

The nature-based economy: **How Australia's prosperity depends on nature**



**AUSTRALIAN
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FOUNDATION**



**Australian
Ethical**



Contents

Preface	3
Forewords	4
Executive summary	6
Introduction	10
The nature crisis	12
The Australian economy’s dependence on nature	21
Nature and risk	31
Nature and climate	36
Recommendations for action	38
Appendix	41

“This is why we’re trying to encourage our fellow Australians, our brothers and sisters out there, to get to know where you live, because it’s place-based. **The land is alive, the rivers are alive, the living systems are alive, the birds and the fish - everything communicates.** Don’t see yourself as a human being, as elitist and above other living systems. This is the gift of Indigenous People across the world, saying we want you, because your DNA is embedded here. We want you to get to know your country, to feel your country, to heal your country, because it’s all our country.”

Professor Anne Poelina

Nyikina Warrwa women and Traditional Owner Martuwara (Fitzroy River), Chair of Indigenous Studies, University of Notre Dame, Australia

The Nature-based Economy: How Australia’s Prosperity Depends on Nature is an Australian Conservation Foundation report supported by Pollination and Australian Ethical Investments.

Economic Analysis provided by IDEEA group



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We acknowledge the Traditional Owners of Country and their continuing connection to land, waters and community. We pay respect to their Elders past and present and to the pivotal role that First Nations Peoples continue to play in caring for Country across Australia.

Preface

Since Europeans colonised this land, economic development has been focused on extraction and exploitation with little to no regard for the impact and legacies left behind.

First Nations people have suffered the full brunt of colonial expansion and expropriation of land and its resources. Where once we were the “Original Affluent” societies, as described by anthropologist Marshal Sahlins, we now remain impoverished, marginalised, and excluded peoples living on the margins of market driven consumer capitalist societies. These colonial economies are built on the theoretical base of the wealth of nations and have developed to the detriment of nature.

Wealth is understood as the stock of six different forms of capital: human capital, intellectual property, physical/produced property, social/institutional capital, net foreign assets, and natural capital. Natural capital is also of particular interest to the generation of wealth in First Nations, where the elements of natural capital comprise renewable and non-renewable resources, the ecosystems that support and maintain the quality of land, water, air and water and the vast genetic library referred to as biodiversity. The production of these forms of First Nations capital is underpinned by complex social and spiritual relationships.

As custodians of the land, First Nations/Indigenous peoples are engaged in sustainable natural capital production by maintaining the integrity of ecosystems. We understand nature is life and from an Aboriginal cultural and spiritual perspective, our community and our way of life and our identity is linked back to nature. The natural world is part of our family. So when we’re looking after community, looking after nature and the parts of nature, whether it’s plants, animals, landscapes, processes, these are all an extension of our spiritual family, which is part of our community. Community, culture and nature all go hand in hand.

We live in a social universe made up of relationships with each other, relationships with the spirit world, and relationships with the land. It’s a kinship-based understanding of the universe and dreaming, and spirituality is the core.

So when we start to move into the this new era of natural capital, we need to be reminded and we need to build in key principles for how we effectively resource the spiritual and cultural values of First Nations/Indigenous peoples and guard against wanton adoption of purely market driven financial models defining access, use and representation of natural capital.

Kado Muir is an First Nations Australian artist, anthropologist and indigenous rights activist based in Leonora, WA. He is a cultural leader and senior knowledge holder of the Ngalia dialect group of Mantjiltjara language group, with traditional connection to the Western Deserts of Western Australia.

Kado is Chair of the National Native Title Council, Co-Chair of the First National Heritage Protection Alliance and is a steering group member of the First Nations Clean Energy Network.



Forewords

Geoff Summerhayes, Pollination

**Nature is our ‘natural capital’.
Healthy ecosystems and biodiversity
fundamentally underpin our economy
and society at large.**

However, to date, we have failed to recognise the true value of our natural capital – we have assumed that nature is abundant and an endless resource to be extracted from, cleared, fished, dumped into without consideration of the cumulative effects of those actions. Most significantly, we have never accounted for natural capital in financial statements. That is all changing, and it is likely to change very rapidly.

The planet is exhausted. We are facing an unprecedented point in human history: both because of the rapid decline in nature we have witnessed in our lifetimes and because we hold the future of the planet in our hands. This decade is the critical decade for action to address the multiple pressures on nature and biodiversity – of which climate change is just one. I am hopeful we will meet this challenge, armed with the knowledge that this is not just an environmental issue, but that it is a critical economic one.

In Australia, we have our work cut out for us. The 2021 Federal Statement of the Environment Report is disturbing reading. It noted, amongst other things, that “[t]here were 1,385 plant species, 533 animal species and 88 ecological communities listed as threatened ... in June 2021, including 21% of all Australian mammals. Around 200 plant and animal species and 15 ecological communities have been added to lists since 2016”. These statistics speak directly to the fact that Australia’s natural capital is being destroyed at an alarming rate.

From an economic perspective, this has significant implications. Every sector in the Australian economy is dependent on nature to varying degrees and in different ways. This report has laid bare the fact that approximately half of Australia’s GDP is directly dependent on specific ecosystem services derived from natural capital. The balance of Australia’s GDP is indirectly dependent on natural capital across complex value chains.

In order to ensure Australia’s continued prosperity, business, the public sector and civil society must come together to address the financial risks associated with the decline in our natural capital. International policy and regulatory settings are already shifting, following the climate playbook but on ‘fast forward’. The launch of the Task-force on Nature-related Financial Disclosures (TNFD) is one example of international development with implications for Australia. Some Australian businesses are already embracing the draft TNFD framework, while others risk being caught flat-footed and playing catch up.

The cause for hope is nature’s ability to regenerate. It was recently pointed out to me that “if you zoom in from the big picture of global biodiversity, a mosaic appears; in amongst the stories of loss there are inspiring stories of regeneration and positive change, with nature making a difference in people’s lives, and people valuing and nurturing their natural environment.”

Australia has the opportunity to be part of that mosaic. We can and must put the nation on a pathway to a Nature Positive future. This will require significant change in business practice and government policy settings, and time is of the essence. We must improve our understanding of our economic dependency on nature and act swiftly to protect and regenerate our critical ecosystems and biodiversity. This Report is a helpful resource to that end.

Geoff Summerhayes is a Senior Advisor at climate investment and advisory firm Pollination, Non-executive Director at Zurich and Heartland Bank, Chair of Beyond Zero Emissions, and former Australian Prudential Regulation Authority (APRA) board member.

Amanda Richman, Australian Ethical Investment

Our planet’s 11,000-year era of climate stability is coming to an end, not by the geological rhythms of nature but by the frenzied activities of humans.

Humanity’s impact on nature’s finely tuned ecosystems is intensifying and we are approaching tipping points at our own peril.

For too long, human beings have availed themselves of nature’s services without accounting for them effectively. That we cannot see climate regulation in the atmosphere nor nutrients in the soils does not mean we will not feel the fallout from their disruption. But given our growing ecological deficit, our understanding of our ecological balance sheets is evolving.

Today, the consideration of nature in the world of corporates and finance, in the language of risks and returns, now has real momentum. This report tackles the enormous and urgent job of beginning to understand Australia’s economic dependencies on nature and provides very practical guidance to business and government on how to help halt and reverse the loss of nature.

We absolutely commend ACF for orchestrating this important research that will hopefully open the eyes of people sitting around board tables across corporate Australia and in government, and propel the work needed to address our collective blind spot.

As a financial organisation seeking to invest for the long-term financial interests of our customers, we recognise that nature loss poses a systemic risk to the stability of financial, economic and social systems. As an ethical organisation, we recognise that the systemic destruction of nature is a tragedy so much greater than what could ever appear on a balance sheet.

Hold on to that knowledge and that heartbreak when reading this report, because ultimately that is what will save us.

Amanda Richman is the Ethical Stewardship Lead at Australian Ethical Investment, Australia’s largest ethical investment fund.



Executive summary

Australians love nature. We put it on our money and name our sports teams after it. But do we understand just how much we depend on nature or how closely our economic prosperity is tied to the state of our fragile environment?

Globally, nature is in crisis. About 75% of the planet’s land and 66% of marine environments have been significantly altered by human actions. Humans and the livestock farmed for our food now make up 96% of the mass of all mammals on earth. A quarter of all the world’s living species are threatened with extinction.

The changes we have made to the land and seascapes in Australia have driven more mammals to extinction than on any other continent. The 2021 State of the Environment report finds Australia’s natural environment is in an overall poor condition and is deteriorating due to increasing pressure from climate change, habitat destruction, invasive species, pollution, and resource extraction.

Beyond the loss of intrinsic, cultural and ecological values associated with biodiversity, these impacts are likely to have major social and economic consequences. As nature’s limits are exceeded, ecological systems and functions are altered, along with the ecosystem services they provide to people, and nature’s contribution to the economy falls.

We seriously undervalue nature. Our social and economic structures systemically downplay our true dependence on it. A landmark report from the World Economic Forum found that US\$44 trillion of global GDP is at risk because it directly depends on nature. The task force on nature-related financial disclosures (TNFD), its framework due to be finalised in 2023, is premised on the assumption that our impacts and dependencies on nature are material to the economy.

It’s up to Australia’s business and the Federal government to identify the risks of this undervaluation and take action to protect nature and restore natural capital before the damage becomes irreversible.

This report calculates the Australian economy’s direct dependence on nature and the variation in direct dependency for every major industry sector.

All Australian industries and sectors have a varying dependence on nature, from using electricity in the office to extracting natural resources from the ground. Impairment of an ecosystem service stemming from damage to the environment, or a depreciation of natural capital, can affect the economic performance of those industries, acutely or chronically.

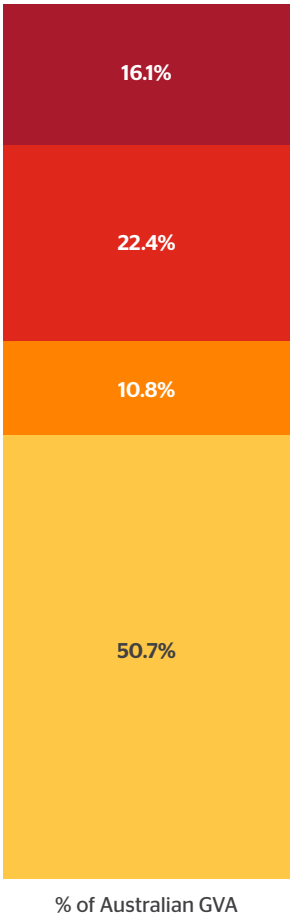
The nature-based economy: How Australia’s prosperity depends on nature finds:

- Approximately **half of Australia’s GDP** (49.3% or \$892.8bn) has a **moderate to very high** direct dependence on ecosystem services.
- Sectors with **very high** direct dependence on nature – primary industries like agriculture, forestry, fisheries, food product manufacturing, construction and waste and water services – generate \$293.6bn per year, approximately 15.9% of Australia’s GDP.
- Sectors with a **moderate to high** direct dependency on nature – such as mining, real estate, transport and logistics, accommodation and hospitality – contribute \$602.7bn to Australia’s economy, or approximately 33.1% of GDP.
- Sectors that have a **high or very high** direct dependency on nature are **responsible for more than three quarters of Australia’s export earnings**, with resources currently accounting for 68.7% of Australia’s export share and agricultural exports another 11.3%.
- Each Australian state and territory has a different relative direct dependence on nature, with **Western Australia’s economy at the greatest risk from nature destruction with 66.95% of gross value added having a moderate to very high direct dependence on nature**. The Northern Territory and Queensland follow with 55% and 53.8% directly dependent on nature.
- Indirectly, **there is not a dollar that doesn’t depend on nature** – sectors with a lower direct dependency score still depend upon nature through their value chains, and every worker and consumer needs clean air and water, sustenance, their health and a stable climate.

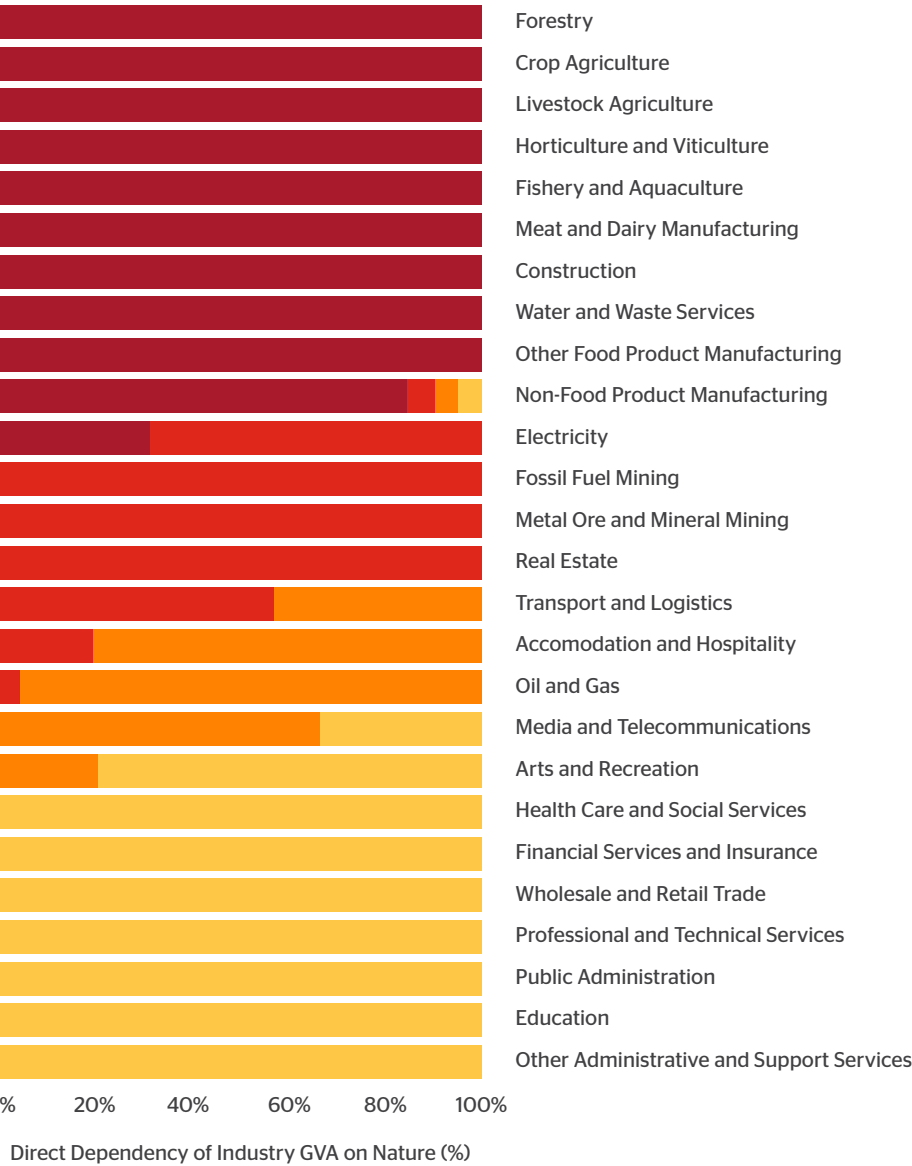
Every sector of the Australian economy is directly dependent on nature to varying degrees, and that dependency is based on different ecosystem services derived from different elements of natural capital. The sectors with the highest dependence are those that rely on the extraction of the earth’s natural resources or directly depend on the provision of ecosystem services such as clean water, a stable climate, pollination,

erosion prevention, healthy soils, and protection from floods and storms - notably primary industries, food manufacturing, and construction. Sector’s like retail can have a low direct dependence on nature based on gross value added (GVA) but have high indirect dependency on nature via their supply chains.

