The Western Australian Restoration Economy

A roadmap towards a sustainable industry with better environmental outcomes

The Western Australian Biodiversity Science Institute

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A roadmap towards a sustainable industry with better environmental outcomes

Prepared by

The Western Australian Biodiversity Science Institute (WABSI)

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The Western Australian Biodiversity SCIENCE INSTITUTE

Ecological restoration at scale can deliver meaningful outcomes to Western Australia; reducing and offsetting emissions will improve environmental condition, whilst direct economic revenue and human wellbeing will benefit all levels of society.

Credit: Steve Martin

Contents

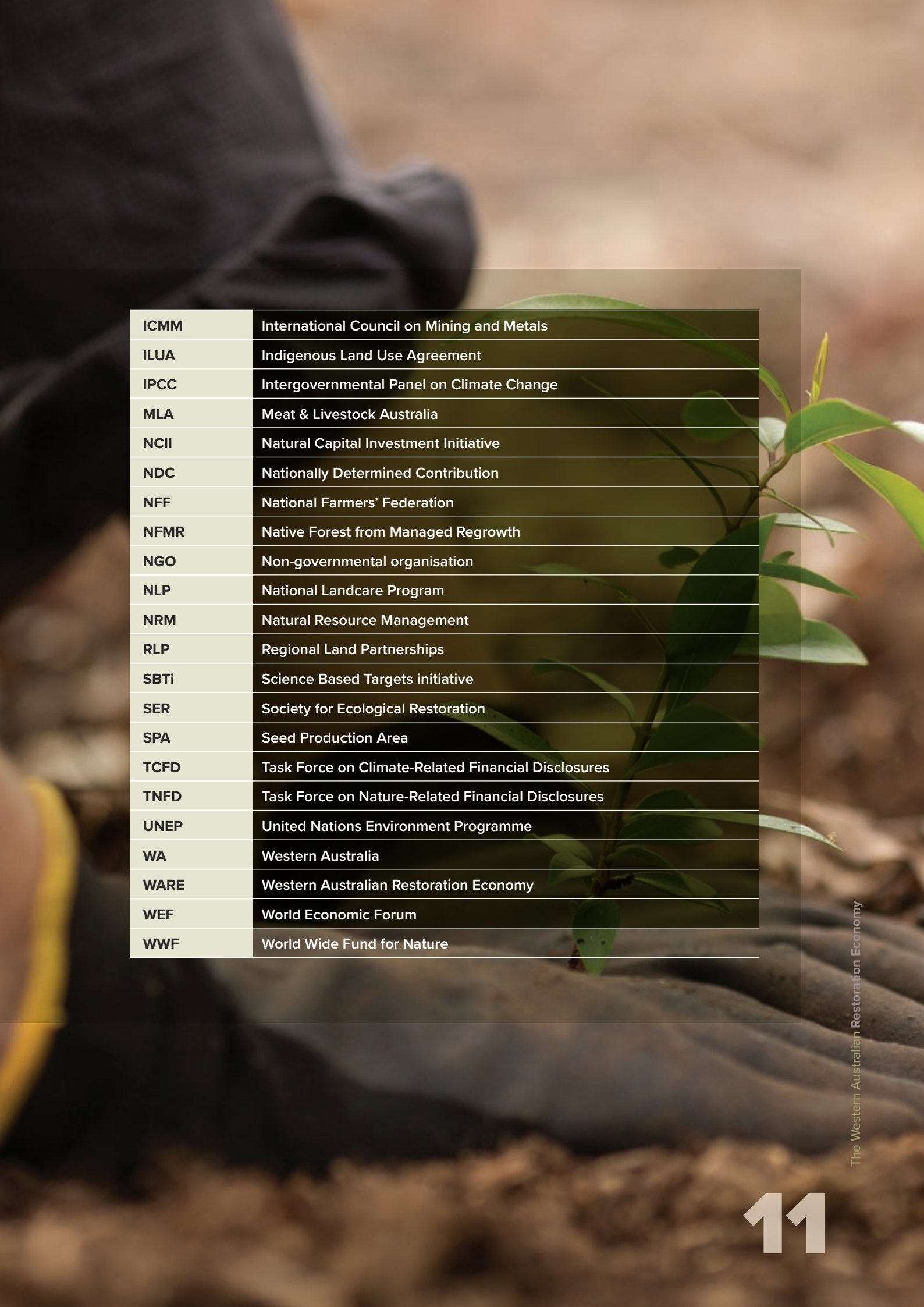
List of Figures

Credit: Megan Hele and Robert McLean (right)

List of Tables

Abbreviations

ACCU	Australian Carbon Credit Units
AFOLU	Agriculture, Forestry and Other Land Use
AL-MAP	Active Land Management & Agricultural Production
ASCI	Australian Council of Superannuation Investors
CBD	Convention on Biological Diversity
CER	Clean Energy Regulator
CF-LRP	Carbon Farming and Land Restoration Program (Western Australia)
CMI	Carbon Market Institute
COP	Conference of Parties
DAFF	Department of Agriculture, Fisheries, and Forestry (Government of Australia)
DCCEEW	Department of Climate Change, Energy, Environment and Water (Government of Australia)
DEW	Department of Environment and Water (Government of South Australia)
DPE	Department of Planning and Environment (Government of New South Wales)
DPIRD	Department of Primary Industries and Regional Development (Government of Western Australia)
DWER	Department of Water and Environmental Regulation (Government of Western Australia)
EPA	Environmental Protection Authority (Western Australia)
ERF	Emissions Reduction Fund
GHG	Greenhouse gas
HIR	Human-induced regeneration
FAO	Food and Agriculture Organization



ICMM	International Council on Mining and Metals
ILUA	Indigenous Land Use Agreement
IPCC	Intergovernmental Panel on Climate Change
MLA	Meat & Livestock Australia
NCII	Natural Capital Investment Initiative
NDC	Nationally Determined Contribution
NFF	National Farmers' Federation
NFMR	Native Forest from Managed Regrowth
NGO	Non-governmental organisation
NLP	National Landcare Program
NRM	Natural Resource Management
RLP	Regional Land Partnerships
SBTi	Science Based Targets initiative
SER	Society for Ecological Restoration
SPA	Seed Production Area
TCFD	Task Force on Climate-Related Financial Disclosures
TNFD	Task Force on Nature-Related Financial Disclosures
UNEP	United Nations Environment Programme
WA	Western Australia
WARE	Western Australian Restoration Economy
WEF	World Economic Forum
WWF	World Wide Fund for Nature

Executive Summary

Biodiversity loss and climate change mutually reinforce each other, and neither will be successfully resolved unless tackled together. Carbon sequestration projects remove excess carbon from the atmosphere but will not necessarily halt or reverse human impacts on nature.

Ecological restoration is key to jointly tackling the twin environmental challenges of reducing greenhouse gas emissions while simultaneously restoring nature loss. As a large, sparsely populated, and politically stable country, Australia, and particularly Western Australia, which occupies a third of Australia's landmass, is in a unique position to take advantage of major investment as the world pushes towards a carbon neutral and nature positive future. The restoration economy could be an important component of developing sustainable futures in Western Australia, but, until now, has been constrained by a lack of market analysis and evaluation.

We define the restoration economy as:

> *"The market of businesses, investors, consumers, and government initiatives engaging in or driving the economic activity related to ecological restoration".*

This project was carried out to understand the size and scope of the Western Australian Restoration Economy and, as such, we undertook a market-based assessment and gap analysis. A draft roadmap identifies actions to lift Western Australia's ability to deliver meaningful, large-scale ecological restoration across the State – as individuals and collectively.

Credit: Lochman Transparencies (middle) and Preeti Castle (right)

Credit: Jesse Collins

The Western Australian Restoration Economy (WARE)

The WARE can be mapped into four key elements: drivers, inputs, restoration activity and outputs. Within Western Australia, we delineate the supply chain into ‘buyers’ and ‘providers’. Buyers include businesses, organisations, and government agencies engaged in urban, agricultural, carbon and mining restoration projects. Providers deliver restoration services and include consultants, suppliers, and researchers.

We sent a survey to 544 groups who had a key role in WARE and received a response rate of 12.5%. Expenditure on restoration in the 2020/2021 financial year was AU$69.6 million, with restorative activities conducted on 35,817 hectares of land. A total of 774 people are reported to be employed in restoration related activities across the companies and organisations surveyed. With cautious extrapolation, we estimate the size of the WARE to be AU$720 million per annum, supporting 5,100 jobs, assuming average values generated from the results are reflective of the wider industry. We expect that this estimation provides a lower bound value of the sector’s economic contribution as the survey was constrained by the identification of all groups associated with the restoration economy and the provision of data. These figures also include some activities that would be classified as supporting ecological recovery, but the outcome may not be an ecosystem that would be classified as ecological restoration.

Most sectors within the WARE are growing, with the strongest growth observed in carbon farming and restoration companies, but significant challenges face the restoration industry including policy barriers, seed and equipment supply, and labour shortages.

Credit: Jesse Collins

Opportunities for the restoration economy

The report identifies three key areas to advance the WARE: expand, deliver, and inform. Research, data, and digital tools and technology will be central to maximising the opportunity of the WARE with findings able to inform governance structures (through leadership, policy, and regulation) and support capacity building (through financial investment, education and training and quality and supply). A robust and enduring restoration economy will require recognition as its own industry with associated strategies that support all actors involved. The multi-faceted nature of the WARE means that these strategies will need to be developed in collaboration with government agencies, industry and researchers.

Benefits of a Western Australian Restoration Economy

Environment	Society	Industry	Government
Habitat provision, land connectivity, resilient systems and healthy waters and soils	Economic returns, agricultural productivity and resilience, human health and connection to land	Business growth, reduced financial risks, maintain ability to effectively trade and be globally competitive	Rapid emission reductions, demonstrated environmental commitment

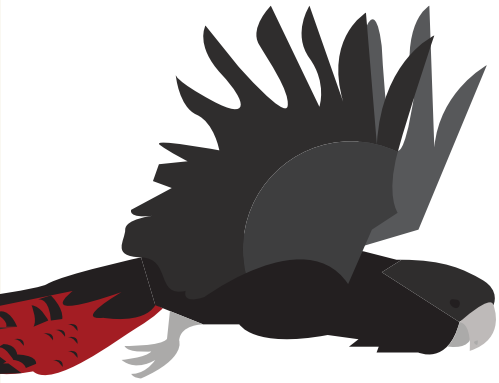
1. Introduction

Australia, as a large, sparsely populated, and politically stable country, is in a unique position to take advantage of major national and international investment opportunities to drive improved environmental outcomes as the world pushes towards a carbon neutral and nature positive future.

Australia is committed to reducing the nation's carbon emissions by 43% by 2030 (from 2005 levels) with an aim to achieve net zero emissions by 2050 (Department of the Prime Minister and Cabinet, 2022). The Western Australian Government is reducing all government agency emissions by 80% from 2020 levels by 2030 and legislating net zero by 2050 (Government of Western Australia, 2023). Over 52 million hectares of Australia is degraded, costing the nation $224 billion annually (in 2015 US$) in lost ecosystem services and production capacity (Sutton, 2016). Nature-based solutions, including ecological restoration, have the potential to shift this liability into an asset while providing cost-effective CO_2 mitigation and increasing the chance of holding warming to below 2°C (Griscom et al., 2017). In an endeavour to increase the adoption of nature-based solutions that will deliver broader environmental benefits while also aiding climate change mitigation, the Australian Government is developing a Biodiversity Certificates Scheme. The scheme will grant tradeable biodiversity certificates to landholders who restore or manage local habitat (Prime Minister of Australia, 2022).

Investing in ecological restoration is expected to generate considerable economic return, with global business opportunities worth US $10 trillion and the potential creation of 395 million jobs by 2030 from nature-positive transitions estimated (WEF, 2020). Studies show that the restoration of 350 million hectares of degraded forest landscapes by 2030 under the Bonn Challenge is predicted to yield between $7–$30 in economic benefits for every dollar invested (Verdone and Seidl, 2017). Ecological restoration investment also supports job growth, predominantly in regional communities (Kellon and Hesselgrave, 2014, Brancalion et al., 2022).

Credit: Lochman Transparencies (far right)



Coupled with this economic stimulus is the realisation that strategically targeted, well designed, biodiverse, and scientifically informed restoration has the capacity to deliver environmental, social, economic, and cultural co-benefits, such as those which:

- support environmental assets such as improved biodiversity and habitat for threatened species, as well as healthier soils, wetlands, water systems, and more productive agricultural landscapes;
- improve the resilience and strength of regional communities by supporting direct and indirect jobs and increasing economic opportunities (Working with Nature, 2021); and
- provide on-Country indigenous business opportunities and new service delivery businesses, as well as supporting cultural and customary connections (Queensland Government, 2021).

Maximum benefit will be realised when on-ground activities move beyond 'environmental plantings' to 'ecological restoration' to achieve the necessary attributes to set an area on a trajectory of ecological recovery.

1.1. Project scope and purpose

The concept of a 'restoration economy' is becoming more widely discussed and accepted within business and stakeholder networks of Western Australia. The Native Vegetation Policy for Western Australia specifically mentions building the restoration economy and creating more jobs as a key policy outcome (DWER, 2022).

While the restoration economy could be an important component of developing sustainable futures in Western Australia, it remains constrained by a lack of market analysis and detailed economic accounting. This project was carried out to understand the scope and size of the Western Australian Restoration Economy (WARE) and undertake a gap analysis and market opportunity assessment.

The focus was on private and public sector investments in restorative activities in Western Australia and comprised a literature review including defining the restoration economy, market evaluation (through a workshop and survey), gap analysis and opportunity evaluation. The opportunities identified provide a tool to focus the next stages of research prioritisation and are available to guide coordinated action across responsible sectors as appropriate.

Credit: Rowan Edwards, (Insets): Megan Hele and Lochman Transparencies

2. The restoration economy

2.1. Definition of the 'restoration economy'

The term 'restoration economy' first emerged in the United States in a book by Cunningham (2002) titled, *'The Restoration Economy: The Greatest New Growth Frontier: Immediate and Emerging Opportunities for Businesses, Communities & Investors'*. It re-emerged almost a decade later becoming more widely adopted following a series of scientific publications from 2011 onwards. Published definitions for the restoration economy use many of the same elements and terminology including combinations of 'ecological restoration' and 'economic activity' (Bendor et al., 2015a, Bendor et al., 2015b, Formosa and Kelly, 2020). Some definitions limit the restoration economy to direct restoration activities (e.g. Faruqi et al. 2018) while others extend the concept to incorporate 'ecosystem health', 'flows' and 'ecosystem services' (Petrakis et al., 2020).

We define the restoration economy as:

> ***"The market consisting of a network of businesses, investors, consumers and government initiatives engaging in or driving the economic activity related to ecological restoration."***

The definition can be widely applied to encompass all types of ecological restoration (Box 1). We adopt the Society for Ecological Restoration's (SER) definition for ecological restoration as:

> ***"Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed."*** (Gann et al., 2019)

The restoration economy captures all activities involving human capital associated with the delivery of ecological restoration including direct (e.g., seeding/planting, land forming, weed management, monitoring) and indirect (e.g., administration, regulation) actions. It includes ecological restoration of all kinds of ecosystems (e.g., forests, wetlands, grasslands, marine), following all kinds of disturbance (e.g., urban development, agricultural expansion, pastoral activities, mining). An important part of the restoration economy is science, which can improve processes, performance, outcomes, and impact.

Box 1.
Ecological restoration

The Society for Ecological Restoration (SER) and partners published the International Principles and Standards for the Practice of Ecological Restoration (International Standards), which are foundational to the design, implementation, monitoring, and evaluation of ecological restoration projects at all scales and in all ecosystem types worldwide (Gann et al. 2019). Core to the International Standards is the Restorative Continuum (**Figure B1**) which articulates that ecological restoration is one of a range or family of restorative activities that can support the recovery of ecosystem integrity. The Standards are underpinned by eight principles that provide a framework to explain, define, guide, and measure the activities and outcomes of ecological restoration practice. They are that ecological restoration: engages stakeholders; draws on many types of knowledge; practice is informed by native reference ecosystems, while considering environmental change; supports ecosystem recovery processes; is assessed against clear goals and objectives, using measurable indicators; seeks the highest level of recovery attainable; gains cumulative value when applied at large scales; and is a part of a continuum of restorative activities.

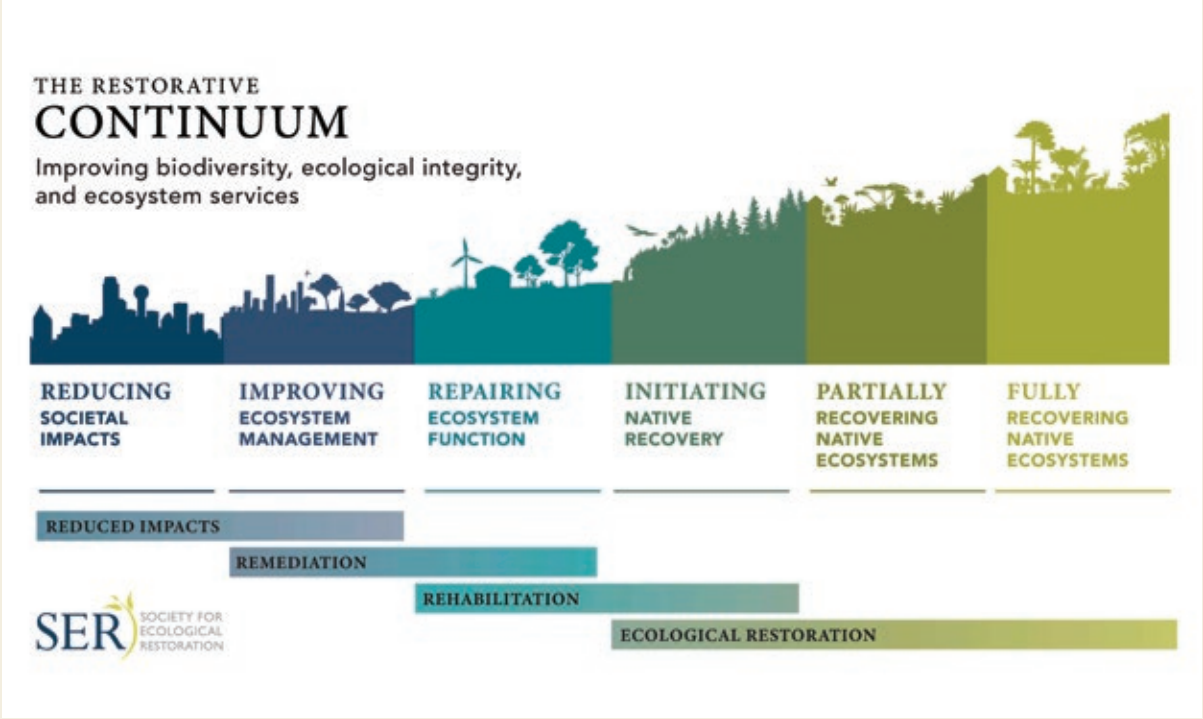


FIGURE B1. The restorative continuum includes a range of activities and interventions that can improve environmental conditions and reverse ecosystem degradation and landscape fragmentation. The continuum highlights interconnections among these different activities and recognises that the specific characteristics of the locality slated for restorative actions dictates the activities best suited for different landscape units. As one moves from left to right on the continuum, both ecological integrity and biodiversity outcomes, and quality and quantity of ecosystem services increase (Gann et al., 2019).

