The Enduring Pilbara

A conservation vision for a land rich in nature, culture and resources

SUMMARY REPORT

This is an independent report

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Acknowledgement of country: The authors acknowledge the Traditional Owners of the Pilbara and their continuing connection to these lands. We pay respect to them and their cultures, and to their Elders past and present. We acknowledge the inextricable links between natural values and Aboriginal values and that the knowledge of Traditional Owners will be vital for maintaining both.

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The Centre for Conservation Geography (conservationgeography.org) is a research group established in 2011 to provide expert technical support and advice to government and nongovernment decision-makers and stakeholders. Based in Australia, we are a multidisciplinary team with expertise in marine and terrestrial protected area planning. Our skills include scientific research, evidence-based policy development, GIS analysis and mapping, and science communications and advocacy. We can support conservation decision-making across the world's ecoregions, and currently have projects in Australia, Canada and Antarctica

Contact: We welcome feedback and ideas. Please email info@outbackwa.org.au

Cover photo: Jajiwarra (Robe River), meaning 'no fine sand', is integral to the cultural identity of the Robe River Kuruma people. All along Jajiwarra are Aboriginal sites, including sacred Thalu (increase sites), ceremony places and archaeological sites. Image: Gavin Canning

CENTRE FOR CONSERVATION GEOGRAPHY
Strategic Tools and Conservation Innovation

UNIVERSITY of TASMANIA

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Foreword

The Pilbara is special to each of us.

As a botanical ecologist, Stephen worked in the Pilbara for 20 years in conservation and land management – documenting the unique flora (including many new species) of this national biodiversity hotspot, investigating the impacts of fire regimes that cause biodiversity decline and weeds such as buffel grass, and assessing the environmental impacts of mining and infrastructure proposals. Many of his efforts were informed by discussions with Traditional Owners and his desire to capture Traditional Ecological Knowledge and understand its application to the ongoing stewardship of Country by the Pilbara's Traditional Owners.

Peter has long been involved in sustainability research, advocacy and strategy work in the Pilbara. His *Pilbara Regional Sustainability Strategy* (2004) and *Pilbara 2050* (2015) report helped set up the current move to Net Zero mining, with its massive potential in green steel, lithium battery minerals and solar-electric based mining now rolling out across the landscape. His work, which also included the *Social Impact Study of the Rudall River Region* (1993), has confirmed that any future economic development not done in partnership with Indigenous people would fail the most basic sustainability test.

The *Enduring Pilbara* report, an initiative of Partnership for the Outback, brings together sound scholarship and ground-truthed awareness of local challenges and opportunities as the basis for an inspiring but realistic conservation vision for the Pilbara. It is a vision we support and an important step forward in the collective effort to achieve sustainable outcomes for the Pilbara that acknowledge nature.

The *Enduring Pilbara* is also a benchmark reference document for those seeking to understand and manage the Pilbara's magnificent environment, its threats and opportunities. The report recognises the complexities and uniqueness of the Pilbara's landscape and ecology and its enduring First Nations peoples, their rights and connections to Country, and their pivotal place in the emerging Pilbara conservation, land management and restoration economies.

Importantly, the report also grapples with economic realities – recognising that mining and pastoralism will continue to be dominant land uses and economic mainstays and calculating the investments needed to also build a thriving conservation economy, which would support and complement existing industries. We believe that the vision of the report is highly ambitious but achievable:

> *By 2031 the Pilbara is the world-leading exemplar of landscape-scale conservation in a region of critical economic importance. Cultural and conservation land management is comprehensively implemented across all tenures, delivered through partnerships between Traditional Owners, industry, government and community.*

The report aligns with much existing work, including our own. As the world moves rapidly towards decarbonised economies, the Pilbara must illustrate how that transition can be realised, especially given its crucial role in the wider Australian economy. The move to a renewable energy net zero economy and the other big transitions needed for sustainability require effective partnerships between government, industry and community. Partnerships are the bedrock of the conservation vision in the *Enduring Pilbara report*.

Although much touted, achieving effective partnerships is challenging – they require genuine commitments and considerable investment of time, energy and funding. The partnerships needed to achieve landscape-scale cultural and conservation land management in the Pilbara will need support to sustainably lift the capacity and capability of Traditional Owners, and also, just as importantly, investment in the capacity and willingness of state agencies, pastoralists and miners to jointly manage with Traditional Owners the land and its inherent cultural and natural values.

We encourage all those who care for and have interests in the Pilbara's land and waters to read the *Enduring Pilbara* report and embrace its vision.

Stephen van Leeuwen and Peter Newman

Professor Stephen van Leeuwen is the BHP Curtin Indigenous Chair of Biodiversity and Environmental Science at Curtin University. He is a respected South West Boojarah Wardandi Noongar leader with a profound respect for Country who engages and builds collaborative relationships with Traditional Owners and other land managers to co-deliver novel and enduring outcomes for biodiversity conservation, bio-cultural land management, and the stewardship of Country. He has a diverse research pedigree extending from threatened flora survey, fire ecology and threatened flora and fauna management through to biological survey, arid zone ecology, plant taxonomy and pollination biology.

Professor Peter Newman AO is Professor of Sustainability at Curtin University. He has written 23 books and over 400 papers on sustainable cities and regions. He has worked to deliver these ideas at all levels of government, including as an advisor to three premiers and on the Board of Infrastructure Australia and the Prime Minister's Cities Reference Group. He is the Co-ordinating Lead Author for the UN's Intergovernmental Panel on Transport. In 2014 Peter was awarded an Order of Australia for his contributions to urban design and sustainable transport. In 2018/19 he was the WA Scientist of the Year.

Python Pool, a popular attraction in Millstream Chichester National Park, is part of the traditional country of the Yindjibarndi people. Image: Gavin Canning

Introduction

The Pilbara epitomises endurance – over geological, evolutionary and cultural timeframes. Geologically, the region is defined by a robust piece of continental crust that has survived billions of years of tectonic upheavals. The Pilbara's plants and animals – exceptionally diverse for an arid region – are survivors of immense climatic swings, many exemplifying ingenious evolutionary innovations to cope with extremes. And through cultural and technological innovation, The Pilbara's Aboriginal people have also survived – some 50,000 years or more – to now count among the world's oldest living cultures.

The Pilbara bioregion (Figure 1) remains a tough landscape for life – and not just because it is naturally one of the most extreme environments in Australia. Since the late 1800s, human and non-human newcomers have intensified the pressures on life. The consequences, not unique to the Pilbara, have been a diminishment of biodiversity and degradation of landscapes. The Pilbara's Traditional Owners have suffered the catastrophes of dispossession and cultural suppression.

These are the big challenges in the Pilbara today – to arrest and remediate the harm to nature, and support Traditional Owners to once again thrive, reconnected with their country and strong in culture.

The Pilbara is also the world's most lucrative iron ore mining province, hailed as the engine room of the Australian economy. Its iron ore mines are Australia's single largest source of export revenue

This coincidence of high-value resources with outstanding natural and cultural values means that conservation in the Pilbara must be done differently from elsewhere. With more than 80% of the bioregion under pastoral or mining tenures or both, and just 6% in conservation reserves, the primary conservation focus must realistically be on establishing conservation management on productive landscapes, in partnership with industry, whatever the tenure.

Our vision is for the Pilbara to become the world-leading exemplar of landscape-scale conservation in a region of critical economic importance, delivered through partnerships between Traditional Owners, industry, government and community.

Essential to this is for the Pilbara to be appreciated as much more than mega-mines and red-dust cattle stations. The Pilbara should also be famous for its ancient geology and fossils, rich and unique biota, relatively intact landscapes, and diverse human cultures.

The purpose of this report is to promote a more expansive Pilbara identity, based on its natural and cultural wealth, and to set out a vision for the region and its economy based on sustaining and restoring these values. We outline the Pilbara's natural values, major land uses, threats, conservation gaps and opportunities, and the benefits of expanding the regional conservation economy.

Figure 1 The Pilbara bioregion (the focus of this report is the bioregion, not the broader region also known as the Pilbara).

Opposite: The low, deeply weathered Chichester Range contains the remnants of iron-rich lava that emerged from deep within the Earth some 2.7 billion years ago and blanketed much of the Pilbara craton. Image: Michael Pelusy

Natural values of the Pilbara

The Pilbara is not the most hospitable place for life – being Australia's hottest and most cyclone-prone region and lacking much surface water. But its endurance through deep time has provided long periods for life to adapt and radiate, facilitated by a complex geology and topography providing diverse habitats and refugia during harsh climatic periods.

The Pilbara is probably the world's oldest stable piece of Earth's crust, with rocks that formed up to 3.6 billion years ago. And it offers the oldest convincing evidence of life, with fossilised colonies of cyanobacteria (stromatolites) that lived in hot springs 3.5 billion years ago.

The Pilbara's wealth of species has earned the region recognition as a biodiversity hotspot, one of just 15 designated by the Australian Government. It is a centre of arid zone biodiversity, with outstanding diversity or endemism, or both, for reptiles, subterranean animals and other invertebrates, wattles and spinifexes.

With rugged rocky ranges and gorges, and spinifex stretching across rich red and stony plains plains, the Pilbara is a photographer's delight. It is the most mountainous region of Western Australia – the iron-rich Hamersley Range is the state's highest at up to 1,250 metres, while the older basaltic Chichester Range is about 600 metres high.

Most fresh water in the Pilbara lies underground. Except after heavy, often cyclonic, summer rains, the rivers (figure 2) run dry along most of their length, with numerous springs and permanent pools providing refuge for aquatic life.

The Pilbara's wetlands are diverse – claypans and clay flats, rockpools in creeks and rocky outcrops, springs, river pools, and ephemeral lakes and marshes. Six wetlands are recognised as nationally significant (figure 2), including the Fortescue Marshes, of international significance for waterbirds, and Karijini Gorges, with spring-fed pools that are refuges for rare animals and disjunct plants.

