



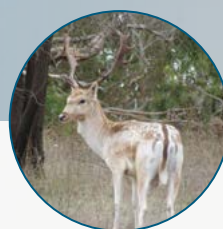
CENTRE FOR
INVASIVE SPECIES SOLUTIONS

COLLABORATION

INNOVATION

IMPACT

2018–2019 ANNUAL REPORT





The Centre for Invasive Species Solutions gratefully acknowledges the financial contribution from its members and partners to support its activities.

Invasive Animals Limited governs and manages the Centre for Invasive Species Solutions.

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Designed by Yvette Cazabon

Main image: Dr Alejandro Trujillo-González, University of Canberra research fellow, testing samples for the presence of DNA using the new MiniT real-time analysis system, as part of our centre's biosecurity molecular screening project. Image by Yvette Cazabon.

Small images (L-R): Fallow deer. Image by A Dezsery. Peri-urban wild dogs. Image by John Smith. Marty Bower, SA wild dog coordinators demonstrates the use of Canid Pest Ejectors at a regional Field Day June, 2018. Image by L Gavin.

Annual Report 2018–19 [Centre for Invasive Species Solutions](#)

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MESSAGE FROM THE CHAIR

It is very pleasing to report that our Centre is making major advances against its 2017–2022 strategy. Our collaborative RD&E platform is driving a broad research and innovation agenda, with early products already developed and ready for refinement.

This success coincides with several national reports into Australia's agricultural innovation system. Three of the major themes that emerged to modernise our system were the need for increased collaboration, a stronger focus on transformational research and innovation, and better ways to improve R&D adoption.

2019 also saw the inaugural Australian Biosecurity Symposium clearly identify the full breadth of our national biosecurity collective with trust, ambition and generosity as key to creating a better biosecurity system.

When combining the national reports and the key qualities for our national biosecurity collective, CISS comes to mind. Australia already has a fit for purpose Centre that is implementing these essential aspirations. Australia's biosecurity systems are on a strong footing when government is supported by the combined capability and capacity of CISS, Animal Health Australia & Plant Health Australia.

The year ahead will see our Independent Performance Review provide an impartial look at the Centre's performance since its inception in 2017. Importantly the review will engage our Members, Partners and key stakeholders to give their insights on the best strategic direction to take the Centre forward ensuring it's long term success by meeting Australia's invasive species research, innovation and engagement needs.

Our strategic direction will also be informed by the long-term opportunities to be explored at Australasia's premier vertebrate pest conference in Melbourne, May 2020. There is so much to be investigated within the theme 'Feral Futures 2051' and I encourage you to join in this weighty conversation.

The importance for taking this strategic and transformational approach is heightened by the continuing challenges from a changing climate, cycling major droughts and their aftermath, international biosecurity shortfalls, human negligence and the unrelenting persistence of invasives that all demand our attention. Clearly new and emerging technology platforms are imperative to extend and maximise the effectiveness of investments to maintain Australia's biosecurity shield.

Once again, my sincere thanks to our dedicated CISS Community, to the Board who have provided wise insights throughout the year, and our CEO – Andreas Glanznig – his team, and all the researchers in our collaboration for their tenacity and drive.



Helen Cathles

Chair

Invasive Animals Limited





OUR MEMBERS AND PARTNERS

Members



Australian Government
Department of Agriculture



ACT
Government



Queensland
Government



Government
of South Australia



Tasmanian
Government



GOVERNMENT OF
WESTERN AUSTRALIA

OUR MEMBERS AND PARTNERS

Partners



THE UNIVERSITY
of ADELAIDE



Australian Wool
Innovation Limited



UNIVERSITY OF
CANBERRA



Department of
Conservation
Te Papa Atawhai



LA TROBE
UNIVERSITY



Murdoch
UNIVERSITY



University of
New England



CENTRE FOR INVASIVE SPECIES SOLUTIONS



CEO SNAPSHOT

Our second year has seen the foundations of the Centre put in place and momentum growing as our first RD&E portfolio hits its stride.

Highlights included the launch of the Centre's first RD&E portfolio focussed on vertebrate pests, and major progress made on developing a CISS national 10 year weeds RD&E investment plan in consultation with our members, partners and key stakeholders and how this could translate into a new coordinated project portfolio.

Our extension and engagement activities remain a strategic focus for the Centre. For the first time, PestSmart website views exceeded half a million, and 365 pest management groups have now adopted our FeralScan community mapping and management platform. The value of these resources in enabling strategic cooperative management of vertebrate pests is well known. This year, a peer reviewed study also showed the important role of FeralScan citizen science data, this time by filling in missing information to enable better modelling and management of rabbits.

Environmental and community biosecurity is a growing strategic priority for the Centre. Our appointment by the National Biosecurity Committee to coordinate the implementation and revision of the National Environment and Community Biosecurity RD&E Strategy will see the Centre's relationship with environmental organisations broaden and deepen. This new role also provides an umbrella for our existing and emerging community detection and surveillance innovation program and our aspiration of making community engagement in biosecurity programs easier and more effective through new digital and genetic tools and systems.

Agricultural biosecurity is in the headlines with African Swine Fever (ASF) now in Timor-Leste, and our collaborative innovation pipeline will soon see a new and timely feral pig toxic bait – HOGGONE® – available as another important tool to manage feral pigs – a major vector for ASF.

The achievements outlined in this Annual Report is a testimony to the collaborations of our 17 Member and Partner organisations, ably supported by another 23 organisations that together have built and are implementing a large-scale and transformational research and innovation agenda through our Centre. This would not have been possible without the commitment and focus of the CISS management and communications team, and I thank you.

I commend this Annual Report to you.



Andreas Glanznig

Chief Executive Officer

Centre for Invasive Species Solutions

THE 18/19 SNAPSHOT

Our 2nd year of
RD&E operations

The problem

Invasive species decrease agricultural productivity

- Pest animals = ~\$600 million per year in costs & damages¹
- Weeds = ~\$5 billion per year in costs & damages²

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

The solution

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



member and partner
organisations:

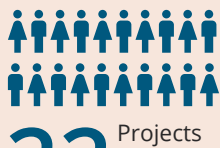
9 governments
5 universities

3 research and
development
corporations

23 institutions involved as third
parties to our research

RESEARCH

31 PROJECTS



22 Projects
are
underway

8 Projects
completed



1 Project under
development

57 PROJECT MILESTONES



46%
Achieved



54%
Advanced progress

17 PUBLICATIONS PRODUCED



1 Economic
impact report



1 Updated
glovebox guide



2 Books



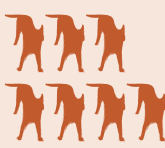
13
Scientific
publications



13
Scientific
publications

DEVELOPMENT

13 PRODUCTS IN DEVELOPMENT



7 Prototype wild dog
related devices



1 Wild deer
aggregator



2 New eDNA validation
techniques
(Red-eared slider turtle
& Asian black spined toad)



2 FeralScan
software
platform
updates



1 'Proof of absence' eradication
tool software package

2 PRODUCTS UNDER AVPMA REVIEW



PAPP-based
lethal trap device



Hoggone®
toxic baits

EXTENSION

FACE TO FACE

123

Stakeholder
workshops conducted



14
Conference
papers
presented



1 Certificate III Course in
Pest animal management
- redeveloped

DIGITAL



2 National digital
platforms in use



22,040
Users of FeralScan



529,537
Pestsmart website views

Achieving adoption

2700+ vials

of RHDV1 K5 have been distributed
across Australia since March 2017
(the first release) enhancing integrated
rabbit management.

365 pest management groups

are registered within FeralScan using collective data to
enhance strategic management outcomes on ground
and connect them with government land managers.



9 state based wild dog coordinator positions

(QLD, NSW, VIC, SA, WA) funded
through industry and government
are supporting strategic and
coordinated wild dog management
through the leadership of our
national wild dog management
coordinator, Greg Mifsud.



2 states (NSW and QLD)

are now
utilising eDNA
technology to detect
Tilapia in rivers.

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.

YEAR IN REVIEW

YEAR IN REVIEW

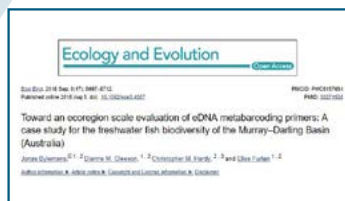
Our centre's first **RD&E Portfolio One** was officially launched at Parliament House by the Hon. David Littleproud MP



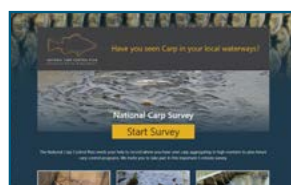
Australia's largest **deer management research collaboration** established, which will oversee much of the deer research nationally



eDNA research progresses toward ecoregion scale evaluation



CarpMap launched in partnership with Fisheries Research Development Corporation (FRDC) and NSW DPI



July 2018

August 2018

September 2018

October 2018

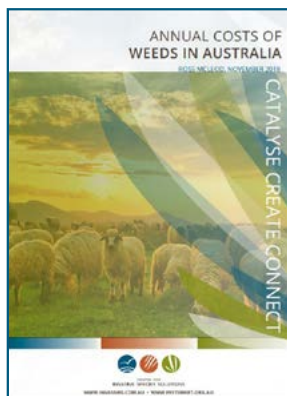
February 2019

March 2019

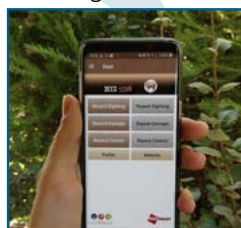
April 2019

May 2019

The latest '**Annual costs of weeds report**' released, showcasing costs to farmers at \$5 billion per year



DeerScan monitoring program launched through FeralScan



CISS National Rabbit Biocontrol program receives an Australian Biosecurity Award



Wild Dog Alert prototype sends first text alerts



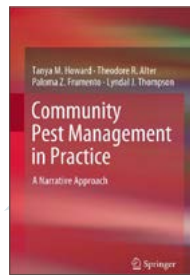
Trials of the latest prototype **Deer Aggregator** begin

'**Community Based Control of Invasive Species**' textbook released by CSIRO publication, developed by UNE researchers



Stage 1 of the National **Incursion Management Framework** completed

**'Community Pest Management
in Practice.'** published



Threatened Species Recovery
Hub releases a joint statement
with CISS acknowledging new
research showcasing **'Invasive
species and habitat loss
are our biggest biodiversity
threats'**



**CISS Member and
Partner Forum**



November 2018

December 2018

January 2019

June 2019

July 2019

August 2019

September 2019

YEAR IN REVIEW

CISS co-hosts the inaugural
**Australian Biosecurity
Symposium**, along with
Animal Health Australia and
Invasive Species Council,
attended by more than 400
delegates



New research finds **wild dogs
in urban areas** carry a range
of parasites that pose risk to
public health

**National Rabbit Biocontrol
Monitoring team** develop
a fly sampling network,
greatly expanding our ability
to monitor disease activity,
including RHDV2

ABC Landline cover our deer
research collaboration

**The Victorian Rabbit
Action Network** receives
a **United Nations Public
Service Award** for their role
in building a community-led
approach to managing rabbits
at landscape scale



The UC led CISS **eDNA project
team** start to trial new
real-time portable analysis
devices for quick and reliable
detection of invasive threats
(BioMeme and minION)



CISS announced as the
coordinator to implement
the **National Environment
and Community Biosecurity
Research Development and
Extension Strategy**, over the
next two years



OUR STRATEGY

Our Vision

Through scientific leadership and alliances we will act as a catalyst to deliver ethical invasive species solutions in Australia and beyond.

Our Mission

We are in the business of creating and brokering powerful and efficient large-scale invasive species RD&E collaborations.

Our Values

As a service and member-oriented company, the Centre for Invasive Species Solutions (CISS) strives to be:

- a trusted authority for delivering effective, independent and science based solutions
- a catalyst for inspiring solutions through collaboration and thought leadership
- a promoter of ethical solutions that respect the welfare of all species
- audacious in pursuing new ideas to disrupt established thinking and identify solutions

Our Five Strategic Pillars

1. Strengthen and build collaborations
2. Develop and implement collaborative RD&E
3. Build capability and best practice management adoption
4. Create new collaboration and innovation opportunities
5. Operate the Centre effectively and efficiently

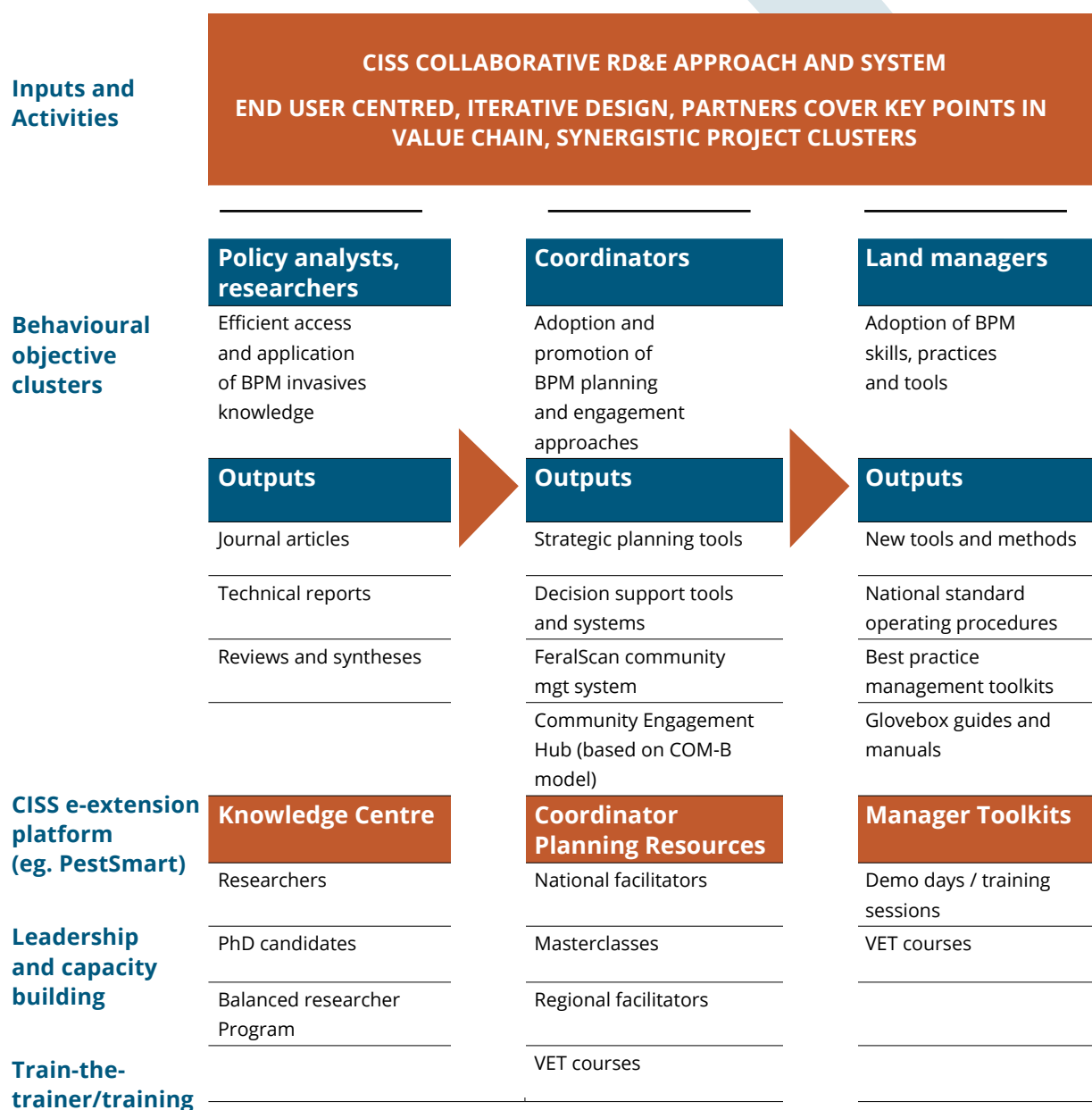
Our Innovation Domains

1. Incursions
2. Integrated Landscape Management
3. Biocontrol
4. Management Systems and Tools
5. Community Engagement and Education

THE CISS APPROACH

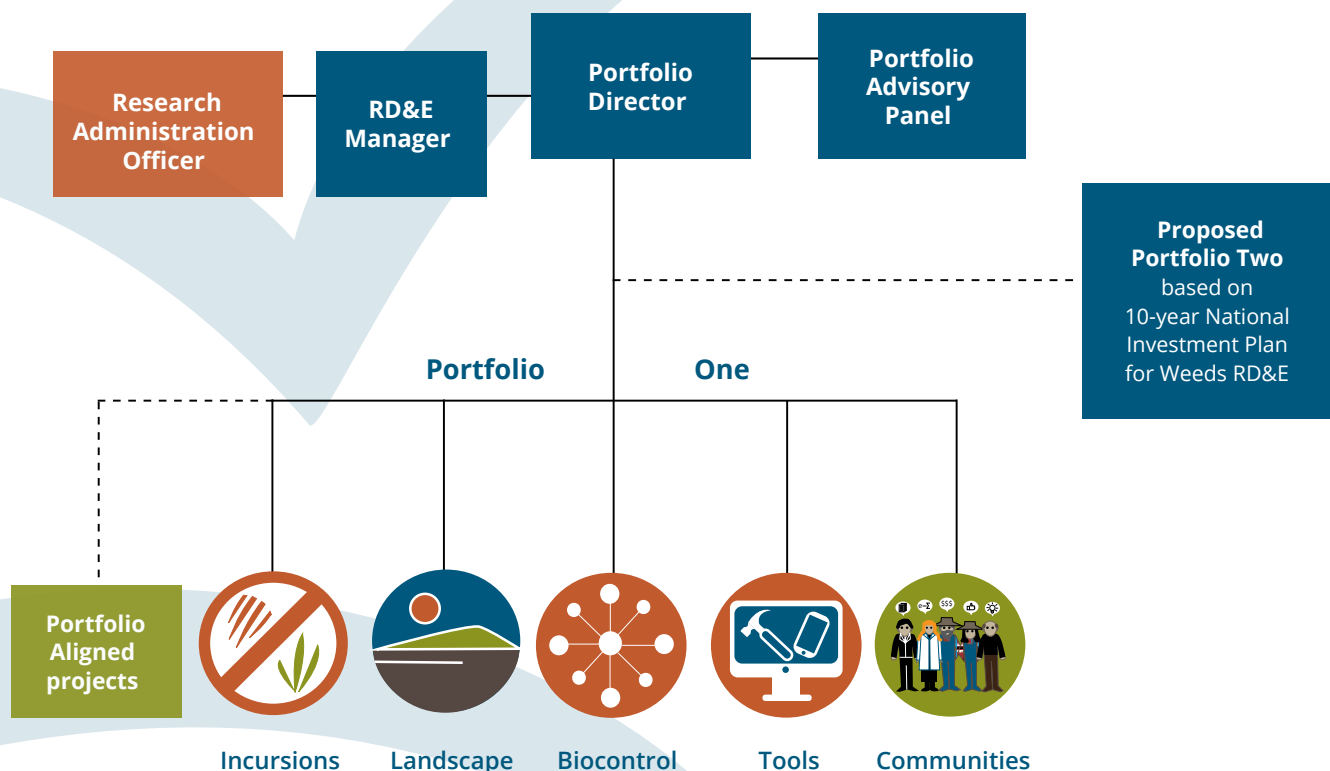
CISS Research, Innovation and Engagement Model and System

The CISS research, innovation and engagement model has been developed and refined over the 12 year Invasive Animals CRC, and has been instrumental in the design of CISS programs. It aims to cover all key points in the value chain from need identification through to engagement and adoption via a managed distributed network of Member, partner and other organisations. A schematic representation of the generic CISS research, innovation and engagement model is below.



OUR RESEARCH AND DEVELOPMENT

OUR RESEARCH AND DEVELOPMENT



Our Centre currently has **31** research and innovation projects. These either fit under the Portfolio One collection of projects, or are aligned with portfolio projects but funded through other external grants.

All projects address a national biosecurity RD&E priority and a national RD&E priority for invasive plants and animals.

The Project Portfolio has:

5 innovation domains

22 Projects are underway, **8** projects are completed and **1** project under development

40 contributing research member, partner, and third party organisations

140 RD&E specialists mobilised across Australia

Our domains

Innovation Domain 1:

Incursions – Protection of Australia's economy, environment and social amenity from the impacts of new invasive species

Innovation Domain 2:

Integrated Landscape Management – Reduction in the economic, environmental and social costs associated with invasive species through development and demonstration of large-scale integrated management strategies

Innovation Domain 3:

Biocontrol – Sustainable reduction of the impacts of established pest animals through biocontrol and exploring other genetic based opportunities.