With a diverse and wide range of restoration activities occurring across the restorative continuum, clear goals and objectives are needed to be able to evaluate the costs and benefits and assess outcomes. A framework to support quality-control of 'environmental plantings' will be required as the restoration economy matures. For example, where environmental plantings are implemented as a mechanism for carbon emission offsets, they may only reach an equivalence of repairing ecosystem function (**Figure B1**). Attaining ecological benefits from ecological restoration requires an additional set of metrics to ensure net gain opportunities are maximised. Engaging and embedding the International Standards (Gann et al., 2019) in this practice enables any two bio-sequestration activities that have identical effects on the atmosphere, but widely differing impacts on biodiversity to be distinguished (Garnaut, 2011). It is particularly important to plan for and implement the highest level of recovery possible as carbon offset sites are subject to long term permanency conditions (with 25 year and/or 100 year periods), and poorly performing sites that fail to establish appropriate trajectories of ecological recovery are costly and difficult to remediate. In order to meet the full natural and economic value of such permanent land use change initiatives, clear goals and objectives need to be stated up front with measurable indicators selected to track the return of ecosystem attributes over time (McDonald et al., 2016). As an example, the SER Ecological Recovery and Social Benefits Wheels (**Figure B2**) can be used as a tool for monitoring selected indicators.

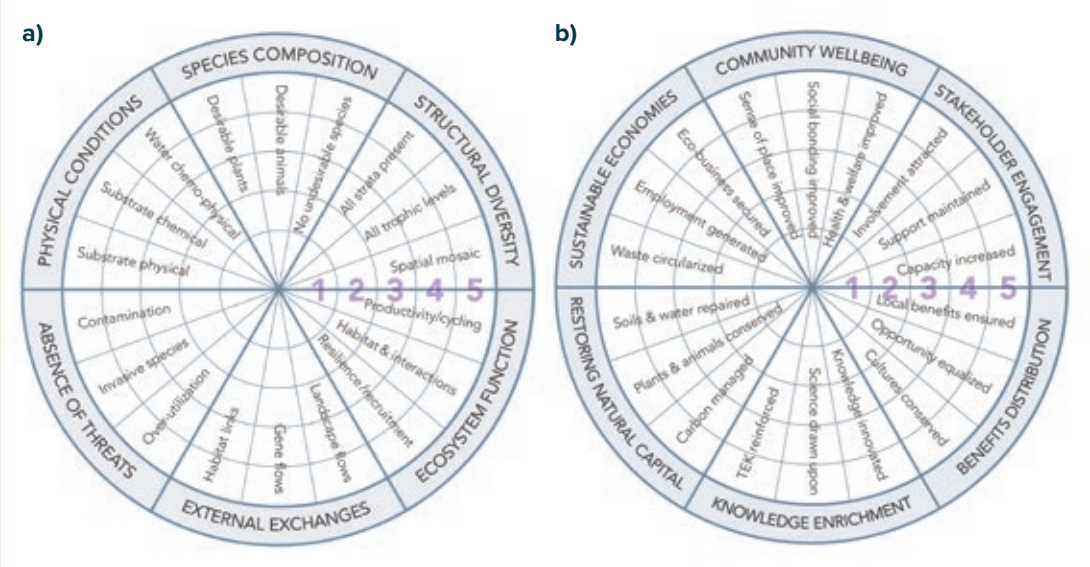


FIGURE B2. Example of a) Ecological Recovery and b) Social Benefits Wheels to assist in tracking the degree to which an ecological restoration project or program is attaining its targets and goals. See Gann et al. (2019) for additional information.

2.2. Elements of the restoration economy

The restoration economy can be mapped into four key elements:

1. **Drivers** set the socio-political context (external environment) that creates the demand for restorative actions.
2. **Inputs** are the direct capital necessary to conduct ecological restoration such as government incentives and grants, and private sector investments.
3. **Restoration activities** are the core of the restoration economy and consist of planning, designing, implementing, and evaluating restoration projects.
4. **Outputs** are the economic, social, and/or environmental effects resulting from the activity.

2.3. Benefits of a thriving restoration economy

The restoration economy has an imperative role as Australia transitions to a sustainable future. To reduce the country's emissions by 43% by 2030 with an aim to achieve net zero emissions by 2050, vast areas of carbon sequestration will need to be a key part of a nation-wide toolkit. Carbon sequestration can be achieved through multiple methodologies, but when delivered through ecological restoration, it can deliver wider environmental benefits including the conservation of threatened species and communities, and provision of ecosystem services (e.g., air and water purification, dryland salinity mitigation). This is critical, as almost half of Australia's Gross Domestic Product (GDP) (49.3% or $892.8 billion) has a moderate to very high direct dependence on ecosystem services (Australian Conservation Foundation, 2022). Current practice whereby 'environmental plantings' are utilised as a mechanism for carbon abatement do not necessarily produce systems that are on a trajectory of ecological recovery. Such plantings can often consist of fast-growing tree species for rapid carbon uptake that confer minimal to no benefits for biodiversity conservation or provide ecosystem services (Díaz et al., 2009, Lewis et al., 2019). This poses a significant threat to the landscapes and, as such, a culture shift from 'environmental plantings' to 'ecological restoration' is required (Box 2). If this culture shift can be achieved, the benefits of a thriving restoration economy in Australia will be wide-ranging and extend to the environment, society, industry, and government.

Environment

A restoration economy that delivers ecological restoration at scale can provide habitat, land connectivity, healthy waters, and soils. Australians value the biological diversity from our natural systems e.g., Subroy et al. (2021), and a strategic approach to prioritise sites for ecological restoration, integrating restoration into our productive systems, and using restoration as offset for emissions, would have great benefits for our native species, communities, and landscapes. Many of the major environmental threats such as species extinction, erosion, desertification, and salinity can be combated through ecological restoration (United Nations Environment Programme, 2021).

Society

Beyond the conservation and restoration of lands to support our native species and communities, ecological restoration can provide economic return to a wide range of demographics, particularly those located in regional areas (Ernst & Young, 2020, Working with Nature, 2021). There is a demonstrated link between nature and human health, with increasing support for ecological restoration to be a preventative measure to relieve some of the pressures on our health systems (Breed et al., 2021). Further, ecological restoration could assist in the healing process for many Indigenous Australians who are impacted from decades of disruption and disconnect from cultural practice and their lands (Cross, 2022).

Industry

Ecological restoration will enable business to reduce their climate and nature related financial risks, maintaining an ability to effectively trade, remain globally competitive and grow the economy. Accompanying large-scale restoration is direct demand for service and supply businesses involved in the delivery of projects. Many of these businesses could be scalable within regional locations supporting demographics with lower employment rates and/or experiencing economic transition (Ernst & Young, 2020, Working with Nature, 2021).

Government

Federal and State governments have set clear targets in relation to emission reductions to curb impacts of climate change (Department of the Prime Minister and Cabinet, 2022, Government of Western Australia, 2023). Compounding this is the deteriorating state of our environment, with increasing pressures causing abrupt changes in ecological systems recorded in the past 5 years (DCCEEW, 2022a). Ecological restoration can be a front-runner strategy to demonstrate a rapid reduction in emissions while also slowing or reversing environmental loss. Climate change and biodiversity loss are increasingly growing on societies' agenda with associated calls to government to demonstrate leadership in this space. Clear support for a restoration economy would demonstrate a response to societal needs with a long-term plan that extends beyond the immediate future or term of government.

A culture shift from 'environmental plantings' to 'ecological restoration' is required.

Credit (from L–R): Lochman Transparencies and Megan Hele

Box 2.
A shift in practice from revegetation to ecological restoration

Meeting the demand for restoration products that provide mitigative actions to address both the climate and biodiversity crises is an emerging challenge with implications across the sector. The generation of Australian Carbon Credit Units (ACCUs) through environmental plantings is experiencing unprecedented growth, but the quality of such plantings in terms of their biodiversity benefit is highly variable. Further, not all locations are equally suitable for environmental plantings or carbon sequestration projects and, as such, can further threaten poorly represented habitat and vegetation communities.

While two woody carbon offset plantings may have an equivalent outcome for carbon sequestration, their ecological outcomes can be markedly different. Nature-based carbon sequestration focusing solely on climate change mitigation primarily utilize fast-growing, short-lived monocultures or compositionally simple tree species for rapid carbon uptake (Lewis et al., 2019, Thornton, 2020). Such plantings, while cheaper to deliver, may not maximise carbon sequestration in the long-term owing to their greater vulnerability to pests, diseases, and extreme climate events that are expected to intensify in the coming decades (Seddon et al., 2020). Carbon sequestration projects that emphasise the restoration of native ecosystems have been shown to deliver greater environmental benefits including biodiversity conservation, and ecosystem services such as soil erosion control, water provisioning services, and also above ground carbon storage (Hua et al., 2022). There has been a call to prioritise the regeneration of natural forests over other types of environmental plantings (Lewis et al., 2019).

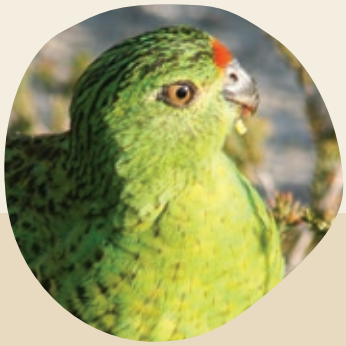
The functional composition of plant and soil communities affects carbon sequestration with dominant plant species strongly influencing the size and turnover rates of above and below-ground carbon stocks (Díaz et al., 2009). Considering these findings, a much-needed shift in perception for nature-based carbon sequestration projects is required. Rather than biodiversity considerations being regarded as ancillary benefits of nature-based carbon sequestration activities, biodiversity can be integrated into climate change mitigation projects and utilised to effectively enhance their carbon sequestration capacities (Díaz et al., 2009), thus moving from primarily carbon sequestration benefits in “revegetation” or “plantings” projects to delivering more inclusive benefits (carbon, biodiversity and ecosystem services) through ecological restoration projects.

The recovery of degraded ecosystems in Australia is feasible and economical if a restoration economy is effectively established to meet demand. Spending about AU$2 billion (0.1% of Australia’s 2019 Gross Domestic Product) annually for 30 years could restore 13 million hectares (or 99.8%) of degraded terrestrial ecosystems and mitigate one billion tonnes of CO_2-eq (Mappin et al., 2022). This could be achieved without compromising intensive agricultural production or urban areas, with revenue from the carbon market alone able to cover up to 111% of the investment needed for this continental-scale restoration (Mappin et al., 2022).

While the well-established carbon market can fund woody plant land use changes, the valuation of ecological benefits generated from different types of offset plantings is only just beginning to gain market recognition and is not adequately recognised within legislation. This has created a short gap in market quality control. Some large-scale plantings that are being implemented under the guise of 'environmental plantings' or 'biodiverse carbon offset plantings' are failing to support ecological communities with the necessary attributes to set an area on a trajectory of ecological recovery (Di Sacco et al., 2021).

The mismatch in demand for carbon and market valuation of other ecosystem values can result in permanent land use changes that fall short in delivery of environmental benefits over the short, medium, and long terms. This in turn locks in a poorly performing land use that is both difficult and expensive to fix. In south-west Western Australia, one of 36 global biodiversity hotspots, this issue will be magnified by the complex mosaic of soil types, soil changes, species richness and endemism that make each potential restoration project site an ecologically unique location. Nature-based projects will need to be carefully thought through before being implemented and grounded in sound ecological principles, while also considering their socioeconomic aspects.

To reduce the risk of poorly established 'environmental carbon plantings' that do not deliver meaningful environmental benefits, Western Australia needs appropriate policy, a restoration plan, and standards that provide scientifically based measurable targets to inform large-scale practices.



Credit (from L–R): Judy Dunlop, Megan Hele and Brent Barrett

3. Understanding the drivers of the restoration economy

To understand the changing environment in which the WARE operates, we summarise existing and emerging drivers of the restoration economy.

The network of drivers and pressures are integrated and complex with some being global **events** (e.g., climate change, biodiversity loss) and others being **actions** (e.g., goals, frameworks, policy) to respond at the global, national, or local levels. Events and actions have direct influence across many **sectors** in the WARE but impacts and responses vary. We mapped the relationships between these components to visualise the inter-relationships on the WARE (**Figure 1**) with high-level descriptions of major events, actions and sector-based responses provided below.

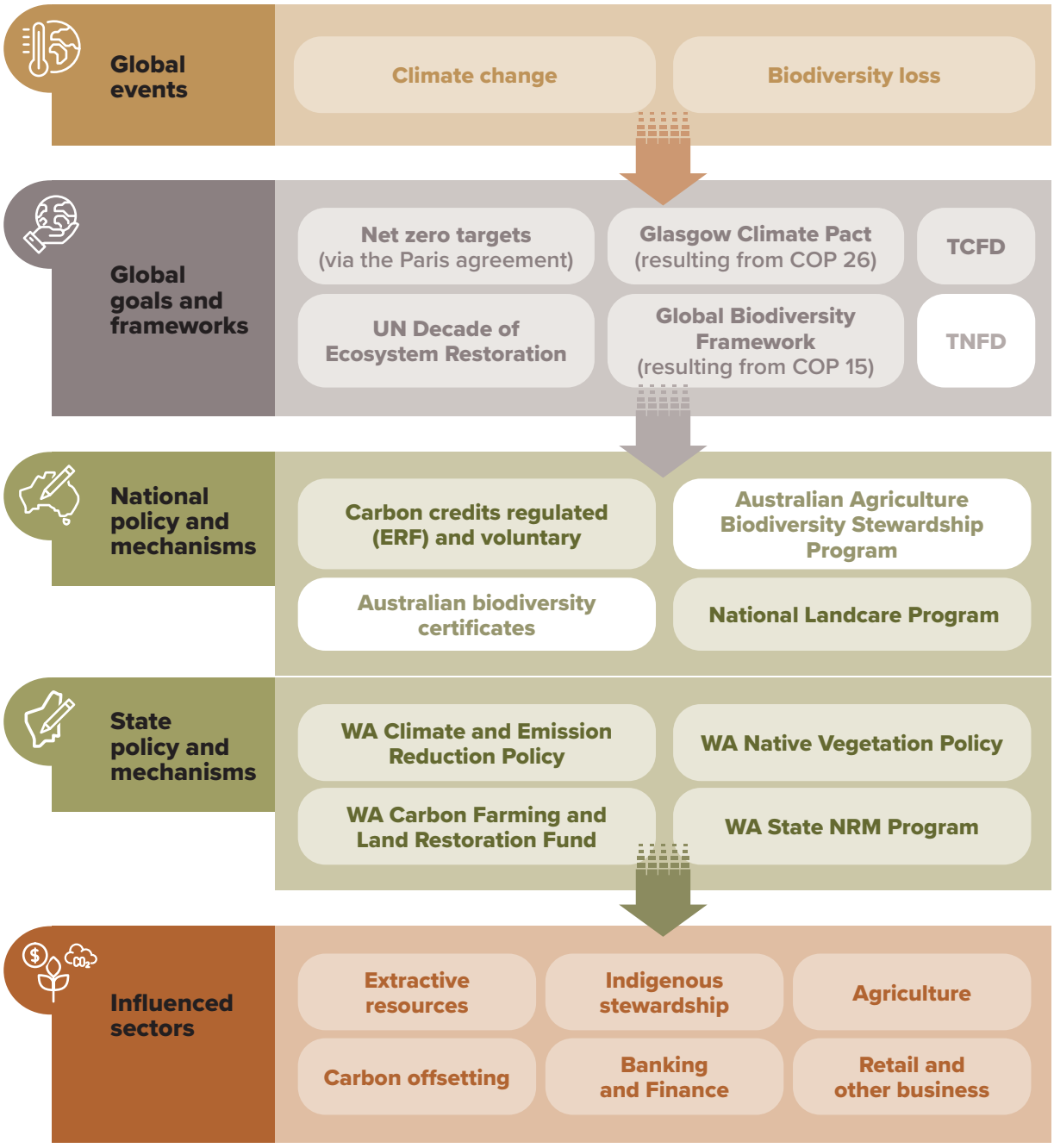


FIGURE 1. Drivers of the Western Australian Restoration Economy and their interactions. Note only policy and mechanisms that are discussed in the report are included as examples and mapped. Light shaded boxes indicated emerging areas still under development. There are many other valuable government, private and community programs that also influence and deliver restorative activities in Western Australia.

3.1 Global events

Biodiversity loss and climate change are both driven by human economic activities and mutually reinforce each other. Neither will be successfully resolved unless both are tackled together (Pörtner, 2021).

