Invasive Animals CRC

RESEARCH PORTFOLIO SUMMARY 2017

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OUR PARTICIPANTS

SUPPORTED UNDER THE AUSTRALIAN GOVERNMENT'S COOPERATIVE RESEARCH PROGRAMME

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Wild dog coming in to feed on a sheep carcass during a trapping and control campaign, image supplied by Chris Thomas

A WA Department of Parks and Wildlife staff member releases RHDV1 K5, as part of the March 2017 national rollout, within the Cape Range National Park

INTRODUCTION

'TOGETHER, CREATE AND APPLY SOLUTIONS'

The Invasive Animals CRC was a collaborative partnership that brought together a diverse range of partners and groups to develop solutions and deliver on outcomes in pest animal management.

The Australian, New Zealand, US and UK economies lose billions of dollars a year in lost agricultural productivity and pest animal control costs, undermining food and fibre security.

The often unseen social impacts from the killing and mauling of livestock, pets and native wildlife can be devastating.

The environment is seriously impacted from pest animals, including whole landscapes, waterways, wildlife and plant species.

In Australia there is a constant risk of new pest animal incursions, particularly new invasive birds, reptiles and fish.

The current extension of the IA CRC to 2017 was a $72.5 million, 27 member partnership to develop new knowledge and products, strategies and services that deliver more strategic and efficient pest animal control.

This Research Portfolio Summary outlines the many key achievements and impacts of IA CRC research projects undertaken between July 2012 and June 2017.

The portfolio is structured into four program areas: Land Pests, Land Pests (Commercial Products), Inland Water Pests and Community Engagement — which together work towards our four outcomes.

OUTCOME	PROGRAM	MAJOR INVESTORS
No new vertebrate pests established in Australia	Land Pests	Tasmanian Department of Primary Industries, Parks, Water & Environment, New Zealand Landcare Research, WA Department of Primary Industries and Regional Development, University of Adelaide, University of Queensland
	Inland Water Pests	Queensland Department of Agriculture and Fisheries, University of Canberra
Improved prediction and control of emerging outbreaks	Land Pests (Commercial Products)	Grains Research and Development Corporation, US Department of Agriculture, Animal Control Technologies, CSIRO, University of Newcastle
Recovery of key land and water regions from rabbit, wild dog and carp impacts	Land Pests	Australian Wool Innovation, Meat and Livestock Australia, NSW Department of Primary Industries, CSIRO, South Australia Department of Primary Industries and Regions, Victoria Department of Economic Development, Jobs, Transport and Resources
	Inland Water Pests	CSIRO, NSW Department of Primary Industries, New Zealand Department of Conservation
Strengthened social networks and institutions around pest animal control	Community Engagement	University of New England, Pennsylvania State University (USA), NSW Department of Primary Industries

PhD candidate Elodie Modave, analysing predator scats, as part of her project to further refine the eDNA detection tools (image taken by Anna MacDonald)

OUTCOME 1
NO NEW VERTEBRATE PESTS ESTABLISHED IN AUSTRALIA

OUTCOME 1: NO NEW VERTEBRATE PESTS ESTABLISHED IN AUSTRALIA	
Theme 1	Incursions response and pest intelligence systems
CA output 1.1	National incursions response and pest intelligence
1.L.1	National Incursions Response Facilitator
1.L.2	Pest-Information hub (Pest iHub)
1.L.4	Exotic vertebrate risk analysis and complex invasion pathway framework
1.L.5	Mobile devices and web-mapping tools for pest species
Theme 1	Forecasting and adaptive planning
1.L.11	Prioritising adaptation actions for managing invasive animals under climate change
CA output 1.2	Long term Tasmanian fox incursion response
1.L.21	Mechanised extraction and next generation sequencing for the analysis of trace DNA in predator scats
1.L.22	Detection and monitoring for fox incursions in Tasmania
1.L.23	Risk assessment for new fox control techniques in Tasmania
1.L.24	Long-term strategy for the Tasmanian Fox program
CA output 3.1	Pest fish detection techniques
1.W.1	The utility of eDNA as a tilapia surveillance tool
1.W.2	New eDNA surveillance for multiple high risk invasive aquatic species

NATIONAL INCURSIONS RESPONSE FACILITATOR

Project leader

Dr Michelle Christy, Department of Primary Industries and Regional Development, Western Australia

Project summary

In addition to loss of biodiversity, vertebrate pests present significant challenges to the sustainability of biologically-based economic systems such as agriculture, aquaculture, forestry, horticulture and tourism as well as having impacts on social amenity/infrastructure.

Incursion prevention and early detection of pest species has been demonstrated to be the most cost-effective stage of the invasion process at which to direct management effort. The aim of the National Incursions Response Facilitator (NIRF) project is to research and develop a nationally recognised incursion response system that can respond to pre-incursion (preventing species from entering Australia) and post-incursion (following entry into Australia) events.

The key to program success is incursion prevention, early detection, and rapid response to invasion. Once implemented, the system should provide tools and techniques to decrease the risk of invasive vertebrate species establishing in Australia.

The ultimate outcome of the project is to prevent new vertebrate pest incursions to Australia.

Project objectives

1. Identify and prioritise incursion risks to Australia.
2. Develop a nationally-endorsed Incursion Response (NIR) Strategy. The NIR Strategy will provide a consistent, practical guide to achieve the ultimate goal of incursion prevention, early detection and effective response.
3. Develop nationally endorsed NIR Plans to support the NIR Strategy.
4. Develop an NIR Training Program to support NIR Strategy and Plans.
5. Facilitate cooperation and information exchange between collaborators.
6. Improve and promote public and stakeholder awareness of vertebrate pest incursion management.

Project impacts

› Completed the *draft National Incursion Prevention and Response (NIPR) Strategy* which provides nationally agreed principles, goals and priorities aimed at facilitating Australia's ability to respond to incursions of potentially invasive animals. This is a key publication that will facilitate the expansion and guide future direction of animal and plant incursion management.

› Completed and published the Invasive Animals and Plants Committee (IPAC) endorsed *National Incursion Response Plan for Terrestrial Snakes*. The plan delivers nationally consistent guidance aimed at incursion response activities of non-indigenous terrestrial snakes (Order Squamata). This document is now being used by states and territory Governments for emergency response preparation.

› Completed shared responsibility concept plan using the Hazard Analysis and Critical Control Point (HACCP) model adapted for invasive species (IS-HACCP). The "National Incursion Prevention and Response Program - A National Incursion Management Standard: Adapting the HACCP Model to Manage Incursions of Potentially Invasive Species. Concept Plan" introduces the approach, discusses its components and how it could potentially work to strengthen Australia's biosecurity, particularly through sharing responsibility and creating operational partnerships with industries and other community groups.

› Completed "National Incursion Prevention and Response Program - A National Incursion Management Toolkit". This toolkit provides summaries of work completed by other incursion researchers to support and deliver stakeholders a practical means adopting and utilising the information.

› Developed a training module for shared responsibility and pathway intervention. Phases include the development of a draft training manual, and the development and delivery of awareness training workshops and presentations. This training is instrumental in the advancement of an industry-led incursion planning process.

› Drafted factual extension material around the National Surveillance Targets, designed to be used in a range of formats (factsheet, web, app) to raise national awareness of the ten Category 1 (National Surveillance) vertebrates approved by the Invasive Plant and Animal Committee (IPAC).

› Provided path to adoption for selected information and tools through the development of selected toolkit elements (e.g., forms, evaluation material, and protocols) in addition to facilitating the uptake of research and tool development (e.g., eDNA, risk assessment) by jurisdictions for incursion prevention and response.

› Strengthened and expanded the NIPR network and functioning NIPR focus group encompassing representatives from Victoria, Western Australia, Queensland, New South Wales, and Tasmania. This group regularly exchanges information and collaborates together and with the NIRF.

› Assisted on a variety of incursion notifications and responses throughout Australia. These actions have consolidated and strengthened incursion incident reporting and response.

Where to next?

Aspects of this project will continue through the Centre for Invasive Species Solutions. This will ensure the strategic documents and toolkits developed through this project can be utilised by key stakeholders, such as government agencies, and that collaboration in this area is maintained.

Project team

Dr Michelle Christy, Mr Viv Read, Dr Malcolm Kennedy, Assoc. Prof Phillip Cassey, Dr Andrea Byrom, Dr John Virtue and Dr Andrew Woolnough

Project collaborators

GOVERNMENT:

Australian Government Department of Agriculture and Water Resources.

Australian Government Department of the Environment and Energy.

Western Australian Department of Primary Industries and Regional Development.

Primary Industries and Regions South Australia.

Victorian Department of Economic Development, Jobs, Transport and Resources.

Queensland Department of Agriculture and Fisheries.

Tasmanian Department of Primary Industries, Parks, Water and Environment.

NSW Department of Primary Industries.

Invasive Plant and Animal Committee (IPAC). Incursions Working Group.

INDUSTRY, RESEARCH, OTHER:

University of Adelaide.

Wildlife Health Australia.

Nursery and Gardens Industry Australia.

Landcare Research New Zealand.

US Geological Survey.

US Fish and Wildlife Service.

SeaGrant USA.

Project resources

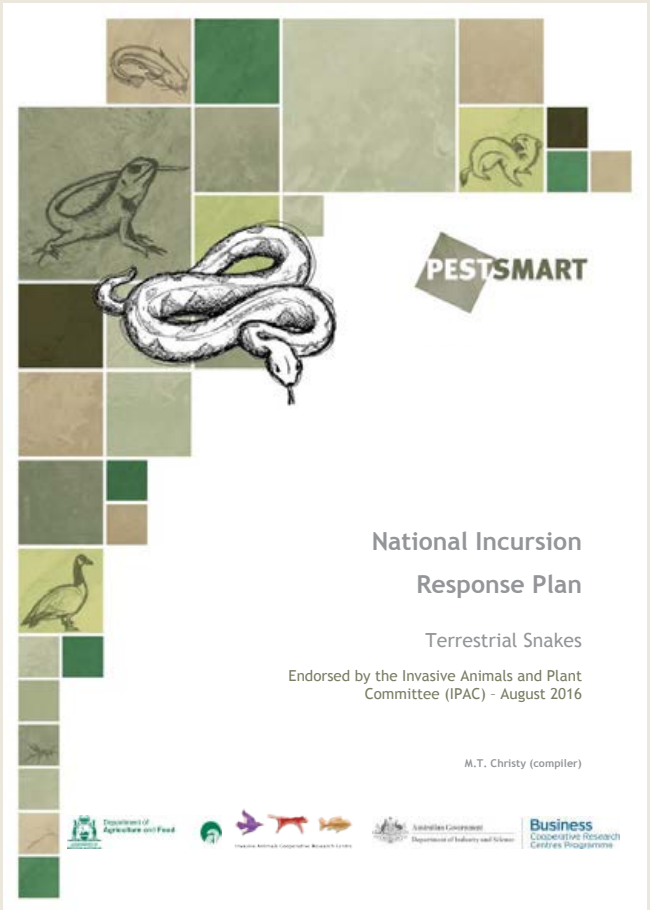
All information relating to this project can be found via www.pestsmart.org.au/incursions

Christy, M (2016). National Incursion Response Plan for Terrestrial Snakes. PestSmart Toolkit publication, Invasive Animals Cooperative Research Centre, Canberra, Australia.

Christy, M (2017) National Incursion Prevention and Response Strategy for Potentially Invasive Animals (2017-2022). Consultation Draft. PestSmart Toolkit publication, Invasive Animals Cooperative Research Centre, Canberra, Australia.

Christy, M (2017) National Incursion Prevention and Response Program - A National Incursion Management Standard: Adapting the HACCP Model to Manage Incursions of Potentially Invasive Species. Draft Concept Plan. Invasive Animals Cooperative Research Centre, Canberra, Australia.

Christy, M (2017) National Incursion Prevention and Response Program - A National Incursion Management Standard: Adapting the HACCP Model to Manage Incursions of Potentially Invasive Species. Draft Concept Plan. Invasive Animals Cooperative Research Centre, Canberra, Australia.



The National Incursion Response Plan for Terrestrial Snakes was released in early 2017 as part of a number of strategic documents to assist in incursion planning for government agencies

PEST INFORMATION HUB (PEST iHUB)

Project leader

Dr Dean Anderson, New Zealand Landcare Research

Project summary

The Pest iHub is a scientific approach for enhancing the effectiveness of vertebrate pest management and policy development.

Management questions are organised around four pest-management actions: incursion detection, eradication, containment and asset protection. The Pest iHub begins with management questions and ends with optimal bio-economic actions, guided by a modelling approach that integrates stakeholder input at every step.

At the outset of a collaborative project, the stakeholder defines the management question, which has the following general form: "what action and effort are required to meet the management objectives given biological, economic and socio-political constraints?" Importantly, this question is applicable to any pest management system.

The modelling framework integrates five key elements:

1. Stakeholder questions and data.
2. Biology of the species.
3. Risk assessment.
4. Statistical modelling.
5. Reliable decision theory.

While these elements by themselves are not novel, most management decisions are presently based only on cursory assessment of data, risks and economic constraints.

The Pest iHub addresses six key areas:

1. Eradication of pest birds.
2. Eradication of invasive vertebrates from islands.
3. Forecasting and early warning of invasive species outbreaks.
4. Development of optimal management strategies in the face of a new incursion.
5. Elaborating optimal programs for preventing pre-border incursions from the exotic-wildlife trade.
6. Reliable decisions for simultaneous control of multiple invasive species.

Each of these six areas will be addressed using case studies that have already been identified with the agreement of stakeholders. Emerging from this work will be important theoretical and statistical advances to increase our understanding of population dynamics, animal movements and detection at low densities, multi-species interactions, incursion processes and applied decision theory. Perhaps most importantly, Pest iHub integrative modelling will become the norm and not the exception in invasive species management.

Project objectives

1. Elaborate a modelling framework that can be generalised to all pest-management systems with guiding principles for data needs, species-biology information, risk assessment, statistics and reliable decisions.
2. Ensure stakeholder collaboration/input from beginning to completion of each of the project areas.
3. Address all five key Pest iHub elements in each of the case studies.
4. Provide evidence-based recommendations on management actions to stakeholders in each case study.
5. Develop more case studies beyond the initial six as the need arises.

Project impacts

- Developed two surveillance data modelling approaches that have the potential to make very important contributions in avoiding or eliminating the deleterious effects of invasive species.
- Completed analysis which reveals that using missing pet websites is a novel resource to obtain information on the numbers and localisation of newly escaped companion animals and constitutes a useful source of information to better understand bird incursions generally.
- Modelling of high-risk areas for starling settlement in WA, to make evidence-based decisions on how to prioritise search effort, has led to the placement of avian audio recorder devices in remote high risk areas as part of the organised surveillance effort.
- Eradication modelling was applied to red-eared slider turtles in Victoria, which demonstrated the complexity of eradication when resources are limited. Results showed that a cost-prohibitive number of trap nights were required to achieve a high level of confidence in eradication success.

Where to next?

- A number of projects focusing on developing eradication planning tools have been proposed for future research and development funding consideration.

Project team

Dr Dean Anderson, Dr Andrea Byrom, A. Prof Phillip Cassey, Dr Peter Baxter, Dr David Ramsey, Dr Malcolm Kennedy, Dr Andrew Woolnough and New Zealand Department of Conservation representatives

Project collaborators

GOVERNMENT:

Western Australia Department of Primary Industries and Regional Development.

Victorian Department of Economic Development, Jobs, Transport and Resources.

NSW Department of Primary Industries.

New Zealand Department of Conservation.

INDUSTRY, RESEARCH, OTHER:

University of Adelaide.

University of Queensland.

Arthur Rylah Institute.

New Zealand Landcare Research.

USA National Wildlife Research Centre.

Project resources

Anderson, D. P., P. McMurtrie, K.-A. Edge, P. W. J. Baxter, and A. E. Byrom. (2016). Inferential and prediction modelling to inform management of invasive mammals on islands. Ecological Applications 26:2548-2559

Anderson, D. P., A. M. Gormley, D. S. L. Ramsey, P. W. J. Baxter, G. Nugent, P. A. J. Martin, M. Bosson, P. Livingstone, and A. E. Byrom. (2017). A bio-economic decision process for in broadscale eradications of invasive pests and disease. Biological Invasions.

Brown, W.E., Ramsey, D.S.L., Gaffney, R., (2015) Degradation and detection of fox (Vulpes vulpes) scats in Tasmania: evidence from field trials. Wildlife Research 41, 681-690.

García-Díaz, P., Ramsey, D.S.L., Woolnough, A.P., Franch, M., Llorente, G.A., Montori, A., Buenetxea, X., Larrinaga, A.R., Lasceve, M., Álvarez, A., Traverso, J.M., Valdeón, A., Crespo, A., Rada, V., Ayllón, E., Sancho, V., Lacomba, J.I., Bataller, J.V., Lizana, M., (2017). Challenges in confirming eradication success of invasive red-eared sliders. Biological Invasions

Vall-llosera, M., A. P. Woolnough, D. P. Anderson, and P. Cassey. (2017). Improved surveillance for early detection of a potential invasive species: the alien Rose-ringed parakeet Psittacula krameri in Australia. Biological Invasions.

Dr Pablo Garcia-Diaz (successful PhD candidate from the IA CRC) published findings in the journal *Biological Invasions* which analysed a series of programs to eradicate or control the invasive red-eared slider turtle from southern Europe, making comparisons to growing local and national threat in Australia (image supplied by Pablo Garcia-Diaz).

EXOTIC VERTEBRATE RISK ANALYSIS AND COMPLEX INVASION PATHWAY FRAMEWORK

Project leader

Associate Professor Phillip Cassey, University of Adelaide

Project summary

This project will establish up-to-date datasets on the identities and abundances of exotic vertebrate species in retail, private and public Australian collections.

Statistical and mathematical approaches will be used to provide computational tools for calculating species incursion risks and constructing complex pathway models for identifying the specific supply regions, transport modes, user groups and taxa that pose the greatest risk to the entry and establishment of pest populations in Australia.

Project objectives

1. Conduct a statistical framework analysis of the successful eradication programs for vertebrate pest species on islands around Australia.
2. Construct up-to-date datasets for the identity of exotic vertebrates in Australian wildlife trade and collection.
3. Develop robust risk pathway analyses for predicting future exotic vertebrate incursions into Australia.

Project impacts

- Published more than 20 journal articles within the scientific literature over the period of the project on topics in relation pest incursion risks within Australia.
- Completed and published a review of Australian vertebrate pest eradication experiences – available online.
- Dr Pablo Garcia Diaz completed, submitted and has had his PhD thesis conferred within the timeframe of the project.

Where to next?

- Future research into understanding and intervening in illegal trade of non-native species has been proposed and is being considered for funding thorugh the Centre for Invasive Species Solutions.

Project team

Assoc. Prof Phillip Cassey, Dr Dean Anderson, Mr Pablo García-Díaz, Dr Miquel Vall-llosera Camps, Ms Elizabeth Smee and Ms Talia Wittmann.

Project collaborators

GOVERNMENT:

Victorian Department of Economic Development, Jobs, Transport and Resources.

Primary Industries and Regions South Australia

Western Australia Department of Primary Industries and Regional Development.

NSW Department of Primary Industries.

Invasive Animals and Plants Committee

INDUSTRY, RESEARCH AND OTHER:

Zoological and Aquarium Association

University of Adelaide.

New Zealand Landcare Research.

Project resources

This project has produced more than 20 peer-reviewed scientific publications based on the research outcomes – below are a selection of these.

Cassey P, Hogg CJ (2015) Escaping captivity: the biological invasion risk from vertebrate species in zoos. *Biological Conservation* 181: 18-26.

García Díaz P, Ross JV, Woolnough AP, Cassey P (2016) Managing the risk of wildlife disease introduction: pathway level biosecurity for preventing the introduction of alien ranaviruses. *Journal of Applied Ecology*, 54: 234-241.

García Díaz P, Ross JV, Woolnough AP, Cassey P (2016) The illegal wildlife trade is a likely source of alien species. *Conservation Letters*

García Díaz P, Cassey P (2014) Patterns of transport and introduction of exotic amphibians in Australia. *Diversity and Distributions 20*: 455-466.

Gregory S, Henderson W, Smee E, Cassey P (2014) Eradications of vertebrate pests in Australia: a review and guidelines for future best practice. *PestSmart Toolkit* publication, Canberra, Australia.

Vall-llosera M, Woolnough AP, Anderson D, Cassey P (2016) Improved surveillance for early detection of a potential invasive species: the alien Rose-ringed parakeet *Psittacula krameri* in Australia. *Biological Invasions*, 19: 1273-1284.

Vall-llosera M, Cassey P (2017) Leaky doors: private captivity as a prominent source of bird introductions in Australia. PLoS ONE 12, e0172851.

Infographic supplied by University of Adelaide

MOBILE DEVICES AND WEB-MAPPING TOOLS FOR PEST SPECIES

Project leader

Mr Peter West, NSW Department of Primary Industries

Project summary

This project provides new platform technology through customised smartphone and mobile device applications (apps) and real-time web-mapping using citizen science to support pest animal management. It provides integrated pest species intelligence and resources directly into the hands of land managers, pest control professionals and the biosecurity community to support surveillance, incursion detection, containment, control, eradication, monitoring and reporting. Through a series of field-ready applications, this project provides mobile technology for improving stakeholder capacity to undertake targeted pest control and participate in pest animal management.

This project addresses the need to develop and institutionalise operational tools and technology for enhanced pest species detection and decision making.

Project objectives

1. Develop new digital platform technology to increase connectivity of end users with pest control information (including PestSmart).
2. Develop new field-ready smartphone and mobile device technology including new field guides to pest animals and pest detection tools (including rabbits, wild dogs and carp) to put resources directly into the hands of end users Australia - wide.
3. Develop improved web-mapping technology through the FeralScan website for mapping pest animals and new customised mapping facilities for key stakeholders Australia-wide.
4. Build improved integrated datasets on pests to support decision making Australia-wide.
5. Improve end-user skills and capacity through online training with mobile technology.

Project impacts

- FeralScan now hosts more than 100,000 pest animal records and photographs since beginning in 2011.
- The FeralScan suite includes:
  - A Rabbit Biocontrol Tracker website and App which was developed to enhance reporting of disease as part of the National RHDV Monitoring Program
  - FeralCatScan website and App - identified as a reporting tool of the national Threatened Species Strategy.

Peter West giving a presentation to a community group in Booroowa, NSW on how to effectively use the RabbitScan program to assist in the management programs (image supplied by Megan Dixon)

  - » The use of WildDogScan as a key resource and promoted by the National Wild Dog Action Plan Stakeholder Consultative Group.
  - » A Feral DeerScan Prototype, which is currently being road tested
- › The FeralScan suite is now being utilised as part of the management programs for many land management and land care agencies.
- › The FeralScan suite was awarded an prestigous 2016 Banksia Award Sustainability Award for its impact.

Where to next?

The FeralScan project will be maintained and enhanced into the future through the Centre for Invasive Species Solutions

Project team

Mr Peter West, Ms Jessica Marsh, Dr John Tracey.

Project collaborators

GOVERNMENT:

Australian Government Department of Environment and Energy.

Parks Australia.

NSW Department of Primary Industries.

Western Australia Department of Primary Industries and Regional Development.

ACT Government.

NSW National Parks and Wildlife Service.

NSW Office of Environment and Heritage.

NSW Local Land Services.

Victorian Department of Economic Development, Jobs, Transport and Resources.

Tasmanian Government Department of Primary Industries, Parks, Water and Environment.

South Australian Department of Environment, Water and Natural Resources.

Wollongong City Council.

Mallee CMA.

Sydney Coast Councils Group.

Phillip Island Council.

Rockdale City Council.

Goulburn Broken CMA.

Kangaroo Island NRM.

King Island NRM.

Western Plains Regional Council.

INDUSTRY, RESEARCH AND OTHER:

NewtonGreen Technologies.

Commonwealth Scientific and Industrial Research Organisation.

University of Adelaide.

University of Western Sydney.

University of New England.

Atlas of Living Australia.

IPAC National Indicators Working Group.

Clarence Valley Conservation in Action Landcare Group.

Upper Murrumbidgee Demonstration Reach. Murrumbidgee Landcare Group.

Canberra Indian Myna Action Group.

Granite Borders Landcare Committee.

Tenterfield Wild Dog Control Group.

Grains Research and Development Corporation.

Bush Heritage Australia.

Agriculture Kangaroo Island.

Natural Resources SA.

Mallee Landcare Group.

Greater Mallee Landcare Area Group.

North-east Singleton Wild Dog Association.

Central West Farming Systems group.

Foundation of National Parks and Wildlife

Kanangra to Wyangala (K2W).

Bellarine Landcare Group.

Natural Resources South Australia Murray-Darling Basin.

Natural Resources Northern & Yorke, Central Highlands Resource Planning Use Cooperative.

Kangaroo Island Council.

Natural Resources Kangaroo Island.

