Conservation Action Plan for the Pilbara Bioregion
Summary Report

DRAFT – December 2015
Acknowledgements

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Greening Australia acknowledges the contributions to this publication of various stakeholders and participants; however, the views contained herein do not necessarily reflect the views of the participating organisations. Greening Australia advises that the information contained in this publication comprises general statements based on scientific research. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in any specific situation. No reliance or actions must therefore be made on that information without seeking prior expert professional, scientific and technical advice.

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Cover Photo: Sunrise at Panorama Point, Brad Glass

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Abbreviations:

<table>
<thead>
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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>CAP</td>
<td>Conservation Action Planning</td>
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<tr>
<td>EPBC</td>
<td>Environment and Biodiversity Conservation Act 1999 (Commonwealth Government)</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<td>NRM</td>
<td>Natural Resources Management</td>
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Founding Partners

[Logos of founding partners]

Funded by

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1 Background

1.1 Overview of the Pilbara Bioregion

The Pilbara biogeographic region of Western Australia (McKenzie et al., 2003) has a wealth of biodiversity and other environmental values, evidenced by its diverse range of terrestrial, aquatic and marine landscapes, numerous flora and fauna species and communities, nationally listed wetlands, and ecological features endemic to the region.

In addition to being one of 15 biodiversity hotspots in Australia, the region is also one of Australia’s development hotspots, of substantial economic importance to both Western Australia and Australia, and with the current and future development of mining and infrastructure development set to continue, it has been recommended that a strategic plan for biodiversity conservation be developed for the region (EPA 2014).

The Pilbara region is an important component of the Rangelands NRM region and part of the area is currently the focus of a collaborative landscape-scale conservation program – Pilbara Corridors – funded through the Australian Government. Founding partners of Pilbara Corridors are Rangelands NRM, the Western Australian Department of Parks and Wildlife (Parks and Wildlife) and Greening Australia. Key stakeholders of the region include Indigenous communities, mining companies, and pastoralists.

While the Pilbara Corridors program has commenced the work of bringing partner organisations together and initiating landscape-scale conservation works, there is now a need to better integrate this work, coordinate a collaborative approach to the program, prioritise activities for the future, and increasingly align stakeholder activities to the priorities. This will enable strategic design and investment to align with long term common goals and agreed strategic actions established for the next 10 to 20 years.

1.2 Aims of the Conservation Action Plan

The Conservation Action Planning (CAP) process will be used to develop and maintain a collaborative, long term conservation strategy for the Pilbara Bioregion.

Conservation Action Planning is a simple, transparent process that assesses biodiversity assets, threats to these assets and strategies for their conservation. It is acknowledged that the Pilbara is a large region with numerous assets, threatening processes, stakeholders and varying views and opinions. Consequently, there have been many workshops and other processes undertaken recently that address the above, at least in part, including:

- Carwardine J et al. (2014) Priority Threat Management for Pilbara Species Of Conservation Significance, CSIRO Ecosystems Sciences, Brisbane;
- A series of Environment Protection and Biodiversity Conservation (EPBC) Act threatened species workshops hosted by Parks and Wildlife in 2013,
- Western Australian Environmental Protection Authority (EPA) guidance for Pilbara (EPA, 2014) and Fortescue (EPA, 2013); and
• the Investment Framework for Environmental Resources (INFFER™) providing a natural asset identification process and investment opportunities as a component of the Rangelands NRM Regional Plan 2014-18 (Rangelands NRM, 2013).

This CAP process builds on this work and provides a systematic and adaptive management framework for knowledge, strategic plans and Indigenous and land manager perspectives. The planning provides the framework for:

• a landscape-scale scope to conservation (ie. landscapes and associated species, not just threatened species) and has a strong intent to represent the region’s stakeholders;
• the development of S.M.A.R.T. (ie. Specific, Measurable, Actionable, Realistic and Time-bound) goals and objectives;
• a shared monitoring and evaluation framework, leading to effective adaptive management and organisational alignment of activities;
• the development of a tangible strategy and action plan;
• long-term organisational partnerships & opportunities to drive effective, on-ground actions.

The Pilbara CAP will assist Pilbara land management and conservation stakeholders to align their work to an agreed plan.
Figure 1: Project Area for the Pilbara CAP
1.3 Current Context

1.3.1 Aboriginal Heritage

*Excerpt edited from Regional Development Australia (RDA 2013)*.

The Pilbara region is home to a great variety of traditional landowner language groups, many of which have a strong spiritual, physical and cultural connection to the Pilbara region and landscape. Aboriginal people are thought to have inhabited the region for up to 40,000 years. As such a rich cultural and historical indigenous heritage exists in the region, particularly in natural features such as rivers, hills and rock formations where people, animals and characters left traces of their journey across the landscape. These places may be valuable because of mythological lore (The Dreaming); because of past use as meeting places for special ceremonies; as burial grounds for ancestors; or as places where culture and history was recorded through rock art. The location of these important cultural sites within the natural landscape means there is considerable overlap between Aboriginal and natural heritage in the region.

Aboriginal heritage is an integral part of Aboriginal culture, customary law, and spirituality and its conservation is critical in ensuring that the unique indigenous culture in the Pilbara is not lost. Over five thousand indigenous heritage sites have been identified in the Pilbara region and are protected under the *Aboriginal Heritage Act* 1972. The geographical spread of places in the Aboriginal Heritage Sites Register largely reflects where Aboriginal heritage surveys have been conducted (EPA, 2007, cited by RDA, 2013). As heritage surveys are normally undertaken in response to development proposals, large areas of the region have not been surveyed. Therefore, site identification is biased towards areas subject to recent development. A number of particularly significant Aboriginal heritage sites have been recognised on a state, national and international level in the Pilbara. The most significant of these is Murujuga, also known as the Burrup Peninsula.

1.3.2 European Heritage

*Excerpt edited from Regional Development Australia (RDA 2013)*.

The European history of the Pilbara began at the coast in 1699 when William Dampier’s ship, ‘The Roebuck,’ laid anchor in the Dampier Archipelago at Malus Island. A series of surveys of the Pilbara coast was undertaken by teams of explorers under the command of Captain King in The Mermaid in 1818 and Captains Wickham and Stokes in the HMS Beagle between 1838 and 1841. In 1861 Frank T. Gregory was sent to report on the country inland of the coast previously reported by King (1818) and Stokes (as unfavourable. Gregory and his party used Nickol Bay, near present day Karratha, as a base and observed several large areas of land suitable for pastoralism, also naming the Ashburton, Fortescue, Sherlock, Yule, Harding, George, Strelley, De Grey and Oakover Rivers.

To encourage agricultural development, settlers were offered 40,000 ha of land upon compliance of stocking conditions. A number of townships were then established along the coast during the late 1800’s as part of the expansion of agricultural and pastoral activities, as well as the short-lived pearling industry and gold rush. The most famous towns are the now ghost town of Cossack, as well as Roebourne, Point Samson, Port Hedland, Marble Bar and Nullagine.
1.3.3 The Natural Environment

Excerpt edited from Cumulative environmental impacts of development in the Pilbara region (EPA, 2014)

The Pilbara IBRA region is approximately 179,000 square kilometres in size and is characterised by ancient and striking landscapes. It consists of four IBRA subregions – the Fortescue, Hamersley, Chichester and Roebourne (Figure 1). The Pilbara has a diversity of habitats, including mangroves, grassland savannahs, mountain ranges, gorges, wetlands and tropical woodlands. It is an area of very high biodiversity value, possessing high species richness, and many endemic flora and fauna species. It has 150 conservation significant flora species, the greatest reptile diversity in Western Australia, contains the richest known groundwater fauna diversity in Australia and is identified as one of only fifteen national biodiversity hotspots.

The rich faunal diversity of the Pilbara is still being described, with new species of vertebrates as well as large numbers of terrestrial and aquatic invertebrates being discovered. The high reptile diversity includes the greatest number of gecko species in Australia as well as high numbers of goannas, dragons and skink species. Terrestrial invertebrates show high levels of diversity and endemism with 375 species of ground dwelling spiders and 429 beetle species.

The Pilbara contains the richest known groundwater and cave-dwelling faunal diversity in Australia with over 1,000 species. Although the Pilbara is in the arid zone it has an abundance of wetlands, ranging from springs and river pools to salt marshes, claypans, and rockpools. Aquatic invertebrates show high diversity for an arid zone with about one-fifth of all species encountered currently believed to be endemic to the region (Pinder et al. 2010 in EPA, 2014). This high richness is considered to reflect the abundance of consistently fresh, permanent water maintained by freshwater aquifers. Of particular importance are the many groups of rare species that are restricted to a limited range of springs and spring-fed pools including those at Millstream Chichester National Park and Karijini National Park.

The ancient iron ore deposits of the Pilbara often support unique biodiversity values not present elsewhere in the region. Many of the links between the underlying geology and the biodiversity are still unknown.

1.3.4 Current Land Use

Excerpt edited from Cumulative environmental impacts of development in the Pilbara region (EPA, 2014)

The Pilbara region is almost exclusively Crown land, with freehold land generally concentrated along the coastline. Layered over the Crown land are various land uses that overlap one another. These include mining tenements, pastoral leases, formal conservation reserves, informal conservation areas, Aboriginal Reserves and Unallocated Crown Land. With this diversity of competing land uses, major constraints apply to any further allocation of land for conservation and many conservation reserves already have mining tenements over portions of them. Currently, only six per cent of the Pilbara IBRA region is held in the formal reserve system, well below the 17 per cent recognised internationally for
biodiversity protection. The conservation reserves are not proportionally distributed among the four subregions. By far the most threatened and least protected is the Fortescue subregion, with only 0.55% currently reserved for conservation. The Chichester and Roebourne subregions are marginally better represented with 3.95% and 3.45% respectively, and the Hamersley subregion has 12.88% held within the reserve system.

1.3.5 Pastoralism

*Excerpt edited from Cumulative environmental impacts of development in the Pilbara region (EPA, 2014)*

Approximately 65 per cent of the Pilbara is grazed by livestock. Van Vreeswyk *et al.* (2004) found that particular land systems have been considerably impacted as a result of preferential grazing by livestock. Preferential grazing can reduce or remove particular species and modify the composition of affected areas, particularly over the long term. Cattle numbers in the Pilbara increased throughout 1993 – 2009 (DAFWA, 2012, in EPA, 2014), with numbers more than doubling in the East Pilbara and De Grey Land Conservation Districts during this period and overstocking is reported as occurring across a number of Pilbara pastoral leases (DAFWA, 2012, in EPA, 2014). Some mining companies have purchased pastoral leases which are coincident with their mining activities. Other leases are held by Aboriginal communities, Government departments and other public sector organisations. Parks and Wildlife also manages a number of ex-pastoral leases.

1.3.6 Mining and Infrastructure

*Excerpt edited from Cumulative environmental impacts of development in the Pilbara region (EPA, 2014)*

The mining and energy sectors make a substantial contribution to economic activity in Western Australia and much of the activity occurs in the Pilbara. Over the past five years Western Australia’s iron ore industry has experienced a time of unprecedented growth. In 2011, the Pilbara region produced more than 90 per cent of Australia’s iron ore and approximately 95 per cent of Western Australia’s iron ore (DMP, 2012 in EPA, 2014). In addition, the Pilbara accounts for 80 per cent of the State’s entire production value from minerals and petroleum (DMP, 2012, in EPA, 2014). There has been a commensurate increase in proposals referred to the EPA for assessment during this period of growth.

There are approximately one billion tonnes per annum of approved mineral export capacity in either existing or approved ports on the Pilbara coast. Supporting this is a network of rail and road infrastructure connecting mine sites with these ports. There is more than 2,300 kilometres of rail infrastructure, comprising three major privately operated rail networks. In addition, there are also eight major rail projects approved totalling almost 1,300 kilometres, some of which are under construction.

1.3.7 Population and urban expansion

*Excerpt edited from Pilbara Planning and Infrastructure Framework (Department of Planning, 2012)*

Given that the Pilbara region is considered an economic powerhouse for Australia and is located close to key markets in Asia, it is predicted that by 2035, the region will have a resident population of some
140,000 persons, due to a more diverse economy that has capitalised on its competitive advantages. The region will have two cities: Karratha City (consisting of the Karratha and Dampier townsites) and Port Hedland City (consisting of Port Hedland and South Hedland). Each is expected to have a population of 50,000 by 2035. These major settlements will be supported by the Newman sub-regional centre (population 15,000). Other settlements (e.g. Paraburdoo, Tom Price and Onslow) will be planned to accommodate growth largely associated with expansion of the mining and oil and gas sectors. The larger population in the region's main urban centres will support a more diversified economic base, providing a much wider range of employment opportunities. More affordable housing and a greater housing choice, together with access to higher standards of education, health, recreation and other community services and a general improvement in amenity will result in many fly-in fly-out workers choosing to live in the Pilbara on a more permanent basis. Some will choose to retire in the region.

The estimated residential population of the Pilbara was 66,300 in 2013, with fly-in-fly-out employees boosting the population by approximately a further 50,000 people (Department of Regional Development, 2015).

1.4 Overview of the Open Standards Conservation Planning Framework

A range of problems are often cited when referring to Natural Resource Management, including:

- a lack of transparency and accountability in decision-making regarding allocation of funds;
- a lack of effective monitoring and evaluation of project outcomes; and
- the short term and isolated nature of conservation projects.

These problems are closely linked to the short term nature of funding cycles and shifting government priorities and policies at a state and federal level. Additionally, there is often a distinct gap between science and practice and a lack of collaboration between organisations working towards similar goals. Practitioners delivering on-ground projects rarely engage in meaningful dialogue with ecologists who are studying threatened ecosystems, communities and species and thinking about priorities for conservation more broadly. These problems can compromise the effectiveness and success of conservation projects.

In response to the problems detailed above, which are relevant across Australia and beyond, there exists a global movement called the Conservation Coaches Network (CCNET, http://www.ccnetglobal.com/, led by The Nature Conservancy and World Wide Fund for Nature) which is dedicated to addressing them. CCNET does this via the development and application of an adaptive management framework with free tools and guidance for conservation projects, referred to as the ‘Open Standards for the Practise of Conservation’ (Figure 2, CMP, 2013). The ‘Open Standards’ are supported by a network of workshop facilitators trained in their application.

This summary document follows the ‘Open Standards for the Practice of Conservation’ (CMP, 2013) in conjunction with Miradi conservation planning and project management software (www.miradi.org) as an internationally recognised and widely adopted framework for natural resource management planning and implementation. The Open Standards is a generic framework that has been developed into more
specific versions such as Conservation Action Planning (CAP, Figure 3), used by The Nature Conservancy and other conservation groups including Greening Australia, and Healthy Country Planning which is used by indigenous groups in Australia (CMP, 2013). The process combines research, analysis and desktop planning with collaborative, workshop-style planning that engages multiple stakeholders in an ongoing dialogue. This process encourages the development of measurable medium and long term goals for conservation action and is aimed at providing genuine solutions to the problems discussed above.

Whilst built on scientific principles, the approach recognises that there are often large gaps in ecological knowledge and data sets and hence a strong on-going adaptive management ethic is implied throughout the process. Further input from local knowledge and additional research to address data gaps are envisaged to refine this plan in the future.

The key steps in the process are:

- the identification of conservation assets and nested assets (i.e. ecosystems, communities and species);
- an analysis of the viability (i.e. health) of the conservation assets;
- a ranking of major threats to the conservation assets;
- the development of objectives, strategies and action steps to achieve the long-term conservation of the assets;
- the identification of practical monitoring indicators to support a robust monitoring, evaluation and adaptive management framework.

This document provides a summary of existing knowledge and strategies in line with this framework while recognising that further and continued input and local knowledge are required to advance the planning and implementation.
Figure 2: The ‘Open Standards’ adaptive management planning cycle

Figure 3: The major conceptual steps involved in Conservation Action Planning
1.5 Pilbara Conservation Action Planning Process

1.5.1 Workshop Process
- An introductory scoping workshop, held in Karratha in March 2015, detailed the CAP Process, key conservations assets, established an appropriate Project Area boundary and discussed future participation.
- A second workshop, held in in Karratha in May 2015, focused on reviewing draft conservation assets, assessing their condition and determining threats to these assets.
- A discussion group, held in Perth in July 2015, provided further input into the outcomes of second workshop.
- A third workshop, held in Perth in late July 2015, focused on developing conservation goals, strategies and actions.

1.5.2 Development of a Vision for the Pilbara
During the scoping phase of developing a Conservation Action Plan, a key step is to develop and refine a vision statement for the project. A common vision statement is key to the process and acts as a source of inspiration, describing the desired state or ultimate condition that the group is collaboratively working to achieve. During the scoping workshop, several key vision statements were developed (Table 1).

Table 1: Vision statements for the Pilbara CAP

<table>
<thead>
<tr>
<th>Natural Landscapes and Species</th>
<th>Healthy, improving, ecologically functional landscapes with abundant populations of threatened species and reduced numbers of invasive species.</th>
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<tbody>
<tr>
<td>Conservation Actions</td>
<td>Restoring native biota including successful translocations, best practice pastoralism and total grazing management and better fire management taken up by all major land managers.</td>
</tr>
<tr>
<td>People and Values</td>
<td>Realistic, well-resourced management across landscapes with raised awareness of cultural values and significance of biodiversity of the Pilbara, supported by more local employment including indigenous people with Traditional Owners involved in rangeland management and leadership</td>
</tr>
<tr>
<td>Planning and Sustainable Development</td>
<td>Resilient, enduring, co-ordinated, sustainable, robust strategic biodiversity management framework with resource company best practise, better integration of mining support and Traditional Owners actively engaged in successful partnerships/own enterprises in relation to land management and leadership on own country</td>
</tr>
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1.5.3 Existing Information and Data
As part of the workshop process detailed above, existing surveys, plans, reports, on-ground activities (including monitoring) and mapping were listed and collated to inform the planning process of the existing body of work already happening in the Pilbara. Where possible, conservations assets and other relevant information were mapped and entered into a spatial database managed by Gaia Resources (http://pilbaracorridors.com.au/the-pilbara/knowledge-management/).
1.5.4 Stakeholder Representation
The workshops aimed to encompass the views of all stakeholders for which the CAP process is relevant. The following sectors of the community were represented during the workshops:

- pastoralists;
- traditional owners and Aboriginal corporations (eg. Gumula Aboriginal Corporation);
- environmental non-government organisations: Greening Australia, Pilbara Mesquite Management Committee, Care for Hedland Environmental Association;
- mining companies: Fortescue Metals Group, Australian Premium Iron, Roy Hill Iron Ore, Citic Pacific Mining, Rio Tinto Iron Ore, BHP Billiton Iron Ore);
- Western Australian State Government: Department of Parks and Wildlife, Department of Agriculture and Food (DAFWA), Department of Mines and Petroleum (DMP), Environmental Protection Authority (EPA);
- Land Conservation District Committees (LCDC): De Grey LCDC;
- Regional NRM organisations: Rangelands NRM;
- local government: City of Karratha;
- Australian Government: Department of Environment;
- researchers (universities, IUCN) and
- environmental consultants and experts.

1.5.5 Process and next steps
The ‘Open Standards for the Practice of Conservation’ (Figure 2) and Conservation Action Planning (Figure 3) are ongoing project management cycles where products are delivered at different stages of the cycle. The key information from the Pilbara Conservation Action Planning process is stored within the Miradi software (https://www.miradi.org/) and this summary document represents one “product” from the process. Although several steps have been addressed to some extent during the workshop process and subsequent work, additional key steps require further development. These include:

- further prioritisation of strategies and action steps, and developing these into projects, as appropriate;
- developing program logic for strategies;
  - creating results chains that describe the theory of change
  - testing the links between undertaking strategies and achieving measurable outcomes;
- developing a monitoring framework with indicators of change to evaluate effectiveness of conservation actions;
- implementing the plan, including establishment of actions, timelines and budgets; and
- review of the plan, where appropriate.
2 Conservation Assets

2.1 Methodology for Identifying Assets
The first step in the CAP process involves the identification conservation assets (i.e. ecosystems, communities or species) that collectively represent the biodiversity of a region. The process assumes that by conserving representative examples of broad-scale communities and ecosystems, the majority of species will also be conserved. Therefore, the list of conservation assets need not be long and exhaustive; rather, it should be representative.

The asset selection process begins by identifying the coarse scale ecosystems and communities for conservation. Whether to lump ecosystems and communities together or split them into individual conservation assets can be a difficult decision; in general, ecosystems and communities should be combined together if they:

- co-occur across the landscape;
- share similar ecological processes;
- share similar threats.

The next step is to screen for species and communities occurring at smaller scales that are not well “nested” within the broader set of ecosystems or communities. That is, those species and communities whose conservation requirements are not met through the conservation of the coarse scale assets. This approach is known as the coarse filter – fine filter approach (Groves 2003). Examples of species often not captured by coarse-scale assets include:

- rare, threatened and endemic species;
- species with highly disjunct (spatially separate) populations or restricted distributions;
- keystone or highly interactive species (those that have a disproportionate influence on the structure and ecological function of the community); and
- wide-ranging species.

Species and communities that fall into the above categories may be captured by threatened species recovery programs or may need to be considered as separate conservation assets. In the context of the Pilbara, a recent process focusing on species of conservation of significance identified a range of strategies to improve the status of these species (Carwardine et al., 2014). This work has been considered in the Pilbara CAP process.

2.2 Description of Assets
During the Pilbara CAP workshop series, 13 broad assets were identified:

1) Offshore Islands;
2) Coastal Mangroves and Intertidal Mudflats;
3) Sandy Beaches and Dunes;
4) Spinifex Hummock Grassland on Plains with Shrubs and Trees (e.g. Acacia);
5) Tussock Grasslands on Plains;
6) Mulga Woodlands and Acacia Shrubland Communities;
7) Rivers, Creeks and Associated Floodplains on Open Plains;
8) Fortescue Marsh (EPA defined area);
9) Springs, Pools and Watercourses Associated with Gorges and Ranges
10) Clay Pans;
11) Subterranean Fauna Habitat;
12) Inland Mountain Ranges, Rocky Hills, Breakaways and Mesas; and
13) Rock Piles and Granites.