Direct nature dependency of the Australian economy by GVA



Direct nature dependency by industry sector

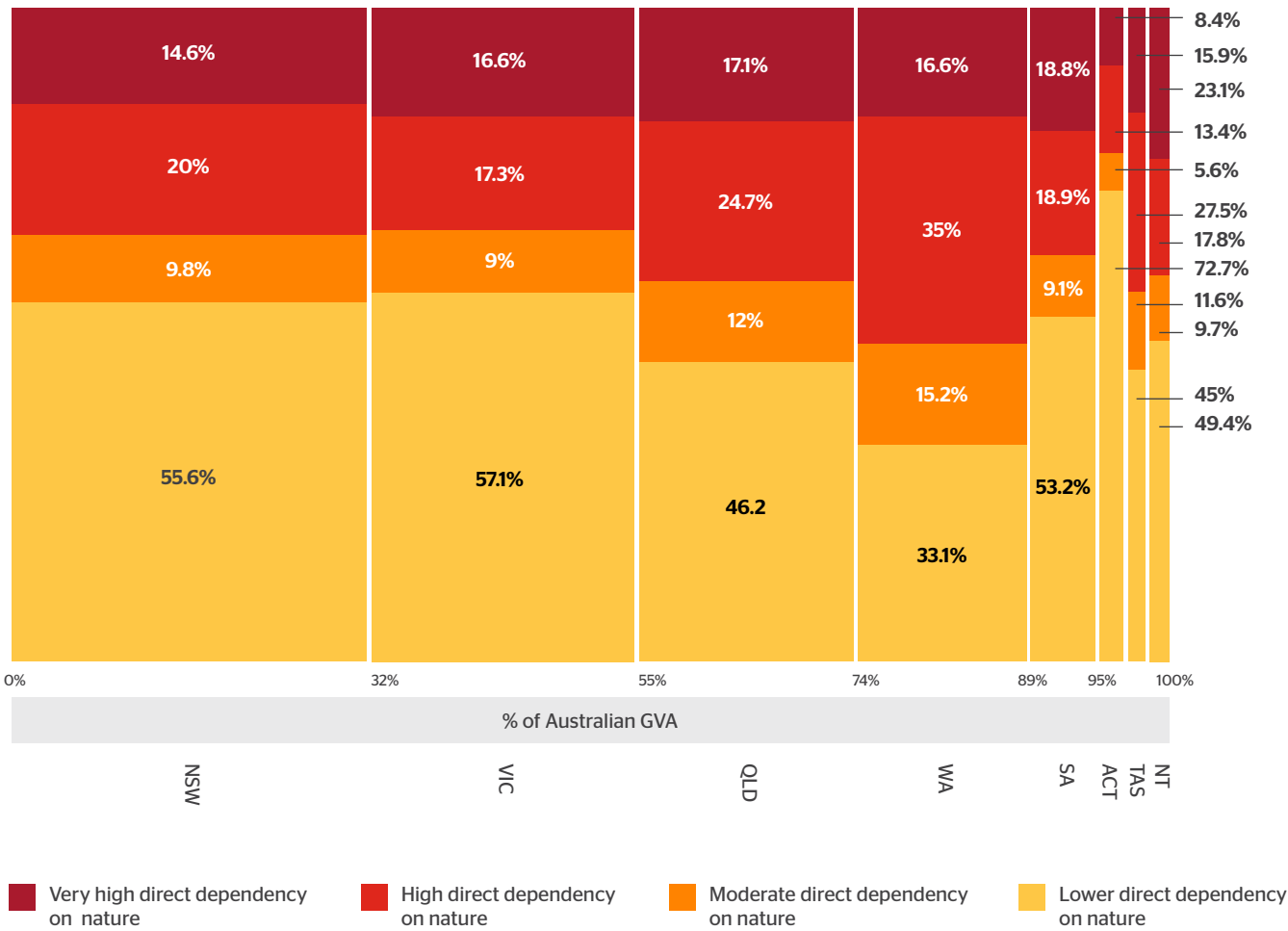


Very high direct dependency on nature High direct dependency on nature Moderate direct dependency on nature Lower direct dependency on nature

Every Australian state and territory is reliant on different industries, resulting in significant variance in direct nature dependency. Western Australia, Australia’s biggest producer of iron ore and gas and a significant producer of wheat and other agricultural products, is Australia’s most nature-dependent

state with 66.9% of state GVA, or \$183.6bn, having a moderate to very high direct dependence on nature. The Northern Territory (55% or \$13bn), Queensland (53.8% or \$187.1bn) and Tasmania (50.6% or \$15.3bn) are the next most nature-dependent jurisdictions.

Percentage of direct GVA nature dependency of Australian state economies



Businesses in sectors with high nature dependence and high impact not only risk reputational, regulatory, legal and financial blowback from damaging nature, they are also exposed to risks associated with the continued degradation of the natural capital and ecosystem services that are material inputs to their businesses as well as systemic, economy-wide risks

associated with the destruction of nature. The financial sector in particular bears responsibility for the economy-wide transition to Nature Positive practices as it determines which activities are financed or insured and under what conditions.

Solving the nature crisis will require a transformation to a Nature Positive world, recognition that the economy and society are both entirely reliant on the biosphere, and sustained, collective action throughout all of society toward a goal of reversing nature destruction so that by 2030 nature is in better health than it is now.

Decision-makers have a lot to learn from First Nations knowledge and leadership. Investing in Indigenous-led land and sea management – including ranger programs, forest management, Caring for Country programs, carbon and biodiversity markets and employment programs – is vital for effective nature recovery.

This report outlines crucial next steps for Australian businesses and government to sustain the ecosystem services we so heavily depend on, create a Nature Positive future and reverse the destruction of nature that is taking place across Australia at an alarming rate.

Our health, our economy and our livelihoods depend on nature thriving. We all have a stake and a role to play – people, community, government and business.

Summary of recommendations

Australian businesses should contribute to reversing nature destruction by:

1. **Measuring, prioritising, and reporting on nature-related impacts and dependencies** to determine the effect their operations, value chains, and investments have on nature. They should also publicly disclose these for transparency.
2. **Engaging with suppliers, customers, stakeholders, and investees** that have related risks or are themselves sources of risk, and address challenges cooperatively.
3. Once nature-related risks and opportunities are identified, businesses should set **time-bound targets and science-based policies to protect nature**.
4. Through direct engagement with policy makers, industry associations and via public communications, businesses should **advocate for reforms of nature-related public policy**, sending clear signals to regulators of the need to protect nature.

5. **Implement actions and embed targets into business decision-making** as a component of strategy and governance with the highest level of accountability and responsibility.

Government can reverse nature destruction and support the transition to a Nature Positive society by:

1. **Creating strong environment laws that protect nature** and establishing an **independent regulator to enforce them**.
2. Increasing **public investment in recovering and restoring Australia’s wildlife and ecosystems** and leveraging private investment through credible incentives and mechanisms.
3. Championing and **leading on ambitious global goals for nature that stop biodiversity destruction, end extinction, and restore nature** and require businesses to measure and report on their nature-related impacts and dependencies and reduce harmful impacts.
4. **Embedding nature in all decision-making** and supporting Australian business to join international efforts to identify and act upon risks to biodiversity by setting national targets implementing effective environmental economic accounting and data collection.
5. **Acting now to slash climate pollution by more than half this decade and recognise nature as a climate solution**. This will require enormous amounts of renewable energy to be built in Australia, sustainably and in a way that protects nature and is fair for people, especially First Nations people and those dependent on coal and gas.
6. **Protecting at least 30% of lands and seas by 2030** including freshwater and inland water systems with particular attention on underrepresented ecosystems.

Introduction

Australia’s plant and animal life developed over millions of years and largely in isolation, resulting in up to 10% of the world’s biodiversity inhabiting our land and seas and the second largest number of endemic species of any country in the world.

Nature is valued by Australians in many ways. It is part of our identity and provides the places we go to relax and rejuvenate. We name our football teams after our wildlife and put them on our money. It has intrinsic, spiritual, and cultural value that can’t be measured by any accounting system. For First Nations people it is the source of First Law, inseparable from culture for 60,000 years.

Since European colonisation we’ve converted roughly half of the land for agriculture, removed almost half of the woodland, drawn down rivers, fished, mined, applied chemicals, and built roads and cities altering every ecosystem in Australia.

Globally, nature is being destroyed at an unprecedented rate, with 1 million species at risk of extinction.

Australia, for its part, has lost more mammal species than any other continent.

This decline is not only a risk to businesses through their dependence on nature, it is also a risk to society that industries contribute to through their negative impacts on nature. Because Australia’s nature is uniquely valuable and also vulnerable, businesses and governments have a heightened responsibility to know and manage their dependence and their impacts upon it.

This report finds approximately half of Australia’s GDP has a moderate to very high direct dependence on specific ecosystem services derived from nature or natural capital. Indirectly, there is not a dollar that doesn’t depend on nature - every worker and every consumer needs clean air and water, sustenance, their health and a stable climate. The sectors that are found to have a lower direct nature dependence in this analysis, such as retail or financial service, have their own indirect dependencies, such as through physical supply chains. This analysis only captures a sliver of our true dependence on nature. It doesn’t recognise the broad range of ways we depend on nature related to culture and wellbeing.

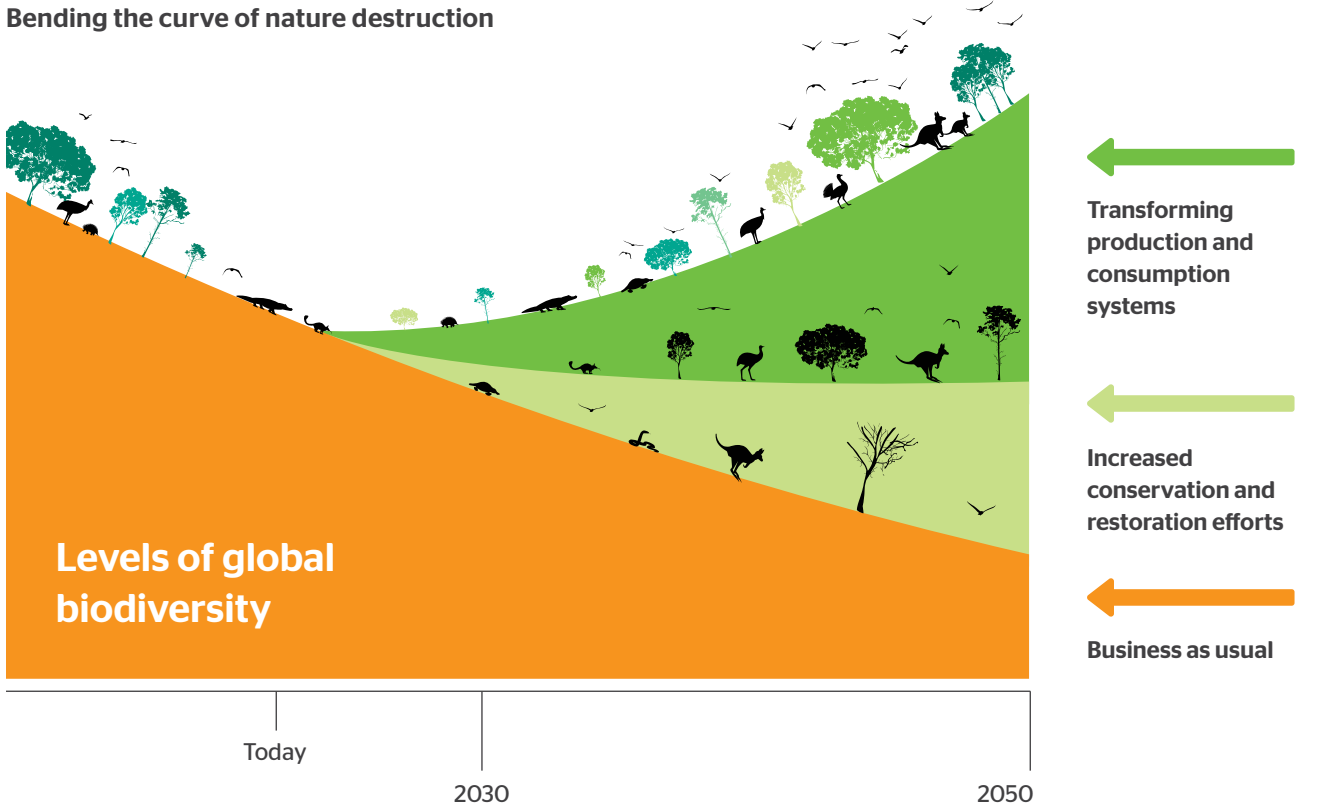
The decline in biodiversity and natural systems is reducing the availability of freshwater, limiting access to natural resources, depleting soils and pollinators that provide most of our food, damaging the natural beauty of the places we love and threatening species like the koala which we all hold dear. The destruction of nature even makes pandemics like COVID-19 more likely.

We must reverse the destruction of nature and put her on a path to recovery which includes more and better protected areas, funding for restoration and species recovery, embedding nature in decision making, and transitioning to production and consumption patterns that are compatible with a Nature Positive world. By 2030 we should have more nature than we have now. The benefits to human health and wellbeing from achieving this are incalculable, but it also makes sense for businesses and finance ministers to support this shift, with an estimated \$10.1 trillion in economic opportunities, and close to 400 million jobs to be created globally from a transition to a Nature Positive economy.¹

¹ World Economic Forum (2020) The Future of Nature and Business, New Nature Economy Report II, Geneva.



Bending the curve of nature destruction



The nature crisis

The global nature crisis

Globally, one million species are threatened with extinction. The average abundance of most terrestrial species has fallen by at least 20%, amphibians by 40%, reef forming corals and marine mammals by 33%. Studies suggest extinction figures are largely driven by human activity and may be one thousand times higher than the pre-human background rate.³

Ecosystems everywhere are in decline, with a suggested 47% reduction in global indicators of healthy ecosystem extent and condition. We've also cut down one third of the world's forests since pre-industrial times, and destroyed more than 85% of the world's wetlands.⁴

Scientists have confirmed that we have now surpassed six out of nine planetary boundaries - the biophysical processes that regulate the Earth-system. As of June 2022, we have exceeded the earth's safe operating space for biosphere integrity, climate change, land system change (land clearing and ecosystem conversion), biogeochemical flows (nitrogen and phosphorus in soil), fresh water, and novel entities (plastic and other man-made chemicals).⁵

Six out of nine planetary boundaries have been surpassed



Source: Stockholm Resilience Centre (2022) <https://www.stockholmresilience.org/>

The destruction of biodiversity is undermining progress towards 80% of the assessed targets under the Sustainable Development Goals (SDGs) related to poverty, hunger, health, water, cities, climate, oceans and land.⁶ Biodiversity destruction is also intricately linked to human health outcomes. Access to nature is strongly linked to mental wellbeing for example, but in more acute terms nature destruction has been linked to global pandemics including COVID-19, as well as the emergence of SARS, Ebola, HIV / AIDS and more recently monkeypox. Up to 75% of novel or re-emerging infectious diseases in the 21st Century have been zoonotic in origin.^{7,8}

In every scenario modelled by the world's scientists, except those that incorporate transformative change, the trajectory of nature decline will continue through to 2050.⁹ Transformative change to halt and reverse nature destruction will require a new economic paradigm, beyond GDP growth.¹⁰ It will require a shift to production and consumption patterns that not only fit within planetary boundaries but result in a net gain in biodiversity and planetary health, alongside traditional and innovative conservation approaches that include recovery programs for threatened species and ecosystems, expansion of the protected area estate, large scale restoration of ecosystems, the incorporation of First Nations knowledge and rights into environmental objectives, and the funding of First Nations-led restoration programs. This depends on environmental laws that are proactive, precautionary, inclusionary and target-based.^{11,12}

² IPBES (2019) Summary for policymakers of the global assessment report on biodiversity and ecosystem services, Bonn.

³ De Vos, J.M., Joppa, L.N., Gittleman, J.L., Stephens, P.R. and Pimm, S.L. (2015), Estimating the normal background rate of species extinction. Conservation Biology.

⁴ IPBES (2019) Summary for policymakers of the global assessment report on biodiversity and ecosystem services, IPBES, Bonn.

⁵ Stockholm Resilience Centre (2022) <https://www.stockholmresilience.org/> accessed June 2022.

⁶ IPBES (2019) Summary for policymakers of the global assessment report on biodiversity and ecosystem services, IPBES, Bonn.

⁷ Alakunle & Okeke (2022) Monkeypox virus: a neglected zoonotic pathogen spreads globally. Nat Rev Microbiol.

⁸ Lawler et al (2021) The COVID-19 pandemic is intricately linked to biodiversity loss and ecosystem health. The Lancet - Planetary Health

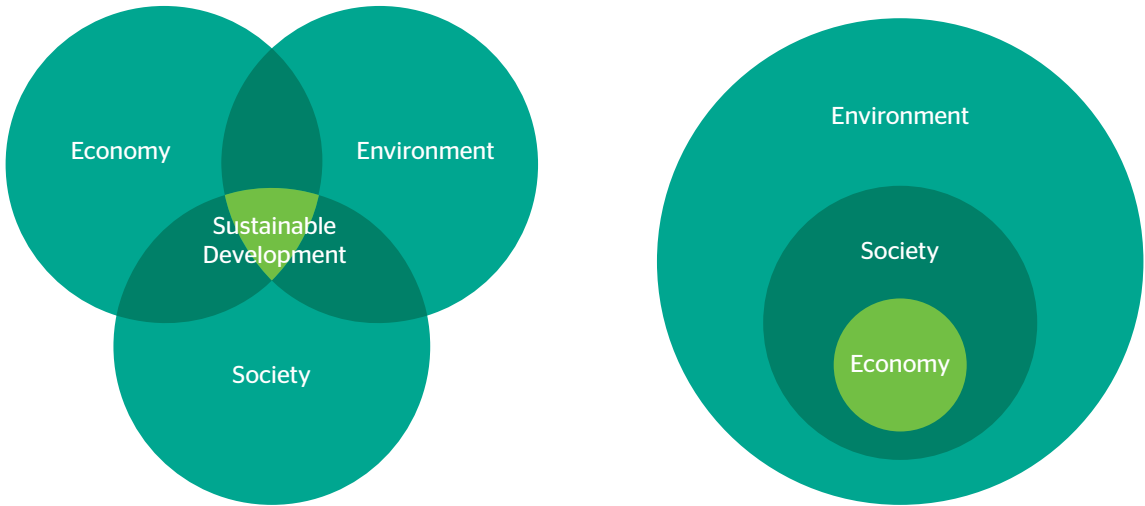
⁹ IPBES (2019) Summary for policymakers of the global assessment report on biodiversity and ecosystem services, IPBES, Bonn.

¹⁰ Dasgupta, P. (2021) The Economics of Biodiversity: The Dasgupta Review (London: HM Treasury).

¹¹ Leclère D, et al. (2020) Bending the curve of terrestrial biodiversity needs an integrated strategy. Nature. 2020

¹² Kai Chan (2019) What Is Transformative Change, and How Do We Achieve It? Think Globally Act Locally. IPBES

A new economic paradigm that recognises that the economy is a function of society and both are embedded wholly within the biosphere.