ACT Waterwatch.

Conservation Volunteers Australia.

New Zealand Landcare Research.

Project resources

All the information regarding this project can be found via www.feralscan.org.au and www.pestsmart.org.au/mobile-phone-apps

West, P (in print) Field Guide to the Pest Animals of Australia. CSIRO Publishing (not yet published, available soon)

PRIORITISING ADAPTATION ACTIONS FOR MANAGING INVASIVE ANIMALS UNDER CLIMATE CHANGE

Project leader

Dr Cameron Fletcher, Dr Josie Carwardine, CSIRO

Project summary

Climate change will bring about substantial changes in the environment and the biotic interactions among species. These changes are likely to necessitate new approaches to the management of invasive animals.

Invasive animals will be subject to the pressures and opportunities climate change provides and are likely to contribute additional pressure on native and livestock species already disadvantaged by the changing climate.

The management of native species and ecosystems in Australia to prevent catastrophic loss and change is one of the major challenges of the coming 50 –100 years. Invasive animals have been identified as one of the leading causes of biodiversity loss in Australia and have considerable economic impacts. Effectively responding to the threat of invasive animals, within foreseeable financial and logistic constraints and while adapting to changing climate drivers, will be key to determining the success of meeting this challenge.

The research effort on how invasive species will respond to climate change has focussed on understanding potential shifts in geographic distribution and identifying and choosing between adaptation actions (potential actions for managing threats under climate change).

This project is based on the assumption that we cannot undertake all possible actions to manage invasive threats in all places and at all times. Ultimately we are forced to make choices of where, when and how much to invest in various adaptation actions, including monitoring for the effects of changes and actions. In order to make these decisions we need approaches that allow us to assess different adaptation actions and their likely cost-effectiveness under global climate change, over various scales and levels of complexity.

This project will develop such a portfolio of approaches, within three sub-projects:

- A cost-effectiveness approach for choosing between adaptation actions for managing multiple invasive animal species (at regional scales, using the Lake Eyre Basin (LEB) as a case study).
- A dynamic approach for prioritising amongst management and monitoring adaptation actions over time for multiple populations of an invasive species (at local or regional scales).
- A spatially explicit and dynamic approach to prioritising the management of invasive animal populations, taking account of spatial interactions between management and the invasive species over time at local scales, using the Wet Tropics as a case study.

Project objectives

1. Generate prioritised climate adaptation management actions through the development of an invasive species cost-effectiveness framework within the Lake Eyre Basin and provide an approach which can be applied in other regions and at other scales.
2. Derive simple and robust rules of thumb to help practitioners allocate resources over time to manage and monitor (survey) undesirable sub-populations of invasive animals, under changing climate conditions, using an application within the Lake Eyre Basin.
3. Use new technologies for monitoring invasive animal movement at individual and population levels and advanced modelling approaches to develop tools, frameworks and guidelines to assess the spatial and temporal interaction between management and vertebrate pest populations, under changing climate conditions, with an application in the Wet Tropics regions of Queensland
4. Integrate the findings of projects 1–3 to produce a portfolio of approaches to the cost effective management of invasive animals under changing climate conditions and to provide guidance on the kinds of problems each approach would be suitable for.

Project impacts

- Developed a priority list of invasive animal management options for the Lake Eyre Basin that maximised the biodiversity and agricultural benefit per unit cost under current and future climatic conditions. The results were presented to end-users in a pamphlet style report “Priority Threat Management of Invasive Animals to protect biodiversity – Lake Eyre Basin” – also available online.
- One key result of the Priority Threat Management analysis was that feral pig management is the most cost-effective strategy for biodiversity outcomes. This has been downscaled to outline the factors determining optimal feral pig management strategies in rainforest ecosystems in Queensland, and is currently being expanded to other regions.

› Finalised a new method for scheduling eradication activities of the invasive fish *Gambusia* for the high conservation area, Edgbaston Springs, QLD. This will enable optimal scheduling of multiple simultaneous management actions across many locations, as well as a new application of classification trees to simplify complex policies into usable rules of thumb that can be applied by managers.

Project team

Dr David Westcott, Dr Tara Martin, Dr Cameron Fletcher, Dr Iadine Chades, Dr Josie Carwardine, Dr Sam Nicol, Ms Belinda Walters, Mr Dean Jones, Dr Peter Baxter, Dr Eve McDonald-Madden, Prof Hugh Possingham, Mr Salvo Vitelli, Mr Bart Dryden, Ms Tania Simmons and Mr Travis Sydes.

Project collaborators

GOVERNMENT:

Queensland Department of Agriculture and Fisheries.

Far North Queensland Regional Organisation of Councils.

INDUSTRY, RESEARCH AND OTHER:

Commonwealth Scientific and Industrial Research Organisation.

Queensland University of Technology.

University of Queensland.

Terrain Natural Resource Management.

National Research Institute of Agronomy.

Project resources

Firn, J., Martin, T., Walters, B., Hayes, J., Nicol, S., Chades, I. and Carwardine, J. (2013), Priority threat management of invasive plant species in the Lake Eyre Basin*, Climate Adaptation Flagship Working Paper No. 17*, CSIRO and Queensland University of Technology.

Firn, J, et al., (2015), Priority threat management of invasive animals to protect biodiversity under climate change, *Global Change Biology*, 1-8. ‘

Firn J, Carwardine J. (2015). Saving the Lake Eyre Basin’s biodiversity. *Australian Veterinary Journal*, 93(12): N22

Nicol, S., Haynes, T., Fensham, R. and Kerezsy, A. (2015), An application of two-species occupancy modelling to quantify the factors driving extinction of a critically endangered Australian fish, the red-finned blue-eye, *Scaturiginichthys vermeilipinnis*, *Ecosphere*, 6(3): 41

Feral pigs in North Queensland can cause a lot damage to the environment (image taken by Steve Maxwell).

MECHANISED EXTRACTION AND NEXT GENERATION SEQUENCING FOR THE ANALYSIS OF TRACE DNA IN PREDATOR SCATS

Project leader

Professor Stephen Sarre, Institute for Applied Ecology, University of Canberra

Project summary

Two developments in scat DNA analysis that would provide important efficiency gains for the detection of foxes in Tasmania will be trialled:

Mechanized extraction of trace DNA from predator scats; and

› Next Generation DNA sequencing approaches to the analysis of predator scat DNA.

This will improve the DNA analysis of scats detected through monitoring and surveillance strategies. They will provide timely information about the possible presence of foxes in Tasmania and of other key vertebrate pests (cats, dogs) and native fauna.

Project objectives

1. Develop faster, more efficient DNA fox detection.
2. Develop tools for obtaining greater information from predator (fox) scats:
   - » Higher proportions of fox scats genotyped
   - » Identification of prey in fox scats including prey provenance.
3. Improve estimates of fox population size and distribution.

Project impacts

› Developed and implemented robotic extraction for trace DNA. Demonstrated that this method was faster and less expensive than the previous manual approach. The robot extraction approach was adopted for the 2014 scat survey conducted by the Tasmanian Government and the University of Canberra.

› Successful adoption of a citizen science approach to the collection of predator scats for the survey conducted by the Tasmanian Government and the University of Canberra in 2014.

› Conducted metabarcoding for predator and prey has been for around 900 scats collected in Tasmania including all remaining scats that tested positive for fox. The analysis of these data is underway.

› Completed survey of fox and other predator scats and integrated into a publication on detection probabilities.

› Elodie Modave and Catriona Campbell submitted their PhD Theses for marking and one honours student has had her Thesis accepted (Nov 2016).

› 11 scientific peer-reviewed publications have resulted from this work.

Project team

Prof Stephen Sarre, Dr Anna MacDonald, Mr Peter Cremasco, Dr Stephen Harris, Ms Candida Barclay, Ms Elise Dewar, Ms Catriona Campbell, Ms Elodie Modave and Ms Sumaiya Quasim.

Project collaborators

GOVERNMENT:

Tasmanian Department of Primary Industries, Parks, Water and Environment.

INDUSTRY, RESEARCH AND OTHER:

University of Canberra.

Queen Victoria Museum.

Tasmanian Museum and Art Gallery.

Holsworth Wildlife Research Endowment

NRM North Community

New Zealand Landcare Research

Project resources

Blackman, D, Corcoran, A, Sarre, S (2013) Are there really foxes: Where does the doubt emerge? *Journal of Knowledge Management Practice*: 14(1)

MacDonald, A.M., Sarre, S.D. (2015) Species assignment from trace DNA sequences: an in silico assessment of the test used to survey for foxes in Tasmania. *Journal of Applied Ecology*, 52 (6) 1649-1655

MacDonald, A.J. and Sarre, S.D. (2016) Framework for developing and validating taxon-specific primers for specimen identification from environmental DNA. *Molecular Ecology Resources.*

Modave, E., MacDonald, A.J., Sarre, S.D. (2017) Mini-barcode for species identification. GigaScience.

Sarre, SD, Macdonald, AJ, Barclay, C, Saunders, GR & Ramsey, DSL. (2012) Foxes are now widespread in Tasmania: DNA detection defines the distribution of this rare but invasive carnivore. *Journal of Applied Ecology*, 50, 459-468.

Scat sample being prepared for eDNA analysis (image supplied by Anna MacDonald)

Sarre, S.D., MacDonald, A.J., Berry, O.F., Barclay, C., Saunders, G.R. and Dave S.L. Ramsey (2014). Defining specificity in DNA detection of wildlife: Response to Gonçalves et al. "The risks of using "species-specific" PCR assays in wildlife research: The case of red fox (*Vulpes vulpes*) identification in Tasmania" Forensic Science International Genetics. 13: 206–207.

Ramsey, D.S.L., MacDonald, A.J., Quasim, S., Barclay, C. and Sarre, S.D. (2015) An examination of the accuracy of a sequential PCR and sequencing-based test used to detect the incursion of an invasive species: the case of the red fox in Tasmania. Journal of Applied Ecology 52 (3) 562-570.

"This project developed and implemented a robotic extraction technique for trace DNA in scat samples. This method was proven to be much faster and less expensive than the manual approach"

DETECTION AND MONITORING FOR FOX INCURSION IN TASMANIA

Project leader

Dr David Ramsey, Arthur Rylah Institute for Environmental Research

Project summary

The ability to detect and destroy the last individuals of an invasive species in an eradication effort continues to be one of the most difficult parts of an eradication program. Similarly, the ability to assess the effectiveness of various eradication techniques in areas of low densities of the target species is equally important to assist in the selection of appropriate tools to target those last individuals and achieve eradication. The accuracy of monitoring and effectiveness of destruction tools at extremely low fox densities are currently unknown.

A long-term strategy for managing fox establishment or incursion in Tasmania was emphasised in a review of the Tasmanian fox programs by Saunders et al. (2006). Such a strategy will require confidence in monitoring to detect density thresholds that trigger management action.

Presently there is uncertainty about the presence, let alone size, of fox populations in Tasmania with no physical evidence having been collected in the last two years and a general decline in the number of reported sightings since January 2008. The response has been a cessation of broad-scale baiting, but the continuation of landscape-scale monitoring with targeted baiting in response to fox evidence.

This project tests the adequacy of the design of the monitoring program, and establishes a small mammal monitoring framework in core fox habitat. The products of this project are fundamental to the development of a long-term strategy for the eradication and prevention of more foxes entering in to Tasmania.

This project analysis was based on scat monitoring in Tasmania, which later helped inform the long-term Tasmanian fox incursion strategy (image supplied by Tasmanian government)

Project objectives

1. Determine the probability of scat detector dogs detecting a fox scat at different levels of survey effort within two different spatial sampling grid resolutions (3x3 km, 1x1 km).
2. Use a simulation exercise to determine the probability of detecting a fox within the landscape at each of the two different spatial sampling grid resolutions (3x3 km, 1x1 km).

Project impacts

- Completed an assessment of the probability of detecting a fox incursion in Tasmania using scat monitoring and the research has been published in the scientific literature.
- Research outcomes from this project have assisted in the development of a long-term Tasmanian fox incursion strategy.

Project team

Dr David Ramsey, Mr Peter Cremasco, Mr Craig Elliot, Dr Stephen Harris, Ms Candida Barclay.

Project collaborators

GOVERNMENT:

Tasmanian Department of Primary Industries, Parks, Water and Environment.

INDUSTRY, RESEARCH AND OTHER:

University of Canberra

New Zealand Landcare Research.

Project resources

Brown, W. E., Ramsey, D. S. L., & Gaffney, R. (2015) Degradation and detection of fox (*Vulpes vulpes*) scats in Tasmania: evidence from field trials. *Wildlife Research* 41, 681–690.

Ramsey, DSL., MacDonald, AJ., Quasim, S., Barclay, C., and Sarre, SD. (2015). An examination of the accuracy of a sequential test used to detect the incursion of an invasive species: the case of the red fox in Tasmania. Journal of Applied Ecology 52: 562-570.

Ramsey D, Barclay, C., Campbell, C., Dewar, E., MacDonald, A., Modave, E., Quasim, A., Sarre, S. (2017) Detecting rare carnivores using scats: implications for monitoring a fox incursion into Tasmania. Ecology and Evolution.

RISK ASSESSMENT FOR NEW FOX CONTROL TECHNIQUES IN TASMANIA

Project Leader:

Ms Candida Barclay, Tasmanian Department of Primary Industries, Parks, Water and Environment

Project summary

Fox control in Tasmania is heavily reliant on the use of the 1080 toxin used in one of two bait matrices – FoxOff® and ProBait® - that is shallow buried in the landscape. The combination of the toxin and the method of delivery place limitations on where control can lawfully occur and its efficacy.

The use of 1080 is restricted by the proximity to residential areas, size of landholdings, method of application and timing and duration of placement. Bait material is subject to potential removal by non-target wildlife, or environmental degradation due to microbial action or physical actions such as leaching.

In recent years, other toxins and delivery methods have been investigated for their potential to control a range of invasive species. There is now a body of research data available from a variety of sources, with some alternatives now being considered for registration.

This project aims to collate information on alternative toxins and delivery techniques and assess the risks and barriers to successful implementation against foxes in the Tasmanian environment.

Project objectives

1. Review existing literature primarily on three potential vertebrate pest toxicants – 1080, PAPP and cyanide, as well as any other highly prospective toxicants
2. Review existing literature on potential bait delivery systems, including M-44 ejectors, Spray Tunnel technology, elevated platforms, suspended cones and lethal trap devices.
3. Assess suitability of toxicants, delivery systems, or combinations of both for use in the Tasmanian environment from practical, impact risk and regulatory perspectives.

Project impacts

- Completed literature review into alternative toxicants for fox control in Tasmania and identified two possibilities: sodium cyanide (NaCN) and para-aminopropiophenone (PAPP).
- Completed risk assessment using published literature to assess the suitability of 1080, sodium cyanide and PAPP for use in the Tasmanian landscape on three main criteria: its toxicity to non-target species, its humaneness, and 'other' (such as the existence of an antidote, or the likelihood of carcass recovery). The applicability of mechanical ejectors was also considered.
- The review found that 1080 remains the recommended toxin for broad-scale use, PAPP would be recommended around peri-urban areas, and ejectors and sodium cyanide would be appropriate and beneficial in small and controlled public access areas such as ports in the event of a known incursion.

Where to next?

Results from this project have assisted in delivering the Long-term strategy for the Tasmanian fox program.

Project team

Ms Candida Barclay, Matt Pauza, Stephen Mallick Charlie Eason, Nick Mooney, Andrew Carter. Contributions from R. Gaffney, Annie Phillips, Simon Fearn, Jodie Elmer, Elise Dewar, Stuart Bowman, Greg Hocking, Mike Driessen, Brett Woodruff.

Project collaborators

GOVERNMENT:

Tasmanian Department of Primary Industries, Parks, Water and Environment.

INDUSTRY, RESEARCH AND OTHER:

Charles Sturt University.

Cawthron Institute.

Project resources

Mallick Stephen, Pauza Matthew, Eason Charles, Mooney Nick, Gaffney Robbie, Harris Stephen (2016) Assessment of non-target risks from sodium fluoroacetate (1080), para-aminopropiophenone (PAPP) and sodium cyanide (NaCN) for fox-incursion response in Tasmania. *Wildlife Research 43*, 140-152.

One of the outcomes from this project was an assessment of the use of non target risks from using poisons to manage fox-incursion responses in Tasmania (image supplied by ACTA)

LONG-TERM STRATEGY FOR THE TASMANIAN FOX PROGRAM

Fox in a canola field on mainland Australia (image by Danny McCreadie)

Project Leader:

Ms Candida Barclay, Tasmanian Department of Primary Industries, Parks, Water and Environment

Project summary

A review of the Tasmanian fox incursion and response (Saunders et al. 2006) recommended the development of a long-term strategy to cover all contingencies from successful eradication to the possibility of full establishment of foxes in the Tasmanian environment.

Clear indicators of progress towards eradication and likelihood of establishment are needed. To prepare for possible establishment, strategies need to be developed to implement actions to protect key biodiversity assets at risk from fox predation, particularly Tasmania's critical weight range fauna, many of which have disappeared from mainland Australia as a result of fox predation. Considerable risk to farming production would also result from establishment of foxes with a consequent high dollar cost to rural industries.

This project aims to address the recommendations of the Saunders et al. (2006) review, and allow the Tasmanian Government to better direct the allocation of resources to respond to the full range of contingencies.

Project objectives

Develop decision guidelines for evaluating the range of management scenarios concerning the prospects of success or failure in eradicating current or future incursions of foxes in Tasmania.

Develop comparative risk analyses of strategic options involving various combinations of baiting and monitoring and consequences of being unable to carry out one or the other.

Develop comparative risk and cost benefit analyses of incursion prevention and response measures.

Develop tools for mitigating risk to high value assets in the event of fox establishment.

Project impacts

- Synthesised all relevant information from numerous contributing works to also assist in forming the long-term strategy for managing fox incursion into Tasmania: how to minimise the risk, recommended surveillance options for early detection, and tools required for incursion response.
- Developed a conceptual map of management pathways and decision points for any future fox incursion
- Developed a cost-benefit analyses of possible ongoing fox surveillance options based on two conflicting data models (carcass model, and scat model)

"This project synthesised all relevant information from numerous contributing works to assist in forming the long-term strategy for managing fox incursion into Tasmania; including how to minimise the risk, recommended surveillance options for early detection, and tools required for incursion response"

- Undertaken an estimate of eradication success and a prediction of population trajectory and distribution across Tasmania based on fox carcass data and a range of passive surveillance datasets
- Undertaken an assessment of the risk involved in proclaiming eradication success given the adequacy of the assessment and ongoing unknown factors

Project team

Dr Tracey Rout, Dr David Ramsey, Dr Peter Caley, Ms Candida Barclay, Dr Glen Saunders, Dr John Tracey, Mr Craig Elliott, Prof Stephen Sarre, Dr Christopher Johnson.

Project collaborators

STATE GOVERNMENT:

Department of Primary Industries, Parks, Water and Environment Tasmania,

NSW Department of Primary Industries

INDUSTRY, RESEARCH AND OTHER:

University of Queensland,

Commonwealth Scientific and Industrial Research Organisation,

University of Tasmania,

University of Canberra.

Landcare Research New Zealand

Project resources

Caley, P., Ramsey, D.L. and Barry, S.C. (2015) Inferring the distribution and demography of an invasive species from sighting data: the red fox incursion into Tasmania. PLoS ONE 10(1): e0116631.

Ramsey, DSL, MacDonald, A., Quasim, S., Barclay, C. & Sarre, S (2015) An examination of the accuracy of a PCR-based test used to detect the incursion of an invasive species: the case of the red fox in Tasmania. Journal of Applied Ecology 52, 562-570

Rout, TM, Barclay, C, McDonald-Madden, E, Caley, P, & Ramsey, DSL. (2016). Finding cost-effective future monitoring strategies for foxes in Tasmania: is more modelling needed? Canberra: Invasive Animals CRC (unpublished report)

THE UTILITY OF eDNA AS A TILAPIA SURVEILLANCE TOOL

Project Leader:

Dr Richard Saunders, Queensland Department of Agriculture and Fisheries

Project summary

Invasive fish pose a major threat to aquatic ecosystems worldwide. Their impact can be severe in tropical regions, such as northern Australia, where over 20 invasive fish species are recorded from freshwater rivers and streams. The prevention of new incursions of invasive species is the goal, however when prevention fails, early detection of incursions is critical for successful control measures. To this end, environmental DNA (eDNA), the DNA that an organism leaves behind in the ecosystem, is proving to be a promising early detection tool for invasive aquatic species and has been used successfully to detect incursions of temperate invasive species. This research project aimed to modify conventional eDNA protocols developed by the University of Notre Dame (USA) for application in tropical environments to detect the invasive pest fish tilapia and to develop an understanding of the detection sensitivity of the method.

Broadly, the method involved collecting and filtering two litre water samples and testing the filtrate for the presence of tilapia eDNA with a species-specific probe. Essential to implementation was the successful development of a species-specific probe and selection of the appropriate filter types for turbid tropical environments. A tilapia specific probe was developed.

Eureka Creek, in the Mitchell River catchment of the Gulf of Carpentaria, is an important site because it was the location of an incursion of tilapia identified in 2008. An eradication program was implemented to remove tilapia from the creek and prevent the spread into other Gulf of Carpentaria river catchments. Follow-up sampling using traditional methods suggested that the eradication program was successful but some concerns remained. Thus, as part of this project a new eDNA survey of Eureka Creek was conducted to follow-up the eradication program. Three locations surrounding the original infestation were sampled. At each location three 2 L water samples from three sites were collected and tested for the presence of tilapia eDNA. No tilapia eDNA was detected in any of these samples adding further weight to the evidence that tilapia were successfully eradicated from Eureka Creek.

To contrast the effectiveness of eDNA as a surveillance tool with the primary traditional sampling tool for tilapia, that of electrofishing, a survey was conducted using both methods at 14 sites, in the lower Fitzroy River catchment, where a recent invasion of tilapia was reported. Tilapia were detected by eDNA methods in eight of the 14 sites surveyed. Two sites had no detectable tilapia eDNA and the remaining four sites failed to meet quality control standards and results from these sites were not confirmed. Positive detections were obtained for the eDNA survey from all three sites where tilapia were detected using electrofishing and at a further five sites where electrofishing failed to detect tilapia. Environmental DNA surveillance has proven to be an effective early detection tool for tilapia incursions and likely to be more sensitive than traditional survey methods but requires considerable care and precision in its implementation due to the potential for sample contamination.

Environmental DNA technology was successfully adapted for the specific purpose of tilapia surveillance and this has resulted in a high-quality service that will be beneficial to many organisations and associations to help early detection of tilapia incursions. Already, the uptake of eDNA as a method of tilapia surveillance and monitoring has occurred; the Fitzroy Basin Association and Catchment Solutions have employed the eDNA services developed from this project to survey the recent invasion of tilapia in central Queensland.

Project objectives

1. Replicate/improve upon the eDNA technology developed by the University of Notre Dame in an Australian genetics laboratory.
2. Use eDNA to confirm the success of a tilapia eradication program.
3. Determine the environmental persistence of tilapia eDNA.
4. Make a quantitative comparison with electrofishing as a surveillance tool.

Project impacts

- Developed eDNA technology to detect tilapia.
- Developed laboratory manual and field use protocols for eDNA detection.
- Applied eDNA method to look for evidence of tilapia in Eureka Creek, the location of a previous infestation that was the focus of an eradication program by Queensland Department of Primary Industry.
- Compared eDNA methods to alternative methods such as electrofishing and proven to be an effective and efficient surveillance tool for tilapia.
- The Fitzroy Basin Association and Catchment Solutions have employed the eDNA services developed from this project to survey the invasion of tilapia in central Queensland.

› Where to next?

eDNA technology is being further developed for future use as a decision support management tool

Project team

Dr Richard Saunders, Prof Dean Jerry, Tansyn Noble, Heather Robson, Dr Michael Hutchison, Keith Chilcott

Project collaborators

GOVERNMENT:

Queensland Department of Agriculture and Fisheries.

Industry, research and other:

James Cook University.

Project resources

Noble, T.H., Robson, H.L.A., Saunders, R.J. and Jerry, D.R. (2015). The utility of eDNA as a tilapia surveillance tool. *PestSmart Toolkit publication*, Invasive Animals Cooperative Research Centre, Canberra, Australia.

Mozambique tilapia eradication from Townsville in Queensland (image supplied by Queensland Government).

NEW eDNA SURVEILLANCE FOR MULTIPLE HIGH–RISK INVASIVE AQUATIC SPECIES

Project Leader:

Associate Professor Dianne Gleeson, University of Canberra

Project summary

Invasive aquatic species are a major threat to native species and ecological communities, nationally and internationally. Early detection of such species while they are still rare is the key to preventing their establishment but can be problematic using conventional sampling. Traditional detection techniques are unable to identify species at all life stages and are often unable to detect incursions until the species has reached a reasonably high density, often after they have become established. This seriously limits the ability to successfully contain or eradicate the species.

