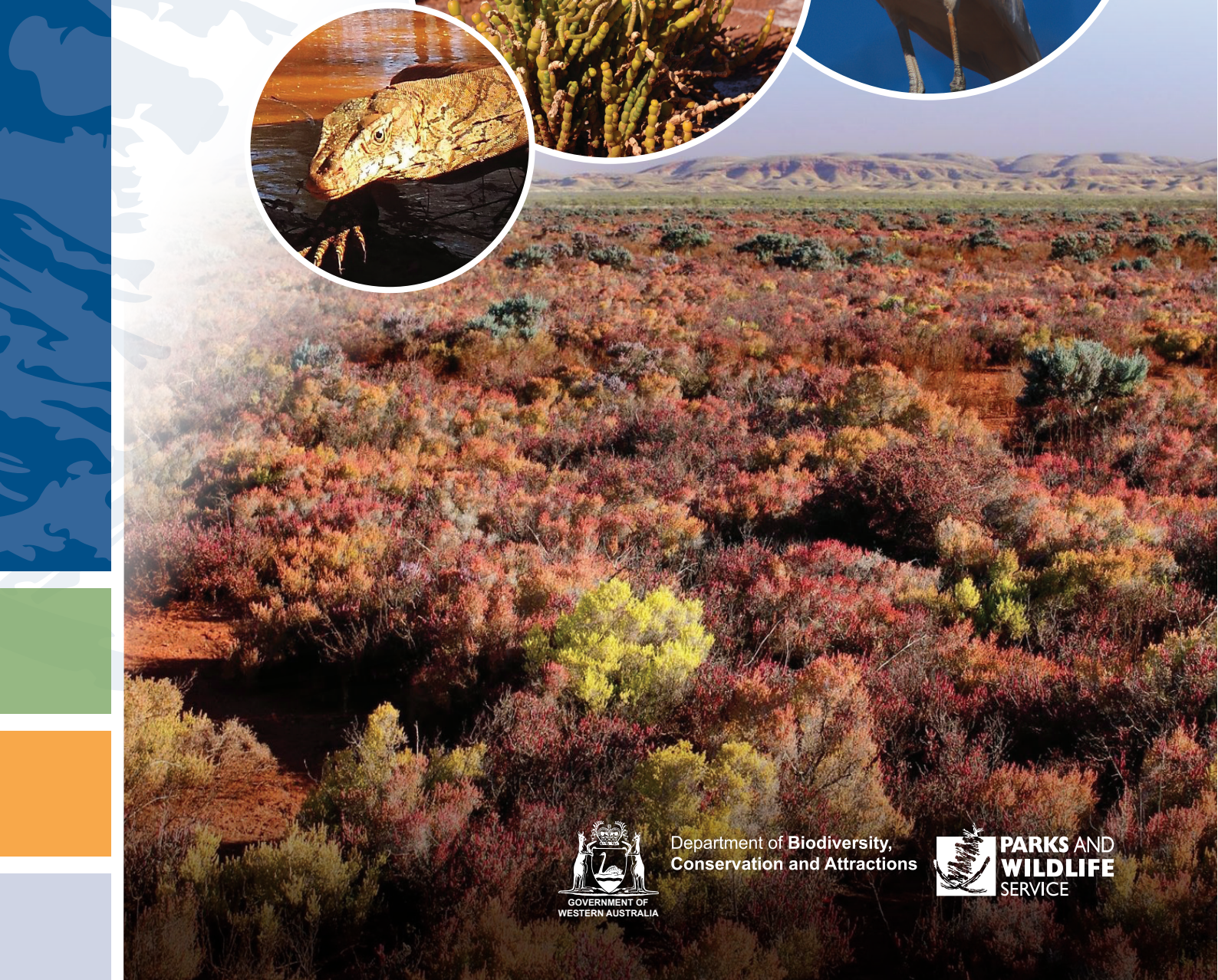
Fortescue Marsh Management Strategy 2018–24



GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

PARKS AND WILDLIFE SERVICE

Department of Biodiversity, Conservation and Attractions
Lot 3 Anderson Road
Karratha Industrial Estate
KARRATHA WA 6714

Phone (08) 9182 2000
dbca.wa.gov.au

This management strategy was prepared by the Department of Biodiversity, Conservation and Attractions.

Questions regarding this strategy should be directed to:
Pilbara Region
Parks and Wildlife Service
Department of Biodiversity, Conservation and Attractions
Lot 3 Anderson Road
Karratha Industrial Estate
KARRATHA WA 6714
Phone: (08) 9182 2000

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Cover (main) Fortescue Marsh. Photo – Steve Dillon/DBCA

Inset cover (left to right): Perentie. Photo – Hamish Robertson/DBCA.
Tecticornia medusa. Photo – Kevin Thiele/DBCA.
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Executive Summary

The Fortescue Marsh (the Marsh) is the largest and most important wetland in the Pilbara region, located on the Fortescue River north of Newman in Western Australia (WA). This management strategy covers 180,000 hectares of unallocated Crown land (UCL), excised from four pastoral leases in 2015 and encompassing most of the Marsh Land System (the strategy area). The Marsh is culturally significant to the Banjima, Nyiyaparli and Palyku traditional owners and there is a long history of use of the area by Aboriginal people. The area provides habitat for several significant fauna species, including the critically endangered night parrot (*Pezoporus occidentalis*), endangered northern quoll (*Dasyurus hallucatus*), greater bilby (*Macrotis lagotis*) and Pilbara olive python (*Liasis olivaceus* subsp. *barroni*). When flooded, the Marsh provides important habitat for large numbers of migratory waterbirds. The Marsh Land System has a regionally significant flora assemblage dominated by samphire (*Tecticornia*) species and important communities of grove-intergrove mulga and snakewood are found on the fringes.

This management strategy outlines the key cultural, natural, economic and community values of the Marsh and its surrounds and provides direction for the protection of these values into the future. It provides a summary of management operations to be undertaken in the area over the next seven years (2018 – 2024). Management objectives and actions highlight priorities for protecting the values of the Marsh and key performance indicators (KPIs) will be used to track progress against the implementation of priority objectives over the life of the strategy. Where possible, the approach is outcome based, providing a framework for adaptive management of the Marsh.

While protection of all values within the strategy area is important, this strategy focusses on several critical priorities for management. The successful implementation of the strategy will result in several key outcomes, namely:

- Improved baseline knowledge of flora, fauna, ecological communities and Aboriginal cultural values through more surveys, research and mapping and a framework for adaptive management based on these findings.
- Strategic fencing of key parts of the strategy area, in conjunction with feral herbivore and stray cattle management and regular consultation with neighbours in relation to straying cattle (*Bos taurus*).
- Containment and eradication of the highest priority weed species, with a focus on *Parkinsonia* (*Parkinsonia aculeata*).
- Fire management to protect key biodiversity and cultural values.
- Significant progress towards the creation of a formal conservation reserve within the strategy area including:
    - defining a proposed conservation reserve boundary,
    - progress towards joint management and Indigenous Land Use Agreements (ILUAs) through consultation and collaboration with traditional owners, and
    - completing the requirements for Ramsar listing of the Marsh.
- Management of feral cats (*Felis catus*) through a broadscale baiting and integrated introduced predator control program, used within an adaptive management framework, resulting in improved survival of populations of significant native fauna species.

The strategy area is surrounded by national park, UCL and pastoral lease. In addition, within and surrounding the strategy area, are important iron ore deposits that make significant economic contributions to the State and the rest of Australia. Several existing and proposed iron ore mines are located within or very close to the strategy area. Therefore, achievement of these strategic priorities requires cooperation with key stakeholders. Building relationships and management partnerships with Banjima, Nyiyaparli and Palyku traditional owners will be important for the successful

implementation of the strategy. Ongoing consultation and cooperation with mining companies and pastoralists will enable more successful outcomes from the strategy, especially in relation to the management of issues across land management boundaries, such as weed and feral animal control and fire management.

Fortescue Marsh and Hamersley Range. Photo Adrienne Markey/DBCA

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Plumed whistling ducks (*Dendrocygna eytoni*), 14-Mile Pool. Photo – Adrienne Markey/DBCA

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1. Introduction

1.1 The strategy area and its values

The Fortescue Marsh is a large ephemeral wetland, located in the Fortescue River valley between the Chichester and Hamersley Ranges, within the Pilbara region of WA, about 100 km north-west of Newman. It is the largest and most important wetland in the Pilbara region, listed on the Directory of Important Wetlands of Australia as a wetland of regional and national significance.

The strategy area comprises 180,000 hectares of UCL within the Shires of Ashburton and East Pilbara (see Map 1); encompassing the Marsh Land System and surrounding alluvial plains of the Fortescue Valley.

The key values of the strategy area are described below.

Aboriginal culture and heritage
The Marsh is of immense cultural significance to the Banjima, Nyiyaparli and Palyku traditional owners and is described as the 'heart' of the region's water system. There is a long history of use of the area by Aboriginal people and it contains many Aboriginal heritage places.

Tall mulla mulla (*Ptilotus nobilis*). Photo – Adrienne Markey/DBCA

Natural
The Marsh is recognised as a Key Biodiversity Area (KBA)[1] for its significance as habitat and feeding area for nationally significant numbers of waterbirds following inundation. The Marsh and surrounds support habitat for several conservation significant fauna species, notably the night parrot, northern quoll, greater bilby and Pilbara olive python. The strategy area supports a high diversity of aquatic and terrestrial invertebrates and stygofauna.

The Marsh Land System comprises an unusual flora assemblage dominated by *Tecticornia* species. Vegetation surrounding the Marsh includes important communities of grove-intergrove mulga on alluvial soils and mixed species shrublands on calcrete and gilgai soils. Several important priority ecological communities (including the Marsh Land System which is Priority 1 ecological community) are found within and surrounding the strategy area. Based on the area's unique and significant species and communities, the Fortescue Marsh will be considered for nomination as a Ramsar wetland over the life of this strategy.

[1] KBAs are sites that contribute to the global persistence of biodiversity in terrestrial, freshwater and marine ecosystems. For sites to qualify as global KBAs, they must meet certain criteria identified by the International Union for Conservation of Nature (IUCN) in its *Global Standard for the Identification of KBAs* (IUCN 2016). The criteria are based on threatened biodiversity, geographically restricted biodiversity, ecological integrity, biological processes and irreplaceability. A partnership of 12 international, non-government nature conservation organisations aim to map, monitor and conserve KBAs worldwide.

Resource
Mineral resource values of the strategy area and surrounds are internationally significant. The iron ore deposits of the central Pilbara contribute significantly to the State and national economies, generating jobs in the mining sector in the region and WA. The strategy area is proximal to several planned and operating iron ore mines including Cloudbreak, Christmas Creek, Roy Hill, Marillana and Koodaideri.

The strategy area also has a long history of pastoral land use which included sheep grazing prior to the 1980s and, more recently, cattle grazing. Pastoral lease areas surrounding the strategy area are actively managed for beef cattle production.

1.2 Strategy area

Under the classification scheme provided in the Interim Biogeographic Regionalisation of Australia (IBRA7), the strategy area is located in the Pilbara bioregion (Fortescue subregion) in the north-west of Australia and is described by Kendrick (2001).

Covering an area of 180,000 hectares, the strategy area extends east-west for about 105km. It lies in the middle reaches of the discontinuous Fortescue River (see Map 1).

White plumed honeyeater (*Ptilotula penicillatus*). Photo – Adrienne Markey/DBCA

This strategy covers the majority of the Marsh Land System. Until 30 June 2015, the Marsh was part of four active pastoral leases (Mulga Downs, Marillana, Hillside and Roy Hill) (Map 1). Due to the area's important natural values, a large portion of the Marsh was excised from these pastoral leases on 1 July 2015 through long-standing negotiated agreements with the respective pastoral lessees and returned to the State with the intention of establishing conservation tenure within these excised areas. The boundary of the strategy area is based on the portions of pastoral lease excluded from pastoral stations during the 2015 pastoral lease renewal process. Following this process, all pastoral leases across the State were renewed for 50 years, including those leases surrounding the strategy area. The eastern portion of the Marsh remains part of Roy Hill station and cannot be considered for inclusion in the conservation reserve system as it will remain as pastoral lease until 2065.

The iron ore deposits within the strategy area are significant and the existing Cloudbreak and proposed Koodaideri iron ore mines are located within the boundary of the strategy area. These are subject to several State Agreements (see 1.3 *Management context – legislation and policy framework*), which are legal contracts between the State Government of Western Australia and the proponents of these major projects and outline the rights, obligations, terms and conditions for the development of these projects. For the parts of the strategy area covered by State Agreements, the Department of Biodiversity, Conservation and Attractions (DBCA or the department) acknowledges

the conditions of these and will fulfil its obligations associated with them. None of the management proposals outlined in this strategy will impose more environmental requirements or supersede the conditions, in addition to those outlined in the relevant of the State Agreements and Ministerial Statements that apply to mining developments adjacent to the strategy area (see *Management context – Management documents*).

The department's management of the strategy area will be focused on the areas of UCL not impacted by existing and proposed mines and infrastructure (see Map 2). For the most part, objectives and actions within the management strategy will apply to this management focus area. The area includes all of the Marsh Land System and land to the east of the BHP Newman-Hedland Railway within the strategy area. Land to the north of the Marsh Land System is not considered part of the management focus area. Where there are objectives and actions that apply to the whole strategy area or across the broader landscape, these are indicated throughout the document.

Across the State, the department manages UCL through an arrangement with the Department of Planning, Lands and Heritage (DPLH) in accordance with DBCA's responsibilities to manage these areas for conservation and biodiversity protection purposes. This will apply generally across the strategy area.

Tenure and reservation process

The *Pilbara Conservation Strategy* (Government of Western Australia 2017) proposes that the Fortescue Marsh be added to the State's conservation reserve system. As a result, the department proposes the establishment of a class 'A' reserve, to be vested in the Conservation and Parks Commission, within the strategy area. An initial step in the process of changing the land tenure will involve the determination of a suitable boundary for the proposed conservation reserve or reserves. Factors that will be considered by the department in determining this will include:

- current and future land uses for example, mining, recreation and customary activities
- the presence of significant natural, cultural, and heritage values, in particular conservation significant species and ecological communities and areas of important biodiversity that will contribute towards a comprehensive, adequate and representative (CAR) system of protected areas
- the ability to manage threatening processes such as weed management and feral animal control
- the area's location and its proximity and connectivity to other reserves, size and shape and
- boundary management issues.

The department will not seek to incorporate land into a conservation reserve that may contain existing or proposed mine sites and other infrastructure, contaminated sites, requires considerable rehabilitation and/or has natural and cultural values that have been significantly compromised. Any reserve boundary may also contain a buffer zone to shield the proposed conservation reserve from the impacts of existing and proposed mining operations and infrastructure.

Once the conservation values, land uses and issues have been established, the department will identify and consult with stakeholders with an interest in the proposed conservation reserve. In the case of the strategy area, these are likely to be mining companies, pastoralists, conservation groups and other State Government departments.

To progress the creation of a conservation reserve or reserves, consultation with the native title holders and claimants will be required. Native title rights have been determined over the western part of the strategy area and are held by the Banjima people. The Nyiyaparli people have a native title claim over the eastern portion of the strategy area, which is yet to be determined. The Palyku people have a native title claim over a small area in the north-eastern part of the strategy area,

which is also yet to be determined. At the time of writing, negotiations towards possible consent determination recognising native title rights for these claimant groups had started (Map 3).

As the previous tenure (grant of pastoral lease) did not fully extinguish native title and will 'affect' native title rights and interests, the reservation of the Marsh under the *Land Administration Act 1997* (Land Administration Act) will constitute a 'Future Act' and the provisions of the *Native Title Act 1993* (Cth) (Native Title Act) apply. The preferred approach of the department for dealing with native title interests and potential interests is the native title non-extinguishment principle and to create a *Conservation and Land Management Act 1984* (CALM Act) reserve through a consent process rather than by compulsory acquisition of native title. The department gives priority to the negotiation of ILUAs with the relevant native title holders or registered native title claimants ahead of resolution of native title. To progress the addition of the Marsh to the conservation reserve system compliance with the 'Future Act' provisions of the Native Title Act is required and will involve the negotiation and implementation of ILUAs with the area's traditional owners. The ILUA negotiated between the department and the determined native title holders will apply the non-extinguishment principle, so that native title rights and interests are not extinguished by the creation of the CALM Act conservation reserve. The creation of a CALM Act conservation reserve will not restrict access to the area by Aboriginal people for customary activities (See *Managing culture and heritage values*).

In line with reservation procedures adopted by the Department of the Premier and Cabinet and DPLH, support from stakeholders including the Department of Mines, Industry Regulation and Safety (DMIRS), local government authorities and water agencies is required before reservation can occur. The reservation process will involve considerable consultation and negotiation with these and other key stakeholders.

DBCA will actively pursue the addition of the Marsh to the conservation reserve system. Given that this was the purpose for which the land was excised from pastoral leases, it is important that the area be officially reserved as soon as possible, so that the nature protection provisions of the CALM Act and associated regulations can be fully applied and investments in management actions can be secured. This approach is consistent with State Government policy as articulated in the Pilbara Conservation Strategy (Government of Western Australia 2017).

If a formal reserve is created within the strategy area and vested in the Conservation and Parks Commission, preparation of a statutory management plan will be required under section 54 of the CALM Act, which will replace this management strategy and guide future management of the reserve.

Summary of management directions for tenure and reservation process

Management objectives	Actions	
1. Progress the formal creation of a conservation reserve within the strategy area.	1. In consultation with key stakeholders, consider an appropriate boundary for a proposed conservation reserve(s) to protect key values within the strategy area.	
	2. Liaise and negotiate with relevant stakeholders to gain their support to create a conservation reserve within the strategy area.	
	3. Work with traditional owners in the development of a Memorandum of Understanding (MOU) as the first step in progressing relevant ILUAs.	
	4. Seek resources and support for negotiating relevant ILUAs with traditional owners to enable reservation.	
KEY PERFORMANCE INDICATORS (KPIs)		
Performance measures	**Targets**	**Reporting requirements**
Defined boundary for the proposed conservation reserve(s).	Defining an appropriate boundary in consultation with stakeholders is well progressed.	Every 2 years.
Land tenure within the strategy area.	Formal creation of a conservation reserve within the strategy area is well progressed.	Every 3 years.

Adjacent lands and their management

Under the *Biodiversity Conservation Act 2016* (Biodiversity Conservation Act), the department has legislative responsibility for the protection of all biodiversity on all lands in the State. This includes listed species which are threatened or require special protection, threatened ecological communities, key threatening processes and critical habitats on private, leasehold and public lands.

The Marsh is mostly surrounded by pastoral leases managed for beef cattle production, namely Mulga Downs and Hillside to the north, Roy Hill to the east and Marillana to the south. The western boundary of the strategy area abuts Karijini National Park and a portion of UCL adjoins the strategy area to the south west (Map 1). The strategy area is strongly influenced by the management of these lands beyond its boundary. A CALM Act management plan describes the management for Karijini National Park (Department of Conservation and Land Management 1999).

As well as pastoral activities, mining is a significant land use in the area and several large mining operations are located within and surrounding the strategy area. Cloudbreak iron ore mine, which is located in the northern part of the strategy area, to the north of the Marsh itself, is operated by Fortescue (Map 5). Christmas Creek iron ore mine, also operated by Fortescue is located north of the Marsh, outside the strategy area. The Roy Hill iron ore mine is located to the east of the strategy area and operated by Roy Hill Holdings Pty Ltd. There are other iron ore mines proposed within and to the south of the strategy area. Rio Tinto's Koodaideri mine is proposed in a south-western portion of the strategy area, to the south west of the BHP Newman-Port Hedland Railway. Brockman Mining Ltd's Marillana iron ore mine is proposed to the south of the strategy area.

The department's *Good Neighbour Policy* outlines the overall approach to dealing with neighbours on cross-boundary issues and includes specific provisions for interactions in the pastoral rangelands. The policy is being reviewed.

Activities on lands within and surrounding the strategy area can influence the successful implementation of this management strategy and the conservation of the values of the Marsh. DBCA recognises the importance of a whole-of-landscape management approach and works with neighbours on issues such as access to land, fences, control of weeds and feral animals, straying stock and fire management. Feral and other problems animals, especially stray cattle, horses (*Equus ferus caballus*), donkeys (*Equus asinus*) and cats, impact the values of the Marsh. Effective management requires ongoing consultation and a cooperative approach with neighbouring land managers. Documenting and agreeing to the roles and responsibilities of each party and outlining management arrangements with neighbours may be important in addressing issues such as weed and feral animal control, prescribed burning and fire suppression. However, this process will not seek to impose additional environmental conditions on mining companies with operations within or next to the strategy area.

Summary of management directions for adjacent lands and off-reserve management

Management objectives	Actions
1. Maintain effective and cooperative working arrangements with neighbouring landowners.	1. Continue to work cooperatively with neighbouring land managers to foster complementary management of lands adjoining the strategy area.
	2. Seek to document and agree on roles, responsibilities and integrated working arrangements with neighbouring land managers to address cross-boundary issues.

1.3 Management context

Management opportunities with traditional owners

Traditional owners have a strong desire to care for, to strengthen cultural ties with and be involved in the management of their country. Working with traditional owners will bring cultural, spiritual and economic benefits to Aboriginal people and the wider Pilbara community and enhance the management of the Marsh.

