcrete was separately colonised by surface species, which then adapted to the dark, low-oxygen aquifer environment by forgoing eyes and pigments and becoming more streamlined. The Australian arid zone used to be warm and wet. Some of the animals living above the water table in calcretes may be a 'relictual rainforest fauna' driven underground as the continent started drying out about 10 million years ago.

Sources: Bradford et al. (2010), Cooper et al. (2002), Cooper et al. (2007), Cooper et al. (2008)

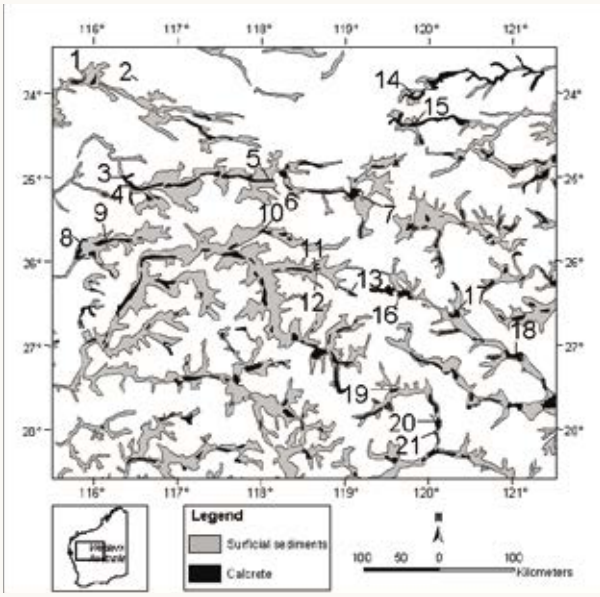
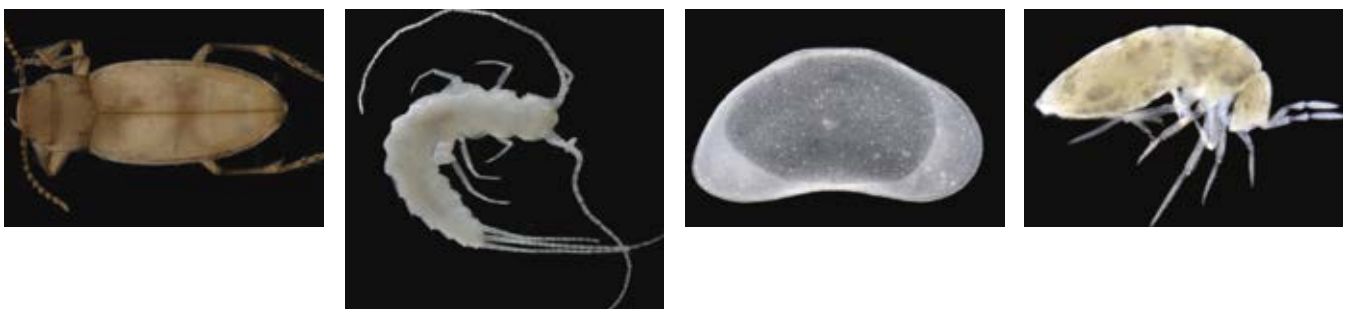


Figure 7-3: Map of calcretes in the northern Yilgarn region showing calcrete populations (black) and locations where amphipods were analysed (indicated by numbers) (Cooper et al. 2007)



The variety of animals inhabiting Yilgarn calcrete aquifers include, from left to right, water beetles, silverfish, ostracods and amphipods (all collected in East Murchison). Photos: Jane McRae, Bennelongia Environmental

Table 7-6: Summary of conservation values of the proposed 'Black Range – Kaluwiri' National Park

ex Lake Mason (149,000 hectares)	
Wetlands	An extensive salt lake system, including Lake Mason, an important waterbird habitat.
Threatened & priority plants	10 species.
Threatened & priority animals	1 bird, 2 mammal species.
Priority ecological communities	4 priority communities: • Lake Mason calcrete groundwater assemblage type on Raeside palaeodrainage on Lake Mason Station (priority 1) (99% of community extent). • Black Range North calcrete groundwater assemblage type on Raeside palaeodrainage on Lake Mason Station (priority 1) (81% of community extent). • Lake Mason vegetation complexes (banded ironstone formation) (priority 1) (79% of community extent). • Montague Range vegetation complexes (banded ironstone formation) (priority 1) (7% of community extent).
Plant communities	7 communities: 2 with 0% representation in existing reserves, 3 others with <5%. Very important for 1 unprotected community (66% of its extent).
Sub-bioregional ecosystems	7 ecosystems: 3 with 0% representation in existing reserves, 4 others with <5%. Critical for 1 unprotected ecosystem (99% of its extent).

ex Black Range (80,000 hectares)	
Wetlands	Small lakes and water features associated with the lake system of Lake Mason.
Threatened & priority plants	6 species.
Threatened & priority animals	1 bird species.
Plant communities	2 communities: 1 with 0% representation in existing reserves, 1 other with <5%.
Sub-bioregional ecosystems	2 ecosystems: 1 with 0% representation in existing reserves, 1 other with <5%.

ex Kaluwiri (103,000 hectares)	
Threatened & priority plants	3 species.
Plant communities	4 communities: 3 with <5% representation in existing reserves.
Sub-bioregional ecosystems	4 ecosystems: 1 with 0% representation in existing reserves, 3 others with <5%.
Buffering	Effective management will help protect 2 priority ecological communities: Yeelirrie calcrete groundwater assemblage type on Carey palaeodrainage on Yeelirrie Station (north-east of ex Kaluwiri) and the Montague Range vegetation complexes (banded ironstone formation), which stretches almost the entire length of ex Kaluwiri on its western border.

All properties (156,000 hectares)	
Wetlands	An extensive system of salt lakes, including Lake Mason.
Threatened & priority plants	15 species.
Threatened & priority animals	2 bird, 2 mammal species.
Priority ecological communities	4 priority communities: • Black Range North calcrete groundwater assemblage type (priority 1) (99% of community extent). • Lake Mason calcrete groundwater assemblage type (priority 1) (81% of community extent). • Lake Mason vegetation complexes (banded ironstone formation) (priority 1) (79% of community extent). • Montague Range vegetation complexes (banded ironstone formation) (priority 1) (7% of community extent).
Plant communities	7 communities: 3 with 0% representation in existing reserves, 4 others with <5%. Very important for 1 unprotected community (66% of its extent).
Sub-bioregional ecosystems	7 ecosystems: 4 with 0% representation in existing reserves, 3 others with <5%. Critical for 1 unprotected ecosystem (99% of its extent).

Sources: See technical notes 1 and 2 (chapter 2).

Table 7-7: Threatened and priority species and ecological communities of the proposed 'Black Range – Kaluwiri' National Park

Species / ecological community	Conservation class	ex Lake Mason	ex Black Range	ex Kaluwiri
Birds				
Malleefowl (*Leipoa ocellata*)	Vulnerable	●		
Peregrine falcon (*Falco peregrinus*)[A]	Specially protected		#	
Mammals				
Brush-tailed mulgara (*Dasycercus blythi*)[A]	Priority 4	#		
Long-tailed dunnart (*Sminthopsis longicaudata*)	Priority 4	●		
Plants				
Acacia rhamphophylla	Threatened	●		
Anacampseros sp. Eremaean	Priority 1		●	
Dampiera plumosa	Priority 1		●	
Pityrodia canaliculata	Priority 1		●	
Stenanthemum mediale	Priority 1	●		●
Acacia burrowsiana	Priority 3	●		
Baeckea sp. London Bridge	Priority 3	●		
Baeckea sp. Sandstone[A]	Priority 3	#		
Bossiaea eremaea	Priority 3	●		
Calytrix hislopii	Priority 3	●	●	
Eremophila arachnoides subsp. *arachnoides*	Priority 3	●		
Euryomyrtus inflata	Priority 3			●
Labichea eremaea	Priority 3		●	
Sauropus sp. Woolgorong	Priority 3	●		
Grevillea inconspicua	Priority 4	●	●	●
Ecological communities				
Black Range North calcrete groundwater a ssemblage type on Raeside palaeodrainage on Lake Mason Station	Priority 1	●		
Lake Mason calcrete groundwater assemblage type on Raeside palaeodrainage on Lake Mason Station	Priority 1	●		
Lake Mason vegetation complexes (banded ironstone formation)	Priority 1	●		
Montague Range vegetation complexes (banded ironstone formation)	Priority 1	●		

Note: A. These species are not in the DBCA databases, but were recorded by Cowan et al. (2017)
Sources: See technical notes 1 (chapter 2).

Table 7-8: The extent of protection (%) in the proposed 'Black Range – Kaluwiri' National Park for plant communities with inadequate representation in existing reserves

Plant communities	ex Lake Mason	ex Black Range	ex Kaluwiri
No protection (<0.1%) in existing reserves			
VT 121 Succulent steppe with open low woodland; mulga	66.6		
VT 862 Hummock grasslands, open low tree & mallee steppe; marble gum & mallee (*Eucalytpus kingsmillii*) over hard spinifex *Triodia basedowii*	2.6	24.0	
Little protection (0.1 to 5%) in existing reserves			
VT 18 Low woodland; mulga (Acacia aneura)	0.4	0.1	0.2
VT 107 Hummock grasslands, shrub steppe; mulga and *Eucalyptus kingsmillii* over hard spinifex	0.7		2.1
VT 389 Succulent steppe with open low woodland; mulga over saltbush	2.0		<0.1
Inadequate protection (5 to 15%) in existing reserves			
VT 39 Shrublands; mulga scrub	0.2		<0.1
VT 125 Bare areas; salt lakes	0.3		

Source: See technical notes 2 (chapter 2).

Triodia basedowii is a spinifex characteristic of inland Western Australia. Recent work has shown that it is a species complex, consisting of several different species, most restricted to Western Australia. Photo: Russell Cumming

7.3 Importance for achieving Western Australia's conservation reserve goals

The proposed parks are all in the East Murchison sub-bioregion, 1 of 2 sub-bioregions in the Murchison bioregion. Because this region is very poorly protected, the proposed parks would make a substantial contribution to Western Australia's reserve system.

Bioregional and sub-bioregional protection

The 2 proposed parks would more than double the current protection for the East Murchison sub-bioregion (from 1.4% to 3.7%) and the Murchison bioregion (from 1.1% to 2.8%) (Table 7-9). There is still a long way to go to achieve the 2020 international benchmark for protection (Figure 7-4), making further reserves in this region a high priority.

Ecosystem and plant community protection

The proposed parks would improve protection of 17 plant communities and 17 sub-bioregional ecosystems (Table 7-10). This would be the first such protection for 7 plant communities (42% of the total) and 11 sub-bioregional ecosystems (65% of the total) currently lacking representation in the conservation reserve system. Protection of the proposed parks is particularly important for 2 ecosystems and 1 plant community with more than half of their entire extent on those properties (Table 7-10). The properties harbor 66% of the entire extent of this community (a succulent steppe with open low mulga woodland) and 99% of its extent in the Eastern Murchison sub-bioregion.

More than a third of Western Australia's sub-bioregional ecosystems lack a minimum level of protection, based on a long-held national target of 15% of each ecosystem to be in reserves (JANIS, 1997, Taylor, 2017). The proposed parks would enable the minimum reserve target of 15% to be met for an additional:

- 4 sub-bioregional ecosystems (24% of the ecosystems on the proposed parks)
- 3 plant communities (18% of the communities on the proposed parks).

Table 7-9: Current and improved protection of bioregions and sub-bioregions (% protected) in Western Australia's conservation reserve system

	Bioregion	Sub-bioregion
	Murchison	East Murchison
Current protection	1.06	1.39
Proposed parks	1.75	2.34
New total	2.81	3.73

Source: See technical notes 2 (chapter 2).

Notes: *Current protection* protection means the percentage of each bioregion and sub-bioregion protected in the existing conservation reserve system. *Proposed parks* means the percentage of each bioregion and sub-bioregion protected in the proposed parks. *New total* means the percentage of each bioregion and sub-bioregion that would be protected if the proposed parks are declared.

Figure 7-4: Progress towards the 2020 international benchmark (17%) for protection of bioregions and sub-bioregions (% area protected) due to the proposed parks

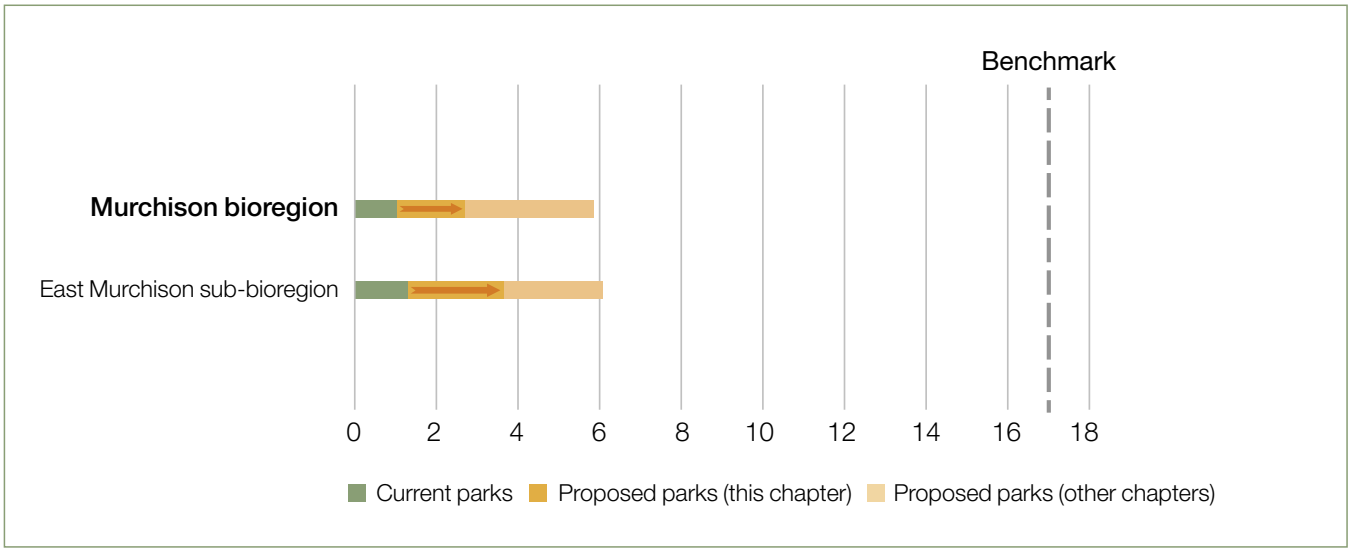


Table 7-10: Numbers of plant communities and sub-bioregional ecosystems in the proposed parks, levels of protection in the existing conservation reserve system and the contribution to protection of particular communities and ecosystems

	Plant communities (number & percentage)		Ecosystems (number & percentage)	
Improved protection in proposed parks				
Total in proposed parks	17	100%	17	100%
Will achieve 15% target[A]	3	18%	4	24%
Current level of protection in reserve system				
No existing protection (<0.1%)	7	42%	11	65%
Little existing protection (0.1-5%)	6	35%	6	35%
Inadequate protection (5.1-<15%)	3	18%	-	-
Exceeds 15% protection	1	6%	-	-
Contribution to protection of particular communities & ecosystems[B]				
Critical (>85% of total extent)	-	-	1	6%
Very important (50–85% of total extent)	1	6%	1	6%
Important (10-50% of total extent)	4	24%	5	29%

Sources: See technical notes 2 (chapter 2).

Notes: A. This assumes protection in other proposed parks and does not include ecosystems that already have more than 15% of their extent protected in the conservation reserve system. B. This represents the number of communities or ecosystems with a substantial proportion of their total extent in the proposed parks. For example, the proposed parks are 'critical' for ecosystem protection where more than 85% of the entire ecosystem extent occurs within those proposed parks.

7.4 Native title and Aboriginal heritage sites

There are currently no native title claimants for all of ex Black Range, the majority of eastern ex Bulga Downs (92%) and ex Lake Mason (85%) (Table 7-11). Native title has been finalised for ex Kaluwiri, with the Tjiwarl people having exclusive possession native title over the property. Native title claims have been lodged for the majority of ex Cashmere Downs and a small part of eastern ex Bulga Downs.

The proposed parks would wholly protect 47 registered Aboriginal heritage sites and partially protect an additional 10 sites (Table 7-11). The properties also contain another 20 sites for which nominations have been lodged.

Ex Bulga Downs is particularly rich in Aboriginal heritage sites, with 47 registered and an additional 20 nominations lodged. Almost half the registered sites are listed as 'mythological', showing the importance of this area to the cultural beliefs of the Traditional Owners. The whole of Lake Noondie is a registered mythological site.

Beyond these registered heritage sites and the significance of the broader landscapes to Traditional Owners, native title parties will play a key role in determining whether the government's original intention for these properties to become parks is implemented.

Table 7-11: Native title and registered Aboriginal heritage sites of the proposed parks

Native title party, claimed or determined (percentage of property)	Registered Aboriginal heritage sites
Proposed 'Cashmere – Bulga Downs' National Park	
ex Bulga Downs (east and west)	
West: No current claimants East: Wutha, claim application (8%)	West: 1 site that would be partially protected, the mythological site of the Lake Noondie. East: 56 sites (47 that would be fully protected, 9 partially). 23 mythological sites, including Yuula (1 of 2 sites is a male-only site), 7 pertaining to the Seven Sister Hills, Minyipurru Tali, Tjiinkarra and Wutu Kumpu, a manmade stone arrangement, a rockshelter on Mt Forrest (Mattner) & other rockshelters, outcrops, caves and boulders. There is also the WATI ceremonial ground and sites relating to caves, quarries, rock shelters and scattered artefacts.
ex Cashmere Downs	
Wutha, claim application (73%)	No registered sites.
Proposed 'Black Range – Kaluwiri' National Park	
ex Lake Mason	
Tjiwarl, non-exclusive possession (15%)	1 site that would be fully protected. artefact, man-made structure and water source at Booylgoo Range.
ex Black Range	
No current claimants	No registered sites.
ex Kaluwiri	
Tjiwarl, exclusive possession (100%)	2 sites (1 that would be fully protected) including artefacts, a ceremonial site, a man-made structure and water source at Bungarra Rockhole; and artefacts, camp and water source at Tadpole Bore.

Sources: See technical notes 3 (chapter 2), data current to November 2018.

The stripe-faced dunnart (*Sminthopsis macroura*) has a gestation period of 11 days, the shortest of any mammal. Although widespread, it has been declining across much of Australia. It has been recorded on all properties of the proposed 'Black Range – Kaluwiri' National Park. Photo: Michael Sale

The pink-eared duck (*Malacorhynchus membranaceus*) is highly nomadic, turning up after floods in inland Australia to breed. Photo: Keith Wilcox

7.5 Geology, prospectivity and mining

The proposed East Murchison parks lie on the Yilgarn Craton, one of the oldest and most stable landforms on the planet. Formed between 2.6 and 3 billion years ago, it is one of the best-preserved examples of Archaean crust on the planet (Anand and Paine, 2002). The evolution of current landscapes has involved 'repeated cycles of denudation, transportation and deposition proceeding at rates controlled by climate variability' (Payne et al., 1998). The low hills, ridges and uplands of Archaean rocks make up only a small part of the region but are prominent landmarks. Ecologically important features include a series of greenstone belts with banded ironstone formations, and the remains of old river systems (palaeodrainage channels) now blocked with sediments that in the lowest parts manifest in large salt lakes that fill occasionally. Calcretes are also common in these palaeodrainage lines. They represent old valley floors whose alluvium has been replaced by limestone (Payne et al., 1998).

The following information about the geology, prospectivity and mining activity on each property comes from the following sources: Belford (2017) and DMIRS (2018a). The extent of proposed and existing mining-related activity is summarised in Tables 7-12, 7-13 and 7-14.

Proposed 'Cashmere – Bulga Downs' National Park

Ex Cashmere Downs

This property is entirely underlain by Archean granite with fringing occurrences of Cenozoic alluvial and lacustrine inset-valley and valley-fill deposits in Lake Barlee along the southern margin. It has very low mineral prospectivity and there are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Cashmere Downs is free of existing or proposed mining-related activities.

Ex Bulga Downs (west)

This property is entirely underlain by Archean granite with fringing occurrences of Cenozoic alluvial and lacustrine inset-valley and valley-fill deposits in Lake Noondie along the north-western margins. This property has very low mineral prospectivity and there are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Bulga Downs (west) is free of existing or proposed mining-related activities.

Ex Bulga Downs (east)

This property is predominantly underlain by Archean granite except for a small portion in the south-west corner underlain by Archean greenstone rocks. Within this greenstone area are known deposits of iron and gold and numerous historic gold workings. The mineral prospectivity of the portion underlain by granite is very low, whereas the area underlain by greenstone has high prospectivity for iron, gold and base metals. There are known deposits of iron and precious metals.

Mining activity: Six mining leases cover 14,000 hectares of the south-west corner of ex Bulga Downs (east) targeting iron and gold. Two miscellaneous licences for ground water extraction overlap the northern corners of the property. Three recent exploration licence applications (E 36/931, E 29/1041, E 29/1035) overlap the eastern corners of the property.

Areas without mining activity: 83% of ex Bulga Downs (east) is free of existing mining-related activities. Applications for exploration covering 16% of the property are currently being considered.

Proposed 'Black Range – Kaluwiri' National Park

Ex Lake Mason

This property is predominantly underlain by Archean granite. This granite is overlain by the Cenozoic alluvial and lacustrine inset-valley and valley-fill deposits of ex Lake Mason running diagonally through the parcel. There is a known uranium occurrence in the valley-fill deposits towards the southern end of ex Lake Mason. The north-west corner of this property is underlain by Archean greenstone rocks which host many known gold occurrences and historic gold workings. The greenstone belt extends under and across ex Lake Mason. The areas underlain by granite have very low mineral prospectivity, whereas the Cenozoic sediments have high prospectivity for uranium, and the greenstone rocks have high prospectivity for gold and base-metals. There are known deposits of gold, uranium and limestone.

Mining activity: The northern section of ex Lake Mason has active exploration licences and mining leases covering 20% of the property (30,000 hectares). Two large miscellaneous licences permitting a search for groundwater in the north and west of ex Lake Mason are also active, covering 14% (20,000 hectares) of the property. Overlapping one of these miscellaneous licence areas is a known deposit of uranium covered by a retention licence.

Areas without mining activity: 68% (100,000 hectares) of ex Lake Mason is free of existing mining-related activities. Applications for exploration covering 1% of the property are currently being considered.

Ex Black Range

This property is underlain by Archean granite that is cut by a major fault structure running north to north-east through the block. It has very low mineral prospectivity and there are no known mineral deposits.

Mining activity: A miscellaneous licence (L 57/46) for groundwater extraction that mostly occurs on ex Lake Mason overlaps less than 5% of ex Black Range.

Areas without mining activity: 995% of ex Black Range is free of existing or proposed mining-related activities.

Ex Kaluwiri

The north-west and central parts of this property are entirely underlain by Archean granite and have very low mineral prospectivity. The other part is predominantly underlain by Archean granite, which in the south is overlain by Cenozoic alluvial and lacustrine inset-valley and valley-fill deposits of Lake Mason. There is a known uranium occurrence in these valley-fill units towards the eastern end of the block. The north-west corner of this block is underlain by Archean greenstone rocks which host many known gold occurrences and historic gold workings. The areas underlain by granite have very low mineral prospectivity, whereas the Cenozoic sediments have high prospectivity for uranium, and the greenstone rocks have high prospectivity for gold and base-metals. There are no known mineral deposits.

Mining activity:A small part of the Yeelirrie Uranium Project, located mainly to the north-east of ex Kaluwiri, overlaps ex Kaluwiri. The uranium deposit was discovered in the 1970s and reactivated in 2005, then sold in 2012 to a Canadian mining company. The project is not operational, with the company stating they are awaiting market signals that additional production of uranium is warranted. Part of a miscellaneous licence for ground water extraction and a temporary reserve are also present in this part of the property.

Areas without mining activity: 91% of ex Kaluwiri is free of existing mining-related activities. Applications for exploration covering 1% of the property are currently being considered.

Table 7-12: Existing mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed 'Black Range – Kaluwiri' National Park				
ex Black Range	-	-	-	5%
ex Kaluwiri	5%	-	5%	4%
ex Lake Mason	17%	-	17%	15%
All properties	9%	-	9%	9%
Proposed 'Cashmere – Bulga Downs' National Park				
ex Bulga Downs (east)	<1%	-	<1%	17%
ex Bulga Downs (west)	-	-	-	-
ex Cashmere Downs	-	-	-	-
All properties	2%	-	2%	9%

Note: Where mining tenements and titles overlap, only 1 value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

Table 7-13: Applications for mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed 'Black Range – Kaluwiri' National Park				
ex Black Range	-	-	-	-
ex Kaluwiri	1%	-	1%	-
ex Lake Mason	1%	-	1%	-
All properties	<1%	-	<1%	-
Proposed 'Cashmere – Bulga Downs' National Park				
ex Bulga Downs (east)	16%	-	16%	-
ex Bulga Downs (west)	-	-	-	-
ex Cashmere Downs	-	-	-	-
All properties	8%	-	8%	-

Note: Where mining tenements and titles overlap, only 1 value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

Table 7-14: Proposed park areas (%) free of existing mining-related activity

	No mineral mining	No oil & gas mining	Combined
Proposed 'Black Range – Kaluwiri' National Park			
ex Black Range	95%	100%	95%
ex Kaluwiri	91%	100%	91%
ex Lake Mason	68%	100%	68%
All properties	82%	100%	82%
Proposed 'Cashmere – Bulga Downs' National Park			
ex Bulga Downs (east)	82%	100%	82%
ex Bulga Downs (west)	100%	100%	100%
ex Cashmere Downs	100%	100%	100%
All properties	90%	100%	90%

Source: See technical notes 4 (chapter 2).

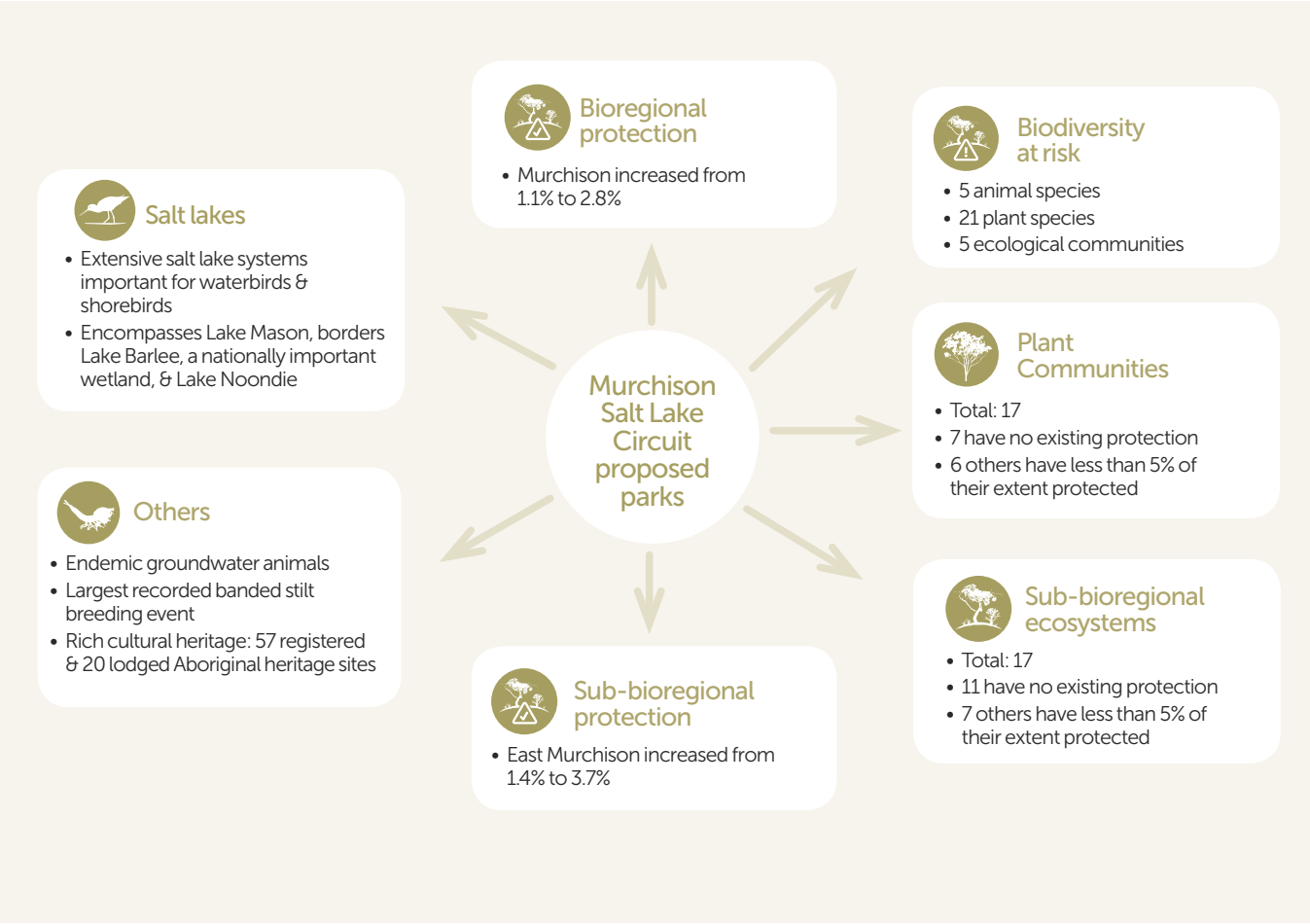
7.6 Recommendations

These proposals to create 2 new national parks would add almost 500,000 hectares to the reserve system in a very poorly protected bioregion. This is consistent with the intention of the Western Australian government as indicated by the Australian government's 2016 Collaborative Australian Protected Areas Database (CAPAD, 2017), except that, as discussed below, the natural values of the proposed parks indicate they should become national parks rather than conservation parks as proposed by the government (CALM, 2006, PWS, 2017).

The parks would protect vast salt lakes important for waterbird breeding, 2 calcrete groundwater communities (both listed as priority 1) and 3 banded ironstone formation vegetation complexes (all priority 1), 7 plant communities and 11 sub-bioregional ecosystems with no current protection in reserves, and 21 plant and 5 animal threatened and priority species (Figure 7-5). They would substantially increase the extent of the poorly protected East Murchison sub-bioregion and Murchison bioregion in reserves.

Part of each of the proposed parks is determined or claimed as native title, by the Wutha and Tjiwarl peoples. The parks would protect 57 registered Aboriginal heritage sites and 20 lodged heritage sites.

Figure 7-5: Some combined values of the proposed new parks



Recommendation 7-1

Declare ex Bulga Downs (east and west) and ex Cashmere Downs as a Class A national park.

