



CENTRE FOR
INVASIVE SPECIES SOLUTIONS

NATIONAL WEED BIOCONTROL PIPELINE STRATEGY

A ROADMAP TO GUIDE AUSTRALIA'S FUTURE WEED BIOCONTROL
RESEARCH, DEVELOPMENT, AND EXTENSION

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COVER IMAGES

Tahina Rajoanera collecting biocontrol agents on mother-of-millions (*Kalanchoe delagoensis*) in its native range of Madagascar. Source: NSW DPI.

Community celebrating the successful control of Hudson pear; Weed - *Cylindropuntia pallida*; Source: NSW DPI; People in photo: attendees at a Hudson pear training workshop (from Lightning Ridge, Cumborah and Grawin).

The leaf-feeding beetle *Cassida distinguenda* in host-specificity testing for African boxthorn (*Lycium ferocissimum*). Source: CSIRO.

CSIRO researchers releasing the leaf-smut fungus *Kordyana brasiliensis* at a monitoring plot of wandering trad (*Tradescantia fluminensis*) in NSW. Source: CSIRO.

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Tahina Rajoanera collecting biocontrol agents on mother-of-millions in the native range of Madagascar; Weed – Kalanchoe delagoensis; Photo – NSW DPI; Person in photo – Tahina Rajoanera (Phd student).



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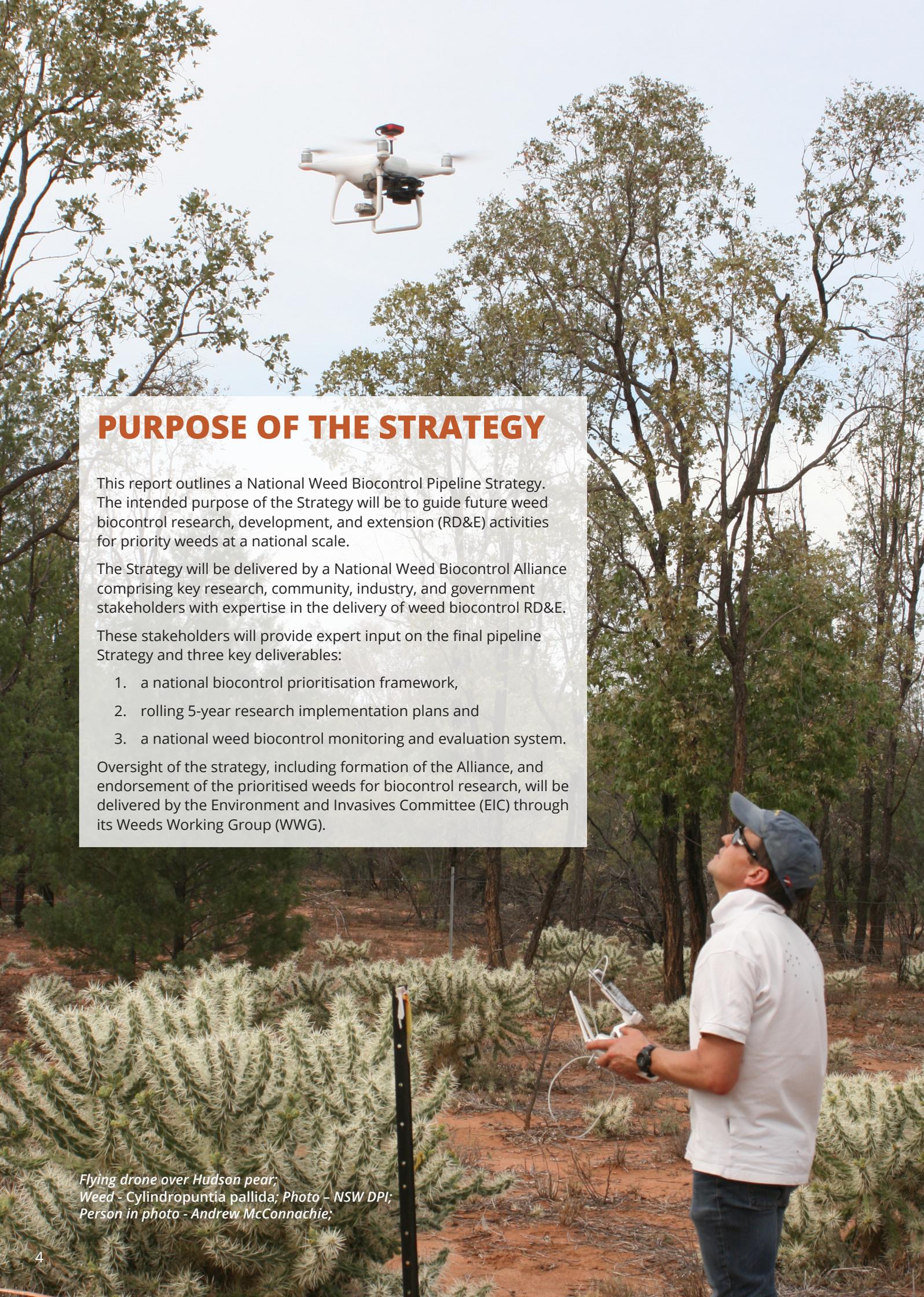
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A white drone is flying in the sky above a field of trees. In the foreground, a person wearing a white polo shirt, a blue cap, and sunglasses is looking up at the drone while holding a remote control. The background consists of tall, thin trees and a field of low-lying, spiky plants.