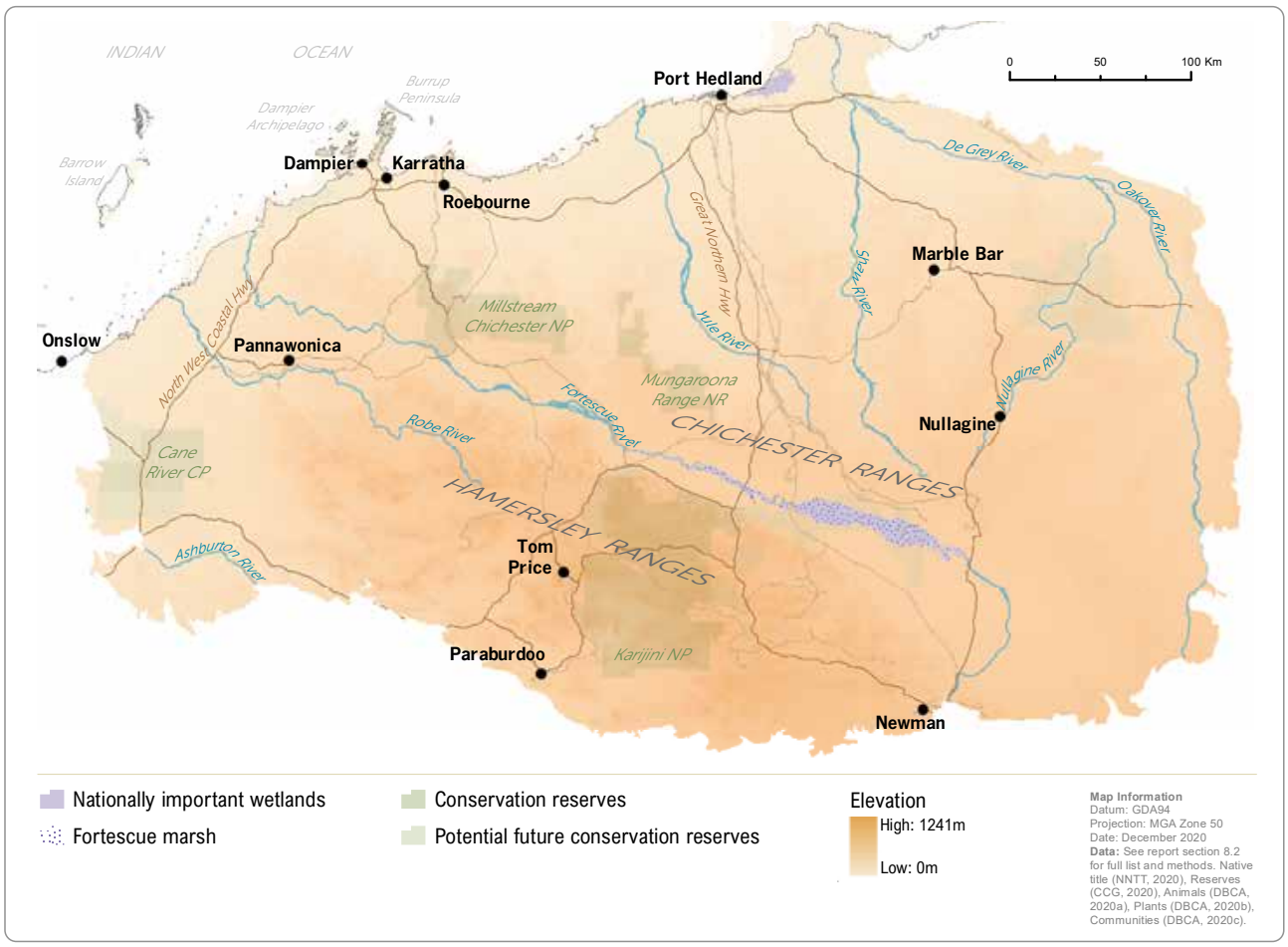


Figure 2 Rivers and nationally important wetlands of the Pilbara bioregion.

Opposite: The Pilbara is a globally significant lizard hotspot. This rock dweller is a ring-tailed dragon (Ctenophorus caudicinctus), also known as the bicycle lizard, for looking like a cyclist when it runs on its back legs. As with many Pilbara reptiles, it is part of a species complex, with genetic differences between populations across the arid zone indicating as many as 4 different species, reflecting a complex climatic history of alternating drier and wetter periods. Image: Stephen Zozaya

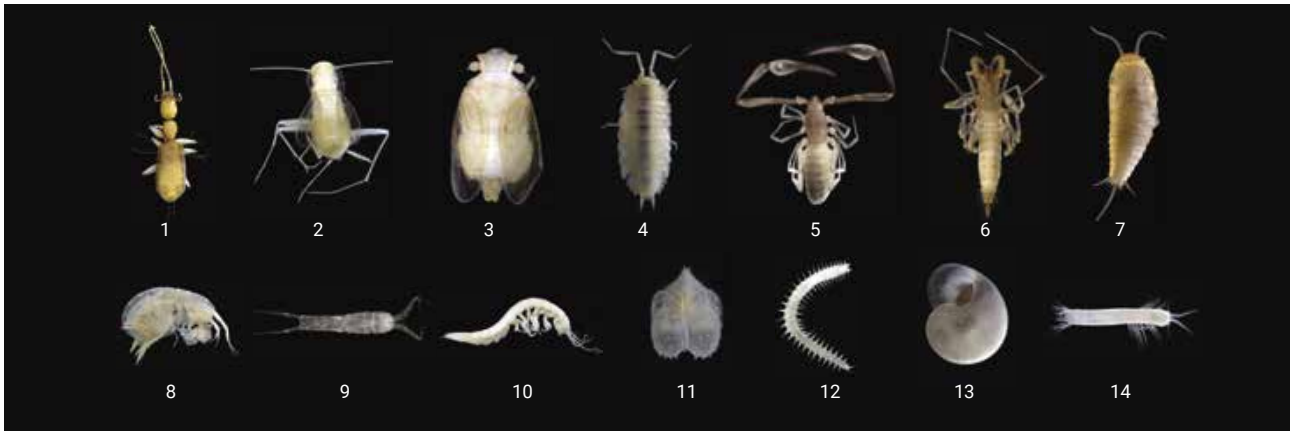
The Pilbara coast has globally significant geoheritage values, and the coast and nearshore islands have high conservation and cultural values. Murujuga (the Dampier Archipelago, a chain of 42 islands) hosts important mammal populations, diverse reptiles and plants and several endemic land snails. Many islands serve as refuges for species threatened by cats and foxes. The striking block volcanic rocks of the Archipelago feature more than a million engraved artworks – spectacular evidence of Aboriginal people's long occupation of the Pilbara coastline. Added to the tentative World Heritage list in 2020, Murujuga's enduring cultural heritage is of global significance.

PLANTS AND ANIMALS IN THE PILBARA

Subterranean animals: Some of the most surprising animals of the Pilbara live in the perpetual darkness of underground aquifers, fissures, voids and caves – most discovered in the past 20 years. Their diversity in the Pilbara is globally significant – one of the highest, if not the highest, in the world for both stygofauna (animals living in groundwater) and troglofauna (air-breathing animals living in voids a metre or more below ground) The tally for the Pilbara is likely to approach 3,000 species, almost all unique to the bioregion. Conserving subterranean animals is challenging. Their small ranges make them highly vulnerable to extinction from single mining developments and little is known about their ecology and distribution.

Reptiles: Hot, geologically diverse and rocky – the Pilbara is well made for snakes and lizards. The region has the highest reptile diversity in Western Australia and is part of an Australian lizard hotspot running from central Australia to the Pilbara coast. More than 150 lizard and snake species (not counting sea snakes) have been recorded so far, many unique to the region. Fifteen reptiles are listed as threatened or priority species in Western Australia and 6 are listed nationally as threatened.

These are 2 of 15 threatened or priority reptiles in the Pilbara. Nevin's slider (above) is an endangered nocturnal sand-swimming skink known only from near Cape Lambert, over an area of less than 500 hectares. The Pilbara olive python (below), found only in the Pilbara and Gascoyne bioregions and listed as vulnerable, is one of the half dozen longest snakes in the world. Image: Brian Bush



Here are examples of some of the immense diversity of troglofauna (top row) and stygofauna (bottom row) in the Pilbara, many not yet scientifically described. Images: Jane McRae, Bennelongia

Top: 1. Beetle, 2. Cockroach (Nocticola), 3. Planthopper (Phaconeura), 4. Isopod (Hanoniscus), 5. Pseudoscorpion (Indohya), 6. Schizomid (Draculoides), 7. Silverfish (Atelurinae)

Bottom: 8. Amphipod (Amphipoda), 9. Copepod (Haifeira pori), 10. Isopod (Pygolabis), 11. Ostracod (Gomphodella yandi), 12. Polychaete (Namanereis pilbararensis), 13. Snail (Hydrobiidae), 14. Syncarid (Billibathynella)

The Pilbara is the main stronghold of the endangered northern quoll, with many populations in other regions collapsed or likely to collapse in the near future due to poisoning by cane toads. Image: Henry Cook

Mammals: The mammals of the Pilbara are masters of endurance – often persisting in low numbers when resources are low and rapidly recolonising habitats when conditions improve. Many can save enormous amounts of energy and water by entering daily torpor. Before European colonisation there were at least 60 mammal species in the Pilbara, a number exceeded in Australia's arid zone only in the Carnarvon bioregion. Six species are unique to the Pilbara or almost so (extending slightly into adjacent regions). The Pilbara has lost 20% of its known mammal fauna (12 species), most probably due to cat and fox predation. Four mammals are listed as threatened at state and national levels and 7 are state priority species.

Birds: The relatively high diversity of birds in the Pilbara – more than 300 species (including seabirds and vagrants) – reflects the diversity of habitats and proximity to tropical, arid and subhumid regions. But, reflecting the harsh and changeable conditions, fewer than half the species are residents. Many are nomads, moving in when conditions are favourable. Thirteen species are listed as threatened at a state or national level and 5 are state priority species. The Pilbara is particularly important for the night parrot – one of Australia's most threatened and iconic birds.

