Research Priorities Plan

Facilitating coordinated, collaborative research

The Western Australian Biodiversity Science Institute

We invite you to engage with our research programs.

To get in touch, please contact info@wabsi.org.au

Photo acknowledgement:

- Robert McLean
- Lochman Transparencies
- Megan Hele
- Preeti Castle
- Urban Development Institute of Australia
- Claire Greenwell
- Judy Dunlop
- Greening Australia
- Alcoa
- Renee Young
- Bruce Webber
- Department of Biodiversity, Conservation and Attractions
- Alan Danks

COVER: Robert McLean and Lochman Transparencies

Proudly supported by:

CSIRO

Curtin University

ECU Australia Edith Cowan University

Murdoch University

The University of Western Australia

Western Australian Museum

Government of Western Australia Department of Biodiversity, Conservation and Attractions

Government of Western Australia Department of Primary Industries and Regional Development

Government of Western Australia Department of Jobs, Tourism, Science and Innovation

Government of Western Australia Department of Mines, Industry Regulation and Safety

Government of Western Australia Department of Water and Environmental Regulation

Contents

ISBN: 978-0-646-83790-1

Published July 2021

Facilitating coordinated, collaborative research

Supporting end users to make more informed decisions with greater confidence and certainty

Western Australia is rich in both biodiversity and in mineral, oil and gas resources. With a thriving agricultural sector and a growing population, there are increasing levels of urban and industrial expansion. The challenge is to integrate the future social and economic development of the State with strategies for the effective management of biodiversity.

The Western Australian Biodiversity Science Institute (WABSI) is a collaboration of leading research organisations which facilitates partnerships across industry, government, community and researchers.

As an independent institute, WABSI provides a safe space for diverse stakeholders to come together from across community, industry, government and regulators. Collectively we can address complex problems that involve the consideration of a range of issues which require a robust and rigorous scientific information base.

Driven by the needs of end users, WABSI facilitates research which addresses priority biodiversity science knowledge gaps and enhances access to knowledge and information. We offer a better leveraged investment through coordination and collaboration of effort to maximise efficiencies.

WABSI research programs build strong cross-sector stakeholder relationships through extensive consultation, take into account Indigenous knowledge systems, regional and landscape contexts. Program development and implementation is underpinned by effective communication of relevant, timely research to facilitate uptake of new scientific knowledge to enable decision making with greater confidence and certainty, and lift biodiversity outcomes.

5

Research Priorities Plan: Facilitating coordinated, collaborative research

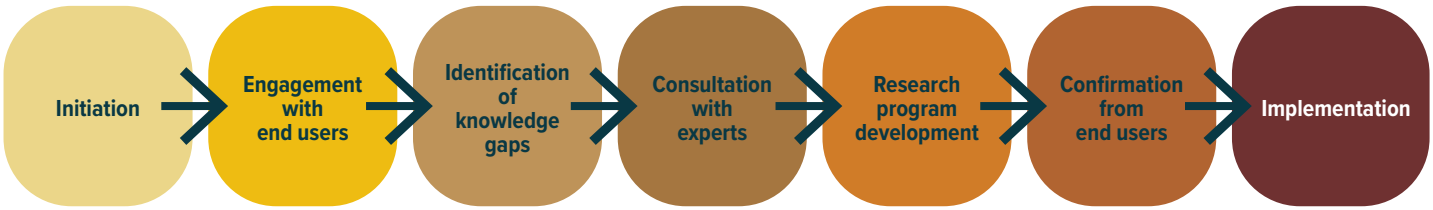
End user needs drive research program development

Strategic programs address large, complex issues

We enable collaboration by bringing together industry, government, science researchers and the community to identify biodiversity science issues and priorities of end users.

We develop strategic programs of work that address large, complex issues and close research knowledge gaps thus enhancing knowledge, lifting certainty and enabling better management decisions.

The program development process takes the following steps:



- **Ongoing engagement with end users** gives us a deep understanding of the complex biodiversity science issues that face industry, government and community.
- **We bring together expertise** from across sectors for a series of consultations to help identify science knowledge gaps and set research priorities.
- **A program plan is developed and published.** It sets out clear objectives, focus areas for research and the outcomes sought for end users.
- **We establish program governance** to ensure a coordinated effort. A working group or steering committee helps attract investment partners and guides a coordinated research effort.

