Research Highlights

Invasive plants and animals research 2023-24

Department of Agriculture and Fisheries

Queensland Government

Cover: Prickly acacia (*Vachellia nilotica*) plant with recently released biological control insect *Acaciothrips ebneri* damaging stem tips. See page 37 for more details.

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Contents

Introduction

This document summarises the 2023–24 program of the Invasive Plants and Animals research group in Biosecurity Queensland. Our applied research program aims to better manage Queensland's worst weeds and pest animals, reducing their impacts on agriculture, the environment and the community.

Our work is undertaken at four centres across the state:

- Ecosciences Precinct, Dutton Park
- Pest Animal Research Centre, Toowoomba
- Tropical Weeds Research Centre, Charters Towers
- Tropical Weeds Research Centre, South Johnstone

We also collaborate with numerous Queensland, interstate and overseas organisations. Higher degree students are supported to work on several research projects in weed and pest animal management.

The research projects summarised in this document cover the development of effective control strategies and methods (e.g. biological control and herbicides), as well as improved knowledge of pest species' biology and assessment of pest impact.

Notable activities of the research program for 2023–24 are outlined below.

Invasive plant research

- Our biological control program is at an exciting stage with releases continuing for gall thrips on prickly acacia and a leaf mining moth on bellyache bush. The gall thrips has been released at 32 sites across northern Queensland and has established at the majority. There is early evidence of high impact on young prickly acacia plants. The leaf miner has also been released widely at over 30 sites in north Queensland and the Northern Territory. Further promising agents are in the pipeline for both weeds.
- Unfortunately, testing cannot continue for two species of wasps as potential biological control agents for giant rat's tail grass. Colonies of neither species could be maintained in quarantine. One wasp species was also able to complete development on an Australian native grass, albeit for only a single replicate test plant. Nevertheless, a damaging, naturalised leaf smut pathogen continues to be assessed for active spread in Australia as a control agent. Studies also continue for endemic pathogens that could be used as mycoherbicides or augmentative biological control for giant rat's tail grass.
- Host testing of a flower smut pathogen for Navua sedge is almost complete, being delayed by the difficulty in getting some host test plants to flower in the laboratory. Host testing of the leaf rust in the UK has been suspended because the same rust species has been found naturalised and now widespread on Navua sedge in north Queensland. Confirmation of its host specificity will now be undertaken in the field and glasshouse outside quarantine. A release application for the flower smut should be drafted by mid-2025.

- Other weeds with current biological control projects include clidemia, cat's claw creeper, lantana, parthenium, chinee apple, sicklepod, *Urena lobata*, Singapore daisy, African tulip tree, harrisia and opuntioid cacti. We have submitted a release application to Australian Government regulators for the damaging leaf spot pathogen for cat's claw creeper and expect to submit applications to release pathogen agents for lantana and bellyache bush in 2024-25.
- The first phase of the National Weed Biocontrol Pipeline Strategy has been funded by the Australian Government. With other scientists, we are developing a framework for prioritising weeds for biological control leading to eventual development of implementation plans.
- We continue to mass-rear and release biological control agents to control Siam weed, parkinsonia and *Cylindropuntia* cacti. We are monitoring previously released biological control agents (e.g. cactus and parthenium) to determine their establishment, spread and impact. This will help decide when releases can cease, the need for other agents or control methods, and to evaluate the benefit of biological control. We are compiling locations of agents released in north Queensland which will allow redistribution of agents by land managers.
- A trial in collaboration with the University of Queensland is describing best use of wick wipers to selectively apply herbicides and possibly fertiliser to giant rat's tail grass. We continue to work with land managers to identify and control or eradicate strategic outlier infestations of gamba grass, grader grass and giant rat's tail grass. The results will be documented as a set of case studies.
- Projects continue to support state and national eradication programs for numerous weeds, including red witchweed, miconia, mikania and limnocharis. We carry out ecological studies to determine seed bank persistence and age to maturity, developing control methods and techniques to monitor eradication progress.
- Herbicide trials are being conducted for several weeds including sicklepod, gamba grass, bogmoss, sticky florestina and weedy shrubs and trees. Trials have assessed the efficacy and non-target impact of new aquatic herbicides (Clipper® and ProcellaCOR®) in managing aquatic weeds such as sagittaria, cabomba and salvinia in a range of environments.
- We are studying the ecology of several weeds to assist management. Weed seed longevity and age at maturity is needed to determine the timing and duration of treatment at a site.
- We have assessed over 100 of 300 emerging weed species in Queensland to determine their priority for management. Ideally, limited resources should be directed now before the weeds are widespread and abundant. Problematic weeds have common traits and are likely to be predictable.
- Drones are now being widely used to detect weeds in broadacre crops and spot spray. We are working to extend this capability to rangeland weeds such as parthenium, chinee apple and Navua sedge. This project will be supported by a PhD student with a scholarship from CSIRO.

Pest animal research

- We are continuing to monitor the response of fauna to the virtual removal of wild dogs inside cluster fences in western Queensland. Despite teething problems, we are persisting with trials of video-GPS collars on wild dogs to determine encounter rates with canid pest ejectors and cameras. We are also assessing the ability of dogs to detect the odours of 1080 and possibly PAPP with ramifications to bait uptake. Initial results indicate that, while a scent detector dog can detect 1080 solution and a commercial bait, it cannot detect it in a fresh meat bait or pest ejector capsule.
- We have been assessing surveillance methods for two high-risk pest animals, red-eared slider turtles and Asian black-spined toads. For the latter, while lures such as light and calls appear useful, cane toad traps appear ineffective and alternative trapping methods are needed.
- We have continued our collaborations to determine how to cost-effectively manage wild deer in peri-urban, agricultural and conservation settings. In north Queensland, a long-term project on chital deer ecology and management funded partly by the Australian Research Council will continue through 2024-25. On Wild Duck Island, QPWS have successfully eradicated rusa deer. Our researchers monitored the decline in numbers (and so the effectiveness of removals) since 2019 using a large camera grid which allowed the probability of eradication (99%) to be determined.
- By monitoring population composition and abundance, our researchers have recorded poor breeding success in southern Queensland rabbit populations without access to harbour such as warrens and log piles. Furthermore, removal of harbour was found to be effective at reducing rabbit numbers by virtually stopping recruitment.
- A new project is developing monitoring and control strategies for high-risk vertebrate incursions. Strategies have been developed for American corn snakes and African pygmy hedgehogs with plans for other species to be developed during 2024-25.
- For rangeland populations of feral deer and pigs, we are evaluating control effectiveness at several demonstration sites. Following successes in temperate Australia, we will assess thermal-assisted shooting in the Queensland tropics.
- We are working with collaborators to better understand feral pig movements and habitat use. This will help design control and monitoring strategies and support modelling the spread of exotic diseases within feral pig populations. We are also working with collaborators to determine prevalence of particular diseases such as Japanese encephalitis in several pig populations.