This section presents descriptions of each of these assets, including important “nested assets” (i.e. species and communities of conservation significance that are considered to be “captured” by the broader ecosystem). The list of nested assets is used to ensure that the requirements of threatened species are considered when ranking threats and developing conservation strategies for each ecosystem.
### Asset #1: Offshore Islands

#### Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Offshore islands of the Pilbara Bioregion; either Quaternary sand accumulations, or composed of basalt or limestone, or any combination of these three. Offshore islands range in size from 0.2 to 3,340 ha.</th>
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| Key locations                                                              | - Dampier Archipelago;  
- islands between Cape Preston and Onslow (as far west as Serrurier);  
- islands between Cape Lambert and Port Hedland;  
- islands off Poissonnier Point;  
- Bedout Island. |
| Total Area (% of bioregion)                                                | 24,707 ha (0.13%) |

#### Nested Assets

| Plant communities                                                          | Most islands, especially rocky ones, are dominated by *Triodia* spp. while hummock grasslands (*Spinifex longifolius*), with emergent trees and shrubs (eg. *Acacia coriacea, A. bivenosa*) are also found.  
|                                                                           | Mangrove communities on islands including internationally significant examples around the Dampier Archipelago. |
| Mammal assemblage                                                          | Rothschild’s Rock-wallaby (*Petrogale rothschildi*), Pale Field-rat (*Rattus tunneyi*), Northern Quoll (*Dasyurus hallucatus*) on Dampier Archipelago |
| Reptile assemblage                                                         | Sea Turtle breeding - Loggerhead Turtle (*Caretta caretta*), Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricata*) and Flatback Turtle (*Natator depressus*).  
|                                                                           | Pilbara Olive Python (*Liasis olivaceus barroni*) |
| Cultural heritage                                                          | A range of places including engraving, habitation sites, quarries, shell middens, stone arrangements, ethnographic sites – ceremonial sites and mythological sites. |
Asset #2: Coastal Mangroves and Intertidal Mudflats

**Summary**

| Description                                                                 | Mangroves occur in creek mouths and reef-sheltered embayments along the Pilbara coast. As mangrove communities are rare in arid conditions, those of the Pilbara are of great scientific importance. 80% of mangrove sites in the Pilbara region meet RNE (Register of the National Estate, Australian Heritage Commission) criteria, with 15 of these sites already listed and a further 46 sites nominated for listing, with some of these sites being recognised internationally as significant. Although there has been extensive loss of mangrove communities in the Pilbara regions due to industrial activities, those mangrove communities that still exist are in near pristine condition. Fringing mangroves of the region are typically backed by extensive intertidal flats that are characterised by a rich and diverse fauna of burrowing invertebrates, and are major habitats for migratory birds that use the mud flats as feeding grounds. |
| Key locations                                                               | Mouth of De Grey, Turner, Yule, Harding and Cane Rivers, Port Hedland, Balla Balla, Dixon Island, West Intercourse Island, Nickol Bay, Fortescue River delta, Maitland River delta, Robe River delta, Cossack to Harding Delta complex (highest diversity of mangrove plant species), Sherlock Bay, Ronsard Island |
| Total Area (% of bioregion)                                                | 124,693 ha (0.67%)                                                                 |

**Nested Assets**

| Plant communities              | The deep-water fringe is dominated by White Mangrove (*Avicennia marina*) with Spotted-Leaved Red Mangrove (*Rhizophora stylosa*) behind, and Spurred Mangrove (*Ceriops tagal*) on the landward edge. On gently sloping rises Club Mangrove (*Aegialitis annulata*) is found and River Mangrove (*Aegiceras corniculatum*) lines the seaward ends of creeks. |
### Mammal assemblage
- Nine species of microbats comprise a distinct community residing in mangroves with three endemic to these communities (*M. loriae, Nyctophilus arnhemensis* and *N. geoffroyi pallescens*; Water Rat (*Hydromys melanogaster*)

### Bird assemblage

### Cultural heritage
- Aboriginal middens – from antiquity back to around 7,000 years ago, ethnographic sites - ceremonial sites and mythological sites
Asset #3: Sandy Beaches and Dunes

<table>
<thead>
<tr>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
</tbody>
</table>
| **Key locations** | - Munda;  
- Port Hedland;  
- Point Sampson beaches;  
- 40 mile beach (South of Karratha);  
- Wickham; and  
- Cape Preston |
<p>| <strong>Total Area (% of bioregion)</strong> | 1,992 ha (0.01%) |</p>
<table>
<thead>
<tr>
<th>Nested Assets</th>
<th>Plant communities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Spinifex (<em>Spinifex longifolius</em>) hummock grasslands, with emergent trees and</td>
</tr>
<tr>
<td></td>
<td>shrubs (eg. <em>Acacia coriacea, A. bivenosa</em>)</td>
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<tr>
<td></td>
<td>• Note that Buffel grass (<em>Cenchrus ciliaris</em>) and Kapok (<em>Aerva javanica</em>) have</td>
</tr>
<tr>
<td></td>
<td>taken over most dunes.</td>
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<tr>
<td></td>
<td>• Coastal dune native tussock grassland dominated by <em>Whiteochloa airoides</em> (PEC,</td>
</tr>
<tr>
<td></td>
<td>Priority 3).</td>
</tr>
<tr>
<td></td>
<td>Reptile assemblage</td>
</tr>
<tr>
<td></td>
<td>• SEA TURTLES: Loggerhead Turtle (<em>Caretta caretta</em>), Green Turtle (*Chelonia</td>
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<tr>
<td></td>
<td>mydas*), Hawksbill Turtle (<em>Eretmochelys imbricata</em>), Flatback Turtle (*Natator</td>
</tr>
<tr>
<td></td>
<td>depressus*).</td>
</tr>
<tr>
<td></td>
<td>• <em>Lerista nevinae</em> (a species of skink) in the vicinity of Cape Lambert.</td>
</tr>
<tr>
<td></td>
<td>Bird assemblage</td>
</tr>
<tr>
<td></td>
<td>• INTERTIDAL SPECIES: numerous migratory species may frequent intertidal areas</td>
</tr>
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<td></td>
<td>although they are likely to be more reliant on the &quot;Coastal mangroves and</td>
</tr>
<tr>
<td></td>
<td>intertidal mudflats&quot; asset. Species include: including Eastern Curlew (<em>Numenius</em></td>
</tr>
<tr>
<td></td>
<td>madagascariensis*), Common Sandpiper (<em>Actitis hypoleucos</em>), Cattle Egret (<em>Ardea</em></td>
</tr>
<tr>
<td></td>
<td>ibis*), Ruddy Turnstone (<em>Arenaria interpres</em>), Sharp-tailed Sandpiper (<em>Calidris</em></td>
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<tr>
<td></td>
<td>acuminata*), Sanderling (<em>Calidris alba</em>), Red Knot (<em>Calidris canutus</em>),</td>
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<tr>
<td></td>
<td>Curlew Sandpiper (<em>Calidris ferruginea</em>), Pectoral Sandpiper (<em>Calidris melanotos</em>),</td>
</tr>
<tr>
<td></td>
<td>Red-necked Stint (<em>Calidris ruficollis</em>), Long-toed Stint (<em>Calidris subminuta</em>),</td>
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<tr>
<td></td>
<td>Great Knot (<em>Calidris tenuirostris</em>), Greater Sand Plover (<em>Charadrius leschenaulti</em>),</td>
</tr>
<tr>
<td></td>
<td>Lesser Sand Plover (<em>Charadrius mongolus</em>), Oriental Plover (<em>Charadrius veredus</em>),</td>
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<tr>
<td></td>
<td>White-winged Black Tern (<em>Chlidonias leucopterus</em>), Eastern Reef Egret (<em>Egretta</em></td>
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<td></td>
<td>sacra*), Oriental Pratincole (<em>Glareola maldivarum</em>), White-bellied Sea-eagle (*</td>
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<td></td>
<td>Haliaeetus leucogaster*), Caspian Tern (<em>Hydroprogne caspia</em>), Broad-billed</td>
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<td></td>
<td>Sandpiper (<em>Limicola falcinellus</em>), Bar-tailed Godwit (<em>Limosa lapponica</em>), Black-</td>
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<td></td>
<td>tailed Godwit (<em>Limosa limosa</em>), Little Curlew (<em>Numenius minutus</em>), Whimbrel (*</td>
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<tr>
<td></td>
<td>Numenius phaeopus*), Red-necked Phalarope (<em>Phalaropus lobatus</em>), Glossy Ibis</td>
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<tr>
<td></td>
<td>(<em>Plegadis falcinellus</em>), Pacific Golden Plover (<em>Pluvialis fulva</em>), Grey Plover</td>
</tr>
<tr>
<td></td>
<td>(<em>Pluvialis squatarola</em>), Common Tern (<em>Sterna hirundo</em>), Little Tern (<em>Sternula</em></td>
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<td></td>
<td>albifrons*), Lesser Crested Tern (<em>Thalasseus bengalensis</em>), Grey-tailed Tattler</td>
</tr>
<tr>
<td></td>
<td>(<em>Tringa brevipes</em>), Wood Sandpiper (<em>Tringa glareola</em>), Common Greenshank (*</td>
</tr>
<tr>
<td></td>
<td>Tringa nebularia*), Marsh Sandpiper (<em>Tringa stagnatilis</em>), Terek Sandpiper (<em>Xenus</em></td>
</tr>
<tr>
<td></td>
<td>cinereus*) (Johnstone et al. 2013).</td>
</tr>
<tr>
<td></td>
<td>Cultural heritage</td>
</tr>
<tr>
<td></td>
<td>• Asset contains burial sites, shell middens, ethnographic sites - ceremonial sites</td>
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<tr>
<td></td>
<td>and mythological sites – highly sensitive to ground disturbance activity eg.</td>
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<td></td>
<td>vegetation removal, fencing</td>
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</tbody>
</table>
Asset #4: Spinifex Hummock Grassland on Plains with Shrubs and Trees

<table>
<thead>
<tr>
<th>Summary</th>
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<tbody>
<tr>
<td>Description</td>
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<tr>
<td>Much of the Pilbara bioregion comprises spinifex hummock grasslands (<em>Triodia</em> spp.) on plains with emergent shrubs (e.g., <em>Acacia inaequilatera</em>) and trees (<em>Corymbia hamersleyana</em>), generally with percentage cover of 10–30%. An assessment of land systems (van Vreeswyk <em>et al.</em>, 2004) found that most (88%) hummock grassland sites were in good condition, with 6% in fair and 6% in poor condition. Spinifex is a fire adapted plant, and there has been frequent burning throughout history, including &quot;fire-stick farming&quot; practices of the Aboriginals. Termite mounds within this asset act as refugia for a range of invertebrates, small mammals and reptiles. The value of Spinifex Sandplains in supporting fauna assemblages is often closely related to their history, with areas retaining a mosaic of fire ages often providing the best habitat.</td>
</tr>
<tr>
<td>Key locations</td>
</tr>
<tr>
<td>* Asset is widespread throughout the region</td>
</tr>
<tr>
<td>Total Area (% of bioregion)</td>
</tr>
<tr>
<td>6,617,160 ha (35.7%)</td>
</tr>
</tbody>
</table>

Plate 3: Coastal Dune community
(Photo credit: Vicki Long, Astron Environmental)
### Plant assemblage
- Twenty-one species of hummock grasses have been recorded in the Pilbara with the most common species being *Triodia lanigera*, *T. longiceps*, *T. pungens* and *T. wiseana*.
- **THREATENED PLANTS or COMMUNITIES:** Stony saline plains of the Mosquito Land System (PEC), known to contain two endemic Acacias;

### Reptile assemblage
- In the spinifex grasslands, reptiles dominate. Ants and termites feed on the spinifex seed and the reptiles in turn feed on the ants.
- Species include the Pilbara Olive Python (*Liasis olivaceus barroni*), Woma Python (*Aspidites ramsayi*), Black-headed Python (*Aspidites melanocephalus*), Pin-striped Finesnout Ctenotus (*Ctenotus nigrilineatus*) and numerous other taxa.

### Mammal assemblage
- Greater Bilby (*Macrotis lagotis*), Brush-tailed Mulgara (*Dasycercus blythi*), Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti*), Lakeland Downs Mouse (*Leggadina lakedownensis*).

### Threatened birds
- Australian Bustard (*Ardeotis australis*), Bush Stone-curlew (*Burhinus grallarius*), Princess Parrot (*Polytelis alexandrae*), Major Mitchell’s Cockatoo (*Cacatua leadbeateri*), Peregrine Falcon (*Falco peregrinus*)

### Cultural heritage
- Artefact scatters are often concentrated in vicinity of ephemeral water bodies. Ethnographic sites – ceremonial sites and mythological sites. Archaeological sites, specifically habitation sites adjacent to water.

---

**Plate 4: Spinifex Hummock Grassland community (Photo credit: Greening Australia)**
### Asset #5: Tussock Grasslands on Plains

<table>
<thead>
<tr>
<th>Summary</th>
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</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
</tbody>
</table>
| **Key locations** | • Hamersley Station, West Angeles;  
• Roebourne Plains coastal grasslands, Sherlock Station and Roebourne Common, Airport Reserve (between Roebourne and Karratha), Seven Mile Creek;  
• Newman – old aero/glider club grounds. |
| **Total Area (% of bioregion)** | 624,704 ha (3.37%) |

<table>
<thead>
<tr>
<th>Nested Assets</th>
</tr>
</thead>
</table>
| **Plant assemblage** | • Tussock grasses vary from dense, well developed plants (eg. Eriachne benthamii) to open forms (eg. Chrysopogon fallax). Other common tussock grasses include Aristida holathera var. holathera, A. latifolia, Astrebla pectinata, Chrysopogon fallax, Eragrostis eriopoda, E. xerophila, Eriachne benthamii, E. obtusa, Eulalia aurea, Paraneurachne muelleri and Themeda triandra.  
• THREATENED PLANTS or COMMUNITIES: Barley Mitchell Grass (Astrebla pectinata) Grassland on clay or loamy soils, Kangaroo Grass (Themeda) Grasslands - Hamersley Station grass plain, Eragrostis sp. (xerophila) grasslands on Roebourne Plains, West Angeles Cracking Clays (PEC), Wona Land System (PEC), Roebourne Plains gilgai grasslands (PEC),  
• Brockman Iron cracking clay communities of the Hamersley Range (PEC) |
| **Reptile assemblage** | • |
| **Mammal assemblage** | • Planigales (eg. Long-tailed Planigale Planigale ingrami, Common Planigale Planigale maculata) inhabit cracking clays, includes new species found at West Angelas |
| **Bird assemblage** | • Australian Bustard (Ardeotis australis) |
| **Cultural heritage** | • Surface (some outcrops) grinding sites, artefact scatters, some Tussock grassland areas are more attractive for food and material resources. Rock art (engravings) on exposed granophyre (sometimes low lying), ethnographic sites |
Asset #6: Mulga Woodlands and Acacia Shrubland Communities

<table>
<thead>
<tr>
<th>Summary</th>
</tr>
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<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td><em>Acacia aneura</em> (Mulga) is the predominant species in rangelands to the south of the Pilbara and is often the dominant species in woodlands or tall shrublands. Where Mulga is recorded in the north and west of the Pilbara it is most commonly a component of hummock grassland communities.</td>
</tr>
<tr>
<td><em>Acacia xiphophylla</em> (snakewood) shrublands which are often mid-height shrublands, are common throughout the Pilbara, in particular in the south-west areas.</td>
</tr>
<tr>
<td>Mulga is susceptible to fire and its range is restricted by the frequency and intensity of fire which increases in spinifex-dominated areas. It may occur in ‘fire refuge’ areas on spinifex covered ranges. Mulga typically occurs as low woodland over bunch grasses on fine textured soils in valley floors and are sensitive to hydrological changes. There is a large genetic diversity of Mulga – 26 species, and the Pilbara is the northern most occurrence.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Red Hill Station (Mulga Communities of the Fortescue Valley);</td>
</tr>
<tr>
<td>• Balfour Downs, Mulga Downs;</td>
</tr>
<tr>
<td>• Mt Bruce, Mt Newman, Mt Robertson/Giles, Pamelia Hill;</td>
</tr>
<tr>
<td>• Roy Hill, Munyra claypan, Wonnamunna.</td>
</tr>
</tbody>
</table>
### Nesting Assets

<table>
<thead>
<tr>
<th><strong>Total Area (% of bioregion)</strong></th>
<th><strong>970,607 ha (5.24%)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nested Assets</strong></td>
<td><strong>Plant assemblage</strong></td>
</tr>
<tr>
<td></td>
<td>- open Mulga (Acacia aneura s.l.) woodlands and shrublands (with A. subcontorta) over tussock grasses (Themeda triandra, Chrysopogon fallax, Eragrostis spp.) and soft hummock grasslands (T. melvillei, T. pungens);</td>
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<td></td>
<td>- Snakewood shrublands and hard hummock grasslands with emergent (Corymbia hammersleyana / C. semiciara) or snappy gums.</td>
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<tr>
<td></td>
<td><strong>Reptile assemblage</strong></td>
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<tr>
<td></td>
<td>- Comprises species often widespread further to the south of the Pilbara, including arboreal species Strophurus wellingtonae, Caimanos amphiboluroideus, Varanus caudolineatus (Doughty et al. 2011).</td>
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<tr>
<td></td>
<td><strong>Mammal assemblage</strong></td>
</tr>
<tr>
<td></td>
<td>- Several significant species have been recorded within this asset such as Pilbara Leaf-nosed Bat (Rhinonicteris aurantia), Western Pebble-mound Mouse (Pseudomys chapmani), Long-tailed Dunnart (Sminthopsis longicaudata), although most of these species are not specifically associated with it.</td>
</tr>
<tr>
<td></td>
<td><strong>Invertebrates</strong></td>
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<td></td>
<td>- Short Range Endemic (SRE) invertebrates, high diversity of ants.</td>
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<td></td>
<td><strong>Bird assemblage</strong></td>
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<tr>
<td></td>
<td>- Suite of birds - including a suite of parrots and the edge of their range</td>
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<tr>
<td></td>
<td>- The mulga woodlands (see also Burbidge et al. 2000, 2010b) are important habitat for the Desert Gerygone (Gerygone fusca mungi), Inland Thornbill (Acanthiza apicalis), Slaty-backed Thornbill (Acanthiza robustirostris), Chestnut-rumped Thornbill (Acanthiza uropygialis), Yellow-rumped Thornbill (Acanthiza chrysorrhoa), Grey Honeyeater (Conopophila whitei), Spiny-cheeked Honeyeater (Acanthagenys rufogularis), Red-capped Robin (Petroica goodenovii), Hooded Robin (Melanodryas cuccullata), White-browed Babbler (Pomatostomus superciliosus), Crested Bellbird (Oreoica gutturalis), and Grey Butcherbird (Cracticus torquatus). Many of these species are at their northern limit in the Pilbara.</td>
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<tr>
<td></td>
<td>- Night Parrot (Pezoporus occidentalis)</td>
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<td></td>
<td><strong>Cultural heritage</strong></td>
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<tr>
<td></td>
<td>- Wide range of cultural remains, particularly artefact scatters some of which are probably habitation sites – plant community attractive for both food and material. Ethnographic sites.</td>
</tr>
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</table>
Asset #7: Rivers, Creeks and Associated Floodplains on Open Plains

<table>
<thead>
<tr>
<th>Summary</th>
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<tbody>
<tr>
<td><strong>Description</strong></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Key locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• De Grey River, Ashburton River, Fortescue River, Yule River, Sherlock River, Cane River, Robe River, Harding River, Maitland River, Turner River, Miaree Pool</td>
</tr>
</tbody>
</table>

| Total Area (% of bioregion) | 945,461 ha (5.1%) |

<table>
<thead>
<tr>
<th>Nested Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant communities</strong></td>
</tr>
</tbody>
</table>
### Reptile assemblage
- This asset of not considered to support a distinct reptile assemblage, due to the lack of extensive well-developed habitats that are distinct from surrounding areas, and the effects of past arid climate cycles (Doughty et al. 2011).
- Supports Pilbara Olive Python (*Liaisia olivaceus barroni*).

### Mammal assemblage
- Northern Quoll (*Dasyurus hallucatus*), Greater Bilby (*Macrotis lagotis*), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*), Ghost Bat (*Macoderma gigas*), Northern Brush-tailed Possum (*Trichosurus arnhemensis*).

### Bird assemblage
- River valleys and permanent pools on the Yule, Turner and De Grey provide a refuge for birds, within fringing forests/woodlands of river gums and a number of species are more common along these watercourses than in other habitats. They include Black Bittern (*Ixobrychus flavicollis*), Peaceful Dove (*Geopelia striata placida*), Australian Ringneck (*Platycercus zonarius*), Blue-winged Kookaburra (*Dacelo leachii*), Black-tailed Treecreeper (*Climacteris melanura*), Red-browed Pardalote (*Pardalotus rubricatus*), and Star Finch (*Neochmia ruficauda subcarescens*).

### Cultural heritage
- Petroglyphs on rock walls are sites of special Aboriginal significance, artefact scatters, sub-surface remains, high potential for quite dense sites, NB: pools along Fortescue east of Fortescue Marsh and along northern shore. Ethnographic sites – ceremonial sites and mythological sites. High cultural values for permanent water (mythological and large habitation sites).

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![Plate 7: Riparian community (Photo credit: Greening Australia)](image-url)
# Asset #8: Fortescue Marsh (EPA defined area)

## Summary

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<th>Description</th>
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<tr>
<td>The Fortescue Marsh is the largest ephemeral wetland in the Pilbara region and is recognised as nationally important. It is rich in plant and animal species of high conservation value and is part of an ancient and complex array of alluvial aquifers and groundwater systems. It is also at the heart of an important mining province and long-standing pastoral industry, and has high cultural and heritage importance to the Indigenous peoples of the region. A Nationally Important Wetland, it is proposed for the Fortescue Marsh to be listed as a RAMSAR wetland.</td>
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<thead>
<tr>
<th>Total Area (% of bioregion)</th>
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<tr>
<td>583,630 ha (3.15%)</td>
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</tbody>
</table>

## Nested assets

### Plant communities

- Extensive areas of high quality Mulga woodland on north side of Marsh;
- Several new and undescribed flora species;
- Possibility of a monotypic endemic genus;
- Extensive samphire shrublands, with four endemic species associated with these;
- Numerous populations of several Priority Flora species;
- Several range-end or disjunct outlying populations of SW or Kimberley (tropical) species.

### Mammal assemblage

- Northern Quoll (*Dasyurus hallucatus*), Brush-tailed Mulgara (*Dasycercus blythi*), and Bilby (*Macrotis lagotis*).

### Invertebrates

- Endemic or near-endemic invertebrates in both saline marsh and fringing freshwater claypans;
- Richness comparable to Pilbara average of 150 species per wetland but Marsh has a disproportionately large number of significant species compared to other Pilbara wetlands;
- Potential for SRE (including troglofauna) assumed to be high;

### Bird assemblage

- Contemporary Night Parrot (*Pezoporus occidentalis*) record from Minga Well, adjacent the Marsh (Davis and Metcalf, 2008);
- An arid wetland for waterbirds of national importance, 260,000 – 276,000 individuals from 47 species present when inundated between 1999, 2000 and 2003.

### Cultural heritage

- Cultural asset – all one asset from the origin of the Fortescue to the river mouth – values relate to water. Many archaeological sites along northern shore, several sites of special Aboriginal importance.
- NB: difference between archaeological and Aboriginal importance = cultural heritage. Ethnographic sites. High cultural values for permanent pools (large and unusual habitation sites)
Plate 8: Fortescue Marsh samphire community (Photo credit: Jeff Pinder, Parks and Wildlife)

**Asset #9: Springs, Pools and Watercourses Associated with Gorges and Ranges**

**Summary**

Water pools in the Pilbara provide an important source of water in what is largely a dry landscape, and thus attract a diversity of fauna. There are numerous springs, pools and watercourses associated with gorges and ranges, some of which are relatively small and others occur in deeply incised gorges, up to 100 m deep, containing extensive permanent spring-fed streams and pools.

Rare and/or restricted aquatic fauna elements are present, especially in some permanently flowing springs, including those in Millstream and Karijini National Parks.

<table>
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<th>Description</th>
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<tbody>
<tr>
<td>Water pools in the Pilbara provide an important source of water in what is</td>
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<tr>
<td>largely a dry landscape, and thus attract a diversity of fauna. There are</td>
</tr>
<tr>
<td>numerous springs, pools and watercourses associated with gorges and ranges,</td>
</tr>
<tr>
<td>some of which are relatively small and others occur in deeply incised gorges,</td>
</tr>
<tr>
<td>up to 100 m deep, containing extensive permanent spring-fed streams and pools.</td>
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</table>

<table>
<thead>
<tr>
<th>Key locations</th>
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</thead>
<tbody>
<tr>
<td>Millstream Pools within Chichester Range - wetland of national significance;</td>
</tr>
<tr>
<td>Karijini Gorges - wetland of national significance;</td>
</tr>
<tr>
<td>Waterfalls of Hamersley Range with undescribed plant species;</td>
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<tr>
<td>Running Waters and Skull Springs on the Oakover;</td>
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<tr>
<td>Weeli Wolli Spring in the Fortescue;</td>
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<tr>
<td>Nyeetbury Spring on the Robe River;</td>
</tr>
<tr>
<td>Calcretes in Fortescue Valley near Wittenoom between BHPIO Rail and Millstream.</td>
</tr>
</tbody>
</table>

| Total Area (% of bioregion) | 89,729 ha (0.48%) |
### Nested Assets

<table>
<thead>
<tr>
<th>Plant communities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Emergent vegetation of river and creek pools in the Pilbara can include Schoenoplectus subulatus and Typha domingensis. These species typically form dense beds along banks and shallower backwaters.</td>
</tr>
<tr>
<td>- Cyperus vaginatus and Eleocharis spp. May also occur in briefly inundated sites and the shallowly inundated edges of pools and springs.</td>
</tr>
<tr>
<td>- Endemic flora includes Millstream Fan-palm.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reptile assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Pilbara Olive Python (Liaisis olivaceus barroni)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mammal assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Northern Quoll (Dasyurus hallucatus), Pilbara Leaf-nosed Bat (Rhinonicteris aurantius), Ghost Bat (Macroderma gigas)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Invertebrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>- High potential for Short Range Endemic Invertebrates</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bird assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Watercourses, springs and pools provide a refuge for birds, within fringing vegetation and a number of species are more common along these watercourses than in other habitats. They include Black Bittern (Ixobrychus flavicollis), Peaceful Dove (Geopelia striata placida), Australian Ringneck (Platycercus zonarius), Blue-winged Kookaburra (Dacelo leachii), Black-tailed Treecreeper (Climacteris melanura), Red-browed Pardalote (Pardalotus rubricatus), and Star Finch (Neochmia ruficauda subclarescens).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cultural heritage</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Cultural assets, archaeological deposits (currently oldest dated to 47,000 years ago), habitation sites, several sites of special Aboriginal importance, rock art (paintings, engravings), of Hamersley Gorges, Weeli Wolli Springs. Ethnographic sites. High cultural values for permanent pools (large and unusual habitation sites)</td>
</tr>
</tbody>
</table>

---

Plate 9: Pool habitat at Karijini National Park  
(Photo credit: Melinda Salemi)
### Asset #10: Clay Pans

<table>
<thead>
<tr>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Claypans and clay flats capture a large component of the Pilbara wetland flora, and their scattered occurrence across the lowlands of the region poses difficulties in capturing their diversity in the reserve system.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay flats and claypans and lowland creeks with fine sediments are typically highly turbid and also display high numbers of rare plant taxa. Claypans and clay flats have rich assemblages of annual taxa and are also important for invertebrates with a number of endemics and specialists being recorded in regional surveys.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Freshwater claypans downstream of the Fortescue Marsh - Goodiadarrie Hills on Mulga Downs Station (PEC – Priority 1)</td>
</tr>
<tr>
<td>• Gnalka Gnoona Claypan, Moreton Pool, Cane River Claypan, Paradise Pool, DeGrey Claypan, Munreemya Billabong, Coppin Pool, Sweet Well Claypan, Roy Hill Claypan, Mulga Downs Outcamp Claypan, Ethel Creek Claypan, Berringarra Claypan</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Area (% of bioregion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>240,821 ha (1.3%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nested Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant communities</strong></td>
</tr>
<tr>
<td>• Small claypans are often devoid of emergent plants. At larger claypans and crab-hole flats, the dominant vegetation is usually emergent grass, commonly <em>Eragrostis benthamii</em> but sometimes <em>Leptochloa</em> spp. and <em>Pseudoraphis spinescens</em>. <em>Eucalyptus victrix</em> also occurred across the bed and along the margins of some claypans.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reptile assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mammal assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Invertebrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The faunas of springs and claypans show some differentiation between drainage basins. Species are generally less mobile and less likely to be moved around by floods, possibly contributing to subregionally distinctive faunas.</td>
</tr>
<tr>
<td>• A number of endemics were collected only in turbid wetlands (claypans and/or turbid pools), including several rotifers, hydrobiid snails, the new fairy shrimps (<em>Branchinella pinderi</em> and <em>B. mcaerae</em>), new clam shrimps (<em>Limnadia</em> sp. nov. and <em>Eocyzicus</em> sp. nov.) and ostracods (new <em>Paralimnocythere</em>, <em>Limnocythere</em>, <em>Bennelongia</em> and <em>Cypretta</em>). Several other taxa that occurred only once during the survey may also be claypan specialists, including two new Lynceus clam shrimps, a new genus of chydorid Cladocera and several additional ostracods.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bird assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Input required</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cultural heritage</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ethnographic sites – ceremonial sites and mythological sites. Habitation sites.</td>
</tr>
</tbody>
</table>
### Asset #11: Subterranean Fauna Habitat

<table>
<thead>
<tr>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stygoфаuna</strong> are aquatic animals that live in groundwater. <strong>Troglofauna</strong> are air-breathing terrestrial animals that live underground in caves and smaller air-filled voids (meso-caverns) beneath the ground.</td>
</tr>
</tbody>
</table>

The Pilbara is an important region for subterranean fauna. A feature of the Pilbara is that stygofauna occur across most of the landscape, often where the depth to groundwater is considerable. Another feature is high endemicity: on the basis of current taxonomy, 98% of the stygobites and 83% of the other groundwater species occur only within the region (Halse et al. 2014).

