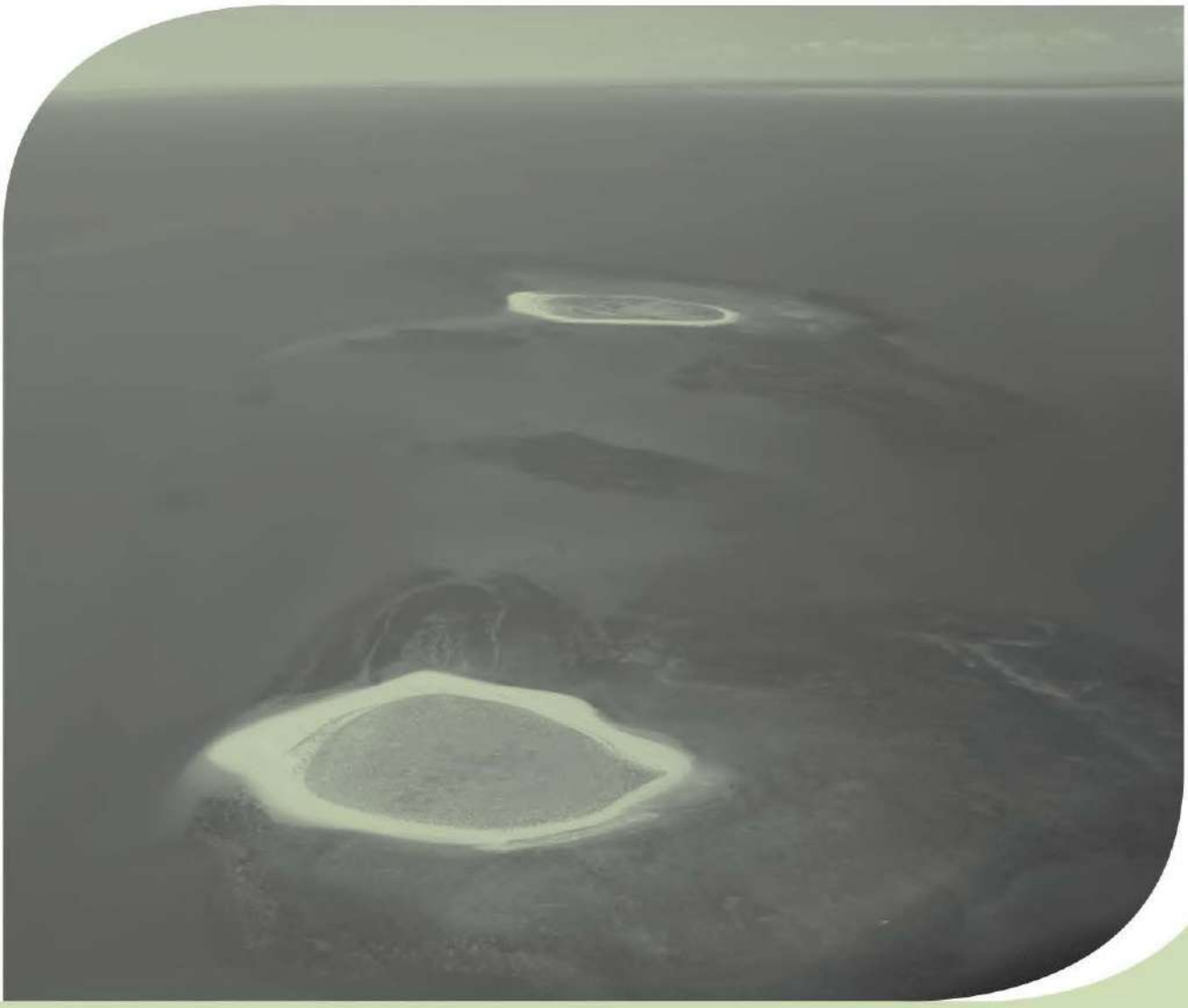
Pilbara inshore islands nature reserves and proposed additions

draft management plan

2020



GOVERNMENT OF WESTERN AUSTRALIA

Conservation and Parks Commission

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Warning: This plan may show photographs of, mention names, and/or refer to Aboriginal people who may have passed away.

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Front cover photos

Main Victor and Y Islands. Photo: T Hamester.

Top left Round Island Nature Reserve (near Serrurier Island).

Top right Carey Island Nature Reserve.

Header photo Tent Island flora. Photo: Vicki Long

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This document is available in alternative formats on request.

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Acknowledgements

This draft management plan was prepared by Department of Biodiversity, Conservation and Attractions (DBCA) staff (Carolyn Williams, Nicole Godfrey, Clare Atkins and Jessica Strickland) employed under the Wheatstone Offset Project D.

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Other work also contributed to our understanding of island nature reserves and we thank Dr Mike Hughes and Dr Kate Rodger (Murdoch University) who delivered a social survey and Vicki Long (Vicki Long and Associates) who completed vegetation association mapping in the field on our behalf.

Invitation to comment

This draft management plan has been released for a two-month period to provide the public with an opportunity to comment on how the reserves covered by the plan are proposed to be managed over the next 10 years and into the future.

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 arrangements – clearly state your reasons, particularly if you disagree;
- give sources of information where possible; and
- suggest alternatives for those aspects of the plan with which you disagree.

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

1. The draft management plan may be modified if a submission

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

2. The draft management plan may not be modified if a submission

(a) clearly supports proposals in the plan or makes general or neutral statements,
(b) refers to issues beyond the scope of the plan,
(c) refers to issues that are already noted within the plan or already considered during its preparation,
(d) is one among several widely divergent viewpoints received on the topic but the approach in the plan is still considered the best option,
(e) contributes options that are not feasible (generally due to conflict with legislation or government policy), or
(f) is based on unclear or factually incorrect information.

To have your say:

The plan can be accessed, a short video viewed, and submissions made online at: dbca.wa.gov.au/haveyoursay.

For more information, please contact:

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All submissions must be received on or before **Wednesday 18th November 2020**.

Executive summary

The Pilbara inshore islands exist in a hot, dry, cyclone-prone environment that has resulted in geologically unique vegetated sand cay islands. Nowhere else in Australia has a chain of islands that are all less than 12m in elevation and are characterised by foredunes surrounding a central depression. Despite being relatively young, less than 10,000 years old, they provide a refuge for threatened species including the 'critically endangered' eastern curlew, great knot, curlew sandpiper, and are nesting beaches for 'vulnerable' green, flatback and hawksbill turtles and 'endangered' loggerhead turtles.

The *Pilbara inshore islands nature reserves and proposed additions draft management plan* ('management plan') has been prepared by the Conservation and Parks Commission (the 'Commission'), through the Department of Biodiversity, Conservation and Attractions (DBCA), herein referred to as the 'department'. It outlines management directions of existing and proposed island nature reserves between Exmouth Gulf and Cape Preston within the planning area.

Bar-tailed godwits are amongst the species of shorebirds that are supported by the island reserves.

The islands include 174 islands in total; 97 islands, islets and rocks that are within 20 existing nature reserves, and an additional 77 small unallocated Crown land (UCL) islands proposed to become nature reserves.

Values

Cultural heritage values of the islands are not well known and further collaboration with traditional owners will likely reveal more sites of significance. A few sites in Exmouth Gulf have been identified for their cultural significance and the draft management plan recommends ongoing collaboration with traditional owners, the Western Australian Museum and universities to assist in revealing more sites of importance.

Aboriginal artefacts are present on many of the islands.

Two native title determinations exist over some parts of the planning area. The department will consult with Nganhurra Thanadri Garrbu Aboriginal Corporation (NTGAC), and the Wirrawandi Aboriginal Corporation, the representative Prescribed Body Corporates for these determinations, on Aboriginal heritage matters.

The islands contain species of regional, state, national and international conservation significance

and are included in the Hamersley-Pilbara 'national biodiversity hotspot'. Despite being very dry, there are five priority flora species and one priority 3 Priority Ecological Community (PEC) (a coastal dune native tussock grassland) is thriving on a few islands in patches.

Tephrosia on Tent Island.

Most visitation to the islands is by private boat and commercial accommodation is only available on Thevenard and Direction Islands. Overall visitation is very low and likely to remain so. Recreational fishers often seek out the furthest islands while family groups tend to access islands closer to the mainland. The current user group values the isolation, lack of facilities and naturalness of the beaches.

Varanus Island has an operating oil facility while oil facilities on Thevenard and Airlie Islands are being decommissioned. These three islands have the most challenges for long-term management of conservation values, while smaller, less-visited islands contain fewer weed species and are mostly free of feral animals. Despite the low level of recreational use, small-scale impacts are occurring at localised sites.

Management

To protect the cultural and natural values of the islands, the draft management plan proposes:

- to identify and classify sensitive sites as the highest priority for management and to direct recreational use away from these areas,
- to implement a pest control program on affected islands,
- to protect the PEC where it occurs, and
- some actions in relation to tenure changes over the longer term.

Resources, including funding to implement the management strategies in the management plan, are available to the department's Pilbara Region.

Mangroves on Potter Island.

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Acronyms and abbreviations

AMSA	Australian Maritime Safety Authority
AtoN	aids to navigation
BC Act	*Biodiversity Conservation Act 2016*
BP	Before present
CALM	Department of Conservation and Land Management
CALM Act	*Conservation and Land Management Act 1984*
CAP	Conservation Action Plan
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions

DMIRS	Department of Mines, Industry Regulation and Safety
DPaW	Department of Parks and Wildlife
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environment Regulation
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
IUCN	International Union for the Conservation of Nature
KBA	Key Biodiversity Areas
KPI	Key performance indicator
LAA lease	*Land Administration Act 1997* lease
LGA	Local government area
LIDAR	Light Detection and Ranging
NCWHA	Ningaloo Coast World Heritage Area
NIS	Non-indigenous species
PEC	Priority Ecological Community
PVS	Parks and Visitor Services
RAAF	Royal Australian Air Force
UCL	Unallocated Crown land
WA	Western Australia

Introduction

The *Pilbara inshore islands nature reserves and proposed additions draft management plan* (the 'management plan') was prepared by the Conservation and Parks Commission (the 'Commission'), through the Department of Biodiversity, Conservation and Attractions (DBCA), herein referred to as the 'department'. The management plan provides broad direction for the Pilbara inshore islands (herein 'the islands') nature reserves that are vested in the Commission and managed, on behalf of the Commission, by the department. The management plan identifies key values, management issues and opportunities to ensure that management actions are determined at a strategic level and prioritised to achieve conservation aims.

This management plan is part of a suite of environmental outcomes funded from an offset project. Approval for Chevron Australia Pty Ltd's onshore gas processing plant (Wheatstone Project) required an offset over five years (2013–18). The key objectives for *Wheatstone Offset Project D – Managing the impacts and risks associated with potential increased visitation to island nature reserves managed under the Conservation and Land Management Act 1984 (CALM Act) within the vicinity of the proposal* (Ministerial Statement 87, Condition 22–6) include:

- manage residual impacts and risks associated with potential increased island visitation and
- fund additional staff to develop ongoing initiatives to:
    - increase knowledge on values, uses and threats on island nature reserves leading to a statutory management plan,
    - increase patrols to island nature reserves and to gather visitation data and
    - distribute information about island values, including closure periods.

Spinifex longifolius on Victor Island.

Island surveys, including flora, fauna, social and cultural heritage, occurred prior to and during the development of this management plan as part of the offset project. Most were visited at least once for multi-disciplinary level one[1] surveys, and islands showing signs of visitation were surveyed again during different seasons and in more detail.

The draft plan should be read in conjunction with plans for nearby parks and reserves including Dampier Archipelago Nature Reserves, Barrow Group Nature Reserves, Montebello/Barrow Islands Marine Conservation Reserves, Ningaloo Marine Park and Muiron Islands Marine Management Area.

[1] Level one surveys derived from *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* and consist of a desktop study, followed by basic ground truthing of flora, fauna and habitat mapping.

1. Overview

Western Australia's many islands are mostly inshore but are relatively undisturbed and provide nesting and resting habitat for several groups of marine species (seabirds, migratory shorebirds, marine turtles, pinnipeds) and refuges for endemic plants and threatened fauna species. Most Western Australian islands are small (less than one hectare). The three largest islands in Western Australia are Dirk Hartog (~70,000 hectares), Barrow (~27,000 hectares) and Augustus (~19,000 hectares). Only a small proportion of Western Australia's islands are protected as conservation estate.

The islands within the area covered by this management plan (Map 1) are 174 small islands[2] with a combined area of over 13,000 hectares and a total coastline of around 500km. The islands provide connectivity through the marine environment from the Dampier Archipelago, Barrow Island and the Montebello Islands (outside of the planning area) down to the southern part of Exmouth Gulf. Most of the islands are gazetted as nature reserves in recognition of their habitat for nesting birds and turtles.

Of the 97 islands that are gazetted as nature reserves;

- 16 are greater than 100 hectares,
- 19 are between 50 and 100 hectares,
- 62 are less than 50 hectares.

Situated between North West Shelf offshore oilfields and onshore processing plants, the islands, along with the Montebello Islands and the Barrow group (Barrow Island Nature Reserve and Boodie, Double and Middle Islands Nature Reserve), provide isolated habitat for a variety of terrestrial and marine threatened species. This management plan notes that conditional environmental approval has been granted for oil facilities on three island nature reserves, two of which are undergoing decommissioning (Thevenard and Airlie Islands). The plan provides information and guidance about the nature reserves but does not impose additional environmental requirements on those industry operators.

There are also two marine management areas around two island groups in the planning area. The Lowendal Islands lie between Barrow Island and the Montebello Islands such that some of the islands, islets and rocks of the Lowendal group are surrounded by the Barrow Island Marine Management Area (Map 2d). The Muiron Islands (North Muiron and South Muiron) and Sunday Island lie outside Ningaloo Marine Park but within the Muiron Islands Marine Management Area (Map 2b).

A beach stone-curlew on Passage Island.

Under the *Interim Biogeographic Regionalisation of Australia* (Commonwealth of Australia 2012a), the islands are included in the Pilbara (Roebourne subregion) and Carnarvon (Cape Range subregion)

[2] There are 94 existing island nature reserves and 77 unallocated Crown land (UCL) islands proposed to become nature reserves.

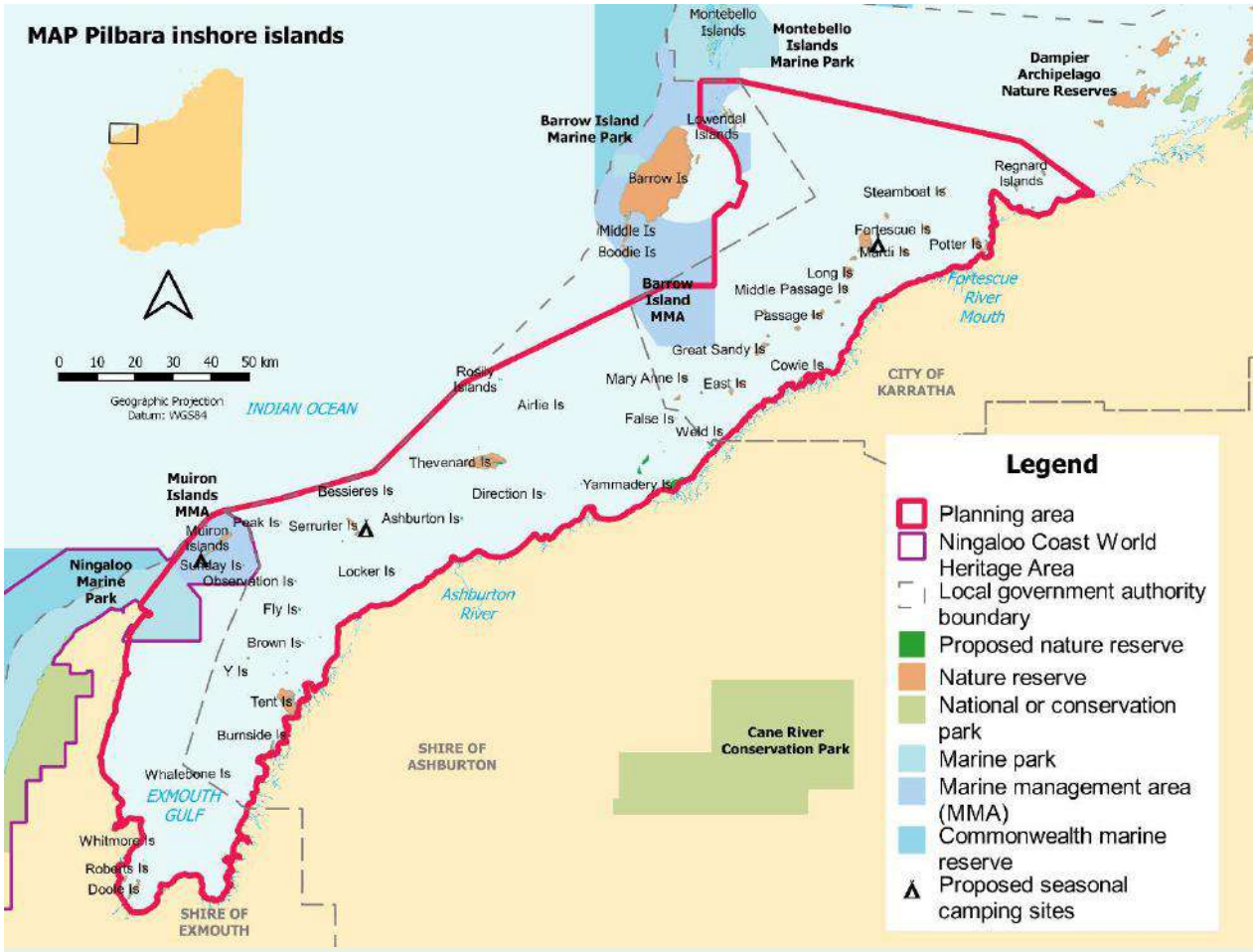
bioregions. Waters around the islands are referred to as the Pilbara (nearshore) and Pilbara (offshore) meso-scale bioregions (Commonwealth of Australia 2006a).

Located between the Ningaloo Coast World Heritage Area and the islands of the Dampier Archipelago, the main recreational marine attractions (boating, fishing and diving) for people who visit the region are not the islands themselves, but the reefs around the islands. These activities, while outside the planning area, have the potential to impact upon island values. Local small-scale impacts are occurring in the form of disturbance to sensitive sites, discarded fishing and camping gear, fires, marine debris, and human toilet waste.

2. Planning area

This management plan covers 20 existing nature reserves made up of 97 islands, islets and rocks. In addition there are 77 small unallocated Crown land (UCL) islands between Exmouth and Cape Preston (Map 1; Appendix 1) off the Pilbara Coast of Western Australia. These 77 UCL islands are proposed to become nature reserves under this plan. On the existing nature reserve islands there are three small unnamed section 5(1)(h) reserves and two small unnamed Crown reserves.[3]

The islands vary in size from around one square metre to 660 hectares at mean high water mark, but can be much larger at low tide, though most are less than 50 hectares. Much of the planning area is intertidal, with the exposed land in the planning area ranging from as little as 5,630 hectares at high tide over 53,000 hectares at low tide.



Location of Pilbara inshore islands in Western Australia.

[3] Detail provided in Section 6 Tenure.

Many of the islands are located within a few kilometres of the coast and, in some cases, are joined to the mainland at spring low tide. The islands are surrounded by shallow reefs, oyster beds and sand banks that may be exposed at low tide. Three islands (North Muiron, South Muiron, and Sunday Island; Map 2a) are part of the Ningaloo Coast World Heritage Area. One statutory management plan (for the Jurabi and Bundegi Coastal Parks, and Muiron Islands) has been prepared for two islands of the planning area (North Muiron and South Muiron Islands) (CALM 1999).

The Lowendal Islands Nature Reserve contains 46 islands and islets, while the Great Sandy Islands Nature Reserve contains 29 islands, including one island (Preston Island) that falls outside the planning area. Thevenard Island Nature Reserve is the largest existing island nature reserve within the planning area, followed by Tent Island Nature Reserve which is made up of smaller islands that are connected by intertidal area and which is predominately mangrove thicket (Table 1).

The 77 UCL islands in the planning area that are not currently reserves, comprise approximately 1,800 hectares and are mostly mangrove islands but also include several round, sandy islands in the northern part of Exmouth Gulf and near Onslow.

The islands are in the City of Karratha, the Shire of Ashburton and the Shire of Exmouth local government areas. All islands are within Western Australian State territorial waters.

Tent Island includes significant flora, mangroves, algal mat and supratidal claypan habitat.

Table 1: Size of notable large islands in the planning area.[4]

Island	Size (ha)
Thevenard	2,345
Tent	2,045
Sholl	1,269
South Muiron	497
North Muiron	493
Long	466
Potter	424
Great Sandy	342
Serrurier	314

This management plan, once gazetted, will apply to all island existing nature reserves (tabled in Appendix 1) as well any UCL islands in Appendix 2 that become nature reserves, as is proposed in this management plan.

3. Key values and management issues

This summary identifies current and future values, management issues and opportunities within the planning area (Table 2). Strategies to protect these values and mitigate pressures are described further in this management plan.

[4] Area information is from cadastre on State tenure maps.

Table 2 Key values, management issues and opportunities.

Values	Management issues	Opportunities
Natural		
• World Heritage values • geological features • conservation significant plants, animals and communities e.g. mangroves, marine turtles, shorebirds and native rodents largely free from mainland threats • habitat values (e.g. mangroves, sandy beaches, rocky ledges)	• impacts from introduced animals like black rats, foxes and cats on marine turtle nesting, terrestrial fauna and birds • impacts on fauna from disturbance of habitats such as shorebird roosting sites • biodiversity knowledge gaps • impacts of climate change • impacts from weeds, especially buffel grass (*Cenchrus ciliaris*) • impacts associated with industrial development and associated activities	• holistic approach for the management of island issues e.g. weeds, introduced animals and fire, in collaboration with neighbouring industry • provide visitor access onto larger islands away from sensitive sites • research and monitoring of the values to inform adaptive management
Culture and heritage		
• traditional cultural knowledge • culturally significant sites • plants and animals of cultural significance • customary activities, including hunting and ceremonies • sites of other heritage	• impacts from introduced species • impacts from commercial activities (oil and gas), recreation and tourism. • traditional ecological knowledge unknown	• joint management • access for traditional owners to country • development of new cultural education and interpretation program to show historical use of the islands
Recreation, tourism and community		
• low-key (passive) remote recreational experiences • landscapes providing opportunities for a range of cultural and nature-based visitor experiences including day trips and camping • commercial tourism operations on Thevenard Island • opportunities on South Muiron Island	• environmental impacts from inappropriate visitor access or activities (e.g. dune erosion, firewood collection, campfire escapes, bird and marine turtle disturbance, pollution of marine environment) at sensitive sites • logistics of management due to distance from management centres, limited on site signage • impacts on turtles from lighting and use of nesting beaches	• cultural tours, including boat-based eco-tourism • increased communications with visitors, commercial operators and external organisations • education and interpretation programs • adoption of 'leave no trace' recreation principles • social research to understand visitor numbers and characteristics

Management direction and context

4. Management context

Legislation and policy

Nature reserves are vested in the Commission and managed by the department in accordance with the CALM Act, which provides for the management of conservation reserves and other specific lands and waters. The *Biodiversity Conservation Act 2016* (BC Act) also applies and provides for the conservation and protection of all native flora and fauna across Western Australia. The BC Act and Regulations 2018 replaced the *Wildlife Conservation Act 1950* and associated regulations on 1 January 2019.

Objectives for the management of nature reserves are stated in section 56(1) of the CALM Act as: "*maintain and restore the natural environment, and to protect, care for and promote the study of indigenous flora and fauna, and to preserve any feature of archaeological, historical or scientific interest*".

In accordance with section 56(2) of the CALM Act, this management plan also has the overarching objective to *"protect and conserve the value of the land to the culture and heritage of Aboriginal persons, in particular from any material adverse effect caused by (i) entry on or the use of the land by other persons, or (ii) the taking or removal of the land's fauna, flora or forest produce; but in a manner that does not have an adverse effect on the protection or conservation of the land's fauna and flora.*

The reserves were created under the *Land Act 1933* and classified as Class A, B or C, or more recently under the *Land Administration Act 1997*.

The Muiron Islands (North Muiron and South Muiron Islands) are jointly vested in the Shire of Exmouth and the Commission and are the only islands with a purpose of 'recreation' as well as 'conservation of flora and fauna'. A recreation zone and special conservation zones were defined within the *Jurabi and Bundegi Coastal Parks, and Muiron Islands Management Plan* (CALM 1999). This assigns as section of beach at the northern end of South Muiron as 'recreation zone' allowing camping with a lawful authority and subject to certain restrictions, and allows for access to the rest of South Muiron and North Muiron to be limited as a 'special conservation zone'.

White-bellied sea eagles nest in winter on most islands. Photo - Carolyn Williams

Reserves gazetted after 23 December 1996 are subject to the future act provisions of the *Native Title Act 1993* whereby consultation with native title claimants during the preparation of a management plan is required. Native title claimants have been notified of the management planning process.

Reserves vested prior to 23 December 1996 have had native title rights extinguished and this applies to all Pilbara inshore islands except Bessieres Island and the 77 islands proposed to become reserves (see Appendix 2).

Legislation administered by other government departments which are relevant in protecting the values of the planning area and implementing the plan are referred to throughout the plan and can be found online.[5]

The Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) contains provisions relating to nationally listed threatened species, ecological communities, heritage listed places and key threatening processes. Actions that may have a significant impact on a matter of national environmental significance, such as migratory species, need approval from the relevant Federal Minister, in addition to any approvals that may be needed in Western Australia.

While nature reserves generally differ from national parks and conservation parks with regard to not having 'recreation' included in the purpose of use, some low impact recreation that does not harm the natural ecosystems is permitted via the department's *Corporate Policy Statement No. 18: Recreation, Tourism and Visitor Services* (DPaW 2017a).

World Heritage and National Heritage

The Muiron Islands and Sunday Island lie within the Ningaloo Coast World Heritage Area and Ningaloo Coast National Heritage place. The Ningaloo Coast World Heritage Area, which also includes Cape Range National Park, Ningaloo Marine Park, Muiron Islands Marine Management Area and Jurabi and Bundegi Coastal Parks, was inscribed on the World Heritage List in 2011 for its Outstanding Universal Value. The National and World Heritage listings recognise the values of the area's diverse and abundant marine life, its cave fauna and the spectacular contrast between the colourful underwater scenery and the arid and rugged land of the Cape Range.
Management of the planning area needs to protect the National and World Heritage values of the Muiron Islands Nature Reserve and adjoining lands and waters including Sunday Island. Any action within the World Heritage area that may have a significant impact on the listed property's heritage values will need to be assessed under the EPBC Act.

Register of National Estate

The Register of the National Estate has been superseded following amendment to the EPBC Act on 19 February 2012. Nonetheless the places that were listed are:

- the mangroves and coastal habitats of Exmouth Gulf East (including mangroves on islands),
- the islands of Exmouth Gulf and the Rowley Shelf, and
- the coastal islands from Mary Anne Island to Regnard Island via Mardie Island.

The islands, regardless of tenure, are included in the Hamersley-Pilbara national biodiversity hotspot (Australian Government 2009a) because of their value as refuges for vulnerable species that are rare or extinct on the mainland.

International agreements

Australia is a signatory to bilateral agreements with China (China-Australia Migratory Bird Agreement), Japan (Japan-Australia Migratory Bird Agreement) and the Republic of Korea (Republic of Korea-Australia Migratory Bird Agreement) to provide a collaborative framework for the protection of habitats of migratory birds within the East Asian-Australasian Flyway. Many species listed in these agreements occur in the planning area (refer Appendix 6) and some are also

[5] See legislation.wa.gov.au.

listed under the *Convention on the Conservation of Migratory Species of Wild Animals* (1979) (Bonn Convention). Australia is also a signatory to the *Convention on Biological Diversity* (1993).

5. Management arrangements with Aboriginal people

The department and the Commission acknowledge the aspirations of Aboriginal people to claim native title over their traditional lands and waters under the provisions of the Australian Government's *Native Title Act 1993*.

The CALM Act, along with the department's *Corporate Policy Statements No. 86: Aboriginal Customary Activities* (DPaW 2015a) and *No. 87: Aboriginal Joint Management* (DPaW 2015b) provide the framework for how the department liaises with Aboriginal people in relation to access to undertake customary activities and potential joint management opportunities.

Yaburara and Mardudhunera representatives with departmental staff on an unnamed island near Cape Preston.

At the time of preparation of this draft management plan, two native title determinations covered part of the planning area.

The *Peck on behalf of the Gnulli Native Title Claim Group v State of Western Australia [2019] FCA 2090* determination covered Tent, Rocky, Burnside, Simpson, Whitmore, Roberts, Doole, North West Doole Islands (all nature reserves). UCL islands within the determination area are Little Roberts Island and unnamed UCL islands 1-20 (Australian Government 2019a). Determination of the Gnulli Native Title Claim Group claim was made in December 2019. Native title was found to exist across these islands and the department will continue to consult with Nganhurra Thanadri Garrbu Aboriginal Corporation (NTGAC), the representative Prescribed Body Corporate, on Aboriginal heritage matters.

