pilbara corridors

‘Pilbara Corridors Project’

Evaluation of the Fortescue River Catchment Corridor Project

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Rangelands NRM
Western Australia

In 2012, the Pilbara Corridors was established as a collaborative partnership between Rangelands NRM, Greening Australia and the WA Department of Parks and Wildlife (now the Department of Biodiversity, Conservation and Attractions).

This report documents the objectives and activities of the Pilbara Corridors partnership as it has operated in the specific Fortescue River Catchment Corridor Project, and an evaluation of the outputs and outcomes of those activities relevant to the objectives of the project.

The report is presented by Rangelands NRM, one of the Pilbara Corridors partners.

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Australian Government
Rangelands NRM Western Australia
Greening Australia
Department of Parks and Wildlife

Evaluation of the Fortescue River Catchment Corridor Project

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Acronyms

CAP	Community Action Plan
CEM	Commission on Ecosystem Management
DBCA	Department of Biodiversity, Conservation and Attractions (formerly DBCA)
DEC	Department of Environment and Conservation
DAFWA	Department of Food and Agriculture Western Australia (former)
DPAW	Department of Parks and Wildlife (Western Australia) (formerly DEC)
DPIRD	Department of Primary Industries and Regional Development (formerly DAFWA and other agencies)
EPA	Office of the Environmental Protection Agency
ESRM	Environmentally Sustainable Resource Management
FMG	Fortescue Metals Group
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for the Conservation of Nature
KJ	Kanyirninpa Jukurrpa
NRM	Natural Resource Management
PBS	Pilbara BioSurvey
PMMC	Pilbara Mesquite Management Committee
RBG	Regional Biodiversity Group
TERN	Terrestrial Ecosystem Research Network
WARMS	Western Australia Rangelands Monitoring System
WoNS	Weeds of National Significance
YACMAC	Yaburara and Coastal Mardudhunera Aboriginal Corporation

EXECUTIVE SUMMARY

Introduction

In 2012 the Pilbara Corridors was established as a collaborative partnership between Rangelands NRM, Greening Australia and the WA Department of Parks and Wildlife (now the Department of Biodiversity, Conservation and Attractions).

This report documents the objectives and activities of the Pilbara Corridors partnership as it has operated in the specific **Fortescue River Catchment Corridor Project**, and an evaluation of the outputs and outcomes of those activities relevant to the objectives of the project. The report is presented by Rangelands NRM, one of the Pilbara Corridors partners.

Project objectives

The objective of the Fortescue River Catchment Corridor Project was to focus on the critical partnerships necessary to tackle ecosystem function and resilience in the face of climate change, through shared knowledge and best practices, in the Fortescue River catchment of WA's Pilbara region.

The following were the targeted project outcomes – regarded to have common benefits to all land managers – despite the underlying land tenure or objective of the individual land managers:

- Coordinating fire planning and management in the Hamersley and Chichester Ranges with land managers to promote carbon stabilisation and reduce loss of biodiversity from extensive intense fires.
- Preventing the spread of invasive species in intact ecosystems through coordination of mapping and data management across tenure, collaborative invasive species management by strategic and coordinated weed and feral animal management, and targeted on-ground control.
- Promoting connected landscapes by reducing loss of ground cover through implementing Ecologically Sustainable Rangeland Management (ESRM) grazing management plans and interventions with pastoral land managers (including pastoral, indigenous and mining land managers) to control livestock access to areas of high biodiversity value and manage heavy grazing pressure.

Evaluation methodology

The evaluation was conducted according to a Monitoring, Evaluation, Reporting and Improvement (MERI) Plan, with a focus on evaluating the achievement of immediate results, and assessing the effectiveness, appropriateness and efficiency of the project delivery, and the current and on-going impact.

Conclusions – the value of the Fortescue River Catchment Corridor Project

The project substantially achieved all objectives, and in some cases achieved more than expected. The evaluation summary is presented against the following evaluation purposes, as presented in the MERI Plan for the project.

Impact

The project has influenced fire management in the Fortescue catchment with invitations from pastoralists to advise on fire management planning and methodologies. The project was invited to take part in the WA Department of Biodiversity, Conservation and Attractions' Fire Management Strategy review.

The WA Government has released a draft Pilbara Conservation Strategy which recognises the work of the Fortescue River Catchment Corridor Project and has set aside funding and resources through the Pilbara Environmental Offset Fund to carry on with the work the Fortescue River Catchment Corridor Project has managed post the project timeline. This continues the work and momentum achieved during the project's term and provides long term acknowledgement of the project's impact on biodiversity in the Fortescue catchment.

The project was invited to be part of the planning team (five team members) for the Fortescue Marsh National Park. This involvement was based on projects carried out on and adjacent to the marsh and the support provided by Pilbara Corridors to the Fortescue Marsh stakeholders group.

The Project established a network of Rangelands AusPlots in the Fortescue catchment. Ausplots is the first nationally standardised monitoring methodology for rangelands vegetation and soils which provides data consistency and ease of accessibility. Prior to Rangelands AusPlots a multitude of methods were used by stakeholders which made data difficult to compare, was often restricted in use due to perceived commercial sensitivities and not easily accessible. Ausplots provides a structured and widely accepted baseline nationally for research priorities in relation to climate change cause, effect and trends.

The project created stakeholder awareness and engagement in landscape-scale management across the Fortescue catchment and Pilbara bioregion through its 22 projects, culminating in a Pilbara Biodiversity Conservation Action Plan (CAP).

The project provided a framework for stakeholders to discuss and engage in biodiversity conservation outcomes. The communications effort has enriched the lives of inhabitants within the catchment and provided a link to consultants, practitioners and service providers such as local and state government in a non-confrontational way.

Acknowledgement of the project and its activities through communication mediums such as TERN, local and state government, International Union for the Conservation of Nature (IUCN), Indigenous corporations and pastoral groups provides evidence of the credibility of the project and biodiversity outcomes achieved which are widely professionally respected.

Effectiveness

The project achieved the immediate results of the project identified in the Program Logic, as follows:

- The area of targeted Weeds of National Significance (WoNS) infestations has been reduced;
- ESRM planning and implementation will lead to a reduction to the impact of pastoral use on biodiversity through improved water and land management methodologies;
- improved fire regimes have been implemented; and
- feral animal control has been enhanced.

Additional project successes are improved stakeholder collaboration within sub-projects and across sub-projects as Pilbara Corridors working partner relationships have matured, and two Indigenous ranger groups are engaged and trained in land management activities;

The WoNS and pastoral ESRM works achieved uptake and results above and beyond original expectations as the service providers have co-contributed additional labour and hours to make a comprehensive difference.

In summary, this project has improved key habitat and biodiversity conservation through coordinated management of fire, weeds and feral animals in the Fortescue catchment at the

landscape scale. Regenerative grazing practices and property planning through ESRM will help stabilise erosive processes.

The project also established a solid environmental baseline on which subsequent projects in the Pilbara can build upon, including an assessment of the samphire on the Fortescue Marsh, monitoring of the ephemeral wetlands associated with the system and the establishment of a range of AusPlots to quantify baselines, and measure future trends in the region.

Appropriateness

Only one substantial change was required to the methodology proposed for the project. The biodiversity fund monitoring methodology was superseded by the Rangelands AusPlots methodology during the life of the project. The decision to adopt the Rangelands AusPlots methodology was primarily based on this being a nationally agreed standardised monitoring methodology providing more detailed data and wider long-term use in conserving rangelands vegetation complexes and soils which better support the project outcomes. Rangelands AusPlots is supported through the Terrestrial Ecological Research Network (TERN) with data available on the AEKOS platform utilised by 17 universities, 29 state and federal organisations, and 5 international organisations.

Relations between pastoralists, state agencies, Indigenous groups and mining companies are often strained or non-existent. The project acted as an intermediary and functional meeting ground to discuss conflicting issues on conservation and to develop relationships to move ahead in a positive way. Information coming via the project has a different social context which provides for collaboration and action which wouldn't exist without the project structure.

The project provided Indigenous communities and groups with an equal voice which they may not receive through direct communication with stakeholders based on prejudices and historical stereotyping. This has provided improvements in the context of social outcomes leading to wider acceptance of Indigenous involvement in conservation and the opportunities through acceptance to engage in positive economic outcomes, in particular for ranger groups operating on country.

Efficiency

The project acted as a catalyst to encourage further stakeholder investment of funds and in-kind contributions from stakeholder resources towards conservation of biodiversity in the Fortescue catchment and the adjoining Chichester and Hamersley Ranges, which would not have occurred without the project presence.

Considerable time and effort has been expended in building relationships, forming partnerships and keeping lines of communication open for the purpose of contributing towards the project's biodiversity targets.

Stakeholders were more likely to contribute resources and support towards project success, as the project is a not-for-profit, non-political and non-commercial undertaking, as opposed to an organisation which may have been perceived as seeking a commercial or conflicting agenda. The project has demonstrated support for all stakeholders' values and endeavours in the Fortescue and has not represented a threat to those values. By developing project relationships with stakeholders, biodiversity targets could be jointly agreed and works funded, extending the effectiveness of project funds, particularly in fire and feral herbivore management.

INTRODUCTION

In 2012 Pilbara Corridors was established as a collaborative partnership between Rangelands NRM, Greening Australia and the WA Department of Parks and Wildlife (now the Department of Biodiversity, Conservation and Attractions).

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ABOUT PILBARA CORRIDORS

Background

The nature resources in the Pilbara IBRA

The Pilbara IBRA region is one of 15 biodiversity hotspots in Australia. It is particularly important for persisting populations of threatened and endangered fauna species and threatened and priority ecological communities (TEC and PEC). It is a centre of endemism and refugia due to the number of ranges and gorges with geological complexity. Two TECs and 29 PECs occur in the Pilbara bioregion. The themeda grasslands of the Hamersley subregion are listed as TECs, while PECs include cracking clay communities of the Chichester ranges and the wetland community at Weeli Wolli Spring.

The Pilbara IBRA region contains nationally and regionally significant biodiversity values as well as large areas of relatively intact native vegetation. The three key subregions are:

- Hamersley, with the high, dissected Hamersley Ranges, the largest mountain range in WA;
- Fortescue, the third longest river in WA, with the wide plains of the upper Fortescue and incised gorges of the lower Fortescue; and
- Chichester, largely represented by undulating uplands of the Chichester Ranges.

The following areas of high biological diversity, endemism and/or refuges exist in the project area:

- endemic species and species-rich ecosystems associated with the Fortescue River, especially Fortescue Marsh, Millstream wetlands, Millstream aquifer and Chichester gorges; and
- species-rich, refugial ecosystems associated with gorges, waterfalls and mountain-tops of Hamersley Range.

Two plant, six mammal, one bird and six reptile species that occur in the Pilbara bioregion are listed as threatened under the *Environmental Protection and Biodiversity Conservation Act* 1999. These include the locally endemic Millstream Fan Palm, Mulgara, Bilby, Pilbara Olive Python, Princess Parrot and Orange-Leaf nosed bat. Six wetlands in the Pilbara bioregion are nationally significant and a further 12 are of regional significance. The Fortescue Marsh is the largest wetland and provides refuge for internationally protected migratory birds. The Pilbara Region Biological Survey recognized the bioregion as being incredibly rich in aquatic invertebrate species. Initial results of the survey suggest that at least 85 per cent of the species collected across the Pilbara bioregion are new to science. The spring-fed and permanent rock pools and gorges of the Hamersley Range provide refuges for vertebrates during dry periods and climatic refuge for many invertebrates, whilst the tops of the range are fire refuges for restricted flora species. The rivers contribute significant recharge to groundwater resources such as the Millstream aquifer. The bioregion is a hotspot for stygofauna with the Pilbara Region Biological Survey indicating significant and previously undetected stygofauna in the Millstream aquifer.

Fire in the Pilbara

In the 14 years between 1993 and 2006, over 72 per cent of the greater Pilbara region was burnt with upwards of 28 per cent being burnt two or more times in this period. The impacts of these processes on biodiversity have not been quantified across the region, but evidence suggests it can be profound.

Whilst much of the landscape is relatively intact and contains persisting populations of threatened flora and fauna, significant land degradation and biodiversity loss has occurred throughout the Pilbara due to over-grazing, introduction of weeds and feral animals and the extinction of many small mammals.

Invasive weed and animal species

Several significant invasive animal and weed species are known to occur in the project area including large herbivores, pest predators and at least two Weeds of National Significance (WoNS).

- The principal threats posed by large herbivores (camels and donkeys) in the Fortescue subregion are habitat degradation, comprising landscape damage and plant biodiversity loss.
- Predators – mainly feral foxes and cats – have caused significant loss of small to medium sized mammal, reptile and bird species throughout the Pilbara bioregion.
- Weed control has focused on the two WoNS present in the project area – mesquite (*Prosopis spp*.) and parkinsonia (*Parkinsonia aculeate*).

Pressures and required responses

The Pilbara bioregion provides most of Western Australia's exports in petroleum, natural gas and iron ore and but contains only about two per cent of the country's population. Major population centres are Karratha, Port Hedland, Newman and Tom Price. Tenure comprises Aboriginal land, pastoral and industry leasehold and conservation reserves. More than 50 per cent of the land is under pastoral leasehold, 8 per cent of lands are in the conservation estate, including Karijini National Park and Millstream-Chichester National Park. Land management of the Fortescue River catchment include 8 mining company managed pastoral leases, 11 family-owned pastoral leases, an Aboriginal reserve, significant portions of conservation reserves and a water reserve (on the Millstream aquifer).

In the Pilbara, the growing intensity of land use and resource development has placed considerable pressure on the biodiversity of the region. Land use stressors including mining, pastoralism, Indigenous and recreational uses are placing major development and management pressures on the biodiversity values. The assessment of the biological resources in the Pilbara concluded that specific, targeted intervention would be cost effective in terms of having a strong impact on improving the sustainability and continued existence of a significant number of vulnerable and endangered species.

There is a need to ensure that ongoing economic development is integrated with the protection of biodiversity and the land resource base more generally. Although the protected area estate in the Pilbara is substantial (i.e. national parks, marine parks and other reserves), the region is of substantial economic importance to both WA and Australia, and with the associated pressures, it has been recommended that a strategic plan for biodiversity conservation be developed for the region by the EPA (2014).

The Fortescue River Catchment

This project addressed the key environmental and land use issues that confront the broader Fortescue catchment, an area of about 4.5 million ha, to maintain ecosystem function and increase ecosystem resilience to climate change. Current condition varies across the very broad project area. For the most part the condition of the native vegetation is good. Six wetlands in the Pilbara bioregion are nationally significant and a further 12 are of regional significance. The Fortescue Marsh is the largest wetland and provides refugia for internationally protected migratory birds. The Pilbara Region Biological Survey recognised the bioregion as being incredibly rich in aquatic invertebrate species. Initial results of the survey suggest that at least 85 per cent of the species collected across the Pilbara bioregion are new to science.

The Pilbara Corridors Partnership

The principal partners

Rangelands NRM Coordinating Group (Rangelands NRM) is a not-for-profit incorporated body established in 2004 and operates across five regions the Kimberley, Pilbara, Gascoyne-Murchison, Goldfields-Nullarbor and Desert Rangelands. While Rangelands NRM's primary focus is on the protection and/or improvement of environmental and agricultural assets this is done within a sustainability framework which seeks to, through partnerships with other organisations, also provide social and economic benefits.

Greening Australia WA has been operating since 1982 and has been working with the community, government and industry in developing sustainable environmental solutions for many landscapes across Australia.

Department of Biodiversity, Conservation and Attractions (DBCA) formerly Department of Parks and Wildlife (DPAW) and previous to that, Department of Environment and Conservation (DEC). The department is tasked with conserving biodiversity and managing the State's national parks, marine parks and other reserves, which cover more than 28 million hectares. The Department is also responsible for fire preparedness and pest animal and weed control over 89 million hectares of unallocated crown land and unmanaged reserves.

The above three partners represent the key foundation partners of Pilbara Corridors. Through the project activities, they drew in additional operational and project-specific partners including other government agencies, non-government organisations and community groups.

Objectives

The Pilbara Corridors partnership is helping realise the vision and nurturing a collaborative approach between all stakeholders to achieving environmental, socio-economic and cultural benefits in the Pilbara by:

- Sharing knowledge about best practice environmental management;
- Providing expert and experienced counsel and advice;
- assisting mining and other resource companies to manage their offset requirements;
- distributing funding in a coordinated way and towards the right priorities;
- removing duplication and providing coordination for the delivery of land management work for pastoralists, mining companies, not for profit organisations, indigenous groups and other local community organisations; and
- proactively encouraging Indigenous training and employment in land management positions through the Indigenous Ranger program.

The aims of Pilbara Corridors are the control of invasive pests and weeds, and the protection of endemic fauna and flora by applying shared knowledge and best practice through disciplined landscape-scale activities. Pilbara Corridors works at a landscape scale and across management boundaries by bringing together people and organisations with environmental expertise representing government, environment, community, mining, pastoralists and Indigenous groups to deliver effective land management.

Objectives in the Fortescue River Catchment Corridor Project

The objective of Fortescue River Catchment Corridor Project was to focus on the critical partnerships necessary to tackle ecosystem function and resilience in the face of climate change, through shared knowledge and best practices, in the Fortescue River catchment of WA's Pilbara region. The Fortescue is a largely intact ecosystem that includes areas of high conservation value, capable in the short to mid-term of being cost-effectively enhanced and protected through focused management input. The project implemented a landscape scale program of activities with pastoral, Indigenous, mining and conservation land managers to protect and improve existing native vegetation, secure and stabilise carbon in ecosystems, and manage threats to biodiversity as the region continues its rapid development.

The following were the targeted project outcomes – regarded to have common benefits to all land managers – despite the underlying land tenure or objective of the individual land managers:

- Coordinating fire planning and management in the Hamersley and Chichester Ranges with land managers to promote carbon stabilisation and reduce loss of biodiversity from extensive intense fires.
- Preventing the spread of invasive species in intact ecosystems through coordination of mapping and data management across tenure, collaborative invasive species management by strategic and coordinated weed and feral animal management, and targeted on-ground control.
- Promoting connected landscapes by reducing loss of ground cover through implementing Ecologically Sustainable Rangeland Management (ESRM) grazing management plans and interventions with pastoral land managers (including pastoral, indigenous and mining land managers) to control livestock access to areas of high biodiversity value and manage heavy grazing pressure. ESRM is also a vehicle for Fire and Weed management actions. These actions will in turn, influence:
    - Stabilising and increasing the populations of threatened flora and fauna species;
    - Reducing the impact of pastoral and recreational use, and increasing vegetation and ground cover;
    - Increasing engagement of land managers in co-ordination of NRM activities; and
    - Avoiding CO_2 emissions and sequestering CO_2.[1]

Activities in the Fortescue River Catchment

Pilbara Corridors worked in the Fortescue River catchment area between 2012 and 2017 where activities included stabilising critical ecosystems by delivering on-the-ground land management including fire planning, grazing management, and coordinated mapping and targeted control of feral animals and invasive weeds.