Adapted from Locke et al (2021) A Nature-Positive World: The Global Goal for Nature www.naturepositive.org

What is Nature Positive? The global goal for nature.

We need to halt and reverse nature destruction and transition to a Nature Positive global world which will require sustained, collective action throughout all of society. 'Nature Positive' means more than just taking actions that improve nature.¹³ It requires an overall 'net gain' in biodiversity, measured from a baseline of 2020. At COP15 of the UN Convention on Biological Diversity, to be held in Montreal, Canada in December 2022, a new Global Biodiversity framework is set to be agreed upon. Scientists have defined a transformative 'Nature Positive' global goal for nature to reverse the rate of destruction, so that by 2030 nature is in better health than it is now and on a pathway to full recovery by 2050. Bending the curve of biodiversity loss from its current negative trajectory will require some specific, transformative global actions, including:

1. Preventing the extinction of all known threatened species.
2. Protecting and conserving at least 30% of the world's land, sea and freshwater systems.
3. Achieving 20% native vegetation recovery in the most heavily transformed (farming and urban / industrial) areas.
4. Meeting the Bonn Challenge's goal of bringing 350 million hectares of degraded and deforested landscapes into restoration.¹⁴
5. Undertaking a fundamental shift to more sustainable production and consumption patterns on the rest of landscape and seascape.

¹³ Milner-Gulland, E.J. (2022) Don't dilute the term Nature Positive. Nat Ecol Evol.

¹⁴ IUCN & the Government of Germany (2011) The Bonn Challenge <https://www.bonnchallenge.org/>

The state of the environment in Australia

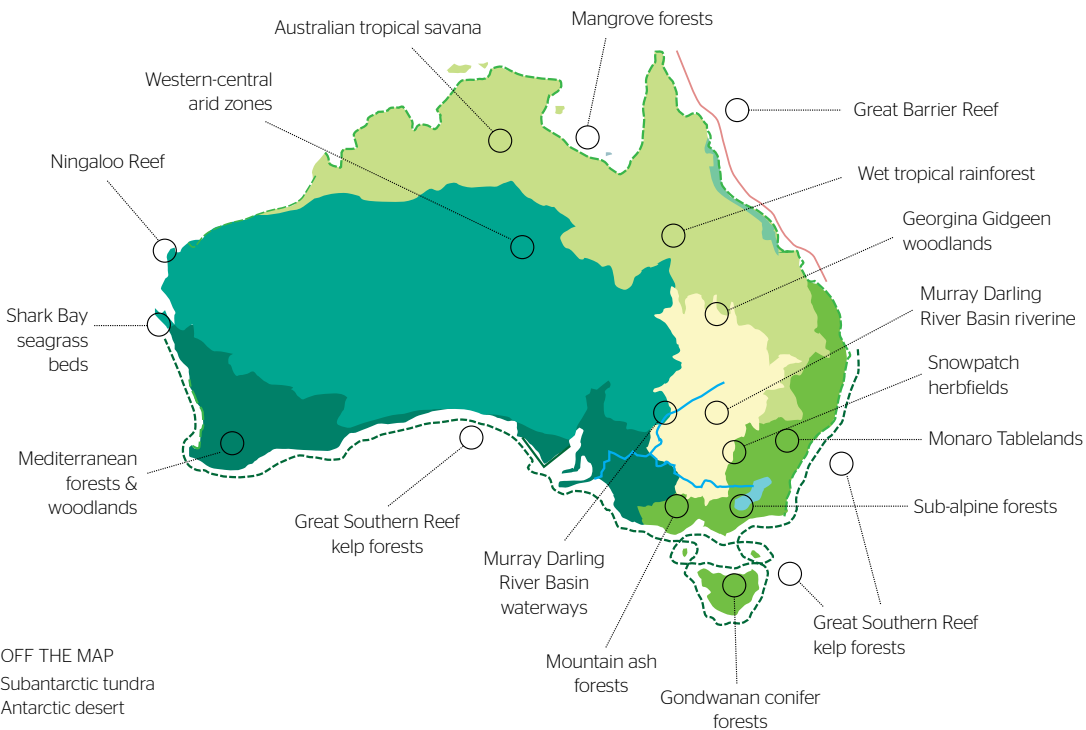
The 2021 State of the Environment report, released in July 2022, contains a catalogue of sobering statistics pointing to a decline in the health of nature and biodiversity in Australia on almost every indicator. Australia has one of the worst extinction records in the world, with the disappearance of more mammals than any other continent since European colonisation. The decline of native species in Australia continues to exceed that of any other country in the Organisation for Economic Co-operation and Development (OECD) - since 2016 the number of species newly listed as threatened or elevated to a higher category of threat has grown by 8%.

Between 2000 and 2017, 7.7 million hectares of terrestrial threatened species habitat was cleared. Many of Australia's landscapes are severely degraded and the remaining native vegetation has

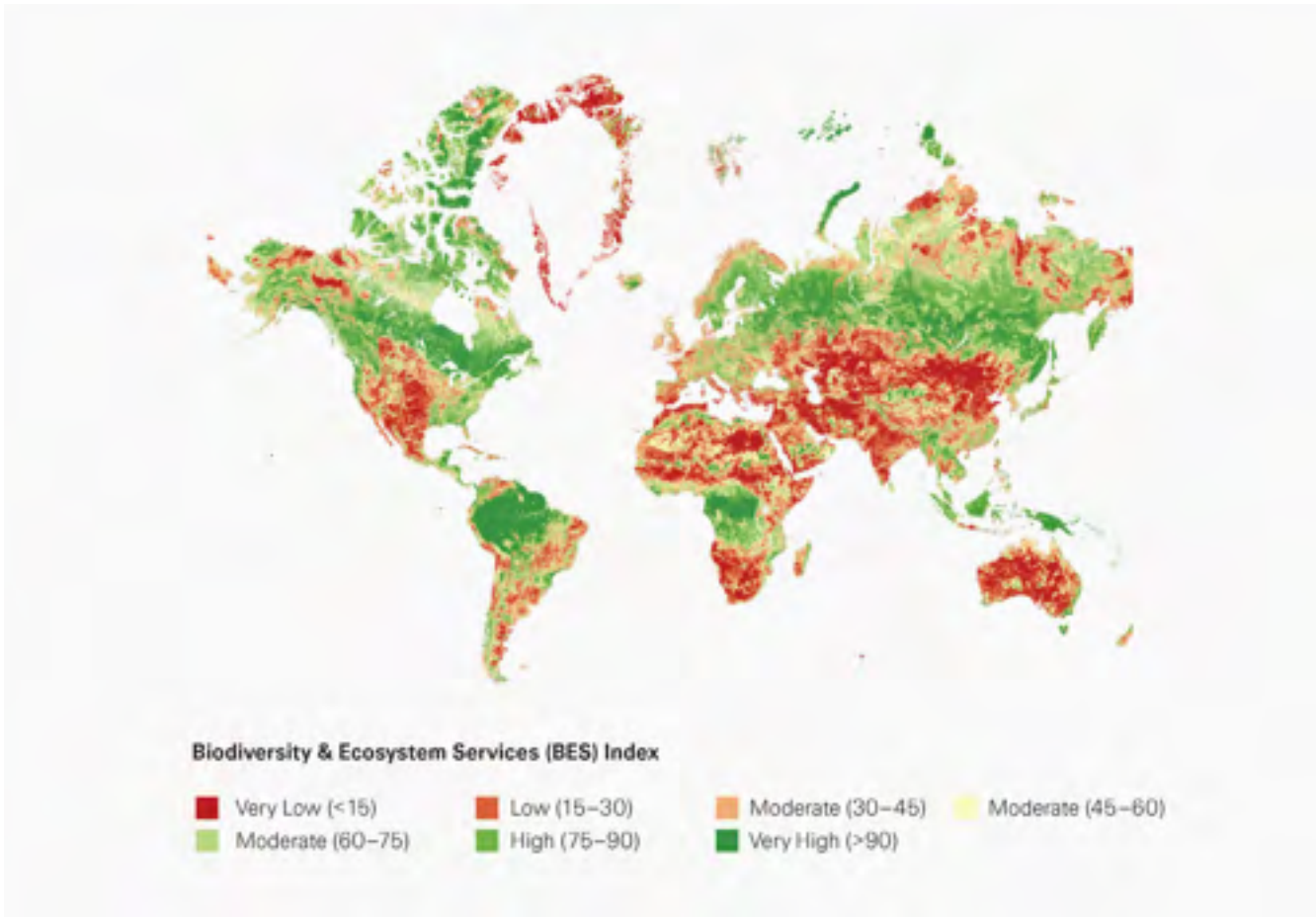
been modified to some extent. Australia now has more foreign plant species than native. Since 2016, freshwater ecosystems assessed in southern, eastern and south-western Australia were found to be in very poor condition with reduced ecological function.

Australia's strategies and investment in biodiversity conservation do not match the scale of the challenge. Our inability to adequately manage pressures will continue to result in species extinctions and deteriorating ecosystem conditions which are already reducing the natural capital on which the economy depends and which future generations have a right to depend on. As with the global decline in biodiversity, what nature needs in Australia is nothing less than transformative, systemic change with the goal of halting and reversing nature destruction.

The 19 Australian ecosystems at risk of collapse



The comparative fragility of ecosystem services according to the Swiss RE BES Index



Source: Oliver Schelske (2020) *Biodiversity and Ecosystems Services Index: measuring the value of nature*. Swiss Re Institute

In a study involving 38 experts, 21 universities, and the CSIRO, released in February 2021, 19 Australian ecosystems were classified as 'collapsing' – including the Murray-Darling river basin, the Great Barrier Reef, Queensland's World Heritage-listed Wet Tropics, and the Australian Alps – with grazing and agricultural expansion, invasive species, and climate change the most prevalent drivers of collapse.¹⁵

Beyond the loss of intrinsic, cultural, and ecological values associated with ecosystem biodiversity, these collapses are likely to have major social and economic consequences.

¹⁵ Bergstrom, Dana M., et al. (2021) "Combating Ecosystem Collapse from the Tropics to the Antarctic."

Ecosystem collapse in Australia - some examples

Ecosystem	Biodiversity values	Direct Human Pressures (distinct from climate change pressures)	Social and economic consequences of collapse
Great Barrier Reef	The Great Barrier Reef is the world’s largest coral reef system (10% of global coral reef area). At least 5,000 species of mollusc, 1,500 species of fish, 400 species of coral, >240 species of birds and many sponges, worms, crustaceans and anemones.	Poor water quality from agricultural sediment runoff and dredge spoils, commercial and recreational fishing, tourism, coastal development and chronic pollution from shipping lines.	The Great Barrier Reef provides ~\$12 trillion of ecosystem services in terms of habitat for marine organisms, water quality and food. It supports >64,000 jobs, and contributes ~\$6.4 billion per year to the Australian economy. The value of coastal protection of 49,000 km2 of coral reef was estimated at \$438 million. More than 70 Aboriginal and Torres Strait Islander clan groups, the Traditional Owners of the Great Barrier Reef, maintain cultural connections to the reef and rely on it for food and ceremony.
Australian Tropical Savanna	Australia’s tropical savannas cover ~1.3 million km² across northern Australia from the Kimberley to Kakadu National Park, Arnhem Land, and Queensland’s tropical coast. It is one of the most intact savannah ecosystems in the world with high levels of biodiversity and endemism. It includes one of the largest networks of free-flowing and least polluted rivers in the world, with the most biologically diverse and healthy aquatic ecosystems in Australia.	Increasing development and land degradation (e.g., extensive cattle grazing and land clearing) leading to habitat loss. Increased prevalence of invasive plant and animal species. Diversion and capture of fresh water. Altered fire regimes due to spread or non-native invasive pasture grasses.	The extension of the fire season due to gamba grass increases the cost of fire management. The loss due to fire of ecosystem services, production and pastoral lands amounted to \$148 million per year. Australia’s savannas are cultural landscapes that support the cultural, spiritual and socio-economic livelihoods of Indigenous people. Economic analysis from Deloitte estimated Kakadu National Park supports over 1,180 jobs and contributes \$136 million to the Australian economy each year.¹⁶

Ecosystem	Biodiversity values	Direct Human Pressures (distinct from climate change pressures)	Social and economic consequences of collapse
Murray Darling River	The Murray-Darling river basin is Australia’s largest river system with >77,000 km of watercourses. It comprises >30,000 wetlands as well as open forests and woodlands and Australia’s largest forest of river red gums. It provides habitat for millions of mammals, birds, fish and other animals; 120 species of waterbird and 46 native fish species. River red gums grow up to 45m tall and live up to 1,000 years, and are keystone species associated with the health of wetlands.	Fragmentation of river habitat, increased suspended sediment loads, introduction of non-native fish. Alteration and loss of water flow due to agricultural and urban water diversion, modified seasonal timing of water release, overall reduction of water flow. Agricultural runoff of nutrients, land use change for agriculture including clearing of riparian woodland and forests; timber harvesting.	The Murray-Darling river basin is home to 46 sovereign First Nations and has at least 10,000 culturally significant places. More than 2.25 million people occupy the Murray-Darling Basin including 9,200 irrigated agricultural businesses. It produces \$22 billion worth of food annually. Tourism contributes some \$8 billion each year. Due to the long running dry period, farm production has declined. Rural exports declined about 18% since early 2017, and for the first time since 2007, Australia had to import certain grains. Farm profits fell by about 30%, and the cost of bread and other cereal products and milk has increased. Other social and economic consequences include the loss of ecosystem functions of rivers and wetlands, loss of pollinators, reduced aesthetic value, erosion, reduced carbon storage, diminished water quality and decreases in endemic fish species (including culturally significant and recreationally valued fish). In 2019, shortages of potable water occurred in some towns while dams at the upper reaches of the system contained water used for the irrigation of water-intensive crops.

¹⁶ Deloitte (2020)



Key pressures driving nature destruction

About 75% of the planet’s land-based environments and 66% of marine environments have been significantly altered by human actions.¹⁷ Humans and the livestock farmed for food now make up 96% of the mass of all mammals on earth.¹⁸ Land degradation has reduced the productivity of one quarter of the earth’s surface.

Global water withdrawals from the environment have more than doubled since the 1960s, leaving 25% of the world’s population in areas of extreme water stress.¹⁹ So extensive has the damming and diversion of water been that the speed of the earth’s rotation has been altered.²⁰

Globally, agriculture has extensively transformed habitats and is one of the greatest pressures on biodiversity. Of the 28,000 species evaluated to be threatened with extinction on the IUCN Red List, agriculture is listed as a threat for 24,000 of them.²¹ The intensification of agriculture is not only contributing to species decline, it is also driving reduction in the availability of ecosystem services linked to biodiversity, including pollination, invasive plant and animal species management, soil health, and water retention.²²

The most significant pressures on Australian biodiversity have come from invasive species, habitat destruction associated with agricultural and urban expansion, and climate change, including extreme weather events, with industrial pollution, mining, and water extractions also having major impacts.²³

Dispossession of Country from its Traditional Owners is a central part of this story. Changed fire regimes, western agriculture, altered waterways, urbanisation and many other landscape transformations cause ongoing harm to Country and its people.