Innovation Domain 4:

Management Systems and Tools – Optimal cost-effective pest management through new tools and systems

Innovation Domain 5:

Community Engagement and Education – Improvement in the human and institutional aspects of pest management



Peter West training Licensed Pest Management Technicians to use FeralScan in WA. August 2018. Image supplied by Meja Aldrich.

INNOVATION DOMAIN 1: INCURSIONS



Jack A. Rojahn (U.C. PhD candidate supported by CISS) testing the new Biomeme analysis kit in the field in Thailand, as part of our centre's biosecurity molecular screening project. Image by Alejandro Trujillo-González.

Incursions

Aim: Protection of Australia's economy, environment and social amenity from the impacts of new invasive species

National biosecurity policy, driven by the Intergovernmental Agreement on Biosecurity (IGAB), has increased government's focus on prevention, preparedness and early intervention. This focus recognises that prevention of and early intervention against new pest incursions represent some of the highest benefit: cost investments in biosecurity. But like many areas of investment, the highest returns often come where the challenges are greatest. In the incursion field, the challenges are often at the exploratory and hi-tech end of the research spectrum or, where they are at the applied end, they tend to be in the planning and policy fields where R&D needs to inform rather than advocate action within a political arena of federal relationships.

The Incursions Domain comprises one project to develop a National Incursion Management Framework, three to develop incursion management tools and one to investigate the extent of illegal trade in exotic animals in Australia and develop an early warning system.

Summary

Over 2018-19, the projects within the Centre's Incursion Domain have contributed either to 1) informing policy, such as through the completion of the InvasivePlan incursion response strategy, 2) guiding potential regulatory responses, such as through shining light on illegal trade in invasive species, 3) guiding management responses to incursions, such as through developing an eradication management toolkit, and to 4) strengthen the technical and community capacity to identify potential new invasions, such as through the development of eDNA and acoustic detection technologies and understanding the potential for citizen science networks to play a role in incursion detection.

The Incursion Domain projects are now at the stage where they will be seeking more direct feedback from end users. Initially, this will be facilitated through the state and Commonwealth government representatives on the Terrestrial Vertebrate Working Group, which is a subcommittee of the Environment and Invasives Committee.



4 projects operational
1 project complete



2 PhDs appointed
1 Hons completed



4 journal articles published
2 technical reports published
7 journals articles submitted



several products
in development

Domain Projects

Development of a national incursion management framework for invasive species (COMPLETE)

Project leaders: Dr Malcolm Kennedy and Dr Michelle Christy | Western Australian Department of Primary Industries and Regional Development

Project partners: Western Australian Department of Primary Industries and Regions, Primary Industries and Regions South Australia, Victorian Department of Economic Development, Jobs, Transport and Resources, Tasmanian Department of Primary Industries, Parks, Water and Environment, New South Wales Department of Primary Industries, Australian Government Department of Agriculture and Water Resources.

Project aim: This project aims to understand the roles and responsibilities with respect to the prevention and detection of invasive animal and plant incursions. It aims to improve recognition of what is required to increase the efficiency and effectiveness of responses to new animal and plant incursions of national significance and will promote pathways to adoption for new incursion technologies.

Tools for developing cost-effective decisions for managing invasive pest eradications

Project leader: Dr Dave Ramsey | Arthur Rylah Institute, Victorian Government

Project partners: Victorian Arthur Rylah Institute for Environmental Research, CSIRO, University of Adelaide, Victorian Department of Economic Development, Jobs, Transport and Resources, New Zealand Landcare Research

Project aim: This project aims to develop new tools and systems for guiding decisions around an eradication response to invasive pests. Specifically, these will improve the capability of government agencies to make cost-effective decisions around the feasibility and use of resources. Use of these tools should therefore result in more successful and cost-effective eradications of invasive pests that maximises the economic benefits to industry and the environment.



Understanding and intervening in illegal trade in non-native species

Project leader: Associate Professor Phill Cassey | University of Adelaide

Project partners: University of Adelaide, CSIRO, Victorian Arthur Rylah Institute for Environmental Research, Primary Industries and Regions South Australia, Australian Museum

Project aim: This project aims 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.

Real-time eDNA tools to improve early detection and response approaches for high risk pest animals

Project leaders: Associate Professor Dianne Gleeson and Dr Elise Furlan | University of Canberra

Project partners: University of Canberra, New South Wales Department of Primary Industries

Project aim: This project aims 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.

Development of integrated passive and active surveillance tools and networks

Project leader: Dr Peter Caley | CSIRO

Project partners: CSIRO, Western Australian Department of Primary Industries and Regional Development, University of Adelaide, Queensland Department of Agriculture and Fisheries, University of Canberra, Victorian Arthur Rylah Institute for Environmental Research.

Project aim: The broad objective of this project is to develop a coherent, complementary approach for combining community surveillance and targeted surveillance using passive (e.g. community sighting) and active sensing (e.g. eDNA) technologies to detect and manage pest incursions in a timely manner.

Image credits on page 12

Progress: Development of a national incursion management framework for invasive species

This project is now complete. For invasive species with environmental and social impacts, a nationally-consistent approach to responding to new incursions at a national, state or territory and local level is being put into action. A final draft of the National Vertebrate Incursion Prevention and Response Strategy 2019-2024 has been submitted to the Environment and Invasives Committee (EIC).

An InvasivePlan Compendium was developed from the outcomes of the Invasive Plan Framework, literature searches and workshops. Engagement and awareness of the InvasivePlan and incursion science in general was delivered through presentations, interviews, articles and workshops.



Progress: Tools for developing cost-effective decisions for managing invasive pest eradication

A workshop held in April 2019 substantially advanced the theoretical framework underpinning eradication tools.

The project team has also provided expert advice and analysis to stakeholder groups conducting pest eradication programs nationally and internationally. Biosecurity QLD was engaged to provide advice and technical analyses around the eradication of Red-imported fire ants in the greater Brisbane area.

Development of a user-friendly web-based software interface to undertake 'proof of absence' confirmation during the final phase of pest eradication programs is underway. It will be road tested with stakeholders through a series of workshops in the coming year, with the first scheduled for October 2019 in Christchurch, New Zealand. The user-friendly graphical interface will enable stakeholders to analyse their own surveillance data. The prototype of this model will be available for users to upload their data, specify appropriate parameters and run the model.



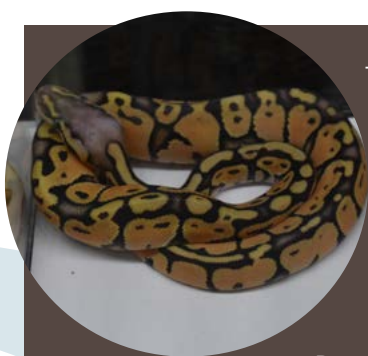
Top image: American corn snake spotted in Lithgow, NSW. Image supplied by NSW DPI.

Bottom image: Red imported fire ants attacking and eating crickets. Image supplied by the National Red Imported Fire Ant Eradication Program.

Page 11 credits: Top image: Testing the new Biomeme DNA analysis kit in the field in Thailand, as part of our centre's biosecurity molecular screening project. Image by Alejandro Trujillo-González.

Bottom image: Alejandro Trujillo-González testing samples using the MinION, as part of our centre's biosecurity molecular screening project.

Progress: Understanding and intervening in illegal trade in non-native species



To combat the illegal trade of non-native species, this project is designing, testing and implementing automated web-scraping tools to analyse exotic live animal trade websites in Australia, United States and Europe. One finding of this project over 2018-19 is that trade in live vertebrates in the United States is a robust estimator of preference for alien vertebrates in Australia. Consistent with U.S. trade activity, the project has found, on Australian e-commerce sites, evidence for illegal trade in non-native reptiles and grey-listed ornamental fish.

Bone and scute samples of Red-eared slider turtles have had preliminary isotopic and ablation laser analyses performed with the results being prepared for publication. A pilot study to determine specimen provenance (captive, wild, international) from analyses of stable isotope ratios has been completed and submitted for publication.



Top image: Captive breeding morph of a ball python (*Python regius*), species traded legally in the US. Image by Adam Toomes.

Middle image: Juvenile green iguanas (*Iguana iguana*), species traded legally in the US. Image by Adam Toomes.

Bottom image: Adam Toomes (University of Adelaide PhD candidate supported by CISS), presenting, as part of our understanding and intervening in illegal trade in non-native species project, at Lincoln College, Adelaide

Progress: Development of integrated passive and active surveillance tools and networks

A survey of primary industry, conservation and NGO organisations identified high-priority established and non-established vertebrate pests. From this, a list was developed of high-priority vertebrate pests for which acoustic surveillance is considered applicable. Preliminary lists identified 54 priority invasive species, with 28 identified by more than one state as a priority.

A newly-employed data technician will improve data handling procedures and assess data entered into the Atlas of Living Australia (ALA) website. Community reporting rates for cane toads, red-eared slider turtles and common starlings to ALA will be assessed. Community reporting lines not captured within the ALA will also be identified and assessed.

Acoustic surveillance units are being procured for the collection of reference calls for Asian black-spined toads and Indian house crows in Singapore. Commercialised acoustic traps for cane toads 'Toadinator®' (Animal Control Technologies (Australia) Pty Ltd) have been modified to play Asian black-spined toad audio, eight traps will be deployed in high risk sites around Brisbane. A local community group will be engaged to help deploy and monitor these traps.



Progress: Real-time eDNA tools to improve early detection and response approaches for high risk pest animals

EcoDNA is the new name of the research team associated with this project, and its website was launched on 5 March 2019 (www.ecodna.org.au). The website will allow end-users to enquire about eDNA and eventually submit samples for analysis.

Real-time detection methods are being trialed using portable DNA sequencing tools. Whole genomes can be sequenced directly from water samples, however methods to improve species identification are underway. Work is currently underway on the eDNA metabarcoding abundance framework and models are being developed to predict competition between DNA sequences.

A proposed national reference laboratory will be developed over three years to perform research and extension to intergovernmental and cross-sectoral department business operations such as border surveillance using real-time tools. The ornamental fish trade will be examined as a proof-of-concept.

Development of proposals for eDNA applications in an expanded list of biosecurity risks and established pests is being prepared in a report by the EcoDNA team.



Top image: Red-eared slider turtles have been smuggled into Australia, and have been illegally kept and released, as part of the illegal pet trade. They pose a significant threat if established. Image by Pablo Garcia-Diaz.

Middle image: The new Biomeme analysis kit has the ability to analyse samples for DNA within minutes. Image by Alejandro Trujillo-González.

Bottom image: The next-generation portable sequencer, MinION from Nanopore Oxford technologies (United Kingdom) is being tested by UC researchers as part of their eDNA invasive species project.

Case Study: Understanding and intervening in illegal trade in non-native species

The latest findings from the Invasion Science and Wildlife Ecology Group at The University of Adelaide add to the growing body of evidence that the international pet trade is a predominant pathway for the introduction and establishment of invasive species globally. Their review, titled *When pets become pests: the role of the exotic pet trade in producing invasive vertebrate animals*, identified an increase in the global demand for non-native pets, both in historical markets where exotic pets are outpacing traditional pets, and in developing nations where living standards are rapidly improving. Further, the review emphasised the need for greater understanding of the interplay between market demand, species traits and the probability that a consumer will (i) purchase a pet and (ii) subsequently release that pet into the wild. The research team will continue to conduct vital socio-behavioural research to determine the drivers of pet trade throughout the introduction pathway in order to reduce invasion risk.



To address the emerging threat of exotic species incursions from legal and illegal trade, recent research has contributed to a “toolbox” of novel techniques to identify the presence of established populations. A review currently under assessment, titled *Pet or pest? Stable isotope methods for the early detection of invasive alien species*, evaluates the potential utility of nitrogen stable isotopes to distinguish Red-eared slider turtles (*Trachemys scripta elegans*) that have recently been released from captivity against those that originate from an established breeding population (captive $\delta^{15}\text{N}\text{‰} \geq 9.7\text{‰}$). Using a potentially non-invasive sampling method, keratin samples from individuals can provide information on an individual turtle’s provenance due to the differences in nitrogen stable isotope ratios between captive and wild diets. With minimum accuracy of 96%, this research outlines a practical and accessible detection tool to rapidly identify established invasive species populations, in order to facilitate effective management and eradication.

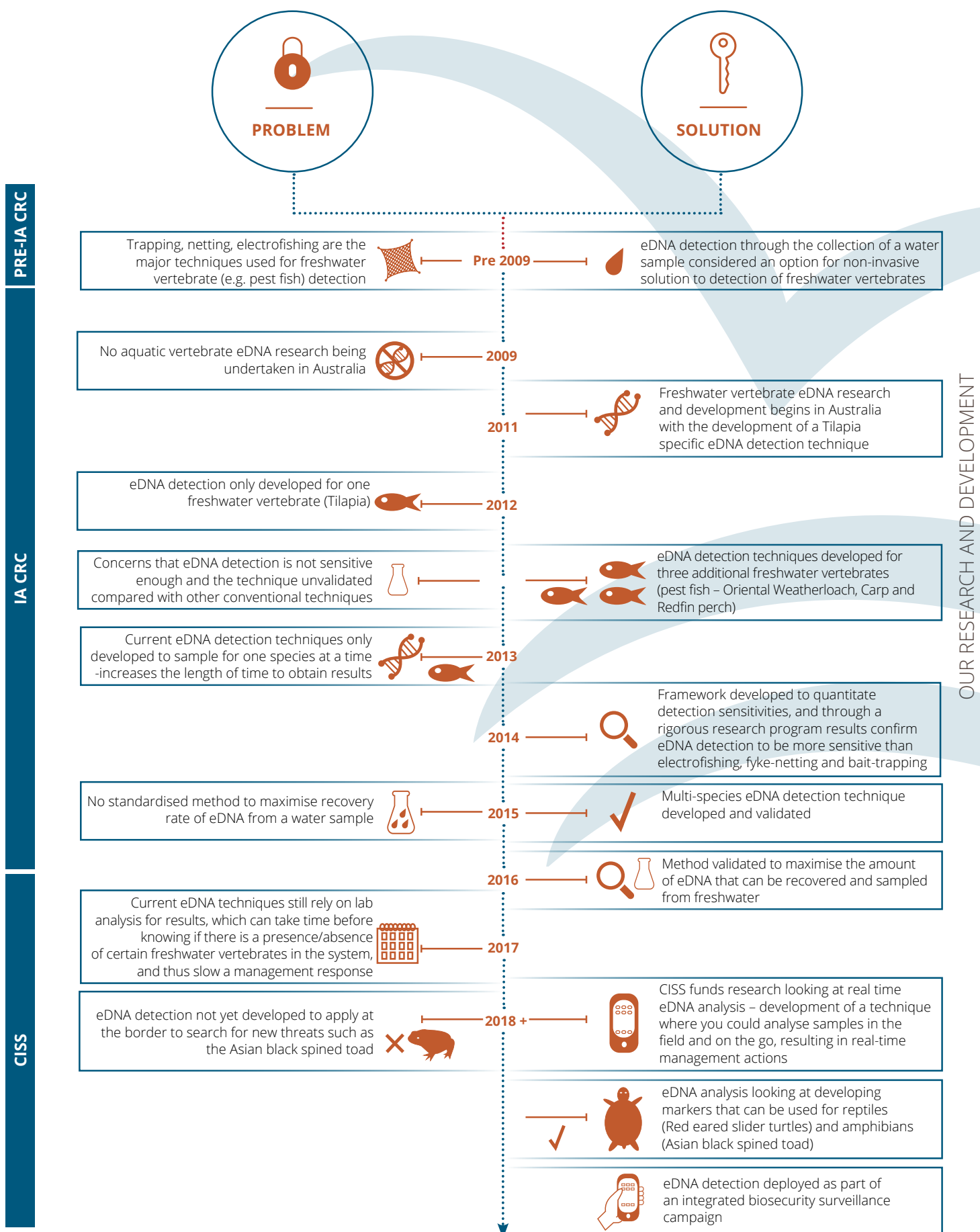


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- Top image: A variety of Ball python (*Python regius*) breeding morphs for sale during Repticon, Palm Beach, FL October 2018. Image by Adam Toomes with vendor permission.
- Bottom image: Two Red-eared slider turtles (*Trachemys scripta elegans*) seized from illegal keeping in South Australia, June 2018. Image by Katherine Hill.

Australian freshwater vertebrates eDNA innovation pipeline.

Achieving smarter, faster and cheaper surveillance methods.



INNOVATION DOMAIN 2: INTEGRATED LANDSCAPE MANAGEMENT



Aerial survey of Chital deer by QLD DAF staff on a property adjacent to the Burdekin River, north west of Charters Towers, QLD.
Image by M.Brennan, QLD DAF.

Integrated Landscape Management

Aim: Reduction in the economic, environmental and social costs associated with invasive species through development and demonstration of large-scale integrated management strategies

The Integrated Landscape Management Domain comprises three projects on deer related landscape management and three projects on landscape level environmental and economic impacts following various predator management strategies. The Domain LogFrame below summarises the outcomes, outputs, related themes and assumptions for each project.

Summary

Deer

The Centre's four deer-related projects are interacting to form Australia's first integrated approach to developing national, but regionally nuanced, guidelines and tools for managing a range of deer species. The Centre's Deer Program puts into effect the outcomes of a 2016 workshop to take a concerted approach to better identifying and articulating the nature of deer impacts and marshalling collaboration to build up a toolkit of solutions. The Cost-effective management of wild deer is essentially overseeing much of the deer research nationally, providing a home for the management implications of various project results. It is also helping to coordinate data collection, sharing and analysis within and between different projects. Through this process the collective findings across the projects in 2018-19 have revealed much about the abundance and distribution of deer populations across Australia, including in peri-urban environments, and the preliminary cost effectiveness and animal welfare outcomes of different shooting regimes. They have also resulted in the design and testing of a screening tool to detect potentially transferable diseases between deer and livestock and the design specifications for a prototype deer aggregator to attract and control deer. A steering committee of end-users overseeing these projects is acting to provide practical feedback to the researchers and help extend the lessons and tools beyond the immediate sites of research activity. This national approach was the catalyst to a substantial ABC Landline segment in July 2019 dedicated to the invasive deer problem in Australia.

Wild Dogs

Wild dogs need contrasting management across a range of environments and land uses. The Centre has four projects examining wild dog management in markedly different situations from peri-urban southeast Queensland to extensive grazing properties in mesic, semi-arid and arid Australia. Our projects are monitoring the cost-effectiveness of environment-specific strategies for wild dog management. Some of these involve new tools, such as para-aminopropiophenone (PAPP) and canid pest ejectors (CPEs). Trials of these in southeast Queensland have initially identified the optimal density and locations at which ejectors should be deployed. It is now four years since two large cluster fences were completed. Control programs have reduced or eliminated wild dogs within the clusters, but kangaroo abundance is proving harder to modify. The benefits of reduced predation should be greater than the grazing pressure from native herbivores, but both are difficult to detect in a fluctuating environment that is currently in drought. It will be important to model the system to disentangle the effects of fencing and the environment. There will be a valuable contrast with more arid areas in Western Australia that are being fenced. That project is now underway. Finally, funding has been obtained for landscape control of exotic predators in a number of areas in New South Wales. This offers greatly-reduced predator (particularly wild dog) abundance that can then be feasibly maintained, with expected benefits to the livestock industry and the environment. Careful monitoring is paramount if all these strategies are to be implemented widely and in the long term.



6 projects operational



2 PhDs appointed
1 Hons completed



5 journal articles published
2 conference papers published
2 journal articles submitted



several products
in development



Andrew Bengsen discussing camera trap placement, Jindabyne Deer Masterclass, April 2019, as part of the Cost-effective management of wild deer project. Image by D. Forsyth, NSW DPI.

Domain Projects

Cost-effective management of wild deer

Project leader: Dr Dave Forsyth | New South Wales Department of Primary Industries

Project partners: New South Wales Department of Primary Industries, Queensland Department of Agriculture and Fisheries, University of Canberra, Tasmanian Land Conservancy, Charters Towers Regional Council

Project aim: Wild deer are present in all Australian states and territories and cause increasing agricultural, environmental and social impacts. There are six species of deer and little is known about best practice management. In collaboration with associated organisations around the country this project looks into cost-effective methods for reducing the impacts of wild deer in Australia and then disseminating this knowledge widely to the deer management community.