Pesticide permits

- We obtain minor use permits from the Australian Pesticides and Veterinary Medicines Authority as required for certain weed and pest animal species, pesticides, application methods and situations or environments. Eleven minor use or emergency use permits were obtained in 2023-24.

Funding, collaboration and research priorities

In the 2023–24 financial year, Biosecurity Queensland's Invasive Plants and Animals research program received funding from several sources. Expenditure from Queensland Government base funds was $2.0 million; expenditure from the Land Protection Fund amounted to $2.6 million; and expenditure under contracts with external partners totalled $0.8 million (see ‘External funding’, page 96). Notable funding bodies for the latter were the Australian Government, CSIRO, Manaaki Whenua Landcare Research New Zealand and Seqwater. The Queensland Government also provided approximately $4.6 million in indirect costs that included facilities, equipment and support services.

Our research program for 2023–24 was endorsed by the Research Review Committee - a group of senior scientific, operations and policy staff from Biosecurity Queensland plus representatives from our external stakeholders, including Queensland local governments, AgForce, the Queensland Farmers’ Federation, the Queensland Conservation Council and NRM Regions Queensland. The committee critically reviews proposed and current projects and allocated investments and makes recommendations on strategic priorities.

Further information

For more information, visit the ‘Invasive plant and animal research’ page at daf.qld.gov.au. Journal articles and scientific reports can be obtained by emailing project leaders (see ‘Research staff’, pages 98-99). In addition, you can browse our recent scientific publications in the eResearch archive at daf.qld.gov.au (search ‘eResearch archive’).

Part 1: Invasive plant research

1. Integrated control of aquatic weeds

Project dates

July 2012 – June 2025

Project team

Tobias Bickel, Christine Perrett and Louise Gill

Project summary

Management of aquatic weeds is challenging due to a lack of efficient control tools and site-specific environmental conditions that interfere with control efforts. Also, aquatic weeds are often hidden below the water surface, challenging detection and monitoring post herbicide application. This project investigates the use of two aquatic herbicides, flumioxazin (Clipper herbicide) and florpyrauxifen-benzyl (ProcellaCOR FX) to control a range of high impact water weeds. These herbicides are integrated with other control tools and remote sensing techniques to improve future aquatic weed management.

The aim of this project is to provide best management advice for integrated control of a range of aquatic weeds in various aquatic environments. For this, we determine control efficacy of aquatic herbicides, integrate different control tools and develop new application techniques and strategies to improve management of aquatic weeds.

Figure 1 Applying ProcellaCOR FX to control parrots feather in Maleny.

Outdoor pond trials were completed to test the efficacy of the two herbicides to control invasive aquatic weeds such as sagittaria, kidney-leaved mudplantain and salvinia. Florpyrauxifen-benzyl (ProcellaCOR FX) proved highly efficient in controlling sagittaria and rotala in several field trials.

Florpyrauxifen-benzyl affects germination and seedling establishment of sagittaria. Flumioxazin (Clipper herbicide) efficiently killed cabomba and water lettuce in field trials and sonar technology was employed to monitor control efficacy of submersed aquatic weeds after herbicide application. Data generated from this project supported the registration of ProcellaCOR FX in Australia in 2024.

Collaborators

- Marie Bigot and Kumaran Nagalingam (CSIRO)
- Junfeng Xu and Nguyen Nguyen (University of Queensland)
- Daniel Clements and Deborah Hofstra (NIWA, New Zealand)
- Fred Oudyn (Department of Environment and Science, Queensland)
- Steve Adkins and Shane Campbell (University of Queensland)
- David Roberts, Perry Ward and Jessica Doman (Seqwater)
- Iain Jamieson (Gold Coast City Council)
- Janine Clarke and Cecilie Draper (Moreton Bay Regional Council)
- Geoffrey Farrant (Brisbane City Council)
- Mark Heilman (SePRO, USA)
- Ray Gurney (Macspred)
- Doug Patton (Sumitomo Chemical)

Key publications

Bickel, **T**.**O**., **Farahani**, **B**.**S**., **Perrett**, **C**., Xu, J. & **Vitelli**, **J**. (2022). Control of the emerging aquatic weed Amazon frogbit with flumioxazin, in Proceedings of the 22nd Australasian Weeds Conference, Melland, R., Brodie, C., Emms, J., Feuerherdt, L., Ivory, S., & Potter, S. eds., Weed Management Society of South Australia, Adelaide, 25 – 29 September.

Kumaran, N. & **Bickel, T.O.** (2023). New tools for Integrated Management of Cabomba in Australia, Management Guide (Seqwater, NRM managers), CSIRO, Brisbane, 23pp.

Nguyen, N.H.T., **Bickel, T.O.**, **Perrett**, **C**. & Adkins, S. (2021). Alien invasive macrophyte put into the shade: The native floating-leaved macrophyte Nymphoides indica reduces Cabomba caroliniana growth performance through competition for light, *Freshwater Biology*, 66: 1123-1135.

2. Management of aquatic weeds in sensitive environments

Project dates

July 2022 – June 2025

Project team

Tobias Bickel, Christine Perrett and Louise Gill

Project summary

Herbicides are a useful tool to control aquatic weeds in a range of water bodies. However, haphazard application of herbicides to water bodies can results in significant non-target damage to native aquatic plants. Aquatic plants perform important ecosystem functions, such as maintaining water quality, and are frequently planted in artificial wetlands at considerable cost. Therefore, native aquatic plants need to be considered when managing aquatic weeds.

The project aims to develop herbicidal control strategies to manage aquatic weeds in sensitive water bodies while maintaining the ecological integrity of native macrophytes. The project will also identify native aquatic plants that are resistant to herbicides for future plantings to simplify aquatic weed management in the long term.

