INVASIVE SPECIES SOLUTIONS TRUST

GENETIC BIOCONTROL

Genetic biocontrol is a breakthrough platform technology that has the potential to transform vertebrate pest management in Australia. In 2022, the University of Adelaide (Centre partner) achieved proof of concept for a world first functioning gene drive in a mammal model (mouse).

THE UNIVERSITY of ADELAIDE

CENTRE FOR INVASIVE SPECIES SOLUTIONS

The impact of invasive species

Invasive species are the primary threat impacting Australia's globally unique fauna and flora. Vertebrate pests like rabbits, feral cats and foxes' impact on hundreds of nationally listed threatened species and have been a major driver for almost all the 34 mammal extinctions since 1788. Agricultural impacts of just five invasive mammal pests (mice, foxes, rabbits, wild dogs and pigs) cost more than $370 million annually.

Invasive rodents, including house mice, are a major cause of both environmental and agricultural impacts. In Australia, exotic rodents have invaded 140 islands where they have significant impact on island biodiversity, including the extinction of five endemic bird species on Lord Howe Island. Regular mouse plagues in grain cropping regions cause agricultural losses of approximately $23 million each year and have a devastating impact on the mental health of rural families.

Development of genetic biocontrol technologies will be a game-changer for invasive mammal management, potentially providing a cost-effective, humane and long-term solution to reverse environmental damage and increase agricultural productivity.

Genetic Biocontrol

The term 'genetic biocontrol' refers to techniques that alter the genes of an organism to control invasive species in the environment. It is a breakthrough platform technology that has the potential to transform vertebrate pest management in Australia. Genetic biocontrol provides opportunities for the control and potential eradication of a number of vertebrate pests. It is a species-specific tool using genetic technologies to modify the development of offspring leading to sterility or biasing sex ratio towards one sex, with the aim of population decline of the targeted pest species.

The mouse is the chosen target model species for the research into the genetic biocontrol of mammals. In addition to their biological

suitability, they are also a target pest species in their own right due to both economic and ecological costs. There is also the added benefit that by studying the mouse, researchers are able to leverage international collaborative networks, particularly the Genetic Biocontrol of Invasives Rodents GBIRD (https://www.geneticbiocontrol.org/).

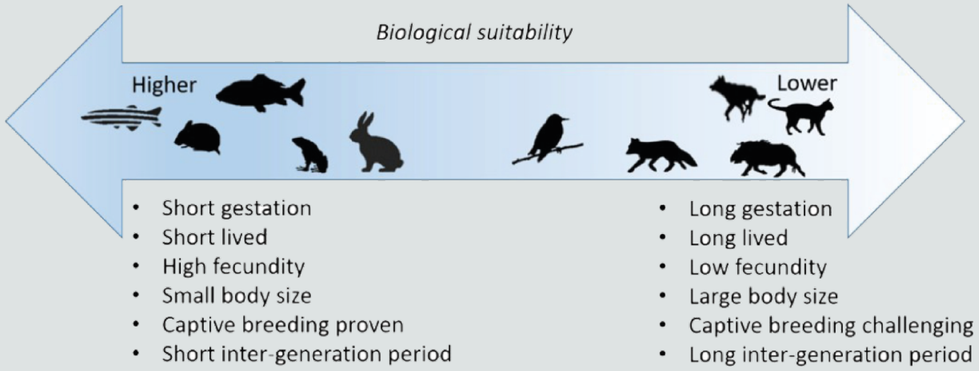

Figure 1: Species that rank highly as proof-of-concept 'model animals' for the initial demonstration of genetic biological control technology in a vertebrate, are not necessarily those with the highest ecological and / or social imperative for the application of new technologies to aid management. Rather, appropriate model species will be those whose reproductive biology and captive keeping requirements are conducive to successful demonstration of genetic biological control technologies in a laboratory setting.

The Science

The Program aims to produce a ready-to-deploy mouse genetic biocontrol tool for suppression of invasive mice, and then through the use of that research, transfer the technology to rats, rabbits, and feral cats, and achieve proof-of-concept for cane toads and pest fish.

Current invasive mammal management is based on a combination of baiting, trapping, fencing, and biocontrol is used with rabbits. At landscape scale, all current methods bar biocontrol are extremely costly and heavily reliant on sustained resources and effort to reduce impacts. Landscape-scale genetic biocontrol strategies have enormous potential for suppression of feral mammals. This project will exploit and transfer the recent breakthrough in mouse genetic biocontrol technology to develop world-first genetic biocontrol systems for invasive rats, rabbits and cats.

The projects outlined in this brochure aim to produce a ready-to-deploy mouse genetic biocontrol technology for suppression of invasive mice, undertake research and transfer technology to rabbits and feral cats, and achieve proof-of-concept for cane toads and pest fish.