¹⁷ IPBES (2019), Summary for policymakers of the global assessment report on biodiversity and ecosystem services, IPBES, Bonn.
¹⁸ Bar-On, Yinon et al (2018) The biomass distribution on Earth, Proceedings of the National Academy of Sciences.
¹⁹ Hofste, R.W. et al (2019). 17 Countries, Home to One-Quarter of the World’s Population, Face Extremely High Water Stress [WWW Document]. wri.org.
²⁰ Fisher, Marshall Jon. “Water whirled.” The Sciences, vol. 36, no. 3, May-June 1996
²¹ Hannah Ritchie and Max Roser (2020) Environmental Impacts of Food Production Published online at OurWorldInData.org. Retrieved on 7 May 2022 ‘https://ourworldindata.org/environmental-impacts-of-food’
²² Naughtin C & Hajkowicz, S et al (2022) Our Future World: Global megatrends impacting the way we live over the coming decade. CSIRO
²³ Cresswell ID, Janke T, Johnston EL (2021) Australia State of the environment 2021. Australian Government Department of Agriculture, Water and the Environment, Canberra

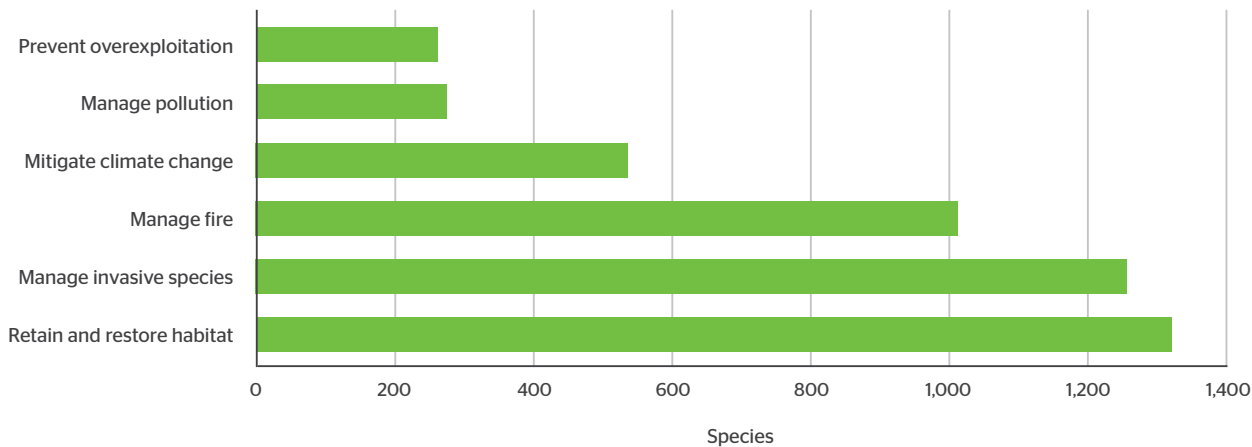
Key pressures and the impacts driving nature destruction in Australia

Pressures	Impacts on nature
Habitat destruction / Land clearing - predominantly for agriculture, infrastructure, urban development, mining and native forest logging.	Bulldozing and clearing of native vegetation is a major cause of habitat loss and fragmentation, heritage and biodiversity decline and has been implicated in 60% of the federal listings of Australia’s threatened species. Land clearing can also lead to processes that degrade soils, such as erosion, salinisation, loss of organic matter and depleted fertility. The impacts of habitat destruction on Australia’s native wildlife are cumulative, meaning the loss of species and ecosystems will not be reversed by managing a single threat – “86% of Australia’s threatened species are subject to multiple threats that result in habitat destruction and degradation, such as logging, mining, urbanisation and agriculture.” ²⁴
Invasive species	The European rabbit, feral cats, pigs and goats are the most commonly cited invasive species affecting Australia’s threatened species. Specifically, feral cats are believed to have been a major factor in the extinction of the 30 Australian native mammal species lost since European settlement. Invasive grasses, introduced mostly as fodder for livestock, have been shown to cause ecosystem degradation, habitat loss and biodiversity decline, as well as an increase in fuel loads, resulting in more intense fires and changed fire regimes.
Chemical pollutants used for agricultural purposes	Man-made chemical pollutants such as pesticides and other chemicals used in agriculture are suspected of causing 8% of fish deaths in coastal and inland catchments in New South Wales over the past 20 years. In 2016-2017 businesses applied 5 million tonnes of fertiliser to 50 million hectares of land across Australia. Agricultural activity is the third most commonly listed threat to biodiversity, affecting 57% of threatened species listed federally.
Modification of water flows	In the south-east of Australia, the most significant impact on freshwater ecosystems comes from the modification of water flows as a result of river regulation as well as surface and groundwater extraction for irrigation.
Extreme weather events	Extreme weather events not only cause direct loss of species, they exacerbate existing pressures. During the 2019-2020 Black Summer bushfires 10.3 million hectares of native bushland was burned and an estimated 1–3 billion native animals were killed or displaced. The bushfires increased the extinction risk of many plants and animals that were already listed as Endangered or Critically Endangered due to other threats.
Mining	Mining affects species, landscapes, and heritage values at various scales from landscape to regional and greater - the discharge of waste and chemical pollution and direct habitat destruction have the most direct impacts, along with transport and resource and groundwater extraction.

²⁴ Cresswell ID, Janke T, Johnston EL (2021) Australia State of the environment 2021. Australian Government Department of Agriculture, Water and the Environment, Canberra

The Australian economy’s dependence on nature

Number of threatened species that would benefit from different management responses in Australia



Source: Cresswell ID, Janke T, Johnston EL (2021) Australia State of the environment 2021. Australian Government Department of Agriculture, Water and the Environment, Canberra

Nature plays a vital role in providing Australians with food, energy, fresh water, feed for livestock, medicines, flood and storm regulation, places for recreation, attractions for international visitation, materials fundamental for people’s physical wellbeing and for maintaining culture.

The survival of remote communities and the social, economic, cultural and political wellbeing of many First Nations people is directly connected to the health of nature.

Many of the benefits we derive from nature are possible because of the application of human toil, knowledge, and technology. But while human endeavour can enhance those contributions or services, it cannot replace them. Ultimately, we are wholly dependent upon nature.

As nature’s limits, or planetary boundaries, are exceeded, ecological systems and functions are altered along with the ecosystem services they provide to people, and the contribution of natural capital to the economy falls. According to one study, depending on how natural capital is managed, it could contribute US\$51 trillion less, or US\$30 trillion more, per year, to the global economy by 2050.²⁹

The Dasgupta Review

In 2019 the landmark *Dasgupta Review* of the economics of biodiversity, commissioned by the UK Treasury, was published.³⁰ In it, Professor Sir Partha Dasgupta called the lack of willingness among businesses and financial institutions, including central banks, to measure and price the true value of nature a global institutional failure.

The review highlighted that because it only measures dollars of output and does not account for the value or depreciation of the ‘natural assets’ an economy depends upon, the use of GDP alone as a measure of an economy’s performance amounts to “a faulty application of economics.”

Dasgupta made the case for a comprehensive approach to integrating nature – its natural capital and the ecosystem services, or nature’s contributions to people, that flow from that capital – into economic decision-making recognising the world’s economic dependence on nature. Most importantly he proposed a shift in thinking and a recognition that economies necessarily operate within the bounds of nature which means that the demands of the economy cannot exceed nature’s ability to supply it.

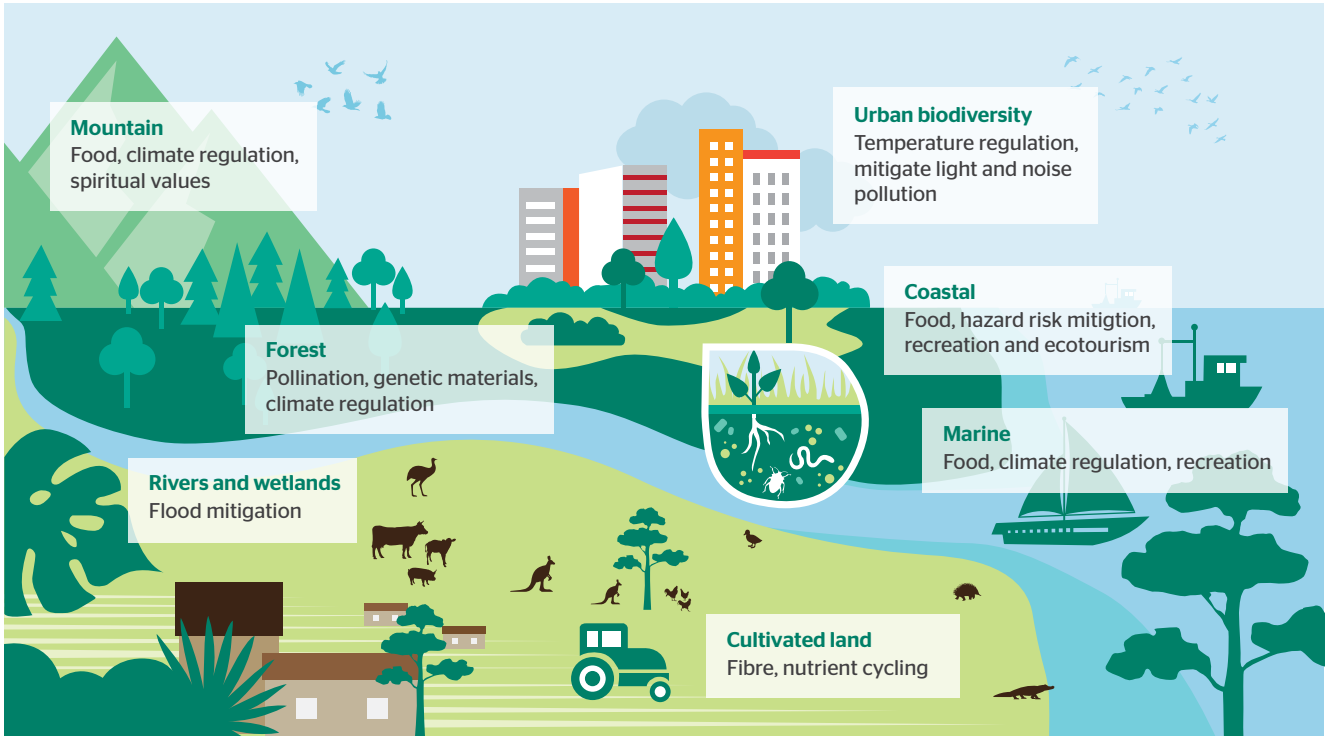
²⁹ Kubiszewski I, Costanza R, Anderson S, Sutton P (2020) The future value of ecosystem services: global scenarios and national implications.
³⁰ Dasgupta, P. (2021) The Economics of Biodiversity: The Dasgupta Review (London: HM Treasury).

Agriculture’s impact and opportunity

Since colonisation, no activity has shaped the Australian landscape as profoundly as agriculture. More than 55% of Australia is agricultural land, the bulk of that grazing land for cattle and sheep, currently accounting for a quarter of all water extractions.²⁵ Agriculture is the primary reason 44% of Australia’s woodland has been cleared during this period,²⁶ and it remains the primary reason for ongoing deforestation and land clearing, including more than 680,000 hectares of clearing in Queensland in 2018-2019 alone, mainly for livestock grazing. But the size of the agricultural estate and the knowledge of Australian farmers mean good agricultural practices, including regenerative livestock grazing²⁷ methods and better use of water and fertiliser, can also contribute to the restoration of damaged ecosystems, improvement of soil health, and carbon sequestration while improving productivity. Agricultural businesses that adapt to a changing environment will also be amongst the greatest economic beneficiaries of the transition to a Nature Positive economy.²⁸

²⁵ Department of Agriculture Water and the Environment (2022) Snapshot of Australian Agriculture 2022. Canberra <https://www.awe.gov.au/abares/products/insights/snapshot-of-australian-agriculture-2022>
²⁶ Department of Agriculture Water and the Environment (2016) State of the Environment Report <https://soe.environment.gov.au/theme/land/topic/2016/regional-and-landscape-scale-pressures-land-clearing>.
²⁷ QLD Government (2021) 2018–19 Statewide Land and Trees Study (SLATS) <https://www.qld.gov.au/environment/land/management/mapping/state-wide-monitoring/slats>
²⁸ Food and Land Use Coalition (2019) Growing Better: ten Critical Transitions to Transform Food and Land Use. www.foodandlandusecoalition.org/global-report/

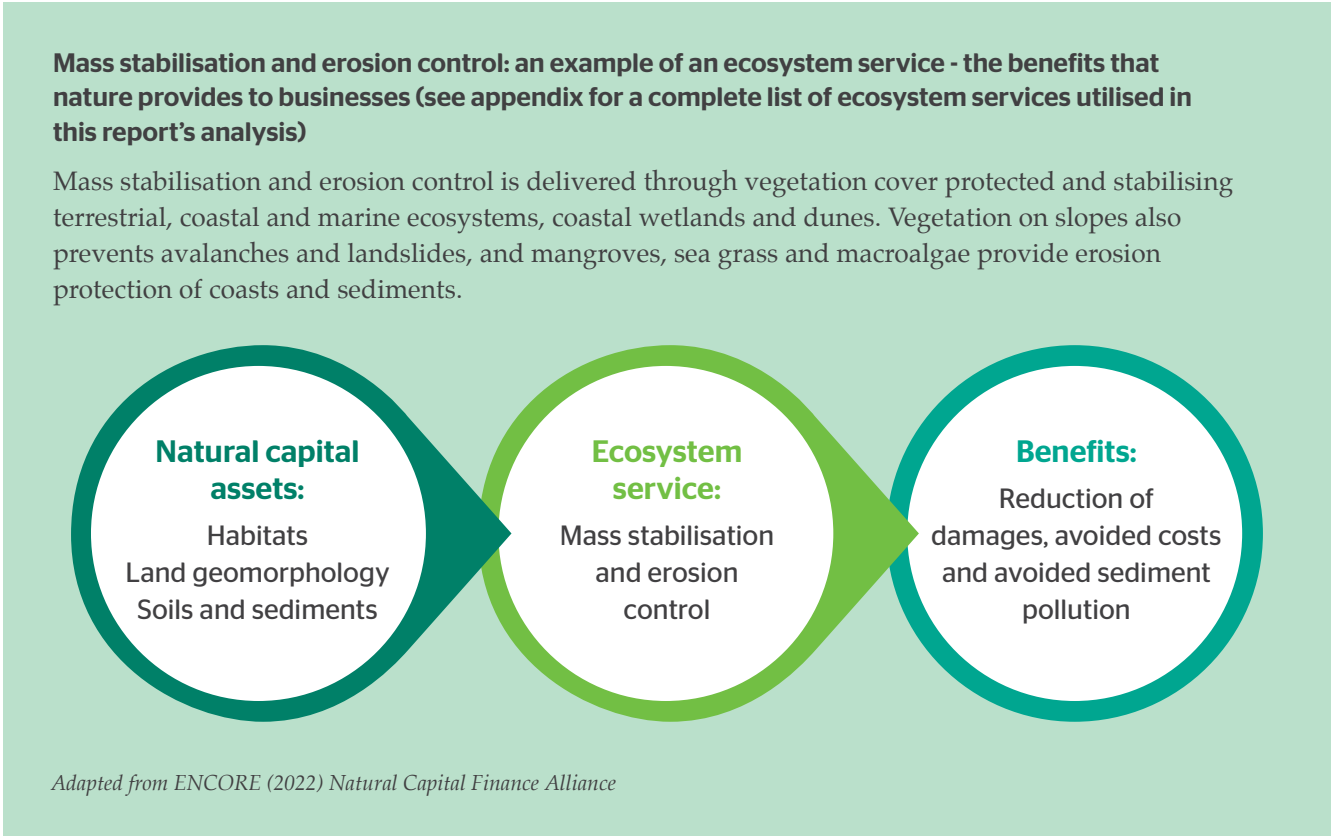
Nature and its contributions to people



Adapted from Dasgupta, P. (2021) *The Economics of Biodiversity: The Dasgupta Review*.

All ecosystem services, or NCP, are derived from the world’s natural assets including soil, geology, air and all living things, or natural capital. Natural capital is the stock of nature from which ecosystem services flow. A forest is an example of natural capital, as

the ecosystem services a forest provides can include climate regulation, timber provision, flood and erosion control, and genetic resources.



Nature’s contributions to people	
Interactions between biodiversity and physical processes such as soil and water chemistry, temperature, and humidity create a stable and liveable planetary system for all life. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) assesses 18 categories of Nature’s Contributions to People (NCP) under three headings: regulating, material, non-material.	
Regulating	Climate, air quality, pollination and natural propagation, soil formation, habitat formation and maintenance, fresh water quality, hazard prevention
Material	Energy, food, labour, medicinal
Non-material	Identity, inspiration, and physical and psychological experiences like happiness, or improved mental health

Sector-based direct nature dependence

Every sector of the Australian economy is directly dependent on nature to varying degrees, and that dependency is based on different ecosystem services derived from different elements of natural capital. Each sector also has indirect dependencies via their value chains, which are not calculated here. It is important to note that the methodology used here does not measure our dependence on nature via its cultural, spiritually, or aesthetic values. Those values contribute to the good life in Australia economically, for example through the tourism linked to natural wonders, and in non-financial ways such as the wellbeing benefits we receive from spending time in nature or the cultural connections First Nations people have to sea country.

Sectors with **very high** direct dependence on nature generate 16.1% of Australian GVA (gross value added), or \$293.6bn per year. This corresponds to approximately 15.9% of Australian GDP. Those sectors include primary industries like agriculture, forestry, and fisheries (\$38.7bn), food product manufacturing (\$23.1bn), as well as construction (\$144.4bn) and waste and water services (\$19.2bn), with 100% of the GVA of those sectors very highly directly dependent on nature. These industries rely on the direct extraction of the earth’s natural resources or directly depend on the provision of ecosystem services such as clean water, a stable climate, pollination, erosion prevention, healthy soils, and protection from floods and storms.



Explanation of Gross value added (GVA)

Gross value added (GVA) represents the value of goods and services produced by a given industry, less the cost of inputs and raw materials attributable to that production. It is typically used to measure producer, industry or sector-level contributions to the economy, as opposed to gross domestic product (GDP), which is a standard measure for national- or multinational-level economic analysis.

Sectors with a **moderate** to **high** direct dependency on nature which include mining (\$127.0bn), real estate (\$207.0bn), transport and logistics (\$89.6bn), and accommodation and hospitality (\$44.3bn) contribute (\$602.7.bn) to Australia’s economy, or (approximately 33% of GDP). Combined, \$896.2bn of GVA or approximately 49% of GDP, has a moderate to very high direct dependence on nature.

How impairment of ecosystem services can affect economic performance

Impairment of an ecosystem service stemming from damage to the environment, or a depreciation of natural capital, can affect the economic performance of those industries, acutely or chronically. For example, disruption to coal mine operations and associated infrastructure associated with flooding events in NSW and Queensland in 2022 saw a 2.7% decrease in GVA for the coal industry for the March quarter. Across the Australian wheat belt, which occupies 6% of the country, the loss of potential yields due to soil constraints – salinity, acidity, and sodicity (an excess of sodium) – results in an estimated \$1.9billion a year of lost income. Those soil constraints are exacerbated by incorrect fertiliser application, land clearing, and other land management approaches - 70% of the wheat belt suffers from soils with high acidity which is mainly caused by excessive application of ammonium-based fertilisers.