Pond trials highlighted the sensitivity of native emergent vegetation to glyphosate, while flumioxazin (Clipper herbicide) and florpyrauxifen-benzyl (ProcellaCOR FX) caused little to no damage to these plants.

Pond trials on other native species showed varying degrees of sensitivity to flumioxazin or florpyrauxifen-benzyl, e.g. water snowflake is resistant to the first but highly sensitive to the latter.

A field trial demonstrated how the invasive cabomba can be effectively controlled with a low dose application of flumioxazin, while not harming the native water snowflake.

Figure 2 March 2024: A Gold Coast wetland that was heavily infested with cabomba. Notice the little white cabomba flowers in the deeper water. The shoreline is covered by native water snowflake, cabomba was also present beneath the floating water snowflake leaves. Flumioxazin (Clipper herbicide) was applied at 100 ppb to the water column on this day.

Figure 3 June 2024: Cabomba has been removed by the herbicide, while the native water snowflake is unharmed and thriving. Also notice the healthy emergent vegetation on the shoreline that was not affected by the herbicide.

Figure 4 A UQ student applies herbicides to native emergent water plants to test their sensitivity.

Collaborators

- Marie Bigot (CSIRO)
- Mathew McVay and Shane Campbell (University of Queensland)
- Iain Jamieson (Gold Coast City Council)
- Janine Clarke and Cecilie Draper (Moreton Bay Regional Council)
- Geoffrey Farrant (Brisbane City Council)

3. Research supporting the National Tropical Weeds Eradication Program

Project dates

July 2008 – June 2024

Project team

Simon Brooks and Kirsty Gough

Project summary

The project develops and refines metrics to monitor progress towards eradication of several tropical weeds under the National Tropical Weeds Eradication Program. These need to be spatially and temporally consistent.

The project quantifies aspects of the life history of weeds targeted for eradication that influence the timing and location of field control operations. These include seed-bank persistence, age to maturity and dispersal potential. Effective control measures are also investigated.

Field and glasshouse trials investigating *Limnocharis flava*, *Miconia calvescens*, *M. racemosa, M. nervosa* and *Mikania micrantha* seed persistence have been running for 8 to 14 years, with all species showing persistent seed banks. Bulk or depth field soil seed bank samples were collected from *L. flava, M. micrantha* and *M. racemosa* infestations. Field crew data and observations on the growth to maturity and reproductive seasonality of invasive melastomes helps to refine guidelines for identifying and preventing seed producing plants. A habitat suitability model will be used to design surveys to detect and remove *M. calvescens*.

Collaborators

- Kim Erbacher, John Edwards, Alex Diczbalis, Michael Graham and Moya Calvert (Biosecurity Queensland).
- Rod Ensby, Brook Hooson, Karen Bell and Xiaocheng Zhu (Primary Industries, Department of Regional NSW).
- Jesse Telford and Rhett Patrick (Rous County Council).
- Tom Price, Nigel Weston and Shelley Inglis, (Department of Environment, Parks and Water Security NT).

Key publications

Brooks, **S**. & **Jeffery**, **M**. (2018). Progress in the eradication of *Mikania micrantha* from Australia. In: Proceedings of the 21st Australasian Weeds Conference, eds S. Johnson, L. Weston, H. Wu and B. Auld. The Weed Society of New South Wales. 9-13 September. pp. 350-3.

Brooks, **S**., **Erbacher**, **K**. & Maher, J. (2022). Progress towards the eradication of *Limnocharis flava* from Australia. In: *Proceedings of the 22nd Australasian Weeds Conference*. C. Brodie, J. Emms, L. Feuerherdt *et al.*, eds. Weed Management Society of South Australia Inc., Adelaide, South Australia. pp. 262-5.

Brooks, **S**. & **Erbacher**, **K**. (2022). Progress in the eradication of *Miconia calvescens* from Australia. In: *Proceedings of the 22nd Australasian Weeds Conference*. C. Brodie, J. Emms, L. Feuerherdt *et al.*, eds. Weed Management Society of South Australia Inc., Adelaide, South Australia. pp. 63-6.

4. Weed seed dynamics

Project dates

August 2007 – June 2030

Project team

Simon Brooks, Dannielle Brazier and Clare Warren

Project summary

Seed longevity is an important determinant of the duration of weed control. This project investigates the seed longevity of priority weeds by (1) burying seeds enclosed in bags in different soil types, under grassed and bare conditions and at various depths, (2) monitoring emergence from seed in field cages and (3) running controlled ageing tests in a laboratory.

The buried packet trials currently include tropical soda apple, a repeat prickly acacia batch and harrisia cactus. The seedling emergence cages include elephant ear vine, parkinsonia, chinee apple, mesquite, prickly acacia and leucaena. The longevity of sagittaria seed is also being studied in immersed packets.

Completed buried packet trials have shown that neem and yellow bells have a relatively transient soil seed bank that are exhausted after one year. The seed packets of yellow oleander, stevia, gamba grass, chinee apple, calotrope and mesquite were exhausted in under five years. Trials of lantana and parthenium showed small numbers of seeds remained viable for up to 10 years and viable prickly acacia seed was retrieved after 13 years. These results and those for many other weeds are being compared to data from a short-term controlled ageing test.

An eleventh batch of seeds from 10 weeds was run through a controlled ageing test this year. A trial involving buried packets of African tulip tree seed was established at South Johnstone.

Figure 5 Photos. Clockwise from top left: 1. Fifty African tulip tree seeds and a permeable mesh packet used in burying larger seeded weeds. 2. Forty-eight pipes buried at South Johnstone Research Station, each pipe contains 3 packets of 50 African Tulip seeds buried at 0, 3 and 10 cm. At 12 intervals, one pipe each from of 4 replicates is retrieved and seed germinated to determine viability over burial time. 3. A block of Calotrope (Calotropis procera) seedlings emerging from surface, 1, 2 and 4 cm, but not 8 cm. For each depth seedling fate can be separated into successful or fatal establishment and viable or unviable seed. 4. Elephant ear vine (Argyreia nervosa) seedling emergence within field cages.