<table>
<thead>
<tr>
<th>Key locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ethel Gorge / Ophthalmia Basin Aquifer Stygobiont Community – Threatened Ecological Community;</td>
</tr>
<tr>
<td>• Robe River Valley;</td>
</tr>
<tr>
<td>• Millstream Aquifer.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nested Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invertebrates</td>
</tr>
<tr>
<td>• Various stygofauna and troglofauna species with restricted occurrence.</td>
</tr>
</tbody>
</table>
Asset #12: Inland Mountain Ranges, Rocky Hills, Breakaways and Mesas

<table>
<thead>
<tr>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>The Chichester Range, Hamersley Range, Ophthalmia Range and Barlee Range consist mostly of rugged, sparsely vegetated hills rising to 1,250 m. In the Chichester and Hamersley Ranges many gorges contain permanent water which is otherwise scarce in the region. The gorges vary from wide, open-sided valleys (e.g. Yampire Gorge) to narrow gorges with precipitous cliffs (e.g. Hancock Gorge). The vegetation of these systems is typically hummock grasses (<em>Triodia</em> spp.) that occur on nearly all hills, ridges and ranges in the Pilbara. Soils are rocky skeletal sands, loams and clays with dense surface mantles of pebbles and cobbles and frequent rock outcrop.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Millstream Chichester National Park;</td>
</tr>
<tr>
<td>• Karijini National Park;</td>
</tr>
<tr>
<td>• Hamersley Range;</td>
</tr>
<tr>
<td>• Chichester Range;</td>
</tr>
<tr>
<td>• Mungaroona Range Nature Reserve.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Area (% of bioregion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7,649,205 ha (41.3%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nested Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant communities</strong></td>
</tr>
<tr>
<td>• Snappy Gum (<em>Eucalyptus leucophloia</em>) over Spinifex (<em>Triodia</em> spp.).</td>
</tr>
<tr>
<td>• The bottoms of many gorges have woodlands of River Red Gum, Coolibah, Melaleuca and Acacia and in some areas, thickets of fig (<em>Ficus brachypoda</em>).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reptile assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reptiles species from these systems (steep rock formations with numerous crevices interspersed by patches of skeletal soils with spinifex grassland) include a number of Pilbara endemics such as <em>Diplodactylus galaxias</em>, <em>D. savagei</em>, <em>Gehyra punctata</em> and <em>G. 'fenestra’; Egemia cygnitos, E. epsisolus, E. pilbarensis, Ctenotus rutilans and Morethia ruficauda exquisita; Ramphotyphlops ganei</em> (Doughty et al. 2011).</td>
</tr>
<tr>
<td>• Pilbara Olive Python (<em>Lialis olivaceus barroni</em>)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mammal assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Northern Quoll (<em>Dasyurus hallucatus</em>), Pilbara Leaf-nosed Bat (<em>Rhinonicteris aurantia</em>) Ghost Bat (<em>Macroderma gigas</em>), Rothschild’s Rock-wallaby (<em>Petrogale rothschildi</em>) are supported in areas featuring deep caves and crevices, overhangs, boulders and outcropping.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key habitat areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mountain top flora - refuge from fire for a large number restricted flora;</td>
</tr>
<tr>
<td>• Deep Gorges in Hamersley Range - protection for fire intolerant species;</td>
</tr>
<tr>
<td>• Bat roosts (especially Pilbara Leaf-nosed Bat and Ghost Bat) (McKenzie and Bullen, 2009);</td>
</tr>
<tr>
<td>• Abandoned underground mines – Warrawoona, Bamboo Creek, Lalla Rookh, Comet Mine, Copper Hills.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Invertebrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Potential for Short Range Endemic invertebrates</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bird assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The central highlands or hilly interior support a number of bird species that are rare elsewhere, including the Striated Grasswren (<em>Amytornis striatus whitei</em>), the Rufous-crowned Emu-wren (<em>Stipiturus ruficeps</em>), Grey-headed Honeyeater</td>
</tr>
</tbody>
</table>
(Ptilotula keartlandi), Western Bowerbird (Ptilonorhynchus guttatus), Spinifex-bird (Eremiornis carteri) and Painted Finch (Emblema pictum).

- Peregrine Falcon (*Falco peregrinus*)

### Cultural heritage

- Cultural assets (habitation sites) in Hamersley caves and elsewhere. Ethnographic sites – ceremonial sites and mythological sites. A wide range of open sites including artefact scatters and grindstone quarries, burial sites, stone arrangements, walled rock shelters.

**Plate 11: Wittenoom Gorges in the Hamersley Ranges (Photo credit: Karen O’Brien)**

### Asset #13: Rock Piles and Granites

<table>
<thead>
<tr>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>Comprises two key areas – the boulder field present at Burrup Peninsula and the abundant granite tors existing on the Abydos Plain. The Burrup Peninsula represents and evolutionary refuge for flora (vegetation is largely different to mainland) and also a minor centre for terrestrial gastropods.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burrup Peninsula (Murujuga National Park) (DEC, 2013)</td>
</tr>
<tr>
<td>Abydos Plain</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Area (% of bioregion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>664,229 ha (3.58%)</td>
</tr>
</tbody>
</table>

### Nested Assets

<table>
<thead>
<tr>
<th>Plant communities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distinct vegetation communities in comparison to other areas of the Pilbara.</td>
</tr>
</tbody>
</table>
- Significant outcrops and boulder piles support dense *Acacia* thickets at their periphery due to water accumulation. Rock fig (*Ficus brachypoda*) is also common.

### Reptile assemblage
- Pilbara Olive Python (*Liasis olivaceus barroni*);
- Regional endemics such as *Varanus pilbarensis*.

### Mammal assemblage
- Rothschild's Rock-wallaby (*Petrogale rothschildi*), Northern Quoll (*Dasyurus hallucatus*), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*), Ghost Bat (*Macroderma gigas*).

### Invertebrates
- High potential for Short Range Endemic invertebrates.

### Cultural heritage
- Cultural assets (rock art and campsites) at a range of sites;
- Largest ‘gallery’ of petroglyphs with the greatest abundance and highest concentration of any known site in the world (Murujuga);
- A lot of small scale (un-mappable) basalt piles e.g. Rocklea land-system or granites (Boolaloo land system);
- Ceremonial sites, mythological sites;
- Stone arrangements, grinding patches.

---

**Plate 12: Rock Piles on the Abydos Plain (Photo credit: Greening Australia)**

### 2.3 Distribution of Conservation Assets
As part of the CAP process, the conservation assets were mapped using existing data sets (eg. vegetation (*Beard et al.*, 2013), land systems, a digital elevation model, hydrological features) and some manual interpretation and alteration, to best represent the assets spatially (**Figure 4**). Several of the assets are relatively limited in extent (**Table 2**), with a three representing <1% of the area of the Pilbara,
whereas two assets dominate, comprising over 75% of the aerial extent of the Pilbara Bioregion (Table 2).

**Table 2: Extent of conservation assets within the Pilbara bioregion**

<table>
<thead>
<tr>
<th>Asset</th>
<th>Area (ha)</th>
<th>Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inland Mountain Ranges, Rocky Hills, Breakaways and Mesas</td>
<td>7,600,021</td>
<td>42.5</td>
</tr>
<tr>
<td>Spinifex Hummock Grassland on Plains with Shrubs and Trees</td>
<td>5,967,843</td>
<td>33.4</td>
</tr>
<tr>
<td>Rivers, Creeks and Associated Floodplains on Open Plains</td>
<td>944,301</td>
<td>5.3</td>
</tr>
<tr>
<td>Mulga Woodlands and Acacia Shrubland Communities</td>
<td>930,271</td>
<td>5.2</td>
</tr>
<tr>
<td>Rock Piles and Granites</td>
<td>663,017</td>
<td>3.7</td>
</tr>
<tr>
<td>Tussock Grasslands on Plains</td>
<td>624,295</td>
<td>3.5</td>
</tr>
<tr>
<td>Fortescue Marsh (EPA defined area)</td>
<td>583,060</td>
<td>3.3</td>
</tr>
<tr>
<td>Coastal Mangroves and Intertidal Mudflats</td>
<td>259,722</td>
<td>1.4</td>
</tr>
<tr>
<td>Clay Pans</td>
<td>240,130</td>
<td>1.3</td>
</tr>
<tr>
<td>Springs, Pools and Watercourses Associated with Gorges and Ranges</td>
<td>29,198</td>
<td>0.16</td>
</tr>
<tr>
<td>Offshore Islands</td>
<td>24,197</td>
<td>0.14</td>
</tr>
<tr>
<td>Sandy Beaches and Dunes</td>
<td>1,992</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Total Area</strong></td>
<td><strong>17,868,049</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Figure 4: Distribution of broad conservation assets within the Pilbara bioregion (layers created by Gaia Resources, 2015)
3 Viability (Health) of Conservation Assets

3.1 Methodology for Assessing Viability (Health) of Assets

The assessment of viability (or overall health) of the conservation assets was conducted using a simple ranking process that examines indicators based on four categories: very good, good, fair and poor (Table 3).

Several key questions were posed to help understand the viability (health) of the identified assets as follows:

- **Size (total area):** has there been large-scale clearance of this asset (how much, where, what, % of total distribution)?
- **Condition:**
  - Fauna/Flora – are the assemblages intact (what’s lost, declining, still present)?
  - Water quality – is water quality (turbidity, organics, chemistry) within reasonable parameters?
- **Landscape Context:**
  - Fire regime – do regimes maintain healthy flora and fauna assemblages (if not, what is the issue, where, how significant)?
  - Connectivity – are native species able to move between key habitat areas (if not, what are the issues and where, how significant)?
  - Hydrological regime – are natural flows / hydrological regimes able to maintain the health and condition of this asset (or has this been disrupted and causing significant issues – where, what)?

**Table 3: Criteria used to rank viability (health) of conservation assets**

<table>
<thead>
<tr>
<th>Level</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good</td>
<td>Most desirable status; Requires little intervention for maintenance</td>
</tr>
<tr>
<td>Good</td>
<td>Indicator within acceptable range of variation; Some intervention required for maintenance</td>
</tr>
<tr>
<td>Fair</td>
<td>Outside acceptable range of variation; Requires human intervention</td>
</tr>
<tr>
<td>Poor</td>
<td>Restoration very difficult; May result in complete loss / extinction</td>
</tr>
</tbody>
</table>

3.2 Viability (Health) Assessment Results

The results of the discussion of these questions against the identified assets are presented overleaf.
### Table 4: Assessment of viability (health) of conservation assets

<table>
<thead>
<tr>
<th>Size</th>
<th>Condition</th>
<th>Landscape Context</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Offshore Islands</strong></td>
<td>• 80 – 100 islands.</td>
<td>• fire regime – require more information, 5-6 islands have been burnt by lightning.</td>
</tr>
<tr>
<td></td>
<td>• significant variation in terms of intactness, development (e.g.</td>
<td>• connectivity – naturally isolated.</td>
</tr>
<tr>
<td></td>
<td>infrastructure) and resultant condition of flora and fauna assemblages.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• archipelago islands are in better condition than the sandy islands.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• islands with bird nesting colonies are in worse condition – birds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>introduce buffel grass seed.</td>
<td></td>
</tr>
<tr>
<td><strong>Coastal Mangroves and Intertidal Mudflats</strong></td>
<td>• mostly intact.</td>
<td>• disruption around town sites due to changes in hydrological regimes, pastoral outlets, infilling of coastal creeks, discharges, new roads</td>
</tr>
<tr>
<td></td>
<td>• fauna – limited knowledge, although condition considered good.</td>
<td>• mangroves aren’t on pastoral leases as the pastoral lease is 40 m above high water mark.</td>
</tr>
<tr>
<td></td>
<td>• flora – no weeds, no loss of mangrove species, water quality impacts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>from dredging.</td>
<td></td>
</tr>
<tr>
<td><strong>Sandy Beaches and Dunes</strong></td>
<td>• no significant clearing</td>
<td>• habitat is naturally discontinuous.</td>
</tr>
<tr>
<td></td>
<td>• large scale erosion, potentially natural, localised erosion around</td>
<td>• fire unknown in the dunes.</td>
</tr>
<tr>
<td></td>
<td>towns, generally poor-fair condition.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• transformed vegetation on the dunes with buffel increasing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• fauna – changes in nesting patterns of turtles due to artificial light etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• requires monitoring, shorebirds require monitoring.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• flora – buffel grass affecting dune habitats.</td>
<td></td>
</tr>
<tr>
<td><strong>Spinifex Hummock Grassland on Plains with Shrubs and Trees</strong></td>
<td>• no significant clearing</td>
<td>• fire regime – frequently burnt as part of pastoral operations.</td>
</tr>
<tr>
<td></td>
<td>• fauna – more information required.</td>
<td>• National Parks are burned regularly as well. Size of fires considered an issue – fires are too big, although frequency is not considered an issue. Those pastoralists conducting patchwork burns prevent larger fires. Some areas (e.g. front of Hamersley Range) are fire prone.</td>
</tr>
<tr>
<td></td>
<td>• flora – assemblage has changed, buffel grass now prevalent in sandplain country.</td>
<td></td>
</tr>
<tr>
<td><strong>Tussock Grasslands on Plains</strong></td>
<td><strong>Fauna</strong> – continued decline in assemblage (e.g. Spectacled Hare-wallaby, Emu, Australian Bustard).</td>
<td><strong>Fire regime</strong> – few fires on pastoral areas as this habitat does not carry fire well, patchy burns in in National Parks.</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------------------------------------------------</td>
</tr>
<tr>
<td>Unchanged, with localised exceptions</td>
<td>Flora – decline in assemblage, buffel grass has largely taken over.</td>
<td>Connectivity – unchanged.</td>
</tr>
<tr>
<td><strong>Mulga Woodlands and Acacia Shrubland Communities</strong></td>
<td>Fauna – continued decline in fauna assemblage (eg. Greater Bilby, avifauna, bats)</td>
<td>Fire regime – changed completely, more frequent, broader scale, more intense, mulga is killed and replaced by grasses leading to a more intense fire regime.</td>
</tr>
<tr>
<td>No significant clearing.</td>
<td>Flora – more information required</td>
<td>Connectivity – massively reduced.</td>
</tr>
<tr>
<td>Impacted by cattle.</td>
<td><strong>Rivers, Creeks and Associated Floodplains on Open Plains</strong></td>
<td>Water quality – declining due to cattle, sedimentation, sand lenses, increased turbidity, runoff from roads, movement of asbestos through the landscape (old stockpiles eroding).</td>
</tr>
<tr>
<td>Localised impacts, clearing for access, but limited to infrastructure (roads, rail, pipelines, basic raw materials), less than 10% overall</td>
<td>Fauna – no known change to aquatic assemblage, more information required.</td>
<td>Connectivity – still largely intact, native fish won’t go through culverts in dams, changes in hydrological regime affecting flow rates and availability.</td>
</tr>
<tr>
<td><strong>Fortescue Marsh (EPA defined area)</strong></td>
<td>Flora – erosion of banks, hydrological regime changes, weeds, cattle trampling of banks, buffel grass replacing vegetation, minesite water discharge impacting mature trees.</td>
<td>Fire regime – impacting on mulga, more frequent post mining development.</td>
</tr>
<tr>
<td>Mining development impacting on the margins of the Marsh but not on the Marsh itself</td>
<td></td>
<td>Water quality – naturally saline in the Marsh.</td>
</tr>
<tr>
<td>Springs, Pools and Watercourses Associated with Gorges and Ranges</td>
<td>Fauna – continued decline (uniformity of habitat, predation), no known change to aquatic assemblage, spectral signature of the power lines creating a “wall” effect, collared donkeys don’t move up the hills from the marsh due to fencing.</td>
<td>Landscape context – natural flows are disrupted, surface water runoff impacted from rail, roads along the south and west.</td>
</tr>
<tr>
<td></td>
<td>Flora – mulga in poor condition from grazing pressure, weeds, direct clearing, reinjection. Chenopod shrubland mostly intact, with localised weeds infestations.</td>
<td>Connectivity – mining development around the Marsh will have impacts on feed-in waterways, loss of connectivity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fire regime – impacting on mulga, more frequent post mining development.</td>
</tr>
<tr>
<td>Clay Pans</td>
<td>Subterranean Fauna Habitat</td>
<td>Inland Mountain Ranges, Rocky Hills, Breakaways and Mesas</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
| • localised impacts, clearing for access, but limited to infrastructure (roads, rail, pipelines, basic raw materials), less than 10% overall. | • fauna – no known change to aquatic assemblage, decline in terrestrial assemblage from habitat loss and fragmentation.  
flora – dust from mine sites.  
feral cattle accessing pools created from increased discharge. | • water quality – reasonable although affected by runoff from cattle,  
mine sites destroying some pools and leaving ineffective pools on side of mine pits.  
Weeli Wolli Springs – example of an asset that has experienced changes to hydrological regime.  
Pit voids, pit lakes, rail and road developments are causing fragmentation. | • fauna – more information needed, especially for invertebrates.  
flora – mostly in good condition, except where buffel grass is present at margins of habitat. |
| | • changes to the physical structure of the clay pans (e.g. pig rooting, cattle trampling). | • water quality – 99% of Pilbara water is potable based on Pilbara survey.  
connectivity – not an issue as subterranean fauna have extremely low mobility. | • fauna – loss of Ghost Bat habitat in the Hamersleys. Adits and natural roosts being lost for Pilbara Leaf-nosed Bats. Northern Quoll impacted from mine development.  
flora – declining condition from too frequent fire. |
| • no loss | • low loss overall but severe losses at a local scale. | • fire regime – weeds like ruby dock and natal redtop causing more opportunity for fire.  
connectivity – loss of bats roosts impacting on connectivity of bat habitat at broad scales. | • modest loss of asset – Abydos Plain, changes from rail infrastructure. |
| | • fauna – poor understanding, most taxa are undescribed and short-range endemics. | | • fauna – continued decline in diversity (e.g. Spectacled Hare-wallaby at Shay Gap, Burrup Pilbara Olive Pythons on Burrup Peninsula).  
flora – continued decline in diversity due to fire, grazing, weeds.  
poor condition in places due to presence of Passiflora (e.g. Burrup Peninsula). |
| | | • connectivity – fire regime – Burrup and Abydos Plain experience too frequent fire.  
connectivity – fragmentation due to infrastructure, restricting fauna movement, habitat change from altered water flows. |
Rankings were assigned using the above criteria (Table 3), information (Table 4) and a preliminary viability (health) value assigned.

**Table 5: Indicative rankings of viability (health) for conservation assets**

<table>
<thead>
<tr>
<th>Conservation Assets</th>
<th>Size</th>
<th>Condition</th>
<th>Landscape Context</th>
<th>Overall Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Offshore Islands</td>
<td>Very Good</td>
<td>Fair</td>
<td>-</td>
<td>Good</td>
</tr>
<tr>
<td>2 Coastal Mangroves and Intertidal Mudflats</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>3 Sandy Beaches and Dunes</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>4 Spinifex Hummock Grassland on Plains with Shrubs and Trees</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>5 Tussock Grasslands on Plains</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>6 Mulga Woodlands and Acacia Shrubland Communities</td>
<td>Good</td>
<td>Fair</td>
<td>Poor</td>
<td>Fair</td>
</tr>
<tr>
<td>7 Rivers, Creeks and Associated Floodplains on Open Plains</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>8 Fortescue Marsh (EPA defined area)</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>9 Springs, Pools and Watercourses Associated with Gorges and Ranges</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>10 Clay Pans</td>
<td>Very Good</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>11 Subterranean Fauna Habitat</td>
<td>Good</td>
<td>Good</td>
<td>-</td>
<td>Good</td>
</tr>
<tr>
<td>12 Inland Mountain Ranges, Rocky Hills, Breakaways and Mesas</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>13 Rock Piles and Granites</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
</tbody>
</table>

| Project Biodiversity Health Rank                                                       | Fair       |

During the workshop process, a significant amount of variation in the viability (health) of conservation assets and ‘nested assets’ was documented, with only a summary presented here. A more detailed approach to ranking the condition of assets, focusing on key ecological attributes, and linked to appropriate measureable indicators would strengthen the process and should be considered in the future.
4 Assessment of Threats

4.1 Description of Threats

A detailed description of threats to the Pilbara's biodiversity can be found in Carwardine et al. (2014), and is summarised below:

4.1.1 Fire

Much of the vegetation of the Pilbara is well adapted to fire, and many species require fire as part of their life cycle. However, when fires are too frequent or intense, negative ecosystem impacts occur, such as the loss of understory growth that provides many reptiles and mammals with protection from predators, and the loss of food resources, such as seeding grass for graminivorous birds. Aboriginal burning practices in the Pilbara involved burning patches of vegetation creating a mosaic of burnt and unburnt patches, a practice that regulates fuel loads and manages against large intense fires. Changes in land cover as well as an increased ignition risk promoted by the region’s railway network have led to more frequent intense wildfires in the hummock grasslands and these altered fire regimes have been implicated as one of the causes of decline and extinctions of medium-sized mammals in arid Australia.

Plate 13: Fire within Spinifex Hummock Grasslands (Photo credit: Craig Wimble)

4.1.2 Over-grazing and Feral Herbivores

Most of the Pilbara is gazetted as pastoral land. The conservation and land management practices implemented by the bioregion’s pastoralists are therefore key to conserving and managing the region’s biota. Early settlers introduced a range of grazing animals now considered feral, including pigs, rabbits, camels, donkeys and horses. Some of these invasive herbivores occur across all tenures, including national parks while others are now confined to localised and restricted habitats, such as pigs within riparian environs along
the De Grey River and rabbits on alluvial flats associated with the Fortescue Marsh. The main impacts of introduced herbivores in the Pilbara are compaction and erosion of soil, loss of grazing-sensitive plant species, reduced native grass biomass, introduction of weed seeds and trampling of seedlings and mature plants. Widespread loss of vegetation caused by invasive herbivores can lead to a reduction in vegetation structure and thus habitat and food resources for native animals, and the loss of vegetation cover can expose small native animals to increased risk of predation. If areas are subject to high total grazing pressure resulting from high livestock and/or feral herbivore numbers, then soil erosion and ground cover loss can occur on these areas, and this may also lead to eutrophication of waterways, and sedimentation of wetlands and riparian habitats, including the nationally significant listed wetlands of the Pilbara.

Plate 14: Cattle grazing, an activity of relevance to biodiversity conservation in the Pilbara

(Photo credit: Sara Rawlings)

4.1.3 Introduced Predators

Feral cats are widespread across the Pilbara while red foxes appear to be confined to the coastal plain of the Roebourne subregion and may move further inland along the frontages of some of the larger drainage systems such as the Robe and De Grey Rivers. Together they are responsible for range reductions and population declines of many native fauna species and in particular, small to medium sized mammals. The role of top predators such as dingoes, goannas and raptors in exerting control over the interactions between cats, foxes and their prey is an area of growing interest. The regular baiting of dingoes and wild dogs as a measure to protect livestock may exacerbate the problem of introduced feral cats, as cat behaviour appears to be suppressed by dingoes. Cane toads are currently an irregular, episodic arrival in the region, but the establishment of this species in the Pilbara has the potential to reduce populations of native predators as well as many reptiles, small frogs and invertebrates.
4.1.4 Invasive Plants

Invasion by exotic plant species is often associated with inappropriate fire and grazing regimes as well as mining operations. Compared to other regions of Australia, the exotic flora of the Pilbara (103 taxa) is relatively small, representing only 6% of the Pilbara’s total flora (Keighery 2010, cited by Carwardine et al., 2014); however, the threat of weed incursions is increasing with a 20% increase recorded from 2004 to 2010. Of the 103 weeds identified by Keighery (2010, cited by Carwardine et al., 2014), 14 species occur across the region at a landscape scale, altering fire patterns, modifying soil characteristics, or competing directly with native species. A further 21 species pose a threat to particular habitats, especially wetlands and islands. Major weeds currently impacting on landscapes and biodiversity values or which pose a future risk (DEC 2013) include Mesquite (*Prosopis* sp), Buffel Grass (*Cenchrus ciliaris*), Birdwood Grass (*Cenchrus setiger*), Kapok Bush (*Aerva javanica*), Ruby Dock (*Acetosa vesicaria*), Bellyache Bush (*Jatropha gossypiifolia*), Leucaena (*Leucaena leucocephala* subsp. *leucocephala*), Raintree (*Albizia lebbeck*) and Caribbean Stylo (*Stylosanthes hamata*).
4.1.5 Hydrological Change

Mine dewatering removes groundwater and can create permanent surface flows if discharged directly into ephemeral drainage systems. This has impacts both above and below the surface. Below the surface, dewatering may affect the rich groundwater dependent ecosystems of the Pilbara. The Pilbara has been identified as an international hotspot for stygofauna (groundwater dwelling). The stygofauna of the Pilbara remain poorly documented and the extent of the impacts of changed hydrology are unknown. On the surface, the presence of permanent water or changed flow regimes can alter the ecological composition of aquatic-dependent species.