The project will use a combination of advanced DNA detection methods utilising genomic technologies with a robust analytical framework that will enable rapid field application for a wide range of taxa.

eDNA technologies have been shown to be an effective tool for detecting aquatic species at low-density including invasive fish. eDNA is also highly specific, allowing identification of species at all life stages including eggs and larvae, which often evade morphological identification.

Species-specific markers will be developed to target a number of Australia's most noxious invasive fish. Research activities will deliver a platform for rapid, sensitive and cost–effective detection for a wide range of aquatic pest species that threaten Australia's biosecurity. The project will also contribute towards establishing detection parameters and limitations around eDNA in Australian waterways with additional research into DNA degradation.

Dr Elise Furlan was a Post Doctoral fellow funded through this project based at the University of Canberra, analysing water samples for pest fish DNA (image supplied by Institute for Applied Ecology, UC)

Project objectives

1. Generate a list of candidate high-risk invasive species and obtain validated reference samples for each.
2. Select target species for experimental trials based on existing risk assessments, current operational activities and biological attributes.
3. Provide a conceptual analytical framework that informs experimental design for selected taxa.
4. Develop sensitive diagnostic molecular markers for species of high risk.
5. Conduct trials under both aquarium and outdoor containment to determine detectability parameters.
6. Establish high throughput detection systems that target multiple invasive aquatic species.
7. Develop standardised protocols for sampling with defined detection probability thresholds that are informative to management outcomes.

Project impacts:

- Completed eDNA field validations for three key invasive fish species (*Perca fluviatilis, Misgurnus anguillicaudatus, and Cyprinus carpio*).
- Developed a standardised protocol that incorporates field sampling, laboratory methods, and data analysis and interpretation that is the most cost effective and efficient using available technologies.
- Successfully implemented the direct application of eDNA for the management of an invasive species, redfin perch, with findings published in an international scientific journal.
- Developed a multispecies detection method for whole fish community analysis within a water system.
- Completed field-testing of the eDNA meta-barcoding high throughput detection system for multiple species within a community and submit results for publication.

Where to next?

eDNA technology is being further developed for future use as a decision support management tool, through the Centre for Invasive Species Solutions.

Project team

Assoc. Prof Dianne Gleeson, Dr Elise Furlan, Prof Richard Duncan, Prof Arthur Georges, Prof Stephen Sarre, Assoc. Prof Tariq Ezaz, Dr Mark Lintermans, Dr Chris Hardy

Project collaborators

GOVERNMENT:

Primary Industries and Regions South Australia.

NSW Department of Primary Industries.

Inland Fisheries Service Tasmania.

INDUSTRY, RESEARCH AND OTHER:

University of Canberra.

Commonwealth Scientific and Industrial Research Organisation.

Curtin University.

Cawthron Institute New Zealand.

University of Waikato New Zealand.

The Nature Conservancy USA.

Secretariat of the Pacific Community Noumea New Caledonia.

Key publications and information

Bylemans, J., Furlan, E.M., Pearce, L., Daly, T., Gleeson, D.M. (2016). Improving the containment of a freshwater invader using Environmental DNA (eDNA) based monitoring. *Biological Invasions.* 18: 3081.

Bylemans J., Furlan E.M., Hardy C.M., McGuffie P., Lintermans M., Gleeson D.M. (2016) An environmental DNA (eDNA) based method for monitoring spawning activity: a case study using the endangered Macquarie perch (*Macquaria australasica*).

Furlan E, Gleeson D (2016) Improving reliability in environmental DNA detection surveys through enhanced quality control. *Marine and Freshwater Research*.

Furlan E, Gleeson D (2016) Environmental DNA detection of redfin perch, *Perca fluviatilis*. *Conservation Genetics Resources*. 8:115.

Furlan E, Gleeson D, Hardy C, Duncan R (2016) A framework for estimating sensitivity of eDNA detection. *Molecular Ecology Resources*. 16:641-654.

Hinlo R, Furlan E, Suitor L, Gleeson D.M. (2017). Environmental DNA monitoring and management of invasive fish: comparison of eDNA and fyke netting. *Management of Biological Invasions* Management of Biological Invasions 8, (1) 89–100

A feral pig sow can potentially produce two litters of 4-10 piglets in a year (image taken by Leigh Deutscher)

OUTCOME 2 IMPROVED PREDICTION AND CONTROL OF EMERGING OUTBREAKS

OUTCOME 2: IMPROVED PREDICTION AND CONTROL OF EMERGING OUTBREAKS	
Theme 2	New toxins and delivery systems
CA output 2.1	Avicide
2.C.1	Avicides
CA output 2.2	Rodenticide
2.C.2	Rodenticides
2.C.3	Surveillance and forecasts for mouse outbreaks in Australian cropping systems
CA output 2.3	Feral pig / invasive species management products
2.C.4	HOGGONE® - USA field trials and US registration
2.C.5	Managing finalisation of new tactical tools
2.C.11e	Protecting the endangered malleefowl from introduced predators near Mt Hope, NSW (IAL project)
Theme 3	Fertility Controls
CA output 2.4	Fertility control
2.C.12	Fertility control oral delivery
2.C.13	Development of reagents for the sterilisation of pest animal species

AVICIDES

Project leaders

Dr Simon Humphrys, Invasive Animals Ltd (IAL), Dr Kurt Vercauteren, Dr Scott Werner, United States Department of Agriculture (USDA)

Project summary

IAL and the USDA's Animal and Plant Health Inspection Service (APHIS) National Wildlife Research Center (NWRC) are entering into an agreement to research and develop new humane lethal pesticides and delivery systems as wildlife management tools. Invasive animals rank only second to land clearing as the biggest threat to biodiversity around the world. At the same time individuals and governments are becoming more environmentally conscious and accountable as to how humans manage ecological threats. This dichotomy has seen governments actively withdrawing invasive species management tools despite the continuing demand. Internationally, there is a pressing need for more humane, species-tailored and environmentally-benign toxicants and anti-fertility agents for managing the threats posed by invasive species.

The United States and Australia are leading this push to ensure that they are not left without primary management tools.

In this project NWRC and IAL will develop delivery systems and toxicants for control of European starlings.

In Australia, development of sodium nitrite as a humane vertebrate pest toxicant has been occurring for five years and has involved research into improved formulations, risk analysis, residue assessment and registration hurdles.

In the US, pest birds are also require management and the NWRC has experience in developing and testing potential new avicides for starling management. This research program will ensure that Australia and the United States will mutually benefit from a research collaboration that will deliver tools and ultimately improve the humaneness and selectivity by which we manage European starlings in both countries.

Little research exists to support the development of an attractive avicide for European starlings, however some research has shown that birds have taste receptors that lead to preferential likes and dislikes within a species and between species and that these physiological differences can be taken advantage of to attract and repel.

This project will use and add to this research to make an encapsulated active as attractive as possible to European starlings, while making it as unattractive as possible to non-target bird and other species.

Project objectives

1. Achilles heel review for potential new starling actives/avicides.
2. Toxicodynamic research to assess the efficacy of micro/nano-encapsulated sodium nitrite.
3. Determine the stability of micro/nano-encapsulated formulated active(s) alone and in manufactured baits.
4. Determine the efficacy of formulated sodium nitrite as an avicide for European starlings *in vitro* and *in vivo*.
5. Micro/nano-encapsulated formulated active can be delivered as a shelf-stable, attractive, palatable and lethal product to European starlings at high density feeding naturally in large aviaries (>1 acre).

Project impacts

- Completed Achilles heel review of starlings, which highlighted physiology/behaviour that might pre-dispose starlings to consuming a lethal dose of sodium nitrite formulated as a drink.
- Tested and determined acute toxicity of two silica nitrite formulations to starlings - both formulations were consumed in the free choice study. The highest concentration resulted in 10% mortality and clinical signs in sub-lethally affected birds. Obvious aversion to formulations was also observed.
- Proved neither formulation at any concentration sufficiently effective to warrant further regulatory studies and the project has been suspended until new formulation technology leads are available.

Project team

Dr Simon Humphrys, Dr Kurt Vercauteren, Dr Scott Werner, Ms Katherine Horak, Mr Mike Avery, Ms Janette O'Hare

Project collaborators

GOVERNMENT:

United States Department of Agriculture.

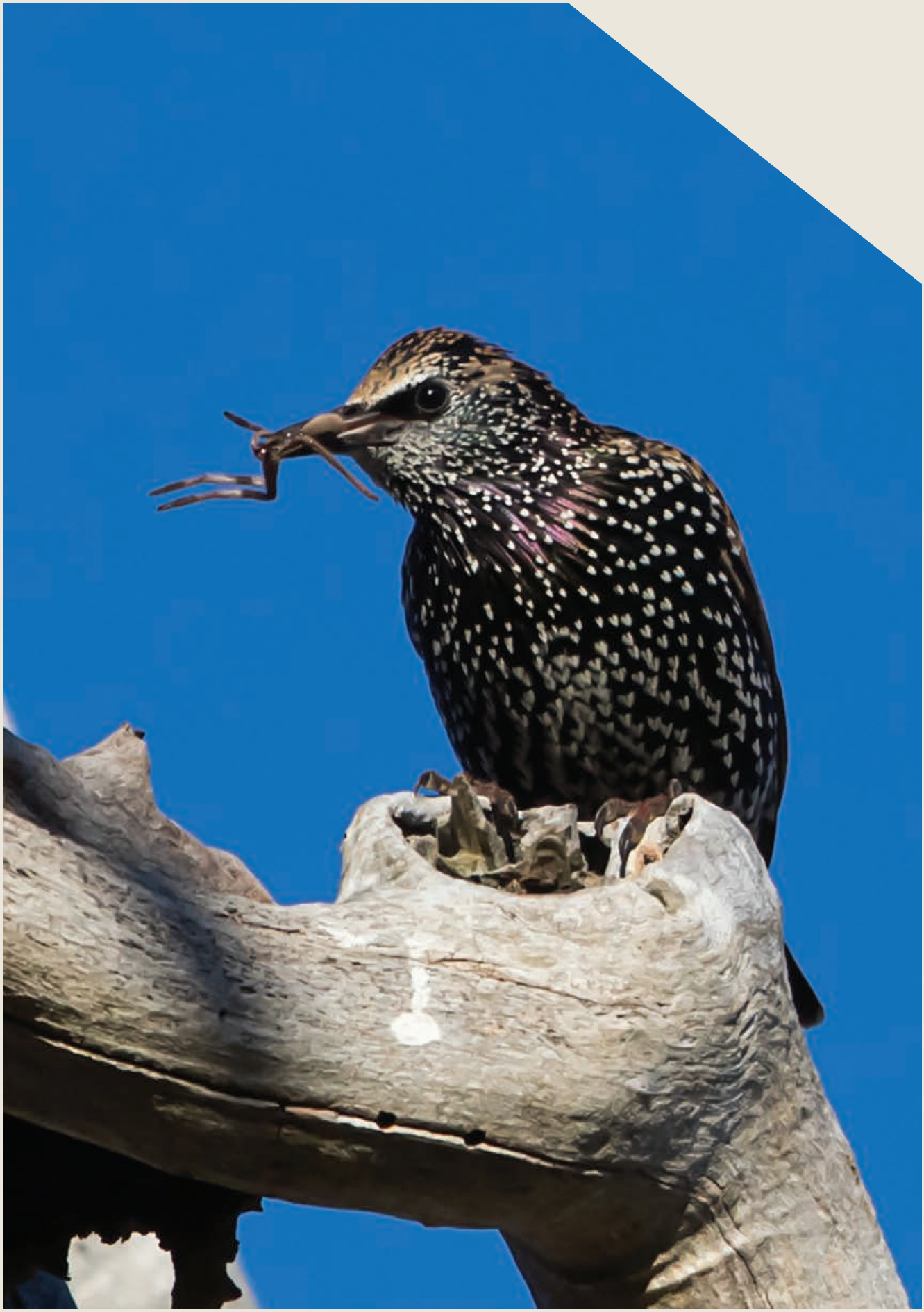
INDUSTRY, RESEARCH AND OTHER:

Grains, Research and Development Committee.

Australian Pork Limited.

Grain storage facilities.

Piggery managers.



Starling taken by Danny McCreadie

RODENTICIDES

Project Leader:

Dr Simon Humphrys, Invasive Animals Ltd

Project summary

The greatest strategic risk Australian grain producers face in effectively controlling mice during population eruptions and plagues is their reliance on a single approved chemical zinc phosphide (ZnP) that can be used in-crop.

The following factors add to the need for additional approved actives:

1. All approved manufacturers of ZnP for use in mouse baits are offshore, which creates logistical challenges affecting the supply chain in emergencies.
2. Need to treat grain bait prior to supply to prevent weed seeds contaminating crops
3. Occupational health and safety risks of exceeding acceptable exposures to phosphine when making bait on-farm using ZnP or aluminium phosphide.
4. Risk that in the event of supply disruptions other chemicals are used off label to prevent mice damaging crops.

Preliminary data from proof-of-concept studies have demonstrated that formulations of sodium nitrite can be used to humanely and rapidly kill rodents (Witmer G. (2013) Final Report, QA-1752, A preliminary evaluation of sodium nitrite as a rodenticide: unpublished data). Despite the initially encouraging results, the efficacy of sodium nitrite formulations will need to be improved before they are commercially viable.

Successfully achieving the above outcomes has the potential to result in additional effective manufactured bait products and a pre-formulated product that can also be safely used by growers on-farm to treat grain for broadcast over cropping areas or into crops to prevent mice damage and grain loss.

Project objectives

1. Collaborate with the United States Department of Agriculture (USDA) for the registration of sodium nitrite as a vertebrate pesticide. This objective will be met within a separate but related project that requires sodium nitrite as an active constituent in a feral swine bait.
2. Toxicodynamic research to assess the efficacy of micro/nano-encapsulated sodium nitrite alone and in combination with other actives.
3. Determine the stability of micro/nano-encapsulated and other formulated active(s) alone and in formulated baits that can be made on-farm using grain as the bait substrate.
4. Determine the efficacy of formulated sodium nitrite/other actives as rodenticide products *in vitro* and *in vivo* by the IA CRC, Animal Control Technologies and the USDA.
5. Formulate micro/nano-encapsulated active(s) that can be incorporated into on-farm batched and commercially manufactured bait(s).

Project impacts

- Completed Achilles Heel review that highlighted a couple of physiological/behavioural traits in mice that could be targeted by a new chemical.
- Completed screen of US and Australian chemical databases.
- Short-listed 2 chemicals to progress to attractiveness/palatability/efficacy studies
- Addition of a genetic-based approach to target the house mouse with a tailored active that will be selectively toxic and therefore safer for end-users and non-target species.
- Genetic-based approach has identified a cellular target in rats that leads to a rapid humane death, and we are using that to identify a similar cell target in mice.
- Identified formulation technologies that will increase the efficacy and safety of product prototypes.
- Oral toxicity and free choice bait studies using short-listed chemicals being undertaken late 2017

Where to next?

- Additional regulatory studies that will characterise primary and secondary poisoning risks as well as operator safety risks from the preferred short-listed chemical.
- If warranted, partnering with commercialiser(s) to continue the development of a product to add to the tool box for controlling mouse plagues.

Project team

Dr Simon Humphrys, Assoc. Prof Linton Staples, Dr Kurt Vercauteren, Dr Gary Witmer, Dr John Eisemann, Paul Miebusch, Ian Senior.

Project collaborators

GOVERNMENT:

United States Department of Agriculture.

INDUSTRY, RESEARCH AND OTHER:

Grains Research and Development Research Corporation.

Animal Control Technologies Australia.

University of Queensland.

New Zealand Landcare Research.

Mice and rats can cause significant damage to crops and products such as Lucerne hay stored in sheds (image taken by Robert Hoogers)

SURVEILLANCE AND FORECASTS FOR MOUSE OUTBREAKS IN AUSTRALIAN CROPPING SYSTEMS

Project Leader:

Professor Roger Pech, Landcare Research NZ

Project summary

The aim of this project is to reduce the economic impacts of damage caused by outbreaks of mice for Australian grain producers. This will be done through:

- Improved monitoring and surveillance of trends in mouse populations using information currently available from industry and State government networks, from long-term, 'benchmark' sites and from local networks of 'rapid-assessment' sites established in representative grain producing areas.
- Delivery of new knowledge of the regional and national status of mouse populations to advisors and producers at critical times during the year, including information on:
  - current trends with mouse populations
  - forecast probabilities of outbreaks (peak populations or plagues) up to 12 months in advance, based on existing predictive models.
- Structuring a sustainable national monitoring network that makes efficient use of qualitative information from grains industry sources and quantitative data collected with low-cost field techniques. A national monitoring network will be designed to meet regional requirements for:
- Detecting an initial build-up of mouse numbers
- Predicting a continued increase in mouse numbers to outbreak levels
- Estimating the likelihood of mouse damage exceeding acceptable limits
- Incremental development of improved predictive models for mouse outbreaks that build in specificity to particular regions and crop-production systems, with the aim of improving real-time forecasting of outbreak probabilities.
- The project adds value to GRDC and IA CRC research and investment in new rodenticides with the IA CRC and complements current monitoring initiatives for improved strategic management of mouse populations at regional and national levels.

Project objectives

Monitor mouse populations at selected long-term benchmark sites and from local networks of rapid assessment sites in representative grain producing areas at critical times during the year.

Provide regular reports to the grain-growing community based on data from the monitoring network and outbreak predictions from existing models.

Design a national monitoring network to meet regional requirements for:

1. detecting an initial build-up of mouse numbers
2. predicting a continued increase in mouse numbers to outbreak levels
3. estimating the likelihood of mouse damage exceeding acceptable limits.

Use new monitoring information, progressively develop improved predictive models for mouse outbreaks.

Project impacts

- Completed seasonal surveys of mouse abundance using the project's 3-tier monitoring system across the major grain-growing regions.
- Regular monitoring and reporting of mouse activity and risks to grower's enterprises, including reports to growers in northern, southern and western regions via key stakeholders
- Completed new mouse plague forecasting model for south eastern Australia using quantitative data from benchmark and rapid assessment sites.

Where to next?

Further research and monitoring is ongoing through CSIRO and GRDC, in the short term.

Project team

Prof Roger Pech, Dr Andrea Byrom, Dr Dean Anderson, Dr Jennyffer Cruz, Dr Peter Brown, Dr Lyn Hinds, Mr Stephen Henry, Ms Julianne Farrell, Adj Prof Simon Humphrys, Mr Peter West.

Steve Henry from the CSIRO has been monitoring mouse numbers over the course of this project and this year his findings have received significant media attention due to mice in some areas being in plague proportions and the media wanting to highlight the topic.

Project collaborators

GOVERNMENT:

NSW Department of Primary Industries.

INDUSTRY, RESEARCH AND OTHER:

Commonwealth Scientific and Industrial Research Organisation.

Grain Research and Development Corporation.

New Zealand Landcare Research.

Project resources

All information related to this project can be found at www.pestsmart.org.au/pest-animal-species/mouse and the Mouse Alert app can be downloaded at www.mousealert.org.au

HOGGONE®: USA FIELD TRIALS AND US REGISTRATION

Project Leader:

Dr Simon Humphrys, Invasive Animals Ltd (IAL) and Dr Kurt Vercauteren, United States Department of Agriculture (USDA)

Project summary

IAL and APHIS's National Wildlife Research Center (NWRC) have entered into an agreement to research and develop new humane lethal pesticides and delivery systems as wildlife management tools. Invasive animals rank only second to land clearing as the biggest threat to biodiversity around the world. At the same time individuals and governments are becoming more environmentally conscious and accountable as to how humans manage ecological threats.

This dichotomy has seen governments actively withdrawing invasive species management tools despite the continuing demand.

Internationally, there is a pressing need for more humane, species-tailored and environmentally benign toxicants and anti-fertility agents for managing the threats posed by invasive species. The US and Australia are leading this push to ensure that they are not left without primary management tools.

In this project NWRC and IAL will develop delivery systems and toxicants for control of feral pigs.

In Australia, development of sodium nitrite as a humane feral pig toxicant has been occurring for five years and has involved research into improved formulations, risk analysis, residue assessment and registration hurdles.

In the US, feral pigs have dramatically increased in total number and range and are requiring greater management than trapping and shooting so they are seeking to register poison baits as they are the most cost-effective management tool.

NWRC personnel are experts in feral pig management in the USA and it benefits the IAL to learn from NWRC's experience.

Conversely, NWRC is interested in the potential development of sodium nitrite as a humane toxicant for feral pigs in the US.

Both countries also stand to gain economically and environmentally from the exchange.

The research program will ensure that Australia and the US will mutually benefit from a research collaboration that will deliver tools and ultimately improve the humaneness and selectivity by which we manage feral pigs in both countries.

Project objectives

1. Test non-toxic bait substrates for attractiveness and palatability to feral pigs in the USA.
2. Toxicodynamic research to assess the efficacy of micro/nano-encapsulated sodium nitrite.
3. Determine the stability of micro/nano-encapsulated formulated active(s) alone and in manufactured baits.
4. Determine the efficacy of formulated sodium nitrite as a feral pig active *in vitro* and *in vivo*.
5. Formulate micro/nano-encapsulated active that can be incorporated into manufactured bait(s), remain shelf-stable, attractive, palatable and lethal to feral pigs.
6. Collaborate with USDA to apply to the US Environmental Protection Agency (EPA) so that the toxic baits can be field-trialled as a population/damage control tool.

Project impacts

- Completed stability and Good Laboratory Practice (GLP) studies on microencapsulated active constituent and bait carrier. This is critical for product development.
- Tested the final product prototype, which was found to be sufficiently efficacious in the field in Australia and in pens/enclosures in the USA.
- Submitted an experimental use permit application package to the Environmental Protection Agency for HOGGONE. Approval of this application will allow field testing in the USA in the first half of 2018.
- Completed full assessment of attractiveness, palatability, effectiveness and stability of HOGGONE paste prototype in Australia in field trials.
- Submitted HogGone product registration package to APVMA for review.

Where to next?

- HogGone field trials are ongoing in the USA.

Project team

Dr Simon Humphrys, Prof Linton Staples, Mr Ian Senior, Dr Kurt Vercauteren, Mr John Eisemann, Dr Nathan Snow, Mr Michael Lavelle, Mr Kevin Grant, Mr Aaron Anderson, Mr David Long, Dr Justin Foster, Mr Jason Wishart and Mr Cameron Allan.

Project collaborators

GOVERNMENT:

Animal and Plant Health Inspection Service of the United States Department of Agriculture.

Texas Parks and Wildlife Department.

INDUSTRY, RESEARCH AND OTHER:

Animal Control Technologies Australia.

Queensland Murray Darling Committee.

Meat and Livestock Australia Ltd.

Project resources

Snow NP, Halseth JM, Lavelle MJ, Hanson TE, Blass CR, Foster JA, et al. (2016) Bait Preference of Free-Ranging Feral Swine for Delivery of a Novel Toxicant. *PLoS ONE* 11(1): e0146712.

Due to their size and breeding capacity, feral pigs are also a major threat to the US agricultural industry, as they are in Australia (image taken by Rebbekah Hearn)

MANAGING FINALISATION OF NEW TACTICAL TOOLS

Project Leader:

Dr Simon Humphries, Invasive Animals Ltd

Project summary

This project will manage the finalisation of research outputs from four projects carried over from the previous IA CRC so that the probability that new lethal management tools will be developed and delivered to end-users is maximised. The separate projects managed under this overarching project are:

- Carbon Monoxide (CO) pressure fumigation device for burrowing animal control.
- Sentinel automated spray device or grooming trap prototype and testing in proof of concept studies. The project aims to demonstrate that a sentinel device is able to distinguish cats and foxes (target species) from native non-targets before spraying the target species with a lethal dose of an active that they will actively groom off their coat.
- Lethal trap device (LTD) product and subsequent registration application submission to the Australian Pesticides and Veterinary Medicines Authority (APVMA) that enhances the humanness of leg-hold traps.
- Gonacon registration package submission to APVMA.

Continuing to improve the effectiveness and humaneness of lethal management techniques is integral to reducing the risk that necessary control tools are lost due to poor public perception (e.g. trapping) and that new tools are brought on line in the event that existing tools are deemed inhumane (e.g. chloropicrin fumigation). The process of phasing out certain inhumane controls is being undertaken by the National Vertebrate Pest Committee and this project is strongly aligned to that process as its outputs underpin the timeframes for the withdrawal of warren fumigation using chloropicrin and the use of strychnine laced cloth on trap jaws to euthanase wild dogs and foxes.

Project objectives:

1. New carbon monoxide (CO) pressure fumigation device for burrowing animal control.
2. Sentinel automated spray device for cat, fox and potentially wild dog control.
3. Lethal trap device that enhances the humanness of leg hold traps.
4. Ejector and cyanide capsule (project will also contribute to a 1080 capsule registration) tools for fox and wild dog management.