As part of the process of adding the strategy area to the conservation reserve system, the development of ILUAs with the Banjima native title holders and/or registered Nyiyaparli and Palyku native title claimants will be required (see *Tenure and reservation process*). ILUAs may include provisions for joint vesting and management of any proposed conservation reserve(s) with traditional owners. Joint vesting is a tenure arrangement whereby responsibility for land in accordance with the CALM Act is shared between the Conservation and Parks Commission; and an Aboriginal native title holding corporation. National parks, conservation parks and nature reserves can be jointly vested with Aboriginal people. The responsibilities of the joint vesting parties is to provide advice on matters relating to the management of lands so vested; and to consider any physical amendment to the boundaries of the land.

The Fortescue Marsh is known as *Manggurdu* to the Banjima people and *Martuyitha* to the Nyiyaparli people and is a place of immense cultural significance. Photo – Steven Dillon/DBCA

Banjima native title holders are represented by Banjima Native Title Aboriginal Corporation RNTBC. Nyiyaparli have two registered native title claims. One of these (WAD6280/1998) covers the strategy area and legal representation, future act and agreement making assistance is provided by Yamatji Marlpa Aboriginal Corporation (YMAC). Karlka Nyiyaparli Aboriginal Corporation is the heritage body for Nyiyaparli and is responsible for organising heritage surveys. YMAC also provides legal representation for Palyku's native title claim (WAD6387/1998) and future act and agreement making assistance is provided by MacClean Legal. The department recognises the importance of engaging with these organisations to deliver environmental, social and cultural outcomes that will benefit both the traditional owners, the department and other stakeholders involved in the management of the Marsh.

The finalisation of ILUAs is likely to take considerable time and resources. In the meantime, DCBA will work towards building relationships with traditional owners and fostering ongoing cooperation and consultation. Development of an MOU between each of the traditional owner groups and the department is likely to be a good first step in building positive and enduring relationships. Following this, the development of joint management arrangements with traditional owners may be possible.

Highly successful Indigenous Ranger Programs have been implemented in many parts of the Pilbara, Kimberley, Goldfields and other parts of Australia. These programs build on Aboriginal biocultural knowledge to protect and manage land and sea country and provide sustainable employment for Aboriginal people. Through the community-based Banjima Country Management, Banjima have established a ranger program. Rangers do fire, feral animal and weed management, work with mining companies and carry out environmental and heritage surveys and monitoring. There are many opportunities for collaboration with Banjima associated with this program and for Banjima rangers to be involved in work associated with the Marsh. Nyiyaparli have also expressed an interest in developing a similar program on Nyiyaparli country. The department will work with local Aboriginal ranger groups in implementing projects to protect the natural and cultural values of the strategy area[2].

Other organisations, such as Rangelands NRM and Greening Australia have experience in working with traditional owners and fostering their involvement in work to protect the natural and cultural values of their country. Where appropriate, the department will seek the assistance of other

[2] The State Government has launched a $20 million Aboriginal Ranger Program to be delivered over five years from 2017, extending across a range of land tenures.

organisations to facilitate the development of management opportunities with Aboriginal people and to provide coordination, planning and training to increase the capability and capacity of local groups to undertake land management activities to protect country.

Summary of management directions for management opportunities with traditional owners

Management objectives	Actions
1. Involve traditional owners in the planning and management of the strategy area.	1. Build relationships with the Banjima, Nyiyaparli and Palyku people and their representative bodies.
	2. Work with traditional owners and their representative bodies to seek greater involvement from traditional owners in the planning and management of the strategy area and work towards to the development of ILUAs and joint management agreements.
	3. Ensure that department staff have opportunities to meet and work on country with traditional owners and gain the cultural authority to undertake land management activities across the strategy area.
	4. Where possible, engage Aboriginal rangers and traditional owners to carry out projects to protect the natural and cultural values of the Marsh.

KEY PERFORMANCE INDICATORS (KPIs)		
Performance measures	**Targets**	**Reporting requirements**
Management opportunities with traditional owners.	Traditional owners are involved in management of the strategy area and are actively taking part in on-ground operations.	Every 2 years

Administration

DBCA's Pilbara Region has responsibility for coordinating the implementation of this strategy. The Fortescue Marsh Conservation Officer oversees the delivery of on-ground management activities. Collaboration with neighbours and other key stakeholders will be critically important in the implementation of this strategy and other groups, organisations and agencies may take a lead role in undertaking some actions outlined in this strategy (see 4.3 *Involving the community*).

The Fortescue Marsh Reference Group was established to provide expert input into the management of the Marsh and the development and implementation of this management strategy. The group comprises stakeholders from mining companies, traditional owners, conservation groups, universities, other government departments and DBCA representatives. The group meets as required to discuss management issues associated with the Marsh, with external experts providing technical and management advice. The department's Fortescue Marsh Conservation Officer and Pilbara Region also report to the Reference Group about the implementation of the management strategy and the associated operational plan (see *Management documents*). A key component of this will be reporting against the KPIs associated with the priority management issues in this strategy (see *Performance assessment*). Other departmental specialist branches and external experts will provide support, direction and assistance when required.

Fortescue operates its Cloudbreak iron ore mine in the northern part of the strategy area, to the north of the Marsh. *Ministerial Statement 899 – Cloudbreak Life of Mine, Pilbara* outlines conditions associated with the conservation of significant vegetation, flora and fauna and other management issues associated with the Marsh. Offsets funds associated with this were also provided for weed management and feral animal control in the Marsh and for research projects to improve the understanding of local conservation values, (in particular the night parrot and bilby). Much of this work has been implemented or is continuing to be implemented. The on-going priorities are highlighted in this document. Another condition of environmental approval for the Cloudbreak iron ore mine is the requirement by Fortescue to provide funding to the department for the fencing of ex-pastoral lease lands containing the Marsh (see *3.6 Feral animals – feral herbivores and stray cattle*).

Fortescue also operates the Christmas Creek Iron Ore Mine, located to the north of the strategy area and east of the Cloudbreak mine. This mine and the associated East-West Railway operate under the *Ministerial Statement 1033 – Pilbara Iron Ore Infrastructure Project (Christmas Creek Mine, East-West Railway and Mindy Mindy Mine)*. This includes conditions associated with conservation of significant flora, vegetation and fauna, subterranean fauna, hydrological processes and inland water quality, rehabilitation and decommissioning. The offsets package associated with this Ministerial Statement provides funding until 2024 for a position within the department to manage a Fortescue Marsh conservation program. In addition it provided funds for a weed management program for the Marsh management area as well as a one-off contribution for the development of a Marsh conservation area management plan (this strategy). Two State Agreements also apply*; FMG Iron Ore (FMG Chichester Pty Ltd) Agreement Act 2006* and *TPI - Railway and Port (The Pilbara Infrastructure Pty Ltd) Agreement Act 2004* (see Table 1)

In 2012, the Environmental Protection Authority (EPA) approved the expansion of the Cloudbreak mine. Until this time, environmental offsets were determined on a case by case basis. However, the State Government has recognised the need for a strategic, more coordinated way of allocating funds from environmental offsets. Consequently, offsets determined from conditions under this project and other subsequent resource and infrastructure developments may be pooled in the Pilbara Environmental Offsets Fund (the Fund). Contributions to the Fund will be used to implement biodiversity projects that counterbalance the significant residual impacts of developments at a landscape level. The biodiversity projects chosen will be based on existing conservation priorities and strategies and action plans for the Pilbara region. The Fund may provide additional resources to implement the unfunded parts of this management strategy.

Unfunded parts of this management strategy include the development of an ILUA with native title holders and other processes required to establish a conservation reserve (see *Management documents*), fire and visitor use management and more research and survey work. Funding from other sources may be sought to implement these components.

Management documents

Fortescue Marsh management strategy

This document outlines the range of issues associated with the management of the values of the Marsh and provides an overarching summary of policies, objectives and actions aimed at protecting the values of Marsh. A table summarising management objectives, actions and KPIs is shown in Appendix 1. As funding for the conservation and management of these values is limited, the strategy outlines priorities for implementation.

Other documents

Sitting underneath this strategy is a Fortescue Marsh Operations Plan (operations plan), which outlines strategic priorities for management and the specific actions which contribute towards achievement of these priorities. In addition, the operations plan will outline the detail of the performance measures and targets associated with the KPIs and the monitoring regime required for reporting. The operational plan will be reviewed on an annual basis. Underneath this, project plans will also be developed to outline the implementation of particular management measures.

The department's high level, strategic priorities for wildlife management are focused on:

- conservation and protection of plants and animals, with an emphasis on threatened species
- science and conservation programs that deliver on-ground outcomes
- working in partnership with traditional owners, the community and other organisations
- undertaking landscape-scale restoration and reintroduction programs and
- mitigating threats to plants and animals from diseases, feral animals and weeds.

Much of the work addressing these priorities is carried out in the regions and regional nature conservation plans outline the delivery of these. The *Pilbara Regional Nature Conservation Plan (2015-2019)* (Department of Parks and Wildlife 2015a) identifies the key values across the region, their condition and threatening processes and the objectives and actions to address these. This plan recognises the Marsh as an important listed ecological community and the need to maintain low densities of feral herbivores and stray cattle, introduced predators and weeds to maintain its biodiversity.

A range of other documents have been prepared by different organisations that consider management of the Marsh. The *Pilbara Conservation Strategy* (Government of Western Australia 2017) outlines a landscape scale approach to biodiversity conservation across the Pilbara region. It provides strategic direction for conservation actions that may be funded from a variety of sources, including State and Commonwealth Governments, natural resource management groups, non-government organisations, community groups and industry, including offsets to counterbalance the significant residual impacts of resource and infrastructure projects. This strategy aims to deliver improved conservation outcomes by integrating on-ground actions across a variety of tenures. The development of partnerships between traditional owners, mining companies, natural resource management groups, pastoralists, State and local Government and research organisations throughout the Pilbara region is a critical component. The Marsh is a priority area highlighted in the *Pilbara Conservation Strategy* document.

The Pilbara Conservation Action Plan (Pilbara CAP) provides a framework for planning and implementing a coordinated range of actions to conserve biodiversity across the Pilbara bioregion, based on broadly agreed priorities and targets. The plan was developed by the Pilbara Corridors and is a collaborative landscape-scale conservation program involving Rangelands NRM, Greening Australia, DBCA and other key stakeholders such as traditional owners, mining companies and pastoralists. The process of developing the plan was a phased approach, with phase 1 involving stakeholder workshops and the development of a draft and final summary document that identified landscape biodiversity assets and threats and 60 preliminary strategies that addressed priorities and issues raised by stakeholders (Heydenrych *et al*. 2016). Phase 2 involved a review of the Pilbara conservation assets, a refinement of the strategies to provide greater focus for actions and outlined options for collaboration and partnerships to support its implementation (Heydenrych and Parsons 2018). The action plan contains a list of prioritised activities to enable strategic investment in long term goals and actions over the next 10-20 years. These were considered in the preparation of this document. Four of the top five priorities outlined in the Pilbara CAP coincide with the high priority management issues detailed in this management strategy. These are:

- improved weed management in the Pilbara
- targeted introduced predator control
- coordinated fire management and
- feral herbivore (ungulate) control.

The identification of similar priorities at a broader landscape scale will contribute to a more coordinated approach in managing these issues on the Marsh.

The EPA report titled *Environmental and water assessments relating to mining and mining-related activities in the Fortescue Marsh management area. Report and recommendations of the Environmental Protection Authority. Advice of the Environmental Protection Authority to the Minister for Environment under Section 16 (e) of the* Environmental Protection Act 1986 (EPA 2013) outlines the water regime and environmental values of the Marsh. Within this advice, the EPA identifies management zones prioritised according to their environmental significance and specific actions to be implemented within each of these zones. Most of the Marsh zone and some of the Northern Flank zone were both identified as having high levels of conservation significance. Parts of the Calcrete Flats (to the south east of the Marsh) and the Poonda Plains (to the south west of the Marsh), identified as having medium levels of conservation significance, are in the strategy area. Most of the highly conservation significant Marsh zone aligns with the management focus area where the department is concentrating the bulk of its management efforts.

The advice also provides guidance for relevant government agencies on the management of impacts from mining and related infrastructure required to protect the ground and surface water and other environmental values of the Marsh. In addition, it provides advice to mining company proponents about values and management objectives for the Marsh. Where applicable, this advice was considered in the development of the objectives and actions within this document and is highlighted throughout. Generally this relates to conducting more surveys to map and identify the distributions of conservation significant species and priority ecological communities (PECs), adding high priority habitats containing conservation significant species to the conservation reserve system, undertaking feral herbivore and predator control, managing stray cattle and conducting research and monitoring to determine the extent of cumulative hydrological impacts on the Marsh. The advice also contains recommendations that are applicable to the department in relation to the advice it provides to the EPA about the potential impacts of proposed developments on the natural and cultural values of the strategy area (see 3.3 *Hydrology* and 3.8 *Mineral operations*). Responsibility for the implementation of the remaining recommendations from this advice, especially those relating to the hydrology of the Marsh lies with organisations other than DBCA.

Triodia hummock grassland and the Fortescue Marsh with the Hamersley Range in the background. Photo – Adrienne Markey/DBCA

At the completion of the environmental impact assessment of development proposals, if the Minister for Environment considers that a proposal may be implemented, an implementation agreement or decision (a Ministerial Approval Statement) is issued under s 45(5) of the *Environmental Protection Act 1986* (Environmental Protection Act). This outlines the conditions and procedures that the proponent must comply with during the project implementation. As part of Ministerial Statement conditions associated with existing and proposed iron ore mines within and surrounding the strategy area, mining companies are required to monitor changes (for example to flora, vegetation and fauna) that may impact on the condition or conservation values, attributable to their development projects. To address this, mining companies produce management plans with objectives for establishing the baseline health and condition of vegetation and fauna of areas next to and within the Fortescue Marsh, monitoring for any changes attributable to the projects and implementing any actions to maintain the health of values associated with the Marsh and its surrounds. These Ministerial Statements are statutory documents, and, as a result, mining companies must comply with their conditions during project development, implementation and decommissioning. In contrast, this management strategy is not a statutory document and therefore the objectives and actions will not override or be in addition to the conditions outlined in relevant Ministerial Statements. This strategy outlines only the department's priorities associated with the management of the Marsh but encourages a collaborative approach to this between the department, traditional owners, mining and consulting companies, pastoralists, conservation groups, government agencies, research organisations and other stakeholders.

The Banjima Yurlubajagu Strategic Plan outlines Banjima's vision for managing country and the goals and targets for achieving this. The Banjima Healthy Country Plan (in prep.) identifies areas of cultural

and environmental values for Banjima and their condition. The document also outlines management required to look after Banjima country (D. Whitelaw pers. comm. 1 May 2017).

Legislative and policy framework

A variety of Acts, Regulations, policies and agreements apply to this strategy and the strategy area and are shown in Table 1 below.

Table 1: Legislation applicable to the strategy area.

State Government Legislation		
Legislation	**Responsible Government Authority**	**Details**
Biodiversity Conservation Act	DBCA	Provides for the conservation and protection of native flora and fauna within Western Australia. The Biodiversity Conservation Act received Royal Assent on 21 September 2016 and replaces the *Wildlife Conservation Act 1950* and the *Sandalwood Act 1929* and their associated regulations. The Biodiversity Conservation Act enables the Biodiversity Conservation Regulations 2018 which were published on 14 September 2018.
Conservation and Land Management Act 1984 (CALM Act)	DBCA	Provides for the protection of native flora and fauna and Aboriginal culture and heritage on lands and waters to which the Act applies. As the strategy area has not been added to the conservation reserve system, the CALM Act does not yet apply to these areas. However, under the CALM Act, the department can • enter into voluntary agreements to jointly or solely manage private land, pastoral lease land or other Crown land that is above the low water mark • facilitate the involvement of Aboriginal people in the management of lands for conservation, recognising the intrinsic connection Aboriginal people have with land; or • manage land for conservation, recreation and other purposes without changing the tenure of that land
Biosecurity and Agricultural Management Act 2007 (BAM Act)	Department of Primary Industries and Regional Development (DPIRD)	In relation to the strategy area, this Act and regulations provide for the prevention of new animal and plant pests and diseases from entering WA and the management of the impacts and spread of those pests already present.
Contaminated Sites Act 2003 (Contaminated Sites Act)	Department of Water and Environmental Regulation (DWER)	Provides for the identification, investigation, assessment, registration and remediation of contaminated sites.

State Government Legislation		
Legislation	**Responsible Government Authority**	**Details**
Environmental Protection Act	DWER	Provides for the prevention, control and abatement of pollution and environmental harm, and for the conservation, preservation, protection, enhancement and management of the environment. This includes environmental impact assessments and auditing compliance against environmental approval conditions issued under Part IV of the Environmental Protection Act. Part V provides for the regulation of industrial emissions and discharges to the environment through a works approval and licencing process. The Marsh is declared as an Environmentally Sensitive Area under Section 51B of the Environmental Protection Act.
Rights in Water and Irrigation Act 1914 (RIWI Act)	DWER	Provides for the approval and regulation of groundwater abstraction and surface water management, using permits to modify beds and banks of watercourses.
Water Agencies Powers Act 1984	DWER	Under this Act, the Water Minister is responsible for protecting water resources and water quality. DWER is required to provide specialist advice to the EPA and to the Environmental Protection Functional Group within DWER (as well as DMIRS if requested).
Mining Act 1978 (Mining Act)	DMIRS	Outlines the law in relation to mineral exploration and mining, through the granting of various tenements.
*Aboriginal Heritage Act 1972 (*Aboriginal Heritage Act)	DPLH	Provides protection to Aboriginal heritage sites across all land tenures.
Land Administration Act	DPLH	Deals with the acquisition of land for public works. DPLH undertakes land acquisition functions on behalf of State and local Governments.
BHP - Iron Ore (Mount Newman) Agreement Act 1964	Department of Jobs, Tourism, Science and Innovation (DJTSI)	BHP Billiton operates its Port Hedland-Newman Railway, which traverses the strategy area, under this State Agreement.
Rio Tinto - Iron Ore (Mount Bruce) Agreement Act 1972	DJTSI	The strategy area traverses Mining lease 252SA which is held by Rio Tinto pursuant to this State Agreement for the proposed Koodaideri project.
Rio Tinto - Iron Ore (Hamersley Range) Agreement Act 1963	DJTSI	Covers Rio Tinto's proposed railway for its Koodaideri project, which traverses the strategy area.
FMG Iron Ore (FMG Chichester Pty Ltd) Agreement Act 2006	DJTSI	Multiple tenements held by Fortescue pursuant to this State Agreement are located in the strategy area.

State Government Legislation		
Legislation	**Responsible Government Authority**	**Details**
TPI - Railway and Port (The Pilbara Infrastructure Pty Ltd) Agreement Act 2004	DJTSI	Covers the portion of the Fortescue Railway that traverses the strategy area between the Christmas Creek and Cloudbreak iron ore mines and Port Hedland.
Commonwealth Government Legislation		
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Department of the Environment and Energy	Relates to the protection of nationally listed species and ecological communities, heritage and migratory species protected under international agreements. Actions that have, or are likely to have, a significant impact on a matter of national environmental significance (for example, listed threatened species and ecological communities, and migratory species), need approval from the responsible Australian Government Minister, in addition to any approval that may be needed in WA.
Native Title Act	National Native Title Tribunal	Recognises and protects native title, determines where native title exists, how a future activity impacting on native title can be undertaken and provide compensations when native title is impaired or extinguished. Under the Act, Aboriginal people who hold native title rights or have made a claim to native title, have the right to be consulted and participate in decision-making about proposed activities on the land.

These Acts and other legislation (administered by other government departments and relevant in protecting the values of the strategy area and/or implementing this strategy) are referred to throughout this strategy, and can be obtained from the State Law Publisher or Federal Register of Legislation.

International conservation agreements

The Convention on Wetlands (known as the Ramsar Convention) is an international treaty concerned with the conservation and wise use of wetlands and identifies wetlands of international importance. In 1999, the department's predecessor, the Department of Conservation and Land Management, undertook an assessment of significant wetlands across WA and determined their suitability for nomination for Ramsar listing. Nomination of the Marsh as a rare and unusual wetland type within its biogeographic region was recommended, although the assessment recognised that more information on the biodiversity values of the Marsh would be required to progress a nomination (Jaensch and Watkins 1999). Detail about the department's obligations and implications for management should the Fortescue Marsh become listed under the Ramsar Convention is available at the Australian Government's Department of Environment and Energy website.

Cockatiels (*Nymphicus hollandicus*). Photo – Adrienne Markey/DBCA

In 2008, the State Government identified several areas in WA, including the Marsh, to be put forward to the Commonwealth Government for nomination as a Ramsar wetland as it represents one of the highest priority wetlands for nomination in WA based on its uniqueness and significant species and ecological communities. To progress this nomination, an Ecological Character Description for the Marsh is required, with a Ramsar Information Sheet. Recent survey data is likely to be required, especially for birds, and support from other stakeholders will be crucial (M. Coote pers. comm. 13 September 2017). Through the implementation of this strategy, progress towards documenting and compiling existing background work and survey information and gathering support can be made.