PURPOSE OF THE STRATEGY

This report outlines a National Weed Biocontrol Pipeline Strategy. The intended purpose of the Strategy will be to guide future weed biocontrol research, development, and extension (RD&E) activities for priority weeds at a national scale.

The Strategy will be delivered by a National Weed Biocontrol Alliance comprising key research, community, industry, and government stakeholders with expertise in the delivery of weed biocontrol RD&E.

These stakeholders will provide expert input on the final pipeline Strategy and three key deliverables:

1. a national biocontrol prioritisation framework,
2. rolling 5-year research implementation plans and
3. a national weed biocontrol monitoring and evaluation system.

Oversight of the strategy, including formation of the Alliance, and endorsement of the prioritised weeds for biocontrol research, will be delivered by the Environment and Invasives Committee (EIC) through its Weeds Working Group (WWG).

*Flying drone over Hudson pear;
Weed - *Cylindropuntia pallida*; Photo - NSW DPI;
Person in photo - Andrew McConnachie;*

Weeds: a \$5 billion problem for Australia's ecosystems, waterways and agricultural lands

Weeds have a major impact on Australia's environment, livelihood and agricultural productivity. They cause significant impacts and are estimated to impose an overall average cost of nearly \$5 billion across Australia each year.^{1,2} Weeds negatively affect natural ecosystems, waterways and vast areas of agricultural and pastoral lands, impacting the health, viability and function of ecological communities, ecosystems and landscapes.³

In an environmental context, weeds:³

- threaten biodiversity
- disrupt ecosystem services, such as pollination and seed dispersal
- degrade ecosystem function, in particular soil health
- modify or degrade habitats through changed fire regimes (increase the intensity of fires, in the case of many invasive grass species)
- change water flows or reduce access to water
- increase competition for resources.

Australia's biodiversity, ecosystems and cultural values are at particular risk from weed invasion. Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) there are at least three Key Threatening Processes (KTPs) caused directly by invasive plants:

1. loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
2. invasion of northern Australia by Gamba grass and other introduced grasses
3. novel biota and their impact on biodiversity.

Land clearance, fire regimes and other climate change issues are also listed as KTPs. These 'key established threats' to biodiversity, threatened native ecosystems and species, require landscape-scale management and threat-mitigation actions.³ Land managers also recognise the importance of new or improved control methods for more efficient and sustainable weed management.⁴

In an agricultural context the Australian Government has identified that managing threats from weeds to soil, water, threatened species and natural resources is a key challenge to agricultural productivity and livelihoods.^{5,6}



Inspecting Parkinsonia infestation on property for biocontrol agents using a beat sheet in North-western Queensland; Weed – Parkinsonia aculeata; Photo – CSIRO; Person in photo – Andrew White (Research Technician) and council weed officers.