The role of wild deer in the transmission of diseases of livestock

Project leader: Dr Dave Ramsey | Victorian Arthur Rylah Institute for Environmental Research

Project partners: Victorian Arthur Rylah Institute for Environmental Research, New South Wales Department of Primary Industries, Victorian Department of Economic Development, Jobs, Transport and Resources, La Trobe University

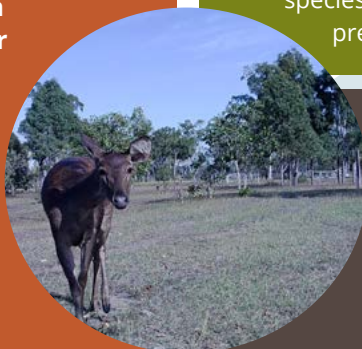
Project aim: This project will directly investigate the risk posed by deer to the livestock industry as hosts for exotic disease. This project will also evaluate the effectiveness of possible mitigation strategies should an outbreak occur. This will be achieved by estimating deer population density adjacent to farms, quantifying their level of interactions with livestock, the level of connectivity between local deer populations and by estimating the cross-species infection rate between deer and livestock species trade in Australia, which will lead to preventing the incursion of new alien species.

Management of wild dog and deer in peri-urban landscapes: strategies for safe communities

Project leader: Dr Matt Gentle | Queensland Department of Agriculture and Fisheries

Project partners: Queensland Department of Agriculture and Fisheries, New South Wales Department of Primary Industries, ACT Parks and Conservation, New South Wales Local Land Services, Griffith University, Sunshine Coast Council, Brisbane City Council

Project aim: Peri-urban local governments have identified the need for better tools and strategies for control of wild dogs (and foxes) and deer. This project aims to provide pest managers, through collaborations and community-led actions, with alternative strategies for managing wild dogs and deer in peri-urban areas of Australia.



Preparing for reset landscape-scale predator management [Prep4Reset]

Project leader: Dr Peter Fleming | New South Wales Department of Primary Industries

Project partners: New South Wales Department of Primary Industries, New South Wales Local Land Services, Meat and Livestock Australia, Australian Wool Innovation

Project aim: Prep4Reset will 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 funds crucial networking to generate financial and time co-investment from multiple stakeholders in the Full Reset project. This project facilitates the economic and environmental benefits that only integrated landscape-scale management can provide.



Top image: Fencing to exclude Fallow deer from a lucerne crop, Teresa McIntyre property, Liverpool Plains, NSW, as part of the Cost-effective management of wild deer project. Image by D. Forsyth, NSW DPI.

Middle image: A female Rusa deer, caught on camera at Yeppoon, QLD. Camera trap grids are established at sites throughout southeast Queensland, as part of the Management of wild dogs and deer in peri-urban landscapes project. Image supplied by Biosecurity Queensland.

Bottom image: Jindabyne deer masterclass group photo 2 April 2019. Image supplied by Dave Forsyth.

Domain Projects

Assessment of the biodiversity, economic and productivity gains from exclusion fencing (WA)

Project leader: Dr Malcolm Kennedy | Western Australian Department of Primary Industries and Regional Development

Project partners: Western Australian Department of Primary Industries and Regional Development, Western Australian Department of Biodiversity, Conservation and Attractions, Murdoch University, Meat and Livestock Australia

Project aim: This project aims to understand the relationships between active predator management, cell-fencing and water availability on native herbivores, introduced herbivores and introduced predators. It also aims to assist landholders by assessing viability of increasing small stock production through manipulating predation and herbivores using active predator control, fencing and water availability. To address these aims the project will determine changes in density of introduced predators (primarily wild dogs and cats), native and introduced herbivores in response to fencing, predator densities and water availability. 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.



Assessment of the biodiversity, economic and productivity gains from exclusion fencing (Queensland)

Project leader: Dr Joe Scanlan | Queensland Department of Agriculture and Fisheries

Project partners: Queensland Department of Agriculture and Fisheries, Queensland Department of Environment and Science, New South Wales Department of Primary Industries, Western Australian Department of Primary Industries and Regional Development, Meat and Livestock Australia

Project aim: This project aims 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.



Mount Hope Malleefowl Recovery

Project leader: Dr Tony Buckmaster | Centre for Invasive Species Solutions

Project partners: New South Wales Office of Environment and Heritage, New South Wales National Parks and Wildlife Service, Mt Hope Pest Management Group

Project aim: Malleefowl have declined since European settlement as a result of habitat change and through predation by, and competition with, invasive animals. Breeding populations exist around the Mount Hope area in NSW, where continuous mallee habitat is available, however those populations are under threat from invasive predators. This project builds on previous work to refine and implement a long-term best practice pest animal management program by collaborating with local landholders and neighbouring National Parks to maintain or, preferably, recover the Malleefowl population in the region. Improvements to livestock production, relative to unfenced areas. It will also assess biodiversity benefits through vegetation cover and increases in wildlife abundance and biodiversity.



Images: An SA farmers delegation visited the QLD cluster fencing area of Longreach, QLD, to understand the rollout and benefits of exclusion fencing. Images by Joe Keynes.

Progress: Management of wild dogs and deer in peri-urban landscapes: strategies for safe communities

Wild dogs:

Interviews were conducted with peri-urban residents in the Toowoomba area who have an interest in wild dog control. A working group has been established to progress a community-led plan for invasive animal management.

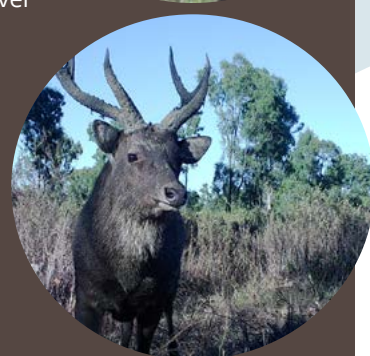
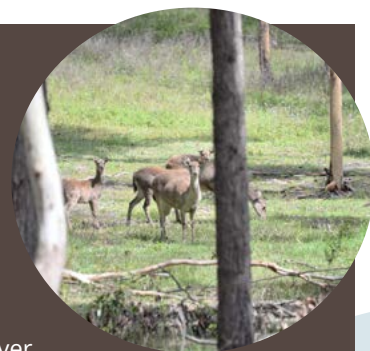
Sightings and impacts of wild dogs reported to local authorities are being recorded to help refine guidelines for the safe use and effectiveness of long-term canid pest ejectors (CPEs) deployment in peri-urban areas. An average of 22% of toxic CPEs were activated over three-week periods by wild dogs and foxes at five sites in QLD.

GPS-collared wild dog movement was overlaid with modelled locations of control tools (CPEs, traps) placed at different distance intervals. Strategic placement of control tools at high impact locations (trail intersections) efficiently target wild dogs during long-term deployments. Alternatively, CPE placement at the highest permitted density would reduce the time until first encounter and removal of wild dogs.

Wild Deer:

Preliminary analysis of historical transect sites (NSW) indicate a population decrease in urban transects and an increase in rural transects since 2018. These transects will be monitored in 2020, and an improved analysis incorporating the historical data, management effort and biophysical values will be conducted.

Transect sites have also been established around Brisbane in 2018, with follow-up monitoring scheduled for 2020. Faecal pellet density and camera grids will help to determine deer abundance and determine efficacy of control by local authorities.



Progress: Preparing for RESET landscape-scale predator management [Prep4Reset]

The Prep4Reset project has facilitated a range of collaborations and funding, including a 5-year, \$30 million Environmental Trust-funded collaborative predator management project in NSW; "Developing strategies for effective feral cat management." RESET aims to be a national predator management project, and to this end negotiations are underway with NT, WA, SA, VIC and QLD partners to extend the reach of this project.

Three technical staff positions have been filled, progressing field work and data analysis significantly. Newly-designed camera posts should prevent theft, and restoration of sites damaged by natural disasters is underway. New monitoring sites and GPS collaring for wild dogs is being investigated on the North Coast.

Numerous workshops were presented throughout multiple states and territories. Analyses on dingoes was presented to the Royal Zoological Society forum on The Dingo Dilemma in September 2019. A workshop held in April 2019 substantially advanced the theoretical framework underpinning eradication tools.



Top image: Group of female Rusa deer at Lake Kurwongbah, southeast QLD. This work is a collaborative project with local governments within the southeast and funded through CISS. Image by Matt Amos.

Middle image: A Rusa stag, caught on camera at Yeppoon, Queensland. Camera trap grids are established at sites throughout southeast QLD, as part of the management of wild dogs and deer in peri-urban landscapes project. Image supplied by Biosecurity QLD.

Progress: Cost effective management of wild deer



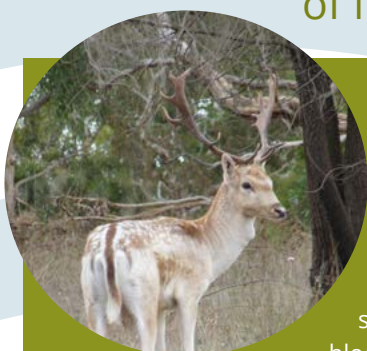
An additional field research site to assess the effectiveness of aerial shooting of wild deer was established in the ACT. The cost effectiveness of aerial shooting for the new site can be estimated and included with other sites from NSW and QLD. Negotiations are underway to assess the effectiveness of aerial shooting at additional sites in SA and NSW.

Welfare outcome assessments of aerial shooting were conducted in the ACT site for Fallow deer and in QLD for Chital deer. Negotiations to assess welfare outcomes of aerial shooting programs in NSW are underway.

Post-control helicopter surveys of a long-term aerial shooting site (treatment and non-treatment areas) in Mudgee, NSW indicate that control has been effective at suppressing the population to a low density. Ground and aerial surveys in north QLD monitoring Chital deer population recovery from control efforts compared with areas without control activities. These surveys give insight into the population dynamics for Chital deer in the dry tropics which impacts control strategies.

Negotiations are underway with Melbourne water to collaborate on an upcoming ground shooting program in their water catchments. A meeting is also scheduled with Tasmanian Land Conservancy to discuss potential sites to evaluate ground shooting.

Progress: The role of wild deer in the transmission of diseases of livestock



A high-throughput sequencing system (Illumina Hiseq) was used to analyse five serum samples from wild Fallow deer. The sequencing depth was increased five-fold from initial sequencing analysis to provide a greater scope of detection. Preliminary evidence of viral genetic material was found in some samples with confirmation and further analysis ongoing.

Microscopic examination of blood smears from NSW has revealed the presence of several morphological forms, possibly compatible with blood-protozoa. DNA from each blood sample was tested for seven parasitic genera using PCR, returning a negative result for these parasite groups. Analysis of additional blood samples is ongoing.

Deeper analysis of the viral sequences found in the last trial of metagenomics is necessary. This will allow the development of specific primers to detect individual viruses using PCR. PCR analysis of the blood samples from NSW revealed negative results, despite microscopic analysis revealing evidence of possible presence of some microorganisms. Metagenomics analysis of a specific RNA region will help identify the microorganism and provide information to develop a screening tool.

Top image: An aerial-survey being carried out as part of the Cost-effective management of wild deer project. Image by M. Brennan, QLD DAF.

Bottom image: Fallow deer. The Role of wild deer in the transmission of diseases of livestock aims to quantify the risk of endemic/exotic disease transmission between wild deer and livestock species. Image by A. Dezsery.

Progress: Assessment of the biodiversity, economic and productivity gains from exclusion fencing (QLD)

Pasture, wild dog and wildlife monitoring, assessment of livestock productivity and economic analysis are currently underway for the Morven and Tambo cluster sites.

Wild dog activity inside and outside the Morven cluster is very low. Removal of wild dogs has occurred since 2014, with decreasing numbers trapped each year. The Tambo cluster has similar population trends, apart from April-August 2018, when activity outside the fence was high. Dry conditions have resulted in low wildlife activity at both sites.

Kangaroo density at the Morven cluster is much lower than at Tambo, higher activity inside the clusters at both sites is most likely due to more fertile land within the clusters. Cattle producers at the Morven cluster have utilised lower kangaroo numbers by stocking sheep and goats, while maintaining cattle numbers. Sheep production within the Morven cluster has declined due to below average rainfall. The Tambo cluster received higher rainfall, though cold weather resulted in losses of drought-affected sheep and a large reduction in lambing rates.

Remotely-sensed vegetation cover at a paddock scale is not well correlated with visual observations at the small plot scale. The reasons are being investigated. Bird species abundance and richness is being sampled. Potential positive and negative effects of the cluster fences may influence different species.



Progress: Assessment of the biodiversity, economic and productivity gains from exclusion fencing (WA)

Investigations into livestock productivity in relation to wild dogs within the Murchison cell hub as it is being built is underway. Management options for wild dogs (CPEs) and monitoring livestock and wild dog abundance at all water points will be analysed. As the cell-fencing is completed, small stock will be tracked, and their activity monitored.

A journal article is currently being prepared based on the findings of a completed honours project, focusing on camera trap surveys for both predator and prey species.

A PhD candidate has begun their tenure, including planned field visits and completion of a literature review and project proposal in January 2020. The candidate is also assisting with CISS project Behaviorally effective wild dog management. A possible second honours student may also be recruited examining bait uptake by wild dogs in a small-scale, established fenced enclosure on the Nullarbor.



Top image: Landholders take a tour of the cluster fences in Western QLD, as part of the National Wild Dog Action Plan (NWDAP) stakeholder meeting. Image supplied by NWDAP.

Bottom image: Tracey Kreplins (DPIRD), Moses Omogbeme (Murdoch University PhD Student) and John-Michael Stuart (Murdoch University) in the field, as part of the Assessment of the biodiversity, economic and productivity gains from exclusion fencing (WA) project. Image by Magdalena Zabek.

INNOVATION DOMAIN 3: BIOCONTROL



CSIRO Rabbit Biocontrol researcher, testing rabbit tissue samples in the lab in Canberra.

Biocontrol

Aim: Sustainable reduction of the impacts of established pest animals through biocontrol and exploring other genetic based opportunities

The Biocontrol Domain comprises two projects on rabbit biocontrol, one project on aquatic pest management and one project on gene drive technology.

Summary

Rabbits

As per the CISS rabbit biocontrol pipeline strategy (page 32), the Centre's two large rabbit projects have come online within the past 12 months. The aim of these large collaborative projects is to develop strategies to maximise the impact of rabbit biocontrol and to maintain a biocontrol pipeline for the sustainable long-term reduction of rabbits in Australia. The different project components assess the possibility and likely benefit of registering the exotic virus RHDV2, a virus of unknown origin that appeared in Australia in mid-2015. RHDV2 has different properties to the RHDV1-K5 virus which was released nationwide in 2017, and these differences can be harnessed to increase the effectiveness of rabbit biocontrol. Work is now well underway to gather efficacy data required to register RHDV2 as an additional biocide product, including assessments of the virulence and welfare impacts of RHDV2, and the ability of the different viruses to overcome immunity to the respective other viruses. Importantly, the project is also supporting the development of an RHDV2 specific vaccine to protect pet and farmed rabbits. At the same time, monitoring of national rabbit calicivirus activity continues, determining which virus is active where and when, providing critical information for the development of tailored application strategies. A key achievement of the project has been the inclusion of carrion feeding flies (known vectors of RHDV) into the analysis, through the establishment of a fly sampling network of over 30 sites covering all States and Territories. This is greatly expanding our ability to monitor disease activity at a continental scale.

Tilapia

A third biocontrol project relates to the preparation of a business case for the assessment and potential registration of a biocontrol agent for Tilapia (*Tilapia mariae* and *Oreochromis mossambicus*) and potentially the initial investigation of a prospective agent, subject to additional funding becoming available. This pest species is presently the 'carp of the north' but poses risks elsewhere if not managed quickly. For better or worse, a prospective collaboration with Israel has failed to materialise and has delayed the commencement of the project, though undertaking the work in local environments is always a better course of action with biocontrols.

Gene drives

Rounding out the Domain, a blue-sky project looking at the strategic value of genetic technology as an alternative non-lethal means of managing invasive populations has begun in earnest, with some of the best interdisciplinary minds coming together in a Steering Committee to guide this project forward. The strategic application of the technology for the kind of use envisaged for pest management may be a decade or two away, but early preparation is essential to deal with the likely biological, technological and ethical challenges ahead. This includes a knowledge gap analysis and development of a business case.



4 projects operational
2 projects complete
1 project awaiting approval



1 product under review



1 journal article published
2 journal articles submitted



CSIRO Rabbit Biocontrol researcher, testing rabbit samples in the lab in Canberra.

Domain Projects

Understanding RHDV2 interaction with other RHDVs and its potential as an additional rabbit biocontrol agent

Project leader: Dr Tarnya Cox | New South Wales Department of Primary Industries

Project partners: New South Wales Department of Primary Industries, CSIRO, Primary Industries and Regions South Australia, Meat and Livestock Australia, Australian Wool Innovation

Project aim: This project aims 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.



National rabbit biocontrol optimisation

Project leader: Dr Tanja Strive | CSIRO

Project partners: CSIRO, New South Wales Department of Primary Industries, CSIRO, Primary Industries and Regions South Australia, Meat and Livestock Australia, Australian Wool Innovation

Project aim: Rabbit management is not about one-off applications of solutions but regular, community-based approaches drawing from a pipeline of new, existing and evolving solutions. This project aims 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.

RHD Boost Plus (and expansion of the RHDV Monitoring Program) (COMPLETE)

Project leaders: Dr Tarnya Cox | New South Wales Department of Primary Industries and Dr Tanja Strive, CSIRO

Project partners: New South Wales Department of Primary Industries, New South Wales Local Land Services, Meat and Livestock Australia, Australian Wool Innovation

Project snapshot: The RHD-Boost project identified a new strain of RHDV virus (referred to as RHDV1 K5) as suitable for release into Australia's rabbit population. This extension project enabled the broad-scale release of RHDV1 K5 through a network of 323 release sites.

The citizen science part of the project partnered with landholders, who provided 218 complete monitoring datasets. The monitoring program showed that RHDV1 K5 led to a national average rabbit knockdown of 34% at release sites, though it performed more as a biocide rather than a biocontrol agent.

The monitoring network detected the outbreak and movement of the exotic RHDV2 virus. RHDV2 would have likely gone undetected for some time without having the national monitoring network in place.

RHD Accelerator – Stage 2

Project leader: Dr Tanja Strive | CSIRO (COMPLETE)

Project partners: Meat and Livestock Australia, Australian Wool Innovation, Australian Government Department of Agriculture

Project snapshot: The Accelerator project aimed to develop a platform technology to enable a pipeline of new effective RHDV variants to be produced and potentially released to mitigate genetic resistance to current RHDV strains. The project investigated the development of technology to facilitate the accelerated, but directed, evolution of the RHDV into viruses suitable for biocontrol in Australia.

Despite initial successes in developing the platform technology and demonstrating proof of concept that selection of an antigenic virus variant was possible, attempts to further select this virus to overcome immune protections of existing strains were unsuccessful. The main impediment for the adoption of these methods is the lack of a robust cell culture system for in vitro cultivation of RHDV.



Top image: Dr Robyn Hall holding a rabbit sample in preparation for analysis, as part of the national rabbit biocontrol optimisation project.

Bottom image: PhD student Elena Smertina analysing a rabbit sample, as part of the national rabbit biocontrol optimisation project.

Rabbit parasites – additional biocontrol agents (COMPLETE)

Project leader: Dr David Peacock | PIRSA

Project partners: Primary Industries and Regions South Australia, Western Australian Department Primary Industries and Regional Development, CSIRO, New South Wales Department of Primary Industries, Australian Government Department of Agriculture

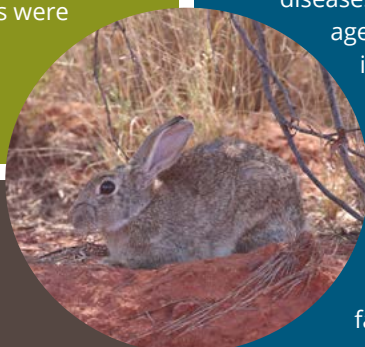
Project snapshot: This project used genetic testing to assess and validate the distribution of *Eimeria intestinalis* and *Eimeria flavescens*, recognised as the most pathogenic rabbit coccidian parasites in Australia. Genetic analysis found that the pathogens were more widely distributed than previously recorded, which diminishes their utility as potential biocontrol agents.

Genetic technologies for pest animal control – developing a priority framework.

Project leader: Dr Wendy Ruscoe | CSIRO

Project partners: CSIRO, Department of Biosecurity Conservation and Attractions, Department of Primary Industries and Regional Development WA

Project aim: This project commenced late in the reporting year, however it was able to co-develop an initial framework to assess the potential, priorities and risk parameters for using gene drive approaches to target key invasive species in Australia.