Project impacts

- Transitioning of the automated sentinel device to the better resourced Wild Dog Alert project so that an algorithm for automatically detecting cats in real-time can be validated.
- Completed field studies that assessed and proved the effectiveness of two LTD prototype products. Survey of trappers indicated a preference for the impregnated cloth prototype. An APVMA application for a new agricultural product is in preparation.
- Proof of concept studies showing that methylene blue may potentially be safely administered intraperitoneally and induce methylene blue pharmacokinetic profiles in a slightly delayed but similar way to intravenous administration.
- Submission of HogGone registration package to APVMA for assessment, by ACTA.
- Submission of GonaCon (for use in deer and macropods) registration package to APVMA for assessment.

Where to next?

Aspects of this project, including registration and assisting with delivery to market, will continue under the Centre for Invasive Species Solutions.

Project team

Dr Glen Saunders, Dr Paul Meek, Adj. Prof Simon Humphrys, Mr Frank Gigliotti, Mr Jason Wishart, Mr Bill Aylett, Dr Andrew Bengsen, Dr Tarnya Cox, Mr Paul Aylett, Dr Duncan MacMorran,

Project collaborators

GOVERNMENT:

NSW Department of Primary Industries.

Local Land Services NSW.

INDUSTRY, RESEARCH AND OTHER:

WB&G Manufacturing, and General Dogs Body.

Connovation New Zealand.

Animal Control Technologies Australia Pty Ltd.

Fox biting down on a Canid Pest Ejector (CPE) (image suppied by Ben Allen)

MALLEE FOWL PROJECT (IAL PROJECT)

INVASIVE ANIMALS LIMITED RECEIVED EXTERNAL FUNDING FROM THE AUSTRALIAN GOVERNMENT BIODIVERSITY FUND FOR THIS PROJECT.

Project Leader:

Jason Wishart, Invasive Animals Ltd at time of project (currently working for Animal Control Technologies Australia)

Project summary

A 2011 aerial survey undertaken by the Lachlan Catchment Management Authority (CMA) found a breeding population of endangered Malleefowl on 'Kilparney Station' near Mt. Hope NSW. Malleefowl are also found about 40km south of Kilparney in the Nombinnie and Round Hill Nature Reserves. Fortunately, a large stretch of continuous intact mallee connects these two areas.

Two of the largest threats to the survival of Malleefowl are habitat fragmentation and predation by introduced predators.

In the Mount Hope region, feral pigs and foxes are particularly abundant. The predator management program championed by this project will protect existing Malleefowl populations and permit their expansion via the creation of a predator-free land bridge between the two sites.

The project is also in the process of establishing a large-scale coordinated predator control program on all properties that adjoin the target site. This will help to achieve an even greater level of predator control, and provide additional benefits to biodiversity and agriculture.

End-users have been involved in the project through various forms of communication and engagement activity including direct stakeholder meetings. They have also been provided with project updates, up-to-date information on best practice predator management and a series of modern management products, including HOGHOPPERs™.

Project objectives

The overall aim of this project is to develop, and implement, a long-term best practice pest animal management program to maintain and/or recover Malleefowl populations near Mt. Hope, New South Wales.

The project has five objectives:

1. Establish a stakeholder steering committee.
2. Improve community awareness, understanding and capacity building regarding pest animal management.
3. Implement best practice pest animal management to maintain and/or recover Malleefowl populations.
4. Monitor, evaluate, adapt and report to enable continuous management program improvement.
5. Explore research opportunities to clarify invasive animal impact on Malleefowl populations, and to enhance management efficiency.

Project impacts

- Gathered indices of predator abundance within the core area using remote cameras and implemented a comprehensive ground baiting program
- Deployed Canid Pest Ejectors throughout core mallee habitat in to prevent predator population build up between intensive ground baiting efforts.
- Assisted in establishing the Mt. Hope Pest Control Group (MHPMG), which includes private landholders that surround key mallee habitat on private land.
- Establishing the regional pest management steering committee which ensures that various management action on each of the different land tenures are undertaken in a coordinated fashion to achieve the best outcomes.
- Provided the group with new technologies including 10 CPE's and 5 remote cameras which we hope will encourage their broad-scale use.
- Prepared a long-term and detailed management plan (2017-2022) for the area, which outlines the proposed activities within the core area and captures activities being undertaken on surrounding private and public lands.

Project team

Mr Jason Wishart, Mr Stuart Brown, Dr Simon Humphrys, Dr Paul Meek, David Creeper, Laura Douglas, Marc Irvin, Jessica Marsh, Milton Lewis and Michelle Hines.

Project collaborators

GOVERNMENT:

NSW National Parks and Wildlife Service,
Western Local Land Services, NSW

Project resources

Wishart, J (2017) Management Plan 2017-2022: Integrated pest management for Malleefowl conservation near Mt. Hope New South Wales. Invasive Animals Limited. Canberra. ACT.

A feral cat on top of a Malleefowl mound – the remote camera trap didn't capture the feral cat attacking the Malleefowl however there is evidence of feathers next to the feral cat in the bottom images (image supplied by Ashleigh Harris)

FERTILITY CONTROL ORAL DELIVERY

Project Leader:

Dr Lyn Hinds, CSIRO and Dr Eckery, USDA

Project summary

Management of over-abundant pest mammal populations using non-lethal approaches, such as fertility control agents, could be highly effective in some landscapes (eg urban and peri-urban areas, semi-enclosed or enclosed populations). Injectable forms of fertility control agents have been shown to effectively block fertility in a number of species and include immunocontraceptive vaccines against gonadotrophin hormone releasing hormone (GnRH) and zona pellucida proteins.

However, effective delivery of these vaccines via the oral or intra-nasal route has not been achieved for any species. In this project, we plan to trial intra-nasal and oral delivery of different GnRH constructs alone and in the presence of particulate carrier systems. The constructs comprise GnRH conjugated to a foreign immunogen(s) and will be tested initially in laboratory rodents.

Delivery will be optimised using different formulation approaches in order to protect, but also enhance uptake of the agent.

After successful optimisation of the GnRH constructs for non-injectable delivery, they will be incorporated into food bait for testing in target species in captive animal trials.

If successful, the outcome of the project will be orally deliverable fertility control agent(s) for use in management of wildlife and domestic animals. Alternative approaches for fertility control include the use of chemosterilant compounds. The USDA National Wildlife Research Center (NWRC) has a large database of candidate chemicals which will be reviewed to determine if there are any potential compounds which warrant assessment.

Project objectives

1. Develop, optimise and evaluate (in-vitro and in-vivo) a system for non-injectable delivery of GnRH constructs which inhibit the fertility of rodents.

› Year 1: Assess two GnRH construct formulations conjugated with fragments of *Mycobacterium avium*.

› Year 2: If immune responses generated and effects on reproductive tissues observed, then progress to formulations that are protected but enhanced for uptake by the gastrointestinal lymphatic system.

2. Chemical database reviewed; possible candidates defined based on mechanism of action, synergism with complementary compounds and likelihood of regulatory approval.

Project impacts

› Decreased reproductive organ weights and decreased spermatogenesis was achieved with one formulation of GnRH constructs (GnRH-KLH plus ISCOMs) which also generated high immune responses, compared to other formulations tested.

› Completed a further trial in male mice assessing intranasal administration at Weeks 0, 2 and 4, of GnRH-KLH plus ISCOMs. Strong systemic IgG immune responses were recorded in all animals treated with GnRH-KLH plus ISCOms and 4 out of 6 mice showed decreased reproductive organ weights at Week 14.

› Develop an ELISAs at NWRC to confirm conjugation of GnRH antigens to M. avium fragments (MAF) and to measure antibody responses to M. avium fragments.

› Evaluated another formulation of GnRH (GnRH construct conjugated to fragments of Mycobacterium avium) in male mice by both intranasal and injectable routes. Injectable treatment of mice at Weeks 0, 2, 4 and 9 resulted in 3 out of 6 mice showing immune responses against GnRH and 1 out of 6 showing decreased reproductive organ weights at Week 14.

Project team

Dr Lyn Hinds, Dr Sameer Sharma, Stephen Henry, Dr Kathleen Fagerstone (retired - replaced with Dr John Eisemann), Dr K. Vercauteren, Dr Doug Eckery, Dr Richard Mauldin.

Project collaborators

GOVERNMENT:

United States Department of Agriculture.

INDUSTRY, RESEARCH AND OTHER:

Commonwealth Scientific and Industrial Research Organisation.

Meat and Livestock Australia.

Project resources

McDonald, IJ, Sharma, S, Hinds, LA (2012) Improving the immunogenicity of Gonadotrophin Releasing Hormone (GnRH) immunocontraceptive formulations with ISCOms and CpG ODN adjuvants. 7th International Conference on Fertility Control for Wildlife, Wyoming, USA.

McDonald, IJ, Sharma, S, Finnie, K, Passioura, T, Barbé, C, Hinds, LA (2012) Assessing amorphous silica nanoparticles as an oral vaccine delivery system. 7th International Conference on Fertility Control for Wildlife, Wyoming, USA.

Sharma S, Hinds LA. (2012) Formulation and delivery of vaccines: Ongoing challenges for animal management. *Journal of Pharmacy & Bioallied Sciences*. 4(4):258-266

Sharma, S, McDonald, IJ, Knight, S, Barbé, C, Finnie, K, Khatri, A, Somerville, J, Hinds, LA (2013) Evaluation of Amorphous Silica Nanoparticles for Mucosal Delivery of Vaccines. *Annual meeting of American Association of Pharmaceutical Scientists*, Sano Antonio Texas.

Sharma S, McDonald IJ, Miller L, Hinds LA, (2014) Parenteral administration of GnRH constructs and adjuvants: Immune responses and effects on reproductive tissues of male mice, *Vaccine*, 32: (43), 5555-5563.

Research outcomes from this project were published in the prestigious Vaccine journal

DEVELOPMENT OF REAGENTS FOR THE STERILISATION OF PEST ANIMAL SPECIES

Project Leader:

Laureate Professor John Aitken, University of Newcastle

Project summary

The purpose of this project is to develop novel strategies for the regulation of fertility in brumbies. The fundamental approach involves the development of novel reagents with which to target key aspects of the reproductive process in horses comprising (i) the primordial follicle population (ii) the maternal recognition of pregnancy (iii) the Sertoli cell population (iv) the male germ line. The suite of reagents we are developing to target these processes comprise two fundamental elements (i) a targeting peptide and (ii) a cytotoxic chemical warhead. The targeting peptides will be generated using random peptide phage display technology, while cytotoxicity will be generated using redox-cycling quinones.

Project objectives

1. Deliver an optimised strategy to the IA CRC for the non-surgical sterilisation of female mammals coupled with proof-of-concept data in laboratory animals (rats, mice).
2. Deliver reagents that have been specifically developed for use in horses and potentially rabbits.

Project impacts

- Successfully generated a library of peptides that target key cell types within the reproductive system.
- Optimised peptides with reagents to create a 'bacteriophage' sterilising agent which targets fertility, and tested these in mice.
- Sterilizing agents had some success in reducing fertility in mice and this is being further assessed but it was felt that for larger animals such as horses or camels an immunological approach might also need to be considered.
- PhD Theses for Aleona Swegen and Sally Hall completed, submitted and conferred.

Where to next?

The NSW Government has been approached to consider funding future trials in this area.

Project team

Laureate Prof John Aitken, Miss Sally Hall, Ms Aleona Swegen, Dr Zamira Gibb, Miss Sarah Lambourne, Ms Barb Fraser, Prof Brett Nixon.

Project collaborators

INDUSTRY, RESEARCH AND OTHER:

University of Newcastle.

University of Sydney.

Hunter Valley Brumby Association Inc.

Found Animals Foundation, USA

Project resources

Gibb, Z., Lambourne, S. R., Curry, B. J., Hall, S. E., & Aitken, R. J. (2016). Aldehyde Dehydrogenase Plays a Pivotal Role in the Maintenance of Stallion Sperm Motility. *Biology of reproduction*.

Hall, S. E., Bernstein, I. R., Sutherland, J. M., McLaughlin, E. A. & Aitken, R. J. (2014), Phage peptides fertility control: Non-surgical sterilisation of female equids, Confirmation Proceedings, Newcastle, Australia.

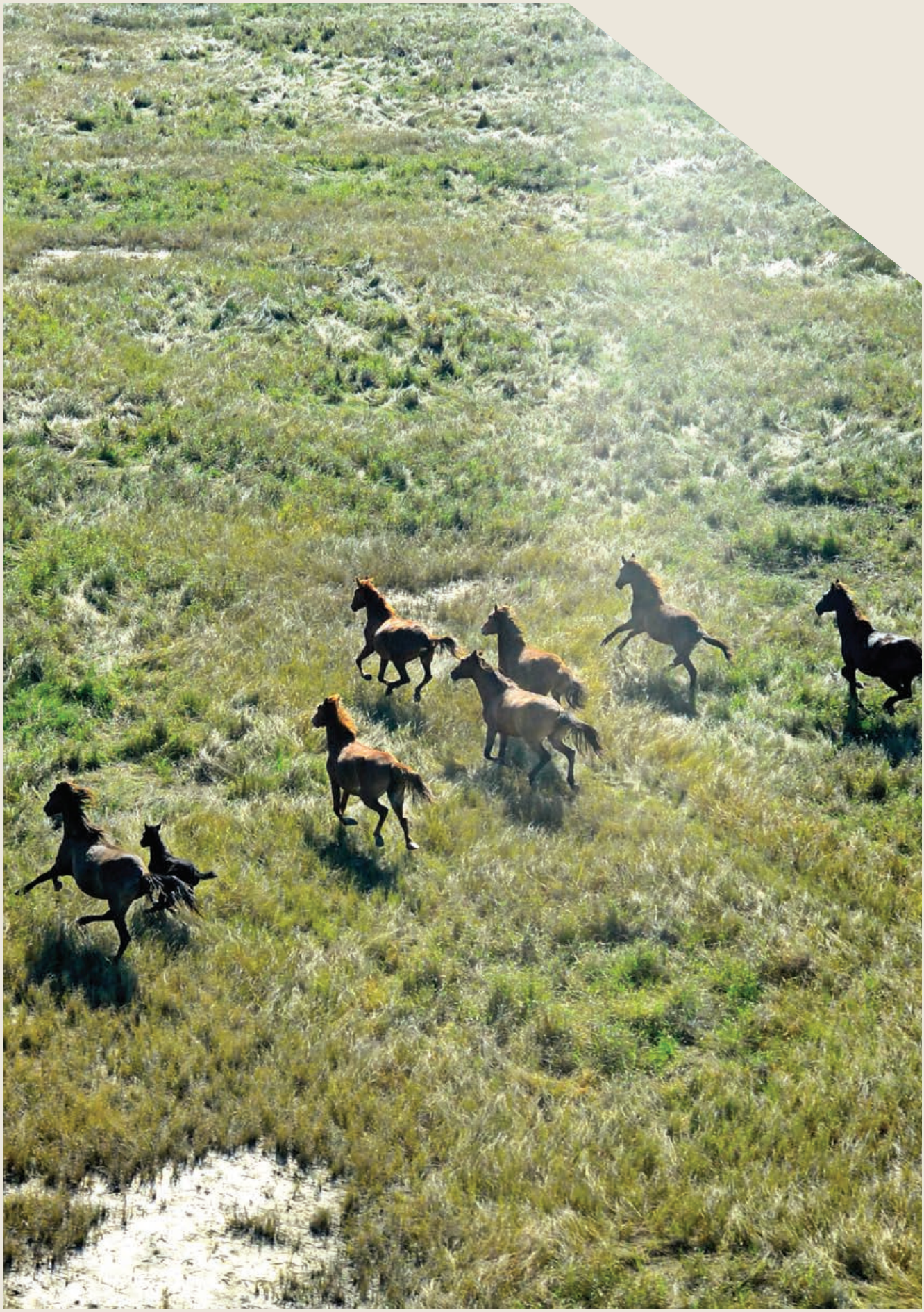
Hall SE, Nixon B, Aitken RJ (2016) Non-surgical sterilisation methods may offer a sustainable solution to feral horse (*Equus caballus*) overpopulation. Reprod Fertil Dev.

Hall SE, Aitken RJ, Nixon B, Smith ND, Gibb Z. (2017) Electrophilic aldehyde products of lipid peroxidation selectively adduct to heat shock protein 90 and arylsulfatase A in stallion spermatozoa. Biol Reprod. 96(1):107-121

Swegen A & Aitken R.J. (2014), Characterisation of the stallion sperm proteome, *Journal of Equine Veterinary Science*, 34:1, 35-37,

Swegen, A. & Aitken, R. J. (2014), Prospects for immunocontraception in feral horse population control: exploring novel targets for an equine fertility vaccine, *Reproduction Fertility and Development.*

Swegen A, Lambourne SR, Aitken RJ, Gibb Z. (2016) Rosiglitazone Improves Stallion Sperm Motility, ATP Content, and Mitochondrial Function. Biol Reprod. 95(5):107.



Feral horses. Taken by Trent Cini

This is a series of images of a carp egg close up. One carp egg may look harmless, but a single large female carp can produce upwards of 1 million eggs and is the reason why the European carp are taking over our pristine waterways (image taken by Danswell Starrs)

OUTCOME 3
RECOVERY OF KEY LAND AND WATER REGIONS FROM RABBIT, WILD DOG AND CARP IMPACTS

OUTCOME 3: RECOVERY OF KEY LAND AND WATER REGIONS FROM RABBIT, WILD DOG AND CARP IMPACTS	
Theme 4	Strategic Rabbit Control
CA output 1.3	RHD Boost: roll out of new RHDV strains
3.L.1/3.L.1c	RHD Boost and RHD Boost Plus
3.L.2	Comprehensive RHD resistance model
3.L.3	Non-pathogenic rabbit caliciviruses
CA output 1.4	RHD Accelerator platform technology
3.L.4	RHD Accelerator – Stage 1 and Stage 2
3.L.5	New potential rabbit biocontrol agent prospecting and assessment
3.L.6	Decision-support systems for effective rabbit management
Theme 5	Strategic Wild Dog Control
CA output 1.5	Strategic wild dog control
3.L.11	Co-management solutions for wild dogs in agri-ecosystems: predators, prey, plants and the triple bottom line
3.L.13	Limiting the source – peri-urban wild dog control
3.L.14	Facilitating strategic management of wild dogs throughout Australia
3.L.15e	North East NSW Wild Dog Facilitator (IAL project)
3.L.30f	Wild Dog Alert System (IAL project)
Theme 6	Strategic Carp Control
CA output 3.2	Cyprinid herpes virus-3 evaluation and rollout
3.W.1	Cyprinid herpesvirus-3 (CyHV-3): its potential as a biological control agent for carp in Australia
3.W.2	Cyprinid herpesvirus-3 (CYHV-3) registration, release and selected monitoring
	Hunting and Game Management
3.L.20ea	Scientific Evaluation of Hunting in NSW (IAL project)
3.L.20eb	Native Game Bird Management (IAL project)

RHD BOOST AND RHD BOOST PLUS

ADDITIONAL FUNDING WAS RECEIVED FROM THE AUSTRALIAN GOVERNMENT DEPARTMENT OF AGRICULTURE AND WATER RESOURCES AS PART OF THE NATIONAL RELEASE OF RHDV1 K5. THIS PROJECT IS NOW FUNDED UNTIL JULY 2018.

Project Leader:

Dr Tarnya Cox, NSW Department of Primary Industries

Project summary

IA CRC research shows that Australian native vegetation is very sensitive to rabbit damage: as few as 0.5 rabbits per hectare can remove all seedlings of the more palatable native trees and shrubs thus impeding natural regeneration.

Rabbits impact 75 Commonwealth listed threatened plants species and five threatened ecological communities. Rabbits are Australian agriculture's most costly pest animal with the annual cost exceeding $200 million.

Surveys have confirmed that since 2003 rabbit numbers have been increasing and investment in conventional control has been escalating over the past several years. The current apparent genetic resistance to current RHDV strains derived from the originally-released strain, immunity to these strains acquired by young rabbits and the reduced efficacy of current strains in temperate regions due to the endemic RCV-A1, has led to the evaluation of other RHDV strains under the RHD-Boost project.

Monitoring the effects of the release of another RHDV strain is necessary to:

1. Understand the impact of another strain on both rabbit populations and existing biocontrol efficacy in the field under a range of environmental conditions.
2. Evaluate and demonstrate the benefit of this expenditure on the natural and agricultural ecosystems of Australia.

Project objectives

1. Evaluate the impact of the selected rabbit bicontrol agent for release on rabbit populations at release sites across Australia.
2. Monitor the impact that a reduction in rabbit numbers has on a range of ecosystems across Australia, including remnant vegetation, pastures and threatened vegetation communities.
3. Improve knowledge of the effects that adequate and effective control of rabbits has on various ecosystems across Australia, particularly arable lands and endangered vegetation communities.
4. Feed on-ground knowledge into decision support systems to allow land managers to be better informed, particularly regarding financially based decisions on how best to control the impacts of rabbits.
5. Evaluate the success of multiple biological control agents in the suppression of rabbit numbers throughout Australia.
6. Recommend optimal strategies for the further release of additional RHD strains and/or other forms of biological control keeping in mind that the maximum predicted benefit from RHD Boost will begin to decline after eight years due to acquired immunity and genetic resistance.

Project impacts

- APVMA registration of RHDV1 K5, a Korean strain of the calicivirus disease.
- Collaborated with Federal and State Government agencies enabling regulatory authorities to authorise release.
- Undertook rabbit 'Roadshows' in Victoria, Queensland, NSW and Western Australia, reaching inexcess of 1000 landholders. In Victoria, the Roadshows were conducted in collaboration with the Department of Economic Development, Jobs, Transport and Resources and encouraged best practice and follow-up control.
- Completed a successful Expression of Interest (EOI) process encouraging landholders across Australia to participate in the roll-out of the new strain of RHDV. 755 EOIs were received, encompassing 977 possible release sites
- 618 sites around Australia registered to release RHDV1 K5, and maintained ongoing engagement with these sites through e-news and mail-outs.
- National release of RHDV1 K5 in March 2017.
- Reported average 42% reduction in rabbit numbers across release sites in Australia.
- RHDV1 K5 confirmed in rabbits, in all states except NT – reported through the Rabbit BioControl Tracker.

Where to next?

Final analysis of rabbit population counts from release sites and publication of results.

Project team

Dr Tarnya Cox, Dr Anthony Buckmaster, Dr John Tracey, Dr Glen Saunders, Ms Emma Sawyers, Dr Quentin Hart, Dr Greg Mutze, Dr Ron Sinclair, Dr Joe Scanlan, Mr Michael Brennan, Dr Peter Elsworth, Dr Tanja Strive, Dr Susan Campbell, Dr Don Fletcher, Mr Chris Condon, Mr Brett Scourse, Mr Steve McPhee, Dr David Forsyth, Dr Ivor Stuart and Mr John Matthews.

Dr Tarnya Cox was one of the first to release RHDV1 K5 virus laced carrots on a property the team was monitoring in Mirrabooka, NSW

Project partners

GOVERNMENT:

Australian Government Department of Agriculture and Water Resources.

Department of Primary Industries and Regions South Australia.

Western Australia Department of Primary Industry and Regional Development.

NSW Department of Primary Industries.

Queensland Department of Agriculture and Fisheries.

ACT Territory and Municipal Services Directorate.

ACT Environment and Sustainable Development Directorate.

Tasmanian Department of Primary Industries, Parks, Water and Environment.

NT Department of Primary Industries and Fisheries.

Victorian Department of Economic Development, Jobs, Transport and Resources.

Industry, research and other:

Commonwealth Scientific and Industrial Research Organisation.

Australian Wool Innovation Ltd.

Meat and Livestock Australia Limited.

New Zealand Landcare Research.

Project resources

Bengsen A & Cox T. (2014), The role of rabbit and other invasive herbivore control in reducing Australia's greenhouse gas emissions, Invasive Animals CRC, Canberra, Australia.

Cox, T., Strive T., Mutze, G., West, P., & Saunders, G (2013) Benefits of rabbit biocontrol in Australia. Report to Invasive Animals CRC

Liu, J., Fordham, D., Cooke, B., Cox, T., Mutze, G. & Strive, T. (2014), Climate influences the distribution and prevalence of non-pathogenic rabbit calicivirus in Australia - Implications for rabbit disease ecology and population management, *PLoS One*.

