CENTRE FOR
INVASIVE SPECIES
SOLUTIONS

ANNUAL REPORT 2021–22

A CELEBRATION OF THE CENTRE'S FIRST 5-YEAR RD&E PORTFOLIO

COLLABORATION | INNOVATION | IMPACT

The Centre for Invasive Species Solutions gratefully acknowledges the financial and in-kind contributions made by its members, associate members and partners.

We are a not-for-profit, member-based organisation formed to address the impact of invasive plants and animals across Australia.

The Centre is governed and managed by Invasive Animals Ltd with an independent skills-based Board of Directors. Bruce Christie is the Chair of the Board and Andreas Glanznig is the Centre's Chief Executive.

We acknowledge the Traditional Custodians of the lands on which we meet and work and pay our respects to Elders — past, present and emerging.

We acknowledge all Aboriginal and Torres Strait Islander peoples and their continuing connection to country, culture and community.

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Cover images
Front — Elena Smertina, a participant in the Centre's Balanced Research Program (left); feral rabbit (centre); Greg Mifsud, the Centre's National Wild Dog Management Coordinator, providing hands-on wild dog management training (right), credit Gillian Basnett.

Back — Prickly pear (left); Rock wallaby (centre); sheep grazing (right).

CONTENTS

SECTION 1

STRATEGIC OVERVIEW

1.1 MESSAGE FROM THE CHAIR

Does anyone remember the last drought? Some thought it would never end. I'm old enough to remember many droughts and you can bet that after every drought some things are certain. The first is, it rains. Sometimes it rains a lot, and we get floods. I was in Alice Springs in 1973–75. They used to say if you saw the Todd River flow three times, you'd live in Alice forever. It rained and flooded across the country for three years on that occasion and the Todd River flowed for months. We've got another three-year flood crisis happening now.

Regardless of whether we get floods or not, you can be certain there will be an increase in invasive species numbers and their negative impacts at the end of the drought — feral animals, weeds, mosquitoes, diseases spread by insects and locusts. The difference this time was that in addition to the usual plagues that occur after a drought, just to make it a bit more interesting we've had the COVID plague.

Five years ago, this company and its members, associate members and partners set out on a challenging journey to undertake an RD&E program that would help to reduce the impact of invasive species across the country and despite all of the obstacles thrown at us, drought, floods and Covid, I'm proud to say that this Annual Report tells a great story of how different groups and organisations from around Australia have worked together to achieve these amazing results. This report is the Centre's moment in the sun.

The independent impact assessment and evaluation of our first five-year RD&E portfolio gave the Centre a glowing commendation. It found the Centre has been "a highly successful organization" and demonstrated the value of nationally coordinated and collaborative invasive species RD&E.

The numbers speak for themselves with Portfolio No. 1 on track to deliver a net value of nearly $395m with a strong Benefit Cost Ratio of 5.1 to 1 and ensured strong leverage of the core $20 million Commonwealth grant with $2.93 of State, industry and research organization cash and in-kind resources invested for every $1 of Commonwealth investment to scale the portfolio.

This effort would not have been possible without the strong and diverse collaboration of 22 core members, associate members and partners, and I thank you for your trust and hard work to make our national collaboration work. I would like to single out the Commonwealth Department of Agriculture, Forestry and Fisheries — formerly the Department of Agriculture, Water and the Environment — who enabled our Centre to transition from a CRC into an on-going organization. Australia is so much better for this sound judgement.

Looking ahead, we continue to work hard to bridge the transition from our 2017–2022 Portfolio No. 1 to our next strategic RD&E portfolio. Based on advice from our members, our planned portfolio gives equal weight to invasive animals and weeds, and we are also aiming to strengthen our work in the environmental biosecurity space while maintaining our core RD&E programs tackling established pests such as rabbit biocontrol.

Maintaining the Centre's momentum will also enable the very smart PhD graduates of our Balanced Researcher Program to put their nous and skills to good use. I was privileged to recently meet many of them, who praised our Program and its importance in delivering a 96% PhD completion rate which is an incredible achievement in anyone's language. These industry ready graduates will be vital to our future 21st Century ready biosecurity system.

Biosecurity is all about managing the risks to economy, environment and the community from pests, diseases and weeds and there are plenty around. What is not always clear to everyone is how interdependent the world of biosecurity is. You rarely get a pest or a disease that only impacts on the economy, the environment or the community. Usually, they impact on all three in some way. Take Foot and Mouth Disease (FMD) for example. It's topical because the risk of it getting here has risen slightly. Its main impact is on livestock production, but feral pigs and deer could impact on our ability to control or eradicate it. I could use many other examples of this interdependence but let's stick with FMD.

Over many years we have invested in Animal Health Australia (AHA) and Plant Health Australia (PHA) to make sure we are ready if one of the major exotic agricultural industries pests or diseases makes it into Australia. FMD, if it made it to Australia is estimated to have a potential negative impact on our economy of $80 billion over 10 years. That's $8 billion a year for 10 years. Investing in AHA and PHA makes good sense.

But what if I told you that we already have something in Australia that is causing around $25 billion in losses every year, not including most of the environmental losses, and that something is invasive species.

As someone who has worked for over three decades strengthening both a State and national biosecurity system, I know how important the present Centre and its RD&E we is to our biosecurity future, but. as I've discussed with many of you, it could also do so much more if it were to become the equivalent of AHA and PHA for the environment and invasive species.

The Centre is a proven and unique institution. But time is short. Our national collaboration model now has seven months to successfully bed down a new strategic RD&E portfolio to deliver the next tranche of solutions needed by Australian farmers, land and environmental managers, community groups and government agencies. I implore you to support the Centre to continue with its RD&E and to look closely at what else we can offer the invasive species and environmental biosecurity areas.

I encourage you to join our journey.

Finally, I would like to especially thank David Palmer for his long service and dedication to the Centre. David has been a Director since 2013 and the Company has benefited immensely from his strategic insights and leadership for nearly a decade. I would also like to thank the Centre's management team for their hard work and dedication in making the Centre such a success to date.

Bruce Christie
Chairman

1.2 MEMBERS & PARTNERS

MEMBERS

- Australian Government, Department of Agriculture, Fisheries and Forestry
- Government of South Australia
- NSW Government
- Queensland Government
- Victoria State Government
- CSIRO
- ACT Government
- Tasmanian Government
- Government of Western Australia
- mla Meat & Livestock Australia

ASSOCIATE MEMBERS

- invasive species council
- NRM Regions Australia
- Nature Foundation
- Rabbit-Free Australia
- Woolproducers Australia

PARTNERS

- The University of Adelaide
- awi Australian Wool Innovation Limited
- University of Canberra
- Department of Conservation Te Papa Atawbai
- La Trobe University
- Murdoch University
- une University of New England

Much of the remant habitat for the Superb Parrot is degraded, with regeneration of nest trees prevented by overgrazing from stock and rabbits, by inappropriate fire regimes and by the lack of eucalypt recruitment. Credit Suzannah Macbeth.

1.3 CEO's SNAPSHOT

The 2021–22 Annual Report comes at an important watershed moment. The Centre's first five-year RD&E portfolio is complete and a truckload of new tools, systems and better management strategies are now being rolled out. The range and number of invasive species and technologies that we work on make the Centre different from many other RD&E collaborations that have a narrower focus.

This was brought home for me at our recent Portfolio No. 1 showcase, which celebrated the achievements of over 150 researchers and the 17 government, industry and research organisations that formed the Portfolio's engine room. This included eDNA and digital surveillance tools, evaluations of potential rabbit and tilapia biocontrol agents, new control tools, great progress on our nascent genetic biocontrol program, as well as our important community engagement tools and national coordinators who work tirelessly to accelerate adoption of best practice management.

I and the Centre team would like to especially commend the efforts of the over 150 researchers and engagement staff that have enabled the Centre to succeed.

One of many areas where the Centre pushed the knowledge and technology frontier, and played a vital role in nurturing nascent technologies, is in genetic surveillance. In 2011 — as the former Invasive Animals CRC — we were heavily scrutinised by our CRC rebid assessment panel for wanting to back the development of eDNA detection of invasive species, based on an argument that it was too blue-sky and a long way from any applied application. A decade on, genetic surveillance is now common place, PCR or Polymerase Chain Reaction is part of our vernacular, and the work of our strategic research partner — University of Canberra — has led to real time, portable eDNA technology being rolled out to greatly improve the efficiency of detecting major biosecurity threats both at the border as well within Australia. We are proud that this strategic partnership has now matured, with University of Canberra hosting the new National eDNA Reference Centre. Onwards and upwards.

Underpinning the Centre, a small and fabulous management team has ensures its wheels have turned smoothly over the past five years. I would like to publicly thank you for always going above and beyond. The Centre's completion of Portfolio No. 1 also coincides with the departure of two key staff. Associate Professor Richard Price, who in his role as Portfolio Director, was a major driving force for our portfolio and ably guided it from inception to our recent celebration. It's success and performance has been greatly fostered by his deep understanding of driving large-scale RD&E collaborations, and bringing out the best in his team and broad researcher network. I would also like to thank Catherine Walsh, our Weeds R&D Manager for her efforts in helping shape our proposed weeds RD&E portfolio.

Andreas Glanznig
CEO

Cats have been the primary contibutors to over two-thirds of the 34 mammal species that have become extinct since European settlement. Credit Simon Ferguson.

1.3 CEO's SNAPSHOT

5 YEARS OF RESEARCH, DEVELOPMENT AND COMMUNITY ENGAGEMENT

The problem

Invasive species decrease agricultural productivity

- The cost and damage from vertebrate animals is about $600 million/year[1]
- The cost and damage from weeds is about $5 billion/year[2]

Invasive species are the #1 pressure on Australia's threatened species.[3]

Have high or medium impact on 42% of nationally listed threatened species[4]

The solution

The Centre for Invasive Species Solutions is a national collaborative research, development and engagement organisation, formed to tackle the ongoing threat from invasive species through achieving adoption of new innovation and transformational technologies.

Member and partner organisations:

9 Governments

1 CSIRO

5 Universities

62 Institutions involved as third parties to our research

2 Research and development corporations

5 Industry, NRM and conservation NGOs development corporations

Community adoption

606 pest management groups

Strategic pest management outcomes enhanced by the data collection undertaken by 606 pest management groups using FeralScan, and by connecting these groups with government land managers.

3 national pest animal coordinator positions

The Wild Dog, Feral Deer, and new Feral Cat and Fox National Coordinators are hosted by the Centre, with a National Feral Pig Coordinator hosted by Australian Pork Limited.

3 PhD submitted
1 Masters

Research

PROJECTS

56 PROJECT ARE UNDERWAY: (31 ARE FUNDED UNDER PORTFOLIO NO. 1)

9 PROJECTS COMPLETED

PUBLICATIONS PRODUCED

5 TECHNICAL REPORTS

SCIENTIFIC PUBLICATIONS **28***

Development

PRODUCTS IN DEVELOPMENT

- PASSIVE ACOUSTIC SURVEILLANCE DETECTION KIT PROTOTYPE FOR STARLINGS
- FERAL DEER SPECIFIC AGGREGATOR
- **2** WEB SCRAPERS TO MONITOR E-COMMERCE SITES
- COMPUTER VISION ID APP AND WEEDSCAN MANAGEMENT PLATFORM
- NEW REAL TIME eDNA TECHNIQUES (Red-eared slider turtle, Asian black spined toad, Kaphra beetle, Myrtle rust and invasive ants)
- 'PROOF OF ABSENCE' ERADICATION TOOL SOFTWARE PACKAGE **1**
- **1** AUDIO LURE TRAP FOR ASIAN BLACK SPINED TOADS AND STARLINGS
- **1** LINE OF GENETICALLY MODIFIED ZEBRA FISH
- **1** ARTIFICIAL INTELLIGENCE TRAINED THERMAL IMAGING ANALYSIS FOR FERAL PIGS AND DEER

Engagement

FACE TO FACE

272 STAKEHOLDER WORKSHOPS CONDUCTED

1 CERTIFICATE III COURSE IN PEST ANIMAL MANAGEMENT – REDEVELOPED

DIGITAL

PESTSMART
FERALSCAN
WEEDSAUSTRALIA
COMMUNITYINVASIVESACTION

×4 NATIONAL DIGITAL PLATFORMS IN USE

38,805+ FERALSCAN USERS

324,390 PESTSMART WEBSITE VIEWS

303,643 FERALSCAN RECORDS

233,229 WEEDSAUSTRALIA PAGE VIEWS

1 McLeod, R. (2016). Cost of Pest Animals in NSW and Australia, 2013-14. eSYS Development Pty Ltd. Report prepared for the NSW Natural Resources Commission.

2 McLeod, R. (2018). Annual Costs of Weeds in Australia. eSYS Development Pty Ltd. Published by the Centre for Invasive Species Solutions, Canberra, Australia.

3 Kearney, S. G., Carwardine, J., Reside, A. E., Fisher, D. O., Maron, M., Doherty, T. S., ... & Wintle, B. A. (2019). The threats to Australia's imperilled species and implications for a national conservation response. Pacific Conservation Biology, 25(3), 328-328.

4 Ward M, Carwardine J, Yong CJ, Watson JE, Silcock J, Taylor GS, et al. A national□scale dataset for threats impacting Australia's imperiled flora and fauna. Ecol Evol. 2021.

* Within the 2021–22 financial year.

1.4 INVASIVE SPECIES SOLUTIONS TRUST

The Invasive Species Solutions Trust has completed its first full financial year. The work of aligning the work of the Centre with a philanthropic approach is progressing well. From a marketing perspective we have progressed from statements about 'how' to alleviate the threat of invasive species to a focus on 'why' such an approach is needed. That 'why' is the need for the Centre: to protect threatened species, the environment and support primary producers. In conjunction with the Communications Team the Centre's website content and navigation has been refreshed to align with this paradigm shift, and new functionality has been stood up to enable the payment of electronic donations with receipts for donors generated automatically. Four videos have also been created: a five-minute introductory video accompanied by three 30-second social media videos. All four have been well received.

The highlights of the Trust's first full year were it's launch at an in-person event held at Government House, Canberra, in the midst of the COVID19 pandemic, and a promotional breakfast meeting at the 2nd Australian Biosecurity Symposium held on the Gold Coast. Both functions led to positive discussions with potential supporters. The year also saw the final components required to operationalise the Trust fall into place. The Invasive Species Solutions Trust is now registered with the Australian Charity and Not-for-profits Commission and has obtained a licence to fundraise in all Australian states where registration is needed.

During the first financial year, although not actively recruiting donations, the Trust was supported through the generosity of a number of donors. The Trustees are committed to actively using donations as they are received and thanks to these donors, three PhD students who are part of the Balanced Researcher Program were granted Leadership Development Bursaries to assist them in their career.

The coming financial year will open up new opportunities to approach potential donors and businesses for donations or sponsorships. Our research made it clear that potential donors did not wish to support programs that they saw as Government responsibility. During 2021–22 the Centre identified a number of programs that urgently need startup investment or an injections of extra funds to reduce the impact of invasive species. We know that the more rapidly the impact of invasive species is reduced the greater the potential to save threatened species. Every decade over four threatened species are lost.

AREAS WHERE SUPPORT IS SOUGHT

Name of Program Area	Sample Projects
25 Million Eyes	Through a national engagement program establish a community awareness program to involve them in general biosecurity surveillance.
Weeds	Opportunities are available to increase the number of weeds on the WeedScan App or to support the mobilization of groups committed to reducing the number of harmful weeds in Australia.
Genetic Biocontrol	Breakthroughs in genetic biocontrol have opened the door to expanding the biocontrol from mice to rats and rabbits. Co-investors are needed to join us.
Building Future Leaders	The Centre is seeking to create a pipeline of future research leaders by updating educational programs, promoting kids' conferences on invasive species science, and supporting scholarships for PhD students.
Predator Proofing Partnerships	Partners are sought to create a National Coalition of investors committed to reducing the impact of predatory invasive species.

Attendees at the launch of the Invasive Species Solutions Trust, Government House Canberra.

Trust Patron, Her Excellency Mrs Linda Hurley.

Leadership Development Bursary recipients: Elena Smertina (University of Canberra; left), Katherine Hill (The University of Adelaide; centre) and Adam Toomes (The University of Adelaide; right).

If you are in a position to work with us to lessen and control the impact of invasive species on our threatened species, our environment and our primary producers, please contact:
Trevor Capps, Fundraising Manager
(02) 6201 5509
trevor.capps@invasives.com.au

FIA ORGANISATIONAL MEMBER CODE COMPLIANT

REGISTERED CHARITY acnc.gov.au/charityregister

1.5 THE YEAR IN PHOTOS

CEREMONY FOR THE CLOSING OF THE FERAL CAT FENCE AND OTHER ACTIVITIES AT THE KANGAROO ISLAND OCTOBER 2021

Kangaroo Island Landscapes Board, Kangaroo Island Land for Wildlife, Australian Wildlife Conservancy, and SA Parks and Wildlife, along with local landholders are undertaking a range of measures to protect Kangaroo Island's wildlife such as the threatened Kangaroo Island Dunnart from predation by feral cats.

LAUNCH OF THE INVASIVE SPECIES TRUST LAUNCH 1 DECEMBER 2021

The launch of the Invasive Species Solutions Trust by Her Excellency Mrs Linda Hurley at Government House Canberra.

THE NSW & VIC COMBINED WEEDS CONFERENCE 21–24 MARCH 2022

The Centre was a sponsor of NSW and Victorian combined Weeds Conference in Albury NSW and hosted an exhibition booth.

THE 2022 NATIONAL CONFERENCE OF THE NATIONAL FARMERS FEDERATION 5–6 APRIL 2022

The Centre hosted an exhibition booth at Sustaining the Nation, the 2022 National Conference of the National Farmers Federation in Canberra.

THE 2ND ANNUAL BIOSECURITY SYMPOSIUM 3–5 MAY 2022

The Centre was a partner in the delivery of the 2nd Annual Biosecurity Symposium held on the Gold Coast, hosting a stakeholder breakfast and an exhibition booth.

1.6 THE YEAR IN REVIEW

JULY 2021

AUGUST 2021

National Feral Cat and Fox Coordinator, Gillian Basnett, appointed.

Draft Feral Deer Action plan presented to the Environment and Invasives Committee — a sectoral committee of the National Biosecurity Committee.

SEPTEMBER 2021

OCTOBER 2021

NOVEMBER 2021

Centre's first Invasive Weeds RD&E Manager, Catherine Walsh, appointed.

Tilapia biocontrol susceptibility trials and business plan completed

Release of the joint report with CSIRO: **Fighting plagues and predators**

Release of **Genetic Biocontrol Technology for Pest Vertebrates**

DECEMBER 2021

The Invasive Species Solutions Trust officially launched at Government House by Her Excellency Linda Hurley.

JANUARY 2022

FEBRUARY 2022

MARCH 2022

Release of the **Benefits of Rabbit Biocontrol in Australia report**

APRIL 2022

Nearly 150,000 WildDogScan reports secured from landholders, pest controllers and biosecurity groups Australia-wide. photo

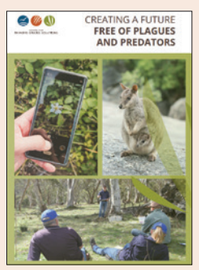
The Centre's ThermEye (thermal detection algorithm) used as a part of the survey in Queensland.

Passive acoustic surveillance towers installed in two locations in Western Australia for the detection of starlings, using the Centre's detection algorithm.

MAY 2022

2nd Annual Biosecurity Symposium held on the Gold Coast. The Centre held an exhibition booth, stakeholder breakfast and participated in several plenary events, including the launch of the Decade for Biosecurity.

Release of **Creating a future free of plagues and predators**



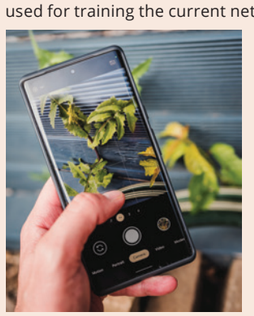
Digital Surveillance of Illegal Wildlife Trade prototype tested by a group of government end users and is ready for finalisation.

JUNE 2022

Progressive upgrade of the PestSmart portal and development of the WeedsAustralia portal guided by the Centre's 2015 Digital Strategy.

eDNA varroa mite assay licensed to CSIRO to detect extent of outbreak in New South Wales.

Artificial Intelligence WeedScan ID app trained by CSIRO to recognise approximately 300 priority weed species across Australia. WeedScan test site is a functioning web application. Training of the artificial intelligence system has progressed with over 52,000 photographs used for training the current network.



1.7 CENTRE DOMAINS

INNOVATION DOMAIN 1: INCURSIONS

The Centre's Incursions Domain focuses on RD&E associated with new vertebrate pest threats arising from illegal importation and keeping, escape from legal keeping, and as hitchhikers in the international movement of goods and people. The Incursions Domain currently includes six RD&E projects aimed at developing new and innovative detection and surveillance techniques, along with management strategies to ensure Australia's environment and agricultural industry is protected from new pest threats.

Key Outcomes

- Submission to the Commonwealth government of InvasivePlan as the National Incursion Management Framework for Invasive Species enabling:
  - jurisdictions to better understand the roles and responsibilities associated with prevention and detection in the animal and plant incursion space.
  - improved recognition of what is required to increase efficiency and effectiveness of responses to new animal and plant incursions of national significance.
- Adoption by State Government departments of:
  - Internet monitoring systems to best inform the surveillance, compliance and disruption of illegal pet trade sales and networks, and
  - Biogeochemical analysis of alien seizures (illegal confiscations and at-large captures) for direct evidence-based means to provenance new incursions.
- Design of complementary surveillance approaches that combine community surveillance and targeted surveillance using passive and active sensing technologies to detect and manage vertebrate pest incursions in a timely manner.
- Adoption of rapid detection tools (particularly eDNA) that can be deployed in the field for targeted high-risk invasive animal species.
- Better decision making around eradication responses resulting in more successful and cost-effective eradications of invasive pests that maximise the economic benefits to industry and the environment. This is achieved through adoption of purpose-built decision-support software and user guides for guiding the response and allocation of resources during an eradication response.
- Improved ability to assess, prioritise, act, and guide resource investment in post-border incursion management.
- Improved prioritisation for development of a standardised, multi-functional, integrated assessment/decision-making model (or toolkit) that practitioners may use to assess their specific state/territory incursion management actions.
- Submission to the Commonwealth government of a National Incursion Response Plan for the Asian Black Spined Toad.

INNOVATION DOMAIN 2: INTEGRATED LANDSCAPE MANAGEMENT

The Centre's Landscape Domain focuses on RD&E associated with established vertebrate pests that continue to cause considerable impact to Australia's agricultural industries, the environment, and the well-being of its communities. The Landscape Domain has two sub-groups, one focussed on wild dog management and the other on management of deer, and currently includes six projects targeted at developing knowledge of pest animal management to develop strategies that are solutions-oriented and provide direct benefits to farmers on-ground farmers and protects the environment.

Key Outcomes

- Increased and improved adoption of cost-effective feral deer management best practice. For example:
  - Information and data generated by the project are being used in real-time by land managers to guide feral deer control activities.
  - Also, though not a primary aim of the project, the application of scat genotyping techniques has been widely requested by local councils and other organisations (e.g. NSW Department of Primary Industries) to support their deer management programs.
- Improved information and data on the total annual impact costs of feral deer that may be used by analysts to prioritise, monitor and evaluate feral deer RD&E.
- Access by biosecurity agencies to new and improved EAD models to improve decision-making and management of both endemic and exotic diseases that affect invasive species and that may impact livestock and other Australian species.
- Enhanced capacity of local government agencies and other relevant stakeholders to implement improved/optimized strategies for management and control of peri-urban feral deer and wild dogs.
- Enhanced capacity of wild dog management agencies to:
  - access expanded stakeholder networks,
  - tap into a database of necessary predator, livestock and native prey abundance and impact data, and
  - ensure activities and outputs are delivered through additional co-investment commitments.
- Better prioritisation, decision-making and resource allocation for cluster fencing by landholders, NRM groups and governments across Australia through increased understanding of the effects of:
  - landscape scale control of predators,
  - cell fencing, and
  - management of water availability.

1.7 RESEARCH, DEVELOPMENT & ENGAGEMENT DOMAINS

INNOVATION DOMAIN 3: BIOCONTROL

Classical biological control of vertebrate pests using self-disseminating viral agents has served Australia well as the basis of cost-effective continental scale management, particularly for rabbit management. The Centre's Biocontrol Innovation Domain currently includes five projects, two of which are major new projects that will continue to implement the 20-year rabbit biocontrol pipeline. The other projects are associated with RD&E of biocontrol options for tilapia and the possibility of using genetic technologies for pest animal management.

Key Outcomes

- Landholders and other rabbit management personnel can better utilise the existing APVMA approved RHDV1-K5 biocide within an environment where RHDV2 is prevalent.
- Researchers are better able to prioritise and deliver rabbit biocontrol pipeline research, including new and improved biocontrol agents, through implementation of an improved path for the identification, evaluation, and registration of rabbit biocontrol tools.
- Researchers and regulatory personnel can identify and prioritise additional RD&E for biocontrol of tilapia in Australian waterways.
- Researchers, regulatory personnel, and other key stakeholders are better placed to assess and prioritise applications of gene drive technology.

INNOVATION DOMAIN 4: MANAGEMENT TOOLS AND SYSTEMS

The Centre Management Tools and Systems Domain is associated with funding optimal, cost-effective pest animal management tools. Currently four projects have been directly funded under the Tools Domain but there also are a number of aligned projects funded through other, external grants (such as Agricultural White paper funding) that also feed into the Tools Domain.

Key Outcomes

- Adoption of the species-specific feral deer aggregator to enhance control of feral deer populations in Australia.
- Working version of passive acoustic surveillance and automated detection tools for starlings, and potentially other pest species, and providing great than 95% detection accuracy.
- Registration process is well advanced to deliver multi-state uptake of an APVMA approved, 1080-based bait for broad-scale feral cat control.
- Progress has been made towards registration of priority baits for feral deer and goat management using selective feeders.

INNOVATION DOMAIN 5: COMMUNITY ENGAGEMENT AND EDUCATION

Invasive species detection and management relies on adoption of best practice strategies. Landholders, governments and other stakeholders must be sufficiently motivated and empowered, and have the capacity and capability, to change behaviours/ practices and adopt new approaches and tools. the Centre has funded a number of projects under its Community Engagement and Education Innovation Domain to enhance community engagement with invasive species management and provide user-friendly information. Further, investments under the Community Engagement and Education Domain are building capacity with postgraduate studies to ensure they have the skills for the future workforce.

Key Outcomes

- Increased adoption of landscape-scale, nil-tenure best management practices for wild dog control.
- Implementation of improved surveys by behavioural scientists and wild dog management coordinators that contribute to reducing constraints to the adoption of existing wild dog management strategies.
- Adoption by landholders and other interested parties of new, enhanced web- and app-based pest surveillance, detection, and alert systems.
- Communities can access new and improved resources that connect land managers to services, supporting organisations, pest control practitioners, regional organisations, and access to the latest pest control technologies.
- Farmers, community-groups, local governments and regional stakeholders adopt new and improved packaged toolkits and pest animal data resources.
- Implementation of the National Feral Deer Action Plan to reduce the negative impacts of feral deer.
- A cohort of new, trained wild dog coordinators that go on to increase and capability of invasive species management.
- A cohort of post-graduate students that will proceed to increase the capacity and capability of invasive species research in Australia.
- Increased community knowledge and awareness of invasive species impacts and management best practice through engagement with the Centre digital community platforms including PestSmart and WeedAustralia.