Cryptic, enigmatic and elusive – the night parrot is one of Australia's rarest and most sought-after birds. Fortescue Marsh in the Pilbara is one of a handful of locations where it is known to have survived. Image Bruce Greatwich

The green sawfish nursery in the Ashburton River estuary and adjacent tidal mangrove creeks is potentially the most important in the world for this critically endangered species. Image: Kathie Atkinson/AUSCAPE

Fishes: The freshwater fish of the Pilbara are dominated by the relatively few species – 10 recorded species – that can survive the extremes of massive flooding and high-velocity flows and the long dry season when rivers contract to isolated pools. Another species, an eel, is one of just 3 vertebrate animals in Australia known to live their entire lives underground. The Pilbara rivers also host 16 fish species that spend most of their lives in the ocean or estuaries, including barramundi. At least 2 freshwater species are unique to the Pilbara, and genetic studies indicate there are likely to be more. Four species are listed nationally or internationally as threatened and by the state as threatened or priority species.

Plants: The Pilbara's plants are also masters of endurance – able to withstand nutrient poverty and large fluctuations in temperature and moisture. The dominant families are characteristic of those across the arid zone – grasses, legumes, mallows, daisies and chenopods – but with more than 2,000 taxa recorded, the Pilbara has a richer flora than most other arid regions. About 15% are unique to the region. The likely reasons for high diversity are similar to those for animals – the complexity of the landscape with multiple soil types and landforms, the long-term geological stability, and refugia that enabled survival during periods of peak aridity. Wattles are particularly rich, with more than 125 species recorded. Other diverse groups are the emu bushes and spinifexes. Close to 10% of Pilbara plant species(figure 3) (186) are listed as state threatened or priority species. About a quarter of these have not yet been scientifically described.

The Pilbara is a centre of spinifex diversity and endemism, with at least 26 species, including 10 endemic and 5 near-endemic species. Image: Reg Morrison/AUSCAPE

Snails, spiders and other invertebrates: For most invertebrate groups, too little is known about them to discern the significance of the Pilbara. Just 1 of 22 species of scorpions and 15% of 375 ground-dwelling spider species collected during surveys by the Western Australian Government in 2003–2006 had been described. The Pilbara is likely to be an important refugial area for some groups, including trapdoor spiders, beetles and land snails. For an arid zone, the Pilbara also has a rich array of aquatic invertebrates, probably about 1,2000 species, due in part to the abundance of wetlands maintained by groundwater aquifers and the diversity of habitats in river pools. Eight invertebrate species endemic to the Pilbara are listed by the state as threatened and 5 are listed as priority species.

Little is yet known about the spiders of the Pilbara – most are not even described – but they promise to be another highly diverse group of animals with much to reveal about the deep past. The pale spider on the left (found in a mining survey in 2013 and not yet named) lives underground in fissures. It is blind (eyes are no use in perpetual darkness) and hunts with the help of highly sensitive hairs on its legs. Missulena langlandsi (right), described only in 2013, is a mouse spider known only from the floodplain of Weeli Wolli Creek. Images: Volker Framenau

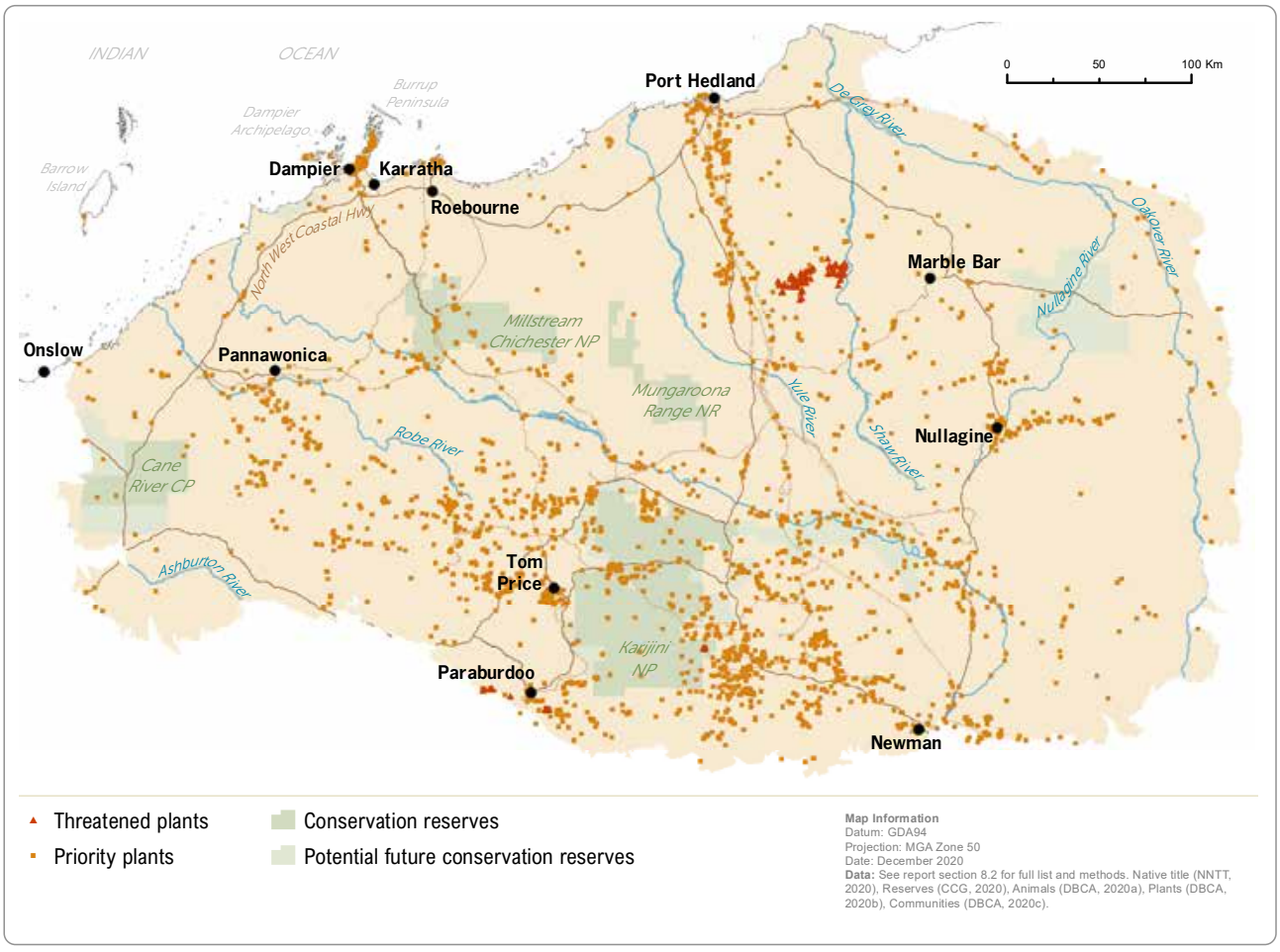


Figure 3 The distribution of state-listed threatened and priority plant species in the Pilbara

This map indicates a survey bias in the Pilbara. Records of the distribution of threatened and priority species are closely aligned in several places to the locations of mines and railways, due to the surveys required for approving new mining infrastructure.

Land uses and threats to nature in the Pilbara

Although the Pilbara is one of Australia's most ecologically intact bioregions, much has been damaged or altered since pearlers and pastoralists arrived almost 160 years ago. The most severe threats in the Pilbara are those that operate almost everywhere in Australia – invasive plants and animals, altered fire regimes, overgrazing, habitat destruction and changes to water flows.

LAND USES IN THE PILBARA

Pastoralism: Spurred by over-optimistic reports of the Pilbara's grazing potential, European colonists rapidly established sheep stations from the 1860s. When the industry collapsed in the 1930s, with sheep numbers dropping by almost two-thirds from a peak of 1.8 million, the more-nutritious pastures had been severely degraded – saltbush and bluebush largely lost from the Roebourne Plains, grasses depleted along the rivers, and tussock grasses displaced by spinifexes in many areas. Drought, wallaroos, wild dogs, blowflies, grasshoppers, mice, financial hardship and a lack of labour were other reported tribulations. Low wool prices and low wool cuts, followed by the collapse of the wool reserve price scheme in 1991, eventually drove a complete shift to cattle. The industry today consists of 57 leasehold properties (and small parts of others) (figure 4), as well as 2 Aboriginal reserves, operating across 10.6 million hectares (60% of the Pilbara), with a herd of about 260,0000 cattle.