[1] The contractual deliverable in terms of CO_2 sequestering and abatement was later removed from the Heads of Funding Agreement post contract execution by common agreement between the Head Funder (Department of Environment and Energy and the contractees). Current Western Australia state legislation states that the crown retains all rights to carbon generated through sequestration activities on crown land. This includes on crown land that is currently under lease (i.e. pastoral lease) or part of the conservation estate. Methodologies for carbon abatement projects suitable to the land system of the Pilbara (i.e. feral animal culling (e.g. camel) is still under development.

In addition to 'on the ground' support, Pilbara Corridors provided advice and counsel to land managers in a timely manner to connect and co-ordinate the activities of land managers across boundaries. This umbrella approach helped to develop and maintain a landscape scale, holistic vision for the Pilbara region. The projects described and evaluated in this report are:

- Conservation Action Planning (CAP), including research and education;
- Weed Management;
- Feral Animal Control;
- Fire Management;
- Land use and management; including;
    - Working with Pastoralists;
    - Working with Traditional Owners.

Pre-project (application) history

The *Australian Biodiversity Conservation Strategy 2010-2030* was prepared in 2009 and adopted in 2010. The strategy was reviewed in 2016, resulting in number of recommendations to make the strategy more practical and effective. The review highlighted the importance of initiatives to enhance collaboration with Indigenous people, private landowners, businesses, environmental organisations and communities to achieve tangible on-ground outcomes that protect Australia's unique species, improve productivity of landscapes and preserve habitat.

The Pilbara Corridor partners – Rangelands NRM, Greening Australia and the (now) Department of Biodiversity, Conservation and Attractions (DBCA) – recognised that a joint response was needed in order to protect and sustain the Hamersley-Pilbara region in the face of increasing development pressures and an inconsistent response between land managers of adjoining properties. The critical issue was the need for further communication and collaboration between land managers. A successful application for a project in the Fortescue River Catchment was submitted to the Biodiversity Fund in 2012. The project has been managed through the National Landcare Program within the Australian Department of the Environment and Energy.

The approach in the Fortescue River Catchment

This project took an innovative approach in its insistence that the foundation activity was to bring together partners to think on the landscape or broader scale rather than working within individual land holdings. By coordinating the actions of local communities with those of Government and industry stakeholders, this project would be able to generate net conservation benefit – conservation gains additional to those delivered under standard land management obligations.

The key objective of the project was to 'enhance and maintain the ecosystem function of the Pilbara Interim Biogeographic Regionalisation of Australia (IBRA) region, in the face of rapid economic development'. The target areas were limited to the following two areas as being under threat from development, with motivated land managers and most importantly, federally regarded as being critical areas of biodiversity:

- Fortescue river wetland systems; and
- Areas of the Hamersley and Chichester Ranges located within the Fortescue River Catchment.

Despite narrowing the focus, the land parcels included in both regions include a cross section of tenure types and uses including mining, pastoralism, conservation estate and Indigenous communities and surrounding traditional lands. This greatly added to the complexity of bringing together the land managers as each had in some cases competing priorities and interests. However, there was considerable interest within as well as externally in determining whether mining

companies, pastoralists and government agencies could both work within their land holdings and expand the activities to a cross-tenure approach.

Accomplishments by design

The funding for activities in the Fortescue River Project enabled the three partnering organisations to come together and prioritise, facilitate and implement actions above and beyond their individual core business for the benefit of the area. The contract and funding enabled all three of the direct partnering organisations to expand their initial operations and to seek out and develop new partnerships with active land managers in the area. This resulted in a significant increase in the number of engaged stakeholders that actively contributed to project activities in the Fortescue River Catchment in one manner or another.

As it was the lead delivery organisation (as per the contractual and reporting requirements), Rangelands NRM acted as the lead agency and provided continuity and was responsible for maintaining communication networks between agencies.

EVALUATION METHODOLOGY

This evaluation has been conducted by Rangelands NRM staff operating at 'arms-length' from the management of Pilbara Corridors. The evaluation methodology was presented in the *Monitoring, Evaluation, Reporting and Improvement (MERI) Plan for the Fortescue River Catchment Corridor Project*. The evaluation involved the following steps.

Program Logic

The Program Logic for the project is presented in Figure 1**.**

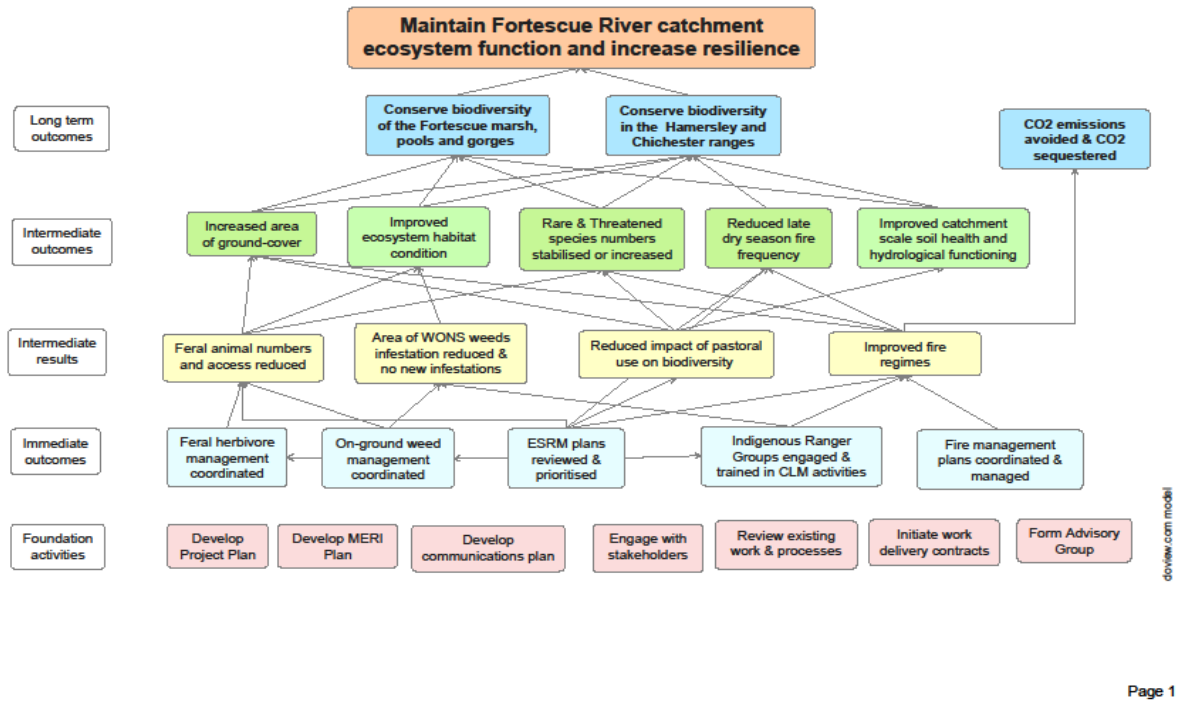


Figure 1: Program Logic for the Pilbara Corridors, Fortescue River Catchment Project

This identifies the key components to be achieved to ensure that each of the project outcomes is fully achieved. In developing the Program Logic the proposal was tested by:

- Identifying the assumptions underpinning the choice of activities to address the targets;
- Identifying evaluation questions necessary for assessing performance and achievement in delivering against the outcomes; and
- Establishing the review and improvement processes to ensure the project delivered on its funding deed.

The Program Logic was used to develop the subsequent sections of the MERI Plan including the monitoring and evaluation plan.

Focus for the evaluation

Given the time-lag between activity and long-term outcomes, the focus for this evaluation, conducted at the end of the project, is on the 'Intermediate Results' which were identified in Figure 1 as:

- area of WoNS weeds infestation reduced and no new infestations (see Section B of this report);
- feral animal numbers and access reduced (see Section C);
- improved fire regimes (see Section D);
- reduced impact of pastoral activity on biodiversity (see Section E).

In addition, in Section A of this report, a further activity described as 'Conservation Action Planning' describes the work undertaken collectively by many parties in aggregating existing knowledge, gaining new knowledge, developing monitoring systems and conservation action planning.

Evaluation questions and answers

The questions that were considered in preparing this evaluation report are presented in Table 1. These are taken from the MERI Plan.

Table 1: Evaluation questions

Evaluation purpose	Evaluation questions
Impact	1. What, if any, unanticipated positive or negative changes or other outcomes have resulted? 2. To what extent were the changes directly or indirectly produced by the project interventions? 3. To what extent was the impact of the project enhanced by collaboration with other groups/partners?
Effectiveness	1. Have planned activities been undertaken? 2. To what extent have project outcomes been achieved? 3. How could the effectiveness of the activities be improved?
Appropriateness	1. How appropriate was the project design and assessment in improving biodiversity outcomes? 2. To what extent were the project approach and strategies appropriate in influencing targeted stakeholders? 3. What are barriers to improving rangeland management practices?
Efficiency	1. To what extent has the program attained the highest value out of available resources? 2. How could efficiency have been improved?

The methods used in obtaining information to address the above questions included nearly all of those identified in the MERI Plan. These are presented in Table 2.

Table 2: Summary of project monitoring methods

Method	Details
Interviews	Interviews conducted with project participants, key informants and other stakeholders.
Document analysis	Documents including project records, minutes of meetings of advisory group and partner organisations, survey results, and baseline biophysical data.
Fire - indicator species	Changes to presence/absence indicators for agreed species
Fire - habitat extent	Average size of fire scars and fire frequency based on remote sensing of agreed monitoring points
Fire - habitat condition	Condition monitoring of reference points in key landscape locations
Invasive weed species	Occurrence and location of WoNS weeds; Sites of WoNS weed treatment
Feral herbivores	Numbers, types and locations of feral animals culled; No. of transmitter collars tracked/replaced; No. of helicopter hours flown.
Advisory Group	The Project Advisory Group will meet regularly to review project activities and to examine the evidence and judge the extent to which the MERI Plan has contributed to the five year outcomes.
Case studies	In-depth studies of individual or group participation in projects that examine social and environmental issues.
Impact Stories	Impact stories involve interviewing or surveying a range of different participants and stakeholders of the project. These interviews are designed to collect stories about participant experiences, achievements and lessons learnt through their involvement in the project.
Attendance records at field days	A simple way to measure the number of attendees at an event, where they are from and to obtain their details for any future events/follow-up.
Photos	Evidence of changes to environmental condition as well as of an event being held and can also give an idea of how many people attended.

Reporting

The responses to the questions are presented under the activity headings (A-E). Under each of the headings the activities undertaken are described, in some situations with reference to case studies. An assessment is made of how these outputs translate into immediate results as per the project objectives and Program Logic. Finally, future activities based on project results are discussed briefly.

THE FORTESCUE RIVER CATCHMENT

The Fortescue River Catchment

The Fortescue River, like all Pilbara rivers is ephemeral, flowing after rainfall from summer cyclones and autumn thunderstorms. The alluvial aquifer is recharged from direct infiltration through the riverbed during these periods of flow. The catchment boundaries are shown in Figure 2.

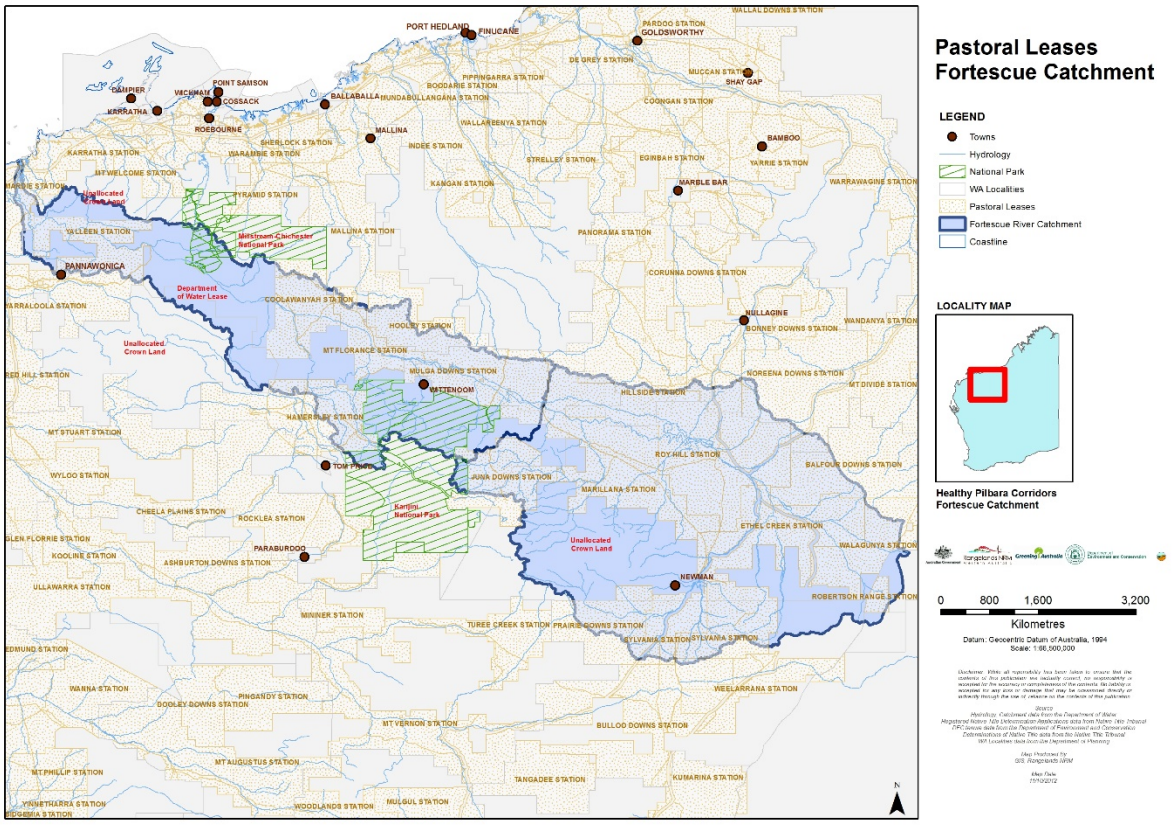


Figure 2: The Fortescue River Catchment

The total area of the catchment is 4,500,000ha. The Fortescue is located within the Pilbara Interim Biogeographic Region (IBRA), with the Fortescue River Catchment being one of the three sub-IBRAs. The Fortescue River Catchment comprises the following landscape types.

Fortescue Plains subregion is comprised of alluvial plains and river frontage. The plains support extensive salt marsh, mulga-bunch grass, and short grass communities on alluvial plains on the east. Deeply incised gorge systems occurs in the western (lower) part of the drainage. River gum woodlands fringe the drainage lines. The northern limit of mulga (*Acacia aneura*) occurs in the catchment. An extensive calcrete aquifer (originating within a paleo-drainage valley) feeds numerous permanent springs in the central Fortescue, supporting large permanent wetlands with extensive stands of river gum and cadjeput-melaleuca woodlands.

Millstream Wetlands are extensive permanent spring-fed streams, pools and river flow that extend for up to 40km or more below the springs. Large areas of wetland community, including large, deep (up to 2km long and 15+m deep) riverine pools, springs, riffle streams, marshes and swamps. Extensive areas of cadjeput and river gum forest. The wetlands support large stands of *Livistona alfredii*, a species restricted mainly to the Fortescue valley around Millstream.

Millstream aquifer: An extensive calcrete aquifer, lying between the Hamersley and Chichester Ranges, and formed through in situ deposition within an ancient river drainage basin. The present aquifer is approximately 400 square kilometres in area (and about 50 km long), with a thickness of calcrete greater than 30 metres. The aquifer is highly transmissive. The Fortescue River flows over part of the aquifer, and recharge is primarily during floods. Numerous springs discharge along the northern lip of the aquifer, where either the Fortescue River or associated streams have eroded into the water carrying calcrete.

Fortescue Marsh: An extensive, episodically inundated samphire marsh, approximately 100 km long and 10 km wide. The marsh is constricted at the western (downstream) end by the Goodiadarrie Hills, and the flows from upper Fortescue River are prevented from flowing through into the lower Fortescue drainage except in extreme rainfall events. These hills effectively separate the Fortescue into two separate drainages. In periods following heavy rain, the Fortescue Marsh supports large numbers of breeding water-birds.

Hamersley subregion: *A* mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite). Drainage is into either the Fortescue River to the north, the Ashburton River to the south, or the Robe River to the west. Special features of the Hamersley Ranges include gorges, particularly those in Karijini National Park. The gorges are up to 100m deep, containing extensive permanent spring fed streams and pools.

Climate

The south east of the Pilbara region climate is classified as semi-arid to arid, hot desert in the northern and inland areas and hot grasslands in the north-west and tropical along the coastal areas. There is low and variable annual rainfall and hot dry conditions for most for the year. The coastal region is classified as tropical. Average monthly temperatures exceed 32^{o}C for eight months of the year with average daily maxima exceeding 35^{o}C from October to March. The region gets the most sunshine hours a day of locations in Australia (averaging more than 10 hours a day) and has seven of WA's top 10 hottest days on record (Sudmeyer 2016).

The majority of the annual rainfall falls between the months of November to April, often in association with low pressure systems and cyclones. Although rainfall is generally low (mean average rainfall between 1971 and 2017 is 327mm at Newman), the Pilbara has the second highest inter-annual variability in rainfall (second only to Central Australia). Tropical cyclones can generate as much as 34 per cent of the total annual rainfall near the Pilbara coast and as much as 86 per cent of summer rainfall in the north west (Sudmeyer 2016). While the Pilbara often experiences considerable spatial variations in rainfall, rarely is the whole area subjected to long periods of drought. Rainfall in the eastern Pilbara is most influenced by tropical and monsoonal drivers, which are predominantly active in the summer and autumn. Rainfall in the western Pilbara is also influenced by southern mid-latitude drivers, such as frontal systems, during autumn and winter. The higher areas of the Hamersley Ranges are cooler, are subject to greater cloud cover, have the greatest average rainfall (500mm per annum) as well as the lowest evaporative demand.

The Pilbara is within the most cyclone-prone region of Australia, with 36 tropical cyclones crossing the Pilbara coast between 1980 and 2007. The cyclone season runs from mid-December to April and peaking in February-March. Cyclone frequency tends to increase during La Nina years. Rainfall totals exceeding 100mm are common, with much heavier rainfall occurring in some years (Sudmeyer 2016).