Collaborators

- Shane Campbell and Bhagirath Chauhan (University of Queensland)
- Faiz Bebawi, Geoff Swan, Matthew Ryan and Ashley Blokland (Biosecurity Queensland)

Key publications

Bebawi, F.F., Campbell, S.D. & Mayer, R.J. (2015). Seed bank longevity and age to reproductive maturity of *Calotropis procera* (Aiton) W.T. Aiton in the dry tropics of northern Queensland, *The Rangeland Journal* 37, 239-247.

Long, R.L., Panetta, F.D., Steadman, K.J., Probert R., Bekker, R.M., **Brooks**, **S.J** & Adkins, S.W. (2008). Seed persistence in the field may be predicted by laboratory-controlled ageing. *Weed Science* 56: 523-8.

5. Encapsulated herbicide control of woody weeds

Project dates

January 2021- June 2025

Project team

Simon Brooks, Dannielle Brazier and Clare Warren

Project summary

Stem injection is an under-utilised tool for the control of woody shrubs and small trees. There is a new tool to deliver dry encapsulated herbicides directly into woody stems. This method is safe to applicators as there is no need to mix with water or diesel as a carrier, to have any contact with the herbicide and cart the solutions to the plants. This method is also safer for the environment as the herbicide is contained in the target plants near water and amongst desirable vegetation.

A series of trials aim to determine the efficacy of encapsulated herbicides on rubber vine, pond apple, leucaena, African tulip trees and neem trees. Trials compare encapsulated dry herbicides with standard individual stem treatments and the stem injection of herbicide solutions. Subject to trial results and research gaps, the project will continue to refine rates and investigate active ingredients suited to stem injection as either dry or liquid formulations. Two trials found that rubber vine is extremely susceptible to a range of dry (capsules) and liquid stem injection treatments, which provides alternative and effective treatments for tall rubber vine plants amongst creek line vegetation.

An initial trial on leucaena identified three effective encapsulated herbicide treatments. Similar efficacy was found for four encapsulated treatments on African Tulip trees and a second trial has been established in Tyto Wetland (Ingham). Encapsulated herbicide was very promising for the control of pond apple and a second trial using stem injected liquid herbicides has been established near Babinda. Trials of capsules and stem injected liquid herbicides on neem trees are also looking highly effective.

This project has also assisted a PhD candidate from the University of Queensland to conduct encapsulated herbicide trials on chinee apple.

Figure 6 Photo (L) A rubber vine plot in a dry creek bed that was successfully controlled with a drill and fill herbicide (Tordon™ 75-D) into the base of plants at 10 cm intervals 6 months earlier. (Centre) Liquid stem injection application on rubber vine (drill and fill). (R) Encapsulated dry herbicide application on rubber vine.

Figure 7 Eight large neem trees treated with a basal drill and fill herbicide (Tordon Regrowth Master) 1 month prior. Smaller dead neem trees in the left and right foreground were treated with encapsulated herbicides 8 months prior.

Collaborators

- Vic Galea, Ciara O'Brien and Shane Campbell (University of Queensland).
- Matthew Buckman (Hinchinbrook Shire Council), Whitsunday and Burdekin Shire Council staff.

- Chris Roach (Queensland Parks and Wildlife Service).

Key publications

Goulter, K.C., Galea, V.J. & Riikonen, P. (2018). Encapsulated dry herbicides: A novel approach for control of trees. *Proceedings of the 21st Australasian Weeds Conference,* Sydney, 247−50.

6. Biological control of Koster's curse (*Miconia crenata*)

Project dates

July 2023 – June 2026

Project team

Jason Callander and David Comben

Project summary

Miconia crenata (Koster's curse) is a highly prolific, aggressive weed of grazing, plantations, cropping and natural ecosystems in many countries across the world. The weed was initially part of the national cost-share eradication program, based in north Queensland, until deemed no longer feasible. Koster's curse is a category 2, 3, 4 and 5 restricted invasive plant under the Biosecurity Act 2014 and was endorsed by the Environment and Invasives Committee as a candidate for weed biological control in 2014. If left uncontrolled, Koster's curse could spread south along the eastern coast of Queensland as far as Hervey Bay.

The *Miconia crenata* biological control project was initiated with funding support of the Australian Government. Based on host testing undertaken in quarantine, the first target candidate, *Liothrips urichi,* was not considered sufficiently host specific to pursue further. However, prospects for biological control remain positive and Biosecurity Queensland have engaged Centre for Agriculture and Bioscience International (CABI) to conduct host specificity testing of the leaf-spot pathogen, *Colletotrichum clidemiae*, another prospective agent which is established and effective in Hawaii. CABI have imported the leaf-spot pathogen and have it in culture on artificial media awaiting host plant material from Australia.

As this project is being undertaken offshore at CABI, a major challenge has been the shipment of native Australian Melastomataceae species to the research facilities in the United Kingdom. To comply with permit conditions, plants leaving Australia need to be bare-rooted and free of soil contaminants. Multiple shipments have been made, with delivery time being unpredictable and unreliable. To date only a few plants have survived the journey and transplant shock on the other end, and this has delayed the commencement of any host specificity testing. Alternative options are being considered.

Figure 8 Liothrips urichi larvae attacking Koster's curse.

Collaborators

- Sarah Thomas and Marion Seier (Centre for Agriculture and Bioscience International, UK)
- Tracy Johnson (USDA, Institute of Pacific Islands Forestry, Hawaii)
- Darcy Oishi (Hawaii Department of Agriculture, Hawaii)
- Local governments
- Kim Erbacher (National Tropical Weeds Eradication Program, South Johnstone)
- Garry Sankowsky (Cairns)

7. Biological control of cactus species

Project dates

July 2021 – June 2024

Project team

Jason Callander, Zachary Shortland, and David Comben

Project summary

All cactus species in the genera *Opuntia*, *Cylindropuntia*, and *Harrisia*, except for the Indian fig (*Opuntia ficus-indica*), are regulated in Queensland and classified as either restricted or prohibited under the *Biosecurity Act 2014*. The biological control of invasive cacti in Australia has generally been very successful. However, in some cases, existing agents may not provide adequate control due to mismatches between agents and cactus hosts, hybridization between different lineages, or extreme environmental conditions. Biosecurity Queensland continues to work on reducing the impact and spread of invasive cacti by using host-specific and effective biological control agents. Agents such as *Dactylopius* and *Cactoblastis* are maintained at the Ecosciences Precinct and supplied to interested parties upon request.