Programs define research priorities and identify projects

- **Projects aligned to research priorities** are implemented and driven by the program's governance body and undertaken by a project team that pulls in the best science expertise from across WABSI's joint venture partners and beyond.
- **Projects deliver real world outcomes** that benefit industry, government and community, and leave a legacy for Western Australia.

Effective communication facilitates uptake of research

- **We lead** the stakeholder communication process from program development and implementation through to facilitating the uptake of research outputs. For example, preparing science-informed frameworks, guidelines and tool kits that are ready for adoption by end users.
- **We support** the program governance body to ensure continuity of communication and reach end users to facilitate the adoption of research that helps lift certainty and confidence in decision making.

Research themes underpin research program development

Ecosystem processes and threat mitigation

Land use change, climate change and invasive alien species represent the three biggest threats to the effective conservation of biodiversity. Greater clarity on these impacts and solutions to mitigate them will build the capacity of land managers to understand and manage the processes that maintain or threaten ecosystems such as fire regimes, water availability and management, climate, introduced species, disease and fragmentation/ loss of connectivity through land clearing.

Conservation and restoration

Collaboration between industry and researchers has developed restoration technologies for regions of the State, notably within alumina leases on the Darling Ranges. These capabilities will be extended across other land use systems and ecological communities, including developing technologies for ex-situ conservation and translocations of plants and animals.

Biodiversity data and information management

This theme supports the collection, analysis and reporting of information derived from other research themes.

- Biological survey and data collection: Western Australia has an incredible diversity of plant and animal species across varied landscapes and ecological communities. An understanding of the State's biological resources, their distribution and processes that underpin their distribution is crucial. Although a great deal of information has already been collected and interpreted by government, industry and research agencies, an improved knowledge management system is needed.
- Data aggregation, interpretation and access: We continue to facilitate a coordinated effort to create and lead a culture of shared expertise, common data standards, policies and incentives for data sharing across sectors.
- Our work supports optimised policy and decision making, transparent, efficient assessment and assurance processes as well as informed environmental adaptive management frameworks to provide investment confidence and an informed community.

A clear focus on key research areas

Biodiversity knowledge and standards

Rationale

A number of foundational activities are required to underpin and facilitate a culture of data sharing across government agencies, industry and research organisations. Improved information management requires a high level commitment from the key organisations involved, a willingness to be guided by a coordinating agent and a capacity to contribute to a common infrastructure and standard.

Each stakeholder that collects biodiversity information must be recognised and have their right to store and manage data for their own purposes reaffirmed. However, an obligation to share information, including in a format that complies with common standards, is normative in many industries – including disciplines such as medical research, accounting and engineering.

Priority areas

WABSI will seek to develop an agreed framework and approach for the management of biodiversity information including:

- **Organisational commitment** — a commitment from all participating organisations to a common vision, objectives, principles and a road map. It would include early initiatives for biodiversity information management to establish a governance mechanism through WABSI in order to coordinate organisational efforts so as to invest in common standards and infrastructure over time. For example, key business analysis and project management for organisational consultation, together with mapping and understanding of user needs, priorities and barriers.
- **Policy incentives** — that facilitate open access to data and its reuse including storage and access associated with government environmental approvals and licensing and strengthened incentives for sharing of data collected for research and academic publication.
- **Data standards** — that establish minimum requirements for data collected for different purposes such as vouchered collections, biological survey and so on.
- **Data collection workflows** — that map, standardise and streamline workflows for the collection and storage of data, including processes for lodgement of data associated with government approvals and licensing arrangements used for environmental impact assessment.
- **Knowledge networks** — that establish and recognise data custodians and providers, as well as the tools for annotation and validation of different data types.

Research Priorities Plan: Facilitating coordinated, collaborative research

New technologies

Rationale

Given the scale of the task in understanding the elements of biodiversity, their geographic distribution and condition, new technologies and approaches are required to drive faster and more cost-effective biodiversity assessment.

A key priority is to develop, identify and trial innovative new technologies and systems for the collection, collation and analysis of biological survey data that enables the taxonomic resolution of species, informs the definition of ecosystems and biological communities, and enables distribution of species across Western Australia to be predicted. A main driver for new technologies relates to the lack of adequate biodiversity data across large areas of the State to inform land management decisions, and generally the current high cost of traditional approaches to biodiversity survey.