Weed biocontrol is a powerful tool to mitigate emerging and established weed threats at the national landscape scale

Biocontrol is the practice of managing a weed by the deliberate introduction of one or more natural enemies (biocontrol agents) sourced from the weed's native range. This involves rigorous exploratory surveys in partnership with global experts in weed ecology, entomology, fungal pathology, taxonomy and molecular biology. This multidisciplinary approach ensures that the most promising candidate biocontrol agents are prioritised for further research in the Australian context.

Candidate biocontrol agents are approved for release into the Australian environment if rigorous risk assessment demonstrates them to be of negligible risk to native and other valuable non-target plant species. Biocontrol risk assessments are undertaken within high-level biological containment (quarantine) facilities managed by Commonwealth and state government agencies.

After their introduction and establishment, populations of biocontrol agents can build up to very high levels, leading to a decline in the abundance,

density, reproduction and spread of the host weed (Figure 1). Biocontrol agents, once established, are self-sustaining and can assist the recovery of threatened biodiversity, ecosystems and agricultural assets.

Biocontrol is a proven safe and sustainable means of managing weeds in sensitive environmental and agricultural settings where off-target effects from the use of mechanical and chemical herbicide tools are undesirable. It is increasingly recognised as a complementary tool for managing weeds that are developing herbicide resistance, especially in agricultural contexts.

Mass release and distribution of approved biocontrol agents are facilitated by networks of community members and other stakeholders, usually drawn from the environment, restoration and agricultural sector. The benefits of biocontrol agent releases are frequently evaluated through long term on-ground monitoring of changes in weed populations and evaluating the recovery of environmental and agricultural assets over time.

Biocontrol solutions do not come about quickly. The long-term pipeline of discovering, assessing risks and releasing biocontrol agents at a national scale demands a clearly articulated strategy.