Climate change

Climate change is accelerating, and its impacts are projected to continue and become more severe. The south-west of Western Australia is one of the nine most at risk regions to climate change in Australia according to the Intergovernmental Panel for Climate Change (IPCC) AR6 Second Working Group report on impacts, adaptation, and vulnerability (IPCC WGII, 2022). Under all IPCC emissions scenarios, Western Australia is expected to experience serious threats from climate change including (DWER, 2021a):

- An increase in extreme temperatures with the number of very hot days (>40°C);
- Longer fire seasons with a 40% increase in very high fire danger days;
- Sea level rise of about 24cm along the West Australian coast;
- Further average rainfall decline in south-west Western Australia, with changes over northern Australia uncertain;
- Further decline in water catchment flows;
- Greater variability in rainfall and an increase in extreme rain events, leading to more very wet and very dry years; and
- Higher intensity tropical cyclones.

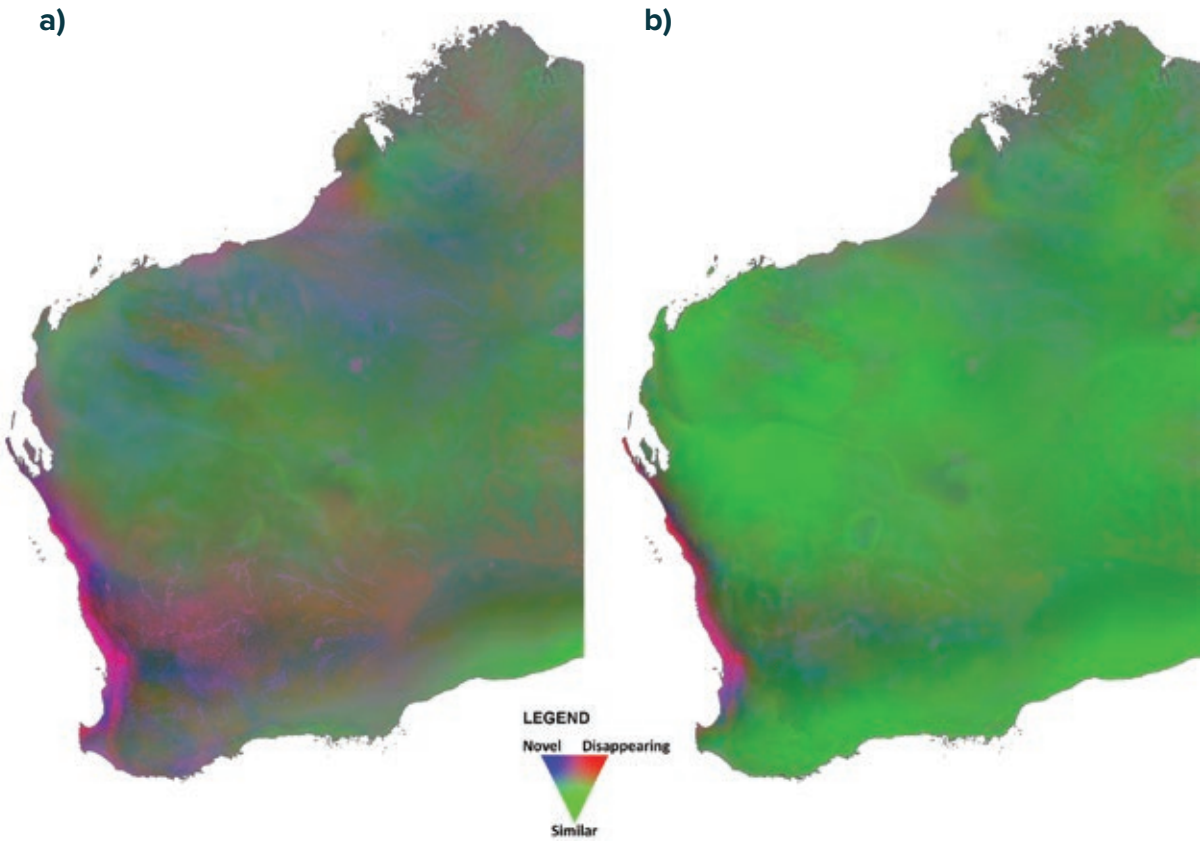


FIGURE 2. Composite ecological change patterns for vascular plants under two climate change scenarios a) 2050 CAN ESM2 RCP 8.5 and b) 2050MIROC5 RCP 8.5 from Williams et al. (2014). The Swan Coastal Plain in Western Australia is under significant threat with vegetation communities expected to substantially change or disappear under most scenarios.

The agriculture, forestry, and other land use (AFOLU) sector has a significant role in climate change mitigation. The AFOLU could provide 20-30% of the global mitigation needed (8–14 $GtCO_2$-eq yr^{-1}) to limit warming to 2°C by 2050, with nature-based solutions, including ecological restoration, embedded in this sector likely to be more successful than other measures (IPCC WGIII, 2022). However, even with mitigation, the effects of climate change will have a major impact on current distributions of flora and fauna. The Swan Coastal Plain is one of the areas at greatest risk with the unique vegetation in the region expected to substantially change or disappear under most scenarios (Williams et al. 2014); (**Figure 2**). Thus, ecological restoration projects must consider climate change when setting their reference models, and subsequent species selection, if they are to be successful as a long-term carbon sequestration strategy (DWER, 2021a).

Biodiversity loss

Over half the world's economic output of US$44 trillion is moderately or heavily dependent on nature and its services (WEF, 2020). Biodiversity is vital to human health, economies and livelihoods, but it is declining faster than at any other time in history with over 41,000 species (or 28% of all assessed species) threatened with extinction (IUCN, 2022). In Australia, scientists have predicted the collapse of 19 Australian ecosystems including Ningaloo Reef, the Shark Bay seagrass beds, and the Mediterranean forests and woodlands in south-west Western Australia owing to pressures from climate change and human-induced impacts (Bergstrom et al., 2021). The State of the Environment Report 2021 assessed the overall state of biodiversity in Australia as being poor with a declining trend. Climate change, pollution, resource extraction, habitat loss, and invasive species were deemed principal causes for this decline (DCCEEW, 2022a). While the trajectories of 24 priority listed species showed improvements by 2020, on the whole, the number of species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (*Cth*) increased for all taxonomic groups since 2016, by an average of 8%, with listings growing the most for invertebrates and frogs (22% and 21%, respectively) (DCCEEW, 2022a). Currently, only 15% of the funding needed to avoid extinctions is spent annually on threatened species recovery projects in Australia (Wintle et al., 2019).

Ecological restoration programs targeting 15% of converted lands in priority areas globally (including south-west Western Australia) could prevent 60% of expected biodiversity extinctions while sequestering 299 gigatonnes of CO_2 (Strassburg et al., 2020). Investment in nature-based solutions to mitigate carbon emissions via ecological restoration if planned and executed well, will reduce the loss of biodiversity, and generate important ecosystem services. Box 2 highlights the significance of the required culture shift from environmental plantings to ecological restoration that will be required to achieve these goals.

3.2 Global goals and frameworks

Serious and genuine intent to curb the impacts of the climate and biodiversity crises have seen coordinated attempts across all nations to make the required policy and societal change. Discussed below, these are roughly presented in chronological order and do not infer order of significance or influence on the restoration economy.

The Paris Agreement and net zero target setting

The Paris Agreement, a landmark, legally binding international treaty, was adopted by 196 parties at the 21st Conference of the Parties (COP 21) in December 2015 to limit global warming to below 2°C (UNFCCC, 2015). Achieving this goal would require global carbon emissions to be halved by 2030 and reach net zero by 2050 (Exponential Roadmap Initiative & Race To Zero, 2020). An aggressive approach to simultaneous, inevitable technology disruptions across sectors, could directly eliminate over 90% of net greenhouse gas emissions worldwide within 15 years (Arbib et al., 2021). New technologies while addressing climate change are also posited to reduce humanity's ecological footprint and open up vast areas of land available for ecological restoration (**Figure 3**).

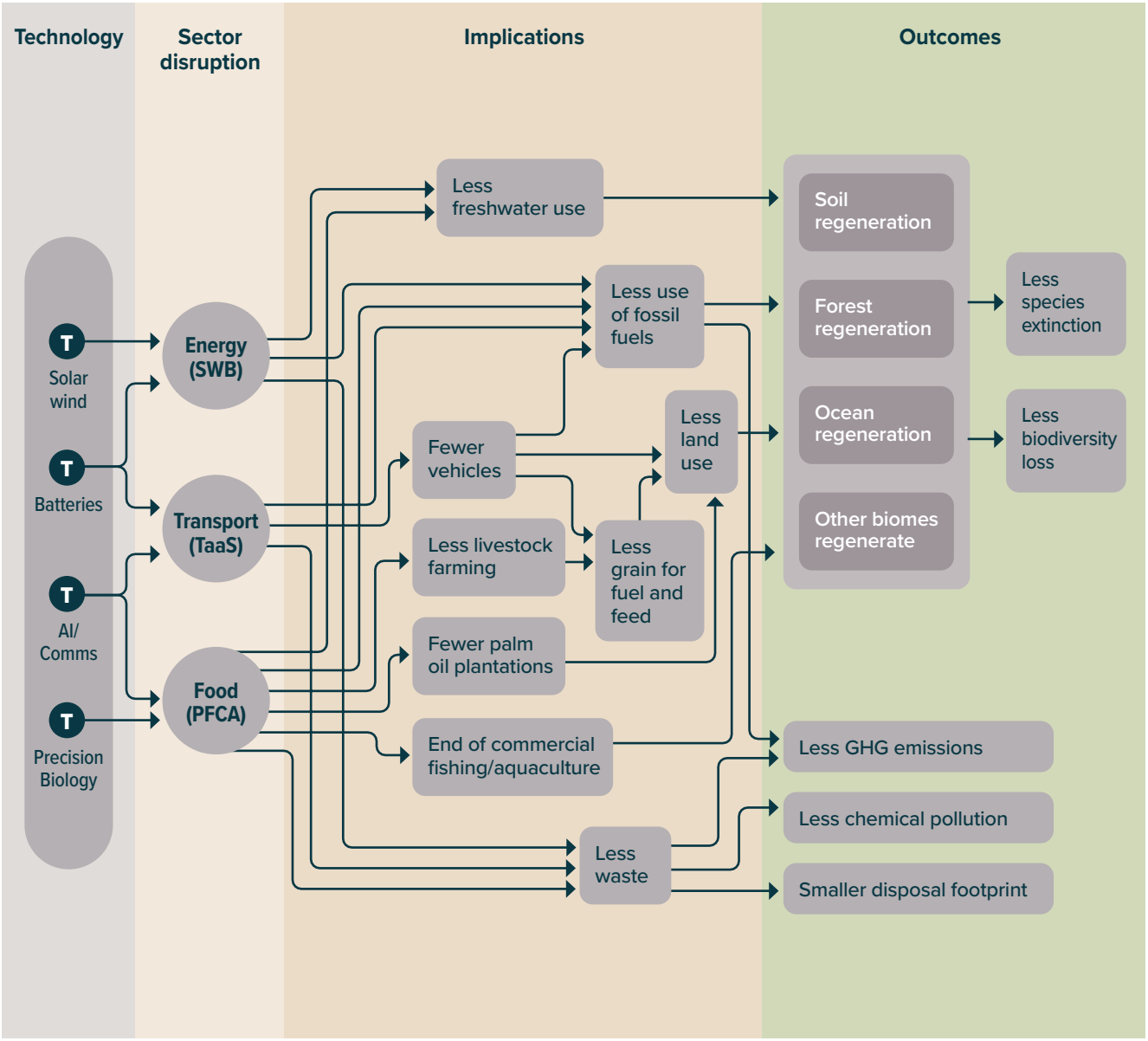


FIGURE 3. Technology disruption supports ecological restoration.
Source: Arbib et al. (2021)

Credit (from L-R): Judy Dunlop, Megan Hele and Robert McLean

The UN Decade on Ecosystem Restoration 2021–2030

Phase 1 of the UN Biodiversity Conference (COP 15) in October 2021 marked the beginning of the UN Decade on Ecosystem Restoration (2021-2030) to restore millions of hectares across the globe over the next ten years. The UN Decade on Ecosystem Restoration was adopted by the United Nations General Assembly on 1st March 2019, with the aim of preventing, halting and reversing the degradation of ecosystems globally (UNEP and FAO, 2021). Led by the United Nations Environment Programme (UNEP) and the Food and Agriculture Organization (FAO), a top-down *and* bottom-up approach to ecosystem restoration has been taken through building political momentum for restoration and by supporting on-ground initiatives.

In Australia, 16 prominent environmental organisations[1] have announced the formation of a Restoration Decade Alliance (2021) to support the objectives of the UN Decade on Ecosystem Restoration. Guided by the 'Darwin Agreement' initiated at the 2021 Society for Ecological Restoration Australasia conference, the Alliance urges concerted support of the UN Decade on Ecosystem Restoration by all sectors of society – policy makers, industry, and communities – to retain ecosystems, reduce impacts on them and repair ecosystems to optimise potential for humanity to revive the natural world (Armitage et al., 2021).

COP 26 and the Glasgow Climate Pact

The 2021 UN Climate Change Conference of the Parties (COP26) in Glasgow saw all Parties agree to the Glasgow Climate Pact, whose focus is on mitigation, adaptation, finance, and collaboration, and which categorically asserts the connection between nature and climate (COP26, 2021a, TNFD, 2021a). COP26 secured near-global net zero Nationally Determined Contributions (NDCs) from 153 countries, covering over 90% of world GDP and around 90% of global emissions, projected to result in the lowering of greenhouse gas (GHG) emissions by five billion tonnes by 2030 (COP26, 2021b) with 92% of the 114 revised NDCs at the COP26 including nature-based solutions (WWF, 2021). Further, commitments were given to protect nature, end deforestation and restore ecosystems and finance sustainable supply chains. Commitments were given by 137 countries to protect natural habitats and halt and reverse deforestation and land degradation by 2030 (COP26, 2021c).

COP 15 and the Global Biodiversity Framework

COP 15 saw the landmark adoption of the Kunming-Montreal Global Biodiversity Framework (GBF) to guide global action through 2030 to halt and reverse nature loss (UNEP, 2022). The GBF includes four goals and 23 targets for achievement by 2030 to halt the perilous loss of biodiversity and restore natural ecosystems. Foremost among the agreed targets is the effective protection and management of at least 30% of the world's lands, inland waters, coastal areas, and oceans by 2030, with emphasis on ecologically-representative, well-connected and equitably-governed systems of protected areas, recognizing indigenous and traditional territories and practices (CBD, 2022). It also includes restoration on at least 30% of degraded terrestrial, inland waters, and coastal and marine ecosystems (CBD, 2022). Importantly, the GBF also calls for mobilising finance and aligning financial flows toward nature-positive investments by requiring large and transnational companies and financial institutions to monitor, assess, and transparently disclose their risks, dependencies, and impacts on biodiversity through their operations, supply and value chains and portfolios (CBD, 2022).

[1] The Australian Restoration Decade Alliance includes the United Nations Decade on Ecosystem Restoration, Aboriginal Biodiversity Conservation Foundation, Australian Association of Bush Regenerators, Australian Coastal Restoration Network, Australian Network for Plant Conservation, Australian Seed Bank Partnership, Bush Heritage Australia, Global Evergreening Alliance, Gondwana Link, Great Eastern Ranges, Greening Australia, Invasive Species Council, Landcare Australia Ltd, National Landcare Network, Restore Australia, Society for Ecological Restoration Australasia and World Wide Fund for Nature (WWF) Australia.

The Taskforce on Nature-related Financial Disclosures (TNFD)

The Taskforce on Nature-related Financial Disclosures (TNFD) was formed in June 2021 in response to increasing recognition for the need to factor nature into financial and business decisions and closely follows the structure of the Taskforce on Climate-related Financial Disclosures (TCFD). The TNFD aims to develop a globally inclusive, science-based, market usable and adaptable risk management and disclosure framework to help corporates organisations and financial institutions report on nature-related risks and their management with the ultimate aim of shifting "financial flows away from nature-negative outcomes to nature-positive outcomes" (TNFD, 2021b).

The TNFD will have a major influence on corporate performance and sustainability within Australia. Australia is one of five nations funding the TNFD Taskforce which has three members: Macquarie Group, KPMG and Deloitte (TNFD, 2021c); and multiple companies signing up to the TNFD Forum (TNFD, 2022a). Companies signatory to the TNFD will disclose nature-related risks and their management. Targeted ecological restoration will contribute to reducing the risk profile of companies which, for example, opens-up or maintains access to financial lending, provides access to robust insurance and asset management services, and enables high quality and timely valuation, risk and credit analysis which form the key foundations for economic stability and growth.

3.3 Policy and mechanisms

Western Australia's climate and emissions reduction policy

Western Australia is an emissions-intensive, export-oriented economy, with around half of Australia's national exports of goods originating from the State each year, including minerals, petroleum, agri-food, and specialised manufactured goods (DWER, 2021b, JTSI, 2022). The State Government recently announced plans to commitment to net zero carbon emissions by 2050 in law which would apply to the entire economy(Government of Western Australia, 2023).

The Western Australian Climate Policy provides a plan to facilitate the transition of the State to a sustainable, low-carbon future (DWER, 2020). Among the six focus areas for a transition to net zero by 2050 is "Storing carbon and caring for our landscapes". In 2019, the Western Australian Government paved the way for pastoralists to undertake carbon farming on pastoral leasehold land. Western Australia's Rangelands occupy an area of 2.2 million km^2 and provide considerable opportunity for carbon sequestration projects in the State. In August 2020, the Government invited proposals for carbon farming projects on the conservation estate, with an emphasis on carbon sequestration and emissions avoidance projects that would support the employment of Traditional Owners and accrue co-benefits including biodiversity conservation and improved fire management. This led to 59 projects being registered under the Australian Government's Emissions Reduction Fund, which are expected to deliver about nine million tonnes of carbon abatement and around $130 million in revenue for pastoralists. An additional 15 million tonnes of carbon abatement are expected to be directly sold to major greenhouse gas emitters (DWER, 2020).

Credit: Threshold Environmental

Western Australia's Native Vegetation Policy

The Government of Western Australia recently released the first Native Vegetation Policy for the State that sets long-term strategic direction for state government agencies interacting with native vegetation (DWER, 2022). Among other outcomes, the policy aims to enable all sectors to contribute to a net gain in native vegetation and landscape-scale conservation and restoration. The policy recognises the importance of the restoration economy by stating the need to ensure ecologically sustainable development in Western Australia that balances environmental, economic, and social considerations in decision-making; and the need to reverse the decline of native vegetation through strategic coordinated management across all land tenures (agriculture, mining, pastoral), maintaining vegetation connectivity and, ecosystem function. Importantly, the document presents emerging prospects for the restoration sector in the State including the growth of the restoration economy and opportunities to engage with Traditional Owners and utilise their rich cultural knowledge of ecosystems to co-manage and restore native vegetation.