Climate change projections conclude there is very high confidence temperatures will continue to rise; high confidence the intensity of heavy rainfall events will increase; and natural variability will continue to be the primary driver for the amount of rainfall the region receives (Sudmeyer 2016). Temperatures have increased most during winter and spring and cooled during autumn and summer. Annual average temperature is projected to increase 0.6-1.5C by 2030 (under all emission scenarios). Over the last 40-60 years, annual rainfall has increased over most of the Pilbara except in the west where it has decreased. A recent study of tree growth found that five of the top ten wettest years since 1805 have occurred since 1995 (Sudmeyer 2016). Mean rainfall and temperature data are shown for three Pilbara localities in Figure 3.

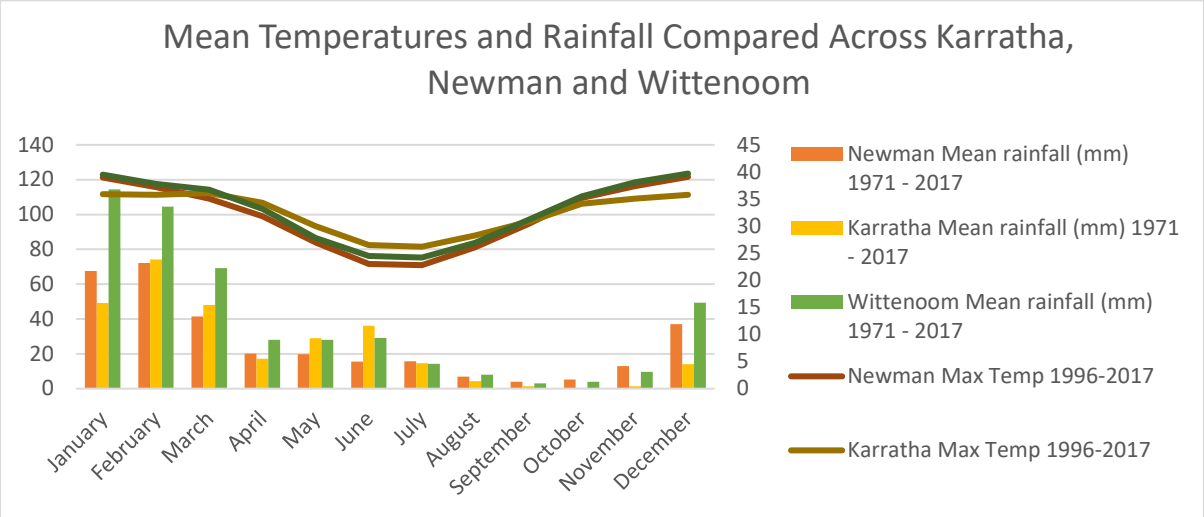


Figure 3: Mean rainfall and temperatures at three Pilbara centres

Land Tenure and Management

The Fortescue River Catchment is contained within a range of tenures, including mining leases, water reserves, pastoral leases, registered and determined native title, conservation tenures and road and rail alignments. Details of the most relevant tenures are presented below.

Pastoral leases

The areas held under pastoral lease are confined mainly to the areas with greater pastoral potential which lie on the riverine flood plains and adjacent alluvial plains along the Fortescue River Valley. There are also leases on the isolated areas of productive land on the Hamersley and Chichester Ranges. In total, 61.6 per cent or 2,990,000 ha of the catchment is pastoral leasehold land (see van Etten, 2013). Of the 18 pastoral leases, 8 are held by mining companies, with the remaining 11 held by family companies. Cattle are grazed on all the leases.

Native Title

Nearly all of the catchment is subject to Native Title Determinations and Active Applications (both Scheduled and Registered) claims, as shown in Figure 4, and as listed below:

- The Yaburara & Mardudhunera people have a Scheduled Native Title Application over the land around the lower Fortescue River (WC1996/089).
- River pools of the lower Fortescue and the fauna they support remain cultural important to the Kuruma Marthudunera people.
- This application abuts a non-accepted for registration Scheduled Application by the Robe River Kurrama people (WC2016/002).
- This in turn abuts the large, Ngarluma/ Yindjibarndi Native Title (WCD2005/001, 24,354.37 km2) which was determined in 2005.

- Prior to that the water flows through Yindjibarndi #1 (Applications Schedule) (WC2003/003),
- then to The Banjima People Native Title Determination (WCD2014/001, 8,138.64 ha) litigated in 2014, and
- The river originates in the Nyiyaparli Application (RNTC) active claim area (WC2005/006, 36,595.08 km2).

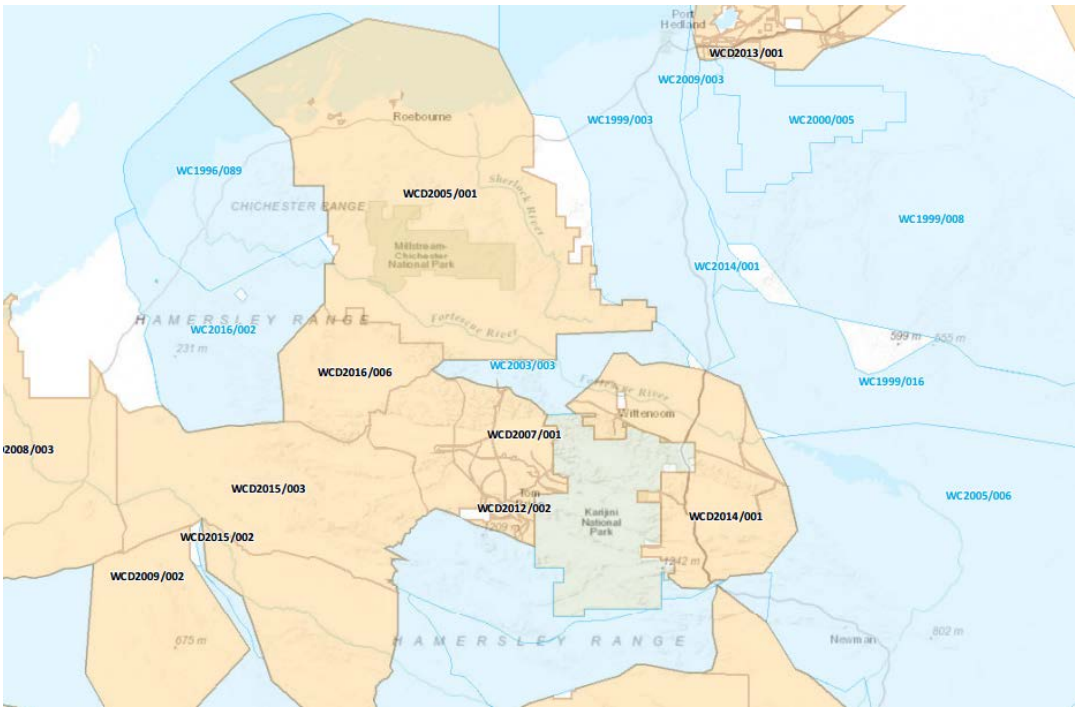


Figure 4: Registered and determined native title across the Fortescue River Catchment (determined in brown, registered titles in blue)

Conservation estate

The two major conservation tenures are the Karijini National Park and the Millstream Chichester National Park. Both parks have Aboriginal Traditional Owners involved in the management of conservation activities, fire and tourism.

Karijini National Park is located in the Hamersley Ranges between Tom Price and the Great Northern Highway. It has an area of 627,422 ha. In the park's north, Oxer Lookout has views of the Weano, Red, Hancock and Joffre gorges. At the edge of Weano Gorge, a trail leads to Handrail Pool. To the east are the red rocks of Dales Gorge and the cascades of Fortescue Falls. Indigenous wildlife includes Australian goshawks, ring-tailed dragons and desert tree frogs. The vegetation consists mainly of hummock spinifex grasslands below a variable tree and shrub layer.

Millstream Chichester National Park (238,200 ha) is an oasis in the desert, located within the Chichester Range, dotted with spinifex and snappy gums. Permanent pools are fed by springs that draw water from the underground aquifer within porous dolomite rock. The Millstream area has been a sacred land since well before the arrival of Europeans to the area, and the Yinjibarndi people still gather here as the traditional custodians of their country, which stretches from the Hamersley Range foothills and Fortescue River Valley in the south to the Chichester Range escarpment in the north.

Mining tenures

Most of the catchment has been incorporated with mining tenures, with iron ore being the most important mineral sought. There are a number of active iron ore mines in the catchment, with railways transporting the ore to coastal ports. Further developments are planned.

Biological assets

General

The Pilbara IBRA region contains nationally and regionally significant biodiversity values as well as large areas of relatively intact native vegetation. The following areas of high biological diversity, endemism and/or refuges exist in the project area:

- Endemic species and species-rich ecosystems associated with the Fortescue River, especially Fortescue Marsh, Millstream wetlands, Millstream aquifer and Chichester gorges; and
- Species-rich, refugial ecosystems associated with gorges, waterfalls and mountain-tops of Hamersley Range.

Flora

A total of 284 taxa (species, subspecies and varieties) were recorded from the combined records of the current survey and data from sites sampled for the Pilbara BioSurvey (Gibson *et al.* 2015). The current survey recorded a total of 249 taxa with 140 taxa not recorded for the Fortescue Valley study area by the previous survey.

Floodplain wetlands

The middle to upper Fortescue valley supports the greatest number and diversity of floodplain wetlands, including areas upstream and downstream from the Fortescue Marsh. The middle to upper Fortescue Valley is distinguished by extensive floodplains, a large salt marsh, anabranching river channels and a large number and diversity of non-riverine wetlands. A fifth of aquatic fauna species found in the Pilbara are found nowhere else, and improving knowledge of their part in ecological systems, the threats to these systems and effects on fauna occurrence is crucial. Knowing more about the ecosystem will enable better planning to enhance and conserve endemic aquatic and riparian flora and fauna and will also enable improved catchment scale soil health and hydrological function and a reduction in threats to biodiversity.

Aquatic fauna

The Fortescue River has the highest diversity of freshwater fish taxa of all Pilbara rivers. A previous study (2001) identified 96 birds, 17 native mammals, five introduced mammals, 58 reptiles and three amphibians in the lower Fortescue area. The pools of the lower Fortescue River are representative of aquatic ecosystems of coastal Pilbara rivers. They provide habitat and food for aquatic and terrestrial fauna with permanent pools acting as drought refuges. Permanent pools are considered to sub regionally significant as they support vertebrate and invertebrate fauna.

FORTESCUE RIVER CATCHMENT CORRIDOR PROJECT ACTIVITIES

A Conservation Action Planning

Reviewing baseline data

Existing biophysical data sets for the Fortescue River Catchment

There were several spatial and point source biophysical data sets available to the Fortescue River Catchment Corridor Project team, as shown in Table 3.

Table 3: Sources of spatial and point source biophysical data for the Pilbara

Data set	Organisation (year)	Description
Review of all Pilbara biological surveys	PIEC* (2000)	The project developed comprehensive bibliographical-style database containing descriptive information about all biological surveys carried out in the Pilbara IBRA. The work was carried out in three phases, an initial, extensive literature search, migration of the collated information to an on-line environment at the Western Australian Herbarium and then additional information entered by CALM staff into a purpose-built database. The Department of Biodiversity, Attractions and Conservation (formerly Parks and Wildlife) is now the custodian of the database that currently features almost 800 records (https://science.dpaw.wa.gov.au/projects/pilbaradb/).
Inventory and condition survey of the Pilbara Region, WA (1995-1999)	DPIRD** (2004)	The field work for the report was completed in the years 1995-1999. The report provides a regional inventory and descriptive reference of land resources to accompany a land system map. The report includes reviews of background information such as land use history, climate, geology and hydrogeology, and declared plants and animals. Detailed accounts are provided of survey methodology, geomorphology, soils, vegetation, site type ecology, land systems and resource condition (in terms of pastoral impact) of the survey area. A comprehensive plant species list is provided as an appendix (Van Vreeswyk *et al*. 2004a). A companion report focusing on pastoral resources and pastoral management was also produced, with pastoral lease specific data including recommended stocking rates (Van Vreeswyk *et al*. 2004b).
Pilbara Region Biological Survey (2002-2013)	DBCA*** and WA Museum, Rangelands NRM and resource industry partners (2002-2013)	800 sites representing a cross section of the regions soils, landforms and major geological formations, climate and vegetation types, were sampled. Most sites were sampled twice in different seasons of the year. The field component of the Pilbara Region Biological survey was conducted over five years between 2002 and 2007. The botanical component of the survey (over 80,000 plant specimens) is still underway. There were six major components of the Pilbara Region Biological Survey: terrestrial flora (including weeds); terrestrial fauna (vertebrates); terrestrial fauna (invertebrates); wetland flora; wetland fauna; and Stygofauna. The survey resulted in a significant increase in knowledge of the Pilbara region, including several discoveries of new species. The information publicly available via the Nature Map to further investigations for many years to come.

Data set	Organisation (year)	Description
		https://naturemap.DBCA.wa.gov.au/
Other sources	EPA (2014)	Advice on the cumulative environmental impacts of development in the Pilbara (EPA 2014)
	CSIRO (2014)	Cost-benefit analysis of conservation strategies for threatened species (Carwardine *et al*., 2014)
	Rangelands NRM (2016)	Threatened species research priority workshops (e.g. Northern Quoll workshop June 2016)

* PIEC – Pilbara Industry Environmental Committee; ** DPIRD – Department of Primary Industries and Regional Development; *** DBCA – Department of Biodiversity, Conservation and Attractions

Existing monitoring programs in the region

Existing vegetation monitoring programs operating in the Fortescue River catchment are shown in Table 4.

Table 4: Existing Vegetation Monitoring Programs within the Pilbara Bioregion

Monitoring system	Description
West Australian Rangeland Monitoring System (WARMS)	Used by DPIRD, provides information on rangeland condition trend at a regional/ district scale. DPIRD staff collect photographic and physical data from grassland and shrubland sites. Grassland sites in the Pilbara are monitored every three years with the sixth cycle (Epoch 6) completed in 2011. The Commissioner of Soil and Land Conservation uses this information to report annually to the Pastoral Lands Board which uses the information in their annual report on the current condition of land under pastoral lease – available from the Department of Lands.
Rangeland Condition Monitoring assessment	Until 2009 DPIRD would conduct regular lease inspections on behalf of the Pastoral Lands Board. While the PLB continue to investigate methods of using spatial imagery to monitor and assess rangeland condition, currently they encourage pastoral lease holders to adopt Voluntary Rangelands Monitoring (RCM) protocols in order to demonstrate improvement within a timeframe for rangelands condition issues that have been identified on a lease. The adoption is *ad hoc* and scattered across the WA Rangelands.
AusPlots	Assesses 1ha sites for rangelands condition and soils, to be extended to fauna in the future. There are 38 sites within the Fortescue River Catchment; Pilbara Corridors was the primary funder for all Pilbara sites. All of the data (the 580 national sites including the 38 Fortescue catchment sites plus 49 other sites in WA) is freely available through the AEKOS data portal (www.aekos.org.au) or the Soils to Satellites website (http://www.soils2satellites.org.au).
DBCA	400+ permanently marked baseline inventory sites across the Pilbara capturing floristic and vegetation structural details
Other local scale monitoring	Primarily mining and resource companies, and via a wide range of environmental consultants. Documentation may be available via Environmental Impact Assessment process.

Further research requirements

A review of the several surveys and compilations of biophysical resources in the Fortescue River catchment undertaken by Pilbara Corridors suggested there are still significant gaps in the amount of collected data needed for the identification of biodiversity values and management responses. Several specific issues were identified prior to activities undertaken by Pilbara Corridors. These are shown as follows, with the resulting activity undertaken by Pilbara Corridors shown in *italics*.

- Currently there is no environmental geology/regolith mapping at better than 1:250,000. No broad-scale soil mapping is available at finer scale than 1:2,000,000 (1967).

- A quantitative subregional survey of vegetation or fauna has not been undertaken for the Chichester subregion.
- Quadrat-based floristic data is available from some localities but a quantitative subregional survey of flora has not been undertaken.
- There are little detailed data on ecological requirements and life histories for virtually all invertebrate species, plants, persisting CWR mammals, uncommon vertebrate and plant species, and ecologically dominant plan species (e.g. hummock grasses). *See Conservation Action Planning below.*
- No quantitative data existed on the impact of changes to fire regimes in hummock grasslands, particularly upon vertebrate communities, invertebrate communities and non-vascular plants. *For the work undertaken in fire management through the project, see D Fire management.*
- No quantitative data existed on the impact of weed colonisation (especially buffel grass) riverine and other grassland communities, particularly upon recruitment of perennial species, and consequent effects on invertebrate and vertebrate communities. *For the work undertaken in weed management through the project, see B Weed management.*

Activities undertaken by Pilbara Corridors

Conservation Action Plans (CAPs)

One response to the review of the existing biophysical data was the development and part-implementation by Pilbara Corridors of Conservation Action Plans (CAPs) for the region. The Pilbara CAPs along with other pertinent resources such as the Pilbara Biological Survey (completed 2014) was used to inform the design of a strategic investment plan for biodiversity conservation in the Pilbara which will link to the Pilbara Conservation Strategy (https://www.dpaw.wa.gov.au/management/pilbara-conservation-strategy).

A number of organisations and individuals are involved in biodiversity conservation activities in the Pilbara. However, the effectiveness of these activities was constrained by the lack of a regional scale strategic plan and a land management governance framework. The Pilbara CAP process aims to develop and maintain a collaborative, long-term biodiversity conservation strategy and a collaborative framework that addresses these issues.

Conservation Action Planning provides a framework to help land managers deliver improved biodiversity conservation outcomes within their broader business programs. It involves clearly defining conservation assets, articulating threats to these assets, formulating and implementing actions to address the threats, and measuring success (or otherwise) in a manner that will enable 'learning by doing' and thereby increased effectiveness over time. The process seeks to improve communication, collaboration and alignment of conservation plans and actions amongst groups of land managers.

- The Pilbara CAP Project Stage 1 (PJ120110) involved a series of stakeholder workshops groups to identify key conservation assets, threats to these assets and strategies for their protection and enhancement. The workshops were well attended and a range of stakeholder interests were represented. A revised Summary Document addressing the collated feedback was released in June 2016. This document included a high-level appraisal of landscape conservations assets and threats, and 60 preliminary strategies addressing stakeholder priorities and interests.
- The Pilbara CAP Project Stage 2 (PJ120122) involves more detailed characterisation of Pilbara conservation assets, refinement of strategies to provide greater focus for conservation actions, and facilitation of collaborations and partnerships to support strategy implementation.