INNOVATION DOMAIN 6: WEEDS

The Commonwealth Grant Agreement for Portfolio No. 1 specified that the Grant would be used to create and manage a portfolio of projects associated with invasive vertebrate animals, invasive weeds, and, over time, other invasive species groups as appropriate. The initial Portfolio No. 1 Grant was intended to focus primarily on research and innovation activity on invasive vertebrate pest solutions and to undertake strategic planning to scope a weed management research and innovation investment plan. The following investments were funded under Portfolio No. 1 to meet the Centre's requirement for initial scoping for strategic investment in future weeds RD&E.

Key Outcomes

- Improved efficiency and effectiveness of monitoring and surveillance of the illegal plant trade into and out of Australia.
- Contribution to improved preparedness and detection of potential invasive species incursions through the illegal plant trade.
- Expected contribution to reduced impact costs from WoNS through increased effectiveness and efficiency of WoNS managed with the availability and extension of up-to-date WoNS manuals.
- Expected increased effectiveness and efficiency of RD&E associated with WoNS chemical, mechanical and biological control through identification of gaps in control methods for different weed species.

1.8 STRATEGY & APPROACH

THE CENTRE IS FOCUSING ON FOUR STRATEGIC AREAS, DESIGNED TO LEAD TO EIGHT STRATEGIC SHIFTS.

STRATEGIC AREA	STRATEGIC SHIFT
1. Leveraging, leading and amplifying invasive species outcomes through strategic collaborations.	• Growth across national and international collaboration • Creation of critical mass for greater impact.
2. Advancing large-scale coordination and breakthroughs by designing integrated solutions that encompass research, innovation and community engagement.	• Translation of technologies across species • Scaling solutions and impact.
3. Building communities of impact by accelerating their capability and adoption of best management practices.	• Increased land manager and community engagement • Increased adoption of cross-tenure and landscape scale management.
4. Striving for greater efficiency and effectiveness through strong internal governance, operations and financial management, purposeful communication and skilled staff.	• Longevity of investment across sectors • Enhanced recognition of our brand value.

WE ARE A COLLABORATION OF

9 Government Departments *And* CSIRO | **5** Universities | **5** Not-For-Profit Organisations | *And* **2** Research and Development Corporations...

...working together to reduce the impact feral animals, weeds and pathogens by creating innovative solutions.

We coordinate applied and blue-sky research on invasive species

Building better tools and systems to control invasive species

- New real time eDNA techniques to identify the emerging pest species
- New biocontrol agents for pest animals
- Genetic biotechnology 'proofs of concept'
- Novel toxins
- Management strategies that work
- Web scrapers to monitor illegal trade in plants and wildlife on e-commerce sites

And improving management practices and invasive species planning with

- The PestSmart and Weeds Australia websites that provide Australians with up-to-date practical management information.
- The FeralScan website and suite of apps that allow Australians to record pest management activity at a local level.
- A world-first computer vision ID app and website that will allow Australians to identify and manage invasive weeds. We call it WeedScan and it's coming in 2023.
- A network of National Coordinators that support communities across Australia to manage wild dogs, feral cats, foxes and deer.

weedSCAN weedsAUSTRALIA pestSMART feralSCAN

And why do we go to all this effort?

So that...

Australian's can take **effective, coordinated action** on feral animals, weeds and pathogens.

There are **fewer incursions** of new invasive species.

The **control measures** are effective, efficient and humane.

There is **less chance** that Australia's threatened species will become extinct.

The cost of managing invasive species drops and **farm productivity** rebounds.

SECTION 2

RESEARCH, DEVELOPMENT & ENGAGEMENT

RESEARCH, DEVELOPMENT & ENGAGEMENT

2.1 OUR RESEARCH, DEVELOPMENT & ENGAGEMENT

The Centre's RD&E effort is focused on both prevention and early response to new and emerging invasive species, and strategic landscape scale management of established vertebrate and weed pests. Our 56 RD&E projects — 31 of which were funded under Portfolio No. 1 — all address national biosecurity and invasive species RD&E priorities. The projects' outputs aim to strengthen strategic responses to vertebrate pests and weeds challenges in the following areas:

- Incursion prevention and response, through:
  - development of response tools and systems, and
  - development of detection tools.
- Integrated landscape management and empowering action, through
  - a coordinated Feral deer RD&E program,
  - a coordinated Wild dog RD&E program, and
  - other pest management tools and services.
- Biocontrol technologies and systems, through
  - a Rabbit biocontrol program,
  - evaluation of potential tilapia biocontrol agents
  - advancement of a nationally coordinated approach to vertebrate pest genetic biocontrol.

The research and development section is divided to highlight achievements against the three areas above, supplemented by achievements in cross sectoral capacity building and RD&E planning.

COLLABORATION

Collaboration is the key to developing and scaling solutions that arise from, and must be implemented in, complex operating environments. For this reason, around 85% of the Centre's Portfolio No.1 projects involve between two and ten collaborating organisations. Collaboration is an important part of ensuring research outputs translate into innovation, positive outcomes and impact by i) designing solutions that take into account multiple perspectives, ii) building different pathways to adoption tailored to the different operating environments in which decisions are made, and iii) coordinating and clearly communicating about new solutions from the sources considered most credible to different stakeholders.

WORKING TO AND FACILITATING NATIONAL PRIORITIES

All Centre RD&E projects are designed to address national biosecurity priorities, such as those agreed to by the National Biosecurity Committee (NBC) and its Environment and Invasives Committee (EIC). In some cases, however, documented priorities are dated, or new ones are yet to be agreed. In these cases, the Centre can play a role in facilitating and setting future priorities, such as through the preparation of a 10 Year National Investment Plan for Weeds RD&E, which involved considerable national consultation, and through assisting the Office of the Chief Environmental Biosecurity Officer prepare a National Environment and Community Biosecurity RD&E Strategy.

MONITORING, EVALUATION, AND REPORTING

Since early 2018 the Centre has had a Research Excellence and Impact Framework to guide its monitoring, evaluation, and impact assessment activities. The primary elements of the Framework implemented to date cover detailed monitoring of project progress against a range of inception to impact criteria, prospective impact assessments, for example for our rabbit and wild dog programs, and coordination of a mid-term review of overall Portfolio No.1 progress.

The impact of the investment in projects co-funded by the Department of Agriculture, Fisheries and Forestry under Portfolio No. 1, has been independently assessed by Talia Hardaker (ACRE Economics) in association with Peter Chudleigh (Agtrans). These assessments were based around the themes of economics, environment and social. These project summaries include the impact types identified to calculate the economic impact of Portfolio No. 1 RD&E outputs and services.

Economic benefits are represented by the **graph** icon, Environment by the **leaf** icon and Social by the **people** icon.

2.2 INVASIVE ANIMALS PORTFOLIO

2.2.1 DETECTION AND INCURSION RESPONSE

THE CHALLENGE

Global trade and illegal imports (including e-commerce) will rise markedly over the next decade causing a major increase in incursion risks. These risks are already significant, with 1,551 biosecurity incidents covering 138 vertebrate species between 2010-2015. The most commonly intercepted vertebrate hitch hiker is the Asian black-spined toad.

The incursion risk is further amplified by non-native plants and ornamental birds, reptiles and fish which are already in Australia, but are yet to naturalise in the Australian landscape: this includes over 5,900 non-native plant species already in Australia have weed histories overseas. This large reservoir of potential future weeds is the driver for about 20 new weeds naturalising in the environment each year or 1 every 18 days.

THE SOLUTION

Our incursions prevention and response investments aim to protect Australia's economy, environment and social amenity from the impacts of new pest animals and invasive plants through the following proposed outputs delivered by the end of 2022.

OUTPUTS

DETECTION TOOLS

- Real time eDNA detection tools
- Passive/ Active surveillance systems
- Acoustic detection tools
- Thermal imagery detection tools

Outputs driving action

Incursions of new pest animals are detected through an ongoing national surveillance network in time to mount feasible responses

RESPONSE TOOLS

- Illegal trade surveillance tools for pest animals and weeds
- Cost-effective decision tools for eradication proof-of-absence
- FeralScan Red-eared slider turtle and Corn-snake incursion tracker
- AI-based weed identification app and WeedScan community alert system
- InvasivesPlan
- Asian black-spined toad incursion response plan

New pest animal incursions of national significance are subject to successful eradication programs

- Jurisdictions, industry and the community working together to protect Australia from border and post-border incursions
- Effective interventions are in place nationally for key international and domestic ways of new pest animals

Outputs driving impact

DETECTION AND INCURSION RESPONSE

P01-I-001 DEVELOPMENT OF A NATIONAL INCURSION MANAGEMENT FRAMEWORK FOR INVASIVE SPECIES

Project status: Completed

IMPACTS

ECONOMIC

- Improved efficiency of resource allocation for invasive species responses.
- Reduced total impact costs of new incursions through more rapid and coordinated responses.

ENVIRONMENTAL

- Reduced risk of environmental damage from the incursion and the exotic invasive species potentially becoming established.

SOCIAL

- Increased capacity of invasive species response managers.

2021–22 ACHIEVEMENTS

The Invasive Plan Framework ('the Plan') covers a broad range of species across the terrestrial and freshwater groups but does not include marine pests and diseases. The accompanying Compendium is a manual for implementing the Plan.

The Centre's Invasive Plan project started in 2018, following endorsement of a project plan by the Invasive Plants and Animals Committee (IPAC) in 2017. Dr Michelle Christy, the National Incursion Prevention and Response Facilitator (NIPRF), led the development of the two key outputs: the Invasive Plan and its Compendium. The project ran for 12 months and delivered a National Vertebrate Incursion Data Curation and Summary, and a communication plan.

Both the Plan and Compendium are 'living documents' that need to be maintained and updated. The Environment and Invasives Committee Plan owns the Plan. It endorsed the Plan and Compendium in 2019.

LEADERS

Dr Michelle Christy | WA Department of Primary Industries and Regional Development; and Dr Malcolm Kennedy formerly with WA Department of Primary Industries and Regional Development.

PARTNERS

WA Department of Primary Industries and Regions, Department of Primary Industries and Regions SA, Vic. Department of Economic Development, Jobs, Transport and Resources, Tas. Department of Primary Industries, Parks, Fisheries and forestry, NSW Department of Primary Industries, Australian Government Department of Agriculture, Fisheries and Forestry.

AIM

To understand roles and responsibilities with respect to the prevention and detection of invasive animal and plant incursions. It also aimed to improve recognition of what is required to increase the efficiency and effectiveness of responses to new animal and plant incursions of national significance.

DETECTION AND INCURSION RESPONSE

P01-I-006 DEVELOPMENT OF A NATIONAL INCURSION MANAGEMENT FRAMEWORK FOR ASIAN BLACK-SPINED TOAD

Project status: Completed

IMPACTS

ECONOMIC

- Improved efficiency of resource allocation for Asian black-spined toad (ABST) incursion responses.
- Reduced total impact costs of new incursions of ABST.
- improved effectiveness to develop future plans for other amphibian invasive species.

ENVIRONMENTAL

- Reduced risk of environmental damage from the incursion and potential establishment of ABST.

SOCIAL

- Increased capacity for invasive species response managers responsible for ABST.

2021–22 ACHIEVEMENTS

A response plan for Asian black-spined toad was delivered to the Environment and Invasives Committee (EIC) Vertebrate Pest Working Group. The plan included:

- an introduction setting out the general context of the plan's purpose, who it targets, and where and how it sits under existing national biosecurity frameworks
- background on the species' biology
- assessment of the incursion and establishment risk, including its potential pathways into Australia
- tools and techniques that include design and data recording, detection and delineation, containment and eradication, and euthanasia
- disease, parasite and infection risks
- workplace health and safety
- regulatory requirements.

LEADER

Dr Michelle Christy | WA Department of Primary Industries and Regional Development

PARTNERS

WA Department of Primary Industries and Regions, and Department of Agriculture, Fisheries and Forestry.

AIM

To develop a national incursion response plan for the Asian black-spined toad as a model for other invasive amphibian response plans.

DETECTION AND INCURSION RESPONSE

P01-I-002 UNDERSTANDING AND INTERVENING IN ILLEGAL TRADE IN NON-NATIVE SPECIES

Project status: Completed

IMPACTS

ECONOMIC

- Reduced invasive species monitoring and surveillance costs.
- Reduced total impact costs of new incursions by identifying and prioritising threats.

ENVIRONMENTAL

- Reduced risk of environmental damage from the incursion and the exotic invasive species potentially becoming established

SOCIAL

- Increased capacity for government invasive species managers.

2021–22 ACHIEVEMENTS

This project, along with its sister project P01-W-003, was completed during 2021–22. Activity was focused on testing and finalising a tool for monitoring illegal trade.

The project found Australia's current biosecurity surveillance and management systems are not keeping up with the growing demand for novel species. The diversity and scale of the trade is much greater than previously realised. Most of the domestic Australian trade in exotic pets and ornamental plants occurs without regulation or documentation.

In consultation with government stakeholders and scientists, the project captured websites that may be used in illegal trade. Social media sites were excluded. This project then:

- constructed automated monitoring systems for 93 'open-web' websites (i.e. ecommerce sites, stores and forums) in Australia, the US, Europe and Japan
- collected more than 7 million unique online wildlife advertisements at a rate of c. 2.5 million advertisements per year
- constructed a user-friendly website – Digital Surveillance of Illegal Wildlife Tracking (DIWT) (https://diwt.org) – to query our database and enable registered users to receive email alerts
- used the dataset of online advertisements to report on several case studies on the illegal plant and animal trade in Australia, and the growing trade in live invertebrates as pets.

Based on 7,203,971 advertisements as of 12 May 2022, this project found:

- Most advertisements came from websites from the United States (c. 4.8 million ads), followed by Australia (c.1.6 million).
- Classifieds and forum websites comprised c. 91% of all advertisements, followed by lost-and-found sites (c. 5%), then pet stores and plant shops (c. 3%).
- The median rate of new advertisements per website was 2,400 ads per year per website.
- Classifieds websites, on average, had 20 times more advertisements (median c. 20,000 ads per year per website) than online pet stores and plant shops (median c.1,000 ads per year, per website).
- One Australian classifieds website contained most advertisements collected from Australia (c. 78%; c. 491,000 ads per year).

With the rapid increase in ecommerce, Australia can expect more environmental biosecurity threats to emerge, requiring substantial surveillance and enforcement efforts.

LEADER
Associate Professor Phill Cassey | University of Adelaide

PARTNERS
University of Adelaide, CSIRO, Victorian Arthur Rylah Institute for Environmental Research, Department of Primary Industries and Regions SA, Australian Museum, and Department of Agriculture, Fisheries and Forestry.

AIM
To develop a comprehensive understanding of the nature of exotic pet keeping and illegal vertebrate species trade in Australia, which will lead to preventing the incursion of new alien species.

DETECTION AND INCURSION RESPONSE

P01-I-004 REAL TIME eDNA TOOLS TO IMPROVE EARLY DETECTION AND RESPONSE APPROACHES FOR HIGH-RISK PEST ANIMALS

Project status: Completed

IMPACTS

ECONOMIC

- Reduced biosecurity monitoring and surveillance costs.
- Reduced total impact costs by quickly and accurately detecting and responding to new incursions.
- More effectively containing and eradicating an invasive species where a detection occurs.
- Increased effectiveness of resource allocation for future eDNA research, development and extension.

ENVIRONMENTAL

- Reduced risk of environmental damage from the incursion and the exotic invasive species potentially becoming established.

SOCIAL

- Increased scientific knowledge and research capacity for eDNA.

2021–22 ACHIEVEMENTS

The National eDNA Reference Centre (NRC) at the University of Canberra was established in 2022 building on its national leadership role fostered by the Centre.

This project aims to create a tool using environmental DNA (eDNA) surveillance for biosecurity and wider border protection.

Developing a specific approach for the Asian black-spined toad (ABST) was a project highlight. The approach can differentiate between genetically different individuals from Indonesia and elsewhere in South-East Asia. This is a key component in detecting ABST and determining the origin of captured specimens before they enter Australia.

Validating eDNA methods on environmental water sources was challenging because there are no current ABST incursions in Australia. As such, the project team collaborated with researchers in Indonesia. Water samples were collected around the campus of Institut Pertanian Bogor (IPB University). ABSTs were detected at six of the 11 sites where presence was unknown.

Assistance from international collaborators also enabled red-eared slider turtle (REST) tissue to be sourced. The project could then sequence data and primers to detect both REST and ABST.

EcoDNA (ecodna.org.au) is a new website that gives end-user organisations information, updates on studies, and is a direct point of contact for enquiries.

LEADER
Professor Dianne Gleeson and Dr Elise Furlan | University of Canberra

PARTNERS
University of Canberra, NSW Department of Primary Industries, and Department of Agriculture, Fisheries and Forestry.

AIM
To develop an enhanced detection method for aquatic invasive species, both those that are identified as high-risk and those that could potentially pose a biosecurity risk, using real-time environmental DNA sampling techniques.

DETECTION AND INCURSION RESPONSE

A-019 BIOSECURITY MOLECULAR SCREENING

Project status: Completed

2021–22 ACHIEVEMENTS

Environmental DNA (eDNA) monitoring collects, amplifies, and identifies trace amounts of DNA species shed into the environment. eDNA is an effective tool for identifying the presence or absence of invasive species, particularly the aquatic environment.

This project comprised four phases. Each phase was built on the outputs of the previous and developed a range of assays to detect species that are biosecurity concerns for Australia. The Department of Agriculture, Fisheries and Forestry funded the project.

A total of 15 assays were developed over the four phases of the project (Table 15).

Table 15: List of assays developed for the eDNA detection of species of concern.

Phase	Target species
1 & 2	*Dactylogyrus extensus*
	Dactylogyrus extensus+ vastator
	Argulus sp.
3	*Khapra beetle eDNA-16S*
	Khapra beetle eDNA-NADH6
	Khapra beetle eRNA-NADH6
	Yellow crazy ant *Anoplolepis gracilipes 1*
	Yellow crazy ant *Anoplolepis gracilipes 2*
	Tropical fire ant *Solenopsis geminata*
	Electric ant *Wasmannia auropunctata*
4	Asian honeybee, *Apis cerana*
	Dwarf honeybee, *Apis florea*
	Asian and dwarf assay
	Varroa mite, *Varroa destructor*
	Asian honeybee varroa mite, *Varroa jacobsoni*

Several assays were deployed to detect the Yellow crazy ant in Queensland and in response to the current varroa mite incursion in New South Wales. The assay to detect the khapra beetle was also deployed for screening shipping containers coming into Australian ports.

LEADER
Professor Dianne Gleeson and
Dr Alejandro Trujilo-González | University of Canberra

PARTNERS
University of Canberra and Department of Agriculture, Fisheries and Forestry.

AIM
To develop a real time eDNA protocol to detect biosecurity threats quickly and easily through international trade.

DETECTION AND INCURSION RESPONSE

UA-032 NSW ENHANCE PREPAREDNESS

Project status: Ongoing

2021–22 ACHIEVEMENTS

This project seeks to improve capability to screen and diagnose pests and diseases that pose a risk to New South Wales primary industries. These rapid and scalable diagnostic tests will support the sampling regime of a biosecurity response. A consolidated list of over 200 priority species has been developed. The project seeks to develop detection assays over its 5-year life.

LEADER
Dr Brendon O'Rourke | NSW Department of Primary Industries

PARTNERS
NSW Department of Primary Industries

AIM
Improved capability to screen and diagnose pests and diseases using a combination of targeted and multiplexed testing and to strengthen response and tracing capability by building analysis pipelines for whole genome sequencing.

DETECTION AND INCURSION RESPONSE

P01-T-002 AUTOMATED DETECTION: TRIGGERING SMARTER, FASTER, BETTER RESPONSE TO INCURSIONS

Project status: Completed

IMPACTS

ECONOMIC

- Increased effectiveness of monitoring and surveillance of invasive starlings in Western Australia.
- Improved efficiency of resource allocation for invasive starling responses in Western Australia.
- Reduced total impact costs of new starling incursions through improved detection.
- Contribution to faster and more accurate detection of other invasive species through the use of passive acoustic surveillance (PAS).

ENVIRONMENTAL

- Helped avoid negative environmental outcomes from future invasive species incursions by improving detection that allows for more effective responses.

SOCIAL

- Increased scientific knowledge and research capacity has been developed for PAS technology.

2021–22 ACHIEVEMENTS

This study aimed to create and trial a passive acoustic surveillance (PAS) technology to detect starlings, other pest species such as the Asian black-spined toad (ABST), and potentially threatened species. This technology may be useful in preventing high-risk invasive species from establishing in both developed and developing nations.

The project successfully installed and operated permanent PAS towers for starling surveillance in WA at Bremer Bay (April 2022) and Gibson (May 2022). These PAS towers operate with proven end-to-end acoustic signals communication over the Telstra Narrow Band Internet of Things (NB IoT) network to cloud servers.

The detection range of recording units investigated through playback trials revealed starling playback calls up to 130 metres from the PAS. The project team also proved remote connection to both devices for algorithm and firmware updates, microphone (gain) testing, and soundscape recordings. It remotely downloaded around two hours of field recording to validate playback investigations. These were extra features outside of the original scope. Project partner DKB Solutions Australia delivered these features at no extra cost.

Machine learning

The Australian Institute of Machine Learning designed and implemented this highly accurate and precise bioacoustics-based starling call recording and recognition system. The one-dimensional convolutional neural network (CNN) method produced the detection model. Installing desktop run-time CNN code in Adelaide has enabled ongoing re-training of Model_2 with ‘real life’ false positives returned from PAS towers in WA and archived recordings from SongMeter units.

Model training

The starling detection algorithm is being licensed to various state environment departments. It will be retrained to detect threatened and endangered species such as the western ground parrot, the Bassian thrush and the Australasian bittern.

The first version of a similar bioacoustics-based detection system for the ABST has been trained on recordings provided by collaborators in India, Indonesia and Madagascar. We have collated and annotated an international reference library for the ABST, which comprises:

- 561 positive files
- 523 negative files
- 194 files containing background only (no target).

This collation has enabled the development of ABST Model_0. The project team can now retrain this ABST Model_0 with fresh ‘test’ data from the species’ extensive global range.

Overseas deployment

The team still has five BAR-Lt (Frontier Labs, QLD) acoustic recorders with collaborators in Singapore. However, due to COVID-19 disruptions, the team could not reconnect with researchers to redeploy these units. It will be important to test the ABST Model_0 with examples from throughout the species’ range. This includes situations where multiple ABST individuals are chorusing concurrently, other frog calls and signal sources, and overlapping calls of the target species.

LEADER

Dr Susan Campbell | WA Department of Primary Industries and Regional Development

PARTNERS

WA Department of Primary Industries and Regional Development, DKB Solutions and Specialised Zoological, and Department of Agriculture, Fisheries and Forestry.

AIM

To demonstrate the benefits of using Passive Acoustic Surveillance (PAS) technology by deploying multiple units in key locations, building on the development of an automated remote detection system for starlings and Asian black-spined toad in the CSIRO sister-project.

DETECTION AND INCURSION RESPONSE

P01-T-003 AUTOMATED THERMAL IMAGERY ANALYSIS PLATFORM FOR MULTIPLE PEST SPECIES

Project status: Completed

IMPACTS

ECONOMIC

- Increased effectiveness of monitoring and surveillance for invasive species over large land areas.
- Reduced impact costs of invasive species through more effective management and improved monitoring
- More effective resource allocation for incursion responses due to increased capability in large area monitoring and surveillance.
- Reduced total impact costs of invasive species incursions by improving detection that allows for more effective responses.

ENVIRONMENTAL

- Contribution to reduced negative environmental impacts from invasive species through more effective management helped by improved monitoring and surveillance

SOCIAL

- Increased scientific knowledge and research capacity developed for thermal imaging and automated analysis algorithms.

2021–22 ACHIEVEMENTS

This project set out to use thermal imagery and artificial intelligence to identify vertebrate pests. Automated computer software systems can analyse large imagery datasets quickly and accurately.

The 'ThermEye' analysis algorithm was developed and proven through field testing. To secure the intellectual property, trademarking of ThermEye is underway.

The ThermEye platform has been improved by retraining the algorithm and refining the user-interface software with extra training data, including additional footage of target species, target species under different conditions (canopy, climate, geography), and new species. ThermEye can identify and differentiate between sheep, cattle, deer, goats, rabbits and kangaroos.

As ThermEye is designed for ecologists and land managers to use, not IT professionals, it requires a logical and easy to navigate user interface. Tom Low from TomCat Technologies refined the user interface. The final version became available in June 2022.

Using ThermEye in the field

In May 2022, the Queensland Thermal Survey was conducted over three days. It targeted feral pigs and macropods in a 392 km^2 site comprising open grazing with some cereal cropping and forested areas. While the data has not been fully analysed, there were substantially more sightings of feral pig groups than the surveys completed on the site in 2021. This site also contains high macropod densities, particularly of eastern grey kangaroos, and a low-density, localised population of red deer.

In June 2022, the WA Northampton Thermal Survey targeting feral pigs and deer was conducted over four days in a c. 842 km^2 survey area comprising mostly cropping and grazing land with scattered low shrub and heath. ThermEye was used in the field to analyse footage on the same day, allowing 'near real-time' data analysis. Selected areas where deer were sighted were followed up with thermally assisted aerial culling, demonstrating the integration of ThermEye into landscape management.

LEADER

Dr Peter Adams | WA Department of Primary Industries and Regional Development

PARTNERS

WA Department of Primary Industries and Regional Development, NSW Department of Primary Industries, QLD Department of Agriculture and Fisheries, Charles Sturt University, Thomas John Low.

AIM

Development of automated analysis platform compatible with multiple thermal sensors and specific to multiple target species.

DETECTION AND INCURSION RESPONSE

P01-I-003 DEVELOPMENT OF INTEGRATED PASSIVE AND ACTIVE SURVEILLANCE

Project status: Completed

IMPACTS

ECONOMIC

- Reduced risk of Asian black-spined toad incursion and establishment, and its associated triple-bottom-line impact costs.

SOCIAL

- Increased scientific knowledge and research capacity.

2021–22 ACHIEVEMENTS

Australian citizens are increasingly involved in helping monitor exotic species being introduced into Australia. This project aims to bring citizen science together with other forms of scientific monitoring to deal with surveillance challenges throughout Australia.

The most common pathway for exotic vertebrates to enter our ecosystem will continue to be pets escaping or being released, analysis shows. It's uncommon for these animals to enter our ecosystem without assistance. The range of species kept legally is diverse. Many reptile species are kept illegally.

Tools that allow citizens to share photographs of animals increase the likelihood of exotic species being reported. This is challenging with most difficult-to-photograph species, although FrogID capitalises on their readily identifiable calls.

The study also evaluated the effectiveness of citizen surveillance for mammal, bird, reptile, amphibian, and fish vertebrate groups.

Birdwatching

The network of citizen birdwatchers is far-reaching, with surveillance extending well beyond urban environments. The network has detected pest species such as Canada geese and escaped aviary birds. One failure was the entry of the common starling into WA, highlighting a need to develop targeted surveillance tools. The passive acoustic surveillance (PAS) technology being developed in this project for starlings (with more details available from the project P01-T-002) is helping to fill this surveillance gap.

