CENTRE FOR
INVASIVE SPECIES SOLUTIONS

COLLABORATION | INNOVATION | IMPACT

2017–2018
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

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MESSAGE FROM THE CHAIR

The need for the Centre for Invasive Species Solutions (CISS) is even greater now than when it was conceived. Pests, weeds and other invasive species continue to cost Australia over $13.6 billion a year and every month there are new biosecurity challenges at our borders. CISS is the only national collaborative biosecurity RD&E organisation specifically established with the Australian and State governments, industry and CSIRO to replace the now closed biosecurity CRCs. As outlined by the recent review of the Intergovernmental Agreement on Biosecurity, the scale and complexity of the invasives challenge continues to demand this strong long-term cooperative approach.

We have done the hard but very constructive yards to set up CISS through full and exhaustive consultation to ensure that all stakeholders have had input. The result of this considerable investment by Invasive Animals Ltd, government and industry is a trusted centre that enables agile and efficient operations, as well as smart leveraged investment underpinned with solid relationships and extensive networks. This translates into the capacity for robust large-scale collaboration that secures sound pipeline strategies to combat invasives in the agricultural and environmental sectors and our border.

Launching the CISS Portfolio No.1 at Parliament House this year with strong support from NFF, the Invasive Species Council, and Commodity Councils as well as our Members and Partners, CISS demonstrated the efficiencies and effectiveness of the new CISS Portfolio Hub model. Now the Weeds Portfolio No.2 is under development taking advantage of and expanding these efficiencies and effective synergies. Most importantly, the CISS and its Portfolio Hub model supports and builds the extremely valuable collaborative network of elite researchers who create the innovative and transformational solutions.

CISS has clear strategic priorities and key performance indicators outlined in the Centre for Invasive Species Solutions Strategy 2017 – 2022 and I commend the Strategy to you.

Collaborative governance is a key strategy of our new Centre. CISS is robustly governed through a not-for-profit company limited by guarantee. The CISS Constitution was collaboratively written with Members, and we have strong and well documented governance systems. We have added a Research Excellence Committee to our Board sub committees of Audit & Risk and Governance & Remuneration. Our collaborative governance model now includes the new Members Committee, which approves the CISS Portfolios following close consultation with Partners. We have a strong independent skills-based Board and a highly skilled and dedicated management leadership team. Included in our membership are the Australian & State governments, Meat & Livestock Australia and CSIRO; currently our additional partners are Australian Wool Innovation, the Universities of Adelaide, Canberra, La Trobe, Murdoch, & New England plus the NZ Dept. of Conservation. CISS is also well supported by national and state agricultural groups and key conservation NGO's. This is an excellent base on which to build solid success.

After working in the invasives sector for several decades it is very satisfying for me as a landholder and IAL Chair to now see as the 'norm' government, industry and conservation working hand in glove toward achieving the common goal of great biosecurity. Whichever way you look at it, the future of invasive species RD&E is extremely well served by CISS.

The evolution of CISS has seen some major partnership changes. We welcome Meat & Livestock Australia as a Member and recognise its important role in helping to shape the CISS future. We also thank the IA CRC Essential Participants that are moving to a more flexible arrangement: Animal Control Technologies Australia and the Universities of Queensland and Newcastle. We look forward to collaborating with them in the future.

On behalf of the IAL Board our sincere thanks go to the tenacious CISS Management team led by Andreas, who all kept a strong focus throughout the protracted negotiations to ensure that contracts were executed and CISS became operational. The dedication of this team was integral in the establishment of CISS.

My sincere thanks to the IAL Board for their support during the year and their probing discussions to always bring the best outcome forward.

On behalf of the IAL Board our sincere thanks also to everyone who has assisted in achieving this mammoth goal and we now invite you to participate in the next stage of CISS's evolution.

The Board clearly sees that to counter the growing $13.6 billion invasives impact, CISS must be secured as the permanent institution to efficiently broker and manage strategic, large-scale collaborative invasive species RD&E with at least a 10 year funding commitment. If we just sit on the current invasives capacity and capability scenario, in a short time the devastating impact of invasives will take off again. Australia's biosecurity must not be compromised.

Helen Cathles

Chair
Invasive Animals Limited

Helen Cathles with the Hon David Littleproud MP, Federal Minister for Agriculture and Water Resources, Fiona Simson, President of the National Farmers Federation, and Andrew Cox, CEO of the Invasive Species Council, at the CISS portfolio launch at Parliament House

OUR MEMBERS AND PARTNERS

Members

Australian Government
Department of Agriculture and Water Resources

ACT Government

CSIRO

mla
MEAT & LIVESTOCK AUSTRALIA

NSW GOVERNMENT

Queensland Government

Government of South Australia

Tasmanian Government

VICTORIA
State Government

GOVERNMENT OF WESTERN AUSTRALIA

Partners

THE UNIVERSITY of ADELAIDE

awi Australian Wool Innovation Limited

UNIVERSITY OF CANBERRA

Department of Conservation
Te Papa Atawhai

LA TROBE UNIVERSITY

Murdoch UNIVERSITY

une University of New England


CENTRE FOR
INVASIVE SPECIES SOLUTIONS

Economic Losses to Agriculture

PROBLEM

$216 million per year

Rabbits

are Australia's most costly environmental and agricultural vertebrate pest

$89 million per year

Wild Dogs

attack livestock causing stock and financial losses, as well as spread of disease

$28 million per year

Foxes

prey on young sheep causing significant stock and financial losses

$14 million per year

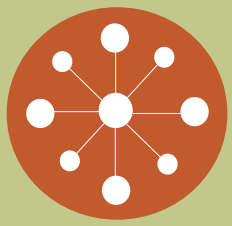
Feral pigs

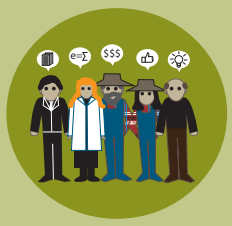
cause agricultural damage and compete with stock for feed

34 Research and Innovation Projects

in the 2017/18 Financial Year

SOLUTION





INCURSIONS	LANDSCAPE MANAGEMENT	BIOCONTROL	MANAGEMENT TOOLS	COMMUNITY ENGAGEMENT
5	6	4	1	5
	1	2	9	1

PORTFOLIO PROJECTS

OTHER PROJECTS

Decreasing Invasive Species Impact

Impact on Native Threatened Species

322
threatened species impacted by
EUROPEAN RABBITS

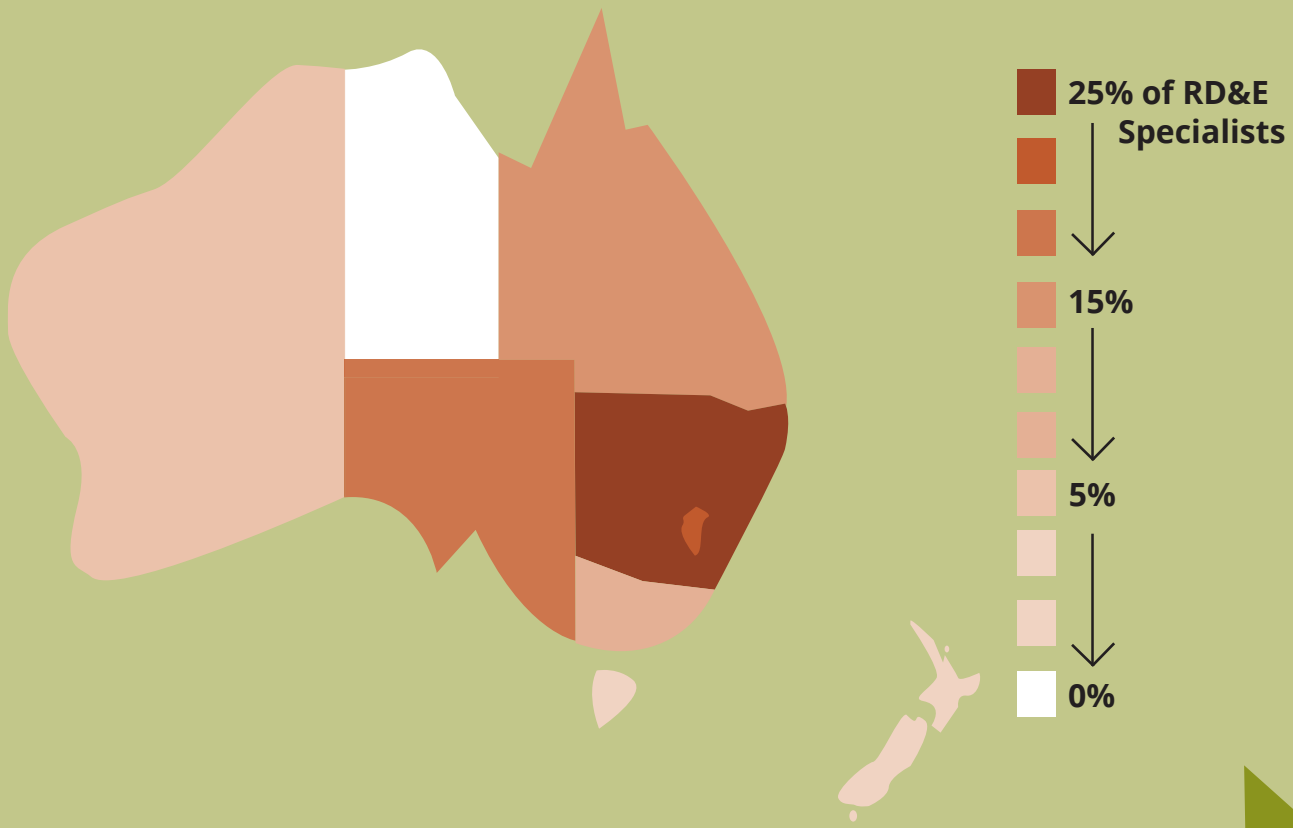
79
threatened species impacted by
WILD DOGS

149
threatened species impacted by
FERAL PIGS

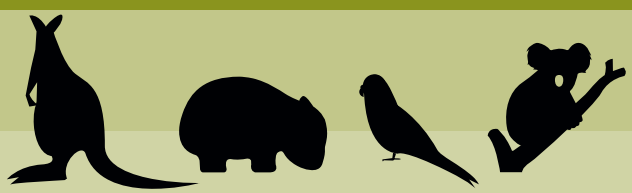
95
threatened species impacted by
FOXES

123
threatened species impacted by
FERAL CATS

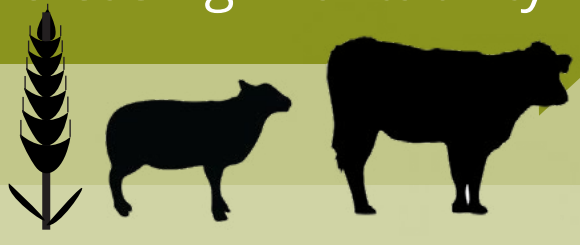
Mobilised Over 100 RD&E Specialists



Enhancing Biodiversity



Increasing Profitability



CEO SNAPSHOT

This has been a watershed year for our new Centre. The launch of our new Centre and its first vertebrate pest focused project portfolio has brought 17 government, industry and research partners together into a powerful and unique collaboration. As only one of 15 out of 180 Cooperative Research Centres that have successfully transitioned – and indeed the only biosecurity CRC to do so – we have been able to maintain the momentum, scale and capability to develop the knowledge and innovation to assist future-proof the National Biosecurity System.

To be successful will require Australia to rapidly evolve our current biosecurity research and innovation system into one that is better networked, collaborative and able to synergise and transfer learnings and innovations within and across different media – terrestrial, freshwater and marine. Large-scale collaborations supported for the right time-frames needed to deliver and encourage adoption of transformational new technologies or best practice management are integral to this future-proofing challenge.

The new Centre is implementing this approach by bringing our members and partners together to:

- form Australia's largest deer research and management collaboration
- drive our 20 year rabbit biocontrol research and innovation pipeline forward
- develop a national incursions response framework underpinned by new detection technologies.

Our key achievements for the year are summarised on the following pages. For a first start up year the results are impressive. Our new legal and management foundations have been put in place and I would like to especially thank our new Member based Domain leaders: Drs John Virtue, Brad Page, Tony Pople and Tanja Strive, as well as the CISS management team for their work in getting our project portfolio up and running.

Our achievements include working to frame a 10 year weeds RD&E plan with stakeholders, with the intent that it will catalyse future investment from governments, industry and research providers into our second collaborative project portfolio. With the impact of weeds to agriculture alone costed at well north of $4 billion a year, huge impacts on our biodiversity and a new weed establishing in Australia every 18 days, Australia urgently needs to move beyond the boom-bust investment model that characterises too much of the biosecurity research and innovation space.

The Centre portfolio hub model offers a smart, efficient way forward.

With Portfolio One now underway, I commend our Annual Report to you.