Funding support from the Department of Agriculture, Fisheries and Forestry (formerly the Department of Water and Environment) and Biosecurity Queensland allowed evaluation of existing and established cochineal agents against novel restricted and prohibited *Opuntia* species to determine their suitability and potential impact. This pre-emptive study identified some effective matches, but also highlighted that many cactus species might not have suitable cochineal agents available if they become established in the field. Additionally, routine surveys were conducted at two field sites in southeast Queensland to assess the impact of cochineal on the large velvet tree pear (*Opuntia tomentosa*), a species generally considered unaffected by the cochineal insect. Over two years, these surveys revealed that the cochineal insect can significantly damage and kill large trees. However, the establishment and population growth of this agent in the field, which is crucial for cactus control, are heavily impacted by the presence of insect predators, particularly *Cryptolaemus montrouzieri*.

Figure 9 (L) Typical damage caused by Lagocherius fenestus larvae and (R) L. fenestus adult male.

Fortunately, a long-lost agent, *Lagocheirus funestus*, was rediscovered at a field site south of Gatton and appears to be making a resurgence. This cerambycid beetle, with wood-boring larvae, was originally introduced into Queensland, from Mexico in the 1930s, to control tree-form cacti. Initial post-release observations were very promising, as the larvae cause substantial damage to the cactus by boring into the branches and trunk, weakening and ultimately felling them. However, the agent's population declined across the state due to several prolonged and devastating droughts, and it was last reported just south of Toowoomba in the late 1980s and thought to be extinct. A colony of *Lagocheirus funestus* has now been established at the Ecosciences Precinct to assist redistribution efforts.

Collaborators

- Department of Agriculture, Fisheries and Forestry (Funding support)
- Duncan Swan, Eloise Kippers, Nathan March and Stephen Downey (Biosecurity Officers)
- Kyle Morris, Environmental Advisor (Powerlink Queensland)
- Matt Tucker, Ranger Sunshine Coast (Department of Environment and Science)
- Kirstin Beasley, Ranger (Department of Environment and Science)
- Lucas Mackie, Project Officer (Southern Queensland Landscapes)
- Andrew McConnachie (NSW Department of Primary Industries)
- Iain Paterson (Rhodes University, South Africa)

Key publications

Shortland, Z., & **Callander, J. T**. (2023). Optimising control of invasive cactus using biological control. In *Proceedings of the 2nd Pest animal and weed symposium*, pp 231-236, Invasive species Queensland, Dalby, 28-31 August 2023.

8. Weed management in the Pacific

Project dates

July 2020 – June 2024

Project team

Jason Callander, David Comben and Zachary Shortland

Project summary

Department of Agriculture and Fisheries is working in collaboration with Manaaki Whenua - Landcare Research New Zealand, with funding support from New Zealand Ministry of Foreign Affairs and Trade, to undertake biological control research on a novel target weed, Singapore daisy (*Sphagneticola trilobata*), a serious environmental weed in the Pacific Region and the State of Queensland. Singapore daisy is a category 3 restricted invasive plant under the Biosecurity Act 2014, and an approved candidate for weed biological control (endorsed by EIC July 2023).

Sphagneticola trilobata is native to Mexico, and native range exploration is currently underway. To date, half a dozen prospective insects, a mite and a pathogen have been shortlisted as candidate species of interest. Efforts to identify these species is ongoing and a crucial step in the process. A highly damaging spittlebug, consistently found attacking Singapore daisy in Mexico, was identified to be *Clastoptera compta* and imported into quarantine at Ecosciences Precinct, under permits issued by DAFF and DCCEEW. Host specificity testing has commenced.

African tulip tree (*Spathodea campanulata*) remains a focus of weed biological control research in the Pacific region. This weedy evergreen tree has escaped cultivation and is a serious environmental weed in coastal Queensland. African tulip tree is a category 3 restricted invasive plant under the Biosecurity Act 2014, and an approved candidate for weed biological control (endorsed by the Environment and Invasives Committee, March 2022). Two agents, a leaf-feeding flea-beetle (with leaf-mining larvae) and a leaf and shoot-galling mite, have undergone detailed host specificity testing (carried out by Rhodes University South Africa under contract with Manaaki Whenua - Landcare Research New Zealand). The galling mite has been approved and released in the Cook Islands, Vanuatu, and Tonga, while the flea-beetle has been approved and released only in the Cook Islands.

The leaf and shoot-galling mite, *Colomerus spathodeae* (Eriophyidae), was prioritised and imported into quarantine at the Ecosciences Precinct, May 2023. This project component, funded by Queensland Land Protection Funds, seeks to build upon previous research and evaluate *Colomerus spathodeae* as a biological control agent in Australia. A thorough host specificity testing methodology has been developed to scrutinize this candidate agent and to ensure that it is safe for release into the Australian environment. Initial no-choice tests have focused on Australian native species within the family Bignoniaceae, closely related to African tulip.

Figure 10 A mating pair of Clastoptera compta on the Singapore daisy, in Mexico (left) and right, leaf and shoot-galling mite infested African tulip plant.

Collaborators

- Manaaki Whenua Landcare Research NZ Ltd
- Secretariat of Pacific Regional Environment Programme (SPREP)
- New Zealand Ministry of Foreign Affairs and Trade
- Biól. Ricardo Segura Ponce de León, Mexico
- Department of Environment and Biosecurity, Niue
- Ministry for Natural Resources, Republic of Marshall Islands

- Department of Environment, Tonga
- Ministry of Agriculture, Tonga
- Department of Agriculture, Tuvalu

Key publications

Paterson, I.D., Paynter, Q., Neser, S., Akpabey, F.J., Orapa, W. & Compton, S.G. (2017). West African arthropods hold promise as biological control agents for an invasive tree in the Pacific Islands, *African Entomology*, 25(1), 244-247.

9. Biological control of lantana

Project dates

July 2021 – June 2026

Project team

Jason Callander and Zachary Shortland

Project summary

Lantana is a category 3 restricted invasive plant under the Biosecurity Act 2014 and a weed of national significance. Despite an extensive history of biological control research, only about half the established agents are considered to cause significant seasonal impact. This highly resilient weed remains persistent in the Australian environment. Biosecurity Queensland seeks to enhance management options for this weed by building on previous research of two prospective agents.