Conservation considerations

This proposed national park would add 165,000 hectares to the conservation reserve system. Ex Bulga Downs and ex Cashmere Downs each border large salt lakes important for waterbirds. One of these, Lake Barlee, is Western Australia's second largest lake and listed as a nationally important wetland and key biodiversity area. It is a major breeding site for banded stilts. The park is also important for protecting a priority-1 ecological community associated with banded ironstone formation, 11 threatened and priority species, and 8 plant communities with no current representation in the reserve system.

The values of these properties – particularly the adjacent nationally important wetland, a priority-1 ecological community and 4 threatened and priority-1 species – are of national significance, warranting protection as a Class A national park. The proposed park would also make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. It would add 0.8% of the East Murchison sub-bioregion (with less than 2% in existing reserves) and 0.6% of the Murchison bioregion (with just over 1% in existing reserves) to the reserve system, and protect 15 sub-bioregional ecosystems with little to no current representation in the reserve system.

The native title claimants over part of this proposed park are the Wutha people, whose consent would be needed for any tenure change. Fifty-seven registered Aboriginal heritage sites and 20 lodged sites would be protected.

Mining considerations

Ex Cashmere Downs and ex Bulga Downs (west) are 100% free of existing or proposed mining-related activities and have low prospectivity. While 2 exploration licenses are located immediately adjacent, and extend just inside proposed park boundaries, measures to restrict impacts to outside the park should be administratively and practically straightforward, as well as necessary to promote reserve integrity.

Ex Bulga Downs (east) is 83% free of existing mining-related activities and mostly has low prospectivity. The mining leases in the south-west corner overlap important ironstone habitats including the Mt Forrest priority-1 ecological community and a large number of registered Aboriginal heritage sites. We recommend the government seek a voluntary surrender of these leases in order for this area and its values to be maintained. If unsuccessful, the Minister for Mines should make any changes necessary to mining lease conditions to ensure the area's natural values are not further compromised. When mining ceases, this area should be assessed for inclusion in the national park.

The miscellaneous licenses for groundwater abstraction overlapping the northern corners of ex Bulga Downs (east) should be reviewed for their impact on the conservation values of the park. If necessary, alternative arrangements for any critical operational requirements should be found outside the proposed park, and the voluntarily surrender of these tenements sought; otherwise, conditions should be applied to ensure that operations are consistent with maintaining the values of the park.

Three recent mining exploration applications that overlap the eastern corners of ex Bulga Downs (east) spanning 16% of the property should not be granted on public interest grounds.

Several of the proposed parks are important for malleefowl (*Leipoa ocellata*), 1 of 3 Australian mound-builders (megapodes). The species is listed nationally as vulnerable, with threats including habitat destruction and feral predators. Photo: Keith Wilcox

Recommendation 7-2

Declare ex Lake Mason, ex Black Range and ex Kaluwiri a Class A national park.

Conservation considerations

This proposed national park would add 332,000 hectares to the conservation reserve system. It features an extensive salt lake system and unique ecological communities associated with ironstone ranges and subterranean aquifers. The groundwater calcretes on ex Lake Mason contain 2 listed priority-1 ecological communities, which likely include endemic animal species, and are part of an archipelago of groundwater communities with the most diverse water beetle assemblage in the world and a highly diverse crustacean fauna. The proposed park would also protect 2 priority-1 vegetation complexes associated with banded ironstone formations, 19 threatened and priority species, and 3 plant communities lacking representation in existing reserves.

The values of these properties – particularly the 4 priority-1 ecological communities and 6 threatened and priority-1 species – are of national significance, warranting protection in a Class A national park. The proposed park would also make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. It would add 1.6% of the East Murchison sub-bioregion (with less than 2% in existing reserves) and 1.2% of the Murchison bioregion (with just over 1% in existing reserves) to the reserve system, and protect 7 sub-bioregional ecosystems with little to no current representation in the reserve system.

Native title interests over part of this proposed park are held by Tjiwarl people, whose consent would be needed for any tenure change. Three registered Aboriginal heritage sites would be protected.

Mining considerations

The majority (82% or 270,000 hectares) of ex Lake Mason, ex Black Range and ex Kaluwiri are free of existing mining-related activity. Prospectivity is very low except for areas of banded ironstone formation with high prospectivity for iron ore, gold, base metals and, in some places, uranium.

Of the 32 granted mining tenements overlapping the proposed park, 28 have been granted while the properties have awaited gazettal as conservation reserves. Some tenements overlap listed priority-1 ecological communities associated with banded ironstone formations and groundwater calcretes.

These communities have a restricted distribution and are vulnerable to disturbance from mining (DBCA, 2017a). The Lake Mason vegetation complexes on banded ironstone formation is almost entirely overlaid with granted mining exploration, as is the nearby Lake Mason calcrete, which is also overlaid by a large exploration application (L 57/45).

Two granted miscellaneous licences for groundwater abstraction correspond with priority-1 ecological communities that would be adversely affected by altered hydrological regimes. Licence L57/46 covers almost all of the Black Range North calcrete groundwater assemblage and L57/45 corresponds with the Lake Mason calcrete. These licences also overlap the sub-bioregional ecosystem that occurs only on ex Lake Mason. These miscellaneous licences should be referred to the Environmental Protection Authority for review at the highest level and conditions applied to ensure they do not impact the values of the proposed national park.

There are 2 mining leases spanning 1500 hectares or 0.9% of ex Lake Mason which could be excised from the proposed park to accommodate existing interests.

The hooded robin (*Melanodryas cucullata*) is characteristic of the inland. Although not listed as threatened, it has declined in range and abundance in south-eastern and south-western Australia. Photo: Keith Wilcox

8 Tallering Botanical Trail

Mungada Ridge is part of a priority-1 ecological community on ex Karara associated with banded ironstone formation, which is under a mining tenement. Photo: DEC

8.1 At a glance

Proposed parks

Table 8-1: Former leasehold properties acquired for conservation

Property*	Year Acquired	Size (hectares)	Traditional Owners (native title parties)
ex Barnong	1999	168,000	Southern Yamatji (81%), Mullewa Wadjari (14%), Widi Mob (6%)
ex Burnerbinmah	1995	60,000	Badimia People (100%) (native title determined not to exist)
ex Kadji Kadji	2003	21,000	Southern Yamatji (77%), Widi Mob (23%)
ex Karara	2002	109,000	Widi Mob (100%)
ex Lochada	2000	115,000	Widi Mob (99%), Southern Yamatji (1%)
ex Thundelarra	2007	156,000	Badimia People (100%) (native title determined not to exist)
ex Warriedar	2004	72,000	Widi Mob (6%), Badimia People (94%) (native title determined not to exist)
ex Woolgorong	2005	116,000	Mullewa Wadjari & Wajarri Yamatji (75%), Mullewa Wadjari & Wajarri Yamatji & Widi Mob (25%)

* The current tenure of all properties is unallocated Crown land.

Natural highlights

Outstanding floral diversity and endemism

94 threatened and priority species such as malleefowl and painted snipe

5 priority-1 banded ironstone plant communities, 2 priority-1 calcrete groundwater communities,

Nationally important wetland – the Thundelarra lignum swamp

A major part of an Australian centre of wattle endemism

Very high level of habitat diversity with 54 sub-bioregional ecosystems, 36 lacking protection in existing reserves

Progress towards the 2020 international benchmark for protection

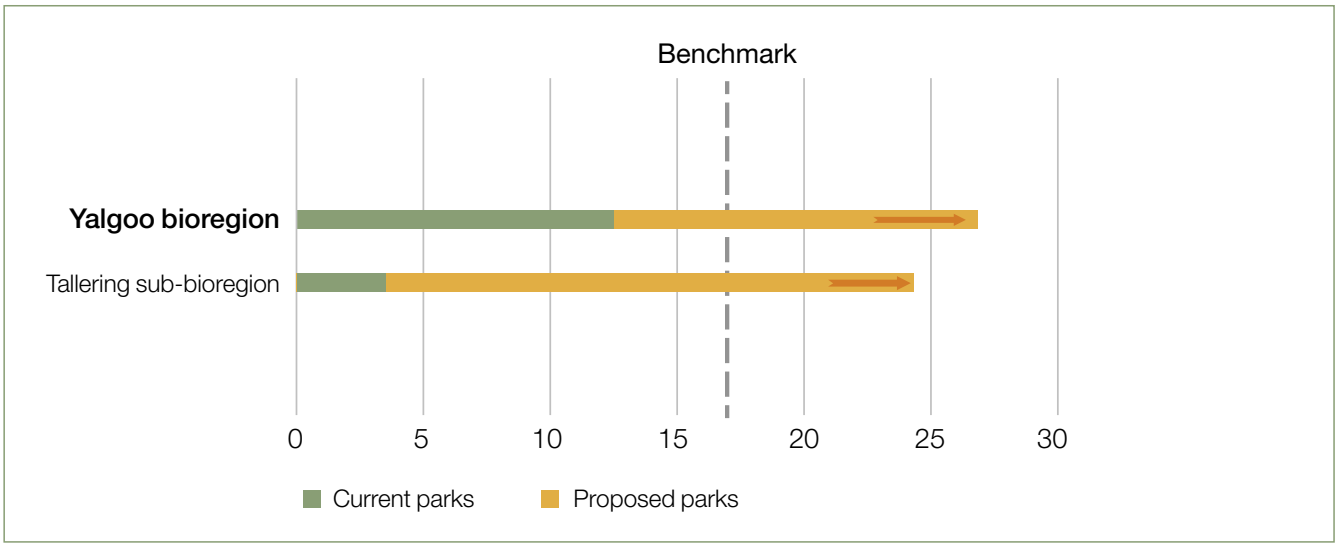


Figure 8-1: The potential increase in protection (% area) due to the proposed parks in bioregions and sub-bioregions where substantial progress can be made towards the international benchmark of 17%.

Reserve recommendations

Table 8-2: Proposed parks

Property	Recommended Protection	Recommended Classification
ex Barnong	Create a new national park	Class A
ex Burnerbinmah, ex Thundelarra, ex Kadji Kadji, ex Karara, ex Lochada, ex Warriedar, adjacent timber reserves	Create a new national park	Class A
ex Woolgorong	Create a new conservation park	Class A

P art of the magnificent granite outcrops on ex Woolgorong. Photo: David Blood (DEC)

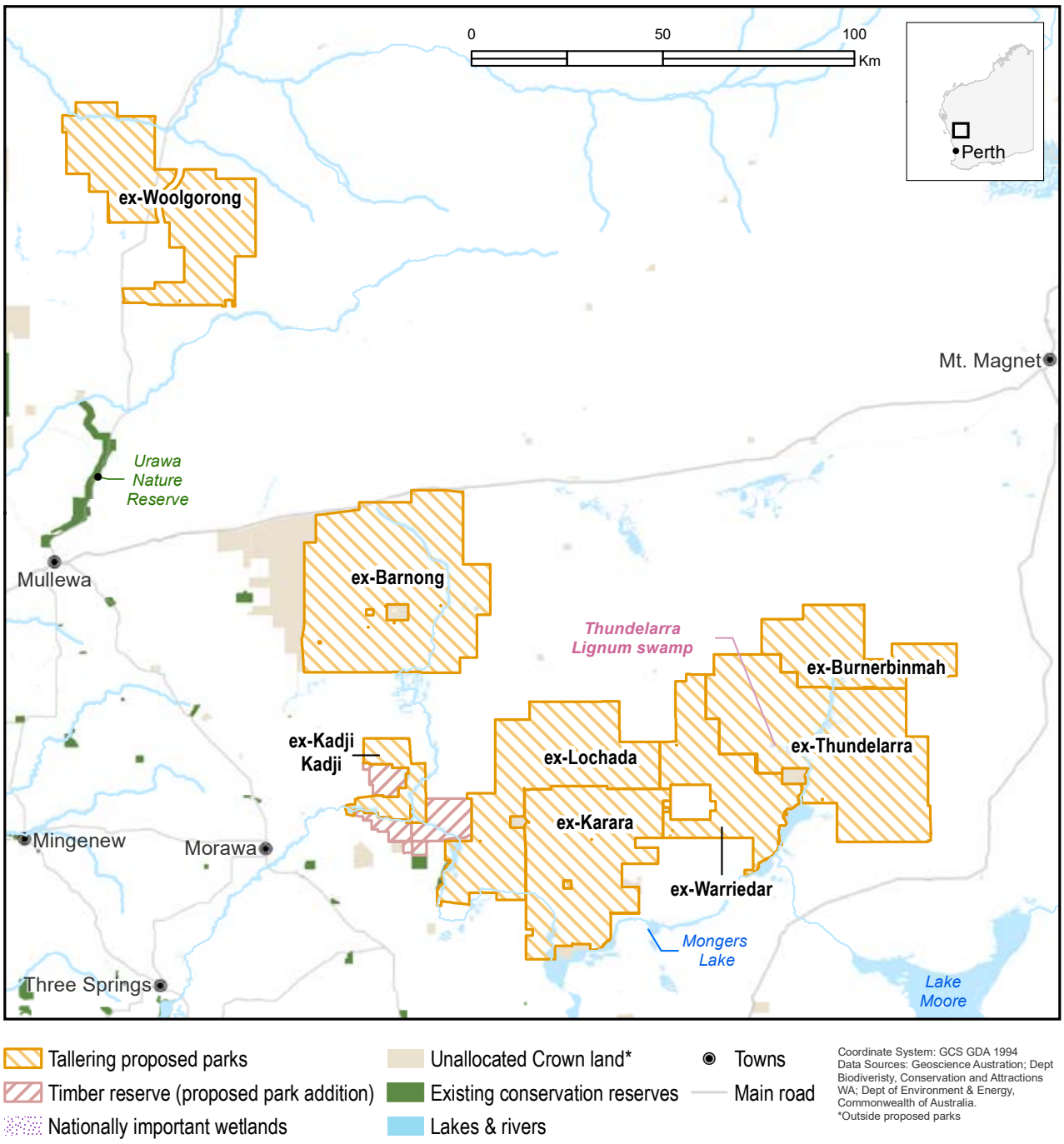


Figure 8-2: The proposed parks of the 'Tallering Botanical Trail'

8.2 Natural values for conservation

This country – named here for the Tallering sub-bioregion – is in a transition zone overlapping 2 botanical provinces: the highly diverse South West province and the arid Eremaean province. The transition is reflected in a shift from low mulga woodlands in the north to denser woodlands and shrublands dominated by wattles and eucalypts in the south-west. Plant diversity is high due to the overlap and the topographical and geochemical diversity provided by granite outcrops and greenstone and banded ironstone ranges, which are prominent landmarks in the vast red- and buff-coloured sandy plains typical of the area (Payne et al., 1998). The soils on the plains are mainly shallow and infertile and, in low areas, often underlain by a siliceous hardpan above shallow aquifers. The area features salt lakes – the remains of ancient river systems that fill every few years after heavy rains – as well as freshwater lignum swamp wetlands (Payne et al., 1998).

The 8 properties reviewed here were mostly bought under the Gascoyne-Murchison Strategy by the state government (with contributions from the federal government) to add to the reserve system. Although most were acquired more than 15 years ago, they remain as unallocated Crown land. As such, they lack the legal protections requiring assessment of the impact of new projects on the natural and cultural values for which they were acquired. Formal responsibility, but not full resourcing, for property management lies with the Department of Biodiversity, Conservation and Attractions.

The proposal to create 3 new conservation reserves offers the opportunity to protect a botanically diverse area with many unique species and communities. The floral values of the region are similar to those of the floral transition zone of the Shark Bay World Heritage Area (see chapter 3). The high diversity of the proposed parks is reflected in the 54 sub-bioregional ecosystems, 40 plant communities and 75 threatened and priority plant species recorded there. About two-thirds of the ecosystems and a third of the plant communities have no current representation in the conservation reserve system. The parks would improve protection for 9 listed priority ecological communities. They are important for protecting 1 plant community and 4 sub-bioregional ecosystems with more than 85% of their extent on the properties.

The proposed parks would also protect a high diversity of vertebrate animals. As is the case elsewhere in Western Australia's rangelands, a substantial proportion of mammals are locally extinct. A 1998 inventory of rangeland condition in the Sandstone-Yalgoo-Paynes Find area, which encompasses the proposed parks, notes that almost a quarter of the mammal species (11 of 48 species) have been lost since European colonisation (Payne et al., 1998). Two are globally extinct. More than 150 bird species and 100 reptile species have been recorded in the broader area (Payne et al., 1998). The proposed parks would protect 11 threatened and priority animal species, including the threatened western spiny-tailed skink and malleefowl.

The parks would add 817,000 hectares to the conservation reserve system, taking protection of the Tallering sub-bioregion from 2% to 24% (section 8.3).

Here, in 3 subsections corresponding with the recommendations in section 8.6 and the map in Figure 8-2, we describe the natural values of these 8 former leasehold properties acquired for conservation.

The proposed 'Kadji Kadji – Burnerbinmah' National Park has outstanding botanical richness with close to 900 plant species, including 63 threatened and priority species. This photo is of ex Warriedar. Photo: David Blood (DEC)

8.2.1 Proposed 'Kadji Kadji – Burnerbinmah' National Park

Former leasehold properties: ex Burnerbinmah, ex Kadji Kadji, ex Karara, ex Lochada, ex Thundelarra, ex Warriedar

These 6 properties, covering 533,000 hectares, offer the opportunity to create a large reserve with spectacular plant diversity and many rare and unique plant species associated with banded ironstone ranges. The proposed park would protect the nationally important wetland Thundelarra Lignum Swamp, a key biodiversity area significant for malleefowl, 5 priority ecological communities, 71 threatened and priority species and dozens of ecosystems with no protection in existing reserves. The park would comprise the third largest wildlife corridor in the Southwest Australian Floristic Zone, a globally significant biodiversity hotspot.

These properties lie across the boundary of the Avon Wheatbelt and Yalgoo bioregions, in a transition zone between the South West and the Eremaean botanical provinces. Much of the area lies within the Southwest Australian global biodiversity hotspot. The landscapes are diverse, with red and buff-coloured sandplains broken by granite outcrops, greenstone (basalt) ranges, freshwater wetlands and salt lakes. The basalt hills, formed during the Archaen Eon from 3.8 to 2.5 billion years ago, rise 100 to 200 metres above the sandplains. Some have spines of banded iron formations, which are layered sedimentary rocks, rich in iron oxide, formed due to the photosynthetic activity of early lifeforms which saturated seas with oxygen about 2.5 billion years ago (see Box 7-2).

The vegetation is diverse, as reflected in the 32 plant communities represented in the proposed park, more than half of which have less than 5% representation in the conservation reserve system (Table 8-3). The communities are mainly shrublands and low woodlands dominated by different types of wattles, some with scattered eucalypts, as well as shrublands of saltbush and bluebush. Of 43 sub-bioregional ecosystems found on the proposed park, 27 have no protection in existing reserves. It is critical for the protection of 1 plant community and 3 sub-bioregional ecosystems with more than 85% of their entire extent on the proposed park (Table 8-5).

Thundelarra lignum swamp, a freshwater wetland on ex Thundelarra, is listed as a nationally important wetland (DEE, 1992). When it fills – about once every 5 to 10 years – it covers 13,500 hectares and is up to 1.5 metres deep. The wetland is covered in open scrub and shrubland dominated by lignum (*Muehlenbeckia cunninghamii*) and canegrass (*Eragrostis australasica*). It is important for waterbirds – of 24 species recorded, at least 14 have bred there (mainly in the lignum bushes), including the freckled duck and whiskered tern (DEE, 1992).

The vibrancy of these landscapes when wildflowers bloom (here on ex Lochada) makes them a valuable tourism asset.
Photo: Linda Goncalves

The proposed park also features many salt lakes, which fill only occasionally, and scattered soaks and springs. Partly lying within the park is Mongers Lake, a regionally significant saline wetland 200 kilometres long (Desmond and Chant, 2001). Ex Kadji Kadji is dominated by salt lakes, including Burrillgabby Lake, Nullewa Lake and Wollothea Pool (Payne et al., 1998).

These properties support outstanding plant diversity, with 883 native plant species recorded, several unique to the area (DBCA, nd-a). They harbour 63 threatened and priority plant species, 12 of which have not yet been scientifically described (Table 8-4). The threatened species include the jingymia mallee (*Eucalyptus synandra*), listed as vulnerable, which is unusual for its ability to flower when just 15 centimetres tall, making it probably the most precocious of all eucalypts (ANPSA, 2016). Another of the threatened species – the triggerplant *Stylidium scintillans* – is an ephemeral plant with a very small area of occupancy, currently found only on land covered by mining tenements (Wege, 2012).

Many of the threatened and priority species are associated with the banded ironstone ranges on ex Karara, ex Warriedar and ex Thundelarra, a centre of specialised ironstone species. These ranges harbour at least 15 plant species found nowhere else (Meissner and Coppen, 2014). Three vegetation complexes associated with these ironstone formations are listed as priority-1 ecological communities due to their tiny distribution and the threat of mining (DBCA, 2017a) (Table 8-4).

All ironstone ranges surveyed on the Yilgarn Craton are biologically important, but the ranges on this proposed park, as well as on the nearby Kooklanooka Hills and the Helena and Aurora Ranges to the south, should be accorded a particularly high conservation priority for 'it is in these areas that the evolutionary processes that lead to the unique ironstone flora can be conserved' (Gibson et al., 2015). The ironstone ranges are probably both 'refugial habitats of great antiquity' – providing refuge when the surrounding landscape was inhospitable – and 'areas of recent speciation' (Gibson et al, 2007).

Wattles are the most species-rich of plant genera in the proposed park (and Australia-wide), and several species are endemic. In fact, the proposed park is a major part of an Australian centre of wattle endemism (see Box 8-1). One of the unique wattles is Woodman's wattle (*Acacia woodmaniorum*), which only grows high up in ironstone ranges. With all 3 surviving populations threatened by mining (see Box 8-2), it is a prime example of a species that will not be secure without protection in Class A reserves.

The proposed park is also important for animal conservation. Species recorded include 19 mammals, 122 birds, 53 reptiles, 6 frogs and 104 invertebrates (DBCA, nd-a). Eight are listed as threatened and priority species, including painted snipe (endangered), and malleefowl, gilled slender blue-tongue, western spiny-tailed skink and shield-backed trapdoor spider (all vulnerable).

Part of the park – on ex Karara, ex Lochada and ex Warriedar – has been designated a key biodiversity area by Birdlife Australia due to its 'significant viable population' of malleefowl (Birdlife International, 2018a). Elsewhere, there have been major declines in the population and range of malleefowl largely due to extensive clearing of mallee habitats for wheat and sheep production (Benshemesh, 2007).

Two adjacent timber reserves (35,000 hectares), if included in the proposed park, would be an important link in a substantial wildlife corridor, improve the integrity of the park and protect a critically endangered ecological community and 6 threatened and priority species. One timber reserve, lying between ex Kadji Kadji and ex Lochada, contains most of a priority-3 Western Australian Wheatbelt eucalypt woodland community listed as critically endangered by the Australian government. It also contains 2 priority plant species and the western spiny-tailed skink (vulnerable). The other timber reserve, on the western border of ex Kadji Kadji, contains 3 threatened and priority plant species. Its inclusion would serve to substantially consolidate the reserve boundary and increase management effectiveness.

Jingymia mallee (*Eucalyptus synandra*) (vulnerable) is probably the most precocious of all eucalypts, able to flower when just 15 centimetres high. Photo: Tatiana Gerus

Box 8-1: Centre of wattle endemism

Wattles (*Acacia* species) are important plants in the proposed park – they are the richest genus of plants in the proposed park and the dominant plant in many communities. Wattles are also Australia's largest plant genus, with more than 1000 described species. They diversified as Australia became much drier 15–10 million years ago.

The proposed park makes up a major part of a centre of wattle endemism in Australia (the central Yalgoo) and is also part of a primary region of endemism (southwest Western Australia).

Soil properties are a driving force for the distribution of endemic wattles, especially in southwest Western Australia, where high variability in soil produces 'steep gradients that produce a mosaic of differentiated niches'. The diversification of wattles proceeded in tandem with major geochemical changes as Australian landscapes adjusted to aridity. They are a very good example of the co-evolution of landscapes and biota.

Several wattles on the proposed park are very rare with tiny distributions. Five species are listed as threatened or priority species (Table 8-4).

Sources: Gonzalez-Orozco et al. (2011), Bui et al. (2014)

Box 8-2: Found only in the proposed park – Woodman's wattle

One of Western Australia's rarest species, *Acacia woodmaniorum*, survives in 3 populations in the banded ironstone ranges on ex Karara. It grows high up (above 400 metres) on steep exposed slopes, often in rock crevices. One population was destroyed by mining in 2012, and the remaining populations are all on mining or exploration tenements.

According to the recovery plan for Woodman's wattle, all known habitat 'is critical to the survival of the species' and all populations are 'important populations'. However, in 2013 a permit was issued for a mining company to remove part of 2 populations.

For small or isolated populations, connectivity between them is necessary to maintain their genetic diversity and adaptive potential. Genetic work on Woodman's wattle indicates that maintaining connectivity is likely to be critical for its persistence. The current levels of gene flow, through pollen or seed movement, have been sufficient to prevent inbreeding. This is probably facilitated by pollen-carrying insects being occasionally blown several kilometres.

Sources: Millar et al. (2013), DPaW (2015b)

The future of woodman's wattle (*Acacia woodmaniorum*) (vulnerable), which only grows high up in ironstone ranges, is at risk unless it can be securely protected in a conservation reserve. Photo: Neomyrtus

Shield-backed trapdoor spiders (*Idiosoma nigrum*), listed as threatened, build elaborate twig lines around their burrow for foraging and to channel water for drinking. They occur in small isolated populations, relics of a time when the climate was wetter. Females are thought to live for more than 20 years. Photo: Volker Framenau

Table 8-3: Summary of conservation values of the proposed 'Kadji Kadji – Burnerbinmah' National Park

ex Burnerbinmah (60,000 hectares)	
Threatened and priority plants	7 species.
Plant communities	6 communities: 2 with 0% representation in existing reserves, 4 others with <5%.
Sub-bioregional ecosystems	10 ecosystems: 7 with 0% representation in existing reserves, 3 others with <5%

ex Kadji Kadji (21,000 hectares)	
Threatened and priority plants	9 species.
Threatened and priority animals	1 bird, 1 mammal, 1 reptile species.
Priority ecological communities	1 priority community: Eucalypt woodlands of the Western Australian Wheatbelt (priority 3, critically endangered nationally) (<1% of its extent).
Plant communities	11 communities: 3 with 0% protection in existing reserves, 2 others with <5%.
Sub-bioregional ecosystems	14 communities: 7 with 0% protection in existing reserves, 5 others with <5%.

ex Karara (109,000 hectares)	
Threatened and priority plants	42 species.
Threatened and priority animals	3 bird, 1 mammal, 2 reptile, 1 invertebrate species.
Priority ecological communities	2 priority communities: • Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) (priority 1) (77% of its extent). • Eucalypt woodlands of the Western Australian Wheatbelt (priority 3, listed nationally as critically endangered) (10% of its extent).
Plant communities	13 communities: 2 with 0% protection in existing reserves, 3 others with <5%.
Sub-bioregional ecosystems	17 ecosystems: 7 with 0% representation in existing reserves, 5 others with <5%. Critical for 2 unprotected ecosystems (100% and 74% of their extent).
Key biodiversity area	Karara and Lochada KBA – listed primarily for viable populations of malleefowl.

ex Lochada (115,000 hectares)	
Threatened and priority plants	15 species.
Threatened and priority animals	3 bird, 1 mammal, 1 reptile, 1 invertebrate species.
Priority ecological communities	3 priority communities: • Eucalypt woodlands of the Western Australian Wheatbelt (priority 3, listed nationally as critically endangered) (22% of its extent). • Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) (priority 1) (14% of its extent). • Minjar and Chulaar Hills vegetation complexes (banded ironstone formation) (priority 1) (7% of its extent).
Plant communities	13 communities: 2 with 0% protection in existing reserves, 3 others with <5%.
Sub-bioregional ecosystems	16 ecosystems: 6 with 0% representation in existing reserves, 5 with <5%.
Key biodiversity area	Karara and Lochada KBA – listed primarily for viable populations of malleefowl.
Buffering	Management of ex Lochada would also help protect the woodlands of the Koolanooka System (banded ironstone formation), a threatened ecological community just to the west of ex Lochada, and Weelhamby Lake and the adjacent Weelhamby Lake Nature Reserve.

Table 8-3 (continued)

ex Thundelarra (156,000 hectares)	
Wetland of national importance	Thundelarra Lignum Swamp, with highly sensitive and at-risk ecosystems of lignum-dominated plant assemblages.
Threatened and priority plants	10 species.
Threatened and priority animals	1 bird, 2 reptile species.
Priority ecological communities	3 priority communities: • Lignum-canegrass shrubland (priority 3) (100% of its extent). • Warriedar Hill/Pinyalling vegetation complexes (banded ironstone formation) (priority 1) (51% of its extent). • Minjar and Chulaar Hills vegetation complexes (banded ironstone formation) (priority 1) (2% of its extent).
Plant communities	13 communities: 6 with 0% representation in existing reserves, 5 others with <5%.
Sub-bioregional ecosystems	18 ecosystems: 14 with 0% representation in existing reserves, 4 others with <5%. Very important for 2 unprotected ecosystems (52% and 60% of their extent).
Key biodiversity area	Karara and Lochada KBA, listed primarily for viable populations of malleefowl.

ex Warriedar (72,000 hectares)	
Threatened and priority plants	30 species.
Threatened and priority animals	1 bird, 1 reptile, 1 invertebrate species.
Priority ecological communities	3 priority communities: • Warriedar/Pinyalling/Walagnumming Hills vegetation complexes (banded ironstone formation) (priority 1) (37% of its extent). • Minjar and Chulaar Hills vegetation complexes (banded ironstone formation) (priority 1) (45% of its extent). • Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) (priority 1) (8% of its extent).
Plant communities	11 communities: 5 with 0% representation in existing reserves, 3 others with <5%. Critical for 1 unprotected plant community (a wattle, jam scrub, york gum and sheoak shrubland) (85% of its extent).
Sub-bioregional ecosystems	11 ecosystems: 6 with 0% representation in existing reserves, 3 others with <5%. Critical for 1 unprotected ecosystem (85% of its extent).