³¹ Australian Bureau of Statistics (2022) Weather and natural disaster impacts on the Australian national accounts <https://www.abs.gov.au/articles/weather-and-natural-disaster-impacts-australian-national-accounts>
³² Orton, Thomas et al (2018) Quantifying the economic impact of soil constraints on Australian agriculture: A case-study of wheat. Land Degradation and Development Volume29, Issue11
³³ Natural Capital Finance Alliance (2019) Natural Capital Credit Risk Assessment in Agricultural Lending. www.naturalcapital.finance/

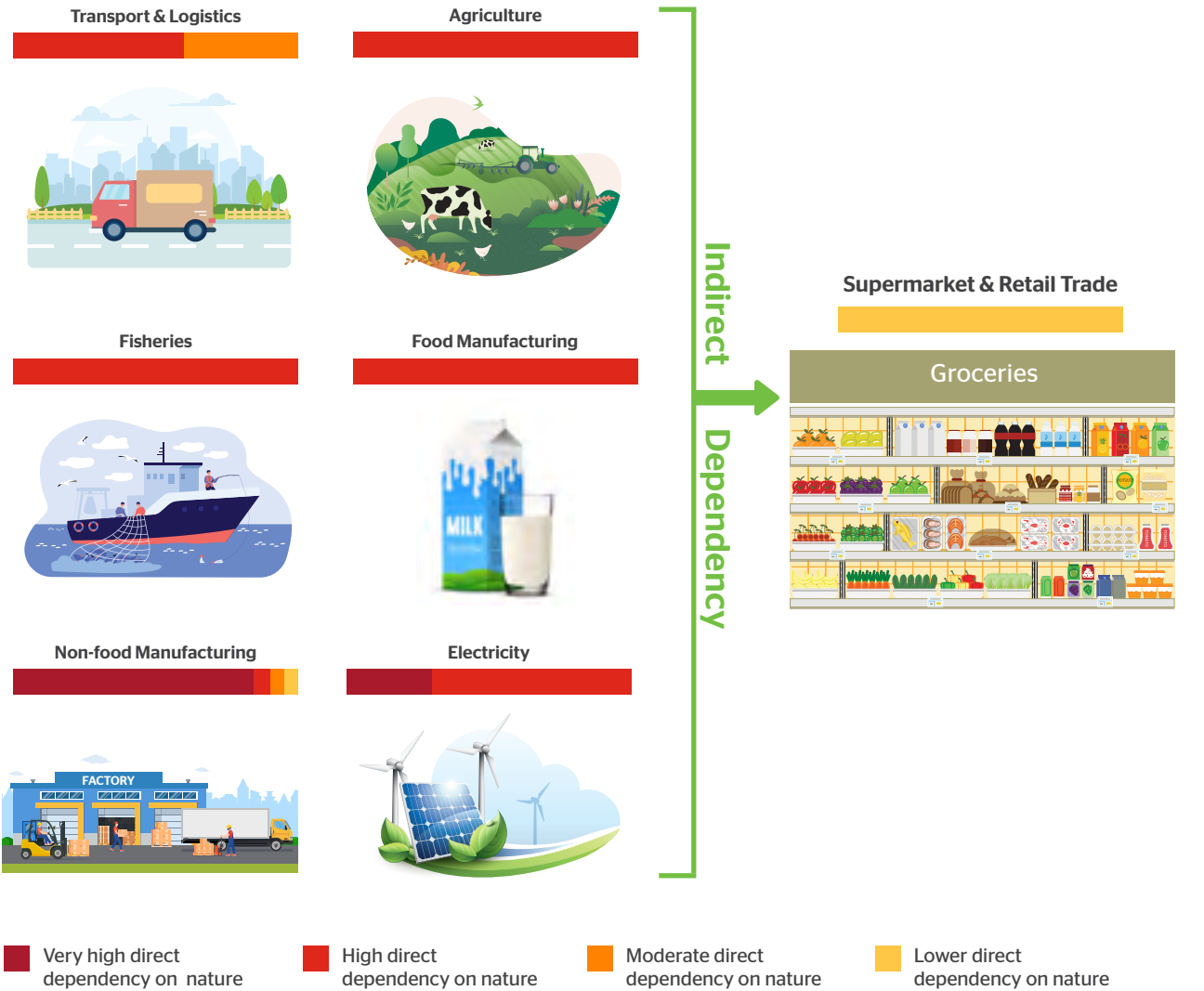
Hidden, indirect nature dependencies

For some sectors, nature dependencies are hidden. The wholesale and retail trade sector may only have a lower direct dependence on nature by GVA, but the goods sold in supermarkets, local grocery shops, butchers and bakers – manufactured food (100% very high) and non-food products (80% very high to high) and fresh fruit, vegetables, meat, and dairy (100% very high) – have much higher direct nature dependency. Retailers are also major consumers of

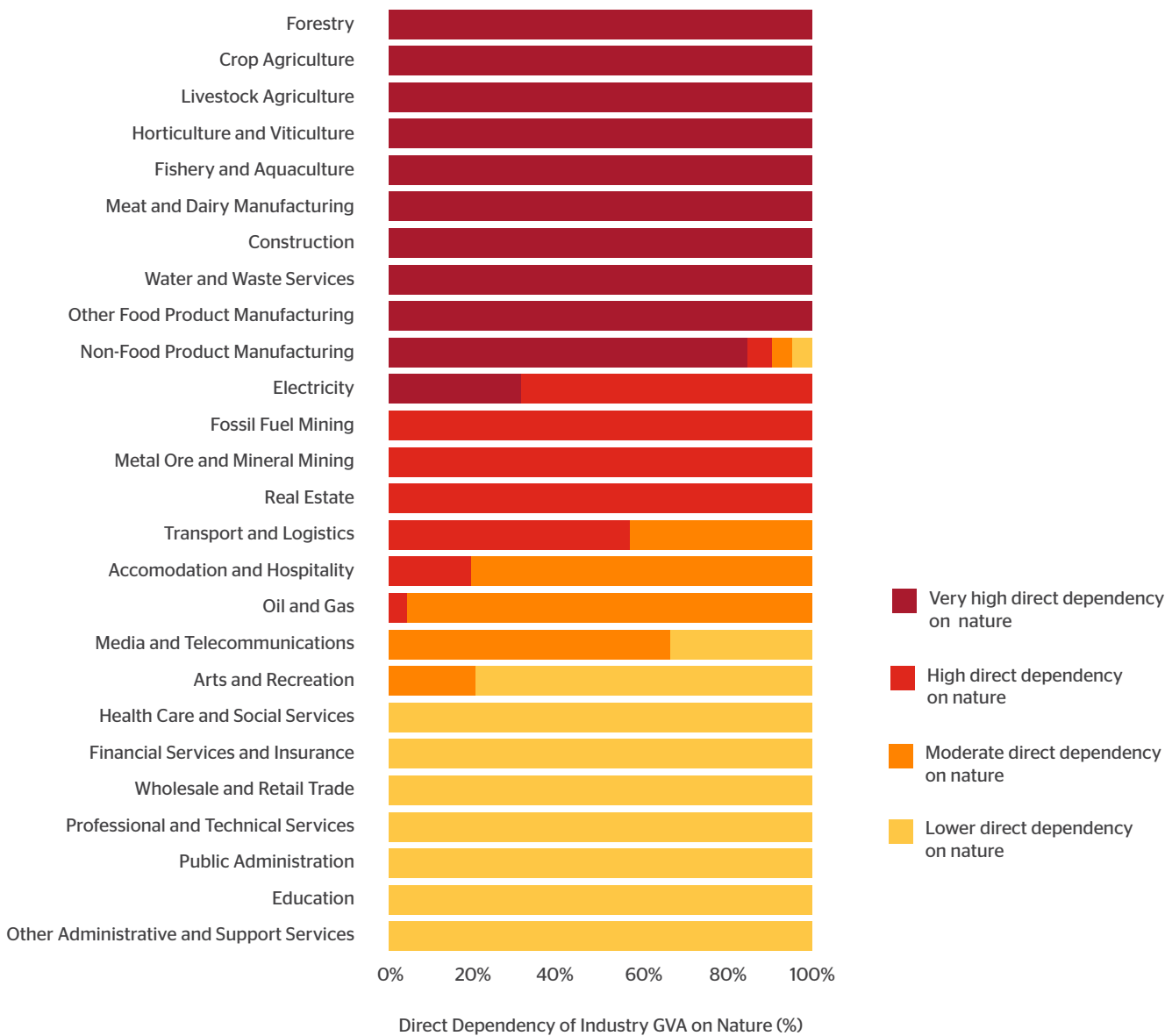
electricity, which itself has a 100% very high to high direct dependency on nature, and rely heavily on transport and logistics (25% high and 75% moderate) direct nature dependency. Without those goods and access to services, retailers would have no products to sell and couldn’t keep the lights on. This shows a sector with a relatively low direct dependency score, can in reality have a high indirect dependency based on its value chain. Indirect dependencies are no less important - you can’t have a supermarket that doesn’t have food in it!

Hidden, indirect nature dependencies are highly material to some sectors

The wholesale and retail trade industry has a neutral direct dependency score based on GVA but the sector has an indirect dependence on transport and logistics, agriculture, food manufacturing, non-food manufacturing, electricity all of which have much higher direct nature dependencies.



Direct nature dependency by industry sector



Variations in nature dependency within a sector

Within each sector, there are sub-sectors, and individual businesses, which will each have a different level of overall direct nature dependency, and a dependency on different specific ecosystem services. Within the electricity sector hydropower, solar, and

wind rely on different ecosystem services, for example, while some electricity sub-industries, like coal-fired power and biofuels, involve the direct consumption of natural capital.

Variations in ecosystem service dependence within the highly nature-dependent energy sector	
The energy industry within Australia includes energy produced from both renewable and non-renewable sources. 76% of Australia’s 2020 electricity generation was derived from fossil fuels such as coal (54%), gas (20%), and oil (2%). The remaining 24% was based on renewables such as solar (9%), wind (9%), and hydropower (6%). ³⁴ Each of these energy sources is reliant on nature and the natural inputs it provides in some way, as is the transmission of electricity and distribution of solid and liquid fuels around the country. Some of these dependencies on ecosystem services include:	
Energy source	Nature dependencies
Biofuels	Biofuel based energy is derived directly from biomass and can be considered a process of directly consuming natural capital for energy production. The provision of fibres for biomass based energy production is a critical ecosystem service for this energy type and relies upon a host of other ecosystem services relating to water provisioning and climate regulation.
Coal	Electricity produced from coal is both based on the consumption of natural resources and dependent on ecosystem services that enable the coal mining process and the operation of power stations. Water related ecosystem services are among the most important in enabling coal-based electricity production, however, climate regulation and mass stabilisation and erosion control services are also material.
Hydropower	Hydropower production is based on energy generation via surface water and water flow maintenance related ecosystem services. As a result of Hydropower reliance, climate regulation is also of key importance as are mass stabilisation and erosion control and flood and storm control protection services that ensure the safe operation of relevant infrastructure.
Oil and gas	Oil and gas based energy production is directly dependent upon ecosystem services relating most prominently to the provision of water during, for example, processes involved in the extraction phase and as a coolant during combustion. In addition, ecosystem services that relate climate regulation, flood and storm protection, mass stabilisation and erosion control, and others are necessary to ensure the safe and efficient use of oil and gas.
Solar and wind	As renewable energy sources, solar and wind energy are not based on consumption of natural capital directly. The generation of solar and wind energy is dependent largely on climate regulation services as well as mass stabilisation and erosion control and flood and storm protection services that ensure the safe operation of relevant infrastructure.

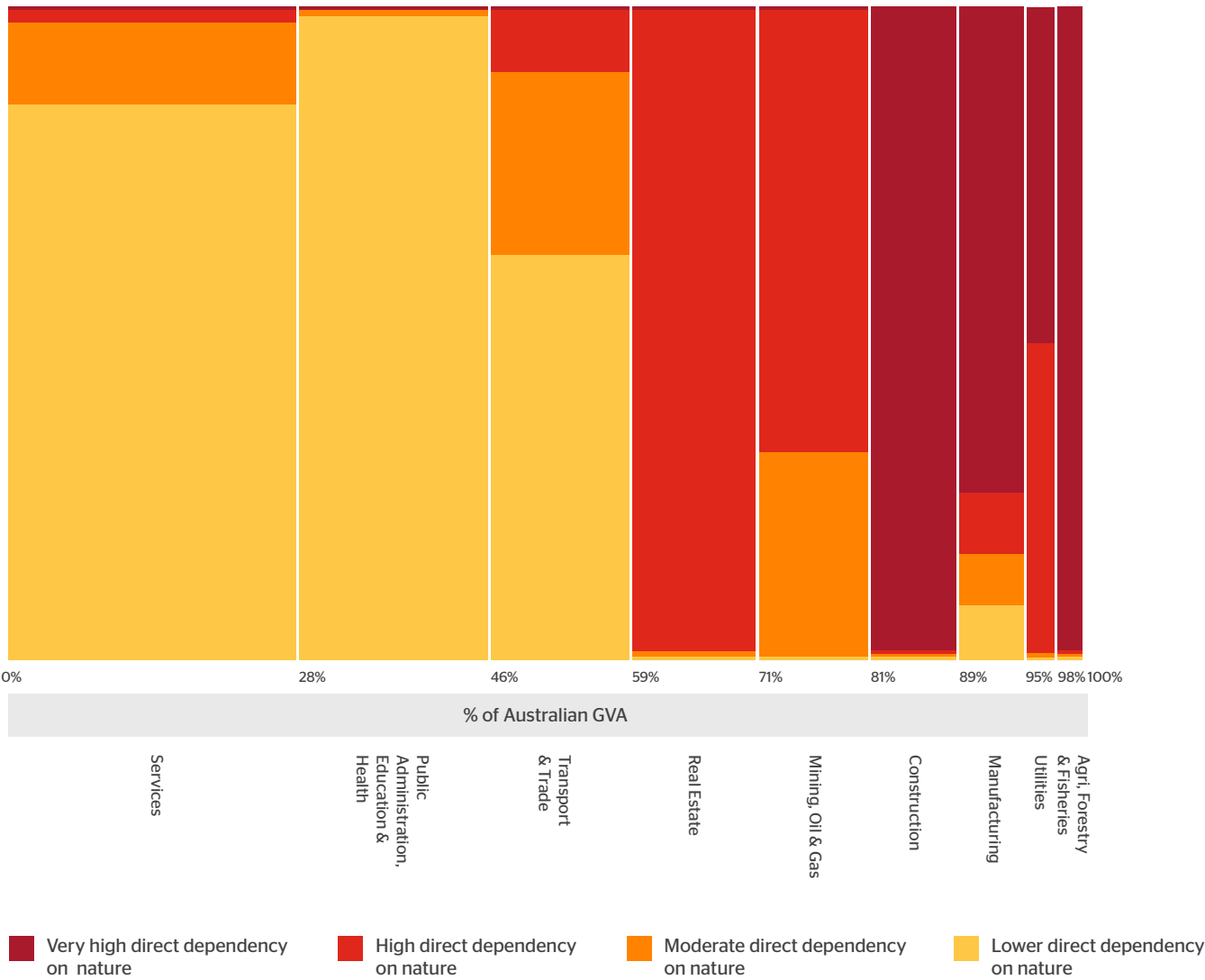
³⁴ Department of Climate Change, Energy, the Environment, and Water (2020) Australian Energy Generation. www.energy.gov.au/data/electricity-generation accessed on 18 July, 2022

Calculating the Australian economy’s dependence on nature

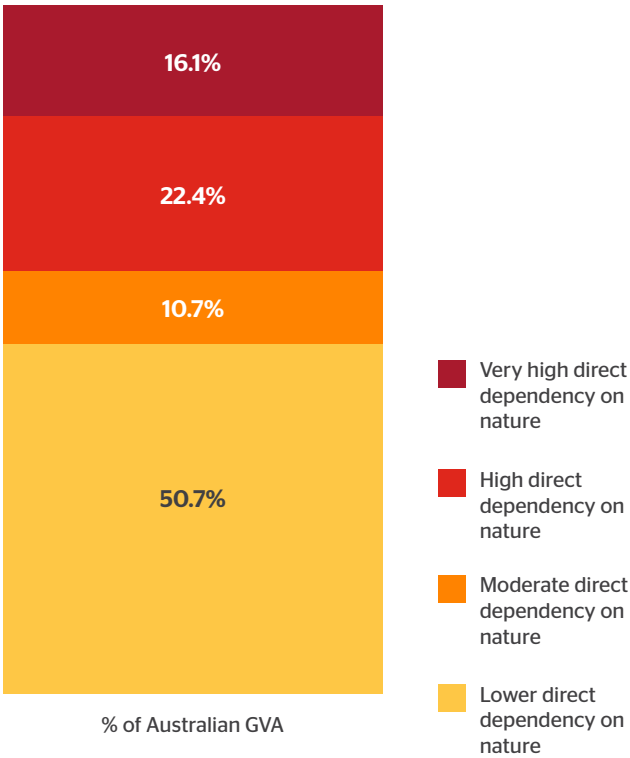
In 2018-19 the Australian economy had a total GDP of \$1,952.7bn having experienced 28 consecutive years of growth before the COVID-19 pandemic upended the national and global economy. Contrary to perceptions, the Australian economy is dominated by service industries. 35% of GVA comes from sectors sometimes called the knowledge industries, public administration, health, education, financial and professional services, all of which have a lower direct

dependency on nature because they tend to draw upon human capital and technology. But roughly half of the Australian economy (approximately 49%) measured by GDP has a moderate to very high direct dependence on nature. Meanwhile Australia’s exports are dominated by sectors with the highest nature dependency, in particular mining, manufacturing, and agriculture. Sectors that have a high or very high direct dependency on nature are responsible for more than three quarters of Australia’s export earnings, with resources making up 68.7% of Australia’s export share and rural exports another 11.3% in 2022.³⁵

Direct nature dependency of Australian industries and their contribution to the economy



Direct nature dependency of the Australian economy by GVA



State-by-state nature dependency

Every Australian state is dominated by different industries which results in significant variance in direct nature dependency, and each state in turn contributes a different proportion to Australia’s GVA. Western Australia, which is Australia’s biggest producer of iron ore and LNG, and a significant producer of wheat and other agricultural products, is Australia’s most nature-dependent state with 66.9% of state GVA, or \$183.8bn, having a moderate to very high direct dependence on nature. While WA only contributes 15% to Australia’s GVA, its contribution to Australian exports was 36.5% in 2019. The Northern Territory (55% or \$13bn), Queensland (53.8% or \$187.1bn), and Tasmania (50.6% \$15.3bn) are the next most nature-dependent jurisdictions.