Priority areas for commissioned work

There is an opportunity to not only investigate the utility of new technologies singularly, but also to identify the most effective ways of integrating their deployment to deliver more robust and comprehensive biodiversity assessments. A further opportunity comes from the need to identify solutions to managing the enormous quantities of data arising from these approaches.

Examples of technologies applicable to biodiversity survey and assessment include:

- **Molecular and genomic technologies**
  - DNA barcoding – identification of species using this approach has become increasingly popular and more cost-effective in recent years. DNA sequencing is particularly useful for separating cryptic taxa and those groups where there are few taxonomic specialists.

- **Environmental DNA (eDNA)** – DNA captured from an environmental sample, such as water or soil, can be used to detect single species, communities or even describe entire ecosystems. Multispecies detection (eDNA metabarcoding) combined with high throughput sequencing is emerging as a powerful tool that has multiple applications for biodiversity survey and monitoring.
- **Remotely sensed technologies**
  - Satellite platforms (geospatial and temporal coverage) – the increasing availability (including for free) of higher spatial and broader spectral resolution imagery has increased the utility of satellite imagery for many applications. In addition, archive and search platforms enhance the capacity to undertake advanced analyses of imagery at no added cost.
  - Airborne platforms (UAVs to aircraft) – the increased availability of even higher resolution imagery, in combination with sensors such as hyperspectral, radar, laser and passive thermal, makes the utility of these platforms considerable.
- **Automated detection tools and mobile apps**
  - Remotely operated camera traps and audio recording units have significantly increased the capacity to detect species, particularly those that are difficult to detect using more traditional approaches.
  - The development of automated visual and sound recognition software will increase the efficiency and accuracy of the above tools.
  - Mobile device ‘apps’ coupled with citizen scientist programs have dramatically increased the ability to target data collection and increase coverage, with in-built functions to help improve data quality.
  - Use of machine learning and artificial intelligence particularly for the analysis of ‘big data’.

Identification tools and information systems

Rationale

End users need confidence that species and ecological communities have been robustly surveyed, correctly identified and that their geographic distributions are properly understood. A key priority is the development of identification tools, robust methodologies and minimum standards for data collection that can be used in multiple contexts. End users are seeking greater confidence in the capacity to reliably and efficiently identify species, ecological communities and interpret genetic data and information.

Priority areas for commissioned work

WABSI supports research for developing tools, systems and standard processes to allow for consistent and efficient collection and interpretation of biodiversity data.

Examples of key resources that would support the identified needs of end users include:

- **eFlora of Western Australia** — An online electronic version of a Flora, or an eFlora, provides contemporary and integrated taxonomic and descriptive information in a single resource that is readily accessible to a wide audience, including industry, government and the community. It will have built-in keys and other tools to identify species occurring in any given area such as a reserve or bioregion; vast and comprehensive information about species that can be searched, filtered and packaged in different formats for different audiences, and is easy to maintain and keep up-to-date in the face of growing and changing knowledge, with links to other online resources.
- **Western Australian Vegetation Information System** — This assists the establishment of protocols and procedures, deploys innovative technologies and maintains data and analysis methods to deliver fit-for-purpose derived products such as vegetation maps suitable for biodiversity assessment and site-based plot data to inform on trends in habitat condition.

Data collection and access

Rationale

To achieve the objective of simplifying access to biodiversity information, a considerable investment needs be made in infrastructure. This would help enable biodiversity data to be mobilised, organised and aggregated from a variety of sources in a web-based platform to support end user access and use.

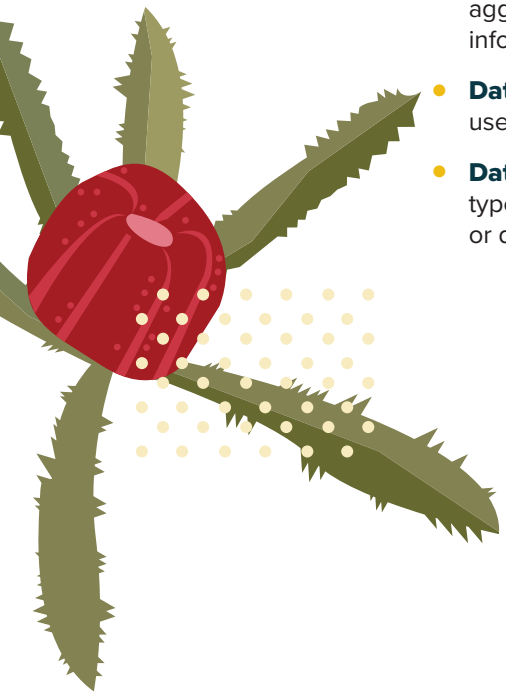
The benefits of a capacity to aggregate biodiversity information from multiple sources onto a shared platform are compelling. However, this in turn requires each agency and stakeholder to commit to investing in the common infrastructure and also ensuring that their own data management systems and standards are interoperable with the requirements of the shared platform.