Reptiles and amphibians

For reptiles and amphibians, the smooth newt in Melbourne was first detected by citizen surveillance. However, despite many citizen reports, red-eared slider turtles and corn snake groups became well-established – wary of humans and hence difficult to control. Citizens continue to be highly engaged in frog surveillance using FrogID.

Through citizen science initiatives such as FrogID, we are confident a new incursion of Asian black-spined toads (ABST) will be detected if the incursion occurs close to an urban location. The project has explored two forms of active surveillance in a collaborative research partnership with IPB University (Indonesia) and James Cook University – an extension of the PAS approach applied to starlings – and the development of acoustic cage traps.

A Queensland trial that focused on major ports and industrial areas where shipping containers are first opened deployed 20 acoustic cage traps set in suitable ABST habitat during the most favourable breeding conditions. No ABSTs were detected.

Since this deployment, research has identified:

- improvements to trap construction and placement
- that camera traps be used in combination with acoustic traps to detect movement
- that visual searching of high-risk sites during summer rainfall events is worthwhile.

Education campaigns to help people correctly identify invasive species of concern and vertebrates could help reduce costs associated with false-positive reports arising from species misidentification while improving citizen observations.

LEADER

Dr Peter Caley | CSIRO

PARTNERS

CSIRO, WA Department of Primary Industries and Regional Development, University of Adelaide, QLD Department of Agriculture and Fisheries, University of Canberra, Victorian Arthur Rylah Institute for Environmental Research, and Department of Agriculture, Fisheries and Forestry.

AIM

To develop a coherent, complementary approach for combining community surveillance and targeted surveillance using passive (for example community sighting) and active sensing (for example eDNA) technologies to detect and manage pest incursions in a timely manner.

DETECTION AND INCURSION RESPONSE

P01-I-005 TOOLS FOR DEVELOPING COST-EFFECTIVE DECISIONS FOR MANAGING INVASIVE PEST ERADICATIONS

Project status: Completed

IMPACTS

ECONOMIC

- Reduced total costs for containment and eradication programs.
- Reduced total impact costs of invasive species new and existing incursions.

ENVIRONMENTAL

- Reduced total environmental damage from current and future incursions of exotic invasive species.

SOCIAL

- Increased capability of invasive species managers.

2021–22 ACHIEVEMENTS

This project aimed to develop an evidence-based approach for managing invasive pest eradications.

In biosecurity policy, early intervention to eradicate pest incursion requires intensive investment and offers high potential returns on that investment. After deciding to eradicate a pest, managers must decide how to proceed, and when to cease the program and declare success. These decisions are usually based on subjective reasoning rather than scientific evidence.

The Eradication Response Framework (ERF) comprises three phases:

1. **Feasibility:** use basic information on pest species biology, the extent of the incursion, and the control methods used to work out whether eradication is likely to be feasible for its cost.
2. **Progress:** use information collected while undertaking activities to monitor progress, such as estimating residual population size at each stage and calculating simple metrics that convey the level of population impact of control activities.
3. **Proof of absence:** Once pests are no longer detected, how much more monitoring is needed to declare successful eradication? How confident are we that the pest has been eradicated?

Web-based decision-support tools were developed to target each ERF phase. Each tool allows information to be uploaded, including:

- spatial data on the region of interest (GIS shapefile)
- locations of monitoring devices and surveillance information
- spatial information on risk of occurrence and habitat suitability (raster file).

An eradication primer documents different stages of the ERF and the quantitative approach used to manage pest eradication programs. Comprehensive user guides have been prepared.

Eradication feasibility tool (EradSim)

A theory for obtaining quantitative support for eradication success uses analytical Bayesian methods to provide:

- quick calculations of eradication success
- optimal surveillance
- likely residual population size, given zero-pest detections.

A new analytical method and software were developed to calculate the detection probability of Judas animal monitoring. This can be combined to infer the probability of successful eradication if no wild individuals were detected.

The eradication feasibility tool modifies earlier versions of TrapSim to include multiple control methods and control costs. This lets the user explore the cost-effectiveness and feasibility of scenarios to control a population to a desired level. The app, 'EradSim', is currently available at: https://landcare.shinyapps.io/EradSim

Eradication progress tool

The ERF progress was tested on aerial culling of deer in East Gippsland as part of an Australian-funded bushfire recovery project. Lessons from this project will be used to refine the Centre's eradication progress app for aerial and ground culling of hoofed mammals.

Proof of absence tool

Managers from Hawke's Bay Regional Council (HBRC) in Napier, New Zealand used the proof-of-absence tool to design a surveillance system for their possum eradication program on the Māhia Peninsula. The research team worked with HBRC staff to assess two networks of leghold traps and trail cameras. They also explored the effect of variable parameters on the overall system-level sensitivity and probability of possum absence. This work gave the managers more confidence that their surveillance design is fit for purpose.

LEADER

Dr Dave Ramsey | Victorian Arthur Rylah Institute for Environmental Research

PARTNERS

Victorian Arthur Rylah Institute for Environmental Research, CSIRO, University of Adelaide, Vic. Department of Economic Development, Jobs, Transport and Resources, Manaaki Whenua Landcare Research, New Zealand, and Department of Agriculture, Fisheries and Forestry.

AIM

To improve the capability of government agencies to make successful and cost-effective eradication decisions to maximise the economic benefits to industry and the environment.

2.2.2 INTEGRATED LANDSCAPE MANAGEMENT

THE CHALLENGE

Wild dogs

Wild dogs are the single biggest threat holding back sheep production in Australia and are a major cause for the contraction of the rangeland sheep grazing industry. They also cause major impacts to other livestock industries and peri-urban communities. Large-scale cooperative management strategies are critical to reversing this trend.

Other predator pests

Foxes, cats, pigs, and other vertebrate pests continue to wreak environmental havoc and damage to agricultural assets across the country. In many cases these pests are experienced in tandem with each other as well as with deer and wild dogs. This reinforces the need for landscape scale solutions, as well as strategies that ensure the solution to managing one pest species does not create a void for other pest species to fill.

Feral deer

The six deer species established in Australia are expanding in abundance and range. While agricultural, environment and social impacts are increasing rapidly in many regions, there is currently little knowledge on the most cost-effective management strategies, and no best-practice guidelines for managing deer anywhere in Australia.

THE SOLUTION

Our integrated landscape management program aims to see a reduction in the economic, environmental and social costs associated with invasive species through development and demonstration of large-scale integrated management strategies. The program has a specific target towards developing new and improved tools for wild dog and feral deer management and empowering communities to take collective action. Projects such as Prep-for-Reset also consider the challenge of managing multiple pest species.

National coordination is an important element of our activities as a means of applying consistent and practices proven through both diverse and collective experience, and in galvanising the critical mass in community responses needed at the landscape scale. We have National Coordinators for wild dogs, feral deer, and most recently, feral cats and foxes.

OUTPUTS

Deer Outputs

			Outputs driving action
Understanding impact	Economic impact of deer in Australia	Role of deer in hosting exotic livestock disease	Quantification and evidence supporting a call-to-action for landscape scale management of deer
New tools	Feral deer aggregator		Availability of tools fit for purpose specific to deer
Optimising management	Developing best management strategies for deer in rural environments	Developing management strategies for deer in peri-urban environments	New codes of practice and standard operating procedures for deer management
Community management	National Deer Management Coordinator	Wild DeerScan monitoring and reporting alerts	Best management practice guides and management toolkits
			Outputs driving impact

Wild Dog Outputs

				Outputs driving action
Understanding impact	Evaluation of the National Wild Dog Action Plan	Assessment of the biodiversity, economic and productivity benefits of cluster fences		Quantification and evidence supporting a call-to-action for landscape scale management of wild dogs
New tools	PAPPPutty™ based lethal trap devices	Innovative wild dog alert technology	Innovative automated Intelli-traps	Availability of tools fit for purpose for managing wild dogs
Optimising management	Developing landscape scale best management strategies for dogs in a multi-predator context	Developing management strategies for dogs in peri-urban environments		New codes of practice and standard operating procedures for wild dog management
Community management	National Wild Dog Management Coordinator	Behaviourally effective community engagement strategies for managing wild dogs	WildDogScan monitoring, reporting and alerts	Best management practice guides and management toolkits
				Outputs driving impact

WILD DOGS AND OTHER PREDATORS

INTEGRATED LANDSCAPE MANAGEMENT: WILD DOGS AND OTHER PREDATORS

P01-L-004 PREPARING FOR RESET LANDSCAPE-SCALE PREDATOR MANAGEMENT [PREP4RESET]

Project status: Completed

IMPACTS

ECONOMIC

- Contribution to reduced impact costs of endemic invasive animal species (largely predatory species such as dogs, foxes and cats).
- Contribution to more effective invasive species management resource allocation.
- Increased effectiveness of resource allocation for landscape-scale invasive species monitoring, evaluation, reporting and improvement processes.

ENVIRONMENTAL

- Contribution to reduced negative environmental impacts of predatory invasive animals, including reduced or avoided loss of biodiversity, and reduced landscape and habitat damage through improved invasive species management.
- Contribution to maintained or improved animal welfare.

SOCIAL

- Contribution to maintained social licence to operate for invasive species managers by increasing community awareness and understanding of invasive species and their impacts and best management practice.

2021–22 achievements

This project addresses predator management across large areas. As a baseline for long-term monitoring of management effectiveness, the Prep4Reset project provides the essential framework to:

- synthesise existing multi-predator management research
- build and maintain stakeholder networks
- collect important pre-treatment predator (wild dogs and foxes), faunal and livestock impact data.

The body of work the project collected since 2017 represents the achievements of the largest and longest-standing vertebrate pest research team in Australia. The research and monitoring undertaken covers a large footprint across multiple tenures, and has contributed to:

- improved baiting practices
- policy and legislation
- codes of practice and standard operating procedures
- advances in animal welfare
- improved trapping practices and policies
- developing new toxins and tools
- improved monitoring practice and camera trapping standards
- international animal welfare policy recommendations.

Resulting changes

This project has led to changes in practice regarding aerial baiting. Practitioners recognise the benefits of increasing aerial bait rates for wild dog control. Practitioners also now recognise the benefit of better data collection. In some locations, this recognition has increased the adoption of the FeralScan app for property owners and the opportunity to expand this application to improve data collection on private lands.

A key behavioural shift has been land managers accepting scientific findings on predator ecology, including activity and behaviour. Engagement in radio-tracking studies has provided valuable interpretive tools to bridge the information gap between researchers and land managers.

Findings

Findings from this project:

- show the targeted native species most likely to be preyed upon by dogs
- show foxes should be acutely monitored to study population responses to control efforts
- show how predator and prey populations fluctuate over time
- indicate how dogs, foxes and feral cats interact
- demonstrate that dingoes do not suppress foxes and feral cats in tableland and coastal ecosystems
- demonstrate that the control effort of wild dogs has not been satisfactory to reduce and maintain low relative abundance of populations
- indicate the population trajectory of native species, including quolls, in landscapes where control activities are undertaken
- show the response of predators and prey to large-scale wildfires and the time needed to recover following habitat disturbance.

Overall, the project found that implementing parallel monitoring programs administered by research groups during pest-control activities provided a more robust and independent analysis of efficacy. The sheer volume of spatial and temporal data required by land managers to accurately measure effort, success and failure is impossible for agencies and private landowners to implement because of logistics, costs, resourcing, and technical capacity.

LEADER

Dr Paul Meek | NSW Department of Primary Industries

PARTNERS

NSW Department of Primary Industries, NSW Local Land Services, Meat and Livestock Australia, Australian Wool Innovation, and Department of Agriculture, Fisheries and Forestry.

AIM

To synthesise research and collect before-control predator, wildlife and livestock impact data to enable the planning, implementation and evaluation of the Full Reset project. Prep4Reset also supports crucial networking to generate financial and time co-investment from multiple stakeholders in the Full Reset project.

INTEGRATED LANDSCAPE MANAGEMENT: WILD DOGS AND OTHER PREDATORS

P01-L-003 MANAGEMENT OF WILD DOGS AND DEER IN PERI-URBAN LANDSCAPES: STRATEGIES FOR SAFE COMMUNITIES

Project status: Completed

IMPACTS

ECONOMIC

- Increased efficiency of wild dog and wild deer management practices in peri-urban areas.
- Reduced impact costs of wild deer and wild dogs in peri-urban areas through improved control methods and strategies.
- Reduced impact costs of wild deer and wild dogs through increased collaboration, cooperation, and knowledge sharing for management efforts between jurisdictions.
- Reduced impact costs of related invasive species, such as foxes, through improved awareness, understanding, and by adopting integrated multi-species pest animal management.

ENVIRONMENTAL

- Increased animal welfare through increased and improved adoption of best practice management, ensuring high welfare outcomes.
- Contribution to improved environmental outcomes, such as reduced biodiversity loss and land degradation, due to more effective and species-specific management of wild deer and wild dogs.

SOCIAL

- Contribution to increased community wellbeing by reducing stress, anxiety or injury as a result of fewer wild dog attacks and fewer wild deer impacts.

2021–22 ACHIEVEMENTS

Traditional pest-management approaches for wild dogs and deer are less effective in peri-urban areas, where urban areas transition into bush or farmland. These areas are rapidly growing in many countries worldwide, including Australia. This project has worked to fill the information gap, particularly for managing wild dogs and deer.

Ejector trials

A canid pest ejector (CPE) was developed and trialled. The trial showed that, when the device has been deployed safely and effectively on a site, 75% of individual dogs will encounter it. Data indicates CPEs are relatively target-specific to canids, with lower rates of interaction and activation by non-target species. The risk of ingestion or a lethal dose is very low to non-target species.

Collectively, the data suggests CPEs in peri-urban areas are a useful and target-specific tool for some, but not all wild dogs. It shows relying on a single control tool is insufficient for 'total' wild dog control. Multiple control tools are required.

A trial to assess the impact of environmental exposure on 1080 (sodium fluoroacetate) and PAPP (para-amino propiophenone) capsule degradation continues. Four capsules tested for toxin content/concentration regularly sampled over one year showed no significant degradation.

Integrated management: wild dogs

The effectiveness of an integrated management program for wild dogs in South-East Queensland was assessed. Between 2018 and 2021, wild dogs and foxes were regularly removed. Properties monitored continuously with motion-sensing cameras showed that wild dog activity decreased significantly over the four-year period. Community complaints to local government declined. This evaluation indicates the potential benefits of coordinating wild dog control activities in peri-urban landscapes.

Deer populations

Genetic analysis has provided some interesting insights into peri-urban deer populations. Based on 180 tissue samples, four genetic clusters were identified within the rusa deer population of the Illawarra Basin. Three clusters present a north-south geographical structure. While still connected, these clusters potentially define management units within the deer population where shooting operations could be more targeted and effective. The fourth cluster represents a group of rusa deer scattered across the top of the escarpment. Those deer probably originated from a different release event. The national survey of rusa deer genetics may help identify source populations.

The welfare assessment of vehicle-based shooting for peri-urban rusa deer by professional contractors is complete. It shows similar outcomes to other programs for hoofed mammals, with variation in skill among shooters to shoot and kill deer. Improved training of shooters could improve the welfare outcomes of these operations. South East Local Land Services expressed an interest in adapting the design of the ground-shooting operations to ensure high welfare outcomes are maintained.

In cooperation with project P01-L-001, this project has prepared two deer-related best management toolkits that cover managing deer in rural and peri-urban environments.

LEADER

Dr Matthew Gentle | QLD Department of Agriculture and Fisheries

PARTNERS

QLD Department of Agriculture and Fisheries, NSW Department of Primary Industries, ACT Parks and Conservation, NSW Local Land Services, Griffith University, Sunshine Coast Council, Brisbane City Council, and Department of Agriculture, Fisheries and Forestry.

AIM

To provide pest managers, through collaborations and community-led actions, with alternative strategies for managing wild dogs and deer in peri-urbans areas of Australia.

INTEGRATED LANDSCAPE MANAGEMENT: WILD DOGS AND OTHER PREDATORS

P01-L-005 ASSESSMENT OF THE BIODIVERSITY, ECONOMIC AND PRODUCTIVITY GAINS FROM EXCLUSION FENCING (QLD)

Project status: Completed

IMPACTS

ECONOMIC

- Increased effectiveness of resource allocation for design and implementation of cluster fencing in Queensland.
- Contribution to reduced invasive species impacts on agricultural production by improving design and implementation of cluster fencing.

ENVIRONMENTAL

- Contribution to potentially reducing negative impacts of cluster fencing on environmental factors such as ground cover and macropod activity in Queensland.

2021–22 ACHIEVEMENTS

This project assessed whether exclusion fencing is effective in Queensland. Substantial investments have been made in pest-proof netting fences ('cluster fences') around grazing properties in western Queensland. This project has combined and expanded the existing studies to inform future cluster-fencing activities.

Remote sensing ground cover analyses for pasture monitoring using ground surveys and satellite imagery was conducted for six cluster fence test areas in western Queensland. There is little evidence of improvement in ground cover since cluster fences were set up in the test locations in 2015. Green and total ground cover inside and outside the cluster boundaries are similar. Ground cover has declined in some areas. Small gains in ground cover are possible with grazing pressure.

The rapid construction of cluster fencing surrounding the study site generated a challenge for analysis, as sites 'outside' cluster fences have become partially or fully enclosed over the project duration.

'Four scientific publications on wildlife monitoring arose from this project. Two journal articles relating to the wildlife monitoring data have been published, and a third is close to submission. In addition, a master's thesis on this topic has been submitted for assessment.

Wild dog activity

Wild dog activity in exclusion-fenced properties was much less than in traditionally fenced properties, but large variations in annual lamb marking, ewe mortality, and calf weaning rates between years masked differences between fence treatments. This was mainly because of variations in climate, the productivity of land types, and the incidence of reproductive disease.

Economic impacts

Economic data for two intensive sites was collected. It was then developed into a bioeconomic model to understand the implications of the exclusion fence on production outcomes over time. These results allowed an assessment of the marginal changes to their total property gross margin. Results from the bioeconomic models were then pooled and analysed. The analysis shows exclusion fences made a significant difference to the lambing percentage for the two properties. However, the marginal increase was not as high as other landholders were expecting.

LEADER

Dr Malcolm Kennedy | QLD Department of Agriculture and Fisheries

PARTNERS

QLD Government Department of Agriculture and Fisheries, QLD Government Department of Department of Environment and Science, NSW Department of Primary Industries, WA Department of Primary Industries and Regional Development, Meat and Livestock Australia, Central Queensland University, and Department of Agriculture, Fisheries and Forestry.

AIM

To determine the cost-effectiveness of cluster fencing in the short and long term through the reduction in predation by wild dogs and reduced competition from kangaroos. This requires an assessment of the effectiveness of pest control by landholders, improvements in pasture production and, ultimately, improvements to livestock production, relative to unfenced areas. It will also assess biodiversity benefits through vegetation cover and increases in wildlife abundance and biodiversity.

INTEGRATED LANDSCAPE MANAGEMENT: WILD DOGS AND OTHER PREDATORS

P01-L-006 ASSESSMENT OF THE BIODIVERSITY, ECONOMIC AND PRODUCTIVITY GAINS FROM EXCLUSION FENCING (WA)

Project status: Completed

IMPACTS

ECONOMIC

- Increased effectiveness of resource allocation for design and implementation of cell fencing in Western Australia.
- Contribution to reduced invasive species impacts on agricultural production through improved design and implementation of cell fencing or more effective use of improved CPEs for wild dog control.

ENVIRONMENTAL

- Contribution to reduced negative impacts of cell fencing on environmental factors such as ground cover and macropod activity in Western Australia.
- Contribution to reduced environmental impacts of invasive species — particularly predation of native fauna — by designing and implementing more effective cell fencing in WA to reduce the impacts of predatory invasive animals such as feral cats and dogs.

2021–22 ACHIEVEMENTS

This project sought to understand how active predator management, cell fencing, and water availability impacted the ecosystem. In particular, the project examined impacts on introduced predators, native and introduced herbivores, and biodiversity. It also sought to help landholders by assessing the viability of increasing small stock production by manipulating predation and herbivores.

Wild dog activity

The larger Murchison River Vermin Cell fence was completed in mid-2022. During the project, wild dog activity decreased. Emu and juvenile goat activity events caught on camera increased. After closing the cell south of the Great Northern Highway, sheep travelled further each day. However, the sheep used a smaller core area, based on the livestock residency index. There is evidence to show that when wild dogs have been at water points, as seen on the camera traps, livestock take many days to return.

Where wild dogs could enter the cell fence easily, sheep activity events decreased. Daily sheep movements increased after wild dogs were removed from the completed portion of the cell fence. Without predation pressure, juvenile goat activity events increased over time. Fence maintenance will be an ongoing issue.

Competition for grazing between livestock and macropods (kangaroos and wallabies) will become an issue, as macropods will thrive with the food on offer and lack of predation pressure.

Alterations to biodiversity within the cell without wild dogs seem minimal to date. Feral cat activity was unchanged.

Canid pest ejectors

Canid pest ejectors (CPEs) deployed during this research reduced the wild dog population, despite high temperatures, multiple rainfall events and livestock trampling. CPEs led to a greater reduction in wild dog density per linear kilometre than has been reported for baiting in the same landscape.

Macropods

This project was one of the largest annual broadscale surveys of a group of native species in Australia. Results of macropod monitoring surveys across Australia are rarely interrogated or reported, which is concerning given the important ecological role of large macropods and the impacts of their overabundance.

Red kangaroos, western grey kangaroos, and euros (the common wallaroo) select habitat according to environmental factors such as terrain ruggedness and vegetation cover. All three species were significantly affected by livestock grazing, water, and potential dingo control — Restricted Chemical Permit (RCP)-permitted area. Red and western grey kangaroos were more abundant in food production landscapes than reserves. Unlike western grey kangaroos, red kangaroos and euros were more abundant in greater RCP-permitted areas.

LEADER

Dr Tracey Kreplins | WA Department of Primary Industries and Regional Development

PARTNERS

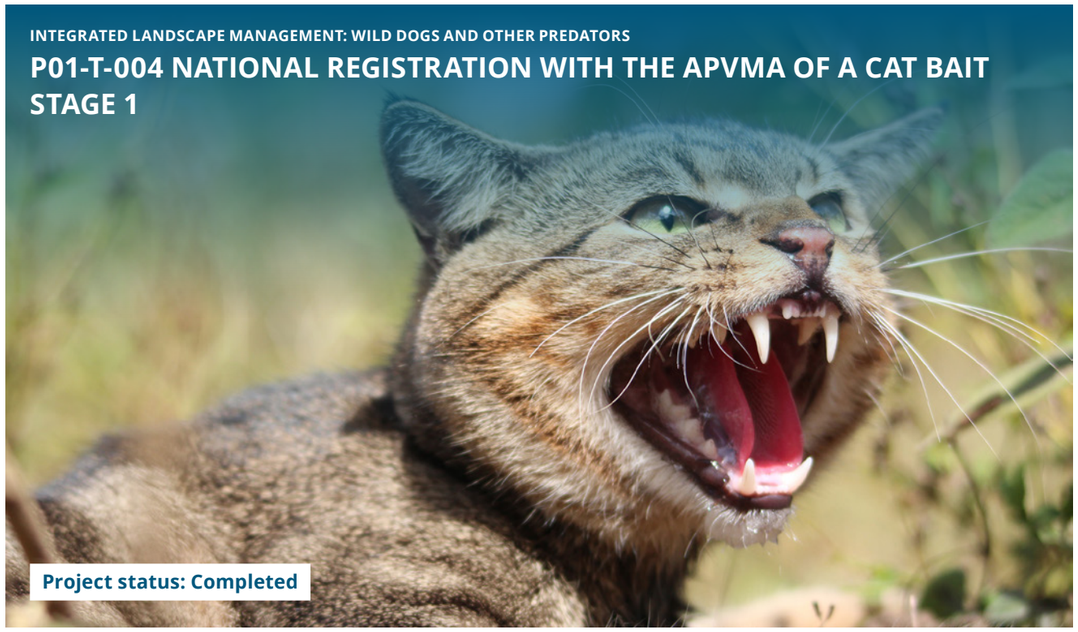
WA Department of Primary Industries and Regional Development, WA Department of Biodiversity, Conservation and Attractions, Murdoch University, Meat and Livestock Australia, and Department of Agriculture, Fisheries and Forestry.

AIM

To understand the relationships between active predator management, cell-fencing and water availability on native herbivores, introduced herbivores and introduced predators. It will ultimately identify how changes in predator and herbivore density can be practically utilised by landholders to improve small stock production and native biodiversity.

INTEGRATED LANDSCAPE MANAGEMENT: WILD DOGS AND OTHER PREDATORS

P01-T-004 NATIONAL REGISTRATION WITH THE APVMA OF A CAT BAIT STAGE 1



Project status: Completed

IMPACTS

ECONOMIC

- Reduced impact costs of feral cats through future adoption of a nationally registered bait (EradiCat™) to manage feral cats in Western Australia, South Australia, Northern Territory and Queensland.

ENVIRONMENTAL

- Reduced environmental impacts on native fauna from predation by feral cats through improved feral cat management.

2021–22 ACHIEVEMENTS

This project sought to prepare an application to the Australian Pesticides and Veterinary Medicines Authority (APVMA) to extend the registration of the WA government owned Eradicat™ bait beyond Western Australia to South Australia, the Northern Territory and Queensland. A possible future Stage 2 of this project will continue field trials and aim to register the bait in the eastern seaboard States.

An external consultant review indicated there was likely sufficient data to apply for the registration of Eradicat™ at a national level. After 15 months, the APVMA advised that there was insufficient environmental data for registration in New South Wales, Victoria and Tasmania but has agreed to reassess that outcome.

Project staff are preparing the required registration application modules for the registration of Eradicat™ in South Australia, the Northern Territory and Queensland. The team will also submit those documents to the Western Australia Department of Biodiversity, Conservation and Attractions (DBCA) for submission to the Australian Pesticides and Veterinary Medicines Authority (APVMA). This should result in the registration of Eradicat™ in those states.

LEADER
Dr Brad Page | South Australian Department of Primary Industries and Regions

PARTNERS
Department of Primary Industries and Regions SA, SA Department of Environment and Water and WA Department of Biodiversity, Conservation and Attractions, and Department of Agriculture, Fisheries and Forestry.

AIM
To collate available data, and collect new priority data, on bait efficacy and non-target risks to significantly progress the national registration of the bait with APVMA.

INTEGRATED LANDSCAPE MANAGEMENT: WILD DOGS AND OTHER PREDATORS

UA-029 NSW PREDATORS AND PREY

Project status: Ongoing

2021–22 ACHIEVEMENTS

Funded by NSW Department of Primary Industries, this project will extend its wild dog, fox and feral pig RD&E activities after Portfolio 1 concludes.

LEADER
Dr Guy Ballard | NSW Department of Primary Industries

PARTNERS
NSW Department of Primary Industries

AIM
To deliver management solutions (tools and practices) into the hands of land managers to minimise the negative economic and social impacts of invasive predators.

INTEGRATED LANDSCAPE MANAGEMENT: WILD DOGS AND OTHER PREDATORS

P01-E-005 NATIONAL WILD DOG MANAGEMENT COORDINATOR

Project status: Completed

IMPACTS

ECONOMIC

- Reduced impact costs of wild dogs and other vertebrate invasive species such as foxes.

ENVIRONMENTAL

- Reduced negative environmental impacts of wild dogs and related invasive species such as foxes, particularly predation of native fauna, due to reduced overall wild dog density and distribution.