The blister-rust pathogen *Puccinia lantanae* was host tested by the Centre for Agriculture and Bioscience International (CABI) in the UK against about forty plant species for New Zealand, South Africa, and Australia. The agent was approved for release in New Zealand and South Africa, but further testing of two plant genera, not previously tested, was deemed necessary for Australia. CABI-UK are conducting these additional tests to support Biosecurity Queensland's import release application to Australian federal regulators.

The lantana gall fly (*Eutreta xanthochaeta*) was introduced to Australia twice in the 1970s but failed to establish both times. This tephritid fly is native to Mexico where it attacks several Verbenaceae taxa. Effective in Hawaii as a biological control agent against lantana, this fly still holds potential in Australia due to there being no native Verbenaceae species here, and several species are in fact environmental weeds. Biosecurity Queensland have host tested 29 species from five plant families, and the gall fly has demonstrated a very strong preference for *Lantana camara* and *Lantana montevidensis*. Minor development has been reported on *Verbena bonariensis* and *Stachytarpheta australis*. Results are promising and suggest that it could be useful in managing this weed in Australia.

Figure 11 Clockwise from left - Eutreta xanthochaeta laying an egg in the shoot tip; developed galls after about 6 weeks; Puccinia lantanae developing on Lantana leaves.

Collaborators

- Sarah Thomas and Marion Seier (Centre for Agriculture and Bioscience International, UK)
- Alan Wood (Plant Protection Research Institute, South Africa)
- Tracy Johnson (USDA, Institute of Pacific Islands Forestry, Hawaii)
- Particia Lu-Irving (NSW Royal Botanic Gardens)
- Queensland Parks and Wildlife Service
- Local governments in coastal and subcoastal Queensland

Key publications

Lu-Irving, P., Encinas-Viso, F., **Callander**, **J.**, **Day**, **M.D**. & Le Roux, J. (2022). New insights from population genomics into the invasive *Lantana camara* L species complex. *Proceedings of the 22nd Australasian Weeds Conference.* Eds. Brodie, C., Emms, J., Feuerherdt, L., Ivory, S., Melland, R., Potter, S., Weed Management Society of South Australia Inc., Adelaide. pp. 45-47.

Lu-Irving, P., Encinas-Viso, F., **Callander**, **J**., **Day**, **M**.**D**. & Le Roux, J. (2023). Population genomics of invasive lantana: implications for improved biocontrol, *4th International Congress on Biological Invasions*, New Zealand, Christchurch, 3 May.

Thomas, S.E., Evans, H.C., Cortat, G., Koutsidou, C., **Day**, **M**.**D**. & Ellison, C.A. (2021). Assessment of the microcyclic rust *Puccinia lantanae* as a classical biological control agent of the pantropical weed *Lantana camara*. *Biological control* 160. Doi: https://doi.org/10.1016/j.biocontrol.2021.104688

10. Initial phase of the National Weed Biocontrol Pipeline Strategy

Project dates

October 2023 – December 2024

Project team

Jason Callander, Dhileepan Kunjithapatham, Tamara Taylor and Di Taylor

Project summary

Biological control research is a lengthy and costly process requiring considerable investment and commitment to identify, test, release, and monitor agents against Australia's worst weeds. The National Weed Biocontrol Pipeline Strategy (CSIRO and Centre for Invasive Species Solutions, 2023) aims to guide research, development, and extension nationally, ensuring investment supports the entire biocontrol process, from prioritizing weed candidates to native range exploration, risk assessment, agent release, and impact monitoring and evaluation.

The Australian Government has endorsed this approach and funded the initial phase of the strategy. Under a consultancy agreement, Biosecurity Queensland has committed in-kind contributions to:

- Create a weed biocontrol research development and extension alliance
- Design a national weed prioritization framework
- Apply the national weed biocontrol prioritization framework
- Estimate the costs to develop five-year implementation plans

Biosecurity Queensland will undertake this work with collaborators. The funding of the initial phase by the Australian Government offers optimism for further investment from both the Australian Government and industry in the subsequent phases of the strategy.

Collaborators

- Department of Agriculture, Fisheries and Forestry
- CSIRO
- Biosciences Research Division of Agriculture Victoria
- NSW Department of Primary Industries

- Wild Matters
- Atlas of Living Australia

11. Biological control of parthenium (*Parthenium hysterophorus*)

Project dates

January 2007 - June 2025

Project team

Kunjithapatham Dhileepan and Boyang Shi

Project summary

Parthenium weed (*Parthenium hysterophorus* L.), a noxious weed of grazing areas in Queensland, is a Weed of National Significance in Australia. Parthenium also causes severe human and animal health problems. Eleven biological control agents (nine insects and two rust pathogens) have been released against parthenium in Australia. Most of these agents have become established and have proven effective against the weed in central Queensland (CQ). Parthenium is spreading into south Queensland (SQ) and southeast Queensland (SEQ), where many of the widespread and effective biological control agents in CQ are not present. Hence, the seed-feeding weevil (*Smicronyx lutulentus*), the stem-boring weevil (*Listronotus setosipennis*), the root-boring moth (*Carmenta ithacae*), the summer rust (*Puccinia xanthii* var. *parthenii-hysterophorae*) and the winter rust (*Puccinia abrupta* var. *partheniicola*) have been redistributed from CQ into SQ and SEQ.

Monitoring of two properties in southeast Queensland (Kilcoy and Helidon Spa), and roadside parthenium infestations from Injune to Clermont in central Queensland in May 2024 highlighted the widespread incidence of the root-feeding Carmenta moth and the seed-feeding Smicronyx weevil in all the sampling sites. At Kilcoy, Carmenta moth larvae were found in more than 90% of mature parthenium plants. At Helidon Spa, incidence of the Smicronyx weevil was found in majority of plants with flower buds. Both agents were also recovered from most of the sampling sites between Injune and Clermont in central Queensland. However, incidence of other agents (leaf-feeding Zygogramma beetle, stem-boring Listronotus weevil, stem-galling Epiblema moth, and the summer and the winter rust) were very low, and sporadic with no visible impact. Monitoring the establishment and spread of parthenium biological control agents will continue.

We hosted overseas delegations who were interested initiating biological control programs. We provided the Sultanate of Oman with advice on commencing a biological control program for parthenium in Oman (see Figure 12). We also hosted a delegation from South Africa (see Figure 13) and provided support on the collection and export of parthenium biological control agents from southeast and central Queensland to South Africa for colony establishment and host specificity testing in quarantine.