Hydrological change is particularly relevant to aquatic invertebrates, as many invertebrates are adapted to intermittent presence of water. Abstracted groundwater that discharges into existing permanent water bodies may alter water quality or promote invasive species. Permanent water on the surface (from mine dewatering or other sources, such as stock watering points) may also attract terrestrial vertebrates, and may support increased populations of introduced pest species in arid areas.
4.1.6 Mining
Today mining is a significant industry in the Pilbara, representing 38% of Western Australia’s Gross Regional Product (GRP) and 6% of Australia’s Gross Domestic Product (GDP). The mining industry has direct impacts on the region’s flora and fauna including the loss and alteration/fragmentation of habitat. Indirect impacts result from the construction of roads, railways and infrastructure, growing use of water resources and altered hydrological regimes, contamination of water and soil resources, and altered fire regimes with an increase in unmanaged anthropomorphic ignitions.
Plate 18: An aerial view of the Marandoo mine in Pilbara Bioregion  
(Photo credit: Rio Tinto Iron Ore)

4.1.7 Agriculture  
Owing to the Pilbara’s arid environment, irrigated agriculture in the region has been localised and small-scale. The Northern Australian Taskforce found the potential for sustainable expansion of irrigated agriculture in the Pilbara to be low, but political and economic interest in the proposition of northern Australia as a ‘food bowl’ of Australia remains and there is interest in investigating and investing significant resources and revenue in the development of irrigated agriculture schemes in the Pilbara utilizing excess mine water. The level of water extraction required for large-scale agricultural development in the region may lead to significant impacts on its ecology, especially of ephemeral riparian systems and extensive alluvial plains where irrigated crops may be grown.
4.1.8 Tourism Expansion
The Pilbara is increasingly recognised for its natural values, and as such, the region has experienced an increase in tourism. Parks and Wildlife regulates ecotourism within the conservation estate at present, but inadequate regulation on other land tenures and at entry points could lead to negative impacts on biodiversity including increased risk of fire, the introduction of exotic species and associated fragmentation and pressure on sensitive communities from infrastructure developments.
Plate 20: Karijini National Park, a location subject to significant pressure from tourism
(Photo credit: Scott Godley, Parks and Wildlife)
4.2 Methodology for Assessing Threats

The threat assessment process ranks the overall severity of various threatening processes to each asset based on the following criteria (Table 6). Subsequent to assessment of threats, a summary rating is generated by the CAP software, resulting in a threat summary table.

Table 6: Criteria used to assess threats to conservation assets

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Very High</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Severity of damage</strong></td>
<td>The level of damage that can reasonably be expected within 10 years under current circumstances</td>
<td>Destroys or eliminates the conservation asset</td>
<td>Seriously degrades</td>
<td>Moderately degrades</td>
<td>Slightly degrades</td>
</tr>
<tr>
<td><strong>Scope of damage</strong></td>
<td>The geographic scope of impact on the conservation asset that can be reasonably expected within 10 years under current circumstances</td>
<td>Very widespread</td>
<td>Widespread</td>
<td>Localised</td>
<td>Very localised</td>
</tr>
<tr>
<td><strong>Irreversibility of damage</strong></td>
<td>How reversible the damage is</td>
<td>Not reversible</td>
<td>Reversible, but not practically affordable</td>
<td>Reversible with reasonable commitment of resources</td>
<td>Easily reversible at low cost</td>
</tr>
</tbody>
</table>

4.3 Threat Assessment Results

During the Pilbara CAP workshop process, 25 threats were listed and ranked (Table 7).
Table 7: Summary of major threats, based on ratings developed during the CAP workshop process

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Weeds (Buffel Grass, Kapok, Ruby Dock, Passiflora, etc)</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>VH</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>VH</td>
<td>H</td>
<td>H</td>
<td>VH</td>
<td></td>
</tr>
<tr>
<td>Feral Carnivores (cats, foxes, dogs)</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>VH</td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>Clearance from Mining (Mine sites)</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>VH</td>
<td>M</td>
<td>H</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Feral Herbivores (Donkeys, Horses, Camels)</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>H</td>
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<tr>
<td>Mesquite and Parkinsonia - WONS Weeds</td>
<td>VH</td>
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<tr>
<td>Feral Bees</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>H</td>
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<tr>
<td>Climate Change (sea level rise, increased cyclones, warming climate)</td>
<td>H</td>
<td>H</td>
<td>H</td>
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<tr>
<td>Inappropriate Fire Regimes (too hot, too frequent, too large)</td>
<td>H</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td></td>
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</tr>
<tr>
<td>Clearance from Infrastructure Development (roads, rail, ports, other development)</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>M</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
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<tr>
<td>Unsustainable Stock Grazing Pressure</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td></td>
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<tr>
<td>Altered Hydrology from Infrastructure Development (roads, rail, etc)</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>M</td>
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<tr>
<td>Water Abstraction (e.g. urban use)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td></td>
<td></td>
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<tr>
<td>Reinjection of Mine Water underground</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
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<tr>
<td>Dams</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>M</td>
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<tr>
<td>Mine Water Discharge into Creeks and Springs</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>L</td>
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<tr>
<td>New Irrigated Agriculture (eg. irrigated pasture)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>L</td>
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<tr>
<td>Unmanaged Access / Recreational Impacts</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
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<tr>
<td>Mine Dewatering (increased river flows, reduction in groundwater)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>L</td>
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<tr>
<td>Pigs</td>
<td>L</td>
<td>L</td>
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<td>L</td>
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<tr>
<td>Introduction of mice, rats, etc (lack of biosecurity)</td>
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<td>Removal of Basic Raw Material</td>
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<tr>
<td>Sedimentation from Infrastructure Development (dredging, etc)</td>
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<tr>
<td>Invasive Aquatic Invertebrates</td>
<td>M</td>
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<tr>
<td>Rubbish Dumping</td>
<td>L</td>
<td>L</td>
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<tr>
<td>Pollution from Mining Activities (includes eutrophication, dust, hydrocarbon)</td>
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<tr>
<td>Threat Status for Assets and Project</td>
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<td>M</td>
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</table>
5 Objectives, Strategies and Actions

5.1 Methodology for developing strategies

Prior to the development of strategies, the CAP process requires setting measurable objectives that, if achieved, would ensure the long term conservation of the assets. In particular, objectives are developed in line with the S.M.A.R.T principles (i.e specific, measurable, actionable, realistic and time-bound) and are aimed at addressing high priority threats or achieving improvements in size, condition and landscape context attributes.

Upon establishment of measurable objectives, effective strategies are identified and action steps to achieve conservation objectives developed. This is a three step process (Table 8).

<table>
<thead>
<tr>
<th>Step</th>
<th>Conduct a thorough situation analysis of the key factors related to the conservation objectives</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>This includes consideration of the causal factors underlying particular threats and potential hurdles for enhancing the condition of conservation assets (e.g. social, cultural, economic and individual motivations). This can help pinpoint opportunities for intervention and guide decisions about which regional delivery mechanisms are best employed to achieve the conservation objectives (e.g. direct targeting of landholders, competitive market based instruments, education programs, legislative or policy changes).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th>Brainstorm conservation strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conservation strategies are the broad courses of action required to achieve the conservation objectives. There are essentially three “pathways” for strategy development that should be considered for threat abatement objectives. These include:</td>
</tr>
<tr>
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<td>● direct protection or management of land or water</td>
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<td></td>
<td>● influencing a key decision maker</td>
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<td></td>
<td>● addressing a key underlying factor</td>
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<table>
<thead>
<tr>
<th>Step 2</th>
<th>Brainstorm action steps</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Once the major conservation strategies are identified, they may be broken down into smaller, more detailed action steps.</td>
</tr>
</tbody>
</table>

5.1.1 Use of Conceptual Models

A conceptual model is a visual method of representing a set of causal relationships between factors that are believed to impact on one or more of the conservation assets. A good model should explicitly link the conservation assets to the direct threats impacting them, the factors (i.e. indirect threats) influencing the direct threats, and the strategic activities proposed to mitigate those factors. The Miradi software program (www.miradi.org) can be used to develop conceptual models.
During the CAP workshop process, 18 objectives were developed to address key threats and improve the viability (health) of assets. These objectives were based on those key threats ranked as high or very high, and those threats associated with altered hydrology from infrastructure development. The objectives were developed for groupings of assets, grouped based on similar landforms, threats or other affinities.

Brainstorming sessions were conducted to look at underlying factors, and 64 strategies and their associated action steps were developed. In addition, existing Pilbara projects and programs were identified and listed during this workshop. In undertaking the situation analyses in the workshop, initial conceptual models and other information was captured on butcher’s and later developed in the Miradi software program as diagrams (Appendix 1).

The strategies were later given an initial prioritisation rating (Very High Effectiveness, High Effectiveness, Medium Effectiveness and Low Effectiveness) in Miradi, which takes a number of factors into account, under two criteria: Potential Impact and Feasibility. This initial prioritisation process will be revisited as part of the future CAP process.

During process, the role of Traditional Owners and other Indigenous people was seen as extremely important in developing and implementing the strategies and action steps further. It was also noted that the existing CSIRO study (Carwardine et al., 2014), which focused on threats and strategies to protect species of conservation significance, contained substantial strategy information and where appropriate this information was incorporated into the current process. Additionally, strategies for the EPA-defined Fortescue Marsh area (EPA, 2013) were incorporated into the CAP process strategies, as appropriate.

5.2 Strategy Results
This section details the 18 objectives that were developed to address the highest ranked threats, together with 64 strategies and their associated action steps. Some strategies were common to more than one asset/group of assets.

Situation analysis diagrams showing key drivers of threats, opportunities and key knowledge gaps, and current projects documented as part of the strategic planning process are presented in Appendix 1.
Table 9: Strategies and action steps developed during the workshop process

### 5.2.1 Coastal Assets

<table>
<thead>
<tr>
<th>Asset grouping</th>
<th>Assets</th>
<th>Threats</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>COASTAL ASSETS</td>
<td>1) Off-shore Islands 2) Coastal Mangroves and Inter-tidal Mud flats 3) Sandy Beaches and Dunes</td>
<td>Feral Carnivores (cats, foxes, dogs)</td>
<td>By 2025 reduce predator pressure on populations of native fauna species (sea turtles, migratory birds, shorebirds, marsupials, reptiles etc.) to allow populations to become self-sustaining within their range. (NB Migratory species spend much of their lifecycle outside the Pilbara).</td>
</tr>
</tbody>
</table>

**Strategy 1)** Identify priority assets and high risk areas (Need to know using a modelling exercise where the highest asset values are)

**Key Actions**

- Develop funding proposal for asset prioritisation and monitoring
- Undertake six month asset prioritisation (if good data does exist) - examine asset data, including on-ground (ground truthing) and modelling
- Product is a strategy and map which indicates key assets, weed occurrence and density and priority areas for action, based on costs (lighter infestations removed first), as well as feral carnivore occurrence and priority areas for action, and also a plan of where the key fire sensitive areas are.

**Strategy 2)** Develop and implement an integrated feral carnivore control strategy

**Key Actions**

- First step/priority is to find funding to develop an integrated carnivore control strategy, which uses existing data. <$100k, two year timeframe
- Map key areas for predator control based on species, then prioritise (pick battles)
- Better engagement of pastoralists and other stakeholders
- ESRM planning to include predator management (feed into landscape plans)
- Ensure that strategies for the beaches and dunes integrate with those developed for the inland areas (plains)
- Prioritise Islands for pest control programs
- Integrated Pest Management Plan - role of various control techniques - e.g. baiting vs other techniques including new techniques
- Co-ordinated, integrated (with other predators) wild dog management plan for the Pilbara
- Change dingo control programs to account for fox/cat control
- Implement a predator control program for towns, & other areas of human habitation: licensing, desexing, chip implant, enforcement
- Integrate management program with other threats/management (e.g. burn lines - then trap along lines)

**Strategy 3)** Undertake Applied Cat Research to guide future management

**Key Actions**

- Research into grooming traps
- Determine the impact of predators on threatened species in the Pilbara
- Identify spatial distribution and densities of predators; develop tools to be able to collect this information
- Investigate interactions between dogs, dingoes, cats

**Strategy 4)** Implement pest control program around key coastal fauna sites

**Key Actions**

- Research into grooming traps
- Determine the impact of predators on threatened species in the Pilbara
- Identify spatial distribution and densities of predators; develop tools to be able to collect this information
- Investigate interactions between dogs, dingoes, cats
### Key Actions
- Explore alternative bait methodologies (to reduce off target damage) to enable control in intertidal areas
- Prioritise Islands for pest control programs
- Eradicate rats from islands
- Eradicate cats and foxes from islands
- Secure funding for control on key coastal fauna sites

#### Strategy 6) Implement a Communications/Education strategy around feral carnivores
- Medium Effectiveness

#### Key Actions
- Identify and demonstrate effective examples of control (e.g. before and after - Port Hedland Turtles and Foxes)

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<th>Objective</th>
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</thead>
<tbody>
<tr>
<td>COASTAL ASSETS</td>
<td>3) Sandy Beaches and Dunes</td>
<td>Unsustainable Stock Grazing Pressure</td>
<td>By 2025 manage grazing pressure to the asset to protect grazing-sensitive ecosystems and species (TBD), retain habitat structure and minimise the risk to threatened flora and fauna populations and cultural assets (TBD = to be determined)</td>
</tr>
</tbody>
</table>

#### Strategy 7) Strategic Fencing to exclude stock from priority assets.
- High Effectiveness

#### Key Actions
- Assess priority areas (high value assets) for fencing
- Include cultural and historical sites in asset prioritisation
- Determine what length of fencing is required - map/survey
- Develop fencing plan including assessment of links to other requirements such as weed management.
- Develop fence maintenance strategy addressing who is responsible for repairs and maintenance and who insures
- Acquire funds for strategic fencing, maintenance and monitoring of high value coastal assets - develop a compelling case, no landholder contribution
- Boundaries Act - enforcement? to what extent can/would this happen - use this as a basis for implementing
- Erect fences using appropriate contractors and groups such as Aboriginal Ranger Groups, Green Army

#### Strategy 8) Engagement with pastoralists via Ecologically Sustainable Rangeland Management (ESRM) Plans to protect coastal biodiversity
- High Effectiveness

#### Key Actions
- Develop compelling reason - not only biodiversity
- Standardise communications material/message
- Use legislation
- Engage appropriate extension staff
- Long term planning for the right person/people
- Ensure pastoral lands board are involved in the process

#### Strategy 9) Implement Nutritional Self Shepherding Trial
- Medium Effectiveness
### Key Actions
- Seek properties that can participate in self-shepherding trials that include coastal dune areas (If successful pilot project will sell itself from pastoralist to pastoralist)
- Acquire funding for a trial in 2016 (~$10k) to implement a self-shepherding trial
- Acknowledge that dunes not part of pastoral lease - remove windmills etc., which promote stock access & camping

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<tbody>
<tr>
<td>COASTAL ASSETS</td>
<td>1) Off-shore Islands 3) Sandy Beaches and Dunes</td>
<td>Weeds (Buffel Grass, Kapok, Ruby Dock, Passiflora, etc)</td>
<td>By 2025, control TBD% of core infestations to prevent further spread or for significant, isolated conservation assets eradication of weed occurrence.</td>
</tr>
</tbody>
</table>

**Strategy 1)** Identify priority assets and high risk areas (Need to know using a modelling exercise where the highest asset values are)  
**High Effectiveness**

**Key Actions**
- See strategy as mentioned above.

**Strategy 10)** Develop a Pilbara-wide integrated weed strategy  
**High Effectiveness**

**Key actions**
- Undertake scoping of funding requirements, current funded projects, shortfalls and budget for Pilbara weed strategy
- Use threatened species to lever funds for weed control work
- Develop funding application for PMMC to expand its scope
- Pilbara Mesquite Management Committee (PMMC) to rename itself & expand into a program across tenures including mining companies
- Work with Indigenous people to get knowledge of weed control and link to working on country
- Identity local champions/groups/ Aboriginal rangers
- Seek resources to implement weed actions including community groups, Green Army, Aboriginal Rangers
- Incorporate weed monitoring as part of the strategy
- PMMC to develop research and monitoring plan across the Pilbara
- Implement a Prickly Pear Management Program
- Implement a buffel & kapok management program
- Include biological control methods for weed control
- Review Parks and Wildlife prioritisation of weeds on the conservation estate - both mainland and islands

**Strategy 11)** Develop biosecurity strategy and action plan targeted at high risk coastal and island areas  
**Medium Effectiveness**

**Key Actions**
- Develop signage at boat launches areas and on fore-dunes
- Develop pamphlets on weeds and other biosecurity matters that are linked to licenses
- Learn techniques from other places such as Dirk Hartog and Barrow Islands (Chevron Principles could be used as a benchmark)
- Develop key winning strategies on a couple of islands and sites
- Monitor for new incursions - new weeds, new locations
- Develop Integrated Coastal Zone Strategy- Review & collated coastal management strategies
- Restrict cattle & horses in coastal zone
- Acknowledge that dunes not part of pastoral lease - remove windmills etc., which promote stock access & camping
- Make dunes a type of conservation reserve (change tenure)

**Strategy 12) Implement a coastal weed education strategy**

**Key Actions**
- Source funding for a weed education strategy
- Develop a weeds booklet
- Develop signage at boat launches areas and on fore-dunes
- Develop pamphlets on weeds and other biosecurity matters that are linked to licenses

**Medium Effectiveness**

**Strategy 13) Develop a weed research strategy**

**Key Actions**
- Develop model for pool of funds
- Identify key collaborators (e.g. Universities, CSIRO)
- Identify research needs
- Use research to demonstrated impact (informed by monitoring)
5.2.2 Inland Mountain Ranges, Rocky Hills, Breakaways and Mesas

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<th>Asset grouping</th>
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<th>Threats</th>
<th>Objective</th>
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<tbody>
<tr>
<td>INLAND MOUNTAIN RANGES, ROCKY HILLS,</td>
<td>12) Inland mountain ranges, rocky hills, breakaways &amp;</td>
<td>Clearance from Mining (Mine sites) Clearance from Infrastructure</td>
<td>By 2020 ensure new mining developments and associated clearance are managed to environmentally appropriate standards and limit development in regionally significant ecological areas (e.g. threatened species habitat)</td>
</tr>
<tr>
<td>BREAKAWAYS AND MESAS</td>
<td>mesas</td>
<td>Development (roads, rail, ports, other development)</td>
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**Strategy 14)** Develop a transparent, co-ordinated approach to data collation, management and sharing  
**Key Actions**  
- Break down barriers between companies to provide central repository for data sharing  
- Provide portal for stakeholders to access

**Strategy 15)** Development of a regional land-use plan to inform design and assessment of mining related development  
**Key Actions**  
- Collate existing information  
- Determine valuing/prioritisation methodology (does it exist already?)  
- Investigate potential for shared use of infrastructure (e.g. rail corridors, common development hubs)  
- Examine other processes - Fortescue Marsh-type guidelines - attempts by CSIRO, TNC's development by design  
- Develop criteria for regionally significant ecological and cultural areas - veg mapping etc.  
- Use data from mining assessments for cultural data  
- Vegetation mapping - see CSIRO report  
- Map extent of significant areas & publish this  
- Infrastructure master plan - collate data from "identify significant areas" strategy (very low feasibility)  
- Product is a regional land-use plan

**Strategy 16)** Develop a co-ordinated Pilbara-wide offset strategy  
**Key Actions**  
- This Conservation Action Plan (CAP), CSIRO Threat Report (2014) and the Pilbara Biodiversity Audit should be used to Influence investment plan.  
- Use offsets to gain knowledge, protect EPBC species (link to no net loss)  
- Use offsets to replicate lost features  
- Evaluate offsets (outcomes-based) in 10 years to see how well they are working

**Strategy 17)** Integrate ecological outcomes into mine planning process  
**Key Actions**  
- Develop guidelines to minimise impacts  
- Consultation with stakeholders  
- Best practice guidelines - explore/encourage standard conditions  
- Develop planning to account for biodiversity post closure  
- Retrofitting necessary features - including opportunistic
## INLAND MOUNTAIN RANGES, ROCKY HILLS, BREAKAWAYS AND MESAS

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<tr>
<td>12) Inland mountain ranges, rocky hills, breakaways &amp; mesas</td>
<td>Inappropriate Fire Regimes (too hot, too frequent, too large)</td>
<td>By 2020, patchy, cool, early season fire regimes are in place across 10% of the asset annually to protect fire-sensitive ecosystems, maximise habitat diversity and minimise the risk to threatened flora and fauna populations.</td>
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### Strategy 18) Develop a Pilbara-wide fire ecology research strategy
**Key Actions**
- Develop funding proposal for strategy
- Build a better fire information system (NAFI/other systems from Queensland etc.)
- Undertake collation and analysis of fire histories at a landscape scale
- Explore potential effects of Climate Change on fire regimes

### Strategy 19) Develop a regional operational fire management plan
**Key Actions**
- Involve multiple stakeholders
- Community fire strategy - incorporate input from broad stakeholders
- Manage for multiple objectives
- Develop funding proposal for strategy
- Look at funding of EcoFire model - Rangelands NRM
- Develop a brief for a regional fire management plan (Rangelands NRM and others - using information from models used by RNRM for mosaic burning)
- First step is to review data - analysis by 2016
- Develop strategy to monitor ecological and economic investment - all the funding sources - to demonstrate if investments are working or not
- Aboriginal Rangers trained for fire management under experienced leaders
- Determine pastoralists motivations
- Develop incentives for pastoralists and Indigenous people and others to undertake "appropriate" fire management
- Accept teething problems - overburn etc.
- Implement strategic burns - Asset protection burns to become part of breaks - Prescribed burning for priority area protection
- Product is a multi-stakeholder operational fire management plan
- Integrate traditional knowledge of fire management (including cultural site information) into current ecological research/thinking - Indigenous engagement - Incorporate Local knowledge - Create/bring in workforce - Utilise existing workforce - training permits - capacity building
- Develop and implement a fire monitoring strategy

### Strategy 20) Develop a fire education strategy
**Key Actions**
- Secure funding for fire education strategy
- Target arsonists for inappropriate burning
- Develop messages of what is ecological burning and why (don't necessarily be afraid of fire)
- Promote fire resilient design of infrastructure
- Fire communication strategy - increase profile of effect of large-scale intense fires
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<th>Objective</th>
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<tbody>
<tr>
<td>INLAND MOUNTAIN RANGES, ROCKY HILLS, BREAKAWAYS AND MESAS</td>
<td>12) Inland mountain ranges, rocky hills, breakaways &amp; mesas</td>
<td>Weeds (Buffel Grass, Kapok, Ruby Dock, Passiflora, etc)</td>
<td>By 2025, X% (or X,000ha) annual reduction of new infestations of Ruby Dock and town escapees e.g. Leuceana, Washingtonia, Cotton Palm, Malay almond, to prevent further spread.</td>
</tr>
</tbody>
</table>

**Strategy 1)** Identify priority assets and high risk areas (Need to know using a modelling exercise where the highest asset values are)

**Key Actions**
- See strategy as mentioned above.

**Strategy 10)** Develop a Pilbara-wide integrated weed strategy

**Key Actions**
- See strategy as mentioned above.

**Strategy 13)** Develop a weed research strategy

**Key Actions**
- See strategy as mentioned above.

**Strategy 21)** Weed control strategy for mining related development (primarily ruby dock)

**Key Actions**
- Regulated control - weed management strategy - "off the shelf" standardisation
- Contain ruby dock and maintain weed free areas
- Develop a compelling "why"
- Road funding includes weed control component

**Strategy 22)** Weed control strategy for town weeds Education/information strategy for town weeds

**Key Actions**
- Education/information strategy for town weeds: Nurseries to provide alternatives to weeds, town population dumping, local government streetscape
- Legislation (traffic light system) and enforcement
- Provide alternatives to weeds: nursery supply, demonstration sites

**Strategy 23)** Improve Biosecurity Management

**Key Actions**
- Prevent new incursions
- Better access management (Road, rail etc.)
- Community education and engagement
- Compliance and enforcement (enduring)
- Build biosecurity into roads maintenance
- Quarry hygiene (road metal)
- Develop coordinated biosecurity strategy - who, when etc.