Left: Great egret (*Ardea modesta*) (top right) is a migratory species protected under the EPBC Act, pictured here with other waterbirds, straw necked ibis (*Threskiornis spinicollis*) (bottom right), yellow-billed spoonbill (*Platalea flavipes*) (bottom left) and white-necked heron (*Ardea pacifica*) (top left). Right: Black-winged stilt (*Himantopus himantopus*). Photos – Colin Trainor

In addition to the Ramsar Convention, Australia is a signatory to bilateral agreements with China (China–Australia Migratory Bird Agreement), Japan (Japan–Australia Migratory Bird Agreement) and the Republic of Korea (Republic of Korea–Australia Migratory Bird Agreement) to provide a collaborative framework for the protection of habitats of migratory birds within the East Asian–Australasian Flyway. Several species listed in these agreements use the Marsh while transiting through the northwest and some are also listed under the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Summary of management directions for international conservation agreements

Management objectives	Actions
1. Recognise and provide increased protection to the wetland values of the Marsh.	1. Develop an Ecological Character Description and Ramsar Information Sheet for the Marsh to progress a recommendation to the Commonwealth Government for nomination under the Ramsar Convention.
	2. Develop and implement a public participation strategy to inform stakeholders and gain support for a recommendation to the Commonwealth Government for nomination under the Ramsar Convention.

KEY PERFORMANCE INDICATORS (KPIs)		
Performance measures	**Targets**	**Reporting requirements**
Nomination of the Marsh as a Ramsar wetland.	Preparation of materials for nomination of the Marsh as a Ramsar wetland.	Every 2 years.

1.4 Performance assessment

Progress towards achieving the objectives of this strategy will be demonstrated by regular monitoring, evaluation and reporting to investigate the effectiveness of management actions and identify opportunities for improvement. These are key elements of an adaptive management framework, enabling actions to be properly evaluated and revised where needed. Throughout the strategy, KPIs will be used to assess the implementation and success of this plan.

The KPIs (comprising performance measures, measurable management targets and reporting requirements[3]) have been identified for selected values and management issues and are presented in the relevant management tables throughout this strategy document. The KPIs are linked to objectives and actions. Not all objectives and actions have associated KPIs and those that do, reflect the highest conservation and management priorities of the department. Objectives and actions with KPIs will provide the focus for management of the Marsh. For the outcome-based KPIs, any sustained change (for example a continuous decrease or increase) will trigger the need for additional investigation to determine the cause of that change and therefore the requirement for, and type of, management intervention.

The measurement and tracking of the progress of implementing the management strategy will aim to:

- determine whether strategies and actions are achieving their desired goals
- show trends in the condition of assets and levels of threat
- demonstrate the effectiveness of investment in management strategies
- link local management outcomes to broader programs and
- help with securing future funding for sustaining action.

Greater detail about how, what, when, where and why data is collected, to address the KPIs, will be provided in the operations and project plans (see *Management documents*).

Providing accurate and relevant data and information as evidence of implementation is essential to ensure the assessment process is performed quickly and effectively. The Marsh Conservation Officer has responsibility for collating reporting information for KPIs listed in this strategy, and outcomes will be considered by DBCA's Pilbara Regional Manager and members of the Fortescue Marsh Reference Group on an annual basis. Where external funding sources are used during the implementation of the strategy, reporting to these external organisations may also be required (for example, the Pilbara Environmental Offsets Fund).

Reporting information for KPIs will be maintained in a portfolio showing evidence of those areas where the strategy is being successful and those where changes are needed. Some examples of evidence that may be used to assess implementation of this strategy include:

- specific, quantitative monitoring of significant assets such as conservation significant flora, fauna and ecological communities
- series of fixed point photographs, mapping or other imagery that show whether spatial and temporal changes have occurred
- checklists
- scientific survey reports
- incident reports or records and
- other written documents or correspondence (for example budget expenditure reports).

[3] While reporting requirements may be annual, determining reliable trends might not be possible for several years.

The collection and reporting of information in addressing the KPIs are important components in making informed decisions to achieve best practice environmental management and in determining the successful implementation of this management strategy.

For convenience, the conservation of the values of the strategy area and the issues affecting these are dealt with separately in the management strategy. However, the department recognises that the management of the combined and cumulative impacts of these threats will be critical in the management of the Marsh. For example, one of the key objectives of the strategy is the strategic fencing of parts of the Marsh, together with feral herbivore and stray cattle management and the successful implementation of this will result in protection of the important Marsh ecological communities, the priority flora species within the Marsh and important areas of habitat for the night parrot and greater bilby. Furthermore, the management of issues at a landscape scale will be of benefit to the protection of many of the Marsh's natural and cultural values.

1.5 Term of the strategy

The strategy will guide the department's management of the Marsh and surrounding areas for a period of seven years from the date of its endorsement. During this time, the strategy may be reviewed and management adapted based on the latest understanding of the values of the Marsh. If the strategy is not reviewed and replaced by the end of the seven-year period, it will remain as the primary guiding document for the area.

Plumed whistling ducks at 14-Mile Pool. Photo – Adrienne Markey/DBCA.

2. Managing culture and heritage values

2.1 Aboriginal cultural heritage

For Aboriginal people, the phrase 'caring for country' means a deep spiritual attachment to land and water bodies, to creation beings, plants and animals, to social and cultural norms, and to stories, songs and art. Under traditional law, the Banjima, Nyiyaparli and Palyku people have a binding responsibility to care for country and keep culture strong. Traditional custodians and DBCA therefore have a shared interest in land management and in protecting the cultural heritage values of the strategy area.

Archaeologist, Nigel Bruer examines a stone artefact during a heritage survey within the strategy area.
Photo – Hamish Robertson/DBCA

Goode (2009) emphasised the cultural, social and economic significance of water bodies such as creeks, rivers and permanent pools to Aboriginal groups throughout the Pilbara and WA. Research indicates that water is conceptualised by Aboriginal people as a sacred domain with mythical and metaphysical connections. Water plays a key role in cultural practices, stories and songs, and many of the sites in the strategy area have spiritual value. For the Nyiyaparli people for example, there are mythological stories associated with these water bodies that describe their creation by a snake being from the Dreaming (Nyiyaparli Community *et al*. 2015). Aboriginal groups also have traditional names for creeks, rivers and waterholes, including areas in and around the Marsh, which feature in traditional songs that effectively provide a spoken map of the landscape (Goode 2009).

The Marsh itself (known as *Manggurdu* to the Banjima people and *Martuyitha* to the Nyiyaparli people) is a place of immense cultural significance and described as the 'heart' of the region's water system (Banjima People 2016; Nyiyaparli Community *et al*. 2015). It is also recognised as an important site for Aboriginal groups in the wider region that interact with or have claims to country on or next to the Fortescue River. A songline is reported to run along the length of the entire (Marsh

and Fortescue River) system culminating at a large *yinta* (permanent waterhole) named *Mirlimpirrinha* in the north-west of the Marsh where the Fortescue River goes underground to Millstream (Goode 2009). According to the Nyiyaparli people, traditional songs associated with the Marsh and surrounding waterholes are shared with ceremony participants from other Aboriginal groups who travel to the area during the seasonal "Law time" when young men are initiated into new status and knowledge within their culture (Archae-aus 2016).

Most heritage surveys in the strategy area to date have been north of the Marsh and have related to the development of Fortescue's Chichester iron ore mining hub operations. About 250 Aboriginal heritage sites within the strategy area are recorded on DPLH's Register of Aboriginal Sites, many of which are artefact scatters that are not formally registered. All Aboriginal sites registered or otherwise, are protected under the Aboriginal Heritage Act. These sites can be vulnerable to a variety of management issues (for example weeds, introduced animals, inappropriate visitation, mine dewatering, infrastructure development and climate change). If proposed management actions may disturb an Aboriginal site, an assessment is required before the operation proceeds. DBCA will work with DPLH and the traditional custodians of the strategy area to ensure Aboriginal sites are not damaged. The department will also comply with the State Government's Cultural Heritage Due Diligence Guidelines when actions are proposed.

Archae-aus archaeologist Nigel Bruer and Nyiyaparli traditional owner conducting a heritage survey within the strategy area. Photo – Hamish Robertson/DBCA.

In 2016, Archae-aus carried out an Aboriginal heritage survey along the proposed alignment of a 43km fence line around the eastern portion of the Marsh, within Nyiyaparli country (Archae-aus 2016). Five archaeological sites were recorded, including Coondiner Pool in the south-east of the strategy area. This is a significant archaeological and ethnographic site that continues to be used to the present day. It comprises an extensive and numerous artefact scatter suggesting that families and large groups travelling in the area use the pool as a ceremonial and camping place, particularly as it provides a semi-permanent source of water.

Leases for pastoral stations around the Marsh were granted in the 1880s and 1890s and Roy Hill, Mulga Downs and Hillside Stations were all established around this time on Banjima, Nyiyaparli and Palyku country. Marillana Station was established in the 1920s. As a result, many Aboriginal people worked on pastoral stations as stockmen and domestic workers and played a vital role in the development of pastoralism in the Pilbara. The pastoral industry is a part of many Banjima, Nyiyaparli and Palyku people's history and many have a strong connection to pastoral locations. For example, Warrie Outcamp which lies just outside of the strategy area is important to Aboriginal people of the area. The buildings and other structures are evidence of the contribution that Aboriginal workers made to the development of the pastoral industry and are an important aspect of the heritage and contemporary identity of traditional custodians (Nyiyaparli Community *et al*. 2015).

Aboriginal people collectively hold an extensive body of biocultural knowledge that has been developed over millennia. In accordance with traditional law, elders are responsible and obliged to transfer knowledge to the younger generations. This is typically undertaken while spending time on country camping, hunting bush meats, fishing, collecting plant foods and medicine, telling stories and

attending Law business. Therefore, the ability for the Banjima, Nyiyaparli and Palyku people to access the strategy area for customary practices is essential. Management will also explore and promote opportunities for traditional and contemporary scientific knowledge to be used side by side to address management issues and find solutions. Collaborative research and management projects provide a means to help build relations and capacity and enhance the health of country and culture.

Customary activities

Customary activities by Aboriginal people can include hunting for food, preparing medicine and engaging in artistic and ceremonial events[4]. These activities are an important part of Aboriginal culture, enabling maintenance of relationships with the land, water and fire; sharing of knowledge; engagement in traditional practices; and accessing and looking after places of significance. Access to the strategy area for customary activities is important for traditional owners as it ensures the continuation of traditions, the transfer of knowledge to younger generations and the protection and conservation of cultural values.

2.2 Other Australian heritage

The former pastoral properties that make up the strategy area contain evidence of historical pastoral activity including fences, yard, machinery, wells and bores, tanks, access roads and tracks and equipment. There is also old infrastructure associated with mineral resource developments within the strategy area.

The department has responsibilities for historic heritage protection under the *Heritage of Western Australia Act 1990*, the Government Heritage Property Disposal Process, the *State Cultural Heritage Policy and State Planning Policy 3.5: Historic Heritage Conservation*. The *Burra Charter, the Australian (International Council on Monuments and Sites) Charter for the Conservation of Places of Cultural Significance 1999* is also relevant. The department commits to applying the standards embodied in the Burra Charter, the underlying principle of which is that all significant places should be conserved as an integral part of good management. State and local Government heritage registers provide guidance on key built infrastructure but are not exhaustive.

Within the strategy area, there are no sites registered on the State Register of Heritage Places or on local government municipal inventories. To date there has been no survey of historical heritage across the strategy area. Undertaking an assessment of old infrastructure will establish whether any is of heritage significance and worthy of protection. Infrastructure that has no heritage significance will be removed.

The strategy area contains several old fences that were once old pastoral boundaries. These contain barbed-wire and can cause death or injury to waterbirds (when the Marsh is inundated), night parrots and ghost bats if they collide with fences or become entangled. Ghost bats and night parrots are particularly vulnerable to entanglement in fences as they often fly at fence height (Armstrong and Anstee 2000). Ghost bats roost across the Hamersley Range and forage on the Marsh. Fences that do not have any heritage or management value will be removed.

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

Summary of management directions for Aboriginal and other Australian cultural heritage

Management objectives	Actions
1. Protect Aboriginal and other cultural heritage values.	1. Engage traditional owners to provide cultural awareness training for DBCA staff and other personnel working in the strategy area.
	2. Develop a shared understanding and appreciation of the cultural significance of the strategy area to the Banjima, Nyiyaparli and Palyku people (for example through cultural heritage mapping on country or other means as appropriate).
	3. Reflect the interests of traditional owners in the management of cultural heritage and in all other management activities which may impact culture and heritage values.
	4. Explore opportunities to integrate traditional knowledge with contemporary science programs and where appropriate, encourage the uptake of traditional management knowledge.
	5. Support traditional owners to monitor the condition of culturally significant sites and species and determine whether these are being adequately protected and maintained.
	6. Support on-country trips by younger and older generations of traditional owners to maintain or improve the health of country and keep culture strong.
	7. Consult the Aboriginal heritage register maintained by DPLH, traditional owners and other stakeholders with heritage information (for example mining and consulting companies) to ensure, where possible that, management actions do not impact on Aboriginal cultural heritage values and sites.
	8. Work with Banjima, Nyiyaparli and Palyku to agree to an appropriate Aboriginal name for the Fortescue Marsh and undertake the necessary steps to formally change the name of the area.
	9. Assess historical pastoral and mining infrastructure for its heritage value and remove where no heritage significance is detected or where the infrastructure poses a threat to visitors or wildlife.

3. Managing natural values

3.1 Climate and climate change

The strategy area is in a semi-arid region and experiences a climate described as desert: hot and persistently dry (Stern *et al.* 2000). It is characterised by hot, dry summers and mild winters. Temperatures are high year-round, with mean daily maximum temperatures for Wittenoom ranging from 24.3˚C in winter to 39.7˚C in summer (BoM 2017).

Climatic conditions are influenced by tropical cyclone systems that predominantly occur between January and March. Most rainfall occurs during these months associated with the passage of cyclones and thunderstorm activity (BoM 2017). Records from the Marillana weather station located 4.5 km south of the south-eastern boundary of the strategy area provide an indication of the rainfall regime. Long-term, mean annual rainfall is 321.8mm, but is highly variable between years and over longer time scales (BoM 2017). Higher than average rainfall has occurred since the mid-1990s (Equinox Environmental Pty Ltd 2013). Annual evaporation rates exceed rainfall by a factor of 10, affecting groundwater recharge and surface water retention time (Dogramaci *et al*. 2012).

Climate change is a recognised long-term threatening process affecting the conservation values of the strategy area and the broader region. There is an interaction between climate change and other threats, such as habitat loss and invasive species, contributing to more complex and unpredictable outcomes (Steffen *et al*. 2009). Geographically restricted species with narrow climatic tolerances will be at risk of extinction due to changes in climate, in particular increases in temperature and evaporation rates. Changes in species assemblages are likely to be the long-term outcome of extinctions, losses and migration, meaning there may be 'winners' and 'losers' in the strategy area. Other risks include loss of ecosystem services and changed species interactions, including pollinator services and predator-prey interactions.

Future climates for the Upper Fortescue region are expected to become 1.8 to 2.9 °C hotter by 2050, but it is not clear whether it will be wetter or drier. Modelling suggests that a drier climate is more probable than a wetter climate (CSIRO 2015). Changes in flooding regime over the last 20 years suggest that the frequency and intensity of extreme rainfall and tropical cyclones are increasing for the region (Cullen and Grierson 2007; Rouillard *et al*. 2014). In response, surface water at the Marsh is likely to be present for longer periods, which in turn will impact on the structure and functioning of the ecosystem (Rouillard *et al*. 2014).

The waterbodies of the strategy area, including the Marsh itself and freshwater claypans such as Coondiner Pool, are likely to act as ecological refugia (Davis 2014). They provide 'reservoirs' to which species contract during drought periods and the seed and egg banks present in the sediments of these systems act as biotic reservoirs. They can also provide additional resources that enable populations to replenish during wet phases. These temporary aquatic habitats potentially play important roles as 'stepping stones' between perennial sites across the broader landscape (Davis 2014; Roshier *et al*. 2001). The Marsh may also be important as a movement corridor of suitable habitat for some highly mobile species (for example bilby) connecting Pilbara and desert populations father inland (M. Dziminski pers. comm. 11 November 2017).

Management aims to increase the resilience of species and ecosystems and decrease their vulnerability to a changing climate. Uncertainty about appropriate responses to the effects of climate change means that removing or minimising other pressures (for example weeds, introduced animals, fire and physical disturbance) is likely to be one of the best options to conserve biodiversity in the immediate future. In some cases, the impacts from these pressures may far exceed those of climate

change. Implementing actions that are good for biodiversity are often referred to as 'no-regret' or 'low-regret' actions as they address short-term conservation challenges under current conditions and provide large benefits under a range of future climate scenarios (Gross *et al*. 2016).

Climate vulnerability assessments and more research will be important in better understanding climate change impacts at a species and community level, and management of the strategy area should be adapted based on new information.

Summary of management directions for climate and climate change

Management objectives	Actions
1. Improve the survival of species and ecosystems by increasing their resilience to climate change. 2. Evaluate the importance of climate change for the ongoing management of the strategy area.	1. Undertake and encourage research on the vulnerability of key habitats and values to climate change and if necessary, identify additional indicators to monitor the effects of a changing climate. 2. Adapt management in response to improved knowledge and understanding of climate change and its impacts on the natural values.

3.2 Geology, landforms and soils

Geology and landforms

The geology of the Marsh is described by Thorne and Tyler (1997) and MWH (2015) and is summarised below. The Marsh is located in the Pilbara Craton, which contains the Earth's oldest rock formations, up to 3.5 billion years old. The Marsh is part of the Hamersley Basin and the underlying geology was formed in the late Archaean to early Proterozoic (2,765-2,470 million years ago). The Marsh lies within the Fortescue Valley, a flat low-lying complex sequence of Quaternary and Tertiary alluvial, colluvial and lacustrine sediments overlying the basement.

Parallel to the Marsh and the Fortescue Valley is the Hamersley and Chichester Ranges (Figure 1). The roughed Hamersley Range is located to the south of the Marsh and comprises extensive mountains up to 1,250 m above height datum (mAHD) and steep-sided gorges. The ridgelines and peaks of the Hamersley Range have steep slopes and deep drainage lines in major valleys. In contrast, there are gentle undulating slopes at the base of the ranges. Main drainage lines from the northern Hamersley Ranges include the Fortescue River, Weeli Wolli Creek, Coondiner Creek, Kalgan Creek and Mindi Mindi Creek, which flow into several deltas in the Fortescue Valley. The footslopes of the Hamersley Range are in the southern portion of the strategy area. The geology of the Hamersley Range is mainly outcrops of Weeli Wolli Formation (jaspilite, chert, shales and dolerite sills) and Brockman Iron Formation (Banded Iron Formation [BIF], shale and chert bands).

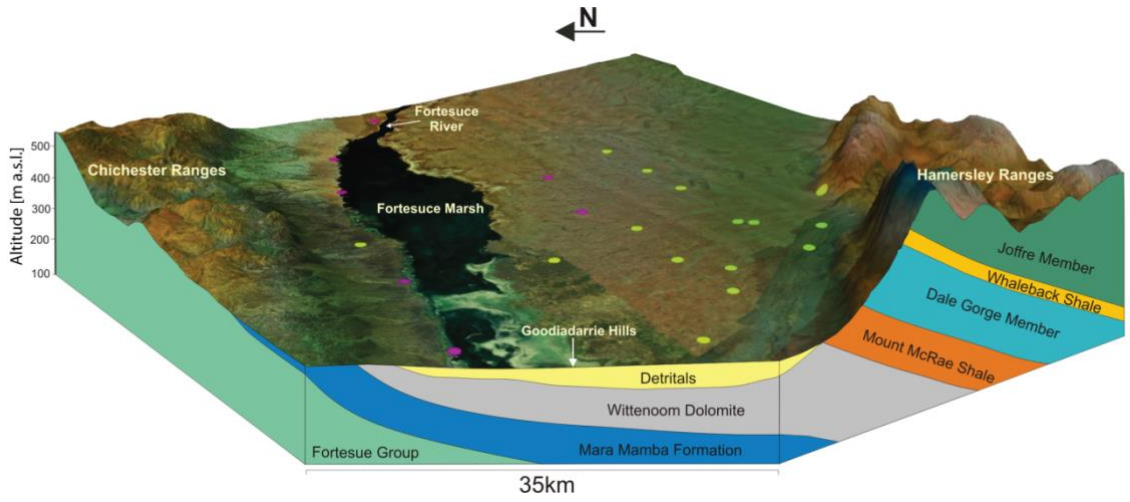

Figure 1: A conceptual geological model of the Fortescue Marsh, Hamersley and Chichester Ranges (Skrzypek, *et al.* 2013).

The Chichester Range is a west; northwest/east, southeast plateau rising to 500mAHD and bound by the Fortescue Valley to the south. Runoff flows south towards the Marsh via a series of floodplains, alluvial fans and ephemeral creeks. Margins of the Chichester Range are in the northern part of the strategy area. The geology of the Chichester Range comprises outcrops of Marra Mamba Iron Formation and Wittenoom Formation. The major rock types of the Chichester Range are chert, basalt, shale, BIF, mudstone, dolomite and thin-bedded meta-sandstone.

The Fortescue Valley, an elongated, gently undulating, north-west alluvial plain, separates the Hamersley and Chichester Ranges. The Marsh itself comprises sparsely vegetated clay flats, surrounded by flats of the Fortescue River Valley, where Cainozoic alluvial and colluvial deposits form gently sloping plains and broad valleys. These deposits are up to 100m thick within the Marsh and there are also exposures of calcrete and dolocrete on the fringes.