SOCIAL

- Contribution to maintained social licence to operate for invasive species managers through improved community engagement.
- Increased capability of invasive species managers through access to best practice resources and education on wild dogs and other invasive species management.

2021–22 ACHIEVEMENTS

The National Wild Dog Management Coordinator (NWDMC) continued to help drive consistent wild dog reporting by state governments. This follows the Environment and Invasives Committee (EIC) endorsing data-collection protocols. Inaugural reports under this arrangement were received between August and December 2021.

The National Wild Dog Action Plan (NWDAP) Coordination Committee met online in July and December 2021, and face-to-face in Canberra in June 2022.

A survey identified how the NWDAP could support their activities, promote their successes, provide further information to improve management, and provide an overarching national approach to managing social licence issues.

A survey was created to assess the five major themes associated with the goals of the NWDAP. This worked extremely well. The survey results flagged how similar the issues were between stakeholders and practitioners around the country. The survey results were summarised and will be used for an online forum with representatives involved in wild dog management.

Misconceptions about the role of dingoes in the landscape continues to divert NWDMC attention. The Coordinator and the NWDAP Coordination Committee took a strong position against the idea set forth in Victoria's Greater Gariwerd Landscape Management Plan to reintroduce dingoes into the Grampians.

After the NWDAP Coordination Committee made a formal submission arguing against the reintroduction, and undertook media interviews that garnered strong public support, the Victorian Government dropped its plan to reintroduce dingoes.

Protecting livestock from wild dogs

Working with local consultants, the Coordinator guided the implementation of the 'Less Predators More Lambs' producer demonstration site in Mansfield, Vic. Involving 10 sheep graziers and funded by Meat and Livestock Australia, the project aims to increase lamb survival through effective predator management. On average, landholders had a 2–5% increase in lamb survival by adopting new predator management practices and on-farm activities.

The NWDMC worked with cattle producers and the Fitzroy Basin Authority to better understand how wild dogs behave, their ecology, and what is considered current best-practice management to bring them under control.

Professional wild dog trapper and vertebrate pest controller Tony Townsend, of Rockhampton, helped with the demonstration. Together with the Coordinator, he undertook several inspections to demonstrate:

- where dogs will travel
- how to look for signs of dog activity
- how to select the best trap placement
- how to use canid pest ejectors (CPEs) and cameras.

LEADER
Greg Mifsud | Centre for Invasive Species Solutions

PARTNERS
Australian Wool Innovation, Meat and Livestock Australia, QLD Department of Agriculture and Fisheries, Vic Department of Economic Development, Jobs, Transport and Resources, Vic Department of Environment, Land, Water and Parks, WA Department of Primary Industries and Regional Development, NSW Department of Primary Industries, Animal Health Australia, Sheep Producers Australia, Wool Producers Australia, and Department of Agriculture, Fisheries and Forestry.

AIM
To build on the platform for strategic management of wild dogs that has been developed over the past ten years.

2021–22 ACHIEVEMENTS

This project is aiming for best known and best practice change in the management of wild dogs in the Northern Tablelands and Hunter regions of NSW. The project aligns with the National Wild Dog Action Plan 2020-30 and the strategies of Australian Wool Innovation (AWI), and the Northern Tablelands Local Land Services (LLS) and Hunter LSS.

The project will improve productivity, animal welfare and on-farm biosecurity. An industry-funded wild dog and vertebrate pest coordinator will drive practice change. The coordinator will work with industry, statutory authorities, and public land managers. The goal is to reduce impacts from these pests on agricultural, biodiversity and social assets across the Northern Tablelands and Hunter regions of NSW.

Initial funding supported the position until mid-2024 or until spent, whichever is sooner. The Northern Tablelands LLS and the Hunter LLS have provided extra funding to ensure the project can continue until June 2024. The Centre has employed Dave Worsley in the role. So far, 26 local wild dog management plans have been produced for the North-East region of NSW.

LEADER
Dave Worsley | Centre for Invasive Species Solutions

PARTNERS
Australian Wool Innovation, Northern Tablelands Local Land Services. Hunter Local Land Services.

AIM
To mitigate the impacts by wild dogs and vertebrate pest species through the delivery of best practice wild dog and vertebrate pest management programs.

2021–22 ACHIEVEMENTS

Gillian Basnett was appointed as the National Feral Cat and Fox Coordinator. As part of her role, Gillian has promoted and increased the use of FeralCatScan as a reporting tool for collating feral cat detections and damage. She has attended many community-based events and community groups promoting best practice feral cat management. She has also supported community engagement and participation in managing feral cats.

A guide to forming feral cat and fox management plans was developed as part of the project. The guide will be available to community and regional groups to help them implement best practice feral cat and fox management on the lands they manage. This portion of the project has concluded.

In May 2022, the then Commonwealth Department of Agriculture, Water and the Environment extended funding for the position of the National Feral Cat and Fox Coordinator through to 30 June 2023. The coordinator has been working closely with community groups to expand the level of community education and action in managing feral cats. Several demonstration sites have been identified and work is underway to establish working programs in those areas.

LEADER
Gillian Basnett | Centre for Invasive Species Solutions

PARTNERS
Department of Agriculture, Fisheries and Forestry.

AIM
With a focus on the seven priority bushfire affected areas and a focus on the Environment Protection and Biodiversity Conservation Act 1999 (Cwth) priority species, the coordinator is to promote the adoption of best practice management for foxes and cats, raise awareness of fox and cat management techniques, engage local and regional organisations and government to facilitate regional scale fox and cat management linked with community based monitoring.

FERAL DEER

INTEGRATED LANDSCAPE MANAGEMENT: FERAL DEER

P01-L-001 COST-EFFECTIVE MANAGEMENT OF WILD DEER

Project status: Completed

IMPACTS	ECONOMIC	ENVIRONMENTAL	SOCIAL
	• Increased effectiveness of wild deer management programs. • Reduced wild deer impact costs.	• Contribution to improved environmental outcomes such as increased biodiversity and reduced land degradation.	• Contribution to a maintained social licence to operate for wild deer managers.

2021–22 ACHIEVEMENTS

This project delivered national leadership by coordinating existing and planned deer management programs across Australia. It also provided the tools and expertise required to manage wild deer cost-effectively.

Wild deer are present in all Australian states and territories and cause increasing agricultural and environmental impacts. During 2021–22, the annual cost of wild deer to the Australian economy was calculated. The cost of environmental impacts was not included in the assessment.

Better data is needed to manage wild deer populations. Global usefulness of deer abundance and density estimates would be substantially improved by:

- reporting key methodological details
- assessing bias
- using methods that increase detection probability
- reporting the precision of estimates.

Aerial shooting

The effectiveness and cost of helicopter-based deer shooting was assessed at nine sites in eastern Australia. The study showed rapid reductions in deer populations over large geographic areas. However, the size of the reduction depended on deer density, the hours of shooting and the size of the area. The major control cost was the helicopter charter.

To assess animal welfare outcomes using this method, three deer-control operations were set up:

- chital deer were targeted in Queensland
- fallow deer were targeted in the Australian Capital Territory and New South Wales.

For each operation, an independent veterinarian observed from the helicopter as the deer were shot and also observed the deer later on the ground after shooting had finished. The best animal welfare outcomes were achieved when animals were shot multiple times and checked on in a fly-back.

Ground shooting

The sambar deer was identified as a major threat to high-elevation peatlands in south-eastern Australia. The effectiveness and costs of ground-based shooting have rarely been quantified in Australasia. However, the use of volunteer versus contract shooters for controlling sambar deer was evaluated in a five-year management program in eastern Australia. The study showed that the catch-per-unit-effort of contract shooters was four times greater and cost-per-unit-killed was 10.1% greater than that of volunteers.

Vehicle-based shooting

Vehicle-based shooting is commonly used to control peri-urban deer populations. Outcomes varied among shooters and shooting distance. The animal welfare outcomes of this technique have not been quantified in Australasia.

LEADER
Dr Dave Forsyth | NSW Department of Primary Industries

PARTNERS
NSW Department of Primary Industries, QLD Department of Agriculture and Fisheries, University of Canberra, Tasmanian Land Conservancy, Charters Towers Regional Council, Department of Agriculture, Fisheries and Forestry.

AIM
To investigate cost-effective methods for reducing the impacts of wild deer in Australia and to disseminate this knowledge widely to the deer management community.

INTEGRATED LANDSCAPE MANAGEMENT: FERAL DEER

P01-L-002 THE ROLE OF WILD DEER IN THE TRANSMISSION OF DISEASES OF LIVESTOCK

Project status: Completed

IMPACTS

ECONOMIC

- Contribution to improved best practice management, and therefore, reduced impact costs of feral deer.

SOCIAL

- Increased scientific knowledge and research capacity associated with diseases and disease transfer in feral deer in Australia.

2021–22 ACHIEVEMENTS

This project has advanced the knowledge of diseases in feral deer in Australia. It has expanded understanding of potential disease transfer between deer and domestic livestock.

The detection of picornavirus was the first report for Australian feral deer. The virus was initially detected in fallow and rusa deer samples and later in sambar and chital deer.

Detecting genetic sequences compatible with beta retrovirus in feral deer was equally important. While this is likely endogenous insertions into the deer genome, it is the first report of retrovirus insertions in the genome of the Australian feral deer herd.

At least two different strains of Entamoeba parasite were detected. One of these, Entamoeba bovis, infects livestock. Of the faecal samples collected, 75% of deer and 100% of cattle tested positive via polymerase chain reaction (PCR) tests for E. bovis. While the impact of E. bovis on livestock is mild, its impact on deer is unknown.

Data from extensive genetic testing of collected samples does not support cross-species infection between deer and livestock. While the same species of virus/parasite was detected in both deer and livestock, there was no evidence of cross-species interchange of that virus/parasite between deer and livestock and/or vice versa — this is opposed to intraspecific interchange (for example, deer-to-deer interchange). This impacted the ability to determine a cross-species infection rate.

The modelling of deer and livestock interactions based on scat and camera data analyses is ongoing. The modelling was delayed because of the lack of signatures on an agreement with the Australian Government to give Victorian Government employees access to the Australian Animal Disease (AADIS) modelling platform. Modelling will be undertaken and completed when legal impediments are overcome.

LEADER
Dr Carlo Pacioni | Victorian Arthur Rylah Institute for Environmental Research

PARTNERS
Victorian Arthur Rylah Institute for Environmental Research, NSW Department of Primary Industries, Vic Department of Economic Development, Jobs, Transport and Resources, La Trobe University, Department of Agriculture, Fisheries and Forestry.

AIM
To investigate the risk posed by deer to the livestock industry as hosts for exotic disease and to evaluate the effectiveness of possible mitigation strategies should an outbreak occur.

INTEGRATED LANDSCAPE MANAGEMENT: FERAL DEER

UA-028 NSW WILD PIGS AND DEER

Project status: Ongoing

2021–22 ACHIEVEMENTS

Funded by New South Wales Department of Primary Industries, the project focuses on wild deer, feral pigs and wild rabbits. It will use research and demonstration sites to help land managers minimise the impacts of these pest species. Land managers will be able to allocate resources confidently to control and manage these pests as part of an integrated approach to pest and land management.

LEADER
Dr Dave Forsyth | NSW Department of Primary Industries

PARTNERS
NSW Department of Primary Industries

AIM
To optimise the effectiveness of vertebrate pest management techniques and provide greater understanding of best practices.

INTEGRATED LANDSCAPE MANAGEMENT: FERAL DEER

P01-T-001 FERAL DEER AGGREGATOR

Project status: Completed

IMPACTS

ECONOMIC

- A net reduction in feral deer impact costs through the adoption of the feral deer aggregator.

ENVIRONMENTAL

- Contributed to reduced environmental impacts of feral deer.

SOCIAL

- Increased capacity and capability associated with developing invasive species management tools.

2021–22 ACHIEVEMENTS

This project will help refine a feed structure suitable for attracting feral deer. It builds on the NSW Office of Environment and Heritage's foundational research. The project tested a refined structure in areas with high densities of kangaroos, possums, and feral fallow or red deer.

The feral deer aggregator is a deer-specific feeder that can integrate into a range of management strategies. It attracts deer to feed while excluding non-target native animals. It is a cost-effective tool for attracting deer to a specific location, providing a focal point for monitoring, ground shooting, or large-scale trapping. In the future, it may help to deliver toxic baits safely. It will also be useful in areas where deer numbers are low or shooting is limited, such as peri-urban areas.

Trial results

Using the final prototype of 25 aggregators over 18 months, field trials in SA confirmed the design is effective in excluding a range of native non-target species.

Western grey kangaroos and swamp wallabies (including young, lighter-weight animals) were effectively excluded (100%) from accessing feed, as were red-necked wallabies. Common wombats often visited but didn't attempt to feed from the device.

Access by possums became a problem, after they familiarised themselves with the device. Polycarbonate and metal spikes were attached to the faceplate of the feeder to deter them and restrict access.

Grain-eating birds active during the day were excluded by restricting opening hours to between dusk and dawn. Emus investigating the deer aggregators avoided stepping on the mesh base extension. In any case, they were active during the day when the feeder was closed.

Fallow and red deer were attracted to the aggregators during the night when feed was accessible, and during the day when closed. The extended mesh bases designed to stop emus did not appear to impede access as they placed all four feet through the mesh base. If a deer triggered the base during a feeding attempt, they typically waited for the feeder to reopen.

The presence of kangaroos at night did not appear to detract deer from feeding.

Feeding attempts by deer were low over the winter months but increased over spring and summer.

The deer aggregator project has delivered a field-tested prototype that can be commercialised to enable greater uptake and application of the tool. The Centre will manage this process.

LEADER
Dr Brad Page | Department of Primary Industries and Regions SA

PARTNERS
Department of Primary Industries and Regions SA, SA Department for Environment and Water, Department of Agriculture, Fisheries and Forestry.

AIM
To develop a deer aggregating device for testing in areas with high densities of native fauna e.g. kangaroos, possums and feral deer. It builds on foundational R&D by the NSW Office of Environment and Heritage primarily aimed at goats.

INTEGRATED LANDSCAPE MANAGEMENT: FERAL DEER

P01-T-005 TOWARDS REGISTERING A TOXIC BAIT FOR FERAL DEER

Project status: Completed

IMPACTS

ECONOMIC

- Contribution to future reduced feral deer impact costs through improved management with the registration and adoption of a specific feral deer toxic bait.

SOCIAL

- Increased effectiveness of additional RD&E required to register a toxic bait for feral deer by identifying and understanding knowledge gaps.

2021–22 ACHIEVEMENTS

Feral deer populations have increased to the point where existing control measures are inadequate, and baiting is worth exploring. Methods to control deer are limited to shooting from the air, shooting from the ground (sometimes assisted by traps), or fencing them out. Baiting is the most efficient and widely used method for controlling most vertebrate pests in Australia.

This project reviewed potential toxins and palatable delivery mediums or bait substrate that could control feral deer. It also identified gaps in data that need to be filled before applying to the Australian Pesticides and Veterinary Medicines Authority (APVMA) to register a toxin.

Toxins reviewed

A comprehensive report has been drafted on the potential registration of five toxins for the control of feral deer in a deer-specific feeder. Experts from five Australian states and New Zealand guided the development of the review. They also recommended steps to register one or more baits. This Project undertook a literature review of potential toxins that could be used on deer. It then started components of an APVMA registration package for a toxic bait that would be used exclusively in a deer-specific feeder.

The following recommendations have been listed in order of suitability to register a toxic bait for feral deer in Australia:

1. Progress the registration of 1080, starting with a penned trial to assess how humane it is for deer.

2. Possibly progress cyanide following penned trials to determine palatability and efficacy of encapsulation.

3. Undertake further research and/or trials for sodium nitrite to determine palatability, extend field life, and inform future options for registration.

4. Undertake further trials for para-amino propiophenone (PAPP) to determine palatability and efficacy, and calculate a lethal dose for at least 50% of tested animals (LD50) to inform future options for registration.

Zinc phosphide is not recommended as a suitable toxic bait for feral deer.

Registering bait

This project has addressed some knowledge gaps required to register 1080. Tracking data of collared deer was analysed to determine distances baited deer may travel. The analysis will support proposed directions for use (e.g. buffers around treatment areas) that will form part of a registration package. The deer management community supports the intent to progress registration of more than one bait.

The project has prompted discussions at the EIC Terrestrial Vertebrate Working Group, NSW Vertebrate Pest Group, Queensland Biosecurity Reference Group and at masterclasses in Queensland, Victoria and South Australia. Agency staff in the states are enthusiastic about having access to a registered bait.

LEADER
Dr Brad Page | Department of Primary Industries and Regions SA

PARTNERS
Department of Primary Industries and Regions SA, and the Department of Agriculture, Fisheries and Forestry.

AIM
To review potential toxins and palatable delivery mediums or bait substrates that could control feral deer

INTEGRATED LANDSCAPE MANAGEMENT: FERAL DEER

P01-E-003 NATIONAL FERAL DEER COORDINATOR

Project status: Completed

IMPACTS

ECONOMIC

- Reduced feral deer impact costs.

ENVIRONMENTAL

- Reduced negative environmental impacts of feral deer, such as land degradation and habitat destruction.

SOCIAL

- Contribution to maintained social licence to operate for invasive species managers.
- Increased capability of invasive species managers

2021–22 ACHIEVEMENTS

Community-led feral deer control

The project supported several community groups and land management agencies in their efforts to coordinate feral deer-control projects. These include new projects in:

- West Tamar, Tasmania
- Buckleboo, South Australia
- Gold Coast, Queensland
- Gold Coast Hinterland, Queensland
- Cape Liptrap and Foster, Victoria
- Mount Best, Victoria
- South West Western Australia

It also covered program expansion in the Limestone Coast (South Australia), the Northern Rivers (New South Wales) and Harrietville (Victoria).

Working with these communities has highlighted the diversity of resources, capacity, governance, legislation, and size of feral deer problems. A suite of case studies now features a range of control and engagement strategies. Project staff have worked with each community to ensure collaborative deer control will grow independently.

There was value in co-investing small amounts with community groups. Investments included using 4G real-time cameras in the Gold Coast Hinterland, contributing to awareness campaigns in four regions, and supporting local investment in ground control. The project also co-funded camera monitoring in Buckleboo, resulting in the local agency funding a follow-up aerial cull.

- Other activities included:
- facilitating community meetings
- presenting workshops and webinars
- providing tailored information to address specific community issues
- reviewing control and communication plans
- designing workshops and courses.

New tools

The project facilitated trials on new control tools for land managers. These included:

- thermal-assisted aerial control for feral red and fallow deer
- an ongoing eDNA trial to inform an aerial cull plan and eradicate an isolated population of feral deer
- using artificial intelligence (AI) and 4G cameras to inform ground culling
- investigating potential baits for feral deer.

The project co-invested in a training course for nine marksmen to learn and practise the new thermal-assisted aerial culling.

Successful use of AI with 4G cameras and eDNA has prompted interest from deer program managers from New South Wales, Tasmania, Queensland and Western Australia who wish to use this new technology.

Environmental outcomes

Two community groups have trialled simple metrics to measure the impacts of feral deer on bushland. They also have ongoing programs to track the effectiveness of feral deer control on environmental assets in Victoria and Queensland..

Working with staff from the Threatened Species Divisions of the Department of Agriculture, Fisheries and Forestry, we progressed a potential nomination of feral deer as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwth). Recent literature was reviewed, and relevant information compiled for a submission.

Raising awareness

A national awareness campaign is being piloted, with masterclasses being held in South Australia, Victoria and Queensland. Deer-control training courses are also being held in WA. Newsletters, stories, web links and operational and planning documents have been added to the project's website and distributed to community networks.

Project staff were interviewed for several media stories. Videos tailored to local community audiences have been developed.

Action plan

The draft National Feral Deer Action Plan has supported priority actions by state agencies. Actions supported include:

- new deer-control programs in Tasmanian national parks and peri-urban areas around Launceston
- eradications of satellite populations in the Peel-Harvey Estuary region (Western Australia) and the Eyre Peninsula (South Australia).

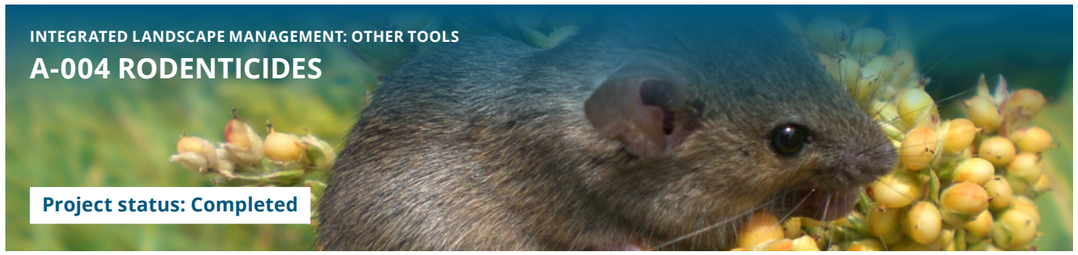
The draft plan has also been used to support and guide three new state deer management plans (Tasmania, South Australia and Queensland), and local community plans.

LEADER
Dr Annelise Weibkin | Department of Primary Industries and Regions SA

PARTNERS
Department of Primary Industries and Regions SA, and the Department of Agriculture, Fisheries and Forestry.

AIM
To support community-led deer control in all states and territories, compile national deer distribution data, current state and national laws, policies and practices, and facilitate the development of a National Action Plan for feral deer.

OTHER TOOLS



A suitable toxin was identified to complement the current use of zinc phosphide to control rodents in broadacre cereal farming. Preliminary testing indicated the toxin results in a quick and humane death for rodents. In December 2018, the Centre and the USDA executed a cooperative research and development agreement.

LEADER
Dr Tony Buckmaster | Centre for Invasive Species Solutions

PARTNERS
GRDC, USDA

AIM
To progress the R&D and subsequential registration of a new rodenticide for use in Australia.

The Centre continues to collaborate with US Department of Agriculture and the licenced manufacturer, SpayFirst. Because stability and production data were not required to register GonaCon in the US but is a requirement for registration in Australia, preparing the APVMA registration package has been delayed until this data issue can be resolved.

LEADER
Dr Tony Buckmaster | Centre for Invasive Species Solutions

PARTNERS
ACT Government

AIM
To register GonaCon in Australia as an injectable fertility control agent for macropods.

2.2.3 BIOLOGICAL CONTROL

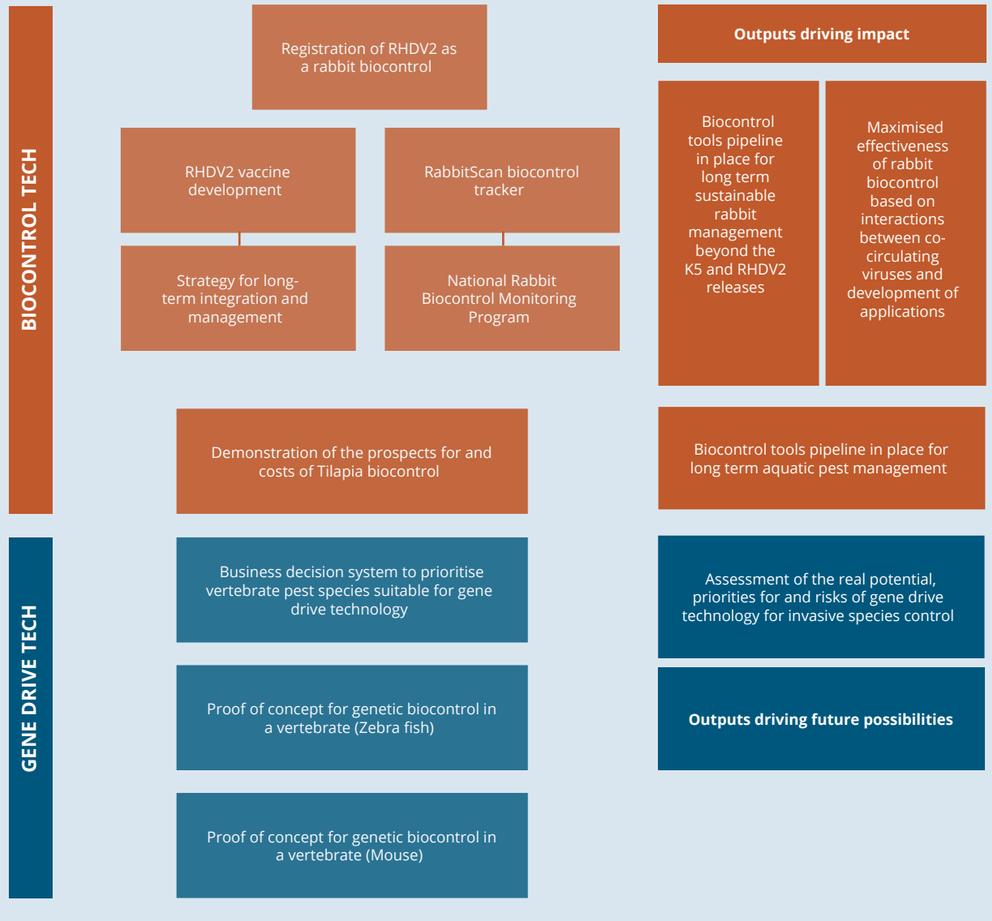
THE CHALLENGE

Rabbits have invaded two-thirds of Australia and are our most costly vertebrate pest: they cause a $216m/yr loss in agricultural productivity and impact 322 nationally listed threatened species. From a rabbit population high of between 1 and 10 billion rabbits, rabbit biocontrol has led to over $70 Billion in increased agricultural productivity between 1950 and 2010, but on-going genetic resistance to any viral biocontrol agent means that a new agent needs to be released every 8–10 years to secure the benefits of past biocontrol. Additionally, existing biocontrol agents ebb and flow across landscapes over time and thus to maintain effectiveness, on-going releases are needed.

THE SOLUTION

Our biocontrol program aims to roll out new and improved biocontrol agents every eight to ten years as part of our rabbit biocontrol pipeline, and as a result hopes to see a sustainable reduction of impacts of established pest rabbit populations. It is also looking at biocontrol and genetic technologies for other species such as pest fish (tilapia) and gene drives.

OUTPUTS



BIO CONTROL

P01-B-001 UNDERSTANDING RHDV2 INTERACTION WITH OTHER RHDVS AND ITS POTENTIAL AS AN ADDITIONAL RABBIT BIOCONTROL AGENT

Project status: Completed

IMPACTS

ECONOMIC

- Contribution to increased effectiveness of ongoing rabbit biocontrol in Australia through improved understanding of endemic RHDV2.
- Potential contribution to maintaining lower rabbit impact costs through future registration of an RHDV2 biocide.
- Increased efficiency and effectiveness of resource allocation for RD&E associated with rabbit biocontrol.

ENVIRONMENTAL

- Contribution to improved environmental outcomes in the future through improved management of wild rabbits.

SOCIAL

- Contribution to a maintained social licence to operate for invasive species managers using RHDV or other biocontrol agents for rabbits by developing and registering effective vaccines for domestic rabbits.
- Increased scientific knowledge and research capacity associated with biological control of rabbits.

2021–22 ACHIEVEMENTS

Rabbit Haemorrhagic Disease Virus (RHDV)

This project monitored RHDV2's speed, spread, evolution, and interactions with other biocontrol agents in Australian wild rabbit populations. It also examined the case for RHDV2 as an additional tool for biocontrol.

Wild rabbits were trapped from five South Australian locations for experimental RHDV infection trials. Blood samples were collected for antibody analysis immediately before experimental virus inoculation, and at seven days post-inoculation.