Western Australia's Carbon Farming and Land Restoration Program

As part of the plan to transition the agricultural sector to net zero emissions by 2030, the Western Australian Government launched the Carbon Farming and Land Restoration Program (CF-LRP) in July 2021 to help Western Australian farmers undertake carbon sequestration through soils and vegetation (DPIRD, 2022). The $15 million program supports projects that deliver environmental, social, biodiversity and economic co-benefits and contribute to the long-term sustainability of the farming industry. The CF-LRP aims to ensure that the carbon sequestration potential of agriculture is realised, and the sector can also contribute to growing the carbon market in Western Australia. In 2022, the first round of successful applicants were announced with projects that span the South West, Great Southern and Eastern Wheatbelt, covering more than 7,000 hectares and expected to remove over 260,000 tonnes of carbon dioxide equivalent from the atmosphere over the next decade, in exchange for ACCUs (DPIRD, 2022).

National Landcare Program

The Australian National Landcare Program (NLP) is a key part of the Australian Government's commitment to natural resource management (NRM), biodiversity protection and sustainable agricultural practices DCCEEW (2022b). Phase one saw an investment of $1 billion over four-years with a committed $1.1 billion for phase two of the program (2018-2023). The program supports a series of sub-programs including Regional Land Partnerships (RLP), Smart Farms, Indigenous Protected Areas, 20 Million Trees, Environmental Small Grants, Threatened Species Recovery Fund, Reef 2050, Bush-Blitz and the Centre for Invasive Species Solutions (DCCEEW, 2022b). The most significant sub-program of the NLP phase two is the $450 million investment in RLP to support the activities of 50 regional NRM service providers covering 54 NRM management units (DCCEEW, 2022b).

The 20 Million Trees program has seen almost 30 million trees tress, over 2m in height, planted, more than 30,000 hectares revegetated, over 2,500 species planted, almost 18,000 hectares treated for weeds, almost 100,000 people participating as volunteers, and 141 Indigenous people employed through ranger programs. Estimates indicate that the program will sequester on average 1.47 to 2.95 million tonnes CO_2 over the decade from 2021 to 2030 (DCCEEW, 2022c).

Australia's Agriculture Biodiversity Stewardship Package Program

The Australian Federal Government's $66 million Agriculture Biodiversity Stewardship Package Program aims to establish a scalable program which rewards farmers who deliver biodiversity and environmental benefits through native vegetation management on their farms (Jervis-Bardy, 2021). The intent is to incentivise the adoption of improved on-farm land management practices and develop a mechanism that rewards farmers for delivering biodiversity and sustainability services that benefit both their farms and the wider community, thus allowing farmers to earn an extra source of income while delivering carbon and biodiversity benefits (DAFF, 2022). The components of the program include the carbon and biodiversity pilot, the enhancing remnant vegetation pilot, the Australian farm biodiversity certification scheme, the national stewardship trading platform and, the Australian Agricultural Sustainability Framework (DAFF, 2022).

Emerging policy—Biodiversity credits

Following the release of the State of the Environment 2021 report the Australian Government announced the creation of a biodiversity certificates scheme that will grant tradeable biodiversity certificates to landholders who restore or manage local habitat (Prime Minister of Australia, 2022). The Government will be developing a legislative framework that would underpin a voluntary biodiversity market.

The biodiversity market is intended to raise and direct significant private investment for conservation and restoration to reverse the decline of Australia's environment. Investment is intended to drive projects that provide habitat for species, protect waterways, and deliver other environmental benefits such as reduced erosion, protecting topsoil and improving drought resilience. The market would facilitate investments in nature through a common framework, operate in a manner similar to the current carbon market and be administered through the Clean Energy Regulator (Prime Minister of Australia, 2022).

In its draft form, the market is projected to issue project-based biodiversity certificates that capture key attributes in a standardised way. However, that would not mean that all certificates would be equivalent. Projects would be managed through a public register supported by biodiversity integrity standards and a compliance and assurance system.

New South Wales (DPE, 2021), Victoria (DEWLP, 2018, Daly et al., 2022) and South Australia (DEW, 2022) all have versions of a biodiversity credits scheme, which have been implemented with varying levels of success in those states.

3.4 Sector-based responses to drivers within Australia

Responses to the climate and biodiversity crises in Australia are, and will continue to be, integrated across all major sectors to support increasingly sustainable business operations. These shifts are happening rapidly, with tree plantings one of the key strategies currently employed by companies to demonstrate reduced carbon emissions (Moodie, 2022). The role of the restoration economy in these transitions will be significant as evidenced by the role of carbon farming highlighted in the 'Powering Australia' plan (ALP, 2021). The carbon and emerging biodiversity markets are inherently entwined with many of Australia's major industries as they respond to net zero targets and nature positive goals. However, each sector has unique pressures and opportunities which relate to the restoration economy. To understand these relationships and infer the needs of the growing restoration economy we examine key sector-based initiatives influencing the role of restoration within focal industries.

Banking and finance

Building on the TCFD and the TNFD global frameworks, the finance sector is one of the biggest drivers of change with access to financial capital increasingly being influenced by Environment, Social, Governance (ESG) performance. Large banking and financial institutions are increasingly assessing how they can support the private sector to understand their impacts and dependencies on nature, and shift to nature-positive investments and outcomes. Many of the large banks in Australia have specific initiatives, programs, and products to support the transitions needed under future market scenarios. The National Australian Bank (NAB), for example, is aiding The Natural Capital Investment Initiative (NCII) being led by ClimateWorks Australia to support the transition to a more sustainable land use system in Australia (ClimateWorks Australia & NAB, 2021); ANZ have set targets to fund and facilitate $50 billion by 2025 to support customers in their efforts to achieve improved environmental outcomes, including the reduction of their greenhouse gas emissions (ANZ, n.d.); and Rabobank is entering into partnerships to provide sustainability-linked loans (Rabobank, 2021).

Carbon industry

The Australian domestic carbon industry is underpinned by the Emissions Reduction Fund (ERF) that was established following the passing of the *Carbon Credits Act 2011*. Under the ERF, which is administered by the Clean Energy Regulator (CER), various activities are eligible to earn ACCUs for emissions reductions[2]. Nature-based solutions for carbon abatement under the ERF involve vegetation projects that increase stored carbon in vegetation. Approved vegetation project methods include avoided deforestation, avoided clearing of native regrowth, reforestation and afforestation including reforestation by environmental or mallee plantings, plantation forestry, native forest from managed regrowth (NFMR), and human-induced regeneration (HIR) of a permanent even-aged native forest, among others (CER, n.d.). The Western Australian Government has recently released three million hectares of Crown land for carbon farming to allow pastoralists to earn carbon credits through HIR projects (CMI, 2022).

Valuing co-benefits from carbon farming is an emerging focus for Federal and State Governments in Australia (CMI, 2022). A new 'Active Land Management and Agricultural Production' (AL-MAP) method is being proposed by the carbon farming industry. Designed by carbon farming developer Climate Friendly (https://www.climatefriendly.com/), this method enables diverse carbon sequestration and carbon abatement activities to be undertaken on a single property (moving away from the current single-property single-activity focus of ERF projects) (CMI, 2021). Simultaneous abatement activities can generate more carbon abatement from a property with a corresponding improvement in economic viability. The Carbon Market Institute estimated that the AL-MAP Method could generate an additional 2.5 billion ACCUs from over 5,000 added projects (CMI, 2021) opening up a diversified income stream for farmers and land managers and making ACCUs available to corporations and organisations to meet their emissions reduction targets.

[2] An independent review of the integrity of Australian Carbon Credit Units is currently underway, which may see estimates revised.

Agriculture

At both the federal and state level, climate resilient food systems and achieving carbon neutrality is a becoming prominent discussion in Australian agricultural sectors. Agriculture is in the unique position of being both a source and a sink for GHG emissions. As the peak agricultural advocacy organisation, the National Farmers Federation 2030 Roadmap outlines an ambitious plan for the Australian farming industry to become a $100 billion industry by 2030, it also includes commitments to achieve carbon neutrality in Australia's agriculture sector by 2050 with net benefits for ecosystem services equal to at least 5% of farm revenue (NFF, 2019).

The Australian red meat industry has also committed to achieving carbon neutrality by 2030 with an associated roadmap that facilitates decision-making to reduce greenhouse gas emissions and tackle climate change challenges (MLA, 2020). Carbon storage is one of the four key strategies to achieve this goal with associated actions including the planting of trees and shrubs for carbon storage, animal health and biodiversity (MLA, 2020).

Indigenous stewardship

The most comprehensive Native Title agreement negotiated in Australia's history with six Indigenous Land Use Agreements (ILUAs) between the Noongar people and the Western Australian Government concluded in 2021 (Government of Western Australia, 2022). The settlement package provides the Noongar people with sustainable assets and options for developing Noongar interests, including opportunities for the State Government to work in partnership with the Noongar people to elevate economic, social and community outcomes. A key component of the package is the Noongar Land Estate to be held by the Noongar Boodja Trust where the State Government will transfer up to 300,000 hectares of land allocated as reserve or leasehold and up to 20,000 hectares of land allocated as freehold for cultural or economic development use. Extensive areas of these lands may require ecological restoration to improve environmental condition or may be restored with the ability to generate ACCUs with co-benefits and would contribute and benefit from a restoration economy.

Recognising the integral role that Indigenous Australians have in the future management of Australia's environment, the Australian Government supported the award and establishment of a major Australian Research Council funded research program, the Industrial Transformation and Training Centre for Healing Country in 2021. Healing Country, a 5-year research centre, is entirely Indigenous-led and aims to be a world-first on-country capability, employment, and business development training centre for Indigenous Australians. It will focus on cost-effective restoration solutions that grow and strengthen Indigenous enterprises, expanding and bolstering diverse training pathways, and conducting innovative research to support the advancement of a diversified Indigenous-led restoration economy. Healing Country will fuse Indigenous culture in a cooperative vision where science and traditional approaches to land management and rehabilitation will create and nourish an economy that supports healthy land and transform Indigenous restoration businesses into a major employer of on-country regional jobs.



Credit (from L-R): Robert McLean, Claire Greenwell and Megan Hele

Extractive resources

Environmental and social issues have been identified as the number one risk for mining and metals in 2022 (Ernst & Young 2022). The International Council of Mining and Metals (ICMM), a global leadership organisation making up one-third of the global mining and metals industry, including, but not limited to, Alcoa, BHP, Newmont, Rio Tinto and South32, has collectively committed to a goal of net zero Scope 1 and 2 greenhouse gas emissions by 2050 or sooner in line with the Paris Agreement (ICMM, 2022). Within the industry, much of the focus to date has been on portfolio shifts (that is, divestment of coal assets); however, the industry is facing increasing pressure from regulators, investors, and customers to decarbonize operations. The sustainability of miners is increasingly a focus for the capital markets, with access to capital now more frequently dependent on sustainability (see TNFD and Banking and Finance sections above). The cost of capital can be 20-25% higher for those miners with the lowest ESG scores (Legge et al., 2021).

While the primary focus of decarbonisation in the State's mining sector is on direct reduction of emissions at the source (e.g., conversion to sustainable fuels, operational efficiencies), there will be an inherent need for restoration as an emission offset strategy. BHP expects to spend US$4 billion (AU$5.7 billion) on decarbonisation projects over the next eight years and will ask traditional owners to file a 'traffic light' assessment of their relationship with the mining giant under an updated "social value" agenda. The company has announced plans to tackle biodiversity loss, seeking to place 30% of the land and water it owns, leases or manages under conservation, restoration or regenerative practices by 2030 (BHP 2022a, 2022b).

Retail and other business

Outside agriculture and the extractive resources industries, the retail sector is also undertaking significant change within their business models to address climate change and biodiversity loss. As an example, Officeworks Australia is committed to becoming a zero-waste business—having zero deforestation in their supply chain and using 100% renewable energy from 2025 to reduce supply chain emissions. They also committed to planting two million trees by 2025 on behalf of their customers (Officeworks, 2021) with the Officeworks strategy not solely focussed on net zero but extending to biodiversity with an emphasis on restoring woodland ecosystems, improving habitat for threatened species, and rejuvenating existing bushland. In Western Australia, almost 100,000 trees have been planted in the central Wheatbelt to help restore habitat for native animals, including the Threatened Black Cockatoo (Officeworks, 2022).

Pharmaceutical companies like AstraZeneca have committed to global reforestation efforts and the elimination of GHG emissions and improvements to biodiversity. AstraZeneca have committed to planting 50 million trees globally over the five years from 2020 including 25 million trees in Australia in partnership with Greening Australia (AstraZeneca, 2020). Similarly, Nature's Own has a strategy to re-green Australian cities and urban spaces through the 'Our Park, Our Place' project targeting urban hotspots in Perth, where a lack of trees and vegetation is contributing to higher temperatures (Greening Australia, 2018).

The Exponential Roadmap Initiative, a leading climate-action initiative, and an accredited partner of the United Nations' Race to Zero campaign has brought out a Roadmap highlighting 36 cost-effective, market-ready, solutions that can be scaled exponentially to halve greenhouse gas emissions worldwide by 2030 (Exponential Roadmap Initiative & Race To Zero, 2020).

Credit: Threshold Environmental

4. The Western Australian Restoration Economy

The demand for ecological restoration is expected to increase globally in the coming years, including in Australia, owing to a network of interconnected drivers. A need was identified to understand the WARE i.e., the market of businesses, investors, consumers, and government initiatives engaging in or driving the economic activity related to restoration aligned activities in Western Australia. It was deemed necessary to understand the size and scope of the WARE, its potential for growth, and barriers that need to be overcome to enable the expansion of the sector.

This work involves:

1. mapping the WARE supply chain;
2. identifying organisations and companies involved in the WARE supply chain;
3. exploring the size of the WARE in terms of employment and flow of money; and
4. understanding the barriers that limit growth of the WARE.

4.1 Mapping the WARE supply chain

Key elements of the WARE supply chain were identified and mapped during a stakeholder workshop held in August 2021 with 18 professionals primarily engaged in restoration aligned activities in Western Australia. The workshop was attended by representatives from research, consulting, non-profit organisations, government agencies, and industry.

Topics covered in the workshop included:

1. Definition of the restoration economy;
2. Activities included in the restoration economy;
3. Economic processes involved in ecological restoration;
4. Supply chains;
5. Data sources and collection; and
6. Opportunities and obstacles for the WARE.

Workshop participants agreed that the restoration economy should encompass economic activities and actors (e.g., businesses) associated with different stages of a restoration project from planning and design to implementation, monitoring, and evaluation, and apply to a variety of land uses (e.g., rangelands, wetlands, mine sites).

The workshop also identified five participant categories within the WARE supply chain (**Table 1**):

1. **"Businesses/organisations"** that include groups, associations, and companies, such as NRM groups, 'Friends of' and community groups, NGOs, local councils/shires, mining companies, carbon companies and ecological restoration companies who undertake restoration and maintain restored areas. While diverse, these groups all operate at the local scale.
2. **"Government agencies"** that include departments/bureaus such as the Department of Biodiversity, Conservation and Attractions, Main Roads, and Department of Water and Environmental Regulation who undertake terrestrial restoration, maintain restored areas, and are also involved in other restoration related activities such as regulation, approvals and grants and operate at the State scale.
3. **"Consultants"** that include businesses who provide ecological restoration services including designing and implementing the restoration, monitoring, and evaluation.
4. **"Suppliers"** that include those who supply goods and services for ecological restoration such as nurseries and seed suppliers, fencing and watering supplies, and
5. **"Researchers"** who include those conducting restoration-related research.

The supply chain can be divided into two segments:

1. **'buyers'** (businesses/ organisations/ government agencies); and
2. **'providers'** (consultants/ suppliers/ researchers) of the WARE.

We acknowledge that the boundaries between participant categories and supply chain segments is not clear-cut with some entities potentially able to be assigned to more than one category.

TABLE 1. Participant categories in the WARE supply chain.
Note many of these are separated out in the results analysis that follows.

Phase	Supply chain category	Role in supply chain	Examples
Buyers	**Businesses/ organisations**	Restore and maintain areas on government or privately owned lands.	Mining companies, NGOs, NRM groups, Landcare groups, Friends-of groups, naturalists' clubs, not-for-profit organisations, community groups, businesses providing restoration services.
	Government agencies	Restore and maintain areas of land under government management. Also involved in restoration related activities such as approvals, grants, species conservation.	State government departments, local councils or shires that manage the environment.
Providers	**Consultants/ Practitioners**	Provide services to aid in restoration or restoration related activities.	Consultants that provide environmental, agricultural, social, legal, hydrological, geotechnical, mapping/ GIS/ imaging, civil, earthworks, landscape design, pest and weed control services, laboratory technicians/ analysis.
	Suppliers	Provide supplies to aid in restoration or restoration related activities.	Groups that provide seeds, greenstock (seedlings), specialised equipment, irrigation materials, fencing materials, pest control supplies.
	Researchers	Conduct restoration related research.	Universities, Federal Government research institutes, State Government research institutes, independent research institutes.

Credit: Threshold Environmental

4.2 Organisations and companies involved in the WARE supply chain

A list of companies/organisations/agencies etc. in each of the five participant groups of the WARE was compiled utilising information gathered from the workshop (where potential data sources were suggested) as well as from publicly available online sources such as company internet pages, search engines and online directories. When compiling this list, the relevant contact person(s) for the organisation/company/research group was identified.

For businesses/organisations, we further categorised the companies and organisations involved according to the type of business/organisation as:

- **Carbon and ecological restoration companies:** who either carry out ecological restoration or undertake planting for carbon credits for profit.
- **Landcare and community groups:** community-based groups who undertake revegetation projects for restoration. They can either be entirely volunteer-based or employ paid staff and have operational budgets.
- **Mining companies:** businesses involved in mining who are required as part of regulatory approval conditions to undertake rehabilitation.
- **NGOs and not-for-profits:** including charities that undertake restoration aligned activities.
- **Natural Resource Management (NRM) regions:** Not-for-profits focusing on the integrated management of natural resources in Australia at a landscape or catchment scale. There are six NRM regions in Western Australia.