The DPIRD's Pilbara Ranges Project (van Vreeswyk *et al*. 2004) identified over 100 land systems on the basis of topography, geology, soils and vegetation in the region. There are 16 land systems in the strategy area. Three of these are restricted to the Fortescue Valley and have high conservation significance (EPA 2013):

- Christmas – stony alluvial plains with snakewood and mulga shrublands with sparse tussock grasses.
- Cowra – plains fringing the Marsh system and supporting snakewood and mulga shrublands with some halophytic undershrubs.
- Marillana – gravelly plains with large drainage foci and unchanneled drainage tracts supporting snakewood shrublands and grassy mulga shrublands (van Vreeswyk *et al*. 2004).

The EPA (2013) recommended that the Christmas and Cowra Land Systems be added to the conservation reserve system. Most of the Cowra Land System is located within the northern part of strategy area, along the northern flank of the Marsh. Consequently, inclusion of the strategy area in the conservation reserve system would protect most of this land system. Only a very small portion of the Christmas Land System is found in the strategy area.

Soils

Van Vreeswyk *et al*. (2004) reported 15 soil types within the strategy area. In general, these comprise red loamy soils and earths, of varying depths; some with abundant cobbles and stony mantles. There are also areas of deep red/brown non-cracking clays. Many of these soil types are susceptible to

erosion, particularly if the overlying stony mantle is removed (Department of Environment and Conservation 2011a).

The soils of the Marsh are saline and comprise red/brown highly alkaline clays with a high gypsum content. Soils of the surrounding alluvial plain are typically fine textured with a sodic subsoil[5], cobbles and stones.

3.3 Hydrology

The Fortescue River catchment is defined to the north by the Chichester Range and to the south by the Hamersley Range. The river's catchment is divided into upper and lower portions by the Goodiadarrie Hills near the western end of the Marsh. The Marsh forms the terminus of the endorheic[6] Upper Fortescue catchment and is the main hydrological feature of the strategy area. Water predominantly enters the Marsh from direct rainfall and surface runoff including inflows from the Fortescue River and Jigalong Creek in the east, Weeli Wolli and Kulkinbah creeks and other tributaries draining the Hamersley and Chichester ranges (Pinder *et al*. 2010; Department of Environment and Conservation 2009).

14 Mile Pool. Photo – Adrienne Markey/DBCA

Episodic inundation of the Marsh follows cyclonic or significant rainfall, where pools, lake beds and surrounding floodplains are filled with surface water. The surface area of the Marsh is ~1,000 km^2, although the zone of potential inundation, which includes the adjacent alluvial flats, is up to 100 km long and 30 km wide (Skrzypek *et al*. 2013; EPA 2013). The area filled varies greatly between years. For the smaller runoff events, isolated pools form on the Marsh opposite the main drainage inlets (FMG 2009). The entire system may flood following larger runoff events, on average once every 5-7 years. Surface water accumulates in the Marsh, but, with minimal discharge from the system,

[5] Having a disproportionately high concentration of exchangeable sodium.

[6] A closed drainage catchment that retains water and allows no outflow to rivers or oceans externally.

evaporative processes are dominant which causes water loss and salt accumulation. This process results in the progressive transformation of the Marsh from a freshwater ecosystem to a saline lake to a dry playa (Aquaterra 2005; EPA 2013).

Within the Fortescue Valley, groundwater salinities increase with depth and towards the centre of the Marsh (CSIRO 2015). A deep (>50m), hypersaline (>100 g L^{-1}) aquifer underlies the Marsh. Groundwater inflows and outflows to the Marsh are minimal due to the low, hydraulic gradient (0.0001) of the surrounding Fortescue Valley (Dogramaci *et al.* 2012; Skrzypek *et al*. 2013). Thus, vertical flow processes dominate the Marsh groundwater system. Recent hydrochemical evidence suggests the Marsh may be a hydrological but not hydrogeological terminal basin, with constant but extremely low outflow along unidentified pathways (Skrzypek *et al*. 2016).

Shallow aquifer systems associated with drainages (for example Weeli Wolli Creek and Fortescue River alluvial aquifers) contribute to locally complex groundwater regimes within the Fortescue Valley. These are recharged following significant rainfall (Dogramaci *et al*. 2012) and may support persistent or permanent pools in some locations, such as 14-Mile Pool near the eastern end of the Marsh (Skrzypek *et al*. 2013).

Information collected by mining and consulting companies for environmental assessments under the Environmental Protection Act has contributed significantly to the knowledge of the ground and surface water hydrology within and outside the strategy area. In particular, this research had led to a better understanding of the three-dimensional hydrology of the area, which has been used to inform risk mitigation strategies implemented by mining companies, apply adaptive management to groundwater levels and chemistry and better inform the cumulative impacts upon the hydrology of the Marsh.

Summary of management directions for hydrology

Management objectives	Actions
1. Improve understanding of the ecological water requirements of the Marsh ecosystems and associated biota. 2. Support a catchment management approach to maintain and protect natural surface and groundwater regimes and the hydrological values of the strategy area.	1. Liaise with industry, pastoralists and other key land managers in considering the cumulative impacts of activities on the hydrological values of the Marsh and maintaining the wetland ecological water requirements.
	2. With a focus on management needs, encourage more research and monitoring to: • review and update hydrological models of the strategy area • improve understanding of the ecological water requirements of species and communities on the Marsh and • determine the extent of the cumulative hydrological impacts of approved and proposed developments and activities and adapt management accordingly.
	3. Assess, collate and incorporate research and monitoring findings relating to the hydrology of the strategy area into the assessment of future development proposals and operational management, performance assessment against the objectives of this management strategy and adapt future management where appropriate.

3.4 Flora, fauna and ecological communities

Flora and vegetation communities

Broadly, the strategy area covers the Marsh Land System, which consists largely of samphire vegetation, surrounding areas of spinifex (*Triodia*) grasslands, and *Eucalyptus* and mulga woodlands (Beard *et al*. 2013).

The Marsh Land System supports samphire shrublands, saltwater couch grasslands and halophytic shrublands. Vegetation on the lake beds of the Marsh and saline floodplains has to cope with climatic extremes of hot, dry conditions, punctuated by periods of inundation (Markey 2017). Species zonation into the floodplains of the Marsh is driven by inundation frequency and duration, soil water and salinity and depth to the water table. Markey (2017) notes the proportion of chenopod taxa for the Marsh Land System (13 per cent) is double the proportion occurring in the wider Pilbara region reflecting the unique habitat of the Marsh. A more diverse range of shrublands, shrubby grasslands and *Acacia* woodlands dominates the margins of the Marsh and adjoining land systems (van Vreeswyk *et al.* 2004; Markey 2017).

Markey (2017) completed a comprehensive floristic survey of the Marsh, with a focus on the halophyte-dominated samphire vegetation of the Marsh Land System and some consideration of other vegetation communities in adjoining land systems (Map 4). Markey (2017) also mapped the extent and distribution of individual vegetation communities within the Marsh Land System using aerial imagery and field observations. Vegetation mapping has also been carried out by mining and consulting companies associated with the approval of development proposals. This mapping information has been combined in Map 4. Sourcing the necessary digital aerial imagery and mapping the vegetation for the remainder of the strategy area to a similar detail as has been done for the Marsh, will help provide a baseline for future assessments and inform management and monitoring programs.

A total of 322 taxa (species, subspecies and varieties) were recorded across the strategy area in several surveys (Markey 2017; Department of Parks and Wildlife 2017a). Markey (2017) recorded 14 taxa of State priority conservation significance, including several endemic or near-endemic taxa for the Marsh. Six other priority species were previously recorded from or near the Marsh. Priority flora is listed in Table 2, although as noted above, not all may be present in the strategy area. Reviewing the status of priority flora species is a recommended management action. For annual and short-term

From left to right: Priority 1 *Samolus* sp. Fortescue Marsh, Priority 1 *Eremophila spongiocarpa* and Priority 3 *Tecticornia medusa*. Photos – Adrienne Markey/DBCA

perennial conservation-listed species, Markey (2017) noted the need to consider seasonal variability when undertaking targeted surveys in the future. An additional 18 species were documented as new species for the Marsh, 11 of which were a significant range extension (that is >100km) from their recorded distribution.

Table 2: Flora of conservation significance recorded in and around the Fortescue Marsh

Species	State priority listing[7]
Calotis squamigera	Priority 1
Eremophila spongiocarpa	Priority 1
Myriocephalus scalpellus	Priority 1
Nicotiana heterantha	Priority 1
Samolus sp. Fortescue Marsh (A. Markey & R. Coppen 9702)	Priority 1
Tecticornia globulifera	Priority 1
Tecticornia sp. Christmas Creek (K.A. Shepherd & T. Colmer *et al.* KS 1063)	Priority 1
Teucrium pilbaranum	Priority 2
Atriplex flabelliformis	Priority 3
Marsh crumbweed (*Dysphania congestiflora*)	Priority 3
Eragrostis crateriformis	Priority 3
Eucalyptus rowleyi	Priority 3
Eleocharis papillosa	Priority 3
O'Meara's goodenia (*Goodenia* sp. East Pilbara [A.A. Mitchell PRP 727])	Priority 3
Rhagodia sp. Hamersley (M. Trudgen 17784)	Priority 3
Stackhousia clementii	Priority 3
Tecticornia medusa	Priority 3
Eremophila youngii subsp. *lepidota*	Priority 4
Goodenia nuda	Priority 4
Lepidium catapycnon (Hamersley lepidium)	Priority 4

Markey (2017) identified a total of 21 vegetation community units from the Marsh Land System, grouped into three broad categories: species-poor samphire communities of the far interior; samphire and shrub-samphire communities distributed from the margins to the interior; and woodland, shrubland and grassland communities on the periphery (Map 4). Several of these appear to be outside the boundary of the strategy area, including those restricted to locations in the eastern part of the Marsh.

Samphire community, Fortescue Marsh. Photo – Adrienne Markey/DBCA

One feature of the Marsh which sets it apart from other generally bare salt lakes in WA is the extensive cover of samphire vegetation over most of the saline flats. Changes to groundwater and surface hydrological regimes associated with mining operations have increased concerns about the impacts on the

[7] Conservation code definitions can be found on the Parks and Wildlife Service website

healthy function of the Marsh and its unique samphire community (Shepherd and van Leeuwen 2011). The University of Western Australia (UWA) in conjunction with Fortescue and the Western Australian Herbarium have recently undertaken a research project that involved studying the ecophysiology of a range of samphire species on the Marsh to distinguish the impacts of natural dynamics of changing water regimes from potential mine-related effects. These studies demonstrated that species of *Tecticornia* that dominate the Marsh generally have a very high tolerance to salinity and vary in their tolerance to flooding, depending on their location on the Marsh (those species found in low lying areas, prone to longer, deeper and more frequent flooding were more tolerant to being submerged than those species that inhabit higher elevations) (Konnerup *et al*. 2015; Moir-Barnetson *et al*. 2016). Despite inhabiting different locations on the Marsh, the tolerance of different species to drought was similar (Marchesini *et al*. 2014). These studies demonstrate the adaptions of samphire shrublands to the high degree of variability of flooding, drought and salinity regimes of the Marsh.

Pinder *et al*. (2017) completed a survey of riparian flora biodiversity in the middle to upper Fortescue Valley (upstream and downstream of the Fortescue Marsh) to inform the management of wetlands on pastoral leases. The only wetland within the strategy area to be surveyed was Coondiner Pool. The riparian vegetation community surrounding this pool was dominated by annual herbs and grasses and is significant due to the particularly large number of rare and restricted flora species recorded here. In addition to those recorded by Markey (2017), notable range extensions included *Cardamine* aff. *paucijuga* (previously known from south-eastern Australia and Tasmania), *Isolepis congrua* (known to have a wide southern distribution) and *Lachnogrostis filiformis* (known from temperate, arid and semi-arid parts of southern Australia). These all represent new records for the Pilbara.

Snakewood (*Acacia xiphophylla*) woodland. Photo – Adrienne Markey/DBCA

The strategy area also contains floristically unique grove-intergrove mulga communities and snakewood woodlands and shrublands including mosaics of *Acacia aneura sens. lat*, *Acacia distans*,

Acacia xiphophylla, *Acacia catenulata* subsp. *occidentalis* and *Acacia citrinoviridis*. These mulga communities are generally considered to be at the northern limit of their distribution in WA (EPA 2013), especially for those on the southern foot slopes of the Chichester Range. Mulga communities are common on the northern and southern stony plains bordering the Marsh. Communities on the northern side of the Marsh are regarded as being intact as they are relatively weed free, appear to have experienced low fire frequencies until the recent decade and low total grazing pressure. In the south, mulga have been subject to degradation because of increased total grazing pressure, altered fire regimes and invasion by the ecosystem transforming weed buffel grass (*Cenchrus ciliaris*) (EPA 2013). In its advice to the Minister about the impacts of mining on the Fortescue Marsh, the EPA recommended more research to gain a better understanding of the cumulative impacts to mulga communities (EPA 2013). Mulga is generally killed by moderate to high-intensity fires that can also destroy the seeds required for regeneration, making fire management a high priority for the mulga communities of the strategy area (see *Fire*).

Extensive *Triodia* hummock grasslands predominate along the southern perimeter of the Marsh, in the Calcrete Land System and the south-east of the strategy area. Hummock grasslands provide habitat for desert fauna and may be of importance in the strategy area for conservation significant species such the night parrot and the greater bilby (see *Native fauna*). More frequent fire is a characteristic of the more flammable hummock grasslands compared with other parts of the strategy area. The south-east of the strategy area had an area of long unburnt spinifex, although a large extent of this was burnt in a bushfire in late 2017. Numerous unburnt pockets of this dense spinifex still remain and will be a priority for fire management (H. Robertson pers. comm. 11 April 2018). Markey (2017) noted that increased vegetation sampling would identify more heterogeneity within this broad vegetation community.

Markey (2017) also identified several vegetation communities associated with the alluvial flats, floodplains and river channels upstream and in the east of the Marsh. These distinctive communities are geographically restricted and vulnerable to particular threats (for example weeds, feral herbivores and stray cattle) because of their small size. They are mostly located outside of the strategy area, however it is important for DBCA and other groups to work collaboratively with neighbouring land managers to ensure relevant cross-boundary issues are considered and addressed.

Native fauna

The Pilbara olive python, listed as vulnerable under the Biodiversity Conservation Act, is found in the strategy area. Photo – Janine Guenther

Surveys conducted to date have identified 730 species of native fauna in the strategy area: 34 mammals, 199 birds, 92 reptiles, 3 amphibians, 2 fish and 400 aquatic and terrestrial invertebrates (Department of Parks and Wildlife 2017a). A large amount of survey effort has been associated with environmental impact assessments and monitoring around existing and proposed mining developments in the north and south-west of the strategy area. It is anticipated that additional survey work in other locations will identify more species.

Nine fauna species that are known to occur or possibly occur in the strategy area are listed under Section 19 of Biodiversity Conservation Act or under the EPBC Act (Table 3).

Table 3: Fauna of conservation significance recorded in the strategy area

Species	Biodiversity Conservation Act	EPBC Act	IUCN Red List
Night parrot	Critically endangered	Endangered	Endangered
Northern quoll	Endangered	Endangered	Endangered
Australian painted snipe (*Rostratula benghalensis* subsp. *australis*)	Endangered	Endangered, Marine	Endangered
Greater bilby	Vulnerable	Vulnerable	Vulnerable
Ghost bat (*Macroderma gigas*)	Vulnerable	Vulnerable	Vulnerable
Pilbara leaf-nosed bat (*Rhinonicteris aurantia*)	Vulnerable	Vulnerable	Least concern
Pilbara olive python	Vulnerable	Vulnerable	Not assessed
Grey falcon (*Falco hypoleucos*)	Vulnerable	Not listed	Vulnerable
Peregrine falcon (*Falco peregrinus*)	Specially protected	Not listed	Least concern

Eight priority species – the blind snake (*Anilios ganei*), pin-striped finesnout ctenotus (*Ctenotus nigrilineatus*) [both Priority 1]; spotted ctenotus (*Ctenotus uber* subsp. *johnstonei*) [Priority 2]; brush-tailed mulgara (*Dasycercus blythi*), long-tailed dunnart (*Sminthopsis longicaudata*), western pebble-mound mouse (*Pseudomys chapmani*), Lakeland Downs mouse (*Leggadina lakedownensis*), striated grasswren (*Amytornis striatus* subsp. *striatus*), and Fortescue grunter (*Leiopotherapon aheneus*) [all Priority 4], have also been recorded in the strategy area.

Night parrot

The night parrot is a nocturnal, ground-feeding species and regarded as Australia's most enigmatic bird. Broadly, night parrots have been located in arid and semi-arid zones and prefer habitats of old-growth spinifex grasslands (especially ring-forming hummocks) and/or chenopod shrublands for roosting and areas of native grasses and herbs for foraging (Department of Parks and Wildlife 2017b; Threatened Species Conservation Committee 2016). In April 2005, three parrots were sighted within the strategy area, drinking at Minga Well (*Qwirriawirrie*) at dusk (Davis and Metcalf 2008). The sighting renewed hope that a viable night parrot population existed in the Pilbara region, and Davis and Metcalf (2008) postulated that the "juxtaposition of freshwater, spinifex and samphire may make the Marsh an important habitat for this species either permanently or as a refuge." During follow-up searches and surveys conducted at the Marsh since 2009, there have been no more night parrot sightings. Night parrots roost and forage in different habitats and can fly up to 40km in one night to forage. The best method of surveying is by identifying their calls as they leave roosting and nesting sites to forage and then return at the end of the night. Parrots are not known to call during foraging and foraging sites can be dispersed over a large area, be highly seasonal and more difficult to define. Consequently, despite concerted survey efforts, night parrots can be difficult to detect, especially if none are found within likely roosting sites. More surveys are needed to establish the current presence of the night parrot within the strategy area and hopefully, greater advances in

acoustic surveying techniques will improve the ability to accurately detect the presence of the night parrot (Department of Parks and Wildlife 2017b; A. Burbidge pers. comm. 27 November 2017).

Fortescue developed a night parrot research plan (Murphy 2014) which identifies the highest priority areas of research required for the species and focusses on improving detection strategies, understanding of habitat preference and use, distribution and threats to night parrots. This plan has largely been implemented. A national Night Parrot Recovery Team ensures a coordinated approach to night parrot research and management activities. The department is a member of this team.

Little is known about the threats to night parrots and these are likely to vary, depending on the location of the population; although inappropriate fire regimes, predation by introduced predators including feral cats, habitat degradation and simplification caused by feral herbivores, stray livestock and development activities are likely threatening processes (Blyth 1996; Threatened Species Conservation Committee 2016). Anecdotal evidence suggests that night parrots are at increased risk of collision with fences compared with other birds, as they tend to fly low over the ground. Despite recent monitoring of the population in southwestern Queensland, significant knowledge gaps remain. In its advice to the Minister, the EPA recommended more surveys for night parrots and research to improve understanding of habitat requirements of this species as well as seeking to include habitat in future conservation reserves (EPA 2013).

Northern quoll

There are records of the northern quoll in the strategy area although the NatureMap database suggests they are more prevalent in complex, rocky areas in the north, central and west Pilbara, and are less likely to occur through the south and east of the Hamersley Ranges and the Marsh (Cramer *et al*. 2016a). Hill and Ward (2010) also recognise the importance of rocky landforms for northern quolls, as these areas retain water, have a diversity of microhabitats, and cats, fire and livestock grazing are likely to have less of an impact within them. In 2014, a 10-year monitoring program for the northern quoll in the Pilbara was begun by DBCA (Cramer et al. 2016a). While the strategy area is not a stronghold for the species, undertaking surveys in and assessing the habitat suitability of certain land systems where northern quolls have been recorded (for example Calcrete and Turee Land Systems) will help understanding of distribution and habitat requirements. The EPA recommended more surveys to identify suitable habitat for the northern quoll, seeking to include habitat in future conservation reserves and implementing feral predator control measures (EPA, 2013).

Greater bilby

The greater bilby has been recorded at several locations across the strategy area but little is known about the local population (for example population size and dynamics). Within the strategy area, bilbies may occur in sand plains, isolated dunes and dune fields, alluvial and calcareous areas with sandy, sandy clay or sandy loam soils; along creek and drainage lines with red earthy and sandy soils and along rises with lateritic, small gravel, stony matrix (Cramer *et al*. 2016b). Bilbies in the Pilbara are usually associated with stands of particular plant species, especially some *Acacia* spp. which support cossid moth larvae (grubs) in their root systems. This larva is a major food source for bilbies in the Pilbara. Preliminary distribution modelling identified soil type and depth, and elevation as major contributing variables to predict likely bilby habitat (Dziminski and Carpenter 2017). Bilbies can be highly mobile and individuals have large home ranges. Mean home range of male bilbies can be up to 316 ha (Moseby and O'Donnell 2003). Unsuitable fire regimes, introduced predators, habitat degradation from grazing by stock and introduced herbivores (for example, feral camels [*Camelus dromedaries*] and donkeys [*Equus asinus*]) and loss of habitat for development are the major threats to the species in the strategy area. Rabbits (*Oryctolagus cuniculus*) also have a negative effect on bilby populations by occupying burrows and displacing bilbies and elevating the densities of

predators (Bradley *et al*. 2015). The introduction of the RHD K5 virus in the strategy area in 2017 has likely reduced the significance of this threat (see *Introduced animals*).