Gnulli representatives with staff and researchers.

The *Holborow on behalf of the Yaburara and Mardudhunera People v State of Western Australia (No 3) [2018] FCA 1108* determination covered Cowie, Passage, Solitary, Angle, Middle Passage, Long, Round, Sholl, Stewart, Mardi, Fortescue, Steamboat, Potter, Carey, South West Regnard, North East Regnard and Preston Islands as well as unnamed island (407) within the Great Sandy Island Nature Reserve (Australian Government 2018). Determination of the Yaburara and Mardudhunera claim was made in July 2018. Native title was found not to exist; however, the

department will engage with Wirrawandi Aboriginal Corporation, the relevant Prescribed Body Corporate, on Aboriginal heritage matters.

The planning area is also adjacent to the *Hayes on behalf of the Thalanyji People v State of Western Australia [2008] FCA 1487* native title determination area. The department will liaise with Buurabalayji Thalanyji Aboriginal Corporation RNTBC, the relevant Prescribed Body Corporate, on related Aboriginal heritage matters as appropriate.

Should the department and relevant native title holders agree to enter into a joint management agreement for islands within this management plan area, then the joint management agreement relating to those islands will be attached to the management plan.

6. Strategic direction

Vision

The biodiversity, cultural and social values of the Pilbara inshore island nature reserves will be conserved or enhanced. The role islands play in providing key habitat for resident and migratory species will be respected and valued by the community. The cultural heritage of the islands and their significance to Aboriginal people will be recognised, supported and protected.

Strategic goals

Statewide strategic directions underpin a set of strategic goals that have been developed for the planning area. These goals provide a link between the vision statement above and the desired outcomes and management objectives identified in this management plan. The various parts of this management plan (e.g. *Caring for country (natural values)*) each follow one of these strategic goals.

The strategic goals are:

1. Protect and manage islands in a holistic manner as a single management unit for natural values focussing on threatened resident and migratory species and their habitats.
2. Protect and conserve biodiversity, ecological integrity and geological features.
3. Protect and conserve the cultural and heritage values of the land to Aboriginal people.
4. Allow for nature-based recreation and tourism experiences without compromising the cultural, heritage and natural values of the islands.
5. Minimise impact of resource exploration and development on key values.

The findings of the *Status Performance Assessment: Biodiversity conservation on Western Australian Islands*[6] (CCWA 2009) (refer Appendix 3) have been considered and as such the management plan addresses 15 of the most relevant recommendations.

Management objectives and strategies

Within each part, the values, management issues and opportunities are organised into sections (e.g. Section 8: *Physical environment*) and each one has a 'management objective'. Under the management objective are 'management strategies' which are presented to deliver on these management objectives. A selection of the values and management issues have 'key performance indicators' (KPIs) assigned to them to measure performance and adequacy of the management plan (see *Performance assessment* below).

[6] Of the 28 recommendations in the performance assessment only 15 are relevant to the planning area.

Administration

The planning area lies within the department's Pilbara Region, with management responsibility residing with the Pilbara Regional Manager. The islands will be managed from the Karratha and Exmouth work centres, within the Pilbara Region.

The operational management of the reserves in the planning area is incorporated into work programs. Research and monitoring activities may also be supported by staff from the department's specialist branches or where necessary by volunteers, consultants or universities.

The final management plan will guide management of the planning area for 10 years from the date that a notice is published in the Government Gazette. If the plan is not reviewed and replaced by the end of the 10-year period, it will remain in force until a new plan is approved. Amendments to the plan may be made in accordance with the CALM Act.

Performance assessment

The Commission will assess the implementation of this management plan in accordance with section 19(1)(g)(iii) of the CALM Act. The KPIs in this management plan deliver the desired outcomes for the planning area while management strategies guide the department's contribution to achieving these KPIs. Achievement of desired outcomes may depend on other stakeholders fulfilling their respective environmental management requirements.

Looking after country (administrative arrangements)

Strategic goal 1: *Protect and manage islands in a holistic manner as a single management unit for natural values focussing on threatened resident and migratory species and their habitats.*

7. Tenure

Existing reserves

The 20 existing island nature reserves are set aside primarily for 'conservation of flora and fauna'. The Muiron Islands Nature Reserve is the only reserve that also includes 'recreation' in the purpose of use (Appendix 1). There are also

- two unnamed Crown reserves, one on part of Y Island with the purpose of 'navigation aid site' and the other on part of Great Sandy Island with the purpose of navigation, communication, meteorology and survey (though the existing structure falls to the north-east of the reserve boundary).
- three unnamed section 5(1)(h) reserves located on portions of North Sandy (see photo), Airlie and Bessieres Islands, which are for the purpose of conservation, navigation, communication, meteorology and survey.

North Sandy Island light tower section 5(1)(h) reserve.

Five of the natures reserves are Class A Reserves:

- Bessieres Island Nature Reserve,
- North Sandy Island Nature Reserve,
- Locker Island Nature Reserve,
- Little Rocky Island Nature Reserve, and
- Gnandaroo Island Nature Reserve.

Two of the small section 5(1)(h) reserves are Class A Reserves; the one on part of North Sandy Island (A44667) and the one on part of Bessieres Island (A44665). The remaining island nature reserves are declared 'other than Class A' (Appendix 1).

In most instances, the nature reserve tenure covers all of each of the islands. There are some exceptions which include

- a portion of UCL on the south-east corner of Mary Anne Island,
- three portions of UCL on Thevenard Island. Mackerel Islands Pty Ltd operates a holiday resort and an associated airstrip on two of these portions of UCL under two *Land Administration Act 1997* leases issued by the Department of Planning, Lands and Heritage (DPLH), and
- on many islands where the reserve does not extend to the low water mark (Appendix 1).

The CALM Act and Regulations 2002 applies to land that includes

a) tidal land;
b) tidal waters in any inlet, estuary, lagoon, river, stream or creek; and

c) the waters of any inlet, estuary, lake, lagoon or swamp or of any river, stream or creek whether flowing continuously or intermittently.

Where the reserve is declared to low water mark the intertidal waters are included in the reserve (see Appendix 1).

Proposed changes to existing reserves

Amalgamation of reserves in planning area

It is proposed that all the existing island nature reserves in the planning area be amalgamated and declared as a single reserve to be known as the 'Pilbara Inshore Islands Nature Reserve'.

Reserve class

The security of tenure of Crown reserves created under the *Land Administration Act 1997* varies, depending upon whether the reserve is a Class A Reserve or unclassified (i.e. other than Class A). However, 15 of the island nature reserves were created under the previous *Land Act 1933* and classified as Class B or C. The level of approval required to change their area or purpose reflects the security of tenure. Changes to Class A Reserves require the agreement of both Houses of Parliament. Changes to reserves other than Class A Reserves require approval at Ministerial level.

The department seeks to ensure Class A Reserve status for island reserves Statewide (CCWA 2009). This management plan therefore proposes that all reserves in the planning area that are other than Class A should be changed to Class A Reserves (Appendix 1). The Pilbara inshore islands are worthy of Class A Reserve status as they possess unique attributes, including

- breeding populations of threatened animal species;
- priority flora, flora uncommon on the mainland and flora at the edge of their natural range and contains a poorly conserved floral community (coastal dune native tussock grassland dominated by *Whiteochloa airoides*);
- significant habitat for nesting seabirds and marine turtles;
- important resting and feeding habitat for migratory species listed under international treaties;
- geological form of islands that is not represented elsewhere in Australia;
- archaeological, cultural and historic sites; and
- sites previously classified as national estate and classified as a national biodiversity hotspot.

Vesting extent

Both the Great Sandy Island and North Sandy Island Nature Reserves are vested to the low water mark and the Thevenard Island Nature Reserve is vested approximately to the low water mark. These reserves, comprising 30 islands in the planning area, provide the only current protection for the intertidal habitat in the planning area, outside of where islands are adjacent to marine reserves (the Muiron Islands Marine Management Area and the Barrow Islands Marine Management Area).

The remaining reserve islands are vested to the mean high water mark only (or approximately to the mean high water mark), meaning much of the intertidal habitat for threatened migratory and resident species in the planning area is not protected. Where there are no adjoining marine reserves, terrestrial reserves should be vested to the low water mark, as per the report, *Status performance assessment: biodiversity conservation on Western Australian islands, Phase 1* (CCWA 2009).

It is therefore proposed that the islands of the following nature reserves should be vested to the low water mark:

- Lowendal Islands Nature Reserve (but only the islands not adjoined by the Barrow Island Marine Management Area);

- Whitmore, Roberts, Doole Islands and Sandalwood Landing Nature Reserve (with the exception of Sandalwood Landing); and
- Burnside and Simpson, Tent, Serrurier, Bessieres, Y, Airlie, Weld, Locker, Victor, Round, Little Rocky, Gnandaroo, Rocky and Whalebone Island Nature Reserves.

In some instances, reserve boundaries do not accurately match either the low or high water mark. In these cases, it is proposed that the tenure be amended and to ensure the islands are accurately vested to the low water mark (or high water mark if the island is adjoined by a marine reserve).

Fairy and roseate terns on Brown Island being photographed by Dan Weller, BirdLife Australia.

Sandalwood Landing, which forms part of the Whitmore, Roberts, Doole Islands and Sandalwood Landing Nature Reserve is located on the mainland. As a result, the management issues associated with this portion of the nature reserve are quite different to the remainder of the nature reserve, which are all islands. This management plan proposes that Sandalwood Landing be excised from the island nature reserve and become a separate nature reserve.

Preston Island, which is currently part of the Great Sandy Island Nature Reserve, has also been excluded from the planning area as it has been extensively altered by development, is connected to the mainland by a jetty and is not considered to have any remaining significant conservation value. It is proposed that Preston Island be de-gazetted as a nature reserve and excised from the Great Sandy Island Nature Reserve.

Existing management plan

An existing statutory management plan for the Muiron Islands exists within the planning area: the *Jurabi and Bundegi Coastal Parks and Muiron Islands Management Plan 1999-2009* (CALM 1999). This management plan, once gazetted, will replace the existing plan for the Muiron Islands and will be the statutory management plan for all of the reserves within the planning area (including any proposed reserves that become vested with the Commission).

Proposed new reserves

The planning area also encompasses 77 UCL islands. This management plan proposes that all the UCL islands become nature reserves on the basis of providing habitat for threatened fauna, particularly seabirds, shorebirds and marine turtles. These islands would become part of the proposed Pilbara Inshore Islands Nature Reserve and be managed in accordance with this management plan, once gazetted.

This management plan also proposes that

- the three portions of UCL on Thevenard Island, on which Mackerel Islands Pty Ltd operates its holiday resort and associated airstrip, become section 5(1)(h) reserve vested in the Commission for the purpose of ‘recreation, tourism and airstrip’; and
- Direction Island become a nature reserve and the existing *Lands Act 1993* lease become a section 5(1)(h) reserve.

It is proposed that any UCL islands that do become nature reserves are vested to the low water mark, except where adjacent to marine reserves.

Other proposed changes

Naming

While some island names are formally State-approved[7], there are many islands that have unofficial names or are unnamed (Appendix 1). The department's *Nomenclature Guidelines* (CALM 1995) provide guidance on the process of approval of names for reserves, features or assets, which includes community consultation and referral to the department's Nomenclature Committee, the Commission, and the State's Geographic Names Committee (where names are formally approved).

It is proposed in this management plan that the unofficial names for the islands be adopted and proposed as official names, unless there are more suggestions for these islands put forward by the community during the period that this draft management plan is open for public comment.

Any names will be further assessed on a case-by-case basis in consultation with key stakeholders, including Aboriginal people and local government authorities.

Accuracy of tenure information

In many cases, the legal area and/or perimeter recorded by Landgate for the existing reserves and UCL lots does not accurately reflect the cadastral information from State tenure maps. It is proposed that tenure information be amended over the life of the plan.

Management objective: Standardise protection of all island reserves within the planning area.	
Key management challenges • Ensure vesting, tenure, purpose and classification of reserves reflects their value. **Management considerations** • The department's *Management Guideline No.2: Necessary operations* provides guidelines for managing operations on a day-to-day basis.	**Management strategies** 1. Implement the tenure recommendations in Appendix 2, subject to government consideration and determination. 2. Manage any proposed reserve additions that become vested with the Commission or managed by the department under the CALM Act in accordance with this management plan. 3. Where there are no adjoining marine reserves, gazette existing and proposed island reserves to the low water mark during the life of the plan. 4. Ensure the existing and proposed reserve boundaries align with the low water mark (or high water mark if the island is adjoined by a marine reserve). 5. Remove Sandalwood Landing from the Whitmore, Roberts, Doole Islands and Sandalwood Landing Nature Reserve to become separate as Sandalwood Landing Nature Reserve. 6. De-gazette and excise Preston Island from the Great Sandy Island Nature Reserve. 7. Establish official reserve names for unofficially named and unnamed nature reserves and islands. 8. Incorporate all existing and proposed island nature reserves into the proposed Pilbara Inshore Islands Nature Reserve as a single Class A Reserve, containing 174 islands, vested in the Commission. 9. Ensure tenure area and boundary information is amended over the life of the plan.
Key performance indicators	
Performance measure	**New reserves are declared and boundaries standardised.**
Target	Complete all the tenure actions within the life of the plan.
Reporting	At expiry of plan.

[7] Names that have been formally approved by the Executive Officer, Chairman, the Geographic Names Committee or the Minister for Lands are deemed to be 'official' or 'approved' names (see landgate.wa.gov.au/maps-and-imagery/wa-geographic-names).

Caring for country (natural values)

Strategic goal 2: *Protect and conserve biodiversity, ecological integrity and geological features.*

The islands are a refuge for migratory and threatened species including seabirds, shorebirds and marine turtles, and include remnant continental islands that represent potential translocation sites for species requiring conservation intervention.

The islands will be prioritised for management actions based on decisions relating to values and pressures.

The values and recognised conservation listings within the planning area include:

- Populations of native fauna free from predation by non-indigenous species (NIS). As such the islands are included in a national biodiversity hotspot.
- Refuges for conservation translocations of golden bandicoot (*Isoodon auratus*) on Doole Island and Lakeland Downs short-tailed mouse (*Leggadina lakedownensis*) on Serrurier Island.
- Habitat for four species of marine turtle; flatback *(Natator depressus)*, green *(Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and loggerhead *(Caretta caretta)*, including four islands that are nationally significant turtle rookeries.
- Habitat for birds with some threatened species present in internationally significant numbers; grey-tailed tattler (*Tringa breviceps)*, bar-tailed godwit (*Limosa lapponica)*, ruddy turnstone (*Arenaria interpres)*, sanderling (*Calidris alba)*, greater sand plover (*Charadrius leschenaultii)* and roseate tern (*Sternula dougallii*).
- Relatively undisturbed flora and vegetation comprised of primarily coastal species in associations not represented anywhere else in the State.

Eastern curlews flying over North West Doole Island and Cape Range (mainland) in the background.

8. Physical environment

Climate and projected climate change

The planning area has very hot summers, mild winters, low and variable rainfall and high temperatures. Nearby Barrow Island (where climate data has been collected since 1998) experiences an average of 299mm of rain per year. Rainfall can be highly variable and is mostly associated with cyclone activity during the first six months of the year. Mean maximum temperatures are at their highest in February (33.7°C) and lowest in July (23.7°C). Conditions on the islands are often windy with average wind speeds ranging from 19.4–28.8kmph throughout the year.

Cyclones are a regular occurrence in the planning area between December and April. The north-west coastline of Western Australia between Broome and Exmouth is one of the most cyclone-prone regions in Australia with an average of five cyclones occurring off the coast and two crossing the coast each year (BOM 2016). As a result, while cyclones have a significant impact on the key values of the planning area by eroding beaches, cays and sand spits and creating new ones, some species utilise the altered habitat. Tropical Cyclone Vance impacted all the islands in Exmouth Gulf on 22 March 1999 with a maximum recorded wind gust of 267kmph resulting in extensive inundation and erosion of island ecosystems.

Climate change impacts on islands include increasing temperatures, sea level rise, altered rainfall patterns, changes in frequency and intensity of extreme weather events and increased atmospheric carbon dioxide (Paice and Chambers 2016). The processes of erosion and accretion of islands and their surrounding rocky platforms and reefs are not well understood.

Climate change resulting in increased sand and water temperature may impact on marine turtle (Stubbs et al. 2014) and coastal bird populations (Australian Government 2011). Impacts relate to changes in food availability, breeding colony failures, changes in sex ratios and impacts on hatching success (Jensen et al. 2018; Butt et al. 2016).

Exposed coral reef on Sholl Island being surveyed by Dr Mick O'Leary, Curtin University. Photo – Dr Nicola Browne

In the north-west of Western Australia, the impacts of climate change have resulted in increases in summer rainfall, particularly associated with each tropical cyclone and other types of low weather systems. Modelling suggests warming temperatures in the north-west in the future and the likelihood of fewer, but more intense cyclones (IOCI 2012). All the islands are less than 12m in elevation, with many of the smaller, low-lying islands and sand cays being only 1–2m in height. Consequently, they will be highly vulnerable to sea level rise and storm surge, which could see some islands decrease in size and others disappear completely. This will have a significant impact on flora and terrestrial fauna with no means of relocating to larger islands or the mainland. Changes in ocean currents that occur because of changing ocean temperatures may also impact upon marine turtle, seabird and shorebird populations.

Consequently, identifying islands that are less likely to be adversely affected by increases in sea level, cyclone intensity and other factors affected by climate change, and targeting management strategies that focus on maintaining the natural values on these and the larger islands (i.e. Tent, Thevenard, North Muiron, South Muiron, Serrurier, Sholl, Doole and Potter Islands) is important.

Geology, landforms and soils

Most of the islands are recent in origin and comprised of alluvial, shoreline and aeolian deposits. They occur in a range of shapes and sizes. Except for Rocky Island, they have carbonate sand dunes deposited during the Holocene Period[8], which can reach elevations of up to 12m above sea level. These carbonate dunes appear to have accumulated over older Pleistocene[9] limestone deposits consisting of either lime-cemented red, shelly sands or fossil coral reefs. It is thought that these limestone deposits form the stable core of the islands, as they are occasionally observed outcropping beneath the Holocene dunes along the intertidal zone (M O'Leary, personal communication, 2015).

The geomorphology of the sandy islands is varied but most are similar in form, with a sandy spit, a fringing reef platform, foredunes and a central depression within the inland part of the island (see Figure 1).

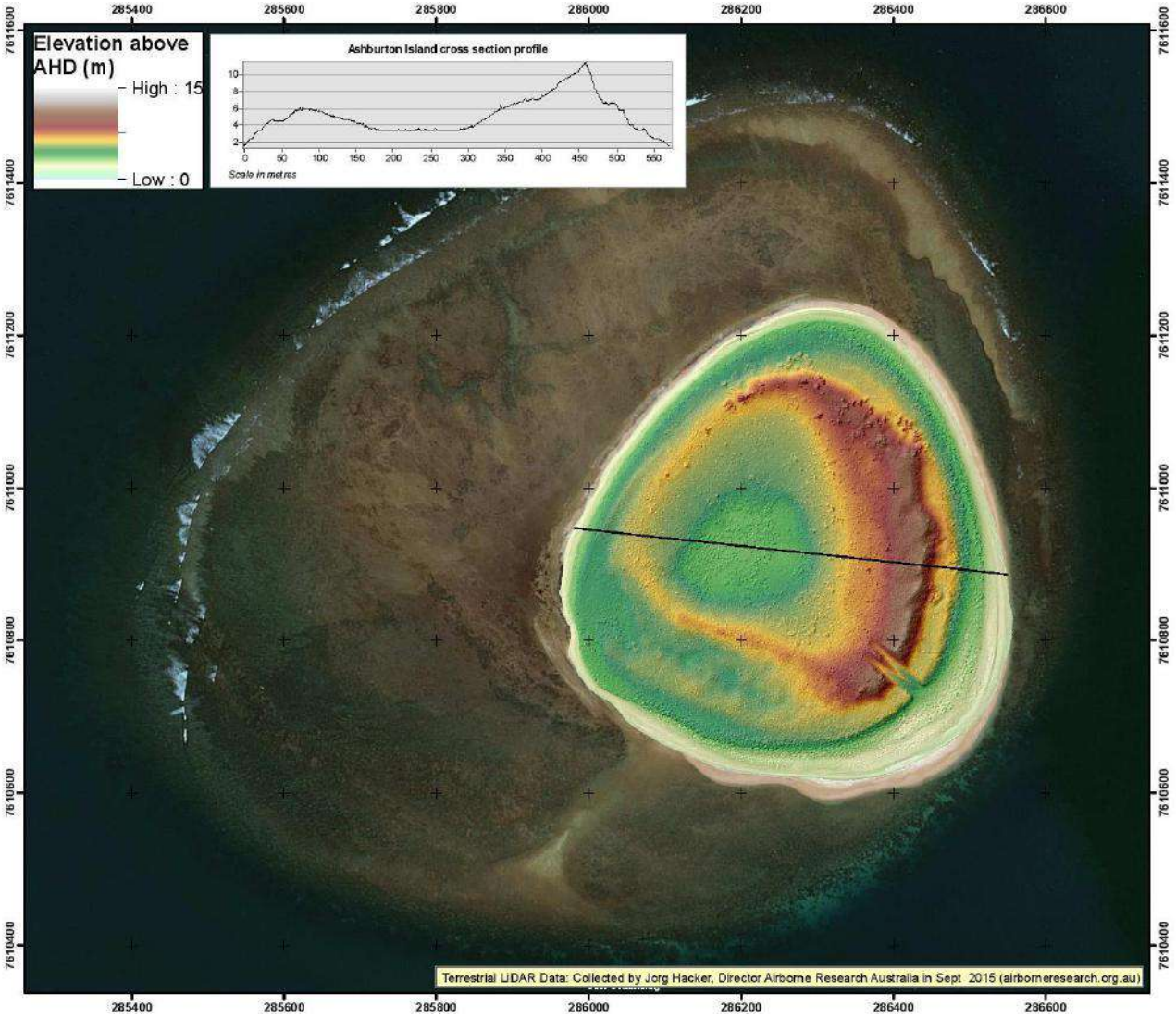


Figure 1 Ashburton Island LIDAR image. Shows typical 'round' island features including extensive reef flat.

Maximum spring tide amplitude is 2.66m for Exmouth and 4.85m at Dampier and for many of the nature reserves a large proportion of the area within the reserve boundaries are intertidal. Intertidal areas may be exposed cemented beach rock, beach sand, limestone platform or mud flat, which may

[8] From about 10,000 years ago.
[9] 1.8 million to 11,700 years ago.

connect islands to each other and the mainland during low tides. Beach rock exposures are more common on the smaller islands and if beach sand is present it is often perched within the upper intertidal zone. The largest accumulation of intertidal sand generally occurs on the islands' south-east margins where active sand spits are also present. The islands constantly change, with beach sand migrating and sand spits eroding or accreting in response to changes in tide, wind, waves and other weather conditions, either on a seasonal scale with changing ground swell or trade wind conditions, or event scale with high energy cyclone events (M O'Leary, personal communication, 2015; Eliot et al. 2013).

Many islands are low-lying, bare rocky stacks and islets. Rocky shorelines up to 5m in height are common on the Lowendal Islands. Wave erosion has undercut the rock creating notches on rock faces on the seaward side.

Simpson and Burnside Islands in the Exmouth Gulf have erosional scarps on their west coasts, like the rocky stacks of the Lowendal Islands. Limestone ridges formed from cemented carbonate dune sands have been undercut by extensive wave action, resulting in piles of boulders at their base. Where large blocks of limestone have fallen from these scarps, the deep chasms left behind provide habitat for nesting birds such as the eastern reef egret (Start and McKenzie 1992).

Beaches comprising overlapping or imbricated boulders are common to many of the islands. They usually occur at 2–3m above the high tide level and are the result of extreme high energy cyclonic events impacting the islands. These boulder beach deposits likely protect the island dunes from more erosion during subsequent high energy wave events (M O'Leary, personal communication, 2015).

Saline flats are found on Simpson and Tent Islands in the Exmouth Gulf. These were once lagoons and on Tent Island about one quarter of the island area is taken up by salt flat inhabited by algal mat.

Beach sand from Serrurier, West and Cowie Islands reveal different sources, colour and grain size.

Sand types vary within the planning area. At the Lowendal Islands, beaches are comprised of fine white sand (Pendoley 2005). On the islands within the Exmouth Gulf (for example, Doole, Roberts, Whitmore and North West Doole Islands) beaches are comprised of a coarser sand of shell fragments and larger pieces of shell and coral, as well as pebbles.

The sandy islands are vulnerable to erosion, particularly if surface vegetation is removed because of fire, cyclones, trampling by visitors, vehicles and excavation by marine turtles. There are also impacts on the geology of the islands from the oil and gas industry, particularly where the construction of infrastructure on island coastlines can impact on coastal processes, which in turn may erode beaches and create new ones. Cyclones have one of the largest impacts on island geomorphology. Physical evidence has been found of islands being overtopped in storm surges and Doole Island was photographed following Cyclone Olwyn showing wrack lines and other evidence a large portion of the island was inundated because of the cyclone.

The geology and landforms of Potter and Carey Islands differs from that of the other islands in the planning area. They are in an area of changing geology and exhibit the same igneous rocks comprising the spine of nearby Cape Preston. These form rocky outcrops; basalt-derived stony plains and low stony hills in addition to the usual limestone terraces, beach rock and carbonate beach sand and some coastal mudflat. These islands were formed during the Quaternary Period from deposited mud, clay, salt and aeolian sand (Eliot et al. 2013).

Hydrology

Surface water in the planning area is rare; ephemeral surface water flows and pools of fresh to brackish water form after heavy rainfall, and small pools probably accumulate within cracks in limestone pavement. A brackish sump was once used as a source of water for Thevenard Island (K Morris, personal communication, 2016). While it is possible that freshwater lenses may develop in the dunes of the sandy islands under certain weather conditions within the planning area, this is by no means certain and no investigation has been carried out to date.

The Department of Mines, Industry Regulation and Safety (DMIRS) have advised that no fresh water source has been discovered on Thevenard, Varanus or Airlie Islands and that oil and gas installations ship in fresh water or set up desalinisation plants to supply fresh water requirements (I Briggs (DMIRS), personal communication, 2017).

There is one wetland of national significance within and adjacent to the planning area: Exmouth Gulf East which includes marine waters less than six metres deep at low tide, mangroves, tidal mudflats and several islands including about 58 percent of Tent Island.

The mangrove creek system on the eastern side of Tent Island is extensive but shallow. Several creek mouths on the western side have been infilled, presumably by significant cyclonic events resulting in isolated creeks lined with dead mangroves. During spring high tide, sea water inundates large areas of Tent Island forming a temporary wetland utilised by resident and migratory birds.

Infilling of the mouths of some creeks on Tent Island (left) has resulted in the death of mangroves (above).

Management objective: To protect and conserve the physical environment and their geological and hydrological values, and minimise impacts from climate change, altered hydrology and other physical processes.

Key management challenges	Management strategies
• Water and wind erosion. • Protection of shallow intertidal waters and tidal mudflats from inappropriate human disturbance. **Management considerations** • Exmouth Gulf East is a wetland of national significance which includes Tent Island mangroves.	1. Identify and protect corridors, microhabitats and landform features, particularly on larger, higher islands, suitable for species migration and refugia in response to extreme weather events and climate change. 2. Limit other stressors such as non-indigenous species (NIS), inappropriate fire, pollution and human disturbance. 3. Identify and protect geological and hydrological features and values vulnerable to environmental damage, and assess the potential for impact on these values from land uses, development proposals and management activities, referring proposals that may have significant impacts to the Department of Water and Environment Regulation (DWER) for assessment.

9. Biota and sensitive sites

The islands contain species of regional, state, national and international conservation significance. The small size of most islands limits the resources available to support large fauna. Euros (*Macropus robustus*) have previously been recorded on five islands but, at the time of writing, are known to occur on only two. These islands are located close to the mainland and may be reached during a low tide. This is the only large terrestrial species recorded within the planning area; all others weigh in at the low end of the critical weight range (between 50g and 5kg) or less.

Surveys have recorded the following native fauna in the planning area[10]:

- 17 terrestrial mammal species including the western chestnut mouse (*Pseudomys nanus*), little red kaluta (*Dasykaluta rosamondae*) and pale field rat (*Rattus tunneyi*) neither of which are now found on the adjacent Pilbara mainland, but do still occur in northern Australia.
- 137 bird species, with grey-tailed tattler (*Tringa brevipes*) and pied oystercatcher (*Haematopus longirostris)* present in internationally significant numbers.
- Four species of marine turtle (green, hawksbill, loggerhead and flatback) on the islands with sandy beaches.
- 41 terrestrial reptile species.
- 18 invertebrate species.
- Dolphins such as Australian humpback dolphins (*Sousa chinensis*) and Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) and dugong (*Dugong dugon*) that utilize the shallow intertidal waters around islands.

So far, 253 species of flora from 54 families have been recorded. These include five mangrove species, five priority flora (the priority 2 *Tephrosia* sp. North West Cape, and the priority 3 *Corchorus congener, Gymnanthera cunninghamii, Lepidium biplicatum and Carpobrotus sp* Thevenard Island (M. White 050)) and one Priority Ecological Community (PEC), 'Coastal dune native tussock grassland dominated by *Whiteochloa airoides*'.