The number of businesses/organisations identified from publicly available sources under each category (or sub-category) is summarised in **Table 2**.

4.3 The WARE survey

An online survey was conducted to collect representative data on the size of the WARE and the economic value and flows through the restoration supply chain. The survey was developed using an online platform, Qualtrics (Qualtrics^{XM}, Provo, UT, USA) and administered to relevant individuals identified in each business/organisation/government agency/group. The survey could be completed by either a single person or multiple people from the same organisation.

The survey collected data on the type(s) of restoration undertaken and its nature, area restored, revenue, expenditure, and personnel numbers in the 2020–2021 financial year, and any change in trend for each of these factors over the last five years. The survey also asked respondents to detail any barriers encountered when undertaking restoration aligned activities.



Credit: Robert McLean (far left), Lochman Transparencies (far right)

TABLE 2. The number of companies/organisations identified, and the number of responses received from each category/subcategory in the WARE supply chain

Phase	Supply chain category	Sub-categories	Number Identified	Number of responses received
Buyers	**Businesses/ organisations**	Carbon and ecological restoration companies	6	4
		Landcare groups and community groups	153	24[a]
		Mining companies	116	7
		NGOs and not-for-profits	8	5
		NRM regions	6	3
	Government agencies	Government departments	8	6
		Shires and councils	132	6[b]
Providers	**Consultants**	Environmental	80	5
	Suppliers	Native seed, nurseries, and suppliers	21	4
	Researchers	University groups, Federal and State Government research groups	14	4

[a] While 24 responses were received in total from Landcare and community groups, one of the responses could not be included as the respondent answered the survey as a "Consultant" rather than a community group. Usable responses for Landcare and community groups were therefore, 23.

[b] One of the Shires responded noting that they do not undertake restorative activities. The number of usable responses for the Shires and Councils category were, therefore, 5.

Specifically, for each organisation the survey asked information regarding the:

- Number of employees/volunteers involved in restoration aligned activities
- Expenditure on employees
- Expenditure on restoration aligned activities
- Internal capital used for restoration
- Revenue generated from restoration aligned activities
- Type of restoration undertaken
- Area restored
- Restored area maintained
- Expenditure on consultants/contractors
- Expenditure on supplies

Survey respondents were also presented with Likert scale questions where they were asked to indicate how key economic indices had changed over the last five years.

Credit: Tranen Revegetation Systems

Human Ethics approval was provided by the University of Western Australia's Human Research Ethics Office (2021/ET000985) to conduct the survey. A qualitative analysis was performed on the survey results to assess the size and flow of money through the WARE supply chain. The ethics approval granted did not extend to engagement with Aboriginal and Torres Strait Islander people and, as such, prevented the engagement for the survey and data attrition with these groups.

Responses and data analysis

The survey was open for 5.5 weeks from early February until mid-March 2022. Sixty-eight responses were received in total from all sectors from 544 that were sent out (a response rate of about 12.5%) (**Table 2**). Questions on expenditure were commonly unanswered indicating that respondents may not have had access to this data or were reluctant to share this information despite assurances of confidentiality and aggregation of data.

Although we surveyed about 12.5% of the groups identified to have a key role in the WARE sector, we may not have identified and reached all individual businesses/organisations that contribute to the sector. This includes some major sectors such as Indigenous ranger groups, and land forming contractors. Consequently, values presented are likely to be conservative and should be interpreted in the context of the survey groups targeted and percentage of those that responded.

Data was analysed using the statistical software packages R (The R Foundation for Statistical Computing, Vienna, Austria) and Stata (StataCorp LLC, Texas, USA). Averages, standard deviations, and visualisations of the spread of data were used to observe trends and differences in key economic indicators within and among the groups. Visualisations were created using R and SankeyMATIC (https://sankeymatic.com/build/). For the Likert scale questions on trends in economic indicators over the past five years, a score was assigned to the different degrees of change ranging from 1 for "substantially decreased" to 5 for "substantially increased". Averages of these scores were then plotted with a colour gradient for each supply chain group to generate a heatmap to understand the direction of growth for the different sectors for each economic indicator. Summary statistics (**Table 3**) were calculated for all responses to the extent that information was provided. Diagrams on the financial flow through the restoration economy (**Figure 7**) and trends in economic indicators over the past five years (**Figure 8**) excluded companies/organisations who did not provide information on spending and changes in economic indicators. In the Sankey diagrams (**Figure 7**), the breakdown for employment is the number of employees and not the salaries.

Average expenditure per company/organisation was calculated within each subcategory. Expenditure values were multiplied according to the proportion of survey respondents. Summation across all sub-categories gave the extrapolated total annual expenditure on restorative activities for the WARE. The size of the WARE, based on the number of people employed, was extrapolated in a similar manner. This calculation assumed that all non-respondents were from the same population with the same characteristics as respondents.

To ensure values presented did not include any potential double counting when reporting on areas restored and expenditure on restoration projects only data from the 'buyers' is considered. A separate analysis of the providers is given.

4.4 Survey results

Types and areas of restoration

Out of the 47 businesses/organisations surveyed that participate in the restoration economy, 28 (60%) were involved in urban terrestrial restoration, 19 (40%) undertook general regional restoration, 18 (38%) conducted agricultural land restoration, 11 (23%) undertook plantings for carbon credits[3], 10 (21%) were involved in mine site restoration, and 5 (11%) conducted other types of restoration that included riparian and wetland restoration and, restoration of regional parks and Crown reserves. Businesses/organisations were often involved in more than one type of restoration, indicated by the numbers against each type.

Survey respondents reported that restoration-aligned activities occurred across 35,817 hectares of land in the past year and 182,231 hectares in the last five years. These results included responses from carbon companies (n=3), Landcare and community groups (n=24), mining companies (n=6), NGOs and not-for-profit organisations (n=5), NRM regions (n=3), shires and councils (n=5) and, government agencies (n=6) (**Table 3**). Government agencies reported undertaking the largest extent of restoration-aligned activities compared to other sectors (a total of 15,414 hectares in the last year and 115,904 hectares in the last five years) followed by NRM regions (12,430 hectares in the last year and 27,010 hectares in the last five years). On average, shires and councils, and Landcare and community groups undertook far less restoration-aligned activities annually (25 hectares and 34 hectares, respectively) (**Figure 4**). Within groups, there was considerable variation in the areas reported to have undergone restorative works and maintenance leading to large standard deviations (**Figure 4**), indicating that engagement in restoration activities are highly specific to individual businesses/organisations (**Table 3**).

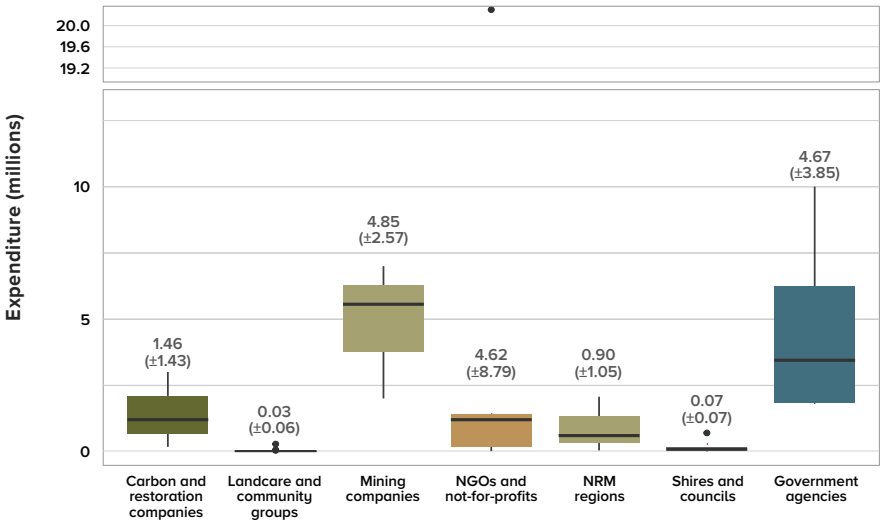
Employment

The survey respondents reported a total of 774 people employed in restoration related activities across the 65 companies and organisations that we surveyed (not all respondents provided data on employment). Government agencies had the highest number of employees in total (194) followed by NGOs and not-for -profits (164) and mining companies (102). Shires and councils employed the lowest number of people to undertake restorative activities (11 in total) (**Table 3**). On average, government agencies and NGOs had the highest number of paid employees across all subsectors (33 each), while expectedly Landcare and community groups and shires and councils had the lowest number (one and two on average, respectively).

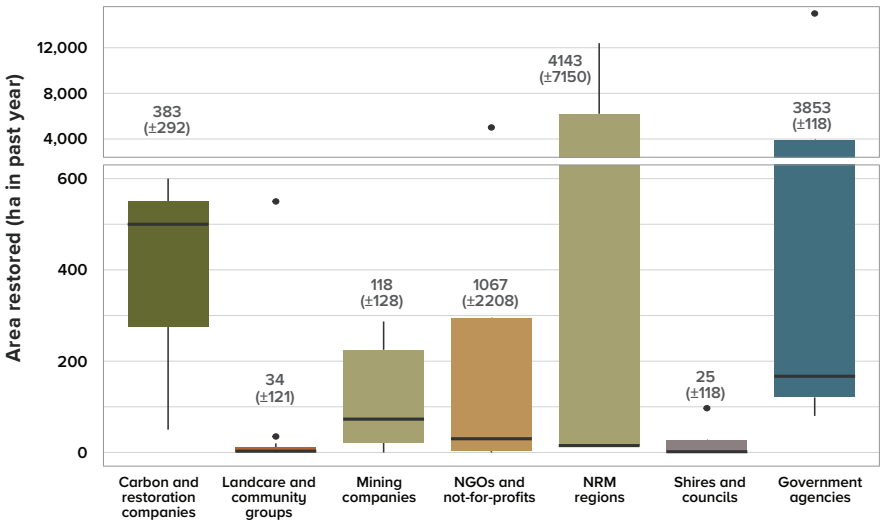
In total, 6,686 volunteers were identified to work with the groups that participated in the survey. NGOs and not-for-profit organisations engage strongly with volunteers and, therefore, had the highest total number of volunteers (5,038), followed by Landcare and community groups (1,214) and NRM Regions (250) (**Table 3**). NGOs and not-for-profit organisations also had the highest number of volunteers on average (1,008), followed by NRM regions (125) and Landcare and community groups (55) (**Figure 5**). The mining sector and carbon and ecological restoration companies did not involve volunteers in ecological restoration.

[3] Agricultural land restoration is undertaken with the primary purpose of remediation from clearing or over-intensive production that has resulted in land degradation. While carbon credits are issued from registered activities that also occur in these systems, the objective here is to generate revenue from plantings. The primary reason for undertaking restoration differentiates these categories, noting that both remedial action and revenue can be achieved from restoration, so it is likely that there is some overlap or dual purpose.

Expenditure on restoration including all employment



Area restored



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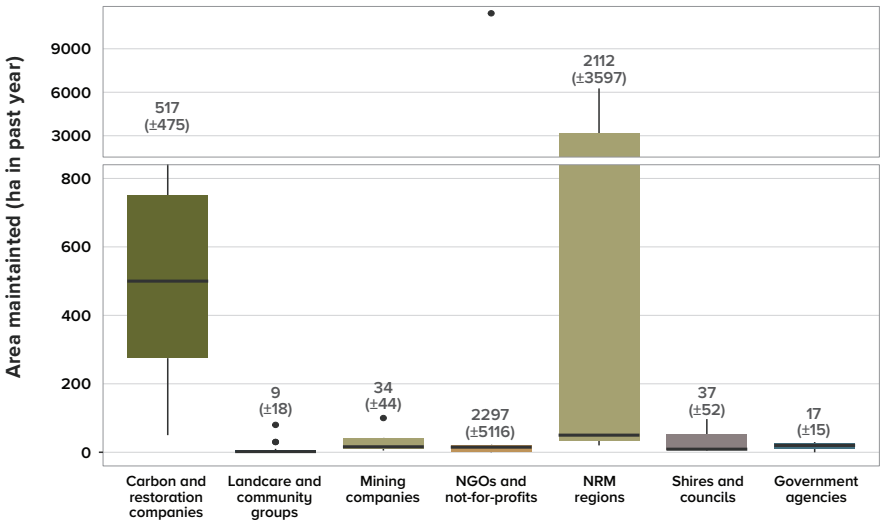

FIGURE 4. Boxplot of the expenditure on restoration aligned activities (including employment), and the amount of area restored and maintained across the different buyer categories in Western Australia in the last financial year with error bars representing the range (minimum and maximum values). Lines within the box plots indicate the median with the mean ± standard deviation presented numerically.

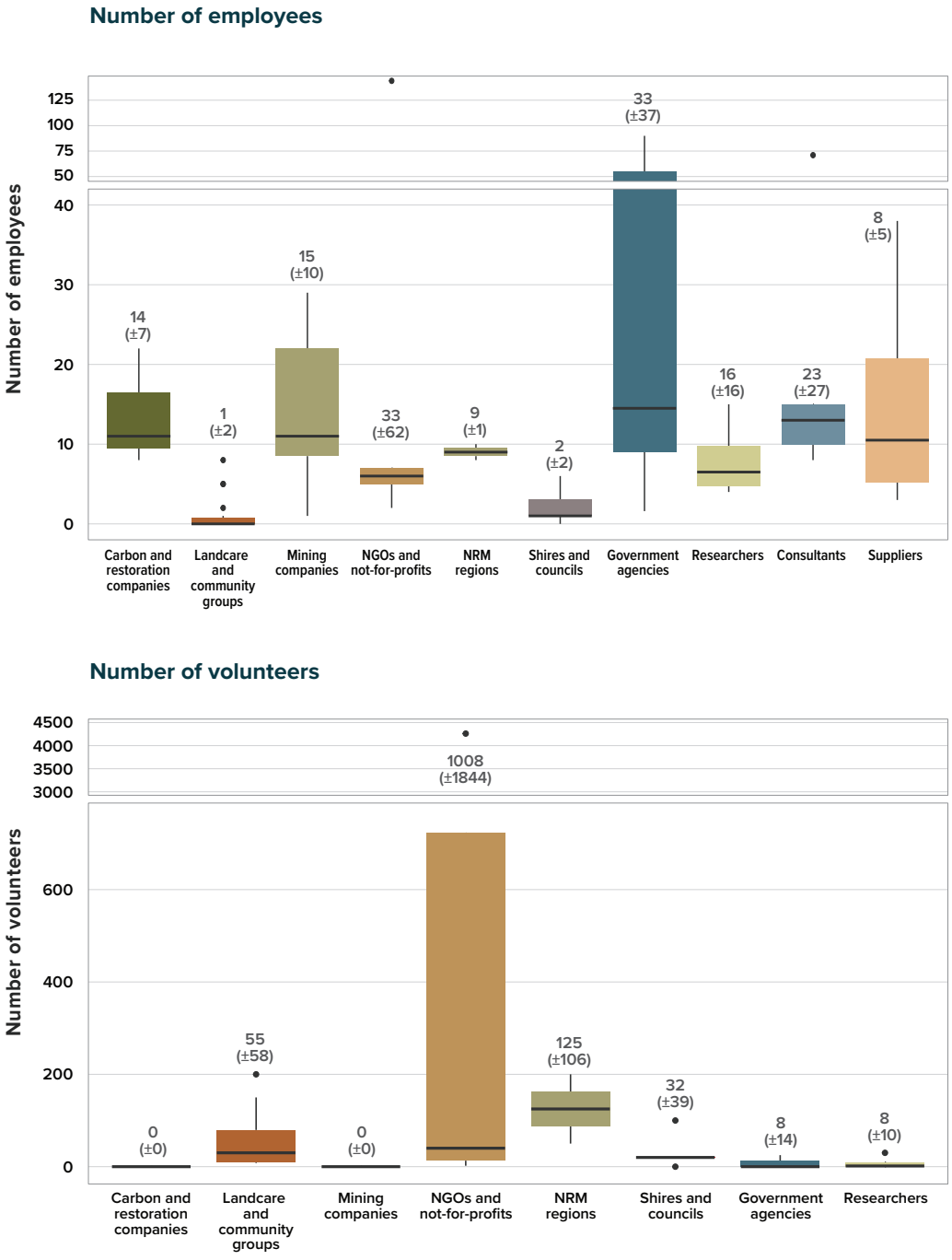

FIGURE 5. Boxplot of the number of employees and volunteers across the various WARE categories. Lines within the box plots indicate the median with the mean ± standard deviation presented numerically.

Expenditure on restoration related activities and value of the WARE

Large portions of the financial flows of the WARE are currently held within government agencies and the mining sector with comparatively smaller amounts flowing to on ground operators and practitioners despite a clear demand for these sectors. Survey respondents reported to have spent a total of $64.2 million on restoration in the 2020/2021 financial year. Of that, $46.1 million was spent on restoration related activities (including employment) by respondents within the business/organisation category while government agencies spent about $18.7 million on the same (**Table 3**). The expenditure on carrying out restoration over the last five years (including employment) was roughly $239 million for businesses/organisations and about $78 million for government agencies (**Table 3**).

On average, mining companies had the highest expenditure on restoration related activities including employment in the last financial year ($4.85 million) followed by government agencies ($4.67 million) and NGOs and not-for-profits ($4.62 million), while Landcare and community groups had the lowest (about $26,000 on average) noting large variances in the results (**Figure 4**). On a per hectare basis and considering expenditure on restorative activities alone, restorative activities undertaken by mining companies were the most expensive ($41,078 per hectare, **Figure 6**) which likely corresponds to 1) the industry being regulated and often subjected to environmental conditions requiring a higher standard of ecological restoration and 2) operating and undertaking restorative activities in highly modified landscapes. Excluding mining companies, the average cost per hectare on restorative activities was $6,085, which is comparable to values reported by Mappin et al. (2022) for forest and woodland restoration.