Threats to the assets

During the CAP planning process, the top 25 threats to the conservation of the Pilbara's natural assets were identified and ranked for their importance. These are summarised below in Table 5.

Table 5: Summary of major threats, based on ratings developed during the CAP workshop process

Very high threat	High threat	Moderate threat	Low threat
Weeds (buffel grass, kapok bush, ruby dock, passiflora) Feral predators (foxes, cats)	Clearing for mining Feral herbivores WoNS (mesquite and parkinsonia) Feral bees Climate change Inappropriate fire regimes Clearing for infrastructure development Unsustainable stock grazing pressure	Altered hydrology for infrastructure development Water abstraction Reinjection of mine water underground Dams Mine water discharge into creeks and springs New irrigation for agriculture Unmanaged access/ recreational impacts Mine de-watering	Pigs Removal of basic raw material Sedimentation from infrastructure development Invasive aquatic invertebrates Rubbish dumping Pollution from mine activities (dust, eutrophication, hydrocarbons)

Pilbara IUCN Consultation (PJ120112)

The purpose of the IUCN (International Union for Conservation of Nature) consultation on biodiversity, ecosystems and ecosystem services in relationship to current projects and the development of projects within the Pilbara Corridors Program. Dr Fisher was engaged by the Fortescue River Catchment Corridor Project to provide consultation on biodiversity, ecosystems and ecosystem services and to link traditional knowledge with environmental science.

Biological survey of ephemeral wetlands (PJ120114)

The middle to upper Fortescue valley supports the greatest number and diversity of floodplain wetlands, including areas upstream and downstream from the Fortescue Marsh. A biological survey of ephemeral wetlands on claypans in the central Fortescue River catchment (between Millstream Chichester National Park and to the eastern boundary of Mulga Downs Station) was undertaken to enhance the information about these important biodiversity refugia. Through the course of the survey, 47 Sites were surveyed, with at least 10 new species discovered, 55 invertebrate samples taken, and over 60 flora plots established.

Pilbara Triodia Field Guide and App (PJ120119)

The project produced three information products on desert spinifex identification and conservation (field guide, application ('app') for field identification and two scientific papers.

Samphire Survey on the Fortescue Marsh (PJ120123)

The project's objectives were to understand recruitment dynamics and drivers of key *Tecticornia species* (samphire) on the Fortescue Marsh, which is a Ramsar wetland. Four sites have been established and monitored. There is evidence that *Tecticornia auriculata* forms annual growth bands and that shrub age is strongly predicted by height and cover dimensions.

Pilbara Corridors Scholarship

This 'Top-up' Scholarship was established to facilitate field work in the Fortescue River Catchment. Jordan Iles was awarded a PhD top-up scholarship at UWA for his research entitled 'Biogeochemical cycling of phosphorus and organic matter within arid freshwater ecosystems'. Jordan has completed his research and has presented his findings (via poster) at the European Geosciences Union General Assembly (Vienna 2017). He found that both nitrogen and phosphorus, along with alluvial groundwater connectivity, have significant and complex roles in regulating production in alluvial groundwater pools (Iles *et al.* 2017).

Key outcomes from the conservation action planning activities in the Fortescue River Catchment

- The Pilbara Corridors initiative has brought together Pilbara community and stakeholders to develop a conservation action plan (CAP) for the Pilbara. This is linked to the Pilbara Conservation Strategy – a landscape scale approach to biodiversity conservation across the Pilbara, led by the Department of Biodiversity, Conservation and Attractions.
- CAP stage 1 is harnessing community and stakeholder input to establish clear targets for priority conservation actions in Pilbara.
- CAP stage 2 will establish partnerships and action groups to tackle the priority issues identified in the CAP. It will provide impetus to action the community-identified environmental priorities of the Pilbara.
- For the best outcomes and sustainability, it is vital to align Federal, State and local community goals and efforts in planning and implementation of conservation actions over large areas. Therefore, investment in stakeholder engagement and a partnership development process is an important part of the Pilbara Corridors initiative.
- A repeatable process has been established, involving the following steps. Develop Vision/ Situational Analysis/ Identifying Assets/ Identifying Threats/ Goals, Strategies & Actions/ Monitoring and Adaptive Management.

Evaluation of the immediate result of conservation action planning

The results of the CAP process have already been used, alongside other key scientific documents, advice and analysis conducted on the Pilbara environment and conservation practices to create the Pilbara Conservation Strategy (https://www.dpaw.wa.gov.au/management/pilbara-conservation-strategy).

The Pilbara Conservation Strategy 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 through offsets to counterbalance the residual impacts of resource and infrastructure projects. This strategy aims to deliver improved conservation outcomes through on-ground actions across a variety of tenures in collaboration with partners throughout the Pilbara region. The vision established for the Strategy is presented in Table 6.

Table 6: Vision for conservation is the Pilbara

Natural Landscapes and Species	Healthy, improving ecologically functional landscapes (intact functional ecosystems, specific fauna assemblages) with viable populations of threatened species and reduced densities of invasive species to thresholds below which there is minimal impact.

Conservation Actions	Restoring native biota including successful translocations, best practice pastoralism and total grazing management, better fire management taken up by all major land managers, optimum feral animal control and weed management
People and Values	Realistic, well-resourced management across landscapes with raised awareness of cultural values and significance of biodiversity of the Pilbara, supported by more local employment including Indigenous people with Traditional Owners involved in rangeland management leadership
Planning and Sustainable Development	Resilient, enduring, co-ordinated, sustainable, robust strategic biodiversity management framework with resource company best practise, better integration of mining support and Traditional Owners actively engaged in successful partnerships/ own enterprises in relation to land management and leadership on own country.

An outcome attributed to the success of the project was an invitation from the WA Government to be part of the five-member Fortescue Marsh planning team for the recently proposed Fortescue Marsh National Park. The Pilbara Conservation Strategy (DBCA 2016) recommends progressing the addition of the Fortescue Marsh to the conservation reserve system through the negotiation and implementation of Indigenous Land Use Agreements and joint management plans with traditional owners). This collaborative approach will help influence environmental activities conducted on and adjoining the marsh.

Further baseline data for ephemeral wetlands have been collected in the Fortescue catchment, which represents a new understanding of their individual flora and fauna uniqueness between wetlands. The wetlands exhibit completely different spatial species components, including new species previously unknown to science. This translates to a new conservation of biodiversity awareness for the pastoralists who have wetlands on their leases, as to the rareness and threats posed to the flora and fauna species in their care that we know very little about. Further work needs to occur in this area to balance the pastoral grazing primary function of the leaseholds with appropriate conservation management.

The 38 Rangelands AusPlots established to create a standardized national monitoring methodology of vegetation complexes and soil in the Fortescue catchment are part of a national program of 400 plus sites across Australia, providing nationally managed accessible web data to monitor cause and effect and trends of the rangelands under climate change. The baseline sites have in many cases been established over historical DBCA vegetation survey sites from the Biodiversity Survey of the Pilbara Region 2002 - 2007 to further existing vegetation and soil temporal knowledge. The long-term outcome of the Rangelands AusPlots will be to conserve biodiversity from a baseline of knowing what actually exists, which previously was represented by disparate survey and monitoring methodologies, often the preserve of consultants and mining companies. A standardised Rangelands AusPlots Indigenous ranger methodology is in development with a reduced data collection format to allow for regular monitoring of vegetation.

B Weed management

The impacts of weeds are well known – they destroy landscape habitats, reduce biodiversity of fauna and flora, hinder pastoral production, alter soil properties, and impact negatively on Indigenous and European heritage connections to the land.

The Pilbara Corridors Fortescue River Catchment Corridor Project funded the expansion of the partnership between Rangelands NRM and the Pilbara Mesquite Management Committee (PMMC) to work together to stop the spread of weeds, reduce their current impact and protect special places across the whole of the Fortescue River catchment. PMMC and Rangelands NRM were able to facilitate long-term engagement through establishing partnerships and collaboration between pastoral stations, mining companies, local and state authorities, contractors and Indigenous groups.

Targeted weeds in the Fortescue River Catchment

Mesquite (*Prosopis spp.)* and parkinsonia (*Parkinsona aculeata*) infestations on Mardie and Yalleen Stations in the lower Fortescue catchment, and parkinsonia on Roy Hill Station in the upper Fortescue have grown into dense, impenetrable thickets and have outcompeted local flora, resulting in a decline in local biodiversity levels. These weeds of national significance (WoNS) occur elsewhere throughout the catchment, mainly on alluvial plains and along major streamlines. Location of infestations of these species, and control work were the main focus of weed control in the Fortescue River Catchment.

Table 7: Targeted weeds in the Fortescue River Catchment

Species	Description	Presence in the Fortescue River Catchment
Mesquite (*Prosopis spp.)*	Mesquite which includes four species and several hybrids, is one of four prickle bushes that have infestations scattered throughout semi-arid Australia. It is a nuisance in rangelands where it forms dense impenetrable stands, particularly around waterways. It is a WoNS*.	Extensive infestations occur on the coastal plain adjacent to the Fortescue River, with numerous occurrences elsewhere along the riverine plains in the catchment.
Parkinsonia (*Parkinsona aculeata*)	Parkinsonia is a spreading, much-branched shrub or tree to 8 or rarely 10 m tall. It has a deep taproot and extensive surface roots. It is a threat top rangelands and wetlands. It is a WoNS.	A major infestation occurs in the upper Fortescue River Catchment on Roy Hill PL, with other infestations along rivers and creeks in the Lower Fortescue River Catchment.
Cactus (*Opuntia* and *Cylindropuntia species)*	Cacti are shrubs or small trees with succulent, cylindrical or flattened stems armed with sharp spines. They are widely cultivated as hedge plants, ornamentals or as food plants. They form dense, impenetrable patches that can harbour pest species and reduce land productivity. The cactus species are WoNS.	Cacti occur mainly around former and existing settlements. Small infestations occur in such locations throughout the catchment.
Calotrope (*Calotropis procera*	Calotrope is a pest in Western Australia (WA). A shrub or small tree growing up to four metres tall. Native to Asia and sub-tropical parts of south east Asia. Stems are smooth pale green-grey. Plant has a white milky sap.	Calotrope is a recent invader, but it is now prolific in the Fortescue River Catchment.

* WoNS – weed of national significance

Weed management projects in the Fortescue River Catchment

Control of mesquite and parkinsonia

Through the Fortescue River Catchment Corridor project, effort and coordination occurred that enabled joint activities along the whole of the Fortescue (split into West and East portions). This allowed the land managers to achieve a greater level of control as skills and strategies on how to approach and deliver weed control programs are adapted and prove successful. Regional aerial surveillance programs have been undertaken, with the distribution of weeds across the landscape mapped per presence and density. The work ensures management of mesquite and parkinsonia is coordinated across tenure and sustainable partnerships are maintained between industry and community to invest in and manage priority weed infestations. Partners include: DPIRD, Roy Hill and Yalleen Station managers, Rio Tinto Iron Ore, Fortescue Metals Group, Roy Hill Iron Ore, Pilbara Mesquite Management Committee (PMMC), Pilbara Regional Biosecurity Group, Rangelands NRM and Greening Australia WA.

Large-scale burning is also having a positive impact on other weed species (date palm, passion vine, morning glory). Burning improves both access and visibility in previously overgrown vegetation that impeded both detection and control of weeds and cattle. Burning has also positively enabled better access to the margins of Jirndawarrunha Pool next to Millstream homestead and to control both Indian water fern and water lilies.

Fortescue River Catchment Corridor weed control projects in the Fortescue River Catchment included those presented in Table 8, with the total efforts summarised in Table 9.

Table 8: Weed control activities in the Fortescue River Catchment

Code	Title	Partner	Brief Description	Results
PJ120106	Weed Management on the Fortescue River Catchment 2013-2017	Pilbara Mesquite Management Committee	This project has undertaken coordinated management of parkinsonia control across tenure in the upper and lower Fortescue River catchment and mesquite on Mardie and Yalleen Stations in the Lower Fortescue.	101,678ha treated for WoNs including mesquite and parkinsonia
PJ120107	Ngurrawaana Rangers Parkinsonia on the Fortescue 2013	Yindjibarndi Aboriginal Corporation	This project undertook management control of parkinsonia on the WA Reserve 40617 Ngurrawaana Community and Ptn 38991 Area B - known as the Leramugadu Lease which is leased by the Ngurrawaana Group Aboriginal Corporation from the Water Corporation, and which surrounds the Ngurrawaana community in the lower Fortescue River catchment.	154 ha (9km river frontage) Weed activity as part of Indigenous ranger training Cert I and II CALM
PJ120108	Cactus Management in the Pilbara 2014	Pilbara Mesquite Management Committee	The project will include visual surveys and collections through all of the towns in the Pilbara to raise awareness, identify locations of cactus weed infestations, and remove identified cacti when in small numbers. An awareness campaign will be run in the media prior to the town surveys. Three areas around old station homesteads that have cactus infestations will be treated by contractors.	6,134ha surveyed and 284 cacti and other WoNS eradicated (93% success rate)

Table 9: Summary of weed control works

Activity	Achieved	Target	Difference
No of Weed Monitoring Activities (Surveys)	9	14	-5
Area of weed cover monitored	50,691.23	Total lineal length (km) of stream frontage and /or roadside treated for weeds	585
Total ha of reported weed cover by species			
Calotropis procera	200	*Parkinsonia aculeate*	31,063.13
Cylindropuntia tunicate	200	*Prosopis glandulosa x prosopis velutina*	10,400
Prosopis sp A	3,813.1	*Prosopis juliflora*	5,000
Total new area (ha) treated for weeds	92,600	90,000ha	+2,600 ha

Weed identification and detection – the Pilbara BioSurvey (PBS)

The results of the wetlands flora component of the PBS showed that the most frequent weed species included *Cenchrus ciliaris* (46% of sites), *Cynodon dactylon* (22%) and *Cenchrus setigera* (17%). In the PBS, these weedy grasses were concentrated in riverine sites with silty and sandy soils, with *Cynodon dactylon* largely restricted to the sandy margins of larger lowland rivers. In the context of Pilbara wetlands, these species in particular can have major impacts on riverine riparian zones, forming dense stands that reduce diversity and abundance of native plants through competition, coupled with their potential to alter fire regimes. The wetlands sampled during the current survey however, did not demonstrate the levels of impact from these taxa seen across the larger rivers sampled during the PBS.

For the combined survey data, the most frequent weed species recorded included *Echinochloa colona* (21 sites), *Malvastrum americanum* (10 sites), *Vachellia farnesiana* (14 sites), and *Cenchrus ciliaris* (12 sites). Whilst formally listed as introduced, *Echinochloa colona* and *Vachellia farnesiana* are regarded as pre-European introductions which may account for their widespread occurrence in the wetlands of the Fortescue River Valley (Bean, 2007; Keighery, 2010). Weed impacts in the Fortescue Valley wetlands were not as significant as those observed for some wetlands types (typically larger river pools) surveyed as part of the broader Pilbara BioSurvey (Lyons 2015).

Notable weeds recorded in the project include the following.

- *Gnaphalium polycaulon*: known from numerous locations across much of eastern Australia and the Kimberly this species was recorded for the first time in the Pilbara from a single site at Coondiner Pool.
- *Cyperus hamulosus*: with scattered occurrences across much of inland Australia, this weed has a near cosmopolitan distribution but was not previously recorded from the Pilbara. Recorded during the current study at Mungthannannie.
- *Echinochloa microstachya*: native to Nth America, 'Prickly Barnyard Grass' occurs in south eastern Australia as a weed of irrigated crops and their surrounds. The only previous potential Western Australian record is a specimen cultivated in Canberra from seed sourced from the CSIRO Kimberley Research Station (Kununurra) in 1962. The exact origin of the seed material is unknown so it may not represent a collection from a local naturalized population. *E. microstachya* was recorded from Koodjeepindarranna Pool and the Fortescue River at the Mulga Downs – Mt. Florance Stations boundary.

Cactus Project

Prior to this project, there were only three naturalised populations of cactus known to exist in the Pilbara and no active programs were underway to contain or control its spread. This project surveyed 16 Pilbara town sites, five stations and one nature reserve, and there was also self-reporting of three infestations.

Twenty-two species of Opuntoid cacti are declared pests in WA as of January 2015 – 16 of which were newly added to the list. Gaining declared pest status means that there is enforceable control as well as restriction of importation into WA. The declared pest species include the following shown in Table 10. Those present in the Pilbara are shown separately.

Table 10: Opuntoid species listed as declared weeds in WA

Not known to be present in the Pilbara	**Known to be present in the Pilbara**
Tiger pear (*Opuntia aurantiaca*) *Opuntia elatior* Engelmann pear (*Opuntia engelmannii*) Indian fig (*Opuntia ficus-indica*) Bunny ears, teddy bear cactus, golden bristle cactus (*Opuntia microdasys*) Drooping tree pear (*Opuntia monacantha*) *Opuntia polyacantha* Wheel cactus (*Opuntia robusta*) Chicken dance cactus (*Opuntia schickendantzii*) Velvet pear (*Opuntia tomentose*) No common name (*Cylindropuntia kleiniae*) Pencil cactus (*Cylindropuntia leptocaulis*) Jumping cholla (*Cylindropuntia prolifera*) Hudson pear (white-spined) (*Cylindropuntia rosea*) Snake cactus (*Cylindropuntia spinosior*) Hudson pear (brown-spined) (*Cylindropuntia tunicata*) Cane cactus (*Austrocylindropuntia cylindrica*) No common name (*Austrocylindropuntia subulata*)	Riverina pear (*Opuntia elata*) Devil's rope, rope pear *(Cylindropuntia imbricata*) Prickly pear (*Opuntia stricta*) Coral cactus, boxing glove cactus (*Cylindropuntia fulgida var. mamillata*)

The town surveys were also very effective with 125 plants identified and killed with a 93 per cent success rate. Also of note were 13 instances of 'dumped' cactus on the outskirts of Pilbara towns. These infestations were treated and taken as an indicator of success of the message that cacti are not appropriate home garden plants. At the same time a number of other weed species encountered were also killed. A summary of the total project effort is presented in Table 11.

Following from the Pilbara Corridors funded effort, PMMC continues to work with DBCA to treat cactus weed infestations found on islands of the Dampier Archipelago. There is currently a low-level infestation on about 30 sites on three islands (West Lewis, East Lewis and Sam's Islands).