There is clear evidence that islands provide habitat for fauna no longer able to survive on the mainland. Islands as nature refuges will be managed to ensure undisturbed habitats are available to threatened species.

[10] These numbers have been compiled from past surveys in addition to recent opportunistic data collection and should not be considered exhaustive lists particularly in the case of invertebrates.

Threatened and significant fauna

Management activities will consider the following:

- *Recovery Plan for Marine Turtles in Australia 2017–2027* (Commonwealth of Australia 2017),
- *Approved Conservation Advice for* Isoodon auratus barrowensis *(golden bandicoot (Barrow Island))* (DoE 2014), and
- *Migratory Shorebird Conservation Action Plan* (Weller and Lee 2017).

A key management issue is adequate protection of habitat for the species listed in Appendix 4 (threatened and significant fauna found within the management planning area). Of the two godwit species listed, most bar-tailed godwits in Western Australia are the critically endangered species.

Sensitive sites

Breeding, feeding and roosting sites used by species in Appendix 4 are referred to as 'sensitive sites' in this management plan. Whole islands may be designated sensitive sites in cases where all available land is occupied by seabird nesting and roosting as in the case of Gnandaroo, Round and North East Regnard Islands, or the island is small (<100 hectares) or has other significant values.

Seabirds and resident shorebirds nesting on beaches during winter are especially susceptible to human disturbance during peak tourist season and school holidays. The critically endangered subspecies of bar-tailed godwit (*L. lapponica menzbieri*) mainly occurs in Western Australia (D Weller (BirdLife Australia), personal communication, 2018) while the *L. lapponica baueri* subspecies mainly occurs in eastern Australia.

Seabirds such as Australian fairy *(Sternula nereis nereis*), roseate (*Sterna dougallii*) and crested terns (*Thalasseus bergii*) favour roosting and nesting areas on or near a sand spit or beach. As these beaches are generally the preferred access onto the island by users, a buffer around each sensitive site is required to minimise disturbance.

Juvenile and immature eastern curlews (*Numenius madagascariensis*) occur in low numbers year-round throughout the planning area and will require special protection measures. Beach stone-curlews (*Esacus magnirostris*) are resident on most islands (but are declining on the mainland) and are easily disturbed by people. The islands represent the southern-most extent of their distribution and are likely to be a stronghold for the species in the Pilbara.

10. Native fauna and their habitats

The islands are included in the Hamersley-Pilbara national biodiversity hotspot[11] and specifically mentioned as "refuges for vulnerable species that are rare or extinct on the mainland, such as the western chestnut mouse, and are breeding sites for turtles and seabirds" (Australian Government 2009a). The western chestnut mouse has been recorded on Potter and Sholl Islands.
The department will manage the islands in accordance with international agreements (see page 3) and *Corporate Policy Statement No. 35: Conserving Threatened Species and Ecological Communities* (DPaW 2015c).

Although the islands are under less pressure than mainland coastal habitats, they collectively support both seasonal and resident species. Conservation strategies would therefore need to consider management of the islands as a single entity, rather than individual islands.

[11] 15 national biodiversity hotspots are recognised by the Australian Government as areas that support natural ecosystems that are largely intact and have species that are not found or rarely found outside the hotspot (Australian Government 2009a).

Birds

Of note is that the islands provide habitat for 13 species of seabirds, seven species of resident shorebirds and 24 species of migratory shorebirds. The planning area supports greater than one percent of the global population of the grey-tailed tattler, pied oystercatcher, sooty oystercatcher (*Haematopus fuliginosus*), bridled tern (*Onychoprion anaethetus*), crested tern and roseate tern (BirdLife International 2020a and 2020b; Onton et al. 2013). For this reason, the Exmouth Gulf mangroves (which extend beyond the nature reserves), the Lowendal Islands, and Sunday Island (UCL) are listed as Key Biodiversity Areas[12] (KBAs) (BirdLife International 2020a and 2020b).

This management plan recommends extending these KBAs to encompass additional adjacent islands based on data collected since 2012 that indicates the ecological connectivity between the islands through the regular movement of birds, particularly nesting roseate terns. All 24 migratory shorebird species are included in the *Wildlife Conservation Plan for Migratory Shorebirds* (Commonwealth of Australia 2015) with seven species listed as threatened or priority species (Appendix 4).

Migratory shorebirds are most abundant in the planning area in the non-breeding season (austral summer); however, low numbers of juvenile and post-breeding adult shorebirds are present all year. Juveniles remain in north-west Western Australia for the first few years of their life until they achieve breeding condition and depart for their northern hemisphere breeding grounds in the austral winter (Menkhorst et al. 2017). Older post-breeding birds may also remain in the planning area year-round rather than migrate during the breeding season (D Weller (BirdLife Australia), personal communication, 2018).

The island reserves provide high tide roost sites, where shorebirds congregate to rest whilst their intertidal feeding habitat is submerged. As the tide ebbs, the birds move to the exposed tidal flats adjacent to the islands to forage for their prey, comprised predominantly of benthic invertebrates that live on or within the intertidal substrate. Undisturbed high tide roost sites near feeding areas are particularly important habitat for shorebirds because they can then devote the energy they accumulate from foraging to preparation for migration, rather than using it escaping predation and disturbance (Rogers 2003).

A recommendation of this management plan is the extension of the reserve boundaries on some islands (particularly Tent Island) to the low water mark to encompass some of this feeding habitat. A key challenge in the planning area is to provide undisturbed habitat for the wary eastern curlew, a critically endangered species that is particularly sensitive to disturbance (Taylor and Bester 1999).

The sandy beaches and foredunes are also important nesting habitat for a range of seabirds and resident shorebirds such as fairy terns (*Sterna nereis*), lesser crested terns *(Thalasseus bengalensis*), pied oystercatchers, beach stone-curlews and red-capped plovers *(Charadrius ruficapillus*). Caspian terns (*Hydroprogne caspia*) nest on the crests of island foredunes on most islands. Bridled terns (*Onychoprion anaethetus*) nest in a range of habitat extending from imbricated rocky beaches on Serrurier and Stewart Islands to the vegetation of the inner island depression on Y Island. Beach stone-curlews are susceptible to human disturbance, and are seldom seen on the mainland but are found on most of the islands, usually on sandy or shingly beaches or tidal reef flats (Johnstone et al. 2013). Australian pelicans (*Pelecanus conspicillatus*) nest on Little Rocky and Gnandaroo Islands for breeding. Recently this species has been sighted nesting on Gnandaroo Island; however, have not been observed on Little Rocky Island since 2013. Pied oystercatchers have highly variable

[12] Key Biodiversity Areas (KBAs) are sites contributing significantly to the global persistence of biodiversity. The KBAs Program is an international, non-governmental conservation partnership which designates sites of global importance for bird and biodiversity conservation, based on strict scientific criteria. The new Global Standard for the Identification of KBAs was launched in September 2016 and the KBAs program is the successor and extension of BirdLife International's Important Bird Areas (IBAs) program, expanding to encompass all wildlife, plants and ecosystems.

productivity, start nesting at about three years of age, require a breeding territory of about 200m (Weller and Lee 2017) and live for up to 32 years (Newman and Woehler 2017). This species prefers to nest along the high tide line of sandy beaches, and often their choice of nesting sites coincides with beaches preferred by recreational users such as those on Serrurier, Simpson, Doole and Steamboat Islands.

The inland sand ridges and swales of many of the larger islands are also home to a range of bird species such as the Australasian pipit (*Anthus novaeseelandiae*) and the white-breasted wood swallow *(Artamus superciliosus*).

Australian pelicans nest on Gnandaroo Island every year between March and July and will abandon their nests or chicks if disturbed.

White-bellied sea-eagles (*Haliaeetus leucogaster*) and ospreys (*Pandion cristatus*) are marine raptors that nest on most islands. White-bellied sea-eagles are particularly vulnerable to disturbance (Dennis et al. 2011) and generally rely on driftwood to construct large nests or eyries. Designation of the area around nests as sensitive sites may assist in providing buffers to disturbance.

Wedge-tailed shearwaters (*Ardenna pacificus*) have significant breeding colonies on seven islands (North East Regnard, Airlie, Bessieres, Serrurier, Locker, North Muiron and South Muiron Islands) within the planning area with burrows also observed on 12 additional islands. Burrowing seabirds are considered ecosystem engineers as their burrowing activity leads to soil biopedturbation[13], that affects physical and chemical properties of the soil within their colonies, thereby influencing vegetation growth and composition (Bancroft 2004).

Long-term monitoring of wedge-tailed shearwaters has occurred on Airlie, Serrurier and the Lowendal Islands since the mid-1980s (Dunlop et al. 2002) and an apparent decline in nesting on Airlie Island between 2005–06 and 2012–13 has been recorded (Surman and Nicholson 2013). An area of shearwater burrows on Serrurier Island (close to recreational camping) appears to have been abandoned (DBCA 2018a) and may require management intervention.

Five of the 11 Pilbara mangrove species of birds are found in the planning area, these being the mangrove golden whistler (*Pachycephala melanura*), mangrove grey fantail (*Rhipidura phasiana*), grey fantail (*Rhipidura albiscapa*), dusky gerygone (*Gerygone tenebrosa*), white-breasted wood swallow and the yellow white-eye (*Zosterops luteus*). In addition, the brown honeyeater (*Lichmera indistincta*), which is a southern visitor, utilises the mangroves (Johnstone 1990). Mangroves provide habitat for other specialist species like the striated heron (*Butorides striata*), brahminy kite

[13] Turning soil over by digging.

(*Haliastur indus*), Australasian darter (*Anhinga novaehollandiae*) and collared kingfisher (*Todiramphus chloris*).

Bird nesting occurs year-round (Appendix 5) and protection of nesting sites is required to minimise disturbance and impacts to nests from human visitation. Where necessary access will be restricted or deterred in accordance with provisions of the CALM Act including designation of closed areas, fencing, signage and community education.

Mammals

Mammal species found on the islands are, for the most part, widely distributed throughout arid or tropical zones, though not necessarily numerous. The families represented are marsupials (two Macropodidae, two Dasyuridae, one Peramelidae), rodents (seven Muridae) and bats (two Pteropodidae, two Molossidae, one Vespertilionidae). It should be noted that the macropodid species are most likely to be occasional visitors taking advantage of low tides, rather than permanent island residents.

Several small terrestrial mammal species are found on one or more of the islands. These include the western chestnut mouse, sandy inland mouse (*Pseudomys hermannsbergensis*) and spinifex hopping mouse (*Notomys alexis*). The pale field rat is relatively widespread and has been recorded on 11 islands so far (four of these are UCL), though rodent activity has been noted on more islands. This species is no longer found on the adjacent mainland (K Morris, personal communication, 2017). Rodent activity has been observed both on the upper beaches and in island interiors. Of interest, much activity is noted around seeding beach spinifex (*Spinifex longifolius*), and diggings around the bases of wild onion (*Cyperus bulbosus*) plants are so dense that, in the clearings where it occurs, the substrate itself feels distinctly softer than on other parts of the islands. Water rat (*Hydromys chrysogaster*) tracks have been recorded on one island in the past.

The little red kaluta has been recorded on the stony hills of Potter Island eating ants in the middle of the day (Kendrick and Stanley 2001; DBCA island surveys 2018). This is the only known island record for this species (CCWA 2009).

Two translocated mammal populations exist within the planning area: the priority 4 Lakeland Downs short-tailed mouse (*Leggadina lakedownensis*) and the vulnerable Barrow Island golden bandicoot (*Isoodon auratus barrowensis*).

The Barrow Island golden bandicoot, found only on Barrow and Middle Islands, was introduced successfully to Doole Island in 2011 as an insurance population (Moro and MacAulay 2010). A recovery plan is in place for the golden bandicoot (Palmer et al. 2003).

The Lakeland Downs short-tailed mouse found on Thevenard Island was previously thought to be a unique form endemic to the island but is now known to be a large form of the same species on the mainland (Moro et al. 1998). Individuals captured from Thevenard Island were successfully translocated to Serrurier Island in 1996 to establish an insurance population of local provenance animals against future planned extermination of the introduced house mouse population on Thevenard (Aplin et al. 2016; Cooper et al. 2003).

There was an attempt to introduce the threatened Shark Bay mouse (*Pseudomys fieldi*) to Doole Island in 1993 with staged releases of 224 animals; however, this was unsuccessful (Johnson and Morris 2005), owing probably to excessive predation by sand goannas *(Varanus gouldii*), and cyclonic tidal surges.

Future translocations of other conservation significant species to the islands must consider the impact of climate change (CCWA 2009).

Mangrove specialist microbats, the north-western free-tailed bat (*Ozimops coburginanus*) and the Arnhem long-eared bat (*Nyctophilus arhnemensis*) have both been recorded in mangroves in the near vicinity of Simpson and Doole Islands in the Exmouth Gulf, and the northern mastiff bat (*Chaerophon jobensis*) has been recorded at Tent Island (McKenzie and Bullen 2009; Reardon et al. 2014).

Reptiles

Reptile species include marine turtles (four Cheloniidae), skinks (17 Scincidae), dragons (three Agamidae), legless lizards (three Pygopodidae), geckos (one Diplodactylidae, four Gekkonidae), snakes (three Elapidae, one Pythonidae, one Typhlopidae), and goannas (four Varanidae).

Turtle tracks on South Muiron Island.

The sandy beaches and foredunes of the islands provide important habitat for nesting marine turtles free from predation by introduced animals. The main concern for marine turtle conservation is management of the impact of lighting on nesting adults and hatchlings.

Any or all of the four species of marine turtle (loggerhead, green, hawksbill and flatback turtles) found within the planning area have been recorded nesting on the beaches of at least 36 islands within the same area between July and March (Pendoley et al. 2016; DBCA island surveys 2018).

Of the nesting islands, the Muiron Islands, Lowendal Islands, Serrurier Island and Sholl Island are listed as nationally significant marine turtle rookeries (Pendoley et al. 2016; Commonwealth of Australia 2017).

Loggerhead turtles are a temperate species with their northern limit being the Dampier Archipelago to the north-east of the planning area (Prince 1993). The Lowendal Islands and Sholl Island are

known hawksbill rookeries, the southern nesting limit of this species being North West Cape (Prince 1993; T Tucker, personal communication, August 2016). The Western Australian Marine Turtle Program on South Muiron Island was operational between 1987 and 2001 revealing that loggerhead, green and hawksbill turtles use the island's beaches for nesting (Prince 1993). Flatback turtles are endemic to Australian tropical waters and are known to nest on Thevenard and Locker Islands as well as many other islands in the Pilbara (DBCA 2017a).

In contrast to the islands mentioned above, islands in Exmouth Gulf contain very low-density nesting beaches for marine turtles. A turtle nest with eggshell remains was recorded on Doole Island while a flatback turtle nest on Tent Island was found destroyed by a fox (*Vulpes vulpes*) with many dead hatchlings surrounding it (DBCA 2018a).

Bynoe's Gecko photographed on Large Island.

The smaller reptiles of the planning area may be found in a range of island habitats from beach vegetation to interior shrubland and hummock grassland. Interestingly, a large cache of camping gear and dingy removed from Large Island was found to house many Bynoe's geckos (*Heteronotia binoei*) and a few Gilbert's dragons (*Lophognathus gilbertii*).

Specialist reptiles including the north-western mangrove seasnake (*Ephalophis greyi*) and black-ringed mangrove seasnake (*Hydrelaps darwiniensis*) have been recorded in the mangroves of the eastern Exmouth Gulf (Humphreys et al. 2005).

Airlie Island is the only island location where the Airlie Island skink (*Ctenotus angusticeps*) has been recorded; however, recent surveys around Port Hedland, Karratha and Broome have detected this species resulting in a name change to north-western coastal ctenotus. The same studies have shown it has specific habitat requirements of landward fringe of salt marsh communities, vegetated with low samphire and marine couch grass, bounding mangal, subject to tidal influences and with numerous crab holes. This habitat is common throughout the planning area and more survey work is needed to determine whether this species is more widely distributed than previously thought (Maryan et al. 2013).

Invertebrates

Invertebrates have been poorly surveyed, and only 18 species in total have been recorded, with most specimens found because of industry surveys on Varanus, Airlie and Thevenard Islands. Further survey work would almost certainly identify many more species.

Wolf spiders are active at night on the islands.

Four species of native ants are known to occur: *Iridomrymex sp chasei* group, *Polyrhachis ammonoeides*, *Odontomachus ruficeps* and *Melophorus sp* (probably *M bagoti*). A non-native cockroach, *Blattella germanica* is present on Airlie Island. The Australian jewel spider (*Austracantha minax*) is recorded from Tent Island.

11. Flora and ecological communities

Priority flora

At the time of writing five priority species[14] had been recorded within the planning area, four of which were found during surveys carried out as a part of the planning process:

- *Tephrosia* sp. North West Cape (priority 2), a low shrub recorded from Fortescue and Doole Islands.
- *Gymnanthera cunninghamii* (priority 3), a shrub on sandy soils recorded on North West Doole Island.
- *Corchorus congener* (priority 3), a low shrub found in hummock grassland recorded on Tent and Potter Islands.
- *Lepidium biplicatum* (priority 3), an herb found on rocky pavement in low open shrubland recorded on Burnside Island.
- *Carpobrotus sp* Thevenard Island form (priority 3), found in dune areas with tussock grasses and coastal platform with halophytes recorded on Thevenard, North Muiron, South Muiron, Serrurier, Eva, Locker, Round, Large and Bessieres Islands.

All these species are under pressure from buffel grass (*Cenchrus ciliaris*), kapok bush (*Aerva javanica*) or both. At the time of writing, South Muiron Island has a limited 300m^2 infestation of buffel grass and the remainder of the island appears to be largely weed-free.

Flora

While weeds are found in some places on the islands, there are many areas of largely undisturbed flora. Island vegetation is surprisingly complex because of ongoing disturbance by extreme weather events, biopedturbation by species like marine turtles and wedge-tailed shearwaters, and fires. Vegetation associations resulting from these natural disturbances are not as simple as they seem at first glance (V Long, personal communication, 2016). Natural disturbance leads to unique differences between dominant species on otherwise similar islands. For example, Thevenard Island has no naturally occurring two-nerved wattle (*Acacia bivenosaI)*; or Varanus Island, with no naturally occurring *Acacia*s (Lohr et al. 2016). For a description of the flora refer to Appendix 7.

Potter Island geology and landform is different from the other islands.

Ecological communities

One priority 3 PEC has been recorded within the planning area; the 'coastal dune native tussock grassland dominated by *Whiteochloa airoides'*. The native tussock grassland of *Whiteochloa airoides* occurs on the landward side of foredunes, hind dunes or remnant dunes with white or pinkish white medium sands with marine fragments on Barrow Island and in the littoral areas of the West Pilbara. Within the grassland there may be occasional *Spinifex longifolius* tussocks or *Triodia epactia* hummock grasses and scattered low shrubs of *Olearia* sp Kennedy Range, *Scaevola*

[14] Priority 1 and 2 flora are still considered to be under threat and protected under section 13(1) of the BC Act.

spinescens, *Scaevola cunninghamii*, *Trianthema turgidifolia* and *Corchorus* species (*C. walcottii* and *C. laniflorus*).

This PEC was confirmed on Thevenard Island in June 2017 (P Hoffman (Chevron Australia Pty Ltd), personal communication, 2017). A new probable occurrence recorded in 2016 on Tent Island and South Muiron Island in 2018 requires further survey as it appears to be in good to excellent condition. At the time of nomination, it was considered there may be some small pockets remaining intact in the West Pilbara; however, 30 percent of these are likely to be impacted by buffel grass. Control of weeds, particularly buffel grass and kapok bush, is a management priority (J Pryde, personal communication, 2016).

Intertidal areas

Intertidal areas of the nature reserves are poorly surveyed in the planning area. Investigations at Barrow Island (RPS BBG 2005) suggest this is a particularly species-rich habitat and this is expected to be similar for the Pilbara inshore islands.

Intertidal areas within the island nature reserves' boundaries are often large because island profiles are shallow and range in tides is high. For example, Thevenard Island Nature Reserve, which is the largest island nature reserve in the planning area, consists of approximately 70 percent intertidal area (area below the mean high water mark including rocky or sandy beaches, sand or mudflat, and rocky reef).

A range of flora and fauna are known to occupy the intertidal area of the islands including seagrass, algae, gastropods, molluscs and crustaceans. Intertidal biota of Barrow Island has been exhaustively described as a requirement of studies relating to the Gorgon Gas Project. This work provides a useful guide to species likely to occur within the planning area (RPS Bowman Bishaw Gorham 2005).

Small burrowing invertebrate species are vital as a food source for resident and migratory shorebirds foraging on tidal mud and sand flats (Heydenrych et al. 2015). Dolphins and dugong are occasionally sighted close to shore during high tide, utilising the intertidal waters around islands.

Algal mats

The upper intertidal zones of Exmouth Gulf are inhabited by extensive cyanobacterial algal mats on the landward side of mangrove belts where tidal inundation is less frequent (Adame et al. 2012). Inundation of these areas, followed by periods of desiccation leads to higher levels of salinity than halophytes and mangroves can withstand, leaving little competition for the cyanobacteria that comprise the algal mat (Adame et al. 2012). These mats occupy 40cm of elevational range within the intertidal zone and contribute between five and 15 percent of total carbon fixed by primary producers within the Exmouth Gulf (Lovelock et al. 2010). This makes algal mats an important contributor to the local carbon budget.

Intertidal coral at Y Island seen under ultraviolet light at night.

Tidal flushing of Exmouth Gulf and intermittent, seasonal heavy rain events are important for reducing sediment salt and nutrient concentrations, and for rehydration of desiccated algae (Adame et al. 2012). Tidal and rainfall flushing facilitates nutrient input into coastal systems including nitrogen and carbon fixed by cyanobacteria potentially making it available for mangroves to use, and thus other species that utilise this habitat (Paling and McComb 1994; Adame et al. 2012; Humphreys et al. 2005).

Most of the mat structure recorded in two studies in the southern Exmouth Gulf was formed of non-heterocystous species; algae which do not contain specially differentiated cells which perform nitrogen fixation. The higher tidal range species tended to belong to the *Oscillatoria* genus, while *Microcoleus*, *Schizothrix* sp and some *Lyngbya* sp were found more in the lower tidal range (Adame 2012; Humphreys et al. 2005). Species commonly found in the area appear to be consistent with species found in similar areas throughout the Pilbara (Humphreys et al. 2005). A large portion of Tent Island's interior tidal lowland area is comprised of algal mat (Humphreys et al. 2005).

Weld Island mangroves.

Mangroves

Mangrove thickets protect against shoreline erosion through damping water action and stabilising sediment; provide structure for species like sponges, tunicates, algae and bivalves; are an important nursery zone for fish, marine turtles and crustaceans; and promote nutrient cycling through providing habitat and a food source for benthic invertebrate detritivores, which break down dead plant matter and, in turn, become a food source for fish and crustaceans, thus making nutrients available at higher trophic levels (Nagelkerken et al. 2008; WAM 2008; EPA 2001).

Mangroves are also roosting and foraging sites for resident waterbirds, passerines, migratory shorebirds, mammals and reptiles, some of which are found exclusively within mangroves.

Management objective: Identify, protect and conserve native plants, animals, and ecological communities, particularly those of conservation significance.

Key management challenges

- Protecting night-active species from altered lighting environments and other forms of human disturbance.
- Protection of beach nesting birds from inappropriate human disturbance, particularly during cooler months.

Management considerations

- Maintaining a biosecurity program for island access including quarantine, detection, and elimination.
- Sandy beaches provide important habitats and are often popular recreation sites.
- The department's *Corporate Policy Statement No. 35: Conserving Threatened Species and Ecological Communities* (DPaW 2015c) provides guidance for the protection and management of threatened plants, animals, and ecological communities.

Management strategies

1. Manage species of conservation significance consistent with priorities established by the *Pilbara Regional Nature Conservation Plan 2015–2019*, policies, guidelines, recovery and other plans and priorities.
2. Assess and provide advice on proposed operations and development proposals for potential impacts on native plants, animals, and ecological communities, and refer proposals that may have significant impacts to DWER for assessment.
3. Identify knowledge gaps relating to threatened, priority and understudied flora and fauna, species distributions and important habitats, and undertake, support and encourage multi-faceted research field work to fill such gaps.
4. Identify and protect sensitive sites by restricting access where necessary and education users about the importance of providing undisturbed habitat for resident and migratory species.

Key performance indicators

Performance measure	**Health and condition of sensitive sites.**
Target	No decline in condition of sensitive sites.
Reporting	Every five years.
Performance measure	**Populations of threatened fauna and flora species.**
Target	No loss or decline in habitat available to protected fauna and flora as a result of human activity. Size of threatened or priority species populations remain stable, subject to natural variation.
Reporting	Every five years or as per recovery plan if applicable.
Performance measure	**Condition of PEC.**
Target	No loss or decline in the area or condition of PEC on islands where it exists.
Reporting	Every five years.

12. Protecting the natural environment

Natural environment management priorities in the planning area are to:

- promote biosecurity measures and prevent establishment of NIS, through eradication;
- manage or control impacts of human disturbance, pollution, waste disposal and contamination on threatened and significant flora and fauna, particularly marine turtles, and migratory and resident shorebirds and seabirds; and
- protect the integrity of ecological systems and processes.

Additional management priorities and actions may be developed utilising the Island Biosecurity database and software (under development) to identify or confirm priority actions.
Across the planning area pressures include climate change, erosion, introduction of NIS, bushfire, industrial development, uncontrolled visitation, and lack of complementary protection for adjacent marine and intertidal habitats.

Biosecurity

Biosecurity describes actions taken to mitigate the risks and impacts to the economy, the environment, social amenity and human health from pests and diseases (Australian Government 2012; COAG 2012).

The introduction of NIS of flora and fauna to islands world-wide has had a greater impact on island biodiversity than any other threatening process. Biosecurity management on Western Australian islands should comprise appropriate quarantine conditions, surveillance for new infestations of NIS, and work towards eradicating NIS (CCWA 2009).

The introduction of NIS is one of the most significant threatening processes impacting on island biodiversity. Lessons learned from Barrow Island will be incorporated into management of the planning area:

- Adverse impacts on ecosystems include species competition and predation, and modification of the structure, function and composition of ecosystems. The impacts of different NIS can combine to result in devastating impacts on island biodiversity.
- NIS are difficult and expensive to manage once established because they reproduce quickly, spread rapidly, and may be impossible to eradicate. Even with regular monitoring, NIS may remain undetected until the populations become significant.
- Island populations can be more vulnerable to local extinction, especially where islands are small, resulting in restricted habitats and low genetic diversity.

A small range of NIS of flora and fauna have been introduced to the planning area and their threats to island biodiversity are significant. NIS can be introduced to islands from boats and aircraft containing contaminated material (clothing, luggage, other goods, vehicles, and machinery), from debris floating onto islands, birds and wind. Introduced fauna can fly, swim or drift onto islands.

Visitation to the islands within the planning area, while low, poses the highest risk of NIS being introduced. A biosecurity plan to ensure education, surveillance, and appropriate quarantine protocols and to prioritise eradication efforts is required. However, if visitation increases throughout the life of the plan, there is an increased risk of visitors bringing pets to the islands or inadvertently introducing exotic organisms. Public education will be important in educating boat users of the values of the islands, the risks associated with the introduction of NIS, and a code of conduct for maintaining quarantine standards. For islands with petroleum, gas and tourism operations detailed environmental management plans have been prepared to ensure strict quarantine conditions are adhered to.

Surveillance of islands for NIS is of considerable importance in detecting the establishment of new infestations (CCWA 2009). The biological cost of infestation rises as the duration of infestation increases. Preventing establishment of introduced species on islands is by far more economical, and success more likely than eradication once they arrive. All staff and researchers from within and outside the department will be encouraged to conduct opportunistic assessments of populations of NIS while visiting islands for other work.

To that end, a biosecurity plan for the planning area will be prepared that:

- educates target user groups about preparing to lower the risk of NIS before landing ashore;
- identifies priorities (that is, ranking islands with consideration for significant biodiversity values, low NIS, and good expectation of success for potential control programs);
- limits the introduction and establishment of new populations of NIS, monitor, evaluate and document control effectiveness;

- provides a coordinated approach with petroleum and gas industry, Australian Maritime Safety Authority (AMSA), and tourism stakeholders on Varanus, Thevenard and Airlie Islands;
- provides a coordinated approach across all islands; and
- include the capacity for adaptive management.

Anthropogenic disturbance

Due to the small size of most of the islands, and the small size of the sandy beach that facilitates shore access, users are likely to displace fauna, particularly marine turtles and shorebirds without realising it. Even low numbers of visitors warrant careful management of impacts, such as visitor disturbance (Hughes and Rodger 2017). Apart from on Thevenard and Varanus Islands the level of human disturbance to date is presumed to be very low (DBCA 2018a) but is present year-round.

Marine turtle nesting can be disturbed or interrupted by human activity on a beach and impacts of lights are well documented. Marine turtles will drop eggs in the water if unable to crawl up the beach as a result of people disturbing them (K Pendoley, personal communication, n.d.). The department is working with lease holders on islands and at mainland processing plants to reduce lighting impacts.