Andreas Glanznig

Chief Executive Officer
Centre for Invasive Species Solutions

Andreas Glanznig presents at the CISS Forum on 24 November, 2017

KEY ACHIEVEMENTS

July 2017

Invasive Animals CRC becomes Centre for Invasive Species Solutions

August 2017

HogGone registration package submitted to APVMA

Australian Pest Animal Strategy 2017-2027 and Australian Weed Strategy 2017-2027 published by Australian Government

September 2017

Centre officially launched by Minister for Agriculture and Water Resources

The Hon. Barnaby Joyce MP

MEDIA RELEASE

Deputy Prime Minister

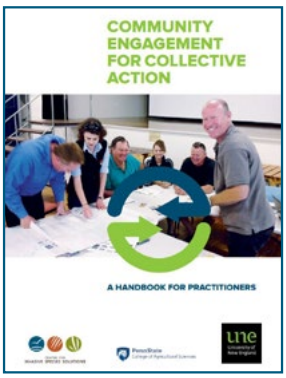
Minister for Agriculture and Water Resources

October 2017

Appointment of Portfolio Innovation Domain leaders and establishment of the Research Management Leadership Team to oversee the management of Portfolio One

February 2018

Community Engagement for Collective Action - A Handbook for Practitioners published



March 2018

One year since the release of RHDV1 K5 – all national and state coordinators get together for a workshop to report on learnings

April 2018

Released discussion document to shape a 10-year investment plan for weeds RD&E

May 2018

Conducted a national workshop to initiate drafting of a 10-Year Investment Plan for Weeds RD&E

November 2017

New Centre website goes live

December 2017

First phase of prototype testing of Wild Dog Alert completed with successful results

PestSmart website reaches more than 1,000,000 page views since going live in March 2015

January 2018

Important paper published outlining the role of RHDV2 in the Australian landscape

June 2018

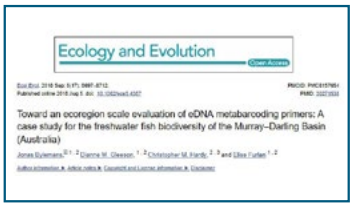
All member and partner delegated representatives sign off on Portfolio Agreement One

Appointment of CISS representatives onto the Environment and Invasives Committee vertebrate pests, weeds and invertebrates Working Groups

July 2018

August 2018

eDNA research progresses toward ecoregion scale evaluation



September 2018

Exposure draft of weeds RD&E Investment Plan released

Centre's first RD&E Portfolio officially launched at Parliament House

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 and Genetic Technologies
4. Management Systems and Tools
5. Community Engagement, Extension and Education

TESTIMONIALS

"In agriculture we often talk about how people don't collaborate very much, and don't work together and how many times I think that we work in silence. **What a great example here of how, not just agricultural industry but also the research and government sector has collaborated to form this wonderful centre** and to launch this first portfolio of projects now, that are going to make a real difference on what people do on farms."

Fiona Simson
President
National Farmers Federation

Launch of CISS Portfolio No. 1, 18 September 2018, Parliament House, Canberra

"**National research collaboration works**. The CISS's predecessors, the multiple pest-focused CRC's have proven that, and I really congratulate them for that successful transition to the model of a stand-alone body. **We hope that it becomes a permanent body**.

...the Centre for Invasive Species Solutions is now well positioned to deliver a big part of that challenge for the [IGAB Review] recommendations. The work of vertebrate pests research can continue, but it can broaden it's brief ... and already we're seeing that the task of developing the research and development investment plan for weeds is well underway, so that's very promising. There's plenty of research needs for environmental biosecurity, which the Review says is desperately needed."

Andrew Cox
CEO
Invasive Species Council

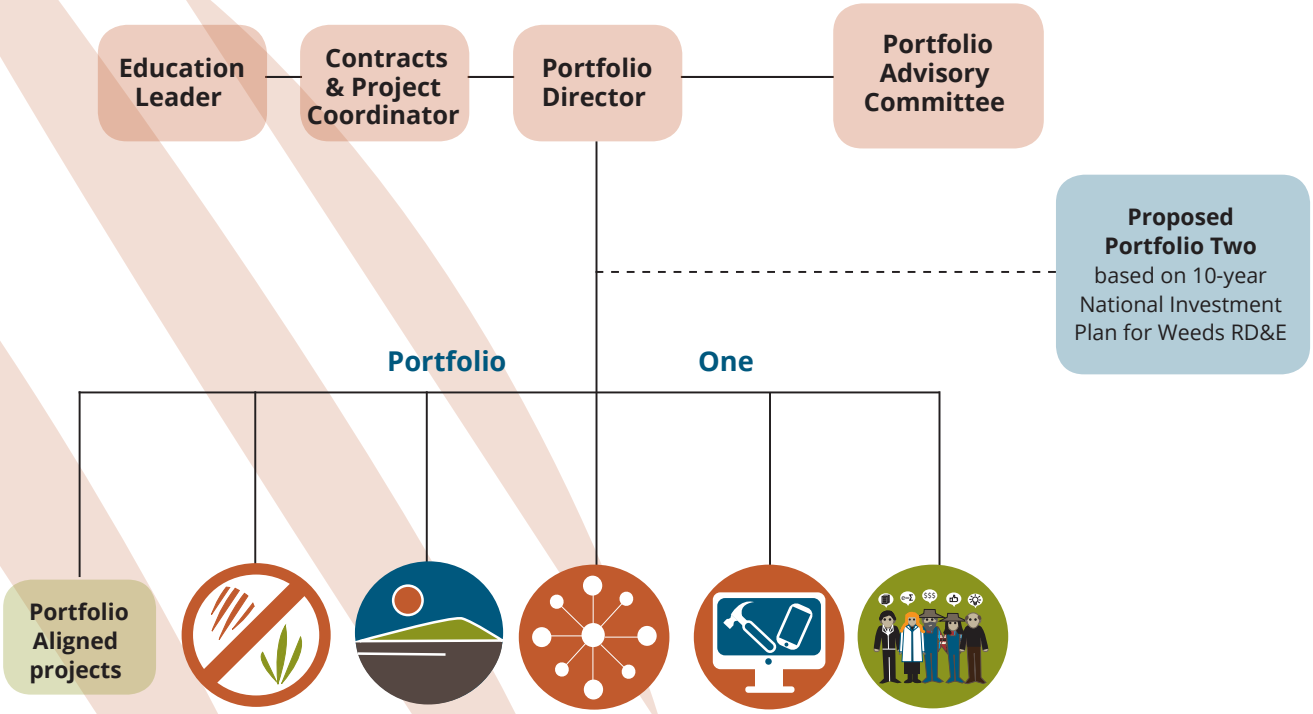
Launch of CISS Portfolio No. 1, 18 September 2018, Parliament House, Canberra

"Invasive species are exerting the greatest pressure on biodiversity. **A collaborative approach is necessary** to address this threat."

Ian Thompson
Chief Environmental Biosecurity Officer
Department of Agriculture and Water Resources

Environmental Biosecurity Roundtable 2, 9 October 2018, The Edge, Brisbane

OUR RESEARCH AND INNOVATION



Our Centre currently has 34 research and innovation projects. These either fit under the Portfolio One project portfolio, or are aligned with portfolio projects but funded through other external grants.

All 34 projects address a national biosecurity RD&E priority and or a national RD&E priority for invasive plants and animals.

The Project Portfolio has:

- 5 innovation domains
- 21 research and innovation projects
- 25 contributing research member, partner, and third party organisations
- >100 RD&E specialists mobilised across Australia

Innovation Domain 1:

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

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

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

There are an additional 13 research and innovation projects led through the Centre funded primarily through the agricultural white paper which are focused on developing new tools and innovation for on farm use to enhance agricultural productivity – these projects are within green boxes.

Maintaining the momentum

Environmental DNA freshwater vertebrate research continues with testing of real-time detection techniques, and new species identification

National Incursions Management Framework being developed

Rabbit biocontrol pipeline progresses with two new national projects

Landscape scale wild dog management research continues

Peri-urban wild dog control research builds on outcomes from previous research

National wild dog management project capability extended

PestSmart and FeralScan digital platforms being upgraded

Behaviour change research focused on enhancing wild dog management programs

Balanced Researcher Program continues with a new cohort of PhD candidates

New RD&E innovation

Understanding the illegal trade of non-native species

Australia's largest deer research and management collaboration with 13 project partners across 4 innovative projects

New tools for surveillance and eradication to improve cost-effectiveness of incursion management

Invasive species gene drive technology business case in development

Tilapia biocontrol prospecting

On the horizon

Centre specific weeds RD&E investment plan in development

Environmental biosecurity RD&E coordination work in the pipeline

DOMAIN 1: INCURSIONS

Australia faces a new wave of vertebrate pest threats, arising from illegal importation and keeping, escape from legal keeping, and as hitchhikers in the international movement of goods and people.

The Centre's Incursions Domain currently consists of five projects which are developing new and innovative detection and surveillance techniques, along with management strategies to ensure we protect Australia's environment and our $60 billion+ agricultural industry from new pest threats.

The Incursions Domain is led by Dr John Virtue and Dr Brad Page from Primary Industries and Regions South Australia.

HIGH LEVEL OUTCOME AND IMPACT	INTERMEDIARY OUTCOME	HIGH LEVEL OUTPUT
Protection of Australia's economy, environment and social amenity from the impacts of new pest animals	Jurisdictions, industry and the community are routinely working together to protect Australia from border and post-border incursions	A National Incursion Management Framework for Invasive Species
	Effective interventions are in place nationally for key international and domestic pathways of new pest animals	Understanding of and intervention in illegal trade in non-native species
	Incursions of new pest animals are detected through an ongoing national surveillance network in time to mount feasible responses	Integrated passive and active surveillance tools and networks
		Real time eDNA tools to improve early detection and response approaches for high risk pest animals
	New pest animal incursions of national significance are subject to successful eradication programs	Tools for cost-effective decisions for vertebrate pest eradications

Development of a National Incursion Management Framework for invasive species

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 snapshot: 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 snapshot: 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 snapshot: 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 snapshot: This project aims to develop an enhanced detection method for auqatic 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 snapshot: 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.

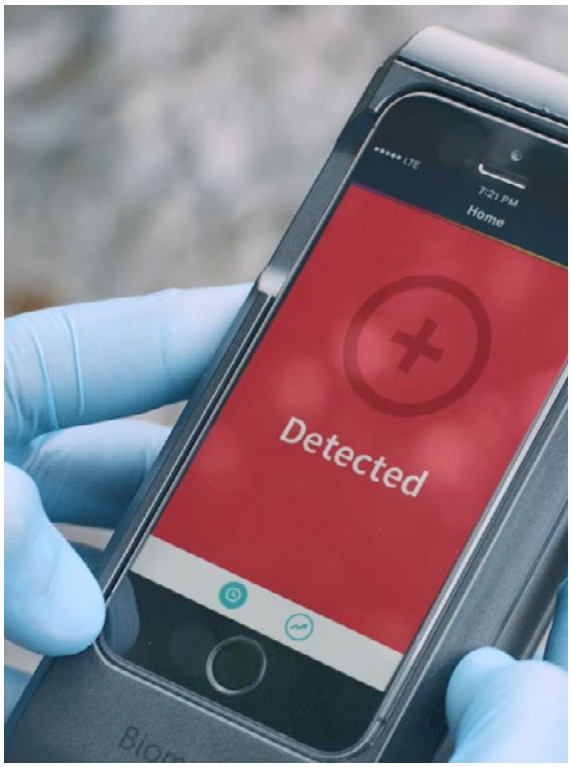
Image supplied by University of Canberra

Domain progress overview:

With increasing shipping, tourism and online trade there are higher risks of entry, illegal keeping and escape of new vertebrate pests. The Incursions Domain seeks to develop tools and procedures to help government, industry and community stakeholders to prevent, detect and respond to incursions of new pest animals in Australia. The Domain has five, inter-related projects encompassing various collaborations between government biosecurity agencies, universities and CSIRO.

An emergency management framework is being developed for the Environment and Invasives Committee to guide responses to incursions of new invasive species at the national, state/territory and regional levels. With a running title of 'InvasivesPlan', the intent is that the framework will be populated with various guidelines, manuals, procedures and templates over time to have the same functionality as AUSVETPLAN and PLANTPLAN which are used nationally for animal and plant health emergencies respectively.

An understanding of the extent of illegal trade in exotic animals in Australia and how to monitor this for compliance purposes is needed to address a significant pathway of new pest introductions. Led by University of Adelaide, a PhD student commenced on the topic 'Mitigating Invasive Species Risk: Analysis of the Legal and Illegal Wildlife Trade'.

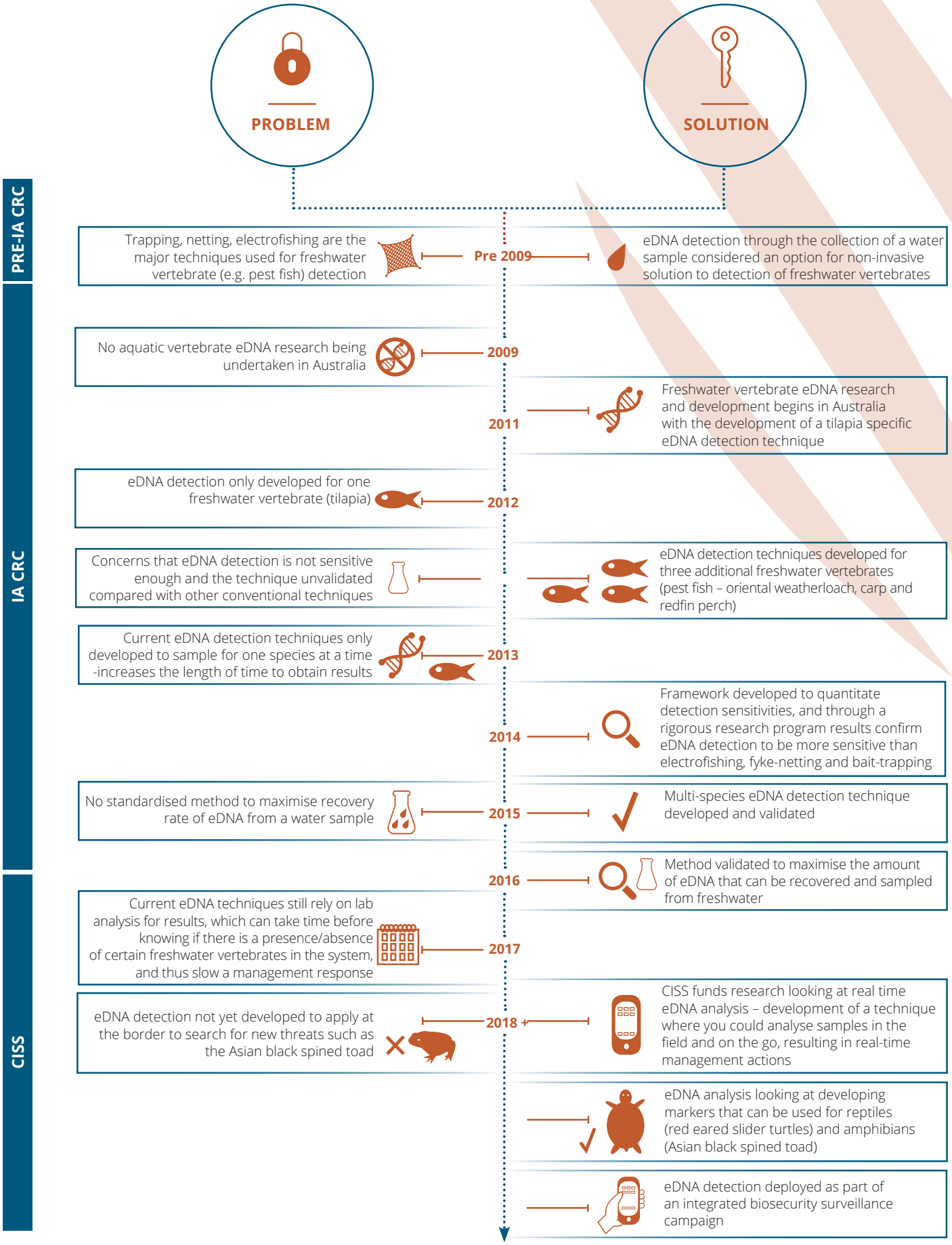


University of Canberra researchers are assessing the viability of realtime eDNA detection of pest fish and incursion threats. Image supplied through Biomeme

Work is underway to further develop and expand the use of eDNA detection technologies for routine use in biosecurity applications. Led by the University of Canberra, the project will develop new tests for targeted high-risk invasive species with an initial focus on the red eared slider turtle and Asian spined toad. The long-term aim is to have real-time technology that can be used operationally in situ for the early detection in water bodies of a wide range of aquatic pest threats (see the innovation pipeline).