In the examination of blood serum (serology), most rabbits showed evidence of RHDV2 infection or reinfection at capture. However, few showed evidence of exposure to circulating RHDV-K5 or the benign calicivirus, RCV-A1. Rabbits were inoculated with different strains of RHDV. All were monitored regularly until their euthanasia at seven days after infection, when samples were collected for testing.

Outcomes across all trials showed evidence of exposure to RHDV2. This suggests that many rabbit source populations had experienced RHDV2 outbreaks and that RHDV2 was dominant at most of the trapping sites, and across most trapping months. This is consistent with reports of RHDV2 now being the dominant strain in the Australian landscape.

Infection rates by age

The project found that RHDV2 can infect young wild rabbits. This is consistent with observations of RHDV2 infecting rabbits less than five weeks of age in laboratory trials. However, maternal antibodies might have prevented lethal RHDV2 infection, preventing mortalities.

In rabbits that did not show antibodies relating to infection at capture, infection rates were highest following inoculation with RHDV2, followed by inoculation with K5 and then the Czech strain. Infection rates depended on rabbit age, with evidence of exposure to RHDV/RHDV2.

Immunity

Case fatality rates did not differ between rabbits that tested negative and rabbits that had been exposed to RHDV/RHDV2. Findings from this study show that K5 can overcome natural immunity to RHDV2 to induce infection and cause mortality to some extent.

The study highlights the need for more research to quantify the cross-protective effects of RHDV immunity more accurately in the face of RHDV2 challenge and vice versa.

Next steps

The National Rabbit Steering Committee will not progress RHDV2 registration further after the Centre's current projects. However, all Australian Pesticides and Veterinary Medicines Authority (APVMA) package documents required for its registration have been updated with RHDV2 relevant information.

A multivalent RHDV/RHDV2 vaccine has been produced through the Elizabeth Macarthur Agricultural Institute (EMAI). It is highly efficient in laboratory rabbits. All documents associated with registering this vaccine through the APVMA were submitted and all associated fees paid. Trials will take 12 to 24 months to complete. After the trials and after receipt of the vaccine safety trial data, all APVMA vaccine requirements will be complete. The vaccine will then be eligible for commercial production in Australia. The EMAI and NSW DPI will meet the extra costs.

LEADER

Dr Pat Taggart | NSW Department of Primary Industries

PARTNERS

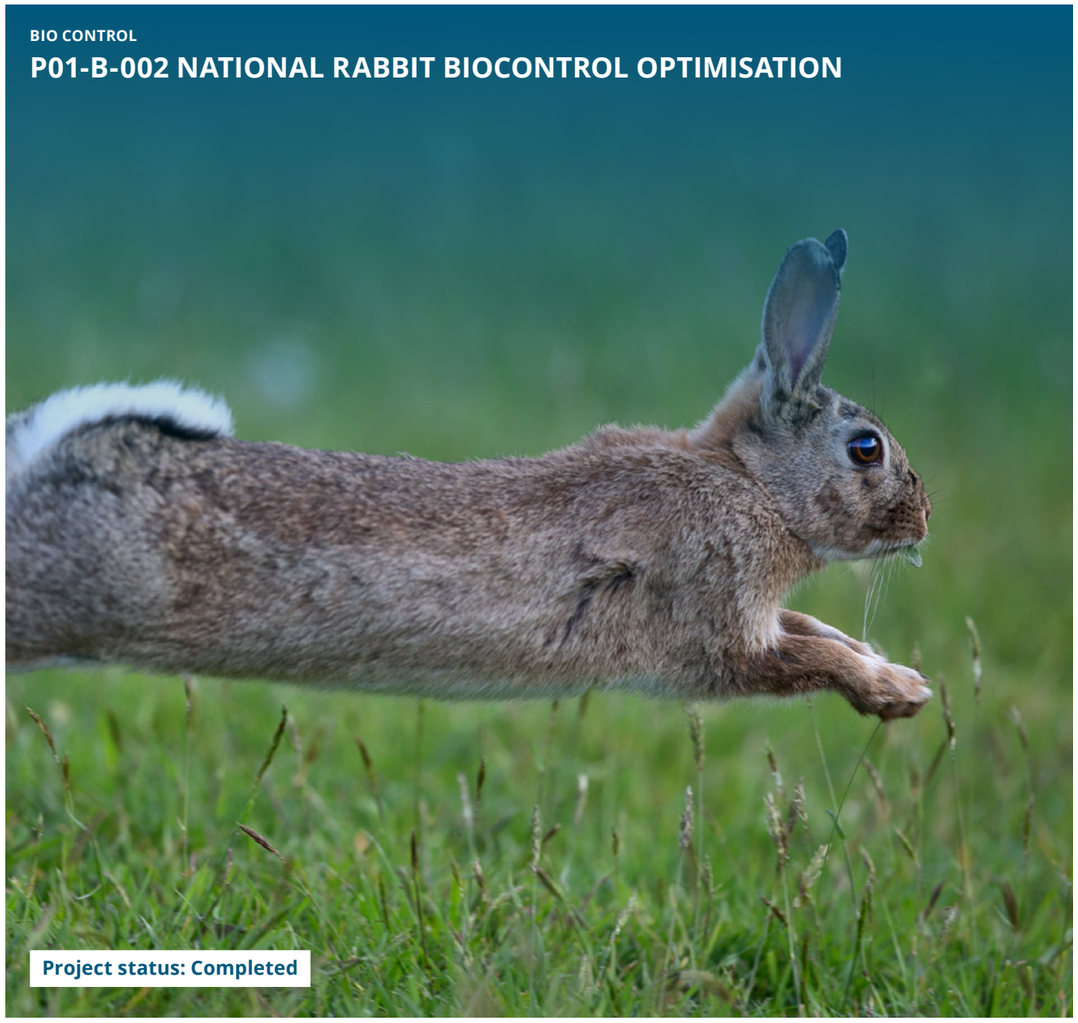
NSW Department of Primary Industries, CSIRO, Primary Industries and Regions South Australia, Meat and Livestock Australia, Australian Wool Innovation, and the Department of Agriculture, Fisheries and Forestry.

AIM

To explore the potential of RHDV2 (an exotic RHD virus first reported as a biosecurity outbreak in wild rabbits in May 2015) to complement existing biocontrol agents through a series of experimental studies. This project plays a vital role in the Centre's 20-year rabbit biocontrol pipeline and aims to understand the potential use of this virus as a future rabbit biocontrol agent. This project will also support the development of a multivalent vaccine to protect pet and commercially bred rabbits.

BIO CONTROL

P01-B-002 NATIONAL RABBIT BIOCONTROL OPTIMISATION



Project status: Completed

IMPACTS

ECONOMIC

- Contribution to increased effectiveness of ongoing rabbit biocontrol in Australia through improved data and understanding of biological control agents in European rabbits in Australia.
- Contribution to the potential maintenance of lower rabbit impact costs through improved best management practice for existing rabbit biocontrol.
- Increased effectiveness of resource allocation for RD&E associated with rabbit biocontrol.

ENVIRONMENTAL

- Contribution to improved environmental outcomes in the future through better management of wild rabbits.

SOCIAL

- Contribution to maintained social licence to operate for invasive species managers using RHDV through more effective use of tactical biocontrol.
- Increased scientific knowledge and research capacity associated with the biological control of wild rabbits.

2021–22 ACHIEVEMENTS

This project sought to determine which strains of RHDV are circulating where, when, and why. It also sought to work out if there is scope for combining strains or using them in sequence to maximise the outcomes of rabbit biocontrol efficacy.

This project cooperated with the Rabbit Haemorrhagic Disease Virus (RHDV) Project P01-B-00.

Main project findings

Both projects B-001 and B-002 support a recommendation not to pursue the registration of RHDV2 as an additional biocide for rabbit biocontrol.

The main findings were:

- Achieving substantial knock-downs from additional releases of a registered RHDV2 biocide is unlikely due to frequent natural outbreaks of RHDV2 and high levels of population immunity.
- As RHDV2 is now established, kittens (young rabbits) carry passive maternal RHDV2 antibodies from their mothers. These maternal antibodies protect from fatal disease but not infection, leading to survival and a strong natural immune response that will protect against RHDV2 for life.
- Experimental infections in wild-caught and laboratory rabbits showed that RHDV2 had limited ability to overcome pre-existing immunity to RHDV1 (including K5). By contrast, K5 had an improved ability to overcome pre-existing immunity to RHDV2. This indicates K5 may now be a more effective biocide compared to when it was released in 2017.
- The cumulative results of this project and the sister project B-001 were summarised and used to inform a cost-benefit analysis (conducted by AcreEconomics) for the registration of RHDV2. The Steering Committee supported a recommendation to not proceed with registration.
- Land managers provided data analysis that revealed a large proportion of current virus releases occur at the wrong time of year.

Blood sample analysis

Field blood analysis for the ongoing five long-term monitoring sites is complete up to January 2022, including myxoma virus. The results confirm that RHDV2 remains the dominant virus in Australian rabbit populations. Recurring detections of short-lived antibodies also suggest frequent virus activity in wild populations.

The data from the blood analysis for the RHDVs and the rabbit spotlight count data for the monitoring sites was analysed using previously published models, Ramsey et al. (2020), to assess strain dynamics and rabbit abundance. This also indicated RHDV2 remains the dominant strain. It continues to suppress wild populations by an average of 64%, compared to levels before its arrival. RHDV2 also appears to be present in the blood of 60–70% of adult rabbits in any population (seroprevalence).

Although seroprevalence of the non-pathogenic, endemic RCV-A1 was initially depressed by competition with RHDV2, this virus now shows stronger evidence of coexistence with RHDV2. This could be due to reduced competition for infection of juvenile rabbits from RHDV2, which are now protected by widespread maternal immunity.

South Australian population

Project resources also supported ongoing analysis of the Turretfield rabbit population in SA, which has been continuously monitored since the mid-1990s. Survival in RHDV-exposed rabbits dropped by 61.6% following RHDV2 arrival. This was consistent with the previously published findings of an overall 60% reduction in rabbit abundance at national RHDV monitoring sites.

Molecular analysis of the community samples confirms that RHDV2 and its variants continue to be the dominant virus in calicivirus fatalities. RHDV2 positive samples have been detected every month since the testing started in 2015. While data suggests that K5 has remained a local biocide in the eastern states, we now have mounting evidence that it is established and circulating in some wild rabbit populations in WA. This confirms that tracking the incidence of circulating rabbit biocontrol agents is dynamic and warrants ongoing study

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LEADER
Dr Tanja Strive | CSIRO

PARTNERS
CSIRO, NSW Department of Primary Industries, CSIRO, Primary Industries and Regions South Australia, Meat and Livestock Australia, Australian Wool Innovation, and the Department of Agriculture, Fisheries and Forestry.

AIM
To improve strategic knowledge about how to apply biocontrol agents to maximise rabbit biocontrol effectiveness, through monitoring and evaluation of current rabbit viruses in the Australian landscape.

BIO CONTROL

P01-B-003 TILAPIA BIOCONTROL: PROSPECTING AND EVALUATION

Project status: Completed

IMPACTS

ECONOMIC

- Increased efficiency of wild deer and wild dog management practices in peri-urban areas
- Reduced impact costs of wild deer and wild dogs through increased collaboration, cooperation, and knowledge sharing to help manage efforts between jurisdictions.
- Reduced impact costs of related invasive species, such as foxes, through improved awareness, understanding, and adoption of integrated multi-species pest animal management.

ENVIRONMENTAL

- Increased animal welfare through increased and improved adoption of best management practice that ensure high welfare outcomes
- Contribution to improved environmental outcomes, such as reduced biodiversity loss and land degradation due to more effective management of wild deer and wild dogs.

SOCIAL

- Contribution to maintained social licence to operate for some invasive species managers, particularly in peri-urban areas.
- Contribution to increased community wellbeing by reducing stress, anxiety or injury as a result of fewer wild dog attacks and fewer wild deer impacts.

2021–22 ACHIEVEMENTS

This CSIRO-led project was funded to review tilapia pathogens and assess their potential as biocontrol agents. It included a business case presentation and potential cost-benefit analysis to advance the selection of new biocontrol agents for the future management of feral tilapia in Australia.

A total of 22 tilapia pathogens were reviewed against standard biological control agent assessment criteria using a traffic-light rating system. Overall, the review found that many bacteria, fungi, and parasites have been associated with natural disease outbreaks in tilapia worldwide. However, none were species-specific to tilapia and so were rejected as candidates.

Promisingly, nine viruses have been reported in tilapia. Six were found to have first been reported in species other than tilapia and were assessed as not suitable as candidates. The other three viruses originally reported in tilapia were considered species-specific and categorised as 'tentatively worthwhile candidates for further investigation'.

Tilapia lake virus (TiLV) has a good track record regarding species specificity. Although there are no native Australian fish belonging to the families tilapia (Cichlidae), gourami (Osphronemidae), or carp and barb (Cyprinidae), rigorous non-target species testing would likely be required before considering the use of any viral biocontrol.

Cost-benefit analysis

A cost-benefit analysis was conducted to assess whether the estimated potential benefits of the proposed biocontrol(s) will pay for the cost of the research and development required to advance new biocontrols for tilapia in Australia. Information on TiLV as the selected biocontrol agent was used in the analysis. The primary impact of the proposed tilapia biocontrol investment is expected to be a net reduction in the total annual impact costs to the Australian community and economy through a reduction in tilapia biomass.

The total expected research, development, and engagement investment was estimated at $18.69 million (present value terms). It was estimated to produce total expected net benefits of $52.53 million (present value terms). This gave:

- a net present value of $33.84 million
- a benefit-cost ratio of 2.81 to 1
- an internal rate of return of 9.3%
- a modified internal rate of return of 7.1%.

Investment criteria were estimated for the total investment, using a 5% discount rate over 50 years from the first year of investment in this project.

The positive investment criteria suggest that initial investments would be worthwhile, given:

- the estimates made for the current and future potential impact and control costs of tilapia in Australia
- the likely pathways to impact for proposed new biocontrol agents
- the extra investment and associated timelines required
- the risks involved.

LEADER
Dr Agus Sunarto | CSIRO

PARTNERS
CSIRO, QLD Department of Agriculture and Fisheries, James Cook University and University of Sunshine Coast, and the Department of Agriculture, Fisheries and Forestry.

AIM
To evaluate Tilapia diseases in the context of biocontrol more broadly and conduct a desktop review of Tilapia diseases and assess their potential as biocontrol agents. If one or more candidate agents are identified, then susceptibility of tilapia in Australian waterways will need to be determined followed by target specificity trials.

BIO CONTROL

P01-B-004 BUSINESS DECISION SYSTEM TO PRIORITISE VERTEBRATE PEST SPECIES FOR DEVELOPMENT OF GENE DRIVE FOR POPULATION CONTROL

Project status: Completed

IMPACTS

ECONOMIC

- Increased effectiveness of resource allocation for future genetic biocontrol RD&E.

SOCIAL

- Potentially increased stakeholder and community awareness, understanding and acceptance of genetic biocontrol technology and associated RD&E.

2021–22 ACHIEVEMENTS

Australia has an enviable environment for developing genetic biocontrol technologies. However, a decision and implementation framework with agreed approaches was needed to develop and attract strong investment in a long-term genetic biocontrol roadmap.

This completed project prepared and published a proposed investment framework. This was generated from various data sources, including two stakeholder workshops (2020–2021); combined expert knowledge among team members (ecologists, geneticists, biologists and social scientists); and the relevant published literature.

Sector workshop

Workshop 1largely comprised representatives from the broader pest and invasive species research community, including CSIRO, the University of Adelaide and Macquarie University. A small number of government representatives, including from state and federal government agencies, also participated, as did representatives from non-government organisations with an interest in this topic. Several civil society organisations were also invited to participate in discussions, including the RSPCA.

While participants were invited to attend the meeting to share their perspectives on using genetic biocontrol technologies and pest species prioritisation, the nature of engagement and participation in these forums could not easily distinguish between personal and organisational views. Thirty-six participants attended Workshop 1, excluding project staff. In general, stakeholders were optimistic towards genetic biocontrol as a future possibility and felt that it could be transformative in pest control, but acknowledged that it was not a ‘silver bullet’ and not appropriate for all pest species. Investment requires a cautious and integrated approach.

Investor workshop

Workshop 2 was run as small online focus group discussions comprising potential investors in genetic biocontrol technologies. This included industry representatives Grains Research and Development Corporation, and Meat and Livestock Australia; multi-jurisdictional government decision-makers and managers (for example, Department of Agriculture, Fisheries and Forestry; Queensland Department of Agriculture and Fisheries; New South Wales Department of Primary Industries; Western Australian Departmen t of Primary Industries, Research and Development; Earth Resources/ECODEV, Victoria) and representatives from non-government organisations such as the Australian Wildlife Conservancy. Eighteen participants attended across two half-day sessions. The broader investment decision-making environment and institutional appetite for investment was discussed.

The final decision and implementation framework included information gathered during Workshop 2 and aligns with existing governance, institutional and social considerations, and expectations with respect to responsible science in invasive species management. The decision framework presents the key themes outlined in group discussions:

- current investment and management environment for organisations potentially funding, supporting or governing genetic biocontrol options
- critical conditions for investment in genetic biocontrol options
- the enabling conditions for investors to support, sponsor and/or fund genetic biocontrol initiatives.

Results

The design, methods and detailed results of both workshops are available in a published journal.

LEADER

Dr Wendy Ruscoe | CSIRO

PARTNERS

CSIRO, Department of Biodiversity Conservation and Attractions WA, WA Department of Primary Industries and Regional Development, and the Department of Agriculture, Fisheries and Forestry.

AIM

To explore the use of gene drive modification in vertebrate pest species in Australia. There are many knowledge gaps and technical hurdles to overcome the jump from invertebrate to vertebrate gene drive manipulation. Risk analysis and social license for gene drives will be necessary to establish a framework and prioritization system. This information is necessary for development of appropriate investment strategies in gene drive research as a pest control tool. By developing framework to assess the potential, the priorities and risk scenarios for key target pests (e.g. rabbit, carp) it will give the Centre a leading national and international role in this innovative field.

BIO CONTROL

P01-B-005 PROOF OF CONCEPT FOR GENETIC BIOCONTROL IN VERTEBRATES

Project status: To be completed by 15 January 2023

IMPACTS

ECONOMIC

- Increased effectiveness of resource allocation for future gene drive RD&E guided by information the proof of concept research generated.

SOCIAL

- Increased scientific knowledge and research capacity associated with gene drive technology for invasive zebrafish.

2021–22 ACHIEVEMENTS

The project seeks to create gene expressions in zebrafish models to control populations of invasive fish species. Two different types of zebrafish have been generated, each with a different expression system. Four systems were tested. Two did not prove viable. This is an important outcome since the level and distribution of expression of the gene variant, dCas9-VPR, is harmful, even to itself. Generating two lines out of four constructs tested is valuable and a critical first step to generating the final 'synthetic' species.

One of the two has been successfully bred. Offspring show inheritance of the dCas9-VPR construct, demonstrating successful integration in the genes. The second is in breeding now and will soon be assessed for transmission to the next generation. The appropriate and functional inheritance of the dCas9-VPR is clearly an essential feature of the trait and necessary to implement an incompatibility system.

These two lines will form the basis for establishing the 'synthetic' species. Genes that can be targeted for lethality during embryo development were identified via a literature review and bioinformatics. From identified gene targets, at least one line of zebrafish has now been developed with a modified promoter region that will protect it from the lethal induction by the dCas9-VPR.

This promoter-modified line has been crossbred with the two dCas9-VPR carrying zebrafish. Offspring will soon be characterised and will deliver the second essential step in creating the 'synthetic' species.

This project will be completed in January 2023. The Centre is responsible for monitoring the project's progress. It will also write a final report covering its post-Commonwealth Grant Agreement progress.

LEADER
Dr Mark Tizard | CSIRO

PARTNERS
CSIRO, Macquarie University NSW, and Department of Agriculture, Fisheries and Forestry.

AIM
To deliver assessment (proof-of-concept) for a genetic biocontrol strategy for vertebrate invasive species with a particular focus on fish. The outcome will either prove or disprove the genetic biocontrol strategy and thereby help to understand the opportunity or limitations to this approach to pest animal biocontrol.

BIO CONTROL

UA-030 NSW GENETIC TECHNOLOGY FOR MOUSE CONTROL

Project status: Ongoing

2021–22 ACHIEVEMENTS

Biocontrol can deliver outstanding returns but has failed to provide a platform solution for vertebrate pest control. Innovative strategic technologies are still an urgent priority. Synthetic (RNA-guided) 'homing' gene drives emerged in 2015. These drives are a genetic mechanism that manipulates reproductive processes to increase the chance of a specific gene being passed onto future.

The project started in 2021 and is making good progress towards its aim of demonstrating proof of concept of genetic technology in a mammal model – the mouse. All GM mouse lines for the X Shredder approach have been generated and breeding has begun to assess sex bias in offspring. It is anticipated that this approach will be established in next 12 months. Early data indicates that fertility may be compromised in some males that carry the X-shredder. Additionally, candidate genes for the Cleave and rescue experiment have been selected and gRNA targeting these genes are currently being screened. Constructs to activity have been generated and are currently being tested in mice.

LEADER
Dr Paul Thomas | University of Adelaide

PARTNERS
University of Adelaide, CSIRO, and NSW Department of Primary Industries.

AIM
To generate and deliver breakthrough genetic biocontrol technology to transform mammal pest management in Australia. It aims to demonstrate proof of concept for genetic biocontrol in a mammal model (and potential target) — the mouse.

2.3 TOWARDS A WEEDS PORTFOLIO

2.3 TOWARDS A WEEDS PORTFOLIO

The Commonwealth Grant Agreement for Portfolio No. 1 specified that the Grant would be used to create and manage a portfolio of projects associated with invasive vertebrate animals, invasive weeds, and, over time, other invasive species groups as appropriate.

The initial Portfolio No. 1 Grant was intended to focus primarily on research and innovation activity on invasive vertebrate pest solutions and to undertake strategic planning to scope a weed management research and innovation investment plan. The following investments were funded under Portfolio No. 1 to meet the Centre's requirement for initial scoping for strategic investment in future weeds RD&E.

TOWARDS A WEEDS PORTFOLIO

P01-W-001: WEEDS INVESTMENT PLAN

Project status: Completed

IMPACTS

ECONOMIC

- Increased effectiveness of resources allocated to weeds RD&E by identifying and prioritising national weeds issues.
- Contribution to reduced future impact costs of weeds through effective weeds RD&E that improves the management of invasive plant species.

Following substantial public consultation, and in partnership with its members, the Centre developed and released a 10-year National Investment Plan for Weeds Research, Development and Engagement in 2019. The Plan complements the *Australian Weeds Strategy 2017–2027*, which was produced by the former Invasive Plants and Animals Committee of the National Biosecurity Committee.

Implementing the plan

The main outcomes included:

- adopting best practice in national weed incursion management, including prevention, early detection and taking up risk-based surveillance systems
- researching and developing support for regional integrated landscape management approaches that target multiple weed species and control techniques
- reducing the impacts of established weeds through strategic control tools, including biocontrol integrated with industry and community delivery
- improving aspects of weed management by enhancing community, industry and organisational capacities
- adopting cost-effective weed management through better information and communication systems.

Analysing weed costs

Two economic studies were undertaken to estimate the cost of weeds to Australia and calculate the potential returns on investment.

- The economic analysis of the cost considered the:
- available literature on the costs of weeds to sectors of Australian society
- financial costs of control and lost production in agriculture
- loss of welfare in agriculture
- expenditure to control weeds in natural environments
- financial costs of control to government agencies that administer public land
- financial costs of other public authorities to invest in weeds research and development
- costs of weed control on Indigenous lands.

The study, completed in 2018, estimates that weeds impose an overall average cost of nearly $5 billion across Australia. Most of this is due to chemical control across broadacre cropping enterprises and production loss costs among the grain, beef and wool industries. Overall costs increased by more than 20% over the 14 years since Sinden et al. (2004) undertook the last comprehensive study.

Table 13 includes weed control and production losses due to residual weeds in Australia. An average production loss cost of $4.8 billion is estimated for winter and summer broadacre cropping, rice, cotton, horticulture, and livestock industries using the 'economic surplus' approach. Costs to agricultural industries comprise the most total costs, as public expenditures were less than $200 million of the overall mean cost of $4.9 billion in 2018.

This study underpinned the second study that estimated the potential benefits from a $10 million investment in implementing the research, development and engineering set out in the 10-Year Investment Plan (P01-W-001). The Centre's weed plan, derived from the 10-Year Plan, allocated the $10 million across four 'Innovation Domains', with each domain receiving equal shares (i.e. $2.5 million per year). The results are outlined in Table 14.

This project concluded that elements of the plan are being developed into a significant portfolio of weed projects that encompass:

- the prevention of new weed incursions (W-003)
- the identification of weeds (A-021)
- digital delivery of best-practice management tools and information (W-004)
- on-farm and rigorous experimental trials of new solutions (A-026).

The results show that at a 5% discount rate, the investment in this activity would result in a net present value (NPV) of more than $35 million for each domain. The benefit-cost analysis (BCA) ratios would be at least 1.8:1. This means each dollar invested in weed research and development is expected to generate at least $1.80 in industry benefits from reduced weed impacts.

LEADER
Associate Prof Richard Price | Centre for Invasive Species Solutions

PARTNERS
Centre for Invasive Species Solutions and its members and partners, and eSYS Development Pty Ltd.

AIM
To prepare a Centre 10-year weeds RD&E investment plan supported by an economic assessment of weed costs and investment plan benefits.

Table 13: Cost of weeds to Australia against low, medium and high scenarios

	LOW	AVERAGE	HIGH
Agriculture			
Loss-expenditure estimate	3,733.2	4,813.7	5,780.6
Economic surplus estimate	4,335.6	4,823.3	5,844.7
Expenditure/other non-agriculture			
Public	29.1	29.1	29.1
Private	132.3	132.3	132.3
Indigenous	4.5	4.5	4.5
Total	**4,501.5**	**4,989.2**	**6,010.6**

nq: not qualified. *uses surplus estimate

Table 14: NPV and BCA ratio returns from implementing the 10-Year Investment Plan

DOMAINS	OBJECTIVES	INVESTMENT CRITERION	DISCOUNT RATE OF 5%
Domain 1	Development and deployment of best practice tools and systems for early detection and prevention of weeds through the use of risk-0based surveillance systems	NPV (ms$)	70.6
		B/C Ratio	2.9:1
Domain 2	Formulate approaches to weed control at the landscape level. Potential activities include devloping communities of practice within NRM regions to deliver intgrated approaches	NPV (ms$)	35.7
		B/C Ratio	1.8:1
Domain 3	Develiopment of control technologies, including biocontrol, within a wider network of land managers and prectitioners involved in applying, monitoring and managing these technologies.	NPV (ms$)	58.3
		B/C Ratio	2.4:1
Domain 4	Research focuses on the institutional and policy dimensions of weeds, including through enhancing agency and industry performance and professional capacity	NPV (ms$)	39.7
		B/C Ratio	2.0:1

TOWARDS A WEEDS PORTFOLIO

P01-W-003: BIOSECURITY SURVEILLANCE OF ECOMMERCE FOR ILLEGAL TRADE IN DECLARED PLANTS

IMPACTS

ECONOMIC

- Improved effectiveness of monitoring and surveillance of the illegal plant trade into and out of Australia.
- Reduced weed monitoring and surveillance costs.
- Reduced total impact costs of new weed incursions by identifying and prioritising threats faster.