Cox TE, Liu J, van de Ven R and Strive T. 2017. Different serological profiles to co-occurring pathogenic and non-pathogenic caliciviruses in wild rabbits across Australia *Journal of Wildlife Disease* 53(3)

Liu J, Fordham D, Cooke B, Cox T, Mutze G and Strive T. 2014. Climate influences the distribution and prevalence of non-pathogenic rabbit calicivirus in Australia - Implications for rabbit disease ecology and population management. *PLOS ONE.*

Prow NA, Hewlett EK, Faddy HM, Coiacetto F, Wang W, Cox T, Hall RA and Bielefeldt-Ohmann H. 2014 "*The Australian public is still vulnerable to emerging virulent strains of West Nile virus*" In: Emergin zoonoses: eco-epidemiology, involved mechanisms and public health implications. *Frontiers Research Topic Ebook*

Ramsey, D (2013) Monitoring the effectiveness of a new strain of rabbit haemorrhagic disease virus – RHD-Boost. Report to Invasive Animals CRC from the Arthur Rylah Institute for Environmental Research

Wishart J and Cox T (2016). Rollout of RHDV1 K5 in Australia: information guide. Second edition. PestSmart Toolkit publication. Invasive Animals Cooperative Research Centre, Canberra, ACT

TOWARDS A COMPREHENSIVE RHD RESISTANCE MODEL

Project Leader:

Mr Greg Mutze, Department of Primary Industries and Regions SA

Project summary

The state of knowledge about RHDV and its impacts on rabbit populations is changing rapidly in Australia, New Zealand, Europe and elsewhere. That expanding knowledge base indicates that significant changes are occurring in virulence of circulating field strains of RHDV, accompanied by development of genetic resistance to the disease in rabbits. The most recent evidence from both Europe and Australia indicates that the changes are affecting mortality in young rabbits in a different manner and possibly to a greater extent than adult rabbits.

To add a further layer of complexity, these changes are occurring within environments where non-pathogenic caliciviruses are now known to have highly variable and complex interactions with RHD mortality.

Much of this knowledge has only been developed in the past three years and/or is yet to be formally published.

During that time, the RHD Boost project was initiated to consider novel RHDV variants for introduction to Australia and it is in this context that the RHD Boost program must now assess variants for possible release to counter recovering rabbit populations.

It is therefore critical for the maintenance of RHD as an effective biological control agent in Australia to have a clear understanding of changes in RHDV virulence and RHDV genetic resistance in rabbits and how these processes are interacting.

The project aims to achieve that understanding by a three-fold approach:

Maintaining regular scientific exchange between scientists working on different aspects of the IA CRC RHDV research program, building a stronger national and international network of researchers to exchange information and promote more rapid, focussed progress towards an understanding of RHDV epidemiology.

- Conducting experimental studies to test hypotheses developed from previous work and in associated projects and fill gaps in knowledge needed for statistical modelling of RHD resistance.
- Developing a statistical model of RHD resistance in rabbits and associated CO-evolutionary changes in the virus that can be used to project the likely benefit of RHD Boost candidates with different epidemiological characteristics.

The work would have wider implications than RHD alone. Current work on RHDV is helping to understand other diseases (especially those caused by caliciviruses).

For example, LePendu et al. (2006) in France have already demonstrated how virus attachment to rabbit cells led to a better understanding of genetic resistance to caliciviruses (Norwalk) in humans.

In another instance, research in New Zealand has exploited the up-take of RHDV virus-like particles as a new way of presenting novel vaccines for both livestock and human use.

Project objectives

1. Produce a more comprehensive model of RHDV resistance in rabbits and associated co-evolutionary changes in the causative virus.
2. Use this knowledge to maintain RHD as an effective biological control agent in Australia into the foreseeable future.
3. Build a stronger national and international network of researchers to exchange information, share preliminary research findings, obtain feed-back and promote more rapid, focussed progress towards an understanding of RHDV resistance in rabbits.
4. Encourage and train younger scientists with an interest in epidemiology and molecular evolution to contribute to future projects.
5. Publish at least three publications in peer reviewed international journals.

Project impacts

- Promotion of more rapid, focused, national and international progress towards understanding RHDV epidemiology, impact and genetic resistance in rabbits.
- Developed a sound conceptual understanding of RHDV/rabbit dynamics that was essential to direct studies of the RHDV1-K5 release to help maintain RHD as an effective biological control agent in Australia, to monitor the incursion of RHDV2, and/or to direct studies of future novel rabbit pathogens.

Project team

Dr Greg Mutze, Dr Ron Sinclair, Dr David Peacock, Mr John Kovaliski, Dr Nina Schwensow, A. Prof Phillip Cassey, Ms Amy Ianella, Dr Tanja Strive, Dr Peter Kerr, Dr Glen Saunders, Dr Tarnya Cox and Dr Andrew Read.

Project collaborators

GOVERNMENT:

Department of Primary Industries and Regions, SA.

NSW Department of Primary Industries.

INDUSTRY, RESEARCH AND OTHER:

Commonwealth Scientific and Industrial Research Organisation.

University of Adelaide.

Meat and Livestock Australia Ltd.

University of Sydney.

Instituto Zooprofilatico Sperimentale.

Brescia, Italy.

CIBIO.

Universidade do Porto, Portugal.

Project resources

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Le Pendu J, Ruvoen-Clouet N, Kindberg E, Svensson L. (2006) Mendelian resistance to human norovirus infections. *Semin Immunol* 18:375-86

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PIRSA Technical Officer, John Kovaliski, testing a dead rabbit for RHD virus (image supplied by PIRSA).

NON-PATHOGENIC RABBIT CALICIVIRUSES

Project Leader:

Dr Janine Duckworth, Landcare Research NZ

Project summary

Rabbit haemorrhagic disease virus (RHDV) is an important biological control agent for overabundant wild rabbits in New Zealand but, as in Australia, the effectiveness of RHD has reduced due to the increasing proportion of rabbits with immunologically-acquired resistance.

The presence of benign caliciviruses in NZ is indicated by cross-reactive antibodies in serum collected prior to the known release of RHDV [2] but no benign rabbit caliciviruses have yet been identified in NZ wild rabbits [three-5]. New Zealand wild rabbits and their benign rabbit caliciviruses have co-evolved separately from Australian rabbits for more than 150 years, so both the rabbit host and viruses are highly likely to show some phylogenetic separation from the Australian populations and display genetic divergence in their interaction with pathogenic strains of RHDV.

This project brings together IA CRC researchers (Landcare Research and CSIRO) with researchers from University of Otago and AgResearch NZ. The proposal complements and augments a project funded by the New Zealand Ministry of Primary Industries Sustainable Farming Fund (SFF) that aims to improve rabbit biocontrol strategies through the identification and selection of virulent NZ–sourced wild field strains of RHDV; accelerated selection for highly virulent strains by passaging RHDV strains through NZ rabbits; and greater understanding of the role of benign rabbit caliciviruses in both RHDV and rabbit epidemiology and biology offering better integration of conventional and biological control strategies for both countries.

The combination of SFF funding and the IA CRC research program offer improved contributions to sample collection and animal care; access to reagents and any highly virulent NZ RHDV strains identified; and greater collaboration.

NZ RHDV strains that exhibit local adaptation to the temperate NZ climate may be particularly useful in temperate areas of Australia. The project complements and builds on previous research on benign RCVs undertaken by the IA CRC in Australia.

Project objectives

1. Confirm the existence of benign rabbit caliciviruses within New Zealand.
2. Increase our understanding of the biology of benign RCVs:

› the likely routes for infection and the pathogenicity of the virus

› determine the degree of protection offered by benign RCVs against subsequent RHDV infection.

3. Increase our knowledge of the likely impact of RCVs on the effectiveness of RHDV-based rabbit biocontrol particularly in temperate climates.
4. Develop diagnostic tools and research capacity in both Australia and NZ through collaboration, technology transfer and joint publications.
5. Identify high virulence NZ-sourced strains of RHDV.

Project impacts

› Developed RCV-specific diagnostic tools for Australian benign caliciviruses are suitable for the analysis of New Zealand benign rabbit caliciviruses and associated antibody responses.

› Serum antibody data confirmed that non-pathogenic RCV strains are present in rabbit populations throughout New Zealand and that a release of the new strain of RHDV (called RHDV1 K5) is likely to improve the efficacy of RHDV biocontrol in the rabbit-prone regions.

› Scientific advice and technical support was provided to New Zealand regional councils and key stakeholders for their current applications to gain regulatory approval for the importation and use of RHDV1 K5 for rabbit biocontrol in New Zealand

› Developed a proposed release strategy for RHDV1 K5 to assist regional and district councils in rabbit prone areas of New Zealand in preparation for a planned release of RHDV1 K5 in autumn 2018. This process included identification of release sites, developing a monitoring system to measure impacts and encouraging best practice through improved understanding of RHDV and benign RCV and by providing resource material for farmers, land managers, and contractors through handouts, websites and at farmer field days

Where to next?

NZ are currently assessing a proposed release of RHDV1 K5.

Project team

Dr Janine Duckworth, Dr Bruce Warburton, Ms Leila Nicholson, Ms Katherine Trought, Dr Frank Cross, Ms Jane Arrow, Ms Sam Brown, Mr Michael Wehner, Dr Tanja Strive, Prof Vernon Ward, Dr Tao Zheng

Project collaborators

INDUSTRY, RESEARCH AND OTHER:

Commonwealth Scientific and Industrial Research Organisation.

Landcare Research New Zealand Limited.

University of Otago.

AgResearch NZ.

Project resources

Eden J-S, Read AJ, Duckworth JA, Strive T, Holmes EC (2015). Resolving the origin of rabbit haemorrhagic disease virus (RHDV): insights from an investigation of the viral stocks released in Australia. *Journal of Virology* 89(23): 12217–12220

Mahar, JE, Nicholson, L, Eden, JS, Duchene, S, Kerr, PJ, Duckworth, J, Ward, VK, Holmes, EC,Strive, T, 2016. Benign Rabbit Caliciviruses Exhibit Evolutionary Dynamics Similar to Those of Their Virulent Relatives. Journal of Virology, 90: 9317-9329.

Nicholson LJ, Mahar JE, Strive T, Zheng T, Holmes EC, Ward VK, Duckworth JA. 2017. Benign rabbit calicivirus in New Zealand. Appl Environ Microbiol 83:e00090-17.

RHD ACCELERATOR – STAGE 1 AND STAGE 2

ADDITIONAL FUNDING WAS RECEIVED FROM THE AUSTRALIAN GOVERNMENT DEPARTMENT OF AGRICULTURE AND WATER RESOURCES TO FUND A SECOND STAGE OF THIS PROJECT.

Project Leader:

Dr Tanja Strive, CSIRO

Project summary

This project aims to use natural selection to produce strains of Rabbit Haemorrhagic Disease Virus (RHDV) that are able to overcome immunity and potentially resistance to existing RHDV strains.

This non-GMO approach will provide a platform technology for the continuous supply of suitable calicivirus strains for subsequent releases that will help to sustainably address Australia's rabbit problem.

The research strategy proposed here is a logical extension of RHD Boost. RNA viruses such as RHDV have naturally very high mutation rates.

During replication, virus genes are not replicated exactly, producing a mixture of progeny viruses that are all slightly different.

Some of these viruses will have altered surface structures that may not be neutralised by antibodies specific to the original strain.

These variants are rarely selected for in natural infections, as RHDV kills the animals too quickly for these selection processes to occur.

Our project aims to develop experimental systems that will allow accelerated evolution and targeted selection for such virus variants.

This exploits the natural high mutation rate that enables the virus to rapidly adapt to changing circumstances.

Project objectives

1. Develop a platform technology that will allow repeated selection of RHDV strains with superior qualities.
2. Select for and characterise one or several RHDV strains that are superior to existing field strains.
3. Develop reliable diagnostic tools to discriminate between the various calicivirus strains produced in this project.

Project impacts

- Delivered a proof of concept that the Accelerator project methods can be used to produce viruses with altered characteristics.
- Developed a national collaboration between the CSIRO, Elizabeth MacArthur Agricultural Institute and Biosecurity SA to consolidate analysis of all RHDV case reports and samples collected nationwide.
- Within the last two years, the project team has quickly adapted to the changing circumstances of the Accelerator project, namely the arrival of exotic calicivirus strains in Australia, and has been leading the development of differential molecular diagnostics, next generation sequencing technologies and epidemiological and evolutionary analyses of the changing RHDV diversity in the Australian landscape.

"Within the last two years, the project team has quickly adapted to the changing circumstances of the Accelerator project, namely the arrival of exotic calicivirus strains in Australia, and has been leading the development of differential molecular diagnostics, next generation sequencing technologies and epidemiological and evolutionary analyses of the changing RHDV diversity in the Australian landscape"

- Confirmed RHDV2 infection of European brown hares. First project team to do so.
- Published more than 13 publications in international, high impact peer-reviewed scientific journals, and submission and acceptance of one PhD Thesis by Dr Nadya Urakova

Where to next?

The RHD accelerator project is an integral part of the rabbit biocontrol pipeline strategy. How the spread of RHDV2 may align with and impact this project is currently being considered in future project proposals.

Project team

Dr Tanja Strive, Dr Robyn Hall, Ms Tegan King, Dr Peter Kerr, Dr Michael Frese, Dr Lorenzo Capucci, Ms Nadya Urakova and Dr Andrew Read.

Project collaborators

GOVERNMENT:

NSW Department of Primary Industries.

Biosecurity SA.

INDUSTRY, RESEARCH AND OTHER:

Commonwealth Scientific and Industrial Research Organisation.

University of Canberra.

Australian Wool Innovation Ltd.

Meat and Livestock Australia Ltd.

University of Sydney.

University of NSW.

New Zealand Landcare Research.

Instituto Zooprofilattico Sperimentale della. Lombardia d dell'Emilia Romagna (IZS) Brescia Italy.

Project resources

Hall, R. N., J. E. Mahar, S. Haboury, V. Stevens, E. C. Holmes and T. Strive (2015). Emerging Rabbit Hemorrhagic Disease Virus 2 (RHDVb), Australia. *Emerging Infectious Diseases* 21(12): 2276-2

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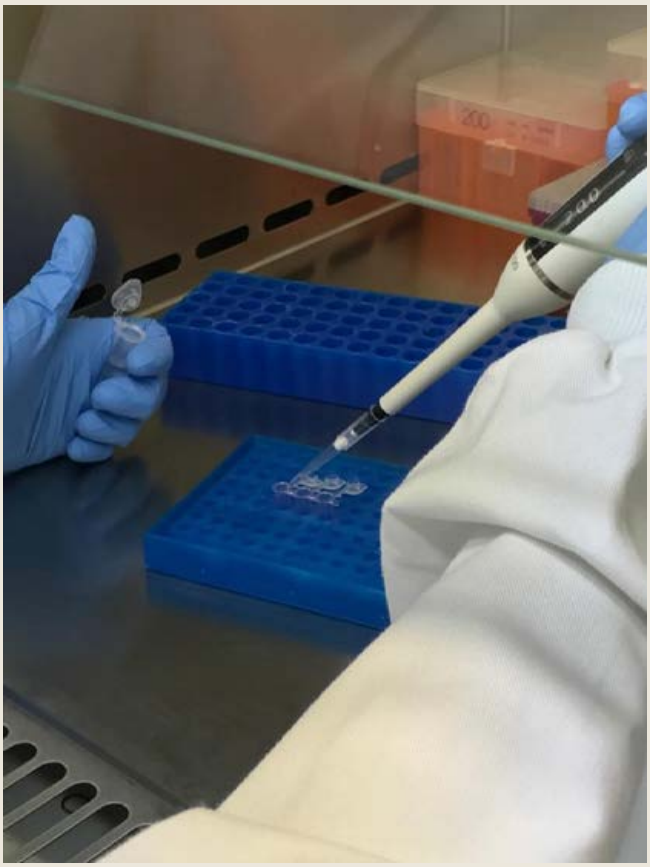

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Urakova, N., M. Frese, R. N. Hall, J. Liu, M. Matthaei and T. Strive (2015). Expression and partial characterisation of rabbit haemorrhagic disease virus

non-structural proteins. *Virology* 484: 69-79.

Urakova, N., N. Netzler, A. G. Kelly, M. Frese, P. A. White and T. Strive (2016). Purification and Biochemical Characterisation of Rabbit Calicivirus RNA-Dependent RNA Polymerases and Identification of Non-Nucleoside Inhibitors. *Viruses-Basel* 8(4).

Urakova, N., T. Strive, and M. Frese*, RNA-Dependent RNA Polymerases of Both Virulent and Benign Rabbit Caliciviruses Induce Striking Rearrangement of Golgi Membranes. Plos One, 2017. 12(1)

NEW POTENTIAL RABBIT BIOCONTROL AGENT PROSPECTING AND ASSESSMENT

Project Leader:

Dr David Peacock, SA Department of Primary Industries and Regions

Project summary

The European rabbit (*Oryctolagus cuniculus*) remains Australia's most serious terrestrial vertebrate pest. The release of myxoma virus in 1950 and rabbit haemorrhagic diseases virus (RHDV) in 1995 reduced Australia's pest rabbit (*Oryctolagus cuniculus*) population providing billions of dollars in economic returns and major environmental benefits. Both viruses initially reduced rabbit numbers in many areas by up to 95%.

However, as expected with pathogen/host relationships, the viruses changed and genetic resistance developed in the rabbits allowing their numbers to recover, albeit to levels lower than those before the virus releases. With seedling recruitment in native vegetation requiring rabbit densities below 0.5/ha (Bird et al. 2012; Mutze et al. 2008; Cooke unpublished data) and continuing agricultural and pastoral impacts, further rabbit control is necessary. This could be achieved economically in arable lands using poisons and rabbit burrow destruction, but in the remote, vast (>1 million km2) and sparsely-populated semi-arid and arid parts of Australia where conventional control of rabbits is not feasible, self-disseminating biocontrol agents are the only realistic solution.

Agents additional to myxoma and RHDV (eg herpesvirus (Onderka et al. 1992; Swan et al. 1991) and episootic rabbit enteropathy (Huybens et al. 2008) have been suggested (Henzell et al. 2008) though not as yet assessed. In conjunction with expert review of these agents, we are developing 'disease networks' among wildlife groups, rabbit researchers and the commercial rabbit industry to detect other biocontrol agents that might assist Australia in its continuing battle with the rabbit.

Project objectives

1. Detect new biocontrol agents that might substantially reduce the impacts of rabbits below levels currently achieved by myxomatosis and RHD by developing and maintaining disease networks among wildlife groups, rabbit researchers and the commercial rabbit industry.
2. Establish a panel of experts to review the recommendations for rabbit biological control agents identified by Henzell, Cooke and Mutze (2008) as well as review potential new agents uncovered by global watch networks.
3. Prioritise potential agents on the basis of: specificity for European rabbits, potential impact on wild rabbit populations in Australia, ease of importation and relative humaneness and recommend the best options for further research, importation and assessment.
4. Develop a discussion paper in conjunction with expert opinions for peer review by a consultative panel for consideration and support.

Project impacts

- Undertaken Economic Impact Assessment of *Eimeria* and RHDV2 through Agtrans Research.
- Finalised and submitted business case for new potential rabbit biocontrol agents.
- Continued the establishment and maintenance of an international network and the search for a new rabbit biocontrol agent and prepare reports.

Where to next?

A new project has been funded through the Australian Government Ag white paper to examine the potential of Eimeria parasites as an additional biocontrol agents for the European rabbit. This project is currently in progress.

Project team

Dr David Peacock, Dr Ron Sinclair, Dr Greg Mutze, Dr Brian Cooke, Ms Tiggy Grillo, Dr Peter Kerr, Dr David Spratt and Dr Antonio Lavazza.

Project collaborators

GOVERNMENT

Department of Primary Industries and Regions SA.

INDUSTRY, RESEARCH AND OTHER:

University of Canberra.

Wildlife Health Australia.

Commonwealth Scientific and Industrial Research Organisation.

Instituto Zooprofilattico Sperimentale della. Lombardia d dell'Emilia Romagna (IZS) Brescia Italy.

Project resources

Hall, RN., Peacock, D., Kovaliski, J. Mahar, JE., Mourant, R., Piper, P., and Strive S. (2016). Detection of RHDV2 in European brown hares (*Lepus europaeus*) in Australia. *Veterinary Record*.

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Peacock, D., Kovaliski, K., Sinclair, RD., Mutze, G., Iannella, A., and Capucci L. (2017). RHDV2 overcoming RHDV1 immunity in wild rabbits (*Oryctolagus cuniculus*) in Australia. *Veterinary Record* 10.1136/vr.104135.

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Thulin, CG. Alves, P., Djan, M., Fontanesi L. and Peacock D. (2017). Wild opportunities with dedomestication genetics of rabbits. *Restoration Ecology* 25: 330-332 doi: 10.1111/rec.12510

Rabbits can cause up to $250 million to our agriculture industry each year – here is an image of a large rabbit burrow within a paddock (image taken by Kye Porter)

DECISION SUPPORT SYSTEMS FOR EFFECTIVE RABBIT MANAGEMENT

Project Leader:

Mr Bruce Warburton, Landcare Research New Zealand

Project summary

To achieve effective management of rabbits, Decision Support Systems (DSS) are required to ensure land managers make decisions on where, when and how to apply the most appropriate management options. A DSS can assist decision making at a range of scales from local farm level in which farmers or landcare groups might be deciding on appropriate spatial and temporal application of control options, up to state or even national level where decisions on funding allocations need to be made. A DSS would support rabbit management in agricultural settings, for biodiversity and production outcomes and for funding-managers to prioritise national and regional actions against the impacts of rabbits.

Development of the DSS will have four key steps:

1. Identification of specific requirements for all major features and objectives of a DSS from end-users and key stakeholders.
2. Development of the system architecture, model framework and system design.
3. Development of the system as required.
4. Testing of the finalised system using the key end-users and stakeholders.

There has been a number of 'first-generation' rabbit related DSSs developed in Australia, New Zealand and England, each having system-specific advantages and disadvantages. The best of these will be selected in conjunction with end-users and if possible environmental impacts will be included.

The final aspect of this project will be to determine if a DSS can be used to prioritise government investment in regional rabbit control programs.

An example of how this could be applied would be under the National Rabbit Threat Abatement Plan (2010) or for specific projects within the Caring for our Country program.

Project objectives

1. Conduct a detailed literature review to accumulate current knowledge on the impacts of rabbits and the cost effectiveness of rabbit control strategies.
2. Use this knowledge to update the existing simulation models (eg CARE rabbit model) and to incorporate biodiversity outcomes in either the same or a separate model.
3. Develop a process for national prioritising of regional rabbit management based on both agricultural and environmental outcomes.

Project impacts

- Produced the conservation related DSS for the ACT Parks and Conservation Service and made it available through the PestSmart website.
- Produced the production land DSS and made it available through the PestSmart website along with the conservation DSS
- Made the source code for the production DSS available via an online repository.

Where to next?

This decision support tool for rabbit management will be further intergrated into and promoted through our PestSmart digital platform.

Project team

Mr Bruce Warburton, Dr Janine Duckworth, Ms Margaret Anderson, Mr Aaron McGlinchy, Dr Glen Saunders, Dr Dave Ramsey, Dr Andrew Woolnough, Mr Cameron Allan, Dr Greg Mutze, Dr Tony Pople, Dr Malcolm Kennedy, Dr Bertie Hennecke, Mr Chris Condon, Dr David Cowan, Dr Jen Cruz, Dr Will Allen, Dr Simon Howard.

Project collaborators

GOVERNMENT:

NSW Department of Primary Industries.

Queensland Department of Agriculture and Fisheries.

Victorian Department of Economic Development, Jobs, Transport and Resources.

ACT Territory and Municipal Services Directorate,

INDUSTRY, RESEARCH AND OTHER:

Meat and Livestock Australia Ltd.

New Zealand Landcare Research.

Project resources

The Rabbit DSS' can be found at www.pestsmart.org.au/pest-animal-species/european-rabbit/dss-for-rabbit-management/

CO-MANAGEMENT SOLUTIONS FOR WILD DOGS IN AGRI-ECOSYSTEMS: PREDATORS, PREY, PLANTS AND THE TRIPLE BOTTOM LINE

Project Leaders:

Dr Peter Fleming and Dr Guy Ballard, NSW Department of Primary Industries

Project summary

Increased numbers of wild dogs are having a significant impact on primary producers and local communities. Cooperative effort is essential for effective management of wild dogs in the complex environmental, social and economic contexts in which they occur.

Pressure is brought to bear on livestock producers by the wider community to reduce lethal control of wild dogs and dingoes in particular because of their iconic status and perceived environmental benefit. The trophic interactions between predators, prey and plants and the likely effects of lethal control of wild canids are speculated but, although untested, are affecting management decisions among conservation workers.

Co-management of wild canids requires knowledge of social impacts and societal attitudes and estimates of economic impacts at property, regional and national scales. Some investigation of social impacts of wild dogs has occurred but is insufficient to be informative for managers. Previous economic studies provide limited and potentially imprecise estimates of impacts at all levels. Without knowing the economic and social costs of predation and control it is impossible to set up measurable management goals for wild dog co-management.

Uncertainty about these interactions and the social and economic values and impacts of wild dogs and their predation on livestock are impediments to their best-practice co-management and has consequent impacts on the management of threatened species and welfare and opportunity costs for livestock production.

