


Jalangurru Manyjawarra Bunuba Muwayi Yarrangu

Draft joint management plan 2019

GOVERNMENT OF WESTERN AUSTRALIA

Conservation and Parks Commission

Department of **Biodiversity, Conservation and Attractions**

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Warning: This plan shows photographs of, mention names, and/or refers to quotations from Aboriginal people who may have passed away.

NB: The spelling of some of the language words for country and species of plants and animals may vary.

Questions regarding this plan should be directed to:
Planning Branch
Parks and Wildlife Service
Department of Biodiversity, Conservation and Attractions
Locked Bag 104
Bentley Delivery Centre WA 6983

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Cover photographs:

Top left: Tunnel Creek Cave in Dimalurru National Park. *Photo – Alison McCarthy/DBCA*
Top right: Waterfall within Miluwindi Conservation Park.
Bottom right: Brooking Creek within Jungi-wa/Guwinyja Conservation Park.
Bottom left: Balili Conservation Park. *Photos – Dave Woods/DBCA*
Main: Jumburrurru (Carpenter's Gap) in the proposed Bandilngan Conservation Park. *Photo – DBCA*

This document is available in alternative formats on request.

Invitation to comment on the draft management plan

This draft management plan has been released for a two-month period to provide the public with an opportunity to comment on the how these national parks and conservation parks of Bunuba country are proposed to be managed over the next ten years.

To ensure your submission is as effective as possible:

- be clear and concise
- refer your points to the page numbers or specific sections in the plan
- say whether you agree or disagree with any or all of the management objectives and strategies – clearly state your reasons, particularly if you disagree
- give sources of information where possible
- suggest alternatives for those aspects of the plan with which you disagree.

The draft management plan will be reviewed in light of the submissions according to the criteria outlined below. A summary of public submissions will be made available along with the final management plan.

The management plan may be modified if a submission:

- provides additional information of direct relevance to management
- indicates a change in (or clarifies) government legislation or management policy
- proposes strategies that would better achieve management objectives
- indicates omissions, inaccuracies or a lack of clarity.

The management plan may not be modified if a submission:

- clearly supports proposals in the plan
- makes general or neutral statements or no change is sought
- addresses issues beyond the scope of the plan
- addresses issues that are already noted within the plan or already taken into consideration during its preparation
- is one among several widely divergent viewpoints received on the topic but the approach in the plan is still considered the best option
- contributes options that are not feasible (generally due to conflict with legislation or government policy)
- is based on unclear or factually incorrect information.

Submissions are welcome during the public comment period and can be made:

- online at https://www.surveymonkey.com/r/bunubacountryparks
- or by writing to:

  Plan Coordinator – Jalangurru Manyjawarra Bunuba Muwayi Yarrangu
  Planning Branch, Parks and Wildlife Service
  Department of Biodiversity, Conservation and Attractions
  Locked Bag 104
  Bentley Delivery Centre WA 6983

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Part 1 – Introduction & management context

This *Jalangurru Manyjawarra Bunuba Muwayi Yarrangu draft joint management plan* ('the plan' or 'this plan' will be used for this, or its final version, throughout the document herein) describes proposed management for conservation reserves in the central Kimberley that are jointly managed by the Department of Biodiversity, Conservation and Attractions ('the department' or DBCA) and Bunuba native title holders. Bunuba language names are used throughout the plan in italicised text; a glossary of these is included in Appendix 1.

1. Management plan area

This plan will apply to the Bunuba Conservation Estate ('the parks') depicted on Map 1 and listed below (along with their proposed Bunuba language names which are shown in italics in this first instance[1]):

- Geikie Gorge National Park – *Danggu* National Park
- Geikie Gorge Conservation Park - *Danggu* Conservation Park
- Brooking Gorge Conservation Park – *Jungi-wa/Guwinyja* Conservation Park
- Windjana Gorge National Park – *Bandilngan* National Park
- Tunnel Creek National Park – *Dimalurru* National Park
- Devonian Reef Conservation Park– *Balili* Conservation Park
- Windjana Conservation Park – *Bandilngan* Conservation Park
- King Leopold Ranges Conservation Park (the Bunuba country or Bunuba *Muwayi* portion only) – *Miluwindi* Conservation Park.

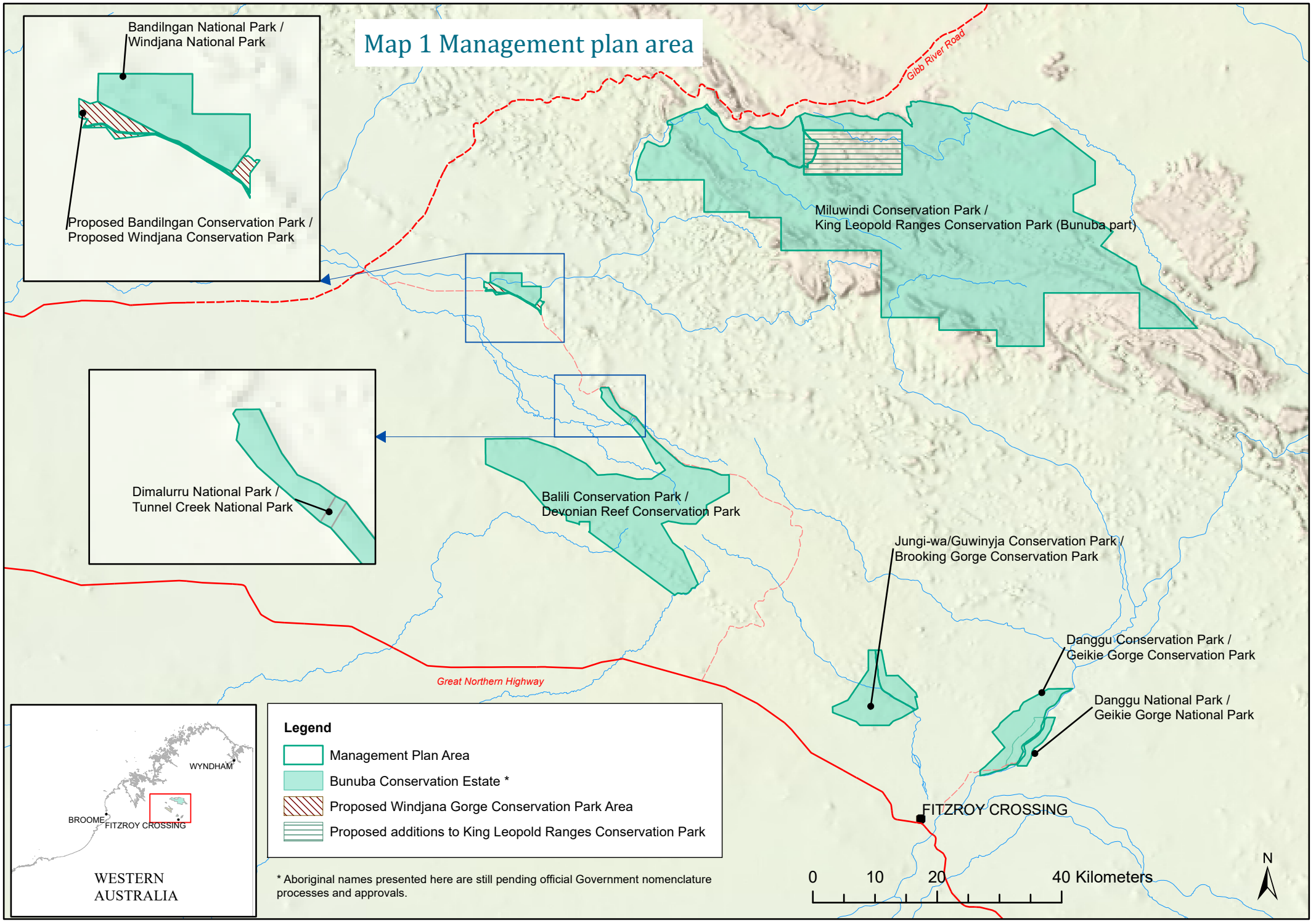
The parks listed above comprise several that have been in the conservation reserve system for some years, some proposed additions to these, and proposed new reserves. The parks are to be jointly vested with the Conservation and Parks Commission ('the Commission') and Bunuba Dawangarri Aboriginal Corporation (BDAC).

Proposed additions to the conservation estate described in this plan (see Map 1) would only be covered by the plan once these areas have been jointly vested with the Commission and BDAC. The processes to create and jointly vest the reserves, and to formalise the Bunuba names for these is underway but not complete at the time of writing. Not all of these reserves currently have legal access or adequate legal access, and this also is a matter that will need to be addressed over the life of the plan.

Only the southern portion of the existing King Leopold Ranges Conservation Park falls within Bunuba country and is therefore to be covered by this plan. This portion will be renamed Miluwindi Conservation Park.

The Indigenous Land Use Agreement described in Section 2 Joint management has identified further 'Future Areas' of land that may also be added to the Bunuba Conservation Estate. If feasible and appropriate, this plan will also apply to these if they or any other areas are added to the Bunuba Conservation Estate over the life of the plan.

[1] Completion of the process to formalise these names through the State's nomenclature procedures is still pending.


Map 1 Management plan area
Bandilngan National Park /
Windjana National Park
Proposed Bandilngan Conservation Park /
Proposed Windjana Conservation Park
Gibb River Road
Miluwindi Conservation Park /
King Leopold Ranges Conservation Park (Bunuba part)
Dimalurru National Park /
Tunnel Creek National Park
Balili Conservation Park /
Devonian Reef Conservation Park
Jungi-wa/Guwinyja Conservation Park /
Brooking Gorge Conservation Park
Danggu Conservation Park /
Geikie Gorge Conservation Park
Danggu National Park /
Geikie Gorge National Park
Great Northern Highway
FITZROY CROSSING
WYNDHAM
BROOME
FITZROY CROSSING
WESTERN
AUSTRALIA
Legend
Management Plan Area
Bunuba Conservation Estate *
Proposed Windjana Gorge Conservation Park Area
Proposed additions to King Leopold Ranges Conservation Park
* Aboriginal names presented here are still pending official Government nomenclature processes and approvals.
0
10
20
40 Kilometers
N

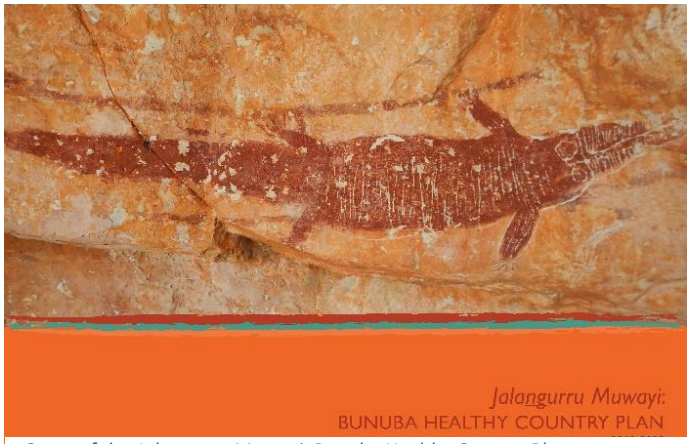
2. Joint management

The parks are for the most part situated on lands the Bunuba Native Title Group hold native title over as determined by the Federal Court of Australia[2]. While the department and Bunuba people have worked together for many years in management operations at Danggu and Bandilngan national parks, more formal and extensive joint management arrangements are now being put in place. An Indigenous Land Use Agreement between BDAC and various State government parties that was registered on the 16th May 2017[3] provides for formal joint management of the parks (*Body corporate Indigenous land use agreement for the creation, joint vesting and joint management of conservation reserves in Bunuba country* – 'the ILUA').

In accordance with the ILUA, the parks will be vested jointly in the Commission and BDAC, and will be jointly managed by BDAC and the department. This draft plan is prepared in accordance with the *Conservation and Land Management Act 1984* (CALM Act). It describes proposed management of the parks for the next 10 years for adoption in a final plan after consideration of public submissions.

A Joint Management Agreement (JMA), to be signed and attached to the final version of this plan, will give effect to joint management of the parks. The JMA will also set out the role of the Joint Management Body (JMB) established pursuant to the JMA. The JMB will comprise representatives of BDAC and the department, and its role will include:

- making decisions in accordance with the plan
- strategically monitoring the management of the parks, including the implementation of this plan.



Cover of the *Jalangurru Muwayi*- Bunuba Healthy Country Plan

This plan has taken into consideration BDAC's *Jalangurru Muwayi* – Bunuba Healthy Country Plan (*Jalangurru Muwayi*), which outlines how Bunuba people see the whole of their country, and how they want to manage it as an interconnected system.

Above Bunuba rangers at a *Jalangurru Muwayi* planning workshop.
Right Tourism planning workshop

Photos – Bunuba ranger team collections.

[2] Determinations by the Federal Court of Australia in Determination #1 - Wurrunnurra vs the State of Western Australia [2012] FCA 1399, in Determination #2- George Brooking on behalf of the Bunuba people (Bunuba #2) vs State of Western Australia [2015] FCA 1481, and in Determination #3 – Mary Aiken on behalf of the Bunuba people (Bunuba #3) vs State of Western Australia [2015] FCA 1482.
[3] On the Register of Indigenous Land Use Agreements pursuant to section 24BI of the *Native Title Act 1993*.

3. Regional context

The parks are in the Kimberley Region of Western Australia within the Shire of Derby-West Kimberley. Fitzroy Crossing, with around 1300 people[4] is the nearest town. There are also numerous small Aboriginal communities throughout the area.

The Bunuba Conservation Estate is generally situated within two biogeographical regions; the King Leopold Ranges of Miluwindi Conservation Park are mainly within the Pentecost subregion of the Central Kimberley biogeographic region; and the Devonian reef parks are mostly within the Fitzroy Trough subregion of the Dampierland biogeographic region[5]. The biogeographical region distinction corresponds with the King Leopold Orogen; a major geological divide separating the King Leopold Ranges on the margins of the Kimberley Plateau from the remainder of the parks in the Canning Basin.

The climate is semi-arid to tropical monsoonal and almost all rain falls in the hot humid wet season, generally between November and April. The dry season is characterised by clear skies and warm weather. Despite receiving high rainfall, the region is seasonally water-limited due to long dry seasons and very high evapotranspiration rates. High intensity rainfall events and flooding are normal occurrences during the wet season. Normal, healthy ecosystem function is intrinsically linked to these fluctuating natural extremes of water abundance and scarcity.

The main industries in the area are pastoralism, mining, tourism and some horticulture. Land surrounding the parks is predominantly under pastoral lease tenure used for cattle production[6], and there is also adjoining conservation estate north of the Gibb River Road[7]. At the time of writing there are also several mining tenements on land around the reserves, and some mining exploration licence tenement applications pending over parts of the conservation estate. Target commodities of these are principally base metals (e.g. zinc, lead and copper) and precious minerals (diamonds). Mining is not generally consistent with the purpose of conservation reserves such as those covered by this plan. The *Mining Act 1978* includes various provisions regarding mining in conservation reserves, including, for example, that mining leases cannot be granted in a national park without the consent of both Houses of Parliament. At the time of writing there are no petroleum titles intersecting the Bunuba Conservation Estate.

The Great Northern Highway provides sealed two-wheel drive access to the area, while the Gibb River Road and the Fairfield-Leopold Downs Road provide unsealed seasonal four-wheel drive access. The Geikie Gorge Road provides two-wheel drive access to Danggu National Park.

There is a small international airport at Broome, and other airports at Kununurra, Derby, Fitzroy Crossing and Halls Creek. There are also a considerable number of small airstrips dotted throughout the region, including ones that are on CALM Act land near Bandilngan National Park and within King Leopold Ranges Conservation Park. Air charter companies offer services for private or corporate purposes, and numerous companies run scenic flights in the area.

The Kimberley is renowned for its spectacular iconic scenery and remote wilderness qualities and attracts tens of thousands of visitors annually. For the years 2015-2017, around 42 per cent of domestic visitors and 93 per cent of international visitors travelled within the Shire of Derby-West Kimberley for holiday or leisure purposes[8]. Opportunities for nature-based tourism and recreation are a key reason people visit the area, with

[4] based on a person's place of usual residence on Census night 2016- Australian Bureau of Statistics, *2016 Census QuickStats*, viewed 1 May 2018, <http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016>

[5] Based on the Interim Biogeographical Regionalisation for Australia (IBRA) version 7. IBRA regions and subregions represent a landscape based approach to classifying the land considering attributes of climate, geomorphology, landform, lithology, and characteristic flora and fauna. Further detail about IBRA Version 7 is available via the Australian Department of Environment and Energy webpages at <http://www.environment.gov.au/land/nrs/science/ibra/australias-bioregions-maps>

[6] Cattle production may intensify in this region as a result of the State Government's 'Water for Food' initiative which is exploring the option of using groundwater resources to support irrigated agriculture, including irrigated pastures.

[7] That is, part of the King Leopold Ranges Conservation Park that is not within Bunuba country but rather coincides with the adjacent Wanjina Wunggurr Wilinggin native title determination area.

[8] According to Tourism WA 2017, Shire of Derby-West Kimberley Visitor fact sheet, Three Year Average – 2015/2016/2017.

popular activities including camping, fishing, four-wheel-driving, walking, canoeing, viewing wildlife, and seeing Aboriginal rock art. The parks protect some of the most spectacular natural attractions in the region and are a significant focus for nature-based recreation and tourism. The parks are closed during the wet season though when key access roads become impassable for months at a time, and very few tourists visit the Kimberley due to the lack of access and the hot humid weather.

Many pastoral station properties also cater for visitors to the area having diversified their operations to include various tourism facilities and services. These include a spectrum of accommodation options ranging from very basic campgrounds, to permanent and semi-permanent 'wilderness lodges' and cabins. Some of these station tourism ventures also run or organise activities and tours (e.g. horseback trail rides, scenic flights, Aboriginal cultural or rock art tours).

4. Legislative context

This draft plan, prepared in accordance with Part V, Division 1 of the CALM Act, has been developed by the 'Joint Responsible Body'[9] for the parks being the Commission and BDAC, through the agency of the department. The parks will be managed jointly by BDAC and the department as described in the JMA that will be attached to the final plan (as stipulated in section 56A of the CALM Act). The JMA will give effect to joint management of the parks and set out the role of the Joint Management Body (JMB).

The reserves covered by this plan include national parks and conservation parks and are managed under the CALM Act. Management plans approved and prepared under the CALM Act must promote the purpose for which the land is reserved. Section 56(1)(c) of the CALM Act specifies that:

> "in the case of national parks and conservation parks, is to fulfil so much of the demand for recreation by members of the public as is consistent with the proper conservation of the natural environment, the protection of flora and fauna, and the preservation of any feature of archaeological, historic or scientific interest".

Management plans must also have the objective of protecting and conserving the value of the land to the culture and heritage of Aboriginal persons as specified in section 56(1)(2) of the CALM Act.

Bunuba entity proposals for tourism or commercial operations on land that forms part of the conservation estate will need to be assessed for consistency with the reserve purpose and suitability for management under the CALM Act. The ILUA explains (in Clause 15) that alternative tenure arrangements will be considered on a case-by-case basis for Bunuba entity proposals that cannot be accommodated under the CALM Act.

The final plan approved by the Minister for Environment will guide management of the parks for ten years from gazettal, or until it is replaced by a new plan. The plan may be amended if necessary, in accordance with section 61 of the CALM Act.

The CALM Act includes provisions for monitoring, evaluating and assessing the implementation of management plans as specified in section 19(g) of the Act. Further information relevant to performance assessment of this plan is provided in Section 9.

Other key legislation relevant to the management of the parks is that which provides for the protection of wildlife and biodiversity and is also administered by the department; such as the *Biodiversity Conservation Act 2016* (Biodiversity Conservation Act).

The parks include numerous values considered as 'matters of national environmental significance' for the purposes of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). More specifically, the parks are included in the West Kimberley National Heritage Area, and support nationally threatened species and migratory species protected under international agreements. Any actions that will

[9] A term defined by the CALM Act.

have or are likely to have a significant impact on a matter of national environmental significance requires assessment and approval under the EPBC Act.

A range of legislative requirements apply or could apply to management of the parks in addition to those associated with the legislation mentioned above. This includes, for example, legislation applicable to heritage protection, fisheries management and bushfire management. Some specific requirements of such legislation are highlighted in relevant sections throughout this plan.

Karst landscapes:
Dimalurru National Park above,
and Danggu National Park left.

Photos - DBCA

5. Key values

The most significant (currently known) values that management of the parks will focus on protecting are listed below and discussed in more detail throughout the plan.

Part of the West Kimberley National Heritage Area

The parks have multiple outstanding heritage values that contribute to the formally recognised national heritage significance of the West Kimberley (see values marked * below).

Bunuba cultural heritage and archaeological values

- The parks are part of Bunuba people's cultural landscape derived from the *Ngarranggani* (Creation time), to which they have a deep and spiritual connection, and that is integral to their law and culture.
- Country for which Bunuba people have cultural responsibilities to care for, and to practice their law, language and culture within.
- Numerous sites of special Bunuba cultural heritage significance (e.g. rock paintings and engravings, water sources, camps, burial sites, ceremonial sites, mythological sites and archaeological deposits).
- Habitats, plants and animals that hold particular cultural importance for a variety of reasons. These include various foods, medicines, ceremonial or other cultural resources that are a fundamental part of Bunuba people's culture and customary practices.
- Country that is linked to traditional knowledge that has been passed down from generation to generation, for thousands of years, and that is integral to keeping Bunuba cultural heritage alive.
- Country associated with Bunuba people's long-standing resistance campaign to the advancing frontier of historical European settlement. The resistance campaign spanned 13-years which was an unusual achievement in the history of the Australian frontier conflict*.
- Bunuba people's and Bunuba country association with the man and the legend of Jandamarra*.
- Important archaeological sites, objects and other values that are not only of immense importance to Bunuba people, but also of global and national significance. These include:
    - The world's earliest evidence of a ground-edge axe blade, between 44,000 - 49,000 years old, the time when or soon after humans arrived in Australia[10].
    - The oldest known shaped and utilised bone implement from an Australian context[11].
    - The oldest known Indigenous habitation site in northern Australia, dated by the radiocarbon dating technique to have been occupied from over 49,000 years ago.
    - The oldest example presently known from Australia of symbolic use of ochre intentionally applied to a rock surface*.
    - Findings that demonstrate the use of marine shell decorative items and traditional Aboriginal social and economic trading networks*.
    - Archaeological deposits with a rare sequence of botanical remains spanning 40,000 years *.

Geo-heritage values

- The King Leopold Ranges (*Miluwindi*) which reveal ancient geological processes and events that were significant in the evolution of the Australian continent, and processes and events that helped build the modern Kimberley topography*.
- Remnants of the Devonian Reef Complex (*Balili*), an ancient limestone barrier reef laid down about 380-360 million years ago. The Kimberley Devonian reef complex is amongst the best-preserved ancient reef complexes in the world, records 20 million years of reef development, and provides insights into a mass extinction event*.

[10] While the artefact was excavated from a site in Windjana Gorge National Park in the late 1990s, its significance was not confirmed until well after the inclusion of the West Kimberley in the National Heritage List in 2011. This significant finding was therefore not identified as one of the national heritage values at that time.

[11] As per the situation described in the previous footnote, this significant finding was also not identified as one of the national heritage values of the West Kimberley as its significance was confirmed after the time of the national heritage listing.

- Numerous and diverse types of well-preserved fossils in the Devonian reef that can provide valuable information about the animals, plants and reef-building organisms that lived in and around the reef during that period, including insights into the evolution of life of early Earth*.
- The Devonian reef is one of the major karst areas of Australia. Caves, crevices, tufa and other karst features in the Devonian reef parks provide important and, in some instances, critical habitat for a range of species including threatened and other species of special conservation significance.
- Specific geo-heritage sites recognised for their special research, education and geo-heritage significance (at Windjana Gorge, Geikie Gorge, Tunnel Creek and Dingo Gap).

Ecological values

- Largely undisturbed surface water and groundwater systems that underpin and sustain many of the parks' most significant assets.
- Rivers and waterholes, springs and other sites of permanent freshwater that provide critical habitat or drought refuge to a wide range of species (including species that are threatened or of other special conservation significance).
- Several wetlands that are recognised in the Directory of Important Wetlands in Australia; at Geikie and Windjana gorges for providing good bioregional examples of permanent river pools, and the Tunnel Creek Cave pool, which provides a good example of a subterranean karst wetland.
- A diversity of vegetation including: tropical savanna of varying structure, species and species associations; riparian communities with species not found in the savanna; and scattered relictual remnants of formerly more widespread rainforest.
- A range of fauna habitats including terrestrial and aquatic environments that together support a rich and diverse native fauna.
- Karst landscapes that support unique and distinctive flora and fauna.
- Refugial habitats that have contributed to speciation and high levels of endemism in some fauna (e.g. certain gecko genera, land snails and subterranean invertebrates)*.
- Threatened flora species – mountain white gum (*Eucalyptus mooreana*) which is almost entirely confined to the King Leopold Ranges within the conservation estate.
- Threatened fauna including species of mammals, birds, fish and land snails. The latter group includes species only known from the parks.
- Numerous priority flora and fauna species and communities that are potentially rare.
- Invertebrates in cave pools and springs in the Oscar and Napier Ranges which include likely relictual elements of ancient freshwater lineages.
- Bird species subject to various international agreements.