Figure 12 Hosting a delegation from Sultanate of Oman for the parthenium biological control project collaboration workshop.

Figure 13 (L) Delegates from Sultanate of Oman visiting parthenium field sites to study the parthenium biological control agents and (R) Hosting a delegation of researchers from South Africa for collection and export of parthenium biological control agents from Queensland.

Collaborators

- Lorraine Strathie and Sakhi Sambo (Agricultural Research Council - Plant Health and Protection, Hilto, South Africa)
- Dr Laila Alharthy (Oman Botanic Gardens, Muscat, Sultanate of Oman)
- Dr Ali H. Al Lawati (Natural and Medical Sciences Research Centre, University of Nizwa, Sultanate of Oman)

- Dr Ali Masoud Al-Subhi (Crops Sciences Department, College of Agriculture and Marine Sciences, Sultan Qaboos University, Sultanate of Oman)
- Chris Hoffmann and Steven Moore (Lockyer Valley Regional Council, Gatton)
- Lachlan Grundon (Balonne Shire Council, St George)
- Melinda Clarke (Burnett Catchment Care Association, Monto)
- Prof Steve Adkins (UQ, Gatton)
- Ken Woodall (RAPID Workforce, Mitchell)
- Tom Garrett and Holly Hosie (Southern Queensland Landscapes)
- Ross Bigwood and Bruce Lord (Healthy Land and Water)
- Pat Ryan (Junction View Pest Management Group)
- Glen Proctor, Jenny Voigt, Neale Jensen and John Pieters (North Burnett Regional Council)
- Eric Dyke (Bundaberg Regional Council)

Key publications

Dhileepan, **K**. (2009). Managing *Parthenium hysterophorus* across landscapes: limitations and prospects, pp. 227-260. In: *Management of Invasive Weeds* (ed. Inderjit, S.), Invading Nature – Springer Series in Invasion Ecology Vol. 5, Springer Science.

Dhileepan, **K**. & Strathie, L. (2009). 20. *Parthenium hysterophorus*. pp. 272-316. In: *Weed Biological Control with Arthropods in the Tropics: Towards Sustainability* (eds. Muniappan, R., Reddy, D.V.P. & Raman, A), Cambridge University Press, Cambridge, UK.

Dhileepan, **K**. & **McFadyen**, **R**.**E**. (2012). *Parthenium hysterophorus* L. – *parthenium*, pp. 448-462. In: *Biological control of weeds in Australia: 1960 to 2010* (Eds. M. Julien, R.E. McFadyen & J. Cullen), CSIRO Publishing, Melbourne.

Dhileepan K., **Callander J**., **Shi**, **B**. & **Osunkoya**, **O**.**O**. (2018). Biological control of parthenium (*Parthenium hysterophorus*): the Australian experience. *Biocontrol Science and Technology 28*(10):970−988.

12. Biological control of cat's claw creeper (*Dolichandra unguis-cati*)

Project dates

January 2004 - June 2025

Project team

Kunjithapatham Dhileepan, Di Taylor and Boyang Shi

Project summary

Cat's claw creeper (*Dolichandra unguis-cati*) is a Weed of National Significance in Australia. Biocontrol is considered the most desirable option to manage the weed. So far, a leaf-sucking tingid (*Carvalhotingis visenda*), a leaf-tying moth (*Hypocosmia pyrochroma*) and a leaf-mining beetle (*Hedwigiella jureceki*) have been released in Queensland. All agents have become widely established, except for *H. pyrochroma* which is restricted to riparian corridors in southeast Queensland.

Since cat's claw creeper is a perennial vine with abundant subterranean tuber reserves, additional agents are needed to complement the existing agents. Surveys in Brazil, Argentina and Paraguay identified a rust-gall (*Uropyxis rickiana*) and a leaf-rust (*Prospodium macfadyenae*), as prospective biological control agents. More recently, an accidentally introduced leaf-spot pathogen (*Neoramulariopsis unguis-cati*), causing widespread defoliation in South Africa (see Figure 14), has been identified as a prospective biocontrol agent as well.

Preliminary host specificity testing of the leaf-spot pathogen and the rust-gall has been completed and the leaf-spot pathogen has been prioritised for detailed host specificity testing. Host specificity testing of 35 non-target test plant species for the leaf-spot pathogen has been completed by CABI (UK). The leaf-spot pathogen exhibited a high level of host specificity, sporulating only on cat's claw creeper. An application seeking its approval to release the leaf-spot pathogen has been submitted to the Australian regulatory authority. Field releases of the leaf-spot pathogen, which are anticipated to complement existing insect agents, will commence once approval has been received.

Other potential biological control agents for consideration and evaluation for release in Australia include the gall-forming rust *U. rickiana* and the seed-feeding weevil *Apteromechus notatus,* both of which target different plant parts than those released to date.

Figure 14 Disease symptom caused by the leaf-spot pathogen Neoramulariopsis unguis-cati on cat's claw creeper in South Africa (Photo, Anthony King, Agricultural Research Council – Plant Health and Protection, Queenswood, Pretoria, South Africa).

Collaborators

- Seqwater
- Marion Seier and Kate Pollard (CABI, UK)
- Anthony King (Plant Protection Research Institute, Pretoria, South Africa)
- Robert Barreto and Adans Colman (Universidade Federal de Viscosa, Brazil)
- Anibal Carvalho (Instituto de Pesquisas Jardim Botanico do Rio de Janeiro, Brazil)
- Kevin Jackson (Gympie, Qld)
- Melinda Clarke (Burnett Catchment Care Association, Monto)
- NSW Weed Biocontrol Taskforce

Key publications

Dhileepan, **K**., Treviño, M., Bayliss, D., Saunders, M., McCarthy, J., Shortus, M., **Snow**, **E**.**L**., Walter, G.H. (2010). Introduction and establishment of *Carvalhotingis visenda* (Hemiptera: Tingidae) as a biological control agent for cat's claw creeper *Macfadyena unguis-cati* (Bignoniaceae) in Australia. *Biological Control* 55(1):58−62.