Marine turtles are at risk of boat strike in breeding aggregations in shallow waters adjacent to islands. Green turtles have been recorded in high densities in the shallow waters at the Muiron Islands. Seasonal camping at South Muiron Island is only permitted between April and October and with a lawful authority to minimise disturbance of nesting marine turtles and this strategy will apply to proposed camping on Serrurier and Sholl Islands.

Human presence near shorebird habitat impacts both long-term population trends, as well as bird behaviour, by reducing the amount of time a bird will spend feeding (Martin et al. 2014). Migratory shorebirds generally feed during low tide, regardless of the time of day, and are less likely to habituate to the presence of people compared to resident birds (Klein et al. 1995). Disturbance to birds results in behavioural changes including reducing time spent feeding and resting, abandonment of eggs and chicks, and flying away (Carney and Sydeman 1999). Apart from approach distance disturbance by people, additional impacts on several aspects of breeding success of bridled terns indicates that chick development may be adversely affected by human disturbance (Gyuris 2004). That study also indicated that bridled terns at a remote island may become habituated to low-level disturbance; however, more research is needed on species that breed during winter months when visitor numbers are higher.

Seabird species that nest at the Abrolhos Islands are susceptible to lights on boats, aerials, masts and from campsites resulting in birds arriving and departing colonies becoming disorientated (Dunlop 2004). Management strategies within the *Abrolhos Seabird Management Strategy* (Dunlop 2004) include closed areas, seabird observation areas, recreational landing areas / unprotected areas. Adoption of similar strategies may be considered for the islands. Wedge-tailed shearwaters are attracted to lights on boats and are known to land on vessels near islands when returning from daytime foraging (DBCA 2018a) and to fly towards gas flares (P Bouteloup (DMIRS), personal communication, n.d.).

There are indications that an increase in ecotourism to remote and previously undisturbed areas is negatively impacting pied oystercatchers (Taylor et al. 2014). Pied oystercatchers typically nest on or near the high tide line and hence are vulnerable to disturbance from camping and recreation (i.e. accidental crushing of eggs) while chicks may starve during periods of frequent human disturbance like beach fishing and camping (Taylor et al. 2014). Short-term disturbance such as beach walking has a temporary impact compared to longer disturbance like sunbathing (Bryant 2002). Risk to

migratory shorebirds from anthropogenic disturbance has been rated as a medium level threat by BirdLife Australia (Weller and Lee 2017).

White-bellied sea eagles are susceptible to human disturbance during their mid-year nesting season, particularly where nesting occurs in open landscapes like coastal cliff areas on Kangaroo Island (Dennis et al. 2011). These authors studied the reproductive success of nests with high disturbance (0.5 young per year) compared with more isolated areas (1.1 young per year) and recommended a nest buffer (2,000m) greater than that in the *Threatened Tasmanian Eagles Recovery Plan 2006–2010* (500-1,000m) (Commonwealth of Australia 2006b). White-bellied sea eagles nest on all the larger islands except Thevenard Island and most of the smaller islands between 30 and 100 hectares, as well as Whitmore Island (seven hectares).

Management strategies to protect these species are necessary.

Temporary beach closures have been shown to be effective in reducing egg crushing of a small beach nesting bird (Weston et al. 2012). Impacts of disturbance can by reduced by placing a buffer around known nesting sites and high tide roosting sites and Martin and colleagues (2014) suggest 80m between any track or walkway and sensitive sites. This management plan proposes implementing access restrictions supported by educational information for users.

Direct human access and activities near sensitive sites will require careful management to ensure nesting and roosting sites remain viable. Activities on islands or near sensitive sites will need to be slow and quiet to not disturb wildlife or the natural ambience of the location. Appropriate activities include nature appreciation, beach fishing, slow walking and daytime wildlife observation at sites that allow for people to be separated from nesting wildlife or roosting shorebirds.

Weeds

There are 35 known weed species found in the planning area. Most islands contain only one or two species. Buffel grass is found on 35 islands, and kapok bush on 17 islands. These two species represent the most serious impacts on the island habitats. Any island with less than two percent weed infestation should be classified as high priority for treatment and surveillance and biosecurity actions (V Long, personal communication, 2017). At the time of writing, South Muiron Island appears to contain very little buffel grass at the northern end, though the southern end of the island has not been surveyed. Varanus Island (27 species) and Thevenard Island (18 species) contain the highest number of weed species (Lohr et al. 2016).

Weeds were introduced to the Pilbara islands during activities such as pearling and marine turtle hunting during the 1800s, installation of navigational aids early last century, more recently from oil and gas exploration and developments, and likely from recreation and tourism operations. Increased population following the mining boom and subsequent increase in boat ownership in the past 20 years has also seen an increase in visitation to the area, which may contribute to a potential increased risk of introduction and spread of weed species (Lohr et al. 2016).

Weeds can have significant impacts on natural ecosystems including competition with and displacement of native species, prevention of seedling recruitment, alteration to geomorphological processes, alteration of hydrological cycles, changes to soil nutrient status, alteration of fire regimes, changes to the abundance of native fauna, and genetic changes. Weeds may also impact on cultural, social, economic, scientific and aesthetic values.

Weed invasion is facilitated by people, vehicles and machinery, animals and birds, surface water flow and wind. Islands are particularly vulnerable to establishment of introduced species from environments with higher pressures from pests, competitors and predators. This may be attributed to

a combination of factors including low native species diversity, missing functional groups, and poorly competitive local species (Denslow 2003).

Disturbance of native island vegetation by way of fire, excavation by fauna or other factors can furnish an opportunity for NIS to establish. The regrowth following a bushfire started by lightning on Thevenard Island in 2013 comprised of entirely buffel grass and is a worrying example of the threat this species poses to the islands (DBCA 2018a).

Onslow bush rangers on Thevenard Island after removing kapok bush.

Coastal environments are naturally disturbed (tropical cyclones, strong coastal winds, king tides, wedge-tailed shearwaters, marine turtles). Local flora has adapted to this environment and form vegetation types that can survive these natural disturbances; however, appear unable to compete with the rapidity with which weed species capitalise on freshly disturbed areas. The potential for weeds to be eradicated from an island once introduced is low (V Long, personal communication, 2016). Heydenrych and colleagues (2015) identified weeds as one of two high-priority threatening processes and recommended the development of a biosecurity strategy and action plan targeting all the islands of the Pilbara bioregion.

Buffel grass increases the risk of fire and inhibits the growth of native species, creating a monoculture (Dixon et al. 1998). Habitat alteration by buffel grass has been highlighted as a threat to the Airlie Island Ctenotus (Commonwealth of Australia 2020). Control programs on Varanus, Thevenard and Airlie Islands have been restricted to within the industry lease areas and do not extend beyond these boundaries to the nature reserves. Reinvasion from beyond lease boundaries limits the effectiveness of any control effort within. Buffel grass was thought to have been removed from Airlie Island, but has returned to densities similar to those seen before control was undertaken (Lohr et al. 2016).

Kapok bush is highly invasive and spreads rapidly, particularly following disturbance. It displaces native flora and is spread by wind, animals, and human activities (Asher and Morris 2015). Lohr and colleagues (2016) state that kapok bush has the potential to colonise more Pilbara islands and increase in density where it is already present. They recommend controlling and preventing its establishment on islands as a high priority.

The woody weeds parkinsonia (*Parkinsonia aculeata*) and tamarisk (*Tamarix aphylla*) are declared pests under the *Biosecurity and Agriculture Management Act 2007* as ‘Weeds of National Significance’ and should, as a priority, be removed from all islands in the planning area (V Long, personal communication, 2017).

There are several plant species native to the Western Australian mainland found on Thevenard or Varanus Islands. These were introduced by accident or for landscaping purposes and, in some instances, have escaped garden areas. Consequently, they are not considered weeds on the mainland but have potential to spread on the islands.

The department manages weeds in accordance with the department’s *Corporate Policy Statement No.14: Weeds Mana*gement (DPaW 2015d). The *Exmouth District Weed Strategy* (DPaW 2016a)

includes kapok bush on Doole and Roberts Islands. Kapok bush at these sites has been hand pulled opportunistically by school students on a couple of occasions and sprayed by departmental staff when on site for fauna monitoring purposes, however, persists in isolated pockets.

Lohr and colleagues (2015) outlined a weed prioritisation process for the Pilbara islands, using a range of different scenarios. This process, along with data collected during ongoing island surveys, indicate that islands and weed species with a high priority for management are Doole, Fortescue and Tent Islands for kapok bush while other islands with a high priority for weed management were Thevenard, Varanus, North Muiron, South Muiron and Airlie Islands.

Introduced fauna

Introduced animals can have significant impacts on natural ecosystems, through direct effects such as predation, habitat destruction, competition for food and space or more generally through environmental degradation by selective grazing and spreading weeds and diseases (Table 3).

Table 3 Known locations of pest animals.

Pest	Island
Black rat	Carey, North West Doole, Tent
House mouse	Carey, Thevenard, Tent, Simpson, Burnside
Cat	Tent
Fox	Tent

Black rats (*Rattus rattus*) have been linked to 54 percent of bird extinctions worldwide (King 1985) and have partially or wholly replaced the native rodents in numerous locations (Burbidge and Manly 2002; Harris 2009; King 2011). Black rats have been implicated in local extinctions of island seabird populations as well as having detrimental impact on invertebrate communities (Jones et al. 2008; Towns et al. 2009). Black rats have been known to indirectly affect island soil nitrogen levels, rate of litter decomposition, and soil stability through their predation of island populations of burrowing birds, and structure and composition of vegetation through selective predation of plant material which in turn impacts upon the fauna that rely on the vegetation for food and shelter (Banks and Hughes 2012).

Black rats are present on Carey, Tent and North West Doole Islands; these islands are all close to the mainland coast and rats possibly swam across from the mainland. Exotic rodents on islands are a key threatening process listed under the EPBC Act and an associated threat abatement plan was developed in 2009 for offshore islands less than 100,000 hectares (Australian Government 2009b). Exotic rodents have a range of impacts on native ecosystems. Both house mice (*Mus domesticus*) and black rats are omnivorous and feed on plant material, insects, small reptiles and their eggs, birds and their eggs, and other small mammals. Introduced rodents also compete with native rodents and small marsupials that occupy similar niches. Exotic rodents can introduce disease and indirectly impact on native fauna by altering ecosystems and interacting with other pests by providing prey for foxes and cats. Numbers of introduced predators then increase because of increases in prey (Australian Government 2009b).

House mice have been eradicated from Varanus (in 1997 then in 2002), Bridled (1997) and Beacon Islands (1997). Morris (2012) recommended the removal of house mice from Thevenard Island be a priority, though any action to remove house mice is likely to impact on the resident short-tailed mouse population.

European red foxes have been responsible for mammal extinctions on Western Australian islands; an example being the black-flanked rock-wallaby (*Petrogale lateralis*) from Depuch Island near Port Hedland (Burbidge and Abbott 2017).

Cats (*Felis catus*) have been associated with extinction of species particularly on arid Australian islands (Burbidge and Manly 2002). After great effort, staff removed a cat from Serrurier Island in 1996 (Moro 1997). Cat tracks were recorded on Tent Island in August 2016 and in August 2017 (DBCA 2018a).

Pollution, waste disposal and contamination

Pollution, waste and contamination within the planning area stems from a variety of activities, including sources adjacent to the reserves, including

- light pollution from industry and town sites, and vessels moored at islands;
- a variety of waste produced by industry which require careful disposal;
- human waste resulting from unregulated camping on island nature reserves;
- and marine debris.

Management of these issues within the planning area will be primarily achieved jointly with scientists and through a combination of liaison with industry and other stakeholder groups, and education of recreational users.

Gas processing activities on Varanus Island and petroleum processing on Thevenard Island (not currently in operation) produce a variety of wastes that require disposal. Infrastructure was removed from Airlie Island mid-2016 and the lease is still under management by Quadrant Energy, as is Varanus Island. Chevron Australia Pty Ltd manages the Thevenard Island facility. The disposal of industrial, solid, liquid and hazardous wastes is outlined in environmental management plans and include:

- *Thevenard Island Care and Maintenance Environmental Management Plan* (Chevron 2016a).
- *Environmental Management Plan Mackerel Islands Lease Thevenard Island* (MIPL 2013).
- *Airlie Island Remediation Works Environment Plan* (Quadrant Energy 2016).

There are three classified contaminated[15] sites within the planning area, these being Airlie, Varanus and Thevenard Islands. Soil, groundwater and coastal contamination can occur because of accidental spills and historical practices in petroleum and gas production, waste disposal and storage of dangerous goods.

The State government maintains a register of contaminated sites in Western Australia. On Airlie and Varanus Islands, hydrocarbons have been found in the soil and groundwater, and on Thevenard Island hydrocarbons have been found in the soil, and petroleum hydrocarbons, heavy metals and contaminants relating to waste water treatment have been found in groundwater. For all three sites, DWER recommends further remediation work. There is a fourth contaminated site within the planning area, which is still to be classified by DWER and is predominantly located over the ocean, but also includes a small portion of Abutilon Island in the Lowendal Islands Nature Reserve. The contamination relates to clays, fluids and other discharges resulting from drilling in the area and predominantly impacts on the marine environment.

Light pollution[16] generated by lights and flares at the oil and gas processing plants, from tourist accommodation on Thevenard Island, from moored vessels, and from town sites can impact on nearby marine turtle nesting beaches or rookeries (Kamrowski et al. 2012) and night migrating birds

[15] Contaminated sites are defined in the *Contaminated Sites Act 2003* as having a substance present in or on that land, water or site at above background concentrations that presents, or has the potential to present, a risk of harm to human health, the environment or any environmental value. Contamination is generally restricted to a medium such as land or water.

[16] Pollution is defined in the *Environmental Protection Act 1986* as direct or indirect alteration of the environment a) to its detriment and degradation; b) to the detriment of an environmental value; or c) of a prescribed kind. Pollution differs from contamination in that it may not be restricted to a medium and can include light or noise emissions.

such as shearwaters (Van Doren et al. 2017). Kamrowski and colleagues (2012) describe several impacts of artificial light on nesting and hatchling marine turtles, including:

- Disrupting the orientation of hatchlings that use visual cues to find the ocean. Greater time finding the ocean leads to greater predation of hatchlings and hatchlings using up energy required for critical offshore migration.
- Discouraging female marine turtles from nesting on particular stretches of beach. They may then attempt to nest on sub-optimal sites or shed their eggs at sea.

Kamrowski and colleagues (2012) also reported that flatback turtle nesting sites near Varanus Island were facing the highest risk from light emissions in Australia. When considering the key flatback turtle nesting sites in Western Australia (being Barrow Island and the Montebello and Lowendal Islands), 87.4 percent of sites were impacted by light pollution. The impacts of lights and flares from oil and gas processing plants are a key threat to marine turtles in this region.

Light emissions can also impact on seabird breeding sites. Impacts on birds can include birds becoming disorientated while flying, which can result in death from colliding with infrastructure or starvation from not being able to successfully forage or reduced time spent foraging. This is particularly critical for migratory species being able to replace energy reserves in preparation for migration and breeding. Nocturnal species like wedge-tailed shearwaters are particularly at risk of being attracted to gas flares and other lights, as are many migratory shorebird species that fly long distances at night (Day et al. 2015). Another impact is nesting birds and young fledglings becoming disorientated where rookeries are located close to lights (Commonwealth of Australia 2012b).

Industry operators have addressed these impacts through the environmental approvals process, environmental management plans and associated documents and licence conditions. For example, industry vessels working on the Wheatstone Gas Project were not permitted to anchor within 1.5km of an island with marine turtle nesting beaches (including Serrurier, Bessieres and Locker Islands) to reduce the risk of potential lighting impact on nesting marine turtles (Chevron 2016b).

Low levels of marine debris are present on the islands' coastlines. Away from sites accessed by recreational users, shorelines are largely free from visible rubbish. In 2007 low levels of marine debris were recorded at Serrurier and Locker Islands with one item of rubbish every 91m and 247m of shoreline, respectively (DEC 2007a). In contrast, rubbish from the inland portion of Serrurier Island included 67 star pickets which were assumed to result mostly from research activities.

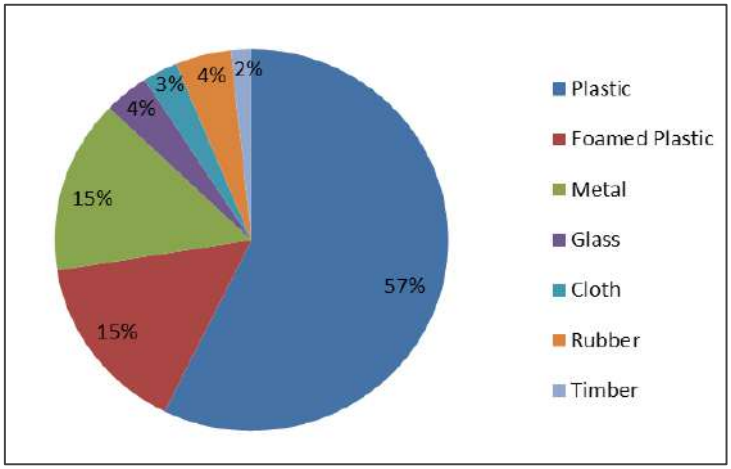


Figure 2 Types of debris collected from island beaches in 2015–16.

A clean up targeting high-use beaches on Serrurier Island in 2015 revealed one item per 25m of beach. Some high energy beaches may have an element of self-cleaning meaning that the amount of debris is underreported. Types of debris collected from islands can be seen in Figure 2.

Debris is harmful to marine life as ingestion or entanglement can result in injury and fatality (Commonwealth of Australia 2018). Marine turtles, shorebirds and seabirds are particularly vulnerable, and as a result marine debris is listed as a key threatening process under the EPBC Act. There were no entangled wildlife or ghost nets found over four years of field surveys from 2014–

18. Marine debris does not appear to pose a significant issue to marine life along the island beaches, but rubbish does impact aesthetically at localised sites where camping occurs. Educational materials including a code of conduct will be provided to educate visitors about appropriate waste disposal when visiting the islands.

Ecosystem rehabilitation

Localised disturbance to some parts of the planning area is acknowledged and sources include

- installation of navigation aids;
- oil and gas production facilities on Airlie, Thevenard and Varanus Islands;
- tourism operations on Thevenard and Direction Islands; and
- visitor and research activities.

Ecosystem disturbance has also occurred because of the introduction of NIS, and mooring activities on beaches. Cyclones and fire also can have significant environmental impacts.

It is the department's first preference to avoid significant disturbance to the natural environment. In cases where disturbance occurs because of on-ground works, ecosystem rehabilitation should be considered. It is the department's policy that companies and/or the lease holder are responsible for rehabilitation of damaged areas to a suitable standard. In such cases, the cost of rehabilitation should also be borne by the organisation.

Industry operators have committed to rehabilitation of disturbed areas upon decommissioning. Oil production infrastructure on Airlie Island has been decommissioned and rehabilitation of the site will follow. Oil production infrastructure on Thevenard Island is no longer in use and under a care and maintenance regime. Rehabilitation will occur following decommissioning of these facilities. Environmental approval conditions for the long-term rehabilitation of disturbed sites require that rehabilitation is

- self-sustaining;
- comparable to, compatible with, and able to be managed as part of, surroundings consistent with the conservation objectives of a Class A Reserve;
- as close as practicable to the pre-existing natural biodiversity and ecosystem functional values; and
- re-colonised by key species and communities that were originally displaced when the site was disturbed.

The necessity for, and complexity of, ecosystem rehabilitation varies according to the type and extent of disturbance. In some cases, natural regeneration with little or no intervention may be preferred. Regardless of the method used, success will be measured by assessing information on physical values such as water, nutrients, topsoil and organic matter, and flora and vegetation against completion criteria derived from key ecological processes that evaluate ecosystem function.

Remote sensing at appropriate resolutions is valuable for demonstrating overall outcomes but programs may require additional information such as targeted fauna surveys to demonstrate full ecosystem rehabilitation and recovery.

Local provenance native species should be used for rehabilitation purposes to ensure the greatest degree of success, enable new vegetation to blend into the existing environment and limit the introduction of exotic plants and disease.

Sources of brushing material (branches of trees and shrubs used to stabilise mobile dune systems) should also be free of disease. Rehabilitation on the islands can be difficult because of the variable rainfall and exposure to strong, salt-laden winds and can take a long time before the benefits of rehabilitation are observed.

Management objective: Minimise the impact of introduced species, human disturbance, and pollution on the key values of the planning area.

Key management challenges

- Islands are expensive to run eradication programs on.
- Achieving a biosecurity program.

Management considerations

- *Pilbara Region Nature Conservation Plan*.
- *Corporate Policy Statement No.14: Weeds Management* (DPaW 2015d).
- Options for prioritising islands for weed control.
- Functionality of available decision support tools.

Management strategy

1. Prepare a Communications Plan incorporating biosecurity, disturbance, and pollution considerations.
2. Manage invasive species consistent with legislative responsibilities, department policies and operational guidelines.
3. Maintain surveillance and recording systems for monitoring significant existing priority or potentially new invasive plants and animals.
4. Ensure that key values are not adversely impacted by pollution, waste disposal or contamination.
5. Ensure that all degraded or disturbed areas (including contaminated sites) are rehabilitated according to departmental rehabilitation standards and guidelines.

Key performance indicators

Performance measure	**Communication/Biosecurity plan**
Target	Plan is developed and implemented.
Reporting	Every five years.
Performance measure	**Introduced fauna control program**
Target	Introduced fauna control program is developed and implemented.
Reporting	Every five years.
Performance measure	**No increase in weed distribution or establishment of new invasive weeds on high priority islands**
Target	Weeds mapped on high priority islands and information added to islands decision support tool.
Reporting	Every five years.
Performance measure	**Marine turtle nesting habitat.**
Target	Nesting beaches are free from detrimental lighting impacts.
Reporting	Every five years.

13. Fire

The department's management of fire[17], including prescribed fire and bushfire prevention and suppression, is regulated by legislation (*Bush Fires Act 1954*, CALM Act and precedents established under common law) and guided by the department's *Corporate Policy Statement No.19: Fire Management* (DPaW 2015e), *Corporate Policy Statement No.88: Prescribed Bu*rning *(*DPaW 2014) and the *Code of Practice for Fire Management* (DEC 2008). Additionally, the *Emergency Management Act 2005* sets out the emergency management arrangements for the State, requiring that several emergency response plans be maintained. The response plan for bushfire is *State Hazard Plan – Fire* (SEMC 2019), which sets out the department's role and obligations (along with those of other relevant agencies) in contributing to bushfire prevention and mitigation, preparedness, response and recovery. The Commission's *Position Statement: Prescribed burning on vested lands* (Commission 2018) and the department's Strategic Directions (DBCA 2018b) also provides guidance on fire management.

Despite supporting areas of flammable vegetation with high fuel loads and the area experiencing periods of severe fire weather, few fires have been recorded on the islands and there is limited understanding of the fire history. Between the 1970s and 2014 fires were recorded on the North Muiron, South Muiron, Sholl, Simpson, Doole, Tent, Thevenard and Yammadery Islands. The causes are mostly unknown, although a fire caused by lightning was detected and extinguished by

[17] See dpaw.wa.gov.au/management/fire for more information about the department's management of fire.

Chevron Australia Pty Ltd on Thevenard Island in October 2013. The Varanus Island fire in 2008 at the Apache-operated processing plant was contained on the lease.
Muller (2009) assessed risk posed by bushfire on nearby Barrow Island. The key findings were that

- risk of ignition is low;
- rapid response and effective initial attack essential to suppress bushfires; and
- it is highly unlikely that resources could be deployed from the mainland in time to contribute to effective fire suppression on the island.

Lightning strikes are uncommon on islands. This tree on Doole Island received a direct strike in 2014.

These factors apply to the planning area. Given the difficulty in dispatching resources from the mainland, it is unlikely any attempt would be made to suppress a fire on islands where there is no management presence. In the event of a fire on either Thevenard or Varanus Islands, where staff associated with the oil, gas and tourism industries are present, suppression activities may be possible. Fire suppression is unlikely to occur on islands with no permanent accommodation.

Little is known about the fire ecology of the islands. A bushfire on any island could potentially have a deleterious impact on natural values. The small size of most islands, long unburnt fuel, and long response times may result in an entire island being burnt, with attendant loss of habitat and food for fauna, and loss of vegetation cover leading to erosion. Many species of island fauna (seabirds, mammals and reptiles) rely on vegetation cover for protection. Buffel grass invasion of burnt ground has been observed on Thevenard Island following a bushfire (DBCA 2018a). This species has been linked with an increase in incidence of fire in dry ecosystems elsewhere in the country (Lohr et al. 2015; Butler and Fairfax 2003; Brooks et al. 2004).

To date, no prescribed burning has been carried out in the planning area. There have been few bushfires on the islands in the last 40 years and the vegetation on many islands is senescing. This inhibits fresh growth in existing species and the establishment of other species (V Long, personal communication, 2016). Consequently, the use of prescribed fire may be trialled on some of the larger islands to encourage vegetation growth. It is essential that this is followed up with weed control as weeds are the first to establish following disturbance such as fire or cyclones.

A fire on Tent Island burnt over 300 hectares in August 2013, likely caused by a campfire.

Given the potential severe impacts of fire on island biodiversity and risks to human life and property, the lighting of fires without lawful authority is prohibited. Information will be provided to island visitors about the risk of fire on the islands and to discourage the lighting of fires.

Management objective: Conserve biodiversity and key values using fire, while protecting life, property and key values from uncontrolled fire.

Key management challenges

- Uncertainty around role of fire on islands.
- Logistics in responding to a fire on any island.

Management considerations

- *Corporate Policy Statement No 19: Fire Management* (DPaW 2015e) and *Corporate Policy Statement No 88: Prescribed Burning* (DPaw 2014).
- Managing fire consistent with the *Pilbara Region Fire Plan*.

Management strategy

1. Manage fire consistent with relevant legislation, Strategic Directions (DBCA 2018b), policies and guidelines and plans using an adaptive management framework.
2. Maintain recording and mapping systems for bushfire and prescribed burning operations.
3. Monitor and manage weed infestations and other environmental impacts following any bushfire or prescribed burning activity.
4. Contribute to the development and implementation of Regional fire planning documents, including the *Regional Fire Management Plan*.
5. Liaise and work with key stakeholders including Department of Fire and Emergency Services, agencies, local governments, neighbours and industry to encourage cooperative and compatible fire management arrangements.
6. Provide information to visitors to the islands on the impacts of fire on island values and visitor safety.

Key performance indicators

Performance measure	**Trial introduction of prescribed fire on larger islands.**
Target	Small scale trials of prescribed burn are incorporated into the Region's fire Management Programs.
Reporting	Every five years.
Performance measure	**Wildfire and any prescribed burning activity are mapped and recorded through departmental fire systems.**
Target	All islands mapped for new fire activity.
Reporting	Every five years.

Connection to country (cultural heritage values)

Strategic goal 3: *Protect and conserve the cultural and heritage values of the land to Aboriginal people.*

Irrespective of whether native title has been determined, Aboriginal people still have the right of access for sustenance, maintenance and protection of important places, and the inheritance of native title rights. Activities that can be undertaken include customary activities, free movement, fishing, ceremonies, visiting and protecting important places.

Management must ensure that Aboriginal sites are protected from damage, and that obligations are fulfilled according to the *Aboriginal Heritage Act 1972* before any planning or public works occur. Most of the planning area still requires assessment for Aboriginal and other cultural heritage values. Incorporation of sites of cultural significance into the system of protected areas can enhance heritage conservation.

14. Aboriginal cultural heritage

Cultural heritage values of the planning area have not been published and are largely unknown. Ethnographic surveys conducted in the 1970s and 1980s and subsequent archaeological research on other Pilbara islands such as Barrow Island, the Montebello Islands and Enderby Island suggests that islands in the planning area have been used by Aboriginal people. Research conducted within Cape Range National Park proposes that Aboriginal people were using coastal areas, including areas that later became islands, up to 30,000 years ago (Morse 1993). At the time, sea levels were low, the coastline extended to the west of Barrow Island and the islands of the planning area would have been in the hinterland of the coastal plain, particularly Doole, Tent and Potter Islands. By 18,000 years BP, the coastline was up to 50km west of Barrow Island. Lower sea levels meant conditions were more arid and use of the area by people would have been focussed on coastal areas where resources were more reliable. Nonetheless, there still would have been some human use of the planning area. Sea levels began to rise and, by 8,000 years BP, Barrow, Doole, Tent and Potter Islands and the Montebello and Muiron Islands were cut off from the mainland. The sea reached its current level about 7,500 years BP and the remaining islands of the planning area were formed through depositional processes since then.