This project will experimentally determine ecological responses to lethal control in a mesic environment where high value livestock production co-occurs with wild dogs and foxes. The impacts and attitudes of various communities around the issue will be measured and new models for better evaluating the economic and financial impacts on those communities will be constructed. The outcomes of the project will be ecologically, socially and economically informed management of wild dogs within an adaptive management framework.

Project objectives

1. Conduct an observed expert workshop about trophic responses to lethal control of predators, with managerial review for practical application of recommendations to World Heritage and other conservation areas.
2. Determine whether current wild dog control practices increase, decrease or have no impact upon populations of (i) native and introduced mesopredators (ii) threatened and non-threatened prey species and vegetation (trophic cascade responses).
3. Determine the legislative and policy incentives for and barriers to effective strategic co-management of wild dogs (cooperation with Community Engagement Program).
4. Determine the attitudes of the Australian community and its various sectors to wild dogs and their control in order to guide policy review.
5. Determine the social and economic impacts of wild dogs and their management on individuals, communities and nationally and the interactions of economic and social drivers.
6. Use this and ecological information from associated projects, propose strategies to enable effective and acceptable co-management of wild dogs.
7. Propose policy improvements for wild dog management across Australia.

Project impacts

- Completed all field research aspects of the project showcasing that application of 40 baits over 10 baits per km more effective for targeted predator control
- Research showcased no spotted tailed quoll deaths during aerial baiting campaigns.
- Research showcased 90% GPS collared wild dogs died from 40 baits km baiting program.
- Developed a series of future policy recommendations for government and research proposals, which have been distributed to key stakeholders.

Where to next

Based on current research outcomes, policy recommendations are being delivered to various govt. agencies and future research proposals are being developed and considered for funding.

Project team

Dr Peter Fleming, Dr Guy Ballard, Ms Bernadette York, Mr Salahadin Khairo, A. Prof Nick Reid, A. Prof Karl Vernes, Dr Gerhard Koertner, Mr Josh Van Eyk, Prof Oscar Cacho, Prof Don Hine, Dr John Hunter, Ms Helen Morgan, Mr Michal Smielak, Mr Mark Tarrant , Dr Paul Meek, Dr Greg Falzon, Ms Catie Gowan, Mt Trent Ford, Ms Fran Zewe, Ms Jessica Sparkes, Mr Huw Nolan, Dr Wendy Brown, Mr Sam Doak, Mr Roger mills, Mr Stuart BoydLaw, Mr Piers Thomas, Ms Nerida Holznagel, Mr Darren Pitt, Mr Brian Campion, Mr David Harrison, Mr Don Noakes, Mr Ed Bloomfield, Mr Tony Hollis, Mr Rob Costello, Mr Bruce Moore, Ms Emma Turner, Mr Bob Cunningham, Mr Dean Chamberlain, Mr Mick Thorman, Mr Neil Hing, Dr Matthew Gentle, Dr Benjamin Allen and Mr Greg Mifsud.

Project collaborators

GOVERNMENT:

NSW National Parks and Wildlife Service.

NSW Department of Primary Industries.

NSW Local Land Services.

INDUSTRY, RESEARCH AND OTHER:

University of New England.

Australian Wool Innovation Limited.

Meat and Livestock Australia Limited.

National Wild Dog Action Plan stakeholder consultative group.

Wild Dog Associations/ Livestock Producers.

National Wildlife Research Center, USA.

Project Resources

This project has produced 42 peer-reviewed scientific publications based on the research outcomes – below are a selection of these.

Matthews, A. Allen, B., Newsome, T., Ballard, G., Fleming, P and Dickman, C (2013) The success of GPS collar deployments on mammals in Australia. *Australian Mammalogy* 35, 65-83.

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Fleming, P.J.S., Ballard, G., (2015). Homo sapiens is the apex animal: Anthropocentrism as a Dionysian sword. *Australian Zoologist* early online 09/2015, 11.

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Newsome, T.M., Ballard, G.-A., Crowther, M.S., Dellinger, J.A., Fleming, P.J.S., Glen, A.S., Greenville, A.C., Johnson, C.N., Letnic, M., Moseby, K.E., Nimmo, D.G., Nelson, M.P., Read, J.L., Ripple, W.J., Ritchie, E.G., Shores, C.R., Wallach, A.D., Wirsing, A.J., Dickman, C.R., (2015). Resolving the value of the dingo in ecological restoration. *Restoration Ecology*.

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LIMITING THE SOURCE: PERI-URBAN WILD DOG CONTROL

Project Leader:

Dr Matthew Gentle, Department of Agriculture and Fisheries Queensland

Project summary

Wild dog impacts are increasingly being felt by producers and residents of towns and suburbs throughout the more populated areas of eastern Australia. Wild dogs in these areas can have substantial impacts on residential communities, fragmented conservation estates and a number of primary industries including grazing, dairy and intensive livestock industries.

In various forums, local governments throughout Australia have consistently identified the need to improve our understanding of wild dog ecology and develop control tools for managing peri-urban wild dogs. State and local governments need this information to assist in planning and coordinating control activities and develop extension materials.

Peri-urban wild dog management is often contentious and difficult to implement given the presence of a variety of stakeholders with wide-ranging and often conflicting ideologies. This conflict is compounded by a general lack of understanding about wild dog ecology and the effectiveness of management techniques in these environments.

There is a critical need to assess the nature, impacts, origins and distribution of wild dog problems and provide a knowledge base from which to manage wild dogs in peri-urban environments.

This project aims to improve management through understanding the ecology and impacts of peri-urban wild dogs and developing best practice management strategies and guidelines for implementing control in peri-urban areas.

Project objectives

1. Provide a basic understanding of the ecology of peri-urban wild dogs in coastal eastern Australian communities.
2. Evaluate the efficacy of management options in peri-urban environments.
3. Recommend management strategies for use in range of peri-urban situations

Project impacts

- Collected, collated, analysed and described diet and movement data of peri-urban wild dogs. A scientific report on the diet of dingoes and other wild dogs in peri-urban areas has been published. Results confirm that wild dogs in peri-urban areas consume a wide variety of prey items, but appear largely dependent on small to medium-sized mammals (e.g. macropods, bandicoots, possums and rats). Importantly, it also supports that peri-urban wild dogs are not reliant on human-sourced foods.
- Completed genetic analysis (genetic heritage) of 900 tissue samples from peri-urban wild dogs.
- Analysed and described diseases and pathogens of wild dogs in peri-urban areas. Confirmed that Urban wild dogs carry significant diseases, and likely pose a significant risk to public and livestock health
- The Canid Pest Ejector (CPE) field trial deployed non-toxic ejectors for over 65,000 ejector nights between two sites at Tweed and Sunshine Coasts. 24 monitoring cameras were used across the two sites. Results indicate that CPE's are target specific to wild dogs and foxes, with wildlife species usually showing interest, but little activity at ejector sites.
- Investigated the potential for genetically-defined populations of wild dogs in peri-urban areas of southern Queensland.
- Examined the factors influencing pathogen carriage rates in wild dogs.

Where to next?

- The research team have developed a series of recommendations to inform future management strategies of wild dogs in peri-urban areas. These recommendations have been distributed to key stakeholders.

Project team

Dr Matthew Gentle, Dr Benjamin Allen, Mr James Speed, Dr Lee Allen.

Project collaborators

GOVERNMENT:

Queensland Department of Agriculture and Fisheries.

NSW Department of Primary Industries.

Moreton Bay Regional Council.

Somerset Regional Council.

Logan City Council.

Sunshine Coast Regional Council.

Brisbane City Council.

Gold Coast City Council.

Tweed Shire Council.

INDUSTRY, RESEARCH AND OTHER:

Meat and Livestock Australia Limited.

University of Queensland.

University of NSW.

University of Southern Queensland.

National Wildlife Research Center, USA

Project resources

Allen, B.L., Carmelito, E., Amos, M., Goullet, M. S., Allen, L.R., Speed, J. and Leung, L. K. P. (2016) Diet of dingoes and other wild dogs in peri-urban areas of north-eastern Australia. *Scientific Reports* 6, 8.

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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

Gentle, M., Speed, J., Allen, B., Harris, S., Haapakoski, H. and Bell, K. (2017) The longevity of PAPP wild dog baits and the implications for effective and safe baiting campaigns. *Environmental Science and Pollution Research,* doi:10.1007/s11356-017-8668-3

McNeill A. T., Leung L. K. P., Goullet M. S., Gentle M. and Allen B. L. (2016) Dingoes at the doorstep: home range sizes and activity patterns of dingoes and other wild dogs in peri-urban areas of north-eastern Australia. *Animals* 6 48

During this project a number of wild dogs were tracked with GPS collars. The research team found that in some cases wild dogs were getting as close as 1000m from urban areas and housing estates (image supplied).

FACILITATING STRATEGIC MANAGEMENT OF WILD DOGS THROUGHOUT AUSTRALIA

Project Leader:

Mr Greg Mifsud, Invasive Animals Ltd

Project summary

The wild dog problem has escalated across the country with impacts being felt by livestock producers and communities across a range of environments throughout the country. Predation by wild dogs is severely affecting the sheep, cattle and goat industries and limiting enterprise selection in some regions of Australia.

Predation by wild dogs is likely to adversely impact isolated populations of endangered fauna (Robert Shaw and Harden 1989). Presently, there are 14 national-level recovery plans, for species listed under the EPBC Act 1999, which identify wild dogs as a known or potential threat to these native animals.

This project aims to achieve a more consistent approach to wild dog management on a national basis. Community planning programs will be focused in areas of wild dog impacts as directed by the National Wild Dog Management Advisory Group and Industry.

The National Wild Dog Facilitator will guide and mentor State, NRM and Industry-funded wild dog Coordinators in supporting and developing functional local wild dog management groups.

Significant work is already underway across Australia through the current project which will be of benefit to MLA and AWI levy payers, however wild dogs continue to threaten the livelihoods of producers across the country and they will need continued assistance.

Project objectives

- Enduring partnerships are established for on-ground work to reduce the impact of wild dogs
- Self-reliant, community-led wild dog management groups are established in communities affected by wild dogs.
- Best practice control methods are disseminated to all relevant agencies, industry organizations and stakeholders.
- New control technologies are registered and their use appropriately regulated to a consistent standard across Australia.

Project impacts

- Worked with multiple stakeholders to incorporate wild dog and feral animal management activities built into national livestock production extension programs in order to see feral animal control delivered as part of on-farm management activities.
- Continued to support and mentor four industry funded wild dog coordinators as well as providing support to state government wild dog management staff throughout Australia.
- Assisted collaborators, participating organisations and stakeholders to deliver the outcomes of the national wild dog action plan and seek endorsement of funding for the next phase of the plan.
- Investigated further options and co-investment models for funding of industry wild dog management coordinators to support community groups.
- Continued working towards informing stakeholders on the use of new control technologies and support their integration into current and newly developed wild dog programs.
- Assisted with providing advice on policy and legislation changes and updates related to wild dog management in Australia.
- Developed a series of engagement tools to enhance wild dog best practice management.

Where to next?

This project will continue with the Centre for Invasive Species Solutions with AWI and MLA funding support.

Project team

Mr Greg Mifsud, Mr Ian Evans, Mr Michael McCormack, Mr Bruce Moore, Mr Peter Bird, Ms Jessica Marsh, Mr Geoff Power, Mr Peter Lucas, Mr Peter Star, Dr Malcolm Kennedy, Mr Scot Pickering, Mr Cameron Allen, Mr Mark Horan, Dr Tony Pople, Dr Peter Fleming, Mr Marc Murphy, Mr Brett Carlsson, Mr Mark Tarrant, Ms Meja Aldrich, Ms Jane Littlejohn, Mr Duncan Fraser, Mr John Robertson, Mr Jim McKenzie, Mr Bruce Duncan, Mr David Worsley, Mr Barry Davies, Mr Brian Dowley, Mr David Krajca, Mr Tim Enshaw, Mr Ashley Dowden, Mr Greg Patrick, Mrs Erlina Compton, Mr Tim Wall, Mr Jake Tanner, Mr Chris Havelberg and Mr Bill Sykes.

Project collaborators

GOVERNMENT:

United States Department of Agriculture.

Australian Bureau of Agricultural and Resource Economics and Sciences.

Queensland Department of Agriculture and Fisheries.

NSW Department of Primary Industries,

Victorian Department of Environment and Primary Industries.

Department Primary Industries and Regions SA.

Western Australia Department of Primary Industries and Regional Development.

NSW Local Land Services.

ACT Territory and Municipal Services Directorate.

Queensland Parks and Wildlife Service

Northern Territory Government

INDUSTRY, RESEARCH AND OTHER:

Australian Wool Innovation Limited.

Meat and Livestock Australia Limited.

NSW Farmers.

Wool Producers Australia.

AgForce Queensland.

Granite Borders Landcare.

Victoria River District Conservation Association.

Gulf Rivers Landcare.

Northern Territory NRM.

Rangelands NRM Western Australia.

Northern New England Landcare.

Northern Territory Cattlemen's Association.

Tilpa Progress Association.

Wanaaring Wild Dog Committee.

Barrier Ranges Landcare.

Western NSW Landcare.

United Wild Dog Alliance Mid North Coast Incorporated.

Pennsylvania State University.

Unit and French National Institute for Agricultural Research.

Project resources

Many of the resources delivered through this project are available via www.nationalwilddogactionplan.org.au

and through the PestSmart wild dog toolkit https://www.pestsmart.org.au/pest-animal-species/wild-dog/

Greg talking to a couple of young boys about the importance of wild dog management, at a field day in rural Victoria.

NORTH EAST NSW WILD DOG FACILITATOR

INVASIVE ANIMALS LIMITED RECEIVES EXTERNAL FUNDING THROUGH AUSTRALIAN WOOL INNOVATION TO FUND THE NORTH EAST NSW WILD DOG FACILITATOR.

Project Leader:

Mr David Worsley, Invasive Animals Limited

Project summary

Wild dogs continue to impact on the livelihoods of wool producers in the North East of New South Wales. Strong and ingrained ideology within this region often complicates collaboration and cooperation, and may reduce the effectiveness and efficiency of management and control of wild dogs.

This project deploys one facilitator to assist woolgrowers, other livestock producers and key stakeholders to work together to reduce livestock predation by wild dogs in North Eastern NSW.

The North East facilitator will increase awareness of strategic management of wild dogs, improve cross plan coordination within and between regions, create management plans and engage public support, produce progress maps for all committees and coordinate skills based training for growers. Additionally, the facilitator will focus on increasing participation in wild dog control programs, establishing/refining reporting procedures and where applicable assist in refining control plans.

Where new groups are being formed the facilitator will initially focus on coordination and assisting local producers and key stakeholders to form wild canid management groups and assist neighbouring groups to work together. Where and when groups already exist and coordination is good, the role will focus more on facilitation between stakeholders and across relationships to enable co-management models to be implemented.

The facilitator will participate in and contribute to, the group of AWI funded Wild Dog Coordinators to enhance their professional development in the role and contribute to the progress of Wild Dog control nationally.

The facilitator will also be supported by producers, project officer(s) and researchers experienced in wild dog management as well as a network of industry bodies who will be able to assist in coordinating events and rolling out communications across North East NSW. These activities will relate to the latest management techniques, case studies of lessons learned as well as successful management models.

Project objective

Provide local producers and agency land managers with the ability to develop strong and effective wild dog management groups and the capacity to plan and conduct ongoing co-management to reduce sheep losses to wild dog predation.

Project impacts

- Facilitated the signoff of management plans with the Wongwibinda, Chandlers River and Jeogla Wild Dog Groups. This has moved the area from a dog hotspot with great hostility between National Parks, Local Land Services, Forests NSW and Producers to a highly functional and cohesive wild dog control group.
- With the assistance of NSW Local Land Services, the Wild Dog Facilitator gained National Landcare Program funding for 28 wild dog groups. The funding was used to purchase cameras, traps, canid pest ejectors, run field days and training plus money for reactive trapping managed by the groups themselves.
- Negotiated additional aerial baiting across the Northern Tablelands including Cathedral Rock National Park, Paddies Land (2017), Torrington State Forest and Arthurs Seat National Park for the first time. There has also been a large increase in the amount of baiting on private land.
- Established four new Wild Dog Management Groups at Atholwood, Ashford, Upper Severn River and Emmaville who have actively participated in both autumn and spring control programs.
- Navigated the autumn aerial baiting programs. All stakeholders work very hard together to get this right and receiving feedback from the air takes this program to a new level.
- Continued to work with all stakeholders in a nil tenure fashion to achieve better outcomes for all involved.
- Moved forward with writing management plans for other associations in the region and bring everyone onto the same page, with the ultimate goal of each association to have its own plan which includes all stakeholders including government agencies.
- Coordinated and managed a large number of field days and training activities: including developing FeralScan groups, trapping schools, camera schools and wild dog awareness field days.

Where to next?

This project is intended to continue outside of the Centre for Invasive Species Solutions

Project team

Mr David Worsley, Dr Peter Fleming, Dr Guy Ballard, Mr Ian Evans, Mr Mark Tarrant, Ms Melissa McLeod, Mr Mark Horan, Mr Bruce Moore, Mr Greg Mifsud and Mr Chris Lane.

Project partners

GOVERNMENT:

NSW Department of Primary Industries.

NSW Northern Tablelands Local Land Services.

INDUSTRY, RESEARCH AND OTHER:

Australian Wool Innovations Limited.

NSW Farmers.

NSW Wild Dog Working Group and Landcare.

Dave running an information session on wild dog control, which included a short tutorial on using Wild Dog Scan (image by Peter West)

WILD DOG ALERT SYSTEM

THE 'WILD DOG ALERT' RESEARCH INITIATIVE IS BEING DELIVERED THROUGH INVASIVE ANIMALS LIMITED, WITH MAJOR FINANCIAL AND IN KIND RESOURCES PROVIDED BY THE AUSTRALIAN AND NSW GOVERNMENTS, UNIVERSITY OF NEW ENGLAND, MEAT AND LIVESTOCK AUSTRALIA AND AUSTRALIAN WOOL INNOVATION.

Project Leader:

Dr Paul Meek, NSW Department of Primary Industries

Project summary

Wild dogs can cause up to $110 million damage to the livestock production industries annually (eSYS 2016) and predation could be minimised if producers had early warning of imminent attack on livestock. Getting on top of wild dogs is particularly difficult, made more so by our inability to detect and manage wild dogs early - before they prey upon lambs and calves, sheep and cattle. Outside of strategic control actions like aerial baiting, it is challenging to engage in preventative actions as producers usually detect wild dogs after predation has started. Invasive Animals CRC research in Walcha has shown that dogs can stay on a farmer's property for weeks before an attack on livestock occurs: it is more difficult to stop predation than to prevent it.

Wild Dog Alert addresses this need, allowing for reduced predation losses by early, targeted and more effective interventions. The Wild Dog Alert system is a need identified by producers and crown land managers- aligning directly with objectives of the National Wild Dog Action Plan, National Wild Dog Management Advisory Group, the Australian Pest Animal Strategy and State Wild Dog Management Strategies. The technology also has broader application to other sites and situations where early warning systems could be advantageous such as mine sites where exclusion fencing of refuse is often breached by wild dogs, or in fenced biodiversity areas where predator exclusion is necessary for species recovery actions. It is anticipated that this technology may be broadened in the future to other pest species such as foxes and feral cats.

The proponents have undertaken much research on the use of camera traps for remote detection of wild dogs and other wildlife (e.g. Meek et al. 2014, Falzon et al. 2014) and are preparing habitat use models to predict the movements of wild dogs through the landscape. This technology will allow for real-time recognition of species and individual recognition and transmission of an alert. Producers and land managers will be alerted by mobile phone, satellite phone, radio or pager as to the location of the incursion, along with a photo of the dog.

Simultaneously, the locational data can be uploaded to WildDogScan and the local and regional planning maps and records will be automatically updated. Producers will be provided with vital facts in real time for early action and cooperative planning. Early intervention will result in more efficient use of labour and reduced opportunity costs, and create greater confidence and less distress among wild dog-affected producers.

This project will develop, integrate and field test the components of the early alert system. The work is an innovative integration of existing and currently developing ecological and behavioural knowledge with computer and camera trap technologies. Wild Dog Alert will provide a net benefit on investment during the first five years of uptake and deployment by producers and other land managers. A recent independent review of AWI investment in wild dog management revealed a benefit cost ratio of 8.6:1 for the years 2012-2015 (Deloitte 2015).

Project objectives

1. Develop a species and individual recognition system based on camera trap imagery.
2. Test and refine a telecommunication system suitable for remote transmission of image data and early alert messaging.
3. Construct a standalone device that will be tested at remote sites, with the capability to detect the presence of wild dogs, recognise them to species and individual level, and initiate transmission of an alert using computer assisted technologies.
4. Evaluate efficacy of the device by comparing the occurrence and movements of radio tagged wild dogs in relation to the detection foot print of the device.
5. Focus on the development of a marketable wild dog alert product.

Project impacts

- The project team carried out community and stakeholder engagement to disseminate information on the project objectives and successfully gained access to numerous test sites throughout Australia.
- Undertaken initial camera trap surveys at over 20 sites in NSW and SA to collect image data for wild dog facial algorithm development.
- Refinement of algorithms and development/customisation of software to process image data and enhance image recognition capabilities has been a primary focus of the team.
- Community awareness of the product testing and capabilities at multiple field days, community meetings and through the media.

Where to next?

This project is ongoing and the development of Wild Dog Alert is continuing.

THIS PROJECT IS ONGOING AND THE DEVELOPMENT OF WILD DOG ALERT IS CONTINUING

Project team

Dr Paul Meek, Dr Guy Ballard, Dr Peter Fleming, Mr Peter West, Dr Karl Vernes, Dr Greg Falzon, Mr Cameron Allan and Mr Ian Evans.

Project collaborators

GOVERNMENT:

NSW Department of Primary Industries,

INDUSTRY, RESEARCH AND OTHER

University of New England,

Meat and Livestock Australia Limited

Australian Wool Innovations Limited.

Project resources:

Falzon, G., Meek, P.D., Vernes, K., (2014). Computer-assisted identification of small Australian mammals in camera trap imagery., in: Meek, P., Fleming, P., Ballard, G., Banks, P., Claridge, A., Sanderson, J., Swann, D. (Eds.), *Camera trapping for wildlife management and research*. CSIRO Publishing, Australasian Wildlife Management Society, Royal Zoological Society of NSW, Collingwood. 299-306.

Meek, P., Fleming, P., Ballard, G., Banks, P., Claridge, A., Sanderson, J., Swann, D., (2014). Camera trapping for wildlife management and research. CSIRO Publishing, Australasian Wildlife Management Society, Royal Zoological Society of NSW, Collingwood, 367.

Meek, P., Ballard, G., Fleming, P., & Falzon, G. (2016). Are we getting the full picture? Animal responses to camera traps and implications for predator studies. *Ecology and evolution*, *6*(10), 3216-3225.

Sadgrove, E. J., Falzon, G., Miron, D., & Lamb, D. (2017). Fast object detection in pastoral landscapes using a Colour Feature Extreme Learning Machine. *Computers and Electronics in Agriculture*, *139*, 204-212.

CYPRINID HERPESVIRUS–3: ITS POTENTIAL AS A BIOLOGICAL CONTROL AGENT FOR CARP IN AUSTRALIA

Project Leader:

Dr Ken McColl, CSIRO

Project summary

There are three components proposed for Phase 3 of this project on the use of Cyprinid herpesvirus-3 (CyHV-3) as a potential biological control agent for carp in Australia. Firstly, further non-target species testing is required. Five non-target species of Australian fish have already been tested, these species including representatives from the taxonomic Orders: Perciformes, Osmeriformes and Salmoniformes. At least a further 9 teleost species, together with an amphibian (tadpole and mature stages), two reptiles, a mammal, a bird and a crustacean, will also be tested. The experimental procedures used in Phase 1 and 2 will again be used.

Secondly, an epidemiological model for CyHV-3 will be developed that can be used to evaluate strategies that will optimize spread of disease, and predict the efficacy of CyHV-3 when released in different aquatic environments. The most appropriate means to study the effects of CyHV-3 in different carp populations would be via an epidemiological model using data already available (from work in Phase 1 and 2, from the literature, and from readily-available experts). This component of the project will be conducted in collaboration with Dr Paul Brown (DPI Vic), Dr Dean Gilligan (NSW DPI) and RMIT University.

Finally, we will transfer the well-characterized Indonesian C07 strain to the non-secure area at the Australian Animal Health Laboratory, ensuring that it is free of any other adventitious viruses that are exotic to Australia. Batches of freeze-dried virus will be prepared, and tested after reconstitution. This is the virus that will be used in any subsequent biological control program.

Project objectives

- Determine the susceptibility to CyHV-3 of 12 further species of fish from Australian inland waters, two amphibians, two reptiles, a mammal, a bird and a crustacean.
- Develop an epidemiological model of CyHV-3 that can be used to assist in developing strategies for the release of CyHV-3.
- Transfer the Indonesian C07 strain of KHV from the secure to the non-secure area at AAHL so that it is ready for use in any future carp control program in Australia. In addition, prepare the virus as a freeze-dried product and test the virulence of the reconstituted virus.