**Strategy 24** Collation of weed data to get baseline and measure change over time - centralised data base that includes monitoring programs  
**Key Actions**
- Utilise existing systems - use existing prescribed methodology
- Work out how much it will cost - standard metrics
- Undertake prioritisation of actions

**Strategy 25** Map and cost weed management that is required now and in the future  
**Key Actions**
- Map distribution of weeds - location/density & prioritise, use predictive methodology, explore detection methodology(s)

**Strategy 26** Develop an inland weed education strategy  
**Key Actions**
- Pest controllers use correct methodology
- Miners - social pressure for participation
- Target town population, tourists, business, shire, road builders
## 5.2.3 Plains Assets

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<tr>
<th>Asset grouping</th>
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</table>
| PLAINS ASSETS  | 4) Spinifex Hummock Grassland on Plains with shrubs and trees (e.g. Acacia)  
5) Tussock Grasslands on Plains  
6) Mulga Woodlands and Acacia Shrubland Communities | Feral Carnivores (cats, foxes, dogs)         | By 2025 reduce feral carnivore numbers in key areas by 75%               |

**Strategy 1** Identify priority assets and high risk areas (Need to know using a modelling exercise where the highest asset values are)  
*Key Actions*  
- See strategy as mentioned above.

**Strategy 2** Develop and implement an integrated feral carnivore control strategy  
*Key Actions*  
- See strategy as mentioned above.

**Strategy 3** Implement Cat Management Activities  
*Key Actions*  
- See strategy as mentioned above.

**Strategy 4** Undertake Applied Cat Research to guide future management  
*Key Actions*  
- See strategy as mentioned above.

---

### Strategy 1
- Identify priority assets and high risk areas (Need to know using a modelling exercise where the highest asset values are)

#### Key Actions
- See strategy as mentioned above.

### Strategy 2
- Develop and implement an integrated feral carnivore control strategy

#### Key Actions
- See strategy as mentioned above.

### Strategy 3
- Implement Cat Management Activities

#### Key Actions
- See strategy as mentioned above.

### Strategy 4
- Undertake Applied Cat Research to guide future management

#### Key Actions
- See strategy as mentioned above.

---

### Asset grouping | Assets                                                                 | Threats                                      | Objective                                                                 |
|-----------------|------------------------------------------------------------------------|----------------------------------------------|--------------------------------------------------------------------------|
| PLAINS ASSETS   | 4) Spinifex Hummock Grassland on Plains with shrubs and trees (e.g. Acacia)  
5) Tussock Grasslands on Plains  
6) Mulga Woodlands and Acacia Shrubland Communities | Inappropriate Fire Regimes (too hot, too frequent, too large) | By 2020 actively manage regionally significant areas to protect fire-sensitive ecosystems, maximise habitat diversity and minimise the risk to threatened flora and fauna populations. |

**Strategy 18** Develop a Pilbara-wide fire ecology research strategy  
*Key Actions*  
- See strategy as mentioned above.

---

### Strategy 18
- Develop a Pilbara-wide fire ecology research strategy

#### Key Actions
- See strategy as mentioned above.
Key Actions
- See strategy as mentioned above.

Strategy 19) Develop a regional operational fire management plan

Key Actions
- See strategy as mentioned above.

Strategy 20) Develop a fire education strategy

Key Actions
- See strategy as mentioned above.

Strategy 27) Engagement with pastoralists via Ecologically Sustainable Rangeland Management (ESRM) Plans to integrate fire management for pastoralism with the protection of fire sensitive ecosystems

Key Actions
- Make sure that fire sensitive areas are mapped before visiting properties

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<tr>
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<tbody>
<tr>
<td>PLAINS ASSETS</td>
<td>4) Spinifex Hummock Grassland on Plains with shrubs and trees (e.g. Acacia) 5) Tussock Grasslands on Plains 6) Mulga Woodlands and Acacia Shrubland Communities</td>
<td>Inappropriate Fire Regimes (too hot, too frequent, too large)</td>
<td>By 2020 actively manage regionally significant areas to protect fire-sensitive ecosystems, maximise habitat diversity and minimise the risk to threatened flora and fauna populations.</td>
</tr>
</tbody>
</table>

Strategy 28) Industry driven improvements

Key Actions
- Pastoral education - grazing, nutrition, ESRM
- Pastoralist on pastoralist education important
- Explore alternative, sustainable feed (irrigated agriculture - could be a threat too)
- Beef development officers
- Explore industry partnerships
- Improve infrastructure
- Resourcing/staff to deliver
- Keep a watching brief on programs to sell environmental services

Strategy 29) Engagement with pastoralists via Ecologically Sustainable Rangeland Management (ESRM) Plans to ensure that landscape scale property planning includes biodiversity objectives

High Effectiveness
Key Actions
- Ensure funding and support in place by 2016 for expansion of ESRM plans and aim for establishment on all pastoral leases over the medium term
- Develop ESRM plans for all pastoral properties (currently + - 20/60)
- Research into matching stocking rates to feed on offer
- Identify "high values assets" which area being grazed unsustainably
- Implement Nutritional Self Shepherding
- Allow alternate land-use (diversification) on pastoral leases (would need legislative/policy change and advocacy)

Strategy 30) Implement stewardship program in priority areas (legislative barriers)

Key Actions
- Develop incentive schemes – stewardship
- Demonstrate value proposition - cost benefit

Strategy 31) Indigenous community linking with pastoral properties

Strategy 32) Develop a program for Pilbara Wide remote sensing-based condition monitoring (Landsat, Veg machine CSIRO)

Strategy 33) Artificial water points phased out strategically on relinquished pastoral leases

Asset grouping | Assets | Threats | Objective
--- | --- | --- | ---

PLAINS ASSETS
4) Spinifex Hummock Grassland on Plains with shrubs and trees (e.g. Acacia)
5) Tussock Grasslands on Plains
6) Mulga Woodlands and Acacia Shrubland Communities
Weeds (Buffel Grass, Kapok, Ruby Dock, Passiflora, etc)

By 2020 (TBD) reduce (extent TBD) significant weeds (calotropis, bellyache bush, cactus, new & emerging weeds), and maintain 5% annual reduction of core infestations of mesquite, to prevent further spread and by 2018 identify outlying occurrences of landscape scale/widespread weeds (kapok, ruby dock, passiflora) that can be targeted for eradication. (TBD = to be determined)

Strategy 1) Identify priority assets and high risk areas (Need to know using a modelling exercise where the highest asset values are)

Key Actions
- See strategy as mentioned above.

Strategy 10) Develop a Pilbara-wide integrated weed strategy

Key Actions
- See strategy as mentioned above.

Asset grouping | Assets | Threats | Objective
--- | --- | --- | ---

PLAINS, WETLANDS & OTHER WATER DEPENDENT SYSTEMS
4) Spinifex Hummock Grassland on Plains with shrubs and trees (e.g. Acacia)
5) Tussock Grasslands on Plains
6) Mulga Woodlands and Acacia Shrubland Communities

Altered Hydrology from infrastructure development (roads, rails, etc) (PRIMARY THREAT)

By 2025 maintain and re-establish optimum hydrological regimes by reducing impacts on natural flows from infrastructure barriers.
7) Rivers, Creeks and Associated
   Floodplains on open plains
8) Fortescue Marsh (EPA defined area)
9) Springs, Pools and Watercourses
   associated with Gorges and Ranges
11) Subterranean Fauna Habitat
12) Inland mountain ranges, rocky hills,
    breakaways & mesas

Strategy 34) Ensure that new design standards for infrastructure address the issues of altered hydrological flows
Key Actions
- Check on current design process
- Ensure environmentally directed design for railways and culverts
- Include catchment function analysis in all ESRM plans
- Seek funding for expansion of ESRM planning to include pastoral lease road effects on hydrological functioning

Strategy 35) Develop environmentally directed road grading methodology
Key Actions
- Source funds for grading methodology training
- Develop a training package around grading methodology
- Hold workshops for drivers
- Engage local councils, contractors, main roads, pastoralists in delivering the project

Strategy 36) Ensure that water from dewatering is not discharged into surface water systems and ensure that water discharge into ground water systems does not lead to pollution of this water resource.
Key Actions
- Refer to EPA, 2013 guidelines for Fortescue Management Area & see also other two strategies - "Avoid negative impacts of Groundwater Drawdown" and "Avoid negative impacts of surface water discharge

Strategy 37) Avoid negative impacts of Groundwater Drawdown to important flora/fauna habitat. (EPA, 2013)
Key Actions
- Ensure that groundwater drawdown does not lead to the loss of keystone species within riparian communities (such as Coolibah) along major tributaries.
- Installation of bores that penetrate multiple aquifers will require a minimum standard of an ADIA Class 2 driller or have equivalent Water Drilling certification approved by the Department of Water.
- Manage groundwater drawdown so that riparian vegetation along major tributaries is not significantly impacted.
- Minimise disruption to groundwater levels or water quality gradients in aquifers that support important habitats.
- Apply an independent peer review of hydrological models to support water and environmental assessments. The review should be consistent with National Water Commission's Australian Groundwater Modelling Guidelines (2012).

Strategy 38) Avoid negative impacts of surface discharge of excess water to important flora/fauna habitat (EPA, 2013).
Key Actions
- Excess water should be managed in accordance with the Department of Water's Pilbara Water in Mining Guideline (2009).
- Excess water should be re-injected in accordance with the Department of Water’s Pilbara Water in Mining Guideline (2009).
- Limit surface discharge of excess water, especially in vicinity of claypan habitats.
- Maintain the natural surface water flow regime.
- Prevent discharge of excess water directly to the wetland or indirectly via industry-induced surface expression of saline or fresh water. If discharge is proposed it should be in accordance with an approved management and monitoring plan and ideally be of an episodic nature (campaign discharge) to coincide with natural flooding/inundation events.
- Minimise surface discharge of excess water, especially in vicinity of claypan habitats.
- Minimise the discharge of surface water to the Poonda Plain that supports sand dune communities.
- Apply an independent peer review of hydrological models to support water and environmental assessments. The review should be consistent with National Water Commission’s Australian Groundwater Modelling Guidelines (2012).

**Strategy 39** Undertake Strategic Research to address key knowledge gaps for the Fortescue Marsh (EPA, 2013) [High Effectiveness]

**Key Actions**
- Undertake research and monitoring to determine the extent of cumulative hydrological impacts on the Marsh.
- Undertake surveys to document and map the extent of the species composition of this important ecological communities (e.g. Sand Dunes on Poonda Plain).
- Undertake surveys to delimit and define samphire vegetation communities.
- Undertake targeted surveys to identify and map distributions of conservation significant species, and persistence, extent, habitat preferences.
- Undertake targeted surveys to document macroinvertebrates within claypans.

**Strategy 40** Communication strategy to improve understanding of underground water sources differences and interactions. [Medium Effectiveness]

**Key Actions**
- Ensure that knowledge from a range of sources is consulted, including the in-depth understanding of Traditional Owners, the long term custodians who value water and wetland systems very highly.
## 5.2.4 Rock Piles and Granites

<table>
<thead>
<tr>
<th>Asset grouping</th>
<th>Assets</th>
<th>Threats</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROCK PILES AND GRANITES</td>
<td>13) Rock Piles and Granites</td>
<td>Clearance from Infrastructure Development (roads, rail, ports, other development) Feral Carnivores (cats, foxes, dogs)</td>
<td>By 2025 ensure regionally significant &amp; culturally significant areas are protected from direct &amp; fragmentation impacts</td>
</tr>
</tbody>
</table>

**Strategy 1)** Identify priority assets and high risk areas (Need to know using a modelling exercise where the highest asset values are)  
**Key Actions**  
- See strategy as mentioned above.

**Strategy 41)** Assess impact of infrastructure on cultural assets of rock-piles and granites  
**Key Actions**  
- Consult with Traditional Owners  
- Secure funding  
- Explore options for Indigenous self-development (if willing) of new projects to protect cultural sites (ownership e.g. Burrup)  
- Cultural survey to be lead by Traditional Owners to identify significant sites and define regional priorities  
- Engage rangers or similar groups to patrol culturally important sites  
- Monitoring, prevention and remediation of culturally important sites

**Strategy 42)** Assess impact of infrastructure on fauna and flora of rock-piles and granites  
**Key Actions**  
- Develop funding proposal and acquire funds  
- Conduct a 6 month project to synthesize a range of studies to get answers on fauna requirements and use (feral & native - especially Northern Quoll and SREs) of these systems  
- Map specific rock piles, assess rank  
- Research on fragmentation to look at connectivity, metapopulation dynamics, what is a barrier  
- Develop design guidelines for new and existing infrastructure to reduce barrier effects
### 5.2.5 Subterranean Fauna Habitat

<table>
<thead>
<tr>
<th>Asset grouping</th>
<th>Assets</th>
<th>Threats</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBTERRANEAN FAUNA HABITAT</td>
<td>11) Subterranean Fauna Habitat</td>
<td>Clearance from Mining (Mine sites)</td>
<td>13) CAR Reserve systems for subterranean fauna to be quantified by 2025 and 17% (IUCN recommendation) of subterranean fauna (stygofauna / troglofauna) habitat to be retained by 2050</td>
</tr>
</tbody>
</table>

**Strategy 43** Develop research questions - such as how good is underground habitat as a surrogate for species  
**Key Actions**  
- Questions include impact thresholds and tolerance  
- Habitat requirements - water quality, water drawdown, reinjection, humidity, resilience to disturbance, recolonising disturbed areas, physical (chemical) (trophic tools - ARC)

**Strategy 44** Undertake research (especially for stygofauna) as to how much drawdown (and reinjection) of water is possible before impacts  
**Key Actions**  
- Confirm which geologies (for sub-fauna) are in the conservation estate  
- Undertake a desk top review - 1 year (BHP and Rio are undertaking as part of strategic survey)

**Strategy 45** Develop a monitoring program for stygofauna  
**Key Actions**  
- Decide if a single large or several small reserves are optimal (driven here by heterogeneity, as opposed to the wheatbelt, driven by fragmentation)  
- Determine significance of habitat and system continuity

**Strategy 46** Design and implement a reserve system for subterranean fauna  
**Key Actions**  
- Define habitat requirements of conservation significant subterranean fauna and ensure that hydrological regimes are maintained.  
- Develop a Fortescue Marsh Management Area subterranean fauna theme within NatureMap.  
- Enhance survey effort to document aquatic fauna within claypans.  
- Enhance survey effort to document presence and richness of subterranean fauna.
### 5.2.6 Wetlands and Other Water Dependent Systems

<table>
<thead>
<tr>
<th>Asset grouping</th>
<th>Assets</th>
<th>Threats</th>
<th>Objective</th>
</tr>
</thead>
</table>
| WETLANDS AND OTHER WATER DEPENDENT SYSTEMS | 8) Fortescue Marsh (EPA defined area)  
9) Springs, Pools and Watercourses associated with Gorges and Ranges  
10) Clay Pans | Clearance from Infrastructure Development (roads, rail, ports, other development)  
Clearance from Mining (Mine sites) | By 2020 ensure regionally significant ecologically and culturally significant areas are protected from direct impacts. |

#### Strategy 14) Develop a transparent, co-ordinated approach to data collation, management and sharing
- Key Actions
  - See strategy as mentioned above.

#### Strategy 15) Development of a regional land-use plan to inform design and assessment of mining related development
- Key Actions
  - See strategy as mentioned above.

#### Strategy 16) Develop a co-ordinated Pilbara-wide offset strategy
- Key Actions
  - See strategy as mentioned above.

#### Strategy 17) Integrate ecological outcomes into mine planning process
- Key Actions
  - See strategy as mentioned above.

#### Strategy 48) Avoid (where possible) and minimise clearing/disturbance of areas of native vegetation that represents important flora/fauna habitat. (EPA, 2013)
- Key Actions
  - Avoid (where possible) and minimise clearing of areas of native vegetation where critical habitat (e.g. EPBC species) has been identified.
  - Avoid (where possible) and minimise clearing of mulga vegetation.
  - Avoid (where possible) and minimise clearing of samphire and halophytic vegetation.
  - Avoid (where possible) disturbance to extant Bilby burrows and minimise clearing of native vegetation where critical habitat has been identified.
  - Avoid locating infrastructure on or in close proximity to major Marsh tributaries.
  - Minimise clearing of native vegetation and abstraction of basic raw material (sand) for construction purposes.
  - Limit disturbance to claypan habitats where possible.
  - Map the condition of riparian vegetation and undertake revegetation activities where appropriate.
  - Undertake an assessment of cumulative impacts to mulga vegetation communities.

#### Strategy 49) Develop new guidelines for restoration - methods for monitoring, measure how effective restoration is
- High Effectiveness
**Strategy 50**) Determine the proportion of assets within formal reserves and ensure that each is represented adequately as per the system Comprehensive Adequate Representative (CAR) Reserve Management (~17%)

**Key Actions**
- Seek acquisition and reservation of mulga-dominated woodland and shrubland vegetation types
- Seek acquisition and reservation of suitable Night Parrot habitat
- Seek acquisition and reservation of suitable Northern Quoll habitat
- Seek acquisition and reservation of areas supporting Cowra and Christmas land systems

<table>
<thead>
<tr>
<th>Asset grouping</th>
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<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WETLANDS AND OTHER WATER DEPENDENT SYSTEMS</strong></td>
<td>7) Rivers, Creeks and Associated Floodplains on open plains 8) Fortescue Marsh (EPA defined area) 9) Springs, Pools and Watercourses associated with Gorges and Ranges 10) Clay Pans</td>
<td>Feral herbivores (Donkeys, Horses, Camels) (PRIMARY THREAT) Pigs (SECONDARY THREAT)</td>
<td>15) By 2020 reduce populations of feral herbivores (by X%) so adverse impacts to assets are reduced.</td>
</tr>
</tbody>
</table>

**Strategy 51**) Review and summary of the past 15 years of donkey control work (includes other species) [Should take < 6 months & cost $25k]

**Key Actions**
- Identify trigger points and thresholds for intervention per species
- Identification of known areas (Fortescue Marsh etc) where current programs are working

**Strategy 52**) Control and eradication of feral herbivores around key locations

**Key Actions**
- Secure funding for key feral control strategies
- Identify priority areas - water sources/high conservation value, e.g. Fortescue Marsh
- Undertake mapping of priority areas
- Decommission redundant waters sources
- Research improved control/monitoring techniques, drone technology (develop model - existing monitoring largely ineffective)
- Research biology of feral herbivores - e.g. home ranges - (significant knowledge gap)
- Investigate alternative control methods
- Continue to resource and expand existing projects
- Upskill, retrain professional contractors
- How to measure reduced impact contribution?
- Investigate feasibility of fencing to prevent new recruitment
- Eradicate donkeys & horses - use non-lethal methods to overcome cultural barriers to control

**Strategy 53**) Education to address cultural barriers to control

**Key Actions**
- Source funding
- Address religious concerns
- Demonstrate impacts to important sites
- Demonstrate contribution to total grazing pressure
- Eradicate donkeys & horses - use non-lethal methods to overcome cultural barriers to control

### Strategy 54) Pig eradication - De Grey River

**Key Actions**
- No new introductions (hunters)

### Strategy 55) Develop Pilbara wide user-friendly maps for different species of feral animals

**Effectiveness:** Low

### Strategy 58) Ensure that key strategies from WONS for Wetland Assets and Weeds for the Inland Mountains etc. integrate and cover weed strategies for these Wetland Assets

**Key Actions**
- Source funding for aquatic weed removal
- Determine what is a weed - e.g. Typha
- Active removal program for aquatic weeds
- Work from upstream downwards when controlling aquatic weeds
- Education program to address the issue of active recreation which can lead to introductions - accidental and deliberate

### Strategy 59) Prevent introductions of aquatic weeds

**Effectiveness:** High

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>WETLANDS AND OTHER WATER DEPENDENT SYSTEMS</td>
<td>7) Rivers, Creeks and Associated Floodplains on open plains 8) Fortescue Marsh (EPA defined area)</td>
<td>Inappropriate Fire Regimes (too hot, too frequent, too large)</td>
<td>By 2025 mosaic, cool, all seasons fire regimes in places across the Fortescue Marsh (EPA area)</td>
</tr>
</tbody>
</table>

### Strategy 60) Strategy to remove date palms (historically planted)

**Key Actions**
- Source funding
- Understand and address vectors for spread - cattle and bats
- Note that control can be cost neutral if re-sale - depending on location
- Education program as to why they need removal

<table>
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<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>WETLANDS AND OTHER WATER DEPENDENT SYSTEMS</td>
<td>7) Rivers, Creeks and Associated Floodplains on open plains</td>
<td>Mesquite and Parkinsonia - WONS Weeds</td>
<td>By 2025 eradicate Parkinsonia from upstream of the Fortescue Marsh and undertake 30,000 ha/year of Parkinsonia and Mesquite surveillance and control from other key assets</td>
</tr>
</tbody>
</table>
### Strategy 1) Identify priority assets and high risk areas (Need to know using a modelling exercise where the highest asset values are)

**High Effectiveness**

**Key Actions**
- See strategy as mentioned above.

### Strategy 61) Eradicate Parkinsonia from upstream of the Fortescue Marsh

**High Effectiveness**

**Key Actions**
- Source funding for the long term - 10 years
- Plan at scale for the entire region
- Integrate into existing WONS programs
- Incorporate existing mapping
- Co-ordinate control efforts
- Undertake training (preferably on site) and registration of contractors (important for all weed programs) and FIFO workers, and in the long term, locals
- Indigenous rangers used for control programs
- Use correct control methods
- Monitoring data, controlled and where it is not standardise this
- Natural regeneration possibly sufficient but active revegetation/rehabilitation may need be required - especially mechanical
- Natural regeneration - need to control with minimal impact

### Strategy 62) Undertake 30,000 ha/year of Parkinsonia and Mesquite surveillance and control from other key assets

**High Effectiveness**

**Key Actions**
- Source funding for the long term - 10 years
- Plan at scale for the entire region
- Undertake a pilot on Parkinsonia - costing/density audit based on works to date (FMG offsets) that can be used for inform other work
- Integrate into existing WONS programs
- Incorporate existing mapping
- Co-ordinate control efforts
- Undertake training (preferably on site) and registration of contractors (important for all weed programs) and FIFO workers, and in the long term, locals
- Indigenous rangers used for control programs
- Use correct control methods
- Monitoring data, controlled and where it is not standardise this
- Natural regeneration possibly sufficient but active revegetation/rehabilitation may need be required - especially mechanical
- Natural regeneration - need to control with minimal impact

### Strategy 63) Contractors and others to mark occurrences of outliers (GPS referenced and added to Pilbara Mesquite Management Committee data base) as a matter of normal business practice

**Medium Effectiveness**

### Strategy 64) Expand to other sub-regions - Roebourne and Hamersley to include current program (end 2016) - this will be point data, not density per areas (<$400K)

**Medium Effectiveness**
6 Monitoring, Evaluation and Adaptive Management

6.1 Methodology for Developing a Monitoring Program

The CAP process requires the development and implementation of a rigorous monitoring, evaluation and adaptive management program. This serves a number of important functions including:

- determining whether the conservation strategies and actions are achieving the desired goals;
- showing trends in the condition of conservation assets and the levels of threat;
- demonstrating the effectiveness and efficiency of investment into the conservation program;
- linking local conservation outcomes with other programs to describe the local-global biodiversity outlook; and
- securing future funding for sustaining action.

In particular, two types of monitoring and evaluation are identified in the CAP framework:

1) monitoring and evaluation for strategy effectiveness; and
2) resource condition (i.e. asset condition and/or level of threat).

The latter is analogous to a medical “check-up”, where the doctor measures indicators such as blood pressure to provide early warning signs of systemic problems. Ideally, a monitoring and evaluation program should include both components.

6.1.1 Results Chains

Results chains are used to test assumptions that an action will achieve a desired goal. By identifying interim results or milestones along a trajectory towards the delivery of an outcome, results chains make implicit assumptions about the expected results of activities explicit. This process typically results in more rigorous strategy development. Once a sequence of outputs and outcomes are represented as a results chain diagram, it is relatively easy to visualise and identify monitoring indicators and milestones along the way to a conservation goal (Figure 6).

![Figure 6: Conceptual diagram of a results chain (Foundations of Success 2007)](image)

6.2 Current Monitoring in the Pilbara Bioregion

During the Pilbara CAP workshop process, knowledge of existing monitoring programmes was documented. This exercise revealed that there is a significant number of monitoring programmes occurring, although some are out of date (e.g. one off projects, programmes that have ceased) and some are unstructured, compromising
their value in measuring the status of, and changes in, conservation assets over time. Furthermore, much of the monitoring being undertaken in the Pilbara is site specific and its broader relevance at a landscape level may be questionable. Existing monitoring programs and projects will be useful for viability (health) and threat assessment of conservation of assets, and to measure the success of implementation of strategies identified in this Pilbara CAP process over time.