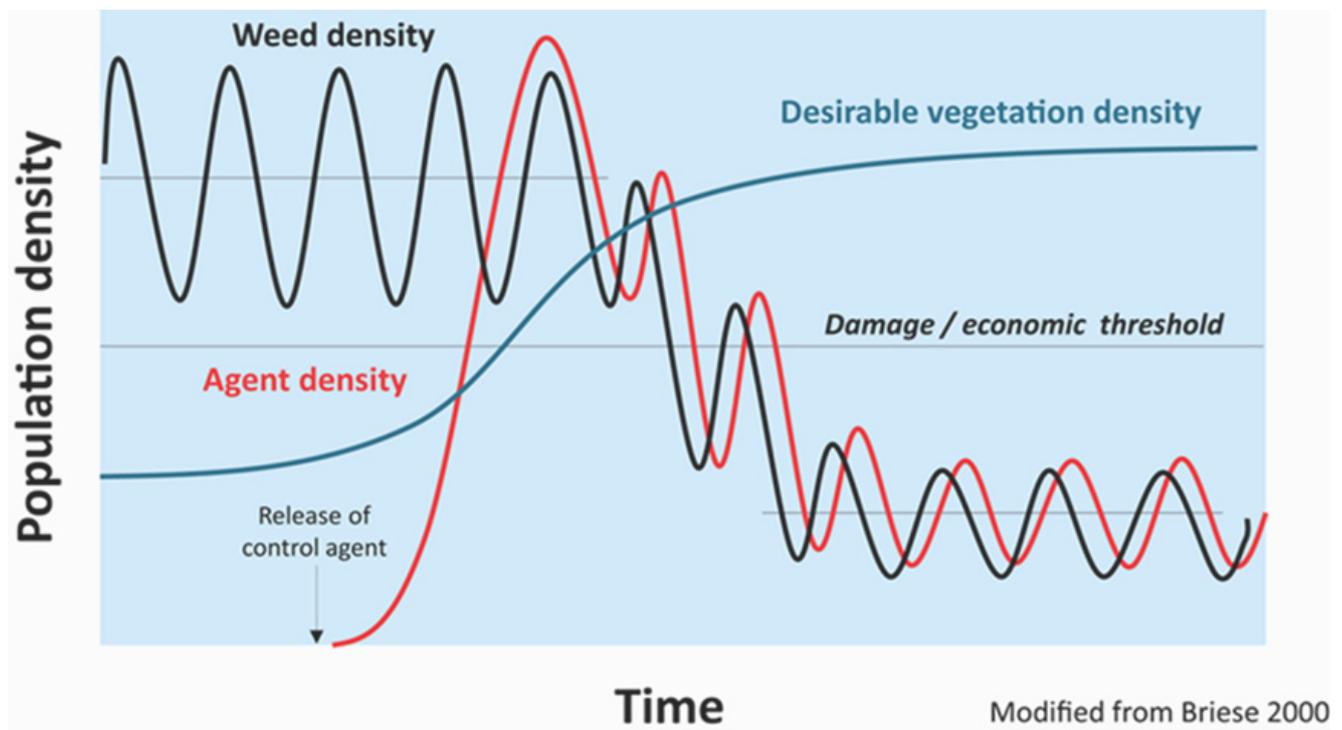


Figure 1: Schematic representation of the desired outcomes of biocontrol. Populations of the biocontrol agent may build up to high levels following introduction and establishment, which may suppress the target weed to a density below a damage/economic threshold and allow desirable vegetation to recover.⁷

Biocontrol is a cost-effective method, but Australia risks losing momentum without ongoing strategic investment

Annual benefits of \$95.3 million from an average annual investment of \$4.3 million was demonstrated in a CSIRO review of all weed biocontrol undertaken in Australia since 1903.⁸ This makes biocontrol one of the most cost-effective solutions currently available in the integrated weed management toolbox, with benefits outweighing costs by over 23:1.^{9,10} Sustaining such returns on investment are vital for maintaining Australia's biodiversity, ecosystem health and agricultural productivity going forward.

Since 2014–15, the Australian government has invested approximately \$20 million in weed biocontrol projects across three rounds of the Rural R&D for Profit program, the Agricultural Competitiveness White Paper and the Established Pest Animal and Weed Management Pipeline program. These initiatives leveraged major co-investment from state governments, research and development corporations (RDCs) and other bodies such as the NSW Environmental Trust.

However, when they conclude in 2023, there is a significant risk that weed biocontrol research capability will decline, lose momentum, and allow weeds to continue impacting priority natural and agricultural assets.¹¹



*Quarantine host specificity testing;
Weed - *Lycium ferocissimum*;
Photo - CSIRO; People in photo - Kylie Ireland
and Gavin Hunter (Research Scientists).*

STRATEGIC COORDINATION OF RD&E FOR ENHANCED WEED BIOCONTROL AT A NATIONAL SCALE

This strategy provides a framework to coordinate weed biocontrol RD&E investment that focuses on national priorities and aligns RD&E across government, industry, research and on-ground weed management practitioners.

This strategy will contribute to implementing Goal 2 (minimise the impact of established weeds), particularly Priority 2.4 (enhance weed control techniques and integrate management options) of The Australian Weeds Strategy (2017-2027), which articulates the need for “*nationally coordinated approaches to selecting new biological control agents for priority weeds*”.¹² The strategy also contributes towards implementing the Intergovernmental Agreement on Biosecurity, which includes “*development of a national framework for biocontrol investment and application*”, as a key deliverable under ‘Priority Reform Areas’.¹³

The strategy does not seek to replace all efforts in weed biocontrol RD&E, instead focusing particularly on weeds that are in the national interest for multiple stakeholder groups. As such, state governments, RDCs and other stakeholders may continue to invest in biocontrol RD&E for weeds that may not necessarily be represented within the national prioritisation framework.



The rust fungus Puccinia cnici-oleracei (ex. Conyza) for the biological control of flaxleaf fleabane in the laboratory pre-release; Weed - Conyza bonariensis; Photo - CSIRO

Establishing a National Weed Biocontrol RD&E Alliance

The strategy proposes the formation of an expert steering group – the National Weed Biocontrol Alliance (the Alliance) – that will formally bring together key stakeholders involved with weed biocontrol RD&E to provide expert advice to the EIC on strategic planning, prioritisation of candidate weeds for biocontrol, and development of implementation plans.

The Alliance will comprise members representing the Australian government, State/Territory governments, Aboriginal and Torres Strait Islander peoples, researchers, weed control practitioners, natural resource managers, biodiversity conservation, agricultural sectors and other relevant stakeholder groups.