Project impacts

- Development of the first model to inform a “release strategy” for viral biocontrol of a vertebrate, in this case the use of CyHV-3 to control common carp in the Lachlan River Catchment.
- Determined the decay (“Shelf-life”) of CyHV-3-infected tissue culture supernatant fluid at 4oC.
- Searched CyHV-3-infected carp for biomarkers of persistent infection.
- Non-target testing undertaken showing no effect of virus on multiple native and introduced fish species, amphibians and mammals.
- Final project report completed and published through the PestSmart website.
- This research project was instrumental in the development of a $15 million Australian Government funded National Carp Control Plan.

Where to next?

The National Carp Control Plan is currently being implemented, which includes further environmental research and non-target testing. Dr McColl and his team are involved in this program.

Project team

Dr Ken McColl, Dr Mark Crane, Dr Agus Sunarto, Dr Peter Durr, Ms Kerryne Graham, Dr Paul Brown, Dr Dean Gilligan, Mr Martin Asmus, Dr David West and Dr Stephen Davis.

Project collaborators

GOVERNMENT:

Victoria Department of Primary Industries.

NSW Department of Primary Industries.

Murray-Darling Basin Authority.

New Zealand Department of Conservation.

INDUSTRY, RESEARCH AND OTHER:

Commonwealth Scientific and Industrial Research Organisation.

RMIT University.

Dr Ken McColl was the 2016 recipient of the IA CRC Professor Dave Choquenot Science Prize for Excellence in Invasive Animal Science and Research, for his research excellence and leadership in the carp biocontrol space.

Project resources

McColl, K.A., Cooke, B.D. and Sunarto, A. (2014) Viral biocontrol of invasive vertebrates: lessons from the past applied to cyprinid herpesvirus-3 and carp (*Cyprinus carpio*) control in Australia. *Biological Control* 72:109-117.

McColl, K. (2016). Final report: Phase 3 of the carp herpesvirus project (CyHV-3). PestSmart Toolkit publication, *Invasive Animals Cooperative Research Centre*, Canberra, Australia.

Sunarto, A., McColl, K.A., Crane, M.S.J., Schat, K.A., Slobedman, B., Barnes, A.C. and Walker, P.J. (2014) Characteristics of cyprinid herpesvirus 3 in different phases of infection: implications for disease transmission and control. *Virus Research* 188:45-53.

Sunarto A, McColl KA (2015). Expression of immune-related genes of common carp during cyprinid herpesvirus 3 infection. *Dis Aquat Org* 113:127-135.

CYPRINID HERPESVIRUS-3: REGISTRATION, RELEASE AND SELECTED MONITORING

Project Leader:

Dr Dean Gilligan, NSW Department of Primary Industries

Project summary

Cyprinid herpesvirus-3 (CyHV-3) offers a genuine option for the control of Common carp in Australia and New Zealand. The use of a virus as a biocontrol agent for Carp in Australia requires approval under the *Biological Control Act 1984*, *Quarantine Act 1908* and *Environment Protection and Biodiversity Conservation Act 1999*. The virus should also be assessed under the *Agricultural and Veterinary Chemicals Code Act 1994* in relation to an accepted critical evaluation of its safety and efficacy as a control agent. By December 2015, IA CRC project 3.W.1 will have completed the necessary non-target species testing, Carp sensitivity analyses and epidemiological modelling required to support these applications. Fisheries NSW (NSW Department of Primary Industries) will prepare the necessary applications under each Act and serve as the proponent throughout the approval processes as deliverables of project 3.W.2. Because inter-jurisdictional support and planning and high level endorsement will be critically important to implementing a National CyHV3 Biological Control Program, an active role in briefing the various government biosecurity and fisheries management councils and committees will also be required.

The three applications require summaries of the biology of Carp and CyHV-3, the impacts of Carp on Australian waterways, a review of cost-effectiveness and limitations of currently available control options, details of the disease caused by the virus, details and results of the host-specificity testing program (undertaken by project 3.W.1) and other environmental, OH&S and economic risks as well as proposed release and monitoring & evaluation strategies and details of collaborative partnerships established. The project will also undertake a scoping study of a potential post-release fish kill clean-up program and prepare a costed tactical clean-up strategy. Any additional data relevant to formal environmental, OH&S and economic risk assessments undertaken as part of the approval process will also be compiled.

Comprehensive benchmarks on Carp abundance and ecological condition (relating to their impacts) need to be established and maintained prior to implementation of a national CyHV3 biological control program, both as a requirement of the Quarantine Act / EPBC Act approval and so that IA CRC outcome 3 'Recovery of key land and water regions after humane control of rabbits, wild dogs and Carp' can be assessed. This requires the collation of existing data on target (Carp) and non-target (native fish and aquatic ecosystems) components, as well as the generation of new data where required. The methods and strategies adopted for the ongoing M&E program will build on these benchmark data and allow assessment of the effect of the

Matt Barwick, affectionately known as the 'carpinator' is now leading Australia's National Carp Control Plan.

virus on Carp abundance and biomass and of the implications of reduced Carp abundance/biomass on aquatic ecosystem health. It will also facilitate the monitoring of the rate of spread of the virus and assessment of changes in its virulence/resistance through time

Project objectives

1. Develop a National CyHV-3 Carp Biocontrol Strategy and facilitate government approval.
2. Provide scientifically robust benchmarks of carp abundance/density and document the status of aquatic ecosystem condition as a foundation for assessment of recovery of freshwater habitats following implementation of a national Carp Biocontrol program.
3. CyHV-3 carp biocontrol ready for implementation in Australia.

Project impacts

- Completed consultation with Invasive Plants and Animals Committee, National Biosecurity Committee and the Agricultural Senior Officials Committee to pursue agreement for declaration of CyHV-3 and Common carp as agent organism and target species under the *Biological Control Act 1984*.
- Submission of application to import the carp herpesvirus (CyHV-3) under the *Quarantine Act 1908*.
- Completion of summer pre-release benchmark monitoring in several catchments within the Murray-Darling Basin.
- Submission of registration package to the APVMA seeking registration of CyHV3 as a carp control agent.
- Aspects of this project led to the development of a $15 million Australian Government funded National Carp Control Plan

Where to next?

The National Carp Control Plan has since superseded this project. More information can be found at carp.gov.au

Project team

Dr Dean Gilligan, Matt Barwick, Dr Jerom Stocks, Mr Justin Stanger, Mr Dylan van der Meulen, Mr Jonathon Doyle, Miss Karen Scott and Mr Chris Keogh.

Project partners

GOVERNMENT:

New Zealand Department of Conservation,

New Zealand Ministry of Primary Industries,

UK's Environment Agency and

Japan's Ministry of Agriculture, Forestry and Fisheries.

NSW Department of Primary Industries,

Murray-Darling Basin Authority,

Commonwealth Environmental Water Office, Department of Agriculture,

Commonwealth Department of the Environment, Australian Pesticides and Veterinary Medicines Authority,

Australian Quarantine and Inspection Service, Tasmanian Department of Primary Industries, Parks, Water and Environment - Inland Fisheries Service, Primary Industries and Regions SA – South Australian Research and Development Institute, Victorian Department of Environment and Primary Industries,

Queensland Department of Agriculture, Fisheries and Forestry,

Western Australian Department of Fisheries,

ACT Territory and Municipal Services,

INDUSTRY, RESEARCH AND OTHER:

Australian Recreational Fishing Foundation,

National Farmers Federation,

National Irrigators Council,

Australian Conservation Foundation,

Invasive Species Council

Cornell University,

Chautaqua Lake Association,

Centre for Environment Fisheries and Aquaculture Science,

KoVax, Dag Noy - Hazorea and Ma'agan Michael Fish Farms,

Japan's Research Institute for Humanity and Nature,
Japan's National Research Institute of Aquaculture Fisheries Research Agency,

Project resources

Information about this project and the National Carp Control Plan can be found at carp.gov.au

SCIENTIFIC EVALUATION OF HUNTING IN NSW

INVASIVE ANIMALS LIMITED RECEIVES EXTERNAL FUNDING THROUGH THE GAME LICENCING UNIT OF NSW DPI TO FUND THIS PROJECT.

Project Leader:

Dr Andrew Bengsen, NSW Department of Primary Industries

Project summary

The NSW Game Licensing Unit (GLU) is responsible for the administration of hunting on public land in NSW, including the establishment of a research program to evaluate the efficacy of recreational hunting as a complementary pest animal control tool on State Forests and Crown Reserves of NSW. This proposal addresses this overall aim.

Specifically, this program will use field trials at matched treatment and non-treatment sites in NSW to address the following research questions in relation to key pest animal species:

1. What impact does recreational hunting have on the local pest population?
2. What impact is recreational hunting likely to have on key resources that are adversely impacted by the pest?
3. How cost-effective is recreational hunting as a means of reducing pest animal impacts, relative to other control methods?
4. How can the management of recreational hunting be improved to deliver more effective pest animal control?

Project objectives

- Estimate the impacts of recreational hunting on key pest species at a series of case study sites.
- Assess the ability of recreational hunting, as currently practiced in NSW Crown Reserves, to reduce important negative impacts of pest animals.
- Make recommendations as to how the management of recreational hunting might be improved to provide better pest management outcomes.

Project impacts

- Twenty one surveys of feral pig, fox, goat and deer populations have been completed at four sites in the New South Wales Central Tablelands. With data collection, processing and analysis are ongoing.
- Three rounds of carcass monitoring have been conducted at three sites to estimate survival in foxes. Foxes have also been fitted with tracking collars to augment survival estimation.
- A characterisation of recreational hunting in Australia and its potential to contribute to vertebrate pest control objectives was presented at the Conservation of Sustainable Use of Wildlife Conference and will be published in the proceedings.
- A survey has been prepared for an audience segmentation study which will give insight into the different groups or ‘mindsets’ of public land hunters in NSW. The survey is expected to help identify some of the drivers and barriers that influence their effectiveness in mitigating the impacts of pest animals.

Project team

Dr Andrew Bengsen, Dr Jessica Sparkes, Dr Steve McLeod and Dr Andrew Moriarty.

Project collaborators

GOVERNMENT:

NSW Department of Primary Industries

NSW Game Licensing Unit.

Project resources

Bengsen, A. J. (2016). *A systematic review of ground-based shooting for pest animal control*. PestSmart Toolkit Publication, Invasive Animals Cooperative Research Centre, Canberra.

Bengsen, A. J., & Sparkes, J. (2016) Can recreational hunting contribute to pest mammal control on public land in Australia? *Mammal Review*

Bengsen, A. J., Sparkes, J., & McLeod, S. R. (2016) Can recreational hunting control pests on public lands? In P. Murray & G. Baxter (eds) *Conservation Through Sustainable Use of Wildlife*. University of Queensland, Brisbane.

NATIVE GAME BIRD MANAGEMENT

INVASIVE ANIMALS LIMITED RECEIVES EXTERNAL FUNDING THROUGH THE GAME LICENCING UNIT OF NSW DPI TO FUND THIS PROJECT.

Project Leader:

Dr Shannon Dundas, NSW Department of Primary Industries

Project summary

NSW Department of Primary Industries Native Game Bird Management Program allows landholders and licensed hunters to harvest ten species of native game birds on agricultural lands. Sustainable management of native game bird populations requires the identification and setting of harvest quotas that will provide crop protection and hunting opportunities without compromising the viability of game bird populations. This project will use population surveys to estimate sustainable harvest rates that can be used to set quotas and inform other management policy, and will provide a foundation for ongoing sustainable management of native game birds in NSW.

Project objectives

- In the immediate term, it will enable the establishment of scientifically robust harvest quotas for ten native game bird species in NSW during the years in which the project is active.
- In the longer term, it will provide an approach for the ongoing establishment of sustainable quotas that provide benefits for crop growers and recreational hunters, including a continual monitoring and improvement component.

Project impacts

- Completed, collated and analysed aerial, drone and ground based waterbird surveys in the Riverina completed.
- A standardised ground survey technique was developed and will now be refined in future surveys.
  - Completed recommendation report for future scientific evaluation of gamebirds and provided to NSW Game Licensing Unit

Project team

Dr Shannon Dundas, Dr Jessica Sparkes, Prof Richard Kingsford, Dr John Porter, Dr Kate Brandis, Dr Steve McLeod, Dr Patrick O'Brien, Dr Andrew Moriarty.

Project collaborators

NSW Department of Primary Industries, University of NSW, NSW Game Licensing Unit


Relationship btwn FACTS + VALUE
Small successes
How we decide, participate
Establish basic pr
TRUST

OUTCOME 4
STRENGTHENED SOCIAL NETWORKS AND INSTITUTIONS AROUND PEST ANIMAL CONTROL

OUTCOME 4: STRENGTHENED SOCIAL NETWORKS AND INSTITUTIONS AROUND PEST ANIMAL CONTROL	
Theme 7	Community engagement
CA output 4.1	Facilitate collective action - Complete
4.E.1	Facilitate collective action
CA output 4.2	Triggers for effective action
4.E.2	Triggers for effective action
CA output 4.3	Reduction of legal and institutional impediments
4.E.3	Reduction of legal and institutional impediments
4.E.4	Action-driven coordination
4.E.4a	Increasing stakeholder participation in biosecurity management
Theme 8	Training, regional capacity building and communications
CA output 4.5	Vocational education and training
4.E.6	Facilitating community led rabbit management in Australia
4.E.11	VET training packages on strategic pest management
4.E.12	National NRM Facilitator
	Education
CA output 4.4	Balanced Researcher Program
4.E.21	Balanced Researcher Program
	The PestSmart toolkit, website and social media channels

FACILITATE COLLECTIVE ACTION

Project Leader:

Professor Ted Alter, Penn State University, USA.

Project summary

This project addresses the human dimensions of invasive animal management, notably the support mechanisms used to facilitate action by private citizens. Effective community action is fundamental to most forms of invasive animal control, particularly control of already established species given re-prioritisation of government funds, and new legal responsibilities for landholder control of established invasive species.

The research addresses control of various species across Australia, with particular focus on wild dogs, feral pigs and rabbits. This project tackles the question 'What strategies and practices will most enable and support effective community-led action for the control of invasive animals'?

The applied goal is that by the end of the current IA CRC, there will be a system in place to support practitioners to deliver ongoing effective community-led invasive animal control at a landscape scale, spanning private and public tenures.

For most pest animal issues (other than the few that can be effectively controlled by a permanently powerful biocontrol) active community engagement is irreplaceable. This is for political, legal and practical reasons. The empirical evidence is that effective engagement is far more likely where the community leads rather than follows technical experts from science and government. This suggests why our focus needs to be not upon traditional extension (principally concerned with knowledge transfer) but upon facilitation of citizen leadership and local action.

There is a significant difference in approaches between community-leadership, and science or government-driven extension, adoption and diffusion. The differences begin with a philosophy that the community has locally situated knowledge and expertise, and that the role of technical specialists is to negotiate and deliver within a social contract based around service to the community. This philosophy fundamentally changes the way in which technical experts go about their duties. It places satisfying the needs as specified by the community, and supporting that community, at the heart of the research and practical implementation challenge.

Aspects of community engagement in invasive animals control that make this particularly challenging are the spatial scale and the mobility of the animal, the diversity of felt impacts from pest species, the requirement for ongoing investment, difficulties in observation of the animals, the need for coordinated action and the diversity of opinions about animal welfare. In a number of jurisdictions, government policy changes have reduced the actual or perceived support, and created new challenges.

Project objectives

The applied objective is an effective system to support ongoing community-led invasive animal control at a landscape scale, spanning private and public tenures. This initiative must be increasingly self-supporting after mid-2017.

A subordinate objective is to create and support a professional cohort of community engagement practitioners. This may occur at two levels:

1. Vocational training and support for frontline practitioners.
2. More advanced training and suport for leaders of teams involved in engagement work.

The project also conducts research to address important questions about the theory and practice of community engagement, with an emphasis upon enabling collective action in rural natural resource management.

Project impacts

- Developed three Online modules in the 'Community Action Tool box' which are now available online via the 'Invasive Action Tool'. These modules package the best research about community engagement in invasive species management into a learning tool that utilises worksheets to guide users through the detailed steps of best practice community engagement planning, implementation and evaluation.
- Held a community engagement masterclass (utilising the online tools) in WA, with 32 invasive species practitioners nominated to attend from various stakeholder organisations.
- A series of practitioner profiles have been completed and published online.

Where to next?

A 'behaviourally effective communications and engagement' project proposal is currently being considered for future funding allocation.

The online Invasives Action Tool will be integrated into the PestSmart digital platform over coming month to enhance its uptake.

Project team

Prof Paul Martin, Prof Ted Alter, Dr Tanya Howard, Dr Lyndal Thompson, Ms Paloma Frumento, Dr Jeffrey Bridger, Mr Bill Shuffstall and Mr Walt Whitmer.

Project collaborators

GOVERNMENT:

Tasmanian Department of Primary Industries, Parks, Water and Environment.

Western Australia Department of Primary Industries and Regional Development.

Victoria Department of Economic Development, Jobs, Transport and Resources.

INDUSTRY, RESEARCH AND OTHER:

University of New England.

Meat and Livestock Australia Limited.

Australian Wool Innovation Limited.

Queensland Murray-Darling Committee.

Murdoch University.

Pennsylvania State University USA.

Cornell University USA.

Sam Houston State University USA.

Project resources:

All outcomes from this project are highlighted via www.pestsmart.org.au/people-and-pests/

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.

Howard et al (2016). Community action for wild dog management. PestSmart publication, Invasive Animals Cooperative Research Centre, Canberra, Australia.

Howard, TH, McLeod, L & Hine, D. (2016) *Increasing Community Participation in Invasive Animals Management: A mixed-methods study of reform in one Australian jurisdiction.*

TRIGGERS FOR EFFECTIVE ACTION

Project Leader:

Professor Don Hine, University of New England

Project summary

This research addresses the human dimensions of invasive animal management, notably the application of behaviourally effecive communications approaches to trigger action by private citizens. Effective community action is fundamental to most forms of invasive animal control. The research will address the management of domestic and feral cats (Tasmania) and wild dogs (Northern NSW/South East Queensland). Other species and issues may be added.

Project objectives

This project is focused on developing, implementing and evaluating improved communications strategies to facilitate the uptake of best practices for the control of invasive animals.

These strategies will draw on the behavioural sciences:

- Best practice principles for behaviourally effecive communications (such as the use of community-based social marketing principles).
- Precise targeting of messages to different audience segments, based upon the analysis of survey data assessing community values, attitudes and current practices.

Project impacts

- Completion of PhD thesis and research looking at behaviour change interventions to reduce impact of domestic cat wandering and enhance cat containment within urban areas.
- Implementation of peri-urban wild (wandering) dog behaviour change communications intervention on the Gold Coast resulting in enhanced awareness of wild dog issues.
- Completion of online learning modules for Auditing Communications and Designing Behaviourally Effective Communications.

Project team

Prof Don Hine, Dr Patricia Please, Ms Lynette McLeod, Ms Bernadette York and Mr Aaron Driver.

Project collaborators

GOVERNMENT:

Tasmanian Department of Primary Industries, Parks, Water and Environment.

Queensland Department of Agriculture and Fisheries.

City of Gold Coast Council.

NSW Department of Primary Industries.

Western Australia Department of Primary Industries and Regional Development..

South West NRM

INDUSTRY, RESEARCH AND OTHER:

University of New England.

Queensland Murray Darling Committee.

Griffith University.

Project resources

All outcomes from this project are highlighted via www.pestsmart.org.au/people-and-pests/

Hine DW, Please PM, McLeod LJ, and Driver AB (2014). Behaviourally Effective Communications for Invasive Animals Management: A Practical Guide. Canberra, Australia: Invasive Animals Cooperative Research Centre.

McLeod L, Hine DW, Bengsen A., (2015). Born to roam? Surveying cat owners in Tasmania, Australia, to identify the drivers and barriers to cat containment, Preventative Veterinary Medicine, 122(3): 339-344.

McLeod, L.J., Hine, D.W., Please, P.M. & Driver, A.B. (2015). Applying behavioral theories to invasive animal management: Toward an integrated framework, Journal of Environmental Management, 161, 63-71.

Ecker, S, Please, PM & Maybery, D, (2016). Constantly chasing dogs: assessing landholder stress from wild dog attacks on livestock using quantitative and qualitative methods, Australasian Journal of Environmental Management.

REDUCTION OF LEGAL AND INSTITUTIONAL IMPEDIMENTS

Project Leader:

Professor Paul Martin, University of New England

Project summary

This research addresses the institutional dimensions of invasive animals management, including laws and policies, program design and implementation and coordination.

Its focus is upon reducing impediments to effective community action, such as funding problems, unnecessary administrative complexities, failures of accountability, legal or bureaucratic impediments to community based innovation and the like.

Effective community action is fundamental to most forms of invasive animal control.

The research will address the case study issues of foxes (Tasmania) and wild dogs (Northern NSW/Southern Queensland), with an emphasis upon peri-urban issues. Other species and issues may be added.

Institutions comprise the rules (government, private or social) and related organisations and their arrangements (administration, coordination) that provide the governance structure for social arrangements, including the governance of natural resources.

Many fundamental challenges in the management of invasive animals derive largely from institutional factors and cannot be overcome without innovations in institutional arrangements. These include (for example):

- The availability of public and private funding. Thus, the absence of effective funding structures for biosecurity risk control, or the insufficiency of public funds for landscape protection, can be attributed to the absence of suitable fiscal incentives for control such as might be created by adjustments to taxation or government funding arrangements, or to legal accountabilities.
- The limited financial or legal accountability of those who generate or harbour pest animal populations, leads to the continuing presence of otherwise controllable populations of pest species. A change in accountability regimes for public or private agents who control land or potentially destructive animals would have the potential to impact strategically on pest animal management.
- Administrative arrangements, such as the complexity of funding schemes, or of licensing arrangements for pest control, are relevant to the efficiency and effectiveness of control arrangements. “Streamlining” funding and support systems, or altering the administrative pathways for such support, might lead to material improvements.
- Rights and obligations are important in natural resource management. One consideration is the extent to which the laws and institutions of private property act as an impediment to integrated (nil tenure) management of pest species.
- Coordination between public and private agents (including landholders for all tenure types) is an essential component of pest animal management. The institutional arrangements to support unified action are weak, limiting the potential of many known management techniques.
- Liability issues, such as responsibility for the hazards associated with the use of poisons, are an important aspect of pest species control strategies. Such risks are managed largely through certification and licensing arrangements, which are relatively inflexible and which limit pest control strategies that may be used. Alternative approaches may be possible.
- Many other institutional considerations arise: the problem of ‘silos’ and layers, the transaction costs of institutional systems, the limited use of citizen intelligence in government programs – there are many areas where institutional innovation ought contribute strategically to reduction of the current and future pest species burden.
- The focus of our research will be wild dog and fox control with an emphasis upon peri-urban issues.

Project objectives

1. Improve understanding of the effects of legal and institutional arrangements on effective invasive species control.
2. Enable advocacy of law and policy reform proposals to improve the effectiveness of invasive species governance arrangements.
3. Develop a policy briefing paper which provides input into government reviews of invasive species management.

Project impacts

- Completed evidence-based proposals to address institutional issues that impede effective citizen action. Recommendations have been filed in report format and distributed to relevant stakeholders
- Trialled a new approach to citizen-led institutions in Southern Queensland, and undertook investigation of the institutional impediments to the control of wild dogs and deer in areas adjacent to Sydney and Brisbane.
- Enhanced awareness of policy makers and key of the extent to which these issues put at risk other reforms, particularly the increasingly central concept of ‘shared responsibiity’.

The major output from this project 'Recommendations for the reform of invasive species management institutions' report is now available online via PestSmart

Project team

Prof Paul Martin, Prof Darryl Low Choy, Dr Elodie LeGal, Dr Kylie Lingard, Dr Silvia Serrao-Neumann and Mr Vivek Nemane.

Project collaborators

GOVERNMENT:

NSW Department of Primary Industries.

Tasmanian Department of Primary Industries, Parks, Water and Environment.

INDUSTRY, RESEARCH AND OTHER:

University of New England.

Griffith University.

Meat and Livestock Australia Limited.

Queensland Murray Darling Committee.

Pennsylvania State University USA.

Project resources

All outcomes from this project are highlighted via www.pestsmart.org.au/people-and-pests/

Martin, P. and Choy, DL (2016). Recommendations for the reform of invasive species management institutions. Invasive Animals Cooperative Research Centre: Canberra.

Martin P, Low Choy D, Le Gal E and Lingard K. (2016). Effective Citizen Action on Invasive Species: The Institutional Challenge. Invasive Animals Cooperative Research Centre: Canberra.

Martin, P and Williams, J (2016). *Legal Aspects of Sustainable Development*. Cham: Springer International Publishing.