All properties (533,000 hectares)	
Wetland of national importance	Thundelarra Lignum Swamp.
Threatened and priority plants	63 species.
Threatened and priority animals	4 bird, 1 mammal, 2 reptile, 1 invertebrate species.
Priority ecological communities	5 communities: 3 banded ironstone formation vegetation complexes (all priority 1), lignum-canegrass shrubland (priority 3) and Eucalypt woodlands of the Western Australian Wheatbelt (priority 3, critically endangered nationally).
Plant communities	32 communities: 10 with 0% representation in existing reserves, 8 others with <5%. Critical for 1 unprotected community (85% of its extent).
Sub-bioregional ecosystems	43 ecosystems: 27 with 0% representation in existing reserves, 9 others with <5%. Critical for 3 unprotected ecosystems (100%, 100% and 85% of their extent).
Key biodiversity area	Karara and Lochada KBA for malleefowl
Buffering and connectivity	Improved protection of Burrillgabby, Nullewa, Wollothea and Weelhamby lakes and the Mongers waterway.

Sources: See technical notes 1 and 2 (chapter 2).

Table 8-4: Threatened and priority species and ecological communities of the proposed 'Kadji Kadji – Burnerbinmah' National Park

Species	Conservation class	ex Burnerbinmah	ex Kadji Kadji	ex Karara	ex Lochada	ex Thundelarra	ex Warriedar
Birds							
Australian painted snipe (*Rostratula australis*)	Endangered			●			
Malleefowl (*Leipoa ocellata*)	Vulnerable			●	●	●	●
Hooded plover (*Charadrius rubricollis*)	Priority 4				●		
Rainbow bee-eater (*Merops ornatus*)	International agreement			●			
Mammals							
Western brush wallaby (*Macropus Irma*)	Priority 4			●	●		
Reptiles							
Gilled slender blue-tongue (*Cyclodomorphus branchialis*)	Vulnerable			●		●	
Western spiny-tailed skink (*Egernia stokesii badia*)	Vulnerable		●	●	●	●	●
Invertebrates							
Shield-backed trapdoor spider (*Idiosoma nigrum*)	Vulnerable			●	●		●
Plants							
Eremophila nivea	Threatened		●				
Acacia woodmaniorum	Vulnerable			●			
Eucalyptus synandra	Vulnerable		●	●	●		
Stylidium scintillans	Vulnerable			●	●	●	●
Acacia diallaga	Priority 1			●			●
Acacia karina	Priority 1			●			●
Acacia sulcaticaulis	Priority 1						●
Allocasuarina tessellata	Priority 1			●			●
Chamelaucium sp. Warriedar	Priority 1			●			●
Chamelaucium sp. Yalgoo	Priority 1			●	●		●
Eremophila oldfieldii subsp. Karara	Priority 1			●			
Eremophila sp. Rothsay	Priority 1			●			
Eucalyptus jutsonii subsp. *kobela*	Priority 1			●	●		
Gnephosis setifera	Priority 1		●	●			
Grevillea scabrida	Priority 1			●		●	●
Hemigenia sp. major	Priority 1		●				
Hydrocotyle sp. Warriedar	Priority 1			●			●
Lepidosperma sp. Blue Hills	Priority 1			●		●	●
Millotia dimorpha	Priority 1		●	●	●		
Petrophile vana	Priority 1	●					
Prostanthera sp. Karara	Priority 1			●			
Ptilotus andersonii	Priority 1	●					
Acacia subsessilis	Priority 2					●	●
Austrostipa blackii	Priority 2			●		●	●
Calotis sp. Perrinvale Station	Priority 2			●			●
Cyanicula fragrans	Priority 2			●	●		●
Dicrastylis linearifolia	Priority 2	●					●
Drummondita fulva	Priority 2			●	●		●
Eremophila grandiflora	Priority 2					●	●
Gnephosis cassiniana	Priority 2						●

Table 8-4 (continued)

Species	Conservation class	ex Burnerbinmah	ex Kadji Kadji	ex Karara	ex Lochada	ex Thundelarra	ex Warriedar
Plants							
Grevillea globosa	Priority 2			●	●	●	●
Grevillea granulosa	Priority 2			●			●
Grevillea leptopoda	Priority 2			●			
Grevillea subtiliflora	Priority 2			●			●
Gunniopsis divisa	Priority 2			●			
Gunniopsis propinqua	Priority 2						●
Melaleuca barlowii	Priority 2			●			
Menkea draboides	Priority 2			●			
Micromyrtus acuta	Priority 2			●		●	●
Micromyrtus trudgenii	Priority 2			●		●	●
Persoonia pentasticha	Priority 2			●		●	●
Petrophile pauciflora	Priority 2			●		●	
Polianthion collinum	Priority 2			●			●
Psammomoya implexa	Priority 2			●			
Rhodanthe collina	Priority 2		●	●		●	●
Stenanthemum poicilum	Priority 2			●			●
Tecticornia fimbriata	Priority 2				●		
Triglochin protuberans	Priority 2	●					
Xanthoparmelia dayiana	Priority 2			●			
Amanita lesueurii	Priority 3					●	
Baeckea sp. Perenjori	Priority 3			●			
Calandrinia kalanniensis	Priority 3			●			
Calandrinia sp. Warriedar	Priority 3			●	●		●
Fitzwillia axilliflora	Priority 3		●				
Grevillea rosieri	Priority 3		●				
Hyalosperma stoveae	Priority 3	●					
Hydrocotyle sp. Coorowensis	Priority 3		●		●		
Lepidium merrallii	Priority 3	●					
Persoonia kararae	Priority 3			●			
Banksia benthamiana	Priority 4				●		
Dodonaea amplisemina	Priority 4						●
Goodenia neogoodenia	Priority 4	●					
Wurmbea murchisoniana	Priority 4			●			
Ecological communities							
Warriedar/Pinyalling/Walagnumming Hills vegetation complexes (banded ironstone formation)	Priority 1					●	●
Minjar and Chulaar Hills vegetation complexes (banded ironstone formation)	Priority 1				●	●	●
Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation)	Priority 1			●	●		●
Eucalypt woodlands of the Western Australian Wheatbelt	Priority 3		●	●	●		
Lignum-canegrass shrubland	Priority 3					●	

Sources: See technical notes 1 (chapter 2).

Table 8-5: The extent of protection (%) in the proposed 'Kadji Kadji – Burnerbinmah' National Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Burnerbinmah	ex Kadji Kadji	ex Karara	ex Lochada	ex Thundelarra	ex Warriedar
No protection (<0.1%) in existing reserves						
VT 268: Succulent steppe with open scrub; scattered *Acacia sclerosperma* over saltbush & bluebush					4.9	
VT 269 Low woodland over scrub; mulga over bowgada scrub					1.9	
VT 326 Low woodland over scrub; mulga over bowgada & minnieritchie scrub	2.8				5.7	4.1
VT 355 Shrublands; bowgada & jam scrub with scattered York gum & red mallee		3.3	37.2	1.5		1.1
VT 414 Succulent steppe with open scrub; scattered bowgada & jam over saltbush & bluebush					7.2	0.9
VT 415 Succulent steppe with open scrub; scattered mulga & other wattles over saltbush & bluebush	2.1				20.4	0.1
VT 419 Shrublands; bowgada, jam and Melaleuca uncinata thicket		2.7	7.0	19.2		
VT 434 Shrublands; *Acacia quadrimarginea* and jam scrub with scattered York gum and *Allocasuarina huegeliana*						85.2
VT 533 Low woodland; mulga & cypress pine					1.3	
VT 683 Succulent steppe with open scrub; scattered *Acacia sclerosperma* & snakewood over samphire		5.8				
Little protection (0.1 to 5%) in existing reserves						
VT 18 Low woodland; mulga (*Acacia aneura*)	0.1				0.2	
VT 40 Shrublands; acacia scrub, various species	2.4	0.2	0.1		0.8	0.8
VT 202 Shrublands; mulga & *Acacia quadrimarginea* scrub					1.2	2.9
VT 352 Medium woodland; York gum		0.1	0.2	0.4		0.1
VT 374 Shrublands; bowgada scrub with scattered York gum				15.0		
VT 420 Shrublands; bowgada & jam scrub	0.1		2.6	1.9	0.6	1.3
VT 631 Succulent steppe with woodland and thicket; York gum over *Melaleuca thyoides* & samphire		3.3		6.5		
VT 676 Succulent steppe; samphire	0.1				0.3	
VT 936 Medium woodland; salmon gum			0.1			
Inadequate protection (5 to 15%) in existing reserves						
VT 39 Shrublands; mulga scrub					0.1	
VT 41 Shrublands; teatree scrub			0.2			
VT 125 Bare areas; salt lakes		<0.1	<0.1		<0.1	<0.1
VT 352 Medium woodland; York gum		<0.1	1.0	1.9		0.1
VT 365 Shrublands; bowgada & jam scrub with scattered York gum & red mallee		3.7		2.7		
VT 686 Medium woodland; York gum & red mallee				1.8		
VT 988 Succulent steppe with thicket; *Melaleuca thyoides* over samphire		1.2				
VT 1198 Mosaic: Succulent steppe with thicket; *Melaleuca thyiodes* over samphire / Shrublands; bowgada open scrub			12.4	10.9		
VT 2081 Shrublands; bowgada and associated spp. scrub		<0.1				

Source: See technical notes 2 (chapter 2).

8.2.2 Proposed 'Barnong' National Park

Former leasehold property: ex Barnong

This 168,000-hectare property offers the opportunity to protect 4 priority-1 ecological communities and 15 threatened and priority species as well as the catchment of the Salt River and several plant communities and ecosystems lacking representation in existing reserves.

The property features many saline waterholes and wetlands as well as lignum-dominated swamps (Kendrick and McKenzie, 2001). It is bisected by the Salt River, an ancient river system connected to the Avon River. Dry most of the time now, it used to be a major river, until uplift of the Yilgarn Craton and the Darling Range some 60 million years ago dammed it, leading to the formation of a large inland lake (Salama, 1997). Over time, the uplifted area was eroded and a connection established with the Avon River during an exceptionally wet period.

Beneath the saline river channel and lakes lie calcretes (limestone aquifers) that contain 2 priority-1 ecological communities. Ex Barnong harbours almost half the Bunnawarra calcrete groundwater assemblage type as well as a portion of the Wagga Wagga and Yalgoo calcrete groundwater assemblage (Table 8-6). These communities – each likely consisting of several animal species unique to a single calcrete – are part of an archipelago of groundwater communities in the Yilgarn region, which together contain the most diverse water beetle assemblage in the world and also, by global standards, a highly diverse crustacean fauna (Cooper et al., 2002, Cooper et al., 2007, Cooper et al., 2008). Calcrete communities are poorly known, with many undescribed species, and threatened by mining (see Box 7-2).

The proposed park would also increase security for 2 priority-1 ecological communities associated with banded ironstone formations (Table 8-6). Ex Barnong contains 88% of the Gullewa vegetation complexes, a highly diverse plant community with 235 species recorded in 50 survey quadrats (Markey and Dillon, 2010). The highest diversity is on Mugga Mugga Hill and Buddadoo Hill in the southern section of ex Barnong. The property also contains 16% of the Yalgoo banded ironstone formation vegetation complexes, with a very restricted distribution of just 500 hectares.

The diversity of the property is indicated by the 15 plant communities and 17 sub-bioregional ecosystems represented there, most with little to no protection in the existing reserve system (Table 8-6, Table 8-8). The park would provide the first representation in reserves for 5 plant communities and 12 ecosystems. Ex Barnong is critical for the protection of 1 ecosystem with 85% of its extent on the property.

Ex Barnong harbours 6 threatened and priority animal species, including the malleefowl and threatened shield backed spider (both listed as vulnerable), and 9 threatened and priority plant species (Table 8-7). The plants include the endangered varnish bush (*Eremophila viscida*) known in 2003 from just 16 populations with about 800 mature plants, threatened by poor recruitment, weeds, salinity and waterlogging, erosion, inappropriate fire regimes, road, track and firebreak maintenance, grazing and trampling by stock, chemical drift and powerline maintenance (Phillimore et al., 2003). This is 1 of 7 threatened and priority poverty bushes (*Eremophila* species) recorded on the proposed Tallering parks, a group of plants characteristic of the Outback and richly represented in Western Australia (see Box 8-3).

This priority-3 species, *Drummondita fulva*, has a tiny distribution associated with banded ironstone ranges, including on the proposed 'Kadji Kadji – Burnerbinmah' National Park. Photo: Neomyrtus

The endangered varnish bush (*Eremophila viscida*), known in 2003 from just 16 small populations, has been recorded on ex Barnong. Photo: Russell Cumming

Box 8-3: The richness of poverty bushes (*Eremophila* species)

Eremophila is an important genus of plants found only in Australia, growing in arid and semi-arid areas. They are often called poverty bushes, due to their occurrence on impoverished soils and degraded rangelands. There are more than 250 known species, including more than 40 yet to be scientifically described. Of the small trees and shrubs in arid and semi-arid country, they are second only to wattles in their diversity.

The greatest centre of eremophila diversity is in Western Australia, where close to 200 species have been named, more than 80% of which are endemic to the state. About half the named species have been scientifically described within the past 15 years and more await description.

Poverty bushes are very hardy – often tolerant to drought, fire, frost, salinity and grazing. Some are grown in gardens due to their drought tolerance and attractive flowers.

Poverty bushes are culturally important – particularly as traditional remedies used by Indigenous Australians to treat ailments such as colds, wounds, scabies, fever and pain and for general wellbeing. This has led to considerable research on their chemistry, revealing an array of unusual compounds including those with antibacterial, antiviral, anti-inflammatory, anti-malarial and cytotoxic qualities.

Some poverty bushes are highly resinous, with the resin sometimes obvious on branches and leaves as a dried transparent varnish. Some Indigenous groups used the resin as a sealant and a glue for attaching spear heads to shafts.

Sources: ALA (nd), Buirchell and Brown (2016), Chinnock (2007)

Eremophilas unique to Western Australia include (from left to right) *Eremophila clarkei, E. viscida* (endangered), *E. splendens* (priority 1) and *E. youngii ssp lepidota* (priority 4). Photos: Russell Cumming

Table 8-6: Summary of conservation values of the proposed 'Barnong' National Park

ex Barnong (168,000 hectares)	
Threatened and priority plants	9 species.
Threatened and priority animals	4 bird, 1 mammal, 1 invertebrate species.
Priority ecological communities	4 priority communities: • Bunnawarra calcrete groundwater assemblage type on Moore palaeodrainage on Bunnawarra Station (priority 1) (46% of its extent). • Gullewa vegetation complexes (banded ironstone formation) (priority 1) (88% of its extent). • Wagga Wagga and Yalgoo calcrete groundwater assemblage type on Yalgoo palaeodrainage on Wagga Wagga Station and Moore Palaeodrainage on Yoweragabbie Station (priority 1) (10% of its extent). • Yalgoo (Gnows Nest/Wolla Wolla and Woolgah-Wadgingarra)¬ vegetation complexes (banded ironstone formation) (priority 1) (16% of its extent).
Plant communities	15 communities: 5 with 0% representation in existing reserves, 3 others with <5%.
Sub-bioregional ecosystems	17 ecosystems: 12 with 0% representation in existing reserves, 3 others with <5%. Critical for 1 unprotected ecosystem (85% of its extent) and very important for another (61% of its extent).
Buffering and connectivity	Improved protection of Salt River.

Sources: See technical notes 1 and 2 (chapter 2).

Table 8-7: Threatened and priority species and ecological communities of the proposed 'Barnong' National Park

Species	Conservation class
Birds	
Malleefowl (*Leipoa ocellata*)	Vulnerable
Common greenshank (*Tringa nebularia*)	International agreement
Great egret (*Ardea modesta*)	International agreement
Rainbow bee-eater (*Merops ornatus*)	International agreement
Mammals	
Long-tailed dunnart (*Sminthopsis longicaudata*)	Priority 4
Invertebrates	
Shield-backed trapdoor spider (*Idiosoma nigrum*)	Vulnerable
Plants	
Eremophila viscida	Endangered
Chamelaucium sp. Yalgoo	Priority 1
Acacia subsessilis	Priority 2
Grevillea globosa	Priority 2
Persoonia pentasticha	Priority 2
Rhodanthe collina	Priority 2
Chthonocephalus muellerianus	Priority 3
Acacia speckii	Priority 4
Dodonaea amplisemina	Priority 4
Ecological communities	
Bunnawarra calcrete groundwater assemblage type on Moore palaeodrainage	Priority 1
Gullewa vegetation complexes (banded ironstone formation)	Priority 1
Wagga Wagga and Yalgoo calcrete groundwater assemblage type on Yalgoo palaeodrainage	Priority 1
Yalgoo (Gnows Nest/Wolla Wolla and Woolgah-Wadgingarra) vegetation complexes (banded ironstone formation)	Priority 1

Sources: See technical notes 1 (chapter 2).

Table 8-8: The extent of protection (%) in the proposed 'Barnong' National Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Barnong
Little protection (0.1 to 5%) in existing reserves	
VT 361 Shrublands: bowgada (*Acacia ramulosa - Acacia linophylla*) and miniritchie (*Acacia grasbyi*) scrub with scattered mulga (*Acacia aneura*)	23.8
VT 404 Shrublands; bowgada & *Acacia murrayana* scrub	0.4
VT 419 Shrublands; bowgada, jam and *Melaleuca uncinata* thicket	16.3
VT 683 Succulent steppe with open scrub; scattered *Acacia sclerosperma* & snakewood over samphire	28.4
VT 2685 Shrublands; *Acacia quadrimarginea* & jam scrub on greenstone	26.2
Little protection (0.1 to 5%) in existing reserves	
VT 10 Medium woodland; red mallee group	0.5
VT 202 Shrublands; mulga & *Acacia quadrimarginea* scrub	<0.1
VT 420 Shrublands; bowgada & jam scrub	4.3
Inadequate protection (5 to 15%) in existing reserves	
VT 125 Bare areas; salt lakes	<0.1
VT 365 Shrublands; bowgada & jam scrub with scattered York gum & red mallee	27.3
VT 686 Medium woodland; York gum & red mallee	11.3
VT 1413 Shrublands; acacia, casuarina & melaleuca thicket	<0.1
VT 2081 Shrublands; bowgada and associated spp. scrub	<0.1

Sources: See technical notes 2 (chapter 2).

A breakaway on ex Warriedar showing oxidized pallidzone below lateritised caprock. Photo: David Blood (DEC)

8.2.3 Proposed 'Woolgorong' Conservation Park

Former leasehold property: ex Woolgorong

This 116,000-hectare property has high botanical values and offers the opportunity to protect 17 threatened and priority species, many plant communities and sub-bioregional ecosystems with no representation in existing reserves, and part of the catchment for 2 rivers.

The property straddles the ranges between the Murchison and Greenough rivers, and the Murchison flows through it in the north. The proposed park would protect an important part of their catchment.

The vegetation consists mainly of low wattle woodlands and shrublands, dominated variously by mulga (*Acacia aneura*), snakewood (*A. xiphophylla*), bowgada (A. ramulosa), jam (*A. acuminata*), limestone wattle (*A. sclerosperma*), minnieritchie (*A. trachycarpa*), sandplain wattle (*A. murrayana*) and bramble wattle (*A. victoriae*) (see Table 8-9). Of the 6 plant communities found on the property, none are adequately represented in existing reserves: 3 have no representation and 3 have less than 5% (Table 8-9, Table 8-11). Similarly, of 8 sub-bioregional ecosystems found there, 6 have no representation and 2 have less than 5% representation in existing reserves.

Ex Woolgorong harbours 13 priority plant species, including 1 found only on the property – *Malleostemon* sp. Woolgorong Station – an undescribed, poorly known myrtaceous shrub in a genus unique to Western Australia (Rye, 2016). The proposed park would protect 4 threatened and priority animal species, including the malleefowl (vulnerable) and the western spiny-tailed skink (vulnerable) (Table 8-10).

Granite inselbergs (outcrops) provide important drought refuge for birds, reptiles and mammals on ex Woolgorong. Photo: Glenn Campbell

Table 8-9: Summary of conservation values of the proposed 'Woolgorong' Conservation Park

ex Woolgorong (116,000 hectares)	
Threatened and priority plants	13 species.
Threatened and priority animals	3 bird, 1 reptile species.
Plant communities	6 communities: 3 with 0% representation in existing reserves, 3 others with <5%.
Sub-bioregional ecosystems	8 ecosystems: 6 with 0% in existing reserves, 2 others with <5%.
Buffering and connectivity	Maintenance of a healthy catchment for the Murchison and Greenough rivers

Sources: See technical notes 1 and 2 (chapter 2).

Table 8-10: Threatened and priority species of the proposed 'Woolgorong' Conservation Park

Species	Conservation class
Birds	
Malleefowl (*Leipoa ocellata*)	Vulnerable
Great egret (*Ardea modesta*)	International agreement
Rainbow bee-eater (*Merops ornatus*)	International agreement
Reptiles	
Western spiny-tailed skink (*Egernia stokesii badia*)	Vulnerable
Plants	
Malleostemon sp. Woolgorong Station	Priority 1
Balladonia aervoides	Priority 2
Dicrastylis linearifolia	Priority 2
Eremophila physocalyx	Priority 2
Gunniopsis divisa	Priority 2
Petrophile pauciflora	Priority 2
Prostanthera petrophila	Priority 2
Psammomoya ephedroides	Priority 2
Ptilotus beardii	Priority 2
Verticordia jamiesonii	Priority 2
Eremophila mirabilis	Priority 3
Frankenia confusa	Priority 4
Goodenia neogoodenia	Priority 4

Sources: See technical notes 1 (chapter 2).



Some of the wildlife typical of the Outback photographed on ex Woolgorong: fairy martins (*Petrochelidon ariel*), whistling kite (*Haliastur sphenurus*) and bungarra (or Goulds monitor, *Varanus gouldii*). Photos: Keith Wilcox

Table 8-11: The extent of protection (%) in the proposed 'Woolgorong' Conservation Park for plant communities with inadequate representation in existing reserves

Plant Communities	
No protection in existing reserves	
VT 240 Succulent steppe with open scrub; scattered Acacia sclerosperma & bowgada over saltbush & bluebush	0.2
VT 326 Low woodland over scrub; mulga over bowgada & minnieritchie scrub	8.7
VT 404 Shrublands; bowgada & Acacia murrayana scrub	9.1
Little (0.1 to 5%) protection in existing reserves	
VT 40 Shrublands; acacia scrub, various species	0.2
VT 160 Shrublands; snakewood & Acacia victoriae scrub	0.2
VT 420 Shrublands; bowgada & jam scrub	0.5

Source: See technical notes 2 (chapter 2).

8.3 Importance for achieving Western Australia's conservation reserve goals

The Tallering proposed parks will substantially build the reserve system and help the government achieve the state's conservation goals. Most of the ecological regions, ecosystems and plant communities on the proposed parks are poorly or not protected at all in the existing reserve system.

Bioregional and sub-bioregional protection

The proposed parks sit almost entirely within the Tallering sub-bioregion of the Yalgoo bioregion. With less than 2% in existing reserves, the Tallering is a national priority for new reserves. The proposed parks would make a nationally significant contribution to the reserve system by increasing protection of the Tallering 10-fold to 24%, enabling achievement of the 2020 international benchmark (Table 8-12, Figure 8-3).

Ecosystem and plant community protection

The proposed parks would improve protection of 40 plant communities and 54 sub-bioregional ecosystems (Table 8-13). This would be the first such protection for 14 plant communities (35% of the total) and 36 sub-bioregional ecosystems (67% of the total) currently lacking representation in the conservation reserve system. Protection of the proposed parks is particularly important for the 17% of ecosystems and 3% of plant communities that have more than half of their entire extent on those properties (Table 8-13), including 2 ecosystems with 100% of their extent on the properties and 1 plant community and 2 ecosystems with 85%.

Currently, more than a third of Western Australia's sub-regional ecosystems lack a minimum level of protection, based on a long-held national target of 15% of each ecosystem to be in reserves (JANIS, 1997, Taylor, 2017). The proposed parks would enable the minimum reserve target of 15% to be met for an additional:

- 24 sub-bioregional ecosystems (44% of the total ecosystems on the proposed parks)
- 10 plant communities (25% of the total communities on the proposed parks)

Table 8-12: Current and improved protection of bioregions and sub-bioregions (% protected) in Western Australia's conservation reserve system

	Bioregion	Sub-bioregion	Bioregion	Sub-bioregions		Bioregion	Sub-bioregions
	Yalgoo	Tallering	Murchison	East Murchison	West Murchison	Avon Wheatbelt	Merredin
Current protection	12.53	3.56	1.06	1.39	0.06	3.39	4.18
Proposed parks	14.35	20.86	0.21	0.25	0.09	0.54	0.42
New total	26.88	24.42	1.27	1.64	0.15	3.93	4.60

Source: See technical notes 2 (chapter 2).

Notes: *Current protection* means the percentage of each bioregion and sub-bioregion protected in the existing conservation reserve system. *Proposed parks* means the percentage of each bioregion and sub-bioregion protected in the proposed parks. *New total* means the percentage of each bioregion and sub-bioregion that would be protected if the proposed parks are declared.

Figure 8-3: Progress towards the 2020 international benchmark (17%) for protection of bioregions and sub-bioregions (% area protected) due to the proposed parks

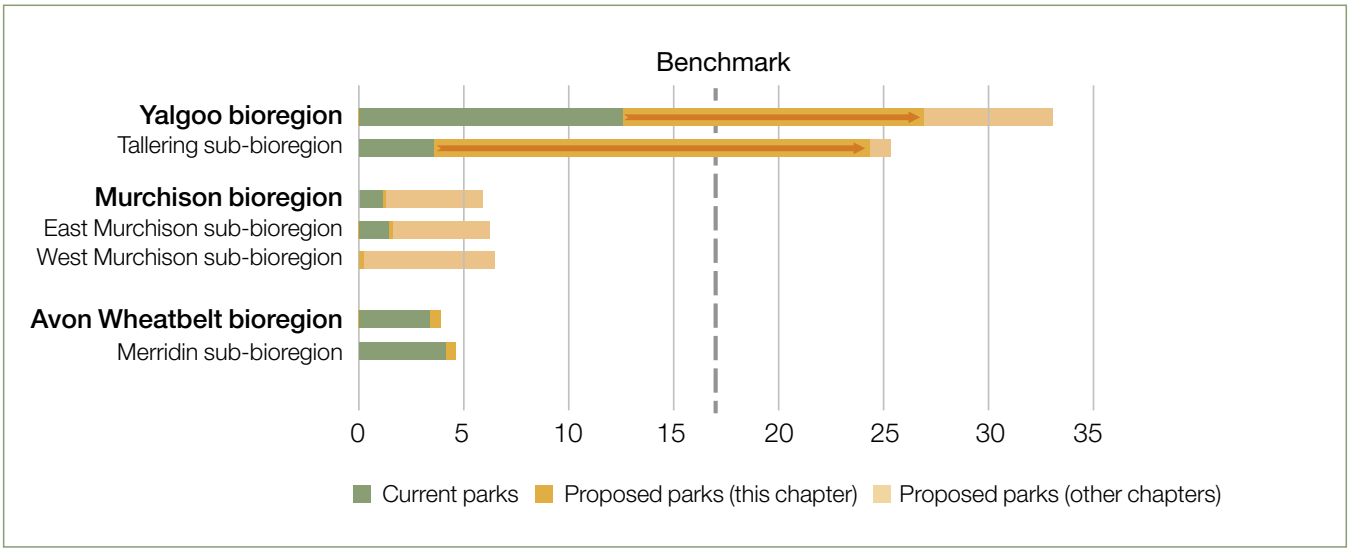


Table 8-13: Numbers of plant communities and sub-bioregional ecosystems in the proposed parks, levels of protection in the existing conservation reserve system and the contribution to protection of particular communities and ecosystems

	Plant communities (number & percentage)		Ecosystems (number & percentage)	
Improved protection in proposed parks				
Total in proposed parks	40	100%	54	100%
Will achieve 15% target[A]	10	25%	24	44%
Current level of protection in reserve system				
No existing protection (<0.1%)	14	35%	36	67%
Little existing protection (0.1-5%)	10	25%	9	17%
Inadequate protection (5.1-<15%)	10	25%	4	7%
Exceeds 15% protection	6	15%	5	9%
Contribution to protection of particular communities & ecosystems[B]				
Critical (>85% of total extent)	1	3%	3	6%
Very important (50–85% of total extent)	-	-	6	11%
Important (10–50% of total extent)	14	35%	32	59%

Sources: See technical notes 2 (chapter 2).

Notes: A. This assumes protection in other proposed parks and does not include ecosystems that already have more than 15% of their extent protected in the conservation reserve system. B. This represents the number of communities or ecosystems with a substantial proportion of their total extent in the proposed parks. For example, the proposed parks are 'critical' for ecosystem protection where more than 85% of the entire ecosystem extent occurs within those proposed parks.

8.4 Native title and Aboriginal heritage sites

The proposed parks in the Tallering floristic zone are part of the Southern Yamatji, Widi Mob and Mullewa Wadjari Community native title claim areas. Native title was determined not to exist on 3 properties that were claimed in part or whole by the Badimia People.

The parks would protect the entirety of 25 registered Aboriginal heritage sites, the partial area of another 3, and 91 lodged sites (Table 8-14).

Table 8-14. Summary of native title and registered Aboriginal heritage sites of the proposed parks

Native title party, claimed or determined (percentage of property)	Registered Aboriginal heritage sites
Proposed 'Barnong' National Park	
ex Barnong	
Southern Yamatji, registered claim application (81%) Mullewa Wadjarri, registered claim application (14%) Widi Mob, registered claim application (6%)	2 sites (both would be fully protected): an engraving site, an artefacts/scatter and paintings site
Proposed 'Kadji Kadji – Burnerbinmah' National Park	
ex Burnerbinmah	
Badimia People, native title determined not to exist (100%)	3 registered sites (all would be fully protected): including Mongers Lake Waterway (an important site associated with the Beemurra story which shaped the topography of midwestern Western Australia)[A], 3 sites with engravings or paintings, a man-made structure, rockshelter and artefacts scatter.
ex Kadji Kadji	
Southern Yamatji, registered claim application (77%) Widi Mob, registered claim application (23%)	No registered sites
ex Karara	
Southern Yamatji, registered claim application (77%) Widi Mob, registered claim application (23%)	13 sites (12 that would be fully protected, 1 partially): artefact/scatters sites, 2 man-made structures, 3 water sources, the Haul Road rock shelter with paintings, artefacts & archaeological deposits, the lizard granites, a mythological site, hunting place & water source, the Karara ochre quarry.
ex Lochada	
Widi Mob, registered claim application (99%) Southern Yamatji, registered claim application (1%)	4 sites (all would be fully protected): Haul Road stone arrangement, a man-made structure, archeological deposit & hunting place, KML PIC stone arrangement, an important mythological feature, hunting place & water source.
ex Thundelarra	
Badimia People, native title determined not to exist (100%)	No registered sites
ex Warriedar	
Widi Mob, registered claim application (6%) Badimia People, native title determined not to exist (94%)	3 sites (all would be fully protected): a painting site at Warriedar Hill, a man-made structure at Warriedar station.
Proposed 'Woolgorong' National Park	
ex Woolgorong	
Mullewa Wadjari & Wajarri Yamatji (overlapping) registered claim application (75%) Mullewa Wadjari & Wajarri Yamatji & Widi Mob (overlapping), registered claim application (25%)	3 sites (1 that would be fully protected & 2 partially), including an engraving site, 2 artefacts/scatter sites along Melia Creek.