With cautious extrapolation and acknowledging some assumptions have been made, we estimate that the size of the WARE to be at least $720 million per annum, supporting about 5,100 jobs. It is important to note, the survey was constrained by the identification of all groups associated with the restoration economy and the provision of data. These figures also include some activities that would be classified as supporting ecosystem recovery, but the outcome may not be an ecosystem that would be classified as ecological restoration.

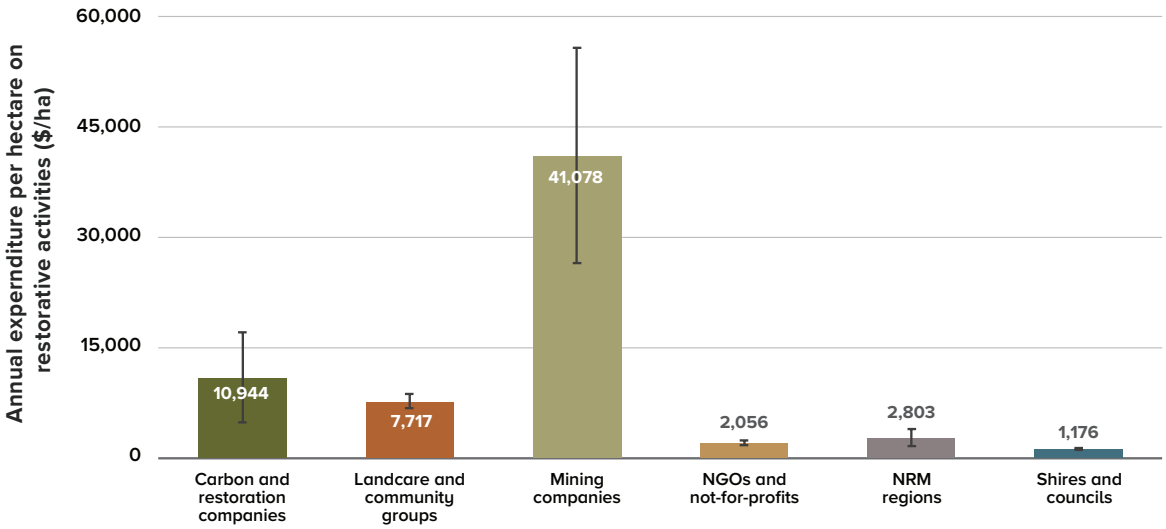

FIGURE 6. Annual expenditure per hectare on restorative activities in the 2020–2021 financial year showing average values and their standard errors for each of the six subsectors of the business/organisation category.

[4] Data on the level of ecological recovery obtained from restorative activities was not collected during the survey and interpretation of results is based on understanding of market pricing and conditions.

TABLE 3. Summary statistics of area maintained, area restored, total expenditure on restorative activities, expenditure on restorative activities per hectare, number of employees, and number of volunteers for different buyer categories in the WARE from the survey

Phase	Buyer category	Number[a]	Mean	SD	Range		Total
					Minimum	Maximum	
Area restored in the last year (hectares)	Carbon and restoration companies	3	383	293	50	600	1,150
	Government agencies	4	3,854	7,431	80	15,000	15,414
	Landcare groups and community groups	20	34	122	0.0043	550	671
	Mining companies	6	119	128	0	287	713
	NGOs and not-for-profits	5	1,068	2,208	0	5,012	5,339
	NRM regions	3	4,143	7,150	15	12,400	12,430
	Shires and councils	4	25	48	0	97	100
Area maintained in the last year (hectares)	Carbon and restoration companies	3	517	475	50	1000	1,550
	Government agencies	3	17	15	0	30	50
	Landcare groups and community groups	21	9	18	0	80	189
	Mining companies	4	34	44	5	100	137
	NGOs and not-for-profits	5	2,297	5,116	0	11,448	11,485
	NRM regions	3	2,112	3,597	20	6,265	6,335
	Shires and councils	3	37	52	5	97	111
Total expenditure on restorative activities including employment in the last financial year (millions of AU$)	Carbon and restoration companies	3	1.46	1.43	0.18	3	4.38
	Government agencies	4	4.67	3.85	1.80	10	18.69
	Landcare groups and community groups	19	0.03	0.06	0.00	0.28	0.49
	Mining companies	3	4.85	2.57	2.00	7	14.56
	NGOs and not-for-profits	5	4.62	8.79	0.02	20.30	23.11
	NRM regions	3	0.90	1.05	0.04	2.07	2.71
	Shires and councils	4	0.07	0.07	0.004	0.15	0.28
	Suppliers	4	0.45	0.70	0.06	1.50	1.81

[a] Number of responses per category. Each response is from a specific company/organisation. The total number of 'buyers'= 53;
[b] Includes expenditure on employment.

(Table 3 continued following page...)

TABLE 3. Summary statistics of area maintained, area restored, total expenditure on restorative activities, expenditure on restorative activities per hectare, number of employees, and number of volunteers for different buyer categories in the WARE from the survey (cont.)

Phase	Buyer category	Number[a]	Mean	SD	Range		Total
					Minimum	Maximum	
Expenditure[b] on restorative activities per hectare in the last financial year (AU$/ha)	Carbon and restoration companies	3	20,783	33,973	350	60,000	–
	Government agencies	3	16,248	13,984	120	25,000	–
	Landcare groups and community groups	16	11,151	16,025	0	50,000	–
	Mining companies	3	49,195	43,463	22,222	99,286	–
	NGOs and not-for-profits	4	4,962	790	4,050	5,972	–
	NRM regions	3	14,278	22,311	167	40,000	–
	Shires and councils	2	1,176	222	1,020	1,333	–
Number of employees involved in restoration in the last financial year	Carbon and restoration companies	3	14	7	8	22	41
	Consultants	5	23	27	8	71	117
	Government agencies	6	33	37	1.6	90	196
	Landcare and community groups	23	1	2	0	8	22
	Mining companies	7	15	10	1	29	102
	NGOs and not-for-profits	5	33	62	2	144	164
	NRM regions	3	9	1	8	10	27
	Researchers	4	8	5	4	15	32
	Shires and councils	5	2	2	0	6	11
	Suppliers	4	16	16	3	38	62
Number of volunteers involved in restoration in the last financial year	Carbon and restoration	3	0	0	0	0	0
	Government agencies	4	6	12	0	25	25
	Landcare groups and community groups	22	55	58	8	200	1,214
	Mining companies	7	0	0	0	0	0
	NGOs and not-for-profits	5	1,008	1,844	2	4,261	5,038
	NRM regions	2	125	106	50	200	250
	Researchers	2	17	19	3	30	33
	Shires and councils	4	40	40	20	100	159

[a] Number of responses per category. Each response is from a specific company/organisation. The total number of 'buyers'= 53;
[b] Includes expenditure on employment.

Sources of funding for restoration

The economic input into WARE is diverse. Funding to undertake activities associated with restoration is sourced internally (mining companies, government agencies) and externally (government, philanthropy, investors, or other private organisations) (**Table 4**). Mining companies and government agencies predominantly self-fund restorative activities, whereas Landcare and community groups, NRM regions and shires and councils secure funding from a number of external resources (**Table 4**).

TABLE 4. Sources of restoration related funding (indicated by coloured blocks) for the various buyer categories in the WA Restoration Economy

	Government (state and local)	Mining industry	Philanthropy	Other industry	Other
Carbon and restoration companies	■	■		■	Private companies and landholders
Landcare and community groups	■		■	■	
Mining companies		■			
NGOs	■	■	■	■	Environmental credit markets and blended finance
NRM regions	■		■		Organisational investment
Shires and councils	■		■		Private landholders
Government agencies	■				

Monetary flow through the WARE in the last financial year

Across 34 businesses and organisations that provided details on expenditure for employees, consultants, and suppliers, a total of $9.3 million was spent on the employment of 153 people, $10.6 million was spent on consultants, and $3.6 million on supplies in the last financial year (**Table 5**). Government agencies that provided complete information on expenditure for employment, consultants, and supplies, spent a total of about $1.5 million on the employment of 13 people, $272,000 on consultants and $2.2 million on supplies in the last financial year (**Table 5**).

TABLE 5. Total expenditure on employment, consultants, and supplies in the last financial year for the various buyer categories in the WA Restoration Economy

Type	Number	Total employees	Total expenditure employment ('000s)	Total expenditure consultants ('000s)	Total expenditure supplies ('000s)	Total Expenditure ('000s)	% on employment	% on consultants	% on supplies
Carbon and restoration companies	3	41	$2,275	$304	$1,275	$3,853	59%	8%	33%
Landcare and community groups	19	20	$225	$137	$70	$433	52%	32%	16%
Mining companies	2	50	$3,600	$9,505	$920	$14,025	26%	68%	7%
NGOs	4	20	$1,388	$409	$222	$2,019	69%	20%	11%
NRM regions**	2	17	$1,641	$180	$725	$2,547	64%	7%	28%
Shires and councils	4	5	$168	$36	$387	$591	28%	6%	65%
Government Agencies	2	13	$1,540	$272	$2,192	$4,004	38%	7%	55%

** Includes data on total expenditure for two NRM regions. However, Figure 7 below shows the cash flow only for one NRM region as the other did not provide sufficient resolution to create a breakdown of spending on consultants and suppliers.

The monetary flow through the restoration economy varied depending on the type of organisation (**Table 5** and **Figure 7**). Mining companies spent a greater proportion of their total expenditure in the last financial year on consultants (68%) while NGOs, NRM regions, carbon and restoration companies, and Landcare and community groups spent a greater proportion of their total expenditure on employment. The breakdown of the types of roles within the business/organisation sector was also explored. Practitioners constituted the greatest proportion of employees (45%), followed by managers (20%), supporting services (15%), other staff (13%), and finally administrative staff (7%) (**Figure 7**).

Most businesses/organisations (except shires and councils) employed a wide range of consultants covering various aspects of restoration including environmental, agricultural, civil and earthworks, mapping and GIS, and pest and weed (**Figure 7**). In addition, NGOs hired social, legal and monitoring consultants, mining companies employed hydrological and geotechnical consultants, and carbon and restoration companies paid for landscape design and laboratory analysis. Mining companies spent a greater proportion of their expenditure on consultants for civil engineering and earthworks (85% or ~$8 million in total) followed by environmental consultants (9% or $900,000 in total) (**Figure 7**), while Landcare and community groups spent the most on pest and weed management (68% or $93,000 in total). Carbon and restoration companies spent nearly equally on pest and weed control (47% or $142,000 in total) and civil and earthworks (45% or $137,000 in total). In general, shires and councils did not hire consultants to assist with restoration aligned activities except one who paid for support with compliance.

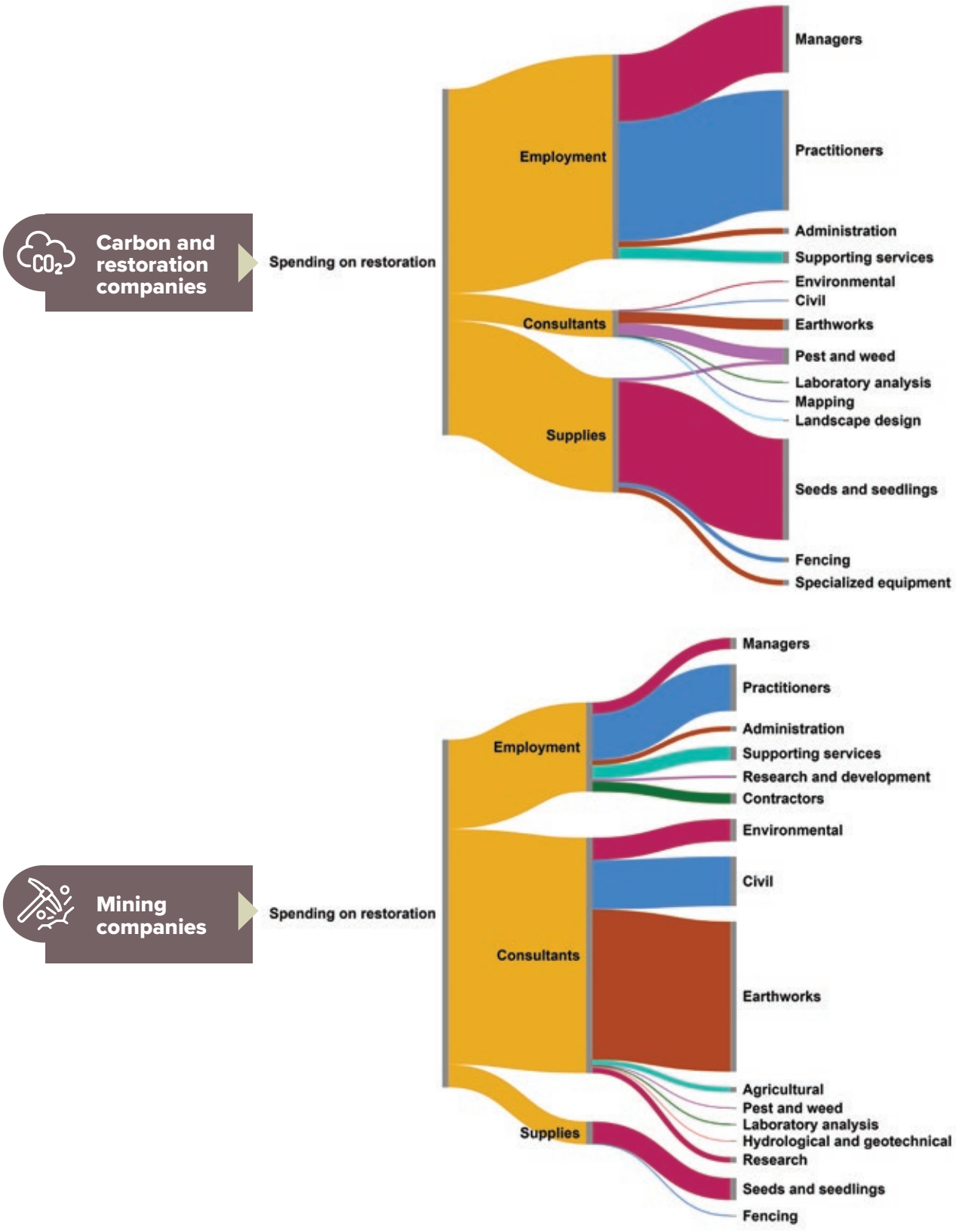

FIGURE 7. Spending on restoration in the last financial year for each of the six subsectors of the business/organisation category created using SankeyMATIC.

(Figure 7 continued following page...)

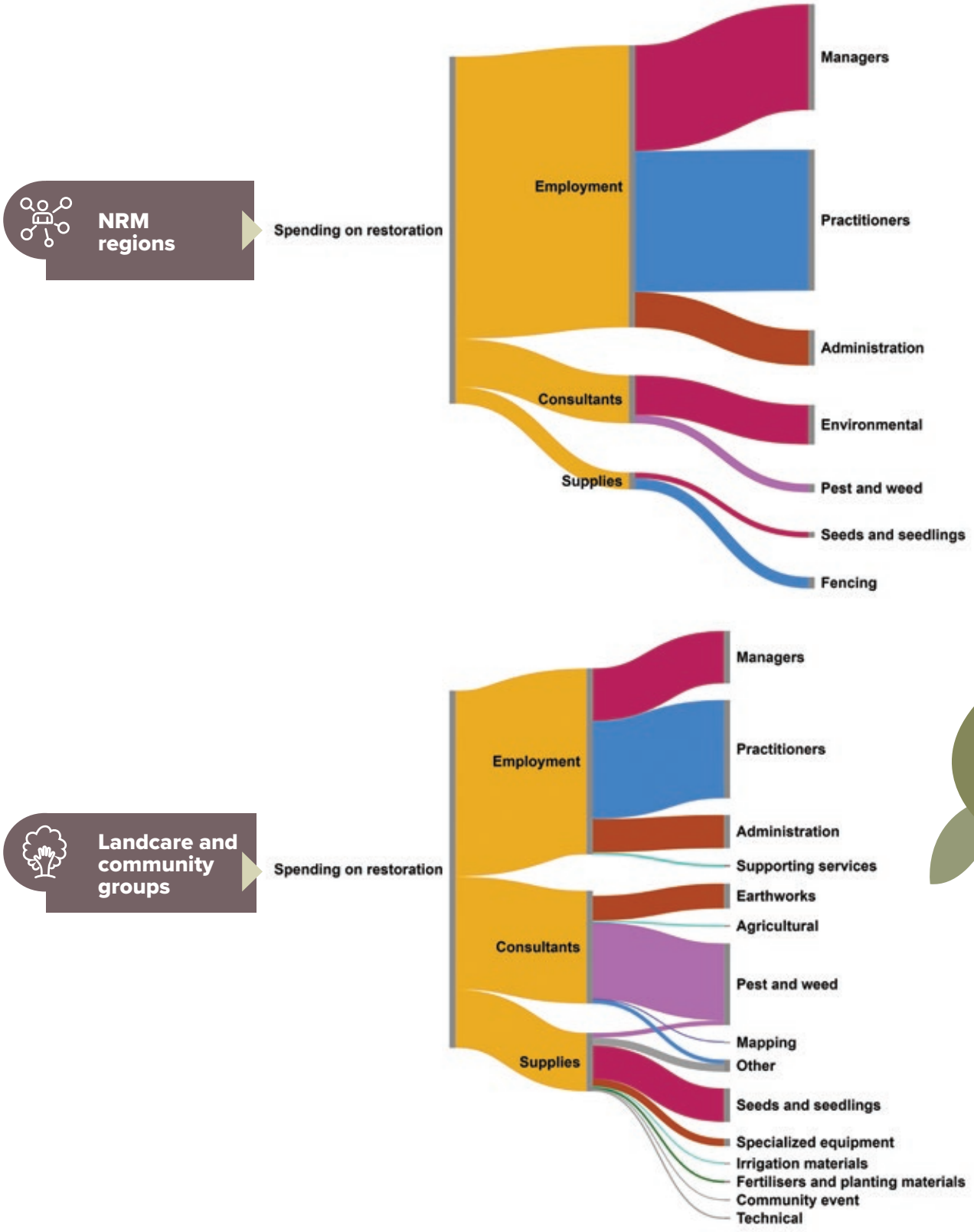

FIGURE 7 (cont.). Spending on restoration in the last financial year for each of the six subsectors of the business/organisation category created using SankeyMATIC.