Recreation and tourism values

- Iconic features of the Kimberley landscape that provide benefits to the regional economy through their tourism value.
- A range of aesthetic characteristics in the conservation estate which combine to create varied and distinctive visual landscapes of exceptionally high quality. Geikie Gorge Conservation Park (Danggu Conservation Park), Geikie Gorge National Park (Danggu National Park), Windjana Gorge National Park (Bandilngan National Park) and the King Leopold Ranges Conservation Park (Miluwindi Conservation Park) have been identified as being of outstanding heritage value to the nation because of their particular aesthetic characteristics valued by the Australian community *.
- Opportunities for visitors to view native wildlife and engage in a range of nature-based recreation and tourism activities.
- Opportunities to enrich visitors' experiences through presentation of the culture, history and stories associated with the parks.

6. Vision

The vision for the Bunuba Conservation Estate is that:

A strong joint management partnership is in place with all parties working effectively together to help realise shared goals. Bunuba people are back on country practising their culture, and visitors have opportunities to learn about the significance of the parks to Bunuba people and culture. Aquatic and terrestrial habitats in the parks are in good condition and support a rich diversity of native wildlife, and threatened species and communities have become more secure. Research is providing valuable insights into the special values of the parks and how best to conserve these. Visitors can enjoy a range of sustainable nature-based recreation and tourism activities in the parks.

Boabs (*Adansonia gregorii*). *Photo – DBCA*

7. Strategic goals

A set of strategic goals have been developed for the parks. These recognise Bunuba people as native title holders, the purpose for which the parks have been reserved, other legally stipulated purposes, and values of international, national and regional significance. These strategic goals provide a link between the vision statement above and the desired outcomes expressed through the objectives identified throughout the plan. The strategic goals for joint management of the Bunuba Conservation Estate are to:

- Conserve biodiversity
- Conserve ecological integrity (ecological systems, processes and function)
- Conserve features of archaeological, historic or scientific interest
- Conserve features of special conservation significance (e.g. rare or endemic plants, animals or habitats; values of international, national or regional significance)
- Protect and conserve the value of the land to the culture and heritage of Aboriginal people
- Acknowledge Bunuba people's rights, interests, culture and knowledge of country
- Provide for Aboriginal customary use and enjoyment
- Promote nature-based recreation and tourism opportunities that are compatible with conservation of natural and cultural values.

8. Plan implementation

The JMB's role will include strategically monitoring implementation of the plan. The implementation of the plan and its effectiveness in achieving management objectives will be assessed as per Section 9 Performance assessment.

Day-to-day and on-ground management to implement the plan will be administered by the department, with the Bunuba rangers and other Bunuba people engaged in this in various ways. This will include, for example, ongoing training of Bunuba rangers, as well as fee-for-service contracts with Bunuba people or businesses. This will provide opportunities for Bunuba people to be engaged in a wide range of land management activities including fire, weed and feral animal management, visitor services and facilities management, tourism initiatives, and biodiversity surveys and other research activities.

The plan will apply to the parks for ten years from gazettal, or until it is replaced by a new plan. To help facilitate implementation of the plan, operational management systems and documents (e.g. work plans) will detail more specific management that is consistent with the plan and supports performance assessment. These operational documents are more frequently reviewed and help facilitate adaptive management of the parks.

9. Performance Assessment

Assessing the implementation and effectiveness of this plan is a vital part of the planning process. Periodic performance assessments facilitate better, more adaptive management, allowing timely implementation of alternative management approaches if objectives are not being met.

The CALM Act includes provisions for monitoring, evaluating and assessing the implementation of management plans as specified in section 19(g) of the Act. The parks are very rich in cultural, ecological and social values and it is not feasible or necessary to monitor the condition of all the key values of the parks. Rather, to help evaluate whether this plan is effective, a set of Key Performance Indicators (KPIs) have been specified for selected values. KPIs focus on the most significant values which, using the best available knowledge at the time of planning, were considered to be (or potentially be) at greatest risk over the life of this plan. Each KPI comprises three components; performance measures, targets and reporting requirements. KPIs are presented at the end of the relevant management summary tables in Part 2 of this plan. These KPIs, and/or other measurable outcomes, will be used for performance assessment of this plan.

KPIs will be reviewed according to the indicative frequency identified in the reporting requirement component for each KPI. The information obtained from these reviews will form the basis of a status report for joint management partner (i.e. the department and BDAC) consideration. This process facilitates adaptive management and timely assessment of management effectiveness in achievement of objectives.

A portfolio of evidence will be maintained to help demonstrate management implementation and outcomes. This will also provide information to assist with reporting requirements identified for each KPI. The following are examples of evidence that may be used for assessment purposes:

- specific, quantitative monitoring of significant assets
- series of photographs, mapping or other imagery which show spatial and temporal changes
- checklists
- surveys
- incident investigation reports or records
- other written documents or forms.

Part 2 – Summary of proposed management

10. Bunuba cultural heritage values

The parks are on country that Bunuba people have been connected to for thousands of generations. Bunuba people call this country their *Muwayi*, a term which in its broadest sense means land, but is a concept that has layers of meaning. Bunuba people and country are deeply connected through their law and culture. The *Jalangurru Muwayi* explains that Bunuba *Muwayi* (Bunuba country) comprises numerous smaller *Muwayi*:

> "The Bunuba people are made up of extended families, or clans, which we call *Dawangarri*. Each *Dawangarri* has a country, or *Muwayi*. So, for example, the people who belong to *Mililiny* are known as the *Mililiny Dawangarri* for the *Mililiny Muwayi*. In the days before the *malngarri* (white man) arrived there were eighteen *Dawangarri*, each with its own territory, who together made up the Bunuba nation. We are *Waringarri, Malunggu, Mililny, Miluwindi, Danggu, Mawanban, Munmaral, Rararrawali, Manjali* and *Galamanda*. We are river, ranges, plains and fringing desert people."[12]

Management for Bunuba cultural heritage values
Values and management issues

Bunuba people, Muwayi (country) and Law

- The parks are on country that Bunuba people have been connected to for thousands of generations. Bunuba people call this country their *Muwayi*.
- Bunuba people and country are deeply connected through their law and culture which is derived from *Ngarranggani* (Creation time). *Ngarranggani* stories and *Junba* (song-lines, dance and song) are passed down from generation to generation. Country is believed to be kept alive through the law and cultural practise of Bunuba people, and Bunuba people are kept healthy, spiritually, physically and emotionally by practising this law and culture.
- Bunuba history includes the long-standing resistance campaign that held back the advancing frontier of historic European settlement for 13 years; an unusual achievement in the history of the Australian frontier conflict, and one of the values identified as contributing to the national heritage significance of the West Kimberley. Similarly, Bunuba people's and country's association with the man and the legend of Jandamarra is recognised as being of national heritage significance. Bunuba people are proud of their history of sustained resistance and of Jandamarra who is remembered as a great warrior, and as a clever and courageous leader who defended Bunuba country against overwhelming odds. Bunuba people also remember him as:

  > "a *Jalnggangurru*, a man bestowed with spiritual powers that flowed from the timeless law of our country, who could disappear, transform into a bird and shield himself from deadly weapons" (quote from *Jalangurru Muwayi* 2018).

Sites, habitats, plants and animals of special cultural significance

- Bunuba people's very long use and connection to land on which the parks are situated is reflected in the myriad significant cultural heritage sites and objects, some of which are formally registered under the *Aboriginal Heritage Act 1972*. The value of Aboriginal heritage sites in the parks is inherently linked to the lands and waters in which they occur, and the ability of Bunuba people to access and manage these sites as necessary.
- Registered sites in the parks include important archaeological sites that are not only of immense importance to Bunuba people, but which have also been recognised as being of national heritage significance. Recent research has also uncovered archaeological findings that are significant on a global scale. Aboriginal cultural heritage sites are protected under the *Aboriginal Heritage Act 1972*, and as some contribute to the significance of the West Kimberley National Heritage area, they are therefore also protected under the EPBC Act.

[12] This quote, along with other quotes and information relating to Bunuba history and cultural values presented in this section, and throughout the plan, have been derived from BDAC's *Jalangurru Muwayi* and otherwise provided by Bunuba people through the planning process.

Management for Bunuba cultural heritage values

- *Garuwa* (water) places and flows hold special cultural significance for Bunuba people. As well as being important places for camping and providing key foods and other resources, many *Garuwa* are associated with sacred *Junba* song-lines, or are homes to the *Ungguds*, the rainbow serpents of the *Ngarranggani* (Creation) time.
- Aboriginal heritage sites and other cultural values could potentially be impacted by inappropriate visitation, weeds, feral animals and fire. The main potential threats to the cultural value and significance of *Garuwa* (water) and associated species include significant alterations to the natural water regimes, weeds, feral animals and inappropriate fire regimes.
- Certain plants and animals hold particular cultural importance for Bunuba people for a variety of reasons. They may for example have a part in the stories of *Ngarranggani* (Creation), have a role as indicators of traditional seasons, or be an important customary food, medicine, ceremonial or other cultural resource.

Customary activities and traditional knowledge

- There are a wide range of customary activities that Bunuba people practise as an inherent part of their cultural heritage. These activities include hunting, fishing and gathering other foods, medicines or other cultural resources. Going onto country to continue these activities, and to pass on associated knowledge, traditions and skills from generation to generation is integral to keeping Bunuba cultural heritage alive.

> Bunuba people stand strong and still retain rich knowledge of our country, culture, language and law. We have lost many of our old people but still have a few elders remaining who carry the most important elements of our cultural knowledge, *Junba* and language. There is no time to waste. It is critical that we immediately document and record this knowledge from our remaining elders.
>
> **Extract from the *Jalangurru Muwayi* 2018**

> Going out hunting gives us opportunities to use our language, teach and share knowledge with our youth, sing, conduct ceremony, celebrate and monitor country and wildlife health. We are spiritually and physically healthier when we undertake these activities on country. We must increase the opportunities for our young people to participate in these activities with elders.
>
> **Extract from the *Jalangurru Muwayi* 2018**

- A fundamental part of safeguarding Bunuba cultural heritage values is ensuring that Bunuba people can access and use their traditional lands and its resources to practise their law, culture and customary activities. The CALM Act provides for joint vesting and joint management of conservation reserves, and, along with the Biodiversity Conservation Act provides for Aboriginal customary activities. With these provisions, and the joint management arrangements in the ILUA and JMA, Bunuba people are in a strong position to make decisions about how the parks are managed, and can access the conservation estate to practise their law and culture, and conserve their cultural heritage.
- In addition to Bunuba people holding positions on JMB, the ILUA and JMA include provisions for Bunuba people to derive benefits from country by way of various employment, training and potential business opportunities associated with management of the

Preparation for smoking ceremony for visitors to country. *Photo – Bunuba ranger team collections*

Management for Bunuba cultural heritage values

parks.

- Improving people's awareness and understanding of Bunuba people's deep connection to country through their law and culture can help with conserving the cultural heritage values of the parks.
- Cross cultural awareness training for staff and other people who work on Bunuba country and with Bunuba people can facilitate more effective joint management of the parks.
- The formal adoption of Bunuba language names for the parks will help to communicate Bunuba people's connection to this land.
- Some parts of the conservation estate, such as Jungi-wa/Guwinyja Conservation Park and Balili Conservation Park, do not currently have adequate legal road access and this hinders not only Bunuba people's access for cultural purposes, but management of the parks in general.

Archaeological sites and associated values

- Certain Bunuba cultural heritage sites in the parks as well as being highly important to Bunuba people, contribute a great deal to archaeological research and a range of other scientific disciplines.
- The parks have several archaeological values that contribute to the national heritage significance of the West Kimberley, including: a rare sequence of botanical remains spanning 40,000 years; evidence of Pleistocene aged use of ochre in rock art; marine shell beads and fragments found hundreds of kilometres away from the coast, and, qualities of the Devonian reef that result in a rare level of preservation of ancient organic materials.
- There have also been significant archaeological findings since the national heritage listing occurred in 2011, albeit from artefacts excavated in the late 1990s. An artefact from Carpenter's Gap has been found to be the world's earliest known evidence of a ground-edge axe, dated between 44,000 - 49,000 years old, when or soon after humans arrived in Australia. Another artefact from the same site is the oldest known shaped and utilised bone implement from an Australian context.

Management objectives

1. Bunuba people can access the parks to carry out their law, culture and customary activities as necessary.
2. The value of the parks' lands and waters to the culture and heritage of Aboriginal people (including its sites, habitats, plants and animals of special cultural significance to Bunuba people) is conserved.
3. Human activities in or near the parks do not adversely affect the Aboriginal cultural heritage sites and other cultural values within these areas.
4. The value of Bunuba people's traditional knowledge is recognised and used in managing the parks where appropriate.
5. Bunuba people have opportunities to be trained and employed in conservation and land management activities relevant to the parks, and to develop or expand commercial tourism business operations in the parks.
6. People working in the parks, and visitors, have opportunities to become aware of the cultural significance of these areas to Bunuba people.

Strategies

1. Facilitate Aboriginal customary activities in the parks consistent with relevant provisions in the CALM Act, Biodiversity Conservation Act, and associated regulations, policy and 'local area arrangements'[13].
2. Facilitate negotiations with relevant parties early in the life of this plan to ensure all the parks have adequate legal access (e.g. establish legal access to Jungi-wa/Guwinyja Conservation Park and Balili Conservation Park).
3. Ensure management operations and developments in the parks do not adversely affect cultural heritage sites and other cultural values, and implement measures to address site-specific issues if considered necessary by Bunuba people (e.g. fire management to protect heritage sites).
4. Make sure that any known potential risks to Bunuba cultural sites and other cultural values are evaluated and highlighted, where relevant when providing advice on external planning and development proposals that have the potential to adversely affect the parks.
5. Use legal mechanisms (e.g. notices under the CALM Act) and/or other measures (e.g. signage, information, education, fences and gates) to restrict or otherwise manage public access to protect culturally sensitive areas if considered necessary by Bunuba people.
6. Facilitate observance of Bunuba cultural protocols as necessary subject to Bunuba advice (e.g. ensure cultural protocols are incorporated into research or commercial operator lease or licence conditions where relevant).
7. Implement strategies described throughout this plan that help conserve native habitats and species to

[13] Further information regarding legislation and policy on Aboriginal customary in conservation estate is available via the department's website. Information about local area arrangements can be obtained from the relevant local departmental office, which in this case is the DBCA office in Broome, Western Australia.

simultaneously conserve the cultural heritage values of these habitats and species. For example, implement strategies aimed at protecting *Garuwa* (water) values and associated habitats and species (e.g. see strategies in Sections 13, 14 and 15).

8. Carry out investigations if considered necessary by Bunuba people to further identify and conserve the value of the parks to the culture and heritage of Aboriginal people.
9. Support Bunuba people in their need to ensure traditional cultural knowledge is transferred from aging elders to and for younger generations (e.g. providing support for on-country trips in the parks with elders, recordings of oral histories, cultural values mapping/databases).
10. Utilise traditional knowledge provided by Bunuba people where relevant to implementing this plan and achieving its management objectives.
11. Provide Bunuba people with training and employment opportunities in conservation and land management activities relevant to the parks (e.g. employing staff to work in the reserves, 'on-the-job' training, fee for service contracts with Bunuba people or businesses, other training in conservation or tourism skills, facilitating Bunuba commercial tourism operations in the parks consistent with the purpose of the reserves).
12. Incorporate information about Bunuba cultural values into education and interpretation materials and programs relevant to the parks, as considered appropriate by Bunuba people.
13. Complete nomenclature procedures and processes to formalise the Bunuba language names for the parks, as necessary in accordance with relevant Government legislation and policies (e.g. the *Land Administration Act 1997*).
14. Facilitate cross cultural awareness training for staff and other people who work within the parks and with Bunuba people.
15. Maintain a portfolio of evidence to facilitate reporting and assessments against the KPIs below.

Key performance indicators

Performance measures	*Targets*	*Reporting requirements*
The existence of legal access to Jungi-wa/Guwinyja Conservation Park and Balili Conservation Park.	Legal access to these parks achieved within 5 years of commencement of this plan.	Every 5 years
Bunuba people's level of satisfaction with the condition and management of sites and other assets of special cultural heritage significance to Bunuba people.	Bunuba people are satisfied[14] that these are being maintained in adequate condition over the life of this plan.	Every 3 years
Identification of processes/procedures to facilitate consideration of Bunuba traditional knowledge in management of the parks.	Any processes/ procedures agreed through the JMB are observed over the life of this plan.	Every 5 years
Opportunities provided to support transfer of Bunuba traditional knowledge to/for younger generations.	Traditional owner satisfaction[15] that opportunities to facilitate transfer of Bunuba traditional knowledge from elders for younger generations within the conservation estate have been supported.	Every 5 years
Number of Bunuba people employed in management activities relevant to the parks.	Maintained or increasing trend in the numbers of Bunuba people employed[16].	Every 3 years
Opportunities for staff and visitors to become informed of the Bunuba cultural context of the parks.	Opportunities provided over the life of this plan[17].	Every 3 years

[14] As expressed through the BDAC representatives on the JMB.
[15] As expressed through the BDAC representatives on the JMB.
[16] Either directly, via fee for service arrangements, or otherwise via Bunuba commercial enterprises.
[17] E.g. through signage, brochures and other information media, and Bunuba led cultural awareness programs.

Jandamarra

By the mid -1880s the sheep men were coming from the south, and the cattlemen from the northeast. Bunuba *Muwayi* had become frontier country. Like all frontier wars it was a harsh time and ancestors did not surrender their country easily. There were clashes and killings aplenty in those first years of the invasion of our country. A great man called Yilimarra was the foremost of the Bunuba leaders. At times he sought to negotiate with the newcomers, but he was also fierce in defending the *Muwayi.* The rough ranges and hidden valleys of our country offered refuge to those Bunuba who refused to settle in the station camps.

In 1894 everything changed. A young man, who we call Jandamarra, and the *malngarri* called Pigeon, grew up on the white side of the frontier on Lennard River Station. He became a skilled horseman and stockman, and adept with the *malngarri's* greatest weapon, the rifle. While undergoing his initiation into manhood, and like so many Bunuba, he was arrested in a police raid and imprisoned for the catch-all crime of spearing stock.

When he came back Jandamarra settled at *Limalurru* (Lillimooloora) with its manager Bill Richardson. The Bunuba resistance, mainly by burning of the grasslands, forced its closure and Lillimooloora became a police station, with Richardson as the trooper in charge, and Jandamarra as his tracker.

The trooper and his tracker captured dozens and dozens of our people who were banished to jails in Derby, Roebourne, and far to the south on Rottnest Island. In October of 1894 they brought in most of the remaining Bunuba leaders, including Jandamarra's uncle Yilimarra. It seemed that the Bunuba resistance could be over, and the pastoralists would have free reign over our *Muwayi*

But over the long days chained there at Limalurru, Yilimarra and his countrymen persuaded Jandamarra to come to his senses and return to his people. Jandamarra shot Richardson and released the prisoners. This was the beginning of his reign as a powerful resistance leader protecting Bunuba country and culture.

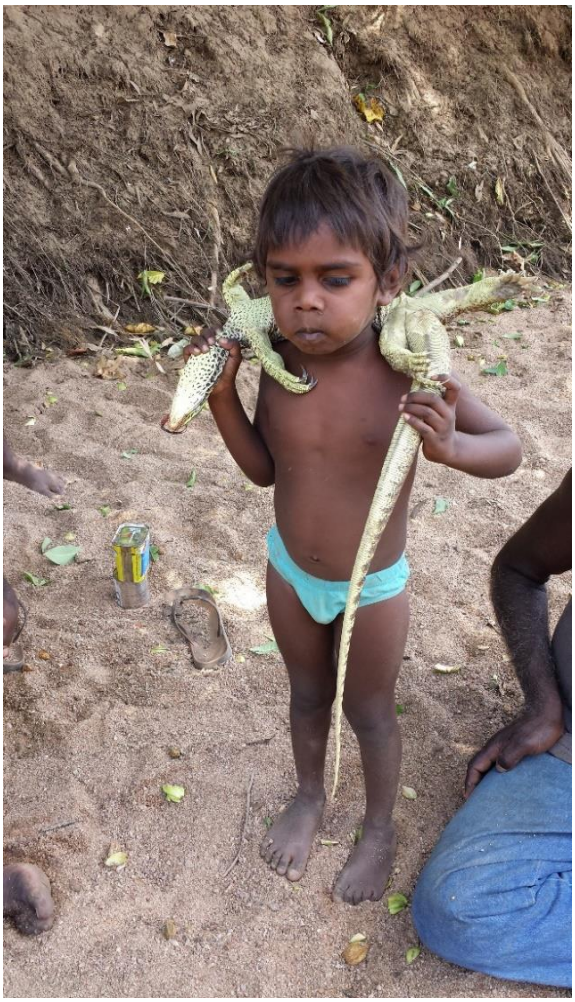
For three years Jandamarra led a guerrilla war against the *malngarri* settlers and police. He frequently ambushed cattleman and police camps to gain arms and supplies for the remaining Bunuba people. The Bunuba people's raids and ambushes were so effective that it kept the settlers at bay and became a major problem for the colony, eliciting bloody massacres of Bunuba and other Aboriginal people in the region.

We remember Jandamarra as a great warrior, and as a clever and courageous leader who defended our country against overwhelming odds. We also remember him as a *Jalnggangurru*, a man bestowed with spiritual powers that flowed from the timeless law of our country, who could disappear, transform into a bird and shield himself from deadly weapons.

It was not until the police brought in a Pilbara tracker named Mingo Mick, who also had the powers of a *Jalnggangurru*, that he met his match. Mingo Mick was the man who shot and killed Jandamarra at *Dimalurru* (Tunnel Creek) on 1 April 1897. He was only 24 years old when he died, but he had become a legend.

Extract from the *Jalangurru Muwayi* 2018

Right Lillimooloora police station ruins
Photo - DBCA

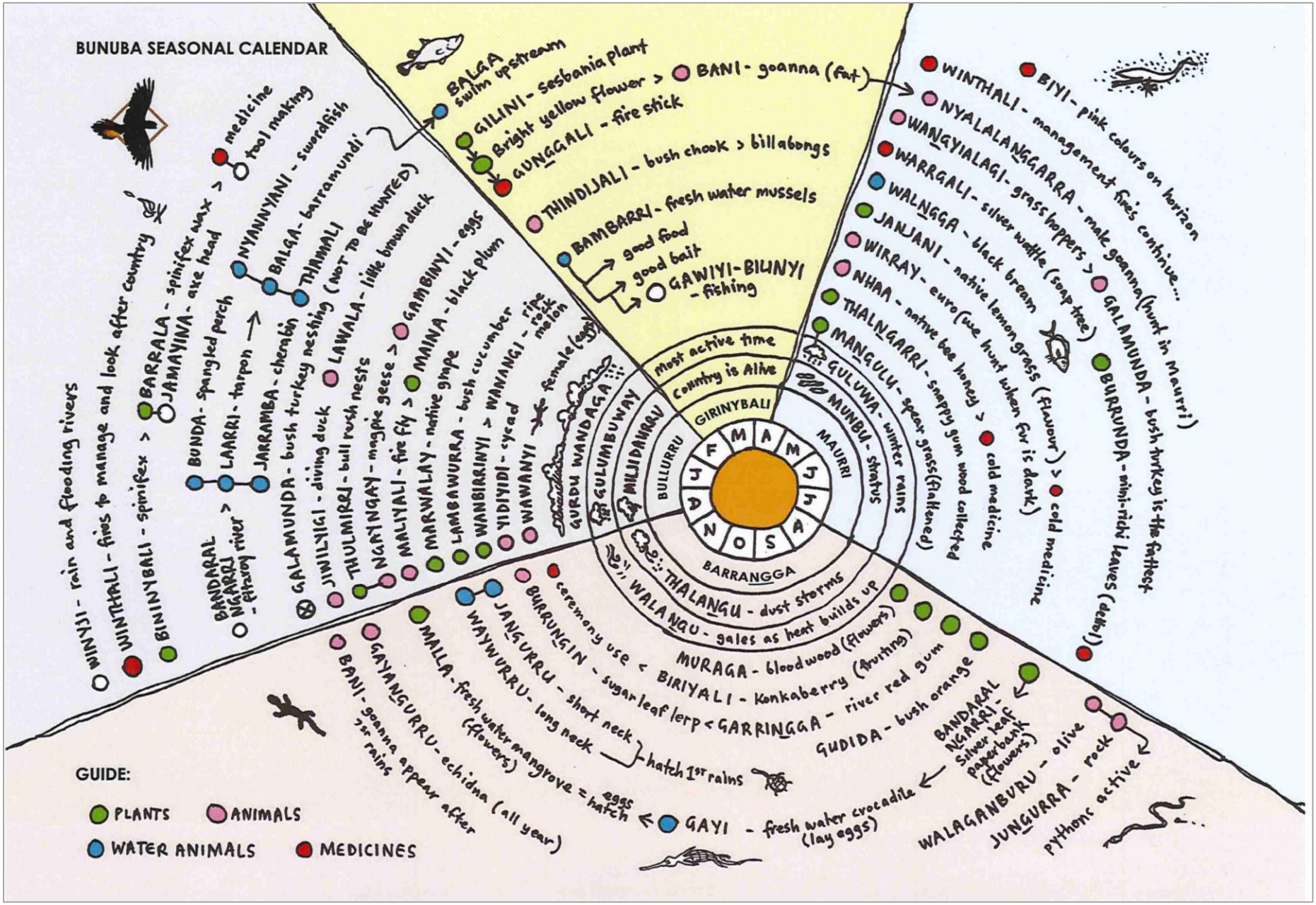


"Thirrili wara yarrangngu muwayi - we stand strong for our country.