ENVIRONMENTAL

- Reduced risk of environmental damage from the incursion and potential establishment of exotic invasive plant species.

SOCIAL

- Increased capacity for government invasive species managers.

2021–22 ACHIEVEMENTS

Future alien plant invasions in Australia are anticipated through the emerging illegal trade in novel alien plant species. Australia invests heavily in preventative biosecurity for pest plants; however, comparatively little is known about the quantity and diversity of species traded domestically on Australian ecommerce websites and online trading platforms.

The capacity to predict future incursions of declared plant species via this trade pathway is limited by insufficient research. The software and analytical approaches this project developed support the data collection, surveillance activities, compliance, and reputation of biosecurity agencies involved in preventing new alien plant incursions.

The Digital Surveillance for Illegal Wildlife Trade (DIWT) database is complete. It includes trade in plant species considered weeds. This project progressed alongside a sister project dealing with illegal trade of pest animals (P01-I-002). The database brings together web-scraped data from over 80 ecommerce websites. There are currently 7.2 million advertisements in the database, with this number growing daily as web-scrapers continue to collect data.

The system has been trialled by biosecurity officers in all Australian states and territories, with users completing manual searches and setting up automatic-detection email alerts. As a result, detections of declared plants were made and compliance activities initiated. A complete description, user guide, and feedback results are in the final report.

Outcomes

The weed component of the DIWT database development noted the following outcomes:

- A list of 1,236 targeted weeds was established. A compiled dataset of plants prohibited to trade in Australia was prepared for the Weeds Australia website.
- Coordination of weed legislation between jurisdictions was analysed so it could be improved.
- The online trade of 1,396 declared plants (154 species) were detected. Detections were made in all states and territories, and 414 plants were deemed illegal. Opuntia cacti, aquatic weeds, and invasive garden plants were traded the most.
- A paper was submitted in collaboration with Queensland Department of Agriculture and Fisheries regarding control and sale of yellow burrhead (Limnocharis flava).

The DIWT project saw the following outcomes:

- Data cleaning of three ecommerce websites was completed.
- The sale of aquatic weeds online was researched.
- The Digital Surveillance for Illegal Wildlife Trade (DIWT) database was established. It was trialled by biosecurity officers in all Australian states and territories.
- A large network of contacts was established Australia-wide to raise the profile of the DIWT database.
- The extent and characteristics of online weed trade in Australia was presented to Australian biosecurity departments, the EIC Weeds Working group (WWG), and at the Australian Biosecurity Symposium.

A presentation to the EIC WWG during the reporting period resulted in most states starting system trials. Project findings were presented at the Australian Biosecurity Symposium (BioSym22) alongside a demonstration of the DIWT database. These actions increased the awareness of online-traded weeds as a serious issue in Australian biosecurity.

LEADER
Associate Professor Phill Cassey | University of Adelaide

PARTNERS
University of Adelaide, and Department of Agriculture, Fisheries and Forestry.

AIM
To ensure that effective interventions are in place nationally for monitoring key international and domestic online sources of illegal plants and e-commerce trade pathways.

Aquatic weeds research

Research into one of the most harmful and traded groups of aquatic weeds in Australia is complete. The project developed techniques for enhancing search-term accuracy to improve detection success by using a more species-specific approach. It focused on:

- water hyacinth (Eichhornia crassipes)
- frogbit (Limnobium laevigatum)
- water lettuce (Pistia stratiotes)
- giant salvinia (Salvinia molesta)
- common salvinia (Salvinia minima)
- other Salvinia species.

Target species occurred in 525 detections of illegal advertisements.

Data on seller behaviour found most sellers advertised only once during the study period. Only a few sellers advertised repeatedly. Sellers were less likely to identify aquatic species in states where the species is declared.

TOWARDS A WEEDS PORTFOLIO

A-021 COMPUTER VISION WEED ID-APP AND WEEDSCAN COMMUNITY MANAGEMENT AND COMMUNICATION SYSTEM

Project status: To be completed mid-2023

2021–22 ACHIEVEMENTS

Mobile apps like PlantSnap and PictureThis have revolutionised plant identification through artificial intelligence, which can instantly suggest plant names for plant photos. WeedsID will produce Australia's first real-time, easy-to-use automated identification of national, state, and regional priority weeds – WeedScan. WeedsID will also develop an online system to better enable cooperative community-led weed management.

WeedScan will help users determine if their plant is a weed. It will then link users to locally relevant weed management information or report priority weeds to government weeds staff.

CSIRO is training WeedScan to recognise approximately 300 priority weed species across Australia. More than 52,000 photographs have been taken for training. The first release of the WeedScan website and smartphone app is scheduled for mid-2023. NSW Department of Primary Industries held many sessions during this reporting period to design, test and refine the prototype website. The test site is a fully functioning web application.

LEADER
Dr Hanwen Wu | NSW Department of Primary Industries

PARTNERS
CSIRO, Atlas of Living Australia, NSW Department of Primary Industries, SA Department of Primary Industries and Regions, Vic Department of Jobs, Precincts and Regions, Vic Department of Environment, Land, Water and Planning, and Department of Agriculture, Fisheries and Forestry.

AIM
To develop, trial, and implement Australia's first real-time, artificial intelligence-based, automated identification of national, state, and regional priority weeds, alongside a fit for purpose community weed management, alert, reporting and communication system — WeedScan.

TOWARDS A WEEDS PORTFOLIO

A-027 WEED BIOCONTROL

Project status: Ongoing to June 2024

2021–22 ACHIEVEMENTS

This project seeks to invest in weed biocontrol solutions, with the goal of streamlining the pipeline of new weed biocontrol agents. It will also assess the efficacy of previously released agents. This project aims to develop the capability to implement new biocontrol solutions faster and reinforce existing ones.

The New South Wales Department of Primary Industries' Weeds Research Unit (WRU) has played a significant role in rebuilding state and national capacity in weed biocontrol. Over the last five years, NSW Department of Primary Industries made significant investment in expanding and streamlining operations between the biocontrol quarantine research facilities at Orange Agricultural Institute (OAI) and the mass-rearing facilities at Grafton Primary Industries Institute (GPII). This project covers activities related to a whole continuum for weed biocontrol agents, from research to implementation.

The NSW biocontrol initiatives will help shape the proposed national Weed Biocontrol Hub that the Centre intends to incorporate into its next phase of operation over 2022–27.

LEADER
Dr Pete Turner | NSW Department of Primary Industries

PARTNERS
NSW Department of Primary Industries

AIM
To progress research into new biocontrol agents, develop standardised protocols for the release of a range of biocontrol agents, and contribute to the rearing/release of new and existing agents as well as analysing their efficacy post release

2.4 COMMUNITY ENGAGEMENT AND EDUCATION PROJECTS

2.4 COMMUNITY ENGAGEMENT AND EDUCATION PROJECTS

Invasive species detection and management relies on adoption of best practice strategies. Landholders, governments, and other stakeholders must be sufficiently motivated and empowered, and have the capacity and capability, to change behaviours/practices and adopt new approaches and tools.

The Centre has funded several projects under its Community Engagement and Education Innovation Domain to enhance community engagement with invasive species management and provide user-friendly information. Further, investments under the Community Engagement and Education Domain are building capacity with postgraduate studies to ensure they have the skills for the future workforce.

COMMUNITY ENGAGEMENT AND EDUCATION PROJECTS.

P01-E-001 BEHAVIOURALLY EFFECTIVE COMMUNICATION AND ENGAGEMENT IN MANAGEMENT OF WILD DOGS

Project status: Completed

IMPACTS

ECONOMIC

- Increased effectiveness of invasive species engagement activities related to managing wild dogs.
- Contribution to reduced impact costs of wild dogs by improving community engagement that leads to improved adoption of best practice management.

SOCIAL

- Increased capability of invasive species managers to engage and communicate with stakeholders.

2021–22 ACHIEVEMENTS

This project aimed to accelerate sustainable participation in best-practice wild dog management. It also aimed to work with practitioners to build community engagement through learning, network development, workshops and masterclasses.

Component 1: Demonstrating the use of behavioural science and targeted engagement

This component started with a focus on wild dog management behaviours. Fourteen wild dog management experts were interviewed. A mixture of landholders, wild dog control coordinators, and representatives from government and non-government organisations were also interviewed. Five distinct behavioural goals to improve wild dog management outcomes were identified:

- planning
- coordinating preventative control
- using deterrents
- targeting reactive control
- monitoring and reporting.

To determine the most impactful behaviours, a random phone survey was conducted. The top four behaviours identified were:

1. taking part in coordinated control efforts

2. including wild dog management in an annual property plan

3. reporting wild dog sightings and impacts

4. providing feedback to relevant agencies.

Three case studies were included in this component. There were several important findings:

- A ‘one-size fits all’ approach to messaging will not be effective.
- Using a persuasive message by itself will not be enough to encourage participation in coordinated wild dog activities.
- Agencies need to demonstrate that reporting will lead to support and assistance with wild dog problems.
- A multifaceted approach is required to educate, train, and support landholders.
- Agencies and developers need to demonstrate not only the benefits of its reporting functions, but also those for planning and funding, as well as the social benefits.
- Landholders who have low motivation or are opposed to wild dog control on their properties need to be engaged.
- To manage wild dogs within such an immense structure will be beyond the capacity of the Regional Biosecurity Group alone. Without solid national, state and local support, a fence strategy project could struggle to succeed.
- Landholders need to carry an equal share of responsibility and recognise their legal responsibilities to control wild dogs as declared pests.

Component 2: Working with practitioners to build their community engagement capacity

Through monitoring online training workshops and meetings, the following lessons emerged during COVID-19 lockdowns:

When participants have previously developed strong relationships in person, regular Zoom sessions contribute to continuous learning.

Zoom sessions are cheaper and more time-effective than in-person events and gatherings, but they are not a replacement for personal interaction. In-person events should be reinstated when possible.

Invasive species management should continue to be prioritised to ensure ongoing collaboration and effectiveness.

To provide maximum benefit and create a legacy for years to come, this project developed three new online masterclass modules for the online Invasives Action Tool (https://actiontool.invasives.com.au). The tool covers guidelines for practitioners to design a useful survey instrument and develop behaviourally effective interventions and functional evaluation plans.

LEADER
Dr Lynette McLeod | University of New England

PARTNERS
University of New England, WA Department of Primary Industries and Regional Development, Meat and Livestock Australia, Australian Wool Innovation, and Department of Agriculture, Fisheries and Forestry.

AIM
To use behavioural science principles to assist wild dog facilitators to understand and engage more effectively with non-participating landholders.

COMMUNITY ENGAGEMENT AND EDUCATION PROJECTS

P01-E-002 FACILITATING COMMUNITY ADOPTION OF DIGITAL RESOURCES (FERALSCAN)

Project status: Completed

IMPACTS

ECONOMIC

- Reduced invasive species triple-bottom-line impact costs through improved pest surveillance, monitoring, and management by adopting the improved FeralScan platform.
- Increased effectiveness of resource allocation for invasive species RD&E.

SOCIAL

- Increased capability of invasive species managers through improved education and access to invasive species management best practice resources.

2021–22 achievements

FeralScan is a community pest animal recording and management tool. The project delivered several significant achievements in this reporting period. The project conducted 51 community and biosecurity group training workshops and information sessions for major stakeholder groups. These focused on PestSmart resources, glovebox guides, FeralScan and camera-trap training, and helping groups to adopt online technology.

FeralScan data collection

Data collection resulted in:

- receiving 148,000 WildDogScan reports from landholders, pest controllers and biosecurity groups Australia-wide.
- receiving 45,374 FeralScan records (236,921 reports from the public since commencement of the project in July 2017).
- registering 27,883 users, plus access for 10,922 non-registered users. (There has been an average of 6,500 new people using FeralScan per year across the five-year project term).
- increasing the total number of FeralScan Groups to 606 (440 new groups since July 2017).
- sending 4,682 alert notifications reaching 23,103 users (25,603 email and in-app alert notifications have been sent from FeralScan reaching 101,130 biosecurity staff, farmers, landholder groups, and pest controllers since the project commenced).
- receiving 5,936 new photographs of pest animals.

FeralScan outcomes

FeralScan data collection led to the Centre:

- implementing real-time sharing of FeralScan occurrence data with the Atlas of Living Australia (ALA) via a series of secure web application programming interfaces (APIs).
- developing a new national wild dog management program map that will be launched soon to enable the Australian public to view aggregated information about wild dog activity and management programs.
- designing and testing a new method of delivering alert messages to wild dog controllers (particularly pest controllers who react to landholder reports). This functionality will now be rolled out Australia-wide.
- developing a new national feral deer management program map to enable the public to view aggregated information about feral deer populations, problems, and management programs.
- developing and testing new WildDogScan mapping interface capabilities to display wild dog information from multiple organisations in New South Wales.
- creating a series of 46 new webinars and eight videos on monitoring and managing pest animals.
- creating a new FeralScan Data Access Portal to enable more effective sharing of FeralScan data with pest management stakeholders. It adds improved value to landholders and communities using it as an interactive platform.

LEADER
Peter West | NSW Department of Primary Industries

PARTNERS
NSW Department of Primary Industries, Australian Wool Innovation, Newton Green Technologies and Department of Agriculture, Fisheries and Forestry.

AIM
To update and promote adoption of the FeralScan community monitoring and management system.

2021–22 ACHIEVEMENTS

The Centre hosts and manages the popular national FeralScan platform used by farmers, communities, land managers and biosecurity groups across the country. It contains 300,000+ records and photographs, representing Australia's largest single information source on the extent and numbers of established pest animals.

The Atlas of Living Australia (ALA) is a national collaborative, digital, open infrastructure program that brings together biodiversity data from multiple sources. ALA contains the most comprehensive dataset of Australian biodiversity, for scientists, policy makers, environmental planners, land managers, industry, and the public. CSIRO hosts the ALA, which receives funding support from the National Collaborative Research Infrastructure Strategy.

This project connects FeralScan with the ALA portal and will share pest animal information collected through FeralScan with the ALA. This partnership has provided a new agreement for near real-time sharing of established pest animal occurrence data collected through the national FeralScan community resource with the ALA, via a series of secure web APIs. This will enable the sharing of previous, current and future data and ensure FeralScan data is accessible to ALA and associated government, industry, research and community stakeholders. The data will inform policy and guide pest management programs.

LEADER
Peter West | NSW Department of Primary Industries

PARTNERS
NSW Department of Primary Industries, Atlas of Living Australia, Newton Green Technologies and Department of Agriculture, Fisheries and Forestry.

AIM
To enable integration of existing FeralScan data sets into the Atlas of Living Australia (ALA) and ensure future public data collected through FeralScan is uploaded into the ALA on an on-going basis.

IMPACTS

ECONOMIC

- Contribution to reduced invasive species impact costs through the availability of up-to-date, evidence-based information and resources that help improve invasive species management.

ENVIRONMENTAL

- Contribution to improved future environmental outcomes through better management of invasive species.

SOCIAL

- Contribution to increased capability of invasive species managers by providing best practice management information, education, and tools.
- Contribution to maintained social licence to operate for invasive species managers through improved community awareness and understanding of invasive species, their impacts, and management practices.

2021–22 ACHIEVEMENTS

The Centre's digital strategy was updated to better position its digital assets to address organisational and audience needs.

The 2015 Centre Digital Strategy guided the upgrade of the PestSmart portal and the Weeds Australia portal development. However, challenges arose when attempting to bring the FeralScan and PestSmart platforms together, as the two websites use different software and drivers. A revised strategy was needed to help integrate assets for a cohesive approach that would better suit an environment of increased citizen science data.

The Centre's management commissioned a consultant, Dr Rohan Rainbow, to revise the digital strategy and prepare a long-term digital asset plan to guide further upgrades. These upgrades would harmonise community engagement platforms.

PestSmart website

The PestSmart website attracted 223,963 users with 324,930 unique page views. The top five toolkits accessed during the reporting period were feral camels, feral cats, feral pigs, rabbits, and foxes. It received and delivered 9,728 Glovebox Guides orders during 2021–2022.

Weeds Australia website

The Weeds Australia website attracted 83,403 users with 233,229 unique page views. The two most visited pages were the Identify page and the first page of the Weeds profiles. The top three weed profiles accessed were puncture vine (Tribulus cistoides), blue periwinkle (Vinca major), and kudzu (Pueraria lobata).

LEADER
Frank Exon | Centre for Invasive Species Solutions;
Dr Ian McDonald | formerly with the Centre for Invasive Species Solutions.

PARTNERS
Department of Agriculture, Fisheries and Forestry.

AIM
To upgrade the Centre's PestSmart and Weeds Australia best practice management information websites.

COMMUNITY ENGAGEMENT AND EDUCATION PROJECTS

P01-W-004 REVIEW AND UPDATE CONTROL SECTIONS OF WEEDS OF NATIONAL SIGNIFICANCE MANUALS

Project status: Completed

IMPACTS

ECONOMIC

- Contribution to reduced impact costs by updating and extending Weeds of National Significance (WoNS) manuals.

SOCIAL

- Increased effectiveness of RD&E associated with WoNS chemical, mechanical and biological control by identifying gaps in control methods for different weed species.

2021–22 ACHIEVEMENTS

The Centre contracted Wild Matters to update control sections of the 27 Weeds of National Significance (WoNS) manuals. These manuals are critical for managing listed weeds. Some sections were outdated. The update addressed the chemical, mechanical and biological control sections of the manuals and added new information as addendums. The project also identified gaps in control methods for different weed species. This knowledge will help identify new research areas to find practical, appropriate solutions.

WoNS manual review

Wild Matters reviewed the WoNS manual and supplementary information regarding control. They delivered a report on 25 February 2022, which was passed on to the Environment and Invasives Committee Weeds Working Group (WWG).

WoNS manual revisions

Wild Matters reviewed and revised herbicide and mechanical control options in the 27 WoNS species manuals. During the reporting period, they developed draft mechanical and chemical control content for 11 manuals. Four manuals may not be reviewed for chemical and mechanical control options (published after 2013). Draft herbicide tables were provided for 20 manuals. Wild Matters delivered the remaining content at the end of September 2022 for the Centre and WWG to review . All content will be updated and collated into final addenda by the end of October 2022.

Wild Matters also reviewed and revised biological control options in the 27 WoNS species manuals. Draft updates were completed for 11 manuals during the reporting period. The remaining content was delivered in September 2022 for the Centre and WWG to review . All content will be updated and collated into final addenda by the end of October 2022.

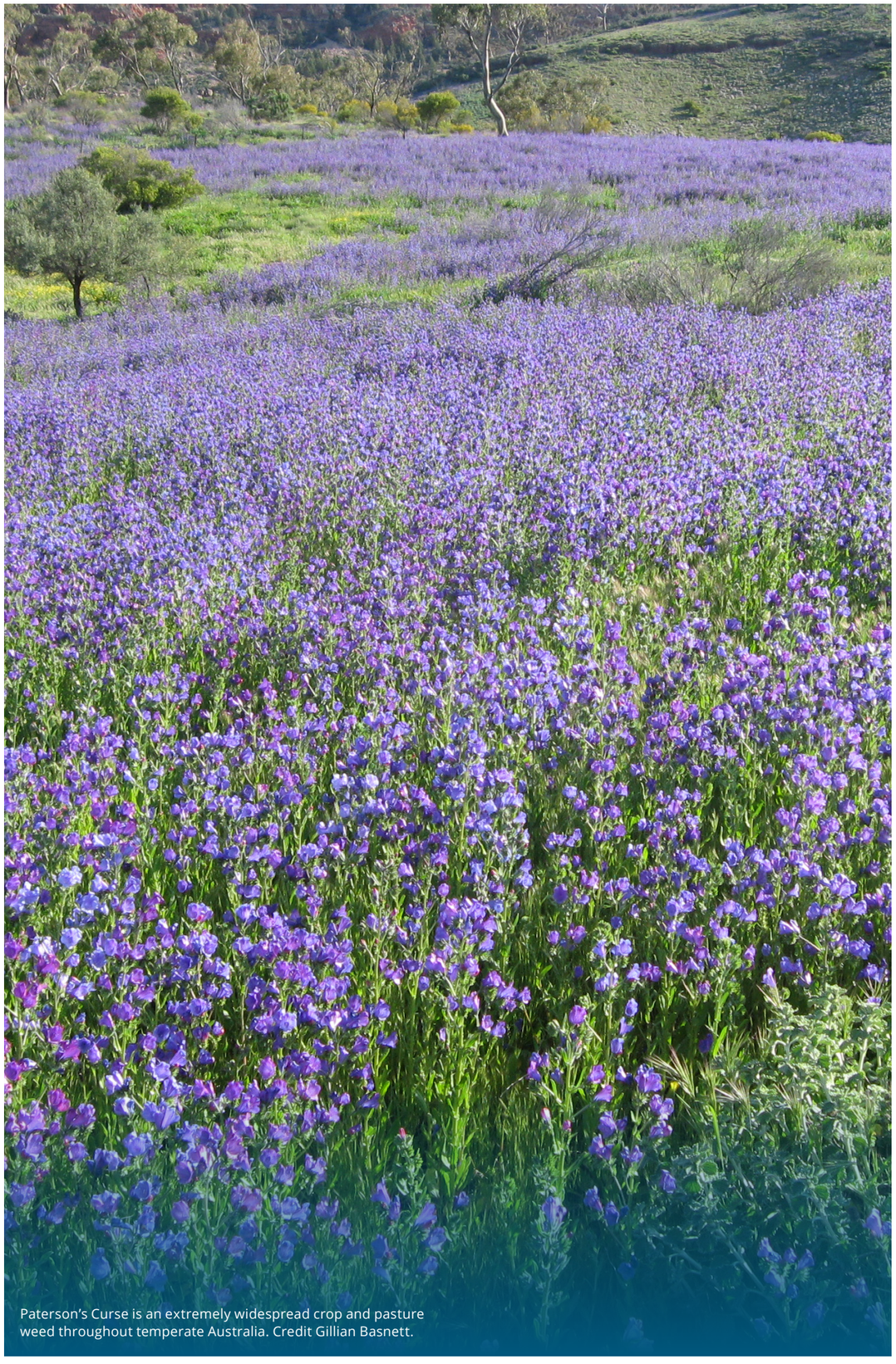
Biological control research status

A draft report provided the status of research into biological control. It was completed in May 2022 and circulated to the WWG for feedback.

LEADER
Dr Shauna Potter | Wild Matters

PARTNERS
Wild Matters and Department of Agriculture, Fisheries and Forestry.

AIM
To update the control sections of 27 Weeds of National Significance manuals.



Paterson's Curse is an extremely widespread crop and pasture weed throughout temperate Australia. Credit Gillian Basnett.

COMMUNITY ENGAGEMENT AND EDUCATION PROJECTS

P01-E-004 BALANCED RESEARCHER PROGRAM

Project status: Completed

IMPACTS

ECONOMIC

- Maintained or enhanced long-term capability in invasive species RD&E to maintain returns on future invasive species RD&E investments.
- Over the longer term, contribution to reduced invasive species impact costs with participants in the Balanced Researcher Program taking part in future invasive species RD&E or invasive species management.

SOCIAL

- Increased wellbeing for individuals, including increased earning capacity due to enhanced personal and professional capability.
- Increased scientific knowledge and research capacity created through post-graduate research projects undertaken by the Balanced Researcher Program.

2021–22 ACHIEVEMENTS

The biosecurity industry needs multiskilled, industry-ready graduates who can enter the workforce and actively contribute to the research and operational goals of their chosen workplace. The Balanced Researcher Program is based on five essential primary attributes for students to gain crucial skills to operate effectively both in the workplace and in the community. The program is nearing the end of its third iteration.

A study showed that the Balanced Researcher Program is still achieving its original aims (from IA CRC 1). It helps form a cohesive and close cohort of researchers with a ready-made system of networks and collaborations in place when they transition from university into the workplace.

Balanced Researcher Program outcomes

Since July 2021, three students have submitted theses for marking.

In the last 12 months, the program held its third participant camp. Due to COVID-19, it was run as a virtual camp. Camilla Myers from CSIRO ran a writing workshop. The workshop was a success, with all participants working on manuscripts for journal submission or on chapters for their theses.

Since the Balanced Scientist/Researcher Program began in 2006, the Centre has committed to ensuring the program delivers its intended outcomes for participants. A longitudinal study has been undertaken in each iteration of the program to see if it is meeting its goals and/or how it can be improved. Independent consultant Dr Saan Ecker (the former head of the Australian Bureau of Agricultural and Resource Economics and Science's social science research program) undertook a study in 2021. Her report, delivered in January 2022, showed the program achieved its goals, with high levels of participation and engagement. Students were highly satisfied with the program.

Completion and retention rates, and participant satisfaction

There was a greater than 50% response rate to a survey on participant satisfaction. Members from all past and current cohorts participated. All participants surveyed agreed that the program had enriched their overall master's, PhD, or postdoctoral experience.

Student completion rates of 96% and a retention rate of over 50% working in biosecurity reinforced the ongoing success of the program.

To mitigate the impacts of COVID-19 on social and professional isolation, regular virtual meetings were held. Participants discussed their current research then engaged in social activities.

During the past 12 months, one seventh-semester scholarship extension was granted, and two participants had funding for their eighth semesters of study approved.

Transition arrangements were finalised for students continuing past June 2022, with ongoing supervision by both academic and industry-based supervisors. Invasive Animals Limited will continue to oversee the transition through the Research, Development and Engagement Manager.

LEADER

Leader: Dr Tony Buckmaster | Centre for Invasive Species Solutions

PARTNERS

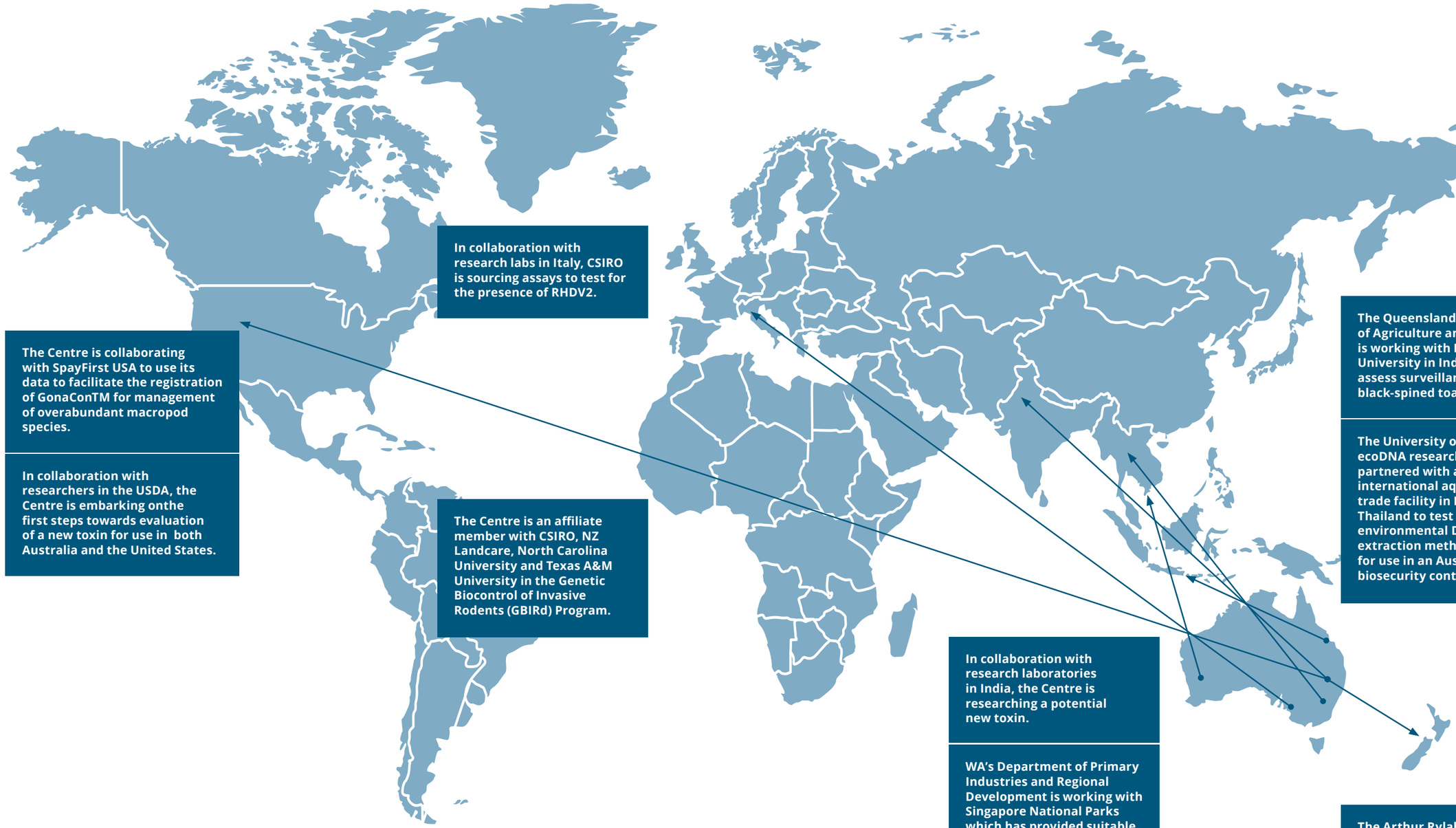
Partners: Department of Agriculture, Fisheries and Forestry, and partner universities.