Tilapia biocontrol: prospecting and evaluation

Project leader: to be determined

Project partners: Queensland Department of Agriculture and Fisheries, CSIRO

Project aim: Recently the Tilapia lake virus has caused widespread mortalities in Israel and Ecuador and has raised hopes of the potential for tilapia biocontrol. However, prior to significant research investment in assessing this virus, it is prudent to evaluate Tilapia diseases in the context of biocontrol more broadly. This project will 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.

Note: Commencement of this project has been delayed due to a prospective collaboration with Israel failing to materialize. The revised plan was to commence the project following receipt of additional funds to undertake the biocontrol prospecting in Australia, working in local environments. This funding has yet to be approved, and the fallback position will be to focus on the business case in 2019-20 in advance of prospecting work commencing.

European rabbits are considered one of the major environmental and agricultural pest animals in Australia. Image by Neil Schultz.



CSIRO Rabbit Biocontrol lab in Canberra.

Progress: Understanding RHDV2 interaction with other RHDVs and its potential as an additional rabbit biocontrol agent



Assessment of the virulence and welfare impacts of RHDV2 in both adult and young rabbits is almost complete. 100% case fatality rate has been observed in laboratory rabbits, with a short illness duration.

Another project aspect is investigating the effect of maternal immunity on the ability of young rabbits to get infected with RHDV2 – a critical piece of information that will inform the timing of any future applications of RHDV2 as an additional biocide.

Wild rabbits which have been trapped and challenged with different strains of calicivirus in box trials, with different survival rates. Two further box trials will take place in Orange, NSW, pending ethics approval.

A prototype vaccine for RHDV2 is currently under review with the APVMA, and a multivalent vaccine is also in progress.

Progress: National rabbit biocontrol optimisation



Ongoing testing of tissue from deceased rabbits shows RHDV2 remains the dominant rabbit calicivirus circulating in Australia, with K5 detected at release sites. A new screening method is being implemented to detect recombinant viruses.

Rabbit monitoring at selected intensive sites in TAS, ACT, WA, NSW and SA is ongoing or ramping up shortly, with a minimum bi-annual sampling taking place. In addition, monitoring and sampling of the rabbit population at the Turretfield research site continues as part of this project, building on extensive knowledge of this wild rabbit population and adding these ongoing monitoring results to the long-term RHDV and myxoma disease database at this site.



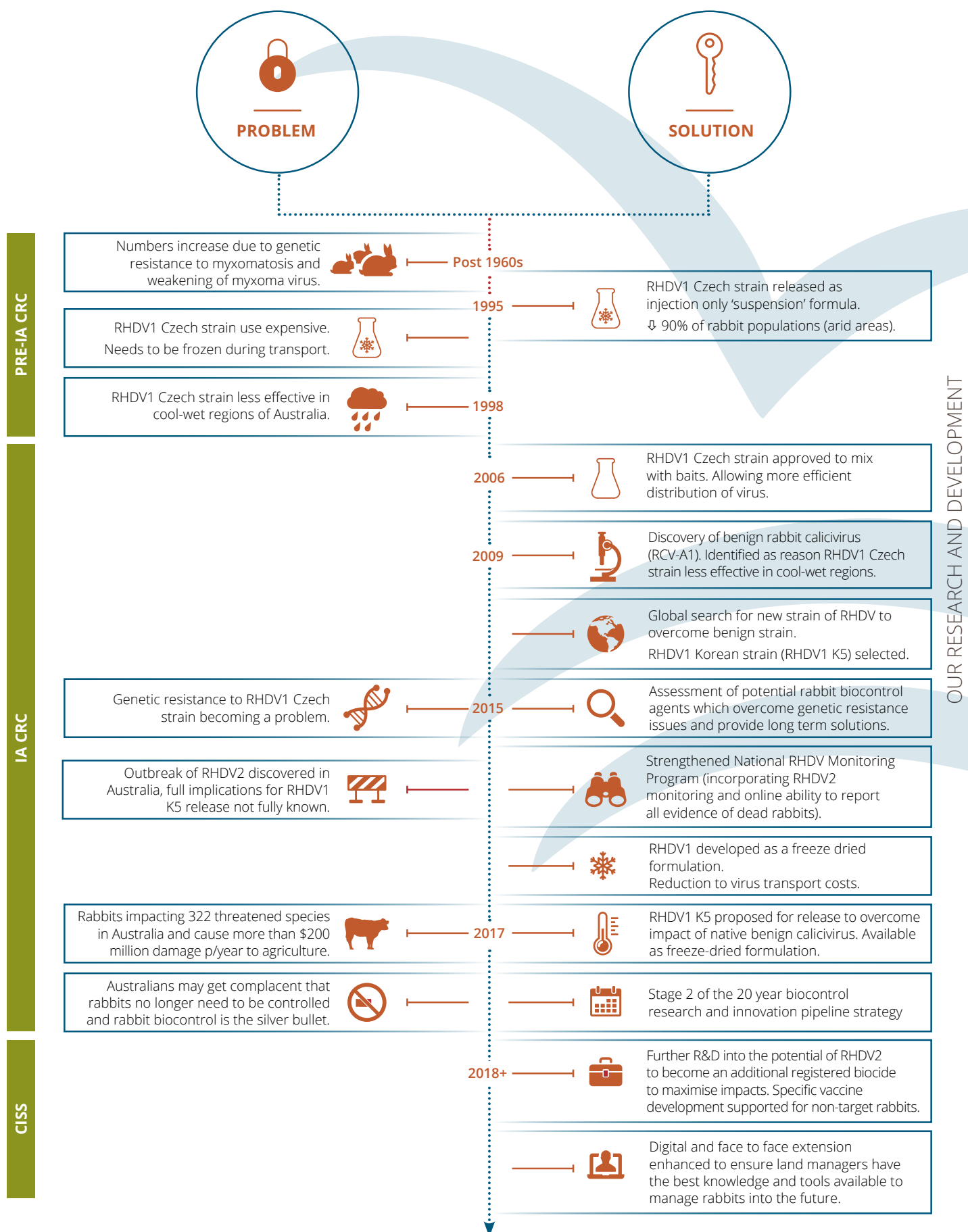
A paper on optimising and validating molecular testing of carrion flies for rabbit calicivirus detection, including associated protocols was published. This provided the basis for a nationwide year-long pilot study now underway.

Top image: Emma Sawyer setting rabbit traps to capture and collect data for rabbit virus analysis. Image supplied by Tarnya Cox.

Bottom image: Rabbit tissue sample sent in by a member of the public, through the RabbitScan portal.

Rabbit biocontrol innovation pipeline.

Achieving sustainable landscape scale rabbit management.



INNOVATION DOMAIN 4: MANAGEMENT SYSTEMS AND TOOLS



Simplified PVC feeder used to attract surrounding species, monitored via motion sensing camera. Image by Matt Korcz.

Management Tools and Systems

Aim: Optimal cost-effective pest management through new tools and systems

The Management Tools and Systems Domain was predicated on the need to develop new tools, technologies and systems to put into the hands of invasive animal managers working on a range of pest species. The Domain comprises only one project, which relates closely to the Deer Program under the Integrated Landscape Management Domain. Its inclusion here is a historical legacy, and similar technological / engineering projects have indeed been placed under the management of the Domain area for which they provide relevant management tools.

Summary

The deer aggregator project under this Domain is a short-term project, building a device inspired by a goat aggregator developed in NSW, so that the increasing deer problem in Australia can be managed more efficiently. If successful, the device would have application nation wide. The project has reached prototype stage, with field testing boding well for its practical utility.

The Domain is also continuing to progress development of a number of digital detection, toxic bait and fertility control products. These include development of prototypes based on facial recognition technology, a new feral pig toxic bait and lethal trap device, and finally a fertility control tool for peri-urban management of kangaroos.



3 projects operational
5 projects completed



8 prototypes developed

Domain Projects

e-Technology Hub – Intelli-traps (COMPLETE)

Project leader: Dr Paul Meek, New South Wales Department of Primary Industries

Project partners: New South Wales Department of Primary Industries, The University of New England, The Department of Primary Industries and Regional Development

Project snapshot: The size and remoteness of many farming enterprises across Australia is increasing the need for remotely operated smart devices for stock protection, managing access to livestock water sources and for remote operation of feral animal management systems.

The E-Tech hub project team developed and tested remote systems for the management of livestock and biodiversity, a system for targeted delivery of baits for wild dogs and an autonomous gate closure system for trapping feral pigs.

The development and testing phases of this project are complete, and a commercialisation feasibility assessment is underway.

Wild Dog Alert (COMPLETE)

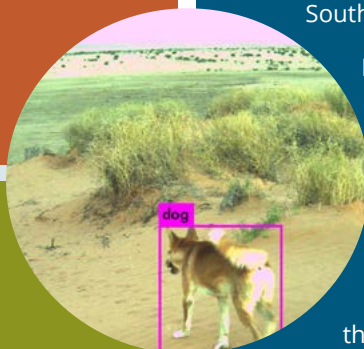
Project leaders: Dr Paul Meek, New South Wales Department of Primary Industries

Project partners: New South Wales Department of Primary Industries, Meat and Livestock Australia, Australian Wool Innovation and Australian Government Department of Agriculture

Project snapshot: Giving land managers access to real time knowledge of wild dogs present on their land would minimise predation events and allow proactive responses to wild dogs rather than current reactive response to damage already inflicted.

This project developed and tested several automated detection system to provide land managers with real time evidence that wild dogs are on their land. the systems are able to be tailored to specific needs and the availability, or lack of, cellular mobile services across their property.

A commercialisation feasibility assessment is underway for these prototypes.



GonaCon™ registration

Project leader: Dr Tony Buckmaster | Centre for Invasive Species Solutions

Project snapshot: Management of overabundant macropods and deer in urban and peri-urban settings has been problematic. The use of single dose fertility control agent GonaCon™, has been seen as a potential way of overcoming many of these management difficulties.

To be used in Australia, GonaCon™ must be registered as a veterinary medicine with the Australian Pesticides and Veterinary Medicines Authority (APVMA). This registration process is currently underway.

Feral deer aggregator

Project leader: Dr Brad Page | Primary Industries and Regions South Australia

Project partners: Primary Industries and Regions South Australia

Project aim: This project is part of the CISS Project Portfolio and is led by PIRSA. The deer aggregator project has mobilised a research team in South Australia to build on foundational R&D by the NSW Office of Environment and Heritage to refine the feed structure of its traps (primarily aimed at goats) so that feral deer can readily use them. This project will test the refined structure (the Deer Aggregator) in areas with high densities of kangaroos, possums and feral Fallow or Red deer.



The Wild Dog Alert prototype identifies wild dogs through a series of sophisticated facial recognition algorithms. Image supplied by Paul Meek.

HOGGONE® Australia (COMPLETE)

Project leader: Dr Tony Buckmaster | Centre for Invasive Species Solutions

Project partners: Animal Control Technologies Australia, Meat and Livestock Australia, Australian Government Department of Agriculture

Project snapshot: In August 2017, Animal Control Technologies Australia (ACTA) lodged the application for registration of HOGGONE® with the Australian Pesticides and Veterinary Medicines Authority (APVMA). On 24 September 2019 the APVMA gazetted HOGGONE® as an Unrestricted S6 chemical with the mandatory use of a hopper.

Blue Healer™ glovebox antidote (COMPLETE)

Project leader: Dr Tony Buckmaster | Centre for Invasive Species Solutions

Project partners: Phebra Pty Ltd, Charles Sturt University, Australian Government Department of Agriculture

Project snapshot: Para-aminopropiophenone (PAPP) is a toxin used for the management of vertebrate pest animals. Unlike 1080, there is an antidote to PAPP toxicosis – methylene blue. This antidote can currently only be administered by veterinarians.

A glovebox antidote which could be administered by domestic and working dog owners located rurally was investigated. Four alternate antidote delivery routes were trialled (oral, buccal, anal and intraperitoneal), though none have proven to be effective, and as such the antidote is still only available through veterinarians.

A best practice guide for the administration of methylene blue was developed in conjunction with the Australian Veterinary Association (AVA) and included post treatment care to ensure the best outcome for domestic or working dogs suffering accidental PAPP toxicosis.

Rodenticides

Project leader: Dr Tony Buckmaster | Centre for Invasive Species Solutions

Project partners: GRDC, USDA

Project snapshot: There has been an extended and comprehensive search to find a suitable toxin to complement the current use of Zinc Phosphide for the control of rodents in broadacre cereal farming enterprises. After extensive literature and desk-top analyses a potential toxin has been identified. Preliminary testing indicates that the toxin results in a quick and humane death for rodents.

In collaboration with researchers in the USDA, CISS has progressed the assessment of this toxin as a rodenticide in both Australia and the United States. A Cooperative Research and Development Agreement (CRADA) was executed between CISS and the USDA in December 2018.

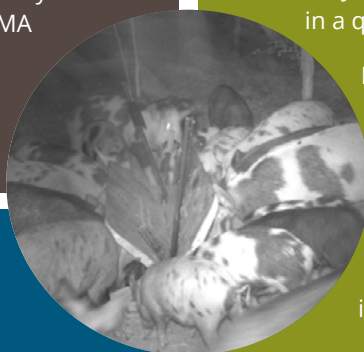
PAPP Putty™- PAPP based lethal trap device (COMPLETE)

Project leader: Dr Paul Meek, New South Wales Department of Primary Industries

Project partners: New South Wales Department of Primary Industries, Connovation, Australian Government Department of Agriculture

Project snapshot: With the phasing out of strychnine in almost all jurisdictions, wild canid trappers need an alternative that could be applied to the jaws of traps to enable the self-euthanasia of trapped wild canids.

Extensive development and field trials resulted in the PAPP Putty™ para-aminopropiophenone (PAPP) based product that could be applied on cloth put on trap jaws, which takes advantage of the wild canids tenacity to bite at the trap when captured. Field testing demonstrated the product is effective for the self-euthanasia of trapped wild canids. An APVMA registration application was lodged in December 2018. This project is complete except for monitoring the progress of the application through the APVMA.



Images: Feral pigs at a HOGGONE™ bait station. Image supplied by Animal Control Technologies Australia.

Progress: Feral deer aggregator



Trials of the latest prototype Deer Aggregator (DA) began in April 2019, when feral deer spend more time in larger groups, increasing effectiveness of the trials. Newly integrated features fine-tuned for large scale field testing have been implemented.

The locations for the trial of the prototype DA were selected by Natural Resource Management (NRM) staff from three regions in SA. A range of feed types (grains) will also be trialed and assessed using motion cameras. No toxins will be trialed in this project. As with previous trials, these will inform design improvements which will be tested again.

NSW Local Land Services (LLS) staff from two regions have expressed interest in trialing DAs on four deer species. To prepare for these trials, potential field sites were monitored using simplified PVC feeders and motion cameras to assess species present and their abundance. The trials also provide data on how different species interact with the feeders, for DA prototype development.



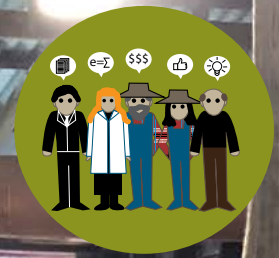
Top image: Simplified PVC feeder being used by a feral deer near Adelaide. Image by Matt Korcz.

Bottom image: Fallow deer. Image by Judi Swain.



Chital deer clambering under fence at Woodford, QLD. Image by Luke-Woodford.

INNOVATION DOMAIN 5: COMMUNITY ENGAGEMENT AND EDUCATION



Greg Mifsud presents at the Swifts Creek Wild Dog meeting, as part of the National Wild Dog Management Coordinator Project. Image supplied by Greg Mifsud.

Community Engagement and Education

Aim: Improvement in the human and institutional aspects of pest management

Consideration of the human and institutional dimensions of invasive animal management is critical to the successful design, development and ultimately adoption of solutions. This Domain aims to support and continuously improve the knowledge and practice base of invasive animal managers across Australia.

Summary

The Centre prides itself on being a significant deliverer of solutions to a wide range of invasive animal problems across Australia. As such, its engagement and communication activities over 2018-19 have been significant to ensure that knowledge is turned into action. It has done this through its research activities associated with uncovering behaviorally effective engagement mechanisms for the management of wild dogs, development activities including the creation of new computer apps to report feral animal sightings, and straight engagement activities, including the coordination of community efforts to manage wild dogs.

This year, users of the FeralScan app exceeded 22,000 users for the first time, no doubt helped by an incredible 69 training workshops held across every state of the country. The app has also been adapted to for use on small islands.

The National Wild Dog Coordinator has played an important role in making the National Wild Dog Action Plan and its national ground-up governance arrangements a potential model for managing other pest species. A significant effort also went into coordinating a review of the Plan and preparation for a new ten-year Plan to come into effect in 2020.



5 projects operational



2 products



2 journal articles published
1 journal article submitted
1 guide update
2 technical reports (internal use)



1 PhD in progress



22,040 FeralScan users

OUR RESEARCH AND DEVELOPMENT

Domain Projects

Behaviourally effective communication and engagement in the management of wild dogs

Project leader: Prof Don Hine | University of New England

Project partners: University of New England, Western Australian Department of Primary Industries and Regional Development, Meat and Livestock Australia, Australian Wool Innovation

Project aim: Best practice community engagement requires a combination of practical 'soft skills' for facilitating dialogue and designing equitable processes, with in-depth understanding of the factors that prevent landholders from adopting best practices for managing wild dogs on their properties. This project uses behavioural science principles to assist wild dog facilitators to understand and engage more effectively with non-participating landholders.

National Wild Dog Management Coordinator Project

Project leader: Greg Mifsud | Centre for Invasive Species Solutions

Project partners: Australian Wool Innovation, Meat and Livestock Australia, Queensland Department of Agriculture and Fisheries, Victorian Department of Economic Development, Jobs, Transport and Resources, Victorian Department of Environment, Land, Water and Parks, Western Australia Department of Primary Industries and Regional Development, New South Wales Department of Primary Industries, Animal Health Australia, Sheep Producers Australia, Wool Producers Australia

Project aim: The national wild dog coordinator project builds on the platform for strategic management of wild dogs that has been developed over the past ten years.



Facilitating community adoption of digital resources - FeralScan

Project leader: Peter West, New South Wales Department of Primary Industries

Project partners: New South Wales Department of Primary Industries, Connovation, Australian Government Department of Agriculture and Water Resources

Project aim: This project facilitates community adoption of the Centre's primary digital technologies including the FeralScan community pest monitoring technology (with mobile Apps) and enhances this with community networking resources to ensure community and landholder needs remain front and centre of our organisation's business.

Balanced Researcher Program

Project leader: Dr Tony Buckmaster | Centre for Invasive Species Solutions

Project aim: The Balanced Researcher Program creates multi skilled, industry ready graduates that can enter biosecurity related employment on graduation and actively contribute to the research and operational goals of their chosen workplace.

Development of a national 'invasive species management' digital information portal

Project leader: Dr Ian McDonald | Centre for Invasive Species Solutions

Project aim: In addition to PestSmart, the Centre has a number of digital tools now developed including FeralScan, the Invasives Action Tool and species-specific Decision Support Systems. This project integrates these resources to create a one-stop shop for invasive species management information and links to other useful digital resources. The project is also incorporating weeds management information so the platform encompasses both invasive plants and animals.

Top image: Dr Louise Morin (CSIRO) leads one of the group sessions at the weeds website workshop, undertaken at the 21st Australasian Weeds conference in September, 2019.

Bottom image: South Australia Biosecurity staff undertaking a FeralScan training session. Image supplied by Peter West.

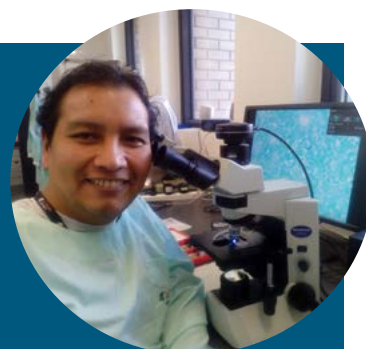
Progress: Balanced Researcher Program

Four PhD students have been recruited to the Balanced researcher program. This is a reduced number than was anticipated, though has allowed other recruitment avenues to open.

The project has been opened to external organisations to have PhD students, Post-Doctoral researchers and early career researchers attend training events as affiliates. Allowing this diversity within the project will ensure all participants are able to form extensive cross-discipline networks

The Balanced researcher camp has been redesigned to benefit the number of participants and is planned for February 2020, which coincides with the CISS mid-term review.

Students will also be encouraged to submit an abstract and attend the AVPC conference in May 2020. A networking breakfast is planned at the conference to link students with researchers in similar fields and increase networking and collaboration opportunities.