ACTION-DRIVEN COORDINATION

Project Leader:

Professor Paul Martin, University of New England

Project summary

1. Support and coordinate the other three projects (4E1, 4E2 and 4E3).
2. Lead research on the question: "What research and research management methods are most likely to ensure that trans-disciplinary and engaged research projects are effective, efficient and fulfilling?"

Project objectives

1. Support and coordinate the other three projects that are concerned with delivery of outputs.
2. Lead research on the question: "What research and research management methods are most likely to ensure that trans-disciplinary and engaged research projects are effective, efficient and fulfilling?"

This second objective is concerned with advancing scholarly methods, rather than the delivery of invasive animals specific outputs.

In relation to the first objective (support and coordination) the goals are:

1. Lead and coordinate the scholarly publications approach, to ensure maximum scholarly credit and impact.
2. Lead and coordinate the stakeholder communications approach, to ensure maximum collaboration and satisfaction with the program.
3. Lead project management and coordination.
4. Lead our strategy for securing additional resources for our program.
5. Negotiation of resource allocation across the team, particularly the:
    - » activities of the three postdocs, and
    - » allocation of our Doctoral funding across PhDs as they are recruited (with a particular emphasis upon candidates who achieve APA scholarships).

Project impacts

- Drafted the textbook 'People managing pests: modern theories and practices for effective community-based control of invasive species' which is currently being considered for publication.
- Finalised the outcomes of the stakeholder views of pest management in Australian and published findings as a report available freely online.
- Successfully managed the completion of the 3 behaviour change and instituional change community engagement projects within this program.

Project team

Prof Paul Martin, Prof Don Hine, Prof Ted Alter, Prof Darryl Low Choy, Dr Elodie LeGal, Dr Lyndal Joy Thompson, Dr Patty Please, Assoc Prof Robyn Bartel, Ms Katrina McDonald, Ms Lynette McLeod, Mr Vivek Nemane, Mr Darren Marshall, Ms Bernadette York, Ms Lisa Yorkston, Ms Roxane Blackley, Ms Jessica Marsh, Ms Lisa Adams, Mr Stephen Johnson, Mr Craig Elliott, Mr Walt Whitmer, Mr Bill Shuffstall, Ms Paloma Frumento and Dr Kylie Lingard.

Project partners

GOVERNMENT:

NSW Department of Primary Industries,

Tasmanian Department of Primary Industries, Parks, Water and Environment,

City of Gold Coast Council

Queensland Department of Agriculture and Fisheries.

INDUSTRY, RESEARCH AND OTHER:

University of New England.

Meat and Livestock Australia Limited.

Australian Wool Innovations Limited.

Griffith University.

Queensland Murray-Darling Council.

Pennsylvania State University USA.

Sam Houston University USA.

Cornell University USA.

Project resources:

All outcomes from this project are highlighted via www.pestsmart.org.au/people-and-pests/

Martin P and Lingard K (2017). Stakeholder Views on Pest Management in Australia. Invasive Animals Cooperative Research Centre, Canberra.

INCREASING STAKEHOLDER PARTICIPATION IN BIOSECURITY MANAGEMENT

INVASIVE ANIMALS LIMITED RECEIVES EXTERNAL FUNDING FOR THIS PROJECT AS PART OF THE BOOSTING BIOSECURITY DEFENCES PROJECT, SUPPORTED BY ROYALTIES FOR REGIONS AND THE WA DEPARTMENT OF PRIMARY INDUSTRIES AND REGIONAL DEVELOPMENT.

Project Leader:

Professor Don Hine, University of New England

Project summary

Community responsibility for invasive species management under the Biosecurity and Agriculture Management Act 2007 (BAM Act) has not led to increased levels of participation in, or compliance with, biosecurity programs and policies. Expertise to undertake community engagement and promote behaviour change has been identified by DAFWA as a requirement to increase participation in biosecurity specifically under Principle 1 of the DRAFT Western Australian State Biosecurity Strategy, but also associated with Principles 4 and 5 of this Strategy.

DAFWA Invasive Species Team has recognised the need for a cultural shift from a reliance on government to solve invasive animals issues, and more broadly, biosecurity issues. Shared responsibility can be facilitated by the development of principles, processes, practices and skills in community engagement and behaviourally effective communications. The approaches depend on understanding the reasons for non-adoption or inconsistent adoption of invasive animals management actions. Additionally, to ensure long-term effectiveness there is a need to encourage biosecurity best practice activities including early detection, surveillance, monitoring, evaluation and reporting.

Currently, we do not know the scope of the issue, the full range of factors affecting participation and non-participation behaviours or how effective a targeted intervention strategy could be to address the issues. The approaches we are adopting are innovative in this field and are aimed at developing and implementing engagement and behaviourally effective communications strategies to promote participation in biosecurity/invasive species management.

Attendees of the Transforming Regional Biosecurity Responses workshop held in Western Australia.

Project objectives

This project aims to address knowledge and practice improvement for community participation in biosecurity activities as outlined in the Draft Western Australian State Biosecurity Strategy (2014). More specific objectives, associated with specific outputs, include:

1. Improved understanding of the social and structural issues impacting citizen participation in biosecurity activities under the BAM Act 2007 with an emphasis on primary producer perspectives and implementing behaviour change.
2. Stakeholder involvement in targeting behaviours and an improved understanding of the barriers and benefits to adopting these behaviours.
3. A jointly developed, implemented and evaluated pilot strategy to improve effective citizen participation.
4. Strengthened capacity of DAFWA staff, industry and community for community engagement and behaviourally effective communications.

Project impacts

- Conducted in-depth interviews with staff and key informants, which have led to reframed project aims into short-term and long-term objectives, improving the planning of the project and assisting the team in identifying priorities for community engagement.
- Completed a literature review and identification of barriers and drivers for behaviour change.
- Development and implementation of two state-wide behaviour change surveys designed to assist DAFWA and community stakeholders better understand the barriers and drivers for individual and group action on invasive species

Where to next?

This project is due for completion at the end of 2018

Project team

Prof Don Hine, Prof Paul Martin, Prof Ted Alter, Dr Tanya Howard, Dr Catherine Baudains and Ms Belinda O'Brien.

Project collaborators

GOVERNMENT:

Western Australia Department of Primary Industries and Regional Development

INDUSTRY, RESEARCH AND OTHER:

University of New England, Murdoch University

Pennsylvania State University USA.

"This project has developed and implemented two state-wide behaviour change surveys designed to assist WA DPIRD and community stakeholders to better understand the barriers and drivers for individual and group action on invasive species"

FACILITATING COMMUNITY LED RABBIT MANAGEMENT IN AUSTRALIA

Project Leader:

Mr Michael Reid, Victorian Department of Economic Development, Jobs, Transport and Resources

Project summary

The project has been established to be a catalyst for more sustainable, effective community-led action on rabbit management across Australia.

The most significant challenge for rabbit management is to influence the human dimensions of natural resource management (NRM) policy and practice. In view of this challenge, the NRF will work with project partners and stakeholders, using systems-based, participatory approaches, to better integrate the human dimensions of NRM with biophysical science-based knowledge and capabilities. Possible methodologies include dialogical learning, collaborative action research, systems mapping, scenario planning, strategic planning, socio-economic analysis and narrative-based research.

The project will support strategic research to inform policy and practice decisions in NRM. An example is to investigate how compliance and other forms of community engagement can work together to better support community led action on rabbits.

The project will assess the extent to which it has influenced systematic improvement in the human dimensions of NRM. Assessment will consider changes to the practices of the project participants; rabbit management systems with reference to transaction costs, feedback mechanisms, community led action, and rabbit management on public and private land; and benefit cost ratios - the target is for the economic benefits to exceed project costs and the developed approaches, over 15 years.

Project objectives

The National Rabbit Facilitator (NRF) will work with project partners and stakeholders to:

- Develop a systems mapping based strategy to support more sustainable, effective community-led action in Victoria and extend the approach to other jurisdictions.
- Build a cohort of community engagement leaders and extend the approach to other jurisdictions.
- Contribute to the RHD Boost release as part of a national leadership team.
- Develop and consolidate knowledge on what strategies, practices and institutional arrangements better support community-led action on rabbit management, and develop analytical, information and communication tools to apply this knowledge.
- Support the research and research utilisation objectives of related IA CRC projects.
- Develop a strategy to extend the benefits of the project beyond the project term.

Project impacts

- Established the Victorian Rabbit Action Network (VRAN) as a facilitating institution which has promoted community led rabbit action across the rabbit system, as evidenced by a growing emphasis on and preference towards collaboration especially between government agencies and community volunteer groups.
- Developed a new generation of rabbit control experts, via the Learning Network, which has begun the re-building of expertise across the system on best-practice rabbit management and community engagement.
- Initial evaluation indicates that knowledge sharing and networks across the rabbit system have been strengthened, especially through the Learning Network and training program initiatives.
- The systems strengthening approach is being adapted for use in other jurisdictions – SA and WA are investigating the use of systems mapping as a means of support community led action on rabbits.

"This four-year project has showcased the importance of collaboration between community groups and governments to achieve effective and sustainable action towards rabbit management"

Where to next?

› The systems strengthening approach is now being applied to management of other invasive species (rabbits, blackberry, gorse, serrated tussock) through funding from the Commonwealth's Agricultural White Paper to the Victorian government – funding was leveraged as a result of the outcomes of the rabbit project. Aspects of this project will therefore continue into the future via the Victorian Government.

Project team

Mr Michael Reid, Ms Annette Radford, Dr Andrew Woolnough, Prof Ted Alter, Prof Paul Martin, Dr Tony Pople, Mr Nicholas Newland, Susan Campbell, Mr Cameron Allan and Mr Ian Evans.

Project collaborators

GOVERNMENT:

Victorian Department of Economic Development, Jobs, Transport, and Resources.

Victorian Department of Environment, Land, Water and Planning.

Victorian Catchment Management Authorities

Queensland Department of Agriculture and Fisheries.

Parks Victoria.

INDUSTRY, RESEARCH AND OTHER:

University of New England.

Rabbit Free Australia.

Australian Wool Innovation.

Meat and Livestock Australia Limited.

Victorian Landcare Networks and Groups.

Victorian Farmers Federation.

Pennsylvania State University USA.

Project resources

Many of the project resources developed through this project can be found via Victorian Rabbit Action Network website - www.rabbitaction.com and www.pestsmart.org.au

Adams L, Victorian Rabbit Management Collaboration Initiative. PestSmart Toolkit publication, Invasive Animals Cooperative Research Centre, Canberra, Australia.

The Victorian Rabbit Action Network has established itself as part of the rabbit management framework within Victoria, with interest from other jurisdictions to create similar community-led networks.

VET TRAINING PACKAGES ON STRATEGIC PEST MANAGEMENT

Project Leader:

Ms Birgitte Verbeek, NSW Department of Primary Industries

Project summary

Develop revised and nationally-accredited Vocational Education and Training (VET) pest training material that is consistent with the recent Australian Pest Animals Strategy (APAS) and the new operating environment and to promote the adoption of the revised packages to current and future pest managers.

A detailed job skills analysis will be undertaken from the Certificate III to Diploma level to determine the appropriate skills and competencies necessary for success as a pest manager and how these will be assessed.

These will then be packaged into training packages for specific pest management positions and tested on a sub-section of target pest managers in NSW to assess their effectiveness and to determine how the training should best be delivered. They will then be revised and made available nationally.

In addition, senior pest managers and those involved in delivering training will be targeted to undertake postgraduate training in strategic pest management.

The aim is to train the trainers. Lack of suitably qualified trainers was a major deficiency that was identified in a recent review of pest management training.

As of January 2013 no formal agreement with Agrifood Skills Australia has been reached for them to support this initiative. The initiative will be greatly enhanced by their participation as they are the Australian agricultural training authority and will promote, endorse and review the developed training materials.

Project objectives

1. Revise and nationally-accredited pest animal competencies and training packages for managing pests that are consistent with Australian Pest Animal Strategy.
2. Develop relevant training materials for revised competencies and training packages.
3. Progressively train officers at the appropriate level under the new training packages. Initial focus will be in NSW and then spread to other jurisdictions.

Project impacts

- Enhanced industry and accreditation standards for pest management planning through inclusion of two relevant units of competency around the human dimension of invasive species management into the current Certificate IV in Pest Management.
- Inclusion of the human dimension of invasive species management units in the national Vertebrate Pest Management Planning Skill Set.
  - Training and assessment tools for the human dimension of invasive species management courses units have been incorporated into a short course called “Community Engagement – moving people towards action”).
- Content from the online “Invasives Action Tool” and the “Behaviourally Effective Communications for Invasive Animals Management: A Practical Guide” publication have been incorporated into the short course and referenced in the participants “Activity Book and Notes”.
- Enhanced professional pest management practitioners’ skills in relation to the human dimension of pest animal management though delivery of 13 accredited short courses with a total of 169 participants.
- Application of best practice management in relation to the human dimension of pest management through practical exercises at the short course that directly apply to the pest issues participants are dealing with in their workplaces.
- Development of a governance structure that meets VET Industry Standards to identify, train and register suitably qualified trainers and assessors to continue delivery of the short course.
- Two Registered Training Organisations (RTOs) contributed to the development of the trainer governance structure. The RTOs are Tocal College in NSW (who also service WA and Victoria) and Rural Training Queensland.

Project team

Ms Birgitte Verbeek, Ms Jodie Bartlett-Taylor, Dr John Tracey, Mr Quentin Hart, Ms Jessica Marsh, Mr Chris Lane, Mr Steve Honeywood, Dr Cameron Archer and Mr Darren Bayley.

Project collaborators

GOVERNMENT:

NSW Department of Primary Industries

INDUSTRY, RESEARCH AND OTHER:

University of New England.

Pennsylvania State University USA.

NATIONAL NATURAL RESOURCE MANAGEMENT (NRM) FACILITATOR

Project Leader:

Ms Jessica Marsh, NSW Department of Primary Industries

Project summary

This project involves bringing public and private land managers together to adopt best practice management techniques to reduce the impacts of invasive animals.

Planning for the management of invasive animals will have a strong emphasis on capacity building outcomes for all stakeholders.

The impacts on agricultural production and biodiversity outcomes will be addressed simultaneously within regions as invasive animal impacts occur across many systems.

This project will allow specialist support to be provided to NRMs and land managers to help develop the knowledge and skills required to implement an integrated approach to pest management.

Project objectives

The primary objective of this project is to provide specialist invasive animal advice and support to regional pest managers on:

1. Pest species and their management for improved natural resource condition.
2. Improved capabilities for best-practice, regional management of invasive animal impacts and community-led programs.
3. Monitoring natural resource responses to pest control, improvements in community engagement levels and identification of barriers to engagement.

Project impacts

- Implemented activities associated with the National Showcase Plan to demonstrate the research and capability of the Invasive Animals CRC which included field days, conference sponsorships and exhibitions, training and promotions
- Provided support to regional groups to improve their pest management approaches
- Appointed to the position of chair in a regional and collaborative LLS feral pig management project
- Broad-scale contact with regions via NRM staff and regional landcare facilitators. Electronic media and hard copy information distribution is still highly valued by the NRM and Landcare community
- Assisted with the roll out of RHDV K5 in 2017 from the base of operations in Orange NSW
- Maintained a strong network of landholder, NRM, LLS, alliance and government agency contacts to ensure long term succession of best practice pest management across tenure

Project team

Ms Jessica Marsh, Mr Chris Lane, Dr Glen Saunders, Dr Peter Fleming, Mr Peter West, Mr Matt Kennewell, Mr Paul Gribben, Mr Phil Elson, Mr Geoff Penton, Mr Jonathan Lawson, Mr Jonathan Berryman, Mr Jason Neville, Mr Chris Chambers, Mr Brett Carlsson, Mr Greg Mifsud, Mr Michael Reid, Dr Michelle Christie, Mr Darren Marshall, Mr Michael Leane, Adjunct Prof Mike Braysher, Dr John Tracey and Mr Jason Wishart.

Project partners

GOVERNMENT:

NSW Department of Primary Industries.

NSW Office of Environment and Heritage.

NSW Local Land Services

Victorian Department of Economic Development, Jobs, Transport, and Resources.

West Gippsland CMA.

Northern and Yorke NRM.

South West NRM.

South Coast NRM WA.

Northern Territory NRM.

Adelaide and Mt Lofty Ranges NRM.

INDUSTRY, RESEARCH AND OTHER:

Queensland Murray Darling Committee

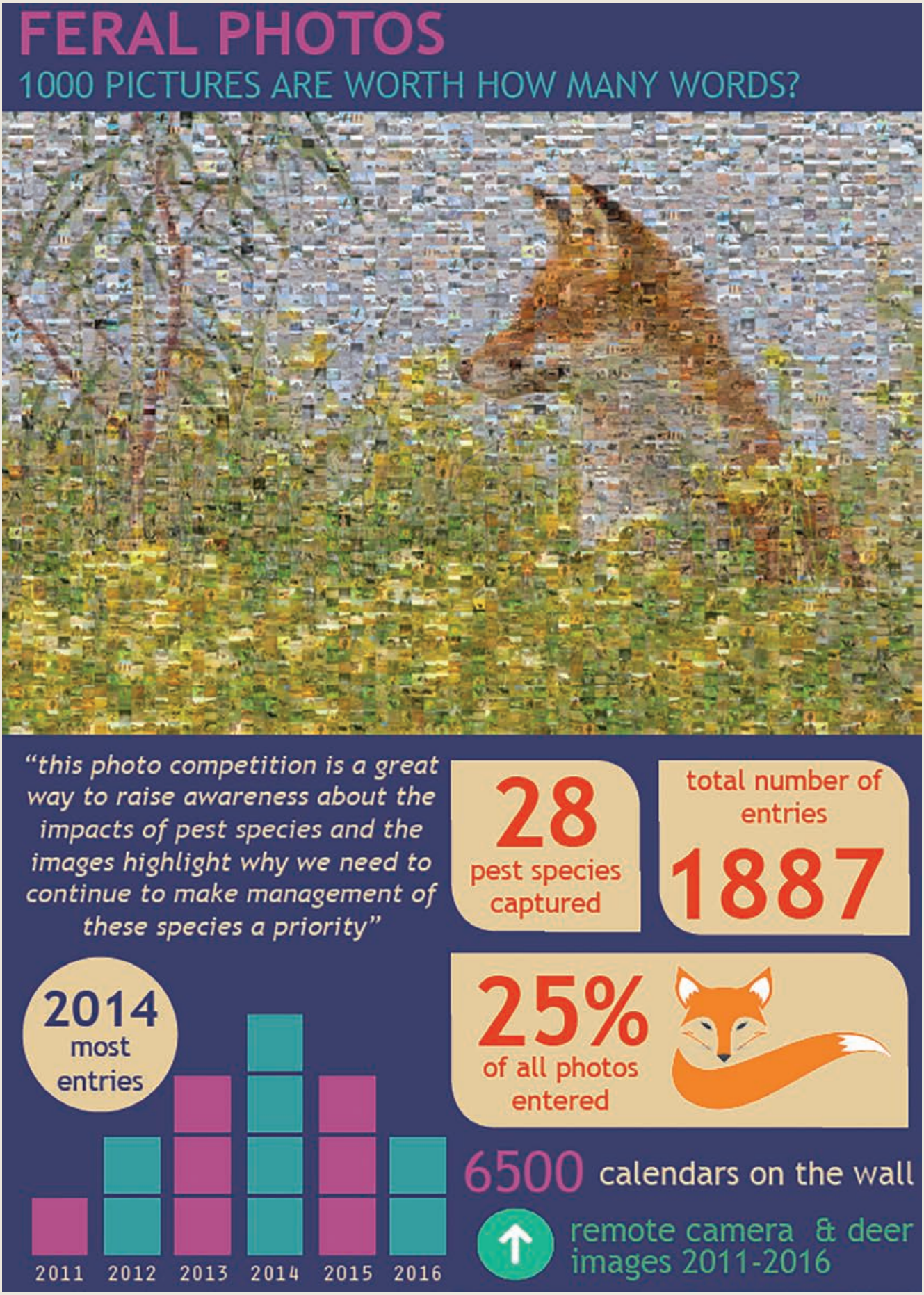
Agforce Queensland.

Braysher Consulting.

North East (NSW) Pest Animal Steering Group.

Pennsylvania State University USA.

New Zealand Landcare Research.



Jess Marsh presented this poster presentation about the Feral Photos competition she developed through her role as NRM Facilitator.

BALANCED RESEARCHER PROGRAM

Project Leader:

Dr Tony Buckmaster, Invasive Animals Ltd

Project summary

The Balanced Researcher program involves creating multi-skilled industry ready PhD graduates from the IA CRC PhD program. Graduates from the program will be able to immediately enter employment on graduation and actively contribute to the operational and research goals and outputs of their chosen workplace.

The program is based around a model with five primary attributes considered essential to helping students gain skills and qualities crucial to being effective within both the workforce and the community as a whole.

Students are required to undertake an additional 80 days training during the term of their PhD studies.

This additional training will consist of a combination of annual training camps for teaching core skills, specific group and individual targeted training to enhance the skill sets of students and at least 20 days of industry based placement in the field in which the student intends to pursue a career – see Dimond and Sarre (2011) for details of the preceding IA CRC PhD program.

To ensure that this additional training does not place an unacceptable burden on students or impact on their ability to complete a quality research project, seventh and eighth semesters of scholarship and operating costs will be provided to students who have completed the requirements of the program.

The eighth semester scholarship and top-up will be fully IA CRC funded for students who have an APA award and obtain a seventh semester extension.

Project objectives

Traditional 3 to 3.5 year PhD programs run through universities aim to produce graduates who, under the supervision of an expert in that field, are able to conceive, plan and execute a substantial research project.

The objective of the Balanced Researcher Program are to take PhD candidates past this point and better prepare them for entry into the workforce as active contributors to that workforce.

Students will be trained in business acumen, leadership, team building skills as well as specific training to enable them to complete their research thesis and fulfil future career goals. Project specific goals include:

1. Maintain completion to conferral of doctorate rates above the national average, Go8 average and all CRCs average.
2. Enhance the employability of BRP students over those who graduate from a traditional research thesis based doctoral program.
3. Complete a longitudinal study of IA CRC PhD student cohorts and employers including publication of the survey results in relevant peer reviewed educational/scientific journals.

Project impacts

- Six of the fourteen PhD students have submitted theses for marking. Three of which have been awarded at time of publication of this report.
- All other PhD students are on track to complete their theses are varying times over 2018/2019 and it is anticipated that a 100% completion rate for the students enrolled in the 2012-17 intake of the BRP.
- 14 traditional PhD and 4 professional doctoral candidates undertook world leading and high value research and produced useable outcomes while receiving training over and above that received during the traditional PhD program.
- There were an excellent number of current and past IA CRC students presenting at the 17th Australasian Vertebrate Pest Conference in May 2017. Twelve current students and seven past students gave talks or presented posters at the conference. This shows the excellent level of research that the current students are undertaking as well as demonstrating continued involvement in the invasive species space by past students of the program.

Where to next?

The Balanced Researcher Program will continue within the Centre for Invasive Species Solution.

A long term survey has been finalised following the students in the 2005-12 intake and results will be published soon.

Project collaborators

Industry, research and other:

Plant Biosecurity CRC.

Commonwealth Scientific and Industrial Research Organisation.

University of Sydney.

University of Canberra.

Project resources

Dimond, W and Sarre, SD (2011). *Guidelines for the Balanced Scientist Program.* Invasive Animals Cooperative Research Centre, Canberra.

"A longitudinal study and survey was undertaken through this program to follow those students who took part and have since submitted their theses. The results from the survey are extremely positive with respondents indicating that the Program enriched their PhD experience, and many noting it gave them a competitive edge when seeking future employment"

PESTSMART

Our PestSmart platform distils over 12 years of IA CRC research into practical and accessible best-practice pest management information, available online and in print.

The toolkit currently holds more than 200 factsheets, case studies, reports and technical guides on various pest animal issues such as wild dog control, rabbit control, carp control and more.

IN THE 2015–16 FINANCIAL YEAR, WE HAD

Website

PAGEVIEWS

900,000+

USERS

280,000+
25% returning visitors
33% rural/regional

DOWNLOADS

37,500+

#social media

FACEBOOK

2600+ page likes

TWITTER

2500+ followers

YOUTUBE

132 videos
400,000+ views
1,120,000+ minutes watches

E-news

325 issues of Feral Flyer

4200+ subscribers

pestsmart.org.au
WEB

@pestsmartAU
TWITTER

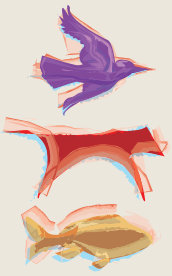
@pestsmart
FACEBOOK

NOW IT'S TIME TO TAKE PESTSMART UP A LEVEL!

The PestSmart digital platform will be upgraded over the next few years and developed further.

TOGETHER, CREATE AND APPLY SOLUTIONS

Invasive Animals CRC



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