The department is coordinating a project in the Pilbara which aims to improve the understanding of the distribution and demographics of bilbies across the region and refining techniques to allow bilby populations to be monitored over time. A population monitoring site has been established on Hillside pastoral lease to the north of the strategy area and Roy Hill Station, to the east of the Marsh, has been identified as a potential future monitoring site (Dziminski and Carpenter 2017). There is also the potential to monitor populations within the strategy area to examine the effects of management. Monitoring has found that populations in the Pilbara are geographically isolated and consist of a small number of individuals, making them vulnerable to threats, especially unmanaged fire regimes and rabbits. Fire management to prevent large scale hot fires is a key strategy for managing bilbies in the Pilbara. Consideration of the effects of interactions between fire, predators and grazing is also important (Dziminski and Carpenter 2017). A greater bilby interim conservation plan (Bradley *et al*. 2015) was prepared in 2015, and a national recovery plan for the greater bilby (Pavey 2006) provides a framework for the conservation of this species. A new national recovery plan is due to be published in 2018.

Waterbirds

The Marsh has been recognised internationally as a Key Biodiversity Area for its large aggregations of breeding and visiting waterbirds (Dutson *et al*. 2009; BirdLife International 2017). Following inundation, the Marsh is one of three major inland wetlands in north-western Australia (along with Walyarta [Mandora Marsh] and Paraku [Lake Gregory]) which between them can support up to 1 million individual waterbirds (Halse *et al*. 2005), or over 20 per cent of the entire estimated

The Fortescue Marsh is a major breeding area for the Australian pelican (*Pelecanus conspicillatus)*. Photo – Colin Trainor

Australian waterbird population of ~4.6 million birds (Kingsford *et al*. 2012). Aerial surveys of the site during 1999-2003 recorded an estimated 270,000 individuals, including ≥1 per cent of the estimated global population of 14 waterbird species (Trainor *et al*. 2016). It is also considered to be an important breeding site for several species, including the Australian pelican and is the most significant site for black swan (*Cygnus atratus*) breeding in WA. More aerial surveys during flooding could generate new information on waterbirds of the strategy area. In addition to the species listed in Table 3, at least 11 other bird species recorded at the Marsh are listed as migratory under the Biodiversity Conservation Act and eight of these are also listed as migratory under the EPBC Act. Compared with other sites in WA, the Marsh is not significant for international migratory shorebirds, but these species are all the subject of international agreements. In its report to the Minister about the impacts of mining on the Marsh, the EPA recommended investment in feral herbivore and predator control, especially on the Marsh Land System to improve the quality of waterbird habitat and their survival (EPA 2013).

Invertebrates

The strategy area has a rich diversity of aquatic and terrestrial invertebrates, with 400 species recorded to date (Department of Parks and Wildlife 2017a; Pinder et *al.* 2010; Pinder et *al*. 2017). In particular, the Marsh has a disproportionately large number of significant species compared to other Pilbara wetlands, with endemic or near-endemic invertebrates occurring in saline marsh and fringing freshwater claypan habitats (Pinder *et al*. 2010). In a study examining invertebrate diversity of wetlands upstream and downstream of the Marsh, Pinder *et al*. (2017) found that the Marsh and Coondiner Pool contained the highest number of rare and restricted invertebrates within the survey area. Salinity is one of the most important influencing factors for aquatic invertebrates and the high salinities of the Marsh support numerous halophilic and halotolerant species, contributing to the highly diverse invertebrate fauna (Pinder *et al*. 2017). Bennelongia (2015) identified the northern and eastern Marsh as an area of high stygofauna (groundwater fauna) richness. As with the rest of the Pilbara, many stygofauna species in the strategy area are likely to be locally to regionally endemic. The conservation significance and need for preservation of subterranean fauna is recognised by the EPA in the requirement for assessment and protection during developments that may affect their habitat (EPA 2013).

Ecological communities

The strategy area contains two priority ecological communities (Map 5):

- 'Fortescue Marsh (Marsh Land System)' – Priority 1 ecological community. The Marsh is a highly diverse ecosystem with samphire shrublands and groundwater dependent riparian ecosystems. As the largest ephemeral wetland in the Pilbara, this community supports a suite of biotic assemblages including endemic flora and fauna. The primary biological attributes that define the Marsh PEC is the presence of samphires and other halophytic plants (*Duma*, *Atriplex*, *Frankenia* and *Muellerolimon*) or communities dominated by or supporting them. Some of the more permanent pools (saline and/or fresh) grow thickets of *Acacia ampliceps*, *Eucalyptus camaldulensis* and *Eucalyptus victrix*. The Marsh PEC includes small outwash fans dominated by *E. victrix* with shrubby melaleucas or a *Melaleuca* thicket, and communities dominated or supporting *Eremophila spongiocarpa*. The PEC does not include the fringing mulga woodlands, snakewood shrublands or the spinifex dominated hummock grasslands.

- 'Narbung Land System' – Priority 3(iii) ecological community. Alluvial washplains with prominent internal drainage foci supporting snakewood and mulga shrublands with halophytic low shrubs. Identified as one of 32 land systems of conservation concern in the Pilbara and threatened from overgrazing (J. Pryde pers. comm. 11 July 2017).

Reviewing the status of these PECs, through surveys and analysing the monitoring data gathered by the resource companies, will help to determine whether they should be reclassified as a threatened ecological community (TEC) or a Priority 5 (conservation dependent) ecological community.

Another two PECs are located just outside of the strategy area, though the implementation of this strategy may benefit their conservation and management (Map 5). These are:

- 'Freshwater claypans of the Fortescue Valley' – Priority 1 ecological community; located to the west.
- 'Vegetation of sand dunes of the Hamersley Range/Fortescue Valley' – Priority 3(iii) ecological community; located to the south.

Vegetation of sand dunes of the Hamersley Range/Fortescue Valley, a Priority 3(iii) ecological community located to the south of the strategy area. Photo – Adrienne Markey/DBCA.

Markey (2017) also noted several restricted ecological communities worthy of more investigation. The red Aeolian sand dunes overlying calcrete and Marsh sediments are only found in the south-eastern portion of the strategy area. Aeolian sand dunes are uncommon landforms in the Pilbara but significant deposits next to the Marsh are outliers of the Little Sandy Desert. The taller dunes contain species typical of desert dunes east of the Pilbara and the lower dunes and sandy flats comprise *Melaleuca glomerata* and samphire with sparse *Melaleuca* spp. shrublands respectively. These were not surveyed in detail and Markey (2017) recommended more surveys to determine their distinctiveness and significance. Markey (2017) also noted the highly restricted and distinctive riparian community comprising *E. camaldulensis*/*A. ampliceps* woodlands and shrublands. This community is found to the north of the Marsh and, with its semi-permanent/permanent fresh water, provides habitat for birds and a refuge for rare flora. These communities are small and geographically restricted and threatened by stray cattle and feral herbivore grazing. Classification of these communities as PECs should be considered.

Summary of management directions for flora, fauna and ecological communities

Management objectives	Actions	
1. Protect native flora and vegetation communities, native fauna and fauna habitats and significant ecological communities.	1. Undertake or support more baseline surveys, research and mapping to identify vegetation communities, fauna, habitats and ecological communities with a focus on conservation significant communities and species and where there are knowledge gaps. Review their conservation status based on this. Encourage the sharing of this information between the DBCA, mining and consulting companies, other State Government departments and other stakeholders and use information to adapt management accordingly.	
	2. Prepare and implement monitoring plans for key conservation significant fauna species such as the greater bilby and night parrot.	
KEY PERFORMANCE INDICATORS (KPIs)		
Performance measures	**Targets**	**Reporting requirements**
Vegetation mapping of the strategy area.	Vegetation mapping of the strategy area completed over the life of the strategy.	Every 3 years.
Populations of key conservation significant fauna species.	The occupancy and abundance of key conservation significant fauna species does not decrease.	Every 3 years.

3.5 Weeds

Weed infestations in the strategy area are generally species that have been introduced through pastoralism or along transport routes such as roads and railway lines. Some of these species are extremely invasive and represent significant threats to the natural and cultural values of the strategy area. As well as invading and displacing natural vegetation, weed species can alter fire regimes which can adversely affect native species. Weeds can also impact on Aboriginal cultural heritage sites and values.

About 20 weed species have been identified in the strategy area. During a floristic survey of the Marsh Land System, Markey (2017) recorded 12 weed species, at least half of which are considered significantly invasive and have the potential to occupy suitable habitats found on the Marsh. These include *Parkinsonia*, kapok bush (*Aerva javanica*), buffel grass (*Cenchrus ciliaris*), spiked malvastrum (*Malvastrum americanum*), ruby dock (*Rumex vesicarius*), black berry nightshade (*Solanum nigrum*) and mimosa bush (*Vachellia farnesiana*). The prickle bush weed, *Parkinsonia,* found in the strategy area, is a Weed of National Significance and a declared plant in WA. It competes with native vegetation and can form dense, impenetrable thorny thickets along watercourses. Buffel grass (which remains a valuable pasture plant in the Pilbara) appears to be established on virtually all landforms across the strategy area except the saline samphire communities in the interior of the Marsh (Markey 2017). The buffel grass invasion, its replacement of native species and adverse effects on biodiversity, is of major concern in relation to flora and ecosystem conservation and it represents an intractable environmental weed in the strategy area and the Pilbara (van Vreesewyk *et al.* 2004).

There are also several weed species not found within the strategy area, that have had significant impacts outside of, and a high potential for establishment in the strategy area. These include

Infestation of *Parkinsonia* (shown here growing under a stand of eucalypt trees, *E. camaldulensis* subsp. *obtusa*) along the upper reaches of the Fortescue River. Photo – Jo Kuiper/PMMC

calotrope (*Calotropis procera*), species of Optuntioid cactus (for example prickly pear), onion weed (*Asphodelus fistulosus*), Caribbean stylo (*Stylosanthes hamata*), stinking passionflower (*Passioflora foetida)* and mesquite (*Prosopis* spp.). Most of these species can spread rapidly, so early detection and eradication of any outbreak will be of critical importance.

Weeds can spread easily and rapidly along linear infrastructure such as BHP's Newman-Hedland railway and the Munjina Roy Hill Road. Regular surveillance of these transport corridors for new weed infestations and carrying out prompt control will be important in minimising the impacts of weeds on the wider strategy area.

For most weeds, control is expensive. Preventing their introduction and spread is the most cost-effective option. Where weed species are detected in the strategy area, the control of small manageable outbreaks is a priority. DBCA has undertaken an invasive plant prioritisation process that ranks weeds in each region, based on their invasiveness, ecological impact; potential and current distribution and feasibility of control (Department of Parks and Wildlife 2014). Purpletop chloris (*Chloris barbata*) is recorded in the strategy area and is ranked as 'high' or 'medium' in the assessment for the wider Pilbara region. Undertaking a specific weed prioritisation process for the strategy area, similar to that carried out for Karijini and Millstream Chichester national parks, will help to identify knowledge gaps and the most appropriate management actions (K. Passeretto pers. comm. 16 November 2017).

The Pilbara Mesquite Management Committee (PMMC) has been coordinating a collaborative project to manage *Parkinsonia* in the upper reaches of the Fortescue River, upstream of the Marsh and to the east of the strategy area. Also involved in the partnership are DBCA, DPIRD, Fortescue, Roy Hill Iron Ore, Roy Hill Station, Rangelands NRM, the Pilbara Corridors Project, and the Nyiyaparli traditional owners. The aim of the project is to eradicate *Parkinsonia* from this area and keep it out of the Marsh. The main infestation is present in the riparian habitats of the Fortescue River with scattered individuals recorded in the surrounding woodlands and floodplains. Data collected during treatment efforts and annual aerial surveillance events inform the on-going *Parkinsonia* management priorities. *Parkinsonia* has not been found on the saline floodplains and lake beds of the Marsh, though it is known to establish in other saline environments in the Pilbara Region. *Parkinsonia* populations have been chemically treated and surveyed to monitor the effectiveness of

treatment and to ensure that any emergent seedlings are identified and also treated. A collaborative *Parkinsonia* management plan was developed in 2013 and the PMMC reviews the eradication target and weed prioritisation within this annually. This also outlines the recommended techniques and timing for control and monitoring (J. Kuiper pers. comm. 22 March 2018).

The development of a publically available Pilbara IBRA region weed database for use in weed risk assessment is a collaborative project currently being developed between the CSIRO and the department. This project aims to provide a single source of Pilbara weed data from hundreds of flora and vegetation reports produced by mining and consulting companies and is due to be available in 2018. This database will assist in identifying priority weeds for control in the strategy area.

Once a weed prioritisation process for the strategy area has been carried out, the development of a weed management plan for the strategy area will be important in prioritising control efforts. The plan will:

- identify weed control priorities and map those identified as a high priority for control
- identify priority areas for surveillance for new weed infestations (for example BHP's Newman – Hedland railway and Munjina Roy Hill Road, cultural sites)
- limit the introduction and establishment of new weeds with potential to significantly impact on key values
- monitor, evaluate and document weed control efforts and effectiveness[8]
- be consistent with and complement regional weed management approaches
- provide a coordinated approach with neighbours and other stakeholders across the broader landscape, including a prompt response to new infestations and greater information sharing
- include hygiene protocols for management activities to limit the spread of weeds
- outline research and monitoring of weeds and their impacts on the values of the strategy area and
- allow for adaptive management.

The Pilbara CAP process identified improved weed management as the second most important priority in the Pilbara, with management focusing on targeting weed control, containing and preventing the establishment of new weeds, improving weed management in the mining industry and developing a Pilbara weed database and research plan. Specifically, reducing the threat and impacts from *Parksinonia* is a focus, with the aim of reducing densities to <1 per cent% in the Fortescue Catchment. These actions will complement those outlined in this management strategy (Heydenrych and Parsons 2018).

[8] The department's *Weed Occurrence and Treatment* phone app is used to document weed control and its effectiveness.

Summary of management directions for weeds

Management objectives	Actions
1. Prevent new introductions of weed species and their spread throughout the management focus area. 2. Minimise the impact of the highest priority weed species on key values of the management focus area through eradication and containment.	1. Undertake a weed prioritisation process based on invasiveness, ecological impact, potential and current distribution and feasibility of control.
	2. Following prioritisation, prepare, implement and review a Fortescue Marsh weed management plan based on the principles outlined above.
	3. Continue to prepare, implement and review an annual weed management program, based on the Fortescue Marsh weed management plan.
	4. Control and eradicate infestations of *Parkinsonia* in the upper Fortescue River.
	5. Regularly monitor new developments and disturbed areas to ensure any new weed infestations (especially *Parkinsonia*, cactus, Caribbean stylo and stinking passionflower) are quickly detected and controlled/eradicated.
	6. In collaboration with neighbouring land managers and traditional owners, implement measures to prevent the establishment of weeds from adjacent lands and control existing infestations where feasible.

KEY PERFORMANCE INDICATORS (KPIs)		
Performance measures	**Targets**	**Reporting requirements**
Presence of *Parkinsonia* in the Marsh Land System.	The Marsh Land System remains free of *Parkinsonia*.	Annually
Introduction and spread of new high priority weed species and infestations.	No new high priority weed species or infestations established in the strategy area over the life of the strategy.	Annually

3.6 Feral and other problem animals

Feral and other problem animals occurring in the strategy area include camels, donkeys, horses, rabbits, cats, foxes (*Vulpes vulpes*), wild dogs[9], honeybees (*Apis mellifera*) and stray domestic cattle.

[9] The term 'wild dog' collectively refers to feral domestic dogs, dingoes and dingo-dog hybrids (all *Canis familiaris*). Dingoes, feral dogs and their hybrids are declared pests under the *Biosecurity and Agriculture Management Act 2007*. Under the Biodiversity Conservation Act, the dingo is an unprotected species.

Feral herbivores and stray cattle

Large feral herbivores and stray cattle have a significant impact on the strategy area and contribute to the compaction and erosion of soil, the loss of grazing-sensitive plant species, reduced native vegetation cover with concomitant reduction in habitat quality, eutrophication and sedimentation of water sources, and the introduction of weed species. They can also damage Aboriginal cultural heritage sites and values. An aerial survey of the Marsh and surrounding areas conducted in October 2014 revealed the greatest densities of feral herbivores and stray cattle were located to the east and south of the Marsh (Oates *et al*. 2015). Markey (2017) observed the *Melaleuca xerophila* tall shrublands on the southern edge of the Marsh were impacted by feral herbivores and stray cattle, which graze and seek shade in this vegetation community.

An aerial survey of the Marsh and surrounding areas conducted in 2014 revealed feral herbivores and stray cattle damage to the east and south of the Marsh. Photo – Hamish Robertson/DBCA

Stray cattle have the greatest impact on the strategy area, followed by feral horses and donkeys. Prior to mid-2015, the strategy area was held under pastoral lease and the neighbouring properties remain subject to livestock grazing. Cattle occur in large numbers and high densities around water and move throughout the Marsh Land System seeking this out (H. Robertson pers. comm. 28 August 2017). The area surrounding Coondiner Pool, a near permanent source of water, contains important vegetation communities, patches of old spinifex and restricted and rare flora species (See *Flora and vegetation communities*). The wetland, riparian zone and surrounding vegetation can be heavily impacted especially during the dry season.

Grazing alters vegetation structure and thus habitat and food resources for native animals, and the loss of vegetation cover can expose small native fauna to increased predation risk (Martin and Possingham 2005; Martin 2010). Bell *et al*. (2014) surveyed winter bird assemblages at sites at the eastern and north-western ends of the Marsh and suggested that a sparse understorey, attributed to grazing damage, may relate to the paucity of small insectivores, such as the chestnut-rumped thornbill (*Acanthiza uropygialis*). Indirect impacts of grazing include altered fire, nutrient and surface water flow regimes. Therefore, stray cattle removal and exclusion and the decommissioning of water

points are a priority. Consultation with neighbouring land managers and other relevant stakeholders about stray cattle control (considering ownership), cattle mustering and stocking rates on adjoining pastoral leases will be important.

There are large numbers of feral horses upstream of the Marsh, which enter the Marsh during autumn and winter. Feral donkeys were a significant problem, but a Judas control program undertaken over the last five years by DBCA has reduced their numbers. The highest densities of donkeys remain to the north of the Marsh (within the strategy area) and across the Chichester Range (outside the strategy area).

Camels are occasionally seen in the strategy area and their impacts are similar to those of other feral herbivores and stray cattle. Control of camels occurs opportunistically during aerial shooting programs.

Carwardine *et al*. (2014) found that feral herbivore and stray cattle management (that is through a program of coordinated aerial shooting and exclusion fencing) would be among the most cost-effective strategies to protect conservation significant species of the Fortescue subregion. It should be noted however that for areas with a long history of grazing, some changes will be difficult or impossible to reverse, and the species most vulnerable to grazing impacts may have long disappeared from the landscape and may not return.

Heydenrych and Parsons (2018) identified targeted coordinated feral herbivore control as a priority strategy in the Pilbara CAP process, with the Judas donkey and horse program, involving collaring and aerial culling, a key component of this. The involvement of the Pilbara Regional Biosecurity Group, in partnership with the department and pastoralists will be important in implementing this control within the strategy area and the broader Pilbara.

Large numbers of feral horses are found upstream of the Marsh and enter the Marsh during autumn and winter (left). A Judas control program has been effective in reducing feral donkey numbers of the Marsh (right). This program relies on the social nature of donkeys and horses. A satellite collar is fitted to an individual, which will then seek out a new herd. By tracking the Judas donkey, the new herd can be located and controlled. Photos – Hamish Robertson and Jon Pridham/DBCA

The department's Pilbara Region has identified fencing of the Marsh as a high priority to reduce the impacts posed by stray cattle and large feral herbivores. A fencing plan prepared by the Region outlines details about fencing parts of the strategy area, including a cost estimate for the entire boundary and a proposed staged approach for implementation (Department of Parks and Wildlife 2016a). Parts of the strategy area boundary have fence lines in good condition, which will be maintained over the life of the strategy. Consideration of fencing priorities will be important in determining a suitable boundary for the proposed conservation reserve(s). The eastern portion of the strategy area is likely to be included in any future conservation reserve(s) and has high biodiversity values (especially flora values around Coondiner Pool), making fencing of the eastern

boundary next to the Roy Hill pastoral lease a high priority. Fences will be built to reduce collisions and entanglements by ghost bats and important bird species (that is, are barbless and contain deflective and reflective devices) (Department of Parks and Wildlife 2016a). In anticipation of the rollout of fully automated trains on the Newman-Hedland railway, BHP is considering fencing the railway corridor to protect trains from straying stock. This will reduce the impacts of stray cattle on the south western portion of the Marsh.

Water availability, especially permanent water, is a major factor that impacts upon the density of feral herbivores in the Marsh. When the Marsh floods, there is an abundance of water in the area. However, during dry periods, water is restricted to a few pools. Artificial sources of water such as Minga Well in the northern part of the strategy area enable populations of introduced and native animals to increase to levels where they can have serious impacts on biodiversity and landscape values. The management of water points is therefore an effective tool in the reduction of grazing pressure. Fencing, closing inlets or infilling of dams and mine voids, capping of wells and decommissioning of bores have all been used to reduce available water for feral herbivores in other rangeland areas managed for conservation in WA. Removal of artificial water sources which have been established for pastoral activities will reduce the availability of water for stray cattle to survive in the landscape. Animal welfare is central to water point management. The department's approach to the management of water points is detailed in the report, *Management of water points on former pastoral leases by the Department of Environment and Conservation* (Department of Environment and Conservation 2011b).