The work will continue with a full residential survey of all Pilbara townships, to detect, record and remove all identified cactus infestations in gardens and those that have escaped. An awareness campaign in each town, including publications with local newspapers, will increase the regional knowledge of invasive cactus species. Additionally, a surveillance and control program of cacti that inhabit pastoral stations will commence, with supported funding provided to land managers to 'kick-start' local programs.

Table 11: Project Output Summary

Location	Cactus	Bellyache Bush	Other (Rubber Vine, *Calotropis*, Parkinsonia)	Total Weed Plants	Area Surveyed (ha)
Urban Coast (Dampier, Karratha, Roebourne, Wickham, Point Samson, Cossack, South Hedland, Port Hedland, Wedgefield)	88	69	62	219	4,096
Karijini (Tom Price and Paraburdoo)	26	5	2	33	776
Southern Pilbara Coast (Pannawonica and Onslow)	3	13	5	21	238
Interior Pilbara Towns (Newman, Marble Bar and Nullagine)	8	1	0	9	743
Stations (Lalla Rookh, Wallareenya, Peedamulla, Karratha, Koodarie) and Cane River Nature Reserve					281ha surveyed 60 ha treated
Total	**125**	**88**	**69**	**282**	**6,134 ha surveyed**

Evaluation of the immediate results of the weed management effort

Weed infestations represent a very high threat to the biodiversity in the Pilbara, and the productivity of some of its more productive land for grazing. On-ground weed management coordinated in national parks and pastoral properties focussed on parkinsonia and mesquite. The activities undertaken in weed management have had a significant and impact on the knowledge of weeds in the Fortescue River Catchment, and has commenced a program of control of the most important of these weeds. The work has also raised awareness of the importance of other WoNS, in particular the cacti species. The activities have also developed the role and profile of the Pilbara Mesquite Management Committee (PMMC), and has extended its influence across the Pilbara. More importantly have been the large number of organisations – public and private – that have been engaged in the weed control effort. The partnerships formed will be a lasting legacy of the Fortescue River Catchment Corridor Project.

The planned activities were undertaken, and considerable areas of mesquite and parkinsonia have been destroyed. However, for a lasting reduction in the impact of these weeds, the level of control undertaken in this project need to be continued for decades – given the hard-seededness of these species – to ensure full and lasting control. Further, there will be other management requirements to prevent the spread of these weeds into new areas by grazing livestock, or in re-infesting previously treated areas.

In summary, the activities undertaken in this component have resulted in a greater appreciation of the weed issue in the Pilbara, engagement of many new partners in weed management, and significant control efforts tackling the two major WoNS, being mesquite and parkinsonia. The challenge faced in taking these achieved immediate results through to long-term outcomes will be in maintaining the partnerships and being able to continue a high level of annual control work on these major species, and others posing a threat to the region's biodiversity.

C Feral animal control

History

Early settlers introduced a range of grazing animals now considered feral, including pigs (*Sus scrofa*), rabbits (*Oryctolagus cuniculus*), camels (*Camelus dromedarius*), donkeys (*Equus asinus*) and horses (*Equus ferus caballus*) (Burbidge and McKenzie 1989). There is also a population of unmanaged cattle (mainly *Bos taurus*). Some of these invasive herbivores occur across all tenures, including national parks (Burbidge and McKenzie 1989) while others, like pigs and rabbits, are confined to localised and restricted habitats such as riparian environs along the De Grey River and alluvial flats associated with the Fortescue Marsh, respectively.

The main impacts of introduced large feral herbivores (camels, horses, donkeys) in the Pilbara are compaction and erosion of soil, loss of grazing-sensitive plant species, reduced native grass biomass, introduction of weed seeds and trampling of seedlings and mature plants. Widespread loss of vegetation caused by large feral herbivores (LFH) can lead to a reduction in vegetation structure and thus habitat and food resources for native animals, and the loss of vegetation cover can expose small native animals to increased risk of predation (Martin 2010). Trampling and high numbers also leads to eutrophication of waterways, erosion and sedimentation of wetlands and riparian habitats, including the nationally significant listed wetlands of the Pilbara (Burbidge and McKenzie 1989, Kendrick 2001a, Kendrick and McKenzie 2001, Pinder *et al*. 2010).

Feral cats (*Felis catus*) are widespread across the Pilbara while red foxes (*Vulpes vulpes*) appear to be confined to the coastal plain of the Roebourne subregion and may occur further inland along the frontages of some of the larger drainage systems such as the Robe and De Grey rivers. Together they are responsible for range reductions and population declines of many native animals and in particular, small to medium sized mammals in many parts of Australia (Burbidge and McKenzie 1989, Woinarksi *et al*. 2011).

The regular baiting of dingoes and wild dogs as a measure to protect livestock may exacerbate the problem of introduced feral cats, as cat behaviour appears to be suppressed by dingoes (Ritchie *et al*. 2013). Cane toads are currently an irregular, episodic arrival in the region, typically invading in freight or shipping containers from the Kimberley, Darwin or eastern states. The establishment of cane toads in the Pilbara has the potential to reduce populations of native predators as well as many reptiles, small frogs and invertebrates (Shine 2010).

The WA Government and land managers have undertaken management of Large Feral Herbivores (feral camels, horses and donkeys) since the 1980s. According to the recent CSIRO Case study entitled, 'Priority threat management for Pilbara Species of conservation significance' (Carwardine *et al*. 2014), feral herbivore management was predicted to be the most cost-effective strategy for investment over the entire Pilbara bioregion.

Pilbara Corridors activities in the Fortescue River Catchment

Partners

The Pilbara Corridors program was implemented through two separate lead agencies, initially through the Pilbara Regional Biosecurity Group (Pilbara RBG) and the then named Department of Agriculture and Food Western Australia (now Department of Primary Industries and Regional Development (DPIRD) and later through the then named Department of Parks and Wildlife (now Department of Biodiversity, Conservation and Attractions (DBCA). The Pilbara RBG is a not for profit association formed under the *Biosecurity and Agriculture Management Act* 2007. The associations'

primary purpose is the control of declared pests using funding from Declared Pest Rates paid by landholders on pastoral stations with matching dollars provided from the WA Government. The Pilbara RBG works across four local government areas - the City of Karratha, Shires of Ashburton and East Pilbara and the Town of Port Hedland. The region extends east to the Northern Territory border and includes Jigalong and other Aboriginal communities in desert country. The region also includes pastoral stations along Eighty Mile Beach – Pardoo, Wallal Downs, Mandora and Anna Plains. There are about 60 pastoral leases in the area.

The Pilbara RBG with operational support and agreements with DPIRD and administrative support from Pilbara Corridors, had undertaken donkey collaring control programs and opportunistic aerial culling of camels and feral horses in the period up to 2014.

During the period of funding for the Fortescue River Catchment Corridor Project, resourcing constraints limited the input from DPIRD and the Pilbara RBG. However, the work continued under a new arrangement developed between the Pilbara Corridors and DBCA. DBCA are the preferred delivery organisation for feral herbivore aerial culls over national parks, reserves and unallocated Crown land (UCL). By 2015, the Department had implemented standardised procedures and guidelines for aerial culls conducted over national parks, reserves and UCL under their management and during the period of transition. Pilbara Corridors contracted DBCA to conduct an aerial cull program over Departmental managed lands and provided the necessary capacity to effectively manage threats to biodiversity from feral herbivores across the Fortescue River Catchment Corridor Project area.

Large Feral Herbivore control - summary

The Pilbara Corridors through the Biodiversity Fund co-invested in cross-tenure aerial culls of large feral herbivores for the purpose of enhancing ecosystem function and to protect the biodiversity of the Fortescue river wetland systems and of the Hamersley and Chichester Ranges as well as the pre-existing target area.

This project worked to reduce the impact and spread of invasive species in intact ecosystems through coordination of mapping and data management across tenure, collaborative invasive species management by strategic and coordinated feral animal management, and targeted on-ground control. This project also contributed to increasing landscape connectivity, carbon stabilisation and reducing loss of biodiversity from invasive feral herbivores through cross tenure feral management activities. This project engaged with of all land managers in the catchment to ensure activities are planned and coordinated at the catchment scale, and were conducted as safely as possible. Landholders were consulted before any activity was undertaken on their land management holdings. All activities adhered to accepted best practice approaches and conformed to animal welfare requirements.

A summary of the projects undertaken is presented in Table 12, the locations where control occurred are listed in Table 13, and the areas covered and the number of animals removed is shown in Table 14.

Table 12: Large feral herbivore projects in the Fortescue River Catchment

Projects	Lead Agencies	Description
PJ120101 Fortescue Feral	Pilbara Regional Biosecurity Group Formerly Department of	The feral herbivore management project undertook feral herbivore management in the Fortescue catchment with the key activities of coordinated feral herbivore control in the central and eastern Fortescue catchment by increasing the activities in the

Projects	Lead Agencies	Description
Herbivore Management	Agriculture and Food Western Australia (now DPIRD)	control program that is implemented by the Pilbara Regional Biosecurity Group and delivered by DAFWA (now DPIRD) in the Pilbara. This was achieved by increasing the effectiveness of the feral donkey collar radio telemetry program and an associated increase in the number of aerial culling operations. The stations targeted were: Bonney Downs, Coolawanyah, Hillside, Hooley, Marillana, Mulga Downs, Noreena Downs and Roy Hill.
PJ120117 Feral Herbivore Cull 2015-17	Department of Parks and Wildlife (now DBCA)	Department of Parks and Wildlife (now DBCA) as the sole approved contractor to conduct aerial culls over national parks, reserves and UCL were engaged to conduct an aerial cull of large feral herbivores (horses, donkeys, camels) on Karijini, Millstream-Chichester National Parks, UCL and Reserves. The funding from Pilbara Corridors allowed DBCA to increase the area controlled for feral herbivores. The landscape scale approach has increased the department's capacity to engage with neighbouring pastoralists and deliver a program of tangible benefits to conservation and the pastoral industry. The strengthening of relationships between the pastoral sector and the Department will continue beyond the project timeframe.

Table 13: Areas where feral herbivore control occurred

Pastoral Stations	Conservation Estate	Indigenous Estate
Kumarina Marymia Ethel Creek Sylvania Prairie Downs Turee Creek Station Pyramid Bonney Downs Coolawanya Hillside Hooley Marillana Mulga Downs Noreena Downs Roy Hill	Karijini National Park Millstream Chichester National Park Harding River Catchment Harding River Dam Reserve Mungaroona Ranges Nature Reserve	Yandeyarra UCL managed by Indigenous Rangers Nunyerry

Table 14: Results of Feral Herbivore Treatment

Year	2014	2015	2016	Total
Hectares influenced by the project	300,000	1,000,000	3,149,000	4,449,000
Feral cattle removed	0	8	164+172 = 366	344
Horses removed	75+416 = 491	396	23	910
Camels removed	56+139 = 195	24	8	227
Donkeys removed	147+324 =471	252	70	793
Hectares treated		900,000 ha treated by DBCA	3.6m ha treated by DPIRD (whole of Judas donkey program project)	4,500,000 ha

The Judas Donkey Program

DPIRD in partnership with the Pilbara Regional Biosecurity Group (PRBG) has conducted a Judas Feral Donkey Telemetry program in the Pilbara since 1998. The project works by exploiting the habits of female feral donkeys (Jennys) to seek company. An individual female is collared and released. She will then actively search for companions, at times travelling long distances. At certain points, DPIRD shooters will track the collared individual and cull all herd members excluding the collared individual. Females are collared in preference to males as males tend to be solitary animals.

Between 2011 and 2014, the Judas donkey program resulted in the control of 1,344 feral donkeys, 381 camels and 169 feral horses, reducing the overall density from 0.2 beasts in 2011 to 0.02 in 2014. Based on these records, radio telemetry (donkey collaring) is the most effective method to locate and cull feral donkeys. There continue to be discussions about the ideal frequency (number per year) of telemetry and aerial culling activities now that more patterns of LFH behaviour are being recognised.

Through funding supplied by the Fortescue River Catchment Corridor Project, the original aim was to increase the scale and scope of the aerial operations by funding two additional runs per annum. While some additional runs were achieved early in the project, changes to capacity and staffing levels at DPIRD and the Pilbara RBG meant that the expansion of the scale and scope could not be achieved solely by these two organisations. As discussed above, Pilbara Corridors engaged DBCA to continue the collaring program and complete aerial culls over DBCA managed lands and adjoining land holdings (with the permission and involvement of those land managers). A map showing the location of collared donkeys in the 2015 program is presented in Figure 5.

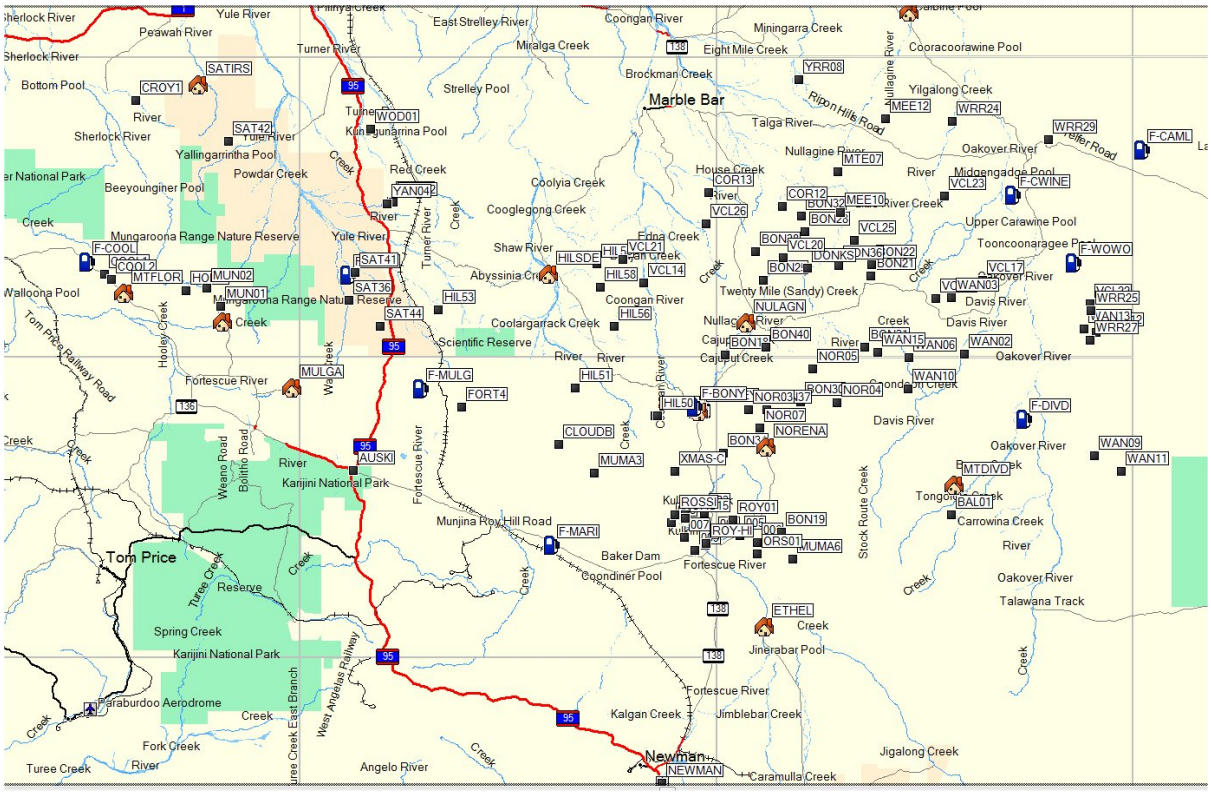


Figure 5: Pilbara collared donkey locations in November 2015

Evaluation of the immediate results of the feral herbivore control effort

The feral animal control effort undertaken in the project was directed at reducing the number and distribution of large feral herbivores – mainly horses, donkeys and feral cattle – in the catchment. The project was able to work with established organisations, such as the Pilbara Regional Biosecurity Group, DBCA and DPIRD, who also had existing knowledge and skills in control technologies. The project activities have resulted in more partners – principally pastoral stations – getting involved in control activity. Removal of large feral herbivores is supported widely within the landholding community, and their uncontrolled grazing has been identified as a high threat to achieving conservation objectives in the Pilbara.

Despite some organisational and resourcing issues, flexibility in project management enabled the planned activities to be undertaken with feral cattle, horses, camels, and donkeys removed over more than 4 million hectares of the central and eastern Pilbara. This represents a major expansion of previous control work for these species, and will have achieved a sustainable reduction in the population of these species.

As well as being successful in all immediate outcomes, a 10-year feral herbivore management strategic plan is being developed with stakeholders, with increased reporting of feral herbivores by land managers.

Given the progress made, it will be important to maintain the level of effort in coming years to achieve effective regional eradication of feral horses and donkeys. This will be challenging as the control technologies are expensive (in particular the Judas donkey program), and there will need to be strong commitment to continuing this expenditure when removing the relatively few remaining animals occurring over a large area.

D Fire management

Fire in the Pilbara

Fire is a fundamental component of the ecology of Pilbara vegetation communities. Many species require fire as part of their life cycle. However, when fires are too frequent, intense or expansive, negative ecosystem impacts occur, such as a loss of understory growth which provides many reptiles and mammals with protection from predators and the loss of food resources (Cawardine *et al*. 2014).

Historically, fire regimes in the Pilbara have been influenced by lightning-induced fires, traditional Aboriginal burning practices and later by European land use. Aboriginal burning practices in the Pilbara involved burning patches of vegetation creating a mosaic of burnt and unburnt patches, a practice that regulates fuel loads across the landscape, and mitigates against large intense fires (Allan and Southgate 2002). After the arrival of Europeans in the 1860s, major changes to fire regimes occurred due to displacement of Aboriginal people and their land uses, and through burning of spinifex at paddock scale to assist mustering of stock and to stimulate new more palatable growth. More recently, changes in vegetation as well as an increased ignition risk promoted by increased human activity in the area have led to more frequent intense wildfires in the spinifex grasslands (Allan and Southgate 2002). The increasing extent and density of buffel grass (*Cenchrus ciliaris L*.), an introduced pasture grass, has arguably had a growing influence on the number, intensity and extent of wildfires. In summary, altered and inappropriate fire regimes have been identified as one of the threats to Pilbara ecosystems (Cawardine *et al*. 2014).

A fire management program to encourage a mosaic fire/age distribution is an appropriate ecosystem recovery action (Kendrick 2001). Previous experience of burning in similar habitats indicates that the introduction of fire into this ecosystem requires a specific suite of environmental conditions to minimise undesirable fire effects, namely:

(i) execute the burn after a rain event with at least 50 mm of rain;
(ii) ensure the soil organic layer is completely saturated with water prior to burn to minimize any possible consumption from glowing combustion;
(iii) maintain flame length below two meters to minimize impacts on shrub and tree layers; and
(iv) burn with wind speed higher than 5 km/h inside the tree layer to minimize canopy desiccation.