The red eared slider turtle would be a major environmental threat if it was to establish in our waterways, image by Dr Pablo Garcia-Diaz

Australian freshwater vertebrates eDNA innovation pipeline. Achieving smarter, faster and cheaper surveillance methods.



DOMAIN 2: INTEGRATED LANDSCAPE MANAGEMENT

Established vertebrate pests continue to cause considerable impact to Australia's agricultural industries, the environment and the well-being of its communities. Our Integrated Landscape Management Domain has six projects aimed at developing our knowledge of pest animal management (specifically wild dogs and feral deer) and develop strategies which are solutions-orientated and provide direct benefits to farmers on-ground and protect our environment. The Domain also includes one portfolio-aligned project focused on feral-predator management aimed at recovering the Mt Hope endangered malleefowl population.

The Integrated Landscape management Domain Integrated Landscape Management Domain is led by Dr Tony Pople from the Queensland Department of Agriculture and Fisheries.

HIGH LEVEL OUTCOME AND IMPACT	INTERMEDIARY OUTCOME	HIGH LEVEL OUTPUT
Reduction in the economic, environmental and social costs associated with invasive species through development and demonstration of large-scale integrated management strategies	The role of wild deer in a potential exotic disease outbreak and the risk to livestock are understood	Documentation of the role of wild deer in the transmission of diseases of livestock
	Cost-effective methods and strategies are understood for managing wild deer in a range of environments	Best practices for cost-effective management of wild deer
	Cost-effective strategies are in place for managing pest animals specifically in peri-urban environments	Best practices for the management of wild dog and deer in peri-urban landscapes
	Wild dogs, foxes and cats reduced to low abundances in a range of environments, increasing livestock production and biodiversity benefits	Best practices for the management of wild dogs on agricultural land
	Re-established and maintained biodiversity in a range of environments following invasive predator management	Demonstration of the biodiversity and productivity gains from wild dog management
	Financially-sound investment decisions are made by landholders and government on exclusion fencing	Demonstration of the economic and productivity gains from cluster fencing

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 snapshot: 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.

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 snapshot: 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-urbans areas of Australia.

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 snapshot: 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.

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 snapshot: 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.

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 snapshot: 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 snapshot: 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.

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 snapshot: 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.

Indigenous rangers are repairing and replacing 264km worth of fenceline in Western Australia, image supplied by Barry Davies (WA DPIRD)

Domain progress overview:

Wild deer management

Two projects concentrate on developing cost-effective management strategies for the five increasing and expanding deer species. Projects collect data alongside deer control undertaken by land managers such as Local Government, NRM groups, Local Land Services and landholders. In north Queensland, aerial culling of chital deer populations has been monitored on a number of properties using aerial and ground survey. Abundance estimates are required to evaluate control effectiveness (e.g. proportion removed) and recovery time as well as the relationship between control costs and deer density. The humaneness of culling has also been assessed. Similar work has been undertaken on fallow deer populations in central and northern NSW. Additional funding has been received to support the aerial surveys. Samples (blood and sera) from culled deer are being collected for the project on disease transmission from deer (see below).

Peri-urban and indeed urban deer populations (mostly rusa) are being monitored in Wollongong and southeast Queensland (SEQ) as part of our deer work. Over 30 transects, where pellet density is recorded, were established in the Wollongong local government area in 2012. These were sampled in April 2018 allowing trends in the deer population to be determined. The trend data will be related to control activities and aspects of the environment.

The risk posed by deer to the livestock industry as hosts for exotic disease is being investigated and field surveys involving pellet counts and camera deployment were undertaken in March and May 2018. Laboratory work has commenced using samples collected in Victoria, NSW and Queensland and a PhD candidate has enrolled with LaTrobe University to take on aspects of this research work.

Wild dog management

Our projects in wild dog management span broad-scale baiting (rural NSW), cluster fencing (rural Qld, WA and NSW) and peri-urban (Qld, NSW and ACT). Research questions and study sites are being finalised in discussion with local government collaborators. Data on wild dog movements from the previous IA CRC projects are being used in modelling to determine optimal placement of control tools such as ejectors and traps.

For the Western Australian component of the cluster fencing work, research questions and experimental designs have been refined for PhD projects. Projects have been advertised and six international students have been interviewed. An honours student is undertaking a project comparing different methods of camera trapping to monitor wild dog and kangaroo activity. Results indicate camera position and image detection method (time lapse/motion sensing) influence detection of both species. This study provides a pre-fencing baseline on one study property.

For the Queensland cluster fencing work, the wildlife monitoring of both Tambo and Morven clusters has continued with three assessments done annually. Monitoring has already recorded valuable contrasts, such as a markedly stronger decline in dog activity on the Morven cluster than on the Tambo cluster. Monitoring has been undertaken inside and outside clusters, but in 2018 monitoring of wildlife on properties 'outside' the Morven cluster has been discontinued.

Vegetation surveys have continued on the Morven and Tambo clusters. The results for ground cover have been compared with values obtained from online VegMachine and FORAGE systems for a subset of the sites. These initial comparisons suggest that the cover estimates from FORAGE are more similar to the observations than the estimates from VegMachine. FORAGE is a modelling system whereas VegMachine is based on analysis of remotely sensed data.

The Preparation for RESET project (Prep4Reset) is drawing on the successes and research results of previous work undertaken in north- eastern NSW under the IA CRC. To date, the Prep4Reset project has facilitated funding and stakeholder networks, the collation and preliminary analyses of wild dog movement behaviour and control efficacy data, and the predictive economic analyses that are essential for initiating the full RESET, Rebuild, Restore project. The full RESET management intervention will use integrated predator control in an experimental framework to nationally demonstrate the livestock and wildlife benefits of landscape-scale predator management and so far has the support of the National Wild Dog Action Plan, NSW DPI, Local Lands Services, NSW National Parks and Wildlife Service, Australian Wool Innovation and Meat and Livestock Australia.

Mt Hope Malleefowl Recovery

Over 50,000 hectares have been actively managed for foxes on an ongoing basis to minimise malleefowl predation. Pulsed meat baiting was undertaken in conjunction with the Mount Hope Pest Management Group to ensure regional coverage. Ongoing management of fox populations is undertaken using Canid Pest Ejectors checked and refreshed monthly. A subset of malleefowl nests have been visited and measured to determine if breeding is occurring. The local community has been engaged with the project through regular discussions and a community meeting.

Australia's largest research collaboration established to tackle feral deer

To tackle the escalating threat of feral deer, the Centre has brought together five state and territory governments, three local councils, three universities, and three private environmental groups to form Australia's largest deer management research collaboration.

This large-scale collaboration was formed following a National Workshop on Deer Management held in late 2016, where participants identified a number of knowledge and innovation priorities that must be addressed to more effectively manage this emerging national issue.

This collaboration underscores the important role of the Centre in fostering nationally coordinated approaches to developing better solutions for invasive species problems.

The collaboration has the support from industry, with Danny Picker, farmer and President of the Australian Superfine Woolgrowers' Association, voicing his support for this collaboration:

"There are six known species of feral deer in Australia, and all states and territories have at least one of these species – it truly is a national issue, which requires this national collaboration to find the answers.

"We are hearing more and more of the damage deer are doing to our agricultural sector and the environment, not just in rural areas but in urban areas too.

"Through this collaboration, we have a real chance to tackle feral deer before they do any more significant damage and the problem becomes out of control," Mr Picker said.

Wild deer can cause death to trees due to ringbarking, image by James Gummer

DOMAIN 3: BIOCONTROL

Classical biological control of vertebrate pests using self-disseminating viral agents has served Australia well as the basis of cost-effective continental scale management, particularly for rabbit management. The Centre has two new major projects which will continue to implement our collaborative 20-year rabbit biocontrol pipeline. However, we are also looking at new areas such as a potential biocontrol option for tilapia management and the possibility of using new genetic technologies for pest animal management.

The Biocontrol domain is led by Dr Tanja Strive from CSIRO.

HIGH LEVEL OUTCOME AND IMPACT	INTERMEDIARY OUTCOME	HIGH LEVEL OUTPUT
Sustainable reduction of the impacts of established pest animals	Biocontrol tools pipeline progressed for long term sustainable rabbit management beyond the release of RHDV1 K5	Strengthened pipeline of new rabbit biocontrols from within Australia and (if available) internationally, including progressing registration of RHDV2
		Increased social acceptance of rabbit biocontrol by supporting the development of a multivalent vaccine
		Scoped potential to use Eimeria spp. to control rabbits in eastern Australia
	Maximised effectiveness of rabbit biocontrol based on understanding interactions between co-circulating viruses and resulting development of improved applications	Increased and extended impacts of existing biocontrol agents by implementing new application strategies
	Biocontrol tools strategies in place for long term aquatic pest management	Assessment of the prospects for and costs of Tilapia biocontrol
	Assessment of the real potential, priorities for and risks of gene drive technology for invasive species control in Australia	Business decision system to prioritise vertebrate pest species suitable for gene drive population control technology

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 snapshot: 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 years 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.

Rabbit parasites – additional biocontrol agents

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 and Water Resources

Project snapshot: This project uses 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 will confirm their presence in WA and confirming their absence at selected sites in eastern Australia will inform the potential to use these parasites to control rabbits at these locations.

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 snapshot: 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)

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 RHDV1 from South Korea (referred to as RHDV1 K5) that was suitable for release into Australia's rabbit population. RHDV1 K5 has been shown to better overcome the protective effects of the endemic benign virus RCV-A1 amongst the strains tested. This project is an extension of the original RHD Boost project funded through the IA CRC, which allowed the broad-scale release of RHDV1 K5 into the Australian rabbit population to be more effectively monitored, analysed and enhanced.

Tilapia biocontrol: prospecting and evaluation

Project leader: to be determined

Project partners: Queensland Department of Agriculture and Fisheries, CSIRO

Project snapshot: 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.

Genetic technologies for pest animal control – developing a priority framework

Project leader: Dr Mark Tizard | CSIRO

Project partners: CSIRO, Western Australian Department of Primary Industries and Regional Development, Western Australian Department of Biodiversity, Conservation and Attractions

Project snapshot: A powerful new technology called 'gene drive' overcomes 50/50 inheritance by fully duplicating itself during sexual reproduction, ultimately pushing itself into every member of a pest population. It works in mosquitos but will it work in vertebrates (mice, rats, carp)? This project builds a framework to assess the knowledge gaps that currently exist, the feasibility and a means to prioritise gene drive in our efforts to control vertebrate pest animals.

Domain progress overview:

Much of the work carried out for the Biocontrol Domain in 2017-18 was preparatory in nature, as most projects commenced after July 2018.

Previous work funded through the IA CRC and the Agricultural Competitiveness White Paper Initiative strongly influenced the composition of the CISS Biocontrol Domain, which aims to strengthen long term sustainable biocontrol pipelines and strategies.

As part of the agricultural white paper, funded project, the RHDV1 K5 virus was released across 373 sites and subsequent monitoring then showed a national rabbit population decline of 36% at community release sites. It also re-established the conversation around rabbit management and best practice and involving the community in a national pest management program. The final project report including the full analysis of data, is due for delivery in the first half of 2019.

Another project is assessing the potential of rabbit Eimeria parasites as posible biocontrol agents. Rabbit faecal and tissue samples were collected from 24 locations. Eimeria strains have been detected during the initial analysis of samples from WA and SA and a genomic analysis method has been successfully established and being progressed to further identify the potential of these Eimeria strains as biocontrol agents.

As part of Portfolio One, two new substantial rabbit biocontrol projects within this Domain will build on the legacy of the national rabbit monitoring network. The appearance of the RHDV2 virus poses both challenges and opportunities. Consequently, the Centre's two new projects are road-testing this new virus through a combination of experimental and broad scale epidemiological studies for its suitability as an additional legally registered viral biocontrol agent.