Much of what is known about Aboriginal use of offshore islands in the Pilbara more generally comes from historical observations from European explorers, mainly associated with other islands outside the planning area. In 1699, English navigator, William Dampier, in the *Roebuck* visited the Dampier Archipelago, mapping the coastline. He anchored off Rosemary Island and recorded smoke coming from another island, suggesting it was inhabited by Aboriginal people. French navigator Nicholas Baudin visited the Dampier Archipelago in 1801 in the *Geographe* and charted some of the nearby islands. He visited Depuch Island and noted evidence of recent fires and chipping stones. The English explorer Phillip Parker King surveyed the north-west coast in 1818 with John Septimus Roe. They landed on Enderby Island and observed human footprints, fireplaces and fish and kangaroo bones. After coming across three people using a log as a boat, they captured one, took him onboard their ship and attempted to pass on gifts. They also met a group of

Aboriginal people on a neighbouring island and attempted to communicate and exchange gifts. In 1840, Stokes and Wickham, in the British ship the *H.M.S. Beagle*, anchored off Depuch Island. The island seemed uninhabited, but they noted numerous engravings and observed Aboriginal people wading across at low tide but "they would not allow us to communicate." The *Mercator* from New Bedford, captained by Obed Delano, spent three months in the Dampier Archipelago from July 1842, hunting whales and catching turtles and observed the fires of 'natives' on the land (Paterson 2014). Given that Aboriginal people were observed on the Dampier Archipelago, it is likely that the islands of the planning area were also used.

There is one site lodged on the *Register of Aboriginal Sites* and protected under the *Aboriginal Heritage Act 1972* on Thevenard Island as an 'other heritage place': a midden scatter with three baler shell containers. Surveys of cultural heritage have been conducted in the planning area since 2014. Aboriginal artefacts were found on 17 islands and include a burial site, stone and glass flakes, burnt shell and bone and baler shells. Possible small occupation sites were found on five other islands, containing materials sourced from the mainland, possible fireplaces, grinding stones and evidence of shell tool manufacture (Paterson 2014). Fossiliferous chert from Doole Island must have been introduced by Aboriginal people as there is no source rock located within the Pilbara Region (M O'Leary, personal communication, n.d.). A few islands are worth investigating to determine levels of risk posed to any artefacts or sites of concern.

Under the *Aboriginal Heritage Act 1972*, Aboriginal sites are protected whether registered or not and it is an offence to alter an Aboriginal site unless permission is granted in accordance with the *Aboriginal Heritage Act 1972*. If proposed management actions may disturb an Aboriginal site, an assessment is required before the operation proceeds and approvals may be required. The department will work with DPLH, and native title claimants to ensure Aboriginal sites are not damaged. Departmental impacts on Aboriginal cultural heritage are unlikely during the life of the management plan but the department will still apply the *Aboriginal Heritage Due Diligence Guidelines* (DPLH and DPC 2013) to assist with minimising the impact on Aboriginal heritage values and sites. Most of the Aboriginal cultural heritage sites and artefacts have been located within sand dunes on the islands and, as a result, are vulnerable to disturbance by cyclones or visitors.

Activities for Aboriginal customary purposes

Customary activities by Aboriginal people can include hunting for food, preparing medicine and engaging in artistic and ceremonial events[18]. These activities are an important part of Aboriginal culture, enabling maintenance of relationships with the land, water and fire; sharing of knowledge; engagement in traditional practices; and accessing and looking after places of significance.

Customary activities will be managed in accordance with *Corporate Policy Statement No. 86: Aboriginal Customary Activities* (DPaW 2015a) for the taking of certain plants and animals by Aboriginal people in conservation reserves (for example, threatened or specially protected flora and fauna species). Wildlife cannot be taken for a commercial purpose. The activity must also be carried out safely and be consistent with this management plan and relevant legislation (for example, regarding the use of fire, firearms and fishing).

Aboriginal people can access most department-managed lands and waters for customary activities, except areas that pose a safety risk or are environmentally sensitive and where permission is required.

[18] Aboriginal customary purpose is defined by section 103A of the CALM Act.

15. Other cultural heritage

Several European navigators charted the coastline and waters adjacent to the planning area including William Dampier in 1699 and Matthew Flinders in 1802. Cartographer Louis de Freycinet named the Muiron Islands while on a voyage with Nicholas Baudin in 1801. American whalers hunted in the waters surrounding the planning area for sperm whales in the 1790s and then later humpback whales. It is possible these people went ashore to the islands in search of fresh water and food. In the 1860s, the waters were used for pearling and later for other resources including guano, fishing and marine turtles (Paterson 2014).

The Exmouth Gulf and offshore islands were treacherous for navigators and several shipwrecks are in the waters in and around the planning area. Mangrove channels and creek lines were used to shelter from bad weather during cyclones. Several shipwrecks have been recorded in the waters adjacent to the planning area, mainly pearling vessels wrecked between 1889 and 1928. It is highly likely there are other unrecorded shipwrecks in the vicinity (Chisolm 2013). The *Occator* was en route to the Muiron Islands in 1856 to look for guano deposits but was wrecked off the North West Cape. Any pre-1900 shipwrecks or debris discovered in the planning area is protected under state and federal legislation.

Heritage surveys on some islands were conducted from 2014–17 by staff from The University of Western Australia and the Western Australian Museum. Several artefacts were located including glass bottles and ballast fragments and pearl shell, thought to originate from pearling vessels in the 1860s (Paterson 2014).

Rock wall remains of original lighthouse base with modern navigation aid in the background on Bessieres Island Nature Reserve.

There was extensive exploration for oil in and around the planning area in the 1960s; remains of exploration infrastructure such as plugged and abandoned drill stems and well heads are still evident on Large, Sholl, Thevenard and North Sandy Islands. Permanent survey markers associated with Navy hydrology surveys are present on several islands as well as the remnants of radio towers associated with the navy and oil industry.

The Bessieres Island Lighthouse is listed on the State Heritage Register and protected under the *Heritage of Western Australia Act 1990*. Only the site is protected as none of the original tower remains.

Management objective: To protect and conserve cultural sites and support the continuation and strengthening of connection to country and sharing of cultural knowledge

Key management challenges

- Identifying and conserving cultural heritage.
- Potential degradation through cyclones, weathering and fire.

Management considerations

- The department's *Corporate Policy Statement No. 87: Aboriginal Joint Management* (DPaW 2015b) provides guidance on involving Aboriginal people in the management of the State's lands and waters.
- *Corporate Policy Statement No. 86: Aboriginal Customary Activities* (DPaW 2015a).

Management strategies

1. Seek aboriginal involvement in all aspects of island management.
2. Identify, record and protect cultural heritage sites and artefacts, and monitor the condition of culturally significant sites to ensure these are adequately protected and maintained.
3. Liaise with traditional owners to determine which sites of high cultural sensitivity may require special management and implement as appropriate (e.g. sites needing access restrictions).
4. Develop an understanding and appreciation of the cultural significance of the planning area to the traditional owners (e.g. through joint on-country visits).

Key performance indicators

Performance measure	**Condition of significant cultural and heritage places.**
Target	• All sites and areas with cultural access restrictions are observed. • No disturbance of Aboriginal heritage sites because of department operations without formal approval and consultation.
Reporting	Annually.

People on country (recreation, tourism and community values)

Strategic goal 4: *Allow for nature-based recreation and tourism experiences without compromising the cultural, heritage and natural values of the islands.*

Visitor management priorities will focus on identifying locations where access can occur without unduly impacting on values. Thevenard, Direction and South Muiron Islands are key locations in this regard.

The department's *Corporate Policy Statement No.18: Recreation, Tourism and Visitor Services* (DPaW 2017a) outlines the principles, operational guidelines, procedures and administrative controls in relation to recreation and tourism on department-managed lands. The policy states that "any recreation and tourism activity should be compatible with the vesting purpose of the reserve". Low-impact recreation is permitted on nature reserves only when the activity does not adversely affect the natural values of the reserve.

Like other island reserves[19] in Western Australia, some historical activities are incompatible with the reserves' purpose. Camping, and leaving behind items used for camping, appears to be waning as other options become available. Boating and other water-based activities in nature reserves are generally not compatible with the reserve purpose (and CALM Regulations 2002) so this management plan proposes to identify and designate suitable locations where camping can occur, and vessels can operate. Land may be classified under the CALM Regulations 2002 as a designated area (for a purpose specified in the notice such as a camping area or boating area), a limited access area, or a prohibited area.

A key challenge for the plan is to identify locations where people can access beaches without unduly impacting on sensitive sites and species vulnerable to disturbance, particularly during nesting.

South Muiron Island has a recreation zone where seasonal camping is permitted.

[19] Refer to *Shark Bay Terrestrial Reserves and Proposed Reserve Additions.*

16. Visitor experience

Regional recreation context

The planning area straddles the two tourism regions of Australia's Coral Coast and Australia's North West. Recreation and tourism activities in the region are appropriately focused on adjoining parks like the Dampier Archipelago islands and marine park, the Montebello Islands and marine park, Ningaloo Marine Park and nearby Cape Range National Park.

When compared with nearby national parks and marine parks (Table 4), use of the Pilbara islands by commercial tours or recreational visitors is very low. An increasing coastal population, more affordable long-range recreational watercraft, and proposals for seaplane or helicopter tours of islands present the greatest challenges as islands become less remote and more accessible over time.

Table 4 Visitor statistics.

Visitation in vicinity of planning area islands 2016–17	Annual visitor numbers
Cape Range National Park	286,000
Dampier Archipelago Nature Reserve	30,500
Montebello Islands Marine Park	2,000
Serrurier Island Nature Reserve	Estimate 200

(Source DBCA 2017b).

Visitors are attracted to the islands for a variety of reasons including fishing, diving and boating opportunities around the islands as well as the protection provided during anchoring from wind and swell. Many visitors enjoy the islands and their scenery without going ashore. The undisturbed, undeveloped nature and perceived lack of regulation derived from a low management presence, contribute to a sense of isolation.

There are several fishing events which attract fishers from all over the State including the Billfish Bonanza, Australian International Billfish Tournament, Australian Junior Billfish Tournament and GAMEX in Exmouth, the Mackerel Islands game fishing tournament at Thevenard Island and the Dampier Classic. It is assumed that these organised boat-based fishing events will continue to grow in popularity, that they do not generally access the islands (other than Thevenard Island) and will not be impacted by implementation of this management plan.

Visitor research and planning

The islands have historically received low visitation (excluding Varanus, Airlie and Thevenard Islands). In keeping with the principles of nature reserves, contemporary access to the islands is primarily for research and monitoring, cultural purposes and management intervention and the future level of access will remain low.

Consideration of the key natural values of the planning area will be at the forefront of planning for visitor activities. Any recreation and tourism within the planning area should be

- low impact and compatible with the purposes and key values of the island,
- consistent with the department's *Corporate Policy Statement No. 18: Recreation, Tourism and Visitor Services* (DPaW 2017a) and *Corporate Guideline No. 32: Recreation, Tourism and Visitor Services* (DBCA 2017c),
- adopt leave no trace principles, and
- adhere to island biosecurity guidelines.

Over the life of the plan visitation is likely to focus on the commercially operated Mackerel Islands Pty Ltd (including Thevenard Island and Direction Island) and boat-based recreation and tourism.

Visitor planning is necessary to ensure natural and cultural values are not inadvertently impacted. Effective planning requires an understanding of the level of use, and to gain an indication of the level and purpose of visitation to the islands a social survey was held between June and December 2016. The findings provided insight into the level and purpose of visitation to the Pilbara islands, though only 169 responses were received despite broad distribution of the survey across the local government areas, social media and various user groups.

The social survey data revealed that people preferred to visit during the cooler months between April and August outside of cyclone season, with slight peaks during the school holidays. Slightly less than 70 percent of respondents were male Pilbara residents aged between 35 and 54 years of age with their own boat, who had visited the islands within the year. The most popular departure points were the Exmouth Marina and the Dampier boat ramps, and the main purposes for being near the islands was fishing from a vessel, and spending time with friends or family. Nearly three quarters of visitors responded that they went ashore on one or more islands and those who stayed overnight mainly slept on the island rather than aboard their boat. Perceived personal benefits of visiting the islands included having fun, relaxing, and escaping the pressure and routine of daily life. Most respondents indicated they would visit again and more than half would recommend that others visit.

Results indicate that Serrurier, South Muiron, and Sholl Islands are the more popular islands for camping. Detailed camping records for South Muiron Island are available through the camping booking system, vessel and aerial patrols. For South Muiron Island, between 1998 and 2017 there were 62 camping licences issued. When combined with data collected during the aerial survey program and vessel patrols the data suggest that visitation to the islands is distinctly lower than the surrounding managed areas. Visitation for the islands in the planning area is expected to remain at a low level over the next 10 years.

Serrurier Island is home to more than 100,000 shearwater burrows, has high levels of turtle nesting and is used by recreational fishers as a base to access nearby fishing grounds.

Recreation settings

Recreation settings proposed for the planning area are based on the ‘Recreation Opportunity Spectrum’ developed by Clark and Stankey (1979), and enable the department to provide a specified range of recreation opportunities in a given area, while limiting unintended incremental development.

Site assessments can consider a combination of the biophysical, social and managerial attributes of a place in which recreation takes place and assess the naturalness of a landscape (DNPSR 2015). Naturalness scores range from 1 (Wilderness/natural/remote) to 9 (urban/commercial/industrial). The island nature reserves were assessed (DBCA 2018) and received a score between 1.6 (East Island) and 6 (Thevenard Island). However, recreation setting diversity is reduced by recreation

succession[20]. Three recreation setting classes apply to the planning area and will guide the department in determining what sort of recreation development may be appropriate over the next 10 years. A visitor management setting of 'highly modified' applies to the leased area on Thevenard and Direction Islands; 'natural/recreation' to designated areas of South Muiron, Serrurier and Sholl Islands; and 'natural' to all other areas/islands (see Appendix 8). Consideration may be given to classifying and limiting access to some islands, or parts of some islands, based on consideration of their natural values (see Appendix 8).

Visitor management settings reflect proposed developments and as such will guide recreational development during the life of this management plan[21].

Visitor safety

Accessing the islands can present several risks to visitors. Risks to visitors are managed through a visitor risk management program that is guided by the department's *Corporate Policy Statement No.53: Visitor Risk Management* (DPaW 2015f) and associated guideline. Risks include (but are not limited to)

- no drinking water available on the islands,
- the risk of injury from causing collapse of wedge-tailed shearwater burrows,
- extreme weather events,
- bird diseases associated with seabird and migratory shorebird colonies,
- high exposure to biting midges (also known as sandflies) which can cause an allergic reaction in some people,
- limited phone reception and long response times for emergency services, and
- issues associated with boating safety. Many of the islands are remote from the mainland and safely securing a boat once on an island can be difficult due to strong tides, changing wind direction and a lack of moorings being available.

Several incidents where people camped on an island overnight have woken up to either a missing vessel or beached and damaged vessel have occurred. The remains of a 'trailer sailer' from one such incident was removed from South Muiron Island at great cost to the department. The department may consider the possibility of installing small boat moorings to facilitate safe vessel mooring near the South Muiron Island camping area.

Some islands in the planning area were used during World War II for encampments, field training, and live firing of weapons or other military activities. The Department of Defence indicates that islands in the Exmouth Gulf as far north-east as Thevenard Island may have been used. No pieces of unexploded ordnance have been found on any of the islands.

Seismic survey lines were installed on Thevenard, Serrurier, North Muiron, South Muiron and Locker Islands and possibly other islands during oil prospecting works by WA Petroleum Pty Ltd during 1986 (K Morris, personal communication, 2014). Old signs on Thevenard still warn of the danger, though they have become difficult to read. Advice from the DMIRS is that old seismic charges comprised 2kg of explosive and could still be viable and as such safety signs should be renewed.

[20] As the recreational use of natural areas increases, attributes can change until the character of the place has been modified to a point where it no longer has the attributes that originally attracted people to the area. As a consequence, the initial visitors are displaced by visitors that are more tolerant of the changed attributes, with the process continuing until a uniform high level of services and facilities is provided in the natural.

[21] Visitor management settings are not static (that is, many of the determining attributes are subject to change and modification), and changes to setting diversity should be sensitive to long-term changing community values and needs but be resistant to short-term trends (particularly those with irreversible consequences) (SRQ 2003), and hence the maintenance of the integrity and character of settings during the life of this management plan.

Visitor information, interpretation and education

The provision of accurate information allows the department to communicate the values of the islands and explain how to protect them. The department provides information about the islands through a range of media, including electronic media (Explore Parks WA website), boat ramp signs (under construction at the time of writing), printed materials, community events in Exmouth, Onslow and Karratha, and social networking.

Over the life of the plan the development of visitor information about the planning area will focus primarily on delivering off-site information. Signage is limited on the islands; it is costly to maintain and detracts from the remote experience so opportunities for onsite interpretation are few. Thevenard Island provides opportunities for interpretation in conjunction with accommodation facilities. The focus of visitor information will also be on

- providing information to visitors on key values, biosecurity and quarantine requirements that is accessible on the department's Explore Parks WA website;
- developing a code of conduct for visitors to the islands;
- developing a visitor guide;
- providing signage at boat ramps on the mainland with information about island values, habitats and threatened species; and
- implementing a camping/user permit or lawful authority system containing site information.

Interpretation will focus on three primary themes:

- Landscapes – learn about isolated islands providing habitat for threatened species.
- Peoples – learn about Aboriginal history on the islands.
- Management – learn about why biosecurity matters and how to protect the islands from invasive species.

Visitor boxes were trialled on three islands with the box on Simpson Island only receiving one comment in 19 weeks.

Basic on-island signage is limited to seven islands in Exmouth Gulf as well as Serrurier, Thevenard and Airlie Islands. Where practical these signs may accommodate small interpretive messages, such as the presence of shearwater burrows or other natural features. Serrurier Island has three timber signs however it is possible to land on the island without seeing any of these signs. Rather than increase on-island signage, opportunities to provide island information through regional and local accommodation providers and other outlets will be pursued. A comments book on Serrurier Island contained 10 comments after 14 weeks.

Education programs focussing on protecting threatened species habitat will be targeted to specific user groups at regional festivals and schools through the *Bush Ranger* program and a school curriculum package. A code of conduct for accessing islands will be developed to guide visitors in this regard.

17. Visitor access

Visitor access to the islands is predominantly by private boat and at the time of writing there were few regular charter vessels offering diving or fishing around the islands. Private vessels can be launched at mainland boat launching facilities at Exmouth, Onslow, Fortescue River and Gnoorea Point (south-west of Karratha). Small boat access is highly dependent on the weather and suitable

conditions when light winds and calm seas are forecast, preferably neap tides and generally outside of cyclone season.

There are a range of factors including but not limited to remote access, boating weather conditions, safe anchorage, tides, and migratory or seasonal species that will limit the range of visitor experiences or opportunities that may exist in comparison to other islands in Western Australia. Nonetheless, there are four island nature reserves where a range of nature-based recreation and tourism opportunities and experiences that could be compatible with conservation if conducted in an appropriate way.

These larger islands (South Muiron, Thevenard, Serrurier and Sholl Islands) allow for access away from sensitive sites. One UCL island (Somerville Island) has features that allow for consideration of recreational use if the island becomes nature reserve. The long beach and relatively deep water facilitate small vessel landing away from the sand spit.

For larger vessels travelling the coast, the islands offer little in the way of protected overnight anchorage (FSC 2014). Serrurier Island offers some protection at two sandy anchorages although is reported to be a marginal anchorage during strong southerly winds.

Limited air access to the islands of the planning area is only possible via a private airstrip on Thevenard Island owned by Mackerel Island Pty Ltd. Permission must be granted from Mackerel Islands Pty Ltd to land aircraft. Landing of helicopters is not compatible with small islands and avifauna and therefore is only permitted for AMSA light maintenance, for approved researchers, or for emergency response where there is no other option.

Sholl Island is located 22km from the Fortescue River mouth and provides for small vessel landing away from birds roosting on the end of the sand spit.

Most islands are small, and the near impossibility of landing a small vessel on a sandy beach without disturbing birds nesting or roosting at the high tide mark is the reason for visitor access being directed to islands where the beach is long enough to allow vessels to land away from sensitive areas. Islands less than 100 hectares in size are designated natural zone and parts of larger islands provide landing areas away from sensitive sites.

To facilitate sustainable use on Serrurier and Sholl Islands, locations for recreation areas will be designated to avoid sensitive areas. A lawful authority to camp on these islands may include providing benefit to the reserve such that the authority holder is required to collect information or contribute toward achieving the management strategies.

There are no roads on any island although Thevenard Island has a management track and 'paved roads' on existing leases. Designated vehicle access will be determined with the resort to ensure minimal impact on nesting turtles, beach vegetation and natural profiles.

Marine management areas allow boat access directly onto the beach up to high water mark which can impact on sensitive site values, an example being the sand spit on South Muiron Island. Complementary strategies are required under marine protected area planning.

Special access

Doole Island is important for the conservation of golden bandicoots, significant high tide roost sites for migratory and resident shorebirds and an example of Carnarvon 4 IBRA subregion that does not experience the mainland pressures of Cape Range and therefore restrictions to access to conserve those values are required.

Access to natural zones, along with prohibited access areas may be approved by lawful authority to researchers who contribute knowledge to island flora and fauna management, including permission to camp on the island for research purposes where there is no practicable alternative.

The intent of this management plan is to minimise camping outside of designated areas, thereby reducing disturbance, abandonment of chicks and risk of introducing pests. Researchers are required to comply with island biosecurity guidelines.

18. Visitor activities

Passive recreation and nature appreciation that is culturally and environmentally appropriate to protect the areas' values on larger islands is appropriate only at locations away from sensitive sites.

Visitors undertake a range of activities including picnicking, beach fishing, beach walking, kayaking, camping (permitted seasonally on a designated section on South Muiron Island with a lawful authority and subject to certain restrictions) and use a few of the islands as an overnight base to gain access to fishing grounds.

Nature appreciation activities, when undertaken in line with best practice boating, fishing, diving and access guidelines, will have minimal impact. Fishing is permitted in terrestrial department-managed land in accordance with the *Fish Resources Management Act 1994* and the CALM Regulations 2002.

The current level of intensity (i.e. very low) of recreational activities appears to be sustainable although concern is noted about campfires and presence of rubbish. Activities that may be suited to larger islands in the islands nature reserves include guided day tours, self-guided day tours, nature appreciation and cultural tours. Smaller islands (<100 hectares) are best observed from the water without landing ashore, thus removing or reducing impacts to sensitive sites.

Day time activities may result in less disturbance than camping activities. Low levels of recreational use in remote areas did not negatively affect Alaskan black oystercatchers (*Haematopus bachmani*) (Morse et al. 2006) although the authors recommended planning campsites away from nesting sites. In contrast, mortality of young pied oystercatchers in New South Wales was attributed to both day

and night recreational beach activity (Wellman et al. 2007). Visitors will have access to web-based information, including a code of conduct which promotes activities that are compatible with natural and cultural values. The location of vessel beach landing and camping sites will be planned to avoid nesting areas.

Nature-based recreation and tourism on Thevenard Island that is low key, and compatible with and respectful to the area's natural and cultural values is supported.

Visitor accommodation

Tourism accommodation

Island accommodation is provided by Mackerel Islands Resort (near Onslow) on two islands in the planning area (Thevenard and Direction Islands) and other nearby mainland options[22] are also available. Management arrangements at Thevenard and Direction Islands, under proposed section 5(1)(h) agreements, will ensure consideration of natural values, particularly marine turtle nesting. No additional commercial accommodation options or facilities will be permitted on the islands to avoid disturbance to shearwater burrows and sensitive sites.

Camping

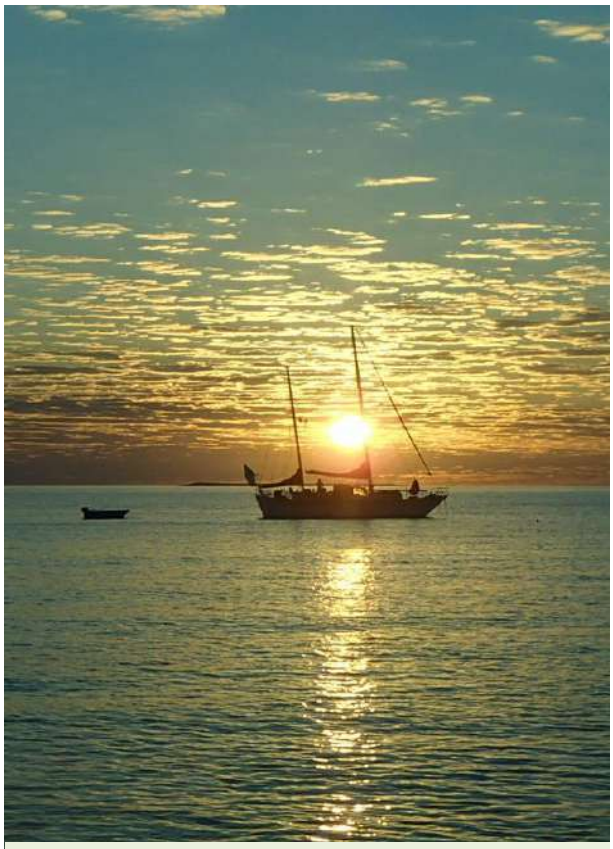
Seasonal camping is permitted on part of South Muiron Island (with a lawful authority and subject to certain restrictions) and this management plan recommends camping be considered for Serrurier and Sholl Islands. As a general principle, camping on boats will be encouraged in preference to camping on islands. Any significant increase in visitation to islands will need to be carefully managed to ensure that the significant natural values of the islands are not impacted.

Camping on South Muiron Island will continue to be permitted via lawful authority as 'remote camping' in line with *Corporate Guideline No. 32: Recreation, Tourism and Visitor Services* (DBCA 2017c). The location of the 'authorised camping area' will continue to be shown on the lawful authority only and not marked or sign-posted onsite.

It is proposed that camping also be trialled at Serrurier and Sholl Islands over the life of this plan, at locations away from sensitive sites and in keeping with the isolated nature of the islands.

Seasonal camping on Sholl Island will be permitted by lawful authority only and may be subject to restrictions. As with South Muiron, the authorised camping area will be shown on the lawful authority and will not be sign-posted.

Camping on Serrurier Island is proposed to occur in a designated 'camping area' which will be sign-posted (see regulation 2, CALM Regulations). Nature reserve signs on Serrurier Island will be modified to indicate this.



Yachts often anchor at Serrurier Island for respite whilst travelling the Western Australian coast.

[22] Coastal camping occurs at Gnoorea Point, mouth of Fortescue River and Wilderness Island (considered to be part of the mainland on the eastern side of Exmouth Gulf).

Camping facilities will not be provided on any of the islands due to the high energy beach environment, presence of wind-direction-dependent camping areas, low management presence, and desire to retain a natural setting.

Campers will need to be fully self-sufficient, adopt leave no trace principles and abide by conditions on the lawful authority. Boat-based camping, as occurs at the Abrolhos Islands and in the Kimberley Region is preferred over island camping to reduce impact on remote islands. As such, will continue to be encouraged to camp on their boat where possible. Moorings to facilitate camping at South Muiron, Serrurier and Sholl Islands may be considered. Camping on boats will not require approval or authority, but visitors may be encouraged to register their visit to the islands online. Should evidence of impacts on turtles and birds from vessel lighting at night become apparent, the department will implement appropriate controls.

To better integrate with the variable nesting habits of different bird species, campers will be asked to choose a section of beach free from bird nesting activity within a stretch of beach (up to 500m in length) that will either be sign-posted (on Serrurier Island) or designated as an authorised camping area on the relevant lawful authority (South Muiron and Sholl Islands). Campers may also be required to contribute to tasks as citizen scientists by recording data, setting or retrieving remote cameras or other management tasks.

Applications for a lawful authority to camp on parts of other islands may be considered in certain situations, at appropriate times of the year and subject to restrictions, in line with *Corporate Policy Statement No. 18: Recreation, Tourism And Visitor Services* (DPaW 2017a) and *Corporate Guideline No. 32: Recreation, Tourism and Visitor Services* (DBCA 2017c). However, camping will generally not be permitted on small islands (<100 hectares) in the planning area, a strategy which also applies at the Dampier Archipelago nature reserves, the Turquoise Coast island nature reserves and Shark Bay terrestrial reserves. The size of the beach is the key factor, rather than the size of the island.

The use of an online booking system to manage camping arrangements may be considered. The management arrangements for camping on the Pilbara inshore islands will be reviewed at the end of the plan period.

Coastal pastoral stations offering camping include Giralia and Bullara near Exmouth Gulf, and Peedamulla Station east of Onslow with camping and access to Cane River.

Visitor Behaviour

The low number of island visitors is not reflected in the visual impact of some current users. Impacts of visitor activities observed during 2013–18 include disturbance to beach nesting birds, half buried or burnt rubbish, equipment being left behind, fires, collection of drift wood, toileting, dogs, and lights impacting species (e.g. disorienting shearwaters returning to the island after dark). Stored items (star pickets, ironing boards, camp chairs, anchors and other items used for camping) among vegetation and nesting areas were found on five islands.

Although some visitors enjoy boating with their dogs or other pets, these animals are not permitted in nature reserves, under the CALM Regulations 2002.

Visitors to the islands should adopt leave no trace principles.

Visitation to the islands generates waste, including human waste. Unburied toilet waste and toilet wipes is an issue on Serrurier Island and some other islands. Users are required to take their rubbish with them when they leave, are encouraged pick up any rubbish they may find whilst visiting and are required to use a chemical toilet. Toilet and rubbish facilities will not be provided on island nature reserves.