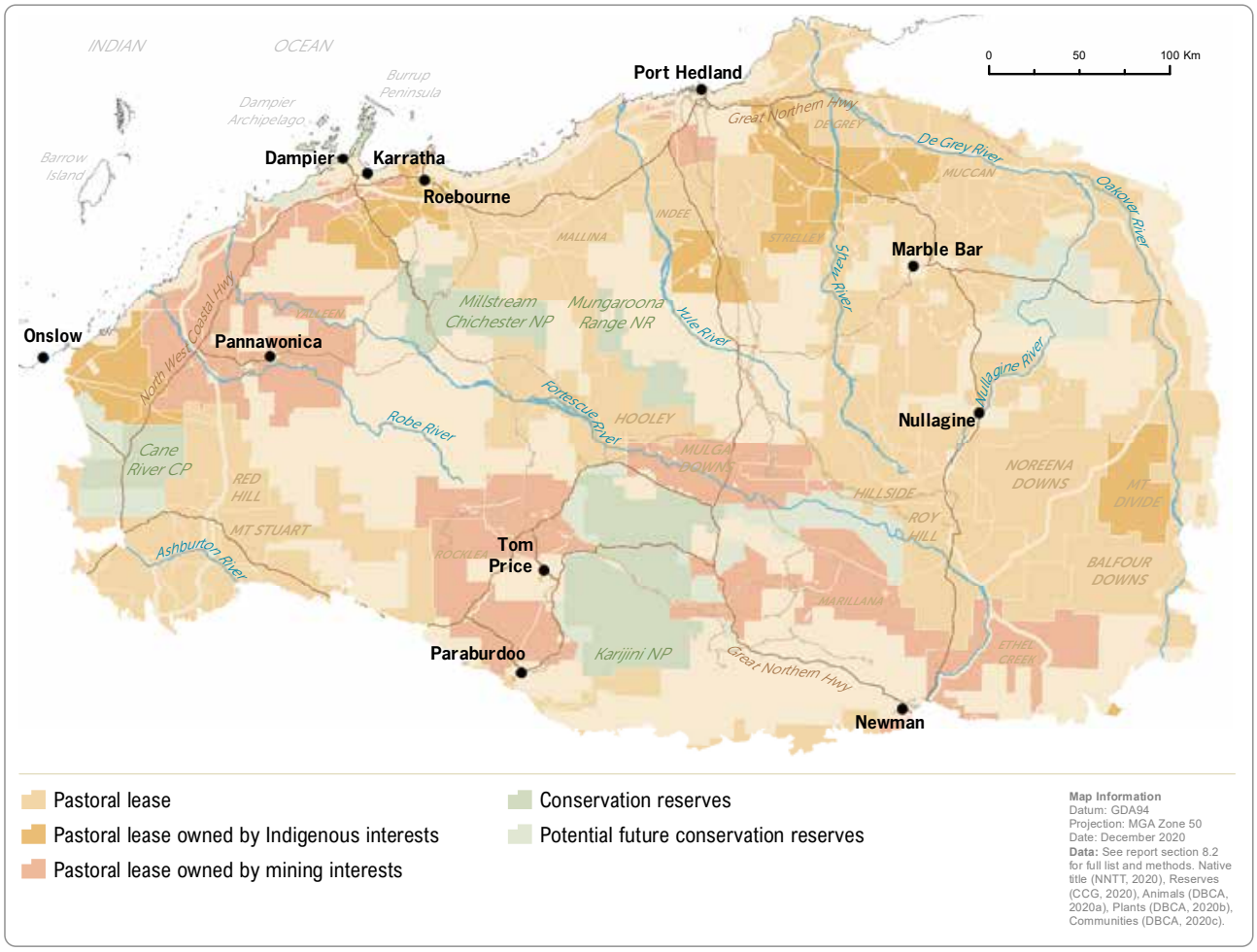


Figure 4. The distribution and ownership of pastoral leases in the Pilbara

Opposite: Can the Pilbara become a showcase for conservation on economically important lands – with economic activity supporting landscape-scale cultural and conservation land management rather than undermining it? This mine (Marandoo) on the lands of the Eastern Guruma people was once national park. Image: Krystle Wright

Prior to the introduction of livestock, Australia was the only inhabited continent lacking hoofed animals. Now, they are our dominant vertebrate animal, including in the Pilbara, where there are about 260,000 head of cattle. The ecological impacts are most evident around rivers and wetlands and on tussock grasslands, chenopod shrublands and the coastal plains. Image: Christine McPherson

Here, the Earth's surface has been sculpted by impressive technological innovations for digging up iron ore. Below are crustaceans, beetles and other creatures living in the perpetual darkness of groundwater – exemplifying extraordinary evolutionary innovation. This is the Eastern Ridge mine in the Hamersley Ranges and somewhere below is the Ethel Gorge Aquifer Stygobiont Community. Image: Krystle Wright

Mining: In 1938, as World War 2 loomed, the Australian Government banned the export of iron ore to prevent sales to Japan. The embargo was p***art***ly relaxed in 1960, bringing news of startlingly large iron-ore discoveries. Within a decade of the ban being completely lifted in 1966, the Pilbara had 10 new towns, 4 railways and 3 deep-water ports, and the population had surged more than 10-fold.

Mining tenements (production and exploration) now cover 55% of the Pilbara – more than in any other Australian bioregion – and will cover more than two-thirds if all pending exploration leases are granted (figure 5). Large swathes of the region have been industrialised, with more than 25 large iron ore mines linked to 4 port terminals by 1,700 kilometres of railway line. The astonishing volumes of iron ore extracted (more than 800 million tonnes in recent years) generate astonishing amounts of revenue ($97 billion in 2019).

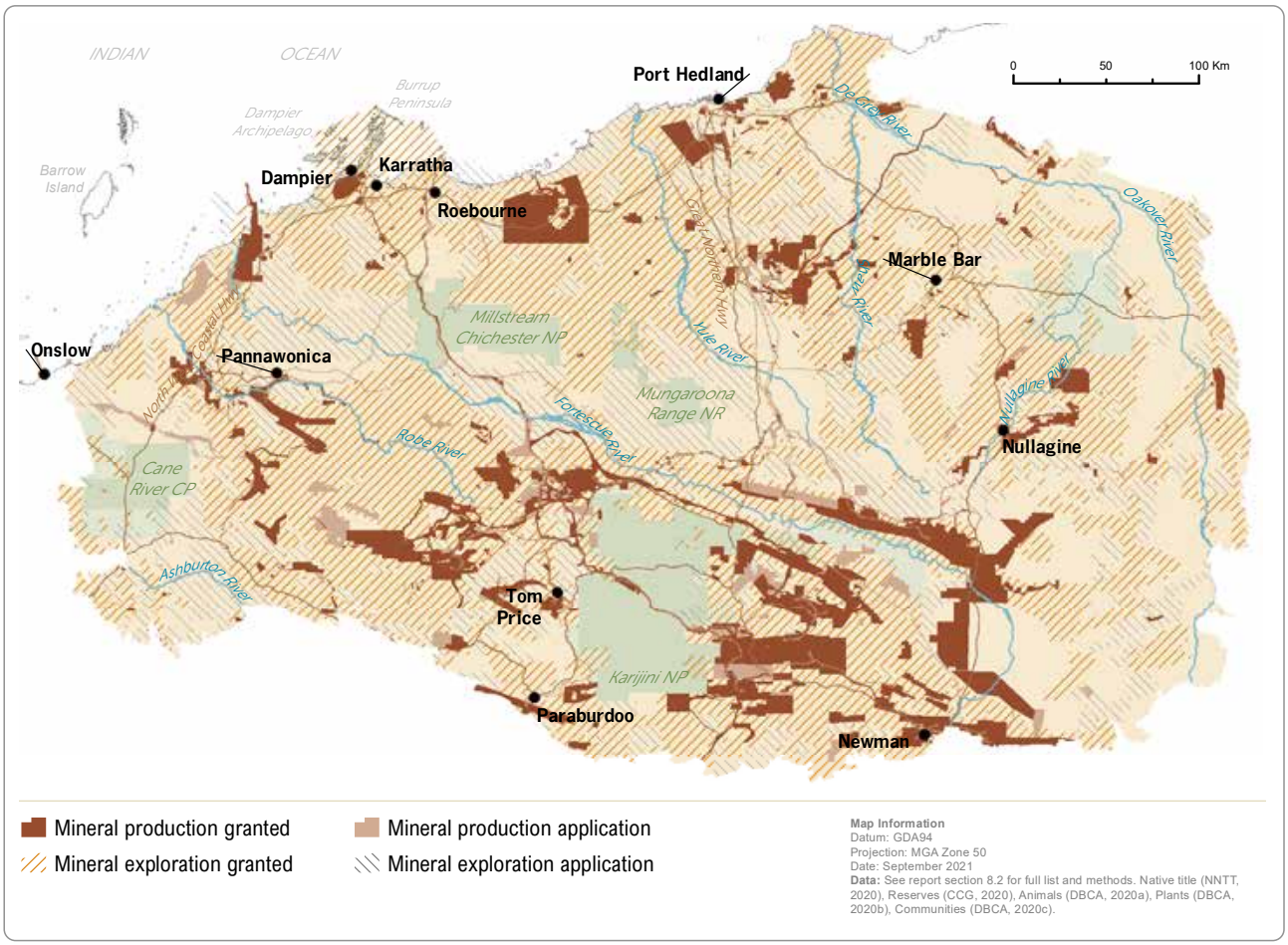


Figure 5. The distribution of mining tenements in the Pilbara – production leases (granted and pending) and exploration leases (granted and pending)

THREATS TO NATURE

Introduced Animals: Foxes (in coastal areas) and feral cats have probably been a major cause of extinctions and declines in the Pilbara. Cats are a major threat to the bilby, northern quoll and night parrot. Introduced herbivores (cattle, horses, donkeys, goats, camels), domestic or feral, are recorded as a threat to 19 of the 31 threatened and priority ecological communities, many of which are tussock grassland or chenopod shrubland communities. Detrimental impacts of livestock are evident mainly in the most productive lowland areas (the Fortescue and De Grey valleys and coastal plains) and in wetland and riparian habitats. The watering of stock at rivers and creeks is mostly not well controlled – resulting in bank erosion, trampled riparian vegetation and water siltation. The riparian zones of the major river systems have been assessed as 'generally degraded to fair' (requiring significant management intervention for recovery).

Government assessments of pastoral land condition have warned for many years that livestock levels in the Pilbara are too high. A 2019 report found that cattle numbers, which had increased by 46% over the prior 20 years, exceeded the estimated potential carrying capacity in all districts, resulting in a 'very high' to 'moderate' risk of vegetation condition decline.

The introduction of red foxes to Australia in the mid-1800s brought ecological catastrophe – with feral cats, they have been the major cause of mammal extinctions and declines. The impacts of foxes are exacerbated by their propensity for 'surplus killing' (they kill more animals than they eat). In the Pilbara foxes occur mainly in coastal areas. Image: Nature Picture Library / Alamy Stock Photo

Weeds: About 180 weed species have been recorded in the Pilbara – almost 1 in 20 of the total flora. Although this is low compared to many other regions, weed numbers are increasing and most are in the early stages of invasion with the potential to get much worse. The Western Australian Government has rated the ecological impacts of 29 weeds in the Pilbara as 'high', and at least 14 species, including buffel grass and mesquite, have landscape-scale impacts by altering fire patterns, modifying soil characteristics or competing directly with native species. About 300,000 hectares is infested with mesquite, a highly aggressive weed that forms thorny thickets. Climate modelling indicates it could invade the entire region.

Mesquite infests about 300,000 hectares of the Pilbara. Image: © State of Western Australia (Department of Primary Industries and Regional Development, WA)

The replacement of traditional burning regimes across much of arid Australia with hotter, larger and more frequent fires is thought to have contributed to the decline of many mammals, by reducing food availability and increasing predator risks. Image: Shutterstock

Adverse fire regimes: Most of the Pilbara is highly flammable. Under traditional management prior to colonisation, much of the region would have been subject to small cool-season fires, resulting in a mosaic of different-age patches. Now, large, intense, lightning-ignited, hot-season fires are more typical, producing large-scale vegetation uniformity. The threat has been exacerbated by the invasion of flammable grasses, particularly buffel grass. Modern fire regimes are a threat to fire-sensitive plants and ecological communities and probably also to the bilby, northern quoll and other threatened animals. Large fires destroy their food and shelter and attract feral cats. When fires are too frequent to allow regeneration of mulga and related wattles, mulga woodlands turn into spinifex grassland. Altered fire regimes is a threat for 11 of 31 listed threatened and priority ecological communities.