Priority areas for commissioned work

Developing improved organisational practices, policies and knowledge management systems to facilitate integrated access, aggregation, sharing and interpretation of the biodiversity related data gathered and held by government, industry and research agencies.

Key activities include:

- **Data storage and quality assurance** — develop a data storage, curation and quality assurance capability to ensure biological datasets are visible, accessible, managed according to best practice, as accurate as possible and able to be aggregated.
- **Data collection** — evaluate and provide data collection tools that enforce data and collection standards.
- **Data service** — establish criteria and select a provider or system for data aggregation service development and support with agreed specifications for data repository, aggregation and interpretation and progressively building the capability of the information management system.
- **Data types** — identify different data types and understand the needs of different end users for different data types and their application.
- **Data mobilisation** — establish agreed priorities for the mobilisation of strategic data types into the data service or platform so as to progressively address knowledge gaps or development pressure points for Western Australia.



Data interpretation and re-use

Rationale

Access to raw data is necessary but not sufficient to meet the needs of users of biodiversity information.

A key requirement is to develop tools, methodologies and interfaces that stakeholders and the general community can use to build an understanding of the nature and value of Western Australia's biodiversity.

Priority areas for commissioned work

WABSI will invest in and support research and development of tools, methodologies and interfaces for improved access and interpretation of biodiversity information:

- **Tools for data access and interpretation** — ensure data users have access to tools to visualise and interpret data in ways that meet their needs.
- **Examples and tools supporting additional data re-use** — provide best practice examples, especially as they connect to data being generated and made available through WABSI.

Restoration technologies

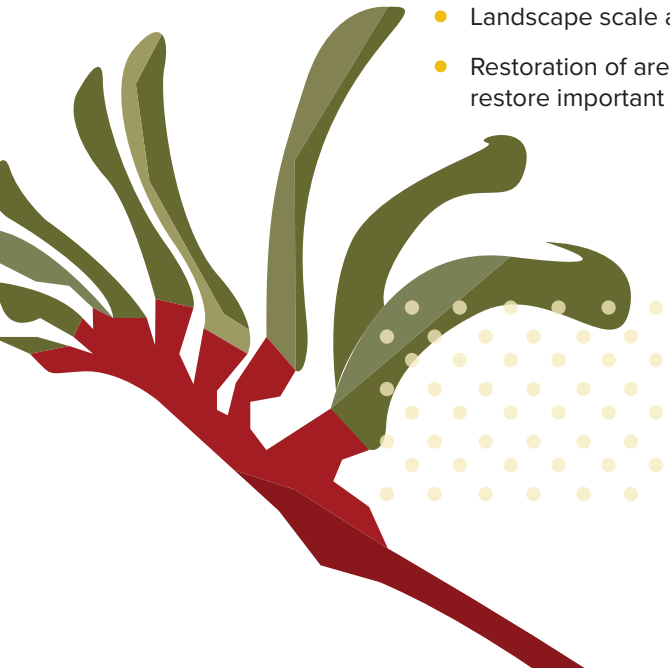
Rationale

The future demands for restoration are significant, ranging from rehabilitation of mine sites, through the restoration of areas within conservation parks that have suffered degradation, the protection of remnant vegetation, to the restoration of fundamental ecological functions (such as ground water balances). Increasingly, restoration will also deliver co-benefits within the carbon markets.

To address these challenges, contemporary restoration programs will aim to restore biodiverse plant and animal communities, often at a large scale. In practice, this means the return of tens to hundreds of species in many ecosystems, potentially across thousands of hectares. Scale and cost are key drivers of research priorities for restoration – there is a clear need to develop proven, cost effective and scalable restoration.