The function of the Alliance will be to:

- Undertake a critical scientific and policy review of existing frameworks^{14,15,16} for the prioritisation of candidate weeds for biocontrol RD&E for endorsement by EIC.
- Oversee the implementation of the approved prioritisation framework for the selection of candidate weeds based on their threats and prospects of biocontrol.
- Develop draft 5-year implementation plans, based on the outcomes of the prioritisation process, for consideration and endorsement by EIC.
- Coordinate the delivery of the approved implementation plans, including regular reporting on progress against agreed objectives to the EIC.
- Investigate opportunities to expand the functionality of the ALA Biocontrol Hub for enhanced monitoring and evaluation of weed biocontrol agent release/impacts, and support knowledge sharing, extension, and capacity building.

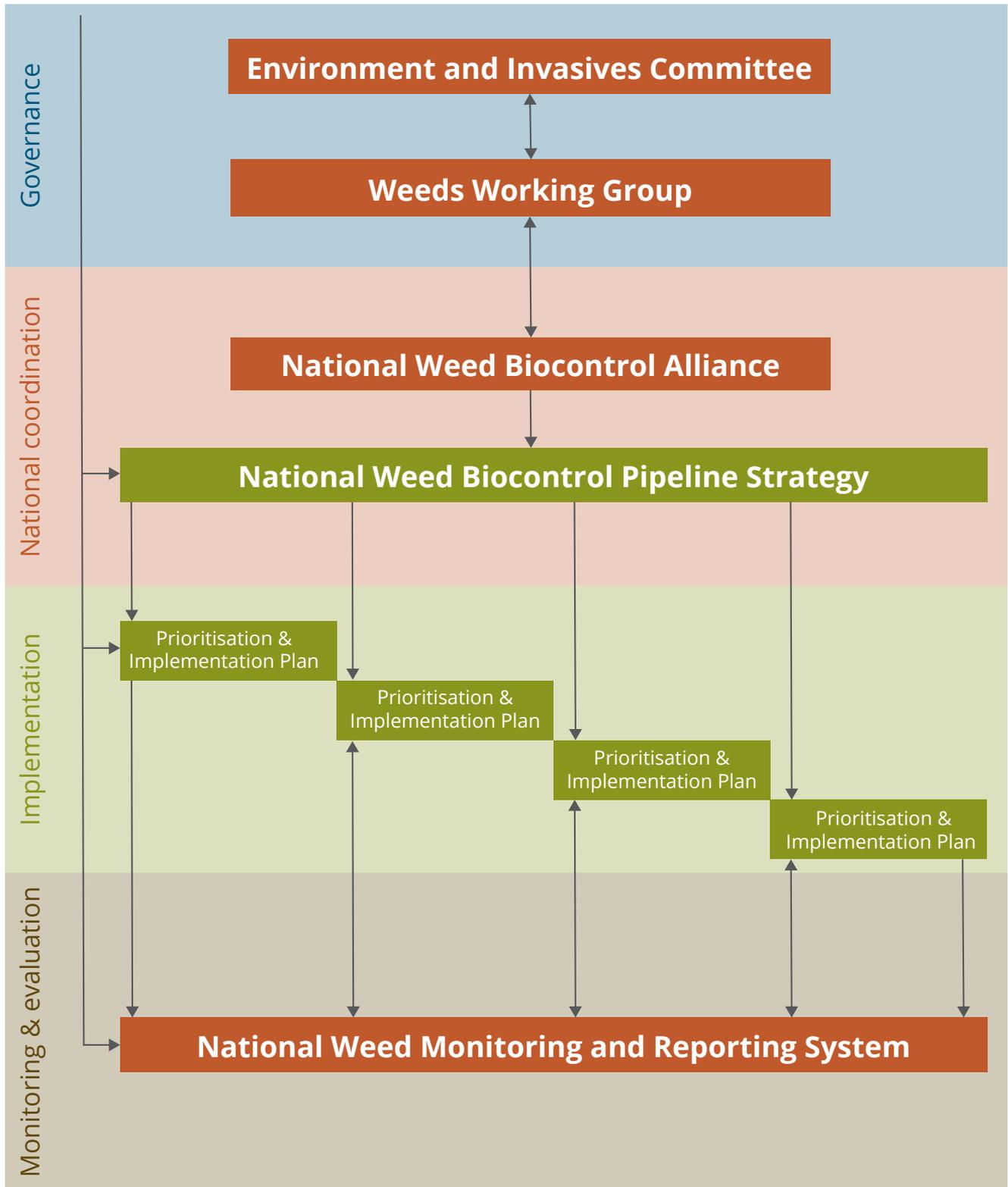


Figure 2: Structure and delivery of the National Weed Biocontrol Pipeline Strategy



Parkinsonia leaf-defoliating pug moth (UU1) in the field after release; Weed - Parkinsonia aculeata; Photo – CSIRO.

Prioritisation of weed candidates for investment

The first initiative under the strategy will be to undertake a critical review of existing weed biocontrol prioritisation^{14,15} and decision support frameworks¹⁵ that have been developed previously for the Australian context. The prioritisation framework will identify priority weed candidates for biocontrol RD&E investment based on a combination of their threat status and prospects of biocontrol (feasibility × likelihood of success).

It is proposed that the prioritisation framework will comprise three distinct stages:

Stage 1 – identifying high threat weeds. Through guided elicitation with government, weed and natural resource management experts (NB – biocontrol research practitioners are intentionally not included at this first stage), criteria will be developed for selecting weed candidates for biocontrol RD&E based on their threat to environmental, social and agricultural assets/values. Listed high threat weeds from each state/territory jurisdiction will also be incorporated into this Stage 1 analysis. This will include existing and new Weeds of National Significance (WoNS) identified through the National Established Weed Priorities framework.

It is important to note that the approved ABARES decision support tool for weed biocontrol prioritisation¹⁶ recommends that a national prioritisation framework also considers the threats of weeds outside of the WoNS program – for example by including emerging weeds with high threat potential and weeds that are considered priorities by a limited number of jurisdictions and stakeholder groups that do not necessarily meet the criteria for national significance under the Established Pests and Diseases of National Significance framework.