Vegetation recovery following the exclusion (stray cattle) or removal of feral herbivores (feral horses and donkeys) can be monitored by comparing vegetation composition in plots in areas where herbivores are no longer present to control plots where they are still present. This will provide information on management effectiveness.

Rabbits

Rabbits are mostly restricted to the large alluvial fans to the south of the Marsh and the rail line embankment. In March 2017, the department introduced the RHD K5 virus at two sites in the strategy area. Initial results have been encouraging and spotlight searches carried out before and after the release of the virus showed a reduction of between 76 and 94 per cent in rabbit numbers close to the release site (H. Robertson pers. comm. 28 November 2017). Being on the northern limit of their distribution, rabbit numbers are low around the Marsh compared with other parts of Australia and populations experience boom and bust cycles which can impact on the effectiveness of control. A more integrated approach with other methods is now required to enable more broadscale control.

Introduced predators

Feral cats, wild dogs and to a lesser extent foxes, have been observed throughout the strategy area and the wider region. Feral cats have had a devastating impact on native fauna and are a major factor in the range reductions and population declines of many native mammals. Between 2012 and 2016, Fortescue funded the implementation of an experimental, landscape-scale feral cat baiting and monitoring program by the department, over a large portion of the strategy area. This aimed to reduce predation impacts on native fauna, in particular, migratory

Fitting a monitoring collar to a feral cat to track its movements around the Marsh. Photo – Hamish Robertson/DBCA

Feral cat baiting operations. Kangaroo and chicken sausages being injected with 1080 poison (left). Eradicat® baits are loaded into a specially modified aeroplane and dropped over the strategy area (right). Photos – Hamish Robertson/DBCA

and EPBC Act listed threatened species (Clausen *et al*. 2016). The aerial baiting campaign demonstrated that baiting for feral cats, using Eradicat® sausage baits injected with the synthetic toxin 1080 (which is the same as the naturally occurring toxin found in some plant species in WA), can consistently achieve highly effective short-term control, although recruitment back into the area suggests that improvements to feral cat management is required. The review of the program made several recommendations to increase the efficiency of baiting efforts, including better targeting of preferred cat habitats, determining appropriate baiting frequencies and using a more integrated approach to control (that is using a combination of tools and techniques) (Department of Parks and Wildlife 2016b).

Eradicat ® baits loaded into the baiting aeroplane, ready to be dropped over the Marsh. Photo – Hamish Robertson/DBCA

Wild dogs are widespread across the Pilbara, prey on native fauna and compete with native predators such as northern quolls for food. They are also a significant pest for the livestock industry in the State. The control of wild dogs is coordinated through the Western Australian Wild Dog Action Plan 2016-2021 (WA Wild Dog Action Group 2016), which aims to minimise the impacts from wild dogs, especially in high risk areas, to allow long term growth in the pastoral, agricultural and tourism industries. Wild dog populations in the Pilbara follow a boom and bust cycle and numbers are typically high following seasons of high rainfall. The Pilbara Regional Biosecurity Group coordinates wild dog control on pastoral lands in the Pilbara, mainly through baiting and shooting. Baiting for feral cats within the strategy area also acts to reduce wild dog numbers.

Feral honeybees

Feral honeybees (*Apis mellifera*) are found around permanent water, often nesting in tree hollows, especially in the *M. xerophila* tall shrubland and in woodlands of *E. victrix* and *E. camaldulensis* on the southern edge of the Marsh. They displace birds, bats, native bees and other fauna from hollows, compete for pollen and nectar, disrupt pollination services and impact on fruit production and seed set in native flora. Colonies will be removed opportunistically when detected.

The development of feral animal management plans for feral herbivores (feral horses, donkeys and camels) and introduced predators for the strategy area will be important in prioritising introduced animal species for control effort. The plans will aim to:

- identify control priorities (for example those impacting on threatened species and communities or areas of high natural value)
- limit the introduction and establishment of new introduced animals with potential to significantly impact key values
- monitor, evaluate and document control effectiveness
- consider animal welfare
- be consistent with and complement regional management approaches
- provide a coordinated approach with neighbours and other stakeholders (in particular the Pilbara Regional Biosecurity Group) across the broader landscape and
- include capacity for adaptive management.

Summary of management directions for feral and other problem animals

Management objectives	Actions
1. Minimise the impacts of feral and other problem animals on key values of the strategy area through fencing and other control methods.	1. Prepare, implement and review feral animal management plans for feral herbivores (horses, donkeys, and camels) and introduced predators (cats) based on the principles outlined above.
	2. Based on the Fortescue Marsh feral animal management plans, continue to prepare, implement and review an annual feral animal control program.
	Feral herbivores and stray cattle 3. Implement the Fortescue Marsh Fence Plan to fence high value areas to protect them from grazing and trampling by feral herbivores and stray cattle and monitor vegetation condition and native fauna populations to determine its effectiveness. 4. Decommission redundant water sources such as Minga Well, considering animal welfare. 5. Liaise with neighbouring land managers, and other stakeholders in relation to the control of stray cattle (considering ownership), cattle mustering and stocking rates to support more effective control.
	Rabbits 6. Determine the effectiveness of the release of the rabbit RHD K5 virus through the monitoring of rabbit numbers and the abundance and distribution of bilbies. 7. Support more widespread rabbit control and monitoring.
	Introduced predators 8. Develop and implement an adaptive cat management program, with a focus on maintaining feral cat baiting across the Marsh and integration with other types of control.
	Feral honeybees 9. Opportunistically remove colonies of honeybees when detected.

KEY PERFORMANCE INDICATORS (KPIs)		
Performance measures	**Targets**	**Reporting requirements**
Construction of boundary fencing around the strategy area, with a focus on boundaries close to high value priority areas of the Marsh.	Length of boundary fence line constructed over the life of the strategy progressively increases.	Every 3 years.
Vegetation condition	Demonstrated vegetation recovery in areas where feral herbivores have been excluded (stray cattle) or removed (feral horses and	Every 3 years.

	donkeys).	
Presence of feral herbivores	A reduction in the presence of feral herbivores following exclusion (stray cattle) or removal (feral horses and donkeys) as demonstrated by camera surveys.	Every 3 years.

3.7 Fire

Fire is an important process affecting Australian ecosystems and biodiversity. Fire has been present in the Australian landscape for thousands of years, through lightning strikes and burning by Aboriginal people. Many Pilbara landscapes experience bushfires with a return frequency of less than ten years. As a result, much of the vegetation of the Pilbara is well adapted to fire.

A bushfire burns in *Triodia* hummock grassland within the strategy area. Photo – Hamish Robertson/DBCA

Aboriginal people used small, patchy fires to improve hunting and foraging opportunities, to encourage certain species to recolonise, to 'clean up the country' by removing dead or aging vegetation, to communicate and for ceremonial purposes (Nicholson 1981; Burrows and Christensen 1991; Haynes 1991; Pyne 1991; Latz 1994; Burrows *et al*. 2000). This frequent burning created a mosaic of vegetation of different ages across the landscape, which controlled fuel loads and reduced the likelihood of large intense bushfires. In turn, a range of different vegetation ages provided small to medium sized animals with habitat, food and protection from predators. In contrast, land use changes, the withdrawal of traditional burning practices since European settlement and climate change has contributed to more frequent, intense and very large bushfires that can burn several hundred thousand hectares over a protracted period. This changed fire regime has coincided with the decline of small to medium sized mammals in arid Australia possibly by changing vegetation structure and composition. This reduces the amount of available cover and makes small to medium sized mammals more vulnerable to predation (Legge *et al*. 2008; Firth *et al*. 2010; Griffiths and Brook

2014; Woinarski *et al*. 2015; Hradsky *et al*. 2017). These types of fire regimes can also increase soil erosion, degrade populations of long-lived woody plants such as mulga and snakewood and promote


Prescribed burning operations. Photos – Hamish Robertson/DBCA

the spread of weeds such as buffel grass (Burrows 2015). Large, intense bushfires also threaten Aboriginal cultural heritage sites, can be difficult to control and can result in the loss of life, property, mining and pastoral assets.

The strategy area contains a range of different ecosystems with different adaptations to fire. The saline flats and associated samphire and halophytic shrublands of the Marsh itself do not support fire and no fires have been recorded on the Marsh in the past 30 years. These shrublands generally do not burn due to the low fuel loads and the high salt content and succulent nature of the foliage. Underneath the dominant samphire and halophytic shrubs, there is an understorey of herbs and grasses and there may be certain circumstances where these grasses will carry a fire. This can occur following periods of high rainfall when there is an associated increase in the growth of the grass/herb groundcover. Alternatively, over grazing of the shrubs can lead to growth of the understorey grasses and herbs, resulting in a greater fire risk. These samphire shrubs do not store seeds and populations can be completely eliminated in a single fire. Retention of these non-flammable samphire shrublands in the landscape is also important as they represent areas of low fuels and act to reduce the potential of large, intense bushfires. Consequently, fire management of the shrublands of the Marsh should focus on excluding fire (Department of Agriculture and Food 2006).

On the stony plains to the north and south of the Marsh are grove-intergrove mulga communities and snakewood woodlands. Both are extremely fire sensitive, with very cool fires killing stands of these species. Mulga is highly vulnerable to cool fires, although some ecotypes can resprout advantageously if the residence time of the fire is relatively short. Both species are long-lived and slow-growing and regenerate from seed. Therefore, mulga and snakewood communities in the strategy area should be protected from fire. This is can be achieved by using prescribed burning to create low fuel buffers around these fire sensitive woodlands.

There are also fire resilient environments within the strategy area. These are species and communities which are well adapted to frequent fire and recover quickly following fire. Within the strategy area, these are mainly *Triodia* hummock grasslands on stony plains, slopes and plateaus. Once mature, the high levels of biomass of spinifex plants mean they are flammable for most of the year, when conditions are windy enough to push fire between the discontinuous hummocks. In these communities, implementing regular cool, patchy burns will create a mosaic of vegetation ages. This will reduce the frequency and scale of large, hot and damaging fires.

The strategy area also contains additional communities that require protection from fire. Night parrots prefer clumps of dense vegetation, particularly long unburnt spinifex for roosting and

nesting. There are pockets of long unburnt spinifex in the south-eastern portion of the strategy area, which may be important habitat for night parrots. Avoiding the introduction of fire to this area and other areas of long unburnt vegetation may be an important strategy in protecting night parrot habitat in the strategy area.

The greater bilby also benefits from specific fire regimes. Bilbies require managed fire, but large scale hot bushfires need to be prevented, as these destroy vegetation structure and food resources (Wright and Clarke 2007) and allow easy predator access to bilby populations (McGregor *et al.* 2014; Doherty *et al*. 2015). Implementing patch mosaic burning to create fire age heterogeneity, increasing habitat and resource diversity for bilbies is required for bilby populations to persist (Southgate and Carthew 2006; Southgate and Carthew 2007; Southgate *et al.* 2007).

The presence of buffel grass further complicates fire management in the strategy area. Buffel grass is an established weed in all parts of the area, aside from the saline flats of the Marsh itself (see *Weeds*). Buffel grass regenerates rapidly after fire and, when growing in fire sensitive communities, it encourages and carries bushfires through these areas. For example, within the strategy area, there are grove-intergrove mulga communities with an understory of spinifex and buffel. The interaction between fire and buffel is not well understood and more research through active adaptive management is required to better understand the fire ecology of this weed.

Fires within the strategy area generally start due to lightning strikes. There is also the risk of fires starting in mines sites and associated infrastructure next to the strategy area. For example, fires can be caused by electrical faults, from hot works such as welding, grinding, blasting operations or leakage of petroleum products, from spontaneous combustion, because of friction from machinery, vehicles, equipment and conveyor belts or from construction works. There is also a risk of fire from vehicle access along the Munjina Roy Hill Road and along the Newman-Hedland railway in the southern part of the strategy area. The implementation of prescribed burning and other mitigation strategies next to the railway line and the Munjina Roy Hill Road will reduce the likelihood of an ignition from rail operations or vehicles escalating to a large, intense bushfire. All existing and proposed mines and associated infrastructure developments in and around the strategy area address these fire risks in their fire management or environmental management plans and maintain an on-site fire suppression capacity (Fortescue Metals Group Ltd 2006; Roy Hill Iron Ore Pty Ltd 2009; ecologia Environment 2010). Consultation with these companies in relation to fire will contribute towards better fire management of the Marsh. There is also the risk of escapes from campfires, especially around Coondiner Pool where visitors are known to camp.

As with other areas of UCL across the State, local government agencies have primary responsibility for bushfire response and suppression in the strategy area.

Fire is important to the Banjima, Nyiyaparli and Palyku people; however, the extent of cultural fire knowledge among Aboriginal traditional owners is not well documented. It is likely there is a keen interest among Aboriginal people to do cultural fire management on country and use appropriate cultural knowledge for burning. Fostering cooperative and consultative working arrangements with the traditional owners of the Marsh will help to ensure the involvement of Aboriginal people in the fire management of the area and the maintenance of cultural knowledge of Aboriginal burning.

Consultation with pastoralists will also be important in implementing more appropriate fire regimes within the strategy area. Prescribed burning is carried out by pastoralists on pastoral leases surrounding the Marsh to reduce fuel loads to protect assets and manage the pasture quality of the vegetation for stock. Pastoralists also maintain a level of fire suppression capacity to reduce the impact of bushfires on life, property and pastoral assets. The department will work collaboratively

with local government, pastoralists and other neighbours during prescribed burning and fire suppression activities to help achieve landscape-scale fire management outcomes.

The development of fire management guidelines for different vegetation types (in particular spinifex hummock grasslands, tussock grasslands, grove-intergrove mulga communities, breakaways and rocky hills, the Fortescue Marsh and vegetation associated with permanent springs) and the expansion of coordinated, cross-tenure fire management were identified as a priorities by the Pilbara CAP (Heydenrych and Parsons 2018). Actions outlined in this management strategy will complement this work.

Summary of management directions for fire

Management objectives	Actions
1. Reduce the impact of bushfire on life, property, pastoral and mining assets. 2. Protect biodiversity and cultural values through the development and implementation of prescribed burning and other fire management programs.	1. Plan and implement a prescribed burning program within the strategy area that aims to: • protect life, property, mining and pastoral assets • create a mosaic of vegetation ages and structure across fire resilient communities • reduce the size and impacts of large intense bushfires on the values of the strategy area and • protect fire sensitive communities (such as grove-intergrove mulga and snakewood communities and long unburnt vegetation) and important cultural sites from bushfire.
	2. Develop a bushfire threat analysis for the strategy area.
	3. Where feasible, establish and maintain a strategic network of access tracks, fire breaks, and low fuel buffers with a focus on protecting areas of high conservation and cultural heritage value and other community and infrastructure assets.
	4. Involve traditional owners in managing fire, including prescribed burning, the protection of natural and cultural assets and incorporate Aboriginal knowledge of fire management wherever possible.
	5. Work with the Department of Fire and Emergency Services, local government, mining companies, pastoralists and other neighbours to determine and implement the requirements for a coordinated fire suppression response and ensure appropriate protection of the values of the strategy area and other assets on adjacent lands.

Management objectives	Actions	
	6. Ensure regulators include conditions associated with hot works from mining company infrastructure in fire management plans for development proposals.	
KEY PERFORMANCE INDICATORS (KPIs)		
Performance measures	**Targets**	**Reporting requirements**
The impact of bushfire and prescribed fire on human life, property, pastoral and mining assets.	No serious injury to people or damage to property, mining or pastoral assets attributed to the department's fire management.	Annually
Diversity and distribution of post fire vegetation ages.	Maintain a fine-scale mosaic of post fire vegetation ages, including recently burnt and long unburnt patches that provide suitable habitat diversity for bilbies and other fauna.	Annually
Size of area treated by prescribed burning.	A minimum of 20% of the planned annual treatment area, as outlined in the burn plan, is treated through prescribed burning.	Annually

3.8 Mineral operations

The Pilbara region of WA contains significant deposits of iron oxide within banded ironstone formations and secondary mineralisation associated with ancient river channels. The Chichester and Hamersley Ranges north and south of the Marsh are no exception. The high conservation values of the Marsh necessitate a balanced approach to conservation and development. The strategy area contains extensive iron ore deposits and continues to be the subject of extensive mineral interest and development (Map 6). The Cloudbreak iron ore mine is located in the strategy area to the north of the Marsh and numerous mining leases are associated with this and the adjacent Christmas Creek iron ore mine. These mines, the associated railway line and other infrastructure located in the strategy area are operated by Fortescue (see *Adjacent lands and off reserve management*). The Roy Hill mine (operated by Roy Hill Holdings Pty Ltd which is majority owned by Hancock Prospecting Pty Ltd) also operates on lands next to the Marsh. The proposed Marillana and Koodaideri iron ore mines (proposed by Brockman Mining Ltd and Rio Tinto respectively) are located on lands to the south of the Marsh. Most of the strategy area is covered by current exploration licences.

Impacts of mineral resource developments include the removal of native vegetation and habitat as well as localised alteration of landforms through the removal of features associated with the ore body. In most cases, these impacts are restricted to the immediate area of the mining operation and are managed by the mining company, however the impacts of infrastructure corridors, exploration activities and indirect impacts on hydrogeology and hydrology (for example dewatering) is often more widespread. Development activities can also encourage the spread of weeds across the broader landscape, through the modification of landforms and soil movement (EPA 2014).

Some iron ore mines target ore bodies below the water table, requiring dewatering of aquifers and surplus water disposal. Surface drainages may also be altered as part of flow line diversions and flood mitigation practices. These disturbances can potentially impact on the surface and groundwater hydrology of the Marsh (RDA 2013); for example, by causing changes in the volume and quality of inflows to the Marsh, modification of surface water catchment areas, erosion and sedimentation. Pinder *et al*. (2017) suggest that mining operations in the Hamersley and Chichester Ranges impact upon surface water flows towards the Marsh. All these hydrological changes have the

potential to impact upon the samphire vegetation communities of the Marsh (Markey 2017) and invertebrate and subterranean fauna communities, especially those that are geographically restricted or rely on groundwater-dependent ecosystems. Iron ore mining leaves a legacy of open pits and pit lakes can form once mining operations and the associated dewatering ceases, allowing the pits to fill with groundwater. These also contain contaminants (such as metal, metaloides and saline, acidic or alkaline water) which can seep into wetlands, waterways and groundwater resources (EPA 2014).

Contamination and pollution from mining operations within and adjacent to the strategy area may also occur. Sources of contaminants and pollution can include handling, storage and transportation of hydrocarbons, lubricants and other chemicals; disposal of saline groundwater; dust from vehicle movements and exposed, dry soils; noise and light pollution from mining equipment, blasting and rail transport; and municipal waste and sewerage from accommodation and other mine facilities. Acid and metalliferous drainage can occur when acidic water drains from potentially acid forming mine waste or exposed surfaces. This can impact on surface and groundwater quality and result in contaminated sites (BHP Billiton 2015). Mining companies have produced management plans to guide the management of contaminants and pollutants.

Two proposed iron ore mines are located in the Hamersley Range to the south of the Fortescue Marsh; Brockman Mining Ltd's Marillana iron ore mine and Rio Tinto's Koodaideri iron ore mine. Photo – Steven Dillon/DBCA

Mineral exploration and mining in WA is often regulated by DMIRS through the granting of various tenements under the Mining Act and its regulations; however the majority of the mining activity near the Marsh is regulated under State Agreement Acts by DJTSI. The holders of tenements are required to meet certain conditions to retain exploration and development rights, including environmental assessment(s). Exploration and development proposals that may cause significant impact on key biodiversity values should be referred to the EPA for environmental impact assessment. Where a mineral resource project has been assessed by the EPA under section 40 of Part IV of the Environmental Protection Act (as part of a proposal referred under section 38), separate vegetation clearing approvals are not required as impacts of clearing are addressed by conditions set out within a Ministerial Statement. This exemption does not apply to proposals which the EPA has decided not

to assess. It also does not apply to expansions or works not covered by the conditions of the original proposal.

As part of this process and to address environmental impacts and risks associated with exploration and mining under the Environmental Protection Act, the mining companies responsible for existing and proposed operations and developments within and adjacent to the strategy area have prepared a range of management plans. These address the risks to the environment and the Marsh and outline strategies for mitigating these risks. Relevant management strategies include:

- groundwater monitoring and surface water testing and the development of relevant trigger points for surface and groundwater quality and quantity compared with baseline results
- the development of contingency plans for aquifer recharge, alternative abstraction areas, and the potential to discharge water downstream of mining pits
- more research to gain a better understanding of groundwater dependent ecosystems
- construction of culverts, spillways, diversion drains, water management structures, bunding, drains, settling ponds and other engineering works associated with mines and railway infrastructure to ensure minimal disruption to surface water flows
- diversion of surface water run-off around mining areas and
- the use of surface water collected within open cut pits in processes on-site.

Impacts to the biodiversity values of the area are also taken into consideration through the offsets packages associated with the Ministerial Statements for the existing and proposed developments within and adjacent to the strategy area (see *Administration*).