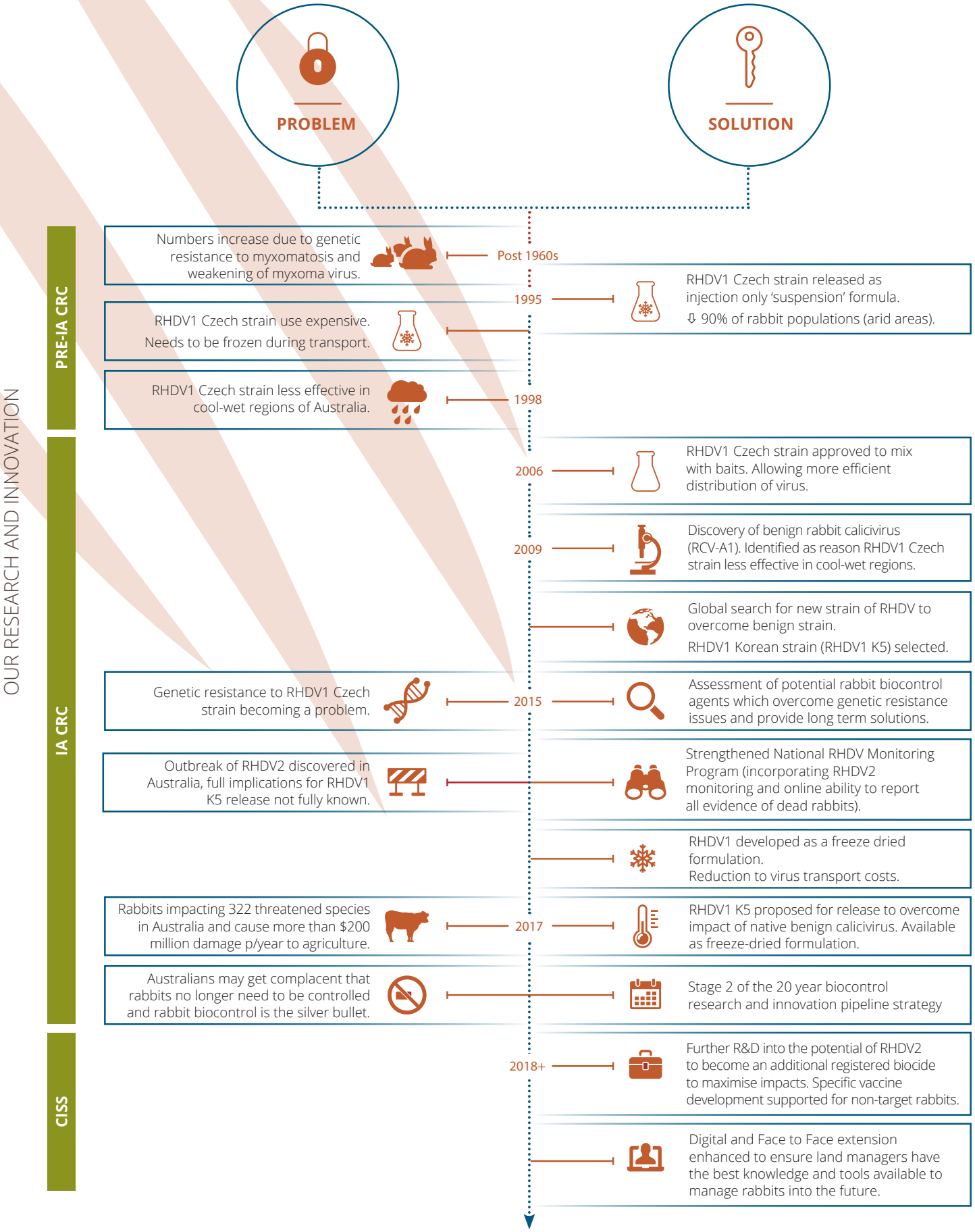
As part of these projects ongoing regular collection of rabbit (and fly) samples at several of the long-term rabbit monitoring sites (in SA and the ACT) have continued seamlessly in the transition phase between previous rabbit projects and the commencement of the CISS rabbit work. Similarly, the diagnostic testing of rabbit samples submitted through RabbitScan and by direct submissions and monthly reporting of what diseases kill rabbits where in Australia has continued without interruption during the transition phase into the CISS funded rabbit biocontrol projects.

The freshwater component of the Biocontrol Domain similarly builds on previous work supported by the IA CRC. Biological control of carp using the herpesvirus CyHV-3 has been developed and a decision for a national release is currently under consideration. Asking the question if similar approaches could be used for other invasive freshwater species such as Tilapia, the Centre's Biocontrol Domain is supporting a scoping study/business case assessing the suitability of Tilapia Lake Virus (TLV) as a potential second viral biocontrol for a freshwater fish pest. Throughout 2017-18, project partners worked through the feasibility of building on a partnership with Israeli researchers doing similar work in Tel Aviv, adding Oreochromis mossambicus in their experiments. This would have negated the need to import the virus to Australia for initial challenge testing. Unfortunately this approach has not come to fruition. Alternative approaches are currently being investigated.

Other work in the Biocontrol Domain is keeping the Centre's finger on the pulse of recent potentially transformational scientific developments. There is currently an active global debate about the potential use of new revolutionary genetic approaches (such as gene drives), regarding their potential for the humane control of overabundant pest animals as well as the potential risks associated with these technologies. In addition to the challenging technical development, the public acceptability and regulatory pathway to delivery of gene technology solutions is also by necessity very long. The CISS genetic technologies business case is a stakeholder engagement project that enables CISS to serve as a hub to progress consideration for the potential application of emerging genetic technologies, such as gene drives, for vertebrate pest management. Throughout 2017-18, the project has been refined in preparation for a start in the new financial year.

A returned gut and faceal sampling kit as part of the Rabbit Parisite Project, collected by Senior Ranger Robert Sleep, of the South Australian Department of Environment and Water in the Nullabor Plains. Image by David Peacock

Rabbit biocontrol innovation pipeline.
Achieving sustainable landscape scale rabbit management.



A Parks and Wildlife Officer from WA releases RHDV1 K5 baits at the Cape Range National Park, image by Heather Barnes

DOMAIN 4: MANAGEMENT SYSTEMS AND TOOLS

In our Management Systems and Tools Domain we currently have one project funded through Portfolio One, however there are a number of projects funded through other external grants such as the Agricultural Competitiveness White Paper which also feed into this Domain. This includes our innovation in wild dog e-technology trapping and surveillance, aswell as new feral pig baits.

The Domain is overseen by Associate Professor Richard Price from the Centre for Invasive Species Solutions.

HIGH LEVEL OUTCOME AND IMPACT	INTERMEDIARY OUTCOME	HIGH LEVEL OUTPUT
Optimal cost-effective pest management through new tools and systems	Reduced impact costs of deer through the development of novel methods for aggregating deer for effective control and management	Development of new tools and technologies for detecting and managing deer
	Reduced impact costs of wild dogs through the development of novel surveillance methods and effective control and management	Development of new tools and technologies for detecting and managing wild dogs
	Reduced impact costs of feral pigs through effective control and management	Development of new tools for managing feral pigs

e-Technology Hub – Intelli-traps

Project leader: 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 and Water Resources

Project snapshot: This project is combining advanced computer vision and machine learning algorithms with artificial intelligence to develop three devices that can perform automated tasks to target specific pest animals.

Lethal Trap Device with PAPP

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 and Water Resources

Project snapshot: This project aims to refine a lethal trap device prototype that can be fitted to all approved leg hold trap models and deliver an effective lethal dose of a humane toxin/anaesthetic. The APVMA application for LTD-PAPP is due to be resubmitted in late 2018.

Blue Healer glovebox antidote

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

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

Project snapshot: Methylene blue is an effective antidote for accidental PAPP toxicosis in domestic dogs. Currently it can only be administered by a veterinarian which is not ideal for many land managers and farm workers who live and work in areas where there are no vets nearby. The project is assessing the viability of a 'glovebox antidote' able to be administered by dog owners themselves. This has proved to be very difficult. A variety of administration techniques and pathways have been trialled, however none have yet been suitable for successful on-ground administration. An application has been made to trial new technologies that have become available since the project started and the Centre is awaiting the outcome of that application before proceeding further.

Wild Dog Alert

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 and Water Resources

Project snapshot: This project is developing, integrating and field testing the components of the early alert system for wild dogs. The work is an innovative integration of existing and currently developing ecological and behavioural knowledge with computer and camera trap technologies. The project is progressing with the team having developed unique technology which combines automated recognition of camera trap images with real-time messages to notify producers that wild dogs have invaded their farm. Componentry testing is now underway.

WildDogAlert prototype, image by Heather Barnes

HogGone Australia

Project leaders: Sigrid Tijs and Dr Tony Buckmaster | Centre for Invasive Species Solutions

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

Project snapshot: The HogGone project has been ongoing since 2005 through the Invasive Animals CRC. During this time, the project has been developing formulations of sodium nitrite and a new bait (HOGGONE®) for feral pig control so that additional tools are available in the future for the ever-expanding number of feral pigs in Australia. The R&D phase is now complete and has informed the HogGone APVMA application. This registration package was submitted through Animal Control Technologies Australia on 4th of August 2017. The application is still being assessed.

Carbon Monoxide Rabbit Warren Fumigator (Project terminated)

Project leader: Sigrid Tijs | Centre for Invasive Species Solutions

Project snapshot: After years of relentless research testing and product development, this project has been unable to find a cost efficient mechanism to meet requisite technical specifications and subsequently has been terminated.

Feral deer aggregator

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

Project partners: Primary Industries and Regions South Australia

Project snapshot: This project is part of 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.

Gonacon registration

Project leader: Sigrid Tijs | Centre for Invasive Species Solutions

Project partners: ACT Parks and Conservation

Project snapshot: After considerable R&D investment through the IACRC in the assessing the efficacy of Gonacon immunocontraception vaccine formulation on macropods in Australia, the registration of Gonacon as an injectable multi-year 'single dose' contraceptive agent for feral deer and macropods is currently being prepared for submission to the APVMA.

The HogGone field trials were completed in 2017 with the final large-scale field trial undertaken in St. George Queensland, thanks to funding through the Australian Government ag white paper. Image supplied by ACTA

New rodenticide

Project leader: Dr Simon Humphrys | Centre for Invasive Species Solutions (until November 2017)

Project partners: GRDC, USDA

Project snapshot: New chemicals to complement zinc phosphide are required for the control of in-crop rodents. This project sought to find and test the efficacy of various sodium nitrite formulations, potentially resulting in additional effective manufactured bait products and a formulated sodium nitrite product. This project is also assessing additional chemicals that were demonstrated to be sufficiently acutely toxic, attractive, palatable, and highly effective in US EPA compliant oral toxicity studies.

Mouse surveillance (Project complete)

Project leader: Dr Simon Humphrys | Centre for Invasive Species Solutions (until November 2017)

Project partners: Dr Peter Brown, CSIRO

Project snapshot: This project was set up in 2012 to monitor mouse populations across five states to reduce the economic impacts of damage caused by outbreaks of mice. It emphasised the use of MouseAlert (via FeralScan) and also undertook specific on-ground monitoring work. This project delivered improved mouse outbreak information through better predictive models as well as the regional and national status of mouse populations using qualitative information from grains industry sources and quantitative data. While this project is now complete, ongoing monitoring has been funded through GRDC to be undertaken by CSIRO.

Domain progress overview:

The Management Systems and Tools 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. Given the Centre's management of several projects of this nature supported under the Agricultural White Paper RD&E funding, an overall balance of Portfolio Projects was achieved by limiting new Portfolio No. 1 projects in the Tools Domain to one. In reality, several projects supported under other Domains also involve the creation of new tools and systems that can be applied by invasive animal managers.

The deer aggregator project under this Domain has mobilised a team of seven researchers in South Australia to build on foundational research and development by the NSW Office of Environment and Heritage to refine the feed structure of its traps (primarily aimed at goats) so that they would work for feral deer. 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 research team was put together and mobilised in 2017-18 to commence activities in July 2018.

The Lethal Trap Device, Gonacon and Hoggone projects focussed on preparing applications for APVMA registration. The Hoggone application was submitted in August 2017, while the other two applications remain in preparation.

The Blue Healer project team has trialled various application methods for a glovebox antidote for PAPP following accidental ingestion by domestic dogs. Further modifications to application methods and field testing are required before a decision on efficacy and registration can be made.

The Centre is working with the USDA on an agreement to test two new formulations for mouse control. These formulations showed promising results in the scoping study on new rodenticides.

The rabbit fumigator project was terminated due to health issues of the Project Leader and the inability of multiple prototype versions of the device to meet the design specifications.

The Wild Dog Alert and e-technology hub project teams continued the development of state of the art technologies combined with machine learning for the detections of wild dogs and other species and the transmission of data in remote areas to allow for swift action once a predator is detected.

DOMAIN 5: COMMUNITY ENGAGEMENT AND EDUCATION

Proposed solutions to invasive species management will typically fail unless landholders are sufficiently motivated and empowered to change behaviours and adopt new approaches. The Centre has several projects to enhance community engagement within invasive species management and provide tailored and user-friendly information.

This Domain is overseen by Associate Professor Richard Price from the Centre for Invasive Species Solutions.

HIGH LEVEL OUTCOME AND IMPACT	INTERMEDIARY OUTCOME	HIGH LEVEL OUTPUT
Improvement in the human and institutional aspects of pest management	Rapid adoption by landholders of "best practices" for managing invasives through enhanced engagement and behaviour change	Behaviourally effective communication and engagement strategies applied to wild dog management
	A culture of collaborative, science-based learning in the human dimensions of pest management within communities, governments and industry	On-line delivery of best management guidelines and tools through updated PestSmart and FeralScan
		Delivery of the balanced researcher doctoral leadership program

Domain projects

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 snapshot: 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.

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 snapshot: 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.

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 snapshot: 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.

Upgrade of the PestSmart digital platform

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

Project snapshot: 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

Image by Meja Aldrich

Remembering a time #BC – Before Carp

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

Project partners: Fisheries Research and Development Corporation

Project snapshot: There is a need to enhance public awareness and understanding of what our waterways could be like if carp were better controlled and what our waterways were like prior to carp. This project collected and developed a series of short stories from Australians who remember what life was like BC (AKA before carp). These stories are published through the Fisheries Research and Development Corporation.

Balanced Researcher Program

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

Project snapshot: 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. Two new students were inducted into the program in 2017-18.

Domain progress overview:

The Centre oversaw smooth transition of its predecessor's wild dog effort and also expedited commencement of a project to strengthen behaviorally effective approaches to wild dog management.

The National Wild Dog Management Coordinator project is a position continuing from the IA CRC. The project, led by Greg Mifsud, had an effective year overseeing the implementation of the National Wild Dog Action Plan. Highlights of achievement included:

- Working closely with Skills Impact Australia to oversee the development and delivery of a new "Cert III Rural and Environmental Pest Management" course;
- Development of a new competency for the use in the new rural and environmental pest management course around the use of poison baits;
- Instigating a collaborative funding approach between the Queensland government, Australian Wool Innovation and Meat and Livestock Australia that saw the appointment of three wild dog and feral animal management coordinators employed across Queensland; and
- Establishment of the National Wild Dog Action Plan Coordination Committee to oversee the Plan's continued implementation and review.