Stage 2 – assess biocontrol prospects for high threat weeds. The biocontrol prospects (feasibility × likelihood of success) will be then assessed for the high threat weeds identified under Stage 1 by weed biocontrol research practitioners. Weed prospects will then be combined with the weed threat status (from Stage 2) to derive a subset of most promising and high value weed candidates for potential future biocontrol RD&E investment. The rationale for these assessments will be robust, transparent, repeatable, and defensible across experts, jurisdictions and sectors, and include estimates of knowledge gaps and uncertainties influencing priority outcomes to allow future refinement.

Stage 3 – categorising prioritised weeds along the RD&E biocontrol pipeline, i.e., Phase I (native range surveys), Phase II (risk assessment, host-specificity testing) and Phase III (mass-rearing and release), Phase IV (monitoring and evaluation).

The draft list of prioritised candidate weeds for biocontrol RD&E and subsequent implementation plans will be coordinated by the Alliance, reviewed by the Weed Working Group and submitted to EIC for endorsement. Also, high priority weeds for which no previous biocontrol research has been undertaken in Australia will be nominated as candidates for biocontrol research through the EIC, to ensure there are no foreseen significant stakeholder conflicts.

Prioritisation will be repeated toward the end of each 5-year RD&E cycle (described below) to improve and inform the development of subsequent implementation plans. Any recommended changes to the prioritisation process or prioritised list of candidate weeds would be submitted to WWG for review and EIC for endorsement.

5-year implementation plans

Each 5-year implementation plan will be informed by the outputs from the prioritisation framework and outline specific research activities that need to be undertaken to deliver novel biocontrol solutions for the agreed weed targets.

Implementation plans will aim to ensure that research efforts are equitably distributed across the four biocontrol pipeline research phases (Figure 3). This

will maintain a sustainable pipeline of biocontrol research across the 5-year implementation cycles, and balance risk and reward for prospective investors.

Within 5-years, this strategic research will seek to deliver novel biocontrol solutions for priority weed targets, leading to a measurable reduction in weed threats and enhance the condition of environmental and agricultural assets across Australia.