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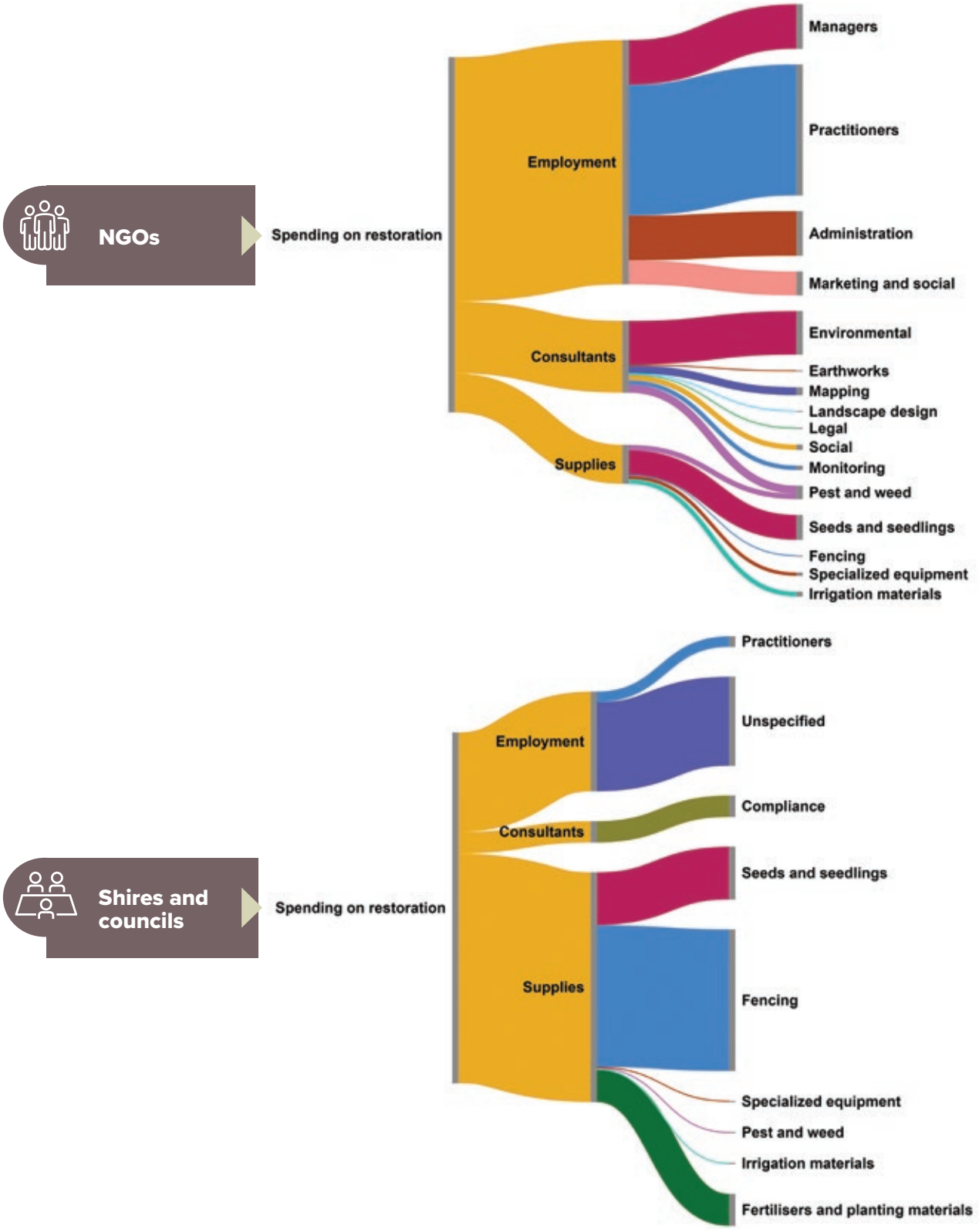

FIGURE 7 (cont.). Spending on restoration in the last financial year for each of the six subsectors of the business/organisation category created using SankeyMATIC.

Credit: Bayden Smith, Greening Australia

Logically, all businesses/organisations incurred expenditure for seeds and seedlings (**Figure 7**) with carbon and restoration companies spending the greatest amount in the last financial year (about $1.1 million) and NRM regions spending the least ($10,000). However, in terms of the proportion of expenditure on supplies, mining companies spent the most on seeds and seedlings (97%), followed by carbon and restoration companies (88%) while shires and councils spent the least (23%). Other common categories of expenditure for supplies included fencing materials, specialised equipment, fertilisers and soil, and irrigation equipment. Expenditure for these categories was highly variable, ranging from $300 for irrigation equipment by Landcare and community groups to a significant ~$239,000 on fencing materials by shires and councils, reflecting the diversity of different restoration aligned interventions pursued by the companies/organisations surveyed in the last financial year. Resolution of data provided was not sufficient to provide expenditure breakdowns for government agencies, consultants, and suppliers within this section.

Providers

Environmental consultancies

Five environmental consultancies participated in the survey. On average, companies have been supplying restoration related consultancy services for 24 years. The oldest company has been in the business for 42 years and the youngest for 10 years. Consultants are mainly contracted by mining companies and local government to provide services for agricultural land restoration, restoration of mine sites and urban terrestrial restoration. Some are contracted by NGOs and private land holders conducting native revegetation/restoration. One company engages in wetland and riparian restoration. Across the five consultancies, 117 people are involved in restorative activities including 11 managers, 35 practitioners, and 66 scientists and engineers, spending an aggregate of just under $2.7 million on employment in the last financial year.

Suppliers

Four supplier companies including nurseries and seed suppliers participated in the survey. On average, the companies have been supplying restoration related activities for 22 years. The oldest company has been in the business for 31 years and the youngest for 10 years. Survey participants indicated that they mainly supply native trees and shrubs to local government and mining companies. One company has a wider customer base and also supplies to NGOs and private land holders conducting native revegetation/restoration. In total, the companies had 62 employees and spent just over $1.8 million[5] in the last financial year on employment.

Revenue generated by environmental consultancies and suppliers

The environmental consultancies generated an aggregate revenue of about $3.7 million in the last financial year and $12.7 million over the last five years while the suppliers[6] surveyed generated an aggregate of just under $1.2 million from restoration-based work in the last financial year and $1.8 million over the last five years.

[5] This figure does not include the employment expenditure from one of the suppliers as they did not provide it.

[6] Note: One supplier did not provide information on revenue generated in the last financial year while two did not provide this information for the last five years.

The research sector

Four research groups that predominantly undertake research for ecological restoration participated in the survey, all of which were located within universities. Ecological restoration research is largely focussed on mine site restoration with all groups having active projects in this space. Three groups are involved in agricultural land restoration as well as in urban terrestrial restoration and half have projects associated with the carbon industry (plantings for carbon credits).

Across the four research groups there were a total of 17 research staff and 15 postgraduate (PhD and masters) students involved in restoration related research. On average, teams were comprised of 8 (±5) staff and students (Figure 5). In the last year, a total of about $810,000 was spent on staff and student salaries and $123,000 was spent on research operations across all research groups. Two of the four groups utilise volunteers to help with research, with a total of 33 people volunteering around 490 hours in total the last financial year.

Information on restoration related research grants in the last five years revealed that the research groups had been awarded a total of 15 restoration related grants having a combined value of $7.35 million, and an average value of around $490,000. The split of grant funding towards operations and towards salaries varied considerably between projects and depended on the individual project. However, on average, about 52% of grant funding was directed towards operations across the 15 projects in the last five years and the rest towards salaries.

4.5 Growth of the emerging WARE

Most sectors within the WARE are growing. The exception to this was NRM regions which reported an economic retraction in the last five years and a corresponding decline across all indicators (**Figure 8**). Carbon and restoration companies, mining companies, NGOs and not-for-profit organisations, and government agencies showed the strongest growth with improvements reported across all indices except volunteer numbers, where government agencies noted a substantial reduction in the last five years (**Figure 8**). Landcare and community groups, shires and councils, consultants, suppliers, and researchers also reported slight improvements or no change for most indicators (**Figure 8**).

Generally, expenditure on restoration, contractors, and supplies showed slight or substantial growth across all sectors (except NRM regions) indicating greater financial input into restoration related activities from various funding sources. Likewise, the number of employees showed an upward trend across all sectors except for Landcare and community groups and shires and councils where there was no change, and NRM regions where there was a decrease. Similarly, the area restored annually also increased across all sectors except for NGOs and not-for-profit organisations and shires and councils where there was no change, and NRM regions where there was a decline. The trend in volunteer numbers reported to be supporting the restoration economy was variable, with some groups not utilising volunteers in restorative activities (carbon and restoration companies and mining companies), some indicating no change in volunteer numbers (researchers), some reporting an increase (shires and councils) and others a slight or considerable decrease (NRM regions and government agencies, respectively) (**Figure 8**). This decline in volunteer numbers is consistent with research that indicates a general decline in volunteers post COVID-19.

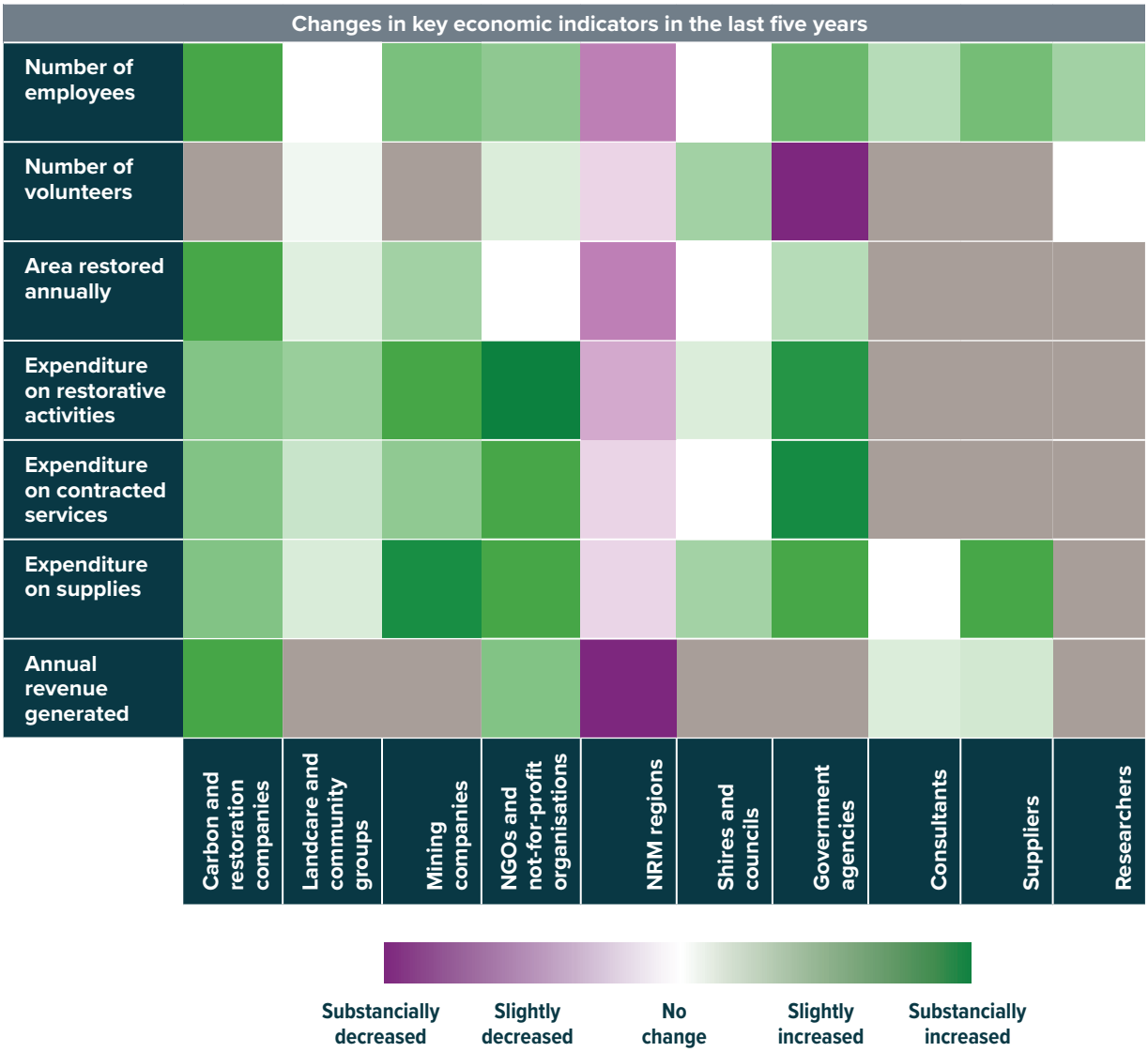

FIGURE 8. Heatmap of average changes in key economic indicators over the last five years for the different supply chain categories. Grey boxes denote that the indicator is not applicable.

4.6 Challenges faced by the restoration industry

Challenges faced by the restoration industry are wide ranging from policy, to supply constraints, and external factors including COVID-19. Some challenges were observed between conflicting policies and national strategies, while others are on-ground localised barriers.

Competing land-use

The Emissions Reduction Fund (ERF) supports activities to reduce emissions across the economy, including through the management of land to regenerate native forests. Concern has been raised that such native forest regeneration projects, which are commonly undertaken on grazing land in rangeland regions, can unintendedly have adverse effects on agricultural production or regional communities, particularly when they are in higher densities and are conducted over a substantial percentage of a property. Recognising these concerns, the Carbon Credits (Carbon Farming Initiative) Amendment (Regeneration Projects) Rule 2022, came into effect from 8 April 2022 (DCCEEW, 2022d). Under this rule, the Federal Minister for Agriculture can prevent environmental plantings and native forest regeneration projects under the ERF methods of human-induced regeneration (HIR) and native forest from managed regrowth (NFMR) from going ahead if they will have an adverse impact on agricultural production or regional communities. Specifically, it would allow the Minister for Agriculture to exclude new HIR or NFMR projects or expansions to existing ones that are bigger than 15 hectares and make up more than a third of a farm. Similar policies have also been drafted at the local government level, creating multiple tiers of approval needed to undertake ecological restoration projects. Such a change, while safeguarding community and agricultural interests can impede the advancement of the restoration economy. Furthermore, competition for land with agriculture, renewables projects, and with other land uses, as well as competition between 'buyers' wishing to meet regulatory requirements/ voluntarily-created targets (e.g., carbon offsets, biodiversity offsets), has been pushing up land prices.

Policy and regulation

The delivery of restoration aligned works requires working within the bounds of specific regulation and policy (e.g., *Western Australia's Biodiversity Conservation Act, 2016*), and successful outcomes require input from personnel that have experience in working within the realms of these policies combined with on-ground experience. Access to staff that have sufficient levels of knowledge and experience within government agencies was flagged as an area of concern by survey respondents. Further, policies themselves were reported to be restrictive, limiting the application of innovative techniques that could lead to improved restoration outcomes. Practices that could enhance or improve soil condition, were highlighted as a specific aspect of land restoration where policy and regulation was limiting, and in need of revision to support the growing need to restore landscapes and the carbon market.

An ability to service demand was a key barrier reported from suppliers. Current policy to protect the environment and the resilience of populations, prevents or limits collection of wild seed and other propagation materials. Within these bounds, suppliers face access constraints to certain areas or species, or collections are capped with requests from 'buyers' exceeding an ability to service requests. Similar constraints were reported in the Australian Network for Plant Conservation 2016/17 National Seed Survey (Hancock et al., 2020), where access to wild populations for seed collections and the securing of seed collection permits were reported as difficulties in seed collection. Survey respondents also considered current provenance range stipulations to be too restrictive.

Climate change

In some areas, climate change will have a significant effect on the establishment and resilience of restoration initiative and projects. A drying climate, rising temperatures, and changing rainfall patterns could prevent the benefits of restoration investments from being realised unless these climatic factors have been considered when designing the restoration projects (for example, shifting the natural distributions of species into drying regions to increase drought-resistance etc.). Promoting landscape heterogeneity and biological diversity safeguards species evolutionary potential and capacity to adapt to a changing environment (Brancalion and Chazdon, 2017). Target species for a restoration site should reflect suitable climate conditions both now and into the future (Butterfield et al., 2017), with a diversity of species and genotypes used to increase the likelihood that species can respond to climate change. Published frameworks, for example, Simonson et al. (2021), can provide guidance on how to build resilience into ecological restoration projects.

Soil health

The State of the Environment Report 2021 assessed the overall condition of land and soil in Australia to be poor with a declining trend attributable to a high loss of soil organic carbon (DCCEEW, 2022a). Soil degradation through erosion, acidification, salt accumulation (dryland salinity), contamination and carbon loss (Wong and Mosley, 2021) affects over two-thirds of Australian agricultural soils (Lumb, 2013), and can be a major challenge to ecological restoration projects, requiring planning, land formation and species selection. In Western Australia, dryland salinity is the major form of land degradation (DPIRD, n.d.) with ecological restoration able to facilitate sound management of soil organic matter (Wulanningtyas et al., 2021) and broader soil health (Williams et al., 2020).

Supply of quality propagation material (seeds and seedlings)

Seed collections from wild populations will be significantly challenged to supply the projected demand for ecological restoration. The majority of annual seed collections or seed purchases are in small quantities (i.e., usually <5kg) and are not sufficiently stocked to support large-scale restoration efforts. Key issues relating to the supply of native seed in Australia include (Hancock et al., 2020) the:

- lack of suitable seed collectors;
- unreliability of seed supply;
- lack of available seed from a broad range of species for restoration; and
- unwillingness for the market to pay for the true cost of seed collection/seed production.

These findings were echoed in the current survey with the supply of quality seeds, seedlings and cuttings impacting the delivery of restorative projects in Western Australia. Evidenced by the high number of responses on this issue, supply constraints are being felt across the sector impacting quality and scale. We identified just 21 companies that indicate they supply propagation material for restoration, with many of these small operations supplying material for gardens and horticulture as well. Competition for available seeds and seedlings was evident with increasing pressure being correlated to the emergence and growth of the carbon market in recent years.