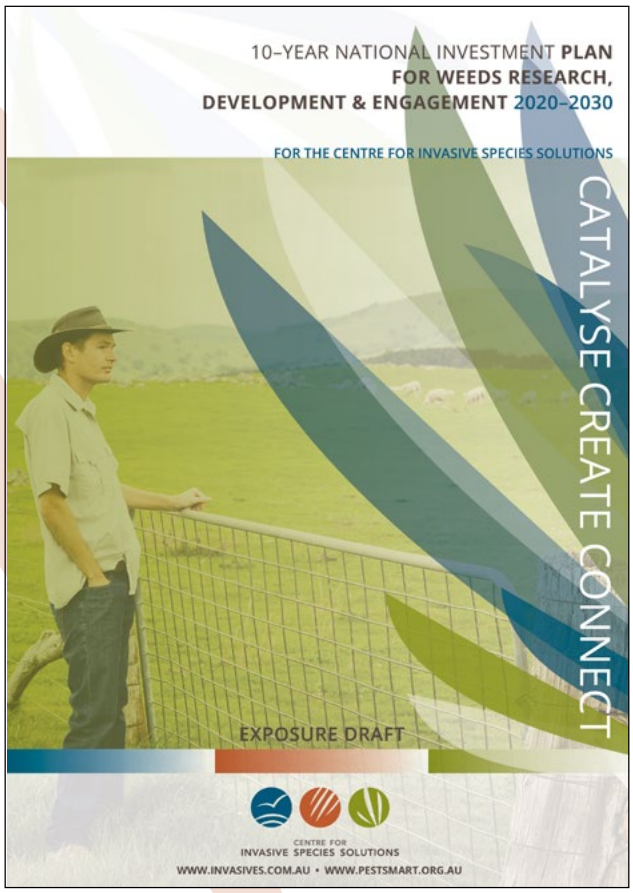
The FeralScan digital suite of invasive animal monitoring apps expanded to incorporate a new DeerScan module. The RabbitScan application's BioControl Tracker also reached 999 samples received post the RHDV1 K5 rabbit biocontrol release.

The PestSmart platform has commenced progressing its significant expansion and upgrade to include weeds management data and information, including through negotiating a deed to commence the transfer of all material on the former Australian Government weeds.gov.au website.

Two students, Adam Toomes (University of Adelaide) and José Huaman Torres (LaTrobe University) have officially enrolled in our Balanced Researcher Program and have begun their studies. The aim is to have nine students as part of the first cohort enrolled by the end of 2018/19 financial year.

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 McCloud

Investment plan for Weeds RD&E



Weeds remain a major threat to the health of Australian landscapes, conservation values and the productivity and profitability of agriculture.

In providing its investment of $20 million in the Centre for Invasive Species Solutions, the Federal Minister for Agriculture and Water Resources requested the Centre to develop a 10-year Investment Plan for Weed Research, Development and Extension that aims to improve weed management in Australia.

The development of the Plan started in the second half of 2017-18 with the engagement of a consultant to prepare a situation analysis and consultation paper, propose a draft plan for public feedback and lead the facilitation of a national workshop in June 2018. A Project Steering Committee was established, comprising representatives of CSIRO, Primary Industries and Region South Australia, Queensland Department of Agriculture and Fisheries, Australian Government Department of Agriculture and Water Resources and Centre staff.

The consultation process to develop the Plan:

1. Stage 1 – Consultation paper release and request for feedback sought (April 2018 – July 2018)
2. Stage 2 – Exposure draft release and request for feedback sought (September 2018 – Feb 2019)
3. Stage 3 – Feedback from exposure draft incorporated into final plan (March 2019 – June 2019)

The preparation of the situation analysis and consultation paper was successfully delivered, and together with the national workshop acted to inform the development of a draft Plan. Ultimately the plan will guide the Centre's future investment in weed RD&E and help determine where and how the Centre can facilitate greater coordination of the national RD&E effort addressing weeds.

The second stage of the project will be underway in 2018-19. It involves incorporating feedback from the consultation draft to create an exposure draft of the Plan for a deeper level of consultation.

Key weeds experts from government, industry and research stakeholders gathering in Canberra on 30 May, 2018 to assist in developing a consultation draft of our Centre's national weeds RD&E investment plan

OUR IMPACT

15
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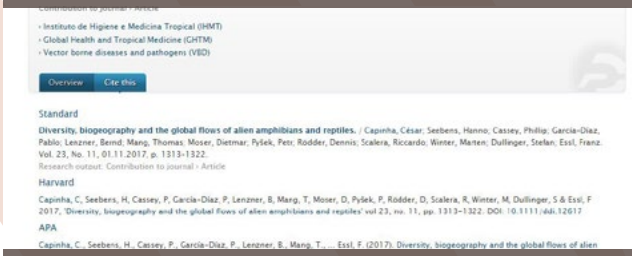

50
Scientific publications

1,227
Online media mentions of the Centre for Invasive Species

CENTRE FOR INVASIVE SPECIES SOLUTIONS

FERAL FLYER

3,620
Feral Flyer subscribers

5,903
PestSmart social followers

18,000+
FeralScan registered users

449,527
PestSmart webpage views

2022 and beyond–what could the future look like?

Environmental DNA detection a key part of biosecurity surveillance programs

The Victorian government recently led an awareness campaign to make the community aware of the highly invasive red eared slider turtle and the risks it poses to the environment.

A few days into the campaign, authorities receive a tweet from a member of the public who believe they saw an exotic turtle in the Yarra River of Melbourne – the local biosecurity officers act immediately.

Through the Centre for Invasive Species Solutions eDNA research program, all biosecurity agencies now have access to a portable smartphone add-on device which can test for the presence of DNA for incursion threats of major concern. This includes detecting the DNA presence of freshwater vertebrates such as the red eared slider turtle and Asian black spined toad.

The local biosecurity officer takes a water sample from the Yarra River where the turtle was spotted and places a small amount of the water sample onto their hand-held device for analysis. After a few minutes, the sample has been genetically sequenced, and it comes up positive with slider turtle DNA.

A biosecurity containment zone is put in place and a secondary water sample is collected and sent to the laboratories for further analysis. This is all done within hours of receiving the original tweet.

Apps, traps and alerts – digital innovation providing land managers with information at their fingertips and peace of mind

A wool producer living on the outskirts of Armidale has contacted the local Local Land Services to set up a coordinated wild dog management program - triggered by information provided through the PestSmart digital platform. With support and guidance from the regional wild dog management coordinator and the local biosecurity officers, the wool producer was able to work together with neighbouring properties to design a strategic management plan.

The group uses feralscan to record, monitor and track feral sightings, damage and action they took, sending each other messages and updates when something significant happened like the sighting of the elusive wild dog with unique coat markings.

They were able to access their data on FeralScan to produce and share localised interactive maps, look at trends and record local control actions, but they were able to interrogate information provided by other individuals, community pest management groups, researchers, and institutions through the FeralScan mapping and data service.

WildDogAlert prototype, image by Heath Milne

For added peace of mind and protection of the livestock, the wool producer also invested in a product called WildDogAlert.

WildDogAlert can identify wild dogs within close proximity to properties (using automated facial recognition sensor software), Once activated, the software automatically sends an alert to the owners mobile phone (SMS) and alerts all the group members within the Feralscan monitoring group. This is a trigger for action as the group can then respond to concrete evidence rather than spending their time trying to find the wild dog in the first place.

Due to this collaborative group monitoring program and incorporation of WildDogAlert, the wool producer has much more sense of security of their livestock and are implementing a much more integrated and collaborative approach to wild dog control on her property and in the region.

New products and commercialisation

The commercialisation and utilisation strategy was broadened and deepened over the last 12 months through the establishment of a new CISS project portfolio and on-going projects through key brokering roles in securing co-investment and partnerships in both commercially focused applied R&D projects and public good projects.

The CISS strategy diversifies key risks involved in innovation in this field, such as:

- research and technical failure
- overcoming market failure to develop products that meet end-user needs and wouldn't be delivered to end users without industry and public good investment
- product development to meet market needs in terms of effectiveness, ease of use, animal welfare and human health concerns.

This brokering and co-investment approach improves end-user, CISS Participant and SME engagement, and builds trust and credibility in research outputs and products.

Intellectual property management

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

Intellectual property strategy

IP as defined in the Portfolio Agreement encompasses all assets resulting from intellectual endeavour excluding Moral Rights. Public Good IP will continue to be managed in the same way as previous years and by the IACRC — that is, all IP is 100% vested in IAL (called Centre IP) and available to all Portfolio Agreement Participants for their own use in research, training and adoption.

IP with commercial potential is managed distinctly from Public Good IP:

- Co-investors (Participants) in a commercially orientated project (Specified Project) are allowed to legally and beneficially co-own project IP.
- Specified Project IP is distinguished from Centre IP.
- Specified Project IP ownership is determined by a process that is agreed to by Specified Project participants directly involved in the project.
- All investors in a Specified Project have a say in developing the terms under which project IP will be commercialised.

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

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:

- Australian granted patent AU 200822121237 — 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.

Digital assets

Through the IACRC, 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

Digital technology is being embraced by CISS and is seen as a core enabler of present and future best-practice pest animal management. Beyond 2018, 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.

Image supplied by Peter West

Intellectual property protected

Table 1: Intellectual Property currently held for commercial purposes

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

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)	2013–2017	Exclusive (worldwide)
HOGGONE USA (CRADA)	2013–2017	Exclusive (worldwide)
Microencapsulated sodium nitrite formulations (CRLA)	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, 50 scientific publications, 5 new PestSmart branded reports, and 1 book 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.

These are al listed in Appendix A (pages 58–61).

Extension

Extension is critically important to promote awareness and adoption of best practice pest animal management. The Centre's communication plan aims to increase the profile of pest animal issues, and the role of the Centre as a national RD&E collaboration providing invasive species solutions.

In addition to our PestSmart resources, our Centre leads major communication campaigns associated with invasive species. 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.

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 built around a 'Learn, Act, Connect' model to assist end-users with practical on-ground action. All end-user and technical publications are available on the website, making it a useful tool for both land managers and researchers.

The website is mobile friendly which is important as we know that 41% of the website users access our information from a mobile or tablet device.

Due to continued brand promotion over the past financial year the awareness of the site has been maintained, even during our Centre's brand transition process. Analytics over a two-year period (July 2016-June 2018) show that the site has received 916,297 page views (figure 1) and just over 36,000 document downloads.

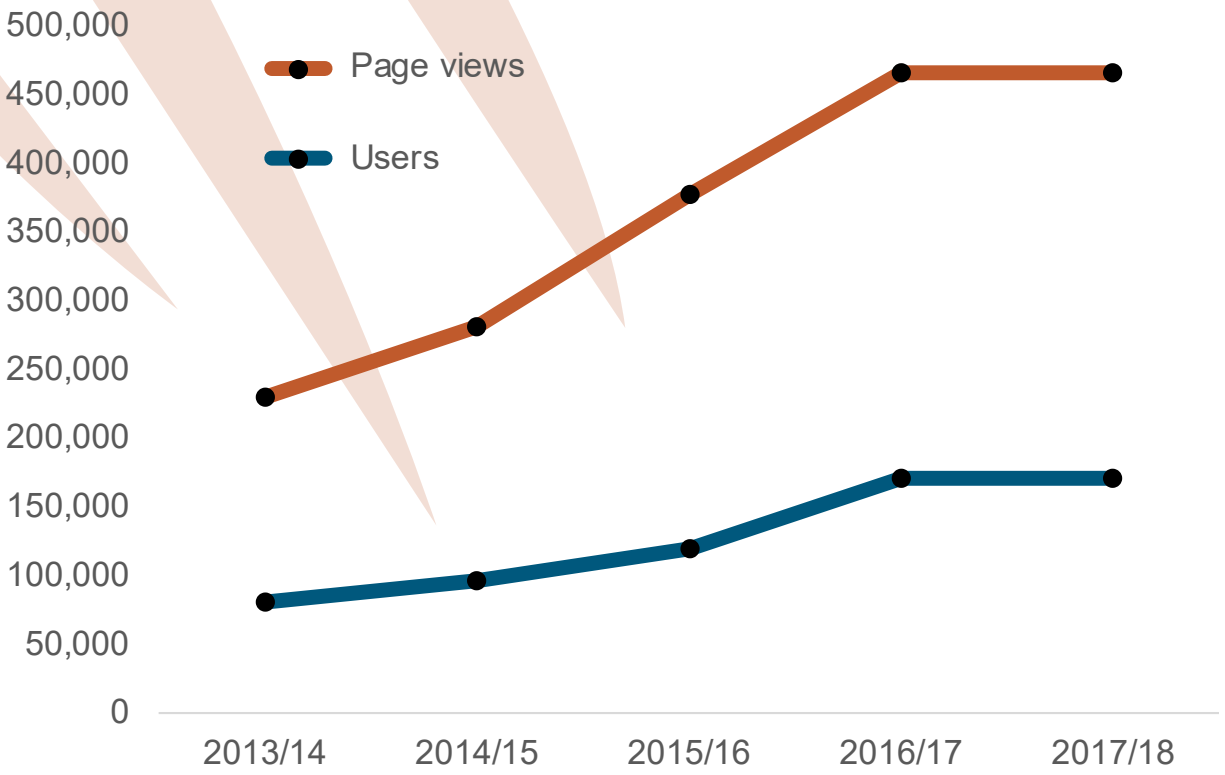

Figure 1: The number of page views and users of the Pestsmart/feral.org.au website over the past 5 years
Note: Pestsmart website launched March 2015

The PestSmart website includes a range of publications including fact sheets, case studies, guides and technical reports which are also available in print PDF form.

The toolkit was developed in 2011 and now totals 225 publications. In the 2017/18 financial year our PDF toolkit documents were downloaded 19,385 (up 5% 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 extension resources of 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 994 tweets and 840 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 5900 followers (figure 2).

During the financial year, followers on Facebook and Twitter increased by 29% and 6% respectively, with our posts reaching over 2.2 million accounts, an overall increase of 25% compared to the previous financial year showcases the impressive reach and impact of the Centre.

Our PestSmart YouTube channel videos have received more than 160,000 views over the course of the financial year. Eight new videos were uploaded, with a focus on wild dog community-led control programs undertaken around the country. These were created thanks to funding through the National Wild Dog Action Plan and the Australian Government. Since the channel was started back in March 2012, our videos have been viewed 587,488 times.