Background

Preceding the Fortescue River Catchment Corridor project, there was not a landscape-scale approach to appropriate fire management. Individual land managers have had a variety of attitudes towards the use and usefulness of fire. Some pastoralists regarded fire as a threat to standing fodder and focused their efforts on wildfire suppression while others used fire proactively as a tool for promoting pasture production. Some land managers used fire to reduce fuel loads aiming to minimise the number and extent of unplanned fires and to protect property assets, maintain biodiversity values, or to safeguard Aboriginal resources and values. However, the majority would only react in response to encroaching wildfires, resulting in a decrease in the frequency of fire and a homogenous age class of vegetation Kendrick (2001).

Fire management activities in the Fortescue River Catchment

Objective

Implementation of a landscape-scale fire management strategy through Fortescue River Catchment Corridor Sub-Project PJ120102 was designed to generate the following benefits:

- reduce critical threats to biodiversity from fire;
- enhance ecosystem condition, function, connective and resilience of habitats;
- stabilise and increase populations of threatened flora and fauna species;
- increase native vegetation ground cover; and
- increase engagement of land managers in coordination of fire management.

At a larger scale, the Pilbara Corridors sought to coordinate and improve cross-tenure fire management, with the following specific objectives.

- To provide yearly updates to land managers through fire scar mapping. The mapping will identify where priority burning needs to take place in the subsequent year.
- To manage fuel loads through targeted mosaic burning.
- To identify burning protocols for different vegetation complexes to conserve flora diversity.
- Provide knowledge through consultation with fire practitioners and experts.
- Reduce and contain wildfire incidents through planning and preventative actions.

Partners

Through funding provided by the Biodiversity Fund, efforts were made to coordinate fire planning and management across the Fortescue River catchment (primarily in the Hamersley and Chichester Ranges) through a partnership between Rangelands NRM and Department of Parks and Wildlife (now DBCA). The two core partners worked over the course of the project to bring in other partners, notably Greening Australia (WA), pastoral, Aboriginal, and industry land managers to manage the area as a whole. The coordination facilitated pooling of resources to create a tenure blind fire mosaic that would develop and sustain a diversity of vegetation age across the landscape.

Diversification of vegetation age generates beneficial indirect effects such as increasing landscape connectivity, promoting carbon stabilisation and reducing biodiversity loss from large intense fires. The entities that participated in fire management in is shown in Table 15.

Table 15: Fire Project Partners and Stakeholders that actively participated in burning activities

Category	Entities involved
National and State Parks and Reserves (5)	Millstream Chichester National Park (MCNP), Karijini National Park (KNP), Cane River Mount Minnie Conservation Park, Meentheena Conservation Park, Fortescue Marsh
Pastoral Leases (15)	Pyramid, Coolawanyah, Mulga Downs, Mt Florance, Hooley, Marillana, Juna Downs, Prairie Downs, Hamersley, Mardie, Yalleen, Bonney Downs, Corunna Downs, Hillside, Roy Hill
Government Departments, Agencies and Shires (8)	Shire of Ashburton, Department of Fire and Emergency Services, City of Karratha, Water Corporation WA, Shire of Exmouth, Main Roads, Shire of East Pilbara, Department of Defence
Indigenous Aboriginal Corporations and Communities: (8)	Western Desert Lands Aboriginal Corporation, Kanyirninpa Jukurrpa (KJ), Gumala Aboriginal Corporation (Karijini Eco Retreat), Youngaleena community, Banjima Aboriginal Corporation, Juluwarlu Aboriginal Corporation, Yindjibarndi Aboriginal Corporation (YAC), Ngurrawaana Community
Indigenous Ranger Groups (4)	KJ Rangers, Ngurrawaana Rangers, Murujugu Rangers, Gumala Rangers

Activities

Over the course of five years (2013-2017), 202,099 ha were burnt in controlled burns, resulting in a total of 1,048,530 ha being fire-managed appropriately. A total of 40 entities, including government agencies, NGOs, communities and pastoral leases were involved in cooperative and active fire management, in addition to DBCA and Rangelands NRM. The annual fire management operations through this period are presented in Table 16.

Table 16: Fire Operations Year by Year Breakdown

Year	Activities	Active Partners
2013	Fortescue River Catchment Corridor Project started (contract executed) DBCA engaged Pilbara Fire Project Officer DBCA developed fire strategy papers for Karijini and Millstream Chichester National Parks incorporating vegetation, assets and fuel load data sets DBCA revised and updated prescribed fire manual Remote sensing of fire scars (2009-2012) using Landsat imagery commenced Several small protection burns were implemented in Karijini National Park in May/ June 2013 Total ha burnt: <100 ha 4 fire monitoring sites in Millstream were established Bushfires impacted about 950,000 ha of land in the central Pilbara (including Fortescue Catchment)	DBCA Yindjibarndi AC, Ngurrawaana community, YAC rangers Water Corporation Rio Tinto Juluwarlu AC YAC Rangers burning alongside DBCA Consultation with Water Corp (MCNP) and Rio Tinto (KNP) for cross tenure risk management on adjoining properties
2014	Approximately 75% (380,000 ha) of Millstream-Chichester National Park (20,000 ha), Karijini National Park (100,000 ha) and adjoining lands burned in 2014 due to a homogenous vegetation age class and large number of ignitions from lightning and deliberate ignitions. The bushfires reduced the scale of prescribed burns due to significant reallocation of resources committed to wild fire management and reduced vegetative fuel load (post wildfires) Ha burnt: 20,000 Emphasis on wet season burning, with 5,500 ha treat in dry season In addition, there was significant staff turnover which also prevented prescribed burning from being undertaken as originally predicted in 2013. Remote sensing and mapping of fire scars completed for 2014/15 season, now detailed interpretation runs from 1999 to 2015	2014 DBCA Yindjibarndi AC, Ngurrawaana community, YAC rangers Gumala Aboriginal Corporation Water Corporation Rio Tinto Fortescue Metal Group Main Roads Local government Authority (LGA) – Shires of Ashburton, Roebourne and East Pilbara KJ Rangers Murujuga Rangers
2015	New fuel classification scheme was developed for the region aiming to facilitate the interpretation of potential fire risk and guide the prescribed burning process. This includes identification of priority cells in the fire strategy papers targeting vegetation > 5yrs old, aiming to create patch size mosaic less than 10,000 ha were possible. The boundaries were determined by the land geography, vegetation, infrastructure, and fuel loads, consistent with previous fire scar mapping and knowledge gained from land managers. Fuel age maps updated with respect to new classification scheme (three fuel age classes - regrowth less than 2 years old/	2015 DBCA YAC Ngurrawaana Rangers Murujuga rangers Gumala Aboriginal Corporation, Banjima Aboriginal Corporation Youngaleena community Pyramid Station

Year	Activities	Active Partners
	regrowth 2>x<4 years old/ regrowth >5yrs old. These maps were shared with pastoral partners, and other key stakeholders including resource industry and local government. Significant staff turnover 28,500 ha of burning planned for early-mid dry season to reduce bushfire risk However prescribed burning resources assembled but not fully deployed due to extensive late season wildfires burnt through targeted area with required effect, plus late rains resulted in flooding which blocked deployment, only some fire breaks on Millstream completed before flooding Ha burnt: 24,900 ha Developed prescribed burn plans for 2016 for expanded area that includes MCNP, Karijini and adjacent areas including Ngurrawaana Community, Water Corp, Pyramid, Coolawanyah, Juna Downs, Rio and BHP	Coolawanyah Station Mt Florance Station Mulga Downs Station Juna Downs City of Karratha Shire of Ashburton Shire of East Pilbara DFES Main roads Water Corporation BHP Rio Tinto FMG Bonney Downs and Corunna stations expressed interest in participating in 2016 prescribed burns.
2016	Prescribed burns targeted to old fuel areas (5 years older and above) anchored into existing fire scars (4 years or younger) plus buffer burns along major roads and tracks. Prescriptions for prescribed burning in and adjacent to priority areas were completed in consultation with adjoining land managers and stakeholders. Late season wildfire in Oct cancelled all subsequent prescribed burning planning and activities until 2017. However, the October wildfires only had a limited impact before burning out when reaching the prescribed burn scars. During the early dry period, DBCA in cooperation with other agencies and landowners implemented a series of prescribed burns the landscape as well as a series of buffer burns around 30 km major roads and tracks. Burning targets were met in terms of ha burnt Ha burnt: 140,054 Planned and containment burns completed with 40,000 ha treated, 109,000 ha completed in terms of training area managed to implement improved practices	DBCA Ngurrawaana Community and Rangers Water Corporation Yindjibarndi AC Mardie Station Marduthuni Rangers Rio Tinto June Downs Coolawanyah KJ
2017	2017 Season: Prescribed burning plans developed with a total area of 904,792 ha. This is in addition to existing prescriptions for the MCNP and KNP (total area 1,505,432 ha). Treatment Area: 187,225 Ha burnt: 38,286 # persons participating (paid, volunteer and Indigenous): 37	DBCA (formerly DBCA) Coolawanyah Yalleen Yindjibarndi (Ngurrawaana lease) Mt Florance DFES City of Karratha Shire of Ashburton Shire of East Pilbara

Benefits

Karijini National Park

The pattern of wildfires and prescribed (controlled) fires in Karijini National Park is shown in Figure 6. The areas of prescribed fires are significantly smaller than the extensive wildfires that occurred in earlier years.

This project contributed to the creation of a mosaic of different vegetation ages in the Fortescue River Catchment area. Different ignition patterns during aerial burns adjusted to the fuel loads result in a mosaic of burnt/unburnt over the treatment area allowing the renewal of vegetation, protection of old spinifex and a break in the horizontal continuity of fuel with a reduced impact in bushfire spread. Ground and aerial burns were implemented to reduce the continuity in the fuel load across the landscape and hence reduce the likelihood of large scale bushfires impacting the area.

As an example, a 'lightning fire' in the late dry season will not be able to expand and increase its intensity as there is a mosaic of burnt patches spread throughout the area being managed. Bushfires tend to burn 80-100 per cent of the available fuel and spread over long distances (e.g. O'Brien's creek fire in KNP in 2015 spread over 75 kms long and 45 kms wide). Results from burning in 2016 and 2017 in the early dry season suggest that burning under mild conditions (low temperatures and low wind speeds) result in percentage burnt varying from 15 to 50 per cent of the treatment area which differs significantly from bushfires.

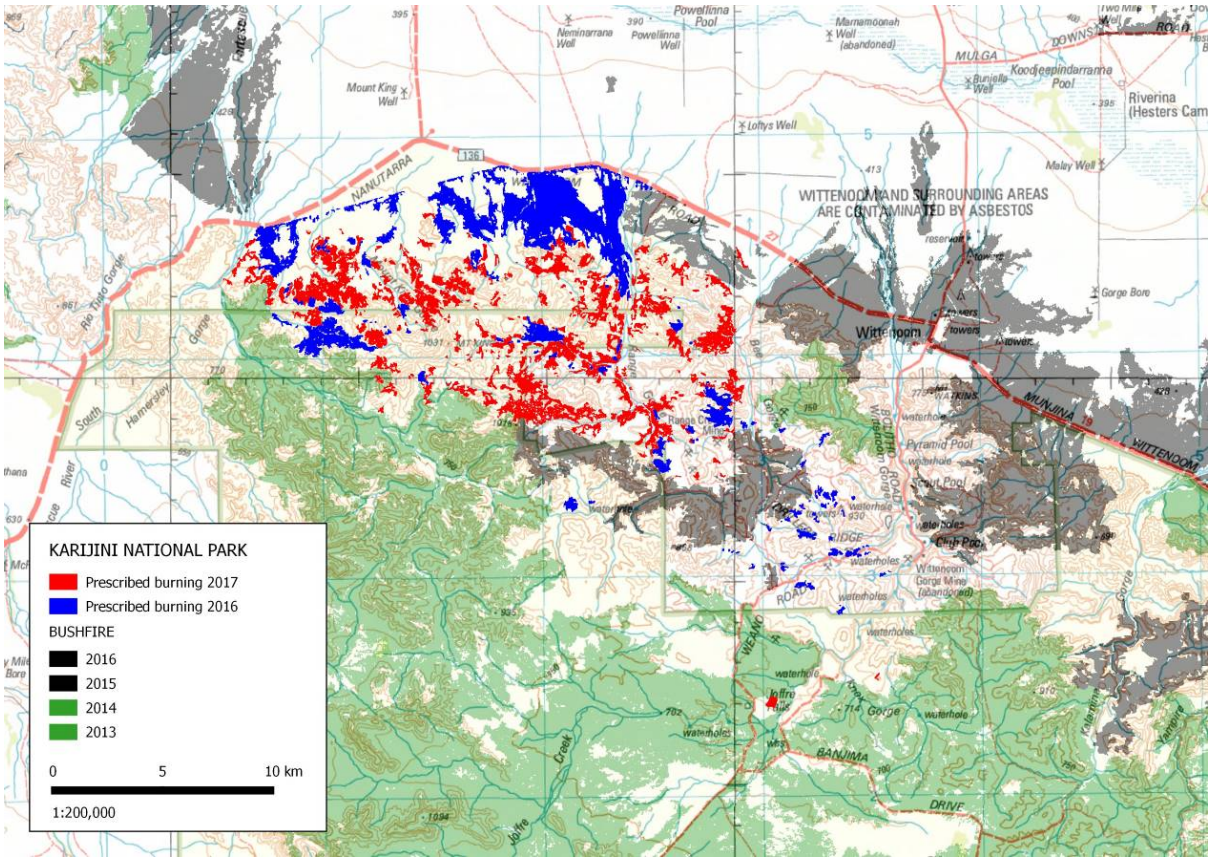


Figure 6: Before and after fire scars across Karijini National Park (KNP)

Vegetation aged five or more years is the trigger point for inclusion in the prescribed burning and fuel reduction activities targeted zones. A fire management program to create an appropriate age/class mosaic will continue to be implemented using the following criteria:

(i) target areas with fuel age equal to or greater than 5 years old;
(ii) anchor burns on existing tracks and roads or fire scars equal to or less than two years old;
(iii) use of ground ignition to anchor burns on tracks and roads and to reduce the risk to infrastructure and main roads;
(iv) use of aerial ignition to target the interior of cells in remote areas; and
(v) targeting mulga woodlands with horizontal continuity of annual grasses.

The three fuel age classes are shown in Figure 7.

Through the Fortescue River Catchment Corridor Project, the partners came together to coordinate and implement a landscape scale approach to fire management to break up the country into a mosaic of different aged vegetation. As described above, prescribed burning has been applied at a landscape level for Millstream Chichester National Park, Karijini National Park and adjacent lands including Aboriginal lands and pastoral leases. These burns were implemented during the wet and early dry seasons with the objective of burning a minimum of 20 per cent of the treatment cells.

Through the burn program, the Fortescue Catchment was broken up into a mosaic of patches of long un-burnt country ringed by more recently burnt country. Also, assets are identified and fire breaks burnt in the surrounding country to protect them from uncontrolled late season wildfire. In addition to burning, ways of restricting the available fuel around valuable assets include dousing the fuel with water or fire retardants, removing the fuel on fire breaks, slashing or crushing vegetation and grazing.

Fig. 1. Fuel age class 1. Vegetation age equal to or less than 2 years since last fire. Fires unlikely to spread under extreme fire weather conditions. Photo courtesy: Pedro Palheiro¤	Fig. 2. Fuel age class 2. Vegetation age with 3 to 4 years since last fire. Fires likely to spread under extreme fire weather conditions. Photo courtesy: Pedro Palheiro¤	Fig. 3. Fuel age class 3. Vegetation age equal to or more than 5 years since last fire. Fires likely to spread under moist fire weather conditions. Photo courtesy: Pedro Palheiro¤

Figure 7: Pictorial guide to fuel age class

In terms of the burning program, the focus has largely been on managing the fuel load. Old fuel areas (5 years old and above) were identified in the burn plans and targeted with the prescribed burning practices. The new burns are anchored into existing fire scars (4 years old or younger fuel). Ground and aerial burning was applied, with ground crews using a drip torch, working along major roads and tracks to create a secure edge to tie in with later aerial burning. A helicopter was used for aerial burning with an ignition pattern that varied from 100m x 200m to 500m x 1000m according with daily weather and fuel conditions. The incendiaries were dropped within controlled burn lines.

Figure 8 shows the contrast between the impact of large scale bushfires (black) and smaller, less intense prescribed burns (dark red inside yellow polygon) in Karijini National Park and the adjoining Juna Downs Station.

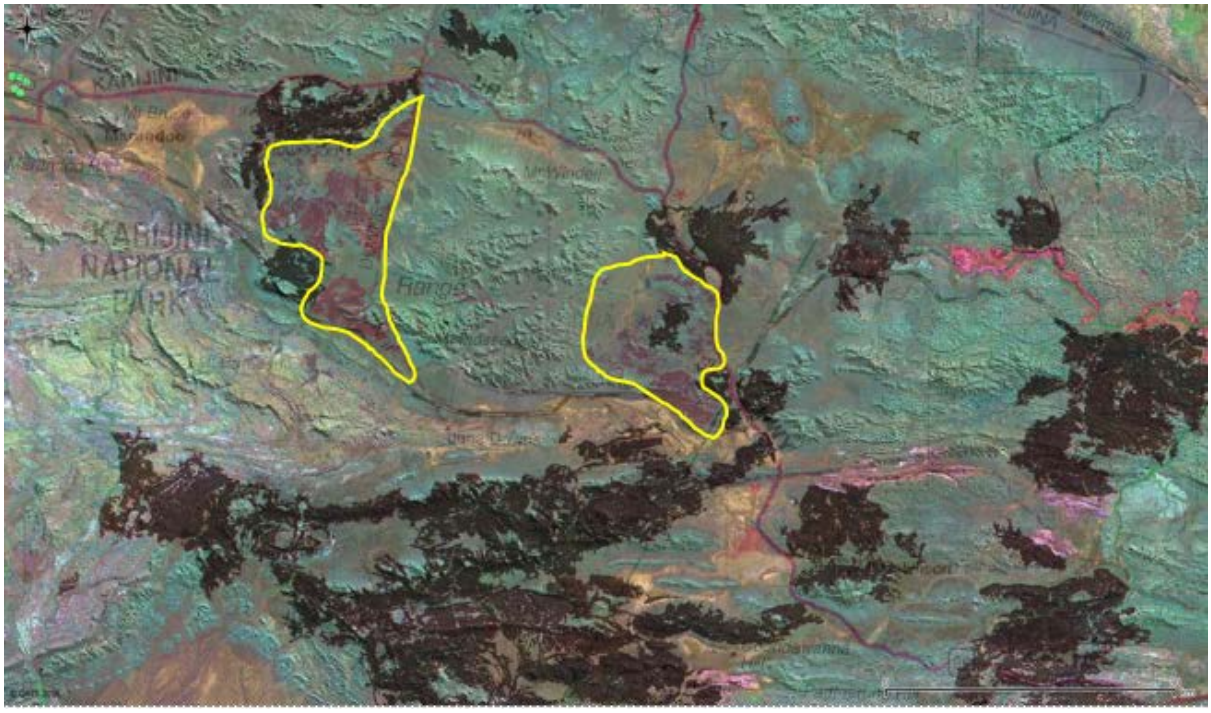


Figure 8: Contrasting the impact of wildfires versus prescribed burns

Co-benefits of prescribed burning

The fire activities generated several co-benefits such as reducing woody vegetation, allowing the native species a competitive advantage in terms of regeneration and facilitating access to areas previously blocked due to dense vegetation growth (refer to Case Study 1: Co-Benefits of Fire Improves Weed Management Efficacy for more details.) Reducing the incidence and scale of late season wildfires curtailed the effectiveness of non-native predator hunting behaviour through the provision and sustenance of native vegetation throughout the year (i.e. no large burn scars for feral cats to hunt small native mammals and reptiles) (Legge 2015). The project contributed to a change in the perception of fire in the region – fire is now discussed in many forums as a tool to be used in weed control, risk mitigation, feed for cattle, and pastoral planning and management.