Bunuba people, country and culture are powerful, proud and everlasting.
We carry the spirt of Jandamarra. Our *Junba*, culture and our country keeps us strong".

Extract from the *Jalangurru Muwayi* 2018

Photos this page – Bunuba ranger team collections.


BUNUBA SEASONAL CALENDAR
BALGA swim upstream
GILINI - sesbania plant
Bright yellow flower >
BANI - goanna (fat)
GUNGGALI - fire stick
THINDIJALI - bush chook > billabongs
BAMBARRI - fresh water mussels
good food
good bait
GAWIYI-BILINYI - fishing
WINTHALI - management fires continue...
NYALALANGGARRA - male goanna (hunt in Maurri)
WANGYIALAGI - grasshoppers >
GALAMUNDA - bush turkey is the fattest
WARRGALI - silver wattle (soap tree)
BURRUNDA - mini-ritzi leaves (dental)
WALNGGA - black bream
JANJANI - native lemon grass (flavour) > cold medicine
WIRRAY - euro (we hunt when fur is dark)
NHAA - native bee honey > cold medicine
THALNGARRI - snappy gum wood collected
MANGULU - spear grass (flattened)
GULUWA - winter rains
MUNBU - stratus
MAURRI
GIRINYBALI
Most active time
Country is Alive
BULLURRU
MILIDAHURRU
GULUMBUWAY
GURDU WANDAGA
female (eggs)
WAWANYI
YIDIYIDI - cycad
WANBIRRINYI > WANANGI - ripe melon
LAMBAWURRA - bush cucumber
MARWALAY - native grape
MAINA - black plum
MALIYALI - fire fly > GAMBINYI - eggs
NGAYNGAY - magpie geese >
THULMIRRI - bull rush nests
JIWILYIGI - diving duck
LAWALA - little brown duck (NOT TO BE HUNTED)
GALAMUNDA - bush turkey nesting
JARRAMBA - cheralin
LAARRI - tarpon
BUNDA - spangled perch
BANDARAL NGARRI - silver leaf paperbark
NYANANYANI - swordfish
BALGA - barramundi
THAMALI
BARRALA - spinifex wax > medicine
JAMAYINA - axe head
tool making
BININYBALI - spinifex >
WINTHALI - fires to manage and look after country
WINYJI - rain and flooding rivers
BARRANGGA
THALANGU - dust storms
WALANGU - gales as heat builds up
MURAGA - bloodwood (flowers)
BIRIYALI - Konkaberry (fruiting)
GARRINGGA - river red gum
GUDIDA - bush orange
BANDARAL NGARRI - silver leaf paperbank (flowers)
WALAGANBURU - olive
JUNGUARA - rock python active
ceremony use < BURRUNGIN - sugar leaf lerp
JANGURRU - short neck
WAYWURRU - long neck
hatch 1st rains
MALLA - fresh water mangrove (flowers)
GAYANGURRU - echidna (all year)
BANI - goanna appear after 1st rains
eggs = hatch
GAYI - fresh water crocodile (lay eggs)
BIYI - pink colours on horizon
GUIDE:
PLANTS
ANIMALS
WATER ANIMALS
MEDICINES

11. National heritage and other heritage values

Management for national heritage and other heritage values

Values and management issues

- The Lillimooloora police station ruins and grotto are the only sites within the parks currently listed under the State Register of Heritage Places in accordance with the *Heritage Act 2018*.
- The parks are all within the West Kimberley national heritage area listed under the EPBC Act in 2011. Multiple values relevant to the parks were identified as contributing to the national heritage significance of the area.
- Further highly significant archaeological findings from the parks have been uncovered since the national heritage listing in 2011.
- Several sites within the parks have been included on a State register of geo-heritage sites, in recognition of their research, education and geo-heritage values.
- The main potential threat to the heritage values described above is insufficient recognition or appreciation of these or their significance.

Management objectives

1. Human activities in or near the parks do not adversely affect heritage sites and national heritage values of the parks.
2. Visitors to the parks have opportunities to become aware of and appreciate the national and other heritage values of the parks.

Strategies

1. Make sure that potential risks to heritage values are evaluated and highlighted, where relevant, when providing advice on planning and development proposals that have the potential to adversely affect the parks.
2. Incorporate information about heritage values into education and interpretation materials and programs relevant to the parks.
3. Make sure that research activities in the parks are subject to relevant approvals, permits and conditions as necessary (e.g. any authorisations required under the CALM Act, Biodiversity Conservation Act, *Animal Welfare Act 2002*, or subject to Bunuba cultural protocols as necessary).

Windjana Gorge panorama in Bandilngan National Park. *Photo – Peter Nicholas/DBCA*

12. Geology and geomorphology values

Management for geology and geomorphology values

Values and management issues

Intrinsic and other values

- Geological features in the parks not only have intrinsic value, but are fundamental aspects of various ecological, geo-heritage, research, archaeological, cultural and social values.

Nautiloid fossil at Windjana Gorge. Photo - DBCA

Lennard Gorge within Miluwindi Conservation Park. *Photo - DBCA*

National heritage and geo-heritage significance of the King Leopold Ranges and Devonian reef

- The King Leopold Ranges and the Devonian fossil reef complex are associated with several values (e.g. geo-heritage, scientific research and archaeological values) of national and international significance.
- The parks are rich in a diverse array of well-preserved fossils providing insights into ancient life on Earth.
- Several sites within the parks have been included on a State register of geo-heritage sites, in recognition of their research, education and geo-heritage values.

Features of special cultural significance to Bunuba people

- The Devonian reef (*Balili*) and King Leopold Ranges (*Winamu*) are of key importance in Bunuba culture, and they contain many sites of special cultural significance including, rock art and engraving sites, ceremonial places, seasonal camping areas and perpetual springs. They also provide important habitat for flora and fauna species of special cultural significance.

Karst

- The Devonian reef complex is one of the major karst areas in Australia, and situated in the remote Kimberley, it is among some of the most intact, undisturbed karst in the country. The karst provides diverse above and below ground habitats that support (and in some instances, provide crucial habitat for), unique and distinctive fauna, including for example, underground specialists, short-range endemics, ancient and relict species.
- Maintaining the integrity of the karst hydrogeological system is a fundamental part of conserving the biodiversity of the parks.
- Tufa are interesting features of karst landscapes, and the Devonian limestone of the Oscar and Napier ranges have a particularly extensive and diverse variety of these. These features can provide valuable insights into paleoclimates and other environmental changes over time.
- Tufa elsewhere have been found to support distinctive ecological communities of special conservation significance, but there is insufficient knowledge about the tufa and associated biological communities in the parks to provide a robust understanding of their specific conservation significance.

Management for geology and geomorphology values

- Characteristics of the Devonian reef contribute to an unusual level of preservation of ancient organic materials, a factor that contributes to the area's known and potential archaeological significance.
- The proposed Bandilngan Conservation Park will see more of the Devonian reef protected for conservation purposes.

Scenic amenity values

- Geological features of the parks are a fundamental part of the scenic amenity that makes the parks such popular visitor attractions.

Brooking Gorge. *Photo - Bunuba ranger team collections*

Potential threats to geomorphic values

- There are no significant pressures known to be currently affecting geomorphic features and values in the parks.
- The main potential threats to geomorphic features and associated values, are from activities or developments that have the potential to cause direct physical damage to landforms, or to disturb the geomorphic or hydrological processes that maintain them.
- Karst landscapes and aquifers are complex and highly integrated systems that require whole-of-catchment, whole of karst-system protection and management. Karst values within the parks could potentially be affected by land-use and development in nearby and adjacent areas, as well as those occurring within the park boundaries.
- Certain aspects of karst management may require consultation with appropriately specialised and inter-disciplinary expertise.
- Karst features such as tufa and speleothems can be particularly vulnerable to direct physical damage, and, as these can take thousands of years to form, damage is essentially permanent. Unfortunately, vandalism, and possibly accidental damage of some speleothems in the Tunnel Creek cave has occurred.
- Recreational fossicking (e.g. for rock, fossils, bones, shells) is not appropriate in these parks and is not permitted.

Management for geology and geomorphology values

Management objectives

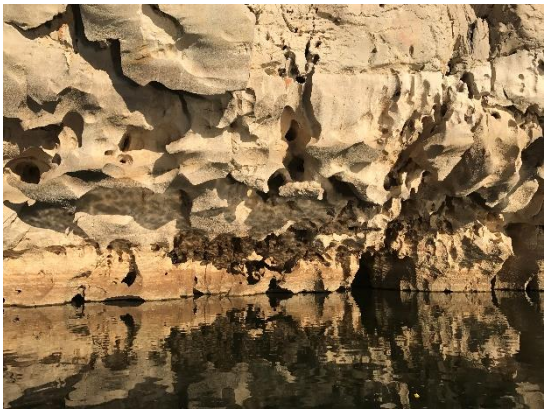
1. To make sure that human activities or developments in or near the parks over the life of this plan do not adversely affect geomorphic features or processes, and in particular geo-heritage or other values of special geo-conservation significance.
2. To raise awareness of significant values associated with geology and geomorphology values of the parks.

Strategies

1. Implement checks and procedures to make sure that management operations or developments in the parks do not adversely affect geo-heritage values, and, that expert advice is obtained where necessary (e.g. advice from geotechnical or karst specialists to evaluate impacts of proposed recreation site infrastructure developments within the Devonian reef parks).
2. Arrange training and awareness programs on karst management for staff involved in managing the parks as necessary.
3. Implement strategies described in Section 13 Water (*Garuwa*), to help maintain the normal natural water regimes that sustain geomorphic features and processes in the parks (e.g. the karst system).
4. Implement visitor management measures (e.g. access management, education and interpretation) as necessary to help protect delicate features such as spelothems and tufa.
5. Carry out research to clarify the conservation significance of tufa and associated biological communities in the parks.
6. Collect evidence to facilitate assessment and reporting against the KPI below for the Tunnel Creek Cave.
7. Take action to exclude introduced animals such as cattle from areas of tufa, as feasible and necessary.
8. Make sure that potential risks to geomorphology and associated significant values (e.g. critical fauna habitats, cultural or archaeological sites, geo-heritage values), are evaluated and highlighted as relevant, when providing advice on external planning and development proposals that have the potential to adversely affect the parks.
9. Include information about the geo-heritage or other values of special significance associated with geological assets in visitor interpretation and education materials.
10. Inform visitors as necessary that recreational fossicking is not permitted in these parks.
11. Make sure that research activities that could potentially adversely affect geomorphology or associated values is appropriately managed (e.g. subject to prior approvals, and in accordance with any associated licence or permit conditions).

Key performance indicator

Performance measure	*Target*	*Reporting requirement*
Evidence of (anthropogenic) physical damage to speleothems in the Tunnel Creek cave.	No evidence of damage from baseline levels to be documented in 2019.	Every five years



Interesting rock formations Danggu National Park. *Photos – DBCA*

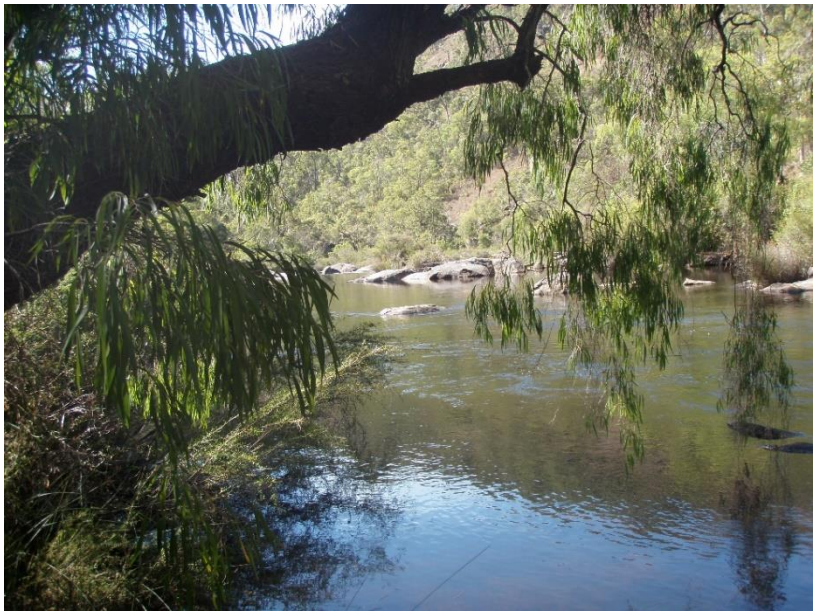
13. Water (*Garuwa*) values

Management for water values

Values and management issues

Naturally highly dynamic hydrological regimes

- Despite receiving high rainfall, the region is seasonally water-limited due to long dry seasons and very high evapotranspiration rates. Significant variability in inter-annual rainfall is not unusual, and the region may experience many years that are considerably wetter or drier than others.
- Because the Kimberley has very high natural variability in water regimes, with periods of both drought and flood contributing to and being key drivers of normal healthy ecosystem function, many plant and animal species are adapted to and dependent on fluctuating natural extremes of water abundance and scarcity.



Above View of the Lennard River in Miluwindi Conservation Park. *Photo - DBCA*

Left Freshwater crocodile at Bandilngan. National Park. *Photo - Janine Guenther*

Below Brolgas at Danggu National Park. *Photo - Peter Nicholas/DBCA*

Left Riverside in Danggu National Park. *Photo - Bunuba ranger team collections.*

Management for water values

Largely undisturbed surface water and groundwater systems and regimes providing critical ecosystem services and functions

- Surface water and groundwater systems, and the interactions between these, underpin and sustain many of the parks' most significant cultural, ecological and social assets, directly and indirectly. To maintain the condition of surface and groundwater dependent assets, it is essential that the integrity and normal temporal and spatial fluctuations of the hydrological systems on which they depend is also maintained.
- During the dry season, the rivers in the parks are reduced to a series of disconnected pools, some of which continue to maintain permanent water through the year. These perennial river pools, as well as springs, soaks and other sites of permanent freshwater, are of very high conservation significance. Many species and communities, including some threatened and priority species and communities, are fully or highly dependent on these for their survival. During the dry season the river pools are possibly being maintained by groundwater inflow.
- While three sites within the parks are recognised in the Directory of Important Wetlands in Australia, all permanent river pools, springs and freshwater habitats in the parks are of high ecological and cultural conservation significance.
- Remnant dry monsoon rainforest communities occurring in drier inland parts of the Kimberley are commonly closely associated with springs and other water sources, and likely have a greater degree of groundwater dependency than those in wetter parts of the region.
- Surface-groundwater interactions are integral aspects of tufa development – these are karst features that are associated with groundwater-fed springs, streams, seepages and caves, and which commonly support distinctive microbial communities of special conservation significance. These features, and associated biota, would be vulnerable to any factors that could substantively alter the usual surface-groundwater interactions.

Above Rock pools in Lennard River, Miluwindi Conservation Park. *Photos – DBCA*

- *Garuwa* (water) places and flows hold special cultural significance for Bunuba people. As well as being important places for camping, food and other resources, many *Garuwa* are associated with sacred *Junba* song-lines, or are homes to the *Ungguds*, the rainbow serpents of the *Ngarranggani* time. Maintaining the normal natural water regimes of surface and groundwater systems in the parks, is an essential part of conserving the value of the area to the culture and heritage of Bunuba people.

Altered water regimes

- Many park values would be vulnerable to significant alterations in the normal water regimes (quantity, quality and flow regimes) and the usual seasonal and other natural variability in these.
- The hydrological systems that sustain many of the parks' most significant values could potentially be vulnerable to land use and developments in nearby or upstream areas, as well as those within the conservation estate. Collaborative

Management for water values

approaches involving other relevant government agencies and neighbours, is needed to promote management that protects the water resources maintaining key values within the parks.[18]

- Karst aquifers such as those associated with the Devonian reef are highly complex, integrated and variable systems. Because of unique characteristics of karst aquifers, assessments of potential environmental impacts of land-use and development proposals on these (and associated ecosystems), usually requires specialised expertise.

Knowledge gaps

- There is currently insufficient adequately detailed knowledge about the local hydrogeology, or ecological water requirements of native species and communities in the parks, to allow proper assessment of land uses and developments that have the potential to significantly alter water regimes.

Introduced animals

- Introduced animals such as cattle and pigs can have localised effects on water quality (e.g. by contributing to increased sedimentation and faeces in the water).

Southern opening Tunnel Creek Cave. *Photo – DBCA*

Management objectives

1. To make sure[19] that human activities or developments in or near the parks over the life of this plan, do not adversely affect the water regimes needed to sustain values of the parks.
2. To improve knowledge of local hydrogeological systems and processes that sustain species and communities highly dependent on aquatic habitats in the parks (with a priority focus on perennial water habitats supporting threatened, priority or other species and communities of special conservation significance).

Strategies

1. Implement checks and procedures to make sure that management operations or developments in the parks do not adversely affect the natural water regimes (i.e. usual water quality, quantity, flow patterns and cycles).
2. Provide advice about external land use planning and development proposals, as necessary and appropriate, to promote avoidance or mitigation of any adverse effects on the parks hydrological systems, or the biota and other values that are dependent on these.
3. Collaborate with the relevant government agencies (e.g. water resource management agencies), neighbours, and other stakeholders as needed, to promote ecologically sustainable management of catchment water resources, and protection of the water regimes that sustain values of the parks.
4. Support research (e.g. work with water resource management agencies and external researchers as needed) to:
   a. improve knowledge about species and communities likely to be most vulnerable to altered hydrological regimes (e.g. those highly dependent on permanent water habitats such as perennial river pools, springs and seeps).
   b. improve knowledge about aspects of the local hydrogeology that provide essential ecosystem services for threatened, priority and other species and communities of special conservation significance.
   c. help with assessing risks from land uses that have the potential to significantly change the normal, natural water regimes sustaining high value assets within the parks.
5. Consult (and/or encourage others to consult) specialist expertise as necessary in implementation of strategies above

[18] At the time of writing, the State Government is engaged in measures to help deliver a 'whole-of-Government' management approach to water resource management and use in the Fitzroy River catchment. This is to be expressed through the development of water allocation and sustainable economic development plans being developed through the Department of Primary Industries and Regional Development, and the Department of Water and Environmental Regulation.

[19] within limits of the department's jurisdiction.

Management for water values		
(e.g. expertise of karst hydrogeologists and biospeleologists for the Devonian reef parks). 6. Control introduced animals such as cattle and pigs around freshwater habitats to help address associated localised water quality issues. 7. Maintain a portfolio of evidence to facilitate reporting and assessments against the KPI below.		
Key performance indicator		
Performance measure	*Target*	*Reporting requirement*
Knowledge of perennial water habitats that support threatened and priority species and communities.	Perennial water habitats known to be important for supporting threatened and priority species and communities mapped over the life of this plan.	5 years

Riparian vegetation Danggu National Park. *Photo – DBCA*

14. Vegetation and flora values

Management for vegetation and flora values

Values and management issues

Plants of special cultural significance

- Plants in the parks hold particular cultural importance for Bunuba people for a wide variety of reasons (e.g. customary food, medicine, ceremonial or other cultural resource).

Many plants provide important cultural resources. Photo of *gungangi* or cluster fig (*Ficus racemosa*) from *Jalangurru Muwayi* Plan.

Diverse vegetation types – savanna, dry monsoon rainforest patches and riparian communities

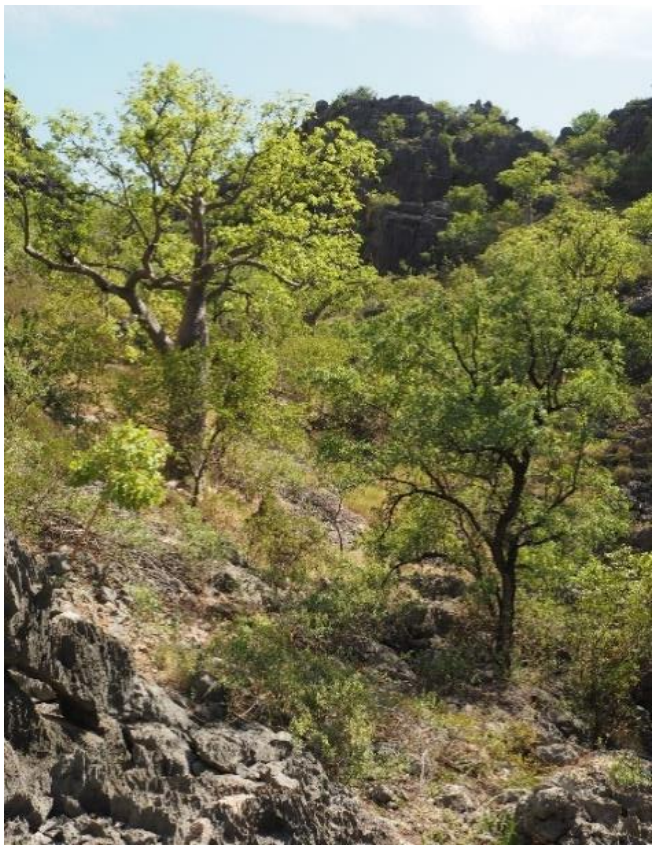
- The vegetation of the parks is dominated by tropical savanna.
- Embedded within the broader savanna landscape are much smaller riparian communities that contain numerous plant species that are not found in the adjacent landscape. As well as contributing significantly to the floristic diversity of the region, these riparian areas provide many ecosystem services and functions, and are important habitat for wide-ranging fauna, as well as riparian specialists.
- Small relictual remnants of 'dry' monsoon rainforest vine thicket communities are also scattered throughout the savanna. These are generally associated with sheltered fire-protected niches that have favourable hydrological conditions (e.g. sub-surface seepage).
- While small, the dry monsoon rainforest patches add significantly to regional floristic diversity, and provide important fauna habitat, including habitat for threatened and other fauna of special conservation significance.
- The Devonian reef limestone appears to support a distinctive form of dry monsoon rainforest community, and occurrences that appear to be associated with threatened and priority land snails. These have both been identified as priority ecological communities in recognition of the need for further survey, definition and assessment as possible threatened ecological communities.
- Collaborative cross-tenure approaches are important to effectively manage many of the pressures impacting on vegetation and flora values.

Threatened, priority and other species and communities of special conservation significance

- The mountain white gum (*Eucalyptus mooreana*), which is almost entirely confined to the King Leopold Ranges within the conservation estate, is a threatened species. A newly identified species closely related to *E. mooreana*, *E. revelata*, appears to have an even more restricted distribution than *E.* mooreana, and is pending assessment of its conservation status. Further research is required to improve knowledge about these species.
- There are numerous 'Priority Flora' species and communities recorded for the parks. As well as the vegetation associated with threatened and priority land snails mentioned above, there are also two other vegetation communities currently recorded as priority ecological communities in and around the parks; these are associated with the Leopold Land System[20] and the Gogo Land System[21]. Further survey is needed to more accurately determine the conservation status of priority species and ecological communities in the parks.
- There is little known about microbial communities associated with tufa in the parks. Elsewhere in the State tufa have been found to support distinctive ecological communities of special conservation significance, so research to investigate the significance of tufa communities in the parks may be warranted.

[20] This comprises cracking clay plains and marginal outcrop plains, grasslands and very open grassy woodlands.

[21] This comprises river flood plains with broad levee zones and moderately extensive back plains of cracking clays with grasslands and grassy woodlands.



The parks are rich in diverse vegetation. *Photos – DBCA*

Management for vegetation and flora

Altered fire regimes

- Changes to fire regimes since European settlement in the Kimberley has seen a tendency towards too frequent, large and intense late dry season fires. These fire regimes can destroy large expanses of vegetation and simplify the structural, species and age diversity of savanna vegetation. Inappropriate fire regimes can lead to the dominance of certain native annual grasses and some exotic species, which can further affect fire regimes by making the vegetation more fire prone.
- Within the savanna are more fire-sensitive species and communities, often associated with naturally fire protected areas in the landscape such as rocky terrain with lower fuel loads, or riparian and other freshwater areas. Under contemporary fire regimes, fires are more likely to penetrate these normally more protected niches.
- There are many gaps in knowledge about specific fire management requirements to meet flora and vegetation conservation objectives for the parks. The current assumption is that flora (as well as other) conservation outcomes in the Kimberley, are likely to be optimised by fire management operations that result in a temporal and spatial mosaic of vegetation across the landscape, including long unburnt patches. Fire management also needs to consider the implications of concurrent and interacting pressures such as climate change, invasive weeds and grazing by cattle or other introduced herbivores.