Sources: See technical notes 3 (chapter 2), data current to November 2018.
Notes: A. Vaughan (nd, citing Yamatji Marpla Aboriginal Corporation 2014)

Sunset at Rothsay Minesite located just outside the boundary of ex Karara. Photo: Jason Carter

Lake Moore, adjoining Ninghan Indigenous Protected Area, just to the south of ex Thundelara, and typical of salt lakes in the area. Photo: Glenn Campbell

8.5 Geology, prospectivity and mining

The Tallering sub-bioregion lies on the Yilgarn Craton, one of the oldest and most stable parts of the earth's surface which formed during the Archaean more than 2.5 billion years ago. The granitic basement is interspersed with a series of mineralisation belts known as greenstones, which protrude as isolated low ranges and hills, and contain volcanic and sedimentary rocks, including banded iron formation (Payne et al., 1998, Markey and Dillon, 2010). These are highly prospective for base and precious metals. All proposed parks in the Tallering group have some form of mining tenure over parts of them.

The following information on the geology, prospectivity and mining-related activity on each property comes from the following sources: Belford (2017) and (DMIRS, 2018a). The extent of existing and proposed mining-related activity is summarised in Tables 8-15, 8-16 and 8-17.

Proposed 'Barnong' National Park

Ex Barnong

This property is underlain by Archean granite and greenstone belt rocks. It is highly prospective for gold, iron and base metals, but there are no known mineral deposits.

Mining activity: There is historic, recent and active gold mining in the south-east section of the property. Existing activity including mining leases and licences for mining-related access roads, pipelines and powerlines cover 2% of the property, and exploration licences cover 35%.

Areas without mining activity: 63% (100,000 hectares) of ex Barnong is free of existing or proposed mining-related activities.

Proposed 'Kadji Kadji – Burnerbinmah' National Park

Ex Burnerbinmah

This property is underlain by Archean granite. It has very low mineral prospectivity and no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Burnerbinmah is free of existing or proposed mining-related activities.

Ex Kadji Kadji

This property is underlain by Archean gniess and granite, which are partly overlain by Cenozoic alluvial and lacustrine valley fill sediments within the Nullewa Lake system. This property has low mineral prospectivity and no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Kadji Kadji is free of existing or proposed mining-related activities.

Ex Karara

This property is predominantly underlain by Archean greenstone belt rocks with lesser granite. The greenstone rocks are highly prospective for gold, iron and base metals, and the area is also of interest for tungsten. There are known deposits of iron and prospects of gold.

Mining activity: There is historic, recent and active gold mining. The eastern half of this property is covered in mineral exploration licences, exploration applications, mining leases and known deposits. The western half has large miscellaneous licences to search for groundwater.

Areas without mining activity: 55% of ex Karara is free of existing mining-related activities. Applications for exploration covering 18% of the property are currently being considered. The southern half of the property is mostly free of existing mining-related activities. There is also a 46,000-hectare area in the north of the property exempt from mining under section 19 of the Mining Act 1978 (DMIRS, 2018c). This area corresponds with part of a priority-1 ecological community, the Blue Hills vegetation complexes on banded ironstone ranges.

Ex Lochada

This property is predominantly underlain by Archean granite. The eastern section is underlain by Archean greenstone rocks highly prospective for gold and iron deposits, and is a long strike for historic, recent and active gold mining.

Mining activity: Almost all of ex Lochada is covered by 2 large miscellaneous licences to search for groundwater. The far eastern section of the property has several active mineral exploration licences and 2 mining leases (M 59/736, M 59/748-I). The remainder of the property has little mining activity. There are 2 small operating pit mines (about 20 hectares each) for gypsum and construction materials in the central south and an application for minerals exploration in the west.

Areas without mining activity: 56% of ex Lochada is free of existing mining-related activities. Applications for exploration covering 2% of the property are currently being considered.

Ex Thundelarra

This property is predominantly underlain by Archean granite. A small part in the north-west is underlain by the southern end of Golden Grove greenstone belt. This part is highly prospective for base metals. In the south-east about 20% of the area is underlain by the Fields Find greenstone belt, which includes some large mafic intrusive bodies. Historic gold mines are common and the area is prospective for gold, iron, base metals and platinoids.

Mining activity: Active exploration licences, prospecting licences and mining leases targeting gold and gemstones cover approximately a third (44,800 hectares) of the southern and western part of the property.

Areas without mining activity: 71% of ex Thundelarra is free of existing or proposed mining-related activities.

Ex Warriedar

This property is underlain by greenstone belt rocks with lesser granite. There is historic, recent and active gold mining. Nearby, there is a known tungsten deposit at Mt Mulgine. The greenstone rocks are highly prospective for gold, iron, base metals and tungsten.

Mining activity: The majority of the property (70%) is covered by mineral exploration licences, and mining leases and licences for mining infrastructure cover 12%, with the largest being for groundwater.

Areas without mining activity: 18% of ex Warriedar is free of existing or proposed mining-related activities. Most of the area free of mining tenements is in the south of the property.

Proposed 'Woolgorong' Conservation Park

Ex Woolgorong

This property is underlain predominantly by Archean granite and gniess with a small linear greenstone belt in the southern area with historic gold mining. The small area of greenstone rocks is prospective for gold, iron and base metals. Located a short distance to the west of this area is a mine for the industrial mineral attapulgite and small lakes in the area may be prospective for this mineral. There are no known mineral deposits.

Mining activity: Two exploration licences (E 59/2232, E 59/2188-I) cover 9% of the south-east corner of ex Woolgorong.

Areas without mining activity: 91% of ex Woolgorong is free of existing or proposed mining-related activities.

A breakaway on ex Warriedar. Breakaways are important geological features in mostly flat landscapes. They are escarpments with a steep debris slope generally only a few metres high (sometimes up to 40 metres), capped by a weathered mantle, and forming a step between tracts of more-level land. Photo: David Blood (DEC)

Table 8-15: Existing mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed 'Barnong' National Park				
ex Barnong	36%	-	36%	2%
Proposed 'Kadji Kadji – Burnerbinmah' National Park				
ex Karara	15%	-	15%	30%
ex Lochada	7%	-	7%	37%
ex Thundelarra	28%	-	28%	1%
ex Warriedar	69%	-	69%	13%
All properties	22%	-	22%	16%
Proposed 'Woolgorong' Conservation Park				
ex Woolgorong	<1%	-	<1%	-

Note: Where mining tenements and titles overlap, only 1 value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

Table 8-16: Applications for mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed 'Barnong' National Park				
ex Barnong	-	-	-	<1%
Proposed 'Kadji Kadji – Burnerbinmah' National Park				
ex Karara	19%	-	19%	-
ex Lochada	2%	-	2%	-
All properties	4%	-	4%	-
Proposed 'Woolgorong' Conservation Park				
ex Woolgorong	<1%	-	<1%	-

Note: Where mining tenements and titles overlap, only 1 value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

Table 8-17: Proposed park areas (%) free of existing mining-related activity

	No mineral mining	No oil & gas mining	Combined
Proposed 'Barnong' National Park			
ex Barnong	62%	100%	62%%
Proposed 'Kadji Kadji – Burnerbinmah' National Park			
ex Burnerbinmah	100%	100%	100%
ex Kadji Kadji	100%	100%	100%
ex Karara	55%	100%	55%
ex Lochada	56%	100%	56%
ex Thundelarra	70%	100%	70%
ex Warriedar	18%	100%	18%
All properties	61%	100%	61%
Proposed 'Woolgorong' Conservation Park			
ex Woolgorong	91%	100%	91%

Source: See technical notes 4 (chapter 2).

8.6 Recommendations

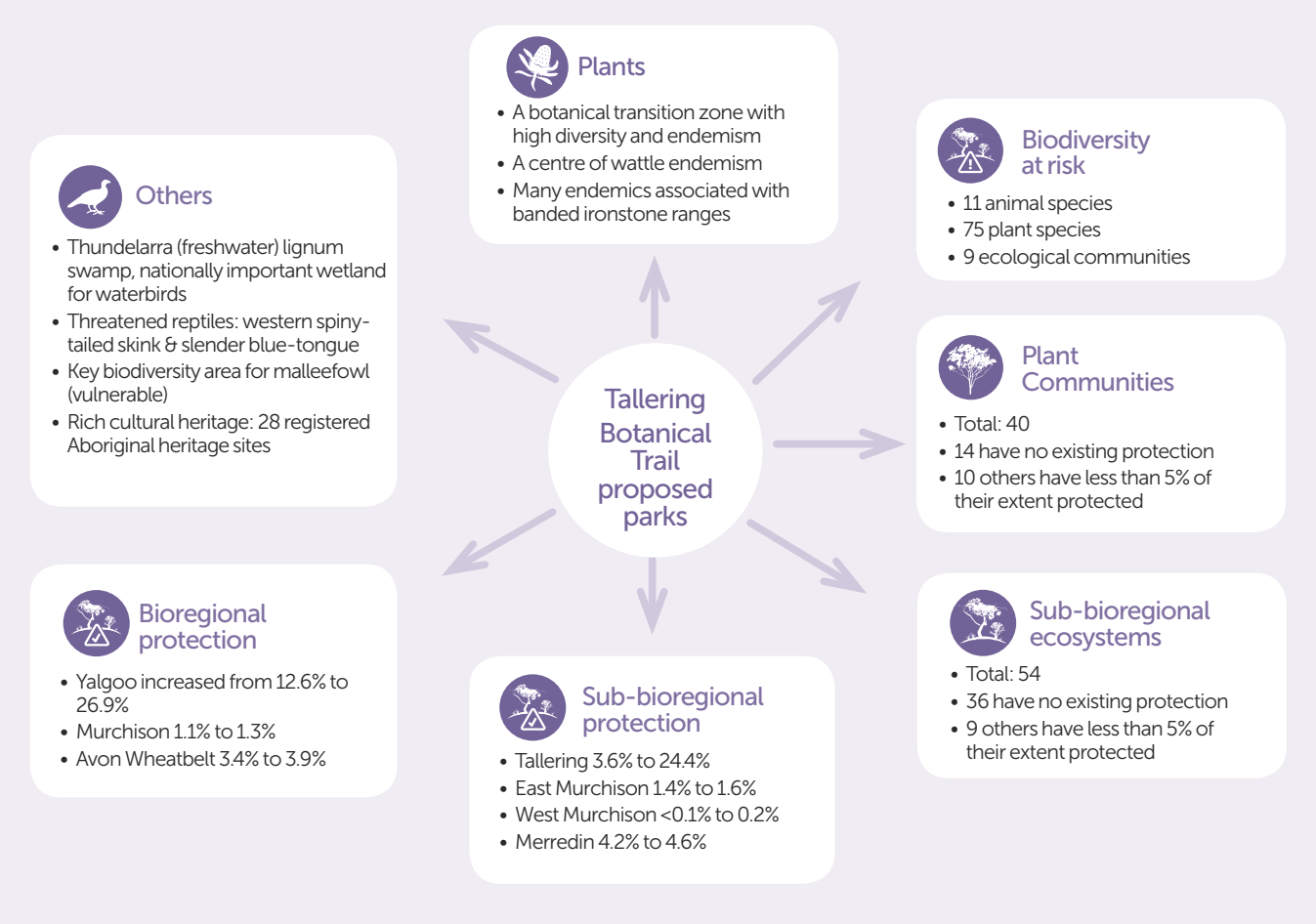
The proposal to create 2 new national parks and 1 new conservation park would add 817,000 hectares to the conservation reserve system and improve protection for a region with outstanding botanical values. The proposed parks would protect a nationally important wetland, 9 priority ecological communities, 86 threatened and priority species, and 14 plant communities and 36 sub-bioregional ecosystems lacking any representation in existing reserves (Figure 8-4).

The parks would substantially improve protection of the Tallering sub-bioregion, meeting the international benchmark for protection (17%) by increasing the extent in reserves from 2% to 24%. They would enable Western Australia to meet the minimum protection target of 15% for 10 plant communities and 24 sub-bioregional ecosystems.

The recommendations below are mainly consistent with the intentions of the Western Australian government indicated in the 2016 Collaborative Australian Protected Areas Database (CAPAD, 2017).

Native title claims are still being assessed on most properties, but native title was determined to not exist on ex Burnerbinmah, ex Thundelarra and most of ex Warriedar.The parks would protect 28 registered Aboriginal heritage sites.

Figure 8-4: Some combined values of the proposed parks



Recommendation 8-1

> Declare ex Burnerbinmah, ex Thundelarra, ex Warriedar, ex Karara, ex Lochada and ex Kadji Kadji as a Class A national park. Incorporate the adjacent timber reserves.

Conservation considerations

This proposed national park would add 533,000 hectares (568,000 with timber reserves) to the conservation reserve system. It features outstanding plant diversity, with almost 900 plant species recorded, and many rare and unique plants and ecological communities. Many of the rare plants are on ranges with banded ironstone formation, thought to be refugial habitats of great antiquity as well as areas of speciation. Wattle diversity is high, and the proposed park is part of a centre of wattle endemism. The park would protect a nationally important freshwater wetland, Thundelarra lignum swamp, as well as part of the regionally significant wetland Mongers Lake, and many other salt lakes, soaks and springs. It harbours 5 listed priority ecological communities, including 3 communities associated with banded ironstone ranges, 63 threatened and priority plant species, and 8 threatened and priority animal species. Part of the proposed park is a key biodiversity area listed due to a significant malleefowl population.

The values of this proposed park – particularly the nationally important wetland, 3 priority-1 ecological communities, 1 nationally critically endangered ecological community, 27 threatened and priority-1 species, and the very high plant diversity – are of national significance, warranting protection as a Class A national park. The proposed park would also make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. In particular, it would add 12.9% of the Tallering sub-bioregion (with less than 4% in existing reserves) and 8.9% of the Yalgoo bioregion (with less than 13% in existing reserves) to the reserve system, and protect 36 sub-bioregional ecosystems with little to no current representation in the reserve system. It is critically important for protecting 1 plant community and 3 sub-bioregional ecosystems. It would enable Western Australia to meet the 2020 international benchmark of 17% protection for both the Tallering sub-bioregion and Yalgoo bioregion.

We recommend the 2 timber reserves surrounding ex Kadji Kadji be included in the proposed park as an important link in a substantial wildlife corridor, to improve the integrity of the park and to protect a critically endangered ecological community and 6 threatened and priority plants and animals. One timber reserve contains most of the Western Australian Wheatbelt eucalypt woodland community listed nationally as critically endangered.

The native title parties of this proposed park are the Southern Yamatji, Widi Mob and Mullewa Wadjari Community, whose consent would be required for any tenure changes. While the Badimia People's claim to the 3 eastern-most properties concluded in a determination that native title did not exist, their interest in these properties remains strong. Twenty-four registered Aboriginal heritage sites would be protected.

Mining considerations

The proposed park has 325,000 hectares (61%) free of existing mining-related activities, mostly in the east and west.

In the east, ex Burnerbinmah and 70% of the adjacent ex Thundelarra have very low mineral prospectivity and no tenements. About 2000 hectares (1%) of ex Thundelarra has mining leases for gemstones and gold and 28% has mineral exploration licenses.

In the west, ex Kadji Kadji, most of the adjacent timber reserve and the western parts of ex Lochada and ex Karara have no mining tenements. Part of ex Karara is exempt from mining under Section 19 of the Mining Act (DMIRS, 2018c). Two large licences for groundwater extraction constitute most of the mining tenements on ex Lochada.

The highest prospectivity and mining-related activity are in the centre of the proposed park, corresponding with the Warriedar greenstone belt and very high conservation values.

Of 186 granted tenements on the proposed park, 87% were granted after the properties were acquired for conservation. Mining and mining infrastructure leases overlay 16% of the proposed park and exploration licences overlay 22%. There are exploration applications over 4% of the area. These tenements overlap very high value conservation features including 3 priority-1 ecological communities associated with banded ironstone formations, a key biodiversity area for malleefowl, many threatened and priority flora and fauna, and a sub-bioregional ecosystem not found elsewhere.

Applications for new exploration licenses or the continuation of permitted exploration activities should be subject to assessment by the Environmental Protection Authority. Any new approvals for mining operations on existing leases, or for groundwater extraction using existing licenses, should also be subject to the highest level of assessment by the Environmental Protection Authority. Existing operations and approvals should be reviewed and, if necessary, further conditions applied to ensure that the natural values for which the properties were acquired are not compromised.

Recommendation 8-2

Declare ex Barnong as a Class A national park.

Conservation considerations

This proposed park would add 168,000 hectares to the conservation reserve system and protect an area with high botanical values. The park would protect part of the catchment area for the Salt River, 2 priority-1 calcrete groundwater communities, 2 priority-1 vegetation complexes associated with ironstone ranges, 9 threatened and priority plant species and 6 threatened and priority animal species.

The values of this proposed park – particularly 4 priority-1 ecological communities and 4 threatened and priority-1 species – are of national significance, warranting protection in a Class A reserve. The proposed park would also make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. It would add 4.8% of the Tallering sub-bioregion (with less than 4% in existing reserves) and 3.3% of the Yalgoo bioregion (with less than 13% in existing reserves) to the reserve system, and protect 15 sub-bioregional ecosystems with little to no current representation in the reserve system. It is critically important for the protection of 1 sub-bioregional ecosystem.

The native title parties of this proposed park are the Southern Yamatji, Widi Mob and Mullewa Wadjari Community, whose consent would be required for any tenure changes. Two registered Aboriginal heritage sites would be protected. Salt River and the Burra Lakes are sacred sites rich in Aboriginal heritage.

Mining considerations

The majority (63%) of ex Barnong is free of existing or proposed mining-related activities. Mining leases and licences for mining-related infrastructure cover 2% of the property. Six tenements overlap the Gullewa vegetation complexes (banded ironstone formation), a priority-1 ecological community. Ideally, the government would seek alternative arrangements for any critical infrastructure needs so that these tenements can be voluntarily surrendered; otherwise, conditions should be applied to ensure that operations are consistent with maintaining the values of the park.

The 35% of ex Barnong subject to exploration licences overlaps some of the property's most species-rich areas including Mugga Mugga Hill, Mardaburia Hill and Buddadoo Range. They also correspond with 4 priority ecological communities, known locations for malleefowl and many threatened and priority plants. Upon declaration of the Class A national park, written consent of the Minister for Mines would be required for the exploration activities to continue. This consent, should, in the public interest, not be granted.

Recommendation 8-3

Declare ex Woolgorong as a Class A conservation park

Conservation considerations

This proposed park would add 116,000 hectares to the conservation reserve system and protect an area with significant botanical values as well as part of the catchment area for the Murchison and Greenough rivers. It would protect 13 priority plant species and 4 threatened and priority animal species, including the malleefowl (vulnerable) and the western spiny-tailed skink (vulnerable). It would provide the first protection in the reserve system for 3 plant communities and 6 sub-bioregional ecosystems.

The values of this proposed park, including 3 threatened and priority-1 species, are of regional significance, warranting protection as a conservation park. The proposed park would make a significant contribution to Western Australia's conservation reserve system, warranting Class A status. In particular, it would add 3.1% of the Tallering sub-bioregion (with less than 4% in existing reserves) and 2.1% of the Yalgoo bioregion (with less than 13% in existing reserves) to the reserve system, and protect 8 sub-bioregional ecosystems with little to no current representation in the reserve system.

The native title parties of this proposed park are the Mullewa Wadjari & Wajarri Yamatji, whose consent would be required for the new park. Three registered Aboriginal heritage sites would be protected.

Mining considerations

Ex Woolgorong is 91% free of existing and proposed mining-related activity and has low prospectivity other than a small greenstone belt in the southern area with historic gold mining. Two exploration licences span 10,000 hectares (9%) of ex Woolgorong in its south-east corner. Applications for new exploration licenses or the continuation of permitted exploration activities should be subject to assessment by the Environmental Protection Authority to ensure operations are consistent with maintaining the values of the park.

9 Mid West Mulga Country

This landscape, dominated by mulga, is typical of the Mid West. Photo: Simon Nevill

9.1 At a glance

Proposed parks

Table 9-1: Former leasehold properties acquired for conservation

Property*	Year Acquired	Size (Hectares)	Traditional Owners (native title parties)
ex Cobra	2000	136,000	Wajarri Yamatji (86%), Gnulli (8%), Thiin-Mah Warriyangka, Tharrkari, Jiwarli (6%)
ex Dalgaranga	2006	102,000	Wajarri Yamatji (100%)
ex Dalgety Downs	1999	101,000	Wajarri Yamatji (100%)
ex Doolgunna	2001	189,000	Yugunga-Nya People (58%), Nharnuwangga (42%)
ex Lakeside	2009	52,000	Wajarri Yamatji (51%), Yugunga-Nya People (15%)
ex Mooloogool	1999	402,000	Yugunga-Nya People (100%)
ex Mt Phillip	2000	114,000	Wajarri Yamatji (100%)
ex Narloo	2001	15,000	Mullewa Wadjari Community & Wajarri Yamatji (100%, overlapping claims)
ex Noongal	2006	48,000	Wajarri Yamatji (100%)
ex Twin Peaks	2002	27,000	Mullewa Wadjari Community & Wajarri Yamatji (100%, overlapping claims)
ex Waldburg	1999	253,000	Nharnuwangga (43%), Wajarri Yamatji (57%)
ex Wanna	2003	289,000	Thiin-Mah Warriyangka, Tharrkari, Jiwarli (29%), Jurruru People (66%), Wajarri Yamatji (3%)
ex Yuin	2002	60,000	Mullewa Wadjari Community & Wajarri Yamatji (69%, overlapping claims), Mullewa Wadjari Community, Wajarri Yamatji & Widi Mob (31%, overlapping claims)

*The current tenure of all properties is unallocated Crown land.

Natural highlights

Richly diverse in mulgas and other wattles

56 threatened and priority species including malleefowl and long-tailed dunnart

Spectacular scenery – rugged ranges, granite inselbergs, inland rivers

High reptile diversity including a unique form of the nationally endangered western spiny-tailed skink

39 ecosystems and 10 plant communities with no protection in existing reserves

Greatly improved protection of the Gascoyne and Murchison bioregions

Progress towards the 2020 international benchmark for protection

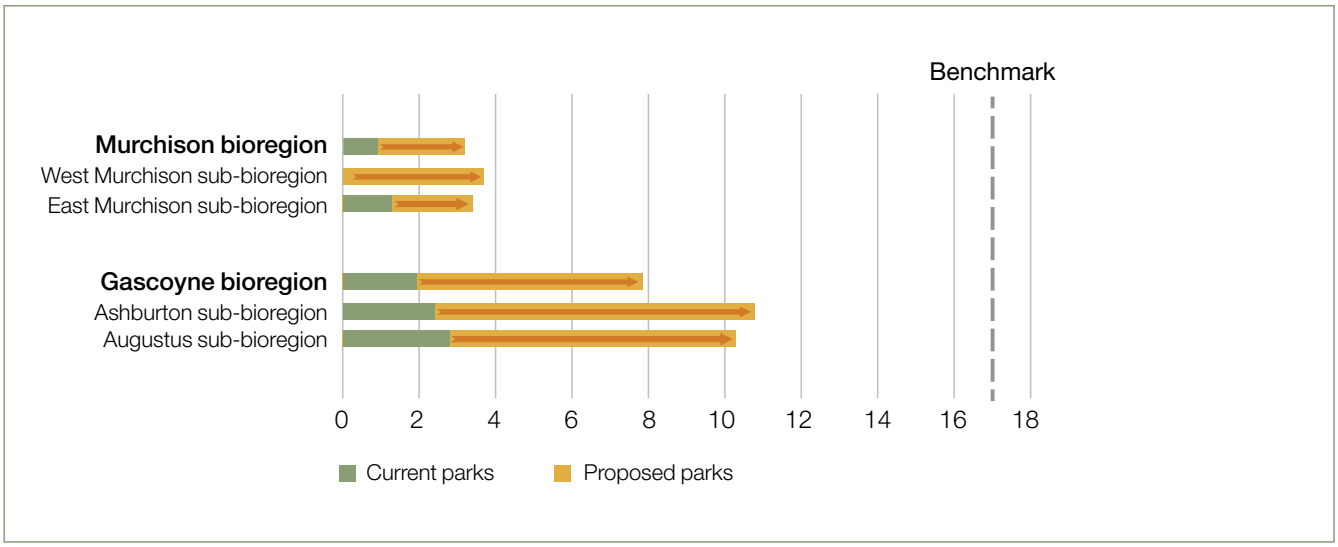


Figure 9-1: The potential increase in protection (% area) due to the proposed parks in bioregions and sub-bioregions where substantial progress can be made towards the international benchmark of 17%.

Reserve recommendations

Table 9-2: Proposed parks

Property	Recommended Protection	Recommended Classification
ex Twin Peaks, ex Narloo, ex Yuin	Create a new conservation park	Class A
ex Dalgaranga, ex Noongal, ex Lakeside	Create a new national park	Class A
ex Mooloogool, ex Doolgunna	Create a new national park	Class A
ex Cobra, ex Waldburg, ex Mt Phillip, ex Dalgety Downs	Expand Mount Augustus National Park	Class A
ex Wanna	Create a new conservation park	Class A

Ex Waldburg, part of the proposed additions to Mount Augustus National Park. Photo: Samille Mitchell (DEC)

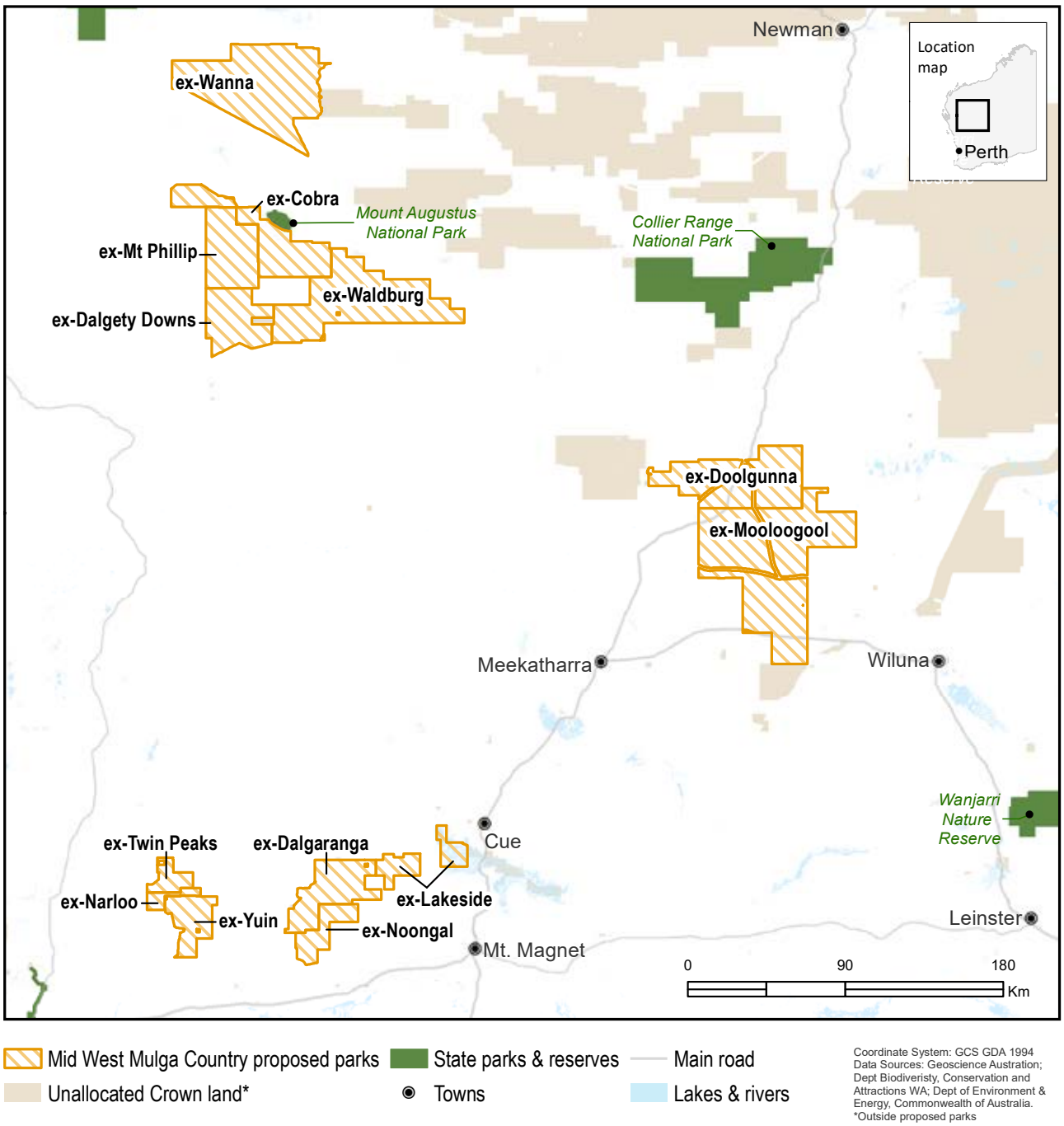


Figure 9-2: The proposed parks of 'Mid West Mulga Country'

9.2 Natural values for conservation

The arid landscapes of the Mid West Mulga Country feature vast low woodlands of mulga and other wattles, with rugged ranges, tors and hills of rock that can be billions of years old. The rivers flow intermittently, but often have refugial spring-fed waterholes. Some ancient river valleys are barely discernable now, blocked by sediments due to much drier times, but their past is evident still in salt lakes that fill occasionally and subterranean calcretes that harbour unique communities of invertebrates adapted to life in the dark. The resources for wildlife above ground fluctuate wildly, depending on rain that falls erratically. The mulgas and related wattles that dominate the landscape are proficient at surviving dry times and responding quickly when rain falls (see Box 9-1).

The 13 properties reviewed here were bought under the Gascoyne-Murchison Strategy by the state government (with contributions from the federal government) to add to the reserve system. Although most were acquired more than 15 years ago, they remain as unallocated Crown land. As such, they lack the legal protections requiring assessment of the impact of new projects on the natural and cultural values for which they were acquired. Formal responsibility, but not full resourcing, for property management lies with the Department of Biodiversity, Conservation and Attractions.

The proposals to create 4 new parks and expand Mount Augustus National Park offer the opportunity to protect 10 plant communities not currently represented in the reserve system as well as 9 listed priority ecological communities and a large salt lake (Lake Austin) important for waterbirds and saltmarsh birds. The proposed parks are also important for protecting rare species such as the western spiny-tailed skink. Fifty-six threatened and priority species are known from the properties: 14 animal and 42 plant species.