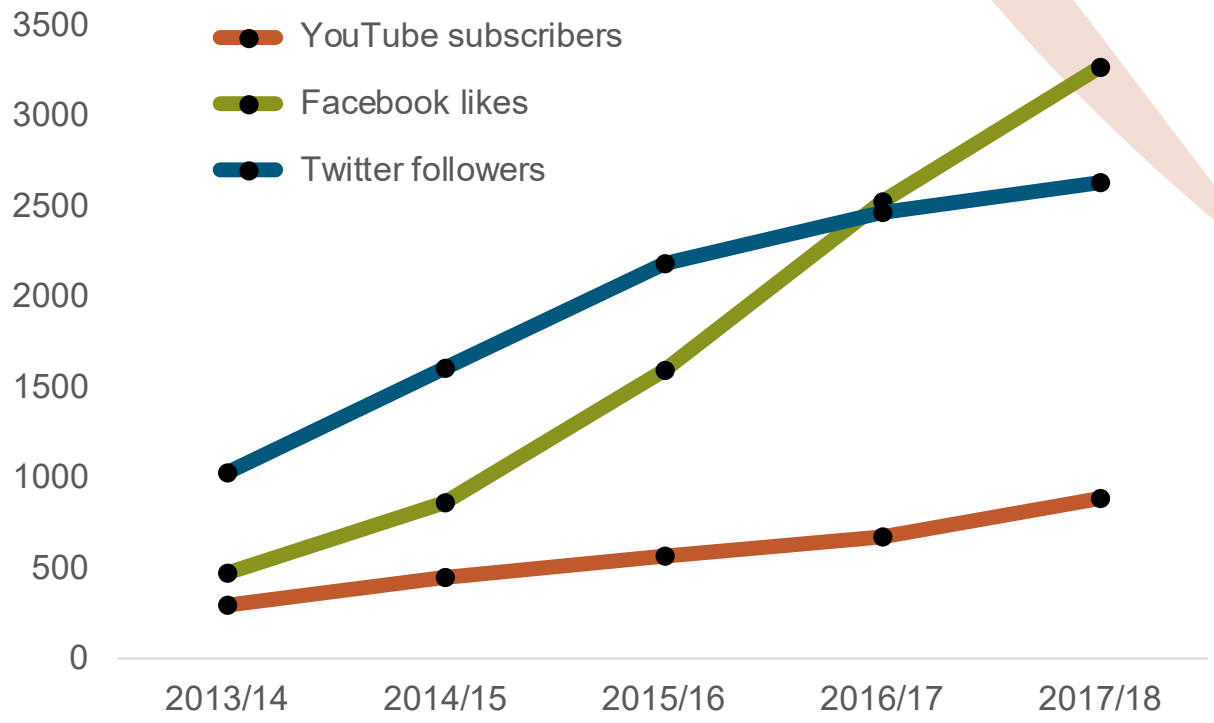

Figure 2: The YouTube, Facebook and Twitter audience numbers for our Pestsmart social platforms

FeralScan community resource

The FeralScan community resource has over 18,000 registered users and contains more than 110,000 records of pest animals, pest problems and control actions coordinated by landholders and community groups Australia-wide. 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.

New services under development and trial include dashboard reports of pest activity, alert notifications about pest-related incidents, automatic reports to Biosecurity groups, SMS notifications, and monthly reports to stakeholders.

The FeralScan mobile app was launched in 2015, enabling this important community tool to be used for mapping pest animal activity in the field, even without phone reception. The app is available for both Apple and Android devices and has been downloaded more than 16,000 times.

Our FeralScan app strengthens efforts in pest animal management

Over the past 12-18 months, Peter West our FeralScan Program Manager based with the NSW DPI has been busily travelling around Australia training landholders, community groups and staff from government agencies on how to effectively use the digital platform to enhance their pest animal management programs.

Peter has spent a considerable amount of time on the west coast, running a number of workshops in Perth, Manjimup and Geraldton which were an 'outstanding success', engaging a broad section of the community.

Peter said workshop participants were keen to work together to reduce the impacts of pest animals, and use FeralScan to help monitor and map pest animal activity in their local area.

"The sessions also helped me to identify how we can improve FeralScan to ensure it helps communities even further," he said.

At the South Perth workshop are Peter West, NSW DPI, Lisa O'Neill, Eastern Wheatbelt Biosecurity Group, Linda Vernon, Central Wheatbelt Biosecurity Association and Andrew and Linda Lockley, WA Feral Animal Management. Image supplied by WA Government

The training sessions were co-funded by Australian Wool Innovation, and the WA Department of Primary Industries and Regional Development and our Centre.

Brian Dowley, a Victorian wild dog coordinator talks about monitoring and managing wild dog to a group of landholders at Clifton Creek, image supplied by National Wild Dog Action Plan

Communication and media

CISS Corporate Website

The new look corporate website – www.invasives.com.au was built and launched in November 2017 and up until June 30, 2018 had 16,771 page views and 3,838 users connect with the site.

Post June 30, 2018, the website has been fully developed and includes a list of the Centre's full suite of RD&E projects (both Project Portfolio and Agricultural Competitiveness White Paper projects) as well as profiles of all the project leaders. As such, we expect a significant increase in usage over the 2018-19 FY tending toward the 2016-17 FY Invasive Animal CRC web site baseline usage of ~50,000 page views.

The Invasive Animals CRC website has now been fully retired and archived through the National Library of Australia's pandora digital platform.

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 3,620 subscribers as of end of June 2018, a net increase of 50% from the previous FY year.

A total of 19 e-newsletters were sent out during the reporting period, with open rates ranging between 33-40% and click rates between 10-19% (61% above the average for non-profit company e-news open rates).

CISS media

The Minister for Agriculture and Water Resources officially launched the new Centre via a media release on 15 September 2017. A media release was also issued on 18 September 2018 to announce and launch the Centre's first series of portfolio projects.

Over the financial year reporting period, 1,227 online mentions specifically related to CISS projects through collaborative communications with our members and partners on topics including but not limited to the economic costs of pest animals (report), the wild dog alert prototype testing and the interactions between the RHDV and myxoma viruses. This resulted in an advertising value equivalent of $1.2 million.

CISS social media

Social media is an important engagement tool for reaching key audiences, in addition to our PestSmart social media channels, our Centre has also established specific social media channels to highlight our Centre's impact:

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

Follow us!

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:

Internal e-newsletter: an internal e-newsletter established for our RD&E project and portfolio community. Led by research management team, this list has 88 subscribers with an open rate of 63.8%. This is sent out on an as needed basis.

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.

The Hon. Barnaby Joyce MP
MEDIA RELEASE
Deputy Prime Minister
Minister for Agriculture and Water Resources
15 September 2017

Think big and work together to combat invasive pests and weeds

- $20 million for the new Centre for Invasive Species Solutions
- Maintaining the momentum of the former Invasive Animals CRC in fighting pests
- Coalition delivering its 2016 election commitment

The national research institute leading the way in pest animal and weed research and development has had a facelift, receiving a new name and $20 million in funding to expand its ground breaking research, delivering on a key Coalition Government election commitment.

Deputy Prime Minister and Minister for Agriculture and Water Resources, Barnaby Joyce, said with funding now underway the new Centre for Invasive Species Solutions (CISS), formerly the Invasive Animals CRC, can continue its coordinated national approach to the management of pests such as wild dogs and feral rabbits, to protect our $60 billion agriculture sector.

"The Nationals as part of a Coalition Government strongly believe in pest and weed management as a vital tool for boosting the productivity and profitability of Australia's agricultural industries," Minister Joyce said.

"The CISS will bring together cutting edge research and development, providing innovative solutions to make managing the land easier for our farmers, who bear an estimated $4 billion in livestock losses and weed management costs each year.

"The centre will build on the excellent work the Invasive Animals CRC undertook into rabbit biocontrol, that is helping to manage one of Australia's most costly vertebrate pests. The rabbit biocontrol agent was released in March this year, the first time a new agent has been released in 20 years.

"The scale and complexity of the pest animal and weed problem needs a cooperative approach between governments, industry, business, universities and research agencies. If we are going to truly take on this national problem, we need to think big and think at a landscape scale."

Chair of the CISS, Helen Cathles, said the new collaborative research and extension portfolio will have a national reach and deliver solutions to pest animal and weed problems at the farmgate.

"This is a very exciting time in land management and the Government's investment will see benefits for all Australians, the environment and to agricultural productivity," Ms Cathles said.

The Hon. David Littleproud MP
Minister for Agriculture and Water Resources
MEDIA RELEASE
Tuesday, 18 September 2018

Turning to DNA in the fight against pests

- New Centre for Invasive Species Solutions launches 21 new projects today
- Coalition Government is investing $20 million to CISS
- CISS 5-year collaborative RD&E projects will help prevent, detect and manage invasive pest animals, improve stakeholder engagement

Australian farmers will have more 'ammo' in the fight against pest animals thanks to a suite of projects launched today by the Centre for Invasive Species Solutions.

The 21 new research, development and extension projects will look at better ways of preventing, detecting and managing pest animals, including through the use of DNA.

Minister for Agriculture David Littleproud said the Coalition Government was contributing $20 million to the Centre for Invasive Species Solutions (CISS) to 2022 to help fund the projects.

"Farmers face huge costs, productivity losses and the spread of diseases at the hands of pests and weeds and keep fighting to stop them in their tracks," Minister Littleproud said.

"The 21 projects target pest animals in particular and will look at new management tools, better strategic decision making as well as community engagement and education.

"One project worth $1.84 million will look at building a machine to test samples of water to identify traces of pest animal DNA in rapid time out in the field. This technology would help track down pests hiding below the surface like the Asian black-spined toad and red-eared slider turtle.

"A $7.5 million project
This will help inform
continue to get value

"Another project worth
looking at their behav
understand their role

"CISS is also develop
areas in our war again

Foxes take $28 million bite out of Australian agricultural sector, so farmers fight back

WATCH

THE LAND
NEWS SPECIAL FEATURES CATTLE SHEEP CROPPING WEATHER CLASSIFIEDS
NEWS EVENTS PROPERTY PHOTOS LIFE & STYLE OPINION POLITICS NEXT CROP HORSES

Feral photos reveal major pest and weed problems

23 Nov 2017, 9:17 a.m.

News

JOINT WINNER: Goats dancing on a Mallee/cow nest. Photo - Fiona Gray, SA.

STOCK & LAND
NEWS MARKETS BEEF SHEEP DAIRY CROPPING MULTIMEDIA WEATHER CLASS
MADE IN TASMANIA AGRIBUSINESS EVENTS LIFE & STYLE POLITICS PROPERTY

Rabbit management army now in pl

People power and collaboration has proven to be one of the most effec
achieving positive action against the rabbit.

QUEENSLAND Country Life
NEWS BEEF SHEEP CROPPING MULTIMEDIA WEATHER CLASSIFIEDS

Wild dog problem hits suburbia

14 Nov 2017, 9:49 am

Australasian Science
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s: you don't know who

Rural Science, University of New

THE WEEKLY TIMES
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NEWS BREAKING VICTORIA TAS COUNTRY RURAL WEEKLY OPINION

Coles Farmer Of The Year Award 2018

NATIONAL

Invasive species: Pest animals 'cost agriculture $797 million a year'

EMMA FIELD, The Weekly Times
October 24, 2017 12:29pm

Wild Dog Alert system offers hope for automated pest animal control

by Terry Sim, 25 June 2018

Share on Facebook
Share on Twitter
Share on Google Plus
Share on LinkedIn
Share on Pinterest
Share via Email

Wild dog control via sensor and satellite is here.

PestSmart Feral Photo Competition in focus

The sight of feral goats dancing on a mallee/cow nest
species shocked Fiona Gray, a regional landcare facilitator in South Australia, who is one of three
winners of this year's PestSmart Feral Photo competition.

"To my shock, as I was going through the images, I see feral goats jumping and dancing around
right on top of the nest, where the mallee/cow eggs were laid," said Ms Gray.

EVENTS

CISS AGM and Forum

Representatives from our Members and Partners and other key stakeholder organisations gathered in Canberra on 24 November, 2017 for our AGM and CISS forum. This was held at the Hotel Kurrajong and included presentations from our CEO, Portfolio Director and Innovation Domain leaders.

Portfolio launch and Innovation Showcase

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 officially launch our Centre's first research, development and extension (RD&E) portfolio on 18 September, 2018 at Parliament House in Canberra.

The Minister reiterated the importance of strategic investment in invasive species RD&E to ensure we develop innovative solutions, to help those undertaking on-ground and on-farm management.

"It's important to understand that the work that you are doing, actually starts to chip away at the four odd billion dollars, that the invasives cost our agricultural sector a year," Minister Littleproud said.

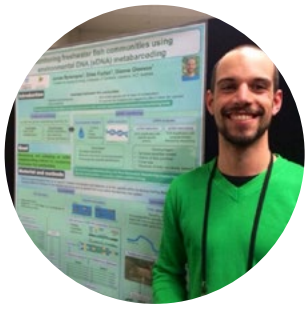
The Minister launched the Portfolio in collaboration with Fiona Simson, President of the National Farmers Federation and Andrew Cox, CEO Invasive Species Council.

Both congratulated the Centre for successfully transitioning from a CRC model into a national research collaboration and look forward to supporting the Centre's activities over the coming years.

After the launch, we hosted a short Innovation Showcase, MCd by ABC Landline's Prue Adams, where many of our Project Leaders had the opportunity to showcase their projects to key stakeholders.

CONGRATULATIONS TO OUR COMMUNITY

Congratulations to five of our PhD candidates affiliated with our Balanced Researcher Program between 2012-2017 who successfully submitted their PhDs during the financial year.



- Dr Jonas Bylemans with his Thesis "Monitoring freshwater fish communities using environmental DNA (eDNA) metabarcoding".

- Dr Catriona Campbell with her thesis "Molecular approaches define the interactions and impacts of Tasmania's native, introduced and invasive marsupials".

- Dr Rheyda Hinlo with her Thesis "Improving eDNA detection probabilities for monitoring aquatic species".