Stinking passionflower (left) and Calotrope (right and below) are highly invasive problem weeds. *Photos – Bunuba ranger team collections*

Weeds

- Serious weed infestations are in localised areas of the parks such as riparian corridors, sites of disturbance such as roads, fire-breaks or fence-lines, and some areas of high visitor use.
- Riparian areas and dry monsoon rainforest patches are very limited in their extent, making these areas particularly vulnerable to the impact of highly invasive weeds. These impacts are heightened where there are other concurrent pressures such as grazing by introduced herbivores and altered fire regimes.
- Management of weeds is prioritised considering species invasiveness, ecological impact, and the feasibility of eradicating or containing populations. Species that can have high ecological impact, are rapidly invasive, and can feasibly be contained or eradicated, are rated as high priority for management. Priority locations for weed management are focused on highest biodiversity, cultural value and visual amenity assets.

Introduced animals

- Several introduced animal species in the parks adversely affect vegetation, grazing and trampling it, compacting the soil, causing erosion and spreading weeds.
- The most significant impacts on vegetation from introduced animals are currently from cattle, particularly in some riparian areas where they seek water and shelter.

Management for vegetation and flora

Altered water regimes

- Any significant alterations to natural water regimes, including the usual seasonal variations in water quantity, quality and flow regimes, can adversely affect plants. Species that have distributions fully or closely associated with wetter parts of the landscape (e.g. species associated with riparian areas or rainforest thickets) are likely to be most vulnerable to altered water regimes.

Knowledge gaps

- Knowledge about many flora species and communities in the parks or their conservation status is fairly basic. More detailed vegetation mapping and floristic survey, particularly of threatened and priority species and communities, would support improved planning and management of the parks.
- More specific understanding of the fire response and fire requirements of flora, especially threatened and priority species and communities, would support improved fire management.

Right Small boab in the limestone at Dimalurru National Park *Photo – DBCA*

Below *Brachychiton fitzgeraldianus*. *Photo – Bunuba ranger team collections*

Management for vegetation and flora

Management objectives

To conserve native vegetation and flora values in the parks by:

- managing the threatening processes significantly affecting the condition[22] of native vegetation types in the parks (e.g. savanna, riparian areas, rainforest patches).
- conserving threatened, priority and other species and communities of special conservation significance.
- addressing key knowledge gaps to support improved conservation of vegetation and flora values.

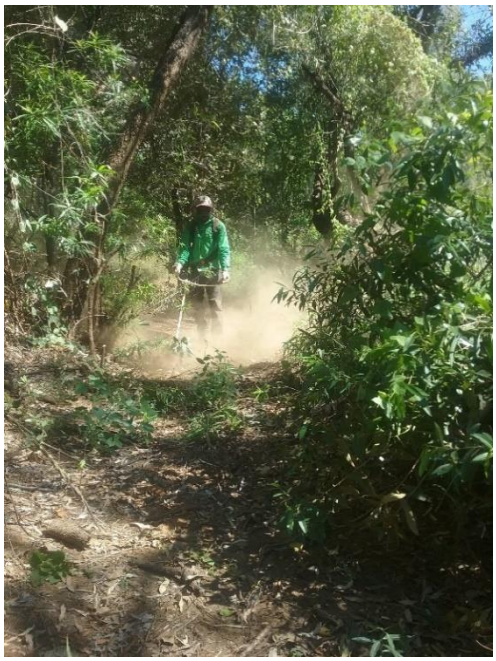
Strategies

1. Use the best available knowledge (drawing from both Indigenous traditional knowledge and conservation science) to plan and implement strategic and adaptive fire management programs[23] to:
   a. try and create a fine-scale patchy mosaic of burnt and unburnt areas, and reduce the likelihood of frequent, extensive and intense fires later in the dry season.
   b. maintain a diversity of post-fire vegetation stages, including retention of old growth areas.
   c. provide protective reduced-fuel buffers around fire vulnerable habitats and other assets as necessary.
   d. avoid the spread of weeds through inappropriate fire regimes (e.g. buffel grass, grader grass).
   e. maintain species and the extent and composition of communities that may be more fire-sensitive or appear to have very specific fire regime requirements (e.g. species and communities associated with riparian areas, dry monsoon rainforest patches, vegetation of rocky uplands, *Eucalyptus mooreana* and other threatened flora) within the bounds of natural variation.
2. Analyse fire history and carry out research as necessary to help inform fire management for flora conservation, including identification of fire-sensitive species and communities, and identification of improved fire management related KPIs specific to the parks (if required).
3. Periodically monitor and assess the threats of weeds and feral animals on native flora and vegetation in the parks to identify priority species and priority areas for control.
4. Implement strategic management programs to eradicate or control priority weeds and feral animal species with a focus on protecting highest value vegetation and flora assets at greatest risk (e.g. threatened and priority species or communities, riparian and dry monsoon rainforest assemblages).
5. Employ collaborative and cross-tenure approaches, working with neighbouring land managers, relevant government agencies and research partners as necessary, to maximise effectiveness of threat management programs in the parks (e.g. for weed and feral animal control, fire management).
6. Implement strategies in Section 13 Water (*Garuwa*) aimed at maintaining the normal water regimes that sustain flora values in the parks.
7. Design and implement a monitoring and management program to support conservation of *Eucalyptus mooreana* and any other threatened flora species restricted or largely restricted to the parks (e.g. investigate population trends, suitable fire regimes and fire management strategies, key threats).
8. Design and implement a monitoring and management program to support conservation of the vine thickets and other vegetation associated with threatened and priority Camaenid land snails in the parks.
9. Develop and implement a research and monitoring program to improve knowledge and clarify the conservation status of Priority flora species and communities in the parks, in particular for those in most urgent need of further survey (i.e. Priority 1 and Priority 2 species and communities).
10. Implement other research, monitoring or recovery actions for threatened and priority flora species and communities, or other species and communities of special conservation significance as necessary (and in accordance with approved recovery plans where relevant).
11. Develop and implement specific strategies if necessary to address significant threats to native plant species of special cultural significance to Bunuba people (e.g. species used for medical or ceremonial purposes).
12. Maintain a portfolio of evidence to facilitate reporting and assessments against the KPIs below.

[22] For example, species richness, species composition and abundance, and vegetation/habitat structure and extent.

[23] Strategic and targeted fire management operations involving a mix of measure such as prescribed burns, establishment and maintenance of reduced-fuel buffers, and targeted fire suppression where feasible.

Management for vegetation and flora		
Key performance indicators		
Performance measures	*Targets*	*Reporting requirements*
Conservation status of *Eucalyptus mooreana* and other threatened flora restricted or largely restricted to the parks[24].	Maintained or improved over the life of this plan.	Every 3 years
Proportions of savanna, riparian or rainforest areas in each reserve burnt by late dry season fires.	Decreasing trend over the life of this plan.	Every 3 years
Area occupied by high priority weed species.	Decreasing trend in area of high priority weed species in priority locations[25].	Every 3 years
Knowledge of Priority flora species and communities in the parks.	Survey at least one P1 or P2 flora species or community per year over the life of this plan.	Every 5 years
Proportion of riparian habitat significantly degraded by cattle, pigs or other large introduced animals.	Decreasing trend over the life of this plan.	Every 3 years



Above Bunuba rangers at work in the parks. *Photos – Bunuba ranger team collections*

[24] At the time of writing *Eucalyptus mooreana* is the only listed Threatened flora in the parks and is listed as 'vulnerable' under both the Biodiversity Conservation Act and the EPBC Act. The closely related but specifically distinct, and apparently even more restricted *Eucalyptus revelata* has recently been identified; it is pending assessment of its conservation status.

[25] That is, high priority weed species and priority locations as determined through implementation of Strategy 3 in this Section 14.

15. Fauna values

Management for fauna conservation values

Values and management issues

Diverse habitats supporting a rich abundant fauna including threatened, priority and other species and communities of special conservation significance

- The parks encompass a range of habitats that support a rich and diverse native fauna, which includes numerous species that are threatened or otherwise recognised as being of special conservation significance.
- Certain animals hold particular cultural importance for Bunuba people for a variety of reasons, they may for example have a role as indicators of traditional seasons or be an important customary food.
- At the time of writing eight threatened fauna species are recorded for the parks, including three species of mammals, two species of bird, two of land snail and one fish. In addition, nine 'Priority Fauna' species are currently recorded for the parks, including species of mammals, fish, one species of bird and two of land snails. Known populations of the latter are almost entirely confined to Balili Conservation Park.
- Four species of bird recorded from the parks are listed under various international agreements (i.e. JAMBA, CAMBA, ROKAMBA, the Bonn Convention).
- The Kimberley has high diversity and endemism in freshwater fishes, and the Fitzroy River, which is one of the most species-rich in the region, supports several species of special conservation significance (e.g. threatened, endemic and near-endemic species). The large-tooth sawfish, (which is a listed species under the EPBC Act and protected under the *Fish Resources Management Act 1994*), and several Priority species of fish have been recorded from the parks.

Above Wallaby. *Photo - Peter Nicholas/DBCA*

- The Tunnel Creek Cave has some interesting fauna including several species of bat, some of which are obligate cave dwellers. The occurrence of freshwater crocodiles in the Tunnel Creek Cave is thought to be unusual as they are not otherwise known to use subterranean habitats in Australia other than during dry season dormancy.
- The Devonian reef karst supports unique and distinctive fauna. Despite limited investigation this karst system has been associated with high levels of endemism in certain gecko genera, Camaenid land snails and unique subterranean invertebrates.
- Three invertebrate communities identified as priority ecological communities occur or are likely to occur within the parks; 'invertebrate community of Tunnel Creek, 'invertebrate assemblages of the cliff foot springs around the Devonian reef system' and 'invertebrate community of Napier Range Cave'.
- Some species of Camaenid land snail from the parks are thought to have undergone speciation after being isolated in small refugial habitats when climatic conditions became hotter and more arid after the late-Miocene. One priority ecological community comprises land snails in association with an unusual vine thicket. Another priority ecological community, comprising land snail and vine thicket assemblages known from the Jeremiah and Ningbing Ranges, may also occur in the parks.
- Invertebrates recorded from cave pools and springs in the Oscar and Napier Ranges include likely remnants of ancient freshwater lineages. It is probable that further investigation of these karst aquifers would reveal more of these.

Management for fauna conservation values

Above Bower bird at Bandilngan National Park. *Photo – Peter Nicholas/DBCA*

Altered fire regimes

- The more frequent, intense and extensive fire regimes that have prevailed in the Kimberley over recent decades are a threat to many species. Those with very restricted distributions, or that have low mobility and limited dispersal capacity, can be particularly vulnerable to intense fire events within their home ranges. Within the parks, examples of this fauna include short-range endemic land snails, some reptiles and birds, including the threatened purple-crowned fairy-wren.
- Species and communities associated with less flammable parts of the landscape, such as riparian areas, or rocky landscapes with sparse vegetation, are likely to be more fire-sensitive.
- Many small to medium sized mammals (including threatened and priority fauna such as the northern quoll and golden-backed tree rat) appear to be particularly reliant on mature long-unburnt habitats.
- The current assumption is that fauna conservation outcomes are optimised by fire management that results in a temporal and spatial mosaic of vegetation across the landscape, and which includes the retention of sufficient and appropriately dispersed patches of old growth vegetation. This helps to maintain habitat diversity and areas for wildlife refuges, and reduces the likelihood of very large, intense and damaging fires. Within this mosaic, the needs of threatened species or communities and other vulnerable habitats with very specific fire regime requirements should be considered and accommodated, drawing on the best available knowledge.

Introduced animals

- Introduced animals can affect native fauna through predation, competition for resources and habitat degradation. Introduced fauna currently presenting the most serious threat to native fauna in the parks are feral cats, cane toads, cattle and pigs.
- Cane toads have not been recorded in the parks but their arrival is imminent. It is not clear exactly how this will impact on the parks' native fauna, but it seems that species that are most vulnerable are those likely to consume adult toads, for example the northern quoll, freshwater crocodiles, some snakes and several lizards. Threatened Camaenid land snails have very restricted distributions and low mobility and these could be vulnerable to predation should cane toads invade their habitat (though the likelihood of this thought to be low).
- Recent research has uncovered a range of new methods that could be incorporated into an integrated suite of management strategies to reduce the impacts of cane toads. One of these, 'conditioned taste aversion', has shown

Management for fauna conservation values

potential to help vulnerable native predators learn to avoid ingesting lethal adult toads, and trials are being implemented in the area.

Introduced flora

- Some weeds can significantly degrade fauna habitat. Riparian habitats and rainforest patches occupy relatively small areas and can quickly become dominated by weeds, which can in turn affect a wide range of fauna species, including many that are fully or highly dependent on these habitats for their persistence. Controlling weeds in riparian areas is challenging as water dispersed seed and propagules result in reinfestation, and chemical control options are not appropriate or have restricted applicability in these areas.
- Stinking passionflower, bellyache bush, Parkinsonia and rubber bush are examples of high impact weeds currently problematic within some of the parks' riparian habitats.
- Some highly invasive weeds can increase the likelihood of larger, more intense fires. This can affect a range of fauna, but especially more fire-sensitive species that inhabit naturally fire protected niches, or fauna that has ecological requirements for late successional stages of vegetation.

Knowledge gaps

- Knowledge about the fauna occurring in the parks is limited as much of the area is very remote, rugged and inaccessible. Surveys that have been carried out often uncover species of special significance, and the biological diversity of the parks is no doubt much greater than what it is currently known to be.
- There are multiple concurrent, interacting pressures impacting the native fauna, including altered fire regimes, grazing, predation and problem weeds. The interactions are complex and not well understood.
- Fauna conservation efforts in the parks could be improved by addressing some key knowledge gaps. There is, for example, a need for better knowledge about threatened and priority fauna, their conservation status and primary threats. This is a priority for species that are endemic to the parks, or for which the parks are a key stronghold.

Altered water regimes

- Many fauna species in the parks, including some threatened and priority species, would be vulnerable to significant alterations in water quantity, quality or usual flow regimes. Aquatic species are particularly vulnerable, including for example, freshwater turtles, fishes, frogs, crocodiles and various other species associated with aquatic and riparian habitats.
- Maintenance of the permanent river pools, springs, and other freshwater habitats that persist through the dry season is critical for numerous species.

Management objective

To conserve native fauna in the parks by:

- managing the threatening processes affecting the fauna.
- conserving threatened, priority and other species and communities of special conservation significance.
- addressing key knowledge gaps to support improved conservation of fauna values.

Strategies

1. Implement strategies in Section 12 Geology and geomorphology, Section 13 Water (*Garuwa*) and Section 14 Vegetation and flora aimed at maintaining or improving the condition of fauna habitats.
2. In addition to implementation of Strategy 1 in Section 14, draw on the best available knowledge to deliver strategic and adaptive fire management that aims to:
    a. retain sufficient and adequately dispersed old growth vegetation to provide accessible habitat for small to medium sized mammals[26].
    b. provide protective reduced-fuel buffers around fire vulnerable fauna habitats as necessary.
    c. consider and be integrated with management of concurrent interacting pressures on native fauna such as introduced herbivores, predators and high impact weeds.
    d. Consider the needs of species and communities that may have more specific fire regime requirements, for example –
        - Camaenid snail fauna and associated vegetation assemblages
        - the purple-crowned fairy-wren and other fauna restricted to riparian areas
        - species restricted to rocky uplands and other terrain with scant vegetation

[26] Unburnt habitat within a distance of 1 to 1.5 km is currently thought to be suitable for most small-medium sized mammals.

Management for fauna conservation values

- endemic geckos in the Devonian limestone and other short-range endemic species
- small mammals and other species particularly reliant on mature long unburnt habitats or larger hollow-bearing trees
- bird species reliant on older age seed bearing grasslands (e.g. Gouldian finch).

3. Analyse fire history and carry out research as necessary to help inform fire management for fauna conservation, including identification of fire-sensitive species and communities, and identification of improved fire management related KPIs specific to the parks (if necessary).
4. Periodically monitor and assess the threats of weeds and feral animals on native fauna in the parks to identify priority species and areas for control.
5. Implement strategic management programs to eradicate or control priority weeds and feral animal species with a focus on protecting native fauna at greatest risk (e.g. threatened or priority species or communities, those restricted to riparian areas and dry monsoon rainforest assemblages).
6. Utilise strategic fencing and gates to exclude introduced animals if considered necessary and appropriate.
7. Provide support for 'conditioned taste aversion' trials to help manage the threats associated with arrival of cane toads.
8. Employ collaborative cross-tenure approaches, working with neighbouring land managers, relevant government agencies, and with research partnerships as necessary to maximise effectiveness of threat management programs in the parks (e.g. for weed and feral animal control, fire management).
9. Design and implement a monitoring and management program to support conservation of threatened and priority Camaenid land snails in the parks (e.g. map habitat, identify appropriate fire management strategies, and monitor habitat for presence of threats such as cane toads and serious weeds) (see also Strategy 8 in Section 14).
10. Develop and implement a research and monitoring program to improve knowledge and clarify the conservation status of threatened, priority and other fauna species and communities thought to be restricted, or largely restricted to the parks (e.g. the 'invertebrate community of Tunnel Creek' and 'Invertebrate assemblages of the cliff foot springs around the Devonian reef system).
11. Implement research, monitoring and recovery actions for other threatened and priority fauna or other species and communities of special conservation significance as necessary (and in accordance with approved recovery plans where relevant).
12. Research the Tunnel Creek Cave fauna as necessary to contribute to implementation of Strategy 5 in Section 16.
13. Develop and implement specific strategies if necessary to address significant threats to native fauna species of special cultural significance to Bunuba people.
14. Maintain a portfolio of evidence to facilitate reporting and assessments against the KPIs below.

Key performance indicators

Performance measures	*Targets*	*Reporting requirements*
Condition of known habitat of threatened and priority Camaenid land snails in the parks.	No evidence of significant declines in habitat quality for threatened and priority Camaenid land snails over the life of this plan (e.g. due to weed invasion, fire, grazing, presence of cane toads).	Every 3 years
Knowledge of threatened and priority fauna species or communities in the parks.	Survey at least one threatened or priority fauna species or community in the parks per year over the life of this plan.	Every 5 years
Proportion of savanna vegetation greater than 3 years old.	At least 25%	Every 3 years
Mean distance between burnt and unburnt patches of vegetation[27].	Decreasing or stable trend over the life of this plan[28].	Every 3 years

[27] The scale of fire mapping currently available may mean that this is only measurable for larger reserves such as Miluwindi and Balili conservation parks.
[28] Unburnt habitat within a distance of 1 to 1.5 km is currently thought to be suitable for most small-medium sized mammals.

16. Recreation and tourism values

Management for recreation and tourism values

Values and management issues

Exceptional and varied settings for nature-based and culture-based recreation and tourism

- The parks contain iconic features of the Kimberley landscape that attract intrastate, interstate and international visitors; they are important tourism assets for the regional economy.
- A range of characteristics in the conservation estate combine to create varied and distinctive visual landscapes of exceptionally high quality. Aesthetic features of the parks have been recognised as being of outstanding value to the nation through the West Kimberley National Heritage Area.
- The most well-known visitor attractions in the parks include Geikie Gorge, Windjana Gorge, Lennard Gorge, and the Tunnel Creek Cave.
- Visitor facilities across the parks include day use sites at Danggu and Dimalurru national parks, and both day use and campground areas at Bandilngan National Park. These provide settings for a range of recreation and tourism activities including camping, walking, picnicking, wildlife viewing, canoeing, and various tours, including boat tours in Geikie Gorge and Aboriginal cultural tours.

Above A family at Windjana Gorge. *Photo – Peter Nicholas/DBCA*

Opportunities to further improve and diversify recreation and tourism settings and experiences

- There is considerable scope to sustainably expand the recreation and tourism opportunities currently on offer in the parks, to further enhance their visitor appeal, and to support more diverse experiences and activities.
- There are also potential opportunities for Bunuba people to derive greater socio-economic benefits from recreation and tourism occurring in Bunuba country (e.g. opportunities to obtain training and experience in tourism management, or for Bunuba businesses to conduct commercial tourism operations in the parks).
- Dimalurru National Park is a popular visitor attraction that also has some cultural and ecological values which can be sensitive to human disturbance. A range of measures can be used to mitigate the potential adverse effects of visitation on values of the Tunnel Creek Cave, while providing a high-quality sustainable visitor experience.
- There is considerable scope to improve the amenity and functionality of the visitor areas at Danggu National Park, to better sustain visitation levels, better support current and new visitor activities and experiences, and to resolve some management issues with the existing facilities and site layout.
- Bandilngan National Park provides for camping as well as some basic day use facilities. There is potential to increase the diversity of day use and camping opportunities at this park.

Management for recreation and tourism values

- There are already a few short easy walks available for visitors to the parks, at Bandilngan and Danggu national parks. The diversity of walking options on offer could be improved by developing longer, more challenging walks, including multi-day options.
- There is capacity to provide additional options for visitors to better explore and understand the significance of area to Bunuba people, culture and history.
- The parks have attributes that could potentially support new adventure activities such as caving and rock climbing (including abseiling). Whether, where and how these could be accommodated without compromising key cultural and ecological values would require detailed investigation.
- There is currently no public visitor access or facilities in Jungi-wa/Guwinyja Conservation Park or the Balili Conservation Park as these parks do not currently have adequate legal road access.

Above A small group on a guided tour of Tunnel Creek Cave. *Photo – Peter Nicholas/DBCA*

Visitor safety

- There are a range of inherent dangers that visitors to the parks could potentially encounter. Factors such as remoteness, extreme weather, and, the limited access and communications, add considerably to the risks.
- As well as presenting a potential safety risk to visitors, fire can cause expensive damage or loss to visitation infrastructure, and can temporarily diminish visual landscape amenity.

Right Visitor viewing walk trail signage in Danggu National Park. *Photo – DBCA*

Management for recreation and tourism values

Management objectives

1. To enhance visitor's experience by improving visitor facilities and services, and diversifying recreation and tourism opportunities in the parks.
2. To expand opportunities for visitors to appreciate the Bunuba cultural context of the parks.
3. To provide opportunities for Bunuba people to derive greater socio-economic benefits from recreation and tourism occurring in Bunuba country.

Strategies

1. Ensure commercial tourism activities in the parks are compatible with the purpose of the reserves, and subject to appropriate leases or licences (e.g. leases or licences issued pursuant to the CALM Act and associated regulations).
2. Incorporate conditions into commercial operator leases and licences as necessary to protect values or otherwise help meet management objectives in this plan (e.g. apply conditions regarding Bunuba cultural values and protocols if necessary).
3. Take relevant aspects of the ILUA into account where applicable in considering Bunuba entity proposals for commercial tourism operations in the Bunuba Conservation Estate.
4. Develop and implement detailed site plans to deliver an improved visitor experience at Dimalurru National Park that also ensures sensitive values associated with the cave are protected. Plans to consider for example:
   - providing for the walk through the cave to be done one way only.
   - more clearly delineating visitor pathways through the cave, to help people avoid areas that shouldn't be accessed, and minimise impacts on cave values.
   - increasing the range of options for people to visit the tunnel on a guided tour that provides visitors with insights into the cultural and ecological values.
   - implementing an associated booking system to help manage the number of visitors within the cave at one time.
5. Develop and implement a program to monitor and manage the effects of visitation on fauna or other sensitive and significant values of the Tunnel Creek Cave (also see relevant strategies and KPI in Section 12 and 15).
6. Develop and implement detailed site plans to upgrade the visitor use areas in Danggu National Park to better sustain visitation levels, support current and new visitor activities and experiences, and resolve management issues resulting from regular flooding of the site. Plans to consider for example:
   - options for improving vehicle parking and circulation, including provisions for parking of long vehicles and tour buses.
   - facilities to better support the Geikie Gorge boat tours, including improving the connection between the visitor arrival area and the dock.
   - developing new facilities to replace those that need to be removed because of flooding.
   - reconfiguring the site layout and design to improve amenity and focus on the river and gorge.
   - developing facilities to support additional recreation and tourism activities and experiences (e.g. an events space, facilities for paddle craft use and access, facilities to accommodate camping or other overnight stays).
7. Develop and implement detailed site plans to provide for increased and improved day use, camping and other overnight accommodation options at Bandilngan National Park. Plans to consider for example:
   - incorporating a cultural activities precinct (e.g. amphitheatre for performances or art and craft displays) into an improved, dedicated day use area.
   - exploring options to provide better separation and management of different user groups of the campgrounds (i.e. quiet, generator and tour group camping areas).
   - diversification of options for overnight stays (e.g. developing a small, more remote, walk-in only camping area; provision for stays in commercially run semi-permanent tent accommodation).
8. Develop (and implement as considered feasible and appropriate) detailed plans to diversify the range of walk-trail opportunities in the parks, including consideration to development of a multi-day long distance walk-trail.
9. Explore and implement options, as guided by Bunuba people, to provide visitors with opportunities to better explore and understand the significance of area to Bunuba people, culture and history (e.g. in signage and other interpretive material, through tours and activities guided by Bunuba people or businesses).
10. Explore options for providing for new adventure recreation activities such as rock climbing or caving in the parks if/as resources allow, if it is established there is an adequate market for these activities, and, if detailed planning indicates these could be accommodated without compromising key cultural, ecological or other values.
11. If legal access is secured, explore options (and implement proposals where feasible and appropriate) to support low level visitor access and enjoyment of Jungi-wa/Guwinyja and Balili conservation parks.