AIM

To prepare PhD candidates for entry into the biosecurity-related workforce and allow them to be active contributors to that workforce from day one. Students are trained in business acumen, leadership, team building skills as well as specific training to enable them to complete their research thesis and fulfil future career goals.

2.5 INTERNATIONAL COLLABORATIONS

Along with our numerous national collaborative RD&E programs, our Centre has engaged in a number of key international collaborations.



In collaboration with research labs in Italy, CSIRO is sourcing assays to test for the presence of RHDV2.

The Centre is collaborating with SpayFirst USA to use its data to facilitate the registration of GonaConTM for management of overabundant macropod species.

In collaboration with researchers in the USDA, the Centre is embarking onthe first steps towards evaluation of a new toxin for use in both Australia and the United States.

The Centre is an affiliate member with CSIRO, NZ Landcare, North Carolina University and Texas A&M University in the Genetic Biocontrol of Invasive Rodents (GBIRd) Program.

In collaboration with research laboratories in India, the Centre is researching a potential new toxin.

WA's Department of Primary Industries and Regional Development is working with Singapore National Parks which has provided suitable recording locations for Asian black-spined toads.
The recordings will help test it's acoustic detection technology

The Queensland Department of Agriculture and Fisheries is working with IPB University in Indonesia to assess surveillance of Asian black-spined toads.

The University of Canberra ecoDNA research team partnered with an international aquarium trade facility in Bangkok, Thailand to test their environmental DNA extraction methods for use in an Australian biosecurity context.

The Arthur Rylah Institute is working with NZ Manaaki Whenua Landcare Research to co-develop proof-of-absence software tools for eradication management

SECTION 3

PRODUCTS & ENGAGEMENT

3.1 NEW PRODUCTS & COMMERCIALISATION

Over the past year, several new commercial products have been registered or progressed. These include legacy products from the Centre's predecessor — the Invasive Animals Cooperative Research Centre (IA CRC) — as well as new products started by the Centre.

IA CRC legacy products include:

- HOGGONE® sodium nitrite feral pig bait. The culmination of more than 10 years work through a strategic partnership between Animal Control Technologies (ACTA), Meat and Livestock Australia, US Department of Agriculture and Invasive Animals Ltd. ACTA obtained Australian Pesticides and Veterinary Medicines Authority (APVMA) registration in September 2019, and the product is now commercially available. (https://animalcontrol.com.au/)
- PAPPPutty™ Lethal Paste for Wild Canids for use on leg-hold traps. This extensive collaboration between Invasive Animals Ltd, NSW Department of Primary Industries and Connovation Ltd resulted in PAPPPutty being registered by the APVMA in September 2020. It is still being commercialised and is not yet available for sale.
- Gonacon Immunocontraceptive Vaccine for the non-surgical sterilisation of kangaroos and wallabies is an international collaboration between Invasive Animal Ltd, the US Department of Agriculture, Spayfirst, CSIRO and the ACT Government. Initial difficulties with manufacturing processes have been overcome. Differences in registration processes between the US and Australia have resulted in added impediments to the Australian registration process. These are gradually being resolved.
- Wild Dog Alert and E-Tech Hub are collaborative artificial intelligence/machine learning based technology projects between Invasive Animals Ltd, Australia Wool Innovation, Meat and Livestock Australia, NSW Department of Primary Industries and the University of New England. They are now cooperating through a Commercialisation Governance Committee to oversee the commercialisation process. Commercialisation of outputs was initially being managed through the NSW Department of Primary Industries Global Ag-Tech Ecosystem (GATE) program however the nominated commercialisation partner withdrew due to the amount of development needed to get the proof of concept to a minimum viable product. Alternate avenues for commercialisation are being examined such as GrowAg.

New product development or registration started under the Centre that will follow a commercialisation pathway to market are the:

- Feral Deer Aggregator which currently has several prototype devices currently under trial and suitable devices will be carried through to commercialisation.
- 1080 based feral cat bait, ERADICAT® which is already registered and available in Western Australia, however Invasives Animals Ltd is progressing national APVMA registration of the bait to enable its Australia wide use.
- RHDV2 vaccine, whose development is well progressed.

For a summary of the progress of these projects, refer to Research, Development & Engagement section of this report.

Intellectual property management

Licensed IAL IP that generates royalties from the sale of products developed through the IA CRC (2005–17) is reinvested into the new Centre. Licensed intellectual property (IP) that generates royalties from the sale of products from the Pest Animal Control CRC (pre-2012) is disbursed to IP owners from that CRC.

IP that is novated and/or managed by IAL is related to the commercialisation of:

- PIGOUT®, 2021–22 financial year royalty of $1,053.33, distributed to Pest Animal Control CRC Participants
- HOGHOPPER, 2021–22 financial year royalty of $1,023.07, retained by IAL
- RODEMISE®, 2021–22 financial year royalty of $1,417.70, retained by IAL
- Wild dog and fox PAPP, 2021–22 financial year royalty of $81.75, retained by IAL
- HOGGONE®, 2021–22 financial year royalty of $23,016.27, retained by IAL.

Intellectual property strategy

IP as defined in the Portfolio Agreement No. 1 encompasses all assets resulting from intellectual endeavour excluding Moral Rights. Public Good IP will continue to be managed in the same way as previous years and by the IA CRC — that is, all IP is 100% vested in IAL (called Centre and/or Portfolio IP) and available to all Portfolio Agreement parties for their own use in research, training and adoption.

- IP with commercial potential is managed distinctly from public good IP:
- Co-investors (Investor Partners) in a commercially orientated project (Specified Project) may legally and beneficially co-own project IP.
- Specified Project IP is distinguished from Centre IP.
- Specified Project IP ownership is determined by a process that is agreed to by Specified Project participants directly involved in the project.
- All investors in a Specified Project have a say in developing the terms under which project IP will be commercialised.

This approach is consistent with national principles for the management of IP generated using publicly funded research and ensures that R&D that is commercialised benefits Australia and Australian investors in innovation in pest animal management.

Digital assets

The Centre for Invasive Species Solutions is maintaining and upgrading a number of our leading pest management digital tools, including:

- PestSmart (knowledge hub) — pestsmart.org.au
- WeedsAustralia (knowledge hub) — weeds.org.au
- Community engagement tool (e-training course) — community.invasives.com.au
- FeralScan (community surveillance digital platform) — feralscan.org.au
- Rabbit management planning decision support tools — https://landcare.shinyapps.io/SimRab
- Field Guide to Pest Animals of Australia (app) — iTunes Apple store

Digital technology embraced by the Centre is seen as a core enabler of present and future best-practice pest animal management. All our digital tools have been enhanced and integrated to provide end users with improved community features and better ways to connect.

Intellectual property protected (non-patent)

Table 1: Intellectual Property currently held for commercial purposes

IP DESCRIPTION AND PRODUCT NAME	IP CREATION DATE BY YEAR	LICENCE NATURE
Blue Healer trademark	2005	Not applicable
HOGHOPPER design and manufacturing specifications	2010	Exclusive (worldwide)
Rodenticide pen/field efficacy studies	2005–2008	Exclusive (in Australia)
Nitrite-based pesticide products: Commercialisation of granted patents, Aus, NZ, USA and Canada	2007 2003–2005	Exclusive (worldwide)
PIGOUT pen/field efficacy studies	2005–2014	Exclusive (worldwide)
PAPP wild dog and fox bait and toxin	2012	Not applicable
PestSmart trademark	2015	Not applicable
LandSmart trademark	2016	Not applicable
FarmSmart trademark	2016	Not applicable
AntSmart trademark	2015	Not applicable
AVPC trademark	2015	Not applicable
Centre for Invasive Species Solutions trademark	2017	Not applicable
PlantSmart	2018	Not applicable
FeralScan trademark	2018	Not applicable
BiteMe trademark	2018	Not applicable
PAPPutty trademark	2019	Not applicable
Wild Dog Alert trademark	2019	Not applicable
WeedScan trademark	2019	Not applicable
BiosecuritySmart trademark	2020	Not applicable

Patents

IAL has maintained and managed patents and patent applications for the use of nitrite salts as poisons in baits foromnivores. The development work in nitrite salts is focused on feral pig control. Patented IP managed during the reporting period includes:

PATENT NAME
Australian granted patent AU 2008221237 — Nitrite Salts as Poisons in Baits for Omnivores
New Zealand granted patent 579357 — Nitrite Salts as Poisons in Baits for Omnivores
United States of America granted patent US 9750242 — Nitrite Salts as Poisons in Baits for Omnivores
Canadian patent application 2677935 — Nitrite Salts as Poisons in Baits for Omnivores. Exclusive (worldwide)

Option agreements to commercialise intellectual property

Table 2: Option agreements to commercialise intellectual property

IP DESCRIPTION AND PRODUCT NAME	CONTRACT	IP CREATION DATE	LICENCE NATURE
Rodenticide (CRADA) with USDA	USDA	2013–2017	Exclusive (worldwide)
HOGGONE® USA (CRADA) with USDA	USDA	2013–2017	Exclusive (worldwide)
Microencapsulated sodium nitrite formulations (CRLA) with Texas Parks and Wildlife	Texas Parks and Wildlife Department USDA	May 2015	Exclusive (worldwide)
Rodenticide (CRADA)	USDA	2017–2022	Exclusive (worldwide)

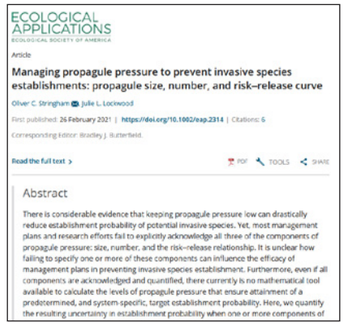
3.2 RESEARCH EXCELLENCE

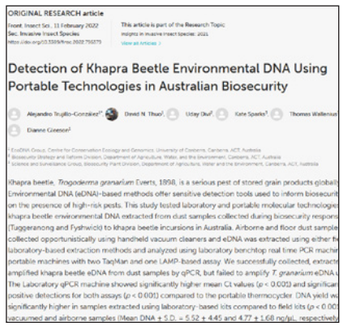
The Centre for Invasive Species Solutions prides itself on research excellence that informs best practice management, and the development and subsequent adoption of new tools, technologies and systems that support land managers to effectively deal with invasive species.

During the financial year, **28** peer reviewed scientific publications and **5** technical reports were published through our extensive RD&E collaboration with a further **22** submitted and awaiting publication.

The majority of these publications are as a direct result of research undertaken as part of the Centre's collaborative research projects, while a small number are the result of flow on work from projects of the Invasive Animals CRC that are now coming to fruition. A full list of publications is presented below.

Over past 12 months Centre project staff have taken part in over **272** stakeholder workshops that have put best practice research into the hands people on the ground.





INCURSIONS

- Stringham, O. C., and Lockwood, J. L. 2021. Managing propagule pressure to prevent invasive species establishments: propagule size, number, and risk–release curve. Ecological Applications 31(4):e02314
- Sinclair, J. S., Stringham, O. C., Udell, B., Mandrak, N. E., Leung, B., Romagosa, C. M., & Lockwood, J. L. (2021). The International Vertebrate Pet Trade Network and Insights from US Imports of Exotic Pets. BioScience. 71 (9) 977-990
- Toomes, A., García□Díaz, P., Stringham, O. C., Ross, J. V., Mitchell, L., & Cassey, P. (2021, August 27). Drivers of the live pet trade: the role of species traits, socioeconomic attributes and regulatory systems (submitted) https://doi.org/10.32942/osf.io/u5mv9
- Stringham, O. C., Moncayo, S., Thomas, E., Heinrich, S., Toomes, A., Maher, J., Hill, K.G.W., Mitchell, L, Ross, J.V., Shepherd, C.R., & Cassey, P. (2021, July 7). Dataset of seized wildlife and their intended uses. https://doi.org/10.32942/osf.io/uyqd3
- Trujillo-González A, Thuo DN, Divi U, Sparks K, Wallenius T and Gleeson D (2022) Detection of Khapra Beetle Environmental DNA Using Portable Technologies in Australian Biosecurity. Front. Insect Sci. 2:795379. doi: 10.3389/finsc.2022.795379
- B. Barnes, M. Parsa, F. Giannini, D. Ramsey, (2022) Analytical Bayesian models to quantify pest eradication success or species absence using zero-sighting records, Theoretical Population Biology, 144: 70-80

LANDSCAPES

- Davies Christopher, Wright Wendy, Wedrowicz Faye, Pacioni Carlo, Hogan Fiona E. (2022) Delineating genetic management units of sambar deer (Rusa unicolor) in south-eastern Australia, using opportunistic tissue sampling and targeted scat collection. Wildlife Research 49, 147-157
- Huaman JL, Pacioni C, Forsyth DM, Pople A, Hampton JO, Carvalho TG, Helbig KJ. (2022) Detection and Characterisation of an Endogenous Betaretrovirus in Australian Wild Deer. Viruses; 14(2):252. https://doi.org/10.3390/v14020252
- Huaman, J. L., Pacioni, C., Kenchington-Evans, L., Doyle, M., Helbig, K. J., and Carvalho, T. G. (2022). First Evidence of Entamoeba Parasites in Australian Wild Deer and Assessment of Transmission to Cattle. Frontiers in Cellular and Infection Microbiology 12. doi: 10.3389/fcimb.2022.883031.
- Huaman, J.L.; Pacioni, C.Sarker, S.; Doyle, M.; Forsyth, D.M.;Pople, A.; Carvalho, T.G.; Helbig, K.J.(2021) Novel Picornavirus Detected in Wild Deer: Identification, Genomic Characterisation, and Prevalence in Australia. Viruses 13, 2412. https://doi.org/10.3390/v13122412
- Li-Williams, S., Comte, S., Stuart K. C., Forsyth, D. M., Dawson, M., Sherwin, W. B., and Rollins, L. A. (submitted) Using population genetic structuring for invasive rusa deer management in peri-urban Australia.
- Amos, M., Pople, A., Brennan, M., Sheil, D., Kimber, M. and Cathcart, A. (Accepted) Home ranges of rusa deer (Cervus timorensis) in a subtropical peri-urban environment in South East Queensland. Australian Mammalogy.
- Li-Williams S. (2021). Rusa deer population genetics structure in the Illawarra (NSW) and implications for management. AWMS annual conference December 2021,
- Hampton, J., MacKenzie, D., Forsyth, D. M. (In Press). Animal welfare outcomes of professional vehicle-based shooting of peri-urban rusa deer in Australia. Wildlife Research, Accepted 28 December 2021
- Castle, G., Smith, D., Allen, L. R., Carter, J., Elsworth, P., & Allen, B. L. (2022). Top-predator removal does not cause trophic cascades in Australian rangeland ecosystems. Food Webs, 31, e00229.
- Castle, G., Smith, D., Allen, L.R. Allen, B.L. (2021) Terrestrial mesopredators did not increase after top-predator removal in a large-scale experimental test of mesopredator release theory. Sci Rep 11, 18205. https://doi.org/10.1038/s41598-021-97634-4
- Dawson S. J., Kreplins, T. L., Kennedy, M.S., Renwick, R., Cowan, M., Fleming, P. A., (in review) Land use and permitted dingo control affect the density of abundant kangaroos in rangeland systems, Journal of Integrated Biology
- Kreplins, T., Miller, J., Kennedy, M. (2022) Are canid pest ejectors effective control tools for wild dogs in an arid rangeland environment. Wildlife Research 49, 227-236 https://doi.org/10.1071/WR21043

BIOCONTROL

- Hall, R. N., King, T., O'Connor, T., Read, A. J., Arrow, J., Trought, K., Duckworth, J., Piper, M. & Strive, T. 2021. Age and infectious dose significantly affect disease progression after RHDV2 infection in naive domestic rabbits. Viruses, V13(6), PG1184
- Hall, R.N., King, T., O'Connor, T.W., Read, A.J., Vrankovic, S., Piper, M. & Strive, T. 2021. Passive immunity against RHDV2 induces protection against disease but not infection. Vaccines, V9(10), PG1197
- O'Connor, T.W., Read, A.J., Hall, R.N., Strive, S. & Kirkland, P.D. 2022. Immunological cross-protection between different rabbit haemorrhagic disease viruses - implications for rabbit biocontrol and vaccine development. Vaccines, 10(5), PG666.
- Patel, K.K., Strive, T., Hall, R.N., Mutze, G., Page, B., Korcz, M., Booth-Remmers, M., Smith, I.L., Huang, N., Kovaliski, J., Jayasinghe Ellakkala Appuhamilage, R.m.J. & Taggart, P.L. 2002. Cross-protection, infection and case fatality rates in wild European rabbits experimentally challenged with different rabbit haemorrhagic disease viruses. Transboundary and Emerging Diseases, DOI: 10.1111/tbed.14530.
- Hardaker, T. 2022. An Analysis of the Potential Net Benefits of the Registration of RHDV2 as a Tactical Biocontrol Agent (Biocide) for the Control of Pest Rabbits in Australia. ACRE Economics.
- Kerr P. and Strive T. (2020) Biological control of vertebrates: Myxoma virous and rabbit hemorrhagic disease virus as biological control for rabbits. In Fath, B.D., & Jorgensen, S.E. (Eds.). Managing Biological and Ecological Systems (2nd ed.). CRC Press. https://doi.org/10.1201/9780429346170
- Ruscoe W, Campbell, S., Carter, L., Mankad, A., Brown, PO., Byrne, M., Oh, K., Tizard, M., Strive, T (2022) Decision and Implementation Framework for Investment in Genetic Biocontrol of Vertebrate Pest Species in Australia. Report to the Centre for Invasive Species Solutions, Canberra

TOOLS

- Ulhaq A, Adams P, Cox TE, Khan A, Low T, Paul M. (2021) Automated Detection of Animals in Low-Resolution Airborne Thermal Imagery. Remote Sensing. 13(16):3276. https://doi.org/10.3390/rs13163276

WEEDS

- Stringham, O. C., Moncayo, S., Thomas, E., Heinrich, S., Toomes, A., Maher, J., ... Cassey, P. (2021, July 7). Dataset of seized wildlife and their intended uses. https://doi.org/10.32942/osf.io/uyqd3
- Summary List of WoNS Manuals & Supplementary Information - Current status of control information (2022). Wild Matters
- Current status of biocontrol research on selected WONS (2022) technical report. Wild Matters.

Red foxes are a primary cause in the decline and extinction of many small and medium-sized rodent and marsupial species in Australia — they also prey on many Australian bird species. Credit Claire Gaughwin.

3.3 NATIONAL COORDINATORS

MANAGING WILD DOGS, FERAL DEER AND FERAL CATS AND FOXES

The National Invasive Species Management Coordinator Model, funded by the Centre between 2017–18 and 2022–23, made significant positive contributions to invasive species management. It comprises three interacting parts:

1. National coordinators appointed to manage wild dogs, feral deer, and feral cats and foxes
2. Best practice management toolkits — PestSmart and Weeds Australia
3. The Centre's community monitoring and management platform — FeralScan and soon, WeedScan.

Through the three National Coordinators and their activities, the Centre has facilitated:

- increased community awareness of invasive species and their impacts
- increased and improved adoption of invasive species best practice management
- greater collective action and community engagement for invasive species management
- more effective resource allocation in invasive species management and RD&E through better coordination, communication, and prioritisation.

ECONOMIC, ENVIRONMENTAL, AND SOCIAL IMPACTS

The National Coordinator Model investment has contributed to the following economic, environmental, and social impacts:

1. a net reduction in invasive species damage and control costs, particularly for wild dogs, feral deer, foxes, and feral cats
2. reduced negative environmental impacts such as biodiversity loss, due to invasive species
3. maintained social license to operate for invasive species managers
4. increased capability and capacity of invasive species managers
5. increased regional community wellbeing.

BENEFITS OF THE NATIONAL COORDINATOR MODEL

An independent evaluation of National Coordinator Model for the period 2017–18 to 2022–23 by Talia Hardaker (ACRE Economics) in association with Peter Chudleigh (Agtrans) found the total investment was $5.85 million (present value terms). The investment generated total expected net benefits of approximately $151.7 million. This gave a net present value (NPV) of $145.5 million and a benefit-cost ratio (BCR) of about 25.9 to 1.

Sensitivity analyses showed if it was assumed the benefits of the overall Centre RD&E investment were just 1.16% less, the investment criteria for the National Coordinator Model still were positive. This demonstrates the positive benefits of the National Coordinator Model over the situation where the Model did not exist.

The results of the case study evaluation of the National Coordinator Model are highly positive.

National Coordinator Model investment has achieved exceptional success within the Centre's RD&E funding. The results should be view favourably by the Centre's management, funding partners including Department of Agriculture, Fisheries and Forestry and state government, invasive species managers, and other stakeholders.

The Greater Bilby is threatened by predation from foxes and feral cats and by the reduction of native vegetation, the prevention of natural regeneration of many plant species and the competition for food and burrows by rabbits.

3.4 DIGITAL ENGAGEMENT

The Centre makes practical resources available for land managers to manage invasive species according to best practice through dedicated websites: PestSmart, FeralScan, Weeds Australia and Community Invasives Action.

The Centre also supports national communication campaigns focused on invasives species and Australian biosecurity in partnership with our members, associate members, partners, and other key stakeholders.

pestSMART

PestSmart provides best practice information on how to plan, manage and improve pest animal control programs in Australia.

pestsmart.org.au

PESTSMART: FOR PEST ANIMAL MANAGEMENT

The PestSmart website provides land managers with information toolkits to manage pest animals and the knowledge to plan, implement and improve their control programs.

Work has been undertaken in 2021–22 to enhance the user interface and attracted 223,963 users and 366,849 page views during the financial year.

The most popular pages were the PestSmart home page, Domestic animal safety: the facts of 1080 baiting, the Pest Birds: Shooting of pest birds, and the European rabbits: Economic and environmental impacts of rabbits in Australia page.

Glovebox Guides

The Centre's Glovebox Guide Series covers best practice management of wild dogs, foxes, feral cats, rabbits, and feral pigs, as well as tailored poison baiting guides for wild dogs and foxes, and feral pigs. Copies can be ordered from the PestSmart website.

Over 9,728 orders for hard copy Glovebox Guides were received in 2021–22 from councils, government agencies, pest management groups, schools, contractors, and other individuals. The Glovebox Guide for Managing Feral Pigs, the Glovebox Guide for Managing Foxes, Glovebox Guide for Managing Feral Cats, and the Glovebox Guide for Managing Rabbits were the most popular.

feralSCAN

FeralScan provides a pest animal recording and management tool for Australian land managers.

feralscan.org.au

FERALSCAN — THE CENTRE'S PEST ANIMAL MAPPING AND MANAGEMENT WEBSITE AND APP

The FeralScan website and app support mapping and management of pest animals by individuals and community groups across Australia.

During 2021–22 the website attracted over 108,428 users with 371,264 page views. The most popular pages were the FeralScan homepage, the Mouse Alert, the FoxScan Map page, and the Wild dog scan Map.

In 2021–22 the FeralScan platform had 623 private community pest control groups, and 40,422 registered (and non-registered) individual users. FeralScan now holds over 316,855 geospatially located records of pest animals, the problems they cause, and the coordinated actions being undertaken to manage them by landholders and community groups.

weedsAUSTRALIA

Weeds Australia provides land managers with the latest information to effectively manage invasive weeds.

weeds.org.au

WEEDS AUSTRALIA WEBSITE

The Weeds Australia website attracted over 83,403 users with 278,429 page views. The most popular pages were Identify a weed in your region page, and the Manage your weed problem page containing weed profiles.

Ongoing improvements to the website continue to be made based on user feedback.

weedSCAN

COMING SOON

Weeds Australia provides land managers with the latest information to effectively manage invasive weeds.

weedscan.org.au

Community Invasive Action

Community Invasives Action provides tailored resources for coordinators supporting communities to take action on invasive species.

community.invasives.com.au

COMMUNITY INVASIVES ACTION MICROSITE

This microsite showcases the best practice resources for community engagement and is designed to support coordinators and extension officers working with communities across Australia.

During 2021–22 the microsite attracted 942 users, with 1377 page views. The microsite includes a range of training guides, a training portal, reports, publications,

3.5 COMMUNICATION & MEDIA

HIGHLIGHTS

WEB

The Centre's website attracted 21,332 users with 57,988 page views. The two most visited pages were the homepage and the research page of the website. Top 37.8% viewers were acquired from organic search and 37.2% from direct search.

EVENTS

The Centre:

- Launched Invasive Species Solutions Trust by Her Excellency Mrs Linda Hurley at Government House Canberra on 1 December 2021.
- Sponsored the NSW and Victorian combined Weeds Conference in Albury NSW on 21–24 March 2022.
- Hosted a national Rabbit R&D webinar in partnership with Rabbit Free Australia on 21 March 2022.
- Hosted an exhibition booth at Sustaining the Nation, the 2022 National Conference of the National Farmers Federation in Canberra, 5–6 April 2022.
- Was a partner in the delivery of the 2nd Annual Biosecurity Symposium held on the Gold Coast 3–5 May 2022, hosting a stakeholder breakfast and exhibition booth

E-NEWSLETTER

Seven issues of the CISS Chronicle were distributed during with open rates exceeding 35% for nearly all issues achieving a click rate greater than 6% for all issues. These results are well above industry averages.

The Centre issued three media releases and was involved in two joint media releases during this period. Active media engagement was undertaken to build relationships with specific journalists and the Centre partnered with CSIRO to maximise media coverage from the release of *Fighting Plagues and Predators: Australia's path towards a pest and weed-free future*. This effort was rewarded with significant media coverage in late November and early December 2021. The other significant driver of media coverage was the release of the report *Benefits of Rabbit Biocontrol in Australia, An Update* in March 2022.