Priority areas for commissioned research

- Understanding physical, chemical, hydrological and biotic attributes of re-made soils and substrates to enable seedling establishment and plant growth and inform landform stability and erosion management.
- Understanding and capitalising on the role of soil biotic processes in the restoration process.
- Techniques for restoring recalcitrant and manage threatened species within restored communities.
- Development of seed technology for effective seed use, delivery, improved germination and survivability.
- Creating native seed production farming enterprises to generate high quality seed and to reduce the impact of seed collection on wild sources.
- Development of surrogate species and ecosystems.
- Landscape scale analysis of the cumulative impact of ecological restoration activities.
- Restoration of areas impacted on by *Phytophthora* dieback and invasive plants to restore important ecosystem services and functions.



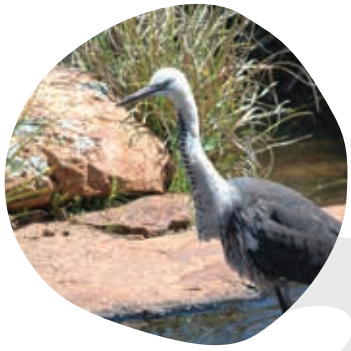
Reintroduction technologies

Rationale

Many Western Australian native animal and plant populations are still declining and captive breeding, translocation strategies and the management of threatening processes need to be improved to prevent extinction of certain WA animals. The technology required to successfully translocate animal and plant populations mirrors the requirements of restoration technologies including landform and soil attributes, seed/animal sourcing, propagation and distribution. However, translocations of rare and threatened species require additional focus on the management of endangered source populations. The ecosystem benefits of translocations also need to be explored, such as the impact of re-introduced 'ecosystem engineers'. Integrated translocation of plants and animals to support enhanced ecosystem restoration programs should also be examined.

Priority areas for commissioned research

- Innovative techniques for captive breeding and appropriate *ex-situ* captive breeding protocols.
- Sourcing and storage of plant propagules, development of technologies to better deliver plants for translocations and improve seedling establishment.
- Understanding biotic and abiotic attributes that both enable and optimise plant establishment, growth, survival and recruitment of subsequent generations.
- Assessing the value(s) of fauna translocations to broader ecosystem restoration practices.
- Creating ex-situ production enterprises (seed orchards and captive breeding) to generate high quality offspring to reduce pressure on wild populations.
- *Ex-situ* management of source material ('insurance populations'), seed banks/orchards and the use of islands for animals.
- Developing appropriate protocols for ex-situ captive breeding.



Research Priorities Plan: Facilitating coordinated, collaborative research

Identifying goals and evaluating restoration success

Rationale

Given the large range of activities, costs and contexts within which ecological restoration takes place, it is important for the conservation of Western Australia's biodiversity to be able to clearly identify goals and evaluate the success of restoration and reintroduction programs. Evaluation requires the development of early and predictive indicators of restoration and translocation success that are robust, meaningful and measurable. Opportunities presented by practitioner-research partnerships in restoration and reintroduction programs should be developed to support more effective identification of goals and success measures.

Priority areas for commissioned research

- Techniques for determining the targets for species richness and community composition appropriate to each restoration site.
- Improved methods for net benefit analysis to better evaluate and optimise investments in restorative activities to underpin restoration planning and overarching goal setting.
- Investigation and development of systems for improved restoration monitoring and shared learning.
- Development of early indicators and measures of long term restoration successes for key species and communities.
- Risk analyses of restoration approaches —understanding climate variability/change, provenance (local versus non-local), and use of surrogate species and ecosystems threat mitigation.
- Adequate genetically representative germplasm in ex-situ collections including seed orchards and captive animal colonies.
- Developing appropriate, robust monitoring techniques and methods for assessing long-term translocation and reintroduction success.

25

Research Priorities Plan: Facilitating coordinated, collaborative research

Understanding pattern and significance

Rationale

Informed decision making by end users requires data on the biodiversity at a site to be placed in the context of the broader geographic area (for example, biogeographic region), as well as the projected trajectory of biodiversity condition over time.

Determining conservation significance and status is critical for both targeting conservation efforts and also informing environmental assessment, including prioritising conservation actions, identifying management and threat mitigation strategies, and targeting offsets.

Western Australia has been covered by an extensive network of biological surveys from which considerable data has been collected. This data can be utilised for the assessment of biodiversity patterns across the landscape that is critical for land management decisions, such as evaluation of cumulative impacts. As there also remains a significant gap in biodiversity data across large areas of the State, strategically filling these gaps is important for more informed decisions. Traditional field surveys are unlikely to be completely replaced by emerging survey technologies, however when used in combination, they are likely to provide a more powerful approach to cost-effectively identifying and monitoring biodiversity patterns.