Management for recreation and tourism values

12. Make sure that all proposed developments to support recreation and tourism in the parks are subject to detailed assessment of site-specific opportunities and constraints, including geotechnical and karst specialist assessments where relevant, and assessments for potential impacts on cultural heritage, ecological, visual amenity and other values of the parks.
13. Provide information, interpretation and education that improves visitors' appreciation of the cultural, ecological and historical values, and promotes behaviour sensitive to the conservation of these values.
14. Carry out visitor surveys or other research to help evaluate trends in visitor satisfaction with recreation and tourism opportunities available in the parks (and to facilitate reporting and assessments against the KPI below).
15. Develop and implement a visitor risk management program applicable to the parks which includes:
    - regular visitor risk assessments including inspections of all recreation sites and facilities
    - implementation of measures to mitigate safety risks as necessary
    - maintaining and implementing an incident or emergency response plan as required
    - providing information to raise visitors' awareness about the main and most serious safety issues.
16. Where practical and appropriate make sure detailed recreation site planning considers services and facilities for people with disabilities or limited mobility.
17. Carry out fire risk assessments and utilise strategic prescribed fire and/or complementary mitigation strategies (e.g. mechanical fuel management) to protect human life and park infrastructure.
18. Consider impacts to visual landscape amenity around key visitation sites when carrying out fire management planning relevant to the parks.
19. Provide advice about external land use planning and development proposals when needed to promote avoidance or mitigation of any potential significant adverse effects on recreation and tourism values of the parks.
20. Maintain a portfolio of evidence to facilitate reporting and assessments against the KPI below.

Key performance indicator		
Performance measure	*Target*	*Reporting requirement*
Overall visitor satisfaction as expressed in visitor surveys.	An increasing trend in the proportion of visitors that are satisfied with their experience of visiting the parks.	Every 5 years

Danggu National Park. *Photo – Dave Woods*

Part 3 – Background and supporting detail

Bunuba cultural heritage

Quotes and other information relating to Bunuba history and cultural values presented in this section and throughout the plan have been derived from BDAC's *Jalangurru Muwayi* and otherwise provided by Bunuba people through the planning process. A glossary of Bunuba language terms is included at Appendix 1.

Bunuba people, Muwayi (country) and Law

The parks are on country that Bunuba people have been connected to for thousands of generations. Bunuba people call this country their *Muwayi*, a term which in its broadest sense means land, but is a concept that has layers of meaning. Bunuba people and country are deeply connected through their law and culture. The *Jalangurru Muwayi* explains that Bunuba *Muwayi* (Bunuba country) comprises numerous smaller *Muwayi*.

> "The Bunuba people are made up of extended families, or clans, which we call *Dawangarri*. Each *Dawangarri* has a country, or *Muwayi*. So, for example, the people who belong to *Mililny* are known as the *Mililiny Dawangarri* for the *Mililiny Muwayi*. In the days before the *malngarri* (white man) arrived there were eighteen *Dawangarri*, each with its own territory, who together made up the Bunuba nation. We are *Waringarri, Malunggu, Mililny, Miluwindi, Danggu, Mawanban, Munmaral, Rararrawali, Manjali* and *Galamanda*. We are river, ranges, plains and fringing desert people."

For Bunuba people, law and country are derived from *Ngarranggani* (Creation time), with associated stories and *Junba* (Song-lines, dance and song) passed down from generation to generation. Bunuba people have a deep and vital connection with the country which is seen as a whole, living, interconnected and integrated system. Country is believed to be kept alive through the law and cultural practise of Bunuba people, and Bunuba people are kept healthy, spiritually, physically and emotionally by practising this law and culture. The *Jalangurru Muwayi* says:

> "We have walked and looked after this beautiful *Muway*i since the *Ngarranggani*. Archaeological work at *Jumburrurru* (Carpenter's Gap) has shown that we have been on this land for at least 46,000 years – almost 2000 generations! Their memory and knowledge is alive in the art and engravings in the caves and on the rock faces, in the law and the stories that have been passed down and which give meaning to the land, and in the songs and dance that we perform to keep the land awake. It is in our harvesting of plants, hunting and fishing by our seasonal calendar, it is in our traditional fire management and agriculture, and it is alive in our language. Through practising this law and culture, as it has been done for thousands of years, we are keeping this country, its animals, plants and spirits alive and healthy, just as it keeps the Bunuba people alive and healthy."

> ***"Going onto country is a spiritual journey"***
>
> **Dillon Andrews**
> Bunuba Healthy Country planning meeting 2015.

And,

> "We need to regularly celebrate country through our *Junba*. We need to tell the stories from the *Ngarranggani* as they are how our law and country came to be. We need to practise hunting, fishing and gathering in the right way, at the right time, in the right areas. We need to continue to make our artefacts and protect our rock art and engraving sites. We need to make sure that law grounds, men's and women's sites, are visited by the right people to keep them powerful. We need to listen to our elders, and make sure that that knowledge is passed down to the next generation. We need to keep speaking Bunuba language, as this is the language the country understands."

> "The responsibility to maintain Bunuba law and culture is a big responsibility, but we see it as an honour and a source of pride to celebrate and share with future Bunuba generations and the wider community

where appropriate. Bunuba people must walk firmly within the traditional Bunuba world and in the *malngarri* (white fella) world too."

The arrival of Europeans in the mid-1880s seeking land to raise sheep and cattle saw the commencement of a very violent and tumultuous period in Bunuba history. Despite concerted resistance efforts by Bunuba warriors many lives were lost and Bunuba people were eventually dispossessed of their lands, with devastating effects on their practise of culture on country, their spirits and wellbeing. Bunuba people are proud of their history of sustained resistance and the warriors, such as Jandamarra, that defended the country against overwhelming odds. Bunuba people's long-standing resistance campaign held back the advancing frontier of European settlement for 13 years; an unusual achievement in the history of the Australian frontier conflict, and one of the values identified as contributing to the national heritage significance of the West Kimberley. Similarly, Bunuba people's and Bunuba country's association with the man and the legend of Jandamarra is recognised as being of national heritage significance. The Lillimooloora police station ruins and grotto which are in the proposed Bandilngan Conservation Park are registered sites under the *Aboriginal Heritage Act 1972* and the *Heritage Act 2018*.

Sites, habitats, plants and animals of special cultural significance

Bunuba's very long use and connection to land on which the parks are situated is reflected in the myriad of significant cultural heritage sites and objects, some of which are formally registered under the *Aboriginal Heritage Act 1972*. The range of registered cultural heritage sites and objects in the parks include: archaeological deposits, paintings and engravings, water sources, camps, artefacts/scatters, burial sites, ceremonial sites and mythological sites. Some sites should be accessed by men only or women only. The value of Aboriginal heritage sites in the parks is inherently linked to the lands and waters in which they occur, and the ability of Bunuba people to access these sites when they wish to do so. Registered sites in the parks include important archaeological sites that are not only of immense importance to Bunuba people, but have also been recognised as being of national heritage significance. More recent research has also uncovered archaeological findings that are significant on a global scale (discussed in more detail below- see Archaeological sites and associated values).

Garuwa (water) places and flows hold special cultural significance for Bunuba people. As well as being important places for camping and providing key foods and other resources, many *Garuwa* are associated with sacred *Junba* song-lines, or are homes to the *Ungguds*, the rainbow serpents of the *Ngarranggani* (Creation) time. Bunuba people are concerned about the health of their *Garuwa* places; "we want to maintain strong flows of our sacred waters on our country through scientific and conservative management of *Garuwa*."

Certain plants and animals hold particular cultural importance for Bunuba people for a variety of reasons, they may for example have a part in the stories of *Ngarranggani*, have a role as indicators of traditional seasons, or be an important customary food, medicine, ceremonial or other cultural resource. Extracts below from the *Jalangurru Muwayi* describe some specific examples.

> "The traditional use and management of our native wildlife on our lands is a Bunuba cultural responsibility. When traveling on country we camp, undertake fire management and *bilinyi* (hunt bush meats), in particular *Gurdunggu* (wallaby), *Gananganyja* (emu), *Galamuda* (bush turkey), *Baniy* (goanna), *Lunggura* (blue tongue lizard), *Bunwunggu* (blackhead python) and *Wanyjirri* (kangaroo), but also *Ngalja* (brown frog) and *Lumburra* (witchetty grub). It is important that we hunt these land animals according to our law, traditional custom and the seasonal calendar, to make sure that we are not over-hunting and that there are plenty left for future generations."
>
> "Bunuba land provides us with a wealth of healthy food plants and *Lumbilumbi* (bush medicine). *Ngirridu* (spinifex wax) is harvested for colds, *Mala* (freshwater mangrove) *Wanjali* (leaves) chewed for tooth ache and *Biriyali* (conkerberry) is used for smoking and for its fruit. The harvesting of these plants needs to be done in a sustainable way according to our traditional calendar and culture, utilising critical knowledge of where the plants grow, when their parts are ripe for harvesting and the ways to process the products. Even if plants are not immediately used for food, medicine or ceremony, they are still important to

> Bunuba country and culture as some are important for our animals, with all species being interconnected."
>
> *"Garuwa* animals are a highly valued by Bunuba for *milha* (meat) and their part in the stories of the *Ngarranggani*." Important Garuwa animals include "*Gayi* (freshwater crocodile), *Waywurru* (long necked turtle), *Nyanyani* (sawfish), *Jawiywiy* (bull shark), *Ngawalhay* (black mussels), *Wabana* (water monitor), *Jarramba* (cherubin) and many species of bony fish such as the mighty *Balga* (barramundi). Most of these live in the billabongs, waterholes and main channels of the rivers that flow through Bunuba country, which are replenished and cleaned with the rains and flooding during the wet season."

Customary activities and traditional knowledge

There are a wide range of customary activities that Bunuba people practise as an inherent part of their cultural heritage. Going onto country to continue these activities and to pass on associated knowledge, traditions and skills from generation to generation is integral to keeping their cultural heritage alive. The *Jalangurru Muwayi* provides the following insights:

> "When we go out hunting, we use our language, teach and share knowledge with our youth, sing, undertake ceremony, celebrate and monitor country and wildlife health. We are spiritual and physically healthier when undertaking these activities on our country. We must endeavour to increase the opportunities for our young people to participate in these activities with elders for customary connection and land management knowledge to be passed on."

And,

> "The process of *milha-bilinyi* (fishing and hunting) is not just about getting a feed, but also for getting out and checking on country, spending time with family and friends, transferring stories between young and old generations."

And,

> "We need to go on-country cultural camps to visit sites, share knowledge and practice song, dance, artefact making and other cultural practices".

The sustainable use of country and its resources is an important feature of Bunuba traditional knowledge. The *Jalangurru Muwayi* explains:

> "We need to practise hunting, fishing and gathering in the right way, at the right time, in the right areas." Hunting needs to be "according to Bunuba law, traditional custom and the seasonal calendar, to make sure that we are not overhunting and that there are plenty left for future generations".

Plants for our food and bush medicine (*Lumbilumbi*) need to be harvested "in a sustainable way according to our traditional calendar and culture, utilising critical knowledge of where plants grow, when their parts are ripe for harvesting and the ways to process the products. "

Through their customary practices, Bunuba people have accumulated extensive knowledge about their country, including its plants, animals and ecological processes, and they have much knowledge and experience to bring to the table in jointly managing this land for conservation purposes.

Archaeological sites and associated values

As well as being highly important to Bunuba people, certain Bunuba cultural heritage sites contribute a great deal to archaeological research as well as a range of other scientific disciplines. The parks have several archaeological values that form part of the national heritage significance of the West Kimberley (as discussed on page 45). Further significant findings relevant to the parks have also come to light since the national heritage listing occurred in 2011.

Sites associated with some of the most notable archaeological findings from the parks were originally excavated in the late 1990s, but analysis and dating of some materials has not occurred until recently, and so

several important findings from these locations have only come to light in the last few years. For example, recent analysis of a stone artefact from *Jumburrurru* (a rock shelter located at Carpenter's Gap in the proposed Bandilngan Conservation Park) found it to be the world's earliest known evidence of a ground-edge axe. The artefact is dated between 44,000 - 49,000 years old, which coincides with, or soon after, the time humans first arrived in Australia (Hiscock et al. 2016). This finding demonstrates that ground-edge axes were made in Australia more than 10,000 years earlier than previously thought (Hiscock et al. 2016).

Recent analysis of another artefact also found at *Jumburrurru* found it to be the oldest shaped and utilised bone implement currently known from Australia (Langley, O'Connor & Aplin 2016). The artefact was shaped from a kangaroo bone and most likely was a piece of personal ornamentation, such as a nose-bone, or an awl (i.e. a tool for working leather or basketry) (Langley, O'Connor & Aplin 2016). If the implement was a nose-bone, the finding constitutes the earliest known artefact of personal ornamentation in Australia and New Guinea (Langley, O'Connor & Aplin 2016). Regardless of its purpose, the find provides evidence of bone tool development in Australia almost 25,000 years earlier than this was previously thought to have occurred, and also at the opposite end of the country where it was previously thought to have been innovated (Langley, O'Connor & Aplin 2016). The preservation of such an ancient organic artefact is unusual, especially because the climate in this area would ordinarily rapidly destroy organic materials (Langley, O'Connor & Aplin 2016).

The archaeological values of national heritage significance in the parks are mainly associated with *Jumburrurru,* which was occupied from over 49,000 years ago and is the oldest known Indigenous habitation site in northern Australia (Department of the Environment and Energy, 2011). It is one of just a few sites known from the northwest of Australia that have deposits dated prior to the Last Glacial Maximum (a period when many occupation sites were abandoned across Australia), and is one of only two of these that have retained organics as well as stone artefacts at the oldest levels (Department of the Environment and Energy, 2011); (Frawley & O'Connor 2010); (Langley, O'Connor & Aplin 2016).

The alkalinity and other characteristics of the Devonian reef result in a level of preservation of ancient organic materials that is uncommon in archaeological deposits of similar age elsewhere, particularly when compared to locations subject to a similar monsoonal climate (Frawley & O'Connor 2010); (Langley, O'Connor & Aplin 2016). Due to these excellent preservation conditions, further archaeological survey in these areas is likely to add to the significant discoveries already made. The potential for the Devonian reef complex to provide new archaeological information which can contribute to understanding of Australia's natural and cultural history is recognised as a value of national heritage significance (Department of the Environment and Energy 2011).

Other finds from the parks associated with values of national heritage significance include:

- a rare sequence of botanical remains spanning 40,000 years
- Pleistocene aged use of ochre in rock art
- marine shell beads and fragments found hundreds of kilometres away from the coast.

A sequence of botanical remains spanning 40,000 years has been found at *Jumburrurru.* This provides rare and valuable insights into changes in flora composition and Aboriginal plant procurement strategies over this time (Department of the Environment and Energy 2011).

Archaeological excavation at *Jumburrurru* has also provided the earliest (Pleistocene aged) direct evidence for the symbolic use of ochre in rock art in Australia (Department of the Environment and Energy 2011). The ochre appears to have been blown onto the rock surface, a common traditional technique employed by Aboriginal people to apply colour pigments to rock surfaces (Department of the Environment and Energy 2011). This finding is the oldest example presently known from Australia, and one of the earliest examples in the world (Department of the Environment and Energy 2011).

Marine shell beads and fragments were excavated from several archaeological sites in Bandilngan National Park in locations that were hundreds of kilometres from the coast at the time of their deposition (O'Connor et al. 2014). These probably would have been transported inland through traditional Aboriginal systems of trade or exchange. The findings of marine shell beads from the parks have been recognised as being of outstanding

heritage value to the nation for demonstrating the operation of traditional Aboriginal social and economic trading networks 30,000 years ago (Department of the Environment and Energy 2011).

Key management issues for Bunuba cultural heritage values

A fundamental aspect of managing Bunuba cultural heritage values is ensuring that Bunuba people can access and use their traditional lands and its resources to practise their law, culture and customary activities. Colonisation by Europeans has had a devastating effect on the lives of Indigenous Australians and their cultural heritage, and in the Kimberley, the establishment of the pastoral industry saw Bunuba people pushed off their traditional lands. Bunuba describe this in the *Jalangurru Muwayi* as impacting on "the practise of culture on country, the speaking of our language, our spirits and well-being" and having weakened "the links in the long chain of traditional knowledge that extends back thousands of years to our Bunuba ancestors". However, through the *malngarri* (white fella) law, Bunuba people succeeded in establishing their native title over most of Bunuba *Muwayi* (country), and have been able to access some of their traditional lands once again. The adoption of Bunuba language names for the parks helps to acknowledge and communicate Bunuba people's connection to this land.

Anything that would significantly impede Bunuba people from accessing and using the resources of Bunuba country would be a threat to conservation of Bunuba cultural values. This is not likely to be applicable to the parks however because of provisions in the CALM Act and the Biodiversity Conservation Act[29], and the joint management arrangements negotiated through the ILUA and JMA. As a result, Bunuba people are in a strong position to make decisions about how the parks are managed (as discussed in Section 2 and Section 4 of this plan), and where feasible, can access the conservation estate to practise their law and culture, and conserve their cultural heritage. This is important as the potential loss and dilution of traditional knowledge is identified as a high management priority issue in the *Jalangurru Muwayi*, and increased opportunities to go out on country to transmit knowledge is identified as crucial to addressing this threat:

> "We have lost many of our old people but still have a few elders remaining who carry the most important elements of our cultural knowledge, Junba and language". "As elders pass away with old age, their knowledge needs to be properly documented and transferred to the next generation through putting this law and culture in practice on country".
>
> "Although Bunuba people these days are living more *malngarri* lifestyles in towns, we must make sure that the knowledge and practise is transferred to the younger generation to live on for another 50,000 years".

In addition to Bunuba people holding positions on the JMB, the ILUA and JMA include provisions for Bunuba people to derive benefits from country by way of various employment, training and potential business opportunities associated with management of the Bunuba Conservation Estate.

Some parts of the conservation estate, such as Jungi-wa/Guwinyja Conservation Park and Balili Conservation Park, do not currently have adequate legal road access and this hinders not only Bunuba people's access for cultural purposes but management of the parks in general. Legal access to these parks should be established early in the life of this plan and will require negotiations between several parties including BDAC, the department and Commission, relevant pastoralists, local government, and other relevant State government agencies (e.g. the agency responsible for land administration - currently the Department of Planning, Lands and Heritage).

Bunuba people's access to the parks for Aboriginal customary purposes is facilitated by provisions in the CALM Act and the Biodiversity Conservation Act. These include provisions to enable Aboriginal people to access the conservation estate to take flora and fauna for customary purposes, prepare and consume traditional foods or use medicine, and to engage in artistic, ceremonial or other cultural activities customarily used by Aboriginal people. There are some circumstances however in which written permission from the department or an

[29] That is, provisions for joint management and vesting of conservation reserves and other areas, and provisions for Aboriginal customary activities.

agreed 'local area arrangement' is required before certain Aboriginal customary activities can occur within the conservation estate[30].

One of the main potential threats to sites, habitats, plants and animals of special cultural significance to Bunuba people is inadequate acknowledgement or recognition of this cultural significance. Aboriginal cultural heritage sites are afforded some protection under the *Aboriginal Heritage Act 1972*. Some Aboriginal cultural heritage sites within the parks are also protected under the EPBC Act, being values that contribute to the significance of the West Kimberley National Heritage area and therefore 'matters of national environmental significance'.

Bunuba people need to have a primary and active role in protecting and managing their cultural heritage sites, and will provide advice through the JMB or otherwise, as necessary and appropriate, regarding whether and what management support and interventions may be needed to better protect these values. Special visitor access management measures may for example need to be implemented to protect inappropriate visitation to certain culturally sensitive sites. Other site-specific measures may occasionally be needed to address issues such as weeds, feral animals and fire which can also sometimes adversely affect cultural heritage sites and other cultural values.

The main potential threats to the cultural value and significance of *Garuwa* (water places) and associated species are not distinct from the factors that can affect the ecological value of these areas, and include for example:

- any activities or developments that have the potential to significantly alter natural water regimes (i.e. water quantity, quality, usual seasonal flow regimes)
- weeds
- introduced animals (particularly cattle and pigs that tend to congregate in riparian areas)
- inappropriate fire regimes.

Implementing strategies described throughout this plan that are aimed at conserving native habitats and species (e.g. Sections 12-15), will simultaneously help conserve the cultural heritage value of these habitats and species.

Improving people's awareness and understanding of Bunuba people's deep connection to country through their law and culture is an important part of safeguarding the cultural heritage values of the parks. Providing visitors to the parks with opportunities to become more aware of the significance of the parks to the culture and heritage of Bunuba people can help promote culturally appropriate behaviour, support cultural heritage conservation efforts, and contribute to improved visitor experience and enjoyment of the parks. Cross cultural awareness training for staff, and other people who work on Bunuba country and with Bunuba people, is also important to help establish and maintain effective joint management partnerships, while further building support for conservation of cultural heritage values of the parks.

National heritage and other heritage

The Lillimooloora police station ruins and grotto, located in the proposed Bandilngan Conservation Park, is the only site within the parks currently listed under the State Register of Heritage Places in accordance with the *Heritage Act 2018*.

The parks are all within the West Kimberley area that was included in the National Heritage List under the EPBC Act in 2011. Multiple values relevant to the parks were identified as contributing to the national heritage significance of the West Kimberley. The following statements of values pertinent to the parks (as well as some other parts of the Kimberley) have been taken from the listing notice:

[30] Further information regarding legislation and policy on Aboriginal customary in conservation estate is available via the department's website. Information about local area arrangements can be obtained from the relevant local departmental office, which in this case is the DBCA office in Broome, Western Australia.

- The King Leopold orogen of the west Kimberley has outstanding heritage value to the nation for recording pre-Rodinian and Proterozoic plate tectonic processes, key events in the evolution of the Australian continent.
- The Devonian reef of the Kimberley has outstanding heritage value to the nation because it is a continuous record of 20 million years of reef deposition, and shows the response of a Late Devonian reef to a mass extinction event.
- The northern Kimberley coast and islands, the Kimberley Plateau, and the west Kimberley Devonian reefs have outstanding heritage value to the nation for plant, mammal, reptile, frog and invertebrate species richness and endemism; and as refugia protecting against human-induced environmental changes.
- Vine thickets of the northern Kimberley coast and islands, the Kimberley Plateau, and the Devonian reefs of the west Kimberley, are of outstanding heritage value to the nation for their evolutionary refugial role that has resulted in high invertebrate richness and endemism.
- Carpenter's Gap 1 and Riwi rock shelters have outstanding heritage value to the nation as they demonstrate the operation of Aboriginal social and economic networks 30,000 years ago over distances of 500 kilometres.
- Carpenter's Gap 1 rock shelter has outstanding heritage value to the nation as it provides evidence of the antiquity of the symbolic use of ochre on a rock surface, the earliest 'art' in Australia's cultural history.
- The limestone ranges of the Devonian reef have outstanding heritage value to the nation as the place where Bunuba resistance held back the advance of European settlement for 13 years, an unusual achievement by Aboriginal people in the history of Australian frontier conflict.
- Carpenter's Gap 1 rock shelter has outstanding heritage value to the nation for its rare archaeological sequence of micro and macro-botanical remains spanning 40,000 years that contributes to our understanding of the impacts of climate change on flora composition though time, and the rare evidence it provides of plant procurement strategies used by Aboriginal people from the Pleistocene through the last glacial maximum (a period when many occupation sites were abandoned across Australia) and into the Holocene.
- The coastline from Cape Londonderry to Cape Leveque and the Devonian reef complex have outstanding heritage value to the nation for their potential to yield significant new archaeological information contributing to an understanding of Australia's natural and cultural history.
- The Fitzroy River and a number of its tributaries, together with their floodplains and the permanent freshwater sources are of outstanding heritage value to the nation for their exceptional ability to convey the diversity of the Rainbow Serpent tradition within a single freshwater hydrological system.
- Geikie Gorge Conservation Park (Danggu Conservation Park), Geikie Gorge National Park (Danggu National Park), Windjana Gorge National Park (Bandilngan National Park) and the King Leopold Ranges Conservation Park have outstanding heritage value to the nation for their aesthetic characteristics valued by the Australian community.
- Aboriginal rock art paintings in the west Kimberley, particularly in the Wanjina-Wunggurr homeland, the Balanggarra native title claim area, and the Devonian reef, are of powerful and of deep religious significance to Kimberley Aboriginal people, and, have outstanding heritage value to the nation as they represent a stunning visual record of an ongoing Aboriginal painting tradition in a substantially unmodified landscape.
- Considered one of the longest and most complex painted 'rock art' sequences anywhere in the world, the west Kimberley complex of painted images is a creative achievement by Kimberley Aboriginal people that has outstanding heritage value to the nation.
- The limestone ranges of the Devonian reef, known to the Bunuba as *Balili*, has outstanding value to the nation for its association with Jandamarra, whose campaign of resistance was unprecedented in Australian history, as was the ferocity of the police and settler response. Jandamarra's death in 1897 ended the last large-scale organised violent resistance by Aboriginal people in Australia's cultural history.

Other significant findings associated with archaeological deposits in the parks have occurred since the formal recognition of the national heritage significance of the West Kimberley in 2011 (more detail regarding these findings is presented on page 42).