To overcoming the significant seed supply shortages that are limiting practitioners' ability to service market demands, Western Australia requires a massive scaling up via a multi-faceted approach. The National Seed Strategy (Van Moort et al., 2021), details an implementation plan that could be actioned through a tailored version for Western Australia. Importantly there needs to be combination of wild seed collections, including a considered approach to increasing access to managed lands and Seed Production Areas (SPAs) to supply the market.

Funding

Access to appropriate levels of funding, which limit groups from undertaking restoration or associated research, were consistently reported in the survey. In particular, longer-term funding, insufficient funding sources, and grants success rates are major impediments for research scientists. The necessity of longer-term funding was noted to be crucial for the success of ecological restoration research and projects with implications of its absence two-fold: (1) the inability to retain research staff, and (2) the limited opportunity to set up long-term restoration studies that in turn limits restoration research. Funding is often short-term (1–3 years), which can conflict with achieving successful restoration outcomes, particularly when funding for the maintenance phase of restoration projects is not factored into the funding duration (Commander et al., 2022).

Skills and labour shortages

Several sectors noted a shortage of skilled staff and labour including volunteers as a challenge in carrying out restoration projects. These included senior scientific staff for environmental consultancies, skilled staff needed to run production nurseries, trained specialist contractors (e.g., earthworks contractors) and paid and volunteer labour for planting by NGOs, not-for-profits, researchers, and community groups. Given the diversity of different restoration aligned activities occurring across the sector, an equally diverse mix of employment strategies and workforce needs is faced by each institution/provider. This includes relying on a mix of both permanent and seasonal labour, and includes engagement of sub-contractors, consultants, employees, and affiliate partners to meet project goals and objectives. High staff turnover was also a concern for many organisations. Investing in capacity building at the national, state, and regional levels to overcome the shortage of skilled labour is required. Increasing knowledge through technical guidelines, fact sheets, face to face workshops, and upskilling are all required, and importantly, ensuring that this training is by people with appropriate experience and/or qualifications (Commander et al 2022). Commander et al. (2022) also advocate extending capacity building to Indigenous communities through Indigenous ranger programs and Indigenous seed collection enterprises and the continuation of generations of caring for Country.

COVID-19

The COVID-19 pandemic was noted as a challenge across several sectors including Landcare and community groups, environmental consultancies, mining companies and NGOs, and not-for-profits. The pandemic was observed to result in lower volunteer numbers, and restrictions on the type and number of activities that could be undertaken as well as delays in procuring equipment and materials for restoration.

4.7 Study Limitations

The study estimates the size of the WARE to be at least $720 million per annum, supporting about 5,100 jobs. The assessment is indicative of the size and market value of the WARE but a more detailed and comprehensive analysis, building on the foundations presented here, would be of value since:

1. Not all contacted responded to our survey — we received 68 responses for the 544 respondents contacted (a response rate of 12.5%). Moreover, some respondents did not answer questions on employment and restoration-related expenditure, presenting challenges for the evaluation of the actual size and market value of the WARE.
2. Compiling an exhaustive list of all suppliers and consultants involved in the WARE supply chain sectors proved difficult – with time- and resource-constraints limiting searches in complementary fields (such as legal, social, landscape design etc.), and suppliers (such as pest control, fencing, irrigation) who would also contribute to the restoration economy being excluded. As such, our focus in this study was on environmental consultants for the consultant sector and seed suppliers and nurseries for the suppliers' sector.
3. In kind contributions, such as remedial actions undertaken on farm to address threats and/or generally improve environmental condition, were unable to be captured within the scope of the current survey. The investment in these land management practices would be expected to considerable within the State.

While the survey focussed on supporting services such as ecological restoration research being conducted in universities and federal and state government conservation agencies, it did not capture the facet of the restoration economy related to education. This includes enrolment in undergraduate and graduate courses at universities, vocational courses at TAFEs, ecological restoration practitioner courses, and accredited professional development courses. The economic value of educational programs and courses is expected to be substantial.

Educational and community awareness campaigns for ecological restoration that are undertaken by either community-based centres or groups were also not captured in our survey. These campaigns are usually run on a voluntary basis and are beneficial in increasing awareness for nature-based solutions for climate change and can help enlist volunteers for local restoration activities. Also, while information on approximate collective volunteer hours for relevant sectors, these hours were not converted to monetary values.

A little under a fifth of all respondents (19%) said they were involved in mine site restoration. However, as three of the largest mining companies in Western Australia actively involved in rehabilitation at their mine sites were unable to respond to our survey, the proportion of mine site restoration being undertaken in Western Australia is very likely under-represented.

Credit (far right): Megan Hele

Credit: Threshold Environmental

5. Synthesis

The WARE supports a wide range of professionals working in government, industry, and research, across all kinds of land-uses and geographies. It supports employment of about 5,100 people with an estimated value of about $720 million per annum. These values represent a lower bound value of the sector's economic contribution due to limitations in identifying and having access to appropriate data from all actors within WARE.

On average, expenditure on restorative activities (excluding mining) equated to approximately $6,085/ha, which is comparable to published estimates to actively restore cleared land to forest and woodland ecosystems (see Mappin et al. 2022). Reported expenditure on restorative activities per hectare were highly variable within groups. Thus, some of the on-ground restorative activities captured in this report are likely to be achieving outcomes that support ecological recovery but may not necessarily be achieving ecological restoration (see Box 1). Evaluation of the level of recovery being achieved (e.g., utilising the SER Recovery System) and spatial mapping of restoration sites to assess landscape connectivity is required to assess the likelihood of these projects delivering meaningful outcomes that support threatened species, ecological communities, and broader environmental condition. The exception to restoration expenditure per hectare was in mining, where an average of $41,078/hectare was reported. In this industry, restoration is regulated with tenements unable to be relinquished unless criteria are met, and an industry that faces significant challenges due the substantially altered geological profile from the preceding mineral extraction and created waste landforms driving cost up.

Analysis of the data acquired during the survey demonstrated that the WARE is skewed to highly-paid specialists who administer or undertake restorative activities within the regulatory processes (State Government agencies and mining). Outside these sectors, the WARE is comparatively small and struggling to respond to the demands of delivering restoration at scale. Supply constraints, skills shortages and competing land-uses, for example, are resulting in a bottleneck between demand and delivery. Unlike other parts of the world where high quality restoration is undertaken at the scale of millions of hectares per annum, which supports large numbers of people engaged in growing plants and seed, there is a lack of support for scaling up capacity in Western Australia.

To drive an increase in the quality of restorative activities being undertaken at landscape scales, Western Australia needs mechanisms that apply economic value to biodiversity. Establishing markets that are willing to offer higher prices for higher-quality restoration plantings could drive the needed shift from environmental plantings to ecological restoration.

Factors such as diversity, function and threatened species need to be considered when pricing for co-benefits. A separate biodiversity credit system, for example the Biodiversity Certification Scheme (Prime Minister of Australia, 2022). Programs achieving ecological restoration are more expensive and complex to install requiring training, experience and adherence to policy and guidance. Delivery agents need to be appropriately rewarded for the delivery of higher-quality services and products. Without these kinds of policy shifts, the sector will struggle to grow to the industrial scales observed in Europe (UNEP-WCMC FFI and ELP, 2020) and the United States (Bendor et al., 2015a, Bendor et al., 2015b) where the ecological restoration industries are worth billions, not millions. The opportunity for the WARE is real and could bring opportunity and transformative change to our regions and environment.

Credit: Threshold Environmental

6. Opportunities for the restoration economy

Ecological restoration at scale can deliver meaningful outcomes to the State, not only in response to the climate and biodiversity crises through the reduction and offsetting of emissions and improved environmental condition that supports our biodiversity, but also through direct economic revenue and human wellbeing that can benefit all levels of society.

This report demonstrates the interconnected nature of the restoration economy and, as such, a pathway to grow and strengthen the industry will stretch beyond biodiversity research. A multi-faceted strategy to build an economy is needed to ensure Western Australia is future-ready to support incoming investment for the restoration economy.

Actions to enable Western Australia's ability to deliver meaningful, climate-resilient, large-scale ecological restoration– as individuals and collectively will come from industry, government and the research sector.

Research, data, and digital tools and technology will be central to maximising the opportunity of the WARE with findings able to inform governance structures (through leadership, policy and regulation) and support capacity building (through financial investment, education and training and quality and supply).

6.1 Supporting a thriving restoration economy

Three actions were identified that will require the focus of senior leaders, as well as practitioners on the ground, to strengthen the delivery of effective ecological restoration and support a thriving Restoration Economy in the State: expand, deliver, and inform (**Figure 9**).

FIGURE 9. Key actions required to strengthen the delivery of effective ecological restoration.

Credit: Preeti Castle

6.2 Focus areas: Targeted research to inform the enabling environment

Within the multi-faceted nature of the restoration economy, we identify nine streams of focus to be developed to support a robust industry (Figure 10). Targeted research that addresses priority knowledge needs will inform the enabling environment for the industry. The focus areas will need to be continually developed and/or implemented over time as global and national frameworks driving demand continue to evolve.

The focus areas reflect the voice of stakeholders engaged throughout the project and go beyond the scope of WABSI as a research-focussed joint venture. However, in seeking end users input on required actions, consolidated feedback identified an interconnected model between key themes.

Credit: Tranen Revegetation Systems

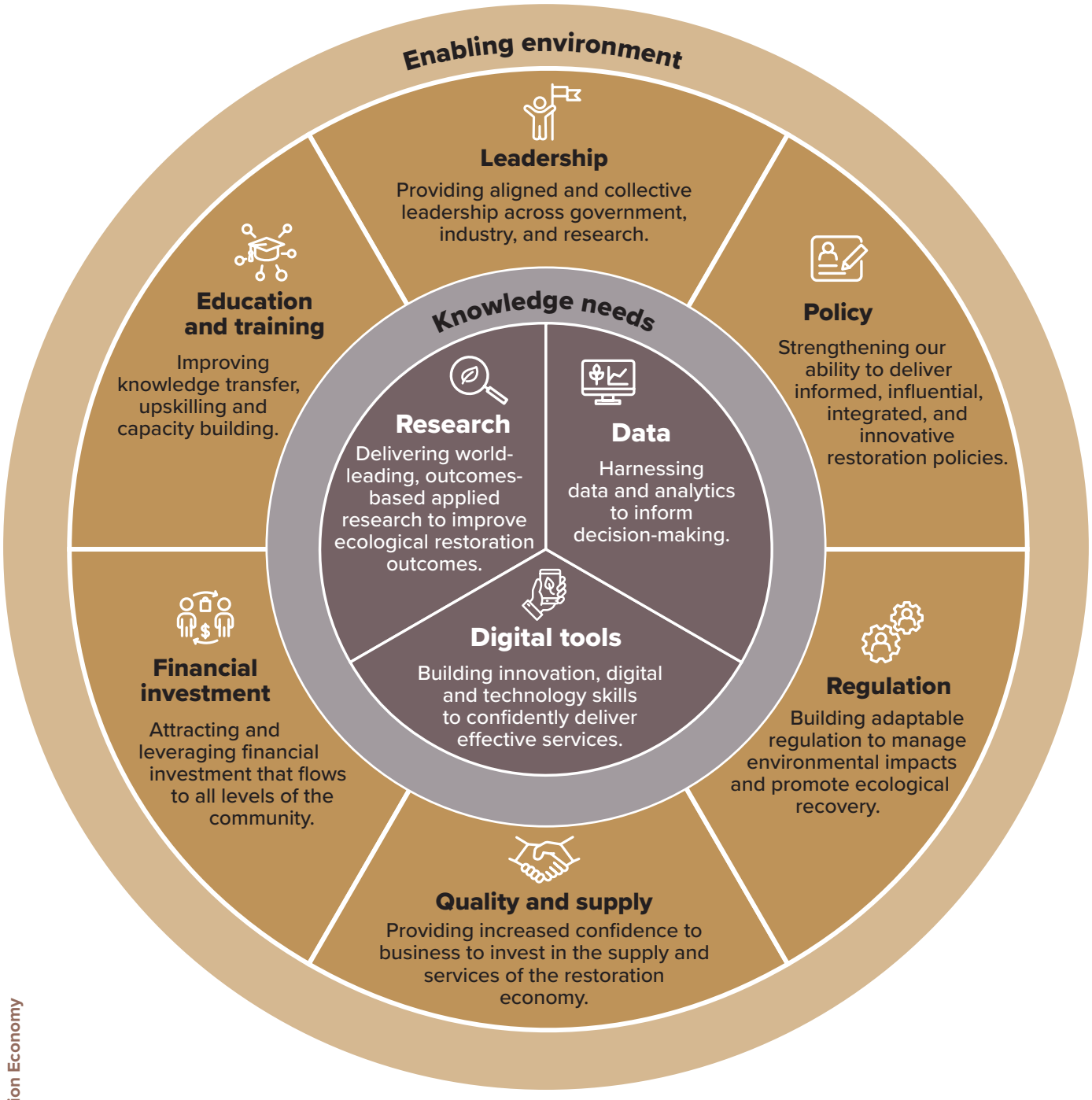

FIGURE 10. Streams of focus for the Western Australian Restoration Economy.

6.3 Knowledge needs: Targeted research

The geographical and climate spread of Western Australia means that restoration research is required in multiple biomes to provide operational and technical guidance on best practice for the return of functional and resilient ecosystems. The WARE will need to be able to effectively integrate with other established industries to successfully contribute to the economy and with land competition evident within the state, there will be a need to develop an understanding of how and where we prioritise restoration efforts, and what outcomes we could achieve under different conditions. There is a wealth of expertise and experience in restoration in Western Australia, but also a clear need for a research prioritisation plan to synthesise what is already being done and where we should target further time and resources.

Data

Decision making to understand the capability and opportunities for the WARE will be better informed with revised baseline mapping of vegetation extent and condition including indices that align with global frameworks. Targeted surveys in data deficient and high priority areas may be needed as well as in existing restoration areas to develop a greater understanding of what has been achieved to date. Data management is transitioning towards digital platforms such as the shared analytic framework for the environment (SAFE) and data capture should be able to feed into these online resources.

Digital tools and technology

A WARE that responds to the climate and biodiversity crises along with global frameworks will need to maximise carbon sequestration and biodiversity. Site prioritisation will be crucial to enable the state to reach targets effectively and efficiently. Natural asset management tools to monitor and co-ordinate activities in remnant vegetation and restoration sites as well as tools to value and measure nature will be needed to support the industry.

Credit: Threshold Environmental

6.4 Enabling environment

Leadership

A restoration economy in Western Australia will need strong leadership. A coordinated working group could facilitate action across multiple groups in different fields to enable outputs to be connected and complimentary. A community of practice could also provide the opportunity to share learnings and promote outcomes in ecological restoration in Western Australia. As highlighted in the report it would be key that this leadership mechanisms promote a culture shift from 'mixed-species environmental plantings' to 'ecological restoration' to maximise environmental outcomes.

Policy

Net Zero and Nature Positive targets would be strengthened with government policy that incorporates ecological restoration to provide long-term biodiversity benefits of the state. Further, policy that supports and rewards the delivery of high-quality ecological restoration guided by Western Australian Restoration Standards will facilitate a drive from environmental plantings to ecological restoration. The role of First Nations culture into land management and ecological restoration practices should be recognised to ensure economic and social opportunities resulting from a WARE have a direct pathway for on ground change. Broader policy actions may include targeting particular challenges identified in this report, such as seed supply issues through a specific Western Australian Seed Strategy or building policy that encourages recovery actions to improve environmental condition in intact, but degraded sites.

Regulation

Two of the most significant global frameworks that are likely to have an influence on the WARE are the Task Force on Climate-Related Financial Disclosures (TCFD) and the Taskforce on Nature-related Financial Disclosures (TNFD). As regulation is updated, opportunities that align Western Australia to the principles of TCFD and TNFD could support improved uptake and performance. Net Zero and Nature Positive targets will need to be able to utilise ecological restoration as an offset mechanism and thus any revised regulation should build in high-quality ecological restoration or improvements in land condition as required outcomes to ensure meaningful benefits to the state and minimise the risk of green-washing activities.

Quality and supply

Scaling up of ecological restoration will require growth in nursery and seed supply chains. Multiple strategies may need to be engaged to support this growth including options for incentivising investment or providing grant opportunities to small and emerging businesses. Further, many regions are experiencing economic transitions where there may be opportunity to reskill or train the workforce, including in remote and rural communities to support the growing WARE industry.

Financial investment

With vast areas and stable governance structures, Western Australia is well positioned to be a 'location of choice' for achieving nature positive targets. Coordinated approaches to attract 'green' investment should be explored and mechanisms to support Western Australian business to adopt TNFD established. Opportunities to attract international investment to the state could be, for example, catalysed through private- or government-led mechanisms such as broker agencies linking investors with land holders.

Education and training

Establishing and strengthening training programs for ecological restoration practitioners would help make Western Australia a leader in upskilling and capacity building for the WARE. Specifically, there could be further opportunity to work with Indigenous Australians in this industry with formal accreditation of skillsets.

Credit: Threshold Environmental

Credit: Greening Australia

7. Concluding remarks

Western Australia is in a unique position to be able to direct emerging and growing capital associated with net zero targets towards actions that can deliver impactful environmental outcomes. The State has witnessed decades of land degradation, species loss and environmental change that is set to continue and intensify as the climate changes.

The opportunity that presents itself from this cascade of events, is that there are vast areas where ecological restoration could be employed to stop and even reverse the adverse impacts. A pipeline of restoration aligned programs are potentially available through external investment, however additional knowledge and capacity building is required for further development, especially to support the forthcoming Australian Biodiversity Certificate Scheme. Importantly, a culture shift from plantings for carbon credits to ecological restoration is necessary to realise the full suite of benefits to the environment, society, industry, and government. The WARE need not impact or diminish other industries such as agriculture, mining, or construction, but work alongside them, so they are able to continue to operate productively and sustainably. While funding for on ground actions is currently available in the market, additional development to embrace the WARE in full, recognising it as its own but integrated industry would help instigate actions to better secure capacity and consistency of the supply chain. As these benefits take time to accrue, it is essential that investment in, and support, to the restoration economy is a long-term commitment from government, industry, and organisations.

7.1 Next steps

WABSI will develop a prioritised research plan focused on addressing identified end user priorities. A dedicated steering committee would then provide oversight and facilitate research delivery, a model which works successfully with WABSI research programs.

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