### Table 10: Existing monitoring programs within the Pilbara Bioregion

<table>
<thead>
<tr>
<th>Vegetation Condition Monitoring</th>
<th>Sites exist on all pastoral leases, programme managed by DAFWA.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WA Rangelands Monitoring Sites</td>
<td>Assesses 1 ha sites for rangelands condition and soils, to be extended to fauna in the future. Early in establishment but programme aiming for approx. 70 in the Pilbara bioregion.</td>
</tr>
<tr>
<td>AusPlots</td>
<td>Completed in 2004, includes soil mapping; land systems for the Pilbara derived from it. Land systems represent the best mapped information for land management.</td>
</tr>
<tr>
<td>DAFWA Rangelands Survey</td>
<td>Primarily mining and resource companies, and via a wide range of environmental consultants. Documentation may be available via Environmental Impact Assessment process.</td>
</tr>
<tr>
<td>Other local scale monitoring</td>
<td>Managed by Parks and Wildlife and contribute to Australian Commonwealth Rangelands Information System). This count includes feral species and is conducted every 3-5 years.</td>
</tr>
<tr>
<td>Fauna Monitoring</td>
<td>Northern Quolls, Pilbara Leaf-nosed Bats, Greater Bilby, turtles. Research is in early stages but EPBC listed species are often monitored on a local scale for mining projects as a matter of compliance.</td>
</tr>
<tr>
<td>Kangaroo counts</td>
<td>Wedge-tailed Shearwater – some project work on offshore islands; Dampier Salt bird surveys – via Birdlife Australia; Fortescue Marsh – national bird survey through UNSW; Freshwater Fish –Dave Morgan, Murdoch University (Morgan et al, 2009); Subterranean fauna – often monitored on a local scale for mining projects as a matter of compliance; Pilbara Biological Survey as a potential baseline dataset.</td>
</tr>
<tr>
<td>EPBC listed species</td>
<td>Not monitoring per se but provides a regular index of abundance. Additionally, some satellite collars are being put on horses around the Fortescue Marsh area with the aim of monitoring movements.</td>
</tr>
<tr>
<td>Other local scale monitoring</td>
<td>Submitted to DAFWA from pastoralists, also collected at mining projects at a local scale.</td>
</tr>
<tr>
<td>Feral Animals</td>
<td>Monitored at the Fortescue Marsh by Parks and Wildlife, pre- and post-baiting only.</td>
</tr>
<tr>
<td>Feral Animals</td>
<td>Not monitoring per se, weed sightings and control only via Pilbara Mesquite Management Committee.</td>
</tr>
</tbody>
</table>
Other local scale monitoring

Weeds monitored on a local scale for mining projects as a matter of compliance, use of unmanned aerial vehicles and remote sensing is increasing.

Fire Regime

Local scale

Fire age maps exist for some key areas around Karijini and Millstream Chichester National Parks.

North Australia Fire Information (NAFI)

NAFI is being extended WA rangelands wide, including the Pilbara (a current initiative by the Fire Forum and Rangelands Fire Leadership Group). This will provide combined fire scar histories, remote sensing and fire monitoring, and reporting capabilities.

CSIRO Sentinel, Landgate Firewatch

Remote sensing and fire monitoring.

Water Monitoring

Local scale monitoring

Licencing and water monitoring has to be conducted and submitted to Department of Water (e.g. Water Information Reporting including water quality) and Department of Environmental Regulation.

Australian River Assessment System

A Commonwealth programme with 5 or 6 monitoring sites in the Pilbara.

Bureau of Meteorology

Gauging stations exist on some rivers in the Pilbara, including flowmeters and water stations.

Pilbara hydrogeology water study

Conducted by CSIRO and BHP.

6.3 Monitoring Indicators for the Pilbara Bioregion

A shared and effective monitoring program for the Pilbara Bioregion should achieve two major outcomes:

- Monitoring of effectiveness of strategies:
  - provide quantitative data to assess the effectiveness of the conservation strategies and action steps and identify areas for refinement;
- Resource condition monitoring:
  - provide quantitative data to assess the current status of the key ecological attributes and overall viability (health) of the conservation assets;
  - provide quantitative data to assess the current status of the key threats;
  - establish/augment baseline data to monitor future changes in the status of the key ecological attributes and overall viability (health) of the conservation assets;
  - establish/augment baseline data to monitor future changes in the status of the key threats.

Monitoring indicators should be closely associated with the status of key ecological attributes that are relevant to the conservation assets and address size, condition and landscape context attributes. A monitoring program should also make use of any existing data and monitoring activities in the region so as to ensure resources are used efficiently. This may involve creating links with other organisations that may have complementary aims or legislative requirements to undertake environmental monitoring.
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APPENDIX 1 Situation Analysis (Conceptual Model) Diagrams

The following 18 Situation Analysis Diagrams (Conceptual Models) were developed from the third CAP workshop (strategy setting) and reflect the information for the 18 Objectives and 64 Strategies presented in Section 5. Strategies in italics are common to more than one asset or asset grouping.
COASTAL ASSETS - Feral carnivores

By 2025 reduce predator pressures on populations of native fauna species (sea turtles, migratory birds, shorebirds, marsupials, etc) to allow populations to become self-sustaining within their range.

COASTAL ASSETS
1) Offshore Islands
   2 x Goals

2) Coastal Rangeland and Intertidal/ Mud Flats
   2 x Goals

3) Sandy Beaches and Dunes
   3 x Goals

Note: Rats are included in the category of offshore islands.

COASTAL ASSET - Feral carnivores
- Cats, foxes, dogs

CONTRIBUTING FACTORS
- Tenure issues – beaches are unallocated crownland therefore no control, the beach is not part of stations
- Low priority to pastoralists (carnivore control is expensive and time consuming)
- Remoteness of areas adds to cost & time for controlling feral carnivores
- Feral carnivores are not controlled at the scale required for effective control (high cost & time)
- Lack of suitable control methodology in tidal areas
- Domestic dogs and cats are a source of feral carnivores
- Cats and shorebirds both in urban and remote areas
- Breeding populations of migratory seabirds most at risk from cats
- Lack of quarantine and biosecurity procedures
- Community perceptions in town unfavorable for hunting feral carnivores
- Opportunity for indigenous rangers on country

STRATEGIES
1) Feral animal impact assessment and high-risk areas (needed to know using a modelling exercise to ensure the highest priority areas are targeted)

2) Develop and implement an integrated feral carnivore control strategy

3) Implement Cat Management Activities

4) Undertake Feasibility Cat Research to guide future management

5) Implement feral control program around key coastal fauna sites

6) Develop Communications/Education strategy around feral carnivores

COASTAL ASSETS - Carnivore CURRENT PROGRAMS & PROJECTS
- Pilbara Regional Coastal Access Strategy, 2014
  - Federal government to focus on cats – Threatened Species
    - Significant areas being mapped and identified
    - Gorgon, NCB, Gorgon Projects Barrow Island Wet Conservation Benefit Fund
  - Joint Industry and community conservation partnerships
  - DPAW – fox control on Pentecost Island and Dyalin Island
  - Feral control on Monts Station
  - Licencing for feral control

- GWR & NRM
  - Yimparra Island quarantine protocols being enforced by Apache
  - Feral cat control on Cape Range National Park
  - DPAW – fox control on Monts Station
  - Licencing for feral control

- Pilbara Bioregion
  - Eradication of feral cats and foxes
  - Feral control programs at Wessel Islands
  - Monitoring of feral cat control programs
  - Feral control programs at Yampi Peninsula

- DPAW (since 2013 for 2 years)

COASTAL ASSETS - Unsustainable stock grazing pressure

GOAL
By 2026 manage grazing pressure to the asset to protect grazing sensitive ecosystems & species (TBD), retain habitat structure and minimise the risk to threatened flora and fauna populations and cultural assets (TBD = to be determined)

COASTAL ASSETS
3 Goals
1) Water
2) Vegetation
3) Beaches and Dunes

THREAT
Unsustainable Stock Grazing Pressure

CONTRIBUTING FACTORS
- Large area, limited funding, few people
- Asset of little benefit to pastoralists
- Dunes can provide a grazing resource for stock from adjacent pastoral leases
- Generally adjacent to pastoral leases, although some are contained within pastoral lease areas
- Pastoral leases go down to 40m above the high water mark
- Opportunity to fence areas would need to place behind the pre dune to stop stock access onto dunes - see 80 mile beach example
- Fencing of dune areas problematic because of short lifetimes of fences - 10 years
- Opportunity for contracting teams to erect fences including indigenous rangers such as Ashburton Aboriginal Corporation
- Difficulty managing within fenced areas
- Entire asset has significant heritage values - both traditional indigenous and modern

STRATEGIES
1) Strategic Fencing to exclude stock from priority assets
2) Engagement with pastoralists via Ecologically Sustainable Rangeland Management (ESRM) Plans to protect coastal biodiversity
3) Implement Nutritional Self Shepherding trial

CURRENT PROGRAMS & PROJECTS
- Self-shepherding stock management – De Grey LCDC (one of six rangelands trials)
- Excurbari Station – BHP
- 80 Mile Beach project – fencing projects over the past 10 years – different funding sources
- Ecologically Sustainable Rangeland Management (ESRM) Plans
- 2016 Pastoral lease relinquishments on Varndie and Karatha Stations
COASTAL ASSETS - Weeds

GOAL
By 2025, control 75% of core infestations to prevent further spread or for significant, isolated conservation assets eradication of weed occurrence.

KnowlEDGE ISSUES
- Lack of knowledge of severity of threat of Weeds on Islands
- Climate change effects on biological control in the future
- Lack of knowledge of prescribed burning regimes on islands
- Lack of weed mapping on islands

CONTROL ISSUES
- Public access is a major contributing factor - industrial development - sand and machinery, introducing & spread of weeds, recreation and disturbance
- Ineffective barriers to public access - e.g. fenced and other barriers
- Lack of signage about weeds
- Weeds promote weeds campfire escapes and deliberate uncontrolled fires
- Cattle and horses cause soil and promote weed establishment
- Remoteness of islands - too far for control effectively

OPPORTUNITY - indigenous ranger groups undertaking weed control

STRATEGIES
- 1.0 Identify priority assets and high risk areas (need to know from modeling exercises where the highest asset values and
- 1.1 Develop a Pilbara-wide integrated weed strategy
- 1.2 Develop biosecurity strategy and action plan targeted at high risk coastal and related areas
- 1.3 Implement a coastal weed education strategy
- 1.4 Develop a weed research strategy

COASTAL ASSETS - Weeds
- Prickly pear control - chemical & biological - CSIRO (Rosemary Island first)
- Buffel in Port Hedland - community development program
- Conservation programs in Karratha - Landcare & Rangelands
- Conservation programs in the western Pilbara
- NBC (Sergison’s Net Conservation Benefits program)
- Decision support system for prioritizing and implementing biosecurity on Western Australia’s islands (> 300 islands) - islands & threatening processes
- Bob Prassey, James Cook University, LCC, & DP&W, funded by NBC (Sergison’s Net Conservation Benefits program)
- Shire Coastal Zone Management Strategies - access mainly
- Fencing dunes from cattle - Pardoo - 99 Mile Beach (ElmoUA, Billabong, Grit)
- BHP - Draft Biodiversity Management Plan includes Coastal access
- Department of Lands - coastal banks survey
- Pilbara Conditions, DP&W, Atlas (Defence), CSRO - Fortescue and RioTinto nutrition weed prioritisation
- Leave no trace program (weeds) - recreation induction, Fortescue River Mouth
- Education and signage at WP (rest stops)
- Sea Ranger program (Chewen out of Onslow)
- Cadmus (Prickly Pear Control - DP&W)
- Information on risk analysis and visitors (Kay – Dept Ag has information)
- Rangelands NRM - report on impacts on coast

NOTE: Once buffel is removed, need to revegetate rehabilitate areas so that they recover.
INLAND MOUNTAIN RANGES, ROCKY HILLS, BREAKAWAYS AND MESAS - Clearance from mining and infrastructure development

CONTRIBUTING FACTORS

- Mining focal area - scale is only within mining specific areas - not Pilbara wide.
- Historical planning.
- Historical mining methodologies - less efficient than today.
- Desperate data sets/contradictions? No consoence record/corporate data sharing.
- National data desire for resources/mining.
- No agreement on what “no net loss” refers to and how to achieve.
- No consistent existing standards for environmental outcomes (remediation/rehabilitation).
- Market forces can cause mines to be mothballed.
- Legislation enforcement not significant enough to discourage.
- Consultants - could give inconsistent and (potentially) incorrect advice.
- No overarching conservation strategy (such as for the Kimberley or for what was done on the Bunbury).
- Offsets are too new to know how well they work.

STRATEGIES

14) Develop a transparent, co-ordinated approach to data collection, management and use.
15) Development of a regional land use plan to inform design and assessment of mining-related development.
16) Develop a co-ordinated Pilbara-wide offset strategy.
17) Integrate ecological outcomes into mine planning process.
INLAND MOUNTAIN RANGES, ROCKY HILLS, BREAKAWAYS AND MESAS - Inappropriate Fire Regime

GOAL
By 2020, patchy, cool, early season fire regimes are in place across 10% of the asset annually to protect fire-sensitive ecosystems, maximise habitat diversity and minimise the risk to threatened flora and fauna populations.

INSTITUTIONAL AND MANAGEMENT CONTRIBUTING FACTORS
- Conflicting reasons for burning which are unsustainable
- Conservationists burn for one reason, pastoralists for another
- Pastoral burns to become breaks for broadleaf - inappropriate frequency (too open)
- Why are we burning? No economic reason to burn but too costly to put fires out
- Cross tenure issues - different fire models and access
- DPAW optimum timing for burning does not coincide with availability of resources

INAPPROPRIATE FIRE REGIMES (too hot, too frequent, too large)

INSTITUTIONAL AND MANAGEMENT CONTRIBUTING FACTORS
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- Cross tenure issues - different fire models and access
- DPAW optimum timing for burning does not coincide with availability of resources

KNOWLEDGE AND INFORMATION CONTRIBUTING FACTORS
- Climate change - fires now too frequent and/or climate means an increased fuel load
- Traditional fire regime has been interrupted & lack of knowledge of what was the traditional burning regime, if any
- Lack of knowledge of what appropriate fire regimes are
- Opportunities for Traditional Owners to be more engaged in informing on “Right Way Fire”
- Too frequently burnt (lightning/human) & not actively managed for fire
- Some areas OK - relatively “optimum” ecological fire regime - e.g. Yarraloo Station
- North Australia Fire Information (NAFI) - monitoring southlands to include Pilbara

CONTROL AND CAPACITY CONTRIBUTING FACTORS
- Exploration geologists burning to assist with survey (e.g. Marble Bar)
- Lack of fire brigades in topographically challenging terrain
- Lack of suppression resources and ability to manage fire at scale
- Access (topographic) restrictions to burn and do fire breaks
- Opportunity for Aboriginal Ranger team support and engage in fire activities

INLAND MOUNTAIN RANGES, ROCKY HILLS, BREAKAWAYS AND MESAS - Inappropriate Fire Regime
CURRENT PROGRAMS & PROJECTS
- Northern Australia Fire Information (NAFI) - requires funding - government & private support
- CSIRO (Olga Barron): Groundwater Dependent Ecosystems (GDE) remote sensing LandSat – DOW/WSF
- Community/Fire Strategy - Pilbara Corndons
- Rangelands NRM - Remote Sensing/Fire Mapping
- AusPlots in Pilbara
- Pilbarra Mulga Study - DPAW
INLAND MOUNTAIN RANGES, ROCKY HILLS, BREAKAWAYS AND MESAS - Weeds

GOAL
By 2035, 90% or (X 000$/ha) annual reduction of new introductions of Ruby Dock and town weed species e.g. Lantana, Washingtonia, Cotinus Palms, Malay almond, to prevent feral spread.

ASSET
1/2 inland mtn ranges, rocky hills, breakaways & mesas, 4 Geels

TREAT
Weeds (Buffalo, Grass, Kikuyu, Ruby Dock, paspalme, etc.)

AGGRESSOR
Lack of education
Translental population
Lack of infrastructure
Lack of management across tenures
Animal vectors of weeds
Lack of alternatives native plants - not weedy
Conflicting objectives (land, food, amenity, fodder, conservation)

INLAND MOUNTAIN RANGES, ROCKY HILLS, BREAKAWAYS AND MESAS - Weeds

CURRENT PROGRAMS & PROJECTS
Climate change modelling - CSIRO
List of weeds - ranking threat - Greg Kitching
Threatened species programs (disseminate action for weeds)

STRATEGIES
1) Identify priority areas and high risk areas - needed to know using a modelling exercise where the highest risk area is
2) Develop a Pilbara-wide integrated weed strategy
3) Improve Resource Management
4) Collaboration of weed data to get baseline and trends of change
5) Max and cost weed management trials required now & in future
6) Develop an inland weed education strategy

Town Weed STRATEGY
2/3 Weed control strategy for town weeds

Broad area - CONTRIBUTING FACTORS
No 2 value to clear weeds by pastoralists / non producers
Tenures - CPAW vs Mining
Lack of funds for weed control
Lack of private mapping for species and locations
Lack of standards for measuring density of weeds for accurate costing of control measures
No coordinated mapping or sharing (surfing sector not sharing information and maps) or approach
Size of the area - scale is enormous - need to be realistic/pragmatic

INLAND MOUNTAIN RANGES, ROCKY HILLS, BREAKAWAYS AND MESAS - Weeds

Knowledge gaps

Pilbara Conservation Action Plan: Summary Report
PLAINS ASSETS - Feral carnivores

**GOAL**
By 2020 reduce feral carnivore numbers in key areas by 75%.

**PLAINS ASSETS**
- Spotted Gum, Hilltop Grassland and Plains with shrubs and trees (e.g. Eucalyptus) - 5 Goals
- Tussock Grassland on Plains - 5 Goals
- Mulga Woodlands and Acacia Salubrida Communities - 5 Goals

**THREAT**
Feral Carnivores (cats, foxes, dogs)

**CONTRIBUTING FACTORS**
- Not enough predation of ferals by dingoes on one hand and pastoralists desire dingo balling
- Pastorists want to do dog control but there is a lack of funding
- Highly mobile
- Not enough control - large areas consist of campfire telemetry
- No impacts assessed - too hard - too many benefits
- Targeted, holistic approach required (foxes take baits but others problems arise)
- Interplay between feral predators and dingoes
- Monitoring needs to be linked to research projects - ecological monitoring is difficult (easier to measure dingo)
- Southern Rangelands NRM programs could be time-limited to Pilbara Communities

**PLAINS ASSETS - Feral carnivores CURRENT PROGRAMS & PROJECTS (refer to other assets as well)**
- Pastoralists - dingo baiting tied to production (Pilbara Regional Biodiversity Group)
- DPAW - Pilbara Regional Biodiversity Group - balling effectiveness research
- Forestac Marsh Feral Cat Baiting (FMC, Offset to DPAW)
- Eradicating red fox in Pilbara - non-targeted research (TRIO offset) funded trail by DPAW
- Non-targeted impacts of eradicating - Northern Dingo (RTIO offset) & Fortescue Marsh (FMC) offset
- Munda Binnu (Munda Binnu) - dingo baiting for control
- Invasive Animals CRC (ACRC) - in Pilbara/T. Interactions between feral predator project
- ECU Southern Rangelands
- E. Fewer (UNSW) - Centre for Ecosystem Science, John Read (Ecological Horizons, not in Pilbara)
- DPAW - dingo baiting, Northern Dingo (RTIO offset), Southern Rangelands
- Species distribution models (NERP) (National Environmental Research Program) funded, Melbourne Uni, DoE and DPAW project
- Eucalyptus carpus fire paper (2015) - not in Pilbara - questions about the science are emerging.

**STRATEGIES**
1. Identify priority assets and high risk areas (need to know using a modelling exercise, where the highest count values are)
2. Develop and implement an integrated feral carnivore control strategy
3. Implement Cat Management Activities
4. Undertake Applied Cat Research to guide future management
PLAINS ASSETS - Inappropriate fire regimes

**GOAL**
By 2020 set up to manage regionally significant areas to protect fire-sensitive ecosystems, maximise habitat diversity and minimise the risk to threatened flora and fauna populations.

**PLAINS ASSETS**
- 4. Spinifex Hummock Grassland on Plains with shrubs and trees (e.g. Acacia)
  - 5 Goals
- 5. Tussock Grasslands on Plains
  - 5 Goals
- 6. Mulga Woodlands and Acacia Shrubland Communities
  - 5 Goals

**THREAT**
- Inappropriate Fire Regimes (too hot, too frequent, too large)

**CONTRIBUTING FACTORS**
- Differences in reasons for burning (values driven) - pastoralists vs conservation
- Opportunity to get buy-in by DPAW and pastoralists sitting around the table
- Good information already exists for focus areas
- Fire scar mapping DPAW - pastoralists can provide feedback to improve maps - North Australian Fire Information (NAFI) process will help
- Monitoring - need a consistent approach (Ecofire example - John Silver has info)

**STRATEGIES**
1. Identify priority assets and high risk areas (Need to know using a modelling exercise where the highest asset values)
2. Develop a Pilbara-wide fire ecology research strategy
3. Develop a regional operational fire management plan
4. Develop a fire education strategy
5. Engagement with pastoralists via Ecologically Sustainable Rangeland Management (ESRM) Plans to integrate fire management for pastoralism with the protection of fire-sensitive ecosystems

**PLAINS ASSETS - Inappropriate Fire Regime CURRENT PROGRAMS & PROJECTS**
- Northern Australia Fire Information (NAFI) - requires government funding - private support
  - Neil Burrows, guiding principles document (U Silver)
  - CSIRO (Olga Barron), Dfifo remote sensing/Landsat - DWS/HA since 1997
  - Community Fire Strategy - Pilbara Corridors
  - Rangelands NRM - Remote Sensing Fire Mapping
  - Auspots in Pilbara ESRM planning
PLAINS ASSETS - Unsustainable stock grazing pressure

CONTRIBUTING FACTORS

- Need to boost pastoral outputs - too many concurrent stock
- Increased stocking pressure due to nutrient losses
- Stock is under stockpiled
- Pastoralists are under sustained pressure
- Natural grazing capacity limits
- Natural capital accounting - International Land Coalition (ILC)
- Sustainable management

STRATEGIES

- Increase production with pastoral systems
- Ecologically sustainable management
- Sustainable Rangeland Management (SRM) plan
- Landholders
- Plans for landscape scale property planning
- Includes biodiversity strategy

CURRENT PROGRAMS & PROJECTS

- Rangelands monitoring - Assists pastoral lease monitoring (DSSR) & RF Regions - Western Australian Rangeland Monitoring System (WARMS) monitoring (DAFW)
- Rangelands survey - carrying capacity
  - Rangelands monitoring
  - DAFF/DWR
  - Pastoral education - grazing management, nutrition (DSSR)
  - DTEC - drought and land degradation
  - Pastoral extension and community engagement campaign
  - Pastoral native grass identification course Pilbara Cluster
  - Pilbara threatened flora app - Rio Tinto & DFW
  - Sustainable pasturisation (DWR)
  - Industry embedded indicators - DFW, Rio Tinto, BHP
  - Industry embedded indicators - WA Museum & BHP
  - Rangelands assessment (AMC) - Pastoral/Soil Sustainable Grazing
  - Irrigated agriculture (RTH, Marandoo, Consolidated Minerals, Bamboo Springs - Warramaring Station)
  - Landscape rehabilitation
  - Landscape restoration workshops (PCP - GAM, BHP)
  - Proposal for Natural Capital - AMU, NAB, Ernst & Young (study has info)
  - Remote sensing - DFW/GIS - DPIRD
  - Altimeter office - Department of Lands (WA)}
PLAINS ASSETS - Weeds

GOAL
By 2020 (TBD) reduce extent (TBD) significant weeds (calotropris, berryach, bush, cactus, new & emerging weeds), and maintain 5% annual reduction of core infections of mesquite, to prevent further spread and by 2018 identify outlying occurrences of landscape scale/widespread weeds (capok, ruby dock, passiflora) that can be targeted for eradication. (TBD = to be determined).

CONTRIBUTING FACTORS
- Good knowledge of weeds, distribution - some are town based - not all everywhere
- Lots of programs
- Lots of project data not collated
- Key competing interests - buffel grass is an asset to pastoralists
- DPAW prioritisation process
- Biosecurity groups - Pilbara Regional Biosecurity Group

STRATEGIES
1) Identify priority assets and high risk areas (Need to know using a modelling exercise where the highest asset values are)
2) Develop a Pilbara-wide integrated weed strategy

PLAINS ASSETS
4) Spinfex Hummock Grassland on Plains with shrubs and trees (e.g. Acacia)
   - 5 Goals
5) Tussock Grasslands on Plains
   - 5 Goals
6) Munga Woodlands and Acacia Shrubland Communities
   - 5 Goals

THREAT
- Weeds (Buffel Grass, Kapok, Ruby Dock, passiflora, etc)

CURRENT PROGRAMS & PROJECTS (refer to other assets as well)
- Good existing programs for some weeds (e.g. berryach bush, cactus)
- Good existing knowledge
- Active management by pastoralists
- DPAW internal regional weed prioritisation
- DPAW, Pilbara Corndors, CSIRO weed prioritisation
- Pilbara Regional Biosecurity Group
PLAINS, WETLANDS and OTHER WATER DEPENDENT SYSTEMS - Altered hydrology

**OBJECTIVE:**
My 2025 vision is to establish optimum hydrological regimens by reducing impacts on natural flows from infrastructure barriers.

**PLAINS, WETLANDS & OTHER WATER DEPENDENT SYSTEMS**
- Plains
- Wetlands
- Groundwater

**THREATS**
The threat of primarily the intrusion of surface hydrological flow due to water management practices. This includes all hydrological related threats identified in this species which cumulatively have a high impact.

**PRIMARY THREAT:**
- Altered Hydrology from infrastructure development (roads, rail, etc.)

**SECONDARY THREATS:**
- Mine De-salting (increased river flows, reduction in groundwater)
- Mine water discharge into creeks & springs

**CONTRIBUTING FACTORS:**
There are management guidelines for Pilbara Woodlands (Fortescue Marsh) for quality of direct flows (e.g. every meter) at all times.

**STRATEGIES:**
- Minimising water flow released from desalting systems (e.g. in Pilbara) - is instead of de-watering.
- Integrated pasture can use water from mine desalting, but there are dangers of certain pasture species becoming
- Water from desaturation used for mining purposes and downstream communities, fish farms & aquaculture.