Mining impacts on habitats and water: Open cut mining is necessarily highly destructive at a local scale and can also cause larger-scale damage due to changes to groundwater and surface water flows and quality, the disposal of tailings and waste, release of contaminants, air pollution and greenhouse gas emissions. The majority of clearing in Western Australia occurs in the Pilbara and the majority of that occurs for mining, much of it on unique landforms such as banded ironstone ridges, which are often areas of high biodiversity value. Western Australia's Environmental Protection Authority has found that most post-mining rehabilitation in the Pilbara is poor, achieving on average only about 15% of the pre-mining biodiversity.

The mining industry accounts for some 90% of water use in the Pilbara, about half of it for discharged mine dewater (water pumped from a mining pit when it is excavated below the watertable). Dewatering can destroy the habitat of stygofauna, dry up springs and perennial pools, and eliminate groundwater-dependent ecological communities. The disposal of dewater in rivers and creeks can change their ecology and destabilise and erode banks by changing their flow regime from seasonally intermittent to permanent. Most mining pits are not backfilled, so when mining ceases they fill with groundwater and become lakes. In 2014, there were an estimated 97 pit lakes in the Pilbara and 178 were proposed; another 670 pits may become lakes in the future. These lakes are typically deep, lack riparian vegetation, and often have poor water quality.

Iron ore mining requires the creation of huge waste dumps (as shown here) and the disposal of large volumes of water when mining drops below the watertable. Image: Krystle Wright

Conservation activities and gaps in the Pilbara

CONSERVATION ACTIVITIES AND GAPS

Despite the outstanding biodiversity values of the Pilbara and the extreme wealth generated there, the conservation focus in the region has been limited – constrained by the dominance of mining and pastoralism on the landscape, economy and government priorities. Outside conservation reserves, much conservation work has been short-term, resulting from mining offsets or grants for individual projects.

Despite the outstanding biodiversity values of the Pilbara and the extreme wealth generated there, the conservation focus in the region has been limited – constrained by the dominance of mining and pastoralism on the landscape, economy and government priorities. Outside conservation reserves, much conservation work has been short-term, resulting from mining offsets or grants for individual projects.

Scientific knowledge: Ecological knowledge of the Pilbara is poor despite a surge of species discoveries driven by the rapid expansion of mining. The first comprehensive survey of the Pilbara, from 2002 to 2007, resulted in the discovery of hundreds of new species. The pace of discoveries remains high, due to new mining projects and genetic research revealing much cryptic diversity (different species that look alike). Many Pilbara species are yet to be described, including more than a fifth of the region's threatened and priority plant species. Recording and naming species is only the first step, and even for iconic species in the Pilbara, the scientific understanding of their ecology and threats is rudimentary. Information about the status of threats, vegetation, species of conservation significance, river and wetland condition and most other environmental indicators is scarce.

Conservation reserves: The Pilbara lacks what is regarded as a cornerstone of conservation – a comprehensive, adequate and representative reserve system. Just 6.4% of the bioregion is held in the formal (state-managed) conservation reserve system – well below the 17% international target for 2020. The majority of threatened and priority biodiversity – 50% of animals, 62% of plants, 81% of ecological communities – as well as 69% of land systems have no representation in the reserve system. The main impediment to more reserves is the reluctance of the state government to protect areas potentially prospective for mining. The reserve system could be improved by adding former leasehold properties acquired by the state government for that purpose, subject to agreement by Traditional Owners. These properties are held as unallocated crown land, a tenure providing no constraints to exploration and mining. Under Western Australia's *Plan for Our Parks*, there is potential for 2 new conservation reserves to be created – Fortescue Marsh and Meentheena – and for Karijini National Park to be expanded.

Managing northern quolls is one focus of Indigenous ranger groups in the Pilbara. Image: Noel Dodd

Opposite: Spinifex and snappy gum – a widespread vegetation type in the Pilbara. Image: Tourism Western Australia

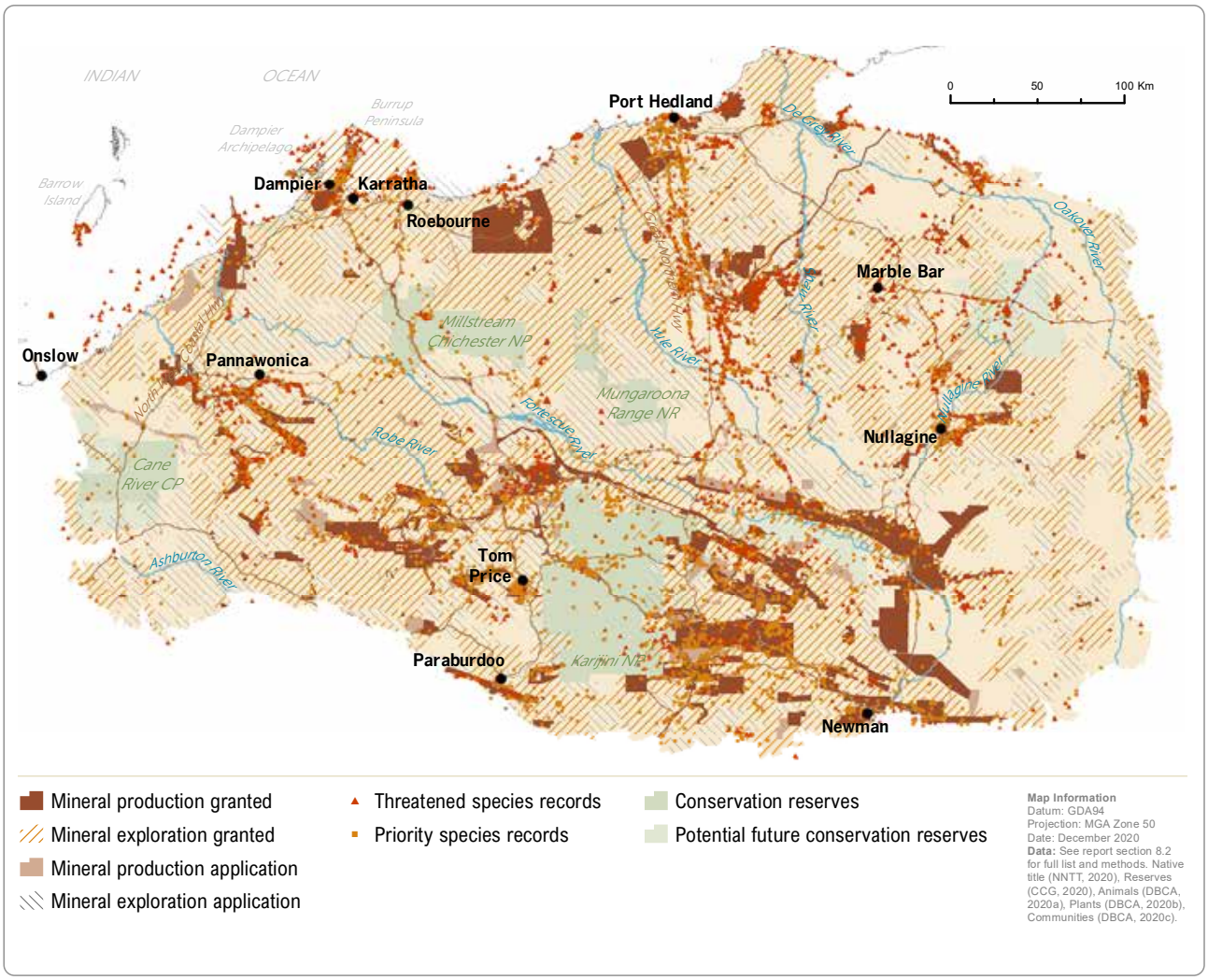


Figure 6. The known distribution of threatened and priority plants and animals in the Pilbara overlaid with mining tenements

Note: The alignment of most records of threatened and priority species in the Pilbara demonstrates the survey bias arising from the requirement for environmental assessments for mines and mine railways.

Conservation plans and strategies: Several regional plans and strategies have been developed for the Pilbara in the past decade, providing guidance on conservation priorities and options. But most have foundered due to a lack of funding for implementation. An exception are plans for the recently established Pilbara Environmental Offsets Fund. The concept plan for 2020–2025 has identified 3 focus areas for spending of $8 million over 5 years – fire management, riparian vegetation management and projects such as vegetation mapping to inform the design, delivery, monitoring and evaluation of projects.

Threat abatement: Threat management in the Pilbara is patchy – mostly done for pastoral purposes or to meet regulatory requirements for mining – with little of the region managed specifically for conservation.

For most weeds, the management capacity in the Pilbara is critically low, particularly on the pastoral estate. However, for more than a decade, there has been a concerted focus on mesquite and parkinsonia, both weeds of national significance. Other targets are bellyache bush, cactus species and stinking passionfruit. Feral herbivores, particularly donkeys and camels, are a threat to industry and the environment alike and are irregularly controlled. At Fortescue Marsh, a recent aerial shooting program has reduced donkey, horse and camel numbers, and the introduction of rabbit haemorrhagic disease virus has reduced rabbit numbers. One major advance has been fencing of the Cane River Conservation Park to prevent access by herbivores, and there are plans to fence high-value areas of Fortescue Marsh. The state environment agency focuses much of its control effort on feral herbivores on properties adjacent to pastoral leases and also controls feral dogs and dingoes for pastoral benefit.

Grazing practices vary considerably across the Pilbara and there are exemplars of sustainable grazing management.

However, a 2017 auditor general assessment concluded that knowledge of the environmental condition of leases in the Pilbara is poor and that current systems of monitoring and administration do not achieve ecological sustainability. There has been little analysis of the drivers for overgrazing and no new initiatives to address this problem.

Since 2015, the state environment agency has undertaken prescribed burning over an average area of 350,000 hectares, burning 10–30% of the treatment area each year, mostly in the conservation estate, on unallocated crown land and along roadsides. There is little information about the extent of prescribed burning for hazard reduction or conservation purposes on other tenures.