Progress: Development of a national 'invasive species management' digital information portal

Over 600 key users and stakeholder groups have been engaged over the past 24 months, to develop the pest animal and weed best practice management digital extension resources.

In partnership with Atlas of Living Australia, the weeds website strategy has been completed. A national website will be delivered by January 2020. An upgrade of the PestSmart website is progressing through user surveys. Further understanding of user experience will ensure development of a wireframe with clear information processes, planned to launch by May 2020.

Both websites will form Australia's first Invasives Portal, a digital system dedicated to promoting best practice management of invasives in Australia.

Once up and running, the weeds website content updates will be managed by a contractor. User experience workshops for PestSmart, and the development of a website tender to start the website build will also be contracted.



Top image: Jose Huaman Torres (PhD) student. Jose's research project focusses on the role of wild deer in the transmission of pathogens to livestock in Australia. Jose is also a part of the Balanced researcher program.

Middle image: Adam Toomes, Phill Cassey and Katherine Hill at the Australian Biosecurity Symposium. Image supplied by Katherine Hill.

Bottom image: Dr Matt Sheehan facilitates a discussion with attendees at the Australasian Weeds conference, to provide feedback on the new Weeds Australia website framework.

Progress: Behaviourally effective communication and engagement in management of wild dogs

Engagement with a broad audience was achieved through a keynote address at the Australian Biosecurity Symposium. Interest has been expressed in applying a behavioural approach to other topics such as *Phytophthora dieback*, community fox projects and biodiversity conservation.



A human research ethics application was approved allowing interviews with wild dog coordinators and other key stakeholders to progress. Rural landholders were surveyed from VIC, QLD and NSW. Survey results and discussion with stakeholders identified four key behaviours to target in the next step of the project. Engagement and communications interventions tailored to each of the identified landholder segments, including evaluation strategies will be co-developed with stakeholders.

Negotiations are underway to include a 'behaviour change' masterclass in outreach sessions in the upcoming Australasian Vertebrate Pest Conference. Development of another landholder survey to explore COM-B barriers and drivers of selected key behaviours is underway. Data from this survey will inform the next research phase of determining leverage points for behaviour change and designing relevant interventions.

Progress: Facilitating community adoption of digital resources (FeralScan)



The FeralScan web and App-based community pest surveillance platform has been successfully adopted by community user groups and government biosecurity stakeholders. Stakeholder assistance includes monitoring pest species, developing detailed knowledge of local pest problems, promoting community participation in monitoring and management activities, receiving regular updates on incidents and track changes in pest activity reporting over time.

Training and promotion of PestSmart and its resources was delivered nationally, including staff training for King Island, Kangaroo Island, Flinders Island, Christmas Island and Norfolk Island. Training was delivered through field days, workshops, pest management conferences, face-to-face landholder meetings and video and teleconferencing.

Software updates now allow the use of FeralScan on remote islands. A prototype dashboard enables charts and tables to be developed as an interactive co-created service for stakeholders. A prototype of a new incursions reporting platform will be tested in NSW for Red-eared slider turtles and American corn snakes, to promote public reporting of these animals. FeralScan adoption rates have continued to increase, including user registrations, pest records and new groups.

Top image: Researchers from the University of New England are working with the wild dog coordinators around the country to enhance best practice community engagement principles so they can more effectively work with landholders to achieve impact. Image by Lynette McLeod.

Bottom image: Western Australian Biosecurity stakeholders from the Bunbury meet with Peter West for a FeralScan training session in July 2019. Image supplied by Peter West.

Progress: National Wild Dog Management Coordinator Project

The national coordinator in conjunction with AWI and CISS oversaw a review of the National Wild Dog Action Plan (NWDAP).

A draft NWDAP including a review of finding will be provided to the EIC Vertebrate Pest Group for endorsement. Through endorsement, an operational component for funding and consultation with industry. The aim to have full endorsement and a funding commitment by May 2020 would allow the launch of the NWDAP at the APVC conference.

The NWDMC helped regional communities take advantage of a \$15M program for communities combating pest and weed impacts during drought, shires in western NSW and WA successfully received funding.

QLD, NSW and VIC local government have shown an interest in the Cert III course (ACH30318) in rural and environmental pest management. A new competency (ACHPMG312) to apply poison baits for vertebrate pest control in rural and environmental landscapes will be added once complete.

AWI and MLA are working with the NWDMC to ensure effective predator management and the adoption of best practice predator management control is included in their on-farm extension programs.

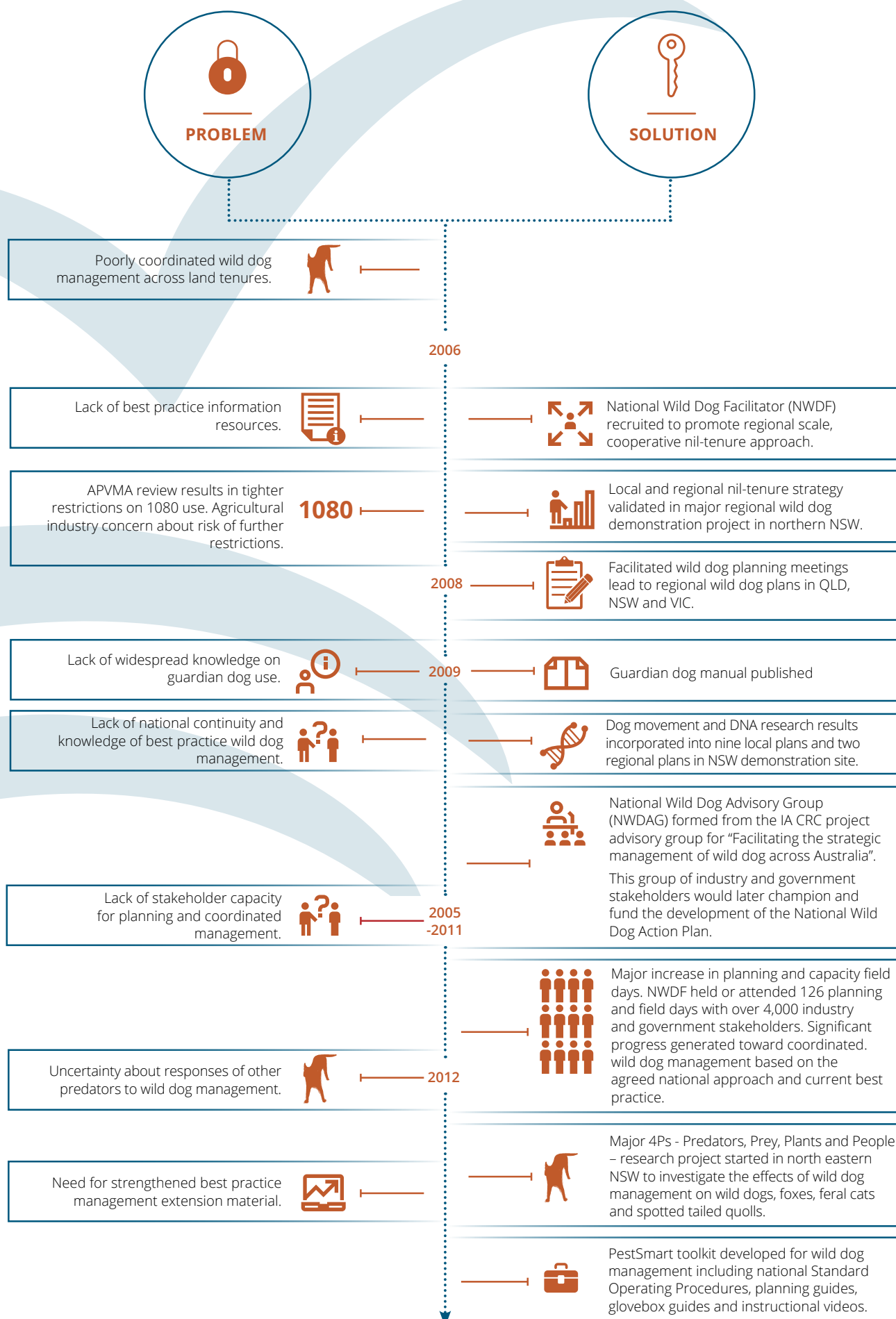
The Cattle Council of Australia, working with the Federal Department of Agriculture and Animal Health Australia will trial a surveillance program targeting several animal-health risks to the cattle industry. The Cattle Council has added 'dog-damage' to the list of risks to be monitored.

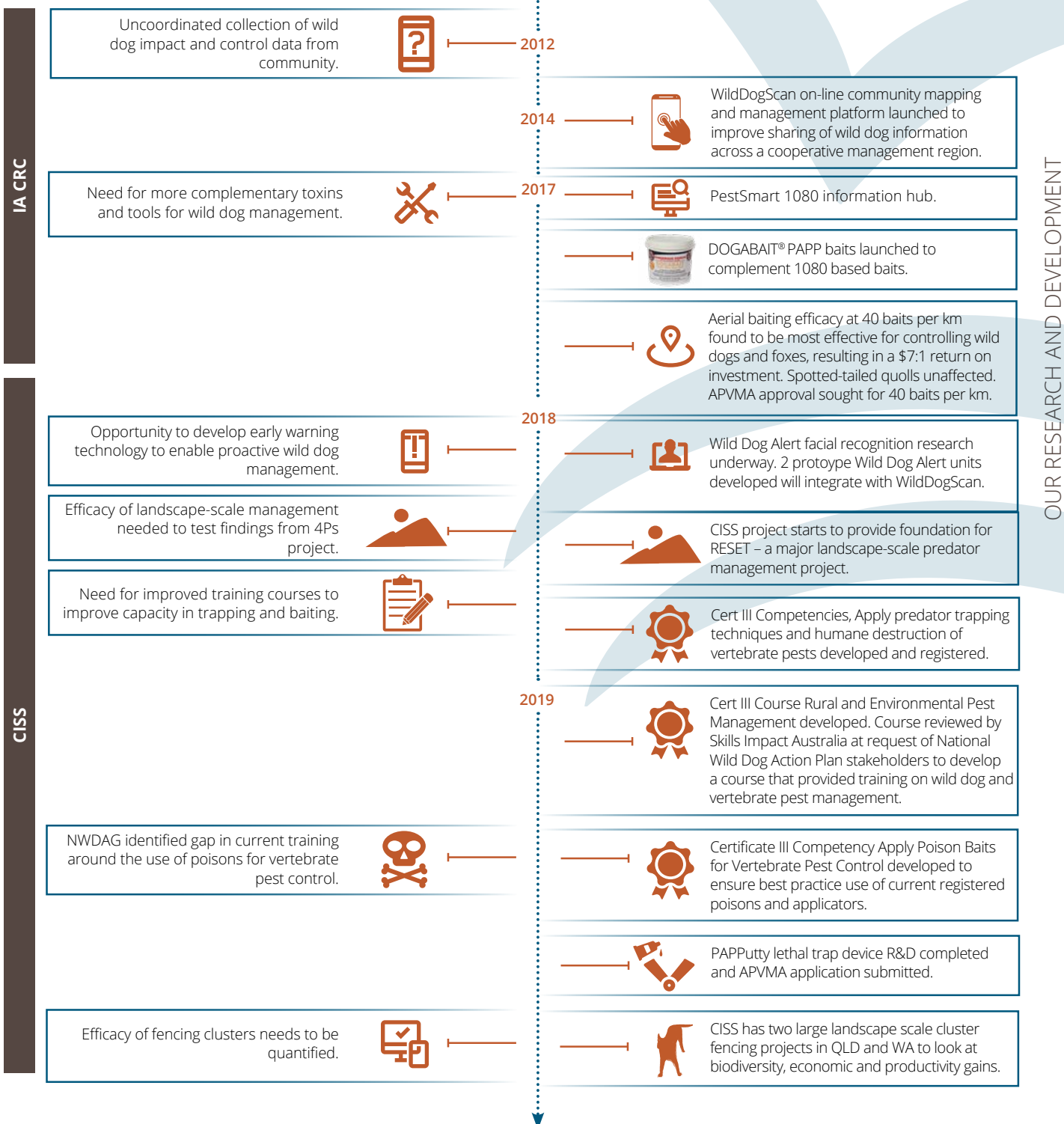
Workshops and stakeholder engagement were delivered nationally, with ongoing stakeholder support and liaison with landholders.



Wild dog research, development and extension pipeline

Achieving smarter, more effective and more engaged management through innovation







FeralScan and PestSmart trade display at the NSW Landcare Coordinators Conference in Redfern, Sydney, May 2019.
Image supplied by Peter West.

Case Study: FeralScan community pest monitoring goes from strength to strength

Throughout the last 12 months, the CISS FeralScan Project, managed by Peter West at NSW Department of Primary Industries, has gone from strength to strength. Peter has been helping communities and biosecurity organisations across the country to use FeralScan for monitoring pest species. He has run an incredible 54 training events over Western Australia, South Australia, NSW, Victoria, Northern Territory, Tasmania and southern Queensland.



Thanks to Peter's efforts, there are now over 22,000 members of the public that have signed up or used FeralScan for reporting problems with pest species in their local area. FeralScan is now helping 365 groups to use FeralScan, including landholder associations, community-groups, local government councils, and regional biosecurity groups. The FeralScan community database now contains 145,000 records of pest animals and over 12,000 photographs of pest animals and their impacts entered by

the community Australia-wide.

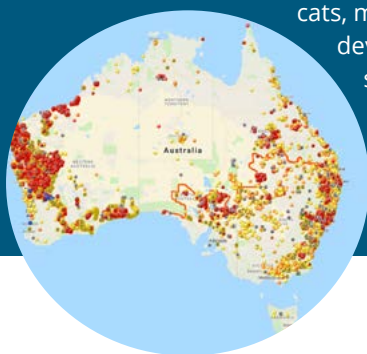
As a pest management planning tool, FeralScan provides a web and app-based resource to help people work together to record information about pest animals in their local area. It helps users to define the problem, collaborate with neighbours and local biosecurity organisations, coordinate a targeted pest animal control program, and monitor the outcomes.

People who use FeralScan can view a live dashboard of pest records in their area, consisting of charts and tables summarizing trends in pest activity. They can receive or send alert notifications from FeralScan to their landholder network and biosecurity groups, which is helping landholders to quickly report wild dog attacks on livestock to their local biosecurity officers.

Professional pest controllers are increasingly using FeralScan to map their control activities, and to work with farmers and community groups. This ensures they can focus their efforts where the problems are most serious. There are over 70 professional pest controllers using FeralScan.

People are using FeralScan to record information about rabbits, wild dogs, foxes, cane toads, feral camels, goats, feral cats, mice, feral pigs, myna birds, starlings, 6 deer species, and pest fish. New facilities are being developed for communities to record feral donkeys, feral horses, and less well known species such as introduced Red-eared slider turtles and American corn snakes, that have been detected in metropolitan, urban and regional areas of Australia.

Recent changes to FeralScan have also allowed it to be used on Christmas Island and Norfolk Island to support monitoring programs for feral cats.



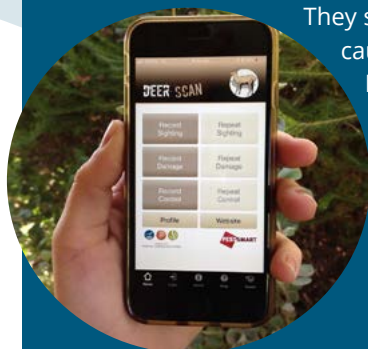
Top Image: Peel Harvey Biosecurity Group FeralScan Training. Image supplied by Peter West.

Bottom image: SA Biosecurity FeralScan Training Session. Image supplied by Peter West.

The latest addition is **DeerScan** – which provides a single avenue for landholders and the community to record where they are seeing or experiencing problems with deer. It has been developed in response to rising concerns from farmers, landholder groups and the community about the negative impacts of deer. There are six species of introduced deer in Australia, and DeerScan received more than 1,700 new sightings from concerned members of the public in its first 6 months of use, helping to inform biosecurity agencies and community groups where to prioritise management action.



In NSW, Cumberland Land Conservancy member Linda Brown is an avid user and advocate of DeerScan and said that knowing more about the distribution, rate of spread and the damage deer cause is imperative to ensure their Western Sydney community can take focused action to reduce the impacts deer are causing.



They started using DeerScan as an additional tool to assist in mapping the damage they cause, while also using wildlife monitoring cameras to measure sightings and abundance. DeerScan is helping them take an integrated approach for their community-led monitoring and management program. They use DeerScan to work closely with neighbouring landholders and NSW Local Land Services.



Top images: DeerScan app in hand. DeerScan is a new feature of the popular Centre for Invasive Species Solutions FeralScan digital community surveillance program. Images supplied by Peter West.

Bottom images: Deer use their antlers to ringbark trees, these images show a paperbark tree being destroyed. Images by James Gummer.

Case Study: Behaviourally effective communication and engagement in the management of wild dogs

This CISS project involves applying behavioural science principles to develop targeted engagement strategies and messaging to improve participation in community-led wild dog management programs.

The approach involves four stages: (1) identifying landholder behaviours that will have the biggest positive impact on improving wild dog management, (2) understanding the factors that cause landholders to adopt or not adopt these behaviours, (3) developing interventions to maximise the likelihood of adoption, then (4) evaluating our interventions using rigorous scientific methods, refining our approach, and implementing a cycle of continuous learning.

Stage 1 of the process has now been completed. The project team consulted with stakeholder groups to identify 11 key landholder behaviours and their potential impact. They then conducted a random digit-dial phone survey of 356 landholders to collect information on existing levels of participation in the identified key behaviours, along with the future likelihood of adoption. To identify the priority behaviours the team mapped this information along with stakeholder's impact data in an Impact-Likelihood matrix (see Figure 1).

The behaviours mapped onto the matrix can fall in one of four quadrants:

1. Behaviours falling in the top right quadrant are relatively easy to adopt and have a large impact on the issue so are the first to be considered. However, more often than not, these behaviours may already have a high adoption rate. So despite their high impact, they are not always the best behaviours to target.
2. Behaviours in the top left quadrant also have a high impact on the issue so may provide better potential targets. Because they are more difficult to do, they tend to have a lower likelihood of adoption, and will require more work and resources to be adopted.
3. Behaviours in the bottom right quadrant have a high likelihood of adoption but lack effective impact on the issue. Because they are easy to adopt, they might act as a catalyst to encourage more difficult behaviours in the future.
4. Behaviours in the bottom left quadrant have both a low impact and likelihood of adoption. These behaviours are low priority, because they achieve little to address the issue and are difficult to adopt.

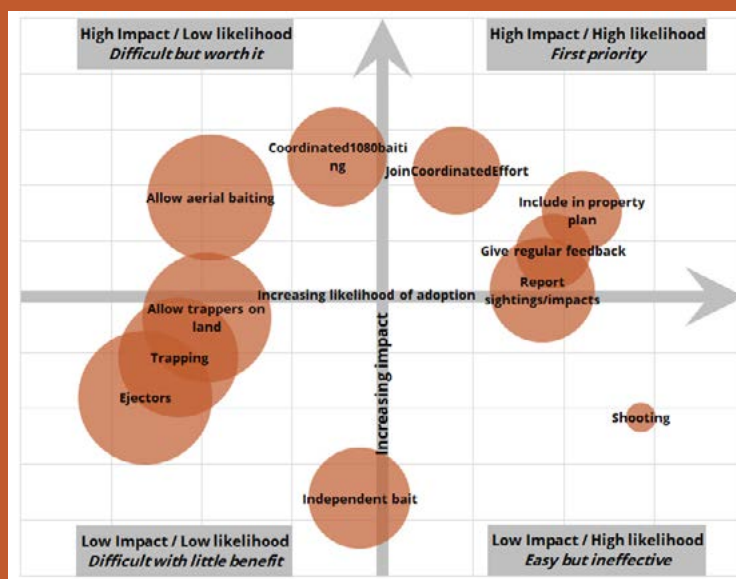


Figure 1: Impact-Likelihood matrix for 11 key wild dog management behaviours. Bubble size indicates potential opportunity for behaviour adoption (i.e. the larger the bubble, the less number of landholders are currently doing that behaviour, so potentially more can adopt behaviour in future).

The project will concentrate on three closely related behaviours to encourage landholders to:

- (1) be proactive and include wild dog management activities in their annual property plan,
- (2) join a coordinated effort in their community, (3) allow aerial baiting on their land.

A fourth behaviour will be to encourage all the community to immediately report any sightings or wild dog impacts. Work is well underway on stage 2 to understand what factors are enabling or impeding landholders' participation in these four chosen behaviours.