**NOTE:**
Flat areas across the Pilbara are subject to higher impacts from changes in hydrological flows. It's important to ensure that water flow follows natural pathways, i.e. ensure good functioning hydrology to minimize local landscape-scale desalination impacts on flora and fauna. Secondary threats may also include other desaturation impacts such as inter-aquifer leakage, pollution, potential for habitat succession.

**CURRENT PROGRAMS & PROJECTS**
- Flood tracking of mine sites for best practices hydrological flows.
- CSIRO, DOW, BHPSO
- De Grey LDC (Peter Andrews & picturesque Tim Valley) - looking at landscape from helicopters using imagery changes over time to see how water flows and how it is affected by roads, which areas are dry channel environments, watercourse changes.
- Rangelands development - Rangelands FRM, Greens Australia
- Existing ESRM planning and inclusion of Catchment Function Analysis.

CSIRO — potential for ground water dependence.
- Mulga — could feed into other assets, Pilbara-wide since 1987 (Old Barren)

Department of Water — license requirements and notes
ROCK PILES and GRANITES - Clearance from infrastructure development

**GOAL:**
By 2026 ensure regionally significant & culturally significant areas are protected from direct & fragmentation impacts

**ISSUE:**
CONNECTIVITY: The issue is largely fragmentation rather than direct clearing
ROCK ART
Ceremony
Grinding stones
Some sites too small to map, but still important culturally and ecologically
(rock shelters)

**ASSET:**
1) Rock Piles and Granites
2) Goal

**INPUTS:**
Clearance from Infrastructure Development
(roads, rail, ports, other development)
Feral Carnivores
(feral cats, dogs)

**NOTE:**
Some of the issues raised here are also applicable to other assets. In particular, Mulga communities and Splendid Sunray grasslands. Need to rethink mine planning (consider what other miners are doing). Cumulative impacts are not dealt with at a federal level, just at a state level. This issue is primarily fragmentation.

**ISSUE:**
Feral carnivores use rock piles as dens etc.
Co-existence of habitat with native fauna
Spatial arrangement is important

**CONTRIBUTING FACTORS:**

### Linear infrastructure
- Perception of threat - unproven
- Adjacent flows from infrastructure itself to each side and from one side to the other across infrastructure
- Environmental impact only considers specific corridor, does not account for adjacent values
- Cumulative impacts from adjacent parallel infrastructure
- As access in increased more interference with cultural sites - rock piles etc.
- Sacred Aboriginal sites should not have roads anywhere nearby

### Mining/Industrial development
- Mining practice: differing values from different cultural groups
- Differing values between rock piles
- Lack of ecological understanding - do terals use them? Endemism? Movements by key species. Define connectivity, meta-populations
- Desegregation of significant sites (challenge upheld - physical vs non-physical
- No focussed research
- Option for a case study
- Quoll sites - mapping and camera trap work by DPAW should pick these up
- Information from this work can help direct Rangelands NRM

### STRATEGIES
1) Identify priority assets and high risk areas (Need to know using a modelling exercise where the highest asset value is)
2) Assess impact of infrastructure on cultural assets of rock piles and granites
3) Assess impact of infrastructure on fauna and flows of rock piles and granites

### ROCK PILES & GRANITES - Clearance from infrastructure development

**CURRENT PROGRAMS & PROJECTS**
- Manjungara Rangers managing rock piles sites on the Burrup Peninsula and islands
  - Threatened taxon: Northern Quoll
  - Blitz interaction with barriers – DPAW, BHP, FGGP
  - Other Northern Quoll research is also happening – Fernands, M. Dow et al., Judy Dunlop – DPAW
  - R.T. Tipton / DPAW - Northern Quoll feral cat bait uptake trial
  - Peter Spencer – Northern Quoll genetics
  - Consulting literature – EPBC species, Short Range Endemics (SREs)
  - Mining company monitoring – feral occurrence, EPBC species
  - Culvert monitoring (threatened fauna) along rail – Roy Hill, FMG, BHP
  - Rangelands NRM work on quoll and bilby align with this (Chris Cumow)

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**SUBTERRANEAN FAUNA HABITAT - Clearance from mining**

** CONTRIBUTING FACTORS **

- Suitable geology in the Pilbara
- Lack of connectivity of habitat
- Lack of knowledge of habitat
- Difficulty and cost and damage of determining habitat
- Suitable geology does not equate to good habitat (more complicated than that)

** ASSET **

1. Subterranean Fauna Habitat

** STRATEGIES **

43) Develop research questions - such as how good is underground habitat as a surrogate for species

44) Undertake research (especially for stygofauna) as to how much drawdown (and reinjection) of water is possible before impacts (thresholds)

45) Develop monitoring program for stygofauna

46) Design and implement a reserve system for subterranean fauna

47) Avoid (where possible) and minimise impacts to Subterranean Fauna and their habitats (EPA, 2013)

** SUBTERRANEAN FAUNA HABITAT - Clearance from mining **

CURRENT PROGRAMS & PROJECTS

- BHP, CSIRO, DPAW DEPA – subterranean fauna modelling project
- Ecogenomics – genetic differences from water samples – can determine how many spp., if not what the actual spp. are – especially stygofauna – being used already but early days

** THREAT **

Clearance from Mining (Mine sites)
WETLANDS AND OTHER WATER DEPENDENT SYSTEMS - Clearance from mining and infrastructure development

GOAL
By 2023 ensure regionally significant ecologically and culturally significant areas are protected from direct impacts.

NOTE
There are a number of indirect threats (stresses) associated with the direct threats of vegetation clearing, including fragmentation, dust etc.

STRATEGIES
1. Development of a regional land-use plan to inform design and assessment of mining related development.
2. Develop a co-ordinated mine-wide offset strategy.
3. Integrate ecological outcomes into mine planning process.
4. Avoid where possible and minimise clearing/disturbance of areas of native vegetation that represents important flora/fauna habitat (EPA, 2013).
6. Determine the proportion of assets within formal reserves and ensure that each is represented adequately as part of the system.

CONTRIBUTING FACTORS
- Resource areas - increase in mining intensity - large scale
- Restoration and rehabilitation in ongoing but often leads to a reduction in quality compared with pre-mining condition
- Lack of information on restoration techniques
- Reference sites to inform restoration condition may be poor quality (weedy)
- Costs for restoration are at the back end of a mining operation and are too low
- Lack of CAR System - but is starting to happen

Current programs & Projects (refer to other assets as well)
- Pilbara Restoration Initiative (DMIP led)
- BHP & Kings Park & mining companies (led, Pilbara rehab. Working group – Pilbara Land Rehabilitation Group - FLPG)
- BHP & Kings Park – Pilbara Restoration Initiative
- Curtin University – ARC Training Centre for Mining Restoration
- Western Australian Biodiversity Science Institute (WABSI) – one node focused on rehabilitation (also lots of work done in other areas - Goldfields, SW etc.)

Clearance from Infrastructure Development
Wetlands Assets
- Fortescue Marsh (EPA defined area)
- 4 goals
- 9 Sprung, Pools and Water courses associated with Gorges and Flanges
- 4 goals
- 19 City Park
- 2 goals

Trends
- Clearing from Infrastructure Development
- Clearing from Mining (Mine site)
WETLANDS AND OTHER WATER DEPENDENT SYSTEMS - Feral herbivores

**GOAL:**
By 2020 reduce populations of feral herbivores (by 30%) so adverse impacts to assets are reduced.

**WETLAND ASSETS**
7) Rivers, Creeks and Associated Floodplains on open plains
   - 5 Goals
8) Fortescue Marsh (EPA defined area)
   - 4 Goals
9) Springs, Pools and Watercourses associated with Gorges and Ranges
   - 4 Goals
10) Clay Plains
    - 2 Goals

**PRIMARY THREATS**
- Feral herbivores (Donkeys, Horses, Camels)
- Pigs - domestic pigs released
- Pastoralists derive $ from running pig hunts
- Widely distributed - hard to control - difficulties getting last ew
- Extent of the area - "sea" of moving herbivores across the Pilbara but congregate at water
- Limited pool of contractors - training, firearms & welfare issues
- Cost of helicopters & access to good pilots
- Indigenous religious value of donkey/camel
- Source of bushmeat - prefer to retain some
- No market infrastructure for camel meat - $ is not high enough to cover costs

**SECONDARY THREAT**
- Pigs

**CONTRIBUTING FACTORS**
- Historic introduction
- Cultural/sentimental value - people don't want them killed
- Pigs - domestic pigs released
- Pastoralists derive $ from running pig hunts
- Widely distributed - hard to control - difficulties getting last ew
- Extent of the area - "sea" of moving herbivores across the Pilbara but congregate at water
- Limited pool of contractors - training, firearms & welfare issues
- Cost of helicopters & access to good pilots
- Indigenous religious value of donkey/camel
- Source of bushmeat - prefer to retain some
- No market infrastructure for camel meat - $ is not high enough to cover costs
- Shooting feral cattle can't be done - pastoralists own them and need to be consultant
- Integration of decrease of feral herbivores with increased weed and fire threats
- Existing resources - Pilbara Regional Biosecurity Group & DAFWA donkey telemetry project. Camel control & DAFWA have good data
- Knock-down shoots to achieve a density (of less than 2%) are not effective (figures available) - as there are different areas and large distances apart
- Lack of Pilbara-wide grid to assess (estimate) the density of feral herbivores
- Current control is 4e per year
- Mungaroo - no information on camels, donkeys, horses
- Is fencing being used and is it effective?

**STRATEGIES**
51) Review and summary of the past 15 years of donkey control work (includes other species)
52) Control and eradication of feral herbicides around key locations
53) Education to address cultural barriers to control
64) Pig eradication - De Grey River
65) Develop Pilbara wide user-friendly maps for different species of feral animals

**WETLANDS AND OTHER WATER DEPENDENT ASSETS - Feral herbivores CURRENT PROGRAMS & PROJECTS**
- Pilbara Regional Biosecurity Group (RRG, DAFWA) - donkey telemetry project, horses and other pests (Fortescue Marsh & Hamersley)
- Federal government - feral camel program (DAFWA & DPAW) - has now ceased - concluded in 2013, now co-ordinated by Pilbara RRG
- Opportunistic shooting
- Initiating Education/awareness
- Pig control work at De Grey River - some pickups by donkey control programs
- FMG - donkey horse telemetry trial using collars on Fortescue marsh (Hannah Robertson - DPAW - Offsets)
- ESRM - traps - pastoralists and Rangelands
WETLANDS AND OTHER WATER DEPENDENT SYSTEMS - Inappropriate fire regime

**CONTRIBUTING FACTORS**

- Fires coming in from adjacent assets, Spinifex rocky areas & Acacia
- If fire issues resolved in other assets will reduce/eliminate the threat for this asset
- Management of buttelpassiflora to reduce fire incidence/impact - need control (passiflora has commenced
- Recreational local area - camp fires, education, monitoring (volunteer/rangers) & management, campsites improvements, strategic firebreaks
- Integrating grazing controls with fuel load management - ESRM

**STRATEGIES**

1. Hot works from rail - education, adherence to Standard Operating Procedures - compliance
2. Ensure implementation of the range of strategies to ensure appropriate fire regimes in adjacent asset areas (PLAINS and INLAND MOUNTAINS ETC. ASSETS)

**GOAL**

By 2025 mosaic, cool, all seasons fire regimes in places across the Fortescue Marsh (EPA area)

**ASSET**

71 Rivers, Creeks and Associated Floodplains on open plains

5 Goals

**THREAT**

Inappropriate Fire Regimes (too hot, too frequent, too large)

**NOTE:**
This asset and threat were only brainstormed briefly to see what differences there were from other assets that address this topic. Most strategies have already been covered under the PLAINS and INLAND MOUNTAINS ETC. ASSETS.
GOL
By 2025 there are no new incursions of weeds (priority weeds) and the impact, distribution and density of weeds is reduced (by x amount) in key asset locations.

NOTE:
These assets and threat were only brainstormed briefly to see what differences there were from other assets that address this topic. Most strategies have already been covered under the Weeds of National Significance (WONS) conceptual model for WETLAND ASSETS, as well as for Weeds examined for the PLAINS and INLAND MOUNTAINS ETC. ASSETS.

WETLAND ASSETS

7) Rivers, Creeks and Associated Floodplains on open plains
5 Goals

8) Fortescue Marsh (EPA defined area)
4 Goals

9) Springs, Pools and Watercourses associated with Gorges and Ranges
4 Goals

THREAT
Weeds (Buffel Grass, Kakadu, Ruby Dock, Passiflora, etc)

STRATEGIES

56) Ensure that key strategies from WONS for Wetland Assets and Weeds for the Inland Mountains etc integrate and cover weed strategies for these Wetland Assets

59) Prevent introductions of aquatic weeds

50) Strategy to remove date palms (historically planted)
## APPENDIX 2: Pilbara Assets from INFFER™ process (Rangelands NRM, 2013)

<table>
<thead>
<tr>
<th>Asset number</th>
<th>Asset name</th>
<th>Description</th>
<th>Current condition</th>
<th>Community and Social values</th>
<th>Environmental values</th>
<th>Economic values</th>
<th>Threats</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop 10</td>
<td>Rocklea Dome</td>
<td>Geological formation</td>
<td>Good</td>
<td>Geological</td>
<td>Mining</td>
<td>Mining</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop 11</td>
<td>Barra wood</td>
<td>Iconic fish species belonging to the perch family</td>
<td>Good</td>
<td>Fishing and recreation</td>
<td>Iconic fish species of north Western Australia</td>
<td>Fishing</td>
<td>Fishing and predators</td>
<td></td>
</tr>
<tr>
<td>Desktop 18</td>
<td>Lowendal Islands Nature Reserve</td>
<td>Islands, nature reserve</td>
<td>Good</td>
<td>Marine animals, flora and fauna</td>
<td>Mining (oil and gas)</td>
<td>Mining (oil and gas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop 23</td>
<td>Barrow Island Group Nature Reserve</td>
<td>Islands, nature reserve</td>
<td>Good</td>
<td>Rare and endemic flora and fauna species. Breeding, feeding, resting, refugia, aggregating area for marine animals and birds.</td>
<td>Mining (oil and gas)</td>
<td>Mining (oil and gas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop 4</td>
<td>De Grey River</td>
<td>River</td>
<td>Good</td>
<td>Water source, supports flora and fauna</td>
<td>Fishing and tourism</td>
<td>Cattle, fishing, tourism, rubbish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop 5</td>
<td>Hamersley Range</td>
<td>Mountain range with many extensively eroded gorges</td>
<td>Good</td>
<td>Culturally significant, tourism and recreation</td>
<td>National Park, geological, water source, flora and fauna</td>
<td>Mining (iron ore), tourism</td>
<td>Mining (iron ore), tourism, rubbish, feral animals, cattle, fire</td>
<td></td>
</tr>
<tr>
<td>Desktop 6</td>
<td>Burrup Peninsula</td>
<td>Unique rock formation and the most prolific collection of Aboriginal rock art in Australia</td>
<td>Good</td>
<td>Culturally very significant</td>
<td>Geological, flora and fauna</td>
<td>Mining, port, industrial, tourism</td>
<td>Erosion (natural), mining, industry, port, tourism</td>
<td></td>
</tr>
<tr>
<td>Desktop 7</td>
<td>Millstream Chichester National Park</td>
<td>National park, gorges and rock pools</td>
<td>Good</td>
<td>Culturally significant, tourism and recreational</td>
<td>Geological, water source, flora and fauna</td>
<td>Tourism and recreational</td>
<td>Tourism, rubbish, feral animals</td>
<td></td>
</tr>
<tr>
<td>Desktop 8</td>
<td>Fortescue Marsh - Floodplain</td>
<td>Floodplain</td>
<td>Good</td>
<td>Significant invertebrate diversity, high degree of species endemism, provides a habitat and refuge for native flora and fauna</td>
<td>National Park, geological, water source, flora and fauna</td>
<td>Pastoral and mining</td>
<td>Weeds, feral animals, pastoral activities and cattle, mining, altered fire regimes</td>
<td></td>
</tr>
<tr>
<td>Desktop 9</td>
<td>Kanjiini National Park</td>
<td>National park, gorges and rock pools</td>
<td>Good</td>
<td>Culturally significant, tourism and recreational</td>
<td>National Park, geological, water source, flora and fauna</td>
<td>Mining (iron ore), tourism</td>
<td>Mining (iron ore), tourism, rubbish, feral animals, cattle, fire</td>
<td></td>
</tr>
<tr>
<td>KA002</td>
<td>White sandy dunes (on soils dataset)</td>
<td>White sandy dunes with sparse vegetation</td>
<td>Varied - degraded to good</td>
<td>Camping, fishing, trail bikes, 4WD. Often containing significant heritage sites (e.g. middens, stone tools)</td>
<td>Unique habitat in Pilbara contains Lerista (skink) which is only found in that habitat; coastline protection/stability (essential for cyclonic event); supports priority grassland community</td>
<td>Mining (sand), tourism, natural erosion protection for Kararri community and pastoral area</td>
<td>Coastal development, feral animals, weeds, mining</td>
<td></td>
</tr>
<tr>
<td>KA003</td>
<td>Rock art - Burrup Peninsula</td>
<td>Indigenous Rock art</td>
<td>Very good</td>
<td>Culturally significant</td>
<td>NA (cultural values)</td>
<td>Some potential tourism</td>
<td>Industry, vandalism</td>
<td></td>
</tr>
<tr>
<td>KA004</td>
<td>Pilbara offshore islands (excluding Barrow Island)</td>
<td>Islands</td>
<td>Generally good</td>
<td>Recreational use, high density of heritage sites</td>
<td>Islands for species which are under significant pressure on mainland. Also includes unique species and habitat. Important for shorebirds/seabirds</td>
<td>Tourism</td>
<td>Uncontrolled access, unmanaged tourism, feral animals, weeds, mining (Barrow Island), sea level rise</td>
<td></td>
</tr>
<tr>
<td>KA005</td>
<td>Montebello Islands</td>
<td>Marine and conservation park, Island group, low lying, shallow coral reef, white dunes</td>
<td>Good</td>
<td>Recreational, tourism, fishing, diving, camping, charter vessels</td>
<td>Low lying islands; diverse range of habitats, flora and fauna; birds, turtles, bilbies, dugongs, whales, coral, fish</td>
<td>Resource industries (gas, oil, ports, commercial fishing, recreational fishing), tourism</td>
<td>Mining, pearl leases, tourism, fire, introduced pests, oil spill, pollution</td>
<td></td>
</tr>
<tr>
<td>KA006</td>
<td>Roebourne Plains</td>
<td>Native grasslands. Unique vegetation</td>
<td>Fair to good</td>
<td>Under represented/not represented in the Comprehensive and Adequate Reserve (CAR) system</td>
<td>Eastral production (grazing), carbon storage</td>
<td>Grazing (domestic and feral animals), fire, weeds, development (e.g. Maitland Industrial Estate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KA007</td>
<td>Rock art - various locations, excluding Burrup Peninsula</td>
<td>Indigenous rock art on various geology</td>
<td>Excellent but is to decline</td>
<td>Very high value to indigenous people, tourist value, Australian heritage value</td>
<td>Indigenous people collect nardoo from Indigenous people collect nardoo from Nickel Bay Remnant Dune wetland (food source), 4wd racing track</td>
<td>Human impacts (off road bikes, 4WDs), weeds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KA010</td>
<td>Ephemeral wetlands behind Nickol Bay remnant dune and Burrup Peninsula</td>
<td>Ephemeral Wetlands, wet after rains for up to four months</td>
<td>Nickel Bay Remnant Dune wetland good but becoming degraded, Burrup wetland pristine</td>
<td>Indigenous people collect nardoo from Rarely found sedges and other species, Burrup wetland contains priority species</td>
<td>Human impacts (off road bikes, 4WDs), weeds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KA011</td>
<td>Maitland River</td>
<td>Riparian zone</td>
<td>Good</td>
<td>Recreation, fishing</td>
<td>Ecological community</td>
<td>Pastoral production</td>
<td>Weeds, sand mining, unmanaged access</td>
<td></td>
</tr>
</tbody>
</table>