MEDIA

The Centre received 937 media mentions during the financial year with many stories being syndicated by media outlets. These reached an estimated broadcast audience of 1,054,838, a print audience of 1,764,842 and an average story audience for online media of 722,389. The advertising space rate for these media mentions was $5.7 million.


NATIONAL

Rabbit control funding gone


NEWS

An $86-billion bunny bounty

More deaths as JEV outbreak grows slowly

PUBLICATIONS

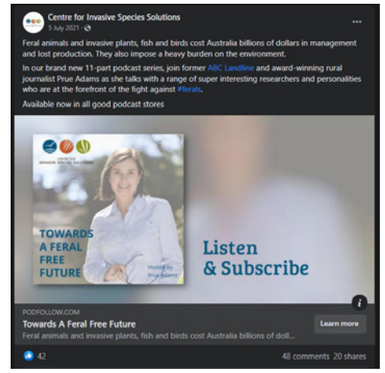
- Genetic Biocontrol Technology for Vertebrate Pests: Decision Framework Summary — November 2021
- Fighting Plagues and Predators: Australia's path towards a pest and weed-free future — November 2021
- Benefits of Rabbit Biocontol in Australia: an update — March 2022
- An Evaluation of the Impact of RHDV1-K5 in Australia — March 2022
- Decision and Implementation Framework for Investment in Genetic Biocontrol of Vertebrate Pest Species in Australia — April 2022

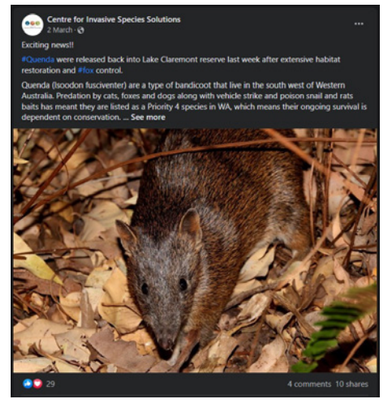
SOCIAL MEDIA

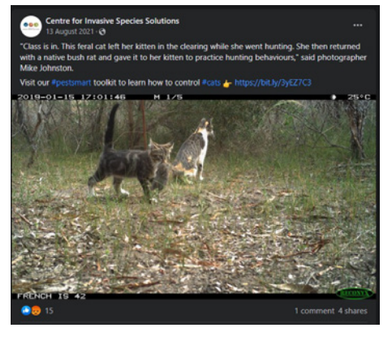
Performance across the Centre's social media channels was positive with the LinkedIn and Facebook audience increasing by 96% and 49% respectively The Centre's social media increased to 1936 across total audience across Facebook and LinkedIn. The most popular channel was Facebook with 1441 followers followed by LinkedIn with 595 followers.

COMMUNICATIONS WITH MEMBERS, ASSOCIATE MEMBERS AND PARTNERS

The Centre distributed four Communiques to its members, associate members and partners during the financial year. It also hosted four Communique meetings and a Showcase event associated with its Annual General Meeting in November 2021.







Top 3 Facebook Posts with highest reach

SECTION 4

GOVERNANCE & FINANCE

4.1 GOVERNANCE & MANAGEMENT

Invasive Animals Ltd (IAL) is a public company limited by guarantee incorporated and domiciled in Australia. It has been endorsed by the Australian Taxation Office, as a tax concession charity and exempt from income tax and is registered as a Charity with the Australian Charities and Not-for-Profit Commission.

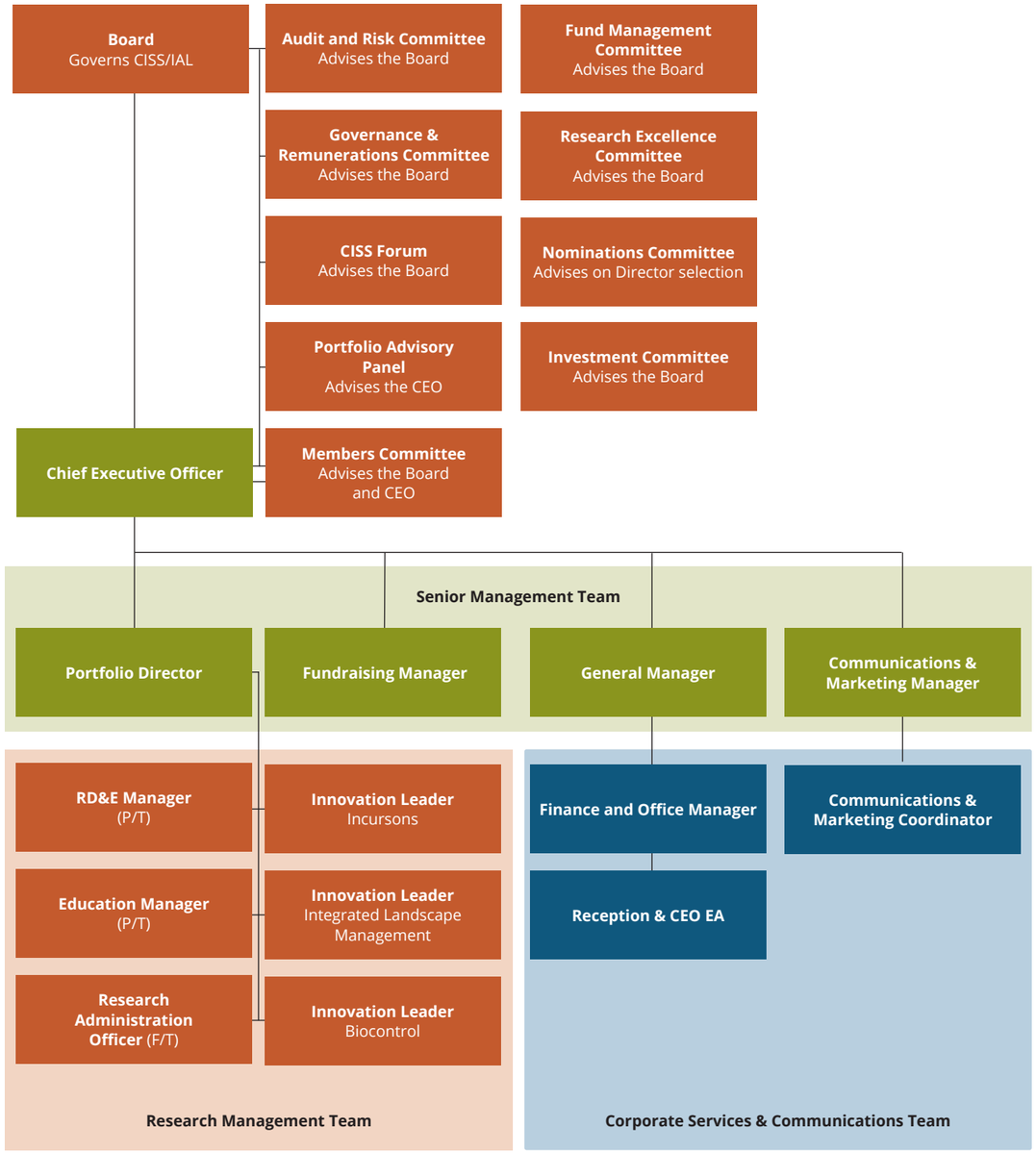
From 15 September 2020, IAL was appointed as the Trustee for the Invasive Species Solutions Trust (ISST).

The ISST and the related Public Fund, known as the Invasive Species Solutions Fund, were formally established by deed on 15 September 2020 (Trust Deed) and the Public Fund was entered in the Register of Environmental Organisations and Deductible Gift Recipient (DGR) status, granted 7 December 2020.

The organisation chart opposite excludes IAL project staff.

The structure and governance of the Centre provides strong support to its operations. The Centre is led by a Board of skills-based Directors, who are independent from its members and partners. The Governing Board meets at least four times a year and is committed to compliance with the Australian Charities and Not-for-Profit Commission, the Australian Security & Investments Commission Corporate Governance Principles and Recommendations and the Register of Environmental Organisations.

In carrying out its governance role, the main task of the Board is to develop and monitor the Centre's strategy, ensure compliance to IAL constitution, to develop policies and ensure the company complies with its contractual, statutory and other obligations.



4.2 BOARD OF DIRECTORS

Bruce Christie
Chair

Director since 2020.

Corporate Biosecurity expert, Research and Development, Adoption Governance

Independent

PETER NOBLE
Director

Director since 2015.

Legal speciality, Governance and Risk Management

Independent

David Palmer
Director

Director since 2013.

Governance, Management & Policy Development

Independent

Murray Rankin
Director

Director since 2013.

Governance, Communication, Business & Commercial

Independent

Robbie Davis
Director

Director since 2020.

Governance, Primary Industries and Regions

Independent

Jan Ferguson OAM
Director

Director since 2018.

Governance, Research & Development, Communication

Independent

PUBLIC OFFICER

Lucie Hassall
Company Secretary

Appointed 14 August 2020.
Centre for Invasive Species Solutions

	BOARD MEETINGS		AUDIT AND RISK		GOVERNANCE & REMUNERATION COMMITTEE		RESEARCH EXCELLENCE COMMITTEE		ISST FUND MANAGEMENT COMMITTEE		TRANSITIONAL NOMINATIONS COMMITTEE	
Number of meetings held for the year	6		5		4		4		5		2	
NUMBER OF MEETINGS ATTENDED	No. eligible to attend	2021–22	No. eligible to attend	2021–22	No. eligible to attend	2021–22	No. eligible to attend	2021–22	No. eligible to attend	2021–22	No. eligible to attend	2021–22
Directors												
Bruce Christie (Chair)	6	6	5	5	2	2						
Jan Ferguson OAM (Chair Research Excellence Committee)	6	6					4	4	5	4		
Peter Noble (Chair Governance and Remuneration Committee)	6	6			4	4					2	2
David Palmer	6	6	5	5								
Murray Rankin (Chair Audit and Risk Management Committee)	6	6	5	5								
Robbie Davis	6	6			4	4			5	5		
Transitional Nominations Committee Members												
Josephine Laduzko (Chair)											2	2
Katherine Clift											2	2
Victoria Aitken											2	2
Mike Darby											2	2

4.3 COMMITTEES, STAFF & DOMAIN LEADERS

COMMITTEES

Audit and Risk Committee

The Audit and Risk Committee operates under Terms of Reference as approved by the Board. The Audit and Risk Committee has responsibility for the oversight of fiscal and legal matters and ensuring appropriate procedures and internal controls are in place. The Committee is responsible for the independence of the external auditors and also manages the internal audit program. The members of the Audit and Risk Committee at any time during the year were:

- Mr Murray Rankin — Chair
- Mr David Palmer
- Mr Bruce Christie (optional invitee).

The Chief Executive Officer, and General Manager and external auditors are invited to Audit and Risk Committee meetings at the discretion of the committee.

Governance and Remuneration Committee

The Governance & Remuneration Committee operates under Terms of Reference as approved by the Board. The members of the Governance and Remuneration Committee at any time during the year were:

- Mr Peter Noble — Chair until 30 June 2022
- Ms Robbie Davis — Chair from 1 July 2022
- Mr Bruce Christie (optional invitee).

The Chief Executive Officer and General Manager are invited to Governance and Remuneration Committee meetings at the discretion of the committee.

Research Excellence Committee

The Research Excellence Committee operates under Terms of Reference approved by the Board. The members of the Research Excellence Committee at any time during the year were:

- Ms Jan Ferguson OAM — Chair
- Mr Bruce Christie.

The Chief Executive Officer and Portfolio Director are invited to the Research Excellence Committee meetings at the discretion of the committee.

ISST Fund Management Committee

The ISST Fund Management Committee was established in September 2020 in accordance with the ISST Trust Deed and Register for Environmental Organisations. The members of the ISST Fund Management Committee at any time during the year were:

- Mr Peter Noble — Chair
- Ms Jan Ferguson OAM
- Ms Robbie Davis.

The Chief Executive Officer and Fundraising Manager are invited to the ISST Fund Management Committee meetings at the discretion of the committee

Investment Committee

The Investment Committee operates under Terms of Reference approved by the Board. It consists of a representative from each full Member of IAL and non-Member Research and Development Corporation partners investing in the ISS2030 Initiative. The Chair of the REC, the Chair of the ARC, Chief Executive Officer and the Portfolio Director are also members of the Investment Committee. The Committee met twice during the year.

- Ms Jan Ferguson OAM — Chair
- Mr Murray Rankin

Transitional Nominations Committee

The Nomination Committee operates under Terms of Reference approved by the Board. The members of the Nominations Committee at any time during the year were:

Name	Position
Ms Josephine Laduzko	Chair
Mr Peter Noble	IAL Director representative
Mr David Palmer	IAL Director representative
Ms Katherine Clift	State member (Victoria)
Ms Victoria Aitken	State member (Western Australia)
Mr Mark Darby	National Farmers Federation representative

STAFF

The Centre's staff coordinate and maintain its administration, communication and research management functions

NAME	POSITION/ROLE	TIME COMMITTED
Andreas Glanznig	Chief Executive	100%
Lucie Hassall	General Manager	100%
Associate Professor Richard Price	Portfolio Director (Research)	100%
Frank Exon	Communications and Marketing Manager	100%
Dr Tony Buckmaster	RD&E Manager and Balanced Researcher Leader	100%
Greg Mifsud	National Wild Dog Management Coordinator	100% *
Andrew Mitchell	Research Scientist	100% **
Gillian Basnett	National Feral Cat and Fox Management Coordinator	100% **
Catherine Walsh	Invasive Weeds RD&E Manager	100%
Dave Worsley	NE NSW Wild Dog Control Coordinator	100% **
Aaron Pobjie	Research Administration Officer	100%
Trevor Capps	Fundraising Manager	100%
Sreshti Nair	Communications and Marketing Coordinator	100%
Shan Southwell	Finance and Office Manager	100%
Jane Leslie	Administration Assistant and EA to the Chief Executive	100%

* funded through Portfolio No 1 project funds ** funded through Aligned project funds

STAFF CHANGES

Dr Ian McDonald (Communications Manager) resigned in August 2021 and was replaced by Frank Exon (Communications and Marketing Manager) in September 2021.

Yvette Cazabon (Senior Graphic Designer and Content Coordinator) resigned in May 2022 and was replaced by Sreshti Nair (Communications and Marketing Coordinator).

DOMAIN LEADERS

NAME	ORGANISATION	DOMAIN	TIME
Dr Brad Page	Primary Industries and Regions, South Australia	Innovation co-leader, Incursions	27%
Dr Tony Pople	Queensland Department of Agriculture and Fisheries	Innovation leader, Integrated Landscape Management	30%
Dr Tanja Strive	CSIRO	Innovation leader, Biocontrol Domain	20% (pro bono)

4.4 FINANCIAL PERFORMANCE

Invasive Animals Ltd (IAL) was established to be a non-profit institution to promote a managed and co-operative approach to RD&E in the field of invasive species management and maximise the benefits from that RD&E. IAL was appointed as the Trustee for the Invasive Species Solutions Trust (ISST) from 15 September 2020. The ISST and the related Invasive Species Solutions Fund, was entered in the Register of Environmental Organisations and DGR status granted on 7 December 2020. The 2020–21 consolidated financial statements and notes represents those of IAL and the entity it controls, ISST, collectively referred to as the Group.

IAL's short term objective is to continue to establish the Centre for Invasive Species Solutions, and deliver its first RD&E project portfolio — Portfolio No. 1. Portfolio No.1 is funded through a five-year agreement between the Commonwealth Department of Agriculture, Fisheries and Forestry, all States and the ACT, two industry Research and Development Corporations, five universities and the NZ Department of Conservation. Portfolio 1 commenced

in 2017 and finishes in 2022. In addition, IAL is attracting further funding from state governments and industry bodies to further pursue its objectives.

IAL's long-term objective is to secure the Centre for Invasive Species Solutions as a permanent national collaborative invasive species institution that enables and drives a more coordinated and efficient approach to invasive species management across Australia's National Biosecurity System. This will include pursuing a broader RD&E scope that covers vertebrate pests, weeds and environmental invertebrates and diseases, and diversifies revenue by attracting deductible gift receipts through the ISST and related Public Fund and additional projects aligned to the Centre's strategy.

PERFORMANCE OF THE CENTRE

The total contributions of resources refers to the Portfolio No 1 plus aligned and other projects. Total contributions available in 2022 were $22,782,200, slightly down from $23,171,574 available in 2021. 2022 cash revenue (including IAL reserve funded projects) being $12,792,874 and total In-kind contributions being $9,989,326.

2022 Total resources available

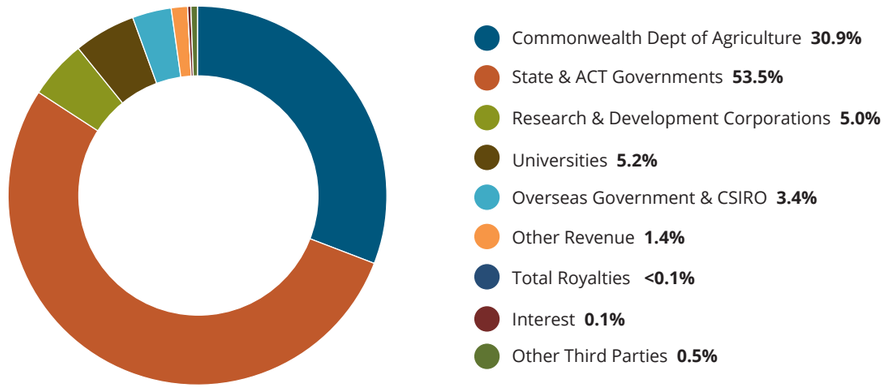


Chart 1: Financial year 2021–22 Total Contributions, both Cash and In-kind by revenue source.

The current whole of the Centre's leveraging ratio at 30 June 2022 was 2.93 (as defined by AgTrans Research). That is, the Centre has secured $2.93 in co-contributions (cash and in-kind, excluding any additional investment by the Department of Agriculture, Fisheries and Forestry) for every $1.00 (cash) of the initial Portfolio No. 1 Grant funding.

Resources applied for 2022

The following chart reflects on a percentage basis, the expenditure allocation of the cash revenue and in kind contributions received for the year. The allocation to research activity of 91.5% is consistent with 30 June 2021. This year a cash revenue amount of $12,472,632 was carried forward to future years to be spent on contracted and committed projects.

Total Resources Applied for 2022

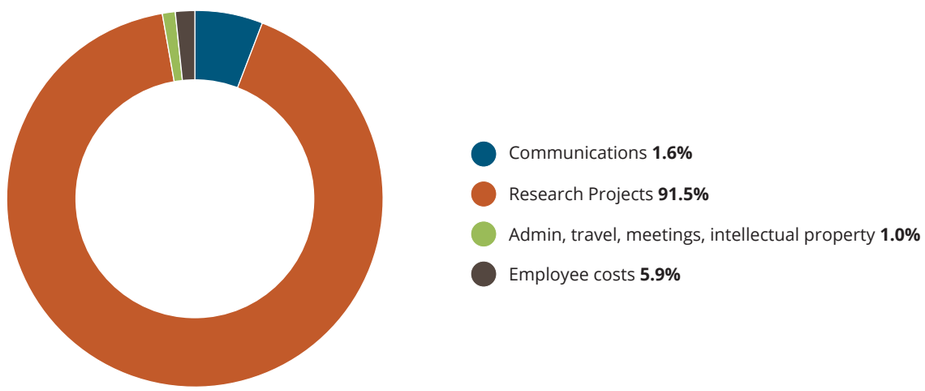


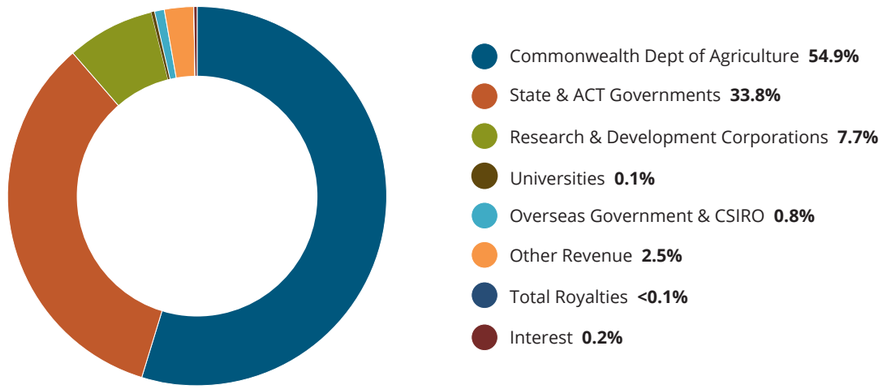
Chart 2: Financial year 2021–22 — Allocation of cash and in kind resources to expenditure by percentage ratio.

Net surplus 2022

The Group achieved a net surplus of $87,817 in 2022 (2021: $152,248). Financial savings were achieved during the year 2021–22 primarily due to savings on expenditure for travel, legal and consultancy costs. IAL also received increased administration fees from the management of aligned projects.

2022 Revenue (cash and other)

The total net revenue of $10,654,497 (total cash $12,792,874 including IAL reserve projects less carried forward movement of $2,138,377) included $7,025,038 invested by the Commonwealth Department of Agriculture, Fisheries and Forestry, with other members and partners also providing significant revenue: $990,982 by Research and Development Corporations (including universities), $4,320,873 by the States and Territories and $100,757 by the NZ government and others.



*Total Royalties includes Pigout Royalties which are paid out annually to PAC CRC Participants.
Chart 3: Financial year 2021–22 — Cash and other revenue received by revenue source.

2022 In-kind Contributions

The total In-kind contributions of $9,989,326 for both Portfolio No 1 and aligned projects was invested by state and territory governments, the universities, CSIRO and other third parties.

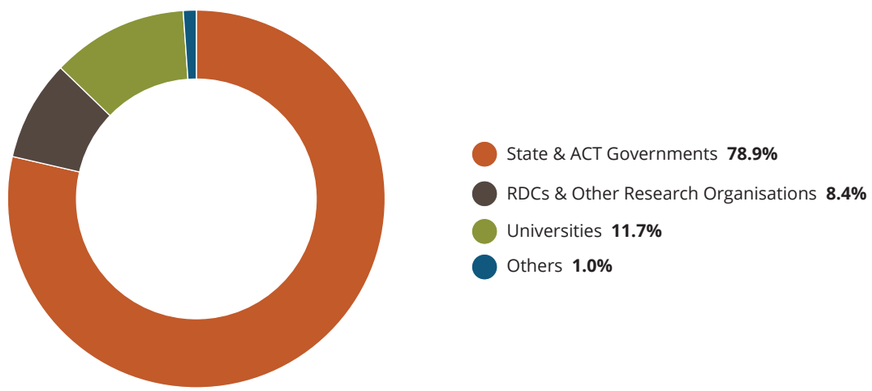


Chart 4: Financial year 2021–22 — Total In-kind Contributions received by organisation group.

The positive total asset position at June 2022 of $15,325,782 represents sufficient cash flow to meet the liabilities of $13,605,616. The Group's equity position at 30 June 2022 was $1,720,166 an increase from $1,632,349 at 30 June 2021.

Balance Sheet

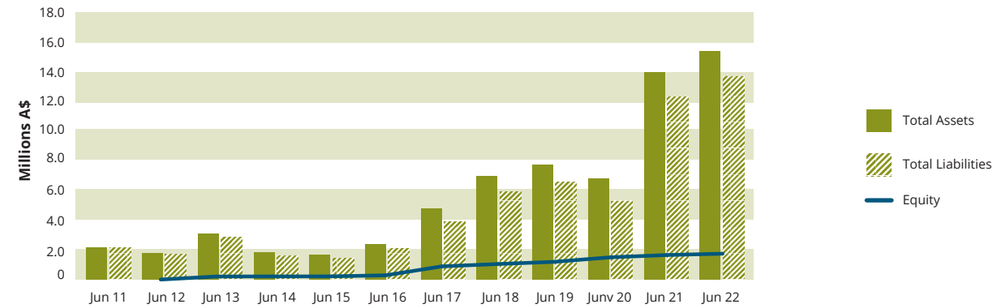


Chart 5: Financial year 2021–22 —
IAL Company Balance Sheet reflecting Total Assets to Total Liabilities and resulting Equity (or Earnings).

Total Cash Reserve

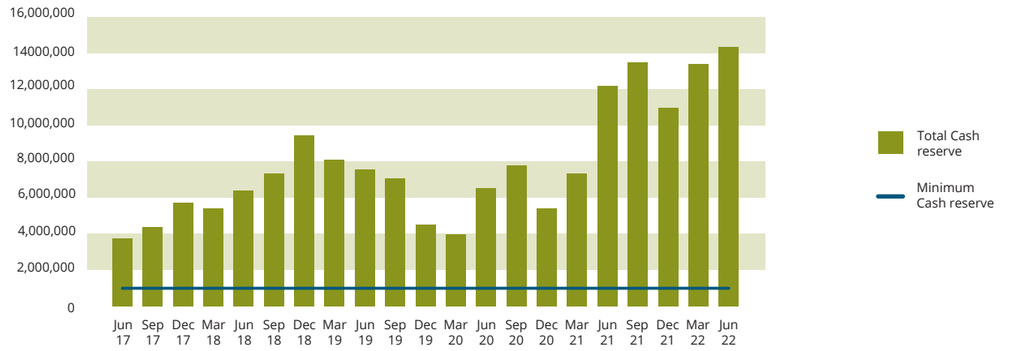


Chart 6: Financial year 2021–22 — Total Cash Reserves for the Group as a quarterly trend over time.

Liquidity Ratio

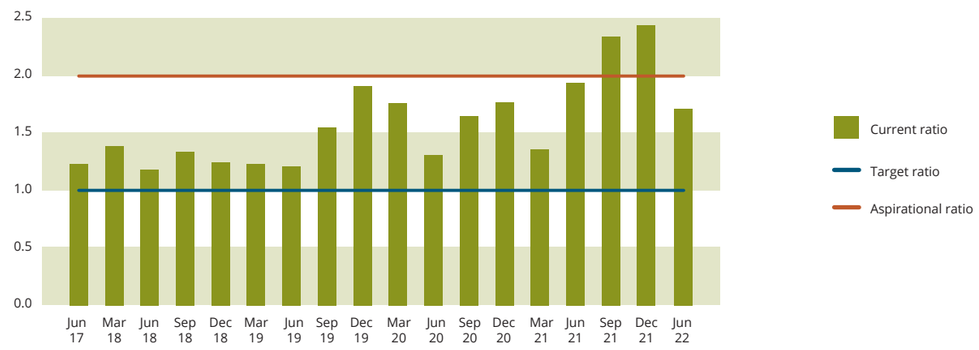


Chart 7: Financial year 2021–22 — IAL's Liquidity Ratio compared to the Commercial best practice benchmark.

The current asset ratio — a measure of liquidity — as at 30 June 2022 was 1.71.
This is significantly above the target ratio of 1:1 but below the aspirational target of 2:1.

Information used in compiling these graphs has been derived from the complete Audited Financial Statements which are available for download from www.invasives.com.au.

A female Alwal (also known as Golden-shouldered Parrot). The Alwal is a significant cultural species for the Olkola of Far North Queensland. It is also listed among top 100 threatened species of the Australian Government. Feral cat control is one the activities supporting its recovery.

CENTRE FOR
INVASIVE SPECIES
SOLUTIONS

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