Campfires and firewood collection have detrimental effects on the natural environment, including loss of vegetation cover, soil compaction, reducing nesting material available to raptors, the accumulation of ash and resultant sand colour changes. Hot ash and coals from beach campfires can be a visitor risk, and campfire escapes can cause bushfires. Lighting more than one campfire to combat biting midges has occurred in the past, and it is likely that escaped campfires caused the Simpson Island fire in July 1999 and the Tent Island fire in October 2013. Fire remains are unsightly and can persist for many years even when not regularly used. Campfires (ground fires or fires in containers) are not permitted on island nature reserves. These issues will be managed by education in the first instance. Educational material will be provided via the department's web page, brochures and boat ramp signs to discourage these offences.

19. Commercial operations and tourism

Commercial tour opportunities in keeping with activities and locations accessed by recreational users are appropriate; for example, nature appreciation and other passive activities. Active recreation activities, aircraft landing or large events are not appropriate for islands zoned as 'natural' however could be considered for Thevenard Island. Existing tourism infrastructure, including a paved runway, warrants a highly modified setting over part of the island (Appendix 8).

Commercial tour operators offer diving at the Muiron Islands.

For all other islands, preferred tourism operations are slow and quiet nature-based tourism that contribute to nature study. A commercial operations licence is required for commercial activities undertaken on department-managed lands and waters.

Visitors with no access to a vessel may take advantage of the water taxi operated by the Mackerel Islands Resort on Thevenard Island. Charter vessels with a commercial operations licence offer diving to reefs around the islands, specifically the Muiron Islands, with access onto South Muiron Island beach included in their licence conditions.

Historically, applications for licences for commercial tourism operations on island nature reserves have been denied, except at South Muiron Island which is the only reserve with recreation listed in the purpose of use of the reserve. Visitation at South Muiron Island by commercial tour operators is low and tends to be by day dive operators wanting their passengers to have a short visit ashore.

Approximately 21 commercial operations licence holders (six marine charter operators with Statewide licences and 15 whale shark operators) are granted access to the Muiron Islands Nature Reserve for bushwalking, subject to conditions contained within the department's *Commercial Operator Handbook* (DBCA 2018c).

The department's *Corporate Policy Statement No. 8: Negotiating Commercial Development and Activities* (DPaW 2016b) and *No.18: Recreation, Tourism and Visitor Services* (DPaW 2017a) and *Commercial Operator Handbook* (DBCA 2018c) provide guidance on approval of and conditions for commercial operations, and *Corporate Policy Statement No. 55: Commercial Filming* provides guidance on commercial filming (DPaW 2017b). Commercial filming on lands and waters managed by the department is encouraged as a passive recreation activity, which helps promote community awareness, understanding and support for biodiversity conservation. All commercial standard photography is regulated via a permit system to ensure wildlife is not disturbed, with permit holders being required to adopt a code of conduct for birdwatching.

There are no CALM Act leases within the planning area for recreation or tourism purposes. There are three leases issued to Mackerel Islands Pty Ltd on two portions of UCL on Thevenard Island and one portion on Direction Island (see second table in Appendix 2).

This management plan proposes that these leases become CALM Act section 5(1)(h) leases. Mackerel Islands provides built accommodation for visitors and provides diving, fishing and sightseeing tours on Thevenard Island Nature Reserve, Direction Island and around the islands.

Negotiations are underway to reduce impact on turtle nesting beaches, specially lighting and vehicle use of beaches. The management track from the airstrip to the western end of the island will remain unsealed and available to Mackerel Islands Pty Ltd via a commercial operations licence. Any proposals for expansion of commercial developments on Thevenard Island will need to consider that natural values of the Thevenard Island Nature Reserve are maintained or improved.

Commercial activities within the nature reserves will require a commercial tour operator licence and may be limited to locations with a natural/recreation setting (i.e. be directed away from sensitive sites).

Chevron Australia Pty Ltd holds a CALM Act lease containing WA Oil infrastructure over a portion of the nature reserve on Thevenard Island. Chevron Australia Pty Ltd is decommissioning the WA Oil infrastructure and will surrender its lease however this will take some years to achieve. Proposals for commercial tourism development and associated infrastructure within the planning area will only be considered on Thevenard and Direction Islands.

Community involvement and partnerships are an integral part of the department's operations, and help promote community awareness, appreciation and support for the protection and conservation of the State's biodiversity and natural and cultural values.

Management objective: Promote community awareness, understanding, and appreciation of natural and cultural environment key values through the provision of sites best able to absorb minimal-impact nature-based recreation and passive tourism.

Key management challenges

- Small islands with limited sandy beaches are highly susceptible to human disturbance.
- Incompatible use of reserves, particularly camping and boating.

Management considerations

- The department's *Corporate Policy Statement No. 18: Recreation, Tourism And Visitor Services* (DPaW 2017a) provides guidance on visitor activities in the planning area.
- The low level of existing use of the reserves
- Visitor access can be directly controlled by classifying specific areas (i) under section 62 of the CALM Act, or (ii) under regulation 5 of the CALM Regulations 2002.
- Recreational fishing is managed in accordance with the *Fish Resources Management Act 1994* and associated regulations.
- Visitor activities need to be mindful of the natural and cultural significance of areas.

Management strategies

1. Ensure visitor access and use of the island reserves is appropriately planned and managed according to Pilbara PVS Strategic Directions (incorporating recreation master plans), departmental policies and guidelines.
2. Understand visitor numbers, activities and trends.
3. Classify or declare restricted or designated areas under section 62 of the CALM Act for regulations 5 and 6 of the CALM regulations for access/boat landing zones and recreation/camping areas.
4. Provide visitors with information about the natural and cultural values of the planning area.
5. Implement a visitor risk management program consistent with the department's *Corporate Policy Statement No. 53: Visitor Risk Management* (DPaW 2015f) and other legislation, and undertake appropriate remedial action as necessary.
6. Maintain visitor settings to ensure islands retain current characteristics.
7. Evaluate proposals for commercial tourism leases according to departmental policy.
8. Ensure tourism operations on Thevenard Island Nature Reserve are consistent with maintenance of natural values.

Key performance indicators

Performance measure	**Appropriate visitor management settings.**
Target	Recreational and tourism development and use is consistent with the visitor settings. Proposal for inconsistent use require approval of the Commission.
Reporting	Annually.
Performance measure	**Camping data collated, and information provided to user groups.**
Target	Camping data reviewed to determine consistency with settings.
Reporting	Every five years.

20. Community involvement and off-reserve management

Community involvement and support

Ongoing involvement with researchers, traditional owners, tour operators and other community stakeholders is essential for the successful implementation of the management plan.

A volunteer program from 2013–18 recorded over 570 hours of volunteer time contributing to a variety of management activities on the islands, including threatened species surveys, marine debris surveys and weed control. A Bush Ranger unit from Onslow School has undertaken weed control on Thevenard Island in conjunction with departmental staff.

Parks and Wildlife Service volunteer, Laurinda Timmins assisting with flora surveys on Doole Island.

Public participation is a core component of the preparation of this management plan. During development of the management plan, the department consulted widely with local stakeholders through meetings, field trips, social media and other public participation opportunities like community events and festivals.

Meetings and site visits were held with the Shires of Ashburton and Exmouth, the Yaburara and Coastal Mardudhunera Aboriginal Corporation, Yamatji Marlpa Aboriginal Corporation, the Ningaloo Coast World Heritage Advisory Committee and special interest groups to explore how best to conserve natural and cultural values and promote and manage recreation on the islands. More information was gathered from the immediate island user group via the social survey circulated between June and December 2016. The release of this draft management plan for public comment will provide additional opportunity for public participation.

Off-reserve management

The department works with other land management agencies, neighbouring landholders and the the local community to achieve effective and coordinated management of cross-boundary issues. The department also liaises with the Australian Department of Agriculture, Water and the Environment, which is responsible for ensuring the protection of migratory bird species and threatened flora and fauna listed under the EPBC Act.

Species recorded within the island mangroves also utilise mangroves on the adjacent mainland coastline. These extensive communities provide continuity between several island nature reserves in Exmouth Gulf and are of a size to ensure resilience in the face of natural disasters such as disease and cyclonic activity (Humphreys et al. 2005).

The arid zone mangroves of the islands of the Exmouth Gulf and the associated coastline between Exmouth Gulf and Cape Keraudren are regionally significant, being the largest single unit of relatively undisturbed tropical arid zone habitats in the world (EPA 2001). The area forms part of the largest discrete area of mangroves outside the Kimberley and has been described as an outstanding example of tidal wetlands of the low coast of northern Western Australia, with well-

developed tidal creeks, mangrove swamps and broad saline flats containing extensive algal mats that provides an important buffer to the coast (Australian Government 2019b).

Exmouth Gulf East is listed as a KBA[23], a wetland of national significance, and a critical environmental asset, and was considered for inclusion into the Ningaloo Coast World Heritage Area (DEE 2016; Dutson et al. 2009; Humphreys et al. 2005). These include the mangroves in the eastern part of Exmouth Gulf from Giralia Bay to Urala Creek, Locker Point and incorporate parts of the Tent, Burnside, Simpson, Whitmore, Roberts and Doole Islands nature reserves. The mangroves of Bay of Rest near Whitmore Island are recognised as a wetland of regional significance in the 2002 Biodiversity Audit of Subregions (McKenzie et al. 2002).

Arid zone mangrove communities are rare, and despite damage to many sites within the Pilbara Region, those that remain are near pristine, making them even more important (Heydenrych et al. 2015). Most of these mangroves are located on UCL and therefore lack formal protection. Semeniuk (1997) recommended that these areas be considered for addition to the conservation reserve system, based on their values and regional significance. The Environmental Protection Authority (EPA) has developed the *Guidance Statement for the protection of tropical arid zone mangroves along the Pilbara coastline* (EPA 2001).

Management objective: Ongoing community involvement in, support for and increased understanding and appreciation of, the conservation of key values.

Key management challenges

- Communicating with reserve visitors offsite.
- Increasing support and understanding for island nature reserves.

Management considerations

- Volunteer groups are small and mainly active on the mainland.
- The department's *Policy Statement: Public Participation and Stakeholder Engagement* provides guidance on undertaking and providing opportunities for public participation and stakeholder engagement.

Management strategies

1. Support, promote and provide opportunities for public participation and community involvement in planning and island management.
2. Maintain records of the number of registered volunteers and the amount of volunteer hours contributed.
3. Liaise with local government and other stakeholders to promote complementary management on adjoining lands and waters.

[23] Previously known as 'Important Bird Area'.

Using country (sustainable resource and economic values)

Strategic goal 5: *Minimise impact of resource exploration and development on key values.*

Resource installations within the planning area are limited to oil and gas facilities on Varanus, Thevenard and Airlie Islands. Light towers for navigation purposes are located on five islands.

21. Mineral and petroleum exploration and development

Mining in Western Australia is regulated under the *Mining Act 1978* by DMIRS. Under section 24 of the *Mining Act 1978*, mining proposals and activities in reserves require the consent of the Minister for Mines and Petroleum and the recommendations or concurrence (depending on the type of reserve) of the Minister for Environment. DMIRS also administers the petroleum legislation, under which access to reserves for petroleum exploration and development requires the recommendations of the Minister for Environment under section 15A of the *Petroleum and Geothermal Energy Resources Act 1967* and relevant provisions under the *Petroleum Pipeline Act 1969*. The department provides administrative support to the Minister for Environment relative to the Minister's statutory functions under the *Mining Act 1978* and petroleum legislation including the *Petroleum Act 1936*.

The planning area lies along the North West Shelf; an extensive area of petroleum and gas resources and Australia's largest gas production area. The area contains numerous oil and gas wells, pipelines, production operations and support facilities. There are also numerous petroleum exploration permits, production licences and retention leases over the planning area (including over Serrurier and Sholl Islands, which are popular recreation sites), and mining exploration licences over several islands close to the mainland.

Applications to explore or mine within reserves vested in the Commission may be referred to the Western Australian Minister for Environment as required under environmental, mining and petroleum legislation. Exploration actions that may have a significant impact on matters of national environmental significance may also require approval under the EPBC Act.

Installations are subject to strict environmental compliance conditions to minimise impact from both large and temporary workforces as well as ongoing operations staff. Companies have therefore imposed restrictions on access to nature reserves outside the lease area. Some islands are surrounded by areas of port operations impacting on recreational access. Three islands within the planning area support production operations and infrastructure associated with the oil industry. The domestic gas pipeline from Barrow Island to the mainland passes between South Passage Island and Passage Island as well as between Solitary and Cowie Islands towards the mainland.

Mainland-based processing facilities with gas flaring, such as Wheatstone, can impact night migrating birds like wedge-tailed shearwaters which are reported to fly towards the flare (S Bowes, personal communication, n.d.).

Varanus Island

A gas hub operated by Santos Limited located on Varanus Island has been in production since 1986 and received EPA approval in 1995 (Ministerial Statement 395). The island is surrounded by a number of offshore fixed production platforms, which feed oil, gas and condensate to the island for processing, storage, delivery or export, primarily for the Western Australian domestic market. The Varanus Island gas hub covers around 30 hectares of the 86-hectare island, which is part of the Lowendall Islands Nature Reserve, and Quadrant Energy operates the hub to support its ongoing operations in this area under a CALM Act lease. The Varanus Island gas hub is a registered contaminated site. Remediation of the contamination is being overseen by DWER under the *Contaminated Sites Act 2003.*

Employee recreational activities on Varanus Island are prescribed by the *Veranus Island Hub Passive Recreation Plan* detailing permitted activities and activity zones with the aim of minimising potential environmental impacts by staff on off lease areas, particularly wedge-tailed shearwater colonies, nesting marine turtles and mangrove communities.

Thevenard Island

WA Petroleum Pty Ltd discovered the Saladin oilfield, just off the coast from Thevenard Island in 1985. Production facilities were approved by the EPA in 1987 (EPA Bulletin 293) and construction on Thevenard Island occurred under a CALM Act lease. This operated until April 2014 at which point Chevron Australia Pty Ltd took over operation of the facilities. The site is classified as a contaminated site requiring remediation following hydrocarbon leakage from the large storage tanks.

Since the end of production, the site has gone into care and maintenance, and a remediation strategy is being developed. Chevron Australia Pty Ltd is decommissioning the facilities with a view to surrendering its lease once remediation and rehabilitation is complete, although ongoing restrictions to recreational access from the contamination may apply.

During operation, employees were provided with a code of conduct brochure (Chevron 2000), which prohibited access to the nature reserve outside the lease area and did not permit driving on beaches.

A tourism and airstrip lease also exists over parts of Thevenard Island (see page 45).

Airlie Island

Santos Limited and its predecessors (Quadrant Energy, Apache Energy, Novus West Australia, and Western Mining Corporation) have operated an oil production facility over the eastern portion of Airlie Island since 1991 under various joint ventures. The facility was approved by the EPA in 1995 (Bulletin 210) and is situated on a CALM Act lease, sourcing oil from offshore oilfields. Oil production ceased in 2002 and the facilities have existed under a care and maintenance regime since then. During 2016–17 Quadrant Energy commenced decommissioning the infrastructure, including two crude oil storage tanks, water discharge tanks, sludge pits and associated office, accommodation and workshop. The facility is classified as a contaminated site with remediation required under the *Contaminated Sites Act 2003*. All of Airlie Island is a contaminated site, therefore the CALM Act lease will remain in place until decontamination has occurred.

Cape Preston

Preston Island was joined to the mainland via a causeway (EPA Ministerial Statements 635 and 822) to allow port operations in the mid-2000s. The island is now joined to the mainland by road and incorporated into the operational area of the port.

This management plan recommends that Preston Island be de-gazetted as a nature reserve and excised from the Great Sandy Island Nature Reserve and.

Preston Island, incorporated into the Citic Pacific Sino Iron project, near Cape Preston.

In conjunction with Leave No Trace Australia Ltd, Sino Iron developed best practice guidelines for offsite recreation by the workforce. Employees are not permitted to recreate on islands near the Cape Preston project tenements, including South West Regnard, Potter and Carey Islands.

Raw materials

Live and pending mineral tenements,[24] and exploration licences for products including salt and magnetite, exist over several islands and adjacent mangrove thickets. Islands potentially affected include Tent, Fortescue, Steamboat, Potter and Carey Islands.

22. Utilities and services

Utilities and services within the planning area are limited to aids to navigation (AtoN) facilities for shipping. There are no telecommunications installations on the islands at the time of writing.

There are four Crown reserves and leases within the planning area on parts of North Sandy, Great Sandy, Airlie and Bessieres for conservation, navigation, communication, meteorology and survey purposes. The AtoN facilities on these islands are the responsibility of AMSA and are serviced by helicopter.

There is one Crown reserve, which is vested in the Western Australian Minister for Transport, on part of Y Island for the purpose of 'navigation aid site' (Appendix 1). This site contains rubbish from maintenance activities

There is also an AtoN on a portion of UCL on Mary Anne Island, which is managed by AMSA under a *Land Administration Act 1997* lease and is serviced by boat.

The occurrence of buffel grass around the helipad and AtoN facilities is common to all vegetated islands with utilities. On Bessieres Island, buffel grass only occurs around the helipad and is absent from the remainder of the island.

To mitigate biosecurity and other risks, any new utilities or services should be located within existing utility locations or off island reserves.

23. Defence force training

Requests received from the Australian Defence Force for permission to carry out training operations on lands managed by the department are infrequent, but likely to increase as RAAF Base Learmonth expands. Previous training activities have occurred on South Muiron Island. Proposed

[24] See DMIR's GeoVIEW.WA online database.

activities are best assessed on a case-by-case basis so that the requirements and impacts of each exercise can be considered, and conditional approval provided, if or as appropriate. The department's *Corporate Policy Statement No. 54: Defence Force Training Activities* (DPaW 2016c) also provides guidance on this issue. Proposed activities may represent an unacceptable level of risk of ecological or cultural impact, and hence not be appropriate for parts of the planning area.

24. Commercial fishing

Corporate Policy Statement No. 39: Access for Commercial Fishing (DPaW 2016d) addresses commercial fishers accessing the fishery through reserves and potentially camping, while protecting reserve conservation values, Aboriginal heritage and culture, and its recreational use and appreciation by visitors. Access for commercial fishing will be managed so that it does not compromise these priorities. There are no shacks or other accommodation existing on any nature reserve, and no proposals for new facilities will be considered.

Under the CALM Regulations 2002 vessels are not permitted in nature reserves where the water forms a creek, stream or river. The creeks on Tent Island fit this description and a strategy to manage boat access may be required if the reserve is extended to low water mark. However, many of the island nature reserves are gazetted to low water mark and due to the high tidal ranges of the area this means that large portions of intertidal areas are often found within the nature reserve boundaries.

The intertidal zones may provide habitat for species collected as part of the Marine Aquarium Fish, Specimen Shell, Land Hermit Crab and Sea Cucumber Managed Fisheries. With the proposed incorporation of UCL islands into the reserve system, this may pose a problem if the intertidal zones of these islands are being used as a collection site. Accessing the intertidal zones may result in damage to food sources utilised by seabirds and shorebirds and their beach habitat.

There are a number of commercial fisheries that operate, or are permitted to operate, within the planning area, most of which do not impact upon planning area values. Recently recorded impacts on islands are limited to rubbish (plastic crates, floats, ropes) containing company or vessel names or fishing licence numbers. The wrecked remains of the fishing trawler *Miss Persephone* are still visible on Y Island at low tide. Fisheries with potential for impacting nature reserve values are the

- Marine Aquarium Fish Managed Fishery,
- Specimen Shell Managed Fishery,
- Sea Cucumber Managed Fishery, and
- Land Hermit Crab Fishery.

At the time of writing there was no use near most island nature reserves indicated in DPIRD's EBFM Risk Assessment Review report. Some catch effort from the above fisheries is recorded for waters on the western side of Exmouth Gulf and this may include intertidal waters of North Muiron, South Muiron, Whitmore, Roberts and Doole Islands.

In the past, Exmouth Gulf has been an important area for pearl production and associated activities. There are eight pearl farm leases, five pearl holding sites and five pearl aquaculture sites located adjacent to islands within the planning area. Debris from previous pearling remains on a few islands.

Management objective: To minimise impacts of mineral, petroleum and gas exploration and development on the key values.

Key management challenges

- Defence activities will likely increase.
- Identifying suitable location.

Management considerations

- *Corporate Policy Statement No. 54: Defence Force Training Activities* (DPaW 2016c).
- *Corporate Policy Statement No. 39: Access for Commercial Fishing* (DPaW 2016d).

Management strategies

1. Manage mineral exploration and development, and other resource use, activities and proposals consistent with government, department and Commission policies and guidelines.
2. Ensure that the operation and maintenance of utilities and services are in accordance with departmental lease conditions including the responsible management of environmental issues, particularly minimizing impact on bird and turtle nesting, and the introduction and spread of introduced species.
3. In consultation with Department of Defence determine which islands are appropriate for use in training activities, assess impacts of specific proposals for undertaking defence force training activities, monitor permitted activities, and require the Department of Defence to report unintended impacts on island values.

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Appendices

Appendix 1: Existing reserves within the planning area.

The following table lists all 97 reserve islands which make up the 20 existing reserves in the planning area. It also includes Sandalwood Landing and Preston Island which fall outside the planning area but are currently part of the Whitmore, Roberts, Doole Islands and Sandalwood Landing Nature Reserve and the Great Sandy Island Nature Reserve, respectively, which comprise of islands within the planning area.

Reserve name	Reserve	Vesting	LGA	Reserve legal area (ha)[25]	Island name	Isla-nd ID	Lot area (ha)[26]	Perim-eter (km)[27]	Gaz-ettal Date	Name status	Purpose	Vested to
Great Sandy Island Nature Reserve	B33831	The Commission	City of Karratha	0.0001	Sholl	54	1,269.4	16.8	1981	Gazetted	Conservation of flora and fauna	Low water mark
					Long	58	465.9	8.6	1981	Gazetted		
					Potter	53	424.4	11.5	1981	Gazetted		
					Great Sandy	66	342.4	10.5	1976	Gazetted		
					Passage	63	232.7	9.3	1978	Gazetted		
					Mardi	56	204.4	5.9	1981	Gazetted		
					Fortescue	52	172.1	5.8	1981	Gazetted		
					East	69	139.0	4.5	1981	Gazetted		
					Middle Passage	59	116.6	4.9	1981	Gazetted		
					Steamboat	50	104.9	6.1	1976	Gazetted		
					South Passage	61	94.7	3.8	1981	Gazetted		

[25] Legal area as listed on Landgate reports.
[26] Area of lots on cadastre of State tenure maps.
[27] From cadastral information State tenure maps.

Reserve name	Reserve	Vesting	LGA	Reserve legal area (ha)[25]	Island name	Isla-nd ID	Lot area (ha)[26]	Perim-eter (km)[27]	Gaz-ettal Date	Name status	Purpose	Vested to
					Middle Mary Anne	70	92.0	4.1	1976	Gazetted		
					Stewart	173	88.1	4.0	1981	Gazetted		
					Barrow Island Shoals	231	85.7	3.5				
					South West Regnard	49	83.8	4.5	1981	Gazetted		
					Round	169	79.4	4.1	1981	Gazetted		
					Carey	55	77.5	5.9	1981	Gazetted		
					West	73	73.5	5.3	1981	Gazetted		
					Mary Anne	68	57.1	4.2	1976	Gazetted		
					Cowie	67	56.6	3.8	1981	Gazetted		
					Angle	60	54.6	3.3	1981	Gazetted		
					North East Regnard	48	53.2	3.4	1981	Gazetted		
					unnamed 1	395	34.6	3.1		unnamed		
					Thringa	72	26.8	2.4	1981	Gazetted		
					Solitary (near Passage)	64	25.7	1.8	1981	Gazetted		
					Pup	65	21.8	2.2	1981	Gazetted		
					Large	71	18.8	1.9	1976	Gazetted		
					unnamed (407)	407	16.0	1.8	1981	unnamed		
					Preston		12.1	1.9	?	Gazetted		
Lowendal Islands Nature Reserve	C33902	The Commission	Shire of Ashburton	178.846	Veranus	39	85.8	9.6	1976	Gazetted	Conservation of flora and fauna	Mean high water
					Bridled	38	23.3	4.0	1976	Gazetted		
					Abutilon	40	21.5	4.9	1976	Gazetted		
					Parakeelya	41	17.2	2.3	1976	Gazetted		

Reserve name	Reserve	Vesting	LGA	Reserve legal area (ha)[25]	Island name	Isla-nd ID	Lot area (ha)[26]	Perim-eter (km)[27]	Gaz-ettal Date	Name status	Purpose	Vested to
					unnamed islands 3-44	vari ous	Total: 169.0	Total: 34.8				mark, approx.
Whitmore, Roberts, Doole Islands and Sandalwood Landing Nature Reserve	C42755	The Commission	Shire of Exmouth	545.9	Doole	95	279.9	14.2	1993	Unofficial	Conservation of flora and fauna	Mean high water mark
					Roberts	92	90.0	4.8	1993	Unofficial		
					North West Doole	130	61.1	4.3	1993	Unofficial		
					Whitmore	90	12.3	2.2	1993	Unofficial		
					Sandalwood Landing		176.3	9.6	1993	Unofficial		
Muiron Islands Nature Reserve	C31775	The Commission, Shire of Exmouth	Shire of Exmouth	988	South Muiron	80	497.0	19.0	1973	Unofficial	Recreation and conservation of flora and fauna	Mean high water mark, approx.
					North Muiron	79	492.7	12.0	1973	Unofficial		
Burnside and Simpson Island Nature Reserve	C42760	The Commission	Shire of Ashburton	114.8	Burnside	87	72.9	5.8	1993	Unofficial	Conservation of flora and fauna	Mean high water mark
					Simpson	88	69.0	5.8	1993	Unofficial	Conservation of flora and fauna	
Thevenard Island Nature Reserve	C33174	The Commission	Shire of Ashburton	1,923	Thevenard	77	2,345.0	26.7	1975	Gazetted	Conservation of flora and fauna (by Petroleum Act 1967-81)	Low water mark, approx.
Tent Island Nature Reserve	C42758	The Commission	Shire of Ashburton	2,015	Tent	86	2,045.5	40.8	1993	Unofficial	Conservation of flora and fauna	Mean high water mark

Reserve name	Reserve	Vesting	LGA	Reserve legal area (ha)[25]	Island name	Isla-nd ID	Lot area (ha)[26]	Perim-eter (km)[27]	Gaz-ettal Date	Name status	Purpose	Vested to
Serrurier Island Nature Reserve	C33834	The Commission	Shire of Ashburton	350.967	Serrurier	78	314.2	13.7	1976	Gazetted	Conservation of flora and fauna	Mean high water mark
Bessieres Island Nature Reserve	A44666	The Commission	Shire of Ashburton	54.5	Bessieres	81	60.4	3.5	2000	Unofficial	Conservation of flora and fauna	Mean high water mark
North Sandy Island Nature Reserve	A44668	The Commission	City of Karratha	20.0943	North Sandy	62	58.4	3.4	1981	Gazetted	Conservation of flora and fauna	Low water mark
Y Island Nature Reserve	C42762	The Commission	Shire of Ashburton	35	Y	85	36.5	2.7	1993	Unofficial	Conservation of flora and fauna	Mean high water mark
Airlie Island Nature Reserve	C40323	The Commission	Shire of Ashburton	41	Airlie	74	33.5	2.6	1987	Unofficial	Conservation of flora and fauna	Mean high water mark
Weld Island Nature Reserve	C42752	The Commission	City of Karratha	22.7096	Weld	75	32.9	4.2	1993	Unofficial	Conservation of flora and fauna	Mean high water mark
Locker Island Nature Reserve	A29011	The Commission	Shire of Ashburton	30.3514	Locker	82	31.7	2.1	1968	Gazetted	Conservation of flora and fauna	Mean high water mark
Victor Island Nature Reserve	C42761	The Commission	Shire of Ashburton	19	Victor (Eva)	84	20.4	1.7	1993	Unofficial	Conservation of flora and fauna	Mean high water mark

Reserve name	Reserve	Vesting	LGA	Reserve legal area (ha)[25]	Island name	Isla-nd ID	Lot area (ha)[26]	Perim-eter (km)[27]	Gaz-ettal Date	Name status	Purpose	Vested to
Round Island Nature Reserve	C42757	The Commission	Shire of Ashburton	7.2258	Round (near Serrurier)	169	3.2	0.7	1993	Unofficial	Conservation of flora and fauna	Mean high water mark
Little Rocky Island Nature Reserve	A34560	The Commission	Shire of Ashburton	4.6452	Little Rocky	76	1.7	0.6	1977	Gazetted	Conservation of flora and fauna	Mean high water mark
Gnandaroo Island Nature Reserve	A33216	The Commission	Shire of Ashburton	3.0594	Gnandaroo	144	1.6	0.5	1975	Gazetted	Conservation of fauna	Mean high water mark
Rocky Island Nature Reserve	C42759	The Commission	Shire of Ashburton	0	Rocky	309	1.5	0.7	1993	Unofficial	Conservation of flora and fauna	Mean high water mark
Whalebone Island Nature Reserve	C42756	The Commission	Shire of Ashburton	1.6129	Whalebone	89	1.5	0.7	1993	Unofficial	Conservation of flora and fauna	Mean high water mark

The following table lists five small reserves for other purposes which are on parts of islands in the planning area.