The parks would add almost 1.8 million hectares to the conservation reserve system, substantially increasing representation of the Ashburton, Augustus, East Murchison and West Murchison sub-bioregions, each with less than 3% of their extent currently protected.

Here, in 5 subsections corresponding with the recommendations in section 9.6 and the map in Figure 9-2, we describe the natural values of these 13 former leasehold properties acquired for conservation.

Tabletop hills on ex Wanna, part of the proposed 'Wanna' Conservation Park. Photo: David Blood (DEC)

Box 9-1: Mulga – no longer just *Acacia aneura*

Mulga woodlands characterise much of the Australian Outback, occurring across about a fifth of the continent – mainly in arid areas where rainfall averages 200 to 300 mm a year. In Western Australia, mulga is extensive in the Murchison, Gascoyne, southern Pilbara, Gibson Desert and Central Ranges bioregions.

A Western Australian project called *Understanding Mulga*, started in 2006, has resulted in a different understanding of mulga. It has shown that mulga is a large, highly variable species complex, comprising at least 15 species in Western Australia, with many newly described as a result of this project. Features that vary include their growth form (some are tall and single-stemmed while others are short, bushy and multi-stemmed), their foliage (some have a silver crown; others are grey or green) and the shape of their phyllodes (the leaf stalks that function as leaves) varies from linear to round. Across Australia there appears to be an east-to-west gradient in mulga diversity, with the Murchison bioregion in Western Australia having the greatest number of species.

Within arid landscapes, mulga tends to grow most commonly on plains that receive additional water by run-off from hills, ranges or upslope. If this run-off is disrupted, dense stands collapse.

With phyllodes held vertically, mulga also minimises heat absorption and water loss, and channels water to its roots – in this way, 25 mm of rainfall can be concentrated into 140 mm within the root zone. The phyllodes are hairy, resinous and dormant during drought, resuming growth within a few days after rain. Under such constraints, mulga grows slowly but can be long-lived, with age estimates from 200 to 300 years.

Mulga is highly vulnerable to fire, often succumbing to even cool burns. In areas such as the Pilbara and the central deserts, much of the mulga has been replaced by spinifex communities due to altered fire regimes.

This can be detrimental to biodiversity, for mulga is ecologically and functionally important. It plays an important role in arid landscapes capturing and distributing nutrients and water, and some species are found only or mainly in mulga systems. For example, 18 birds are 'core' species while more than 50 others use mulga when conditions are favourable.

Mulga is also an important resource for humans. Its hard, dense wood and resins have been used to make Aboriginal weapons and tools. A fruit-like structure, known as mulga apple, which is actually a wasp gall, is eaten. Mulga is also a significant part of the diet of sheep (although not very nutritious).

Sources: Miller et al. (2002), Williams (2002), Maslin and Reid (2012)

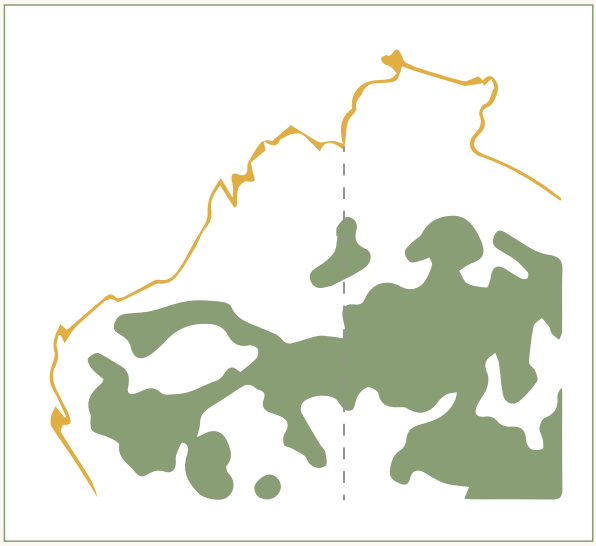


Figure 9-3: Mulga woodlands of Western Australia (recreated from Miller et al., 2002)

Seed pods (top) and flowers (bottom) of mulga (*Acacia aneura*). Photos: Russell Cumming

Open mulga country with flowering mulla mulla (*Ptilotus helipteroides*). Photo: David Blood (DEC)

9.2.1 Proposed 'Twin Peaks – Yuin' Conservation Park

Former leasehold properties: ex Twin Peaks, ex Narloo, ex Yuin

These 3 properties (102,000 hectares) offer the opportunity to protect the headwater catchments of 2 river systems, 4 threatened and priority species, and 3 plant communities lacking representation in the reserve system.

The proposed park lies in the headwater catchments for the Greenough and Murchison river systems, both of which flow intermittently. The Greenough River lies in a valley between ranges on Ex Yuin and ex Narloo. It has many springs and permanent waterholes and is a sacred Aboriginal heritage site (section 9.4). McNab Creek, which flows into the Sanford River, which then joins the Murchison River, starts on ex Twin Peaks.

With rivers, granite hills and ranges, as well as wash plains, stony plains, sand plains and river plains, the landscape is varied and has high scenic qualities. Granite inselbergs such as Poondarrie Hill, Beedeianna Hill and Poona Hill are prominent landmarks and function as drought refugia for plants and animals.

Five plant communities are represented on the property (Table 9-3). Much of the area is covered in mulga woodlands, and there are also shrublands dominated by other wattles such as miniritchie and bowgada, as well as saltbushes and bluebushes. Extensive areas of miniritchie-dominated communities need management of feral herbivores (such as rabbits and goats) to recover, for they only regenerate in the absence of grazing (Kendrick and McKenzie, 2001). Three of the plant communities and 7 of 9 sub-bioregional ecosystems on this proposed park have no protection in existing reserves (Table 9-3, Table 9-5).

The western sections of ex Narloo and ex Yuin are in the transition zone of the South West floristic zone (in the Tallering sub-bioregion), so may have higher floristic values than currently indicated. Three priority plant species are known from these properties (Table 9-4).

The threatened western spiny-tailed skink (*Egernia stokesii badia*), listed as vulnerable, is recorded on ex Twin Peaks (Table 9-4). This is a distinctive black form found only in granite outcrops and lateritic breakaways in the Cue-Yalgoo-Mt Magnet region, and its taxonomy is not yet resolved (Pearson, 2012) (see Box 9-2).

Poondarrie Hill on ex Narloo, part of the proposed 'Twin Peaks – Yuin' Conservation Park. Photo: David Blood (DEC)

Box 9-2: The highly social western spiny-tailed skink

Australia has some of the world's most social reptiles and among the most social of all is *Egernia stokesii*, known in Western Australia as the spiny-tailed skink. It lives in stable family groups of up to 17 members. Group living in reptiles is unusual, recorded in less than 1% of species. Why some animals do and others don't is a major question in evolutionary biology.

Egernia stokesii is a large lizard – about 18 centimetres from snout to vent – patchily distributed across semi-arid Australia. It is a species complex, likely to be split in future into further species or subspecies. A current Western Australian subspecies, *Egernia stokesii badia*, known as the western spiny-tailed skink, is listed as endangered under federal law and vulnerable in Western Australia. There is also an unnamed black form in the Cue-Yalgoo-Mt Magnet region, including on properties proposed as parks here, which could be a different taxa.

The black form lives on granite outcrops and ironstone breakaways, sheltering in horizontal crevices. It may have become isolated from other populations around 2 million years ago due to fire, increasing aridity and the disappearance of habitat. The western subspecies, occurring in the Yalgoo and Geraldton Sandplains regions and probably around Shark Bay, lives in logs and stumps, as well as in human-created habitat such as abandoned buildings and building rubble. Clearing for agriculture has destroyed much of its habitat, which has also been fragmented and degraded.

Spiny-tailed skink mates are typically monogamous. The young are born live and may live for several years with their parents and siblings. They recognise their kin and group members – presumably by smell – and use communal faecal middens outside their crevices, probably as a territorial signal. These skinks can live more than 25 years (in captivity at least).

The benefits of group living include predator avoidance. Individuals basking alone spend more time watching for predators and detect them later than those who bask in groups. However, a downside of group-living is transmission of parasites – they often have higher parasite loads.

Sources: Gardner et al. (2016), Pearson (2016), Pearson (2012)

The 2 forms of the western spiny-tailed skink (*Egernia stokesii badia*) – the black form, found only in the Cue-Yalgoo-Mt Magnet region, and the more widespread brown form. Photos: Terrestrial Ecosystems (left), Jordan Vos (right)

Table 9-3: Summary of conservation values of the proposed 'Twin Peaks – Yuin' Conservation Park

ex Narloo (15,000 hectares)	
Plant communities	3 communities: 2 with 0% representation in existing reserves, 1 other with <5%.
Sub-bioregional ecosystems	6 ecosystems: 5 with 0% representation in existing reserves, 1 other with <5%.

Table 9-3 (continued)

ex Twin Peaks (27,000 hectares)	
Threatened & priority plants	1 species.
Threatened & priority animals	1 reptile species.
Plant communities	4 communities: 2 with 0% representation in existing reserves, 1 other with <5%.
Sub-bioregional ecosystems	6 ecosystems: 5 with 0% representation in existing reserves, 1 other with <5%.

ex Yuin (60,000 hectares)	
Threatened & priority plants	2 species.
Plant communities	4 communities: 3 with 0% representation in existing reserves, 1 other with <5%.
Sub-bioregional ecosystems	8 ecosystems: 7 with 0% representation in existing reserves, 1 other with <5%.

All properties (102,000 hectares)	
Threatened & priority plants	3 species.
Threatened & priority animals	1 reptile species.
Plant communities	5 communities: 3 with 0% representation in existing reserves, 1 other <5%.
Sub-bioregional ecosystems	9 ecosystems: 7 with 0% representation in existing reserves, 2 other with <5%.

Sources: See technical notes 1 and 2 (chapter 2).

Table 9-4: Threatened and priority species of the proposed 'Twin Peaks – Yuin' Conservation Park

Species	Conservation class	ex Twin Peaks	ex Yuin
Reptiles			
Western spiny-tailed skink (*Egernia stokesii badia*)	Vulnerable	●	
Plants			
Dicrastylis linearifolia	Priority 3	●	
Lepidium scandens	Priority 3		●
Sporobolus blakei	Priority 3		●

Sources: See technical notes 1 (chapter 2).

Table 9-5: The extent of protection (%) in the proposed 'Twin Peaks – Yuin' Conservation Park for plant communities with inadequate representation in existing reserves

Plant communities	ex Twin Peaks	ex Narloo	ex Yuin
No protection (<0.1%) in existing reserves			
VT 240 Succulent steppe with open scrub; scattered *Acaica sclerosperma* & bowgada over saltbush & bluebush			1.4
VT 326 Low woodland over scrub; mulga over bowgada & minnieritchie scrub	2.2	1.1	4.1
VT 404 Shrublands; bowgada & *Acacia murrayana* scrub	1.4	0.8	1.2
Little protection (0.1 to 5%) in existing reserves			
VT 2081 Shrublands; bowgada and associated spp. scrub	<0.1		

Source: See technical notes 2 (chapter 2).

9.2.2 Proposed 'Noongal – Lakeside' National Park

Former leasehold properties: ex Noongal, ex Dalgaranga, ex Lakeside

These 3 properties (202,000 hectares) offer the opportunity to protect a large salt lake important for birds, 2 priority ecological communities, 18 threatened and priority species, and 7 plant communities lacking representation in the reserve system.

This proposed park has diverse and interesting landscapes. Ex Lakeside features a large salt lake and surrounding saline plains, extensive sandplains, granite tor fields and mountains of greenstone and meta-sediments (Mount Farmer and Mount Charles). A prominent landmark, on ex Dalgaranga, is Dalgaranga Hill, a rare outcrop of gabbro, which is a dark basalt-like rock usually found in the deep oceanic crust. This hill has a small meteorite crater (24 metres wide, 4.5 metres deep) that is the only confirmed crater on Earth formed by a mesosiderite projectile, a stony-iron meteorite probably created by a collision between metal-rich and silicate-rich asteroids (Hamacher and O'Neill, 2013, Center for Meteorite Studies, nd). This site is recognised for its global significance on the Western Australian geological heritage register (DMIRS, 2017).

The diversity of the proposed park is indicated by the 13 plant communities represented – there are woodlands and shrublands dominated by mulga and other wattles, saltbush, bluebush and samphire shrublands and spinifex grasslands. The proposed park lies in a transition zone between miniritchie-dominated shrublands and spinifex grasslands. Most of its plant communities are poorly protected – 7 have no protection and 2 others have less than 5% in existing reserves (Table 9-6, Table 9-8). Similarly, 16 of 20 sub-bioregional ecosystems have no existing protection and the others have less than 5% protected. One ecosystem would be protected in its entirety and 67% of another would be protected. The extensive areas of miniritchie-dominated communities need management of feral herbivores, for they only regenerate in the absence of grazing (Kendrick and McKenzie, 2001).

The proposed park would increase security for 2 priority-1 ecological communities. Underlying the eastern part of ex Lakeside is part of the Lake Austin calcrete groundwater assemblage type on Murchison palaeodrainage, and on ex Dalgaranga is part of the Gabyon calcrete groundwater assemblage type on Moore palaeodrainage. These invertebrate communities are likely to include species unique to a single calcrete. The communities are poorly known, with many undescribed species, and threatened by mining (see Box 7-3).

Lake Austin is a large salt lake (77,000 hectares) with extensive areas of fringing saltmarsh (van Etten and Vellekoop, 2009). It is thought to be in an endorheic (inward-draining) basin, as the final destination of surface water and groundwater discharge in the catchment (Curry et al., 1994). The lake bed is flat, variably salt-crusted, and dry most of the time. It floods about once a decade, and fills to some extent about 3 times a decade (van Etten and Vellekoop, 2009). Lake Austin played a role in the scientific debate during the early 1900s about the origins of Western Australia's salt lakes. As recounted by Browne (1934), the theory by prominent geologist John Gregory that at least some were 'remnants of dismembered river-systems' was confirmed during exceptionally heavy floods in 1921 when 'former river-systems were moved to rise from the dead, as it were, and, with rushing waters ... to trace out once more their long-deserted paths to the sea'. The waters of Lake Austin formed a wide stream that 'swept down an old valley to Yarra Yarra Lake' and 'thence by way of the Arrowsmith River to the Indian Ocean'.

Lake Austin is important for waterbirds. Birds recorded include the grey teal, greenshank, red-necked stint, red-necked avocet, gull-billed tern, whiskered tern, bar-tailed godwit (Storr, 1985) (Table 9-6). Also recorded near the lake, but not since 1903, is the western grasswren (a priority species) found in the Shark Bay region but presumed to be locally extinct. The night parrot holotype (the specimen upon which a species' scientific name and description are based) was collected near the western end of Lake Austin in 1854 by the Austin expedition (Storr, 1985). Since then, there have been only a few unconfirmed reports of this critically endangered bird in the region. The orange chat and white-winged fairy-wren are 2 birds favouring the saltmarshes that surround Lake Austin.

Other threatened species recorded on the properties include the black-flanked rock-wallaby (endangered), the western spiny-tailed skink (vulnerable) (see Box 9-2) and the shield-backed trapdoor spider (vulnerable) (Table 9-7). Whether the rock-wallaby survives on ex Lakeside is uncertain – searches have failed to find it, but the species can be hard to find, as shown at Kalbarri National Park, where it was rediscovered in 2015 after more than 20 years of searching (Pearson, 2016).

Ex Dalgaranga and ex Lakeside have 2 of the largest populations (of 10 known) of the trapdoor spider. Most other populations are under pressure from mining or impacted by habitat fragmentation (DoE, 2018). Another listed species is the fairy shrimp, *Branchinella wellardi* (priority 1), known from very few sites, which is found in temporary pools on ex Dalgaranga (see Box 9-3).

Birds of Lake Austin (clockwise from top left) include the bar-tailed godwit (*Limosa lapponica*), common greenshank (*Tringa nebularia*), red-necked stint (*Calidris ruficollis*) and red-necked avocet (*Recurvirostra novaehollandiae*). Photos: Fred Coles

Box 9-3: Fairy shrimp – first, fast and fantastically fecund

As Australia has dried out over the 40 million years since breaking from Antarctica, new opportunities have opened up for freshwater shrimp (branchiopod) species. When most of the continent was wet and covered in rainforest, their options were limited for they cannot survive in the same waters as fish, which eat them. But as large swathes of Australia turned into savannas and deserts, and temporary (therefore fishless) waterbodies like ephemeral lakes, ponds, claypans and saltpans proliferated, branchiopods gained many new habitats. Unlike most aquatic animals, they can survive dry periods as dormant eggs. Some are also tolerant of salinity.

Now, Western Australia is the world centre for diversity of fairy shrimps, as well as other inland crustaceans such as brine shrimps and ostracods. Of 42 known Australian fairy shrimp species, 25 occur in Western Australia, 14 unique to the state. Five are listed as priority fauna.

Branchinella wellardi, the fairy shrimp (priority 1) recorded on ex Dalgaranga, has both eastern and western members, being found in a few sites in the Carnarvon and upper Murchison bioregions, as well as in the Paroo basin in southwest Queensland and northwest New South Wales. Growing to no more than 10 millimetres, it is one of the smaller species (which range up to about 50 mm). It inhabits short-lived turbid or clear pools.

Fairy shrimps are an ancient group of animals that became restricted to temporary or saline habitats after the radiation (during the Mesozoic era) of jawed fishes, which are highly effective predators. Most fairy shrimps are filter feeders on algae and other small particles, and are preyed on by flatworms, beetles and dragonfly larva among others. They sustain their populations by 'developing first [and] fast and by fantastic fecundity' (Timms 2015). Their drought-resistant eggs – with an embryo in an arrested stage of development that can remain viable for many years – hatch 12–48 hours after wetting, and they grow rapidly, some species maturing within 4 days. Once mature, they produce a batch of eggs every day or so. Only a fraction of eggs hatch each filling, a bet-hedging strategy to avoid local extinction if the water evaporates before the shrimps are able to reproduce.

Sources: Pinceel et al. (2013), Timms (2015), Timms (2008)

Red-necked stints, which breed in the Siberian tundra and migrate thousands of kilometres every year to Australia, have been recorded at the proposed 'Noongal – Lakeside' National Park. Inland crustaceans such as fairy shrimps can help fuel their journeys. Photo: Georgina Steytler

Table 9-6: Summary of conservation values of the proposed 'Noongal – Lakeside' National Park

ex Dalgaranga (102,000 hectares)	
Threatened & priority plants	3 species.
Threatened & priority animals	1 bird, 1 reptile, 2 invertebrate species.
Priority ecological communities	1 community: Gabyon calcrete groundwater assemblage type on Moore palaeodrainage (priority 1) (16% of its extent).
Plant communities	9 communities: 4 with 0% representation in existing reserves, 2 others with <5%.
Sub-bioregional ecosystems	9 ecosystems: 9 with 0% representation in existing reserves, 1 other with <5%.

ex Lakeside (52,000 hectares)	
Threatened & priority plants	4 species.
Threatened & priority animals	5 bird, 1 mammal, 1 invertebrate species.
Priority ecological communities	1 community: Lake Austin calcrete groundwater assemblage type on Murchison palaeodrainage (priority 1) (7% of its extent)
Plant communities	8 communities: 4 with 0% representation in existing reserves, 1 other with <5%
Sub-bioregional ecosystems	11 ecosystems: 9 with 0% representation in existing reserves, 2 others with <5%. Very important for 1 ecosystem (a bowgada & Acacia murrayana shrubland in East Murchison) (67% of its extent).

ex Noongal (48,000 hectares)	
Threatened & priority animals	1 bird species.
Plant communities	9 communities: 5 with 0% representation in existing reserves, 2 others with <5%.
Sub-bioregional ecosystems	13 ecosystems: 11 with 0% representation in existing reserves, 2 others with <5%.

All properties (202,000 hectares)	
Threatened & priority plants	7 species.
Threatened & priority animals	7 bird, 1 mammal, 1 reptile, 2 invertebrate species.
Priority ecological communities	2 communities: • Lake Austin calcrete community (priority 1) (7%) • Gabyon calcrete community (priority 1) (16%).
Plant communities	13 communities: 7 with 0% representation in existing reserves, 2 others with <5%.
Sub-bioregional ecosystems	20 ecosystems: 16 with 0% representation in existing reserves, 4 others with <5%. Critical for protection of 1 ecosystem (a bowgada & Acacia quadrimarginea shrubland on stony ridges in West Murchison) (100% of its extent: 53% on ex Dalgaranga, 32% on ex Lakeside, 16% on ex Noongal).

Sources: See technical notes 1 and 2 (chapter 2).

Table 9-7: Threatened and priority species of the proposed 'Noongal – Lakeside' National Park

Species / ecological community	Conservation class	ex Dalgaranga	ex Lakeside	ex Noongal
Mammals				
Black-flanked rock-wallaby, warru (*Petrogale lateralis lateralis*)[A]	Endangered		●	
Birds				
Bar-tailed godwit (*Limosa lapponica baueri & L.l. menzbieri*)	Vulnerable / International agreement		●	
Common greenshank (*Tringa nebularia*)	International agreement		●	
Rainbow bee-eater (*Merops ornatus*)	International agreement	●		
Red-necked stint (*Calidris ruficollis*)[B]	International agreement		#	
White-winged tern (*Chlidonias leucopterus*)	International agreement		●	
Peregrine falcon (*Falco peregrinus*)	Specially protected			●
Reptiles				
Western spiny-tailed skink *(Egernia stokesii badia)*	Vulnerable	●		
Invertebrates				
Fairy shrimp (*Branchinella wellardi*)	Priority 1	●		
Shield-backed trapdoor spider (*Idiosoma nigrum*)	Vulnerable	●	●	
Plants				
Millotia depauperata	Priority 1		●	
Petrophile vana	Priority 1	●		
Psammomoya grandiflora	Priority 2	●		
Atriplex lindleyi subsp. *conduplicata*	Priority 3		●	
Eremophila simulans subsp. *megacalyx*	Priority 3	●		
Petrophile pauciflora	Priority 3		●	
Tecticornia fimbriata	Priority 3		●	
Ecological communities				
Lake Austin calcrete groundwater assemblage type on Murchison palaeodrainage	Priority 1		●	
Gabyon calcrete groundwater assemblage type on Moore palaeodrainage	Priority 1	●		

Sources: See technical notes 1 (chapter 2).

Notes: A. The record for this species is undated and the current status is uncertain. B. Not in the DBCA database, but recorded by Storr (1985).

Table 9-8: Threatened and priority species of the proposed 'Noongal – Lakeside' National Park

Plant communities	ex Dalgaranga	ex Lakeside	ex Noongal
No protection (<0.1%) in existing reserves			
VT 204 Succulent steppe with open scrub; scattered mulga and Acacia sclerosperma over saltbush & bluebush	<0.1		2.4
VT 240 Succulent steppe with open scrub; scattered *Acacia sclerosperma* & bowgada over saltbush & bluebush		2.5	
VT 326 Low woodland over scrub; mulga over bowgada & minnieritchie scrub	2.6		1.6
VT 395 Hummock grasslands, mixed sandplain; bowgada, mallee, heath and spinifex	3.8	9.6	7.1
VT 361 Shrublands; bowgada & minnieritchie scrub with scattered mulga			0.9
VT 404 Shrublands; bowgada & *Acacia murrayana* scrub	7.3	0.7	0.5
VT 1127 Mosaic: Saltbush & bluebush/samphire		17.8	
Little protection (0.1 to 5%) in existing reserves			
VT 18 Low woodland; mulga (*Acacia aneura*)	0.2	0.1	<0.1
VT 420 Shrublands; bowgada & jam scrub	<0.1		1.1
Inadequate protection (5 to 15%) in existing reserves			
VT 39 Shrublands; mulga scrub	0.2	<0.1	
VT 125 Bare areas; salt lakes		0.2	
VT 2081 Shrublands; bowgada and associated spp. scrub	<0.1		0.2

Source: See technical notes 2 (chapter 2).

The specially protected peregrine falcon (*Falco peregrinus*) has been recorded on ex Noongal, ex Doolgunna, ex Mooloogool and ex Cobra.
Photo: Gus Meredith

9.2.3 Proposed 'Doolgunna – Mooloogool' National Park

Former leasehold properties: ex Doolgunna, ex Mooloogool

These properties (591,000 hectares) offer the opportunity to protect 2 priority ecological communities, more than 20 priority species, and a variety of striking landscapes.

Ex Doolgunna and ex Mooloogool are on the Meekatharra Plateau, an ancient eroded landscape topped by undulating plains of sand and alluvium, with old rock protruding in outcrops, mesas and low hills and ranges (Smith et al., 2008, citing DEC 1994). Ex Mooloogool features a part of the Glengarry Range and ex Doolgunna a part of the Robinson Range, as well as Mount Leake and extensive breakaway scarps, caves and natural rock gardens. Mount Leake features a small area of stromatolite fossils of *Eucapsiphora leakensis* (a species known only from this locality), which may be up to 1.8 billion years old (Grey, 1994). The outstanding geology of Mount Leake is recognised by a listing in the Western Australian geological heritage register (DMIRS, 2017). On ex Doolgunna the headwaters of Yandthangunna Creek, a tributary of the intermittently flowing Gascoyne River, have permanent rock pools with fish and turtles. Ghost gums (*Corymbia ferriticola*) line the banks of the south branch of the Gascoyne River.

shrublands, which vary in their structure and association with other species to constitute several different plant communities. There are also spinifex grasslands with scattered mulga and *Eucalyptus kingsmillii*, and shrublands of saltbush and bluebush. Of the 7 plant communities recorded on the proposed park, 2 have no protection in existing reserves and 4 others have less than 5% of their extent protected (Table 9-9, Table 9-11). Twelve of the 16 sub-bioregional ecosystems have no protection in the reserve system and the other 4 have less than 5% protected.

The proposed park would protect 2 priority-1 ecological communities (Table 9-12). The Doolgunna calcrete groundwater assemblage type on Gascoyne palaeodrainage is a community of invertebrates, many probably unique to that calcrete due to their isolation for millions of years from other aquatic communities. They are part of an archipelago of groundwater communities in the Yilgarn region, which together contain the most diverse water beetle assemblage in the world and also, by global standards, a highly diverse crustacean fauna (see Box 7-3). The other priority-1 community is the Robinson Range vegetation complexes on banded ironstone formation. As is typical of ironstone communities, this community differs in composition from those on nearby ironstone ranges (Meissner et al., 2009b) (see Box 7-2).

A tussock grass floodplain with river gum (*Eucalyptus camaldulensis*) over claypan grass (*Eriachne flaccida*) on the south branch of the Gascoyne River, ex-Doolgunna. Photo: David Blood (DEC)

The proposed park would protect 20 priority plant species. The priority-1 species include the mallee *Eucalyptus semota*, restricted to a few populations in the Gascoyne (Macpherson and Grayling, 1996), and 2 *Eremophila* species, one yet to be described. This region is part of a centre of eremophila diversity (Chinnock, 2007) (see Box 8-3).

Two priority mammal species – brush-tailed mulgara and long-tailed dunnart – have been recorded on the properties (Table 9-10). The banded hare wallaby (*Lagostrophus fasciatus fasciatus*) (listed as vulnerable) was last recorded there in 1909, but is now found only on Western Australian islands (Woinarski et al., 2014a, DBCA, 2017d). There are also reminders on the properties of 2 other mammals now gone from the region: nests of the greater stick-nest rat, now restricted to islands and fenced sanctuaries, and burrows of the inland boodie, which is globally extinct (Smith et al., 2008). They have been lost due to predation by feral cats and foxes (Woinarski et al., 2014a).

Bird surveys on the 2 properties have recorded 105 species (Bell et al., 2013). As is typical of mulga woodlands, bird numbers and species vary greatly depending on how wet it has been (Recher and Davis, 2018). Many species – such as budgerigars, cockatiels and zebra finches – are nomads that arrive soon after rain and depart when food resources decline again.

Other mulga birds use a variety of foraging behaviours that differ between years and locations to enable survival in this fluctuating environment. Among the birds recorded are malleefowl (vulnerable) (Table 9-10). The elusive critically endangered night parrot may exist on these properties despite a lack of records. It has been found nesting in the region as recently as 2017 (Jacket et al., 2017) and there have been sightings as close as 100–150 km east of ex Mooloogool on properties with similar habitats (Hamilton et al., 2017).

There is likely to be a high diversity of reptiles on the properties, including the charismatic thorny devil, the perentie (Australia's largest goanna) and the western shield spiny-tailed gecko.

The spinifex hopping mouse (*Notomys alexis*), here on ex Doolgunna, is well adapted to aridity, producing the most concentrated urine of any mammal ever recorded. Photo: Harry Everett (DEC)

Permanent rock pools, like this one known as Fish Holes on ex Doolgunna, are important refuges in the arid eastern Gascoyne region. Photo: David Blood (DEC)

Table 9-9: Summary of conservation values of the proposed 'Doolgunna – Mooloogool' National Park

ex Doolgunna (189,000 hectares)	
Threatened & priority plants	17 species.
Threatened & priority animals	3 bird, 1 mammal species.
Priority ecological communities	2 communities: • Doolgunna calcrete groundwater assemblage type on Gascoyne palaeodrainage on Doolgunna Station (priority 1) (80% of its extent) • Robinson Range vegetation complexes on banded ironstone formation (priority 1) (40% of its extent).
Plant communities	6 communities: 1 with 0% representation in existing reserves, 4 others with <5%.
Sub-bioregional ecosystems	9 ecosystems: 5 with 0% representation in existing reserves, 4 others with <5%.

ex Mooloogool (402,000 hectares)	
Threatened & priority plants	5 species.
Threatened & priority animals	3 bird, 1 mammal species.
Plant communities	7 communities: 2 with 0% representation in existing reserves, 4 others with <5%.
Sub-bioregional ecosystems	14 ecosystems: 11 with 0% representation in existing reserves, 3 others with <5%.

Both properties (591,000 hectares)	
Threatened & priority plants	20 species.
Threatened & priority animals	4 bird, 2 mammal species.
Priority ecological communities	2 priority-1 communities: • Doolgunna calcrete community (80%) • Robinson Range banded ironstone formation community (40%).
Plant communities	7 communities: 2 with 0% representation in existing reserves, 4 others with <5%.
Sub-bioregional ecosystems	16 ecosystems: 12 with 0% representation in existing reserves, 4 others with <5%.

Sources: See technical notes 1 and 2 (chapter 2).