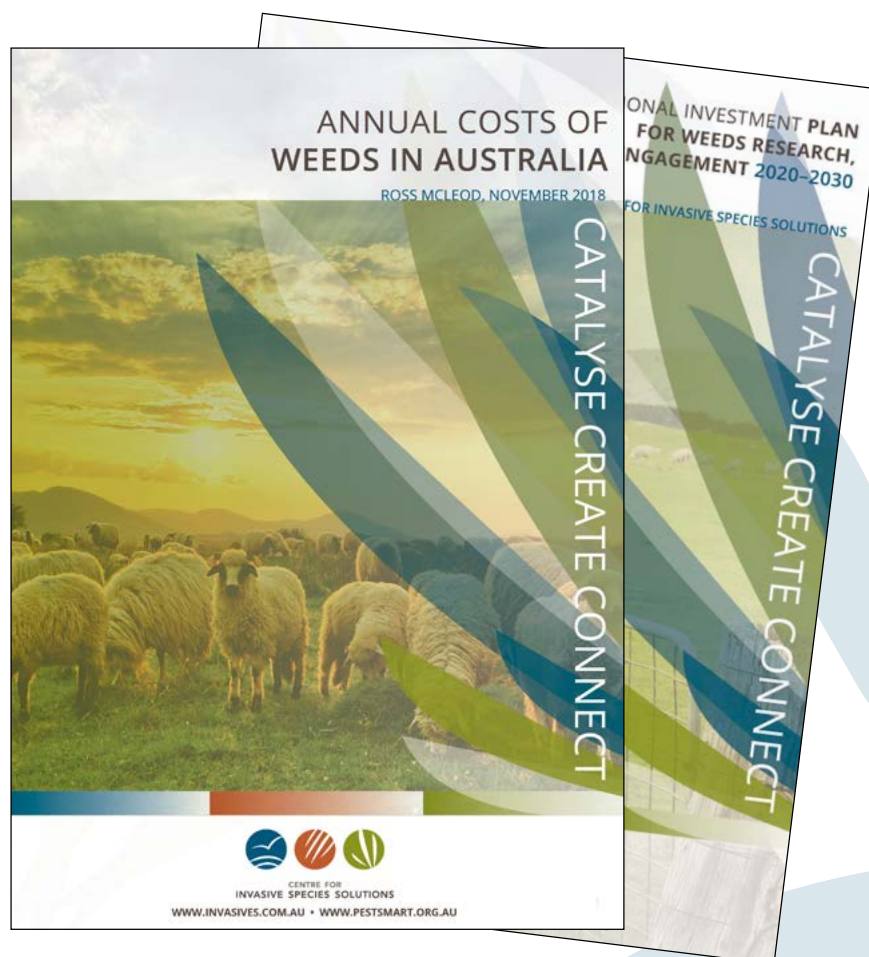


Image: Researchers from the University of New England are working with the wild dog coordinators around the country to enhance best practice community engagement principles so they can more effectively work with landholders to achieve impact. Image by Lynette McCleod.



A Cats Claw Creeper infestation on the Timbarra River near Drake NSW, taken by Amanda Craig.

Weeds



The 2018/19 reporting period saw the completion of 2 substantial studies to underpin investment decisions in the Plan.

These were:

1. Annual Costs of Weeds in Australia

This study estimated that weeds impose an overall average cost of nearly \$5 billion across Australia, with overall costs having increased by more than 20% over the 14 years since the Sinden et al. (2004) study. An average production loss cost of \$4.823 million was estimated for winter and summer broad acre cropping, rice, cotton, horticulture and livestock industries, using the 'economic surplus' approach. Costs to agricultural industries comprise the majority of total costs, as public expenditures are less than \$200 million of the overall mean cost of \$4,989 million in 2018.

2. Cost Benefit Analysis of Implementing the CISS 10 Year Weeds RD&E Investment Plan 2020-2030

In this study, cost-benefit analyses of each of the prospective research domains presented in the 10-Year Weeds Investment Plan were carried out. Estimates of economic pay off were measured by net present value (the difference between benefits and costs over a 20-year period) and benefit cost ratio (the ratio of all benefits to all research and weed management costs).

Environmental Biosecurity RD&E Strategy Coordination

The National Biosecurity Committee through the Environment and Invasives Committee (the NBC's sectoral committee responsible for environmental biosecurity oversight) has appointed the Centre to coordinate the implementation of the National Environment and Community Biosecurity Research Development and Extension Strategy and the preparation of a new strategy over the next two years.

The strategy aims to establish a national, coordinated and strategic approach to maximise benefits from past and future investments and generate cost-effective environmental and community biosecurity RD&E.

The specific role of the Centre will form an important part of the broader efforts to reduce the impacts of pests, weeds and diseases on the natural environment and community through the implementation of well-coordinated RD&E directed at national priorities and effectively delivered in collaboration with stakeholders. To implement this strategy, CISS has brought in the expertise of Dr Matt Sheehan to take on this national coordination role.

Dr Sheehan's involvement in the Australian biosecurity system over the past 19 years has coincided with a time of significant reform. He has played a key role in the development and implementation of these reforms and is well versed in the system and well connected to key personnel – both historical and contemporary – from the local to the national level.

As part of this national coordination role, Matt will be running a series of stakeholder workshops to gather information to ensure the roll out of this strategy is successful and to assist in developing a transition of the strategy post 2020.

This project is funded by the Australian Government Department of Agriculture and all States and Territories, and will work very closely with the Office of the Chief Environmental Biosecurity Officer to deliver the project outcomes.



Andreas Glanznig (CEO, CISS – left) and Richard Price (Portfolio Director, CISS – right) welcome Dr Matt Sheehan (middle) to the role of National Coordinator for the implementation of the National Environment and Community Biosecurity Research Development and Extension Strategy, over the next two years.

OUR PRODUCTS AND EXTENSION

19

registered products and
trademarks



Biol Invasions (2019) 21:2665–2677
<https://doi.org/10.1007/s10530-019-02003-y>

ORIGINAL PAPER

A general model for alien species richness

Richard P. Duncan · Phillip Cassey · Alex L. Pigot · Tim M. Blackburn

17

Publications

\$1.7 million
Online media advertising value
equivalent

A household pet becoming our next pest is 'just a matter of time'

ABC Science By environment reporter Nick Kilvert
Updated 30 August 2018 at 1:06 pm
First posted 30 August 2018 at 12:25 pm



**FERAL
FLYER**

5,304

CISS e-news subscribers

6,330

PestSmart social followers



16,623

FeralScan registered users

529,537

PestSmart webpage views





A buckeye camera trap being tested, in the field, as part of the Wild Dog Alert project. Image by Paul Meek.

Wild Dog Alert prototype sends first text alerts!



This year, the Wild Dog Alert 'SMS 4G camera trap system was officially turned on for testing, and in its first night successfully identified and alerted researchers to potential predators.

The Wild Dog Alert system brings together significant research developments in automated facial recognition of wild dogs (based on camera trap imagery), the latest in digital communication tools (suitable for remote transmission of image data and real-time alert messaging) and the understanding of wild dog movements and behaviour.

It truly shows the importance a strong collaboration bringing together behavioural ecologists and computer engineers to produce an innovative product.

Dr Paul Meek from the NSW Department of Primary Industries (DPI), who is leading the project said this result has been years in the making and was very excited to have proven the system can work.

"We are now working to iron out any potential bugs and refine the system as we go," Dr Meek said.

The current testing has shown image transmission times between the 3 models of camera trap are less than one minute. On average the time from detection to SMS delivery is 25 seconds, with some variability between models.

Satellite signal reception has proven to be impressive across the landscapes tested. However, as expected signal transmission in 100% rainforest canopy cover is problematic and further tests are planned with antenna modifications to assess limitations.

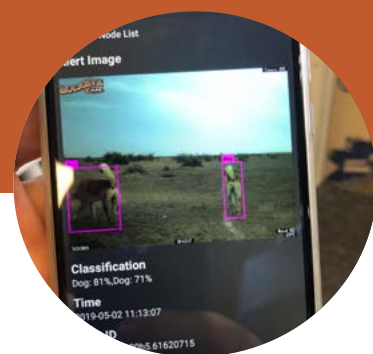
The Wild Dog Alert system is also being integrated with WildDogScan to allow planning modules between producers and land managers.



The Wild Dog Alert project began in 2016 and is being led by researchers at the University of New England (UNE) and NSW DPI. The Development team at UNE led by Dr Greg Falzon have produced three versions of the system – one using an automated Wild Dog Alert system, one using a Buckeye Camera trap system, and this one using the SMS 4G camera trap.

The project was funded by the Australian Government Department of Agriculture and Water Resources, Australian Wool Innovation and Meat and Livestock Australia through the Centre for Invasive Species Solutions.

More information about our digital innovation work can be found online – <https://invasives.com.au/our-solutions/impact-through-collaboration/innovation-digital-technology/>



Top Image: Wild Dog Alert prototype. Image by Paul Meek.

Middle image: The Wild Dog Alert prototype identifies a wild dog. Image supplied by Paul Meek.

Middle image: The Wild Dog Alert notification prototype. Image supplied by Paul Meek.

HOGGONE® meSN® baits in final stages of APVMA approval

With exotic diseases such as African Swine Fever a growing threat to Australia's \$5 billion per year pork industry, the need for strategic and landscape scale management tools for feral pig management is also growing to ensure we reduce the number of feral pigs within Australia who are all potential vectors of disease.

In 2005, a 14-year innovation pathway began from a PhD discovery through to a market ready product, known as HOGGONE® meSN® Feral Big Bait.

The HOGGONE® product uses sodium nitrite, an approved food preservative that in low doses can kill pigs quickly in overdose. HOGGONE® is humane and kills by oxygen depletion to the brain and tissues (known as methaemoglobinaemia). Pigs are more susceptible than other species because they have a limited amount of a protective enzyme that reverses the effects of sodium nitrite.

The HOGGONE® project began through the then Invasive Animals CRC and now our Centre with the strong backing and leadership of Animal Control Technologies Australia, Meat and Livestock Australia and the Australian Government Department of Agriculture.

The product is adding to the growing suite of tools available for feral pig management, including Pigout® baits, the very first collaborative commercial product of the Invasive Animals CRC, which is a manufactured bait containing the 1080 toxin, available for purchase through Animal Control Technologies Australia.

The HOGGONE® project is the next generation for feral pig toxin research and development (R&D) work within Australia, and has been developing formulations of sodium nitrite for on ground feral pig control so that an additional toxin can be made available.

During testing, HOGGONE® baits consistently reduced feral pig activity by 70–90% in field studies. The results of the R&D were then developed into a registration package for the APVMA and submitted in late 2017.

We are pleased to say that the HOGGONE® registration package was gazetted by the APVMA in September 2019 as a Schedule 6 product, to be used in conjunction with a delivery system such as the Hoghopper®. It is anticipated that the product will be commercially available, through Animal Control Technologies Australia, in 2020.

This project is another great example of research leading through to a commercial product and the important need for continued investment in long term R&D to ensure the proper thorough testing can be undertaken to get these products into the market.



Images: Hoggone research and development trials have been ongoing since 2005, which resulted in a registration package being submitted to the APVMA in 2017 and the product being available, likely in early 2020. Images supplied by Animal Control Technologies Australia.

New products and commercialisation

In the past 12 months, the process of registering two new products (PAPP-based LTD and GonaCon™) with the Australian Pesticides and Veterinary Medicines Authority (APVMA) was commenced. When registration is granted, these products will expand the toolboxes of land managers dealing with overabundant and invasive species.

The commercialisation process has also been commenced for a range of new products that were developed through projects that commenced during the Invasive Animals CRC and have continued in CISS with funding from the Commonwealth Department of Agriculture's White Paper grants. These projects are Specified Projects with the IP being held by CISS on behalf of the partner organisations involved in those projects.

Additionally, two projects that continued research commenced during the IA CRC were discontinued, which were the Blue Healer antidote and carbon monoxide fumigator projects. These projects initially showed promise as being able to deliver additional management tools however during the research process it became apparent that they would not be able to deliver their intended outcomes.

Intellectual property management

Licensed IAL IP that generates very modest royalties (\$2,204 in 18/19 FY) from the sale of products developed through the IA CRC (2005–17), which is reinvested into the new Centre. Licensed intellectual property (IP) that generates very modest royalties (\$1,500 in 18/19 FY) 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®, 2018-19 financial year royalty of \$1,500.67, distributed to Pest Animal Control CRC Participants
- HOGHOPPER, 2018-19 financial year royalty of \$1,676.25, retained by IAL
- RODEMISE®, 2018-19 financial year royalty of \$68.85, retained by IAL
- Wild dog and fox PAPP, 2018-19 financial year royalty of \$51.09, retained by IAL
- Hoggone, 2018-19 financial year royalty of \$407.99, 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 by the IACRC — that is, all IP is 100% vested in IAL (called Centre IP) and available to all Portfolio Agreement Members for their own use in research, training and adoption.

IP with commercial potential is managed distinctly from public good Centre 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 towards 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) – www.pestsmart.org.au
- Community engagement tool (e-training course) – www.community.pestsmart.org.au
- FeralScan (community surveillance digital platform) – www.feralscan.org.au
- Decision Support Tools (rabbit specific) – <https://landcare.shinyapps.io/SimRab>
- Field Guide to Pest Animals of Australia (app) – iTunes Apple store

A national weeds digital platform (Weeds Australia) containing weeds management profiles, weeds of national significance documents, case studies and more, is currently under development, with the aim of being the new national weeds knowledge hub with clear linkages back to state based and regional resources. We are aiming to have this launched in 2020.

Digital technology is being embraced by CISS and is seen as a core enabler of present and future best-practice pest animal management. Beyond 2019, our digital tools will be enhanced and integrated to increase uptake as we execute our updated digital strategy and 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
PIGOUT pen/field efficacy studies	2003–2005	Exclusive
Blue Healer trademark	2005	Not applicable
Rodenticide pen/field efficacy studies	2005–2008	Exclusive (in Australia)
PAPP wild dog and fox bait and toxin	2005–2014	Exclusive (worldwide)
Nitrite-based pesticide products: Commercialisation of granted patents (Aus, NZ, USA and Canada)	2007	Exclusive (worldwide)
HOGGHOPPER design and manufacturing specifications	2010	Exclusive (worldwide)
PestSmart trademark	2012	Not applicable
LandSmart trademark	2015	Not applicable
FarmSmart trademark	2015	Not applicable
AVPC trademark	2015	Not applicable
Centre for Invasive Species Solutions trademark	2015	Not applicable
AntSmart trademark	2017	Not applicable
PlantSmart trademark	2017	Not applicable
FeralScan trademark	2018	Not applicable
BiteMe trademark	2018	Not applicable
PAPPutty trademark	2018	Not applicable
HOGGHOPPER trademark	2018	Not applicable
CISS (acronym)	2018	Not applicable
AVPC logo	2018	Not applicable

Patents

IAL has maintained and managed patents and patent applications for the use of nitrite salts as poisons in baits for omnivores. 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	IP CREATION DATE	LICENCE NATURE
Rodenticide (CRADA) with USDA	2013–2017	Exclusive (worldwide)
HOGGONE USA (CRADA) with USDA	2013–2017	Exclusive (worldwide)
Microencapsulated sodium nitrite formulations (CRLA) with Texas Parks and Wildlife	May 2015	Exclusive (worldwide)

Research excellence

The Centre for Invasive Species Solutions prides itself on research excellence to inform best practice management, along with the development and subsequent adoption of new tools, technologies and systems.

During the financial year, **13** scientific publications and **2** books, **1** economic input report and **1** updated PestSmart guide were published through our RD&E collaboration. Many of these publications are a result of flow on work from projects of the IACRC which have either informed or are linked with work of the new CISS portfolio projects.

See our list of publications on the next page.



List of Publications

Incursion pathways

1. Duncan, R., Cassey, P., Pigot, A., Blackburn, T. (2019). A General Model For Alien Species Richness. *Biological Invasions*, 21(8), 2665-2677.
2. Lockwood, J., Welbourne, D., Romagosa, C., Cassey, P., Mandrak, N., Strecker, A., ... & Keller, R. (2019). When Pets Become Pests: The Role Of The Exotic Pet Trade In Producing Invasive Vertebrate Animals. *Frontiers in Ecology and the Environment*, 17(6), 323-330.

Environmental DNA

1. Furlan, E., Gleeson, D., Wisniewski, C., Yick, J., Duncan, R. (2019). eDNA surveys to detect species at very low densities: A case study of European carp eradication in Tasmania, Australia. *Journal of Applied Ecology*, early online 1-13. <https://doi.org/10.1111/1365-2664.13485>
1. Bylemans, J., Gleeson, D., Lintermans, M., Hardy, C., Beitzel, M., Gilligan, D., Furlan, E. (2018). Monitoring riverine fish communities through eDNA metabarcoding: determining optimal sampling strategies along an altitudinal and biodiversity gradient. *Metabarcoding and Metagenomics 2*: e30457. <https://doi.org/10.3897/mbmg.2.30457>

Deer management

1. Hampton, J., MacKenzie, D., Forsyth, D. (2019). How many to sample? Statistical guidelines for monitoring animal welfare outcomes. *PLoS ONE* 14(1): e0211417. <https://doi.org/10.1371/journal.pone.0211417>
2. Cripps, J., Pacioni, C., Scroggie, M., Woolnough, A., Ramsey, D. (2019). Introduced deer and their potential role in disease transmission to livestock in Australia. *Mammal Review*, 49, 60-77.

Wild dog management

1. Harriott, L., Gentle, M., Traub, R., Soares Magalhaes, R., Cobbold, R. (2019). Zoonotic and economically significant pathogens of peri-urban wild dogs across north-eastern New South Wales and south-eastern Queensland, Australia, *Wildlife Research*, 46(3), 212-222.
2. Harriott, L., Gentle, M., Traub, R., Soares Magalhaes, R., Cobbold, R. (2019). The association between diet of periurban wild dogs and zoonotic pathogen carriage. *Australian Mammalogy*, 41(2), 241-249.

Other invasive species

1. Morgan, H., Ballard, G., Fleming, P., Reid, N., Van der Ven, R., Vernes K. (2018) Estimating macropod grazing density and defining activity patterns using camera trap image analysis. *Wildlife Research* 45(8), 706-717.
2. Bishop, J., Falzon, G., Trotter, M., Kwan, P., Meek, P. (2019). Livestock vocalisation classification in farm soundscapes. *Computers and Electronics in Agriculture*, 162, 531-542.

Rabbit biocontrol and management

1. Hall, R., Huang, N., Roberts, J., Strive, T. (2019). Carrion flies as sentinels for monitoring lagovirus activity in Australia. *Transboundary and Emerging Diseases*, 66(5), 2025-2032.

Community engagement and behaviour change

1. McLeod, L., Hine, D. (2019). Using audience segmentation to understand nonparticipation in invasive mammal management in Australia. *Environmental Management*, 64(2), 213-229.
1. McDonald, I., McKinnon, M. (2019). Communicating biosecurity information to Australian-registered veterinarians. *Australian Veterinary Journal*, 97(10), 394-397.

Reports

1. Mifsud, G (2016). A field guide to poison baiting: wild dogs and foxes. 3rd edition 2018. PestSmart Toolkit publication. The Centre for Invasive Species Solutions, Canberra, ACT.
2. McLeod, R. (2018) Annual Costs of Weeds in Australia. eSYS Development Pty Limited. Published by the Centre for Invasive Species Solutions, Canberra, Australia.

Books

1. Howard, T., Alter, T., Frumento, P., Thomson, L. (2019). Community Pest Management in Practice. Springer publishing.
2. Martin, P., Alter, T., Hine, D., Howard, T. (2019). Community-Based Control of Invasive Species. CSIRO publishing



Andreas Glanznig (CISS CEO) was interviewed by ABC Landline, as part of a feature segment aired in March 2019 on our Rabbit biocontrol research program.

Digital Extension

Our centre's digital extension area is a critical and expanding function which is important to promote awareness and adoption of best practice invasive species management.

In addition to our current PestSmart and FeralScan resources, our Centre supports major national communication campaigns associated with invasive species and the broader biosecurity area. The aim is to have a collaborative approach to managing these community engagement and outreach campaigns in partnership with our members and partners and other key stakeholders.

The Centre is also adding to our extension material suite through the development of a national weeds website, to be called 'Weeds Australia' which will be launched in early 2020.

PestSmart digital platform and publication series

The PestSmart website – www.pestsmart.org.au - is a key part of our digital platform providing end-users with toolkits of pest animal management information and knowledge.

The website is currently undergoing a major upgrade as part of the Centre's stage 1, Portfolio 1 projects and the aim is to have this new upgraded site become live in 2020.