- Dr Helen Morgan with her thesis "Management of wild canids and trophic cascades: How is vegetation influenced by top-order predators?".

- Vivek Nemane with his thesis "Improved legal and institutional arrangements for peri-urban invasive animal management in Australia".

A special congratulations to Vivek who also received the University of New England Chancellor's Doctoral Research Medal for his research work.

- One of our newest PhD candidate and Balanced Researcher Program recruit Mr Adam Toomes was awarded the Russell Baudinette Travel Scholarship (May 2018). Adam used these funds to travel to and present at the 'Society for Conservation Biology Oceania 2018 Wellington Conference' in July this year.

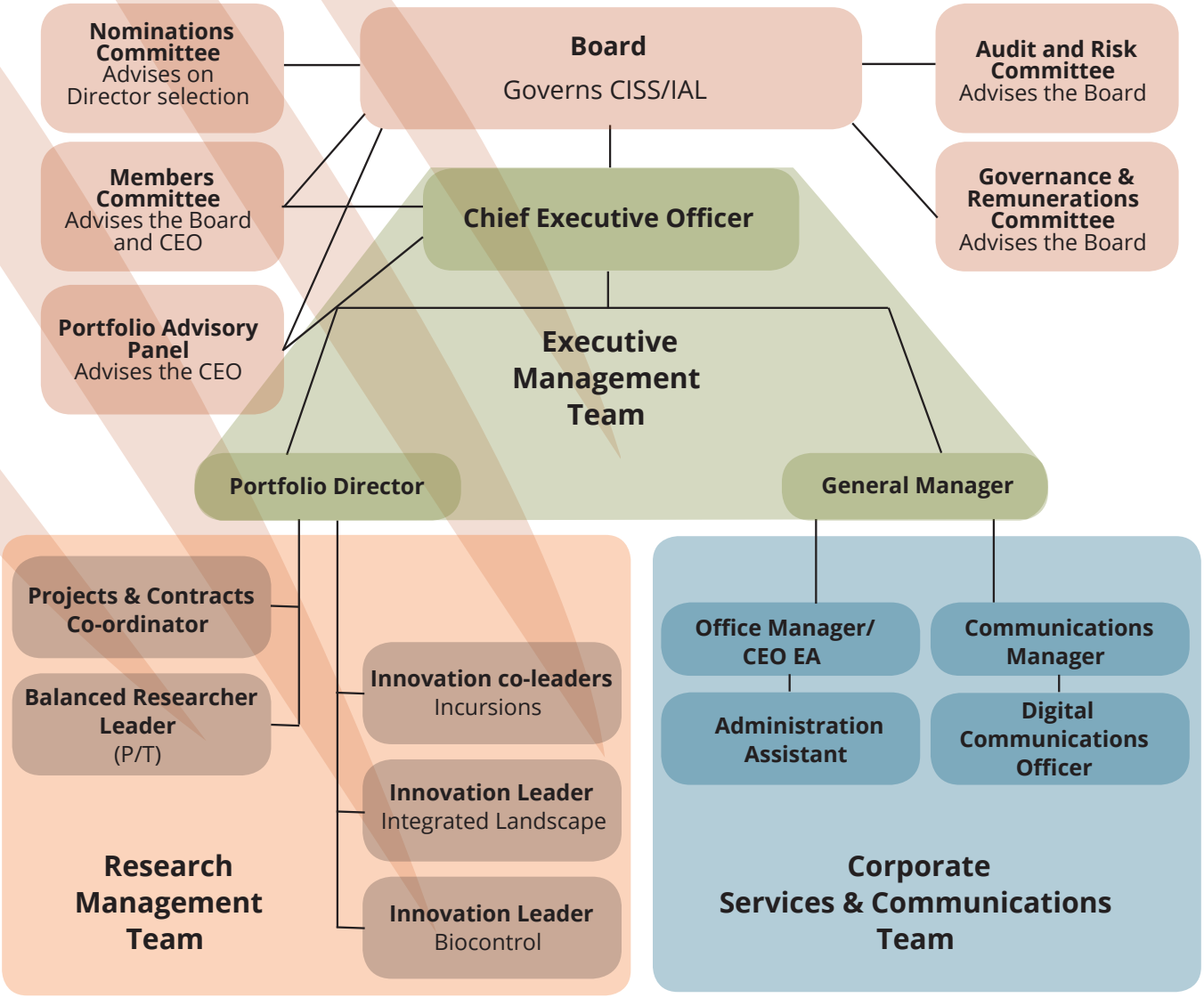
- We are very proud of Associate Professor Dianne Gleeson who leads our Centre's freshwater vertebrate eDNA work. Dianne has been engaged as part of a global team, highlighting eDNA technologies via hunting for the Loch Ness Monster - https://www.lochnesshunters.com/team - sounds very intriguing!!

- A big congratulations to CSIRO rabbit virologist, Dr Robyn Hall, who is one of a selection of women to take part in the next Homeward Bound leadership program. Homeward Bound aims to heighten the influence and impact of women with a science background in order to influence policy and decision making, with a focus on environmental issues. It culminates in a three-week intensive training trip in Antarctica.

- One of our many former Balanced Researcher Program success stories, Dr Kate Grarock, was nominated for the Celestino Eureka Prize for Promoting Understanding of Science. To top things off, Kate was also nominated as one of four, all female, finalists for the 2019 ACT Australian of the Year

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.



The structure and governance of the CISS provides strong support to its operations. CISS is led by a Board of skills-based Directors, the majority of whom 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 was to develop the CISS strategy, amend the IAL constitution, to develop policies and monitor the centre start up, The Board ensured the company complied 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: Peter Noble, Dr Andrew Sanger, Murray Rankin, Helen Cathles, Dr Glen Saunders and David Palmer

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 April 2015. Applied scientific research, Management and Regulatory Governance	NSW Dept of Primary Industries
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 McGuiness	Company Secretary alternate	Appointed February 2018	Centre for Invasive Species Solutions

The number of Director's meetings and number of meetings attended by each of the Directors of the Company during the financial year is:

DIRECTORS	BOARD MEETINGS		AUDIT AND RISK COMMITTEE		GOVERNANCE & REMUNERATION COMMITTEE		TRANSITIONAL NOMINATIONS COMMITTEE	
	No. eligible to attend	2017-18	No. eligible to attend	2017-18	No. eligible to attend	2017-18	No. eligible to attend	2017-18
Number of meetings held for the year:		5		5		1*		1
Number of meetings attended:								
Directors								
Helen Cathles (Chair)	5	5	-	-	1	1	1	1
Peter Noble (Chair Governance & Remuneration Committee)	5	5	-	-	1	1	-	-
David Palmer	5	5	5	4#	-	-	-	-
Murray Rankin (Chair Audit & Risk Management Comm)	5	5	5	5	-	--	-	-
Dr Andrew Sanger	5	5	5	5	-	-	1	1
Dr Glen Saunders	5	5			1	1	-	-
Nominations Committee Members								
Matt Koval - as representative of the Commonwealth Dept of Agriculture and Water Resources (Chair Transitional Nominations Comm)	-	-	-	-	-	-	1	1
Dr Bruce Christie - As representative of the Environment & Invasives Committee							1	apology
Mark Harvey-Sutton - as representative of the National Farmers Federation	-	-	-	-	-	-	1	1

** Due to the establishment of CISS in 2017-18 Governance & Remuneration matters were escalated to full board level.*
 # Directors were on leave at this time.

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.

- Mr Murray Rankin - Chair
- Dr Andrew Sanger
- Mr David Palmer

Governance and Remuneration Committee

The Governance & Remuneration Committee operates under Terms of Reference as approved by the Board and has responsibility for Invasive Animals Ltd governance policy and procedures and remuneration policy.

- Mr Peter Noble - Chair
- Ms Helen Cathles
- Dr Glen Saunders

Transitional Nominations Committee

The Nomination Committee, operating under a Committee Charter as approved by the Board, has responsibility for the Board Directors nomination process and facilitating the Director Election process.

- Mr Matt Koval, Commonwealth Department of Agriculture and Water Resources – Chair
- Mr Bruce Christie, NSW Department of Primary Industries and Chair, Environment and Invasives Committee
- Mr Mark Harvey-Sutton, National Farmers' Federation
- Ms Helen Cathles, IAL Director
- Dr Andrew Sanger, IAL Director

Research Excellence Committee

The Research Excellence Committee is due to start in the 2018/19 FY under the Terms of Reference approved by the Board. The Committee advises the Board on

1.) the Company's strategic alignment with its research, training, education and collaboration objects as set out in cl.3.1 of the Constitution;

2.) the long-term RD&E vision to be oversighted by Company Members (as per Schedule 1 of the Constitution); and

3.) the Company's Research Monitoring, Evaluation, Reporting and Improvement (MERI) and Impact measurement framework and systems.

- Dr Glen Saunders – Chair (due to start in 2018/19 FY)
- Dr Andrew Sanger

Key staff

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

NAME	ORGANISATION	POSITION/ROLE WITHIN CISS	TIME COMMITTED
Mr Andreas Glanznig	Centre for Invasive Species Solutions	CEO	100%
Mrs Carolyn Campbell-Wood	Centre for Invasive Species Solutions	General Manager	100%
Associate Professor Richard Price	Centre for Invasive Species Solutions	Portfolio Director (Research)	100%
Dr John Virtue	Primary Industries and Regions, South Australia	Innovation co-leader, Incursions Domain	27%
Dr Brad Page	Primary Industries and Regions, South Australia	Innovation co-leader, Incursions Domain	27%
Dr Tony Pople	Queensland Department of Agriculture and Fisheries	Innovation leader, Integrated Landscape Management Domain	30%
Dr Tanja Strive	CSIRO	Innovation leader, Biocontrol Domain	20% (pro bono)
Dr Tony Buckmaster	Centre for Invasive Species Solutions	Education leader	40%
Ms Sigrid Tijs	Centre for Invasive Species Solutions	Projects and contracts coordinator	90%
Dr Ian McDonald	Centre for Invasive Species Solutions	Communications Manager	100%
Ms Yvette Cazabon	Centre for Invasive Species Solutions	Digital Communications Officer	80%
Ms Julie McGuiness	Centre for Invasive Species Solutions	Office Manager	100%
Ms Jane Leslie	Centre for Invasive Species Solutions	Administration Assistant	100%

Staff changes

During the period Associate Professor Richard Price was appointed as Portfolio Director (Research) in August 2017 and Sigrid Tijs was appointed as Projects and contracts coordinator in October 2017.


CENTRE FOR
INVASIVE SPECIES SOLUTIONS

FINANCIAL PERFORMANCE

The launch and start up of the new Centre has continued IAL's close control and review of its financial performance, which remains in a solid position.

The transition of the Centre also provided an opportunity to modernise IAL financial control systems.

As the major collaborative RD&E initiative – Portfolio Agreement No. 1 – is now a contract rather than a discrete CRC legal entity, it is audited as part of the total Centre operations.

Performance of the Centre

The total IAL combined resources available in 2018 was $8,949,280 comprising $5,244,466 cash and $3,704,814 in-kind contributions.

The total net cash revenue of $5,244,466 included $4,000,000 invested by the Commonwealth Department of Agriculture and Water Resources, with other members and partners also providing significant revenue: $782,466 by the Research and Development Corporations, $650,000 by the States, and $169,208 by research providers and the NZ government.

The total in-kind contributions of $3,704,814 for both Portfolio Agreement No. 1 and aligned project was invested mostly by the States, universities and CSIRO.

At the end of June 2018, the IAL cash position was $6,400,413, up from $3,730,553 at the end of the Invasive Animals CRC. Most of this cash is committed to Portfolio No. 1 projects, a number of which had delayed starts and as such will be expended in the course of delivering the portfolio.

The positive financial position with a cash position at June 2018 of $6,400,413 represents sufficient cash flow to meet the entities combined liabilities for $ 5,845,182.The current asset ratio (a measure of liquidity) was 1.183.

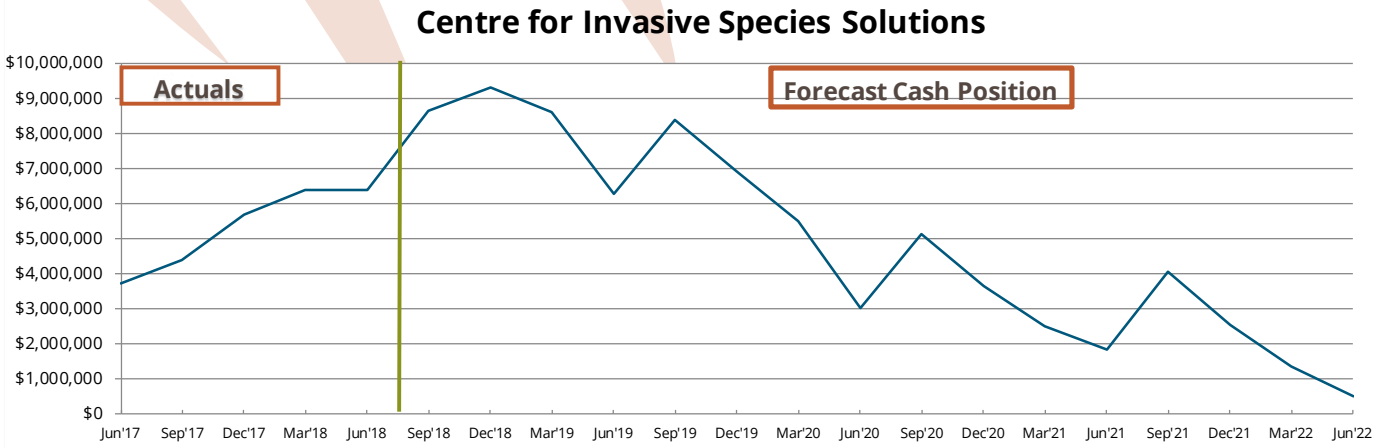


Figure 3: FY18 Revenue (consolidated)

The IAL equity position at end of June 2018 was $1,038,232 an increase from $881,036 at June 2017.

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/publications.

APPENDIX A

Published citations during the 2017/18 FY

For completeness, the below citation list outlines publications which were published during the 2017/18 financial year and are all based on work finalised through either Invasive Animals CRC or CISS-related projects.