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<tr>
<td>KA012</td>
<td>Pastoral land on Maridie and Yarralooia stations</td>
<td>Pastoral land under threat from the invasive weed Mesquite</td>
<td>Degraded to fair</td>
<td></td>
<td>Biodiversity</td>
<td>Pastoral production</td>
<td>Weeds (mesquite)</td>
<td></td>
</tr>
<tr>
<td>KA013</td>
<td>West Mid Intercourse island</td>
<td>Near shore rocky island, providing sheltered habitat at shoreline (mangroves)</td>
<td>Good</td>
<td></td>
<td>Very high density of heritage sites, limited visitation. Endangered species, Mangrove habitat, unique habitat.</td>
<td></td>
<td>Port Development (Malliland Industrial Estate), feral animals, weeds, sea level rise</td>
<td></td>
</tr>
<tr>
<td>KA014</td>
<td>Bungaroo valley aquifer</td>
<td>Aquifer dependent on cyclonic rainfall events to recharge</td>
<td>Excellent</td>
<td></td>
<td>Extremely high cultural values, including individual sites within the valley. Used as a water source. High water quality</td>
<td></td>
<td>To be used as a water source for the west Pilbara water supply</td>
<td>Mining, over-abstraction</td>
</tr>
<tr>
<td>KA015</td>
<td>Meentheena</td>
<td>Ex-pastoral property</td>
<td>Good</td>
<td></td>
<td>Vietnam veterans camp Conservation, some grazing value</td>
<td></td>
<td>Some pastoral production in parts</td>
<td>Fire, unmanaged access and use, feral animals (camels) Could become conservation reserve with 10 Management from indigenous, locals &amp; Vietnam veterans</td>
</tr>
<tr>
<td>KA016</td>
<td>Cleaverville turtle resting sites</td>
<td>Beach; Turtle nesting site</td>
<td>Fair to degraded</td>
<td></td>
<td>8WU, motorbikes, beach access Nesting site for flat back and hawksbill turtles</td>
<td></td>
<td>Tourism</td>
<td>Community use, feral predators (foxes taking eggs)</td>
</tr>
<tr>
<td>KA017</td>
<td>Deep Gorge</td>
<td>Typical and good example of Pilbara rocky gorge with ephemeral waterway</td>
<td>Good, Trend is to decline.</td>
<td></td>
<td>Very high density of Rock Art, Heritage sites Pilbara rockpile communities. Endangered species (Pilbara Olive python, Quoll, Pilbara Leaf-nose Bat)</td>
<td></td>
<td>Tourism (the unofficial Rock Art site)</td>
<td>Human impacts (unrestricted visitor access and damage/vandalism, litter, weeds, feral animals) Potential constraints to mining - significant offset and management commitments required</td>
</tr>
<tr>
<td>KA018</td>
<td>Pilbara leaf-nose bat at API cave</td>
<td>EPBC listed, WA listed, Pilbara endemic species, world class bat cave</td>
<td>Excellent</td>
<td></td>
<td>Nil but holy grail for bat overs 10,000+ Pilbara Leaf-nose Bat in the population which is the largest known by significant factor, maternity roost</td>
<td></td>
<td>Significant mineral value</td>
<td>Mining</td>
</tr>
<tr>
<td>KA019</td>
<td>Skull Spring (upper Oakover, De Grey River)</td>
<td>Spring and pools in Casuarina forest in river bed</td>
<td>Fair</td>
<td></td>
<td>Camping site meeting of Nomads in 1947 River forest/pool habitat</td>
<td></td>
<td>Unmanaged visitation and use</td>
<td></td>
</tr>
<tr>
<td>KA020</td>
<td>Caves Creek</td>
<td>Good Cultural</td>
<td>Good Cultural</td>
<td></td>
<td>High biodiversity</td>
<td></td>
<td>Pastoral production</td>
<td>Mining, grazing</td>
</tr>
<tr>
<td>KA021</td>
<td>Fortescue Marsh - Entire</td>
<td>Saline/halophyte/sapimere dominated flood plain with intermittent inundation</td>
<td>Excellent</td>
<td></td>
<td>Contains sites but area has cultural significance as a whole Bird habitat, ground water recharge</td>
<td></td>
<td>Mineral deposits</td>
<td>Mining (activity and associated infrastructure, dewatering impacts, change in groundwater hydrology and to saline/fresh water interface)</td>
</tr>
<tr>
<td>KA022</td>
<td>Coondewanna Flats Priority Ecological Community</td>
<td>Coolbah, Mulga woodland (dominated) with tussock grassland</td>
<td>Very good</td>
<td></td>
<td>Scar trees - presumably cultural value, hunting</td>
<td></td>
<td>Water resource, for mining development, pastoral production</td>
<td>Grazing pressure, feral animals (horses, cats), mining (and infrastructure corridors), change to flooding regime and surface water/sheetwater</td>
</tr>
<tr>
<td>KA023</td>
<td>Munjina Claypan</td>
<td>Mulga heavy clay soils, unrepresented vegetation commons, proposed CAR addition - 2015, Mitchell grass grasslands</td>
<td>Varies from fair to severely degraded Traditional owner hunting grounds</td>
<td></td>
<td>Unique vegetation types, species with disjunct distributions and undescribed taxa High grazing value - Juna Downs (since 1983)</td>
<td></td>
<td>Grazing (of grassland and understorey in Mulga woodland), fire clearing, dewatering for mining activities, infrastructure corridors</td>
<td>Heavy clay soils are highly resilient</td>
</tr>
<tr>
<td>KA024</td>
<td>Sand dunes of Fortescue Valley</td>
<td>Priority Ecological Community - red sand dunes dominated by atypical vegetation communities for Pilbara, unique/uncommon reptile assemblages</td>
<td>Fair - excellent to severely degraded Traditional owner burial sites</td>
<td></td>
<td>Atypical vegetation, unique uncommon reptiles High pastoral production value (due to Buffel grass), sand source for concrete during mine construction</td>
<td></td>
<td>Weeds (Buffel grass), grazing, mining (sand)</td>
<td></td>
</tr>
<tr>
<td>KA025</td>
<td>Millstream wetland</td>
<td>Riparian ecosystem associated with millstream springs and pools on Fortescue River</td>
<td>Custodian/traditional, historical, current recreational/tourism</td>
<td></td>
<td>Endemic species refuge (invertebrates, plants), riparian system, listed as a subregionally significant wetland</td>
<td></td>
<td>Tourism, water supply for West Pilbara (industry, potable)</td>
<td>Dewatering/unsustainable use of water, fire, weeds and pest plants, feral and pest animals including unmanaged cattle</td>
</tr>
<tr>
<td>KA026</td>
<td>Ethel Gorge</td>
<td>Stygobiot/fauna community in aquifer</td>
<td>Unconfirmed</td>
<td></td>
<td>Species-rich with endemic stygofauna community</td>
<td></td>
<td>Mining (dewatering), recreation</td>
<td>Constraint to mining development</td>
</tr>
<tr>
<td>KA027</td>
<td>Blind Cave Eel</td>
<td>EPBC listed</td>
<td>Unknown</td>
<td></td>
<td>Probably indicative of high quality water</td>
<td></td>
<td>Mining (dewatering potable water)</td>
<td>Constraint to mining and supply to West Pilbara Water Supply</td>
</tr>
<tr>
<td>KA028</td>
<td>Lepidium catapycnon</td>
<td>Short lived perennial; opportunistic species i.e. responds well to disturbance</td>
<td>Unknown</td>
<td></td>
<td>Intrinsic</td>
<td></td>
<td>Clearing, increased fire frequency</td>
<td>Several populations in Karriyo National Park probably increased abundance with increased fire and physical disturbance from mineral exploration</td>
</tr>
</tbody>
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<tr>
<td>KA029</td>
<td>Mulgara</td>
<td>Two species of small carnivorous marsupial. Crest-tailed Mulgara (Dasyurus cristicauda) is EPBC and state listed (Threatened); Brush-tailed mulgara (Dasyurus burru) is not listed</td>
<td>Unknown</td>
<td>Traditional ecological knowledge</td>
<td>Naturally vulnerable and threatened. Presence is indicative of a functioning ecosystem</td>
<td></td>
<td>Altered fire regimes, predators, localised clearing (fragmentation of populations)</td>
<td>Students at Murdoch University are studying the taxonomy. Many locations picked up through the species tracking program</td>
</tr>
<tr>
<td>KA030</td>
<td>Mulgalands proposed Conservation Park</td>
<td>Proposed multi-use conservation park</td>
<td>Excellent to degraded</td>
<td>Spectacular landscape, Traditional Owner significance</td>
<td>Muga woodlands with numerous undescribed and restricted species. Intact ecosystem with little weeds. Ghostbats, dune python etc</td>
<td>Significant mining deposits</td>
<td>Fire, changed hydrological regimes (change in surface flow from infrastructure development), grazing</td>
<td></td>
</tr>
<tr>
<td>KA031</td>
<td>Coral (inshore coastal strip Onslow to 80 Mile Beach)</td>
<td>Coral communities (supports both hard and soft coral species)</td>
<td>Degraded</td>
<td>Fishing, diving, food, cultural</td>
<td>Marine environment</td>
<td>Commercial fishing</td>
<td>Industry, global warming, cyclones (erosion, siltation, etc)</td>
<td></td>
</tr>
<tr>
<td>KA032</td>
<td>Flatback Turtles - at Port Hedland</td>
<td>Threatened species</td>
<td>Unknown</td>
<td>population has been estimated but more data needed</td>
<td>Cultural links to traditional owners, Community interest in population and community monitoring program</td>
<td>Endemic species, keystone species, only turtle restricted to Australian Continental Shelf</td>
<td>Tourism</td>
<td>Sea level rise, mining, harbour developments, boating activity, coastal lighting, beach degradation, feral animals (foxes and cats), overfishing, direct habitat destruction</td>
</tr>
<tr>
<td>KA033</td>
<td>Carnarvon, Canning and Pilbara Basin Aquifer</td>
<td>Aquifer</td>
<td>Good</td>
<td>Water Supply, town, industry, pastoralism</td>
<td>Biodiversity (stygofauna)</td>
<td>Supports life and industry</td>
<td>Mining (dewatering), weeds, contamination/pollution</td>
<td></td>
</tr>
<tr>
<td>KA034</td>
<td>Interdinal and supra tidal habitat (Dampier salina)</td>
<td>Salt ponds at Dampier</td>
<td>Good</td>
<td>Has important heritage sites</td>
<td>Shorebird habitat, both for feeding and roosting. Listed as important bird site.</td>
<td>Salt production</td>
<td>Feral animals, coastal development</td>
<td>Importance of habitat will become more critical as sea level rises and anchor points/feeding stems become less viable</td>
</tr>
<tr>
<td>KA035</td>
<td>Fortescue River</td>
<td>Ephemeral river with areas of permanent water and springs</td>
<td>Good</td>
<td>Tourism, Hitage, Cultural, Recreation, Ophalmia Dam water supply, Millstream Water Supply</td>
<td>High biodiversity - plants and animals</td>
<td>Pastoralism, tourism, Ophalmia Dam, Millstream Water Supply</td>
<td>Overgrazing (domestic and feral animals), tourism and recreation, fire, mining dewatering, weeds</td>
<td></td>
</tr>
<tr>
<td>KA036</td>
<td>Marine mangroves</td>
<td>Mangroves, inshore, estuarine</td>
<td>Fair</td>
<td>Recreational fishing, crabbing</td>
<td>Fish nursery area. Habitat for birds, turtles and crabs</td>
<td>Commercial fishing, recreational fishing (crabs, prawns, fish)</td>
<td>Industry, pollution, global warming (sea level rise, more intense storm events), increased human use</td>
<td></td>
</tr>
<tr>
<td>KA039</td>
<td>Air quality - Port Hedland and Dampier</td>
<td>Clean air polluted by industry, particularly iron ore crushing and transport</td>
<td>Degraded</td>
<td>High</td>
<td>High</td>
<td></td>
<td>Fine particles of iron ore</td>
<td></td>
</tr>
<tr>
<td>KA040</td>
<td>Fish resource (inshore coastal)</td>
<td>Fish targeted by recreational fishers: coral trout, blue bline, barramundi, mackerel, targeted species</td>
<td>Fair</td>
<td>Recreational, cultural, food</td>
<td>Part of marine environment</td>
<td>Associated fishing businesses, boat stores, fishing stores, 4WD</td>
<td>Overfishing (within 50 kms of major towns), industry, commercial fishing, pollution / oil spills</td>
<td>50 km radius around large population under extreme fishing pressure. Dept of Planning report about coastal access points still in draft form.</td>
</tr>
<tr>
<td>KA041</td>
<td>Pastoral rangeland on Mt Florence Station (watershed of the Hamersley Ranges)</td>
<td>Grazing Rangeland Mulga Community</td>
<td>Good</td>
<td>Biodiversity good mulga stands soft spinifex</td>
<td>Quality grazing buffel grass</td>
<td>Mining infrastructure, interrupted water flow, erosion, water deprivation</td>
<td>Unique to this location due to location of railway line</td>
<td></td>
</tr>
<tr>
<td>KA042</td>
<td>Natural structures that allow water within drainage channels</td>
<td>Physical or plant structures that slow and spread water out to flood plains</td>
<td>Varied - good to degraded</td>
<td>These structures create pools/billabongs within water for fishing, swimming, serpent home</td>
<td>Cause flood-out, creating local floodplain/ riparian habitat</td>
<td>High for cattle feed on flood plains for cattle production</td>
<td>Large flood events, over grazing, fire</td>
<td>Many now not functional as they have been eroded or completely washed away</td>
</tr>
<tr>
<td>KA043</td>
<td>Steep slopes at top of catchment</td>
<td>Steep country below breakaway that holds up/slow down runoff in cyclonic flooding rains</td>
<td>Varied - good to degraded</td>
<td>Indirect in that it keeps rivers clean, healthy for fishers and swimming etc</td>
<td>Modest biodiversity but high value ecosystem function in keeps hydrological process/rivers healthy</td>
<td>Pastoral productivity</td>
<td>Fire, overgrazing (both result in slopes devoid of vegetation, leading to erosion gullies)</td>
<td>These areas are dispersed across properties, landscapes, but can be mapped and managed appropriately, Flood damage can result in lost grazing opportunities and therefore lost income until land recovers</td>
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<td></td>
</tr>
<tr>
<td>KA045</td>
<td>Mountain top flora (uplands of the Hamersley Ranges)</td>
<td>Unique vegetation types. Numerous species of biological significance and refugia</td>
<td>Good</td>
<td>Tourism value</td>
<td>Refugia species richness, geological diversity</td>
<td>Limited - mining, tourism</td>
<td>Mining, infrastructure developments (e.g. beacons, tower foundations), inappropriate (more frequent) fire regimes</td>
<td></td>
</tr>
<tr>
<td>KA046</td>
<td>Dampier Sand Banks between Onslow and Dampier excluding Dampier Archipelago</td>
<td>Sandy islands of varying sizes off Pilbara coast.</td>
<td>Varied - good to degraded</td>
<td>Recreation - Fishing, Tourism</td>
<td>Turtle, raptor and sea bird nesting sites, vegetation that has evolved different forms to mainland, big tide fluctuations, mangroves</td>
<td>Tourism (primarily local), potential base for resource industry (overlapping mining tenements for iron sand mining)</td>
<td>Migratory fauna (rare species), feral animals (wolves, foxes), fire, sea level rise, unmanaged tourism and recreation, small 4wds taken over by boats</td>
<td>Survey (by Vicki Long) of 28 islands between Onslow and Dampier highlighted the need to protect at least some islands. Use PBS delta for modelling of potential habitat - due for completion in 2013</td>
</tr>
<tr>
<td>KA047</td>
<td>Rare Flora (Declared Rare Flora, Priority Flora, EPBC listed flora)</td>
<td>Species in various locations: 114 priority flora in various locations; two species listed under both EPBC and state; one species EPBC listed but not state listed</td>
<td>Varied</td>
<td></td>
<td></td>
<td>Fire, pest and feral animals, weeds, overgrazing / grazing pressure, climate change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KA048</td>
<td>Acacia leeuwiniana</td>
<td>Priority/geographically restricted, fire sensitive, very attractive acacia</td>
<td>Good</td>
<td></td>
<td></td>
<td>Inappropriate fire regimes, granite mining (ballast quarries road/traffis)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| KA049        | Limestone islands                                  | Terrestrial limestone island, spinifex dominated, Unusual species, Rattus linneari
on islands - only represented on islands | Unknown assumed good          | Recreation                | Rattus linneari, unique geological composition of Pilbara                                                        | Barrier island - functional value in landscape there, economic value and potential mineral value                                                                                                                      | Resource development, mining, feedstock for iron ore smelting                                                                                                                                                                |                                                                                                                                                                                                                              |
<p>| KA050        | Wonna Land System                                  | Cracking clay on top of Chichester's, Volcanic geologo - basaats, Species-rich grasslands of which three types are listed as Priority Ecological Communities | Varies from severely degraded to degraded | Historical - harvest of sorghum, landscape value/tourism, hunting value | Numerous undescribed species, disjunct or range end species, undescribed species                                                                                                                                       | Pastoral production                                                                                                                                                                                                       | Fragmentation (resulting from infrastructure development), increased weed risk (particularly Buffel grass), inappropriate fire regimes, grazing                              |                                                                                                                                                                                                                              |
| KA051        | Fortescue River - Floodplain on Mt Florence Station | Grasslands flood plain, high value land system                              | Fair to good          | Recreation                | Rapan ecosystem                                                            | Pastoral production                                                                                                                                                                                                     | Weeds (Prickly pear)                                                                                                                                                                                                       |                                                                                                                                                                                                                              |
| KA052        | Western Turner River - Rapan environment           | Rapan environment                                                          | Unconfirmed          | Recreation                | Rapan ecosystem                                                            | Pastoral production                                                                                                                                                                                                     | Weeds (Prickly pear)                                                                                                                                                                                                       |                                                                                                                                                                                                                              |
| KA053        | Themeda grasslands on Hamersley Station            | Tussock grasses on cracking clay                                            | Fair (seasonal)      | TEC and unique community    | High value grazing land, carbon                                            | Fire, grazing, weeds                                                                                                                                                                                                     | EPA has a guidance settlement for arid zone mangroves. In the Pilbara, mangroves form many of the ecological niches these woodlands play for bush birds in other areas                               |                                                                                                                                                                                                                              |
| KA054        | Arid Zone mangroves                                | Mangrove species including Avicennia marina and Rhizophora stylosa. Shows zonation and habitat niches | Generally good     | Important traditional food gathering area, and has associated with Middens and heritage sites | Massive ecological function, coastal protection, base of food webs. Threatened and endemic Species. Unique habitat in Australia and world heritage                                                                                              | Fishing, juvenile breeding ground                                                                                                                                                                                      | Coastal development                                                                                                                                                                                                       |                                                                                                                                                                                                                              |
| KA055        | Tichella/Condon Beaches and Estuaries             | Beach, coastal areas, estuary and fish stocks                              | Varied - good to degraded | Fishing/recreation          | Mangroves, estuary, habitat for fish. Migratory birds, &quot;Salt bush&quot; coastal grass                                                                                           | Pastoral production                                                                                                                                                                                                     | Human use impacts (unmanaged access and use, rubbish), fire, siltation due to erosion upstream                                                                                                                                 |                                                                                                                                                                                                                              |
| KA056        | Sea grasses - inshore coastal strip                | Marine seagrass                                                            | Unknown             | Nursery areas for prawns/crab, fish for food /dugongs, healthy environment                                | Commercial and recreational fishing /dugongs, healthy environment                                                                                                                                                    |                                                                                                                                                                                                                              | Industry, pollution, dredging                                                                                                                                                                                                 |                                                                                                                                                                                                                              |
| KA057        | Grazing Rangelands                                 | Approximately 50 pastoral leases grazing livestock                         | Variable good - degraded | High, Historical bases for the development in the Pilbara. Good stewardship in managing land                   | Representative of majority of Pilbara land systems/communities                                                                                                                                                             | Food production contributes to state economy, carbon                                                                                                                                                                      | Mining, conservation estates, urban spread vs production, under recognised value of food production, feral animals, weeds, fires                                                                                                                                 |                                                                                                                                                                                                                              |
| KA058        | Dampier Archipelago                                | Inshore coastal islands, marine environment, cultural, fish resources       | Fair                | Recreation, camping, fishing, cultural                                                               | Coral communities, endemic species, biodiversity of coral                                                                                                                                                             | Industry, tourism                                                                                                                                                                                                       | Industry, introduced species and invasive marine pestes, fire, global warming                                                                                                                                               |                                                                                                                                                                                                                              |
| KA059        | Karrawine Gorge (Oakover river)                    | Gorge with large freshwater pool                                           | Fair to good         | Tourist camping spot, Fishing and swimming for locals, Indigenous culture                               | Wetlands, fish habitat, visually stunning, fossil stromatolites                                                                                                                                                    | Stock water, tourism                                                                                                                                                                                                     | Flood damage, unmanaged human use                                                                                                                                                                                              | Currently easy access but no facilities or people management                                                                                                             |
| T001         | Springs on Cheeta Plains                           | Ecological hub as water drives biological productivity (fish, birds, etc)    | Very good            |                             |                             | Pastoral production (springs feed surface rivers for stockwater downstream)                                                                                                                                               | Degradation of upstream watershed, overuse by feral animals                                                                                                                                                               |                                                                                                                                                                                                                              |</p>
<table>
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<tr>
<th>Asset number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>T002</td>
<td>Weeli Wolli Spring</td>
<td>Permanent spring fed pool</td>
<td>Good</td>
<td>Significant heritage site/story site, Recreation area</td>
<td>Biodiversity, Threatened Ecological Community, water source</td>
<td></td>
<td>Mining (dewatering, under threat from existing and future mining)</td>
<td>and stock and community, mine dewatering upstream</td>
</tr>
<tr>
<td>T003</td>
<td>Isolated landforms e.g. Mount Robinson, The Governor</td>
<td>Changing topography throughout region</td>
<td>Excellent</td>
<td>Aesthetics, tourism - landscape</td>
<td>General ecosystem component eg surface water flow/watershed. Specific ecosystem - habitat for rare endangered species (known or unknown)</td>
<td></td>
<td>Tourism, potential mining</td>
<td>Mining (leveling of regional breakaway of hills)</td>
</tr>
<tr>
<td>T004</td>
<td>George River - estuary/river mouth</td>
<td>Breeding grounds - Barmamundi estuary and fish stocks</td>
<td>Good to fair</td>
<td>Regularly used by Port Hedland and Karratha locals for fishing / recreation</td>
<td>Breeding grounds, mangroves, estuaries, migrating birds</td>
<td>Tourism, commercial fishing</td>
<td>Fire (inland of George River (no control of burn-offs, too-frequent fires)), pollution (cargo ships, rubbish), over fishing, unmanaged use</td>
<td>River systems get damaged upstream from inappropriate fire regimes</td>
</tr>
<tr>
<td>T005</td>
<td>Catchment areas e.g. Turner syncline (Rocklea Dome)</td>
<td>Connected ranges and hills and upcapes that feed through valleys to rivers and plains</td>
<td>Fair to good</td>
<td>Wheel driving, camping, prospecting, cultural</td>
<td>Ecological framework that is fundamental to whole system functioning - headwaters</td>
<td>Mining, human use impacts (recreation, pastoral, access), too frequent fire</td>
<td></td>
<td>Catches fertility and makes available for productive use.</td>
</tr>
<tr>
<td>T006</td>
<td>Beasley River</td>
<td>Tributary river Hardey to Ashburton rivers</td>
<td>Fair (includes banks and river bed)</td>
<td>Recreation, prospecting, cultural</td>
<td>Tree species in river zone together with shrub and ground cover. River flows to lower catchment, floodplains and ocean.</td>
<td>Stock water</td>
<td>Overgrazing (over extraction of water, adding excessive water by mines, dams, altered flow and hydrology)</td>
<td>Higher proportion of grasslands in degraded condition than other vegetation communities in the Pilbara but their condition in the Pilbara better than it is other subregions. Refer CSIRO report via Bill Cotching</td>
</tr>
<tr>
<td>T007</td>
<td>Native perennial grasses/grasslands</td>
<td>Variety of species</td>
<td>Degraded (generally)</td>
<td>Recreation - aesthetics and comfort, cultural, tourism</td>
<td>Habitat for many lifeforms - all components other than moisture</td>
<td>Grazing - highest productivity of all self-perpetuating vegetation types when in good condition, Fertile and resilient. Direct benefit is to pastoralists.</td>
<td>Overgrazing (stock, fire particularly the overuse of fire / increased fire frequency), mining, weeds, feral and native herbivores (numbers increase due to access to water)</td>
<td></td>
</tr>
<tr>
<td>T008</td>
<td>Minor inland rivers</td>
<td>Tributaries and inland river systems</td>
<td>Fair</td>
<td>Fishing and recreation</td>
<td>Water, riparian vegetation, associated floodplains, drainage function, catch sediment and slow water flows when in good condition</td>
<td>Stock watering, some mining</td>
<td>Overgrazing (leading to erosion), overuse by mining (over extraction or over disposal, interruptions to flow)</td>
<td></td>
</tr>
<tr>
<td>T011</td>
<td>Upper Yule River Catchment</td>
<td>Catchment with high cultural, biodiversity</td>
<td>Fair</td>
<td>High indigenous cultural value LAW ground</td>
<td>Bilby, mulgara, 50+ species of reptiles.</td>
<td>Pastoral production, mine infrastructure, gold Rail lines x4</td>
<td>Mine infrastructure, large feral animals, uncontrolled access, prospectors, fire (late hot fires)</td>
<td></td>
</tr>
<tr>
<td>T020</td>
<td>Mount Meahry</td>
<td>Highest Peak in WA</td>
<td>Good</td>
<td>Highest landform, recreation, amenity</td>
<td>Isolated peak, supports short range endemic species</td>
<td>Limited tourism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T021</td>
<td>Karijini Gorges</td>
<td>Deep incised gorges and pools within Karijini National Park</td>
<td>Good (protected)</td>
<td>Recreation, heritage</td>
<td>Preservation of landscapes and ecosystems</td>
<td>High visitation tourism site</td>
<td>Insufficient management of land, feral animals, fire</td>
<td></td>
</tr>
<tr>
<td>T022</td>
<td>Fortescue Marsh - Floodplain on Marllana station</td>
<td>Floodplain for Fortescue Marsh, a wetland identified in 'A Directory of Important Wetlands in Australia'</td>
<td>Very good</td>
<td>Cultural significance of Fortescue Marsh itself</td>
<td>Wetland ecosystem risk, migratory listed bird species, buffer for wetland</td>
<td>Pastoral productivity, mineral exploration and extraction</td>
<td>Groundwater abstraction especially from multiple mining operations affects water levels and quality, surface water flow interruption (rail, roads)</td>
<td>Draft, Fortescue Marsh Guidelines for mining (EPA policy document)</td>
</tr>
<tr>
<td>T023</td>
<td>Springs and semi-permanent waterholes between Karijini and Newman</td>
<td>Spring fed or deep pools, typically in upper creek systems, which provide water resources within the landscape.</td>
<td>Varied</td>
<td>Some recreational use, Some with heritage value</td>
<td>Refuge, water source habitat for key species</td>
<td>Water source for livestock</td>
<td>Livestock, unmanaged human use (including impacts from increased visitation)</td>
<td>Condition: Most are grazed and subject to stock or feral degradation but generally still maintain biodiversity values.</td>
</tr>
<tr>
<td>T024</td>
<td>Riparian corridors between Karijini and Newman</td>
<td>Riparian corridors</td>
<td>Varied</td>
<td>Linkage for fauna movement and dispersal</td>
<td>Important for livestock water source</td>
<td>Livestock, mining (in certain areas)</td>
<td>Key aspect in maintaining biodiversity dispersion pathways through the landscape. Fauna movement often concentrated around three corridors where vegetation is typically more dense and offers greater level of protection.</td>
<td></td>
</tr>
<tr>
<td>T025</td>
<td>Fortescue freshwater slaypans downstream of the Marsh</td>
<td>Clay pans which are periodically inundated with flows from Fortescue River</td>
<td>Degraded</td>
<td>Extension of biodiversity values of Fortescue Marsh - distinctly different habitat</td>
<td>Highly productive pastoral land</td>
<td>Linear infrastructure (rail, road), grazing (stock and feral animals)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T026</td>
<td>Weeli Wolli pools - example of pastoral lease reform</td>
<td>Groundwater fed spring - permanent flow</td>
<td>Spring itself very good, creek has</td>
<td>Aboriginal heritage significance. Recreational significance of Weeli Wolli Creek, especially TEC (biodiversity), source of permanent surface water flow</td>
<td>Used for discharge point by mining companies</td>
<td>Mine waterway, human use impacts (increased visitation, rubbish, water pollution from lack of toilet facilities, etc)</td>
<td>Pastoral land Reform 2015</td>
<td></td>
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<tr>
<td>T027</td>
<td>Running Waters pool and spring</td>
<td>Spring fed or deep pool in Casuarina forest</td>
<td>Good to fair</td>
<td>Very popular camping, fishing spot for locals. Indigenous site</td>
<td>Small wetlands with pool</td>
<td>Limited grazing value</td>
<td>Human impacts (access, rubbish, etc)</td>
<td></td>
</tr>
<tr>
<td>T028</td>
<td>Bush tucker and medicine plants</td>
<td>Native plants traditionally used for food and medicine</td>
<td>Fair</td>
<td>Very high value for indigenous people for cultural reasons. Also sometimes important for food.</td>
<td>Biodiversity values</td>
<td>Potentially very high importance for medicine</td>
<td>Grazing, hot fires, over exploitation</td>
<td>Populations have been reduced in some areas due to overuse</td>
</tr>
<tr>
<td>T029</td>
<td>Cane River</td>
<td>River System</td>
<td>Riparian zone degraded in places</td>
<td>Contains LAW ground on river bank and other heritage values. Location of live-in training centre for indigenous people</td>
<td>Native fish population with no exotic species, unique swamp plant community. Recharge of Onslow water bores.</td>
<td>Pastoral grazing, town water supply, irrigation potential</td>
<td>Continued erosion in catchment, over burning, inappropriate grazing, some hydrological disruption of the river system</td>
<td>Being developed as key catchment demonstration research e-training property.</td>
</tr>
<tr>
<td>T030</td>
<td>Peedamulla Wetlands and swamp</td>
<td>River delta containing swamp with unusual mix of vegetation</td>
<td>Fair</td>
<td>Limited recreational and indigenous use (limited by poor access)</td>
<td>High due to unique plant community mix</td>
<td>Fairly high grazing value</td>
<td>Disrupted, dysfunctional drainage system</td>
<td></td>
</tr>
<tr>
<td>T031</td>
<td>Native perennial grasses/grasslands on Cheela</td>
<td>Fertile soils supporting a variety of species</td>
<td>Fair to poor</td>
<td>Habitat for many lifeforms - all components other than moisture</td>
<td>Grazing</td>
<td>Overgrazing, increased fire frequency, invasive plants, feral and native herbivores</td>
<td></td>
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