Recovery of threatened biodiversity: Few of the 240 or so threatened and priority species and 32 threatened and priority ecological communities in the Pilbara are the focus of recovery efforts. Most recovery work occurs as part of offset requirements for mines, including for the northern quoll, bilby and the endangered plant *Aluta quadrata*.

Conservation capacity: Although there are several well-considered conservation plans and strategies for the Pilbara, the outcomes so far have been patchy, for they have lacked the conservation workforce, funding and collaborations essential for implementation. A high priority for conservation in the Pilbara must be developing a sustainable conservation workforce and seeding a conservation economy based on collaborations across all major stakeholder groups. For enduring conservation programs in the Pilbara, a core focus must be supporting Traditional Owner-led, cross-tenure, landscape-scale cultural and conservation land management.

Dales Gorge, a popular tourism site in Karijini National Park, features Fortescue Falls, one of very few permanent waterfalls in the Pilbara. Image: Jessica Wyld

CONSERVATION OPPORTUNITIES

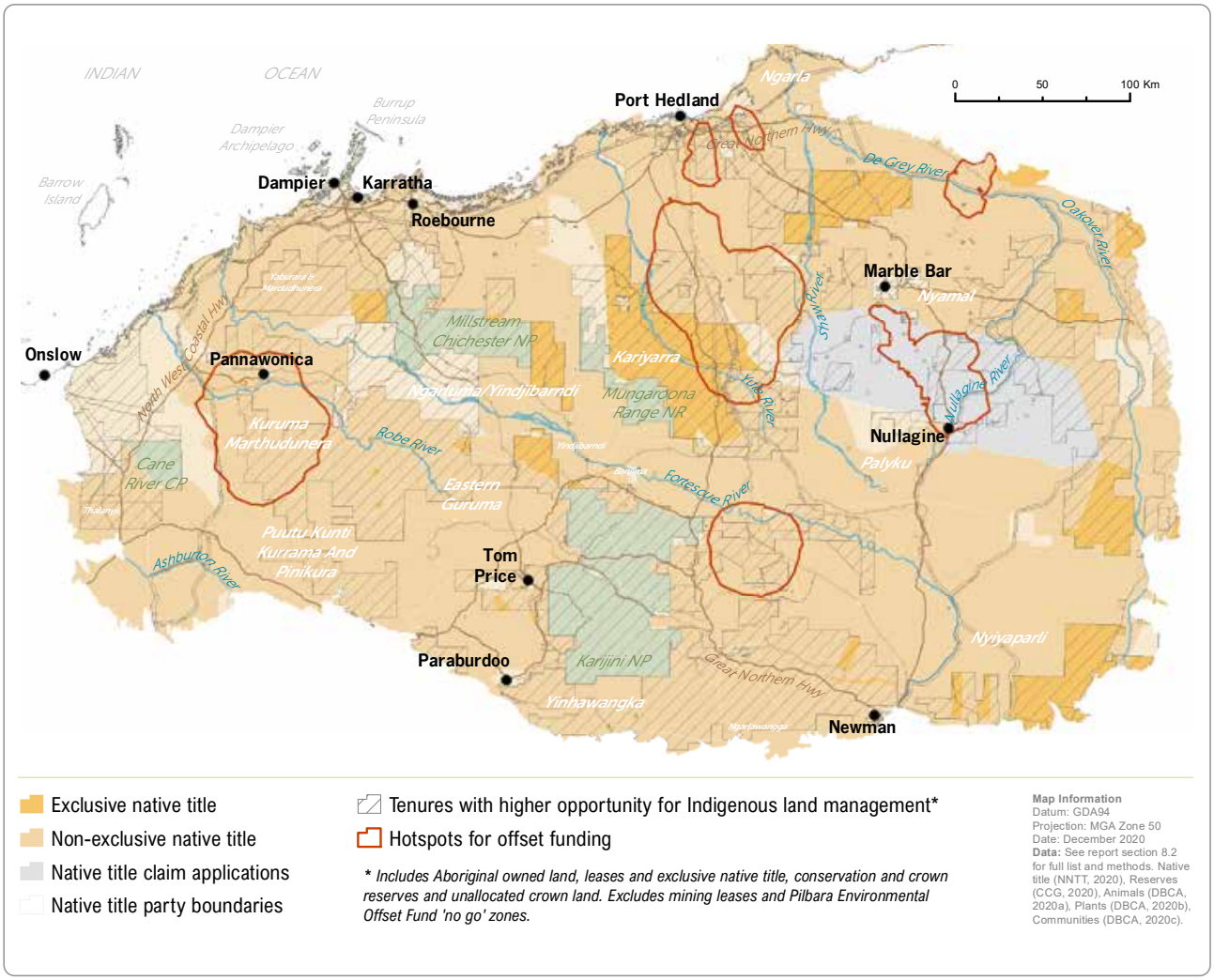


Figure 7. Priority areas for offsets under the Pilbara Environmental Offsets Fund and 'higher-opportunity' tenures for cultural and conservation land management

Note: Higher-opportunity tenures include Aboriginal owned land and leases, conservation and other crown reserves and unallocated crown land.

Major opportunities for improving conservation in the Pilbara lie with Traditional Owners – for they have native title rights across most of the Pilbara, strong conservation motivation, culturally inherited land management knowledge and responsibilities, and considerable latent capacity to establish a conservation workforce.

A second group with conservation potential is pastoralists, for they also have rights across much of the region. However, their motivations, conservation capacity, and external drivers are more variable and complex. Some have demonstrated a strong commitment to conservation, while others are probably limited in their capacity unless demonstration projects show that conservation can be practically integrated into their existing business model or offers economic opportunities.

With native title recognised over most of the pastoral estate, pastoralists will increasingly interact with Traditional Owners exercising their rights of access. Pastoral land can be cooperatively managed – for cultural, conservation and pastoral purposes. There is enormous untapped potential for cooperative, mutually beneficial land management, including with public funding support for Indigenous rangers to undertake management of weeds, feral animals and fire on pastoral leases.

On pastoral leases (60% of the Pilbara), opportunities for strengthening conservation while maintaining a pastoral business include:

- threat management, in mutually beneficial arrangements with native title holders to reconnect to their country and provide pastoralists with skilled management services

- stewardship support and conservation covenants to protect significant sites and species; the high conservation values of the Pilbara pastoral estate are good reason for the Western Australian Government to develop a rangelands stewardship scheme and covenanting program
- biodiversity offset projects under the Pilbara Environmental Offsets Fund (about 1 million hectares have been classed as investment hotspots)
- carbon farming, if new human-induced regeneration methods are accepted under the federal government's Climate Solutions Fund
- nature and cultural tourism.

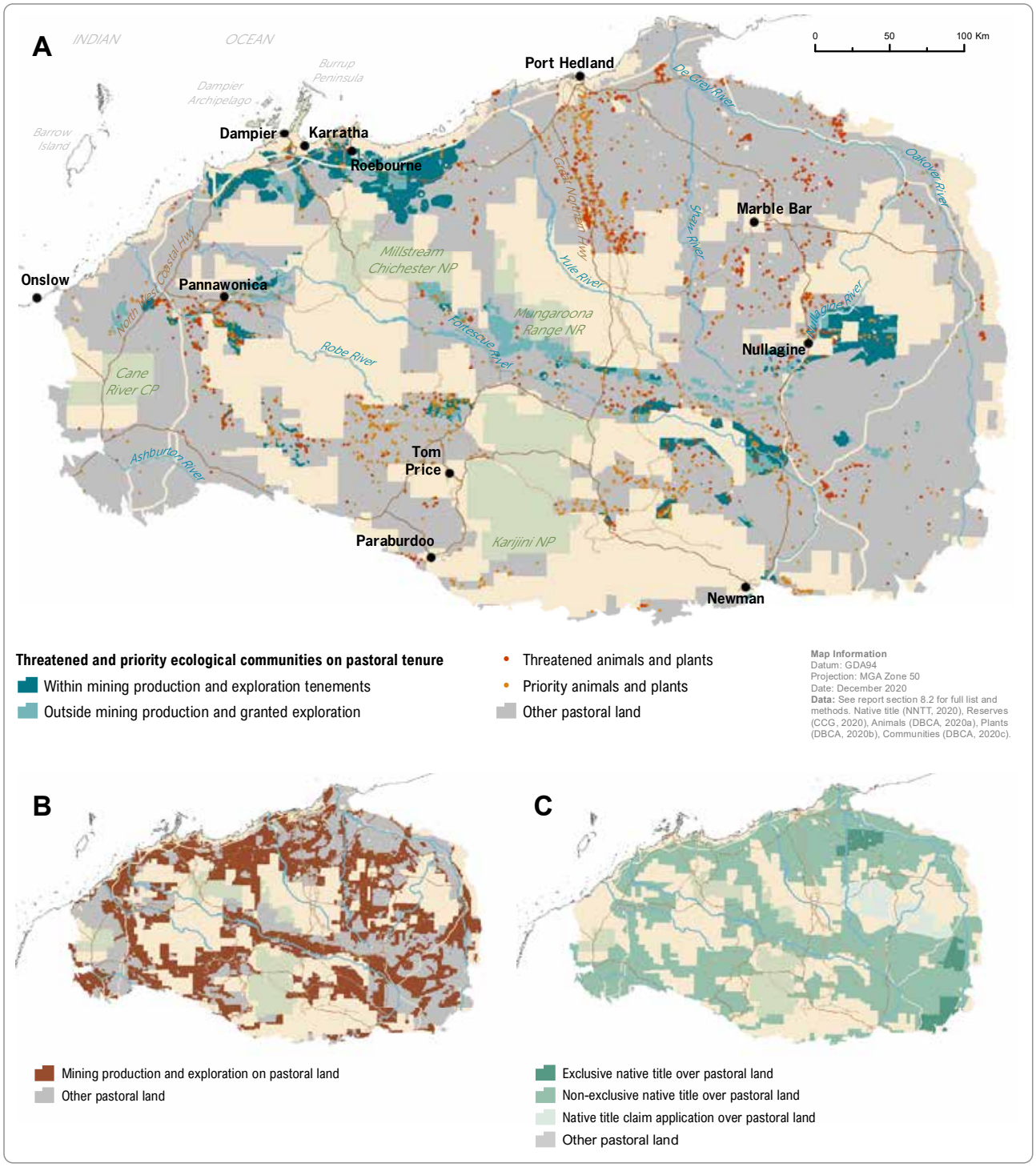


Figure 8. Pastoral leases in the Pilbara and their overlap with (A) threatened and priority species and mining tenements, (B) threatened and priority ecological communities and mining tenements and (C) native title.