DWER administers legislation that governs the management of emissions, discharges and pollutants from premises prescribed under the *Environmental Protection Regulations 1987*. DWER regulates industrial emissions and waste disposal through a works approval and licencing process under Part V of the Environmental Protection Act. Industrial premises with the potential to cause emissions and discharges to air, land or water are known as 'prescribed premises'. A works approval is required for the construction of a prescribed industrial premises and a licence registration is needed to cause an emission or discharge. Proponents are required to report against licence conditions (an Annual Report) and these are reviewed. Licence terms are for 20 to 25 years duration. Sites are also subject to inspections where an audit against licence conditions is conducted.

Where the EPA assesses the environmental impacts relating to mine closure for proposals that are not subject to the Mining Act 1978, the EPA will usually recommend a condition relating to mine closure. The condition will usually require that the proponent implement (or prepare and implement) a Mine Closure Plan consistent with the *Guidelines for Preparing Mine Closure Plans* and/or may require other proposal-specific provisions. The EPA may also recommend a condition relating to mine closure for other mining proposals (that are subject to the Mining Act 1978), noting that the *Guidelines for Preparing Mine Closure Plans* is a joint document prepared by DMIRS and the EPA to meet the Mining Act and Environmental Protection Act regulatory requirements. A Mine Closure Plan prepared in accordance with these guidelines is a requirement under the Mining Act 1978 (Government of Western Australia 2015). Although the joint guidelines are out of date in some respects, they remain the standard procedures followed in the EPA's consideration of mine closure until such time as they are replaced by an updated document.

Summary of management directions for mining operations

Management objectives	Actions
1. Minimise the impacts of mineral development activities on the key values.	1. Work with DMIRS, DJTSI and EPA to provide advice on the potential impacts of development proposals on the natural and cultural values and overall integrity of the strategy area and advise on impact avoidance, minimisation and mitigation of relevant values.
	2. Where relevant, support industry operators and regulators to implement existing environmental management plans/programs, mine closure plans and related documents.

4. Managing visitor use and community values

The department's *Corporate Policy Statement No.18 – Recreation, Tourism and Visitor Services* (Department of Parks and Wildlife 2017c) and related guidelines outline the principles, operational guidelines, procedures and administrative arrangements in relation to facilitating recreation and tourism in conservation reserves across the State. The Policy Statement and the guidelines apply to former pastoral lease areas managed by the department.

The strategy area is in Tourism Western Australia's 'North West' region and situated immediately east of Karijini National Park. With its well-developed facilities, easy access and high visitor numbers, this park is the key focus for visitor use in the area. The western portion of the strategy area is dissected by the Munjina-Roy Hill Road. Little is known about visitor use of the strategy area, although temporary camps are known in the Coondiner Pool area. There is also anecdotal evidence that tourists are interested in access to the Marsh through enquiries to Visitor Information Centres. Given the strategy area was pastoral lease until 2015 and the large number of mining operations within and around the area, the Marsh itself has never been easily accessible to the public. In addition, no visitor facilities are provided within the strategy area. Consequently, visitor numbers are low.

4.1 Planning for visitor use

There is only a limited understanding of visitor use in the strategy area and most knowledge is based on anecdotal reports. Coondiner Pool, in the southern part of the strategy area, on the Munjina-Roy Hill Road is used for camping by local visitors from Newman, Tom Price and Nullagine. Visitors from further afield also use Coondiner Pool for birdwatching and associated camping. There is evidence of impacts from uncontrolled visitor use at this site, including litter, campfires and hunting. Aside from this limited information, the department has little knowledge relating to visitor use across the strategy area.

Planning for visitor use is needed to manage issues such as visitor risk, environmental impacts, social benefit, equity, public demand, potential economic benefit and cultural heritage requirements. In particular, unmanaged visitor use and unauthorised recreational use generally, have the potential to lead to the loss of vegetation, the introduction and spread of weeds and disease, localised soil compaction and erosion problems, the potential for changes in water flows, habitat destruction, fauna disturbance, increased fire risk, damage to cultural heritage sites and cause personal injury or harm. Should the strategy area become a conservation reserve, planning for visitors will occur in more detail. Consideration of the key natural and cultural values of the strategy area will be at the forefront of visitor planning. Any recreation area should be:

- low impact and compatible with the key natural and cultural values of the strategy area
- consistent with the department's *Policy Statement No. 18 – Recreation, tourism and visitor services* and
- adopt 'Leave No Trace' principles.

The first step in developing opportunities for visitors will be to gain a greater understanding of visitor use patterns within the strategy area; where visitors come from, where visitors go, the types of activities they participate in and when they visit and for how long. Implementing some form of monitoring program to establish the number of visitors to the strategy area will be important, as well as developing relationships with tourism stakeholders in the area to gain a better picture of visitor use.

Sites such as Coondiner Pool and others within the strategy area are likely to have visitor use potential. Access through the highly scenic south eastern and southern part of the strategy area is good and represents an easy day trip from Karijini National Park. However, while the strategy area remains UCL, visitor facilities will only be developed to improve protection of the values of the strategy area and visitor safety. Visitor use of the strategy area will not be promoted. The department will need approval (in the form of an MOU or a relevant licence) from DPLH to develop facilities to mimimise disturbance and rationalise access to areas such as Coondiner Pool. Should formal reservation occur in the area, there will be greater opportunities for recreation development and this will be facilitated through a Recreation Master planning process for the strategy area and consultation with traditional owners and other stakeholder groups. Recreation Master Plans document and provide management direction for recreation use and the level of developments and facilities to be provided.

Although numbers are low, visitors are known to use Coondiner Pool for camping and birdwatching. Photo – DBCA

Visitor safety

Outback destinations in the Pilbara pose several risks to visitor safety. As well as the usual risks related to outdoor activities, there are also those associated with remoteness, the lack of reliable communication, risks associated with pastoral and mining infrastructure, poor road conditions and the severe climate.

Risks to visitors to CALM Act managed lands and waters are managed through a visitor risk management program that is guided by the department's *Policy Statement No. 53 – Visitor risk management* (Department of Parks and Wildlife 2015b). Within parks and reserves generally, the department encourages visitors to use appropriate behaviour while undertaking recreational activities that involve some level of risk. While the strategy area remains UCL, the department will

opportunistically provide information to visitors about safety risks and personal preparedness, or refer them to appropriate sources of information. Traditional owners have a cultural obligation to ensure visitor safety.

Visitor information, education and interpretation

Raising community awareness, appreciation and understanding of the biodiversity and cultural values of natural areas via information, interpretation and education fosters a sense of community ownership, engenders support for management and encourages appropriate behaviour.

There is very limited information provided to visitors about the Marsh. The Newman Visitor Centre receives requests from people wanting to visit the Marsh, in particular those with an interest in birdwatching. Until the strategy area becomes part of the conservation reserve system, there will be no development of any visitor sites or facilities and associated promotional material or interpretation. However, given the safety risks associated with people accessing the strategy area (see *Visitor Safety*) there is a need for more comprehensive information to be provided. This will be developed and provided opportunistically to people wanting to visit the Marsh, in consultation with visitor centres in towns surrounding the strategy area such as Newman and Tom Price.

4.2 Visitor access and access management

The only public access near the Marsh is the Munjina-Roy Hill Road which dissects the southern and south-eastern portions of the strategy area. This east-west road is sealed in sections and links the Marble Bar Road to the east of the strategy area with the Great Northern Highway to the west at Munjina. This road is also used by heavy haulage vehicles from nearby mine sites and can pose a hazard for drivers.

Public access to the Marsh itself is difficult. There are tracks that lead to the southern part of the Marsh from the Munjina-Roy Hill Road, east of the intersection with the BHP Newman-Hedland Railway. However, these pass through Marillana Station, outside the strategy area, and permission is required from BHP (which owns the pastoral lease) to access these tracks. There are also tracks from the BHP Newman-Hedland Railway to the western part of the Marsh and permission from BHP, which owns and operates the line, is also required to use the adjoining access track. There are pastoral tracks into the eastern part of the Marsh off the Marble Bar Road, through Roy Hill station. Likewise, permission to use these is required from the Roy Hill lessee. Access to the northern part of the Marsh and the strategy area, through the Cloud Break and Christmas Creek mines is not permitted. Mine roads are gated and there is no public access.

There are numerous unauthorised access tracks within the strategy area. The low vegetation in many parts of the Marsh makes it easy for visitors in four-wheel drives or on quad bikes to create new tracks. This is especially a problem on the Marsh itself where vehicles can damage the fragile samphire communities. The department will provide information to visitors opportunistically and install signage within the strategy area about the importance of staying on existing tracks.

The department has arrangements with pastoralists and mining companies to access the Marsh to do management activities such as feral animal control, fence construction, fire suppression and prescribed burning, weed management and surveys for flora and fauna. The network of access tracks is important to do this work. However, many of the existing tracks are unnecessary or have been created through unauthorised use and should be closed and rehabilitated. An assessment of the existing tracks (including mapping) and their requirement for management will be an important step in rationalising the network of management tracks and closing and rehabilitating those not required.

Maintenance of existing, well established roads that were developed when the strategy area was still part of the surrounding pastoral leases is a priority. Following reservation, access to areas for future visitor use, away from sensitive flora, fauna and ecological communities will also be considered. This access assessment and prioritisation process will take place during the implementation of the strategy.

4.3 Involving the community

The department encourages and facilitates community involvement to:

- raise awareness of, encourage input to and generate greater public acceptance of decisions about the management of the strategy area
- gain additional resources for management of the strategy area and
- provide information, education and interpretation about the area's values to the wider community.

It is essential that the department builds strong relationships with traditional owners (see *Management opportunities with Aboriginal people* and *Aboriginal cultural heritage*), mining companies, pastoral neighbours, and local authorities as these groups are directly affected by management of the strategy area. Cooperative working arrangements have already been established in the strategy area and are still being strengthened. The department has good working relationships with the mining industry surrounding the Marsh and is working hard to ensure this continues. For example, there is communication with staff from the Cloudbreak, Christmas Creek and Roy Hill mines about specific management issues on the Marsh. The department works with neighbours to the strategy area on projects such as heritage surveys, weed management, feral herbivore control and fencing programs. More engagement and consultation with neighbours in relation to these management issues will be a focus over the life of this strategy.

Australian bustard (*Ardeotis australis*). Photo – Colin Trainor

Potential business partnership opportunities exist whereby neighbouring pastoral enterprises, mining companies and local government authorities can be engaged as contractors on projects such as fencing and weed and feral predator control. Companies contribute to research and management programs in the strategy area and there is an opportunity to build on existing relationships and explore new opportunities with the resource sector.

The department also needs to maintain close working relationships with State Government agencies which have responsibilities for aspects of land and project management in the strategy area. These include DJTSI; DMIRS; DPLH; DWER the Pilbara Development Commission.

Conservation, recreation and tourism bodies are also important stakeholders. Continuing partnerships with the natural resource management sector, including Rangelands NRM and Greening Australia, will help to achieve the objectives of this strategy. Special interest organisations such as BirdLife Australia have conducted scientific surveys in recent years. There are opportunities for the involvement of volunteer organisations in the management and monitoring of the survey area. These

groups may be interested in participating in surveys, biological blitzes, rubbish removal and capping of bores and wells and these activities may also encourage support from surrounding mining companies. A broad range of volunteer projects are run by DBCA across the State, which contribute towards achieving departmental objectives. Within the strategy area, volunteers could help with biodiversity and cultural heritage surveys and implementing weed control programs. Volunteers may also contribute to citizen science projects within the strategy area.

There are still many knowledge gaps associated with the management of the strategy area. To date, partnerships with educational and scientific bodies have helped add to the knowledge and understanding of the values of the Marsh and there are opportunities for greater collaboration (see *Research, monitoring and performance assessment*). Examples include research being carried out in partnership with UWA investigating the ecological water requirements of significant flora and vegetation communities and the ecophysiology of a range of samphire species on the Marsh to distinguish the impacts of natural dynamics of changing water regimes from potential mine-related effects.

Summary of management directions for visitor use and community values

Management objectives	Actions
1. Protect key values from significant and adverse impacts of access and recreation activities. 2. Promote and facilitate community involvement in the management of the strategy area.	1. Plan and implement a monitoring program to gain a better understanding of visitor use, especially around Coondiner Pool.
	2. In consultation with DPLH, plan, seek approval for and develop facilities and information at Coondiner Pool to protect visitor safety and the natural and cultural values of this site from unmanaged recreation and access.
	3. Map and assess access tracks and determine their priority for management and/or visitor access. Those that are not required should be closed and rehabilitated.
	4. Identify and rehabilitate eroded sections of tracks, cutlines, cleared areas and water points located outside mining and other areas containing development infrastructure.
	5. Should the land within the strategy area become vested under the CALM Act, provide access, facilities, information and interpretation for visitor use through the preparation and implementation of a Recreation Master Plan.
	6. Develop partnerships that foster cooperation and collaboration with traditional owners, mining companies, pastoralists, local authorities, other State Government agencies, natural resource management groups and other relevant stakeholders to ensure a coordinated approach to managing the strategy area.

5. Research and monitoring

Research and monitoring are essential components of informing management. Research improves knowledge and understanding of the values of the strategy area and the effectiveness of management actions required to protect the values of the area. Research enables a greater understanding of spatial and temporal changes in biodiversity. Well-designed research and effective monitoring is an essential component of adaptive management.

In the past 10-15 years, research carried out in the strategy area has increased significantly, mostly because of mineral exploration and developments in the vicinity and the availability of funding from environmental offsets to spend on new research projects. To date, research carried out on values of the Marsh has included:

- ecological water requirements of species and communities within the Marsh
- biological survey to determine the presence and patterns of flora, fauna and habitats in the strategy area
- geochemical and hydrogeological characteristics of the Marsh
- mapping of vegetation communities of the Marsh Land System
- surveys to determine the presence of particular species such as the night parrot and bilby
- control of feral animal populations, in particular feral cats, donkeys and horses and
- Aboriginal ethnographic and archaeological surveys.

Conservation Officer Hamish Robertson and Senior Technical Officer Steven Dillon conducting a vegetation survey within the strategy area (left). Research Scientist Mike Lyons conducting a vegetation survey at Moorimoridinia Pool (right). Photos – Adrienne Markey/DBCA.

Given the extent of research projects and surveys being carried out within or adjacent to the strategy area, by a range of research organisations and consultants, issues have arisen where methodologies and mapping scales have been inconsistent, preventing the easy comparison of data and assessment of ecological changes over time.

Across WA, considerable time, money and effort are spent each year collecting biodiversity data for environmental assessments under the Environmental Protection Act. The information collected by mining and consulting companies has contributed significantly to the knowledge and understanding of biodiversity values and systems within and outside the strategy area. To date, there has not been a central repository for this data and it has not been easily accessible. DWER has developed the Index of Biodiversity Surveys for Assessment (IBSA) to capture and consolidate biodiversity data from terrestrial field surveys associated with future environmental impact assessments under the

Environmental Protection Act and make it publicly available. Consequently, this project will reduce costs and delays associated with the poor availability of data, allow all stakeholders to get maximum value from existing data and support ongoing strategic planning, decision-making and management. IBSA was launched in May 2018 and will be of great value in contributing towards a better understanding of the Marsh and its management.

There are still many gaps in knowledge and understanding of the Marsh. Through the implementation of this management strategy, the department will collaborate with mining companies, universities and other research organisations to address these gaps, with a focus on those with the highest priority for research. These priorities were developed by considering the results of survey work completed by mining and consulting companies, EPA Annual Reports, other landscape-scale planning that has occurred in the Pilbara (for example; the Pilbara CAP, the *Pilbara Conservation Strategy* and CSIRO's *Priority Threat Management for Pilbara Species of Conservation Significance*) and expert elicitation. Addressing these gaps will include (but not be limited to):

- more cultural heritage mapping
- the collection of traditional ecological knowledge to inform management of the Marsh.
- more vegetation survey and mapping of communities outside of the Marsh Land System
- hydrological models of the strategy area, the ecological water requirements of significant flora and vegetation communities in the Marsh and the extent of cumulative hydrological impacts of development projects
- more surveys for significant fauna, in particular the night parrot and bilby
- survey of aquatic invertebrates using the Marsh
- fire management of the strategy area, in particular:
    - using fire as a weed management tool
    - the interaction between fire, weeds and introduced predator behaviour
    - species and communities that require specific fire regimes and
    - changes in habitat diversity and structure associated with changes in fire regimes.
- the vulnerability of key habitats and values to the impacts of climate change
- visitor use of the strategy area
- improved knowledge of feral herbivore behaviour, distribution and management and interactions between different species of feral animals (especially introduced predators) to inform control management and
- improved knowledge of methods for the control of priority weed species and impacts to the landscape, in particular *Parkinsonia*.

A camera recording site used during the Fortescue Marsh Feral Cat Baiting Program. A lure comprising a strip of silver tinsel, white turkey feathers and a holed sifter jar of oil-based scented lure ('Catastrophic') is used to attract cats to the site. Movement cameras record the presence of cats and other fauna. Photo – Hamish Robertson/DBCA.

Research and monitoring are important components in making informed decisions to achieve best practice environmental management and in determining the success of this management strategy. With multiple land managers in the area, this will require integration, coordination and information sharing between the department, mining companies, consultants, other government departments, research organisations and other relevant stakeholders. Other organisations may be able to help in the facilitation of this data sharing and research communication between the department and other stakeholders. For example, the Western Australian Biodiversity Science

Institute (WABSI) is currently working on a project to improve data sharing between the State Government, conservation groups, industry, science and educational institutions. This will ensure funds and resources are used in the most effective and efficient way. The Fortescue Marsh represents an opportunity to demonstrate effective, cross-sector adaptive management for a range of conservation and cultural heritage outcomes.

Summary of management directions for research and monitoring

Management objectives	Actions
1. Assist the management of the strategy area with appropriate and ongoing research and monitoring.	1. Develop a database or database theme for the strategy area to incorporate flora and fauna survey data and relevant publications into existing publicly-available departmental databases (for example NatureMap).
	2. Develop and implement a research and monitoring program that: • provides for the implementation of research priorities identified in this strategy • standardises data collection methods and mapping to help with identifying trends • specifies outcome-based evaluation methods • uses appropriate control sites and • communicates the outcomes of high priority research projects to external groups and organisations.
	3. Work with organisations, such as WABSI, to facilitate greater sharing of information about the strategy area between the department, mining and consulting companies, State Government departments and other stakeholders and to relevant centralised databases or data platforms (e.g IBSA) where appropriate.
	4. Develop partnerships and programs with mining companies, universities and other external research organisations to encourage research projects that fill priority knowledge gaps as outlined above and support science-based offsets programs (for example corporate sponsorship).