Scientific publications

Incursion pathways

1. Capinha, C., Seebens, H., Cassey, P., García-Díaz, P., Lenzner, B., Mang, T., ... & Winter, M. (2017). Diversity, biogeography and the global flows of alien amphibians and reptiles. Diversity and Distributions, 23(11), 1313-1322.
2. Cassey, P., Delean, S., Lockwood, J. L., Sadowski, J., & Blackburn, T. M. (2018). Dissecting the null model for biological invasions: A meta-analysis of the propagule pressure effect. PLoS biology, 16(4), e2005987.
3. Cassey, P., García-Díaz, P., Lockwood, J. L., & Blackburn, T. M. (2018). Invasion Biology: Searching for Predictions and Prevention, and Avoiding Lost Causes. Invasion Biology: Hypotheses and Evidence, 1.
4. Cope, R. C., Ross, J. V., Wittmann, T. A., Watts, M. J., & Cassey, P. (2017). Predicting the risk of biological invasions using environmental similarity and transport network connectedness. Risk Analysis.
5. Dawson, W., Moser, D., van Kleunen, M., Kreft, H., Pergl, J., Pyšek, P., ... & Dyer, E. E. (2017). Global hotspots and correlates of alien species richness across taxonomic groups. Nature Ecology & Evolution, 1(7), 0186.
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9. Moser, D., Lenzner, B., Weigelt, P., Dawson, W., Kreft, H., Pergl, J., ... & Cassey, P. (2018). Remoteness promotes biological invasions on islands worldwide. Proceedings of the National Academy of Sciences, 115(37), 9270-9275.
10. Pigot, A. L., Cassey, P., & Blackburn, T. M. (2018). How to incorporate information on propagule pressure in the analysis of alien establishment success. Methods in Ecology and Evolution, 9(4), 1097-1108.

Environmental DNA

11. Bylemans, J., Gleeson, D. M., Hardy, C. M., & Furlan, E. (2018). Toward an ecoregion scale evaluation of eDNA metabarcoding primers: A case study for the freshwater fish biodiversity of the Murray–Darling Basin (Australia). Ecology and evolution.
12. Bylemans, J., Furlan, E. M., Gleeson, D. M., Hardy, C. M., & Duncan, R. P. (2018). Does size matter? An experimental evaluation of the relative abundance and decay rates of aquatic eDNA. Environmental science & technology.
13. Campbell, C. D., Sarre, S. D., Stojanovic, D., Gruber, B., Medlock, K., Harris, S., ... & Holleley, C. E. (2018). When is a native species invasive? Incursion of a novel predatory marsupial detected using molecular and historical data. Diversity and Distributions, 24(6), 831-840.
14. Hinlo, R., Lintermans, M., Gleeson, D., Broadhurst, B., & Furlan, E. (2018) Performance of eDNA assays to detect and quantify an elusive benthic fish in upland streams. Biological Invasions.
15. MacDonald, A. J., & Sarre, S. D. (2017). A framework for developing and validating taxon-specific primers for specimen identification from environmental DNA. Molecular ecology resources, 17(4), 708-720.

16. Modave, E., MacDonald, A. J., & Sarre, S. D. (2017). A single mini-barcode test to screen for Australian mammalian predators from environmental samples. GigaScience, 6(8), 1-13.

17. Quasim, S., MacDonald, A. J., & Sarre, S. D. (2018). Towards more efficient large-scale DNA-based detection of terrestrial mammal predators from scats. Mammal Research, 1-7.

18. Ramsey, D. S., Barclay, C., Campbell, C. D., Dewar, E., MacDonald, A. J., Modave, E., ... & Sarre, S. D. (2018). Detecting rare carnivores using scats: Implications for monitoring a fox incursion into Tasmania. Ecology and evolution, 8(1), 732-743.

Rabbit biocontrol and management

19. Barnett, L. K., Prowse, T. A., Peacock, D. E., Mutze, G. J., Sinclair, R. G., Kovaliski, J., ... & Bradshaw, C. J. Previous exposure to myxoma virus reduces survival of European rabbits during outbreaks of rabbit haemorrhagic disease. Journal of Applied Ecology.

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22. Hall, R. N., Capucci, L., Matthaei, M., Esposito, S., Kerr, P. J., Frese, M., & Strive, T. (2017). An in vivo system for directed experimental evolution of rabbit haemorrhagic disease virus. PloS one, 12(3), e0173727.

23. Hall, R. N., Mahar, J. E., Read, A. J., Mourant, R., Piper, M., Huang, N., & Strive, T. (2018). A strain-specific multiplex RT-PCR for Australian rabbit haemorrhagic disease viruses uncovers a new recombinant virus variant in rabbits and hares. Transboundary and emerging diseases, 65(2), e444-e456.

24. Iannella, A., Peacock, D., Cassey, P., & Schwensow, N. Genetic perspectives on the historical introduction of the European rabbit (Oryctolagus cuniculus) to Australia. Biological Invasions, 1-12.

25. Peacock, D., Kovaliski, J., Sinclair, R., Mutze, G., Iannella, A., & Capucci, L. (2017). RHDV2 overcoming RHDV immunity in wild rabbits (Oryctolagus cuniculus) in Australia. Veterinary Record, vetrec-2016.

26. Peacock, D. E., & Grillo, T. L. (2018). Detecting European Rabbit (Oryctolagus cuniculus) Disease Outbreaks by Monitoring Digital Media. Journal of wildlife diseases.

27. Mahar, J. E., Hall, R. N., Peacock, D., Kovaliski, J., Piper, M., Mourant, R., ... & Urakova, N. (2018). Rabbit hemorrhagic disease virus 2 (RHDV2; GI. 2) is replacing endemic strains of RHDV in the Australian landscape within 18 months of its arrival. Journal of virology, 92(2), e01374-17.

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29. Neimanis, A., Pettersson, U. L., Huang, N., Gavier-Widén, D., & Strive, T. (2018). Elucidation of the pathology and tissue distribution of Lagovirus europaeus GI. 2/RHDV2 (rabbit haemorrhagic disease virus 2) in young and adult rabbits (Oryctolagus cuniculus). Veterinary research, 49(1), 46.

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33. Wells, K., Fordham, D. A., Brook, B. W., Cassey, P., Cox, T., O'Hara, R. B., & Schwensow, N. I. (2018). Disentangling synergistic disease dynamics: Implications for the viral biocontrol of rabbits. Journal of Animal Ecology, 87(5), 1418-1428.

Wild dog management

34. Allen, B. L., Fawcett, A., Anker, A., Engeman, R. M., Lisle, A., & Leung, L. K. P. (2018). Environmental effects are stronger than human effects on mammalian predator-prey relationships in arid Australian ecosystems. Science of the Total Environment, 610, 451-461.

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37. Harriott L, 2018, Prevalence, risk factors, and geographical distribution of zoonotic pathogens carried by peri-urban wild dogs, PhD Thesis, School of Veterinary Science, The University of Queensland.

38. Meek, P. D., Shorter, K., & Falzon, G. (2018). Do lethal trap devices threaten foot-hold trap capture efficacy?. International Journal of Pest Management, 1-6.

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40. Morgan, H.R., Hunter, J.T., Ballard, G., & Fleming, P.J.S. (2017) The trophic cascades concept may constrain Australian dingo reintroduction experiments: A response to Newsome et al. (2017). Food Webs 22, 76-87.

Other invasive animals

41. Hall, S. E., Upton, R. M., McLaughlin, E. A., & Sutherland, J. M. (2018). Phosphoinositide 3-kinase/protein kinase B (PI3K/AKT) and Janus kinase/signal transducer and activator of transcription (JAK/STAT) follicular signalling is conserved in the mare ovary. Reproduction, Fertility and Development, 30(4), 624-633.

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44. Snow, N. P., Foster, J. A., VanNatta, E. H., Horak, K. E., Humphrys, S. T., Staples, L. D., ... & VerCauteren, K. C. (2018). Potential secondary poisoning risks to non□targets from a sodium nitrite toxic bait for invasive wild pigs. Pest management science, 74(1), 181-188.

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46. Snow, N. P., Lavelle, M. J., Halseth, J. M., Glow, M. P., VanNatta, E. H., Davis, A. J., ... & VerCauteren, K. C. Exposure of a Population of Invasive Wild Pigs to Simulated Toxic Bait containing Biomarker: Implications for Population Reduction. Pest Management Science.

Community engagement and behaviour change

47. Please, P., Hine, D.W., Skoien, P., Phillips, K. & Jamieson, I. (2018). Prioritising community behaviours to improve wild dog management in peri-urban areas. Human Dimensions of Wildlife.

48. McLeod, L.J., Driver, A.B., Hine, D.W. & Bengsen, A.J. (2017). Refining online communication strategies for cat management. Anthrozoos. 30, 635-649.

49. McLeod, L., Hine, D.W., & Bengsen, A. (2017). Assessing the impact of different persuasive messages on cat owner intentions and behaviors. Preventive Veterinary Medicine, 146, 136-142.

50. Skelton, C. J., Cook, A. S., West, P., Spencer, R. J., & Old, J. M. (2018). Building an army of wombat warriors: developing and sustaining a citizen science project. Australian Mammalogy.

PestSmart branded reports

51. Alter, TR., Bridger, JC., Frumento PZ., Miller MS., & Polley ES, (2017). Using Information Technology to Enhance Community Engagement. PestSmart Toolkit Publication. Centre for Invasive Species Solutions, Canberra, ACT.

52. Alter, Driver, Frumento, Howard, Shufstall and Whitmer (2017) Community engagement for collective action: a handbook for practitioners. Centre for Invasive Species Solutions, Canberra, ACT.

53. Gentle, M., Allen, B.L., and Speed, J. (2017). Peri-urban wild dogs in north-eastern Australia: Ecology, Impacts and Management. PestSmart Toolkit publication, Centre for Invasive Species Solutions, Canberra, Australia.

54. Low Choy, D., Serrao-Neumann, S., Schuch, G., and Martin, P. 2017. Report on Scenario Planning for Institutional Improvements to support Citizen Led Action in Invasive Animal Management. PestSmart Toolkit Publication. Centre for Invasive Species Solutions, Canberra, ACT.

55. McLeod, R. (2016). Cost of Pest Animals in NSW and Australia, 2013-14. eSYS Development Pty Ltd, 2016. Report prepared for the NSW Natural Resources Commission. PestSmart Toolkit Publication. Centre for Invasive Species Solutions, Canberra, ACT.

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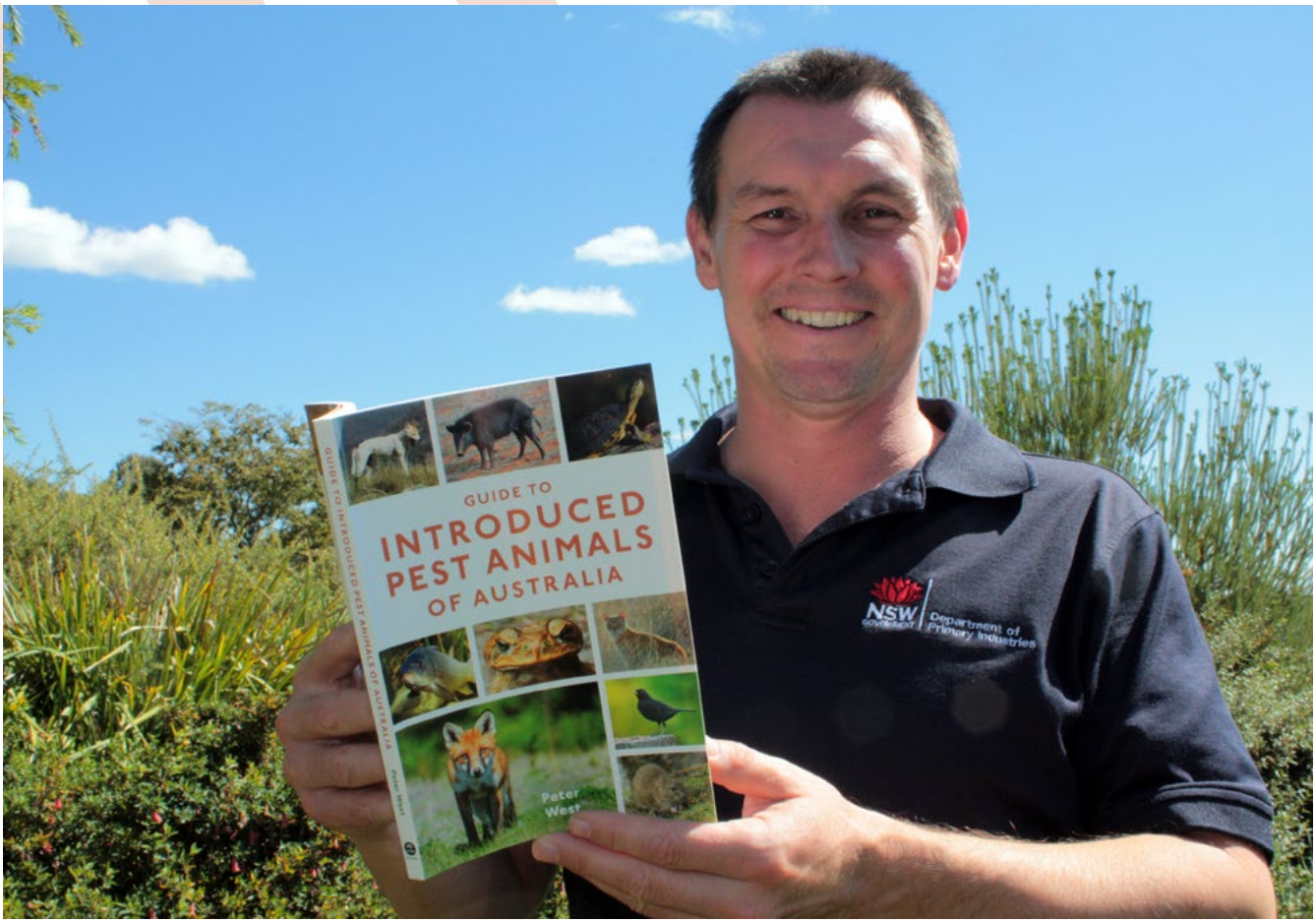

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APPENDIX A

CENTRE FOR
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