Case Study 1: Co-benefits of fire – Improving efficacy of weed management

The Millstream wetlands and surrounding ephemeral creeks (e.g. Millstream Creek) are currently invaded by non-native plants such as date and cotton palms, passion vine (*Passiflora foetida*), stinking passion flower and morning glory (*Ipomoea cairica*). These widespread vines cover the ground and trees limiting the habitat for other plants and cause a fire risk due to high fuel load and vertical continuity, thereby creating 'fire-ladders', facilitating crown fire and long-distance spotting.

In 2015, MCNP Rangers subjected the Millstream Creek to prescribed burns and followed up in 2016 by extending the burns into the wetland areas south of the Fortescue River (Ranger headquarters to Palm Pool Crossing). The burns were applied mainly to reduce the fuel load and risk of damage to existing infrastructure surrounding these areas, but also to trial burning as a potential technique to control the spread of these weeds.

After the prescribed burn, the area was surveyed with the following observations made. The fire had no impact on cadjeput and river gum trees, but the fuel load and fire risk on the area had been significant reduced. Accessibility to the area had improved and as a result, it was now easier to find and access the weed infestations. The reduction in vegetation from the burning had directly improved the effectiveness and ease of application of chemical and contributed to the overall cost reduction of chemical application (persons/day) for the control of non-native weeds.

These burns actively reduced fire behaviour in this high-risk area and contributed towards improving the effectiveness in locating, marking and killing the weeds that had been choking out the native plant species (see Figure 9). Fire reduced the amount of weed vegetation in the wetland areas, facilitating the identification of targeted weed species and improving access by rangers to employ targeted mechanical and chemical weed control methods directly on active weed infestations. The easier access reduced the logistical demands while the increased visibility improved the effectiveness of treatments; ultimately contributing to the ability to treat a larger area within a similar allocation of resources.

Figure 9: Heavily invaded Passiflora foetida *area pre-burn versus after prescribed burning*

It is worth noting that burning alone will not eliminate a weed problem. However, fire when used in combination with other weed control methods can improve the cost and treatment effectiveness of weed control, in addition to greatly reducing the fire risk and negative consequences of widespread wildfires.

Case Study 2: Building Indigenous Ranger capacity in fire management

This project has contributed significantly towards improving the Ngurrawaana Rangers knowledge on fire and building their confidence to start their own burning program within their community lease area. Initially the rangers would only conduct burning under direct supervision and working alongside DBCA rangers. Now, five years later, there is evidence of 'right way fire' (a mosaic of small-scale cool burns and fire breaks protecting known assets) easily spotted across the Ngurrawaana lease (see Figure 10). This demonstrates that the Ngurrawaana Rangers and their community are building capacity and the confidence to implement wildfire mitigations strategies in a self-directed and self-initiated manner.

The prescribed burning training included a number of practical exercises including a joint operation with the Department of Parks and Wildlife (DBCA) to learn about basic wildfire awareness. This has contributed to the building of a strong working relationship between the Ngurrawaana Rangers and DBCA at MCNP. Since the initial training, the Ngurrawaana Rangers have been employed by DBCA at MCNP every winter since 2013 for a period of up to five months. This employment facilitates the

direct application of skills and techniques learnt during training to practical conservation and land management tasks. The rangers have found this application to be most useful for retaining their knowledge and for improving their skill sets.

In addition, joint training, prescribed burning and wildfire treatment activities have resulted in sharing of information and resources between DBCA and Indigenous organisations such as Yindjibarndi Aboriginal Corporation (YAC) and Kanyirninpa Jukurrpa (KJ). The improved partnerships have enabled aerial burns to be conducted based on landscape (tenure blind) requirements. The efficiencies generated by reduction of ferrying costs and sharing of expertise and equipment has contributed to an increase in the scope of activities (i.e. refuelling stations strategically placed across a number of properties reducing the need for expensive ferrying back to the hanger).

Figure 10: Ngurrawaana Rangers burning around the Ngurrawaana community

Evaluation of the immediate results of the fire management activities

Uncontrolled wildfires are a high threat to achievement of conservation objectives in the Pilbara (and elsewhere across northern Australia). Controlled patch burning has been shown to be an effective means of preventing extensive destructive wildfires, and in reducing emissions of greenhouse gases (For the desert/Pilbara as well https://rangelandswa.com.au/wp-content/uploads/2017/04/Guiding-Principles2.pdf).

Fire management activities in the Fortescue River Catchment Project have focused on introducing controlled burning into land management in the Pilbara, with much of the early work being done in the Millstream-Chichester and Karijini National Parks, based on strategic planning by DBCA. The project funded the employment of a Fire Project Officer which assisted in the coordination of many partner organisations with an interest in fire management. As the work proceeded over the years 2013-2017, it is apparent that these organisations increased their involvement and knowledge. The immediate results have been very positive, with clear evidence that areas subjected to controlled burning regime have avoided being affected by extensive uncontrolled wildfires. As well as demonstrating the value of controlled burns, project activities have led to some unplanned benefits, being increasing skills and commitment to good fire management by Aboriginal rangers, and the use of fire to facilitate localised weed control in densely vegetated areas.

Project fire management of the Fortescue River catchment has increased the area of species rich ground cover, improved ecosystem habitat condition, reduced the threat of fire to rare and threatened species, and improved catchment scale soil health and hydrological function. The implementation of strategically timed cold mosaic pattern burns to reduce fuel loads has reduced late season burns and wildfires. The implementation of fire scar mapping to determine where fire

needs to be managed has increased cross tenure collaboration between stakeholders and an increased understanding of fire.

The fire management sub-project has exceeded expectations based on a strong performance by the delivery organisation actively engaged in on ground prescribed burns. Fire management has stepped up with over 90,000 hectares being 'prescribed burnt' across two national parks and pastoral and mining company leases. The cool burns carried out by helicopter, and with on ground drip torches realign historical deficiencies evident in scar mapping records to provide a better managed landscape for flora and fauna.

Overall, the achievements by the project in fire management are very significant in the context of overall land management in the Pilbara. However, the areas 'treated' to date are relatively small compared to the total area of fire-prone landscapes in the Pilbara. Hence it will be important that the knowledge gained and commitment demonstrated are maintained to extend sound fire management across larger areas in the Pilbara.

E Land use and management

Background

In the Pilbara, the growing intensity of land use and resource development has placed considerable pressure on the biodiversity of the region. There is a need to ensure that ongoing economic development is integrated with the protection of biodiversity and the land resource base more generally. Although the protected area estate in the Pilbara is substantial (i.e. national parks, marine parks and other conservation reserves), it does not meet nationally and internationally recognised targets for biodiversity conservation. In addition to expanding the protected area estate where possible, complementary 'off-reserve' actions are necessary and important.

Land use and management activities undertaken in the Fortescue River Catchment

The activities undertaken as part of the land use and management component included:

- Rangelands NRM supported the development of Indigenous ranger teams and the employment of these teams in the management of Aboriginal held land within the catchment. Activities included Conservation and Land Management (CLM) training, ESRM planning, weed control, and improving the community environment.
- Ecological Sustainable Rangeland Management (ESRM) planning was carried out with pastoralists on most of the pastoral leases in the catchment. All ESRM plans completed were supported with an incentive package to help commence implementation of the priority recommendations.
- ESRM planning was followed by intensive implementation of case study demonstrations of on-ground works on three pastoral leases.
- Targeted ecological restoration works were carried out in priority areas identified in the catchment.

These activities carried out as part of the Fortescue River Catchment Corridor Project are summarised in Table 17, with further details presented in following sections.

Table 17: Land use and management projects

Project number	Participants	Activities
PJ120103	Indigenous Ranger Training (Ngurrawaana Rangers)	Rangelands NRM supported the development and training of a Ranger team from the Ngurrawaana community near the Millstream/Chichester National Park and the Fortescue River. Continued support is expected to increase the current Ranger Team's skills and experience across a range of activities including weed control, water monitoring, grazing management and working with tourists, and to develop other Ranger Team opportunities. An Ecologically Sustainable Rangeland Management (ESRM) plan was undertaken with the Ngurrawaana community in 2009/10 and this plan will guide land management activities. Since 2013, Greening Australia, through the Pilbara Corridors Program have been working with the Yindjibarndi Aboriginal Corporation (YAC) and the Ngurrawaana Rangers to upskill them in conservation and land management techniques with the aim to help them protect and enhance existing vegetation on their lease and within Millstream NP and to also manage threats to the biodiversity in both areas. This has enabled 12 Ngurrawaana Rangers to complete their Cert 1 in CLM and 12 Ngurrawaana Rangers to start their Cert 2 in CLM.

Project number	Participants	Activities
		As part of the training, they have completed activities such as prescribed burning, land-based fauna trapping, native seedling planting and growing
PJ120105	Fortescue Pastoral Land Management	This project aimed to reduce threats to biodiversity and improve land management in pastoral systems of the Fortescue catchment through execution of property plans developed under the ESRM and Ecosystem Management Understanding (EMU™) planning processes. During the course of the Pilbara Corridors program, this project evolved from the direct implementation of ESRM plans by Pilbara Corridors staff members to include post ESRM activities as well as direct regenerative work completed by Greening Australia. In turn, each directly funded ESRM and follow up works was developed into an individual project (see below)
PJ120113	Prairie Downs demonstration of ESRM Implementation	An ESRM was completed at Prairie Downs Station and as part of the planning process it was identified that a future priority action would be to restore the Talia bore in the north east of the lease to open up underutilised paddocks to reduce the overall properties grazing pressure. This project represents both the ESRM and the post activities outcomes generated. Each yard consists of a trap yard, a paddock and yards to handle the cattle. The trap yard has spear gates which allow the cattle in and out to access water but donkeys, horses and camels will not go through these gates so are unable to get water. This will mean they no longer live in this area and will keep them out of the river catchment area. The feral herbivores migrate from adjoining properties when surface water dries up and enter the property to drink from the troughs. By installing the troughs inside of yards, it effectively reduces the total grazing pressure by eliminating all non-cattle users from the area.
PJ120118	Pastoral Management demonstrations at Bonney and Corunna Downs	In 2015, an ESRM plan was conducted at Bonney Downs which also encompassed Corunna Downs as both properties are leased by the same party. As a result of the ESRM, action plans for the improvement of ecosystem function through improved grazing management is being adopted To protect and improve existing native vegetation through landscape grazing management initiatives at Bonney Downs Station and the adjoining Corunna Downs Station. This will involve implementing action plans as a result of an ESRM conducted in 2015 to restore and improve water point infrastructure at 10 water bores and fence areas to assist in controlled cattle movement off areas in need of habitat regeneration. The action plans will also contribute to the control of weeds, fire, and feral herbivores. To promote the uptake of ESRM plans by pastoralists through communicating the benefits of the process. This includes the initial ESRM and the subsequent action plans to put into place priority works identified as part of the ESRM. This is a landscape scale partnership and programmed activities with Bonney Downs and Corunna Stations sharing best practice and knowledge to reduce threats to biodiversity. 1. ESRMs are a base level management tool for pastoralists to combine grazing with conservation. 2. This work is combining pastoralists' values with conservation science on the landscape. 3. The ecosystem health will be improved to reduce threats to Bonney Downs and Corunna Downs threatened species. 4. Pastoralism plays a part on the landscape and pastoralists want a healthy and productive ecosystem.

Project number	Participants	Activities
PJ120121	Restoration of the Fortescue Catchment	Partnership between Pilbara Corridors and Greening Australia to deliver landscape restoration works, increase resilience and ecological health by promoting landscape connectivity and co-ordinating activities with land managers to reduce biodiversity loss. The aim is to demonstrate that restoration works can be undertaken in a collaborative partnership with the view to enhance ecosystem function. This included the identification, planning and execution in priority areas (currently identified as Gregory Gorge, Doggers Gorge, Wona land system and Mulga Downs hard pan scald).

Ngurrawaana Ranger Training

Rangers participated in activities such as installing irrigation, fencing, tree planting, using machinery, propagating cuttings, creating garden beds, paving, collecting local mulch such as dry reeds and dry cow manure. At other training events rangers gained accreditation: in operating and maintaining chainsaws, in tree felling, operating in remote environments, workplace communications, occupational health and safety processes and prescribed burning. Specific activities are presented below.

- Through this project and beyond, the reduction and elimination of parkinsonia on the Ieramugadu lease will be a major achievement. Monitoring parkinsonia post-treatment will be important to keep detect regrowth or undetected infestations.
- The on-going prescribed burnings undertaken on a yearly basis by the Ngurrawaana Rangers, both on the Lease and at Millstream-Chichester Range National Park (MCNP) assisted by DBCA, is important in mitigating devastating wild fires and in properly managing the Wona land system (see Van Vreeswyk *et al*. 2014a).
- The winter season on-going treatments of Passiflora, exotic date palms and other WoNS in the MCNP is an important annual task contributing to their control and elimination and prevention of further spread in the catchment.
- Surveys for parkinsonia and fish monitoring provide a valuable baseline dataset for the catchment as little data have been previously recorded. The rangers' surveys, which will complement current research, will assist in better understanding fish movements, population dynamics and abundance, and water quality and health. It is hoped the ongoing survey program will be able to detect and assess any negative impacts from upstream commercial and industrial activities.
- The CLM training has enabled the rangers to undertake fauna and flora surveys, potentially funded by external sources, to assist in conserving the environment and documenting any changes over time. MCNP has benefitted from the rangers input such as contributing to the protection of sacred or fragile areas, and undertaking remedial measures to minimise the impacts from tourism and from natural events (fire, flood etc.).

The rangers are now involved in multiple activities, and their input represents a useful part of the management program undertaken in MCNP. The core group of Rangers are developing as a functioning and motivated group, who are committed to providing better outcomes for their people and their country. The advantage of the rangers gaining certification is that the rangers are now competitive when seeking fee for service contracts. They have already been engaged by PMMC to undertake parkinsonia control work (see Section B Weed management) and are widely considered to be consistently improving and providing better value for money each additional contract they undertake.

A representative of the Yindjibarndi Aboriginal Corporation, summed up the positive change in the way the Ngurrawaana rangers are perceived by other organisations. 'It is no longer a question of whether the rangers have the capacity, training and experience to do the work, but the acknowledgement that they can do the work'.

The Marduthuni Ranger Coordinator highlighted the interest and kudos in securing a ranger role displayed by a broad age group within the community. The Yaburara and Coastal Mardudhunera Aboriginal Corporation (YACMAC) in a recent letter to the WA Government in response to a Pilbara Conservation Strategy public consultation, added to the positive comments about the Fortescue River Catchment Corridor Project made in the draft. It stated 'the Project has provided extensive support to YACMAC whilst establishing its Marduthuni Rangers Team, based out of Karratha. Their support and unwavering commitment to provide improved natural resource outcomes in the Pilbara is highly regarded'. Both ranger groups have a social sense of purpose, self-worth, and see the opportunities provided by the Project as a catalyst to assist them towards full time employment.

Ecologically Sustainable Rangelands Management (ESRM) planning

Ecologically Sustainable Rangelands Management (ESRM) Planning takes a whole-of-property approach and attempts to strike the right balance between maintaining the rangeland's natural resource base and achieving the business goals of the land manager. A whole of property planning specialist works closely with the pastoral land manager to develop a shared understanding of the dynamics of their landscape and provide and alternative perspective on how the landscape operates. A focus of the sustainable pastoral program is for people to learn from one another and implement practice change by doing on ground works after completing the ESRM property plans. Pastoralists are encouraged to manage pastoral areas according to their values, which may include improving productive land systems, protection of high conservation areas, rehabilitation of land subject to over grazing and/or erosion, protection of cultural sites, exploiting carbon sequestration potential, and special management of land with a high fire risk. Some specific actions include:

- Promoting connected landscapes by implementing the ESRM grazing management plan.
- Working with the pastoral land manager to control livestock access to areas of high biodiversity value and manage heavy grazing pressure.
- Reducing the impact on the landscape of pastoral use by reducing loss of ground cover and increasing vegetation.
- Increasing engagement of the land manager in co-ordination of NRM activities across tenures.

The result is both environmentally sensitive and productive areas being better protected, with areas subject to loss of groundcover, excessive surface water runoff and erosion being appropriately managed. Restoration of ground cover increases flora richness, increases water retention in the soil, reduces erosion and provides increased environmental capital.

Managing country to land systems produces a variety of beneficial environmental outcomes, including a decrease in patch grazing, increased growing season spelling, proactive stock rotation and nutritional shepherding (http://www.selfherding.com/rangelands-self-herding.html) to more evenly distribute grazing pressure. Other desirable environmental outcomes include increased ground cover, increased water infiltration, decreased run off and erosion and better soil health. An example of the mapping of land values is shown in Figure 11.