A thorny devil (*Moloch horridus*) on ex Doolgunna.
Photo: Harry Everett (DEC)

Australia's largest goanna, the perentie (*Varanus giganteus*), on ex Mooloogool. Photo: David Blood

Table 9-10: Threatened and priority species of the proposed 'Doolgunna – Mooloogool' National Park

Species / Ecological community	Conservation class	ex Doolgunna	ex Mooloogool
Birds			
Malleefowl (*Leipoa ocellata*)	Vulnerable	●	●
Rainbow bee-eater (*Merops ornatus*)	International agreement	●	
Red-necked stint (*Calidris ruficollis*)	International agreement		●
Peregrine falcon (*Falco peregrinus*)	Specially protected	●	●
Mammals			
Brush-tailed mulgara (*Dasycercus blythi*)	Priority 4		●
Long-tailed dunnart (*Sminthopsis longicaudata*)	Priority 4	●	
Plants			
Eremophila prolata	Priority 1	●	
Eremophila sp. Meekatharra	Priority 1		●
Eucalyptus semota	Priority 1	●	
Euphorbia sarcostemmoides	Priority 1	●	
Rhodanthe sphaerocephala	Priority 1	●	
Indigofera fractiflexa subsp. *augustensis*	Priority 2	●	
Drummondita miniata	Priority 3		●
Gunniopsis propinqua	Priority 3	●	
Hemigenia virescens	Priority 3	●	
Homalocalyx echinulatus	Priority 3	●	
Indigofera gilesii	Priority 3		●
Maireana murrayana	Priority 3	●	
Maireana prosthecochaeta	Priority 3	●	●
Prostanthera ferricola	Priority 3	●	
Ptilotus luteolus	Priority 3	●	
Sida picklesiana	Priority 3	●	
Thryptomene sp. Leinster	Priority 3	●	
Verticordia jamiesonii	Priority 3	●	
Dodonaea amplisemina	Priority 4	●	
Goodenia berringbinensis	Priority 4	●	●
Ecological communities			
Doolgunna calcrete groundwater assemblage type on Gascoyne palaeodrainage on Doolgunna Station	Priority 1	●	
Robinson Range vegetation complexes on banded ironstone formation	Priority 1	●	

Sources: See technical notes 1 (chapter 2).

Euphorbia sarcostemmoides, a semi-succulent shrub, growing here on ex Doolgunna, is classified as priority 1. Photo: David Blood (DEC)

Table 9-11: The extent of protection (%) in the proposed 'Doolgunna – Mooloogool' National Park for plant communities with inadequate representation in existing reserves

Plant communities	ex Doolgunna	ex Mooloogool
No protection (<0.1%) in existing reserves		
VT 166 Low woodland; mulga & *Acacia victoriae*	0.7	0.3
VT 204 Succulent steppe with open scrub; scattered mulga & *Acacia sclerosperma* over saltbush & bluebush		4.3
Little protection (0.1 to 5%) in existing reserves		
VT 18 Low woodland; mulga (*Acacia aneura*)	0.9	0.4
VT 29 Sparse low woodland; mulga, discontinuous in scattered groups	0.8	1.0
VT 107 Hummock grasslands, shrub steppe; mulga and Eucalyptus kingsmillii over hard spinifex	0.7	3.8
VT 202 Shrublands; mulga & *Acacia quadrimarginea* scrub	1.5	3.1
Inadequate protection (5 to 15%) in existing reserves		
VT 39 Shrublands; mulga scrub	0.2	0.2

Source: See technical notes 2 (chapter 2).

This priority-3 plant, *Maireana prosthecochaeta*, found on ex Mt Phillip and ex Dalgety Downs, is able to tolerate salty soils. Photo: David Blood (DEC)

9.2.4 Proposed additions to Mount Augustus National Park

Former leasehold properties: ex Mt Phillip, ex Dalgety Downs, ex Waldburg, ex Cobra

These 4 proposed additions (604,000 hectares) to Mount Augustus National Park offer the opportunity not only to substantially expand that national park but to protect a priority ecological community, 3 plant communities currently lacking representation in the reserve system and 22 threatened and priority species.

Mount Augustus National Park is a small park (9,100 hectares) centred around Burringurrah (Mount Augustus), a large isolated sandstone inselberg that rises some 700 metres above the surrounding stony red sandplain and 'looms as a new Australian icon', commonly compared to Uluru (Bourman et al., 2010). The mountain's rocks consist of sand and gravel deposited by an ancient river system about 1.6 billion years ago (over granite and metamorphic rocks) (PWS, nd-b). These were consolidated and then buried by marine sediments when shallow seas covered the region. Faulting buckled the rocks to their current structure about 900 million years ago, and the marine sedimentary rocks eroded. These eroded sediments now form nearby hills.

Burringurrah, later named Mount Augustus by European explorers, is the geological centerpiece of a national park proposed for significant expansion. Photo: Joanne Wilton

Most of the area is covered in low mulga woodlands or shrublands, which vary in their structure and association with other species to constitute several different plant communities. There are also shrublands dominated by other wattles (*Acacia victoriae,* snakewood, bowgada) and poverty bushes (*Eremophil*a) and cassia (*Senna*). Of 10 plant communities represented on these properties, 3 have no protection in existing reserves and 6 others have less than 5% of their extent currently protected (Table 9-12, Table 9-14). Similarly, 6 of the 10 sub-bioregional ecosystems have no protection in the reserve system and 2 others have less than 5% protected. The new park area would also protect part of the catchment area for the Lyons River, which flows into the Gascoyne river.

The park addition would protect 4 listed priority ecological communities (Table 9-12). The priority-1 Dalgety and Landor calcrete groundwater assemblage type on Gascoyne palaeodrainage hosts unique assemblages of invertebrates, many species of which are likely to be unique to that craton. Calcrete communities are poorly known, with many undescribed species, and threatened by mining (see Box 7-3). The 3 other priority communities are land systems (all priority 3): the Peedawarra (a saline tributary plain drainage system), Bibbingunna (clay flats with crabholes and sluggish drainage) and Diorite (wattle shrublands on basaltic domes and low rough hills) systems (DBCA, 2017a).

These properties harbour 22 threatened and priority species, including the Mt Augustus foxglove (*Pityrodia augustensis*, a small shrub in the mint family) (vulnerable) and, possibly, the black-flanked wallaby (*Petrogale lateralis lateralis*) (endangered) (Table 9-13). Both species occur in rocky areas. While the wallaby has not been sighted at ex Waldburg for a long time, it can be hard to find, as shown at Kalbarri National Park, where the species was located in 2015 after more than 20 years of searching (Pearson, 2016).

The properties have high reptile diversity. The skink *Lerista stictopleura* (known as the Mount Augustus slider) is known only from wattle shrublands around Mount Augustus and the Mount Augustus spiny-tailed gecko (*Strophurus wilsoni*) is known from a slightly larger area in the Gascoyne region (Wilson and Swan, 2013). The gecko is not protected in any reserve.

The desert banded snake (*Simoselaps bertholdi*), here on ex Waldburg, is a burrowing sand-swimmer that preys on small lizards. Photo: Samille Mitchell (DEC)

Table 9-12: Summary of conservation values of the proposed additions to Mount Augustus National Park

ex Cobra (136,000 hectares)	
Threatened & priority plants	8 species.
Threatened & priority animals	3 bird, 1 mammal species.
Priority ecological communities	1 community: Bibbingunna Land System (priority 3) (50% of its extent, 1 of 2 small areas).
Plant communities	8 communities: 1 with 0% representation on existing reserves, 6 others with <5%.
Sub-bioregional ecosystems	8 ecosystems: 4 with 0% representation on existing reserves, 2 others with <5%.
Buffering & connectivity	Extension of Mount Augustus National Park.

ex Dalgety Downs (101,000 hectares)	
Threatened & priority plants	2 species.
Priority ecological communities	1 community: Dalgety and Landor calcrete groundwater assemblage type on Gascoyne palaeodrainage (priority 1) (2% of its extent).
Plant communities	5 communities: 1 with 0% representation in existing reserves, 3 others with <5%.
Sub-bioregional ecosystems	5 ecosystems: 3 with 0% representation on existing reserves, 2 others with <5%.
Buffering & connectivity	Extension of Mount Augustus National Park.

ex Mt Phillip (114,000 hectares)	
Threatened & priority plants	2 species.
Threatened & priority animals	3 bird species.
Plant communities	8 communities: 2 with 0% representation in existing reserves, 5 others with <5%.
Sub-bioregional ecosystems	8 ecosystems: 5 with 0% representation on existing reserves, 2 others with <5%.
Buffering & connectivity	Extension of Mount Augustus National Park.

ex Waldburg (253,000 hectares)	
Threatened & priority plants	5 species.
Threatened & priority animals	2 mammal species.
Priority ecological communities	2 communities: • Peedawarra Land System (priority 3) (100% of its extent) • Diorite Land System (priority 3) (50% of its extent, 1 of 2 small discrete areas)
Plant communities	4 communities: 1 with 0% representation of existing reserves, 2 others with <5%.
Sub-bioregional ecosystems Buffering & connectivity	4 ecosystems: 2 with 0% representation on existing reserves, 2 others with <5%. • Extension of Mount Augustus National Park. • Adjacent to Mount Augustus calcrete community (priority-1) (1% within ex Waldburg, the rest to its north). • Adjacent to Bibbingunna Land System (priority 3) (50%, 1 of 2 discrete areas lies just north of ex Waldburg).

All properties (604,000 hectares)	
Threatened & priority plants	15 species.
Threatened & priority animals	4 bird, 3 mammal species.
Priority ecological communities	4 communities: • Dalgety and Landor calcrete community (priority 1) (2%) • Peedawarra Land System (priority 3) (100%) • Bibbingunna Land System (priority 3) (50%) • Diorite Land System (priority 3) (50%)
Plant communities	10 communities: 3 with 0% representation in existing reserves, 6 others with <5%.
Sub-bioregional ecosystems	10 ecosystems: 6 with 0% representation on existing reserves, 2 others with <5%.

Sources: See technical notes 1 and 2 (chapter 2).

Table 9-13: Threatened and priority species and ecological communities of the proposed additions to Mount Augustus National Park Park

Species / ecological community	Conservation class	Ex Cobra	Ex Mt Phillip	Ex Waldburg	Ex Dalgety Downs
Birds					
Peregrine falcon (*Falco peregrinus*)	Specially protected	●			
Common greenshank (*Tringa nebularia*)	International agreement		●		
Great egret (Ardea modesta)	International agreement	●	●		
Rainbow bee-eater (*Merops ornatus*)	International agreement	●	●		
Mammals					
Black-flanked rock-wallaby, warru (*Petrogale lateralis lateralis*)[A]	Endangered			●	
Long-tailed dunnart (*Sminthopsis longicaudata*)	Priority 4			●	
Western pebble-mound mouse, ngadji (*Pseudomys chapmani*)	Priority 4	●			
Plants					
Pityrodia augustensis	Vulnerable	●	●		
Eremophila rhegos	Priority 1			●	
Acacia petricola	Priority 2	●			
Indigofera fractiflexa subsp. *augustensis*	Priority 2	●			
Rhodanthe frenchii	Priority 2	●			
Schoenus sp. Kalbarri	Priority 2	●			
Stylidium weeliwolli	Priority 2	●			
Wurmbea fluviatilis	Priority 2	●			
Acacia atopa	Priority 3				●
Gunniopsis propinqua	Priority 3			●	
Maireana prosthecochaeta	Priority 3		●		●
Ptilotus crosslandii	Priority 3			●	
Ptilotus luteolus	Priority 3	●			
Goodenia berringbinensis	Priority 4			●	
Ptilotus trichocephalus	Priority 4			●	
Ecological communities					
Dalgety and Landor calcrete groundwater assemblage type on Gascoyne palaeodrainage.	Priority 1				●
Peedawarra Land System	Priority 3			●	
Bibbingunna Land System	Priority 3	●			
Diorite Land System	Priority 3			●	

Sources: See technical notes 1 (chapter 2).

Notes:A The four records for this species are historical, and the current status is uncertain.

Table 9-14: The extent of protection (%) in the proposed additions to Mount Augustus National Park for plant communities with inadequate representation in existing reserves

Plant Communities	Ex Cobra	Ex Mt Phillip	Ex Waldburg	Ex Dalgety Downs
No protection (<0.1%) in existing reserves				
VT 163 Shrublands; eremophila and cassia dwarf scrub		1.4		
VT 166 Low woodland; mulga & *Acacia victoriae*		<0.1		
VT 183 Low woodland; mulga, *Acacia victoriae* & snakewood	4.9	0.6		24.5
Little protection (0.1 to 5%) in existing reserves				
VT 18 Low woodland; mulga (*Acacia aneura*)	0.2	0.1	0.1	0.2
VT 29 Sparse low woodland; mulga, discontinuous in scattered groups	0.3	<0.1	<0.1	0.2
VT 160 Shrublands; snakewood & *Acacia victoriae* scrub	0.5	5.0	5.9	
VT 165 Low woodland; mulga & snakewood (*Acacia eremaea*)	1.7		0.3	
VT 181 Shrublands; mulga & snakewood scrub	1.5		0.6	
VT 182 Low woodland; mulga & bowgada (*Acacia ramulosa*)	0.9			
Inadequate protection (5 to 15%) in existing reserves				
PVT 39 Shrublands; mulga scrub	0.3	0.2	0.1	1.6

Source: See technical notes 2 (chapter 2).

Ex Walburg would add over 250,000 hectares to Western Australia's conservation estate. Photo: Samille Mitchell (DEC)

9.2.5 Proposed 'Wanna' Conservation Park

Former leasehold property: ex Wanna

This property (289,000 hectares) offers the opportunity to protect 5 plant communities with very poor representation in existing reserves and 5 priority species.

Ex Wanna is 50 kilometres north of the proposed Mount Augustus National Park extension, but is in a different sub-bioregion (Ashburton) and contains different plant communities. This is rugged country with granite and quartz ranges, hills, ridges and tors, and stony plains (Kendrick, 2001).

There are chenopod shrublands and spinifex grasslands on plains and calcrete rises. From a range along the southern border of ex Wanna, runoff from most of ex Wanna flows into Irregully Creek and then the Ashburton River. Irregully Creek is a wetland of subregional significance, with permanent springs that serve as watering holes for many species and as refugia (Kendrick, 2001). The range provides spectacular scenery, particularly at Tabletop Hill and Gregory's Gap.

Most of the area is covered in low mulga woodlands or shrublands, which vary in their structure and association with other species to constitute several different plant communities. There are also shrublands dominated by other wattles (snakewood, *Acacia victoriae*) and spinifex grasslands. Of 7 plant communities, 5 have less than 5% of their extent protected in existing reserves (Table 9-15, Table 9-17). Similarly, of 7 sub-bioregional ecosystems represented on the property, 5 have no current protection in the reserve system and another has less than 5% protection.

The proposed park would protect the entire Scoop Land System (stony plains with snakewood and chenopod shrublands), a priority-3 ecological community (DBCA, 2017a) (Table 9-15). It also harbours 5 priority species, including *Eremophila scrobiculata*, known from a single population (Buirchell and Brown, 2016). *Eremophila* species (poverty bushes) are particularly diverse in Western Australia, with almost 200 named species, more than 80% endemic to the state (see Box 8-3). Many are like the ex Wanna species in having tiny distributions.

The Ashburton sub-bioregion currently has just 2.8% of its area in existing reserves, and protecting ex Wanna would more than triple the extent in the reserve system (see section 9.3).

Gregory's Gap, part of the Godfrey Ranges, on ex Wanna. Photo: David Blood

Table 9-15: Summary of conservation values of the proposed 'Wanna' Conservation Park

ex Wanna (289,000 hectares)	
Important wetlands	Permanent springs along Irregully Creek, wetlands of sub-bioregional significance.
Threatened & priority plants	3 species.
Threatened & priority animals	2 bird species.
Priority ecological communities	1 community: Scoop Land System (priority-3) (100% of its extent).
Plant communities	7 communities: 5 with <5% represented in existing reserves.
Sub-bioregional ecosystems	7 ecosystems: 5 with 0% represented in existing reserves, 1 other with <5%.

Sources: See technical notes 1 and 2 (chapter 2).

Table 9-16: Threatened and priority species of the proposed 'Wanna' Conservation Park

Species	Conservation class
Birds	
Great egret (*Ardea modesta*)	International agreement
Rainbow bee-eater (*Merops ornatus*)	International agreement
Plants	
Eremophila scrobiculata	Priority 1
Rhodanthe frenchii	Priority 2
Solanum kentrocaule	Priority 3
Ecological communities	
Scoop Land System	Priority 3

Sources: See technical notes 1 and 2 (chapter 2).

Table 9-17: The extent of protection (%) in the proposed 'Wanna' Conservation Park for plant communities with inadequate representation in existing reserves

Plant Communities	ex Wanna
Little protection (0.1 to 5%) in existing reserves	
VT 18 Low woodland; mulga (Acacia aneura)	<0.1
VT 160 Shrublands; snakewood & Acacia victoriae scrub	0.1
VT 178 Hummock grasslands, grass steppe; hard spinifex, Triodia basedowii	0.1
VT 181 Shrublands; mulga & snakewood scrub	11.9
VT 264 Low woodland; Acacia victoriae & snakewood	0.2
Inadequate protection (5 to 15%) in existing reservess	
VT 39 Shrublands; mulga scrub	1.3

Source: See technical notes 2 (chapter 2).

9.3 Importance for achieving Western Australia's conservation reserve goals

The proposed parks of Mid West Mulga Country will substantially build the reserve system and help achieve the state's conservation goals. Most of the ecological regions, ecosystems and plant communities on the proposed parks are poorly or not protected at all in existing reserves.

Bioregional and sub-bioregional protection

The proposed parks sit across 3 of the state's 27 bioregions – primarily the Gascoyne and Murchison, both with less than 2% of their area in reserves – and 5 of the state's 55 sub-bioregions. In particular, the proposed parks will make a nationally significant contribution to protection of the Ashburton and Augustus sub-bioregions (both in the Gascoyne), which each have less than 3% of their area protected in existing reserves (Table 9-13). The Augustus sub-bioregion is a national priority for new reserves. The proposed parks also make a modest contribution to protection of the East Murchison and West Murchison sub-bioregions (in the Murchison), which each have less than 2% of their area in reserves, more than doubling the extent protected in the Murchison bioregion.

Although these gains would see Western Australia make some progress towards the 2020 international benchmark of 17%, additional reserves in these regions should remain a conservation priority (Figure 9-3).

Ecosystem and plant community protection

The proposed parks would improve protection of 26 plant communities and 50 sub-bioregional ecosystems (Table 9-19). This would be the first such protection for 10 plant communities (38% of the total) and 39 sub-bioregional ecosystems (78% of the total) currently lacking representation in the conservation reserve system. Protection of the proposed parks is particularly important for 2 ecosystems, 1 with 100% and the other with 67% of its extent represented (Table 9-19).

Currently, more than a third of Western Australia's sub-regional ecosystems lack a minimum level of protection, based on a long-held national target of 15% of each ecosystem to be in reserves (JANIS, 1997, Taylor, 2017). The proposed parks would enable the minimum reserve target of 15% to be met for an additional:

- 16 sub-bioregional ecosystems (32% of the total ecosystems on the proposed parks)
- 4 plant communities (15% of the of the total communities on the proposed parks).

Table 9-18: Current and improved protection of bioregions and sub-bioregions (% protected) in Western Australia's conservation reserve system

	Bioregion	Sub-bioregion		Bioregion	Sub-bioregions	Bioregion	Sub-bioregions	
	Murchison	East Murchison	West Murchison	Yalgoo	Tallering	Gascoyne	Ashburton	Augustus
Current protection	1.06	1.39	0.06	12.53	3.56	1.93	2.85	2.53
Proposed parks	2.27	2.14	3.74	0.61	0.89	5.78	7.84	7.80
New total	3.33	3.53	3.80	13.14	4.45	7.71	10.69	10.33

Source: See technical notes 2 (chapter 2).

Notes: *Current* protection means the percentage of each bioregion and sub-bioregion protected in the existing conservation reserve system. *Proposed parks* means the percentage of each bioregion and sub-bioregion protected in the proposed parks. *New total* means the percentage of each bioregion and sub-bioregion that would be protected if the proposed parks are declared.

Figure 9-4: Progress towards the 2020 international benchmark (17%) for protection of bioregions and sub-bioregions (% area protected) due to the proposed parks

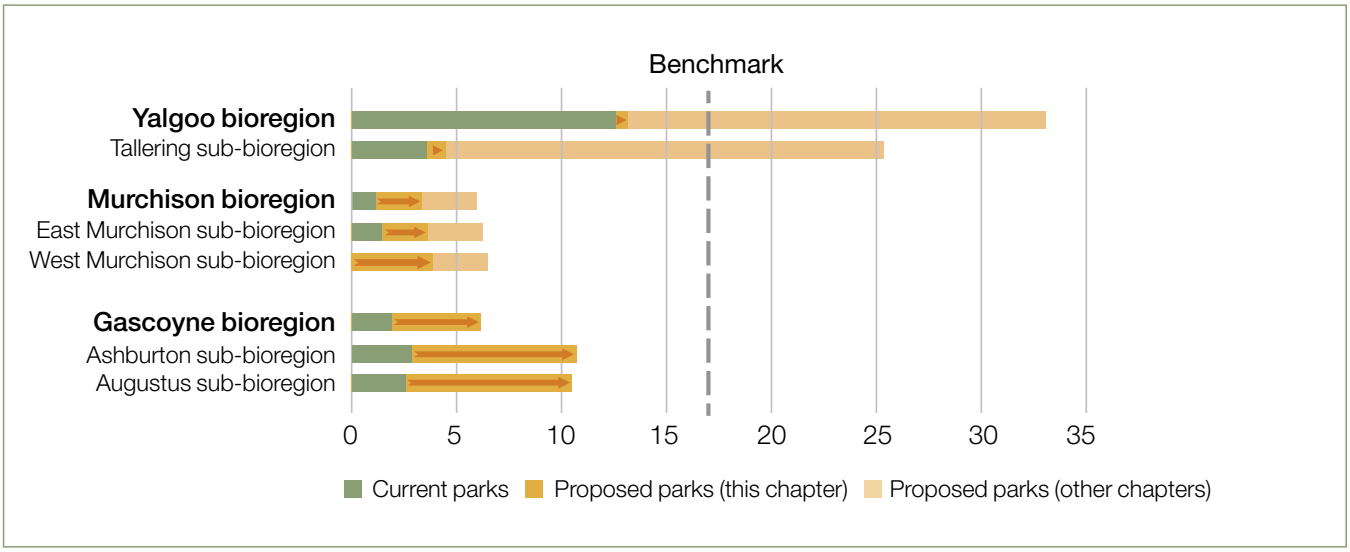


Table 9-19: Numbers of plant communities and sub-bioregional ecosystems in the proposed parks, levels of protection in the existing conservation reserve system and the contribution to protection of particular communities and ecosystems

	Plant communities (number & percentage)		Ecosystems (number & percentage)	
Improved protection in proposed parks				
Total in proposed parks	26	100%	50	100%
Will achieve 15% target[A]	4	15%	16	32%
Current level of protection in reserve system				
No existing protection (<0.1%)	10	38%	39	76%
Little existing protection (0.1-5%)	11	42%	8	16%
Inadequate protection (5.1-<15%)	3	12%	2	4%
Exceeds 15% protection	2	8%	1	2%
Contribution to protection of particular communities & ecosystems[B]				
Critical (>85% of total extent)	0	4%	1	2%
Very important (50–85% of total extent)	0	4%	1	2%
Important (10–50% of total extent)	7	27%	18	36%

Sources: See technical notes 2 (chapter 2).

Notes: A. This assumes protection in other proposed parks and does not include ecosystems that already have more than 15% of their extent protected in the conservation reserve system. B. This represents the number of communities or ecosystems with a substantial proportion of their total extent in the proposed parks. For example, the proposed parks are 'critical' for ecosystem protection where more than 85% of the entire ecosystem extent occurs within those proposed parks.

Waterholes fed by springs, such as Lee Steere Pool here on ex Wanna, provide resources and refuges for many species. Photo: Samille Mitchell (DEC)

9.4 Native title and Aboriginal heritage sites

There are 10 native title holders or claimants for the proposed parks: Mullewa Wadjari Community, Wajarri Yamatji, Yugunga-Nya People, Widi Mob, Nharnuwangga, Gnulli, Thiin-Mah Warriyangka, Tharrkari, Jiwarli and Jurruru People.

The proposed parks would wholly protect 35 registered Aboriginal heritage sites and partially protect 7 sites (Table 9-20). Another 26 nominations have been lodged. The 4 proposed parks of the Mount Augustus extension surround the Aboriginal Land Trust land of Burringurrah or Mount James.

Table 9-20. Summary of native title and registered Aboriginal heritage sites in the proposed parks

Native title party, claimed or determined (percentage of property)	Registered Aboriginal heritage sites
Proposed 'Twin Peaks – Yuin' Conservation Park	
ex Twin Peaks	
Mullewa Wadjari Community & Wajarri Yamatji registered claim application (100%, overlapping claims)	No registered sites
ex Narloo	
Mullewa Wadjari Community & Wajarri Yamatji, registered claim application (69%, overlapping claims)	2 sites (1 that would be fully protected, 1 partially), including a gnamma hole (an important water source)
ex Yuin	
Mullewa Wadjari Community & Wajarri Yamatji, registered claim application (69%, overlapping claims) Mullewa Wadjari Community & Wajarri Yamatji & Widi Mob registered claim application (31%, overlapping claims)	3 sites (1 that would be fully protected, 2 partially), including the Greenough River, an important mythological site, and 2 painting sites.
Proposed 'Noongal – Lakeside' National Park	
ex Noongal	
Wajarri Yamatji, determined non-exclusive (100%)	1 site that would be partially protected: a painting site.
ex Dalgaranga	
Wajarri Yamatji, determined non-exclusive (100%)	10 sites (7 that would be fully protected, 3 partially), including an engraving site, 5 painting sites, a number of artefact/scatter sites, 2 sites used as quarries and a rockshelter.
ex Lakeside	
Wajarri Yamatji, determined non-exclusive (51%) Yugunga-Nya People, registered claim application (15%).	1 site that would be fully protected: an important ceremony site, with paintings, rockshelter, artefacts/scatter and 15 stencilled motifs.
Proposed 'Doolgunna – Mooloogool' National Park	
ex Doolgunna	
Nharnuwangga, determined non-exclusive (42%) Yugunga-Nya People, registered claim application (58%)	1 site that would be partially protected: an important ceremony site, with engravings, man-made structures, paints, and a quarry.
ex Mooloogool	
Yugunga-Nya People, registered claim application (100%)	4 sites (2 that would be fully protected, 2 partially) including a diamond well quarry, 3 artefacts/scatter sites, 1 with an important ceremonial history, engravings, paintings and archaeological deposits.

Native title party, claimed or determined (percentage of property)	Registered Aboriginal heritage sites
Proposed additions to Mount Augustus National Park	
ex Mt Phillip	
Wajarri Yamatji, determined exclusive (64%) Wajarri Yamatji, registered claim application (36%)	4 sites that would be fully protected, including 3 artefact/scatter sites with camps and water sources.
ex Dalgety Downs	
Wajarri Yamatji determined exclusive (100%)	No registered sites.
ex Waldburg	
Nharnuwangga, determined non-exclusive (43%) Wajarri Yamatji, determined exclusive (34%) Wajarri Yamatji, registered claim application (23%)	9 sites that would be fully protected, including a number of engraving sites, 2 water sources, Boom Boom Springs, an important rock engraving site with ceremonial significance, artefact/scatter and man-made structures.
ex Cobra	
Wajarri Yamatji, determined exclusive (29%) Wajarri Yamatji, registered claim application (57%) Gnulli, registered claim application (8%) combined Thiin-Mah Warriyangka, Tharrkari, Jiwarli, registered claim application (6%)	8 sites (7 that would be fully protected, 1 partially), including Babargu (a camp and water source), Bujunggara (ceremonial sacred site with engraving and rockshelter), Coobodgu Waterhole (ceremonial site, watersource and camp), Darlo (ceremonial site and camp with man-made structure), Mamamurnu (ceremonial site), Thomas River north (artefacts / scatter, man-made structure and camp), Thomas River south (artefacts / scatter, modified tree, camp), Thomas River (artefacts / scatter, ceremonial, man-made structure, repository / cache and camp).
Proposed 'Wanna' Conservation Park	
ex Wanna	
Jurruru People, determined non-exclusive (62%) Combined Thiin-Mah Warriyangka, Tharrkari, Jiwarli registered claim application (29%) Jurruru People, registered claim application (4%) Wajarri Yamatji, determined exclusive (3%)	1 site that would be fully protected: an engraving site

Sources: See technical notes 3 (chapter 2), data current to November 2018.

The crested katydid (*Alectoria superba*), here on ex Doolgunna, is the only member of its genus and thought to feed on flowers. Photo: David Blood (DEC)

9.5 Geology, prospectivity and mining

Spanning 5 sub-bioregions in 3 bioregions (mainly the Gascoyne and Murchison), these properties feature a range of geologies. The Murchison properties lie on the northern Yilgarn Craton, one of the oldest and most stable landforms on the planet. Formed between 2.6 and 3 billion years ago, it is one of the best-preserved examples of Archaean crust on the planet (Anand and Paine, 2002). The West Murchison features extensive hardpan wash plains of Quaternary alluvial and eluvial surfaces (Desmond et al., 2001a). The East Murchison is characterised by extensive elevated red desert sandplains, broad plans of red-brown soils, breakaway complexes, and internal drainage into salt lake systems associated with the occluded Paleodrainage system (Cowan, 2001). The Augustus sub-bioregion (in the Gascoyne) is characterised by rugged low Proterozoic sedimentary and granite ranges divided by broad flat valleys with alluvial deposits (Desmond et al., 2001b). The Ashburton sub-bioregion also features ranges divided by broad flat valleys, those associated with the Ashburton Basin having shales, sandstones and conglomerates (Kendrick, 2001).

The following information on the geology, prospectivity and mining-related activity on each property comes from the following sources: Belford (2017) and DMIRS (2018a). The extent of proposed and existing mining-related activity is summarised in Tables 9-21, 9-22 and 9-23.

Proposed 'Twin Peaks – Yuin' Conservation Park

Ex Narloo

This property is underlain by Archean granite. The mineral prospectivity is low and there are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Narloo is free of existing or proposed mining-related activities. A mining exemption under section 19 of the Mining Act (DMIRS, 2018c) covers the entire property.

Ex Twin Peaks

This property is underlain by Archean granite. The mineral prospectivity is low and there are no known mineral deposits.

Mining activity: There are no existing or proposed mining-related activities.

Areas without mining activity: 100% of ex Twin Peaks is free of existing or proposed mining-related activities. A mining exemption under section 19 of the Mining Act covers the entire property (DMIRS, 2018c).

Ex Yuin

This property is underlain by Archean granite. The mineral prospectivity is low and there are no known mineral deposits.