GENETIC BIOCONTROL WILL SAVE AUSTRALIA'S THREATENED SPECIES

Project Title	Summary	Funding Request	Investment Sought
Ready-to-deploy mouse genetic biocontrol tool	The recent world-first proof of concept mouse gene drive (t-CRISPR) developed through the University of Adelaide needs to be re-designed and optimised for the proposed initial field target populations at Ashmore Reef. Scientific research and deployment of these types of gene drives requires ongoing engagement using novel practices with diverse stakeholders and the wider community. This project will leverage recent advances in mouse gene drive technology to deliver a deployment-ready genetic biocontrol tool for invasive mice to provide a world-first biocontrol strategy for the suppression of invasive mice on islands with deteriorating ecosystems and cropping areas subject to plagues.	This project will concurrently develop a social science research program in parallel with the scientific work in order to ensure that the science and its applications are made transparent, diverse publics are appropriately engaged, and these gene drives are aligned with Australian public needs and benefits. The planned outcomes are: - Deployment-ready validated genetic biocontrol tool for mouse population suppression - Validated mouse genetic control technology available as a model for genetic biocontrols for other vertebrate pest species - Regulatory path precedent set for genetic biocontrol technologies in Australia - Effective strategies for ongoing engagement with stakeholders and the public about use of this gene drive and future biocontrols in Australia.	We have $4,971,938 of resources pledged by existing members and partners. We need to raise $11,598,894 over a 5-year period to make this happen.
Development of genetic biocontrol strategies for priority mammalian pests	This project will leverage recent advances in mouse genetic biocontrol technology to develop prototype suppression gene drives for key invasive mammalian pests including rats, rabbits and cats. Genetic “safety switches” that ensure target population specificity will also be generated, informed by state-of-the-art spatial commuter modelling. The commercial benefits of this project will result from improved agricultural productivity, environmental recovery and a significant reduction in the resources required pest management.	The project focus is on product development — specifically, proof-of-concept for genetic biocontrol of rats, rabbits and cats. Informed by the mouse genetic biocontrol deployment plan, key stakeholders including the agricultural, government and public interest sectors will be engaged to seek feedback and explore potential sites for deployment. Additionally, there will be engagement with the Office of Gene Technology Regulator (OGTR) as early as possible to ensure the necessary data for release applications is generated.	We have $2,705,565 of resources pledged by existing members and partners. We need to raise $4,750,900 over a 5-year period to make this happen.
Targeting cane toads through genetic control technologies	This project will develop transgenesis capabilities in cane toads and test genetic biocontrol methods pioneered in zebrafish and insects. Transgenesis refers to the process of introducing a gene from one organism into another (unrelated) organism or cell. Building upon knowledge and capabilities in vertebrate genetic biocontrol from a prior Centre investment in zebrafish. It will leverage new capabilities and personnel provided by funding from the Minderoo foundation for cane toad genetic manipulation.	This project aims to develop genetic biocontrol technology options that are suitable for target pests where it is possible to rear and release large numbers of individual pests relative to population numbers in target environments. This includes the cane toad.	We have $533,517 of resources pledged by existing members and partners. We need to raise $824,686 over a 4-year period to make this happen.
Determining the feasibility of a gene drive against feral cats in Australia	This research will be conducted by a PhD student as their dissertation. The aim is to determine whether gene drive technology can feasibly be implemented for the control of feral cats in Australia. This will occur by examining the genomes of populations of feral cats around Australia to determine whether gene drives offer a reasonable future solution for feral cat management. The study also aims to develop reproductive technologies that would be necessary to implement a gene drive against feral cats.	The dataset will be investigated to answer three important feral cat questions management: (1) what is the average effective population size of feral cats in Australia, and how much does this vary across environments? (2) how much gene flow occurs between populations of feral cats across Australia? (3) how variable is male reproductive success, and how biased are reproductive success towards individual dominant males? The answers to these questions will determine how long it will take for a gene drive to control feral cats across all Australia, while also identifying opportunities to take advantage of feral cat biology to increase gene drive efficacy.	We have $219,885 of resources pledged by existing members and partners. We need to raise $569,554 over a 5-year period to make this happen.

It takes a team.

To reach a point of a world first discovery takes a united effort.The groundwork has been laid through collaboration, but our current resources cannot address the problem fast enough to support primary producers and save threatened species which will become extinct within the decade without urgent action. Whatever assistance you can offer to make this ground-breaking technology into a reality, we would like to hear from you.

Please write trust@invasives.com.au or phone +61 2 62012887

To donate directly scan this QR code or go to our website **www.invasives.com.au**

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The Invasive Species Solutions Trust is the Philanthropic Arm of the Centre