³⁵ Reserve Bank of Australia (2019) <https://www.rba.gov.au/education/resources/snapshots/economy-composition-snapshot/>



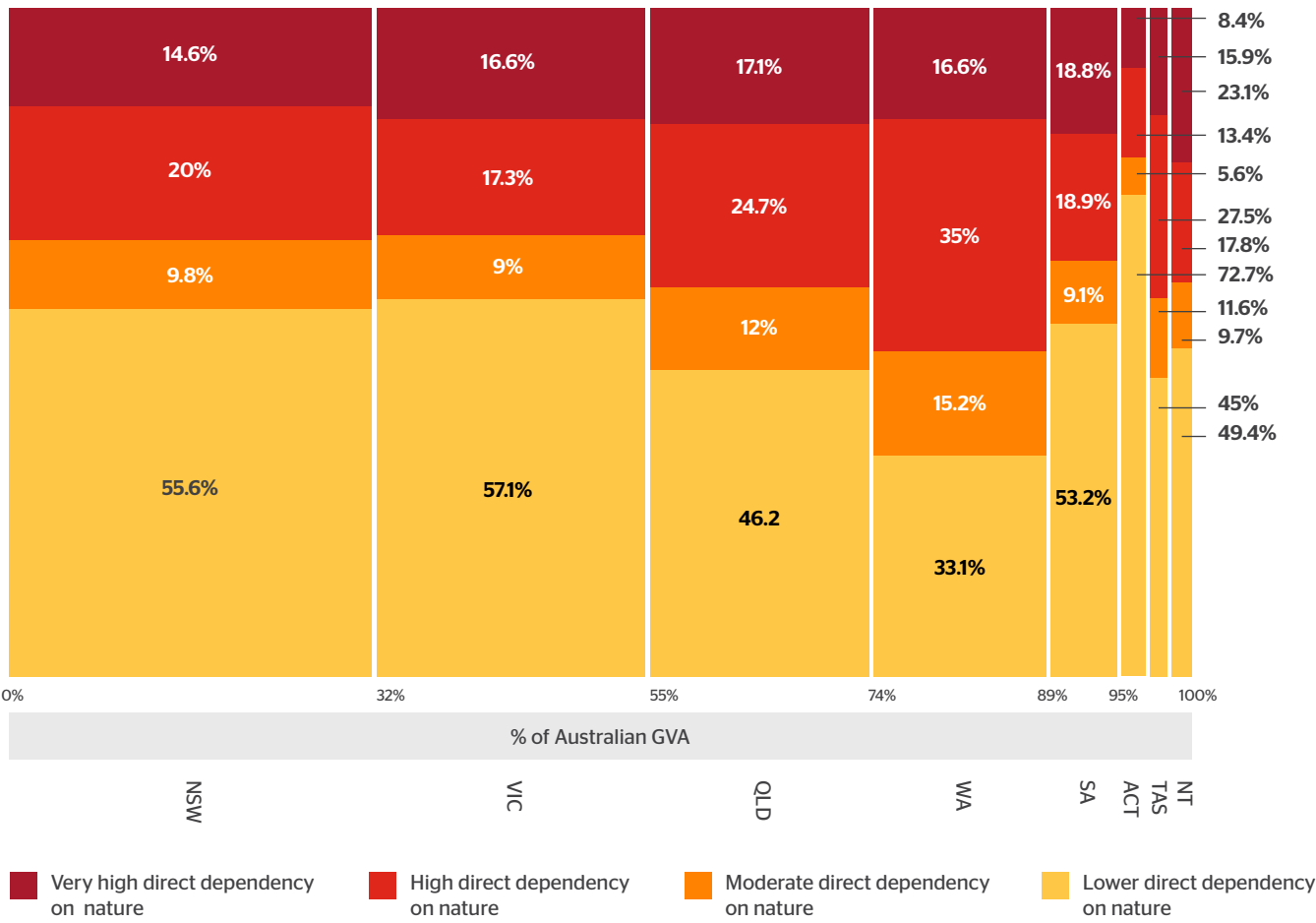
Nature and risk

Because our society and economies are embedded within nature, not external to it, changes in the state of nature manifest as risks to the earth’s systems and therefore to human wellbeing, the economy, financial systems and individual businesses.

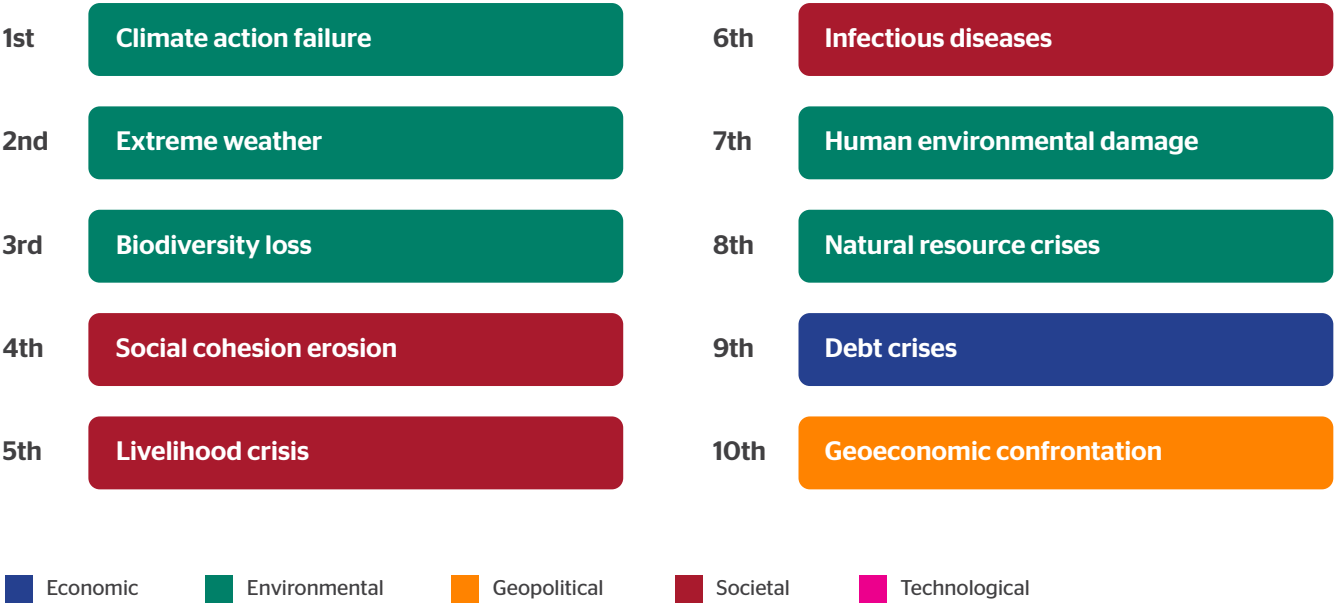
The decline in the natural environment globally, and especially in Australia where our landscapes and biodiversity are particularly unique and fragile, means the ecosystem services we receive from nature are also in decline. The World Economic Forum’s 2022 global risks report listed biodiversity loss as one of the three most severe risks to economic and social stability, alongside climate change and extreme weather.³⁶



Direct Nature Dependency of Australian State Economies



The most severe risks to economic and social stability are environmental in nature



Source: World Economic Forum (2022) Global Risk Perception Survey

³⁶ World Economic Forum (2022) Global Risk Perception Survey

Corporations have, with some exceptions, failed to measure and manage their impacts on nature through their supply chains while banks and investors are only beginning to assess their exposure to nature-related risks through their lending and investments. These efforts must be improved and accelerated at scale. Businesses in sectors with high nature dependence and high impact not only risk reputational, regulatory, legal, and financial blowback from damaging nature (i.e. transition risks), they are also exposed to risks associated with the continued degradation of the natural capital and ecosystem services that are material inputs to their businesses (i.e. physical risk). The financial sector in particular bears responsibility for the economy-wide transition to Nature Positive practices as it determines which activities are financed or insured and under what conditions, including price.

The TNFD, United Nations Environment Program Finance Initiative (UNEPFI), Dasgupta review and others acknowledge that nature and climate-related risks also apply to sovereigns. Finance ministers, treasuries, and central banks – just like corporations and financial institutions – have a responsibility to assess nature-related impacts and dependencies of national economies, model scenarios, and take action to embed nature into budgets and regulation with the view to achieving sustainable Nature Positive economies.

Nature-related risks and opportunities for business and the financial sector

Nature-related risks and opportunities: refers to an organisation or business' impacts and dependencies on nature, as well as the financial, reputational and other business-related risks and opportunities associated with its interactions with nature.

Impacts: are positive or negative contributions of a company or other actor toward the state of nature, including pollution of air, water, soil, the fragmentation or disruption of ecosystems and habitats and the alteration of ecosystem regimes.

Dependencies: are aspects of nature's contributions to people (ecosystem services) that a person or organisation relies on to function, including water flow and quality regulation; regulation of hazards like fires and floods, pollination and carbon sequestration.³⁷

³⁷ Adapted from science-based targets for nature

Nature-related risk and directors' duties

It is arguable that the factors that informed the seminal opinion by Noel Hutley SC and Sebastian Hartford-Davis on Australian directors' duties and climate risk in 2016³⁸ are now also true for nature-related risk.

In the context of nature-related risk, the key factors are:

- 1. Physical risks** – Nature is known to be in decline globally and in Australia, and nature loss gives rise to physical risks with financial implications for companies; and
- 2. Transition risks** – In response, there is an increasing likelihood of tightening regulations in Australia to address negative impacts on nature, as well as of litigation and changing consumer preferences which may also have financial implications for companies.

As a result, nature-related risks may already be relevant to a director's duty of care and diligence under section 180(1) of the Corporations Act 2001 (Cth) (the Act), to the extent that those risks are foreseeable and intersect with the interests of the company. This is because, for some Australian companies, nature-related physical and transition risks are clearly capable of representing risks of harm to the interests of the company and could also be regarded by a Court as being foreseeable at the present time. It follows that a director who fails to properly consider these risks could be held personally liable for breaching their duty of care and diligence to the company under the Corporations Act.

³⁸ Centre for Policy Development (2016) Legal opinion: directors' duties and climate risk www.cpd.org.au/2016/10/directorsduties



Categories of nature-related risks and opportunities³⁹

Group	Sub-group	Risk	Opportunity
Transition	Policy and legal	• Extraction moratoria, lower quotas • Fines, permit suspension or denial • Lawsuits • Trade barriers	• Speedier approval of permits • Reduced lawsuits
	Technology	• Substitution of products with a lower impact alternative • Unsuccessful investment in new technology	• Increased efficiency • Low-impact industrial processes
	Market	• Changes in customer preferences	• New products or services • Markets for ecosystem services • New revenue streams from business-owned or managed ecosystems
	Reputational	• Damage to brand or image • Challenge to social licence to operate	Improved brand or image
Physical	Acute	• Temporary increased scarcity or cost of inputs • Disruption to business operations	Increased resilience to disruptions
	Chronic	• Gradual permanent increased scarcity or cost of inputs • Increasing number of disruptions to business operations	Increased resilience to change
Systemic		• Natural system no longer functions properly (e.g., permafrost melting, fish stock collapsing) • Portfolio-level of a financial institution	Increased resilience to systemic risk

Why compliance with Australia’s environment laws is not a sufficient nature risk management strategy

Environmental laws in Australia have failed to stem the country’s rapid rate of biodiversity destruction. Simply complying with ineffective environmental regulations will not be enough to ensure a business is sufficiently reducing its impact on nature. In October 2020, Professor Graeme Samuel completed a comprehensive statutory review of Australia’s national environment law — the Environment Protection and Biodiversity Conservation Act (EPBC Act). It found our national environment law is failing to live up to its name and requires fundamental reforms to address our greatest environmental challenges, like climate change and the collapse of ecosystems. Similarly, state environmental laws and their enforcement have failed to halt destruction of habitat with land clearing rates tripling in NSW over the past decade,⁴⁰ and latest land clearing data from Queensland showing a doubling of clearing in just one year to 680,000 hectares in 2018-2019.⁴¹

⁴⁰ NSW Environmental Protection Authority (2022) NSW State of the Environment 2021 <https://www.soe.epa.nsw.gov.au/>
⁴¹ Queensland Government (2021) 2018-19 SLATS report <https://www.qld.gov.au/environment/land/management/mapping/statewide-monitoring/slats/slats-reports/2018-19-report>
⁴² Ward, MS, Simmonds, JS, Reside, AE, et al. (2019) Lots of loss with little scrutiny: The attrition of habitat critical for threatened species in Australia. Conservation Science and Practice.

Federal environmental laws failing to protect nature

- Between 2000 and 2017, the first 17 years of the EPBC Act, 7.7 million hectares of threatened species habitat was cleared, and of that, 7.1 million hectares (93%) was not referred to the Australian Government for assessment under the EPBC Act.⁴²
- The recent State of the Environment Report 2021 found that the EPBC Act is not effective in delivering improved outcomes for biodiversity, or arresting biodiversity decline, and does not facilitate effective management of pressures or restoration of the environment.
- A statutory review of the EPBC Act conducted by Professor Graeme Samuel released in 2021 found that:
 - The EPBC Act needs fundamental reform as it is ‘outdated’, ‘ineffective’ and ‘not fit to address current or future environmental challenges’.
 - The Act lacks clear national outcomes and effective mechanisms to address environmental decline.
 - The Act does not facilitate a strategic or systematic approach to managing or restoring the environment. Cumulative impacts and emerging threats are not adequately managed. The current settings cannot halt the trajectory of environmental decline, let alone reverse it.
 - Environmental offsets have become the default, rather than the exception after all practical options to avoid or mitigate impacts have been exhausted.
 - There is no clear, authoritative source of environmental data and information and the right information is not available to inform decisions made under the EPBC Act.

³⁹ Adopted from TCFD (2017) ‘Recommendations of the Task Force on Climate-related Financial Disclosures’ Task Force on Climate-related Financial Disclosures 1–74. Available at <https://assets.bbhub.io/company/sites/60/2020/10/FINAL-TCFD-Annex-Amended-121517.pdf> and Taskforce on Nature Related

Financial Disclosures (2021) TNFD Proposed Technical Scope. Geneva. Available at <https://tnfd.info/wp-content/uploads/2021/06/TNFD—Technical-Scope-1.pdf> and Natural Capital Coalition, 2016. Natural Capital Protocol. https://doi.org/10.1057/978-1-137-39396-8_6

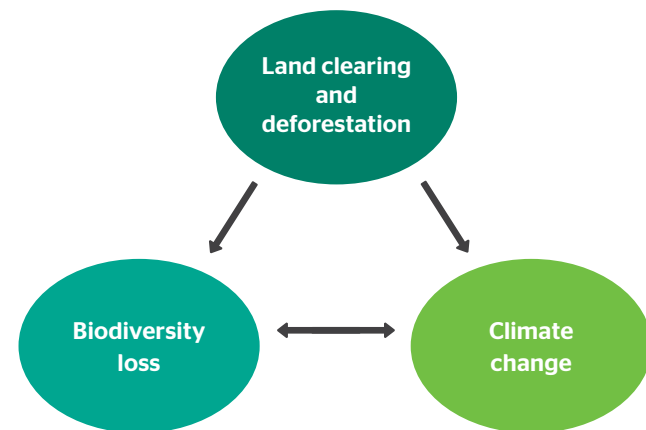
Nature and climate

The challenges of nature destruction and climate change are inseparable. Destruction of nature exacerbates climate change because it reduces the capacity of the earth’s ecosystems to absorb atmospheric greenhouse gas pollution.

Climate change exacerbates biodiversity loss because it causes fundamental changes to ecosystems, such as through desertification, and the loss or relocation of climatic niches essential to the survival of certain species and ecological communities.

Climate change and nature destruction are also driven by many of the same threats. Land clearing and deforestation are responsible for 25% of annual carbon emissions in Australia⁴³ and they remain the number one driver of extinction, in Australia, and worldwide.⁴⁴

Drivers of climate and biodiversity damage



In 2021 the first joint workshop of the IPCC and IPBES – the intergovernmental scientific bodies that inform the UN Climate and Biodiversity conventions – concluded that we must solve the twin crises of nature destruction and climate change together or we will save neither. Fortunately many of the solutions to climate change both come from nature and enhance nature.