Several sites within the parks, at Windjana Gorge, Geikie Gorge, Tunnel Creek and Dingo Gap, have been included on a State register of geo-heritage sites, in recognition of their research, education and geo-heritage values.

A potential threat to the heritage values described above is insufficient recognition or appreciation of these or their significance. Addressing this issue where needed will help promote support for conservation of these values.

Values such as those described above are of interest to researchers from a wide range of science disciplines and their work is important to help us better understand and conserve the values of the parks. It is important that access for research purposes is well coordinated and subject to prior approval, cultural protocols and appropriate licences and associated conditions.

Geology and geomorphology

The King Leopold Ranges (Miluwindi)

The King Leopold Ranges (*Miluwindi* to Bunuba people) extend along the south-western margin of the Kimberley Plateau. They are remnants of an ancient major mountain building event known as the 'King Leopold Orogeny' that took place around 560 million years ago (Tyler et al. 2012). As such, the King Leopold Ranges help tell the story of the shaping of Australia. Massively folded and faulted sandstone rocks that can be seen while traversing Miluwindi Conservation Park along the Gibb River Road reflect the tremendous forces at work when continental plates collided during this mountain building phase (McKenzie et al. 1992); (Tyler 2016). Subsequent effects of climate and erosion by water, ice and wind on the uplifted rock layers has created the dramatic and rugged present-day landscape with its valleys, deep gorges, steep ridges and cliffs (Tyler 2016). Rocks of the ranges include sedimentary types and those formed from magma: white and pink quartz sandstones, siltstones and mudstones, shale, dolomite and basalt, and dark grey dolerite (McKenzie et al. 1992); (Tyler 1997). The King Leopold Orogen has been formally recognised as being of national heritage significance as it records geological processes that were key events in the evolution of Australia. More specifically, the King Leopold Orogen (Department of the Environment and Energy, 2011); (Tyler, 1997):

- provides evidence of Paleoproterozoic plate tectonic activity (from about 2500- 1600 Million years ago), when the Kimberley was part of a separate land mass which then collided and amalgamated with the rest of northern Australia.
- preserves rocks from the King Leopold orogenies (mountain building processes).
- provides opportunities for ongoing scientific research.

There is little consensus among geologists on plate tectonic activity in the early earth, and rocks from 2700 million years ago to about 700 million years ago, such as those of the King Leopold Orogen, are therefore very important in understanding key events in the evolution of Australia.

Devonian Reef (Balili)

The Oscar and Napier Ranges that traverse the plan area are part of an ancient limestone barrier reef (*Balili* to Bunuba people) laid down in a shallow sea that fringed the Kimberley land mass during the Devonian, about 380-360 million years ago (Department of the Environment and Energy 2011). It is thought that the reef became extinct in the late Devonian when it was exposed due to dramatic falls in sea level (Playford, Hocking & Cockbain 2009). Remnants of this ancient reef are represented in the National Reserve System through Bandilngan National Park, Dimalurru National Park, the Balili Conservation Park, Jungi-wa/Guwinyja Conservation Park, and Danggu national park and conservation park. The proposed Bandilngan Conservation Park will protect more of the Devonian reef for conservation purposes.

The Kimberley Devonian reef complex has been formally recognised as being of national significance as part of the West Kimberley National Heritage Area. It is amongst the best-preserved ancient reef complexes in the world and provides a record of 20 million years of reef development (Department of the Environment and Energy 2011). It preserves a complex spectrum of reef environments, varying from the lower energy back reef lagoons through to the more steeply dipping strata that formed at the open ocean reef margins (Tyler 2016).

Playford *et al.* (2009) provide detailed descriptions of the Devonian reef complex and the associated fossil assemblages. Talent et al. (2000) describes studies of fossils of the Devonian reef complex.

Valleys cut through the reef by the Lennard River at Windjana Gorge, and the Fitzroy River at Geikie Gorge, as well as being of spectacular scenic value, provide cross sections that are useful study sites for a range of scientific disciplines (e.g. palaeontology, geology and biology). The section exposed at Windjana Gorge has been described as the most important locality on the Lennard Shelf for study of the Devonian reef complexes (Playford, Hocking & Cockbain 2009). This site, as well as several others within the parks (e.g. Geikie Gorge, Tunnel Creek and Dingo Gap), have been included on a State register of geo-heritage sites in recognition of their research, education and geo-heritage values (Geological Survey of Western Australia 2017).

The ancient reef is extremely rich in numerous and diverse types of well-preserved fossils and provides fascinating and highly valuable insights into the animals, plants and reef-building organisms that lived in and around the reef during the Devonian. The fossil assemblage includes a diverse array of stromatolites; these are structures of various form developed through the trapping or binding of sediments by microorganisms, mainly cyanobacteria (also known as 'blue-green' bacteria). Stromatolites are of research interest for insights they can provide into the evolution of life on early Earth.

The reef and its fossil assemblages record marine mass extinction events that occurred during the Devonian. The late Devonian[31] saw many fish become extinct, and then at the close of the Devonian period there was a mass extinction of shallow warm-water organisms (Department of the Environment and Energy 2011). These events saw changes occur in the organisms primarily responsible for reef development over the late Devonian. Unlike modern limestone reefs which are built primarily by corals, the Devonian reefs were constructed mainly by a group of lime-secreting sponge-like organisms called stromatoporoids, although also by corals and microbes (probably mainly cyanobacteria) (Playford, Hocking & Cockbain 2009). However, in the middle Devonian, corals declined for reasons not known, and the reef was then built mainly by microbes and stromataporoids (Playford, Hocking & Cockbain 2009). Then stomatoporoids virtually disappeared from the fossil record when the mass extinction of shallow water organisms occurred in the late Devonian (Playford, Hocking & Cockbain 2009). Reef formation after this time was almost entirely by microbes (Playford, Hocking & Cockbain 2009). The Devonian reef parks provide uncommon opportunities for further study of these extinction events as late Devonian[32] fossil reefs are believed to be rare throughout the world, and not present elsewhere in Australia (Department of the Environment and Energy 2011).

The Devonian reef is one of the major karst areas of Australia (Playford, Hocking & Cockbain 2009), one of the oldest in the State, and, as it is situated in the remote Kimberley, is amongst some of the most intact, undisturbed karst in the country. Karst landscapes are those formed by the dissolution of soluble rocks, such as limestone, by water, to a greater degree than is usual in most landscapes, that results in a system of distinctive features above and below the ground surface (e.g. caves, karst corridors, tunnels, gorges, vertical shafts, tufa, sinkholes, and surface depressions known as dolines). Karst has developed in the reef since the late Devonian when it was exposed by sea level regression. However, the most extensive karst development is thought to have occurred when the reef was still buried under ice and sedimentary rocks during the early Permian, while an ice age was affecting much of Australia (Tyler 2016). Beneath the ice sheets, the sub-glacial water dissolved the carbonate structures of the reef forming an extensive and deep karst system (Playford, Hocking & Cockbain 2009); (Tyler, Hocking & Haines 2012). The reef was later buried by younger sedimentary rocks: mudstones; limestone and sandstone, however, being less resistant to erosion, much of the overlying strata have gradually worn away to reveal the reef once again (Tyler 2016). The early Permian karst continues to be modified to varying degrees as it is incorporated into the modern karst topography (Playford, Hocking & Cockbain 2009); (Tyler 2016).

Karst systems in general are recognised as landscapes of special conservation significance associated with many diverse values (Watson et al. 1997). However, there has been very little study of the extensive and remote Devonian reef karst system and there are consequently many gaps in knowledge about the specific values it encompasses (Humphreys 1995). An examination of karst and cave fauna of the East Kimberley in the

[31] i.e. late Frasnian-early Famennian stages
[32] i.e. Famennian

mid-1990s also includes brief investigation of some caves and other karst features within the Oscar and Napier Ranges (Humphreys 1995). There has also been some investigation of tufa in these ranges in the late 1990s and early 2000s. Karst landscapes often support unique and distinctive flora and fauna, including for example underground specialists, short-range endemics, ancient and relict species. The Devonian reef karst provides diverse above and below ground habitats, and in some instances critical habitat, important for a wide range of species including threatened and other species of special conservation significance. Further investigation of the karst system (including karst aquifers) is likely to reveal novel and unique species (Humphreys 1995); (Oliver et al. 2014); (Oliver et al. 2016); (Oliver et al. 2017); (Wilson & Ponder 1992).

The cave at Tunnel Creek is one of the best-known caves in the parks and is an important Bunuba cultural heritage site and a popular tourist attraction. The tunnel which passes from one side of the Napier Range to the other has been gradually eroded by groundwater percolating through a prominent fracture in the rock (Lane 2013). The cave is decorated with various speleothems and rock art.

The Devonian limestone of the Oscar and Napier ranges have an extensive and diverse range of tufa (Viles & Goudie 1990); (Wright 2000). These interesting features common in karst environments are formed when calcium carbonate is precipitated from fresh discharging groundwater, and are often associated with groundwater-fed springs, streams, seepages and caves within the ranges (Ellaway et al. 1990). The very high evaporation rate in this region encourages the precipitation of calcium carbonate and is a significant factor contributing to development of tufa in the Devonian limestone (Viles & Goudie 1990); (Wright, 2000). Tufa are also commonly associated with microbial communities (e.g. of algae, mosses and cyanobacteria) and it is thought that these may also play a role in the growth and structure of the formations (Viles & Goudie 1990); (Wright 2000). In most cases, precipitation of calcium carbonate to form tufa is likely to be due to both abiotic and biotic factors (Jones & Renaut 2010). The Napier Ranges have both relict and active tufa which possibly reflects changes in climate from wet to dry to wet (Viles & Goudie 1990). Tufa are of scientific interest as they can provide insights into paleoclimates and other environmental and ecological changes over time (Wallis 2001).

Both the Devonian Reef (*Balili*) and sandstone ranges (*Winamu*) are of key importance in Bunuba culture and they contain many important sites including rock art and engraving sites, ceremonial places, seasonal camping areas and perpetual springs (Bunuba Dawangarri Aboriginal Corporation 2018). Some of these sites within *Miluwindi* and *Balili* are also highly significant archaeological sites, and associated with national heritage values. *Miluwindi* and *Balili* also provide important habitat for species of special cultural significance (Bunuba Dawangarri Aboriginal Corporation 2018).

Alkalinity and other characteristics of the Devonian reef have contributed to uncommon preservation of ancient organic materials in some archaeological deposits. Due to these excellent preservation conditions, further archaeological survey in the Devonian reef is likely to add to the significant discoveries already made, and this potential has been recognised as a value of national heritage significance (Department of the Environment and Energy 2011).

Key management issues for geology and geomorphology values

There are no major pressures known to be currently affecting the values described above.

Potential pressures could arise from any activities or developments that cause direct physical damage to landforms, or those that could disturb the geomorphic or hydrological processes that help sustain the values described above. Because these processes can extend well beyond the boundaries of the parks, values within the parks could potentially be affected by land-use and development in nearby and adjacent areas, as well as those within the park boundaries. This is particularly the case for karst landscapes and aquifers which are complex, highly integrated systems, that require whole-of-catchment, whole of karst-system protection and management (Watson et al. 1997). Maintaining the integrity of the karst system is a fundamental aspect of conserving the biodiversity of the parks.

It is important that significant planning and development proposals[33], both within and near the parks, are evaluated to consider and mitigate potential adverse effects on karst and associated values. This will often necessitate engagement of appropriately specialised and inter-disciplinary expertise (e.g. karst hydrogeologists, geotechnical engineers and biospeleologists) (Watson et al. 1997). Conservation of karst values will also be enhanced by providing relevant staff with training to develop knowledge about karst management. There are many gaps in knowledge about the karst and associated values in the parks, and site-specific, proposal-specific investigations may be necessary to obtain more detail about the assets that could be at risk, and to identify appropriate risk mitigation strategies.

Tufa and speleothems can be particularly vulnerable to direct physical damage as these can take thousands of years to form and therefore damage is essentially permanent. Unfortunately, vandalism of some speleothems in the Tunnel Creek Cave has occurred. Informative signage, access management and various other visitor management measures will help avoid further speleothem damage in this cave (and elsewhere if necessary to avoid damage to sensitive karst features). Cattle could also potentially cause damage to tufa in some areas. Another issue with tufa occurring in the parks is that there is currently not enough known about these and the interconnected biological communities to provide a robust understanding of their specific conservation significance and management implications. Similar formations elsewhere have been found to support distinctive ecological communities of special conservation significance.

Various geological aspects of the parks are important for research in a range of scientific disciplines. While research provides valuable information, it is important that access and activities conducted for research purposes are well managed and subject to appropriate approvals, licences or permits and associated conditions (including for example observance of cultural protocols for access to certain sites).

Recreational fossicking (e.g. for rock, fossils, bones, shells) is not appropriate in these parks and is not permitted.

Raising awareness of the known (and potential) biodiversity conservation, geo-heritage, archaeological, cultural and other significance associated with geological values in the park will help promote support for conservation of these.

Water (*Garuwa*)

The region experiences highly seasonal rainfall, with over 90 per cent of annual rainfall occurring during the wet season (November to April) (CSIRO 2009). Average annual rainfall in the Geikie Gorge area is about 600 millimetres and up to about 1000 millimetres around Miluwindi Conservation Park. Despite receiving high rainfall, the region is seasonally water-limited due to long dry seasons and very high evapotranspiration rates (Department of Water 2010). Substantial variability in inter-annual rainfall is also not unusual, and the region may experience long periods of many years that are considerably wetter or drier than others (CSIRO 2009). Projected changes to rainfall are not clear for the Kimberley region, but extreme rainfall events are likely to be more intense (CSIRO & Bureau of Meteorology 2017). Also, average temperatures are expected to increase in all seasons for the near future (2030) (CSIRO & Bureau of Meteorology 2017), so it is expected that high evapotranspiration rates will continue to affect water availability.

In this dynamic climatic context, highly variable and at times dramatic seasonal changes in water quantity and quality in rivers and other wetlands are normal regular occurrences. Many native plant and animal species have adapted to, and are dependent on, the fluctuating natural extremes of water abundance and scarcity. Variations in water availability and the rate of change of water flow, may, for example, be a trigger for reproduction or migration in some species (CSIRO 2009). Riparian vegetation is well adapted to and dependent on the natural seasonal changes in water levels, flow rates, and other environmental conditions that are common in this region. The specific ecological water requirements of many species and communities in the parks are however generally not known.

[33] Including for example, road or recreation site developments, any works or activities that could significantly alter usual water drainage patterns, mining or water development proposals.

Garuwa (water) places and flows hold special cultural significance for Bunuba people. As well as being important places for camping and providing key foods and other resources, many *Garuwa* are associated with sacred *Junba* song-lines, or are homes to the *Ungguds*, the rainbow serpents of the *Ngarranggani* time. Many *Garuwa* within the parks are registered sites under the *Aboriginal Heritage Act 1972*. Maintaining the normal natural water regimes of surface and groundwater systems in the park is an essential part of conserving the value of the area to the culture and heritage of Bunuba people.

Surface water

The parks are situated in the Lennard River and Fitzroy River (*Bandaral Ngarri*) catchments. The Lennard River arises in the King Leopold Ranges and traverses Miluwindi Conservation Park and Bandilngan National Park. The Fitzroy River combines flow from upper catchment rivers including the Hann, Adcock, Manning and Little Fitzroy rivers, and passes through the Danggu National Park on to Fitzroy Crossing and its coastal discharge point in King Sound. Smaller creeks in the parks include Tunnel Creek and Brooking Gorge Creek.

During the dry season the rivers in the parks are reduced to a series of disconnected pools, some of which continue to maintain permanent water through the year. During this time the pools are thought to be recharged by groundwater (e.g. from shallow local aquifers), and then during the wet season when water levels are high, the rivers recharge the aquifers (Department of Water 2010). These surface-groundwater interactions are however very complex and not well understood at a detailed level (Harrington & Harrington 2015).

The rivers, numerous permanent springs and other wetland areas in the parks are important habitat components for a variety of native plants and animals, including threatened or otherwise conservation significant species and communities, and for numerous species of particular cultural significance to Bunuba people. The perennial pools and springs and other sites of permanent water provide wildlife with dry season refuge, and are particularly critical to the survival of some fauna (e.g. obligate aquatic fauna such as fishes and sawfish, turtles and aquatic invertebrates).

Three sites within the parks are recognised in the Directory of Important Wetlands in Australia; the permanent river pools at Geikie and Windjana gorges, and Tunnel Creek where it passes through the cave. Geikie Gorge and Windjana Gorge were recognised as having good examples of permanent river pools in the bioregion, while the Tunnel Creek site was recognised as a good example of a subterranean karst wetland (Department of the Environment and Energy 2016a); (Department of the Environment and Energy 2016b); (Department of the Environment and Energy 2016c). All three sites met the criteria of being of outstanding historical or cultural significance. The site at Windjana Gorge was additionally recognised for providing a significant dry season refuge for freshwater fishes (Department of the Environment and Energy 2016b). Similarly, the permanent pool at Geikie Gorge was recognised as significant for providing a major drought refuge area for freshwater fishes, as well as marine fishes that occur well inland of the coast (Department of the Environment and Energy 2016a). Tunnel Creek is seasonal, but the cave contains permanent freshwater pools throughout the year (Department of the Environment and Energy 2016c); (Somaweera, Woods & Sonneman 2014). While these three sites have been included in the Directory of Important Wetlands in Australia, all permanent river pools, springs and other freshwater habitats in the parks are of high ecological and cultural conservation significance.

Groundwater

Broadly, aquifer types in the parks are fractured rock aquifers[34] in the Miluwindi Conservation Park area, and limestone aquifers[35] for the remaining Devonian reef parks. Fractured rock aquifers are complex and difficult to define in the absence of detailed investigations (Department of Water 2010). The karst features of the Devonian limestone also create complex, highly integrated and variable aquifer characteristics that are difficult to define (Harrington & Harrington 2015); (Humphreys 1995); (Watson et al. 1997). Karst systems and aquifers often extend well beyond the formal boundaries of the protected areas in which the more obvious features occur (Watson et al. 1997). Further, subsurface drainage in karst can contrast dramatically from what might be

[34] the 'Combined Fractured Rock - Central' aquifer
[35] the 'Canning - Limestone' aquifer

suggested by surface topography, so groundwater divides and catchments may not coincide with those of the surface (Watson et al. 1997).

Documented knowledge about the local hydrogeology of the parks is extremely limited. In fact, knowledge about regional groundwater systems has also been very limited. In recent years however, various hydrogeological investigations are being progressed as part of government initiatives to assess the region's water resource potential to support irrigated agriculture.

While the nature of groundwater dependent species or communities in the parks is not well known, it is understood that a range of species, including species of special conservation significance, are highly groundwater dependent. Invertebrates living in groundwater are obviously groundwater dependent. Species that are reliant on the permanent water pools that persist in rivers throughout the year are also likely to be groundwater dependent. It is thought that these pools are being recharged by groundwater in shallow local aquifers during the dry season. While specific knowledge about such surface-groundwater interactions is limited, they are likely critical ecological processes for the wildlife that depend on the permanent water pools (CSIRO 2009). Similarly, surface-groundwater interactions are also integral aspects of tufa development – these are karst features that are associated with groundwater-fed springs, streams, seepages and caves, and which commonly support distinctive microbial communities of special conservation significance. Rainforest patch communities occurring in drier inland parts of the Kimberley are also likely to have a high degree of groundwater dependency, and to be more commonly associated with springs, compared with those in the wetter northern Kimberley.

Key management issues for hydrology values

Altered water regimes

Both surface water and groundwater systems underpin and sustain many of parks' most important cultural, ecological and social values. In the Kimberley these systems are thought to be, in general terms, currently in good condition (Pusey & Kennard 2009). While currently not known to be under pressure, it is essential that the integrity of these systems is maintained. Many park values would be vulnerable to significant alterations in the normal water regimes (quantity, quality and flow regimes), and the usual seasonal and other natural variability in these. During the long dry-season, the permanent river pools, springs, soaks and other sites of permanent water provide a range of vital ecosystem services and functions. Ensuring that the water regimes that sustain these key assets is maintained is especially important.

> *"*We want to maintain strong flows of our sacred waters on our country through scientific and conservative management of *Garuwa*".
>
> **Extract from the *Jalangurru Muwayi* 2018**

The hydrological systems and processes that maintain values in the parks can extend well beyond the reserve boundaries. These could therefore be potentially affected by nearby or upstream activities, as well as those within the conservation estate. Effective management of highly water dependent assets in the parks necessitates catchment-wide approaches. Liaison and collaboration with other relevant agencies[36] and neighbours is important to encourage ecologically sustainable water use and management. This is especially important for karst aquifers which often extend well beyond the area that obvious surface features might suggest, and in which surface and subsurface drainage can contrast markedly (Humphreys 1995); (Watson et al. 1997). Karst terrain can be highly porous and contaminants at the surface may readily and rapidly move into subterranean habitats. It is not uncommon for actions in one part of the karst to affect distant locations in the landscape (Humphreys 1995); (Watson et al. 1997). It is important that these and other unique characteristics of karst aquifers and associated habitats are considered in evaluating the potential effects of planning and development proposals[37] in or around karst terrain. This may often require appropriately specialised and inter-disciplinary expertise (e.g. karst hydrogeologists, geotechnical engineers and biospeleologists) (Watson et al. 1997).

[36] Including the Department of Water and Environmental Regulation, which at the time of writing is the government agency with primary responsibility for sustainable use and management of the State's water resources.

[37] Including for example, road or recreation site developments, other works that could significantly alter usual drainage patterns, mining or water development proposals.

Knowledge gaps

While it is known that the parks support many aquatic and other biota that are entirely or highly dependent on rivers and other freshwater habitats, there are many gaps in knowledge about the local hydrogeology and specific ecological water regime requirements. For example, the surface-groundwater interactions that help maintain permanent river pools and springs, are vital ecological processes for many species and communities, but are complex and not well understood at a detailed level (CSIRO 2009); (Harrington & Harrington 2015). These limits in knowledge can constrain mitigation of the potential effects of some planning and development proposals on park values (Pusey & 2015).

Introduced animals

Introduced animals such as cattle and pigs commonly congregate in riparian areas and other freshwater habitats to access water and escape the heat. Overgrazing and trampling in these areas can lead to loss of vegetation, erosion and increase sedimentation of waterways. Introduced animals can also affect localised water quality through concentration of nutrients. These pressures are currently most notably present at Danggu National Park and in Miluwindi Conservation Park.

Vegetation and flora

Vegetation of the parks has been mapped at a very broad scale, but there has been no systematic botanical survey. Knowledge about the species and assemblages occurring in the parks, or their conservation status, is therefore fairly basic. More detailed vegetation mapping and floristic survey would support improved planning and management of the parks, but the rugged terrain, extreme weather and access difficulties this presents are significant challenges to be overcome. Even less survey has occurred during the wet seasons, so plants that only grow and flower during this time are particularly likely to go unrecorded.

Many of the plant species of the Kimberley are more closely affiliated with the Northern Territory, Queensland and south-east Asia than elsewhere in W.A.

Vegetation and flora in the parks hold particular cultural importance for Bunuba people for a variety of reasons, they may for example have a part in the stories of *Ngarranggani* (Creation), have a role as indicators of traditional seasons, or be an important customary food, medicine, ceremonial or other cultural resource. “Even if plants are not immediately used for food, medicine or ceremony, they are still important to Bunuba country and culture as some are important for our animals, with all species being interconnected” (Bunuba Dawangarri Aboriginal Corporation 2018).

Savanna

As elsewhere throughout the Kimberley, the vegetation of the parks is dominated by tropical savanna. These are grasslands with varying degrees of tree and/or shrub cover. Savanna varies widely in structure, species and species associations. Broadly, the rocky ridges and uplands of the Miluwindi Conservation Park support grasslands of *Triodia bitextura* and other short grasses and herbs, in association with woodlands or scattered low trees of Kimberley snappy gum (*Eucalyptus brevifolia*) and variable barked bloodwood (*Corymbia dichromophloia*). In the valleys, on the more readily eroded basalts, there is high grass savanna, with the main grass species being whitegrass (*Sehima nervosum*). This occurs with woodlands of predominantly grey box (*Eucalyptus tectifica*) and cabbage gum (*Corymbia grandiflora*).

On the rugged plateaus in the Devonian reef parks areas of bare rock are common. Elsewhere there are sparse hummock grasslands[38] of *Trodia wiseana* and other short grasses and herbs *(*e.g. chaff flower - *Achyranthes aspera*, tick weed- *Cleome viscosa,* and *Indigofera linifolia*), occurring with scattered trees and shrubs of mixed species ('tree steppe'). The boab (*Adansonia gregorii*) and the kurrajong/'Kimberley rose' (*Brachychiton viscidulus)* are conspicuous tree species of the hummock grasslands. Others include various species of Ficus, variable-barked bloodwood (*Corymbia dichromophloia*), kapok tree (*Cochlospermum fraseri*), caustic bush (*Grevillea pyramidalis*), *ngiyali* tree (*Bauhinia cunninghamii*) and Kimberley snappy gum (*Eucalyptus brevifolia*) (Beard 1990). Boabs appears to only occur in a specific floristic assemblage on the Devonian reef limestone.