Reserve	Reserve	Vesting	LGA	Reserve legal area (ha)[28]	Details	Lot area (ha)[29]	Perimeter (km)[30]	Gazet-tal Date	Name status	Purpose	Vested to
unnamed section 5(1)(h) reserve (on Airlie Island)	C40322	The Commission	Shire of Ashburton	0.15	Crown reserve and lease on Airlie	0.2	0.2	2000		Conservation, navigation, communication, meteorology and survey	N/A
unnamed section 5(1)(h) reserve (on North Sandy Island)	A44667	The Commission	City of Karratha	0.14	Crown reserve and lease on North Sandy	0.2	0.2	2000		Navigation, communication; meteorology survey and conservation	N/A
unnamed section 5(1)(h) reserve (on Bessieres Island)	A44665	The Commission	Shire of Ashburton	0.036	Crown reserve and lease on Bessieres	<0.01	0.1	2000		Navigation, communication, meteorology; survey and conservation	N/A
unnamed Crown reserve (on Great Sandy Island)	C44671		City of Karratha	0.4047	Crown reserve and lease on Great Sandy	0.4	0.3			Navigation, communication, meteorology and survey	N/A
unnamed Crown reserve (on Y Island)	C38669	Minister for Transport	Shire of Ashburton	0.01	Crown reserve on Y	<0.01	<0.01	1984	Unofficial	Navigation aid site	N/A

[28] Legal area as listed on Landgate reports.
[29] Area of lots on cadastre of State tenure maps.
[30] From cadastral information State tenure maps.

Appendix 2: Proposed reserves.

The following table outlines the 77 islands within the planning area that are currently unvested UCL islands that are proposed to become Class A Reserves over the life of the plan as part of the proposed Pilbara Inshore Islands Nature Reserve.

Island name	Island ID	LGA	Area (ha)	Perimeter (km)	Comments
Yammadery	225	Ashburton	762.9	49.3	Mangroves; has several cadastral polygons over it.
North Mangrove	162	Ashburton	174.6	6.7	*Rattus tunneyi*, mangroves, shorebirds
Middle Mangrove	160	Ashburton	125.6	7.1	Mangroves
South Mangrove	217	Ashburton	35.8	4.0	Mangroves
Ashburton	107	Ashburton	32.2	2.1	Marine turtle nesting
Fly	207	Ashburton	29.0	2.1	Wedge-tailed shearwaters, ospreys
Flat	139	Ashburton	28.3	2.2	Wedge-tailed shearwaters, bridled terns, crested terns
Direction	182	Ashburton	25.3	2.2	Beach stone-curlews, marine turtle nesting
Observation	83	Ashburton	18.4	1.6	Wedge-tailed shearwaters, ospreys
Brown	203	Ashburton	17.8	2.4	White-bellied sea-eagles, fairy terns, roseate terns, shorebirds
Somerville	202	Ashburton	11.3	1.4	Wedge-tailed shearwaters, shorebirds
Sunday	174	Exmouth	11.1	1.3	Within NCWHA; adjoins Muiron Islands Management Area; IBA for roseate terns; fairy terns; P2 *Carpobrotus* sp.
North East Twin	212	Ashburton	6.3	1.0	Flatback turtle nesting, ospreys
Peak	213	Ashburton	6.3	1.3	Bridled terns, ospreys
Little Roberts	220	Exmouth	5.9	1.4	Fairy tern nesting; joined to Roberts Island at low tide in Oct 2016
False	201	Ashburton	5.3	0.9	Flatback turtle nesting, beach stone-curlews
Tortoise	176	Ashburton	4.9	0.9	Marine turtle nesting
South West Twin (Twin)	218	Ashburton	3.3	0.8	
Table	175		2.6	0.7	Crested terns, bridled terns, ospreys
Little Fly	374?	Ashburton	1.1	0.4	Seabird roosting
unnamed UCL 01	94	Exmouth	5.8	1.2	
unnamed UCL 02	91	Exmouth	1.4	0.6	
unnamed UCL 03	NA		0.4	0.5	
unnamed UCL 04	93	Exmouth	5.2	1.0	
unnamed UCL 05	333	Exmouth	1.3	0.4	
unnamed UCL 06	338	Exmouth	4.2	0.9	

unnamed UCL 07	NA		0.9	0.4	
unnamed UCL 08	343	Exmouth	0.6	0.3	
unnamed UCL 09	NA		2.4	0.9	
unnamed UCL 10 (South Islam)	354	Ashburton	0.2	0.2	
unnamed UCL 11 (Middle Islam)	355	Ashburton	0.6	0.3	
unnamed UCL 12 (North Islam)	357	Ashburton	0.1	0.2	
unnamed UCL 13	362	Ashburton	7.4	1.0	
unnamed UCL 14	365	Ashburton	6.7	1.1	
unnamed UCL 15 (Tent)	NA		1.5	0.6	Part of Tent Island
unnamed UCL 16 (Tent)	NA		3.9	0.8	Part of Tent Island
unnamed UCL 17 (Tent)	NA		1.2	0.6	Part of Tent Island
unnamed UCL 18 (Tent)	NA		5.8	1.2	Part of Tent Island
unnamed UCL 19 (Tent)	NA		0.5	0.3	Part of Tent Island
unnamed UCL 20 (North East Tent)	369	Ashburton			
unnamed UCL 21	372	Ashburton	1.5	0.6	
unnamed UCL 22	373	Ashburton	1.4	0.5	
unnamed UCL 23	375	Ashburton	1.2	0.5	
unnamed UCL 24 (Black Ledge)	234		1.2	0.4	
unnamed UCL 25 (Bowers Ledge)	NA		1.4	0.7	
unnamed UCL 26	384		0.9	0.4	
unnamed UCL 27	219		1.4	0.5	
unnamed UCL 28 (Rosily West)	312		9.2	1.3	
unnamed UCL 29 (Rosily East)	311		4.0	0.9	
unnamed UCL 30	223		162.8	11.8	Made up of multiple cadastral packages
unnamed UCL 31 (Yammadery)	379		0.4	0.2	Part of Yammadery Island
unnamed UCL 32	380		0.3	0.2	
unnamed UCL 33	381		14.1	1.5	
unnamed UCL 34	383		55.7	3.8	
unnamed UCL 35	385		11.2	1.3	
unnamed UCL 36	391		1.0	0.7	
unnamed UCL 37	392		1.0	0.6	
unnamed UCL 38	690		0.3	0.2	
unnamed UCL 39	NA		42.1	3.1	
unnamed UCL 40 (Overhanging Rock)	295		0.9	0.5	

unnamed UCL 41	470		0.2	0.3	
unnamed UCL 42	472		0.1	0.1	
unnamed UCL 43	473		0.1	0.2	
unnamed UCL 44 ((N))	476		2.8	1.1	
unnamed UCL 45	NA		0.1	0.1	
unnamed UCL 46	NA		0.0	0.0	
unnamed UCL 47	474		0.0	0.1	
unnamed UCL 48	477		0.0	0.1	
unnamed UCL 49	NA		0.1	0.1	
unnamed UCL 50	NA		0.0	0.0	
unnamed UCL 51	479		0.2	0.2	
unnamed UCL 52 ((P))	483		0.6	0.4	
unnamed UCL 53	NA		0.0	0.1	
unnamed UCL 54	NA		0.1	0.1	
unnamed UCL 55	NA		0.0	0.0	
unnamed UCL 56	NA		0.0	0.0	
unnamed UCL 57	NA		0.0	0.0	
TOTAL		**77 islands**	**1,692.6**	**142.7**	

The following table outlines five parcels of Crown land that are on parts of islands in the planning area, which are proposed to become section 5(1)(h) reserves over the life of this plan.

Parcel of land	LGA	Vesting	Purpose	Area (ha)	Perimeter (km)	Comments
UCL on Mary Anne	Karratha	leave	AtoN	26.2	2.0	LAA lease, UCL around AtoN (light), managed by AMSA; proposed to become section 5(1)(h) reserve
UCL on Thevenard	Ashburton	unvested	UCL	68.2	4.3	Water and intertidal area near LAA lease N144413; proposed to become section 5(1)(h) reserve
Lease on Thevenard	Ashburton	lease	Fishing holiday resort	13.1	1.7	LAA lease; N144413; Mackerel Island Pty Ltd.; proposed to become section 5(1)(h) reserve
Lease on Thevenard	Ashburton	lease	Airstrip	11.9	2.5	LAA lease; N144422; Mackerel Islands Pty Ltd.; proposed to become section 5(1)(h) reserve
Lease on Direction	Ashburton	lease	Tourism accommodation	0.7	0.3	*Land Act 1993* lease; N144397; Mackerel Islands Pty Ltd.; proposed to become section 5(1)(h) reserve
TOTAL				**120.1**	**10.8**	

Appendix 3: Recommendations from Status Performance Assessment: Biodiversity Conservation on Western Australian Islands. Phase 1.

The performance report (Conservation Commission 2009) provided 29 recommendations of which 15 are relevant to the Pilbara inshore islands. The report provides a summary of some islands, their values and threats and proposes that Western Australia's islands be divided into two groups:

- *Islands with mainly terrestrial values…large enough to allow vegetation communities to grow away from the immediate influence of sea spray, and*
- *Islands with mainly marine values (seabird breeding and resting, sea turtle breeding, seal and sealion breeding and haul-out sites); marine-value islands can be cays (sand and/or coral rubble) or small rocky islands and islets with or without beaches.*

Pilbara inshore islands are mostly marine-value islands and the following recommendations are an extract from the report.

Section 3.5 *(1): Priorities for island surveillance and management be developed. Priority development should take a risk management approach. Biosecurity surveillance of important islands be allocated a high priority.*

(2): A public education program about island biosecurity be developed and implemented, the primary target should be boat owners.

(3): More research into the conservation of island (including littoral zone) biodiversity is required. Priorities include biogeographic survey of reserved islands for which data do not exist or are of poor quality, fire effects and management, and weed distribution, effects and controls.

(4): Research be conducted to identify islands and species on islands, particularly endemics, that will be deleteriously affected by climate change. A first step should be to conduct bioclimatic modelling for species, subspecies or populations of mammals, land birds and reptiles restricted to Western Australian islands. Bioclimatic modelling should also be conducted for all threatened species and any others identified by experts as being likely to be adversely affected by climate change. DEC Policy 29 'Translocation of threatened fauna and flora" should be reviewed so that it includes climate change as a factor to be considered when considering proposed translocations.

(5): Information on marine turtle breeding beaches should be reviewed and those likely to be affected deleteriously by climate change identified. Modelling and other information should be used to develop climate change response plans.

Section 4.7 *(1): Class "A" status should be sought for all conservation reserve islands that are no so classified.*

(2): The seaward limit of island conservation reserves should be extended to low water mark to protect the littoral zone, excluding those surrounded by

marine conservation reserves where the littoral area should be incorporated into the marine park.
(3): Management Plans be developed for all islands with important biodiversity conservation values. Islands with no management plans could be covered by developing plans that include many islands within a region. While some islands will necessarily require a detailed plan that covers one or a few islands; the majority can be adequately covered by 'overview' plans embracing many islands. Groupings could be by archipelago, Interim Bioregionalisation of Australia (IBRA) or by DEC administrative Region or District boundaries.

Section 5.2 *(1) All DEC Regions with islands have an identified budget for island conservation activities. The budget should be sufficient to allow regular visits to high priority islands by boat or helicopter.*
(2) Visits to high priority islands be frequent and regular and include biosecurity surveillance. Staff visiting islands should be trained so that they can record necessary information.
(4) NatureMap or other online database system be developed for recording and extraction of information on biodiversity and management issues on islands. An easy to use online data entry system would greatly improve information recording, as it would allow staff to enter data immediately after a trip. It should be a requirement that all DEC staff enter information after all island visits. Unpublished information should be acquired and entered into such a system.
(5) Existing databases on islands (mammals, seabirds, marine turtles) be maintained and incorporated into NatureMap or another online database of island biodiversity.

Section 6.2 (2) There be better monitoring of and response to illegal use of islands.
(3) Eradication programs, where feasible, be extended to all islands with feral animal populations.
(4) A review be conducted on the occurrence and impact of weeds on island conservation reserves. It should include bioclimatic modelling to indicate where weeds may spread under current and forecast climates. Weed eradication technology be developed and applied to high priority weeds. Development of buffel grass eradication technology or biological control be a very high priority.

Appendix 4: Threatened and significant fauna.

Species	BC Act[31]	EPBC Act[32]	IUCN Red List of Threatened Species[33]
Threatened species			
Barrow Island golden bandicoot (*Isoodon auratus barrowensis*)	Vulnerable	Vulnerable	-
Eastern curlew (*Numenius madagascariensis*)	Vulnerable	Critically Endangered, Marine, Migratory	Endangered
Curlew sandpiper (*Calidris ferruginea*)	Vulnerable	Critically Endangered, Migratory	Near threatened
Northern Siberian bar-tailed godwit (*Limosa lapponica menzbieri*)	Vulnerable	Critically Endangered	-
Bar-tailed godwit (*Limosa lapponica baueri*)	Vulnerable	Vulnerable	-
Great knot (*Calidris tenuirostris*)	Vulnerable	Critically Endangered, Marine, Migratory	Endangered
Greater sand plover (*Charadrius leschenaultii leschenaultii*)	Vulnerable	Vulnerable	Least concern
Lesser sand plover (*Charadrius mongolus*)	Endangered	Endangered, Marine, Migratory	Least concern
Australian fairy tern (*Sterna nereis nereis*)	Vulnerable	Vulnerable	Vulnerable
Loggerhead turtle (*Caretta caretta*)	Endangered	Endangered, Marine, Migratory	Vulnerable
Green turtle (*Chelonia mydas*)	Vulnerable	Vulnerable, Marine, Migratory	Endangered
Flatback turtle (*Natator depressus*)	Vulnerable	Vulnerable, Marine, Migratory	Data deficient
Hawksbill turtle (*Eretmochelys imbricata*)	Vulnerable	Vulnerable, Marine, Migratory	Critically endangered
Airlie Island ctenotus (*Ctenotus angusticeps*)	Priority 3	Vulnerable	-
Other specially protected fauna			
Peregrine falcon (*Falco peregrinus*)	Specially protected	-	Least Concern

[31] Wildlife listed under the Western Australian Biodiversity Conservation Act (*Wildlife Conservation (Specially Protected Fauna) Notice 2018).*
[32] Wildlife listed under the Australian *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
[33] The International Union for the Conservation of Nature Red List of Threatened Species is a comprehensive information source of the global conservation status of animal, fungi and plant species.

Species	BC Act[31]	EPBC Act[32]	IUCN Red List of Threatened Species[33]
Priority species			
Water rat (*Hydromys chrysogaster*)	Priority 4	-	Least concern
Lakeland Downs short-tailed mouse (*Leggadina lakedownensis*)	Priority 4	-	Least concern
Grey tailed tattler (*Tringa brevipes*)	Priority 4	Migratory	Near Threatened

Appendix 5: Breeding seasons and occurrence of significant birds and marine turtles.

Species	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Roseate tern												
Pied oystercatcher												
Sooty oystercatcher												
Fairy tern												
Crested tern												
Osprey												
White-bellied sea-eagle												
Caspian tern												
Beach stone-curlew												
Little tern												
Wedge-tailed shearwater												
Bridled tern												
Adult migratory shorebirds												
Juvenile and post-breeding adult migratory shorebirds												
Hawksbill turtle												
Flatback turtle												
Green turtle												
Loggerhead turtle												

nesting/breeding behaviour/hatching/feeding chick
present in planning area

Appendix 6: Seabirds and shorebirds of the Pilbara inshore islands.

Estimates of population sizes of some breeding species

Common name	Scientific name	Population size (pairs)[34]	# of islands where nesting occurs[34]	Nesting habitat
Wedge-tailed shearwater	*Ardenna pacificus*	800,000	17	Ground: burrow
Bridled tern	*Onchoprion anaethetus*	10,000	10	Ground: low grass/ imbricated rocks
Roseate tern	*Sterna dougallii*	10,000	Est 10	Ground: beach/ scrape
Crested tern	*Thalasseus bergii*	10,000	20	Ground: low grass / scrape
Lesser-crested tern	*Thalasseus bengalensis*	1,000	Unknown. Present on six islands	Ground: low grass / scrape
Caspian tern	*Hydroprogne caspia*	2,000	40	Ground: low grass scrape
Fairy tern	*Sternula nereis nereis*	3,000	40	Ground: beach / scrape
Beach stone-curlew	*Esacus magnirostris*	40	30	Ground: scrape
Australian pelican	*Pelicanus conspicillatus*	200	3	Ground: scrape
Pied oystercatcher	*Haematopus longirostris*	3000	40	Ground: beach / scrape
Silver gull	*Chroicocephalus novaehollandiae*	10,000	40	Ground: low grass/scrape
Osprey	*Pandion cristatus*	100	40	Ground: nest
White-bellied sea-eagle	*Haliaeetus leucogaster*	50	17	Ground: nest of sticks up to 2m high

Migratory shorebirds present in the planning area

Scientific name	Common name	Scientific name	Common name
Actitis hypoleucos	Common sandpiper	*Calidris ruficollis*	Red-necked stint
Arenaria interpres	Ruddy turnstone	*Calidris subminuta*	Long-toed stint
Calidris acuminata	Sharp-tailed sandpiper	*Calidris tenuirostris*	Great knot
Calidris alba	Sanderling	*Charadrius mongolus*	Lesser sand plover
Calidris canutus	Red knot	*Charadrius*	Greater sand plover
Calidris melanotos	Pectoral sandpiper	*Limosa lapponica menzbieri*	Bar-tailed godwit
Limosa limosa	Black-tailed godwit	*Tringa brevipes*	Grey-tailed tattler
Numenius madagascariensis	Eastern curlew		
Numenius minutus	Little curlew	*Tringa glareola*	Wood sandpiper
Numenius phaeopus	Whimbrel	*Tringa nebularia*	Common greenshank
Pluvialis fulva	Pacific golden plover	*Tringa stagnatilis*	Marsh sandpiper
Pluvialis squatarola	Grey plover	*Xenus cinereus*	Terek sandpiper

[34] Source DBCA island surveys (2013–18)

Appendix 7: Flora.

Published descriptions of vegetation in the planning area are broad. Beard and colleagues (2013) listed two primary vegetation types for the planning area:

- **Mangroves**, Thicket (Pilbara bioregion mangroves tend to form thickets) mangroves (*Avicennia marina* dominating with *Brugiera exaristata and Rhizophora stylosa* behind)
- **Shrub steppe**, Hummock grassland (*Triodia* sp) with scattered shrubs (*Acacia* sp, *Grevillea* sp) or mallee (*Eucalyptus* sp).

The islands are generally similar floristically with a few notable exceptions these being Potter Island, Carey Island, Tent Island and Thevenard Island. Potter and Carey stand out because they represent the only islands in the group which display any banded iron formation and stony hills with the associated flora common to those habitats. Three hundred hectares of Tent Island was burnt during a bushfire in 2013, and subsequent rainfall from Cyclone Olwyn in March 2015, and Cyclone Quang in May 2015 resulted in a rich and complex transitional floral community at the time of the survey. Furthermore, island isolation from one another has resulted in slight differences in species that dominate the common assemblages of hummock grassland and coastal dune fields; Thevenard Island is the sole island in the group with *Acacia coriacea* as dominant shrub species, all other islands are dominated by *Acacia bivenosa* apart from Varanus which has no naturally occurring *Acacia*s at all. (V Long, personal communication, 2016; DBCA island surveys 2018).

Mainland habitats similar to the islands are largely infested with NIS which increases the value of the islands as healthy representations of these communities no longer found elsewhere.

Island vegetation, while grossly similar to the adjacent mainland, is surprisingly complex. This is because the islands are subject to ongoing natural disturbance by extreme weather events, biopedturbation[35] by species like marine turtles and wedge-tailed shearwaters, and fires. The result being that boundaries of associations are not as clear cut as they seem at first glance (V Long, personal communication, 2016).

Many of the islands exhibit pale beach sand and beach rock outcrops to a varying degree, with beach species such as *Spinifex longifolius, Ipomoea pes-caprae and Launaea sarmentosa* dominating. *Scaevola crassifolia* and *Scaevola cunninghamii* are also often present.

Hind dunes and consolidated inland low dune fields exhibit low heaths and shrublands of varying combinations of occasional tall *Acacia coriacea,* over low *Acacia bivenosa, Rhagodia preissii* subsp. *obovata, Alectryon oleifolius* and *Sarcostemma viminale* subsp. *australe.* The understorey is often mixed low shrubs such as *Scaevola spinescens, Lepidium platypetalum* or *Zygophyllum aurantiacum* over grasslands of *Eulalia aurea, Triodia epactia,* or less commonly *Whiteochloa airoides,* which forms a PEC in some areas.

Many of the larger islands have an inland basin ringed by higher dunes. The substrate is often darker (orange/brown) and coarser than the beach sand though not always. In most cases these basins house *Triodia epactia* hummock grassland with scattered low shrubs, most commonly *Acacia bivenosa, Acacia coriacea, Sarcostemma viminale* subsp. *australe,*

[35] The mixing or disturbance of soil by living organisms.

Alectryon oleifolius, Rhagodia preissii subsp. *obovata* and various herbs. Alternatively, these inland basins may also be densely infested with buffel grass (*Cenchrus ciliaris*) to the exclusion of other species.

Limestone platforms and tidal fringe share a similar suite of species; primarily a low shrubland of halophytes including *Frankenia pauciflora, Tecticornia indica* and *Tecticornia halocnemoides* often with *Sporobolus virginicus* grassland nearby. These samphire communities may be periodically flooded with seawater during spring tides and storm surges. Tent Island has seasonal damp depressions inland which feature these same species but combined with dense herblands of *Swainsona pterostylis.* As previously mentioned, this assemblage is thought to provide an important habitat niche for the Airlie island skink. Samphire communities of the planning area potentially contain several undescribed species as taxonomic works is incomplete (V Long, personal communication, 2017).

Many of the islands closer to the mainland have an entire or partial fringe of mangrove shrubland dominated by *Avicennia marina* subsp. *marina* but may also include *Rhizophora stylosa, Ceriops australis, Bruigiera exaristata* and *Aegialitis annulata.*

Tent Island exhibits similar beach and hind dune flora to the other islands however inland dune fields feature intermittent tall *Acacia coriacea* and *Acacia tetragonophylla* shrubs over *Acacia bivenosa, Tephrosia* sp Carnarvon, *Crotalaria cunninghamii* over *Triodia epactia* hummock grasslands or *Cenchrus ciliaris* tussock grasslands. *Whiteochloa airoides* tussock grasslands PEC may also be found here.

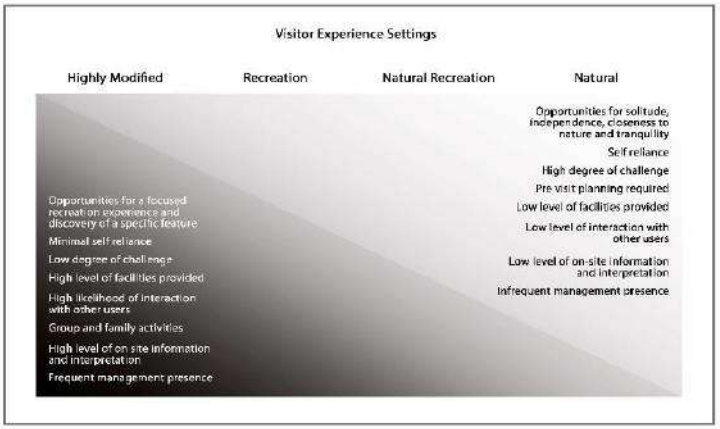
Potter and Carey islands exhibit geology which reflects that of the adjacent mainland with stony hills and ironstone outcrops. Both feature mangal, and beach and coastal dune systems similar to the other islands, however inland stony hills are covered in *Trioda wiseana* hummock grassland with scattered *Acacia bivenosa, Grevillea pyramidalis* and *Trianthema turgidifolia*. Water running off the stony shale has resulted in deep drainage lines which support dense localised shrublands on reddish silt with thick grassy understoreys, and seasonally damp depressions at the low point with herblands or grasslands. These are often weed infested, usually with buffel grass.

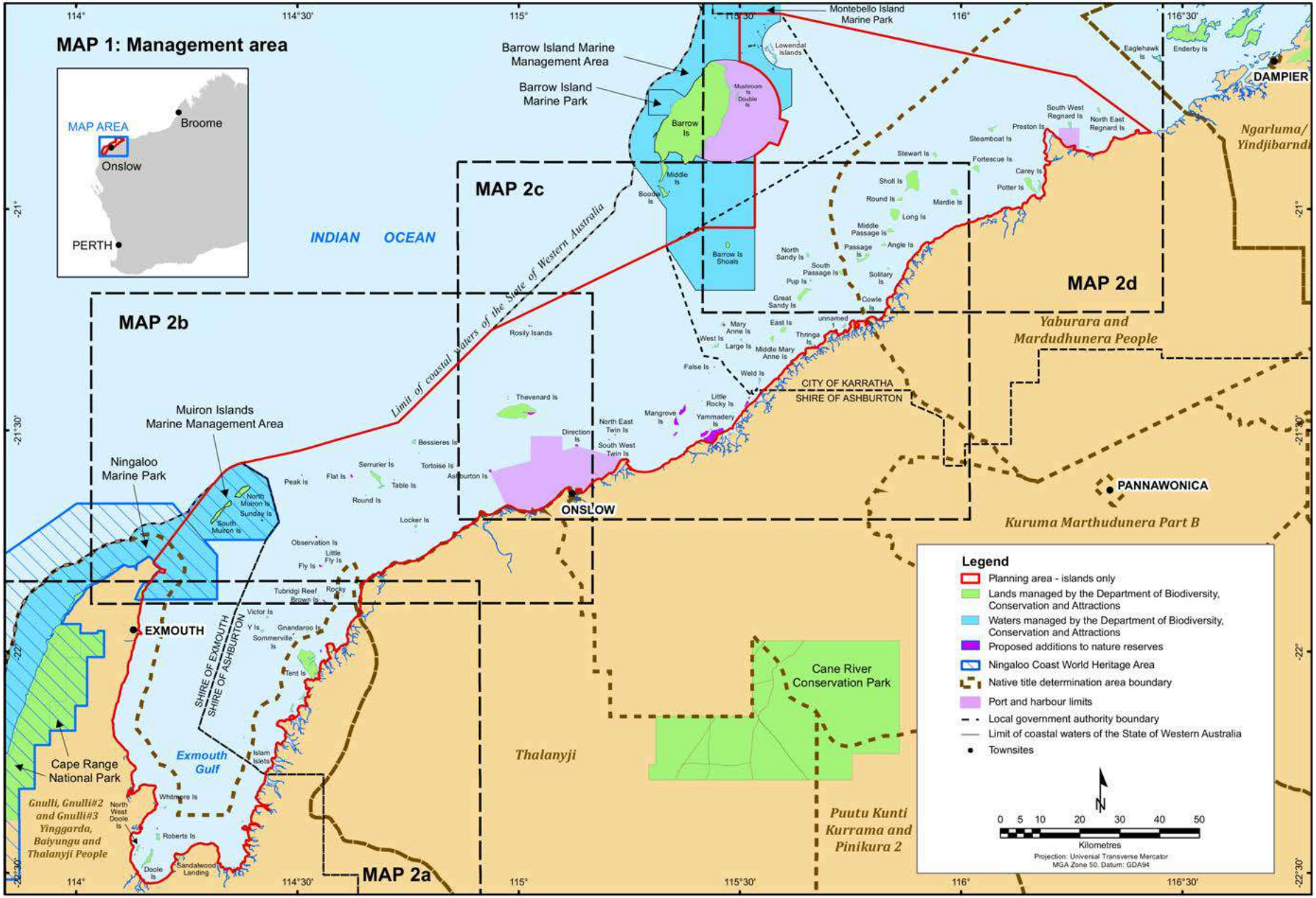
It is of interest to note that some of the Acacia species of these islands have been known to hybridise (DEC 2007b).