Mining activity: A single mineral exploration licence (E5902251) exists in the centre of ex Yuin covering 18,000 hectares (3%). It was approved in November 2017 and appears to overlap with a known deposit of industrial pegmatite minerals.

Areas without mining activity: 97% of ex Yuin is free of existing or proposed mining-related activities. A mining exemption under section 19 of the Mining Act covers the northern part of the property (DMIRS, 2018c).

Proposed 'Dalaranga – Lakeside' National Park

Ex Dalgaranga

This property is underlain by Archean granite, lesser gneiss, and greenstone rocks. Within the greenstone rocks are known deposits of gold, industrial minerals and pegmatites containing tantalum, lithium, tin, and turquoise and topaz gemstones. The greenstone rocks are considered prospective for these minerals.

Mining activity: Most of the eastern half of ex Dalgaranga is overlain by mineral exploration licences, including for prospecting.

Areas without mining activity: 52% of ex Dalgaranga is free of existing mining-related activities. Applications for exploration covering 16% of the property are currently being considered. A mining exemption under section 19 of the Mining Act covers part of the property near its western border (DMIRS, 2018c).

Ex Lakeside

The western part of this property is underlain by Archean granite with a north trending, narrow greenstone belt in the centre. The eastern parts have a surface cover of Cenozoic alluvial and lacustrine inset valley and valley-fill deposits within the Lake Austin paleodrainage and are underlain by Archean granite and minor greenstone along the eastern margin. The greenstone rocks are prospective for gold, and the lake sediments are prospective for uranium. There are no known mineral deposits.

Mining activity: The eastern block of ex Lakeside has no active exploration licences or mining leases and no known deposits. It is overlain by 3 applications for exploration (E 58/512, E 21/205-6) and a small miscellaneous licence area for a pipeline, road and powerline. The western block is overlapped by 2 exploration licences (E 21/195-6), which cover 15% of the property. Deposits of base metals, iron and industrial minerals have been recorded within the

central section of this block.

Areas without mining activity: 85% of ex Lakeside is free of existing mining-related activities. Applications for exploration covering 40% of the property are currently being considered.

Ex Noongal

This property is underlain by Archean granite and lesser greenstone rocks along the northern margin. A long strike within the greenstone rocks are known deposits of gold. The greenstone rocks are considered prospective for gold. There are no known mineral deposits.

Mining activity: The north-east corner and southern sections of ex Noongal are overlain by active exploration licences. The remaining central half of the property is free of mineral tenements.

Areas without mining activity: 51% of ex Noongal is free of existing mining-related activities. Applications for exploration covering 1% of the property are currently being considered.

Proposed 'Doolgunna – Mooloogool' National Park

Ex Mooloogool

This property is underlain by the Paleoproterozic rocks of the Windplain, Mooloogool and Bryah Groups wrapped around an older Archean granite. This area has moderate gold prospectivity and some known deposits of gold.

Mining activity: Most of the property is covered by mining exploration licences and applications for exploration. Known deposits of base metals, precious metals and steel alloys occur in the south and western parts of the property. There is a 200-hectare mining lease near its border with ex Doolgunna.

Areas without mining activity: 32% of ex Mooloogool is free of existing mining-related activities. Applications for exploration covering 14% of the property are currently being considered. A large contiguous area of 90,000 hectares in the central northern section of ex Mooloogool is free of existing mining activities and connects with mining-free areas in ex Doolgunna.

Ex Doolgunna

This property is underlain by the Paleoproterozic rocks of the Windplain, Mooloogool, Bryah and Padbury Groups, in part wrapped around older Archean granites. The contact between the ex Mooloogool and Bryah Groups is a major structure trending north-east. The eastern part has active copper-gold mining at DeGrussa and is highly prospective for gold and base metals. The other parts have known occurrences of iron, gold and base metals, and exploration for gold, iron, manganese and base metals is ongoing.

Mining activity: This property is mostly covered in mineral exploration licences and mining leases. There are 2 operating mines and 1 under development. Target commodities include gold and other precious metals, copper, lead, zinc and construction materials.

Areas without mining activity: 7% of ex Doolgunna is free of existing mining-related activities. Applications for exploration covering 2% of the property are currently being considered. A mining-free area of approximately 10,000 hectares exists in the south, connecting with the mining-free areas in ex Mooloogool.

Proposed additions to Mount Augustus National Park

Ex Cobra

This property is underlain by north-west-trending Mezoproterozoic rocks of the Edmund Group, which have been intruded by contemporaneous mafic rocks. On the southern side of this structure are older Paleoproterozoic granites and sediments. The historic Bangemall mining centre lies with the Edmund Group rocks near the ex Cobra homestead. This was a historic source of alluvial and hard-rock gold. The hard rock gold is hosted by dolerite and the sedimentary rocks of the Edmund Group, so the contact zones of the mafic intrusions with the Edmond Group sediments are prospective for gold. There are known deposits of gold and specialty metals.

Mining activity: Five mining leases (from 10 to 90 hectares) targeting gold lie in the north-west of ex Cobra to the north of ex Mt Phillip. Surrounding these leases are other licences and leases for exploration and mining infrastructure and 3 applications for exploration licences. An application for a mineral exploration licence (E 09/2315) occurs in the large south-eastern section of ex Cobra, which is otherwise free of mineral mining-related activity. This application was submitted in May 2018 and is targeting copper and zinc. A large oil & gas exploration application covering much of the greater Mount Augustus region (STP-EPA-0012) overlaps 75% of ex Cobra. It is the second largest application in the state, and larger than any current onshore exploration permit. Most of the application area (80%) is outside the proposed parks.

Areas without mining activity: 96% of ex Cobra is free of existing mining-related activities. Applications for exploration covering 80% of the property are currently being considered.

Ex Dalgety Downs

This property is underlain by a small north-west-trending basin of Mezoproterozoic sedimentary rocks of the Edmund Group wrapped by older Paleoproterozoic granites and sediments, plus small outliers of Archean gniess. The block is prospective for gold. There are no known mineral deposits.

Mining activity: Eleven mining exploration licences cover parts of ex Dalgety Downs.

Areas without mining activity: 34% of ex Dalgety Downs is free of existing or proposed mining-related activities.

Ex Mt Phillip

The north-east corner of this property is underlain by north-west-trending Mezoproterozoic rocks of the Edmund Group, which have been intruded by contemporaneous mafic rocks. A major structure bounds them to the south against older Paleoproterozoic granites and sediments. In the south-west corner, another north-west-trending basin of Mezoproterozoic Edmund Group rocks abuts a small complex of Archean gniess. In the mid-west of the property are several small deposits of gemstone amethysts and in the south-west is a deposit of beryl. The property is prospective for gemstones.

Mining activity: A small (50 hectare) mining lease in the centre of the property corresponds with a closed gemstone mine. This lease was renewed for 21 years in 2016. Six exploration licences cover 25% of the property in the south and 1 application for an exploration licence (E 09/2286) covers 1.5% of the property in the north. The large oil & gas exploration application covering much of the greater Mount Augustus region (STP-EPA-0012) overlaps 43% of northern ex Mt Phillip.

Areas without mining activity: 75% of ex Mt Phillip is free of existing mining-related activities. Applications for exploration covering 43% of the property are currently being considered.

Ex Waldburg

The north-east part of this property is underlain by Mezoproterozoic sedimentary rocks of the Edmund Groups and contemporaneous mafic intrusive rocks. The south-west corner is underlain by older, Paleoproterozoic granites and sedimentary rocks with occurrences of older Archean gneiss. In the south-west, the Paleoproterozoic sedimentary rocks host known gold deposits, and the belt is highly prospective for gold.

Mining activity: Eight mineral exploration licences overlap 15% of the property in the west and along its south-east border. Two applications for mineral exploration licences cover 5% of the property. The large oil & gas exploration application covering much of the greater Mount Augustus region (STP-EPA-0012) overlaps all but the south-west corner of ex Waldburg.

Areas without mining activity: 86% of ex Waldburg is free of existing mining-related activities. Applications for exploration covering 62% of the property are currently being considered.

Proposed 'Wanna' Conservation Park

Ex Wanna

This property is underlain by the Mezoproterozoic rocks of the Edmund and Collier Groups with contemporaneous mafic intrusive rocks. The north-east corner is underlain by older, Paleoproterozoic Wyloo Group rocks. The Wyloo Group rocks are highly prospective for gold and base metals, and a long strike of this ground has known occurrences and recent mines. The mineral prospectivity of the Edmund and Collier Groups is low for gold and base metals. There are no known mineral deposits.

Mining activity: Mineral exploration licences cover the central 20% (60,000 hectares) of the property. Five applications for mineral exploration overlap parts of the property's eastern border. The large oil & gas exploration application covering much of the greater Mount Augustus region (STP-EPA-0012) covers 90% (3.5 million hectares) of ex Wanna.

Areas without mining activity: 80% of ex Wanna is free of existing mining-related activities. Applications for exploration covering 20% of the property are currently being considered.

Table 9-21: Existing mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed 'Doolgunna - Mooloogool' National Park				
ex Doolgunna	88%	-	88%	5%
ex Mooloogool	68%	-	68%	-
All properties	75%	-	75%	2%
Proposed Mount Augustus National Park expansion				
ex Cobra	4%	-	4%	<1%
ex Dalgety Downs	66%	-	66%	-
ex Mt Phillip	25%	-	25%	-
ex Waldburg	15%	-	15%	-
All properties	23%	-	23%	-
Proposed 'Noongal - Lakeside' National Park				
ex Dalgaranga	48%	-	48%	<1%
ex Lakeside	15%	-	15%	-
ex Noongal	49%	-	49%	-
All properties	40%	-	40%	<1%
Proposed 'Twin Peaks - Yuin' Conservation Park				
ex Narloo	-	-	-	-
ex Twin Peaks	-	-	-	-
ex Yuin	3%	-	3%	-
All properties	2%	-	2%	-
Proposed 'Wanna' Conservation Park				
ex Wanna	21%	-	21%	-

Note: Where mining tenements and titles overlap, only 1 value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

Dingos (*Canis lupus*), here on ex Wanna, are thought to benefit many native mammals by limiting cat and fox numbers. Photo: DEC

The orange chat (*Epthianura aurifrons*), here at Lake Austin, is a nomad often found in low vegetation around inland lakes. Photo: Fred Coles

Table 9-22: Applications for mining-related activity in the proposed parks (% area affected)

	Mineral exploration	Oil & gas exploration	Combined exploration	Mineral production
Proposed 'Doolgunna - Mooloogool' National Park				
ex Doolgunna	2%	-	2%	-
ex Mooloogool	14%	-	14%	-
All properties	10%	-	10%	-
Proposed Mount Augustus National Park expansion				
ex Cobra	17%	75%	80%	-
ex Dalgety Downs	-	-	-	-
ex Mt Phillip	1%	43%	43%	-
ex Waldburg	5%	68%	63%	-
All properties	6%	53%	52%	-
Proposed 'Noongal - Lakeside' National Park				
ex Dalgaranga	16%	-	16%	-
ex Lakeside	41%	-	41%	-
ex Noongal	1%	-	1%	-
All properties	19%	-	19%	-
Proposed 'Twin Peaks - Yuin' Conservation Park				
ex Narloo	-	-	-	-
ex Twin Peaks	-	-	-	-
ex Yuin	-	-	-	-
All properties	-	-	-	-
Proposed 'Wanna' Conservation Park				
ex Wanna	4%	90%	71%	-

Note: Where mining tenements and titles overlap, only 1 value has been calculated, with priority given first to production over exploration, then to existing activities over applications.

Source: See technical notes 4 (chapter 2).

Table 9-23: Proposed park areas (%) free of existing mining-related activity

	No mineral mining	No oil & gas mining	Combined
Proposed 'Doolgunna – Mooloogool' National Park			
ex Doolgunna	6%	100%	6%
ex Mooloogool	32%	100%	32%
All properties	24%	100%	24%
Proposed additions to Mount Augustus National Park			
eex Cobra	96%	100%	96%
ex Dalgety Downs	34%	100%	34%
ex Mt Phillip	75%	100%	75%
ex Waldburg	85%	100%	85%
All properties	77%	100%	77%
Proposed 'Noongal - Lakeside' National Park			
ex Dalgaranga	52%	100%	52%
ex Lakeside	85%	100%	85%
ex Noongal	50%	100%	50%
All properties	60%	100%	60%
Proposed 'Twin Peaks - Yuin' Conservation Park			
ex Narloo	100%	100%	100%
ex Twin Peaks	100%	100%	100%
ex Yuin	97%	100%	97%
All properties	98%	100%	98%
Proposed 'Wanna' Conservation Park			
ex Wanna	79%	100%	79%

Source: See technical notes 4 (chapter 2).

The shores of southern Lake Austin. Photo: Fred Coles

9.6 Recommendations

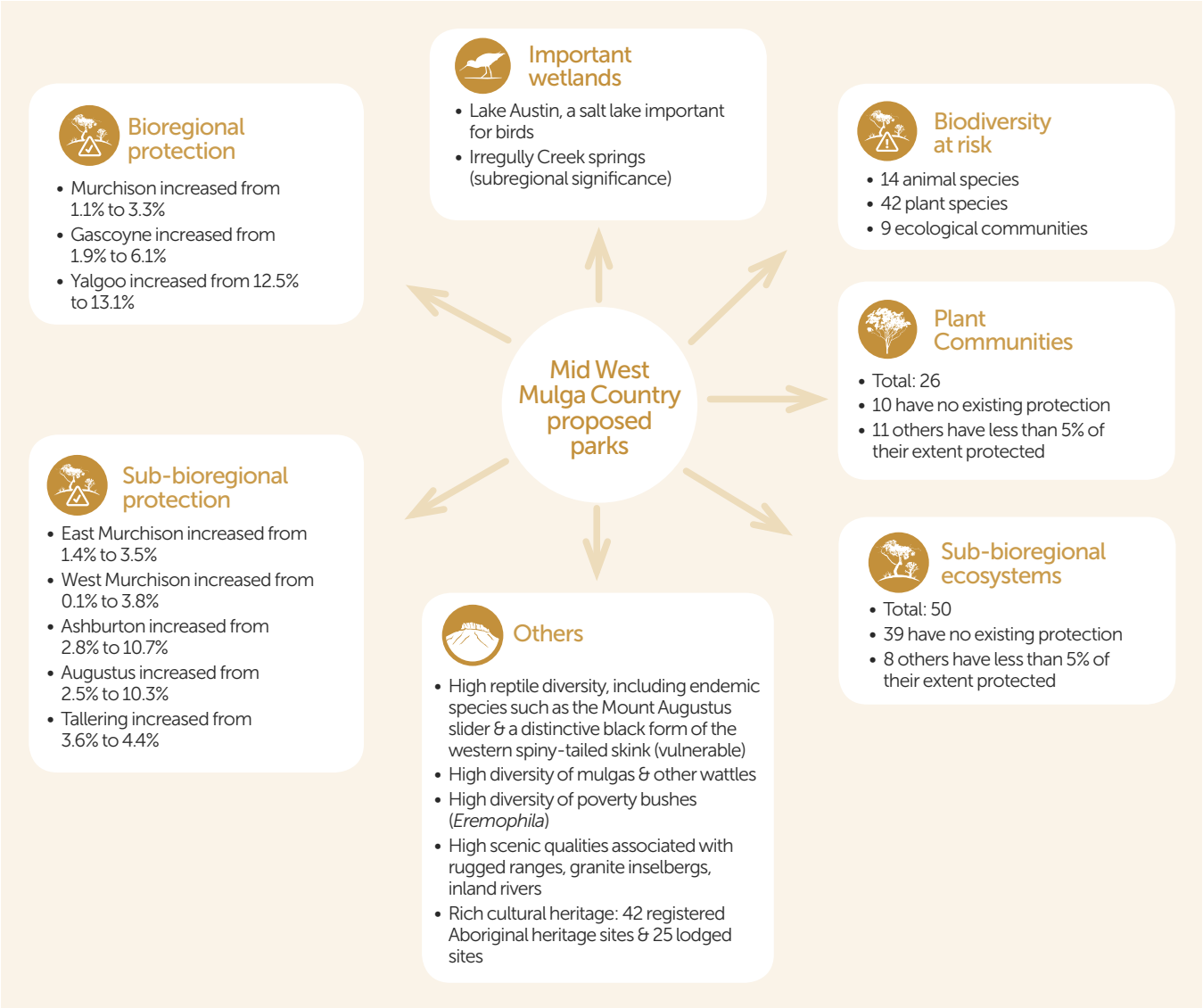
The following recommendations to create 4 new parks and extend Mount Augustus National Park would add 1.7 million hectares to the reserve system. They offer the opportunity to protect 4 unique invertebrate communities in groundwater calcretes, each listed as a priority-1 ecological community. They would protect a large salt lake important for waterbirds, 10 plant communities and 39 sub-bioregional ecosystems lacking representation in the reserve system and 56 threatened and priority species (Table 9-21).

The parks would substantially increase representation of the poorly protected Ashburton, Augustus, East Murchison and West Murchison sub-bioregions, each with less than 3% of their extent currently protected. They would enable Western Australia to meet the minimum protection target of 15% for 16 sub-bioregional ecosystems.

The recommendations below are consistent with the intentions of the Western Australian government, as indicated in the 2016 Collaborative Australian Protected Areas Database (CAPAD, 2017), with the exception of the Mount Phillip and Doolgunna properties, both listed as in-process for gazettal as IUCN IA (nature reserves) rather than IUCN II (national parks or conservation parks) as recommended here.

Apart from a portion of 1 property, the proposed parks are all determined or claimed as native title. They have substantial cultural values and would protect 42 registered Aboriginal heritage sites and 26 lodged sites.

Figure 9-5: Some combined values and benefits of the proposed new parks



Recommendation 9-1

Declare ex Twin Peaks, ex Narloo and ex Yuin as a Class A conservation park.

Conservation considerations

This proposed park would add 102,000 hectares to the conservation reserve system and protect the headwater catchments of 2 major river systems, the Murchison and Greenough. The landscape is varied and has high scenic qualities. The park would protect 4 threatened and priority species, including a unique form of the threatened western spiny-tailed skink (vulnerable), and 3 plant communities lacking representation in the reserve system.

The known values of these properties, including 3 threatened and priority-1 species, are of regional significance, warranting protection in a conservation park. The proposed park would make a significant contribution to Western Australia's conservation reserve system, warranting Class A reservation. In particular, it would add to the reserve system 1.1% of the West Murchison sub-bioregion (with less than 1% in existing reserves), 0.3% of the Murchison bioregion (with just over 1% in existing reserves) and 9 sub-bioregional ecosystems with little to no protection in existing reserves.

Further investigation of the values of this proposed park is recommended. Overlapping the diverse Tallering sub-bioregion, it may have higher floristic values than is currently indicated, warranting a different tenure.

The native title parties for this proposed park are the Mullewa Wadjari Community, Wajarri Yamatji and Widi Mob. Four registered Aboriginal heritage sites would be protected.

Mining considerations

These 3 properties are 98% free of existing or proposed mining-related activity and have low mineral prospectivity. An exploration licence (E5902251, granted in November 2017) covers 1800 hectares in the centre of ex Yuin (3% of the property) and may compromise the integrity and values of the proposed park. Further exploration activities should be subject to assessment by the Environmental Protection Authority to ensure that operations are consistent with maintaining the natural values of the park.

Recommendation 9-2

Declare ex Dalgaranga, ex Noongal and ex Lakeside as a Class A national park.

Conservation considerations

This proposed national park would add 202,000 hectares to the conservation reserve system and help protect 2 listed priority-1 ecological communities, the unique invertebrate communities of the Gabyon and Lake Austin groundwater calcretes. It would protect 7 plant communities with no representation in the reserve system, and Lake Austin, a large salt lake important for waterbirds and saltmarsh birds. Eighteen threatened and priority species have been recorded on the properties, including western spiny-tailed skink, shield-backed trapdoor spider and bar-tailed godwit (all vulnerable) and black-flanked rock-wallaby (endangered, but whose survival on the property is uncertain).

The values of this proposed park – particularly the 2 priority-1 ecological communities and 7 threatened and priority-1 species – are of national significance, warranting protection as a Class A national park. The proposed park would make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. In particular, it would add to the reserve system 2.4% of the West Murchison sub-bioregion (with less than 1% in existing reserves), 0.7% of the Murchison bioregion (with just over 1% in existing reserves), and 20 sub-bioregional ecosystems with little to no protection in existing reserves, including 1 not found elsewhere.

The native title parties for this proposed park are the Wajarri Yamatji and Yugunga-Nya People, whose consent would be required for any tenure change. Twelve registered Aboriginal heritage sites would be protected.

Mining considerations

These 3 properties are 60% free of existing mining-related activity. The proposed park has no mining leases, 40% of its area has existing exploration licences and 19% is subject to applications for exploration. These tenements cover a sub-bioregional ecosystem only found within this proposed park (a bowgada and *Acacia quadrimarginea* shrubland on stony ridges in West Murchison). Existing exploration licences and future applications should be referred to the Environmental Protection Authority for assessment to ensure they do not adversely impact on the values of the proposed park.

The entire eastern part of ex Lakeside, which features Lake Austin (important for waterbirds) and a priority-1 ecological calcrete ecological community, is subject to exploration applications submitted in 2018. In the public interest, these and all future applications in the vicinity of Lake Austin should not be granted.

Recommendation 9-3

Declare ex Mooloogool and ex Doolgunna as a Class A national park.

Conservation considerations

This proposed national park would add 591,000 hectares to the conservation reserve system and protect 2 priority-1 ecological communities – the unique invertebrate community of the Doolgunna groundwater calcrete and the Robinson Range vegetation complexes on banded ironstone formation. The proposed park has striking landscapes and high plant diversity, including 20 priority plant species. Six priority animal species have been recorded, including malleefowl (vulnerable). The proposed park would protect 2 plant communities lacking representation in existing reserves.

The values of this proposed park – particularly the 2 priority-1 ecological communities and 7 threatened and priority-1 species – are of national significance, warranting protection as a Class A national park. The proposed park would make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. In particular, it would add to the reserve system 2.4% of the West Murchison sub-bioregion (with less than 1% in existing reserves), 0.7% of the Murchison bioregion (with just over 1% in existing reserves) and 16 sub-bioregional ecosystems with little to no protection in existing reserves.

The native title parties for this proposed park are the Nharnuwangga and Yugunga-Nya People, whose consent would be required for any tenure change. Four registered Aboriginal heritage sites would be protected.

Mining considerations

Ex Doolgunna is highly prospective for minerals. It has active mining operations and exploration for gold, iron, manganese and base metals. Many of the exploration licences and some of the mining leases overlay poorly understood ecological communities at risk of becoming threatened including 2 priority-1 ecological communities (banded ironstone vegetation complexes and a calcrete groundwater community). Granted exploration licences overlay 70% of ex Mooloogool, but in the centre of the property an area of about 70,000 hectares is free of tenements and corresponds with records for priority plant species.

The complex overlap of mineral and ecological values on these properties will require further information and analysis to harmonise potentially competing land uses. Given the importance of this proposed park for unprotected habitat types, as well as threatened and priority species and communities, the Environmental Protection Authority should be required to develop a whole-of-park plan to ensure that all existing and future mining activities will be conducted in a manner which maintains the natural values for which these properties were acquired.

Recommendation 9-4

Incorporate ex Cobra, ex Waldburg, ex Mt Phillip and ex Dalgety Downs into the Class A Mount Augustus National Park.

Conservation considerations

This proposed expansion of Mount Augustus National Park would add 604,000 hectares to the conservation reserve system. It would protect 4 listed priority ecological communities – the priority-1 unique invertebrate community of the Dalgety and Landor groundwater calcrete and 3 priority-3 land systems (Peedawarra, Bibbingunna and Diorite). It would also protect part of the catchment of the Gascoyne River, and 22 threatened and priority species. Three plant communities would be protected in the reserve system for the first time.

The values of these properties – particularly the 4 priority ecological communities and 3 threatened and priority-1 species – bolster the nationally significant values of the existing park and warrant Class A status. The proposed additions would also make a significant contribution to Western Australia's conservation reserve system, further warranting Class A status. They would add to the reserve system 6.2% of the Augustus sub-bioregion (with less than 3% in existing reserves), 3.3% of the Gascoyne bioregion (with less than 2% in existing reserves), and 8 sub-bioregional ecosystems with little to no protection in existing reserves.

The native title parties for this proposed park extension are the Wajarri Yamatji, Nharnuwangga, Gnulli, Jiwarli, Thiin-Mah Warriyangka and Tharrkari, whose consent would be required for any tenure change. Twenty-one registered Aboriginal heritage sites would be protected.

Mining considerations

The proposed park is 77% free of existing mining-related activity. Assessment of the oil & gas exploration application (STP-EPA-0012) should restrict activities to outside the proposed park. An excision of approximately 250 hectares (<0.01% of the proposed park) would allow for ongoing gold mining operations on ex Mt Phillip and ex Cobra.

The majority of ex Cobra, ex Waldburg and ex Mt Phillip (86%) is free of existing mining-related activities, but 66% of ex Dalgety Downs is subject to granted exploration licences. Most applications for mineral exploration licences are for parts of ex Cobra, covering about 20,000 hectares.

Upon declaration of these areas as extensions to the national park, existing licences for mineral exploration should be referred to the Environmental Protection Authority for assessment. This could lead to the application of guidelines to ensure natural values are not compromised. Any new applications should not be granted. Mining leases should also have conditions applied to ensure that operations are consistent with maintaining the values of the park. Any further applications for operations on existing leases should be referred to the Environmental Protection Authority for assessment at the highest level.

Recommendation 9-5

Declare ex Wanna a Class A conservation park.

Conservation considerations

This proposed park would add 289,000 hectares to the conservation reserve system. It would protect a priority-3 ecological community (the Scoop Land System), 5 listed priority species and 5 plant communities with less than 5% representation in existing reserves.

The values of this proposed park, including a priority-3 ecological community and a priority-1 species, are of regional significance, warranting protection in a conservation park. The proposed park would make a significant contribution to Western Australia's conservation reserve system, warranting Class A status. In particular, it would add to the reserve system 7.8% of the Ashburton sub-bioregion (with less than 1% in existing reserves) and 6 sub-bioregional ecosystems with little to no protection in existing reserves.

The native title parties for this proposed park are the Jurruru People, Thiin-Mah Warriyangka, Tharrkari and Jiwarli, whose consent would be required for any tenure change. One registered Aboriginal heritage site would be protected.

Mining considerations

Ex Wanna is 80% free of existing mining-related activity and has low prospectivity. There are no mining leases. The mineral exploration licences, in the centre of ex Wanna, correspond with major tributaries of the Ashburton River. These licences should be referred to the Environmental Protection Authority to ensure their activity does not impact on the conservation values of the proposed park including these waterways. Assessment of the oil & gas exploration application (STP-EPA-0012), which overlays 90% of ex Wanna, should restrict exploration activities to outside the proposed park.

The presence of malleefowl (*Leipoa ocellata*), listed nationally as vulnerable, is evident by their large egg-incubating mound (shown above on ex Mooloogool), typically 3–5 metres wide and a metre high. After eggs are laid, the male diligently manages the nest to maintain exactly the right temperature for incubation. Photos: DEC (top), David Curtis (bottom)

A masked woodswallow (*Artamus personatus*) family on ex Doolgunna. Photo: DEC

10

Combined significance of the proposed parks

Gregory's Gap on ex Wanna – part of the Godfrey Ranges, a landscape of sheer cliff faces, tabletop hills and rugged red rock. Photo: Samille Mitchell (DEC)

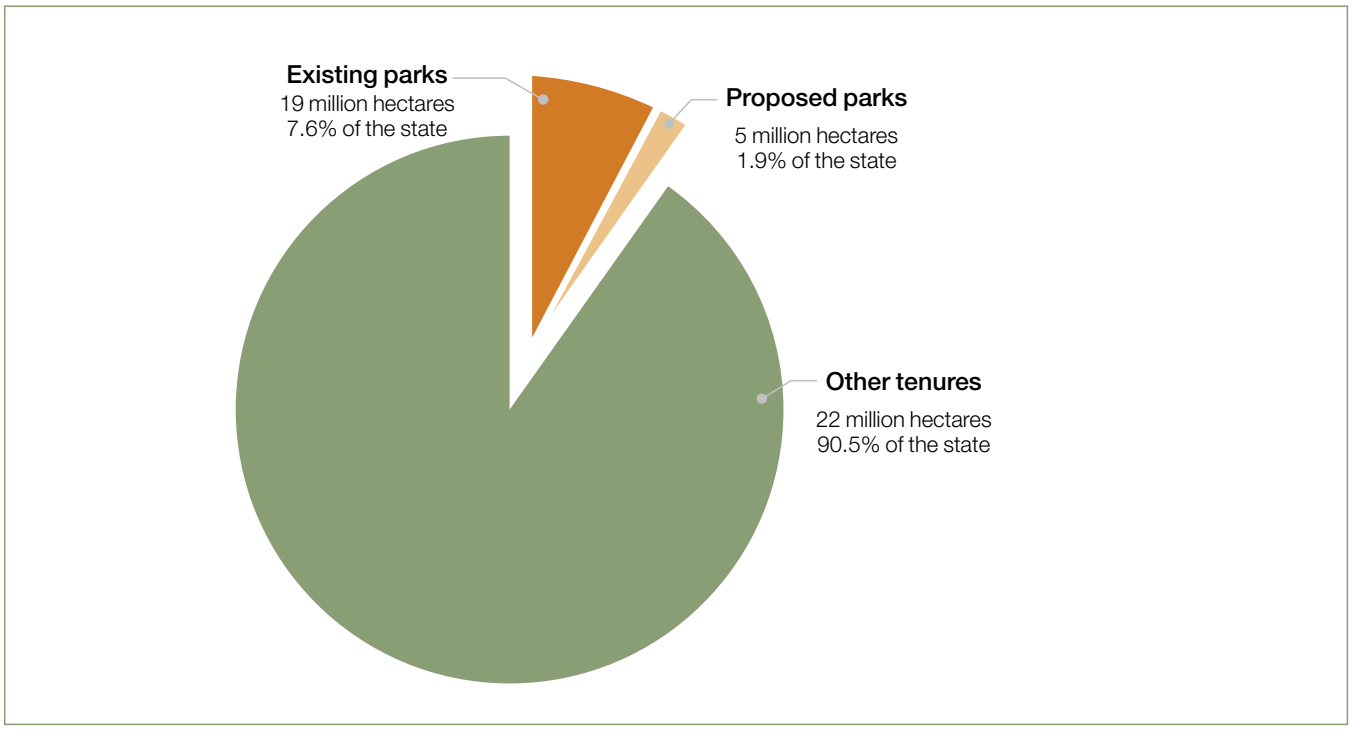
10.1 Expansion of Western Australia's conservation reserve system

Most of the properties assessed in this report, acquired as part of the Gascoyne-Murchison Strategy, were intended to be part of a package to substantially expand the Western Australian conservation reserve system in regions with very little existing protection. The government's intention was to build a 'world class' conservation reserve system representing the full range of landforms and biological communities in the catchments of the Murchison and Gascoyne rivers (Lewis, 2002). As well as protecting biodiversity and increasing eco-tourism in the region, this would enable, in a world-first, 'an industry backed environmental management system' with a reserve system as 'the backbone' of this accreditation. However, progress towards the achievement of a 'comprehensive, adequate and representative' reserve system in these regions has thus far been stymied by the failure to transfer the properties into the conservation reserve system.