[38] Those in which the grasses form scattered round dense clumps – ‘hummocks’

Riparian and aquatic communities

Rivers, creeks and other freshwater places within the parks support dense, species-rich riparian vegetation that is very different to that of the dominant savanna. Plants found in these areas include paperbarks (*Melaleuca* sp.), river red gums (*Eucalyptus camaldulensis*), the freshwater mangrove (*Barringtonia acutangula*), screw-pines (*Pandanus sp*.), Leichardt pine (*Nauclea orientalis*), wild plum (*Terminalia platyphylla*), Ficus sp., palms, various cycads and sedges. Water lilies and other aquatic plants (e.g. *Nymphoides* sp. and bladderworts - *Utricularia* sp.) occur in river pools.

While relatively small in area, riparian habitats add enormously to the local biodiversity and are important components of the most significant values of the parks, including being associated with key Bunuba cultural values, and recreation and tourism values. As well as containing numerous plant species not found in the adjacent savanna, riparian vegetation provides important and, in some cases, essential habitat for a wide range of fauna, including threatened species and other species of special conservation significance. These habitats are also used for seasonal refuge by many savanna species. Riparian vegetation also provides a range of ecosystem services and functions that help maintain riverine systems in good condition. These include for example, water filtration and oxygenation, nutrient cycling and stabilisation of sediments.

Dry monsoon rainforest patches/vine thickets

While most of Australia's rainforests are in the east of the continent, more than 1500 small, isolated rainforest patches are scattered throughout the Kimberley. The Kimberley rainforests are part of a highly fragmented corridor of 'dry monsoon' rainforest extending through the areas of Australasia that have seasonally dry climates (McKenzie 1991). These dry monsoon rainforest patches are understood to be largely relictual elements of a formerly more widespread and continuous rainforest vegetation (McKenzie 1991). This contracted under the more arid conditions that prevailed in the region for much of the Late Pleistocene (Kenneally, Keighery & Hyland 1991); (McKenzie 1991). Kimberley rainforest species are thought to have survived these arid conditions in riverine and other refuges offering moist, fire-protected, sheltered conditions (McKenzie 1991), and/or recolonised from the Northern Territory ((McKenzie et al. 1991).

While the largest and richest rainforest patches occur in the higher rainfall areas of the north-west Kimberley, some have been recorded in the Bunuba Conservation Estate. In these relatively drier inland areas, rainforest patches are generally deciduous or semi-deciduous, smaller and generally only found in fire-protected sheltered niches that have favourable hydrological conditions (e.g. on protected scree slopes, in gorges and gullies and near drainage lines, permanent springs and other freshwater areas).The Devonian reef limestone appears to support a distinctive form of rainforest comprising deciduous vine thicket communities dominated by *Adansonia gregorii* (boab) with mixtures of vine forest and savanna species. Another form of rainforest occurring in the Devonian parks is associated with Camaenid land snails, including species of snails listed under the Biodiversity Conservation Act. Both of these communities are very restricted occurring in only a few small areas, and currently identified as priority ecological communities. Further work is needed to clarify their conservation significance and status, key threats and management requirements.

Despite their limited areal extent, rainforest patches contribute significantly to the floristic diversity of the region, provide habitat for some fauna confined to or dependent on rainforest communities, and may also be important to a range of savanna and other regional fauna that may utilise these habitats intermittently (e.g. birds and bats may use rainforest patches for food sources) (Friend, Morris & McKenzie, NL 1991) (McKenzie et al. 1991) (Carwardine et al. 2011). They often have high levels of endemism in invertebrates. This is true of some vine thickets in the Devonian reef parks which have found to be associated with several endemic species of land snails, including threatened species that are listed under the Biodiversity Conservation Act and the EPBC Act.

Threatened flora and other flora of special conservation significance

As survey has been limited it is difficult to accurately understand rarity, levels of endemism, and overall conservation significance of plant species and communities in the parks. At the time of writing, one flora species recorded from the parks is a listed threatened species under the Biodiversity Conservation Act and the

EPBC Act; the mountain white gum (*Eucalyptus mooreana*)[39], which is largely confined to the King Leopold Ranges. However, what was previously thought to be a morphological variant of this has recently been identified as a separate species – *Eucalyptus revelata* (Nicolle & Barrett 2018). Further research is required to improve knowledge about both these species, including their response to fire and recruitment success. Despite very limited survey, more than thirty 'priority flora' species[40] have been recorded for the parks, including some not known from anywhere else, and which could, quite likely, on further investigation be found to qualify for listing as threatened species. Further survey is needed to more accurately determine their conservation status, key threats and management requirements.

Some vegetation assemblages occurring in the parks are currently identified as (or components of) priority ecological communities requiring further investigation, definition and evaluation of their conservation status:

- 'Monsoon vine thickets and Camaenid land snails of limestone ranges (Napier Range)'
- 'Boab dominated assemblages of Devonian limestone reef complex'
- The Leopold Land System
- The Gogo Land System.

Tufa formations found throughout the Devonian limestone are sometimes associated with microbial communities. In some other parts of the State these have been found to support distinctive ecological communities of special conservation significance. Further research would be needed to clarify the conservation significance of tufa and associated biota (e.g. algae, mosses and cyanobacteria) in the parks.

While not formally identified as threatened or priority flora, the cycad palm *Cycas furfuracea* is a sporadic, uncommon element of the Kimberley flora that occurs in the parks (e.g. on elevated surfaces in the King Leopold Ranges, and in the south-western Oscar Range (Playford, Hocking & Cockbain 2009); (van Leeuwen S 1984).

Key management issues for vegetation and flora values

Altered fire regimes

Flora of Australia's tropical savannas are generally resilient to fire, having a dominance of re-sprouting species that can quickly recover after fire, provided that it occurs at intervals and intensities that do not preclude species from re-establishing (Radford & Fairman 2015); (Andersen, Woinarski & Parr 2012). However, contemporary fire regimes in the Kimberley have tended towards too frequent, large and intense late dry season fires which destroy large expanses of vegetation and simplify the structural, species and age diversity of savanna vegetation.

Altered fire regimes can increase structural and floristic homogeneity in vegetation over time, as species that can respond quickly and favourably after fire become dominant, suppressing, and eventually replacing other slower growing or more fire-sensitive species. For example, anecdotal observations from Miluwindi Conservation Park and elsewhere in the Kimberley, indicate that under contemporary altered fire regimes some annual grasses such as sorghum outcompete and displace slower growing perennial spinifex grasses and woodland shrubs or trees. Communities that move towards a dominance of annual native grasses can result in these areas becoming more fire-prone over time. Inappropriate fire regimes can also promote the spread of certain weed species which can similarly alter fire regimes by making the vegetation more fire prone (Bowman et al. 2014).

Embedded within the broader generally fire resilient savanna of the parks are more fire-sensitive species and communities, often associated with naturally fire-protected areas in the landscape, such as rocky terrain where fuel loads are lower, or riparian and other freshwater areas. Under contemporary fire regimes, fires are more likely to penetrate these normally more protected niches. This is particularly true where there has been extensive weed incursion around and into these habitats.

Species likely to be most vulnerable to the changed fire regimes in the Kimberley include:

[39] currently listed as 'vulnerable' under both the Biodiversity Conservation Act and the EPBC Act.
[40] At the time of wring around twelve of these are Priority 1 species and eight are Priority 2 species.

- Longer-lived species and those that have long juvenile periods
- those that can only regenerate from seed ('obligate seeders')
- those where soil-stored seed banks have short persistence
- those with very restricted distributions, particularly if that distribution is associated with naturally less flammable parts of the landscape.

The threatened species *Eucalyptus mooreana*, and a related species *E.revelata*, grow high up in hills and steep terrain of the King Leopold Ranges. The fire response of these species is not well understood, but their occurrence in high rugged terrain that is not prone to fire may be indicative of fire-sensitivity. Further research is required to improve knowledge about their fire response, and the fire regimes most appropriate for these species, as well as other 'priority' species and communities of special conservation significance.

Callitris columellaris, a native cypress (*Gurru*), is very patchily distributed in some Kimberley savannas and is an example of a species understood to be relatively fire-sensitive[41] (Radford et al. 2013). There has been a decline in this species across the Kimberley and this is likely to be a result of increasingly frequent severe fire regimes (Bowman et al. 2014); (Yates, Edwards & Russell-Smith 2008). Further research is required to better understand the fire regime requirements for this species. Examples of other relatively fire-sensitive woody savanna plants include some re-sprouting species such as cycads and Livistona species (Yates, Edwards & Russell-Smith 2008). Some mistletoes of Kimberley savannas can also be sensitive to frequent or high intensity fires (Start 2013).

There are many gaps in knowledge about specific fire management requirements to meet flora conservation objectives for the parks. Fire management therefore needs to be precautionary and adapted where necessary to accommodate improved knowledge. The current assumption is that flora (as well as other) conservation outcomes in the Kimberley are likely to be optimised by fire management operations[42] that result in a temporal and spatial mosaic of vegetation across the landscape. This aims to maintain structural and floristic complexity and reduce the likelihood of very large, intense and damaging fires. Within this mosaic, the needs of threatened flora and species and communities with very specific fire regime requirements, can be considered drawing on the best available knowledge. Similarly, fire management will be informed by the best available knowledge about managing the complex interactions of fire with other concurrent and interacting pressures such as climate change[43], invasive weeds and grazing by cattle or other introduced herbivores.

Weeds

A proportion the weed species recorded from the parks to date present a significant threat to the native vegetation communities. Some of the most serious weeds currently occurring in the parks include[44]:

- *Passiflora foetida* (stinking passionflower)
- *Calotropis procera* (calotrope, rubber tree)
- *Jatropha gossypiifolia* (bellyache bush)
- *Parkinsonia aculeata*
- *Cenchrus ciliaris* (buffel grass)
- *Themeda quadrivalvis* (grader grass)
- *Sida cordifolia* (sida)
- *Cenchrus pedicellatus* (mission grass)
- *Cenchrus setiger* (birdwood grass).

[41] Because of factors such as: it being an obligate seeder, adults being killed by canopy scorch, a long juvenile period and short persistence of soil stored seedbanks.

[42] e.g. strategic and targeted fire management operations involving a mix of measure such as prescribed burns, maintenance of low fuel buffers, and targeted fire suppression where feasible.

[43] Climate change projections for the Kimberley region include increases in average temperatures with very hot days becoming more common (CSIRO & Bureau of Meteorology 2017).

[44] Some of which, along with others recorded in the parks are declared pests under the *Biosecurity and Agriculture Management Act 2007* and are the subject of legislative requirements for control.

Serious weed infestations are generally in localised areas of the parks such as riparian corridors, sites of disturbance such as roads, fire-breaks or fence-lines, and some areas of high visitor use. Though localised, the effects can be considerable where the affected areas coincide with high value assets. Riparian areas and vine thickets are very limited in extent, so the species strongly associated with these habitats can be particularly vulnerable to the impact of highly invasive weeds. This impact is heightened where there are other concurrent pressures such as grazing by introduced herbivores and altered fire regimes. Stinking passionflower, rubber tree, bellyache bush, grader grass and *Parkinsonia aculeata* are the most serious weeds currently affecting riparian areas in the parks, with Geikie Gorge, Windjana Gorge, Brooking Gorge and Lennard Gorge being the worst affected areas. A significant challenge to controlling many weeds in riparian habitats is that water dispersed seeds and vegetative propagules are transported into the parks along watercourses. Also, chemical control options appropriate for use around wetland areas are very limited. There are no significant weeds currently known to be presenting a threat to dry monsoon rainforest patches/vine thickets in the parks, but these very small areas are vulnerable to weed incursion, and it is therefore important that they are regularly monitored and treated for serious weed threats if necessary. A complicating factor in managing weeds in riparian areas and rainforest patches is that some of these are very remote and difficult to access.

Buffel grass, grader grass and the other introduced grass species listed above can become highly problematic environmental weeds. These have the potential to rapidly invade and replace diverse native vegetation, and to significantly alter fire regimes increasing the propensity to more frequent, large and intense fires.

Management of weeds is prioritised across departmental regions considering species invasiveness, ecological impact, and the feasibility of eradicating or containing populations. Those species that can have high ecological impact, are rapidly invasive, and can feasibly be contained or eradicated, are rated as high priority for management. Priority locations for weed management are focused on highest biodiversity, cultural and visual amenity value assets where weed control can provide the greatest benefits.

Effective management of most problem weeds in the parks will require collaborative cross-tenure approaches, and visitor education. Consideration to the interactions of weeds with factors such as fire and grazing pressure is also an important aspect of weed management. Ongoing monitoring for new introductions of serious weeds is also needed to ensure early intervention while eradication is most feasible and cost effective.

Introduced animals

Several introduced animal species occurring in the park adversely affect vegetation, grazing and trampling it, compacting the soil, causing erosion and spreading weeds. The most significant impacts on vegetation are currently from cattle, both 'feral' populations and stock that has strayed from nearby pastoral stations, and pigs. Donkeys and horses also occur but in fewer numbers. The impacts of cattle and feral pigs are particularly visible in riparian areas where they obtain water and shelter from the heat, and these habitats are also being impacted by several problematic weed species. These pressures are currently most notably present at Geikie Gorge.

Altered water regimes

Significant alterations to natural water regimes, including the usual seasonal variations in water quantity, quality and flow regimes, present a potential threat to flora species and communities. This is not an issue known to be currently affecting the parks. Species that have distributions fully or closely associated with wetter parts of the landscape, such as aquatic or riparian species, those of the dry monsoon rainforest patches, or those associated with tufa, are likely to be most vulnerable to significantly altered water regimes. There is little known of the specific ecological water requirements of many species and communities that may be fully or very highly dependent on freshwater habitats, or of the limits or thresholds of acceptable change in water regimes.

Knowledge gaps

There are significant gaps in knowledge about the parks' flora and further survey and other research is needed to support better informed management. One priority is to improve knowledge about the threatened species *Eucalyptus mooreana* (e.g. its population size and trends, ecological requirements and threatening processes) and management measures that can be implemented to safeguard its survival. There are also many knowledge gaps regarding the conservation status and management requirements for most of the 'priority flora' species,

and the most appropriate fire management strategies for some species and communities likely to have very specific fire-regime requirements.

Fauna

The parks encompass a range of different habitats that are important for supporting a rich and diverse fauna, including numerous species recognised as being of special conservation significance. Broadly, these habitats include:

- highly dissected complex rocky environments (including deep gorges, screes, caves, crevices and overhangs);
- savanna woodlands;
- dry monsoon rainforest patches/vine thickets;
- aquatic environments such as rivers, springs and subterranean aquatic habitats; and
- riparian woodlands.

Knowledge about the parks' fauna is limited as much of the area is very remote, rugged and inaccessible, particularly during the 'wet season', which presents numerous challenges in carrying out fauna surveys and research. Fauna surveys that have been done are restricted to select areas and faunal groups. When biological surveys have been carried out they have often uncovered species of special significance, including for example, previously undescribed and endemic fauna. The biological diversity of the parks is no doubt much greater than it is currently known to be (Oliver et al. 2014); (Oliver et al. 2016); (Oliver et al. 2017); (Pepper & Keogh 2014).

Mammals

Mammals known to occur in and around the parks are mostly species associated with the wetter north, but there are species associated with more arid areas to the south, some with wider distributions, and others which are disjunct from their other populations elsewhere in the State (McKenzie 1981).

Native mammal species abundance and richness has been found to be positively correlated with rainfall (Start et al. 2012); (Turpin 2015). Over 30 native mammals have been recorded as occurring in or near the parks. These include species of threatened or priority fauna such as the northern quoll (*Dasyurus hallucatus*), bilby (*Macrotis lagotis*), rock ringtail possum (*Petropseudes dahli*), golden backed tree-rat (*Mesembriomys macrurus*), scaly-tailed possum (*Wyulda squamicaudata*), ghost bat (*Macroderma gigas*), yellow lipped cave bat (*Vespadelus douglasorum*) and the orange leaf-nosed bat (*Rhinonicteris aurantia*). Some others include Macropods such as the euro (*Macropus robustus*), agile wallaby (Macropus agilis) and the short-eared rock wallaby (*Petrogale brachyotis*), and several rodent species, including the delicate mouse (*Pseudomys delicatulus*), western chestnut mouse (*Pseudomys nanus*), short-eared mouse (*Leggadina lakedownensis*), common rock-rat (*Zyzomys argurus*), and rakali (*Hydromys chrysogaster*).

The Kimberley has the highest species richness of bats in W.A. (Armstrong 2011). While richness is generally understood to be greater in the higher rainfall areas of the north-west Kimberley, the bat communities occupying the inland areas are different to assemblages of the coastal mangrove environments (McKenzie & Bullen 2012). Bat species recorded from the parks include obligate cave dwelling species with particular cave microclimate requirements, such as, the ghost bat *Macroderma gigas*, dusky leaf-nosed bat *Hipposideros ater,* and orange leaf nosed bat *Rhinonicteris aurantia*. Tunnel Creek Cave is an important roost for the obligate cave dwelling species mentioned above, but several bats generally associated with other habitats have also been recorded from this cave (McKenzie & Bullen 2012).

Reptiles

A large variety of reptiles occur in the parks, including numerous species of geckos, skinks, lizards and snakes, and three species of freshwater turtle. The freshwater crocodile (*Crocodylus johnstoni*) or *Gayi* in Bunuba language) which is a specially protected species also occurs in the parks. The freshwater crocodile also occurs in the Tunnel Creek Cave; this is thought to be unusual as there are no other known records of Australian freshwater crocodiles using subterranean habitats other than during dry season dormancy (Somaweera, Woods & Sonneman 2014).

Despite relatively little survey of reptile fauna in the parks, the limited investigation that has been done has revealed the presence of species endemic to the region (Ward & Morris 2017), uncovered previously undescribed species, found the rocky habitats in the Devonian reef system to be associated with high genetic diversity and endemism in certain gecko genera, and provided information that suggests that further gecko lineages may be endemic to the Oscar Ranges and surrounding areas (Oliver et al. 2014); (Oliver et al. 2016); (Oliver et al. 2017).

Birds

Birdlife in the Kimberley has greater affinities with species elsewhere in northern Australia than to the remainder of W.A. (Pearson, Cowan & Caton 2012). The parks have not been comprehensively surveyed for bird fauna, but over 140 species have been recorded through incidental searches of some areas. Species recorded include some that are listed under the Biodiversity Conservation Act: the purple- crowned fairy-wren – western (*Malurus coronatus coronatus*); grey falcon (*Falco hypoleucos*); and the peregrine falcon (*Falco peregrinus*). The Gouldian finch (*Erythrura gouldiae*) which is a 'priority fauna' species in Western Australia has also been recorded in the parks[45]. Several species that are the subject of international migratory bird agreements (e.g. JAMBA or CAMBA) have also been recorded in the parks, these include, the great egret (*Ardea modesta*), glossy ibis (*Plegadis falcinellus*), wood sandpiper (*Tringa glareola*), and the fork-tailed swift (*Apus pacificus*).

Fish

The Kimberley has high diversity and endemism in freshwater fishes (Morgan et al. 2011); (Morgan et al. 2014). Surveys of direct relevance to the parks have mostly focused on the Fitzroy River, which is one of the most species-rich rivers in the region and supports several species of special conservation significance (e.g. threatened, endemic and near endemic species) (Morgan et al. 2004). Fish assemblages vary across the Fitzroy River system, and differences are for example evident in species of the lower, middle and upper reaches of the main river channel, in smaller tributaries, in larger billabongs, and upper gorges (Morgan et al. 2004).

Some species of special note that have been recorded from the parks include:

- the freshwater or largetooth sawfish (*Pristis*[46]) or *Galwanyi* to Bunuba people, which is listed as 'vulnerable' under the EPBC Act, and, along with all sawfish, is a protected species under the *Fish Resources Management Act 1994*. It is identified as a 'Priority 3' species by the department. This species which can live for more than 40 years is believed to spend the first several years of life in freshwater, and then move out of the rivers into the marine environment when mature to breed (Thorburn et al. 2007). It is known from numerous river systems of northern Australia, but the Fitzroy River has been identified an important nursery for sawfish, and a globally significant refuge for this species (Morgan et al. 2004); (Morgan et al. 2014); (Thorburn et al. 2007). Permanent river pools provide critical refuge during the dry season, and sawfish have been recorded from even a very small pool at Windjana Gorge (Sonneman 2017, pers. comm. 7 September).
- the short-finned eel (*Anguilla bicolor*) or *Lanyi* to Bunuba people – a species that migrates from freshwater to the sea to spawn. It is believed to travel from the Kimberley to Indonesia to breed and die, while juveniles then return to freshwaters of the Kimberley to continue their lifecycle (Department of the Environment and Energy 2011). Within WA this species is known only from the Kimberley and Pilbara (Morgan et al. 2004); (Morgan et al. 2011).
- the Prince Regent hardyhead (*Craterocephalus lentiginosus*) or *Jinbirri* to Bunuba people – a species endemic to the Kimberley region[47] (Morgan et al. 2004); (Morgan et al. 2011).
- a relatively newly described species of archerfish – the Kimberley archerfish (*Toxotes kimberleyensis*) or *Girrwali* to Bunuba people, which is restricted to the south-western corner of the region (Allen 2004); (Morgan et al. 2004); (Morgan et al. 2011).

[45] i.e. priority fauna do not meet criteria for threatened species but are nevertheless of special conservation consideration, as they may for example be near threatened or would be vulnerable to changed circumstances.
[46] Previously Pristis microdon.
[47] Listed as a 'priority 2' species at the time of writing.

Invertebrates

Invertebrate surveys in the parks have been largely restricted to work on land snails at selected sites within the Devonian reef parks, and on macroinvertebrates of some watercourses[48]. Some limited collection of subterranean fauna and arachnids has also occurred within and around the parks.

The parks have habitat characteristics that support low mobility short-range invertebrate fauna associated with high levels of endemism (for example Camaenid snails and subterranean invertebrates). Despite very limited and generally opportunistic survey of the area it has been found to support several invertebrate species of special conservation significance. The Oscar and Napier ranges support diverse land snail endemic to the ranges, including some species that are listed under the Biodiversity Conservation Act [49]. These are thought to have become distinct species due to being restricted to small isolated habitats, which provided refuge from aridity and heat as climate conditions became increasingly drier since the late-Miocene (Cameron 1992); (Kohler & Gibson 2009). Some Camaenid snail species recorded from the Napier Range are associated with an unusual vine thicket community; this assemblage has been identified as a priority ecological community in recognition of its restricted distribution and that it requires further investigation and evaluation of its conservation status. Another priority ecological community of Camaenid snails and vine thicket occurring in limestone hills of the Jeremiah and Ningbing Ranges could potentially occur in the parks. Several species of endemic land snail appear to be restricted to the more northerly parts of the Napier Range, and protection of these may be improved by addition of more of the northern part of the Napier Range to the conservation estate.

Despite very limited survey effort, opportunistic collections in the parks have also uncovered previously undescribed and endemic species of subterranean invertebrates, both aquatic and non-aquatic. Sampling of some cave pools and springs in the Oscar and Napier ranges in the late 1980s found previously undescribed genera and species of freshwater isopods (a type of crustacean) endemic to the ranges (Wilson & Ponder 1992)[50]. As the area has not been inundated by seawater since the Devonian, and the groundwater is essentially freshwater, these are likely remnants of ancient freshwater species (Wilson & Ponder 1992); (Humphreys 1995). Further investigation of the karst groundwater system of the Oscar and Napier Ranges is likely to reveal additional undiscovered habitat for this genus, and for other ancient freshwater lineages (Wilson & Ponder 1992); (Humphreys WF 2008).

Sampling of invertebrates in Tunnel Creek has identified a unique invertebrate fauna assemblage; this requires further investigation regarding its conservation status and has been identified as a priority ecological community. Invertebrate communities associated with cliff foot springs in the Devonian reef system are another priority ecological community in need of further assessment of their conservation status. Opportunistic sampling has also found novel terrestrial invertebrates; for example a subterranean-dwelling arachnid which was new to science and that appears to be endemic to the Tunnel Creek Cave (*Bamazomus hunti*) (Harvey MS 2001). Schizomids have very confined distributions, and very few have been recorded from or show associations with subterranean habitats (Humphreys 1995); (Harvey MS 2001).

Amphibians

Almost 50 per cent of W.A.'s currently known frog species occur in the Kimberley (Ward & Morris 2017). The north-west Kimberley is in particular recognised as having a rich frog fauna including several endemic species (Doughty 2011), but relatively few surveys have been done in the lower rainfall areas of the region (including the parks). Eleven frog species have been recorded across the parks to date (NatureMap 2017). The King Leopold Ranges, and the black soil plains to its south, are thought to represent major barriers to amphibian fauna with significant differences in species found to the north and south of these barriers (Tyler, Davies & Watson 1987).

[48] done as part of the 'National River Health Program' Commonwealth government programme in the mid-late 1990s.

[49] At the time of writing two land snail species from the Family Camaenidae recorded from the parks are listed under the Biodiversity Conservation Act – *Mouldingia occidentalis* and *Westralchia alterna*. A further five species of Camaenid land snail are identified as 'priority fauna'.

[50] Tainisopidae; Tainisopus fontinalis, and Tainisopus sp.