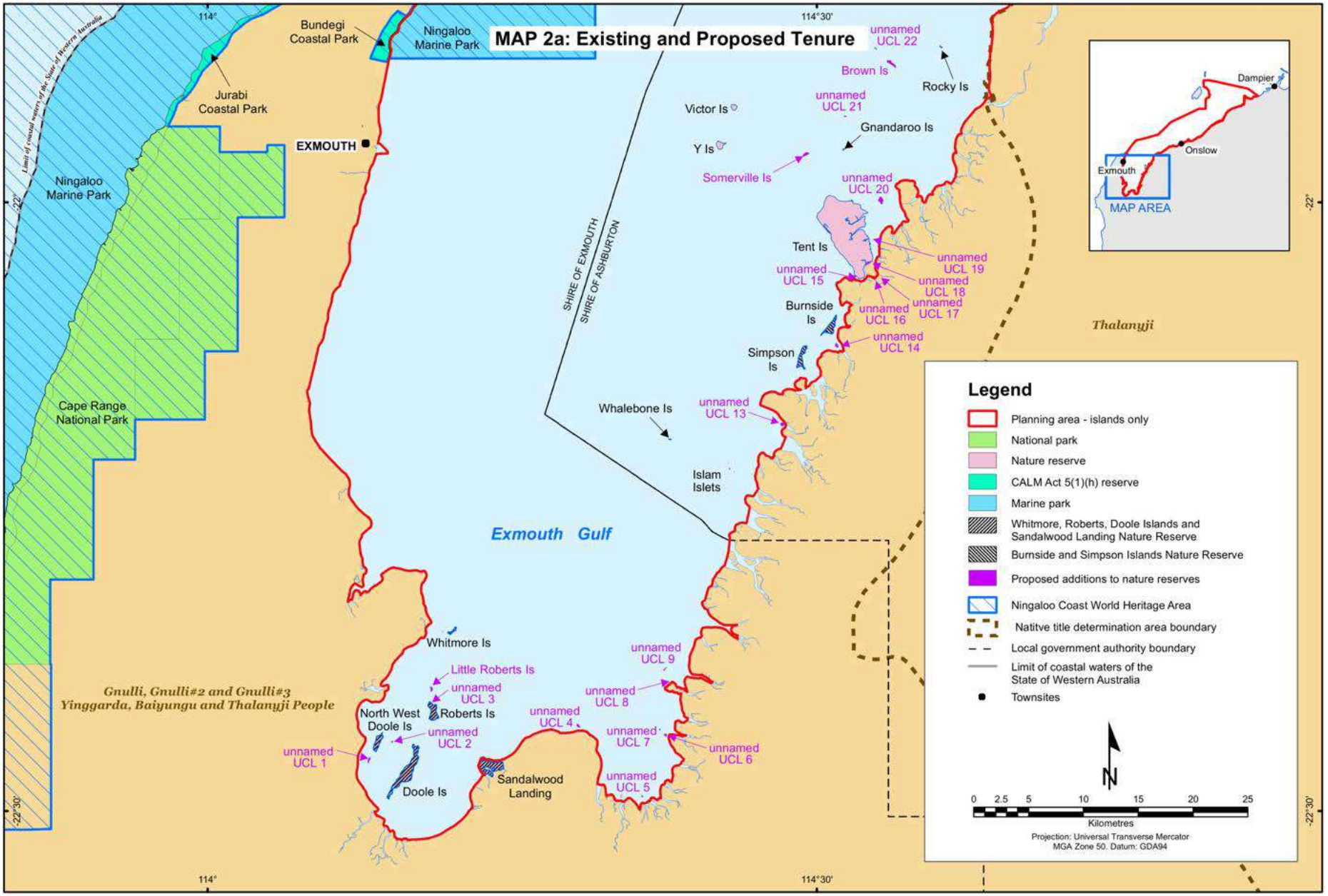
Appendix 8: Recreation settings for islands.

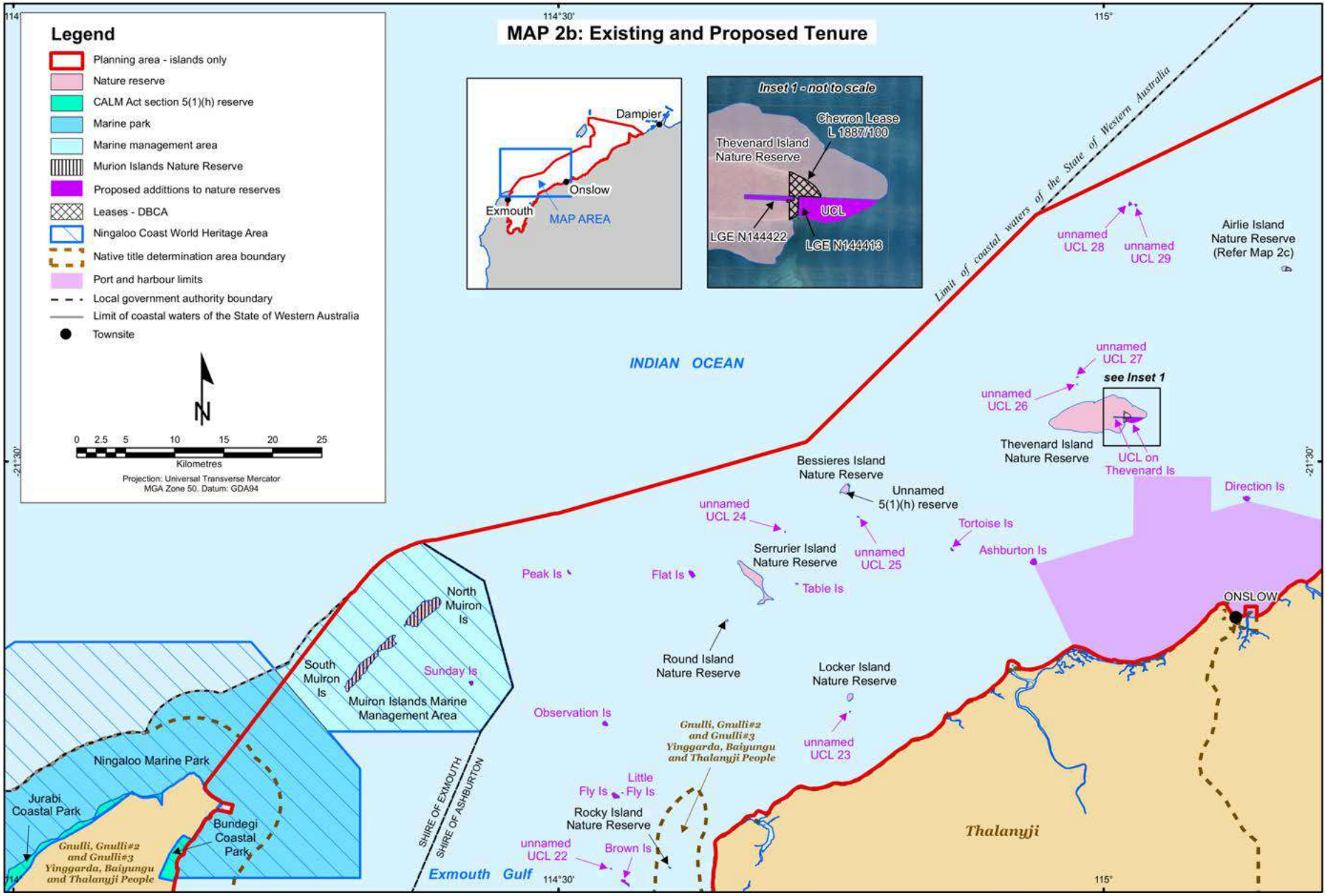
Island	Size (ha)	Setting	Classification (s. 62, CALM Act)
South Muiron	450	Natural with small Natural/ Recreation setting for access/ camping	Recreation area for camping/day access
Serrurier	351		
Sholl	300		
Thevenard	623 (+1,300 ha intertidal)	Highly modified setting at commercial operator site. Natural zone for remainder of island.	Recreation area at eastern end for low key tourism; Limited access area (daytime only) elsewhere.
Direction	24		
North Muiron	465	Natural Zone	Prohibited area above high water mark
Tent	300 (+ 1,715 ha mangroves)		Limited access area to low water mark
Doole	235		Limited access area to low water mark
Potter	175		Limited access area to low water mark
Gnandaroo	3		Prohibited access year-round for bird nesting
Sunday	14		Prohibited access year-round for bird nesting
Stewart	82		Prohibited access year-round for bird nesting
Little Rocky	5		Prohibited access year-round for bird nesting
Remaining islands			Limited access area or temporary control areas may apply as required to protect nesting.

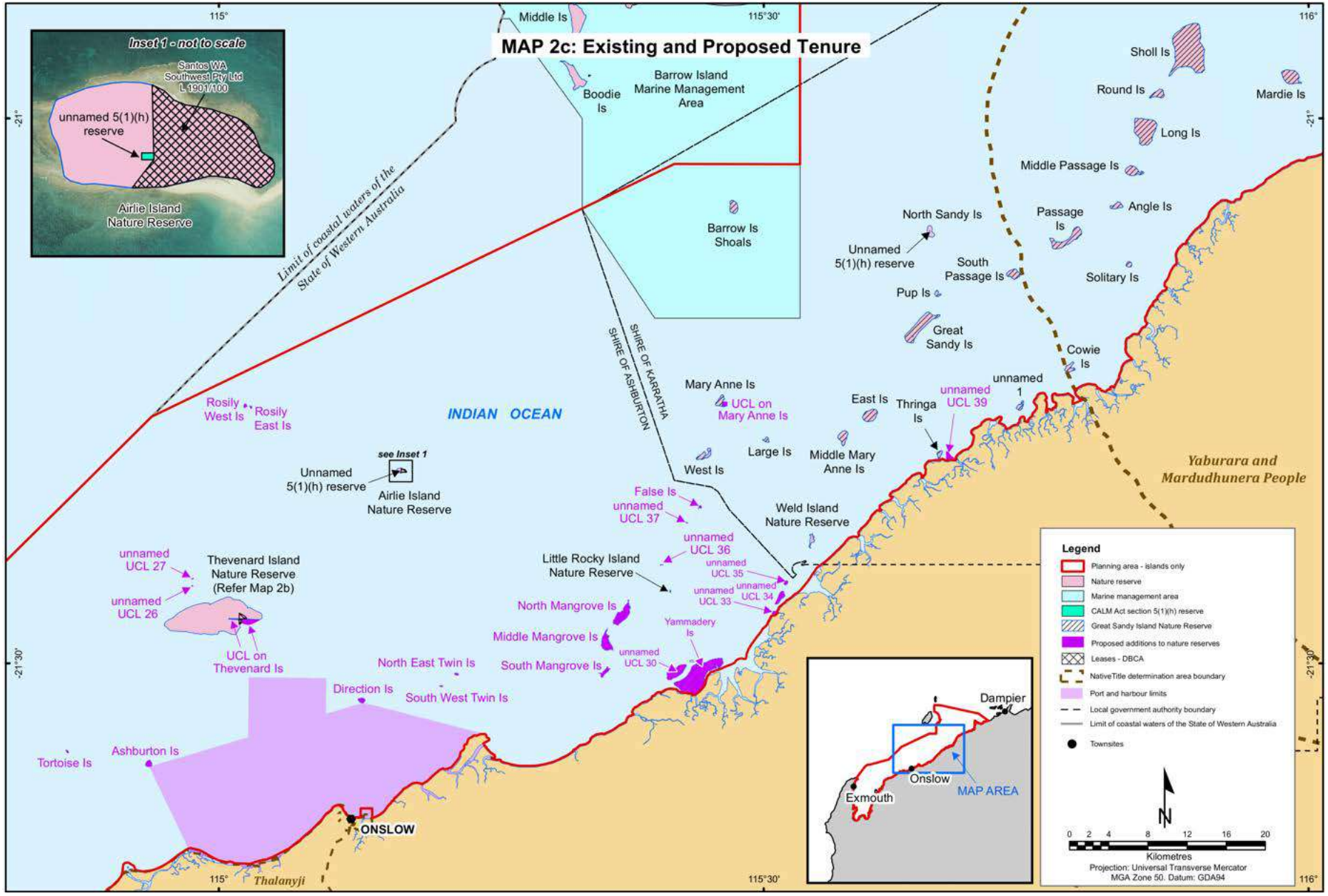
Visitor experience settings include natural, natural/recreation, recreation and highly modified.

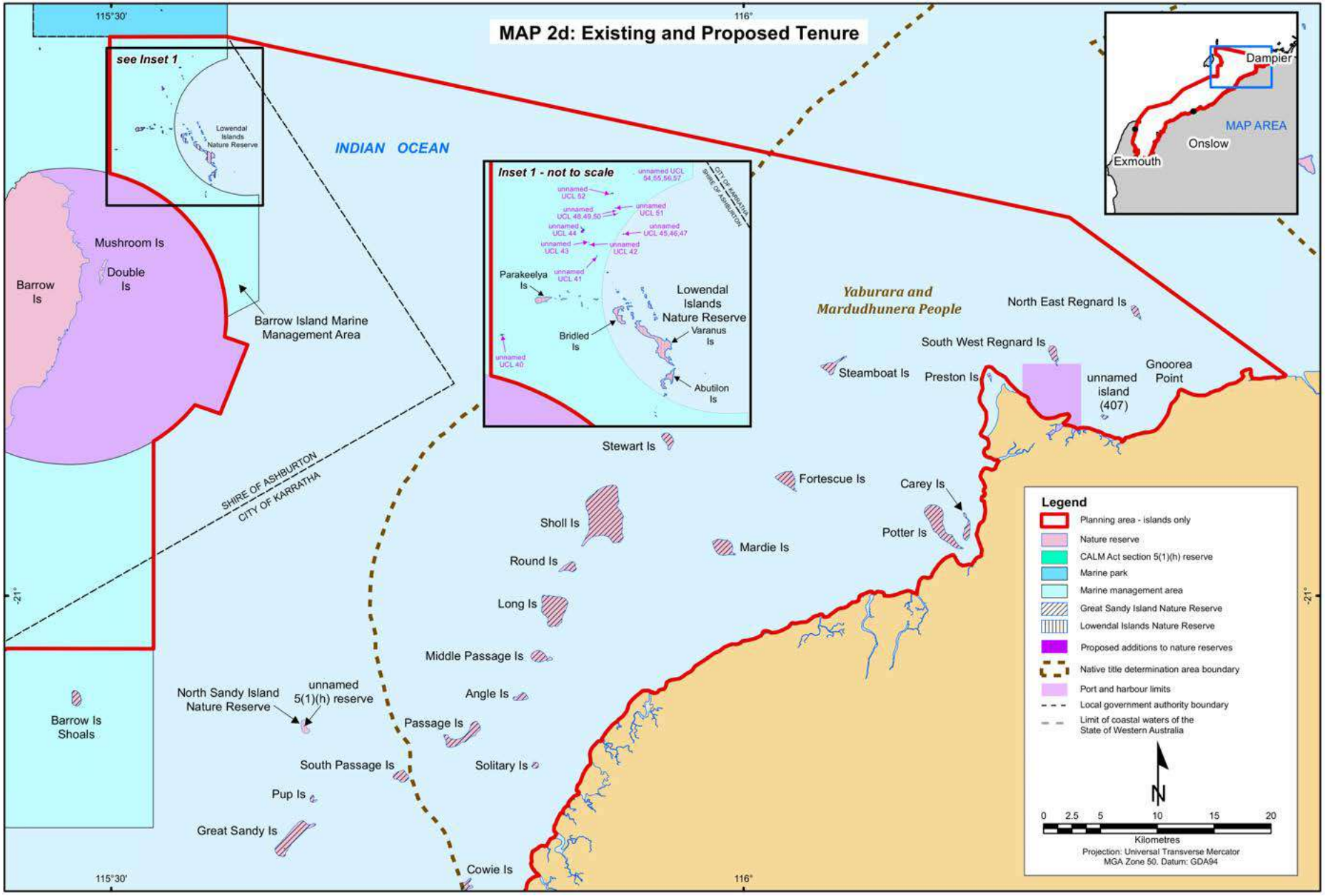


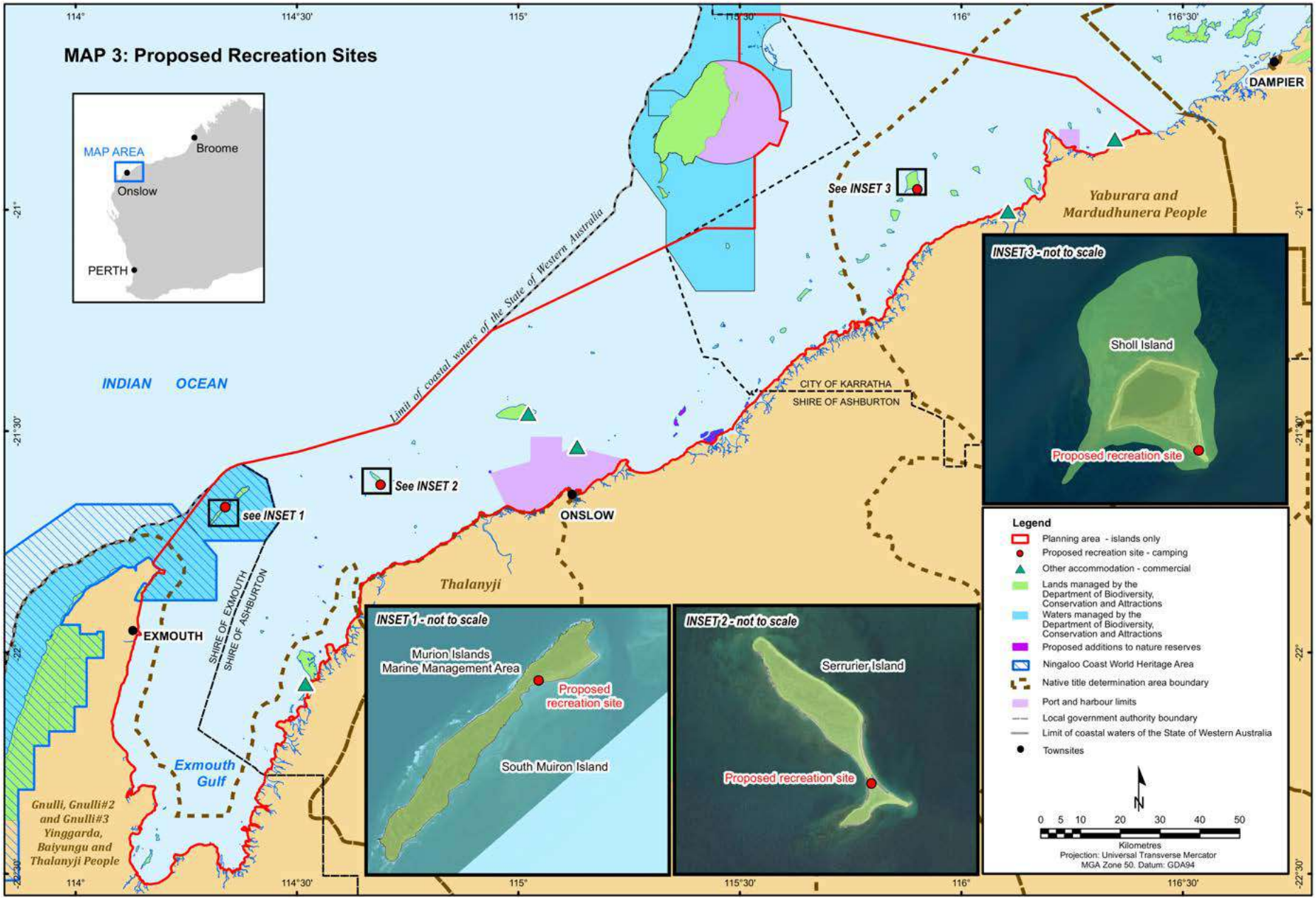

MAP 1: Management area
MAP AREA
Broome
Onslow
PERTH
INDIAN OCEAN
MAP 2a
MAP 2b
MAP 2c
MAP 2d
Limit of coastal waters of the State of Western Australia
Barrow Island Marine Management Area
Barrow Island Marine Park
Montebello Island Marine Park
Muiron Islands Marine Management Area
Ningaloo Marine Park
Cape Range National Park
Cane River Conservation Park
DAMPIER
ONSLOW
EXMOUTH
PANNAWONICA
CITY OF KARRATHA
SHIRE OF ASHBURTON
SHIRE OF EXMOUTH
Exmouth Gulf
Ngarluma/ Yindjibarndi
Yaburara and Mardudhunera People
Kuruma Marthudunera Part B
Thalanyji
Puutu Kunti Kurrama and Pinikura 2
Gnulli, Gnulli#2 and Gnulli#3 Yinggarda, Baiyungu and Thalanyji People
Legend
Planning area - islands only
Lands managed by the Department of Biodiversity, Conservation and Attractions
Waters managed by the Department of Biodiversity, Conservation and Attractions
Proposed additions to nature reserves
Ningaloo Coast World Heritage Area
Native title determination area boundary
Port and harbour limits
Local government authority boundary
Limit of coastal waters of the State of Western Australia
Townsites
0 5 10 20 30 40 50
Kilometres
Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94


MAP 2a: Existing and Proposed Tenure
Bundegi Coastal Park
Ningaloo Marine Park
Jurabi Coastal Park
EXMOUTH
Ningaloo Marine Park
Cape Range National Park
Limit of coastal waters of the State of Western Australia
SHIRE OF EXMOUTH
SHIRE OF ASHBURTON
Victor Is
Y Is
Somerville Is
Gnandaroo Is
Brown Is
Rocky Is
unnamed UCL 22
unnamed UCL 21
unnamed UCL 20
unnamed UCL 19
unnamed UCL 18
unnamed UCL 17
unnamed UCL 16
unnamed UCL 15
unnamed UCL 14
unnamed UCL 13
unnamed UCL 9
unnamed UCL 8
unnamed UCL 7
unnamed UCL 6
unnamed UCL 5
unnamed UCL 4
unnamed UCL 3
unnamed UCL 2
unnamed UCL 1
Tent Is
Burnside Is
Simpson Is
Whalebone Is
Islam Islets
Whitmore Is
Little Roberts Is
Roberts Is
North West Doole Is
Doole Is
Sandalwood Landing
Exmouth Gulf
Thalanyji
Gnulli, Gnulli#2 and Gnulli#3
Yinggarda, Baiyungu and Thalanyji People
Dampier
Onslow
Exmouth
MAP AREA
Legend
Planning area - islands only
National park
Nature reserve
CALM Act 5(1)(h) reserve
Marine park
Whitmore, Roberts, Doole Islands and Sandalwood Landing Nature Reserve
Burnside and Simpson Islands Nature Reserve
Proposed additions to nature reserves
Ningaloo Coast World Heritage Area
Nativte title determination area boundary
Local government authority boundary
Limit of coastal waters of the State of Western Australia
Townsites
N
0 2.5 5 10 15 20 25
Kilometres
Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94
114°
114°30'
-22°
-22°30'


MAP 2b: Existing and Proposed Tenure
Legend
Planning area - islands only
Nature reserve
CALM Act section 5(1)(h) reserve
Marine park
Marine management area
Murion Islands Nature Reserve
Proposed additions to nature reserves
Leases - DBCA
Ningaloo Coast World Heritage Area
Native title determination area boundary
Port and harbour limits
Local government authority boundary
Limit of coastal waters of the State of Western Australia
Townsite
0 2.5 5 10 15 20 25
Kilometres
Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94
Dampier
Onslow
Exmouth
MAP AREA
Inset 1 - not to scale
Chevron Lease L 1887/100
Thevenard Island Nature Reserve
UCL
LGE N144422
LGE N144413
Limit of coastal waters of the State of Western Australia
unnamed UCL 28
unnamed UCL 29
Airlie Island Nature Reserve (Refer Map 2c)
INDIAN OCEAN
unnamed UCL 27
see Inset 1
unnamed UCL 26
Thevenard Island Nature Reserve
UCL on Thevenard Is
Bessieres Island Nature Reserve
Unnamed 5(1)(h) reserve
Direction Is
unnamed UCL 24
Tortoise Is
Serrurier Island Nature Reserve
unnamed UCL 25
Ashburton Is
Peak Is
Flat Is
Table Is
ONSLOW
North Muiron Is
South Muiron Is
Sunday Is
Muiron Islands Marine Management Area
Round Island Nature Reserve
Locker Island Nature Reserve
Observation Is
Gnulli, Gnulli#2 and Gnulli#3 Yinggarda, Baiyungu and Thalanyji People
unnamed UCL 23
Ningaloo Marine Park
Jurabi Coastal Park
Bundegi Coastal Park
Little Fly Is
Fly Is
Rocky Island Nature Reserve
SHIRE OF EXMOUTH
SHIRE OF ASHBURTON
unnamed UCL 22
Brown Is
Exmouth Gulf
Thalanyji
114°30'
115°
21°30'


MAP 2c: Existing and Proposed Tenure
Inset 1 - not to scale
Santos WA Southwest Pty Ltd L 1901/100
unnamed 5(1)(h) reserve
Airlie Island Nature Reserve
Limit of coastal waters of the State of Western Australia
Barrow Island Marine Management Area
Barrow Is Shoals
Boodie Is
Middle Is
Sholl Is
Round Is
Mardie Is
Long Is
Middle Passage Is
Angle Is
Passage Is
North Sandy Is
Unnamed 5(1)(h) reserve
South Passage Is
Solitary Is
Pup Is
Great Sandy Is
Cowie Is
unnamed 1
unnamed UCL 39
Thringa Is
East Is
Mary Anne Is
UCL on Mary Anne Is
Large Is
Middle Mary Anne Is
West Is
SHIRE OF KARRATHA
SHIRE OF ASHBURTON
INDIAN OCEAN
Rosily West Is
Rosily East Is
see Inset 1
Unnamed 5(1)(h) reserve
Airlie Island Nature Reserve
False Is
unnamed UCL 37
Weld Island Nature Reserve
Yaburara and Mardudhunera People
unnamed UCL 36
unnamed UCL 35
unnamed UCL 34
unnamed UCL 33
Little Rocky Island Nature Reserve
unnamed UCL 27
unnamed UCL 26
Thevenard Island Nature Reserve (Refer Map 2b)
UCL on Thevenard Is
North Mangrove Is
Middle Mangrove Is
South Mangrove Is
Yammadery Is
unnamed UCL 30
North East Twin Is
South West Twin Is
Direction Is
Ashburton Is
Tortoise Is
ONSLOW
Thalanyji
Dampier
Onslow
Exmouth
MAP AREA
Legend
Planning area - islands only
Nature reserve
Marine management area
CALM Act section 5(1)(h) reserve
Great Sandy Island Nature Reserve
Proposed additions to nature reserves
Leases - DBCA
NativeTitle determination area boundary
Port and harbour limits
Local government authority boundary
Limit of coastal waters of the State of Western Australia
Townsites
N
0 2 4 8 12 16 20
Kilometres
Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94
115°
115°30'
116°
-21°
-21°30'


MAP 2d: Existing and Proposed Tenure
115°30'
116°
see Inset 1
Lowendal Islands Nature Reserve
INDIAN OCEAN
Inset 1 - not to scale
unnamed UCL 54,55,56,57
unnamed UCL 52
unnamed UCL 48,49,50
unnamed UCL 51
unnamed UCL 44
unnamed UCL 45,46,47
unnamed UCL 43
unnamed UCL 42
Parakeelya Is
unnamed UCL 41
Lowendal Islands Nature Reserve
Bridled Is
Varanus Is
unnamed UCL 40
Abutilon Is
CITY OF KARRATHA
SHIRE OF ASHBURTON
Dampier
MAP AREA
Onslow
Exmouth
Mushroom Is
Barrow Is
Double Is
Barrow Island Marine Management Area
Yaburara and Mardudhunera People
North East Regnard Is
South West Regnard Is
Steamboat Is
Preston Is
unnamed island (407)
Gnoorea Point
Stewart Is
Fortescue Is
Carey Is
Potter Is
Sholl Is
Mardie Is
Round Is
Long Is
Middle Passage Is
Angle Is
Passage Is
Solitary Is
South Passage Is
Pup Is
Great Sandy Is
Cowie Is
North Sandy Island Nature Reserve
unnamed 5(1)(h) reserve
Barrow Is Shoals
SHIRE OF ASHBURTON
CITY OF KARRATHA
-21°
Legend
Planning area - islands only
Nature reserve
CALM Act section 5(1)(h) reserve
Marine park
Marine management area
Great Sandy Island Nature Reserve
Lowendal Islands Nature Reserve
Proposed additions to nature reserves
Native title determination area boundary
Port and harbour limits
Local government authority boundary
Limit of coastal waters of the State of Western Australia
N
0 2.5 5 10 15 20
Kilometres
Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94


MAP 3: Proposed Recreation Sites
MAP AREA
Broome
Onslow
PERTH
INDIAN OCEAN
Limit of coastal waters of the State of Western Australia
See INSET 3
See INSET 2
see INSET 1
ONSLOW
DAMPIER
Yaburara and Mardudhunera People
CITY OF KARRATHA
SHIRE OF ASHBURTON
Thalanyji
EXMOUTH
SHIRE OF EXMOUTH
SHIRE OF ASHBURTON
Exmouth Gulf
Gnulli, Gnulli#2 and Gnulli#3 Yinggarda, Baiyungu and Thalanyji People
INSET 3 - not to scale
Sholl Island
Proposed recreation site
INSET 1 - not to scale
Murion Islands Marine Management Area
Proposed recreation site
South Muiron Island
INSET 2 - not to scale
Serrurier Island
Proposed recreation site
Legend
Planning area - islands only
Proposed recreation site - camping
Other accommodation - commercial
Lands managed by the Department of Biodiversity, Conservation and Attractions
Waters managed by the Department of Biodiversity, Conservation and Attractions
Proposed additions to nature reserves
Ningaloo Coast World Heritage Area
Native title determination area boundary
Port and harbour limits
Local government authority boundary
Limit of coastal waters of the State of Western Australia
Townsites
N
0 5 10 20 30 40 50
Kilometres
Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94
114°
114°30'
115°
115°30'
116°
116°30'
-21°
-21°30'
-22°
-22°30'