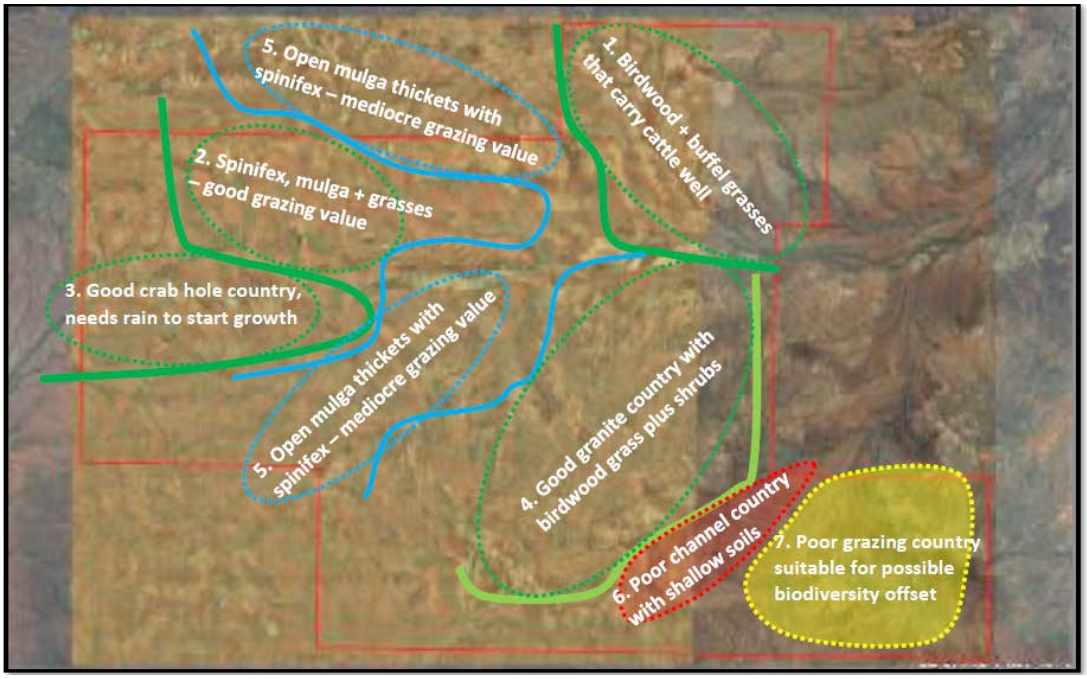


Figure 11: Country Types on Prairie Downs

An ESRM outcome is the development of a property management plan that integrates the production elements of the business with the resource sustainability and nature conservation. The plan outlines the manager's goals for the property and business, described and analyses key property and business resources, identifies the important issues to be addressed and lists the potential actions the manager can take to reach their goals. Increasing ground cover and its condition on pastoral properties that will contribute to enhanced biodiversity in the Fortescue catchment plus increasing cattle productivity and enterprise profitability from improvements in vegetation and cattle management.

The ESRM process also provides a focal point for cross tenure discussions and provides expert advice which would otherwise not be actively sought by pastoralists. By going to the pastoralists and land managers to discuss their values and biodiversity concerns individually, instead of holding central meetings, more support from stakeholders has been achieved.

ESRM plans in the Fortescue River Catchment

Pilbara Corridors facilitated 12 ESRM plans on pastoral stations in the Fortescue River Catchment over 5 years. Six plans were project funded and six plans were funded by private companies. A further two existing plans were reviewed. Overall, the Fortescue River Catchment Corridor project supported/ funded ESRM or post-ESRM activities on 15 Pastoral Leases within the Fortescue River Catchment.

Initially the project concentrated on introducing pastoralists to Total Grazing Pressure (TGP) methodology through delivery of a Grazing Land Management (GLM) Program. This was followed by comprehensive property visits and discussions with the land managers, backed up by the latest software and tools including remote sensing, climate analysis and mapping software. The rangelands assessment on each property included:

- Geomorphological study to assess the different soil types and production potential;
- Vegetation survey to determine the predominant species and the plant community relationships; and

- Rangelands condition status report for erosion, weeds, ground cover and 'rain readiness' of the land.

The individual ESRM plans included a prioritised list of activities that the pastoralist can and will complete in order to improve the grazing and regenerative management practices on the station. These on-ground works or activities included additional fencing, stock watering points and other infrastructure to control stock movement and density, plus the installation of associated monitoring sites. These works were done to manage TGP (managed stock plus feral animals and native herbivores) and control livestock access to areas of high biodiversity value. The underlying assumptions are that implementation of ESRM plans will result in the following benefits.

- Increased ground cover and its condition on pastoral properties that will contribute to enhanced biodiversity in the Fortescue catchment.
- Increased cattle productivity and enterprise profitability from improvements in vegetation and cattle management.
- Pastoral stations will continue as legitimate businesses in the Pilbara rangelands and these businesses need to be financially viable.
- Pastoralism has an environmental footprint in the rangelands that can be minimised through the adoption of best management practices.

Pasture ID Workshops and Book; and Grazing and Land Management Workshops

Pasture ID workshops were held at Yarraloola, Mulga Downs and Ethel Creek Stations in 2014. At these workshops the Pasture Identification Guide for the Pilbara that was developed by Mary-Anne Clunies-Ross and Andrew Mitchell was distributed with significant positive feedback from the pastoralists. These workshops helped pastoralists further identify native pasture species such as herbs, grasses and shrubs, the main families and their genera in the Pilbara and specific indicator species related to rangeland condition monitoring. Around forty people attended the workshops, with the majority of these people representing 15 different cattle stations with some pastoralists travelling from southern catchments to attend.

During subsequent visits, various pastoralists displayed the book which had significant signs of use. This was followed by the production, in association with DPIRD staff and Greening Australia, of a 'Ute Guide' of pasture grasses identification plus pictorial references of herbage dry matter rates associated with the range of pasture types grazed in the Pilbara at a range of growth/consumption stages. Further, an additional two-day pasture identification workshop was convened for pastoralists in the Pilbara.

Land rehabilitation

Over the last year and a half of the Fortescue River Catchment Corridor Project, Greening Australia's (GA) work focused on broad-scale restoration to increase ground cover, enhance habitat quality and improve ecosystem condition in priority locations within the Pilbara. GA has been demonstrating that restoration works can be undertaken collaboratively. This included the identification, planning and execution in priority areas (identified as an area of Wona Land System on the Ngurrawaana Lease and a scalded clay pan on Mulga Downs Station within the Hooley Land System).

Case Study 3: Direct Seeding Trials on Mulga Downs

This activity aims at building on the existing ESRM Plan and contributing to improved grazing management practices locally by:

- demonstrating the application of direct seeding as a means of achieving ecological restoration on pastoral land in the Fortescue River Catchment; and

- providing a blueprint to achieve an increased area of desirable ground cover, and improved vegetation condition, native fauna diversity and abundance.

Fencing of the Mulga Downs restoration site occurred at the beginning of June 2017. A 150-ha area (1.5km x 1km) was fenced by Mulga Downs station staff with support from this project to protect the restoration area from grazing. Approximately 50 ha at the site was seeded using a coarse and fine seed mix comprising the following species; *Acacia aneura*, *Acacia aneura* ssp *macrocarpa*, *Acacia tetragonophylla*, *Acacia victoriae*, *Acacia xipophylla*, *Eucalyptus vitrix*, *Maireana pyramidata*, *Sclerolaena eriacantha*, *Scleroleana diacantha*, *Sida echinocarpa*, *Ptilotus nobilis*, *Ptilotus auriculifolius*, *Ptilotus calostachyus* and *Ptilotus astrolasius*.

Little direct seeding of perennial tussock grasses has been undertaken on pastoral leases in the Pilbara. Consequently, there is little information about methods for seed treatment, soil treatment and preparation (fertilisers, soil ameliorants), and timing of direct seeding etc. This project sought to address this knowledge gap and provided some examples to follow and assess, in the hope of improving direct seeding success, cost effectiveness and accessibility. There are substantial areas of degraded land across the Pilbara region that have become hard and scalded and have lost vegetative cover. It is known that these areas are unlikely to recover without intervention as the hard crust on the soil surface increases water runoff and does not allow infiltration or seed penetration. Mechanical action is crucial to break the soil crust and allow restoration of these areas.

Early indications from this project show that even in areas where seeds have not yet germinated, manipulated soil has transitioned from a hard pan into a cracking clay system, allowing water and seed to lodge and penetrate the cracks (see Figure 12). Further germination without additional seeding is likely on these areas. Ongoing monitoring will determine whether this occurs in the future.

Figure 12: Direct seeding on Mulga Downs.

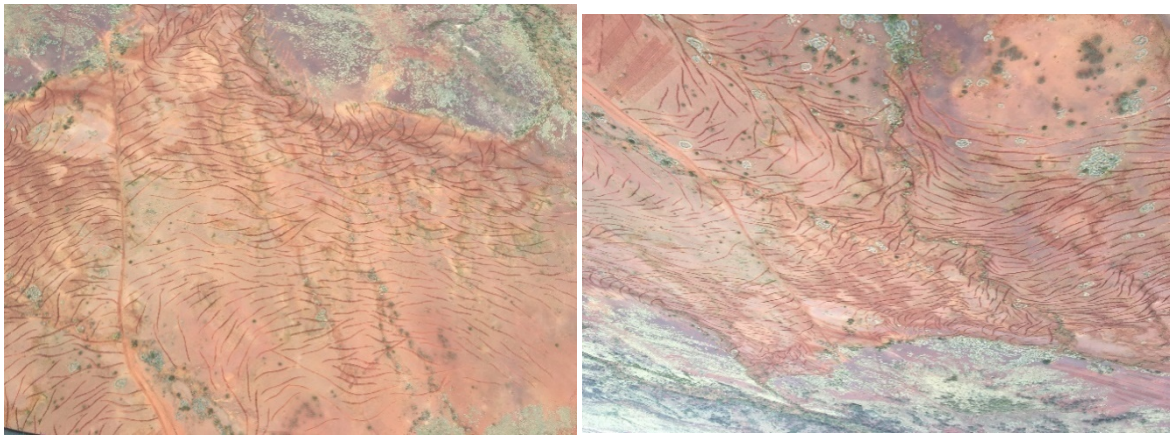
Case Study 4: Bonney Downs ESRM and follow up works

On the Bonney Downs/ Corunna Downs ESRM the priority management actions were to undertake rehabilitation works to improve the landscapes capacity to retain water. The decision was made to trial installation of water ponds – erosion works and restoration of degraded areas undertaken around Matt's bore. A D9 bulldozer was utilised for landscaping in combination with natural and man-made buffers to slow the flow of water across the landscape. This involved significant on-ground works in the upper catchment to pond water behind earth banks, sieve fencing to slow flooding waters on the landscape and low boy constructions on tracks to slow and direct water to

prevent erosion. The works encompassed over 750 land contouring activities which were showing early positive results in 2017. The results of the work are shown in Figure 13.

Pre-work

Extent of work done (aerial images)



Early Results

Figure 13: Comparison of results. Photo A country (left) was ripped and photo B country (right) was not ripped

Evaluation of the immediate results of land use and management activities

The important planned outputs from the Land Use and Management component were the completion of ESRM plans for all the pastoral stations with land in the Fortescue River Catchment, the building of pastoralists' land management knowledge and skills, and the implementation of recommended activities on the stations. The immediate results were that:

- Nearly all pastoral stations in the catchment now have ESRM plans, with several of these being funded by the lessees. The project has established 12 ecologically sustainable rangelands management (ESRM) plans with pastoralists across the Fortescue catchment to maintain ecosystem function and increase landscape resilience.
- All land managers in the catchment have an appreciation of the principles of ESRM planning; and were involved in pasture identification and management workshops; and
- Implementation of recommended activities has either been completed or commenced on many of the stations.
- Success of the ESRM process is currently evident in eight of the 12 pastoral leases post-ESRM, with the process having a wider influence as several pastoral leases in the catchment form part of multiple properties managed by major resource companies with pastoral interests in other regions.

The development of Indigenous Ranger Teams and their involvement in land management activities is another important positive result from the project.

Additional funding was secured from the State NRM Community Action Grants to continue the work commenced under this project. The additional grant will allow GA to undertake another round of seeding trials on the Mulga Downs site, and potentially others in the Pilbara. Further work will be undertaken to look at:

- seed predation impacts of termites, other animals and methods for mitigation;
- optimal timing for direct seeding; i.e. trialling dry seeding before summer rains rather than opportunistic windows during the wet season;
- soil testing for nutrient levels as related to survival of germinates.

Collectively, these immediate results have provided all land managers in the catchment with the tools and frameworks to deliver improved land management and ultimately beneficial environmental and economic outcomes in the catchment.

SUMMARY EVALUATION

As discussed in previous sections and below, the project substantially achieved all objectives, and in some cases achieved more than expected. The evaluation summary is presented against the evaluation purposes shown in Table 1.

Impact

The project has influenced fire management in the Fortescue catchment with invitations from pastoralists to advise on fire management planning and methodologies. The project was invited to take part in the WA Department of Biodiversity, Conservation and Attractions' Fire Management Strategy review.

The WA Government has released a draft Pilbara Conservation Strategy which recognises the work of the Fortescue River Catchment Corridor Project and has set aside funding and resources through the Pilbara Environmental Offset Fund to carry on with the work the Fortescue River Catchment Corridor Project has managed post the project timeline. This continues the work and momentum achieved during the project's term and provides long term acknowledgement of the project's impact on biodiversity in the Fortescue catchment.

The project was invited to be part of the planning team (five team members) for the Fortescue Marsh National Park. This involvement was based on projects carried out on and adjacent to the marsh and the support provided by Pilbara Corridors to the Fortescue Marsh stakeholders group.

The Project established a network of Rangelands AusPlots in the Fortescue catchment. Ausplots is the first nationally standardised monitoring methodology for rangelands vegetation and soils which provides data consistency and ease of accessibility. Prior to Rangelands AusPlots a multitude of methods were used by stakeholders which made data difficult to compare, was often restricted in use due to perceived commercial sensitivities and not easily accessible. Ausplots provides a structured and widely accepted baseline nationally for research priorities in relation to climate change cause, effect and trends.

The project created stakeholder awareness and engagement in landscape-scale management across the Fortescue catchment and Pilbara bioregion through its 22 projects, culminating in a Pilbara Biodiversity Conservation Action Plan (CAP).

The project provided a framework for stakeholders to discuss and engage in biodiversity conservation outcomes. The communications effort has enriched the lives of inhabitants within the catchment and provided a link to consultants, practitioners and service providers such as local and state government in a non-confrontational way.

Acknowledgement of the project and its activities through communication mediums such as TERN, local and state government, IUCN, Indigenous corporations and pastoral groups provides evidence of the credibility of the project and biodiversity outcomes achieved which are widely professionally respected.

Effectiveness

As presented in Sections A to E, the project achieved the immediate results of the **Fortescue River Catchment Corridor Project** identified in the Program Logic (see Figure 1), as follows:

- The area of targeted WoNS infestations has been reduced;
- ESRM planning and implementation will lead to a reduction to the impact of pastoral use on biodiversity through improved water and land management methodologies;

- improved fire regimes have been implemented; and
- feral animal control has been enhanced.

Additional project successes are improved stakeholder collaboration within sub-projects and across sub-projects as Pilbara Corridors working partner relationships have matured, and two Indigenous ranger groups are engaged and trained in land management activities;

The WoNS and pastoral ESRM works achieved uptake and results above and beyond original expectations as the service providers have co-contributed additional labour and hours to make a comprehensive difference.

The project also established a solid environmental baseline on which subsequent projects in the Pilbara can build upon, including an assessment of the samphire on the Fortescue Marsh, monitoring of the ephemeral wetlands associated with the system and the establishment of a range of AusPlots to quantify baselines, and measure future trends in the region.

In summary, this project has improved key habitat and biodiversity conservation through co-ordinated management of fire, weeds and feral animals in the Fortescue catchment at the landscape scale. Regenerative grazing practices and property planning through ESRM will help stabilise erosive processes.

Appropriateness

Only one substantial change was required to the methodology proposed for the project. The biodiversity fund monitoring methodology was superseded by the Rangelands AusPlots methodology during the life of the project. The decision to adopt the Rangelands AusPlots methodology was primarily based on this being a nationally agreed standardised monitoring methodology providing more detailed data and wider long-term use in conserving rangelands vegetation complexes and soils which better support the project outcomes. Rangelands AusPlots is supported through the Terrestrial Ecological Research Network (TERN) with data available on the AEKOS platform utilized by 17 universities, 29 state and federal organisations, and 5 international organisations.

Relations between pastoralists, state agencies, Indigenous groups and mining companies are often strained or non-existent. The project acted as an intermediary and functional meeting ground to discuss conflicting issues on conservation and to develop relationships to move ahead in a positive way. Information coming via the project has a different social context which provides for collaboration and action which wouldn't exist without the project structure.

The project provided Indigenous communities and groups with an equal voice which they may not receive through direct communication with stakeholders based on prejudices and historical stereotyping. This has provided improvements in the context of social outcomes leading to wider acceptance of Indigenous involvement in conservation and the opportunities through acceptance to engage in positive economic outcomes, in particular for ranger groups operating on country.

Efficiency

The project acted as a catalyst to encourage further stakeholder investment of funds and in-kind contributions from stakeholder resources towards conservation of biodiversity in the Fortescue catchment and the adjoining Chichester and Hamersley Ranges, which would not have occurred without the project presence.

Considerable time and effort has been expended in building relationships, forming partnerships and keeping lines of communication open for the purpose of contributing towards the project's biodiversity targets.

Stakeholders were more likely to contribute resources and support towards project success, as the project is a not-for-profit, non-political and non-commercial undertaking, as opposed to an organisation which may have been perceived as seeking a commercial or conflicting agenda. The project has demonstrated support for all stakeholders' values and endeavours in the Fortescue and has not represented a threat to those values. By developing project relationships with stakeholders, biodiversity targets could be jointly agreed and works funded, extending the effectiveness of project funds, particularly in fire and feral herbivore management.

FUTURE

The Department of Biodiversity, Conservation and Attractions (DBCA) in close association with the Office of the Environmental Protection Authority (EPA) has developed the Pilbara Conservation Strategy (https://www.dpaw.wa.gov.au/management/pilbara-conservation-strategy). This strategy draws from the Pilbara Corridors Conservation Action Plan as well as CSIRO's 2014 cost-benefit analysis of conservation strategies for threatened species and DBCA advice on the cumulative environmental impact of development in the Pilbara.

The alluvial plains, saltmarsh and seasonal wetlands and river systems of the Fortescue River Valley were highlighted as important biodiversity assets in the Pilbara Conservation Strategy (Government of Western Australia, 2017) with management of stock and feral animals identified as priorities for action. The work commenced in the Fortescue River Catchment Corridor Project will be built upon in the years ahead.

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