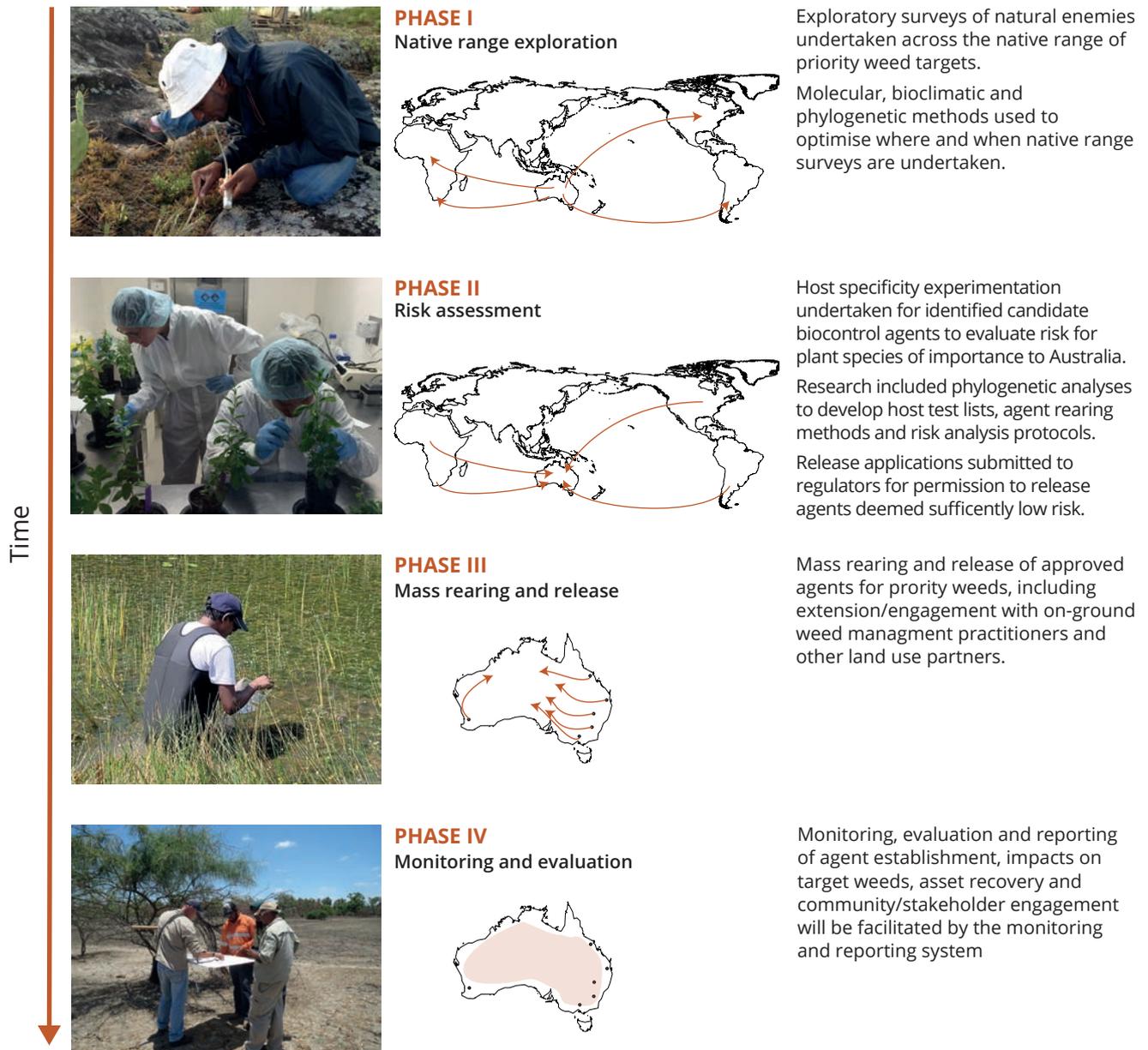


Figure 3: Biocontrol pipeline research and delivery phases

Top to bottom: Tahina Rajoanera collecting biocontrol agents on mother-of-millions (*Kalanchoe delagoensis*) in the native range of Madagascar. Source: NSW DPI; Person in photo – Tahina Rajoanera (PhD student).