The IPCC-IPBES workshop report found reducing land clearing and deforestation combined with improved management of cropland and grazing systems to enhance biodiversity and increase carbon storage offers climate change mitigation potential of 3.4 to 11.8 gigatonnes every year globally.⁴⁵ At the high end, that’s equivalent to about one third of global energy-related carbon emissions,⁴⁶ meaning while nature based solutions cannot replace the necessary rapid reduction of energy related emissions, they can make an enormous contribution to reducing greenhouse gas concentrations in our atmosphere.

Restoring ecosystems that are rich in species and carbon is among the cheapest and quickest nature-based climate mitigation measures to implement, with many benefits to nature.

For example, spending \$2 billion (0.1% of Australia’s 2019 Gross Domestic Product) annually for 30 years could pay for the restoration of 13 million ha of Australia’s degraded landscapes, without affecting intensive agriculture and urban areas. This would deliver close to one billion tonnes of carbon dioxide equivalent abatement and yield up to \$46 billion [net present value] in carbon offset revenue, equal to as much as 111% of the investment required for the restoration.⁴⁷ Nature based solutions also benefit from First Nations knowledge and leadership which means investing in incentives and opportunities for Indigenous-led land and sea management including ranger programs, forest management, urban Caring for Country programs, carbon and biodiversity markets, and employment programs.

Alignment of global nature, climate, and sustainable development targets and frameworks

International multilateral frameworks for state and business action are increasingly aligning on the need to integrate global action on climate and biodiversity with economic progress. Nature and nature-based solutions featured more prominently than ever at COP26 of the UN Climate Convention in 2021 and the first draft of the UN Biodiversity Convention’s post-2020 Global Biodiversity Framework (GBF) includes a global target of 10 gigatonnes of carbon abatement through nature-based solutions every year.⁴⁸

The 2022 Sustainable Development Goals Report confirmed that “Unsustainable patterns of consumption and production are root causes of the triple planetary crises of climate change, biodiversity loss and pollution...[that] threaten human well-being and achievement of the SDGs.”⁴⁹

The formation of the Task Force on Climate-related Financial Disclosures (TCFD) in 2015 and the Task Force on Nature-related Financial Disclosures (TNFD) in 2020, with corresponding frameworks for businesses and financial institutions to assess and report on risks and opportunities, is an acknowledgment that individual enterprises and national and global economies are dependent upon and inseparable from earth’s climate and biodiversity systems. Not only should businesses adopt “an integrated approach to climate and nature-related risks” according to the TNFD, but governments are warned that a “nature- or climate-only approach is likely to be fiscally inefficient, socially, and environmentally ineffective, and not sufficient to reach national or global climate and nature-related targets.”^{50,51}

⁴³ Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DISER) (2013 Australian National Greenhouse Accounts: Australian Land Use, Land Use Change and Forestry Emissions Projections to 2030. Commonwealth of Australia.

⁴⁴ Maxwell, S.L., Fuller, R.A., Brooks, T.M. & Watson, J.E.M. (2016). Biodiversity: The ravages of guns, nets and bulldozers. /

⁴⁵ Pörtner et al. (2021) IPBES-IPCC Co-Sponsored Workshop Report on Biodiversity and Climate Change, IPBES and IPCC.

⁴⁶ IEA (2021) Global Energy Review: CO2 Emissions in 2021, International Energy Agency.

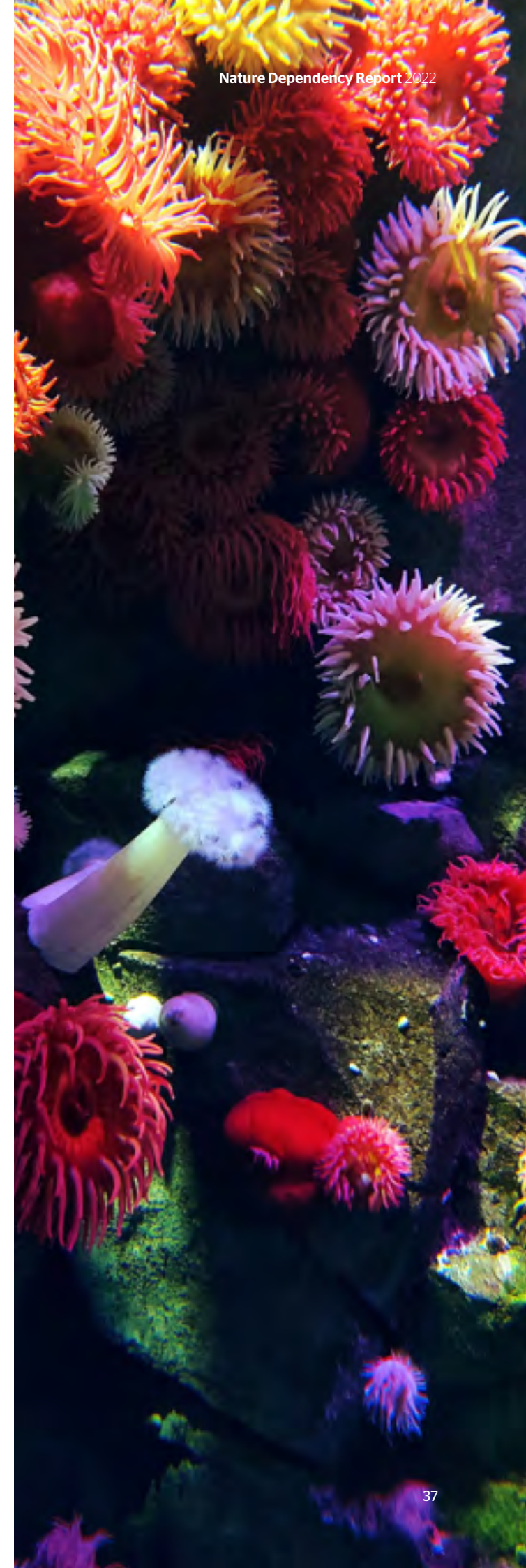
⁴⁷ Mappin, B., Ward, A., Hughes, L., Watson, J. E. M., Cosier, P., & Possingham, H. P. (2022). The costs and benefits of restoring a continent’s terrestrial ecosystems. Journal of Applied Ecology, 59, 408– 419. <https://doi.org/10.1111/1365-2664.14008>

⁴⁸ CBD (2021) First Detailed Draft of the New Post-2020 Global Biodiversity Framework, Convention on Biological Diversity, accessed January 26, 2022, <https://www.cbd.int/article/draft-1-global-biodiversity-framework>.

⁴⁹ UN Department of Economic and Social Affairs (2022) The Sustainable Development Goals Report 2022 <https://unstats.un.org/sdgs/report/2022/>

⁵⁰ TNFD (2021) The TNFD Principles <https://tnfd.global/the-tnfd-principles/>

⁵¹ The Coalition of Finance Ministers for Climate Action (2022) An Overview of Nature-Related Risks and Potential Policy Options for Ministries of Finance: Bending the Curve of Nature Loss <https://www.financeministersforclimate.org/about-us>



Recommendations for action

What next for business?

Businesses should be looking to reduce their exposure to nature-related risks by reducing their harmful impacts and managing their dependencies. They must also play their role in supporting an overarching societal goal to halt and reverse nature destruction so that by 2030 nature is in better health than it is now and on the path to full recovery by 2050. In order to deliver on commitments to contribute to a Nature Positive future, corporates and other organisations must not only demonstrate that they are measuring, avoiding, reducing and compensating for negative impacts on biodiversity as a result of their direct operations and in their value chains, but also deliver outcomes consistent with the wider goal of achieving a Nature Positive future while achieving the Paris Agreement target of limiting warming to 1.5°C.

The following steps offer a pathway to managing nature-related risks appropriately and supporting the necessary transformation:

1. Measure, prioritise, and report on nature-related impacts and dependencies.

Businesses should determine the impacts and dependencies that their operations, value chains, and investments have on nature, and then disclose them publicly and continue to report on them. The scope of impact reporting should be considered independent of financial materiality. The Global Reporting Initiative, ENCORE tool, and Science Based Targets Network are good places to start. To do this accurately, businesses will need location-specific information about their value chain and its interactions with nature – this aligns with the ‘Locate’ step of TNFD’s LEAP approach. Engagement with affected communities including Traditional Owners should also be undertaken at this point.

2. Engage with suppliers, customers, stakeholders, and investees.

Nature related impacts, dependencies, risks and opportunities cannot all be addressed by individual businesses. Businesses should work with suppliers, customers, investees, and partners that have related risks or are themselves sources of risk, and address challenges

cooperatively including by setting expectations for how they manage their impacts and dependencies on nature. SBTN’s guidance on ‘spheres of influence and control’ lays out this approach. The financial sector in particular bears responsibility for the transition to Nature Positive practices as it determines which activities are financed or insured and under what conditions, including price.

3. Set time-bound targets and science-based policies to protect nature.

With nature related risks and opportunities identified, a business can set targets for nature - for example, eliminating deforestation and land conversion from value chains immediately is a target that should be set right now for any business or financial institution with exposure to forest risk commodities or sectors with a significant land use change footprint. Nature targets should be integrated with targets to reduce value chain greenhouse gas emissions and increase carbon removals. The Science Based Targets Network’s interim guidance provides a good starting point for target-setting. A comprehensive biodiversity policy should cover everything from how a business will manage impacts on threatened species and ecosystems and contribute to global and regional biodiversity targets, to how it will engage with stakeholders, respond to grievances, and respect and protect First Nations peoples’ rights and knowledge.

4. Advocate for reforms of nature-related public policy.

Achieving targets for nature is only possible with collaborative action that depends on public policy. Through direct engagement with policy makers, industry associations and via public communications, businesses should send clear signals to regulators of the need to protect nature through strong laws, set science-based global and national targets in line with a Nature Positive world, provide sufficient public funding for nature recovery, and maintain comprehensive environmental accounts and data. Businesses should also consider whether their membership of industry bodies aligns with a Nature Positive approach.

5. Implement and operationalise: implement actions to reduce impacts on nature, embed targets for nature in decision-making, and disclose progress toward them.

Once targets for nature have been set, businesses must act on them with a comprehensive and transparent implementation plan. Disclosing impacts, dependencies, and targets, with regular evidence-based updates on progress and value chain transparency is an essential step to demonstrate good risk management. Environmental-economic accounting can enable this to be implemented in a structured and repeatable manner that is consistent across organisations. Nature should also be embedded in business decision-making as a component of strategy and governance with the highest level of accountability and responsibility.

What next for the Australian Government?

There is a clear and essential need for national leadership by the Australian Government to halt and reverse nature destruction, and set us on a path to full environmental recovery. Delivering this scale of ambition requires a shift in mindset from perceiving nature protection as an economic and financial burden to recognising our dependence on nature, and undertaking significant reform and investment to reverse Australia’s current trajectory of environmental decline. Recognising and embracing Indigenous knowledge and connection to Country is vital. Aboriginal and Torres Strait Islander people have cared for and lived in harmony with the Australian environment for thousands of years. Recognising Indigenous rights, heritage and interests and respectfully learning from and working with Indigenous Australians should sit at the heart of Australia’s efforts to protect and restore nature.

The following steps are a starting point for the Australian Government:

1. Create strong environment laws that actually protect nature and an independent regulator to enforce them.

An Independent Review by Professor Graeme Samuel found Australia’s main national environmental legislation, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), is ‘outdated’, ‘ineffective’ and ‘not fit to address current or future environmental challenges’ and needs fundamental reform. The Review made 38 interconnected recommendations to fix and strengthen the Act and set out a clear pathway for reform. These recommendations included strong, legally enforceable national environmental standards as the ‘centrepiece’ of a broader reform framework.

2. Invest in recovering and restoring Australia’s wildlife and ecosystems.

Spending on biodiversity projects by the federal government has declined by almost 40% since 2013.⁵² Adequate investment is essential to improve the state of Australia’s environment. Spending \$2 billion annually for 30 years could restore almost all (99.8%) of Australia’s degraded terrestrial ecosystems to 30% vegetation coverage, the Australian Government should invest at least this amount to recover critical ecological functions and abate almost one billion tonnes of carbon dioxide equivalent.⁵³ Investment in Indigenous-led approaches including Ranger programs, can provide benefits for nature, culture, communities and climate.⁵⁴ In addition to public investment, the government can leverage greater private investment in conservation and restoration through credible incentives and mechanisms. Any such schemes should have genuine integrity and strong governance arrangements and be complemented by appropriate public investment.

⁵² Australian Conservation Foundation. (2021). Budget throws loose change at environment and climate. Retrieved 10 August 2022, from https://www.acf.org.au/budget_throws_loose_change_at_environment_climate

⁵³ Mappin, B., Ward, A., Hughes, L., Watson, J. E. M., Cosier, P., & Possingham, H. P. (2021). The costs and benefits of restoring a continent’s terrestrial ecosystems. *besjournals*. Retrieved 10 August 2022, from <https://besjournals.onlinelibrary.wiley.com/doi/10.1111/1365-2664.14008?af=R>

⁵⁴ R A. Morgain, S Bekessy, J Bush, D Butler, N Cadenhead, R Clarke, T Croeser, A Dickey, MC. Evans, J Fitzsimons, M Fletcher, R Foley, J Gacutan, S van Leeuwen, C Lovelock, P. Macreadie, E McLeod, R L. Morris, D Neal, C Oke, R Rossel, J Russell-Smith, R Spindler, S Thompson, M Wartman, M Young, B A. Wintle. Nature as a Climate Solution, University of Melbourne, 2021. <http://conservaonfutures.org.au/publications/natureasacimatesolu on.pdf>



3. **Lead on ambitious global goals for nature, that stop biodiversity destruction, end extinction, and restore nature.** The new Global Biodiversity Framework to be finalised at the UN Biodiversity Conference (COP15), in December 2022 in Montreal, Canada, is the biggest global opportunity for nature in a decade. The framework will set out 2030 goals and targets so countries can, individually and collectively, achieve the overall vision of ‘living in harmony with nature’ by 2050. The Australian Government must do everything it can to ensure the agreement delivers the ambition nature needs. The Australian Government should champion ambitious international goals to halt and reverse biodiversity destruction, end extinction, protect at least 30% of land and seas by 2030, and require businesses to measure and report on their nature-related impacts and dependencies and reduce their negative impacts.
4. **Embed nature in all decision-making.** Australian experience demonstrates the need for mechanisms to address biodiversity loss to be embedded across different levels of government in our federal system and across all portfolios. Australian business must also be supported to join with international efforts to identify and act upon risks to biodiversity. This will require setting domestic biodiversity targets and implementing data collection and environmental accounting systems that will allow business and government, decision-makers, as well as civil society, to assess and monitor the state of nature and progress toward those targets.

5. **Act now to slash climate pollution by more than half this decade and recognise nature as a climate solution.** Legislating Australia’s 2030 emission reduction target as 43% is a start to the huge task of achieving net zero emissions by 2050, or earlier. The Australian Government must also implement climate solutions at scale and speed, this will require enormous amounts of renewable energy to be built in Australia, sustainably and in a way that protects nature and is fair for people, especially First Nations people and those dependent on coal and gas.
6. **Protect at least 30% of lands and seas by 2030 including freshwater and inland water systems** with particular attention on underrepresented ecosystems. National leadership is required to drive strategic growth and improve management effectiveness of Australia’s protected areas. New protected areas and other effective conservation mechanisms across all land tenures should help to build a comprehensive, adequate and ecologically representative system and prioritise the protection and management of critical habitats, sites for climate change resilience and connectivity for wildlife.

Appendix

Methodology

We selected a set of industries for the analysis of their nature dependency such that they represent full coverage of the Australian economy. This was done by ensuring all industries collectively aligned to all ANZSIC classification divisions. The methodology is similar to that employed in the World Economic Forum’s 2020 report, Nature Risk Rising. Further information on the methodology that was used to identify and rate dependencies on ecosystem services is available from the Natural Capital Finance Alliance. The set of ecosystem services used is the set contained within the ENCORE database where dependencies consider reliance on ecosystem services as part of the production process. As such, dependency includes inputs to production, operations, research and development, and protection of assets.

The chosen industry groups were mapped to equivalent industries and/or subindustries in the ENCORE database. Relevant processes, and data detailing the materiality of ecosystem services related to these processes, were extracted from the ENCORE database and mapped to the proposed industries.

The materiality of each particular ecosystem service per process is based on the rating in ENCORE with minor adjustments for the Australian context. Direct dependency on nature for each process was given an overall rating from 1 to 5 that is based on the set of relevant ecosystem service ratings provided from ENCORE. This overall rating was calculated with equal weight based on:

- The average rating of each relevant ecosystem service from 1 to 5 (Very Low to Very High)
- The number of ecosystem services relevant
- The maximum rated relevant ecosystem service

Direct nature dependency was classified with respect to overall ratings as being either very high (dependency score ≥ 5), high (≥ 4), moderate (≥ 3) or neutral (< 3).

An example of how a process is rated is shown below:

**Example Process:
Solar Energy Provisioning**

Average Score = $\frac{5+3+3+1+1}{5} = 2.6$

Rating Score = $\frac{2.6+5+5}{3} = 4.2$

Therefore the Solar Energy Provisioning overall dependency rating is ≥ 4 and < 5 so the process is rated **Moderate**.