While the upgrade development is in progress we are continuing to promote the use of PestSmart in its current form and due to continued brand promotion over the past financial year the awareness of the site has been maintained. The 18/19 FY is the first time in the sites history that it has received more than half a million website pageviews (up 17%) and more than 220,000 users (up 29%) in a 12-month period (Figure 1).



Figure 1: The growing trend in use and users of feral.org.au/PestSmart since 2013. Note PestSmart first launched in March 2015.

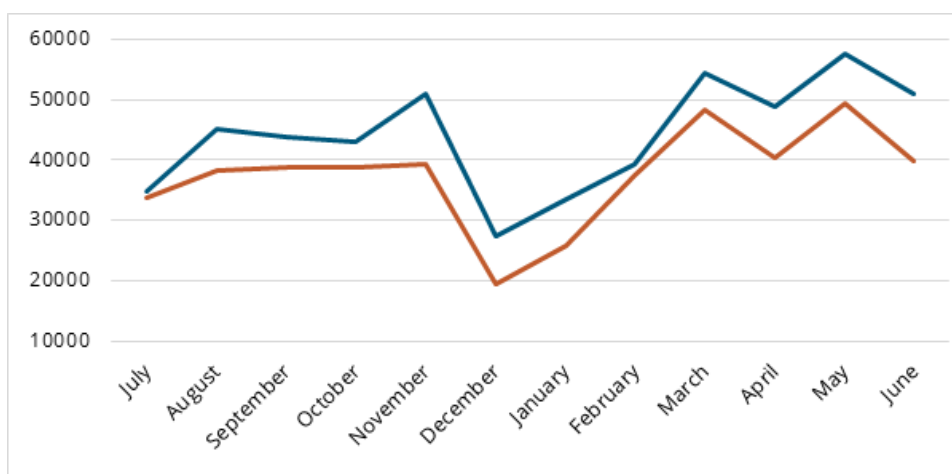


Figure 2: The monthly trends of PestSmart comparing 17/18 (orange line) to 18/19 (blue line).

During the 18/19 FY use of PestSmart website pageviews grew each month compared to the previous financial year, showcasing its growing awareness and value as a digital extension tool (figure 2). The website includes a range of publications including fact sheets, case studies, guides and technical reports which are also available in print PDF form.

In the 2018/19 financial year our PDF toolkit documents were downloaded 25,163 times (up 30% from the previous financial year) and we also distributed the print-friendly versions (particularly the glovebox guides) to many of our key stakeholders for distribution at conferences, field days and agricultural and environmental management specific events.

Key engagement platforms for the PestSmart digital platform include social media channels on Facebook, Twitter and YouTube. These continue to be a very valuable asset for our community to engage in best practice management and talk with other like-minded invasive species land managers.

A total of 1006 tweets and 980 Facebook posts focused around invasive species management programs and awareness of the issue were sent out during the financial year to an audience of over 6,300 followers (up 7% from previous financial year) – see Table 1.

During the financial year, our social media posts reached over 2.17 million accounts with more than 118,000 (~6%) of these followers engaging with our posts in some format (via sharing, commenting or clicking on links).

Our PestSmart YouTube channel videos received more than 172,000 views over the course of the financial year (up 7.5% from previous financial year). The channel now has 1,123 followers – see Table 1.



	Facebook	Twitter	YouTube
13/14	474	1031	298
14/15	862	1610	454
15/16	1597	2185	571
16/17	2525	2474	672
17/18	3265	2638	884
18/19	3625	2705	1123

Table 1: Trends in social media followers per FY. Social media icons by Vecteezy.

FeralScan community 'mapping and management' program

The FeralScan community mapping program now has over 22,000 online users, of which 16,623 are registered, and contains more than 135,000 records of pest animals, pest problems and control actions coordinated by landholders and community groups Australia-wide (Table 2).

The resource has been co-created with landholders, ensuring it is fit for purpose. FeralScan is being used widely by biosecurity organisations, pest control professionals, local government organisations and landholder associations. It has become a vital tool for many land managers for coordinating control programs and provides real-time mapping services to participants.

What is even more great to see are the number of community groups now set up within the system who can share information with each other to ensure they make the best strategic management advice for their region and area. There are now 365 groups across Australia set up to do this, which combine farmers, land managers and government staff.




	Registered users	Community groups	Total records
			
13/14	5,534	8	26,581
14/15	6,417	22	30,422
15/16	8,956	85	45,166
16/17	11,786	166	66,722
17/18	13,956	261	90,430
18/19	16,623	365	135,475

Table 2: FeralScan users, groups and record trends over time. Social media icons by Vecteezy.



Thel O'Shea, Jasmine Whitten and Peter West at the NSW Landcare coordinators conference, March 2019. Image supplied by Peter West.

CISS digital engagement platforms are supporting national pest animal plans and threatened species strategies



The Rabbit Biocontrol Tracker

was created to enable people all over Australia to monitor rabbit numbers and report (and sample) disease affected rabbits as part of the release of the RHDV1 K5 in 2017.

More than 1,600 samples were reported to the biocontrol tracker.

Our PestSmart Rabbit Toolkits contain glovebox guides, videos, factsheets and FAQs and have been viewed 50,000 times.



NATIONAL CARP CONTROL PLAN

RESTORING NATIVE BIODIVERSITY

CarpMap was developed using FeralScan software to enable the community to report carp aggregations to the National Carp Control Plan research program. 568 participants submitted data and photographs over a 6 month period.

PestSmart carp pages have been viewed more than 34,000 times, including information on the research behind the carp herpes virus and short explainer videos in an FAQ section.



WildDogScan is now being used by 300 community groups and over 50 regional biosecurity organisations across the country to inform their collective management action.

The new dashboard interface allows users to track changes in wild dog activity (and attack rates) in response to control efforts.

Wild dog management pages on PestSmart have been viewed more than 43,000 times.



FeralCatScan was created to enable the community to monitor and record feral cat sightings (and impacts) to assist in management program activities.

Feral cats have a major impact on Australia's threatened species, and since its launch more than 6,500 feral cat sightings have been added into the map.

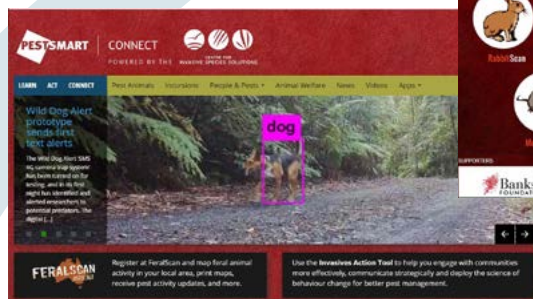
Feral Cat Toolkits have been viewed more than 30,000 times.

Digital resources coming in 2020

In 2020 we are excited to launch our Centre's 'Invasive Species Portal' – a digital hub which will include links to our upgraded PestSmart and FeralScan platforms and links to our brand-new area for weeds management information - Weeds Australia.

There will also be areas to engage with experts, our social media channels and download our best practice community engagement resources.

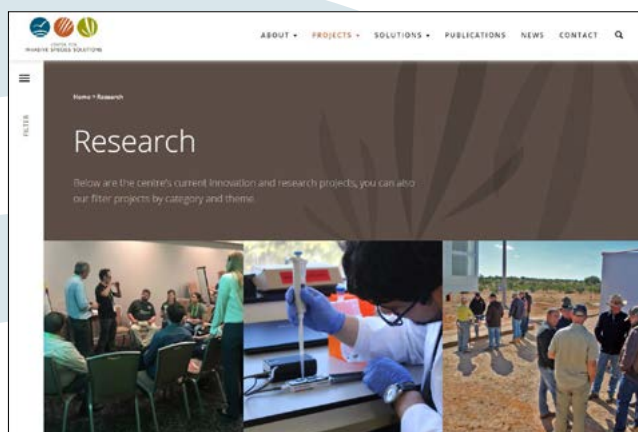
Our aim is to have this portal launched in early 2020, with a strong promotional and marketing strategy to assist in getting the word out.



Communication and media

CISS Corporate Website

The new look corporate website – www.invasives.com.au was built and launched in November 2017.



Our promotional communications resulted in our CISS website receiving 60,868 page views during the 18/19 FY, via 17,764 website users. 18/19 website data is the first full year of website statistics and can now be used as benchmark data for future financial years.

The website is used as a way of promoting the ongoing impact of our research portfolio as well as news and events.

Feral Flyer e-newsletter

Feral Flyer is our Centre's fortnightly e-newsletter

that aims to inform subscribers of the latest CISS achievements, research, publications, events and related external news. The newsletter is aimed at a diverse audience including researchers, farmers, land managers, students and journalists. There were 4,050 subscribers as of end of June 2019, a net increase of 12% from the previous FY year.

A total of 23 e-newsletters were sent out during the reporting period, with open rates ranging between 30-40% and click rates between 10-20%.

In 2020, Feral Flyer will be moving to a monthly digest format, coming out on the second Thursday of each month.



CISS media

420 key online media articles were noted during the 18/19 FY resulted in an advertising value equivalent (AVE) of ~\$1.7 million (up 54% compared to 17/18 FY).

During the 18/19 FY our media interventions were focused on achieving key media reach our rural stakeholders, including:

- Key TV segments on programs such as ABC Landline.
- Key articles within major newspapers, such as the Guardian and the rural Fairfax press.
- Collaborative media releases with major stakeholders, such as National Farmers Federation.

Highlights included:

<p>JUNE-SEP</p>  	<p>The Federal Agricultural Minister produced a media release about our portfolio launch 'turning to DNA in the fight against pests' which resulted in 16 media hits.</p> <p>ABC Science ran a feature article on how household pets could become our next pest is 'just a matter of time' – featuring Associate Professor Phill Cassey.</p>
<p>OCT-DEC</p>  	<p>A CISS led media release highlighted Australia's largest research collaboration established to tackle feral deer which resulted in 110 media hits.</p> <p>A Threatened Species Recovery Hub joint media release with CISS on a paper showcasing how invasive species and habitat loss are our biggest biodiversity threats</p>
<p>JAN-MAR</p>   	<p>A CISS led media release about our rabbit virus program winning a top national biosecurity award resulted in 10 media hits.</p> <p>A CISS led media release about our Wild Dog Alert prototype sending first text alerts resulted in 9 media hits and radio interviews.</p> <p>The National Farmers Federation led a joint release about weeds costing farmers \$4.8 billion per year (a new economic report), which resulted in 26 media hits</p> <p>Our rabbit biocontrol biosecurity award win was highlighted in the Federal Agriculture's Ministerial media release</p> <p>CISS was mentioned as part of the solution to the extinction crisis in The Guardian, in a feature article titled 'We are clearly losing the fight': scientists sound alarm over invasive species.</p> <p>ABC Landline ran a 15 minute feature segment of our rabbit virus program.</p>
<p>APRIL-JUNE</p>  	<p>A CISS-led media release showcasing that four in five urban wild dogs carry parasitic worms, study finds resulted in 10 media hits.</p> <p>A biosecurity symposium media release highlighting that the new biosecurity collective is ready for action.</p>

CISS social media

Our CISS social media presence grew 594% during the 18/19 FY, with a total audience of 930 followers across Facebook, Twitter and LinkedIn – see Figure 3. A total of 515 posts were sent during 18/19 FY reaching more than 217,000 accounts and receiving 4,768 engagements (i.e. likes, shares, comments, etc) – see Table 3.

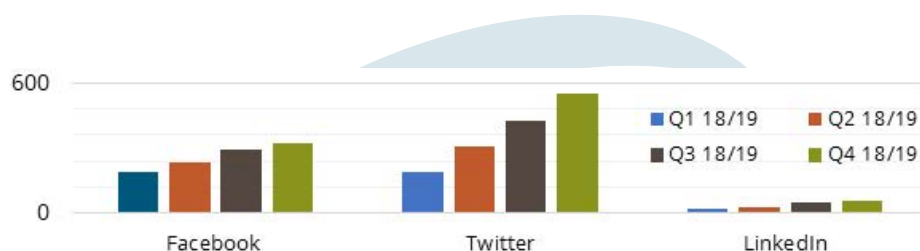


Figure 3: Growth of our social media following during the 18/19 FY quarters.




SOCIAL MEDIA PLATFORM		17/18	18/19
	Messages sent	3	108
	Accounts reached	28,743	50,626
	Accounts engaged	34	1,001
	Messages sent	4	364
	Accounts reached	577	164,334
	Accounts engaged	27	3,589
	Messages sent	0	43
	Accounts reached	0	2,197
	Accounts engaged	0	178

Table 3: CISS social media reach and engagement figures against messages sent out. Social media icons by Vecteezy.

Follow us!

- Twitter: <https://twitter.com/centreinvasives>
- Facebook: <https://www.facebook.com/CentreInvasiveSpecies>
- LinkedIn: <https://www.linkedin.com/company/centre-invasive-species-solutions>

Internal Communications

Recognising CISS' Board, staff and researchers are in diverse locations around Australia and internationally, internal communications is of utmost importance to encourage collaboration, sharing of ideas and to facilitate being part of the CISS community. Internal communication is facilitated through:

Regular teleconferences and email conversations: the Research Management Team meets quarterly via teleconference and many of the research projects steering committees discuss project requirements and outcomes via email and regular teleconferences.

EVENTS

21st Australasian Weeds Conference 9-12 September, 2018



CISS was a major sponsor of the 21st Australasian Weeds Conference, and Andreas was invited to give a keynote address which focused on our Centre's direction in weeds RD&E sector. The conference was attended by more than 300 members of the weeds community from Australia, NZ and surrounding countries.

CISS Portfolio Launch 18 September, 2018



On behalf of our members and partners, we were extremely proud to have the Federal Minister for Agriculture and Water Resources, the Hon. David Littleproud (at the time) officially launch our Centre's first research, development and extension (RD&E) portfolio worth a total combined investment of \$48 million. Andrew Cox from Invasive Species Council and Fiona Simson from National Farmers Federations also spoke about the importance of collaboration to achieve innovation.

CISS Forum 23 November, 2018



Our Annual CISS Forum provides an opportunity for representatives from our members, partners and key stakeholders to receive a snapshot of our achievements and provide strategic input into our Centre's future activities and direction

Established Pests and Weeds Symposium 29-30 April, 2019



The Australian Government Department of Agriculture held a two day symposium to provide researchers an opportunity to present findings from their agriculture competitiveness whitepaper funded projects. A number of project leaders presented on topics funded through this initiative, including updates on Wild Dog Alert, the National Wild Dog Action Plan, the Hoggone product registration and more.

Australian Biosecurity Symposium 12-13 June, 2019

Animal Health Australia (AHA), the Invasive Species Council (ISC) and the Centre for Invasive Species Solutions (CISS) hosted the inaugural Australian Biosecurity Symposium on the Gold Coast on 12-13 June 2019. The Symposium focused on preventative biosecurity practices, research and innovation, outside of the box thinking and the exchange of knowledge and ideas across the biosecurity collective.

The event was a resounding success, bringing together close to 400 biosecurity champions from across Australia, New Zealand, USA, Canada and Mexico to form Australia's first biosecurity movement.

It was a fantastic couple of days, with more than 96% of delegates satisfied with the event overall, and over 95% of delegates indicating that they would attend another Symposium. In particular, delegates noted the positive, energetic atmosphere; the depth and variety of the program; and our fabulous MC Costa Georgiadis and scribe Jessamy Gee.



Australian Biosecurity Symposium 2019. Images by Alannah Andreini, Animal Health Australia.



Top row images: Australian Biosecurity Symposium 2019. Images by Alannah Andreini, Animal Health Australia.

Bottom row and images: Australian Biosecurity Symposium 2019, dinner. Images by Stefan Daniljchenko from Photographer at Large.

Bottom image: The CISS board and a number of staff attended the symposium. Images by Stefan Daniljchenko from Photographer at Large.

CONGRATULATIONS TO OUR COMMUNITY

AWARDS

Our collaborative rabbit biocontrol monitoring program wins a 2019 Australian Biosecurity Award!



CONGRATULATIONS TO OUR COMMUNITY



Members of the collaboration. (L-R: Lyn O'Connell, Department of Agriculture; Johann Schroder, MLA; Emma Sawyers, NSW DPI; Murray Rankin, CISS, the Hon. David Littleproud Minister for Agriculture; Tarnya Cox, NSW DPI; Tanja Strive, CSIRO; Andreas Glanznig CISS; Jane Littlejohn, AWI; Bruce Christie, NSW DPI; and Helen Cathles, CISS). Image by Steve Keough Photography.

Dr Vivek Nenane is awarded a UNE Vice Chancellor award.



Vivek won a Vice Chancellor's Award for his thesis on institutional impediments to innovation in invasive animal control in peri-urban areas. His case studies were focused on wild dogs and deer, in the Brisbane and Sydney peri-urban areas. His supervisors were Professors' Paul Martin (UNE) and Darryl Low Choy (Griffith University). Here he is pictured with his supervisor, Professor Paul Martin, at his graduation ceremony this year.

Victoria's Rabbit Action Network wins a United Nations award.

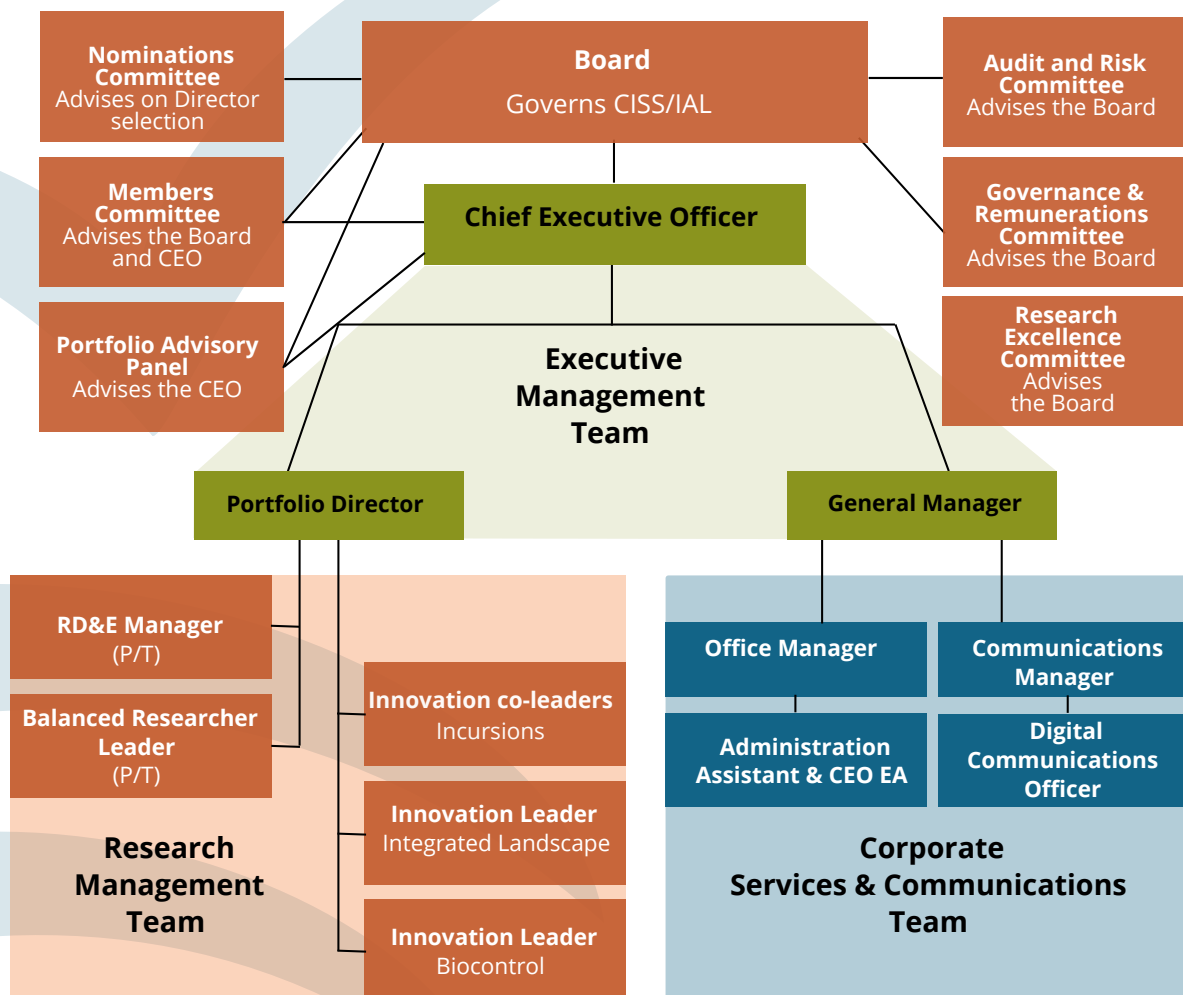


The Victorian Rabbit Action Network (VRAN) won a United Nations Public Service Award for their role in building a community-led approach to managing rabbits at landscape scale. Michael Reid (right of image, former National Rabbit Facilitator with the Invasive Animals CRC hosted by the Victorian Government) along with two of the VRAN community champions, Kaye Rodden and Gerald Leach, received the award in Baku, Azerbaijan, on behalf of the network collective. Agriculture Victoria is now looking at how this model of shared decision-making and responsibility can be applied to managing other invasive species and issues across the state, as well as sharing the model with other jurisdictions to ensure the success of the program can be seen at a national level. Images supplied by Agriculture Victoria.