In this chapter we summarise the combined values of the 24 proposed new or expanded parks, which cover 5 million hectares, close to 2% of the state's total land area (Table 10-1). This would expand Western Australia's conservation reserve system from 19.4 to 24.4 million hectares (from 7.6% to 9.5% of the state) (Figure 10-1). The gazettal of these properties would represent the largest single expansion of Western Australia's terrestrial parks network since its inception almost 120 years ago.

Based on the information presented in the preceding 7 chapters, here we outline the most significant natural and other values of the proposed parks and their combined importance for enabling Western Australia to meet its conservation reserve goals.

Figure 10-1: Current and proposed area of Western Australia's conservation reserve system as a proportion of the state's total area



Source: CCG (2017)

Table 10-1: Proposed new or expanded parks

Property	Recommended Protection	Size (hectares)
Shark Bay World Heritage to Wooleen		
ex Carrarang	'Carrarang' (Edel Land) National Park (Class A)	19,000
ex Yaringa, ex Nanga (north)	'Yaringa – Nanga' National Park (Class A)	108,000
ex Nanga (south), ex Nerren Nerren, ex Murchison House (north), ex Tamala	Zuytdorp Nature Reserve (expansion) (Class A)	286,000
ex Murchison House (south)	Kalbarri National Park (expansion) (Class A)	9,000
ex Muggon, ex Wooleen	'Muggon – Wooleen' Conservation Park (Class A)	192,000
Ningaloo to Exmouth Gulf		
ex Boologooro	'Boologooro' Nature Reserve (Class A)	15,000
ex Giralia	'Giralia' National Park (Class A)	232,000
Kennedy Range Country		
ex Bidgemia, ex Doorawarrah, ex Minnie Creek, ex Jimba Jimba, ex Lyons River, ex Mooka, ex Mardathuna, ex Middalya, ex Williambury	Kennedy Range National Park (expansion) (Class A)	193,000
ex Pimbee	'Pimbee' Conservation Park (Class A)	99,000
Pilbara Biodiversity Hotspot		
ex Hamersley, ex Hillside, ex Juna Downs, ex Roy Hill, ex Mt Florence, ex Rocklea, ex Mulga Downs, ex Marillana	Karijini National Park (expansion) (Class A)	301,000
ex Meentheena	'Meentheena' National Park (Class A)	217,000
ex Mt Minnie, ex Nanutarra	Cane River Conservation Park (expansion) (Class A)	180,000
ex Karratha, ex Mardie	'Karratha – Mardie' National Park (Class A)	18,000
ex Pyramid	Millstream Chichester National Park (expansion) (Class A)	3,000
Murchison Salt Lake Circuit		
ex Cashmere Downs, ex Bulga Downs (west), ex Bulga Downs (east)	'Cashmere – Bulga' National Park (Class A)	165,000
ex Black Range, ex Kaluwiri, ex Lake Mason	'Black Range – Kaluwiri' National Park (Class A)	332,000
Tallering Botanical Trail		
ex Kadji Kadji, ex Burnerbinmah, ex Karara, ex Lochada, ex Thundelarra, ex Warriedar	'Kadji Kadji – Burnerbinmah' National Park (Class A)	533,000
ex Barnong	'Barnong' National Park (Class A)	168,000
ex Woolgorong	'Woolgorong' Conservation Park (Class A)	116,000
Mid West Mulga Country		
ex Twin Peaks, ex Narloo, ex Yuin	'Twin Peaks – Yuin' Conservation Park (Class A)	102,000
ex Noongal, ex Dalgaranga, ex Lakeside	'Noongal – Lakeside' National Park (Class A)	202,000
ex Doolgunna, ex Mooloogool	'Doolgunna – Mooloogool' National Park (Class A)	591,000
ex Cobra, ex Dalgety Downs, ex Waldburg, ex Narloo, ex Mt Phillip	Mount Augustus National Park (expansion) (Class A)	604,000
ex Wanna	'Wanna' Conservation Park (Class A)	289,000
TOTAL	**24 reserves**	**4,974,000**

10.2 Natural and other values for conservation

The proposed parks harbour a substantial number of Western Australia's threatened and priority species – a total of 77 animal and 279 plant species (Table 10 2). Despite making up less than 2% of the state's land area, the parks would help protect more than a quarter (26%) of Western Australia's terrestrial and freshwater threatened and priority vertebrate animal species (Table 10 2). This includes a sixth of the state's threatened and priority mammal species – bilbies and northern quolls among them – and close to half the threatened and priority bird species, including the night parrot, malleefowl and declining shorebirds such as the eastern curlew.

The proposed parks also harbour almost 8% of the state's threatened and priority plant species. For many of these species, the parks would provide their first formal protection.

The long-tailed dunnart (*Sminthopsis longicaudata*), here on ex Waldburg, has an extremely long tail (twice the length of its head and body) that helps it climb. It is distributed patchily in arid rocky areas and is listed as a priority-4 species. Photo: Samille Mitchell (DEC)

Thirty-four threatened and priority ecological communities – more than 7% of Western Australia's total – would be protected in the proposed parks, most for the first time and several in their entirety (Table 10 2). Most are listed priority-1 communities with very restricted distributions and no existing protection in reserves. They include 8 calcrete groundwater communities on palaeodrainages, which host highly restricted stygofauna species, many unique to a single calcrete, and 9 vegetation complexes associated with banded ironstone formations, which often host rare and endemic plant species. Both types of communities are threatened by mining.

The ecological communities that would receive protection in the reserve system for the first time include the priority-1 Fortescue Marsh in the Pilbara, which is also listed as a nationally important wetland and has globally significant values. The proposed parks would also help protect 4 other wetlands listed by the Australian government as nationally important, all important for waterbirds or shorebirds (Table 10-3). Other sites recognised as nationally or internationally significant include 2 proposed parks overlapping the Shark Bay World Heritage Area, 14 proposed parks lying within national biodiversity hotspots and 3 sites designated by Birdlife International as key biodiversity areas because of their importance for birds (Table 10-3).

Some proposed parks are particularly rich in certain groups of organisms – reptiles and stygofauna in the Pilbara Biodiversity Hotspot, plants in the Tallering Botanical Trail and Shark Bay World Heritage to Wooleen clusters, shorebirds in the Ningaloo to Exmouth Gulf cluster, and stygofauna in the Murchison Salt Lake Circuit (Table 10 3).

Many proposed parks are also highly significant as habitats for at-risk biodiversity (Table 10 3). Three proposed parks each harbour more than 50 threatened and priority species and 6 others each harbor more than 20 such species. Seven proposed parks are particularly important for priority ecological communities. Most of the species and all the ecological communities are unique to Western Australia and many are unique to particular proposed parks.

As one indication of the diversity of landscapes and habitats that would be protected, the proposed parks encompass parts of 216 sub-bioregional ecosystems (Table 10 4). More than half (124, 57% of the total) would receive their first protection in the state's conservation reserve system and three-quarters currently have less than 5% of their extent protected in reserves.

The proposed parks also have important geological features revelatory of the deep history of Western Australia's landscapes. Live stromatolites (bordered by proposed parks at Shark Bay) and fossil stromatolites (in the proposed 'Meentheena' National Park) have global significance for what they reveal about the evolution of early life. Banded ironstone formations on ancient weathered hills and ranges in the Tallering and East Murchison parks also reveal the influence of early forms of life that oxygenated the planet through photosynthesis. Salt lakes of the East Murchison and Mid West Mulga Country parks lie along ancient river valleys reminiscent of much wetter times millions of years ago.

Although not a primary focus in this report, the proposed parks also have outstanding cultural significance. Most properties are recognised or claimed under native title and feature sites telling of the connection of people with these landscapes over tens of thousands of years. The proposed parks would protect 270 registered Aboriginal heritage sites (Table 10 5) as well as many more significant cultural sites not yet registered or lodged.

This dry pool on Peak Hill Creek is adjacent to the old Peak Hill homestead on ex Doolgunna. Photo: David Blood (DEC)

Table 10-2: Numbers of threatened and priority species and ecological communities recorded in the proposed parks and their proportion of the state totals

Property	Numbers recorded in the proposed parks	% of state total (terrestrial & freshwater only)[A]
Mammals	13	16.5
Birds	50	45.0
Internationally protected migratory birds[B]	41	51.9
Reptiles	12	15.6
Fishes	1	4.5
All vertebrate animals	76	25.7
Invertebrates	2	0.9
Plants	279	7.7
Ecological communities	34	7.4[C]

Sources: See technical notes 1 and 2 (chapter 2).

Notes: A. These percentages exclude marine mammals (whales and dolphins), seabirds (albatrosses, shearwaters, petrels, storm-petrels, frigatebirds, tropicbirds), seasnakes and marine fishes. Marine turtles are included due to their use of beaches for nesting. B. This is a subset of priority species, some of which are both listed as threatened and protected under international migratory agreements. It doesn't include species recorded at Lake MacLeod, which is bordered by the proposed 'Boologooro' Nature Reserve. C. This value is 8.7% if only considering priority ecological communities.

Ex Boologooro is a 15,000-hectare property on the eastern shore of Lake MacLeod, where more than 100,000 birds have been counted at a time and 70 species have been recorded. Its values are likely to warrant listing as a Ramsar wetland of international importance. Photo: Gnaraloo Wilderness Foundation

Table 10-3: Some nationally and internationally significant features of the proposed parks

Significant Feature	Relationship with proposed park	Values
World heritage sites		
Shark Bay World Heritage Area	Proposed 'Carrarang' National Park Proposed 'Yaringa – Nanga' National Park	Buffering for Hamelin Pool stromatolites. Botanical transition zone with high floristic values. Natural beauty. Globally threatened species.
National biodiversity hotspots		
Hamersley-Pilbara Biodiversity Hotspot	The 5 proposed parks and park extensions in the Pilbara lie within this hotspot.	Recognised for providing habitat for threatened, endemic and fire-sensitive species and communities.
Geraldton Hills to Shark Bay Sand Plains biodiversity hotspot	4 proposed parks of Shark Bay – 'Carrarang', 'Yaringa-Nanga' and the Zuytdorp Nature Reserve and Kalbarri National Park expansions – lie within this hotspot	Recognised for extensive heaths and scrub-heaths and strongholds for native plants and animals. Also part of the South West Australia global biodiversity hotspot.
Carnarvon Basin	The 4 proposed parks of Ningaloo to Exmouth Gulf and Kennedy Range lie within this hotspot	Recognised for extensive hummock grasslands, acacia shrublands, woodlands and coastal environments.
Central and Eastern Avon Wheatbelt	The western section of the proposed 'Kadji Kadji – Burnerbinmah' National Park lies within this hotspot	Recognised for its few remaining remnants of woodlands of Wandoo, York Gum, Salmon Gum, Casuarina and proteaceous scrub heaths. It contains many threatened species and has high endemism for plants and invertebrates.
Nationally important wetlands		
Exmouth Gulf East wetland	Adjacent to and partly overlapping proposed 'Giralia' National Park	Extensive habitat & migration stop-over for shorebirds, including threatened species; nursery and feeding areas for marine fishes and crustaceans, major dugong population.
Lake MacLeod	Adjacent to proposed 'Boologooro' Nature Reserve	Important habitat for migratory and residential shorebirds. Hosts globally significant populations of at least 10 species.
Fortescue Marsh	About two-thirds is encompassed within the proposed Karijini National Park expansion	Large ephemeral wetland with globally significant values that can attract over a quarter of a million waterbirds. Highly diverse ecosystem. Habitat for night parrot and endemic stygofauna. Listed as a key biodiversity area and priority 1 ecological community.
Lake Barlee	Adjacent to proposed 'Cashmere – Bulga' National Park	Western Australia's second largest lake. Important for waterbirds and shorebirds. One of the most significant breeding sites for banded stilts. Also listed as a key biodiversity area.
Thundelarra lignum swamp	Part of proposed 'Kadji Kadji – Burnerbinmah' National Park	Highly sensitive and at-risk ecosystems of lignum-dominated plant assemblages. Important for waterbirds. 14 of 24 recorded species have bred there.

Table 10-3 (continued)

Significant Feature	Relationship with proposed park	Values
Key biodiversity areas (KBAs)		
Fortescue Marshes KBA	Part of proposed Karijini National Park expansion	Important for large bird populations, including threatened species.
Karara and Lochada KBA	Part of proposed 'Kadji Kadji – Burnerbinmah' National Park	Important in particular for malleefowl.
Lake Barlee KBA	Adjacent to proposed 'Cashmere – Bulga' National Park	Important for waterbirds, including 6 species that breed there.
Outstanding species endemism and diversity		
Stygofauna (Pilbara craton)	Proposed Karijini National Park expansion	The Pilbara bioregion is globally significant for stygofauna diversity, including many short-range endemic species. Fortescue Marsh is underlain by a complex array of stygofauna habitats. Many species are yet to be described.
Stygofauna (Yilgarn craton)	Proposed 'Black Range – Kaluwiri' National Park	The Yilgarn craton is underlain by calcretes with the most diverse water beetle assemblages in the world and high crustacean richness. Many species are unique to single cratons. The parks would protect 8 priority-1 calcrete ecological communities.
	Proposed 'Barnong' National Park	
	Proposed 'Noongal – Lakeside'' National Park	
	Proposed 'Doolgunna – Mooloogool' Conservation Park	
	Proposed Mt Augustus National Park expansion	
Plants	Proposed 'Yaringa – Nanga' National Park	Part of the transition zone between the South West and Eremaean botanical zones, with high levels of plant diversity and endemism. 22, 47 and 19 threatened & priority plant species respectively.
	Proposed Zuytdorp Nature Reserve expansion	
	Proposed Kalbarri National Park expansion	
Plants	Proposed 'Kadji Kadji – Burnerbinmah' National Park	Part of the transition zone between the South West and Eremaean botanical zones, with high levels of plant diversity and endemism. Part of an Australian centre of wattle endemism. 32 plant communities, 63 threatened & priority plant species.
Reptiles	Proposed parks in the Pilbara	The Pilbara has the highest reptile diversity in Western Australia and the greatest number of gecko species in Australia.
Shorebirds	Lake MacLeod borders the proposed 'Boologooro' Nature Reserve	Internationally significant numbers of 10 migratory species have been recorded at the lake. Records of 7 threatened migratory species. Counts of 100,000 birds.
Very important for at-risk species		
Threatened & priority species	Proposed Zuytdorp Nature Reserve expansion	55 species.
	Proposed Karijini National Park expansion	117 species.
	Proposed 'Kadji Kadji – Burnerbinmah' National Park	71 species.

Table 10-3 (continued)

Significant Feature	Relationship with proposed park	Values
Important for at-risk species		
Threatened & priority species	Proposed 'Carrarang' National Park	22 species.
	Proposed 'Yaringa – Nanga National Park'	33 species.
	Proposed Kalbarri National Park expansion	24 species.
	Proposed 'Giralia' National Park	24 species.
	Proposed 'Doolgunna – Mooloogool' National Park	26 species.
	Proposed Mount Augustus National Park expansion	22 species.
Very important for at-risk ecological communities		
Threatened & priority ecological communities	Proposed 'Black Range – Kaluwiri' National Park	4 priority-1 communities.
	Proposed Karijini National Park expansion	3 priority-1 communities & 2 priority-3 communities.
	Proposed 'Kadji Kadji – Burnerbinmah' National Park	3 priority-1 & 2 priority-3 communities, including the Eucalypt woodlands of the Western Australian Wheatbelt (critically endangered).
	Proposed "Barnong' National Park	4 priority-1 communities.
	Proposed Noongal – Lakeside' National Park	2 priority-1 communities.
	Proposed Mount Augustus National Park expansion	1 priority-1 & 3 priority-3 communities.
Other		
Fossil stromatolites	Proposed 'Meentheena' National Park	2.7 billion-year-old stromatolites in the bluff above the Nullagine River are significant for what they reveal about the evolution of early life.
	Proposed 'Doolgunna – Mooloogool' National Park	Unique geology at Mount Leake and stromatolite fossils (up to 1.8 billion years old) of a species recorded only at this locality.

Sources: See technical notes 1 and 2 (chapter 2).

Table 10-4: Sub-bioregional ecosystems in the proposed parks, including those with little or no protection in existing conservation reserves

Cluster of proposed parks	Number of sub-bioregional ecosystems in the proposed parks	Sub-bioregional ecosystems with no existing protection (%)[A]	Sub-bioregional ecosystems with <5% existing protection (%)[B]
Shark Bay World Heritage to Wooleen	50	19	25
Ningaloo to Exmouth Gulf	14	9	12
Kennedy Range Country	22	13	17
Pilbara Biodiversity Hotspot	38	15	24
Murchison Salt Lake Circuit	17	11	17
Tallering Botanical Trail	54	36	45
Mid West Mulga Country	50	39	47
Total[C]	**216**	**124**	**162**

Sources: See technical notes 2 (chapter 2)

Notes: A. The sub-bioregional ecosystems counted here have less than 0.01% of their extent in the conservation reserve system. B. The sub-bioregional ecosystems counted here include those with no existing protection. C. Totals represent unique ecosystems and remove multi counting of ecosystems between chapters

Table 10-5: Registered Aboriginal heritage sites in the proposed parks

Cluster of proposed parks	Registered Aboriginal heritage sites
Shark Bay World Heritage to Wooleen	29
Ningaloo to Exmouth Gulf	6
Kennedy Range Country	11
Pilbara Biodiversity Hotspot	97
Murchison Salt Lake Circuit	57
Tallering Botanical Trail	28
Mid West Mulga Country	42
Total	**270**

Sources: See technical notes 3 (chapter 2), data current to November 2018.

The mangroves of ex Giralia are part of an extensive mangrove system of great importance for the continued health and productivity of Exmouth Gulf. Photo: Pepe Clarke

10.3 Importance for achieving Western Australia's conservation reserve goals

In combination, the proposed parks would enable Western Australia to make substantial progress towards its major conservation goal of a comprehensive, adequate and representative reserve system. Progress has been assessed in this report in 2 ways – the extent to which the parks would enable Western Australia to meet (a) the 2020 international benchmark (17%) for protection of bioregions and sub-bioregions, and (a) the national minimum target of 15% ecosystem protection.

Most of the proposed parks are in bioregions with highly inadequate protection, among the lowest in Australia. The Gascoyne and Murchison bioregions currently have less than 2% of their extent in the conservation reserve system and 10 sub-bioregions – including East and West Murchison (Murchison bioregion), Fortescue, Chichester and Robourne (Pilbara bioregion), Tallering (Yalgoo bioregion) and Ashburton and Augustus (Gascoyne bioregion) – have less than 5% of their extent in the reserve system (Table 10-6).

Gazetting the proposed parks would enable Western Australia to achieve the international benchmark of 17% for 2 bioregions (Geraldston Sandplains and Yalgoo) and 2 sub-bioregions (Tallering and Geraldton Hills) and exceed 10% protection for an additional 2 bioregions and 4 sub-bioregions (Figure 10-2). The parks would more than triple protection for the poorly conserved Gascoyne and Murchison bioregions, as well as for 6 sub-bioregions (Table 10-6).

At the ecosystem level, the proposed parks would in combination enable Western Australia to meet the 15% minimum target for an additional 73 sub-bioregional ecosystems (Table 10-7). For 16 ecosystems with at least 85% of their extent on the properties, there is no other way of achieving the target. (Table 10-7).

Table 10 6: Protection of bioregions and sub-bioregions (% area) in the proposed parks

Bioregion	Sub-bioregion	Current protection	Shark Bay World Heritage to Wooleen	Ningaloo to Exmouth Gulf	Kennedy Range Country	Murchison Salt Lake Circuit	Pilbara Biodiversity Hotspot	Tallering Botanical Trail	Mid West Mulga Country	Potential new protection
Avon Wheatbelt		3.39						0.54		3.93
	Merredin	4.18						0.42		4.6
Carnarvon		5.89	0.86	2.93	3.46		0.65			13.79
	Cape Range	3.44		0.63			2.29			6.36
	Wooramel	6.86	1.19	3.84	4.81					16.7
Gascoyne		1.93							5.78	7.71
	Ashburton	2.85							7.84	10.69
	Augustus	2.53							7.8	10.33
Geraldton Sandplains		16.4	2.84							19.24
	Geraldton Hills	15.4	4.53							19.93
Murchison		1.06	0.62			1.75		0.21	2.27	5.91
	East Murchison	1.39				2.34		0.25	2.14	6.12
	West Murchison	0.06	2.52					0.09	3.74	6.41
Pilbara		6.38					3.88			10.26
	Chichester	3.95					2.6			6.55
	Fortescue	0.55					9.36			9.91
	Hamersley	12.88					3.74			16.62
	Roebourne	3.71					4.13			7.84
Yalgoo		12.53	5.57					14.35	0.61	33.06
	Edel	32.28	17.84							50.12
	Tallering	3.56						20.86	0.89	25.31

Sources: See technical notes 2 (chapter 2).

Figure 10-2: Progress towards the 2020 international benchmark for protection (17%) of bioregions and sub-bioregions (% area protected) due to gazettal of the proposed parks

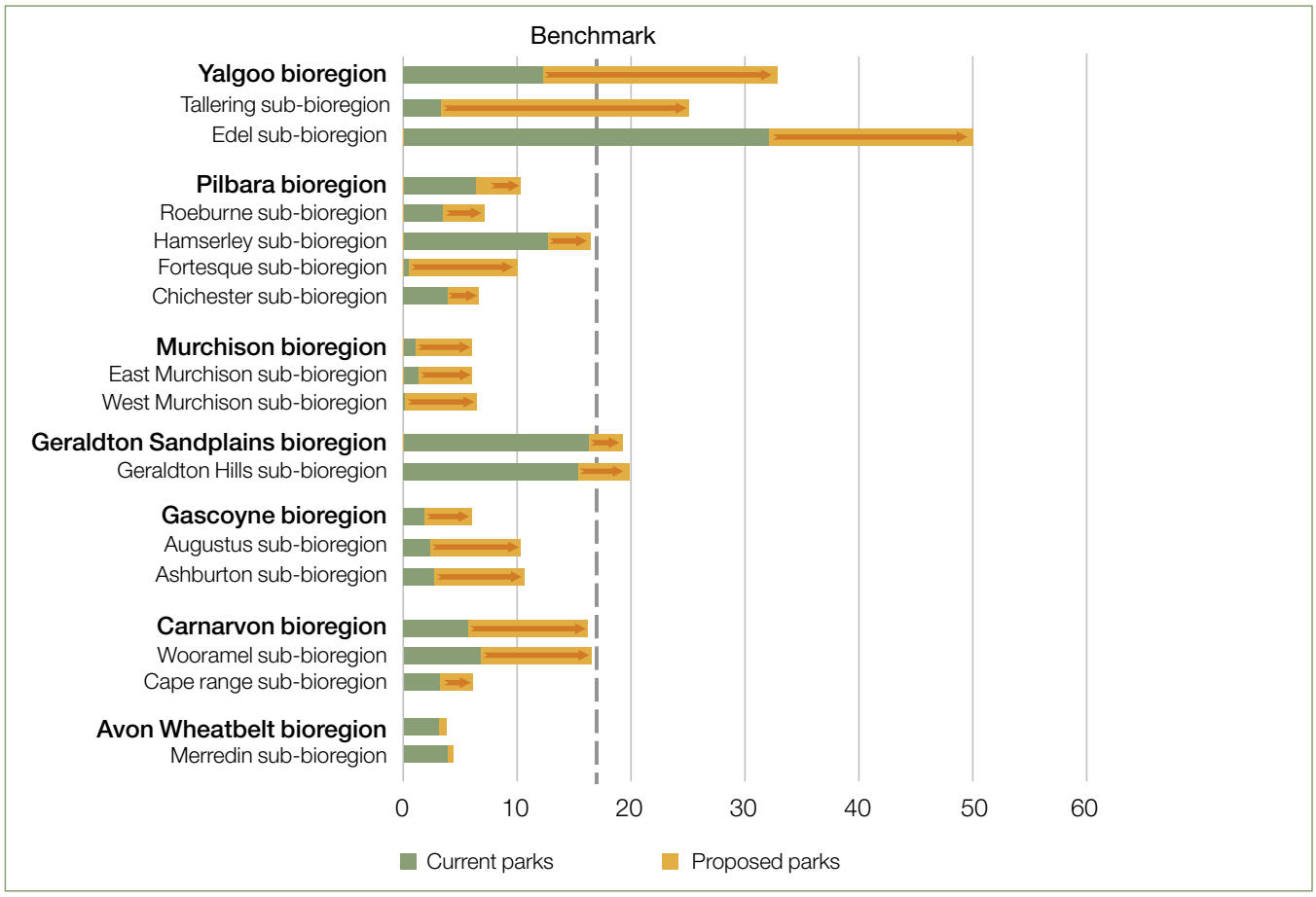


Table 10-7: Contribution of the proposed parks to achieving the state's 15% minimum ecosystem protection target

	Sub-bioregional ecosystems meeting the 15% target if all proposed parks are protected[A]	Sub-bioregional ecosystems with at least 50% of their remaining extent on the proposed parks[B]	Sub-bioregional ecosystems with at least 85% of their remaining extent on the proposed parks[C]
Shark Bay World Heritage to Wooleen	17	9	5
Ningaloo to Exmouth Gulf	5	1	1
Kennedy Range Country	1	0	0
Pilbara Biodiversity Hotspot	5	3	0
Murchison Salt Lake Circuit	4	2	1
Tallering Botanical Trail	24	9	3
Mid West Mulga Country	16	2	1
Total[D]	**73**	**37**	**16**

Notes: A. These values exclude ecosystems already meeting the 15% target. B. These figures include the figures in column 3. C. The state's 15% target for these ecosystems can only be met on the proposed parks. D. Totals represent unique ecosystems and remove multi counting of ecosystems between chapters. For some ecosystems found in multiple chapter groups, when their values are combined more ecosystems meet the specified criteria (e.g. an ecosystem may have 80% of its extent in the Shark Bay proposed parks and 5% in the Tallering proposed parks; hence when combined this ecosystem has 85% of its extent in proposed parks).

Sources: See technical notes 2 (chapter 2)

10.4 Proposed tenures and classifications

Based on considerations outlined in *Methods and approach* (section 2.3.5), we recommend in the preceding chapters that the majority of proposed parks (16 of 24) be gazetted as national parks or added to existing national parks in recognition of their nationally significant values. Two are recommended as nature reserves. The remainder (6 of 24), with values of regional significance, are recommended as conservation parks, but their values should be further investigated and the tenure revised accordingly if new and important values are found.

We strongly recommend that all proposed parks be classified as Class A. This is in recognition not only of their high values, but that they occur in sub-bioregions and bioregions with highly inadequate levels of protection. They were bought mainly for this reason, and represent a rare, not easily repeated, opportunity to fill major gaps in Western Australia's conservation reserve system. The Western Australian government will find it very difficult to make progress on meeting its conservation targets unless these properties are securely protected.

The majority of the proposed parks are largely free of existing mining-related activities (Table 10-8). Just over two-thirds of the total proposed park area, and more than 90% of the Shark Bay to Wooleen and Ningaloo to Exmouth Gulf proposed park areas, for example, are free of such activities. However, the long delay in gazetting these properties – 20 years in some cases – means that some have already been subjected to considerable mining activity. Of 665 current mining tenements, 503 (76%) have been granted since the properties were bought for the purposes of conservation. There are also applications for mining-related activities in process – 111 for exploration (mineral or oil & gas), 15 for mineral mining and 24 for mineral mining infrastructure. Applications for exploration have been made over parts of 17 of the 24 proposed parks.

Our recommendations for the management of existing and proposed mining activities (in the *Mining considerations* sections of this report) are underpinned by both a consideration of what is needed to maintain the properties' natural values for which they were acquired and our understanding of what is possible under Western Australian legislation. Higher standards are expected and required of activities in conservation reserves, so management decisions need to be fully informed by the best available science and best-practice management.

Generally, we have recommended that, in the public interest, applications for new exploration not be granted, to ensure the natural values for which these properties were acquired are maintained. In a number of cases, we propose that exploration applications be assessed by the Environmental Protection Authority prior to consideration by the Minister for Mines. For applications for oil & gas exploration, we recommend that any such activities be restricted to the exceptionally large areas outside the proposed parks.

For existing mineral exploration licenses, we generally recommend that they be referred to the Environmental Protection Authority for environmental assessment, with the potential for conditions to be applied to safeguard important natural values. For locations of high sensitivity or value, we recommend that the Minister for Mines not grant permission for continued operations.

For mining leases, our recommendations to gazette parks as Class A reserves would require that applications for new mining leases are subject to the scrutiny and transparency of the Western Australian parliament in addition to consideration by the Minister for Mines. We generally also recommend that existing mining-related operations and approvals for new activities on existing mining leases be subject to assessment by the Environment Protection Authority at the highest level. In a few cases where important or sensitive values are likely to be substantially compromised by ongoing mining-related activities, we recommend the government enter negotiations to seek the surrender of leases. If that fails, new conditions should be applied to eliminate or minimise environmental impacts. In some cases, we recommend that areas subject to existing mining operations be excised from future parks, due to the likely loss of natural values or to maintain park integrity.

Table 10-8: Proposed park areas (%) free of existing mining-related activity

Cluster of proposed parks	No mineral mining	No oil & gas mining	Combined
Shark Bay World Heritage to Wooleen	96%	100%	96%
Ningaloo to Exmouth Gulf	93%	100%	93%
Kennedy Range Country	100%	73%	72%
Pilbara Biodiversity Hotspot	45%	100%	45%
Murchison Salt Lake Circuit	84%	100%	84%
Tallering Botanical Trail	66%	100%	66%
Mid West Mulga Country	59%	100%	59%
Total	**69%**	**98%**	**68%**

Source: See technical notes 4 (chapter 2).

The assessments of each of the 24 proposed parks in this report make clear that individually and collectively they would make a highly significant, mostly irreplaceable, contribution to Western Australia's conservation reserve system. If securely protected, they would indeed be an extraordinary natural legacy for Western Australia.

Poondarrie Hill on ex Narloo, part of the proposed 'Twin Peaks – Yuin' Conservation Park. Photo: David Blood (DEC)

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