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MULGA DOWNS

HILLSIDE

BONNEY DOWNS

ROY HILL

MARILLANA

JUNA DOWNS

Shire of Ashburton

Shire of East Pilbara

Munjina

Road

Northern

Highway

Munjina

Munjina

Road

Great

Roy

Hill

Road

Road

Marble

Bar

Road

Bar

Marble

Minga Well

Munjina

Coondiner Pool

Map 1. Tenure and locality

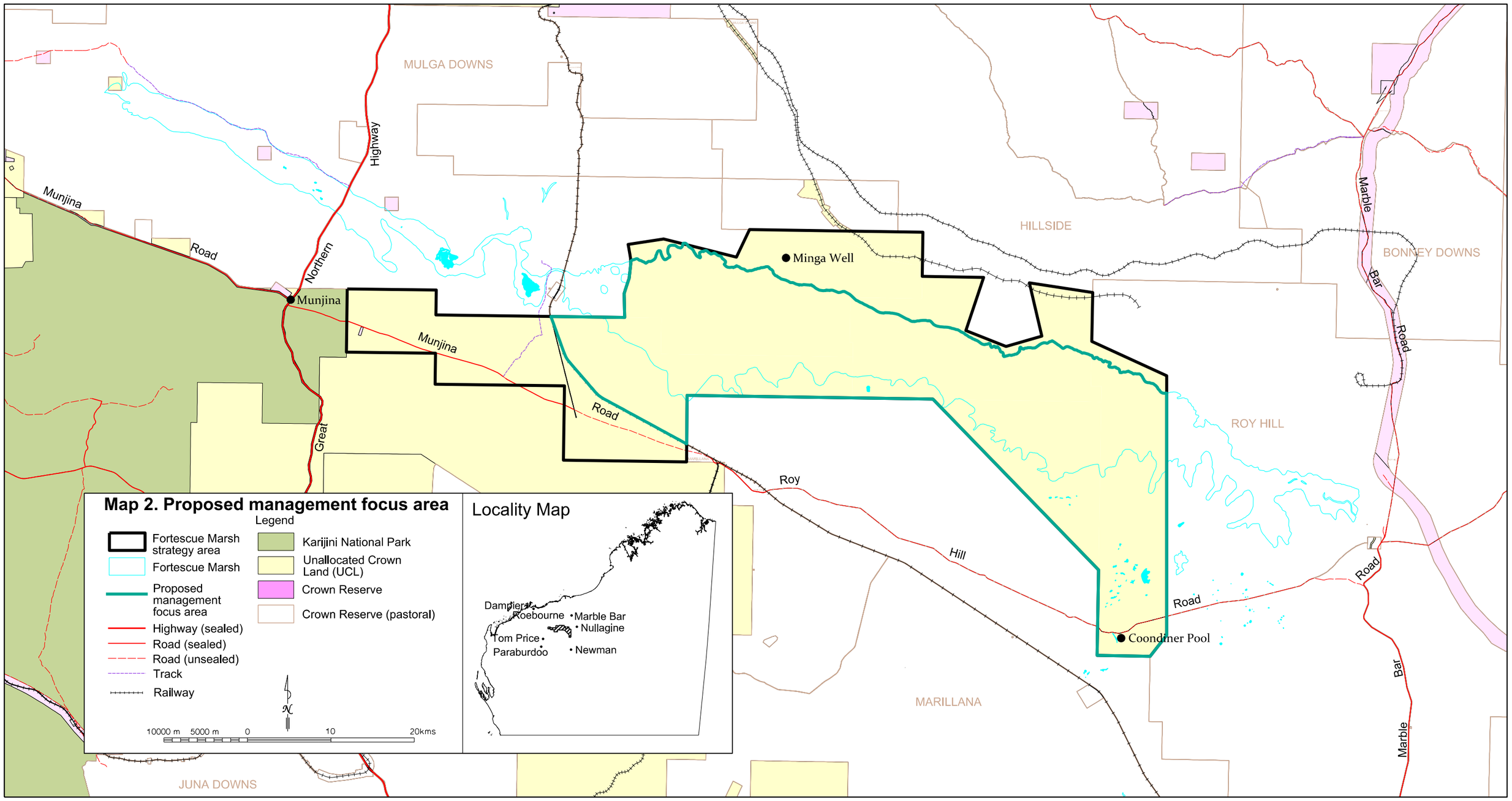
Legend

- Fortescue Marsh strategy area
- Fortescue Marsh
- Highway (sealed)
- Road (sealed)
- Road (unsealed)
- Track
- Railway
- Karijini National Park
- Unallocated Crown Land (UCL)
- Crown Reserve
- Crown Reserve (pastoral)
- Local Government Authority (LGA)

10000 m 5000 m 0 10 20kms

Locality Map

Dampier
Roebourne
Marble Bar
Nullagine
Tom Price
Paraburdoo
Newman


MULGA DOWNS
HILLSIDE
BONNEY DOWNS
ROY HILL
MARILLANA
JUNA DOWNS
Munjina
Road
Northern
Highway
Munjina
Munjina
Road
Great
Minga Well
Marble
Bar
Road
Roy
Hill
Road
Road
Coondiner Pool
Bar
Marble
Map 2. Proposed management focus area
Legend
Fortescue Marsh strategy area
Fortescue Marsh
Proposed management focus area
Highway (sealed)
Road (sealed)
Road (unsealed)
Track
Railway
Karijini National Park
Unallocated Crown Land (UCL)
Crown Reserve
Crown Reserve (pastoral)
N
10000 m 5000 m 0 10 20kms
Locality Map
Dampier
Roebourne
Marble Bar
Nullagine
Tom Price
Paraburdoo
Newman

Banjima People
WCD2014/001

Palyku
WC1999/016

Banjima People
WCD2014/001

Nyiyaparli
WC2005/006

Munjina Road

Northern Highway

Great Northern Highway

Munjina Road

Roy Hill Road

Marble Bar Road

Marble Bar Road

Map 3. Native title claim and determination areas

Legend

Native title claims and determination areas

- Fortescue Marsh strategy area
- Highway (sealed)
- Road (sealed)
- Road (unsealed)
- Track
- Fortescue Marsh
- Banjima People determination area WCD2014/001
- Nyiyaparli WC2005/006 claim area
- Palyku WC1999/016

N

10000 m 5000 m 0 10 20kms

Northern Highway

Munjina

Great Road

Roy Hill Road

Map 4. Vegetation units

Legend

Fortescue Marsh strategy area

Highway (sealed)

Road (sealed)

Road (unsealed)

Track

Fortescue Marsh

Vegetation community (see Appendix 2 for descriptions)

0		9		24	
1		17		25	
2		18		26	
3		19		27	
4		20		999	
7		21			
8		22			

N

10000 m 5000 m 0 10 20 kms

Munjina Road
Northern Highway
Great Northern Highway
Munjina Road
Roy Hill
Road
Marble Bar Road
Marble Bar Road
Freshwater claypans of the Fortescue Valley
Fortescue Marsh Land System
Vegetation of sand dunes of the Hamersley Range 1 Fortescue Valley
Vegetation of sand dunes of the Hamersley Range 1 Fortescue Valley
Narbung Land System

Map 5. Priority ecological communities

Legend

- Fortescue Marsh strategy area
- Priority ecological communities (PECs)
  - Priority 1
  - Priority 3
- Highway (sealed)
- Road (sealed)
- Road (unsealed)
- Track
- Fortescue Marsh

N

10000 m 5000 m 0 10 20kms

Munjina Road
Northern Highway
Great Northern Highway
Munjina Road
Road
Cloudbreak iron ore mine
Christmas Creek iron ore mine
Marble Bar Road
Roy Hill iron ore mine
Koodaideri iron ore project (proposed)
Roy Hill Road
Marillana iron ore project (proposed)
Roy Hill Road
Road
Marble Bar Road

Map 6. Mines and railways

Legend

- Fortescue Marsh strategy area
- Mining tenements
- Mining leases
- Miscellaneous licence
- Mining location information
- Existing and proposed iron ore mines
- Highway (sealed)
- Road (sealed)
- Road (unsealed)
- Track
- Railway
- Fortescue Marsh

N

10000 m 5000 m 0 10 20kms

Appendix 1

Fortescue Marsh strategy area management summary

Management Objectives and Actions	The success of these objectives will be measured by Key Performance Indicators		
	Performance Measure	**Target**	**Reporting Requirements**
1. Introduction			
1.2 Strategy area – Tenure and reservation process			
Management Objective 1. Progress the formal creation of a conservation reserve within the strategy area. **Actions** 1. In consultation with key stakeholders, consider an appropriate boundary for a proposed conservation reserve(s) to protect key values within the strategy area. 2. Liaise and negotiate with relevant stakeholders to gain their support to create a conservation reserve within the strategy area. 3. Work with traditional owners in the development of an MOU as the first step in progressing relevant ILUAs. 4. Seek resources and support for negotiating relevant ILUAs with traditional owners to enable reservation.	Land tenure within the strategy area. Defined boundary for the proposed conservation reserve(s).	Formal creation of a conservation reserve within the strategy area is well progressed. Defining an appropriate boundary in consultation with stakeholders is well progressed.	Every 3 years. Every 2 years.
1.2 Strategy area – Adjacent lands and their management			
Management Objective 1. Maintain effective and cooperative working arrangements with neighbouring landowners. **Actions** 1. Continue to work cooperatively with neighbouring land managers to foster complementary management of lands adjoining the strategy area. 2. Seek to document and agree on roles, responsibilities and integrated working arrangements with neighbouring land managers to address cross-			

Management Objectives and Actions	The success of these objectives will be measured by Key Performance Indicators		
	Performance Measure	**Target**	**Reporting Requirements**
boundary issues.			
1.3 Management context – management opportunities with traditional owners			
Management Objective 1. Involve traditional owners in the planning and management of the strategy area. **Actions** 1. Build relationships with the Banjima, Nyiyaparli and Palyku people and their representative bodies. 2. Work with traditional owners and their representative bodies to seek greater involvement from traditional owners in the planning and management of the strategy area and work towards to the development of ILUAs and joint management agreements. 3. Ensure that department staff have opportunities to meet and work on country with traditional owners, and gain the cultural authority to undertake land management activities across the strategy area. 4. Where possible, engage Aboriginal rangers and traditional owners to carry out projects to protect the natural and cultural values of the Marsh.	Management opportunities with traditional owners.	Traditional owners are involved in management of the strategy area and are actively taking part in on-ground operations.	Every 2 years
1.3 Management context – International conservation agreements			
Management Objective 1. Recognise and provide increased protection to the wetland values of the Marsh. **Actions** 1. Develop an Ecological Character Description and Ramsar Information Sheet for the Marsh to progress a recommendation to the Commonwealth Government for nomination under the Ramsar Convention. 2. Develop and implement a public participation strategy to inform stakeholders and gain support for a recommendation to the Commonwealth Government for nomination under the Ramsar Convention.	Nomination of the Marsh as a Ramsar wetland.	Preparation of materials for nomination of the Marsh as a Ramsar wetland.	Every 2 years.

Management Objectives and Actions	The success of these objectives will be measured by Key Performance Indicators		
	Performance Measure	Target	Reporting Requirements
2. Managing cultural and heritage values			
2.1 Aboriginal cultural heritage **2.2 Other heritage**			
Management Objective 1. Protect Aboriginal and other cultural heritage values. **Actions** 1. Engage traditional owners to provide cultural awareness training for DBCA staff and other personnel working in the strategy area. 2. Develop a shared understanding and appreciation of the cultural significance of the strategy area to the Banjima, Nyiyaparli and Palyku people (for example through cultural heritage mapping on country or other means as appropriate). 3. Reflect the interests of traditional owners in the management of cultural heritage and in all other management activities which may impact culture and heritage values. 4. Explore opportunities to integrate traditional knowledge with contemporary science programs and where appropriate, encourage the uptake of traditional management knowledge. 5. Support traditional owners to monitor the condition of culturally significant sites and species and determine whether these are being adequately protected and maintained. 6. Support on-country trips by younger and older generations of traditional owners to maintain or improve the health of country and keep culture strong. 7. Consult the Aboriginal heritage register maintained by DPLH, traditional owners and other stakeholders with heritage information (for example mining and consulting companies) to ensure, where possible that, management actions do not impact on Aboriginal cultural heritage values and sites. 8. Work with Banjima, Nyiyaparli and Palyku to agree to an appropriate Aboriginal name for the Fortescue Marsh and undertake the necessary			

Management Objectives and Actions	The success of these objectives will be measured by Key Performance Indicators		
	Performance Measure	Target	Reporting Requirements
steps to formally change the name of the area. 9. Assess historical pastoral and mining infrastructure for its heritage value and remove where no heritage significance is detected or where the infrastructure poses a threat to visitors or wildlife.			
3. Managing natural values			
3.1 Climate and climate change			
Management Objectives 1. Improve the survival of species and ecosystems by increasing their resilience to climate change. 2. Evaluate the importance of climate change for the ongoing management of the strategy area. **Actions** 1. Undertake and encourage research on the vulnerability of key habitats and values to climate change and if necessary, identify additional indicators to monitor the effects of a changing climate. 2. Adapt management in response to improved knowledge and understanding of climate change and its impacts on the natural values.			
3.3 Hydrology			
Management Objectives 1. Improve understanding of the ecological water requirements of the Marsh ecosystems and associated biota. 2. Support a catchment management approach to maintain and protect natural surface and groundwater regimes and the hydrological values of the strategy area. **Actions** 1. Liaise with industry, pastoralists and other key land managers in considering the cumulative impacts of activities on the hydrological values			

Management Objectives and Actions	The success of these objectives will be measured by Key Performance Indicators		
	Performance Measure	**Target**	**Reporting Requirements**
of the Marsh and maintaining the wetland ecological water requirements. 2. With a focus on management needs, encourage more research and monitoring to: • review and update hydrological models of the strategy area • improve understanding of the ecological water requirements of species and communities on the Marsh and • determine the extent of the cumulative hydrological impacts of approved and proposed developments and activities and adapt management accordingly. 3. Assess, collate and incorporate research and monitoring findings relating to the hydrology of the strategy area into the assessment of future development proposals and operational management, performance assessment against the objectives of this management strategy and adapt future management where appropriate.			
3.4 Flora, fauna and ecological communities			
Management Objective 1. Protect native flora and vegetation communities, native fauna and fauna habitats and significant ecological communities. **Actions** 1. Undertake or support more baseline surveys, research and mapping to identify vegetation communities, fauna, habitats and ecological communities with a focus on conservation significant communities and species and where there are knowledge gaps. Review their conservation status based on this. Encourage sharing of this information between the department, mining and consulting companies, other State Government departments and other stakeholders and use information to adapt management accordingly. 2. Prepare and implement monitoring plans for key conservation significant fauna species such as the greater bilby and night parrot.	Vegetation mapping of the strategy area. Populations of key conservation significant fauna species.	Vegetation mapping of the strategy area completed over the life of the strategy. The occupancy and abundance of key conservation significant fauna species do not decrease.	Every 3 years. Every 3 years.
3.5 Weeds			

Management Objectives and Actions	The success of these objectives will be measured by Key Performance Indicators		
	Performance Measure	**Target**	**Reporting Requirements**
Management Objectives 1. Prevent new introductions of weed species and their spread throughout the management focus area. 2. Minimise the impact of the highest priority weed species on key values of the management focus area through eradication and containment. **Actions** 1. Undertake a weed prioritisation process based on invasiveness, ecological impact, potential and current distribution and feasibility of control. 2. Following prioritisation, prepare, implement and review a Fortescue Marsh weed management plan based on the principles outlined above. 3. Continue to prepare, implement and review an annual weed management program, based on the Fortescue Marsh weed management plan. 4. Control and eradicate infestations of *Parkinsonia* in the upper Fortescue River. 5. Regularly monitor new developments and disturbed areas to ensure any new weed infestations (especially *Parkinsonia*, cactus, Caribbean stylo and stinking passionflower) are quickly detected and controlled/eradicated. 6. In collaboration with neighbouring land managers and traditional owners, implement measures to prevent the establishment of weeds from adjacent lands and control existing infestations where feasible.	Presence of *Parkinsonia* in the Marsh Land System. Introduction and spread of new high priority weed species and infestations.	The Marsh Land System remains free of *Parkinsonia*. No new high priority weed species or infestations established in the strategy area over the life of the strategy.	Annually Annually
3.6 Feral and other problem animals			
Management Objective 1. Minimise the impacts of feral and other problem animals on key values of the strategy area through fencing and other control methods. **Actions** 1. Prepare, implement and review feral animal management plans for feral herbivores (horses, donkeys, and camels) and introduced predators (cats) based on the principles outlined above. 2. Based on the Fortescue Marsh feral animal management plans, continue to	Construction of boundary fencing around the strategy area, with a focus on boundaries close to high value priority areas of the Marsh. Vegetation condition	Length of boundary fence line constructed over the life of the strategy progressively increases. Demonstrated	Every 3 years. Every 3 years

Management Objectives and Actions	The success of these objectives will be measured by Key Performance Indicators		
	Performance Measure	**Target**	**Reporting Requirements**
prepare, implement and review an annual feral animal control program. Feral herbivores and stray cattle 3. Implement the Fortescue Marsh Fence Plan to fence high value areas to protect them from grazing and trampling by feral herbivores and stray cattle and monitor vegetation condition and native fauna populations to determine its effectiveness. 4. Decommission redundant water sources such as Minga Well, considering animal welfare. 5. Liaise with neighbouring land managers, and other stakeholders in relation to the control of stray cattle (considering ownership), cattle mustering and stocking rates to support more effective feral herbivore control. Rabbits 6. Determine the effectiveness of the release of the rabbit RHD K5 virus through the monitoring of rabbit numbers and the abundance and distribution of bilbies. 7. Support more widespread rabbit control and monitoring. Introduced predators 8. Develop and implement an adaptive cat management program, with a focus on maintaining feral cat baiting across the Marsh and integration with other types of control. Feral honeybees 9. Opportunistically remove colonies of honeybees when detected.	Presence of feral herbivores	vegetation recovery in areas where feral herbivores have been excluded (stray cattle) or removed (feral horses and donkeys). A reduction in the presence of feral herbivores following exclusion (stray cattle) or removal (feral horses and donkeys) as demonstrated by camera surveys.	Every 3 years.
3.7 Fire			
Management Objectives	The impact of bushfire	No serious injury to	Annually

Management Objectives and Actions	The success of these objectives will be measured by Key Performance Indicators		
	Performance Measure	**Target**	**Reporting Requirements**
1. Reduce the impact of bushfire on life, property, pastoral and mining assets. 2. Protect biodiversity values through the development and implementation of prescribed burning and other fire management programs. **Actions** 1. Plan and implement a prescribed burning program within the strategy area that aims to: • protect life, property, mining and pastoral assets • create a mosaic of vegetation ages and structure across fire resilient communities • reduce the size and impacts of large intense bushfires on the values of the strategy area and • protect fire sensitive communities (such as grove-intergrove mulga and snakewood and long unburnt vegetation) and important cultural sites from bushfire. 2. Develop a bushfire threat analysis for the strategy area. 3. Where feasible, establish and maintain a strategic network of access tracks, fire breaks, and low fuel buffers with a focus on protecting areas of high conservation and cultural heritage value and other community and infrastructure assets. 4. Involve traditional owners in managing fire, including prescribed burning, the protection of natural and cultural assets and incorporate Aboriginal knowledge of fire management wherever possible. 5. Work with the Department of Fire and Emergency Services, local government, mining companies, pastoralists and other neighbours to determine and implement the requirements for a coordinated fire suppression response and ensure appropriate protection of the values of the strategy area and other community assets. 6. Ensure regulators include conditions associated with hot works from mining	and prescribed fire on human life or property, pastoral and mining assets. Diversity and distribution of post fire vegetation ages. Size of area treated by prescribed burning.	people or damage to mining or pastoral assets attributed to the department's fire management. Maintain a fine-scale mosaic of post fire vegetation ages, including recently burnt and long unburnt patches that provide suitable habitat diversity for bilbies and other fauna. A minimum of 20% of the planned annual treatment area, as outlined in the burn plan, is treated through prescribed burning.	Annually Annually

Management Objectives and Actions	The success of these objectives will be measured by Key Performance Indicators		
	Performance Measure	**Target**	**Reporting Requirements**
company infrastructure in fire management plans for development proposals.			
3.8 Mineral operations			
Management Objective 1. Minimise the impacts of mineral development activities on the key values. **Actions** 1. Work with DMIRS, DJTSI and EPA to provide advice on the potential impacts of development proposals on the natural and cultural values and overall integrity of the strategy area and advise on impact avoidance, minimisation and mitigation of relevant values. 2. Where relevant, support industry operators and regulators to implement existing environmental management plans/programs mine closure plans and related documents.			
4. Managing visitor use and community values			
Management Objectives 1. Protect key values from significant and adverse impacts of access and recreation activities. 2. Promote and facilitate community involvement in the management of the strategy area. **Actions** 1. Plan and implement a monitoring program to gain a better understanding of visitor use, especially around Coondiner Pool. 2. In consultation with DPLH, plan, seek approval for and develop facilities and information at Coondiner Pool to protect visitor safety and the natural and cultural values of this site from unmanaged recreation and access. 3. Map and assess access tracks and determine their priority for management and/or visitor access. Those that are not required should be closed and rehabilitated.			

Management Objectives and Actions	The success of these objectives will be measured by Key Performance Indicators		
	Performance Measure	Target	Reporting Requirements
4. Identify and rehabilitate eroded sections of tracks, cutlines, cleared areas and water points located outside mining and other areas containing development infrastructure. 5. Should the land within the strategy area become vested under the CALM Act, provide access, facilities, information and interpretation for visitor use through the preparation and implementation of a Recreation Master Plan. 6. Develop partnerships that foster cooperation and collaboration with traditional owners, mining companies, pastoralists, local authorities, other State Government agencies, natural resource management groups and other relevant stakeholders to ensure a coordinated approach to managing the strategy area.			
5. Research and monitoring			
Management Objective 2. Assist the management of the strategy area with appropriate and ongoing research and monitoring. **Actions** 1. Develop a database or database theme for the strategy area to incorporate flora and fauna survey data and relevant publications into existing publicly-available departmental databases (for example NatureMap). 2. Develop and implement a research and monitoring program that: • provides for the implementation of research priorities identified in this strategy • standardises data collection methods and mapping to help with identifying trends • specifies outcome-based evaluation methods • uses appropriate control sites and • communicates the outcomes of high priority research projects to external groups and organisations. 3. Work with organisations, such as WABSI, to facilitate greater sharing of information about the strategy area between the department, mining and			

Management Objectives and Actions	The success of these objectives will be measured by Key Performance Indicators		
	Performance Measure	**Target**	**Reporting Requirements**
consulting companies, State Government departments and other stakeholders and to relevant centralised databases or data platforms (e.g IBSA) where appropriate. 4. Develop partnerships and programs with mining companies, universities and other external research organisations to encourage research projects that fill priority knowledge gaps as outlined above and support science-based offsets programs (for example corporate sponsorship).			

Appendix 2

Vegetation communities of the Fortescue Marsh

Vegetation community code (as shown on Map 4)	Vegetation community description
0	Unvegetated landforms – Koodaideri Spring mosaic, bare lake bed, cleared or disturbed area, creeklines, freshwater channels, gypsum hillocks, narrow gorges, alluvial/colluvial fans or water.
1	Chenopd and samphire shrubland over tussock grasses
2	Chenopod and samphire shrubland
3	Hummock grassland
4	Mallee shrubland over shrubland over hummock grassland
7	Open Eucalyptus woodland over mallee shrubland over hummock grassland
8	Open Eucalyptus woodland over mallee shrubland over shrubland over hummock grassland
9	Open Eucalyptus woodland over shrubland over hummock grassland
17	Open shrubland over chenopod and samphire shrubland
18	Open shrubland over hummock grassland
19	Open shrubland over tussock grassland
20	Samphire shrubland
21	Shrubland over chenopod shrubland over hummock grassland
22	Shrubland over chenopod shrubland over tussock grassland
24	Shrubland over tussock grassland and scattered hummock grasses
25	Open Mulga woodland over shrubland over chenopod shrubland/hummock grassland
26	Open Eucalyptus woodland over shrubland over tussock grassland
27	Mulga woodland over shrubland over tussock grassland
999	No data

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