Economic data was then obtained from the Australian Bureau of Statistics (ABS) in the form of gross value added by industry for each Australian state and territory and input-output tables detailing gross value added by sector for the Australian economy for the 2018/19 financial year. This year was chosen based on both data availability and to reflect the pre-pandemic structure of the economy. Industry, subindustry, and process groupings were aligned to ABS sectors in national input-output tables to enable a direct dependency rating to be aligned with each of the sectors and ultimately to an amount of gross value added. Where there were ABS sectors that could not be clearly mapped across, gross value added was proportioned out across all relevant industry / subindustry / process groupings. Sectoral ratings were then consolidated to industry ratings and proportioned by gross value added to produce the ‘Percentage of Direct GVA Nature Dependency by Industry’ figure.

ABS data on gross value added by industry for each Australian state and territory was then used to proportion out the amount of gross value added by overall direct dependency rating across each Australian state and territory. This data was used to produce the ‘Percentage of Direct GVA Nature Dependency of Australian State Economies’ figure. An inherent assumption in this approach made due to data availability is that the composition of industry groupings is the same as the national average across each state and territory. A consolidated Australian level view of the dependency breakdown was then created to produce ‘Percentage of Direct GVA Nature Dependency of the Australian Economy’ figure.

Description of industry dependencies used in this analysis

Forestry	The forestry industry has a very high direct dependency upon nature via 13 different identified ecosystem services. Given that forestry business models are based directly on consumption of natural capital and on the flow of ecosystem services enabling provisioning this result was expected. Relevant ecosystem services include: Fibres and other materials, Ground water, Surface water, Mass stabilisation and erosion control, Flood and storm protection, Climate regulation, Water flow maintenance, Pest control, Disease control, Pollination, Soil quality, Bio-remediation, and Filtration.
Crop Agriculture	The crop agriculture industry has a very high direct dependency upon nature via 18 different identified ecosystem services. Given that crop agriculture related business models are based directly on consumption of natural capital and on the flow of ecosystem services enabling crop provisioning this result was expected. Relevant ecosystem services include: Filtration, Water flow maintenance, Surface water, Dilution by atmosphere and ecosystems, Fibres and other materials, Pollination, Soil quality, Water quality, Buffering and attenuation of mass flows, Climate regulation, Pest control, Disease control, Ventilation, Genetic materials, Bio-remediation, Ground water, Mass stabilisation and erosion control, and Flood and storm protection.
Livestock Agriculture	The livestock agriculture industry has a very high direct dependency upon nature via 19 different identified ecosystem services. Given that livestock agriculture related business models are based directly on the flow of ecosystem services enabling livestock product provisioning this result was expected. Relevant ecosystem services include: Ground water, Surface water, Flood and storm protection, Water quality, Fibres and other materials, Soil quality, Disease control, Water flow maintenance, Climate regulation, Pest control, Filtration, Bio-remediation, Dilution by atmosphere and ecosystems, Mediation of sensory impacts, Buffering and attenuation of mass flows, Mass stabilisation and erosion control, Genetic materials, Ventilation, and Pollination.
Horticulture and Viticulture	The horticulture and viticulture industry has a very high direct dependency upon nature via 18 different identified ecosystem services. Given that horticulture and viticulture are based directly on consumption of natural capital and on the flow of ecosystem services enabling crop provisioning this result was expected. Relevant ecosystem services include: Filtration, Water flow maintenance, Surface water, Dilution by atmosphere and ecosystems, Fibres and other materials, Pollination, Soil quality, Water quality, Buffering and attenuation of mass flows, Climate regulation, Pest control, Disease control, Ventilation, Genetic materials, Bio-remediation, Ground water, Mass stabilisation and erosion control, and Flood and storm protection.

Fishery and Aquaculture	The fishery and aquaculture industry has a very high direct dependency upon nature via 18 different identified ecosystem services. Given that fishery and aquaculture related business models are based directly on consumption of natural capital and on the flow of ecosystem services enabling seafood product provisioning this result was expected. Relevant ecosystem services include: Surface water, Buffering and attenuation of mass flows, Maintain nursery habitats, Water quality, Climate regulation, Water flow maintenance, Fibres and other materials, Mass stabilisation and erosion control, Flood and storm protection, Pest control, Disease control, Ventilation, Bio-remediation, Dilution by atmosphere and ecosystems, Soil quality, Genetic materials, Filtration, and Ground water.
Fossil Fuel Mining	The fossil fuel mining industry has a very high direct dependency upon nature via 5 different identified ecosystem services. This industry is comprised of mining for solid fossil fuels such as coal. Given the high direct dependency of the mining processes on some ecosystem services, most notably those related to water provisioning, the industry is rated as having a high level of dependency. Relevant ecosystem services include: Surface water, Water flow maintenance, Ground water, Climate regulation, and Mass stabilisation and erosion control.
Metal Ore and Mineral Mining	The metal ore and mineral mining industry has a very high direct dependency upon nature via 5 different identified ecosystem services. This industry is comprised of mining for metals and minerals, most notably iron ore but also a number of other non-ferrous metals and non-metallic minerals. Given the high direct dependency of the mining processes on some ecosystem services, most notably those related to water provisioning, the industry is rated as having a high level of dependency. Relevant ecosystem services include: Surface water, Water flow maintenance, Ground water, Climate regulation, and Mass stabilisation and erosion control.
Meat and Dairy Manufacturing	The meat and dairy manufacturing industry has a very high direct dependency upon nature via 19 different identified ecosystem services. The ecosystem services relevant to this industry include those relevant directly to meat and dairy product processing and some related to livestock agriculture given livestock agriculture provides direct inputs. Relevant ecosystem services include: Ground water, Surface water, Fibres and other materials, Flood and storm protection, Water quality, Soil quality, Disease control, Water flow maintenance, Climate regulation, Filtration, Bio-remediation, Pest control, Dilution by atmosphere and ecosystems, Mediation of sensory impacts, Buffering and attenuation of mass flows, Mass stabilisation and erosion control, Genetic materials, Pollination and Ventilation.

Other Food Product Manufacturing	The other food product manufacturing industry refers to food product manufacturing outside of meat and dairy manufacturing. It has a very high degree of dependency upon nature via 10 different identified ecosystem services. The ecosystem services relevant to this industry include those relevant to manufacturing of goods such as fruit and vegetable products, grain and cereal products, processed seafood products, bakery products, sugar, confectionary, etc. Relevant ecosystem services include: Ground water, Surface water, Flood and storm protection, Water flow maintenance, Water quality, Filtration, Bio-remediation, Dilution by atmosphere and ecosystems, Mass stabilisation and erosion control, and Soil quality.
Non-Food Product Manufacturing	The non-food product manufacturing industry has varying degrees of dependency upon nature via 15 different identified ecosystem services that reflects the diversity of activities that take place within this industry grouping. The ecosystem services relevant to this industry include those relevant to manufacturing of goods such as textiles, fashion goods, furniture goods, chemicals, raw materials, electronics, vehicles, etc. Relevant ecosystem services include: Ground water, Surface water, Genetic materials, Water flow maintenance, Water quality, Flood and storm protection, Soil quality, Climate regulation, Fibres and other materials, Mediation of sensory impacts, Filtration, Dilution by atmosphere and ecosystems, Mass stabilisation and erosion control, Bio-remediation, and Ventilation.
Construction	The construction industry has a very high degree of dependency upon nature via 12 different identified ecosystem services. This industry is comprised of residential building construction, non-residential building construction, and the heavy and civil engineering construction sectors. Given that the construction process is dependent on a number of ecosystem services, most notably those related to protection from extreme events, mass stability, and water, the result is a high level of dependency. Relevant ecosystem services include: Climate regulation, Flood and storm protection, Mass stabilisation and erosion control, Ground water, Surface water, Mediation of sensory impacts, Water flow maintenance, Filtration, Bio-remediation, Soil quality, Ventilation, and Pest control.
Oil and Gas	The oil and gas industry has varying degrees of dependency upon nature via 8 different identified ecosystem services. This industry is comprised of oil and gas drilling, refining, exploration, and distribution services. Relevant ecosystem services include: Mass stabilisation and erosion control, Flood and storm protection, Climate regulation, Ground water, Surface water, Water quality, Filtration, and Bio-remediation.

Electricity	The electricity services industry has a very high degree of dependency upon nature via 10 different identified ecosystem services. This industry is comprised of electricity generation and distribution services where electricity is generated via fossil fuels such as coal and gas, biomass, solar, wind, nuclear, geothermal, and/or hydropower. Relevant ecosystem services include: Flood and storm protection, Ground water, Surface water, Climate regulation, Fibres and other materials, Mass stabilisation and erosion control, Water flow maintenance, Water quality, Filtration, and Bio-remediation.
Water and Waste Services	The water and waste services industry has varying degrees of dependency upon nature via 15 different identified ecosystem services. This industry is comprised of water supply services, sewerage and drainage services, waste collection services, and waste treatment and disposal services. The most relevant ecosystem services are those related to the provisioning of water, however, filtration, protection from weather and climate, soil quality, and other services are also identified as being important. The relevant ecosystem services include: Ground water, Surface water, Water flow maintenance, Water quality, Flood and storm protection, Filtration, Bio-remediation, Climate regulation, Soil quality, Dilution by atmosphere and ecosystems, Mediation of sensory impacts, Mass stabilisation and erosion control, Buffering and attenuation of mass flows, Pest control, and Ventilation.
Wholesale and Retail Trade	The wholesale and retail trade industry has little dependency upon nature and only 2 ecosystem services were identified upon which the industry has a dependency. In both cases the dependency relates predominantly to infrastructure holdings. However, it is expected that the supply chain of this industry would incorporate a number of nature dependencies given the manufacturing processes of goods traded. Relevant ecosystem services include: Mass stabilisation and erosion control and Bio-remediation.
Transport and Logistics	The transport and logistics industry has varying degrees of dependency upon nature via 9 different identified ecosystem services. This industry is comprised of road transport, rail transport, air/space transport, pipelines, postal delivery services, and transport support services. The most relevant ecosystem services are those related to the climate and weather regulation, however, other services including those related to water and mass stabilisation are also material. The relevant ecosystem services include: Climate regulation, Flood and storm protection, Surface water, Ground water, Mass stabilisation and erosion control, Water flow maintenance, Water quality, Ventilation, and Pest control.

Real Estate	The real estate industry has a high degree of dependency upon nature via 7 different identified ecosystem services. This industry is comprised of owned dwellings, non-residential property operators, and real estate service providers. Relevant ecosystem services include: Surface water, Ground water, Bio-remediation, Mediation of sensory impacts, Mass stabilisation and erosion control, Filtration, and Flood and storm protection.
Accommodation and Hospitality	The accommodation and hospitality industry has varying degrees of dependency upon nature via 8 different identified ecosystem services. This industry is comprised of both accommodation and food and beverage services. The dependency varies materially across the two subsets of the industry with the accommodation sector having a higher dependence on nature and ecosystem services. The relevant ecosystem services include: Climate regulation, Flood and storm protection, Ground water, Surface water, Fibres and other materials, Mass stabilisation and erosion control, Water quality, and Ventilation.
Media and Telecommunications	The media and telecommunications industry has varying degrees of dependency upon nature via 5 different identified ecosystem services. This industry is comprised of both relatively low dependency media services and slightly higher dependency services relating to physical network infrastructure. The relevant ecosystem services include: Flood and storm protection, Mass stabilisation and erosion control, Soil quality, Bio-remediation, and Climate regulation.
Financial Services and Insurance	The financial services industry has little dependency upon nature. Only 1 ecosystem service was identified upon which the industry has a dependency and it was relating predominantly to infrastructure holdings of the industry given it is service largely service based. Indirectly there are likely a number of other relevant services such as climate regulation and flood and storm protection that impact credit, market, and insurance risks. In terms of direct dependency the relevant ecosystem service was: Mass stabilisation and erosion control.
Health Care and Social Services	The health care and social services industry has some dependency upon nature via 4 different identified ecosystem services. This includes dependencies relating to infrastructure holding as well as the operation and maintenance of health care facilities to enable service provisioning. Relevant ecosystem services include: Ground water, Surface water, Mass stabilisation and erosion control, and Bio-remediation.

Professional and Technical Services	The professional and technical services industry has little dependency upon nature. Only 2 ecosystem services were identified upon which the industry has a dependency and they relate predominantly to infrastructure holdings of the industry given it is service largely service based. The relevant ecosystem services are: Mass stabilisation and erosion control and Bio-remediation.
Public Administration	The public administration industry has little dependency upon nature. Only 2 ecosystem services were identified upon which the industry has a dependency and they relate predominantly to infrastructure holdings of the industry given it is service largely service based. The relevant ecosystem services are: Mass stabilisation and erosion control and Bio-remediation.
Education	The education industry, including primary, secondary, tertiary, and vocational education, has little dependency upon nature. Only 2 ecosystem services were identified upon which the industry has a dependency and they relate predominantly to infrastructure holdings of the industry given it is service largely service based. The relevant ecosystem services are: Mass stabilisation and erosion control and Bio-remediation.
Arts and Recreation	The arts and recreation industry has varying degrees of dependency upon nature via 6 different identified ecosystem services. This industry is comprised of the heritage, creative and performing arts, sports and recreation, and gambling sectors. A majority of the industries dependencies relate to infrastructure holdings, however, given the inclusion of gambling in the sector there are also relevant services based on the ongoing maintenance of leisure facilities such as casinos. Relevant ecosystem services include: Surface water, Ground water, Flood and storm protection, Water quality, Bio-remediation, and Mass stabilisation and erosion control.
Other administrative and support services	The other administrative services industry has little dependency upon nature. Only 2 ecosystem services were identified upon which the industry has a dependency and they related predominantly to infrastructure holdings of the industry given it is service largely service based including the personal services, repair, and administrative support sectors. The relevant ecosystem services are: Mass stabilisation and erosion control and Bio-remediation.

Description of ecosystem services used in this analysis, based on ENCORE

Animal-based energy	Physical labour is provided by domesticated or commercial species, including oxen, horses, donkeys, goats and elephants. These can be grouped as draught animals, pack animals and mounts.
Bio-remediation	Bio-remediation is a natural process whereby living organisms such as micro-organisms, plants, algae, and some animals degrade, reduce, and /or detoxify contaminants.
Buffering and attenuation of mass flows	Buffering and attenuation of mass flows allows the transport and storage of sediment by rivers, lakes and seas.
Climate regulation	Global climate regulation is provided by nature through the long-term storage of carbon dioxide in soils, vegetable biomass, and the oceans. At a regional level, the climate is regulated by ocean currents and winds while, at local and micro-levels, vegetation can modify temperatures, humidity, and wind speeds.
Dilution by atmosphere and ecosystems	Water, both fresh and saline, and the atmosphere can dilute the gases, fluids and solid waste produced by human activity.
Disease control	Ecosystems play important roles in regulation of diseases for human populations as well as for wild and domesticated flora and fauna.
Fibres and other materials	Fibres and other materials from plants, algae and animals are directly used or processed for a variety of purposes. This includes wood, timber, and fibres which are not further processed, as well as material for production, such as cellulose, cotton, and dyes, and plant, animal and algal material for fodder and fertiliser use.
Filtration	Filtering, sequestering, storing, and accumulating pollutants is carried out by a range of organisms including, algae, animals, microorganisms and vascular and non-vascular plants.
Flood and storm protection	Flood and storm protection is provided by the sheltering, buffering and attenuating effects of natural and planted vegetation.

Genetic materials	Genetic material is understood to be deoxyribonucleic acid (DNA) and all biota including plants, animals and algae.
Ground water	Groundwater is water stored underground in aquifers made of permeable rocks, soil and sand. The water that contributes to groundwater sources originates from rainfall, snow melts and water flow from natural freshwater resources.
Maintain nursery habitats	Nurseries are habitats that make a significantly high contribution to the reproduction of individuals from a particular species, where juveniles occur at higher densities, avoid predation more successfully, or grow faster than in other habitats.
Mass stabilisation and erosion control	Mass stabilisation and erosion control is delivered through vegetation cover protected and stabilising terrestrial, coastal and marine ecosystems, coastal wetlands and dunes. Vegetation on slopes also prevents avalanches and landslides, and mangroves, sea grass and macroalgae provide erosion protection of coasts and sediments.
Mediation of sensory impacts	Vegetation is the main (natural) barrier used to reduce noise and light pollution, limiting the impact it can have on human health and the environment.
Pest control	Pest control and invasive alien species management is provided through direct introduction and maintenance of populations of the predators of the pest or the invasive species, landscaping areas to encourage habitats for pest reduction, and the manufacture of a family of natural biocides based on natural toxins to pests.
Pollination	Pollination services are provided by three main mechanisms: animals, water and wind. The majority of plants depend to some extent on animals that act as vectors, or pollinators, to perform the transfer of pollen.
Soil quality	Soil quality is provided through weathering processes, which maintain bio-geochemical conditions of soils including fertility and soil structure, and decomposition and fixing processes, which enables nitrogen fixing, nitrification and mineralisation of dead organic material.

Surface water	Surface water is provided through freshwater resources from collected precipitation and water flow from natural sources.
Ventilation	Ventilation provided by natural or planted vegetation is vital for good indoor air and quality without it there are long term health implications for building occupants due to the build-up of volatile organic compounds (VOCs), airborne bacteria and moulds.
Water flow maintenance	The hydrological cycle, also called water cycle or hydrologic cycle, is the system that enables circulation of water through the Earth’s atmosphere, land, and oceans. The hydrological cycle is responsible for recharge of groundwater sources (i.e. aquifers) and maintenance of surface water flows.
Water quality	Water quality is provided by maintaining the chemical condition of freshwaters, including rivers, streams, lakes, and ground water sources, and salt waters to ensure favourable living conditions for biota.



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