Priority areas for commissioned work

WABSI facilitates collaborative research that increases the capacity to synthesise a comprehensive view of the status of biodiversity at varying scales within WA. Outputs will support the informed evaluation of the potential impacts of future trends and developments on biodiversity including those required for regulatory processes.

Key priorities include:

- Spatial modelling and decision-support tools.
- Collating and using existing biological, spatial and environmental data to develop predictive models of the patterns in biodiversity across Western Australia's landscapes; across all levels of diversity from genes to ecological communities. This includes developing refined spatial layers for key environmental variables that currently lack adequate resolution or coverage, and identifying gaps in survey coverage.
- Biological surveys to fill priority gaps in data coverage, taking maximum advantage of advances in survey technologies.
- Investigating and developing conservation planning tools that use patterns of biodiversity to address status and significance.
- Developing decision-support tools that integrate the modelled biodiversity patterns with information on ecosystem threats and processes so that the cumulative impact of proposed developments and/or conservation actions can be evaluated.
- Designing and implementing optimal monitoring strategies to track changes to biodiversity condition and status over time.

Identifying and mitigating key threats

Rationale

Capacity is required to identify the key threats to species and communities in order to prioritise research that will improve management outcomes. Methodologies are required to help understand the potential impact of threats on species and landscapes. Examples of key issues include the capacity to determine thresholds for land disturbance and thresholds for local population extinction (minimum viable population size), develop pest and weed management strategies, predict the resilience of ecosystems to a rapidly changing climate, and the management of disease. For example, whilst a landscape planning and prioritisation process may identify the management of predation as a critical issue, the effectiveness of existing techniques and tools for managing feral cat and fox predation are limited. Foundational research is required to understand the underlying mechanisms and processes taking place and how they may be more effectively controlled and managed.

Priority areas for commissioned work

Examples of research that may be supported include:

- Identification of key threats to species and communities including an understanding of global environmental change impacts on biological processes involved in species persistence, and how to improve the management of disease impacts (for example, Phytophthora) at the landscape scale.
- Risk assessment and prioritisation including tools for assessing the potential impacts of key threats and develop appropriate mitigation and management plans, and identifying dominant threats and ranking for management based on agreed criteria such as likelihood, impact and reversibility.
- Invasive alien species management including new and improved techniques for tracking and controlling pests (for example, foxes, cats and cane toads), weeds and diseases, including effective, efficient and humane culling and baiting, biological control and gene editing approaches.
- Land use change threats and opportunities including options and methodologies to identify and respond to changes in land use, and land use planning for existing and new uses such as irrigated agriculture, and developing an understanding of grazing pressure impacts in arid systems.
- Landscape fragmentation including determining population viability and thresholds for loss of small populations, managing species and communities in fragmented landscapes.

Integrating ecosystem processes into adaptive management

Rationale

Tools for the management of biodiversity are required based on a robust understanding of the key processes that drive and determine the persistence of species and communities, and the ongoing condition, viability and resilience of Western Australia's ecosystems and to build understanding of how the environment is likely to change through time.

Managers are seeking capacity to define and understand the key ecological drivers and evolutionary processes, and the interactions between them, for priority regions and ecological communities. Tools are needed to enable researchers and managers to integrate dominant processes into management plans that will assist in targeting conservation and restoration efforts.

The future evolution of the environment is likely to be significantly influenced by our ability to predict and manage fire regimes, develop adaptation and mitigation solutions for the impacts of climate change and implement more effective management of our fragile and ancient soils.

Considerable research is required to understand the knowledge gaps that exist for these interactions, and identify management solutions that factor in direct and indirect interactions is even more challenging. Successful outcomes require interdisciplinary approaches to identify social and economic drivers and options for policy responses.

Priority areas for commissioned research

Examples of research that may be supported include:

- Fire management including implications of climate change and asset protection in the South West, management of fuel loads and re-introduction of Aboriginal burning practices in northern and arid environments.
- Soil nutrients and nutrient cycling including tools for managing soil chemistry and reintroducing critical soil biota.
- Climate change and altered water flows including capacity to model impacts and identify cost effective solutions for managing water regimes, guidelines for identifying and managing climate resilient ecological communities.

31

Research Priorities Plan: Facilitating coordinated, collaborative research

wabsi.org.au