Key management issues for fauna values

Inappropriate fire regimes

Much of the fauna occurring in the parks will be well adapted and resilient to moderate fire regimes, but species do vary considerably in this. The more frequent, intense and large fires that have prevailed in the Kimberley over recent decades do however present a threat to many species.

Species with restricted distributions, that have low mobility and limited dispersal capacity, can be particularly vulnerable to intense, large fire events within their home ranges. Within the parks, examples include land snails and other short-range invertebrates, some reptiles and some birds (e.g. grasswrens such as the purple-crowned fairy-wren and the variegated fairy-wren) (Cameron 1992); (Woinarski & Legge 2013). Generally, species and communities associated with less flammable or wetter parts of the landscape, such as riparian areas, or rocky outcrops with sparse vegetation, are likely to be more fire-sensitive.

Many of the effects of fire on fauna relate to the degree that it changes habitat quality or availability, access to food and other essential resources, or the risk of predation. These effects are amplified and complicated when altered fire regimes interact with the impacts of climate change, grazing, predation and weeds. The affect that these complex and interacting pressures are having on the parks' fauna and ecosystems is not fully understood.

Inappropriate fire regimes can diminish faunal habitat quantity and quality in a variety of ways. These include:

- increasing the structural and floristic homogeneity in vegetation over time; where those species which can respond quickly and favourably after fire become dominant, suppress, and eventually replace other species.
- promoting the spread of certain weeds and negating weed control efforts.
- encroaching into and degrading more fire-sensitive habitats such as dry monsoon rainforest patches and riparian areas.
- Impacting on the availability of, and distances between, unburnt patches of vegetation, and in particular patches of mature, long-unburnt vegetation on which some species are particularly reliant.
- disrupting habitat connectivity.
- Reducing the availability of food or other key resources (such as tree hollows and groundcover important for nesting or shelter).
- making some fauna more vulnerable to predation through loss or reduction of adequate vegetation or ground cover needed to evade predators.

Altered fire regimes, along with the introduction of exotic species, is believed to be a key contributing factor in the decline in native mammals that is thought to have occurred in the drier southern and eastern parts of the Kimberley (Burbidge & McKenzie 1989); (Start et al. 2012); (Turpin 2015). Many small to medium sized mammals (including threatened and priority fauna such as the northern quoll and golden-backed tree rat) appear to be particularly reliant on adequately dispersed mature long-unburnt habitats, and therefore thought to be vulnerable to contemporary altered regimes that make sufficient retention of this uncommon (Andersen, Woinarski & Parr 2012); (Radford 2010); (Radford et al. 2015); (Turpin 2015).

There are many gaps in knowledge about specific fire management requirements to meet fauna conservation objectives. Fire management therefore needs to be precautionary and adapted where necessary to accommodate improved knowledge. The current assumption, is that overall fauna conservation outcomes in the Kimberley are likely to be optimised by fire management operations[51] that result in a temporal and spatial mosaic of vegetation across the landscape, and, which includes the retention of appropriately dispersed patches of old growth vegetation. This should help to maintain habitat diversity, and reduce the likelihood of very large, intense and damaging fires. Within this mosaic, the needs of threatened species or communities with very specific fire regime requirements should be considered and accommodated, drawing on the best available knowledge.

[51] e.g. strategic and targeted fire management operations such as prescribed burns, maintenance of low fuel buffers and targeted fire suppression where feasible.

Introduced fauna

There are several species of introduced animals occurring in the parks, including some that can seriously affect native fauna through predation, competition for resources and habitat degradation. Currently, the main threats are feral cats, cattle, pigs and cane toads, but donkeys and feral horses also occur.

The effects of cattle and pigs occur across the parks but are particularly obvious in riparian corridors and other freshwater places where they commonly gather to escape the heat and access water. These animals and other large introduced herbivores damage vegetation and soil structure, and amplify other pressures such as weeds and inappropriate fire regimes. The consequences can be significant because pressures can combine and affect large proportions of these important habitats. Similarly, cattle and other large herbivores can significantly diminish the fauna habitat value of small rainforest patches. This is not known to be an existing issue for rainforest patches in the parks as these are generally in areas not readily accessible by cattle and other large herbivores.

Pigs are opportunistic omnivores, and as well as causing extensive damage to riparian habitats, they prey on native fauna, including small mammals, reptiles, frogs, invertebrates and eggs (e.g. eggs of the freshwater crocodile, freshwater turtles, small ground-nesting birds) (Department of the Environment and Energy 2017).

Feral cats are a major threat to native fauna. They are a key factor contributing to the decline of many of Australia's native animals, and especially small to medium sized mammals (Carwardine et al. 2011); (Woinarski, Burbidge & Harrison 2015). Feral cats are likely to have significantly contributed to declines in native mammals in the drier southern and eastern parts of the Kimberley[52] (Start et al. 2007); (Start et al. 2012); (Turpin 2015). Cats also prey upon birds, reptiles, frogs, fish and insects. Feral cat control is hugely challenging as shooting and trapping are not very effective, and cats do not readily take poison baits. In any case, poison baits that are used for feral predator control elsewhere in the State are not used in the Kimberley because of risks to certain native species (e.g. the northern quoll, raptors and carnivorous reptiles). Various new baits and delivery systems are being tested for their suitability to use in the Kimberley; if successful these may be used in the future to control cats in the parks.

The cane toad (*Rhinella marinus*) is not yet known in the parks, but it is rapidly spreading westwards across the Kimberley, and its imminent arrival in the southern Kimberley is a serious threat to some native fauna. Cane toads can directly affect native species in a variety of ways, including predating on them, competing with them for food and other resources, and lethally poisoning wildlife that eat them (Shine 2010). Cane toads can also indirectly affect native fauna by disrupting trophic and other ecological relationships, but these indirect impacts are very complex and unclear, particularly in ecosystems subject to multiple concurrent threatening processes (Shine 2010). Little is known about the likely impacts of cane toads on the parks' fauna. It seems species most vulnerable are those likely to consume adult toads, for example the northern quoll, freshwater crocodiles, some snakes and several lizards[53] (Shine 2010).

Threatened Camaenid land snails have very restricted distributions and low mobility and these could be vulnerable to predation should cane toads invade their habitat (Pearson et al. 2009). The likelihood of cane toad populations becoming established in Camaenid land snail habitats is thought to be low, but, because many of these species are not found elsewhere, monitoring of this fauna and associated habitats should include checks for the presence of cane toads (Pearson et al. 2009). Cane toads theoretically present a similar threat to short-range endemic invertebrate fauna if there is habitat overlap.

Current approaches to addressing the cane toad problem include, ongoing research to improve mitigation strategies, surveillance and quarantine measures to try and prevent the establishment of satellite populations ahead of the main invasion front, and lifting community awareness of cane toad identification and management options. Despite extensive efforts to eradicate or control the cane toad it has continued to rapidly advance across northern Australia, so management responses have increasingly focused on trying to protect key biodiversity assets at greatest risk (Tingley et al. 2017). To this end, recent research has uncovered

[52] Particularly of non-flying intermediate or critical weight range species between 35 and 5500 g.

[53] i.e. blue-tongued skinks and several Varanid lizards including *Varanus panoptes* subsp. *panoptes*, *V. mertensi*, *V. acanthurus*, *V. glauerti*, *V. gouldii*, and *V. glebopalma*.

a range of new methods that could be incorporated into an integrated suite of management strategies to reduce the impacts of cane toads ((Tingley et al. 2017). One of these new methods is 'conditioned taste aversion', which a number of studies have demonstrated can be used to help vulnerable native predators (such as Varanid goannas, blue-tongued skinks and quolls) learn to avoid ingesting lethal adult toads (O'Donnell, Webb & Shine 2010); (Price-Rees, Webb JK & Shine 2013); (Tingley et al. 2017); (Ward-fear et al. 2017). Conditioned taste aversion field trials are to be implemented in the parks, but as the cane toad front is rapidly progressing across the Kimberley, there is likely to be only a small window of opportunity to do so.

Introduced flora

Fauna can be adversely affected by the spread of weeds that diminish habitat availability or quality. Certain weeds tend to very quickly and extensively invade and out-compete native flora, simplify and change vegetation composition and structure, and change fire regimes. Over 25 weed species have been recorded from the parks, and a proportion of these have the tendency to cause substantial ecological impact or present a major threat to native fauna. Those that do are high priorities for monitoring and control.

Weeds that can significantly affect riparian habitats or rainforest patches are particularly problematic. These relatively small areas can quickly become dominated by weeds, which can in turn affect a wide range of fauna species, including many that are fully or highly dependent on these habitats for their persistence.

Stinking passionflower[54], bellyache bush and rubber bush are examples of high impact weeds currently problematic within some of the parks' riparian habitats. These highly invasive weeds have characteristics that facilitate dispersal over both short and long distances. The results of control efforts are often short-lived because treated areas are rapidly reinfested through water dispersed seeds or propagules from upstream. Stinking passionflower and bellyache bush are also dispersed and by birds or other animals that consume their fruits. The current and potential impact of these weed species in riparian habitats (in conjunction with interrelated pressures) is of particular concern for species that are riparian specialists, including for example, the threatened purple-crowned fairy-wren. This species has a very patchy distribution and a limited ability to disperse, so weeds and other factors that affect habitat quality and connectivity, even at a local level, can have significant impacts.

Serious weeds in rainforest patches are not known to be an existing issue in the parks, but would be a significant potential threat because the small size of these areas causes them, and the distinct, endemic, and often fire-sensitive fauna associated with them, potentially vulnerable to weed incursion.

Buffel grass (*Cenchrus ciliaris*), grader grass (*Themeda quadrivalvis*), and some other introduced grass species recorded from the parks[55] can be highly problematic environmental weeds. These have the potential to rapidly invade and displace native vegetation, remain very dominant and persistent once established, and significantly alter fire regimes (e.g. increasing the likelihood of larger, more intense fires). These and other weeds that can markedly change fire regimes can affect a range of fauna, but especially those more fire-sensitive species inhabiting naturally fire protected niches, or fauna that has ecological requirements for late successional stages of vegetation. Mapping, ongoing monitoring, and where necessary early intervention is needed to avoid the spread of these weeds with a potential for high ecological impact.

Knowledge gaps

Further survey and other research of fauna occurring in the parks is needed to provide baseline data and help evaluate whether management measures are effectively achieving conservation outcomes. There are knowledge gaps about threatened and priority fauna, their conservation status and primary threats. For this plan area, a priority will be to address key knowledge gaps for species that are endemic to the parks, or for which the parks are a key stronghold.

Another issue is insufficient knowledge about the effects that concurrent interacting pressures are having on the parks' native fauna, and options for more efficient and effective management of these. For instance, a

[54] A large-scale collaborative research project being co-ordinated by CSIRO is exploring biological control solutions for this weed.

[55] e.g. mission grass (Cenchrus pedicellatus), birdwood grass (Cenchrus setiger).

combination of pressures is thought to have contributed to decline in native mammals in the southern and eastern parts of the Kimberley, but there is much that is not known about the relative significance of the pressures, or how they interact (Burbidge & McKenzie 1989); (Start et al. 2012); (Turpin 2015). These knowledge gaps can constrain the effectiveness of management in trying to prevent further impacts on the Kimberley's relatively intact native fauna (Start et al. 2007); (Turpin 2015).

Altered water regimes

Any activities or developments that have the potential to significantly alter natural water regimes (water quantity, quality or usual flow regimes) present a threat to fauna in the parks, particularly aquatic species such as freshwater turtles, fishes, frogs, invertebrates in springs and other subterranean waters, crocodiles and various species associated with riparian habitats. Many species (including threatened, priority and other significant species) are dependent on the permanent river pools that persist through the dry season. These pools are thought to be recharged from shallow local aquifers during the dry season, but these interactions of surface and groundwater are not well understood (Harrington & Harrington 2015).

Recreation and tourism values

The parks contain iconic features of the Kimberley landscape that attract intrastate, interstate and international visitors. They are important assets for a regional economy in which tourism, and nature-based tourism in particular, are substantial generators of economic activity, and, are industry sectors that are considered to have significant unfulfilled potential (Department of Planning 2015a).

A range of characteristics in the conservation estate combine to create varied and distinctive visual landscapes of exceptionally high quality: rugged sandstone and limestone ranges; deep river cut gorges; colourful towering cliffs; scenic rivers and waterholes; attractive lush riparian vegetation; colourful and sculptural rock formations; iconic boab trees; Aboriginal rock art; remarkable fossil decorated rocks; and relatively remote and largely unmodified settings. Aesthetic features of the parks have been recognised as being of outstanding value to the nation through the West Kimberley National Heritage Area.

Opportunities to view native wildlife attract visitors to the conservation estate. Some of the more conspicuous animals that people are likely to encounter include kangaroos and wallabies, freshwater crocodiles, various bats, monitor lizards, a wide variety of birds including waterbirds such as ibis, heron, darters and cormorants, and birds of prey such as the black kite, the whistling kite and osprey.

Many of the parks features of interest are less obvious or tangible, and interpretation is needed to make these more readily accessible to visitors. Providing diverse ways for people to better understand and engage with the culture, history and stories associated with the parks can significantly enhance their experience and add enormously to the tourist appeal of the parks. Opportunities for people to learn about the significance of the land to its Traditional Owners, their culture and way of life add a valuable dimension to the visitors' experience. Presentation of the stories associated with the area can also provide visitors with a fuller appreciation of the values of the parks, and helps build support for conservation. Stories for example, such as that of Jandamarra and the Bunuba resistance to European colonisation, or of the insights that archaeological excavations have provided into the lives of the original inhabitants over 49 000 years ago, or of the ancient Devonian reef and its fossils, that provide rare clues into the animals and plants of that time.

The most well-known visitor attractions in the parks include Geikie Gorge, Windjana Gorge, the King Leopold Ranges, and the Tunnel Creek Cave. Lennard River Gorge is a lesser known more difficult to access attraction in the parks. There is currently no visitor access or facilities in Jungi-wa/Guwinyja Conservation Park or the Balili Conservation Park. Visitor facilities across the parks include day use sites at Danggu National Park and Dimalurru National Park, and both day use and campground areas at Bandilngan National Park. These provide settings for a range of recreation and tourism activities, including camping, walking, picnicking, wildlife viewing, canoeing and various tours, including boat tours in Geikie Gorge, and Aboriginal cultural tours. Fishing is not an activity many visitors to the park engage in, but it does occur at the southern end of Danggu National

Park near the Margaret River sandbar[56]. Visitors to the parks include commercial tour groups and self-drive independent visitors. There is considerable scope to sustainably expand the recreation and tourism opportunities currently on offer in the parks, to further enhance their visitor appeal, and to support more diverse experiences and activities.

Due to the very hot wet summers and unsealed roads that become impassable, visitation occurs in the drier months of the year and the parks are closed for several months during the wet season (approximately between November and March).

Key recreation and tourism management issues

The main recreation and tourism management issues anticipated over the life of this plan largely pertain to improving the capacity, functionality and amenity of existing sites. There is considerable unrealised potential to improve and enhance visitors experience and enjoyment of the parks, to increase revenue that can be used to support management of the parks, and for Bunuba people to derive greater socio-economic benefits from recreation and tourism occurring in Bunuba country.

Some sites have values that can be vulnerable to human disturbance, and these will require measures to monitor and mitigate potential impacts on those values. The parks protect some of the Kimberley's most highly-valued natural landscapes, and developments and operations in the parks are planned so as not to detract from the visual landscape qualities.

Dimalurru (Tunnel Creek National Park)

Dimalurru National Park is a popular visitor attraction that also has cultural and ecological values which can be sensitive to human disturbance. These include for example, Aboriginal heritage sites, roosting areas for several species of bats (including species that are obligate cave dwellers), a unique aquatic invertebrate assemblage, cave penetrating tree roots, and freshwater crocodiles. Visitors walk about 750 metres through the natural tunnel then back the same way. The walk involves wading through permanent pools, and opportunities to view stalactites, Aboriginal rock art, bats, freshwater crocodiles and other animals that live in the cave. A proportion of visitors experience the park as part of a commercial tour. One of these is a tour run by a Bunuba elder, which conveys some of the Aboriginal cultural values of the place, including its association with Jandamarra who was killed there. Large groups of people in the relatively small confines of the cave at one time can reduce the quality of the visitor experience. Bunuba people would like to have visitors to the cave guided, to help manage access to special cultural areas. The cave is decorated with speleothems which can be vulnerable to damage, and vandalism of some of these has already occurred. This type of damage is essentially permanent as speleothems can take thousands of years to form. There are a range of measures than can be used to mitigate the potential adverse effects of visitation on values of the cave, while still providing a high - quality sustainable visitor experience. Options to help achieve this will be further considered and implemented early in the life of this plan.

Danggu (Geikie Gorge National Park)

The day use area at Danggu National Park receives the highest visitation of all the Bunuba parks. There is considerable scope to improve the amenity and functionality of this area to sustain visitation levels, better support current and new visitor activities and experiences, and resolve some management issues with the existing facilities and site layout. It is proposed to redevelop the area to address these matters.

One issue with the site is that much of it is within the flood zone of the Fitzroy River, and therefore facilities are regularly inundated during the wet season. Flooding also impacts on the accommodation and works depot for park staff. Considerable time and expense is expended to re-prepare and present the site for visitors after each wet season. There are also opportunities to reconfigure the layout of the site to:

- better cater for the high level of visitation the area receives
- provide visitors with an improved sense of arrival and connection to the focal area – i.e. the river and gorge

[56] The Department of Fisheries which has responsibility for licencing and managing recreational fishing, has identified specific rules for some species found in the park (e.g. barramundi, cherubin (freshwater prawns) and 'baitfish'). Some fish (e.g. Threatened and Priority species) occurring in the parks are subject to specific protections under the *Fish Resources Management Act 1994*, the Biodiversity Conservation Act, or the EPBC Act.

- provide universal access to more of the site
- improve separation between large tour groups and self-drive visitors
- possibly include facilities to support overnight stays as well as day use.

Options to achieve this will be investigated over the life of the plan with further consideration being given to:

- developing an alternative arrival hub that is visually connected with river, and which provides an improved sense of arrival.
- facilities to better support the Geikie Gorge boat tours, including improving the pedestrian link from the arrival area to the dock, and designing a dock that is more manageable in response to seasonal changes in river levels.
- redeveloping picnic and barbeque areas and improving views to the river from these.
- facilities to support additional recreation activities and experiences such as development of an events space, facilities for paddle craft use and access, and facilities to support overnight stays in the park as well as existing visitor uses.
- options for improving vehicle parking and circulation, including provisions for parking of long vehicles and tour buses.
- Developing a more permanent works depot and staff accommodation out of the flood zone, and that does not visually intrude on visitor areas.

Bandilngan (Windjana Gorge National Park)

This park provides for camping as well as some basic day use facilities. The visitor experience could be improved by developing a dedicated day use space, and potentially incorporating a cultural activities precinct (e.g. amphitheatre for performances, art and craft displays). There is also potential to increase camping capacity in this park, provide better separation and management of different user groups (i.e. quiet, generator and tour group camping areas), and to diversify the options for overnight stays. The concept of developing small, more remote, walk-in only camping areas in this park has been given some consideration, as has the idea of providing accommodation such as semi-permanent tents for visitors to book. Both concepts, along with the concept of providing facilities to support overnight stays at Danggu or elsewhere in the parks, would require more detailed investigation and assessment to progress further, and the development of options such as semi-permanent tent accommodation would depend on commercial operator interest to enter into lease arrangements under which such a business could be established. Both concepts present potential new business opportunities for Bunuba people.

Other recreation and tourism opportunities

Walk trails and guided walks

There are already a few short easy walks available for visitors to the parks, at Bandilngan and Danggu national parks, but the diversity of walking options on offer could be improved by developing longer, more challenging walks for those seeking more immersive, adventurous 'wilderness' experiences. Options for developing a multi-day long distance walk-trail in this park will be explored over the life of the plan. Such a walk could be enhanced by developing options for associated guided walks and camping trips led by Bunuba people.

Lennard Gorge, an existing informal day use area within Miluwindi Conservation Park, also has potential for development of a more challenging walk trail than is currently available elsewhere in the parks. Lennard Gorge can be accessed from a vehicle track off the Gibb River Road, but relatively few people visit it as the four-wheel drive only access to it is slow and difficult compared to other more readily accessed sites in the parks.

Cultural tourism activities

Many tourists, particularly international visitors, are interested in opportunities that help them learn about Australia's Indigenous people and culture. There are already some of these opportunities available in the parks, but there is capacity to provide additional options for visitors to better explore and understand the significance of area to Bunuba people, culture and history. There are numerous ways this

can be done, ranging from simply including information about this into signage, brochures and other interpretive material, through to various tours and activities guided by Bunuba people. It is essential that Bunuba people, through the JMB, make all decisions about whether and how Bunuba culture and history is shared with visitors to the parks.

Consideration may be given to development of associated facilities (e.g. an events amphitheatre) that could be used for cultural tourism activities, performances or other events. Development of a walk trail between the Windjana Gorge camp-ground and the ruins at Lillimooloora would provide an additional activity for visitors to the park, better connect the ruins to the main visitation area, and expose more visitors to a key part of Bunuba history and the story of Jandamarra.

- Other new activities

The parks have attributes that could support new adventure activities. There may, for example, be potential to add to the diversity of recreation opportunities on offer by providing for activities such as adventure caving and rock climbing (including abseiling). However, there are numerous significant features and values that could be affected by such activities, so whether, where and how these could be accommodated, without compromising key cultural and ecological values, would require detailed investigation. Caving and rock climbing can also be high risk, so risk management assessments will be a key component of any investigation exploring the feasibility of providing for these activities in the parks.

Visitor safety

There are a wide range of possible dangers that visitors can encounter exploring the remote and rugged natural environment of the Kimberley. The parks are remote from emergency services, often difficult to access by emergency vehicles and have limited access to communication networks. While all efforts are made to help make visitors aware of some of the most likely dangers they might face, visitors should be encouraged to take all possible steps to ensure their own safety. Some safety issues relevant to the parks include:

- extreme weather conditions and associated risks of dehydration and heat exhaustion
- fire hazards
- bites and stings from animals such as snakes and insects.

Development of new recreation opportunities such multi-day walks, caving and abseiling present a range of safety issues in this environment. More definitive plans to establish these new recreation options within the parks would require detailed risk assessment and identification of associated risk management strategies.

Potential impacts of fire on recreation and tourism values

Fire can present a potential safety risk to visitors to the parks. It can also damage or destroy infrastructure provided to support recreation and tourism in the parks, and negatively affect visual landscape values (albeit usually temporarily). Fire risk assessments are carried out periodically to identify risk mitigation and emergency response strategies aimed at protecting human life and park assets.

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Appendices

Appendix 1. Bunuba language glossary

Bunuba word/s	**Meaning**
Balili	Limestone ranges. This is also the Bunuba name chosen for the Devonian Reef Conservation Park.
Bandaral Ngarri	The Fitzroy River
Baniy	Goanna
Billinyi	Hunting bush meats
Biriyali	Conkerberry
Bunwunggu	Blackhead python
Galamuda	Bush turkey
Galwanyi	Large sawfish (*Pristis pristis*)
Garuwa	Water - fresh
Gayi	Freshwater crocodile
Girrwali	Kimberley archerfish (*Toxotes kimberleyensis*)
Gananganyja	Emu
Gurudunggu	Wallaby
Jalangurru Muwayi	Plan prepared by Bunuba Dawangarri Aboriginal Corporation – The *Jalangurru Muwayi* – Bunuba Healthy Country Plan
Jarramba	Cherubin
Jawiywiy	Bull shark
Jinbirri	Prince Regent hardyhead (*Craterocephalus lentiginosus*)
Jumburrurru	Carpenter's Gap
Junba	Dance and song
Lanyi	Short-finned eel (*Anguilla bicolor*)
Lumbilumbi	Bush medicine
Lumburra	Witchetty grub
Lunggura	Blue tongue lizard
Mala	Freshwater mangrove
Malngarri	White person
Milha	Meat
Milha-bilinyi	Fishing and hunting
Miluwindi	King Leopold Ranges. This is also the Bunuba name chosen for the portion of the King Leopold Ranges Conservation Park within Bunuba country.
Muwayi	Land or country
Ngalja	Brown frog
Ngarranggani	Creation time
Ngawalhay	black mussels
Ngirridu	Spinifex wax
Nyanyani	Sawfish
Ungguds	Rainbow serpents
Wabana	Water monitor
Wanjali	Leaves
Wanyjirri	Kangaroo
Waywurru	Long necked turtle
Winamu	Sandstone ranges
Winthali	Fire

Source: *Jalangurru Muwayi*: Bunuba Healthy Country Plan and Morgan et al. 2004 (for certain fish names).

Appendix 2. Acronyms and abbreviations

BDAC	Bunuba Dawangarri Aboriginal Corporation
CALM Act	*Conservation and Land Management Act 1984*
CAMBA	China Australia Migratory Bird Agreement
DBCA	The Department of Biodiversity, Conservation and Attractions
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
JAMBA	Japan Australia Migratory Bird Agreement
JMA	The Joint Management Agreement
JMB	The Joint Management Body
KPI	Key performance Indicator
ROKAMBA	Republic of Korea Migratory Bird Agreement
The Commission	The Conservation and Parks Commission
W.A.	Western Australia

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