Quarantine host specificity testing for a rust fungus on African boxthorn (*Lycium ferocissimum*). Source: CSIRO; People in photo – Kylie Ireland and Gavin Hunter.

Releasing biocontrol agent weevil into a dam infested with *Cabomba* (*Cabomba caroliniana*). Source: CSIRO; Person in photo – Kumaran Nagalingam.

Inspecting *Parkinsonia* (*Parkinsonia aculeata*) infestation on property for biocontrol agents using a beat sheet in North-western Queensland. Source: CSIRO. Person in photo – Andrew White and council weed officers.

Monitoring, evaluation and reporting to improve biocontrol delivery

Stakeholder consultation has identified the need for a critical review of current digital weed biocontrol monitoring and evaluation systems for improved on-ground monitoring of weed biocontrol agent release activities, their establishment and spread, impacts on host weeds and asset responses at a national scale.

This strategy proposes a series of stakeholder workshops, coordinated by the Alliance, to explore opportunities for enhanced functionality of existing digital infrastructure (e.g., Atlas of Living Australia's Biocontrol Hub), better integration of multiple species-capture data streams (e.g., through the ALA-iNaturalist Australia partnership^{17,18} and other developing platforms such as WeedScan), and consideration of data collection standards and metrics.

Consultation has identified the importance of a dynamic, user friendly interactive digital monitoring and evaluation system to enable real-time, on-ground capture of weed biocontrol activities by weed management practitioners and community groups, especially to support the delivery of biocontrol mass release and redistribution programs. There is also an opportunity to explore the application/deployment of emerging weed surveillance systems in weed biocontrol monitoring and evaluation, such as satellite remote sensing, drones, image recognition and machine learning/artificial intelligence technologies.¹⁹

Governance and coordination

The national weed biocontrol strategy, revised prioritisation framework and suggested list of prioritised candidate weeds will be sponsored by the EIC (Figure 4) (or any other designated sub-committee or working group of the National Biosecurity Committee as relevant) and aligned with its Australian Weed Strategy 2017–27, and the Australian Government's Threatened Species Strategy 2021–2031.²⁰ This unified approach, integrated into Australia's national biosecurity system, is a necessity if Australia is to mitigate the negative impact of weeds.

The WWG would first approve the National Weed Biocontrol Alliance's terms of reference, structure, membership base, and role in providing advice to the EIC on the strategy. The WWG would also have oversight of the development of the strategy and its associated prioritisation framework, with EIC to sponsor and endorse the strategy, any recommendations for national weed biocontrol research investment priorities and implementation activities undertaken by the Alliance through the rolling 5-year implementation plans. The Alliance will play a key role in implementation of the prioritisation framework and approved implementation plans, with oversight of progress regularly reviewed by WWG as required.

The overarching strategy will work within the existing (and future) legislative framework governing weed biocontrol research in Australia. This includes nominating to EIC, via WWG candidate weeds for biological control research, importation and testing permits for prospective biocontrol agent risk assessment, approved arrangement for biocontrol containment facilities, host test list development, and approval of agents for release into the Australian environment following independent risk analysis by federal regulators.

Prickly acacia gall thrips damage;
Weed - Vachellia nilotica subsp. Indica;
Photo - QDAF.



Environment and Invasives Committee

Weeds Working Group

A National Weed Biocontrol Alliance

Activities

- Formation and development of Terms of Reference for Alliance
- Critical review of existing prioritisation methodologies
- Expert advice to WWG on matters related to weed biocontrol

Outputs for endorsement

- Final weed biocontrol pipeline strategy
- Prioritisation framework
- Priority biocontrol candidate weed list
- Implementation plans
- Monitoring and reporting system

Stakeholder engagement and specialist consultative groups convened as required for input on Alliance activities

Figure 4: Governance relationships and Alliance outputs that will go through WWG to EIC for endorsement. Note – this schematic does not include existing weed biocontrol RD&E activities related to EIC, such as nominating weeds as candidates for biocontrol.



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Jatropha gall midge on bellyache bush;
Weed - *Jatropha gossypifolia*; Photo - QDAF.

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