OUR GOVERNANCE AND MANAGEMENT

Invasive Animals Ltd 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 profits commission.

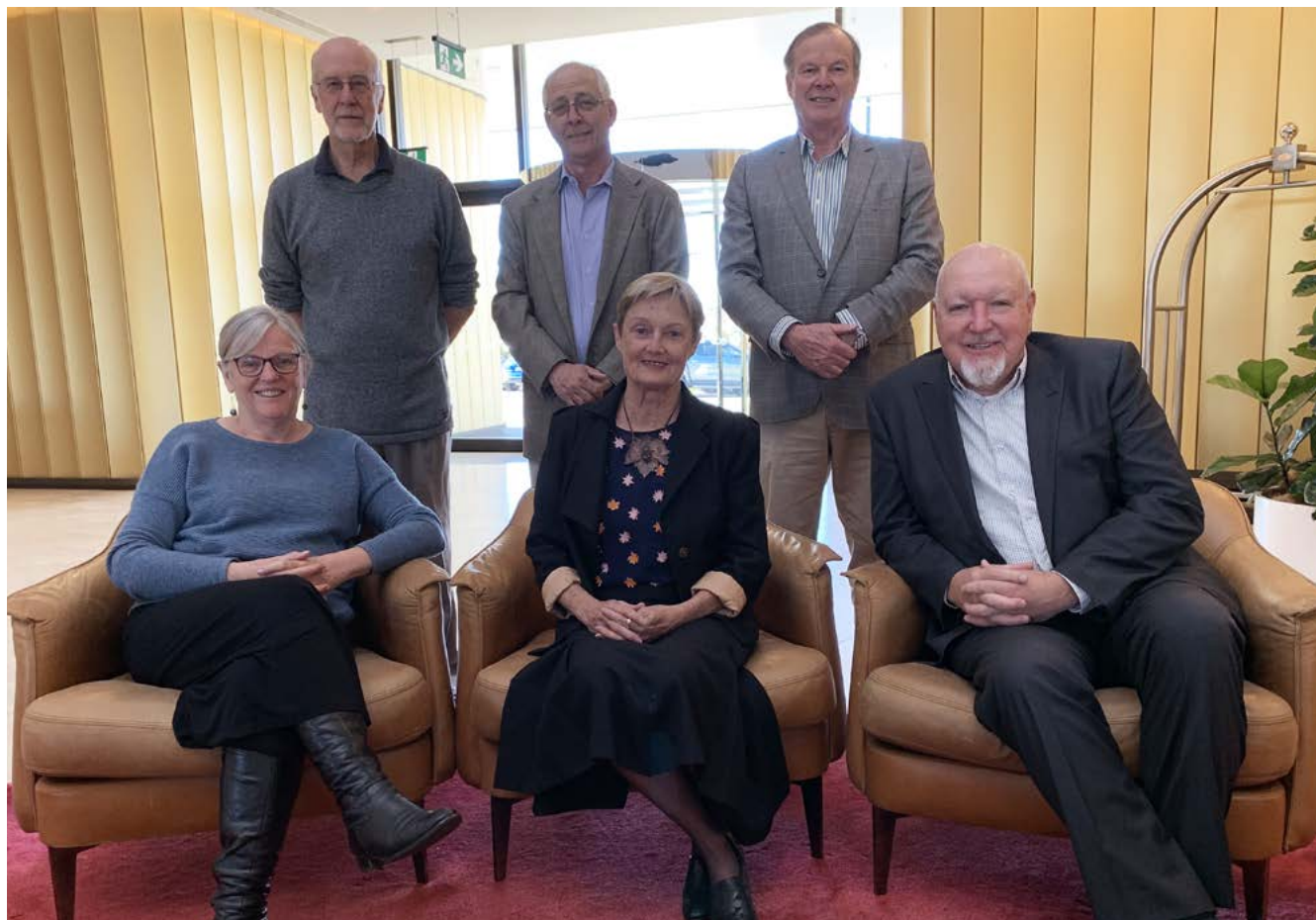
OUR GOVERNANCE AND MANAGEMENT



The structure and governance of the CISS provides strong support to its operations. CISS 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 both Australian Charities and Not-for-Profit Commission and the Australian Security & Investments Commission Corporate Governance Principles and Recommendations.

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

The names and details of the Directors in office during the financial year and up to the date of this report are as follows.



Invasive Animals Limited Board of Directors: (back row L-R) Dr Glen Saunders, Peter Noble, David Palmer (front row L-R) Jan Ferguson, Helen Cathles and Murray Rankin.

DIRECTORS	ROLE	KEY SKILLS	INDEPENDENT/ ORGANISATION
Helen Cathles	Chair	Director since 2005. Corporate Governance, Primary Production, Pest Animal Control	Independent
Peter Noble	Director	Director since 2015. Legal speciality, Governance & 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
Dr Andrew Sanger	Director	Director since 2015. Applied scientific research, Management and Regulatory Governance	Independent
Jan Ferguson OAM	Director	Director since June 2019. Governance, Research & Development, Communication	Independent
Dr Glen Saunders	Director	Director since November 2016. Pest Animal Management and Research	Independent

PUBLIC OFFICERS:

Carolyn Campbell-Wood	Company Secretary	Appointed March 2014	Centre for Invasive Species Solutions
Julie McGuinness	Company Secretary alternate	Appointed February 2018	Centre for Invasive Species Solutions

DIRECTORS	BOARD MEETINGS		AUDIT AND RISK COMMITTEE		GOVERNANCE & REMUNERATION COMMITTEE		RESEARCH EXCELLENCE COMMITTEE		TRANSITIONAL NOMINATIONS COMMITTEE	
	No. eligible to attend	2018-19	No. eligible to attend	2018-19	No. eligible to attend	2018-19	No. eligible to attend	2018-19	No. eligible to attend	2018-19
Number of meetings held for the year:		5		5		5		3		3
Number of meetings attended:										
Directors										
Helen Cathles (Chair)	5	5	1	1	5	5			3	3
Jan Ferguson	3	3					2	2		
Peter Noble (Chair Governance & Remuneration Committee)	5	4#*			5	5			3	2*
David Palmer	5	5	5	3#*						
Murray Rankin (Chair Audit & Risk Management Committee)	5	4#*	5	5						
Dr Andrew Sanger	2	2	2	1#*			1	1		
Dr Glen Saunders (Chair Research Excellence Committee)	3	3			1	1	3	3		
Nominations Committee Members										
Matt Koval - (as representative of the Commonwealth Dept of Agriculture) (Chair Transitional Nominations Comm)	-	-	-	-	-	-			3	3
Dr Bruce Christie - (As representative of the Environment & Invasives Committee)									3	2
Mark Harvey-Sutton - (as representative of the National Farmers Federation)	-	-	-	-	-	-			3	3
Mr Will Zacharin - (as representative of a State Government)									3	2
Mr Selwyn Snell - (as an independant member)									3	2

Directors where on leave at this time

* Apology

Committees

Audit and Risk Committee

The Audit & Risk Committee operates under Terms of Reference as approved by the Board. The Audit & 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
- Dr Andrew Sanger
- Mr David Palmer

The Chief Executive Officer, and General Manager and external auditors are invited to Audit & 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
- Ms Helen Cathles
- Dr Glen Saunders

The Chief Executive Officer and General Manager are invited to Governance & 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:

- Dr Glen Saunders - Chair
- Dr Andrew Sanger
- Ms Jan Ferguson OAM

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

Nominations Committee

The Nomination Committee operates under Terms of Reference approved by the Board. The Committee for the 2018 - 19 year included:

- Mr Matt Koval – Chair
- Mr Bruce Christie
- Mr Will Zacharin
- Mr Mark Harvey-Sutton
- Mr Selwyn Snell
- Ms Helen Cathles
- Mr Peter Noble

Staff

The Centre for Invasive Species Solutions has a number of staff which coordinate and maintain its administration, communication and research management function.

NAME	POSITION/ROLE WITHIN CISS	TIME COMMITTED
Mr Andreas Glanznig	CEO	100%
Mrs Carolyn Campbell-Wood	General Manager	100%
Associate Professor Richard Price	Portfolio Director (Research)	100%
Dr Tony Buckmaster	Project and Education leader	100% *
Mr Greg Mifsud	National Wild Dog Management Coordinator	100% *
Ms Sigrid Tijs	Projects and contracts coordinator	90%
Dr Ian McDonald	Communications Manager	100%
Ms Yvette Cazabon	Digital Communications Officer	80%
Ms Julie McGuinness	Office Manager	100%
Ms Jane Leslie	Administration Assistant and EA to the CEO	100%

*funded through Portfolio One project funds

Staff changes

Sigrid Tijs finished on 30 April, 2019.

Domain Leaders

NAME	ORGANISATION	DOMAIN	TIME
Dr John Virtue	Primary Industries and Regions, South Australia	Innovation co-leader, Incursions	27%
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)

FINANCIAL PERFORMANCE

The Company was established to be a non-profit scientific institution to promote a managed and co-operative approach to RD&E in the field of invasive species management so as to maximize the benefits from that RD&E.

The Invasive Animals Ltd.'s short term objective is to foster the establishment of the Centre for Invasive Species Solutions and develop its first RD&E project portfolio – Portfolio No. 1. The Portfolio No.1 is funded through a five-year agreement between the Commonwealth Department of Agriculture, all States and the ACT, two industry Research and Development Corporations, five universities and the NZ Department of Conservation. It commenced in 2017 and finishes in 2022.

The Invasive Animals Ltd.'s long term objective is to enable the Centre for Invasive Species Solutions (CISS) to be a service provider acting as a broker and catalyst to design and promote investment in, and management of, large-scale collaborative invasive species R&D, education and extension. Through scientific leadership and alliances, it aims to deliver ethical invasive species solutions to grow productivity, to help manage social and environmental threats in Australia and beyond.

The Company's principal activities during the year included the coordination and collaboration on a range of activities as agreed in Portfolio 1. The powerful 17 member and partner collaborative RD&E platform work to achieve system-level improvements and research impacts benefiting the end-user and/or broader community.

This year saw the implementation of further cloud-based technologies to improve efficiencies in the business systems and to add further rigour to the internal financial controls. This year also saw the execution of all Portfolio One projects, and the finalization of the Department of Agriculture funded White Paper Grants. Attendant funds flowed to research partners and regulatory authorities, such as the Australian Pesticides & Veterinary Medicines Authority and IP Australia. This engagement with regulatory bodies supported the establishment of the credentials required for on ground delivery of the technologies developed.

Performance of the Centre

The total combined resources available in 2019 was \$13,136,718 with cash revenue being \$7,723,950 and total In-kind contributions being \$5,412,768.

A significant multiplier resulted for the Commonwealth Department of Agriculture, as the anchor investor, from the 58% of overall contributions being received from State governments, RDC's and others.

FY 2019 Total Contributions

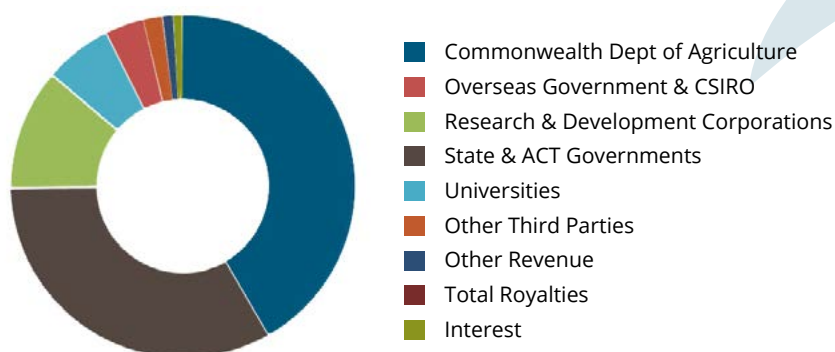
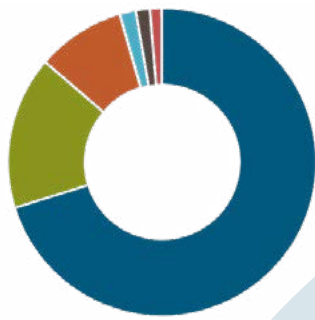


Chart 1: Financial year 2018-19 Total Contributions, both Cash and In-kind by revenue source.

The total net cash revenue of \$7,723,950 (total cash \$7,904,636 less c/f movement of \$180,685) included \$5,552,394 invested by the Commonwealth Department of Agriculture, with other members and partners also providing significant revenue: \$1,341,787 by Research and Development Corporations, \$736,362 by the States and Territories and \$159,725 by the NZ government and others.

FY 2019 Revenue



- Commonwealth Dept of Agriculture
- Overseas Government & CSIRO
- Research & Development Corporations
- State & ACT Governments
- Other Revenue
- Total Royalties*
- Interest

Chart 2: Financial year 2018-19 - Total cash received by revenue source.

*Total Royalties includes Pigout Royalties which are paid out annually to PAC CRC Participants.

The total In-kind contributions of \$5,412,768 for both Portfolio Agreement No. 1 and aligned projects was invested by the States and Territories, the universities and CSIRO.

2019 In-kind Contributions

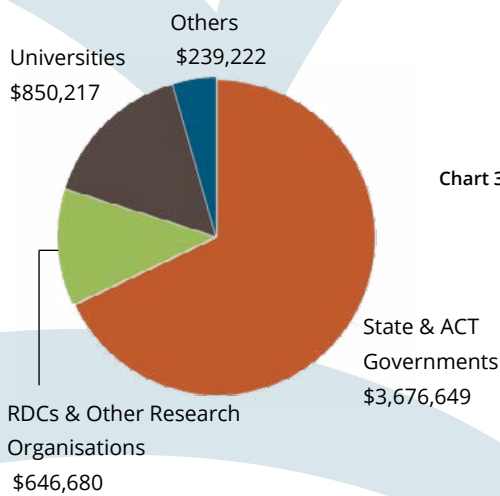


Chart 3: Financial year 2018-19 - Total In-kind Contributions received by organisations

FINANCIAL PERFORMANCE

The following Chart reflects, on a percentage basis, the expenditure allocation of the cash revenue received for the year.

With the finalisation, in 2018-19, of all project details it is anticipated that the allocation to research activity will also increase thereby increasing the overall percentage of funds allocated to Research Projects and decreasing the percentage allocation to other areas. This year an amount of \$5,247,536 was carried forward to future years.

Resources applied for 2019

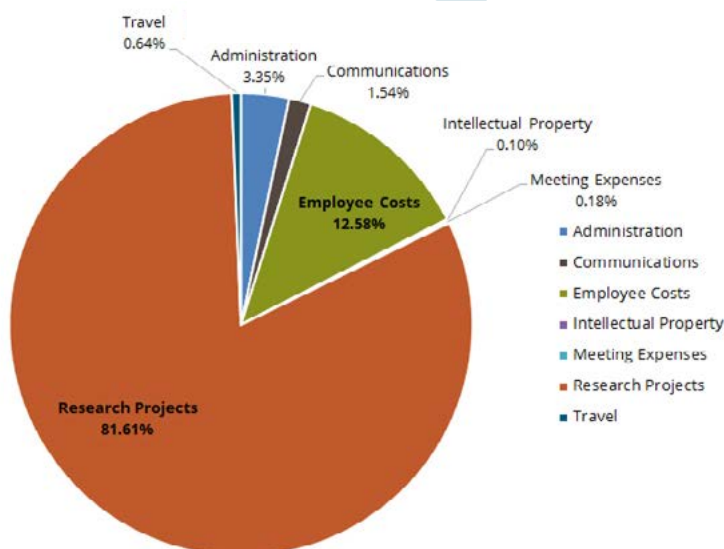


Chart 4: Financial year 2018-19 - Allocation of cash resources to expenditure by percentage ratio.

The positive financial position at June 2019 of \$7,559,727 represents sufficient cash flow to meet the liabilities of \$6,528,534.

The Centre's equity position at 30 June 2019 was \$1,181,928 an increase from \$1,038,230 at 30 June 2018.

Invasive Animals Limited Balance Sheet

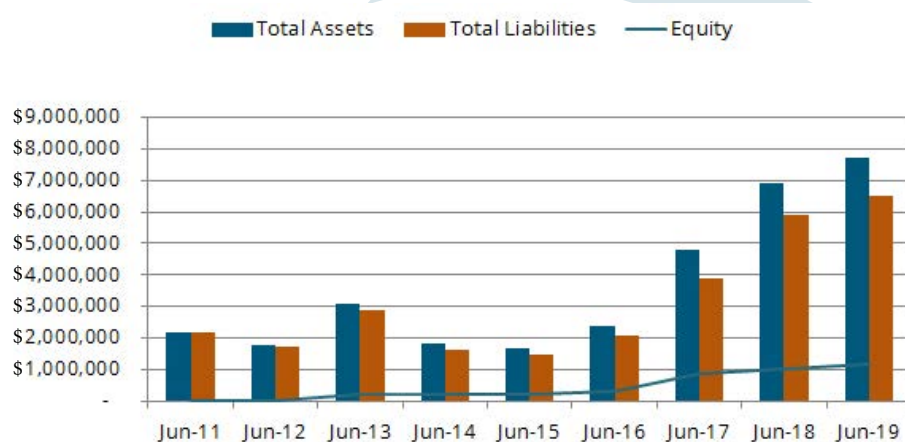


Chart 5: Financial year 2018-19 – IAL Company Balance Sheet reflecting Total Assets to Total Liabilities and resulting Equity (or Earnings) resulting.

Total Cash Reserve

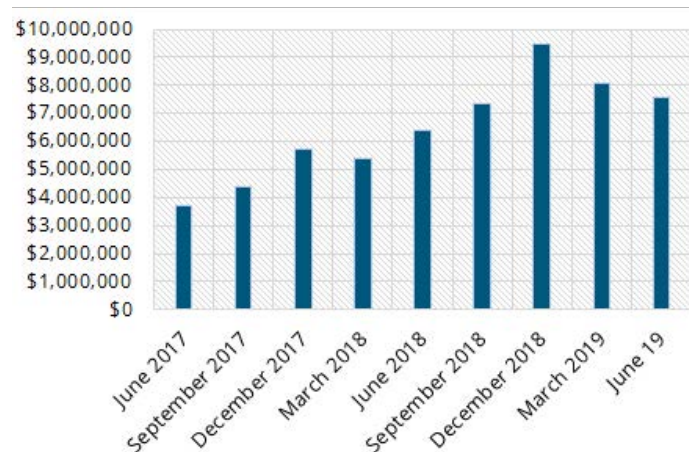
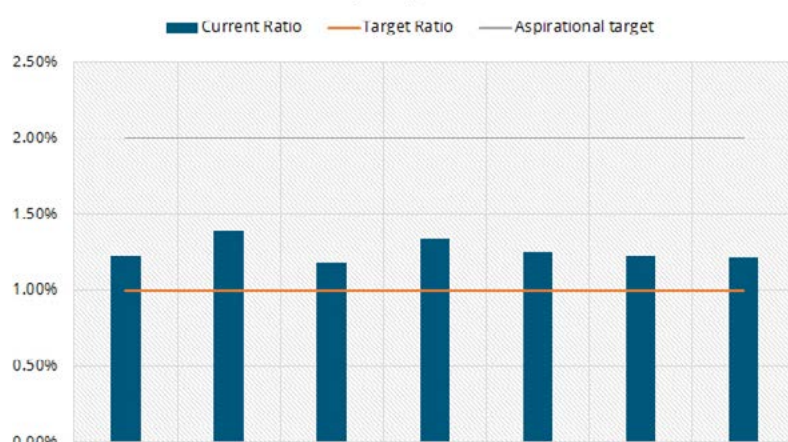


Chart 6: Financial year 2018-19 Total Cash Reserves for the IAL as a quarterly trend over time.

IAL Liquidity Ratio



The current asset ratio, (a measure of liquidity), for the year ended June 30, 2019 was 1.21

Chart 7: Financial year 2018-19 – IAL's Liquidity Ratio compared to the Commercial best practice benchmark.

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



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