On unallocated crown land (24% of the Pilbara), opportunities for strengthening conservation include:

- cultural and conservation land management with native title holders
- establishment of Indigenous protected areas and formal joint management arrangements in areas with high conservation values
- contracting of threat management, mining rehabilitation and water quality monitoring to Indigenous ranger teams
- biodiversity offset projects under the Environmental Offsets Fund, in partnerships between Traditional Owners, the government and researchers
- Indigenous-operated nature and culture tourism and geotourism ventures (with potential for the establishment of a UNESCO Pilbara geopark).

On Aboriginal-managed land (pastoral leases, land held by the Aboriginal Lands Trust and the Woodstock Abydos Protected Reserve, 11% of the Pilbara), opportunities for strengthening conservation include:

- cultural and conservation land management, based on healthy country planning and with Indigenous ranger teams undertaking threat management (including co-management of mining leases)
- biodiversity offset projects under the Environmental Offsets Fund, particularly on Abydos Woodstock
- mining rehabilitation on current mining leases and at legacy sites
- establishment of Indigenous protected areas
- carbon farming, if new methods of human-induced regeneration are accepted
- nature and cultural tourism.

On conservation reserves (6% of the Pilbara), opportunities for strengthening conservation include:

- gazettal of former leasehold properties acquired for conservation, which would take bioregional protection to 10%
- joint management arrangements with Traditional Owners, with support for day-to-day management by Indigenous rangers
- partnerships with Traditional Owners to undertake 'carbon for conservation' projects in reserves.

On other crown reserves (5% of the Pilbara), opportunities for strengthening conservation include cultural land management by Traditional Owners on their native title lands (about half the area).

Traditional Owners exercising their cultural responsibilities for land management takes on many forms. Here, Murujuga rangers are managing beach access. Image: Murujuga Aboriginal Corporation.

Banjima rangers at work. Harnessing traditional ecological knowledge is a key component of successful cultural and conservation land management programs. Image: Banjima Native Title Aboriginal Corporation.

Because most of the Pilbara has low pastoral productivity, sustainable diversification opportunities such as carbon farming, biodiversity offsets and tourism offer the potential to increase both sustainability and profitability. Image: Krystle Wright

A Conservation economy for the Pilbara

The ancient rocks underpinning the biological richness of the Pilbara also drive its current economy – the 800 million tonnes of iron ore shipped from the Pilbara in 2019 generated more revenue than the entire economies of about two-thirds of the world's countries. But while the rocky landscape has fostered ecological diversity, mining has tended to suppress economic diversity.

THE CURRENT PILBARA ECONOMY

Mining and construction account for more than 99% of industry economic output in the Pilbara (figure 9). This lack of diversity is a well-recognised risk to the Pilbara economy, leaving it vulnerable to mining downturns. With about two-thirds of mining workers living outside the region, the Pilbara has been called a 'hollow economy' because so much of the income generated in the region is spent elsewhere.

About 50,000 people live in the Pilbara, of whom about 14% are Aboriginal. Although mining has increased employment for Aboriginal people, 18% of the Aboriginal labour force were unemployed in 2016 compared to only 3% of non-Indigenous residents. Only about a third of the Aboriginal population was better off in 2016 than in 2001. Just to avoid a drop in Aboriginal employment, an additional 150 jobs will have to be created each year (1,500 jobs over a decade). It is clear that job opportunities will have to be sought beyond the mining sector.

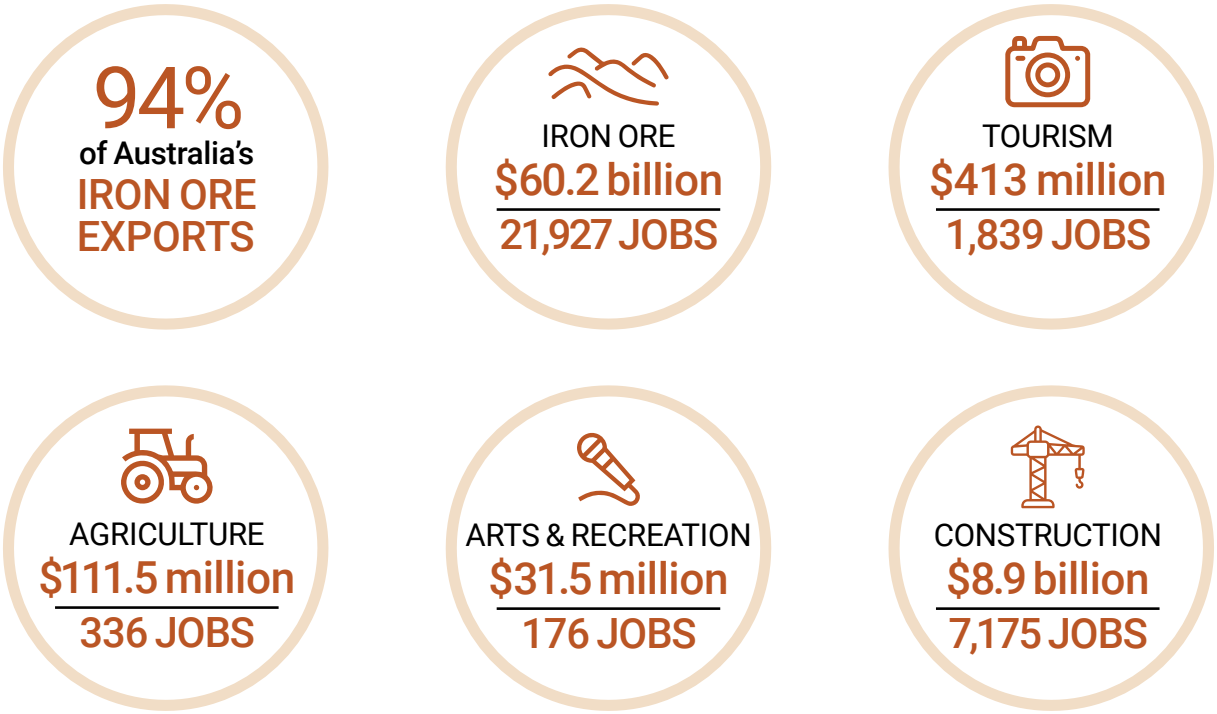


Figure 9. A snapshot of major sectors in the Pilbara economy

Source: Pilbara Development Commission (2019) [1], based on the 2016 census

Note: The data here applies to the broader Pilbara region rather than the Pilbara bioregion. However, all iron ore mines, most pastoral leases and most of the population are in the bioregion, so the data is mostly or approximately applicable.

Opposite: Most Australians know of the Pilbara only as a mining province. Protecting and promoting the region's outstanding natural and cultural values are essential for fostering more diverse economic activities, including an expanded sustainable tourism industry. This is Weano Gorge, Karijini National Park. Image: Tourism Western Australia

A MORE RESILIENT PILBARA ECONOMY

Expanding the conservation economy in the Pilbara would provide a greater choice of livelihoods for Aboriginal people that align with their cultures, aspirations, skills and native title rights. It would enable them to contribute essential services of strategic importance to the nation. By supplementing existing economic activities, an expanded conservation economy would also reduce the Pilbara's risky over-reliance on the mining sector.

Although the majority of participants in an expanded conservation economy would be Traditional Owners, it would also provide opportunities for pastoralists to diversify economic activities and boost productivity through improved land management, including in partnerships with Traditional Owners. More-diverse enterprise options (such as stewardship payments and carbon farming) can increase the adaptive capacity of leaseholders to respond to changing conditions.

The capability for broadscale Indigenous management across all tenures in the Pilbara is still emerging, but successes elsewhere demonstrate its feasibility. An expanded conservation economy would accelerate what is already normal across much of northern Australia – partnerships between Traditional Owners, industry and government for cultural and conservation land management. However, its implementation in the Pilbara will be unique because of the scale of integration required with land users whose rights in crown land are shared with native title holders. Despite the greater challenges, this also means that more resources are available for Indigenous land management

The potential activities of Traditional Owner groups in a conservation economy can be roughly grouped into 3 categories (figure 10):

- community-led opportunities – projects and activities wholly controlled by Traditional Owners, such as rangers operating on Aboriginal land
- partnership opportunities – projects and activities in which Traditional Owner groups share control (typically in non-exclusive native title areas), so as to expand their reach and impact or achieve a mutually desired outcome, such as joint management of conservation reserves, collaborative conservation projects on pastoral leases, and co-management on mining leases
- commercial opportunities – projects and activities undertaken by Traditional Owner groups under fee-for-service contracts or as employees, such as land management, monitoring and rehabilitation services for mining companies and biosecurity programs and land management services for governments.

Such activities are compatible with, and would help sustain, existing economic activities – by improving agricultural productivity, protecting natural systems for nature tourism, meeting carbon and biodiversity offset requirements for resource industries, and rehabilitating degraded and mined land.

For Pilbara Traditional Owners to more fully participate in the workforce will require pathways for developing their skills and capacity for economic activities. One pathway frequently manifesting across Australia starts from community-led projects, which then lead to partnership and commercial projects. Indigenous land management is a well-tested model for delivering not only environmental benefits but economic, health and wellbeing, cultural, social and political benefits. The best estimates for the social returns on investment in Indigenous protected areas and ranger groups are about 3:1 – meaning that every $1 invested generates about $3 in value.

Nyamal Traditional Owners celebrate their native title determination in 2019. The Nyamal led the Pilbara pastoral workers strike in 1946 – the first station walk-off by Aboriginal people, 20 years before the better known Wave Hill strike in the Northern Territory. Image: Jodi Neal

Figure 10. Pathways and opportunities for Traditional Owners in a conservation economy

BUILDING PARTNERSHIPS

The following 4 types of partnerships are an essential basis for a conservation economy in the Pilbara. This reflects the extensive overlapping rights and interests in land, the policies of the government and mining industry in favour of partnerships, and the benefits, power and social license that come from partnerships.

Partnerships between Traditional Owner groups: Traditional Owners are at different stages of readiness to undertake large-scale land management – several have established ranger programs in place, others have just begun ranger programs, some have started planning. A key aim of the Pilbara Cultural Land Management Project is to implement cultural and conservation land management across native title lands in partnership with pastoralists, miners and government agencies.

Partnerships on pastoral land: Pastoralists can be major participants in and beneficiaries of a vibrant conservation economy. The pastoral estate has very high cultural and conservation values and, particularly on leases with ranges, gorges and hilly areas, many pastoralists do not use the full extent of their lease for livestock. Partnerships with Traditional Owners for delivery of cultural and conservation land management are an appropriate way of sharing land (under non-exclusive native title) while achieving beneficial environmental, cultural and relational benefits.

Partnerships on crown reserves and unallocated crown lands: Government-managed lands, two-thirds of which are native title lands, offer major opportunities for partnerships with Traditional Owners to implement cultural and conservation land management through formal partnerships, including but not limited to joint management arrangements.

Co-management on mining leases: Although land access agreements negotiated with mining companies have delivered many benefits to Traditional Owners, their implementation has often not provided the ease of access to country that Traditional Owners need for cultural land management. An alternative model more consistent with a partnership approach would be value-driven agreements for co-management of native title lands. In practice, it could mean Traditional Owners co-developing conservation and cultural heritage programs and undertaking cultural land management, environmental monitoring, rehabilitation and other conservation work – in addition to meeting their obligations for heritage surveys.

Effective co-management would help repair and strengthen relationships that are necessary for mining companies to maintain a social licence to operate. It would provide business opportunities for Traditional Owners while reducing the costs of essential environmental management, monitoring and rehabilitation services for mining companies. Under such arrangements, a Juukan Gorge disaster is far less likely to occur.

ATTRIBUTES OF A CONSERVATION ECONOMY

We estimate that a base level of about $51 million a year is needed for managing fire, weeds and invasive animals across the Pilbara and an additional $17 million for support roles and additional costs, for a total budget of $68 million a year. This would support an estimated 560 local jobs (full time equivalent), including the direct costs of employment for rangers, ranger coordinators and administrative and research roles, as well as equipment, vehicle and infrastructure costs.

This estimate assumes varying intensities of invasive species management, with a lower intensity on pastoral lands than on conservation reserves and Aboriginal-managed land. The costs for fire, weed and feral animal management across the Pilbara equate to a conservative average of $2.89 a hectare, ranging from $2.04 on pastoral leases to $4.28 in conservation reserves. (The latter is much less than the average $9 a hectare spent on managing national parks and Indigenous protected areas in Australia.) Because information about existing conservation effort is scant, it is not possible to precisely calculate the additional funding needed. However, given the limited extent of land in the Pilbara currently managed for fire and invasive species, we think it is safe to assume that new funding of at least $50 million a year is needed.

Although this level of funding seems ambitious – much more than is currently spent and more than is typically spent in remote regions – it is a modest sum compared to the wealth generated in the Pilbara, the environmental footprint of that wealth generation, and the public funding provided to support wealth generation. There are several compelling rationales for governments, industries and landholders to increase their investment in conservation land management in the Pilbara:

- Legal obligations – requirements to control declared weed and pest animal species, pastoral lease conditions to maintain indigenous pastures and use best-practice stock management, and land management obligations under mining licences.
- Industry social licence to operate for mining companies and pastoralists.
- Environmental markets for biodiversity and carbon offsets.
- Government programs in the public interest, including Indigenous ranger and pastoral stewardship programs.
- Exemplary public land management – as one of the largest landholders in the Pilbara, including of lands with very high conservation values, the state government should strive to manage lands to a high standard.
- Cultural and ethical motivations – many people in the Pilbara contribute conservation effort and resources for reasons other than legal obligation and financial gain.

In a first for Australia, Tourism Western Australia's Camping with Custodians program has been supporting the development of high quality public campgrounds owned and operated by Aboriginal communities. Peedamulla Station is an Aboriginal-owned cattle station near Onslow offering campsites, scenic vistas and wildlife. Image: Tourism Western Australia

Table 1. Potential jobs for management of weeds and feral animals (3 levels of intensity) and fire in the Pilbara by tenure type

Tenure	Area (million ha)	Percentage	Weed & feral animal management jobs[D]			Fire management jobs[D]	Coordinator jobs[E]
			Low intensity	Medium intensity	High intensity		
Aboriginal-managed land[A]	2.04	11.5%	26	34	54	15	12
Conservation reserves	1.14	6.4%	15	19	30	8	6
Other crown reserves	0.91	5.1%	12	15	24	7	4
Unallocated crown land	4.34	24.3%	56	72	115	31	17
Pastoral leases[B]	9.29	52.1%	120	155	246	67	31
Other[C]	0.11	0.6%	1	2	3	1	0
Pilbara total	**17.83**	**100%**	**229**	**297**	**474**	**128**	**70**

Notes: Based on data from 4 northern Australian sources (see main report).

A. Aboriginal-managed land includes Aboriginal-owned pastoral leases, Aboriginal Lands Trust land (reserves), Aboriginal Land Trust land with management orders allowing pastoral activities and other Aboriginal reserves. B. Pastoral leases in this category exclude those covered under the 'Aboriginal-managed land' category. C. This category includes freehold land and roads. D. The levels of activity needed (and the job potential) will vary considerably across properties, but there is no available data at a property level. We therefore extrapolated on a per hectare basis from published financial cost and job models from elsewhere in northern Australia. This assumes a uniform condition across the region and does not take into account any economies (or diseconomies) of scale. To counter these limiting assumptions, we drew upon 3 models for weed and feral animal management that cover low, moderate and high intensity management. There was only one published model for fire, so we could provide only a single jobs estimate. We further tested the modelled job and total costs by comparing our modelled numbers against the financial costs of a ranger program as estimated by a Western Australian conservation agency. E. We assumed 1 ranger coordinator position would be needed for every 6 ranger positions and used an average park ranger/coordinator award rate of $85,000 plus 30% on-costs.

Table 2. Funding needed to manage fire and invasive species across the Pilbara

Tenure	Area (million ha)	Assumed management intensity[A]	Funding needed ($million)	$/hectare	Jobs assumed[B]
Aboriginal owned/ managed land	2.04	High	8.70	4.28	81
Conservation reserves	1.14	High	4.80	4.21	44
Other crown reserves & unallocated crown land	5.25	Medium	15.37	2.93	146
Pastoral leases[C]	9.29	Low	22.33	2.40	218
Other	0.11	Low	0.22	2.04	2
Total / average	17.83	Low–medium	51.46	2.89	491
Central administration roles[D]			16.79		68
TOTAL			**68.25**		**559**

Notes: See Table 6-1 fo information about methods.

A. The different levels of intensity for management of invasive species are assumed on the basis of the likely management objectives for different tenures, but they would vary considerably within each category depending on the extent of the weed and feral animal problems and the individual land manager's objectives. B. Funding per ranger job is $75,000 including superannuation, based on the average salary for park rangers in Australia and similar to current advertised government jobs in the region. Funding per ranger coordinator job is $110,000 including superannuation, based on average salary for senior park rangers in Australia and similar to current advertised government jobs in the region. C. This category excludes Indigenous pastoral leases, which have been included in the category of Aboriginal-managed land. D. This estimate is based on an assumed 1:10 administration-staff ratio (and costs of $110,000 per position including superannuation) and additional research and planning jobs (funding at $225,000 per position including superannuation and additional salary loadings) as well as office and infrastructure costs. It equates to an average 30% overheads and covers similar overhead expense items.

A conservation vision for the Pilbara

The Pilbara is so much more than the mines, cattle and red dust of the popular imagination. Its dramatic deep history provides the foundation for a more complex appreciation of the region:

- ***Geologically*** – as the oldest well-preserved fragment of early Earth crust, uniquely diverse in ancient rocks, offering a window into deep time and the evolution of life.
- ***Biologically*** – as an ancient refugia for life during glacial periods and a major centre for the evolution of unique plants and animals.
- ***Culturally*** – as the home for more than 50,000 years of the first Australians, a landscape rich in spiritual and cultural significance, with one of the largest rock art collections in the world.

These are qualities of global significance that have endured despite the rapid transformations and travails of the past 160 years.

Economically, the Pilbara is also remarkable – as the world's most lucrative iron ore mining province, hailed as the 'engine room' of Australia's economy. Therefore, the challenge for those with influence over the future of the Pilbara is how to preserve and restore its great biological and cultural wealth while also enabling the generation of economic wealth.

Any realistic vision for the Pilbara must accept that mining and pastoralism will continue to be dominant industries. It must also recognise that extensive native title rights now engender other opportunities (conservation, cultural and economic) over most of the same landscape. In no other Australian bioregion does native title overlap so comprehensively with industrial output critical to the Australian economy, and in no other landscape are pastoralism and mining so interwoven.

An essential element of a conservation vision for the Pilbara must therefore be strong partnerships between those with overlapping land rights and responsibilities – Traditional Owners, miners, pastoralists and governments. Traditional Owners exercising their cultural responsibilities for land management would be the major participants in a conservation workforce.

Another essential element of a conservation vision is ambition. Bold thinking is conspicuous in the Pilbara – manifest in the engineering, technologies and financial capital needed to dig up and ship out millions of tonnes of Pilbara rock a year. In contrast, conservation has been modest, incremental, intermittent, and generally a low government and industry priority.

A more ambitious conservation endeavour – aligned with the vastness of the landscape, the significance of the conservation and cultural values, and the conservation-enabling wealth of the Pilbara – is proposed in the following vision:

By 2031 the Pilbara is the world-leading exemplar of landscape-scale conservation in a region of critical economic importance. Cultural and conservation land management is comprehensively implemented across all tenures, delivered through partnerships between Traditional Owners, industry, government and community.

Opposite: There are many ways to view the Pilbara – as one of the world's premier iron ore provinces, as a pastoral region, as a biodiversity hotspot and climate refugia, and as a rich cultural landscape subject to native title rights and Traditional Owner custodian responsibilities. Australia's challenge is how to align these different ways of valuing this important region. Image: Paul Mayall Australia / Alamy Stock Photo

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