Dhileepan, **K**. (2012). *Macfadyena unguis-cati* (L.) A.H. Gentry - cat's claw creeper, pp. 351-359. In: *Biological control of weeds in Australia: 1960 to 2010* (Eds. M. Julien, R.E. McFadyen & J. Cullen), CSIRO Publishing, Melbourne.

Dhileepan, **K**., **Taylor**, **D**., Treviño, M. & Lockett, C. (2013). Cat's claw creeper leaf-mining beetle *Hylaeogena jureceki* Obenberger (Coleoptera: Buprestidae), a host specific biological control agent for *Dolichandra unguis-cati* (Bignoniaceae). *Australian Journal of Entomology* 52: 175-181.

Dhileepan, **K**., **Snow**, **E**., **Shi**, **B**., **Gray**, **B**., Jackson, K. & Senaratne, K.A.D.W. (2021). Establishment of the biological control agent *Hypocosmia pyrochroma* for *Dolichandra unguis-cati* (Bignoniaceae) is limited by microclimate. *Journal of Applied Entomology* 145(9):890−899.

Pollard, K.M., Seier, M.K. (2023). The biological control of cat's claw creeper, *Dolichandra unguis-cati* (L.) L.G.Lohmann - final report (June 2018 to June 2023), CABI, UK.

13. Biological control of bellyache bush (*Jatropha gossypiifolia*)

Project dates

January 2007 - June 2025

Project team

Kunjithapatham Dhileepan and Di Taylor

Project summary

Bellyache bush (*Jatropha gossypiifolia*), a Weed of National Significance, is a serious weed of rangelands and riparian zones in northern Australia. Biological control is the most cost-effective long-term management strategy for bellyache bush in Australia. Bellyache bush has been a target for biological control since 1997 with limited success to date. A seed-feeding jewel beetle *Agonosoma trilineatum* from Venezuela was field released between 2003 and 2007 and did not establish.

A renewed biological control effort, involving exploration in tropical America, identified a leaf rust (*Phakopsora arthuriana*) from Trinidad, a leaf mining moth (*Stomphastis thraustica*) from Peru and a gall midge (*Prodiplosis hirsutus*) from Paraguay, as prospective biological control agents.

Based on host specificity tests, approval to release the Jatropha leaf-miner was received in September 2022, and field releases commenced in October 2022. Field releases of the leaf-miner are in progress in partnership with local governments and NRM groups. So far 58 field releases have been made at 30 release sites in Queensland covering central, north and northwest, and far-north Queensland (See Figure 15 and Figure 16). Three releases have been made at three sites in the Northern Territory. Work is underway looking at the potential interaction between this leaf-miner and an existing species already present in Australia (a yet to be described Stomphastis species).

Host specificity tests for the leaf rust were completed at CABI, UK, using a virulent rust strain from Trinidad. An application seeking approval to release the Jatropha rust pathogen in Australia is being prepared.

The gall midge attacks actively growing shoot tips of bellyache bush plants causing shoot tip dieback. Preliminary host specificity tests for the gall midge in Argentina confirmed that the midge has a restricted host range, limited to a few closely related Jatropha species that are not present in Australia (there are no Jatropha species native to Australia). Future work will focus on importing the gall midge from Paraguay into a quarantine facility in Australia for detailed host specificity testing.

Figure 15 Release sites for Stomphastis thraustica in Queensland.

Figure 16 Stomphastis thraustica release site at Rita Island, near Ayr.

Collaborators

- Marion Seier and Kate Pollard (CABI, UK)
- Guillermo Cabrera Walsh, Marina Oleiro and Carolina Mengoni (Fundación Para El Estudio De Especies Invasivas, Buenos Aires, Argentina)
- Peter Kolesik (South Australian Museum, Adelaide)
- Kumaran Nagalingam (CSIRO, Brisbane)
- Jurate De Prins (Royal Museum of Central Africa, Belgium)
- Charles Curry (Southern Gulf NRM, Mt Isa)
- Jo Menneke (Charters Towers Regional Council)
- John Fisher (Barcaldine Regional Council)
- Susan Waters (Central Highlands Regional Council).
- Melissa Hayes (Whitsunday Regional Council)
- Megan Davies (Burdekin Regional Council)
- Russell Jack (Dept. Resources, Cairns)
- Geoff Swan (Biosecurity Queensland, Emerald)
- Bradley Drinkwater (Townsville City Council)
- Graham Wienert (Mareeba Regional Council)
- Loukas Elgey (Ethridge Regional Council)

- Lyn French (Gilbert River Headwaters Action Group)
- Michelle Franklin, Gerald Danao and Bradley Sauer (Dept. Environment, Parks & Water Security, Northern Territory)

Key publications

Dhileepan, **K**., Neser, S., De Prins, J. (2014). Biological control of bellyache bush (*Jatropha gossypiifolia*) in Australia: South America as a possible source of natural enemies, pp. 5−10. In: Impson FAC, Kleinjan CA & Hoffmann JH (eds), *Proceedings of the XIV International Symposium on Biological Control of Weed*, Kruger National Park, South Africa, 2-7 March 2014.

Heard, T.A., **Dhileepan**, **K**., Bebawi, F., Bell, K., Segura, R. (2012). *Jatropha gossypiifolia L.* – bellyache bush, pp. 324−333. In: *Biological control of weeds in Australia: 1960 to 2010* (Eds. M Julien, RE McFadyen & J Cullen), CSIRO Publishing, Melbourne.

Kolesik, P., Kumaran, N., Oleiro, M., Gonalons, C.M., Brookes, D., Walsh, G.C., **Dhileepan**, **K**. (2022). *Prodiplosis hirsuta*, a new species of gall midge (Diptera: Cecidomyiidae) feeding on shoot tips of *Jatropha* (Euphorbiaceae) in South America. *Austral Entomology* 61(1): 37−48.

Taylor, **D**.**B**.**J**., **Snow**, **E**.**L**., Moore, K., **Dhileepan**, **K**. (2017). At last, biological control of bellyache bush, pp. 4−9. In: T Sydes (ed.), *Proceedings of the 14th Queensland Weed Symposium*. The Weed Society of Queensland, Port Douglas, 4-7 December 2017.

14. Biological control of Navua sedge (*Cyperus aromaticus*)

Project dates

January 2017 – December 2025

Project team

Kunjithapatham Dhileepan, Di Taylor and Boyang Shi

Project summary

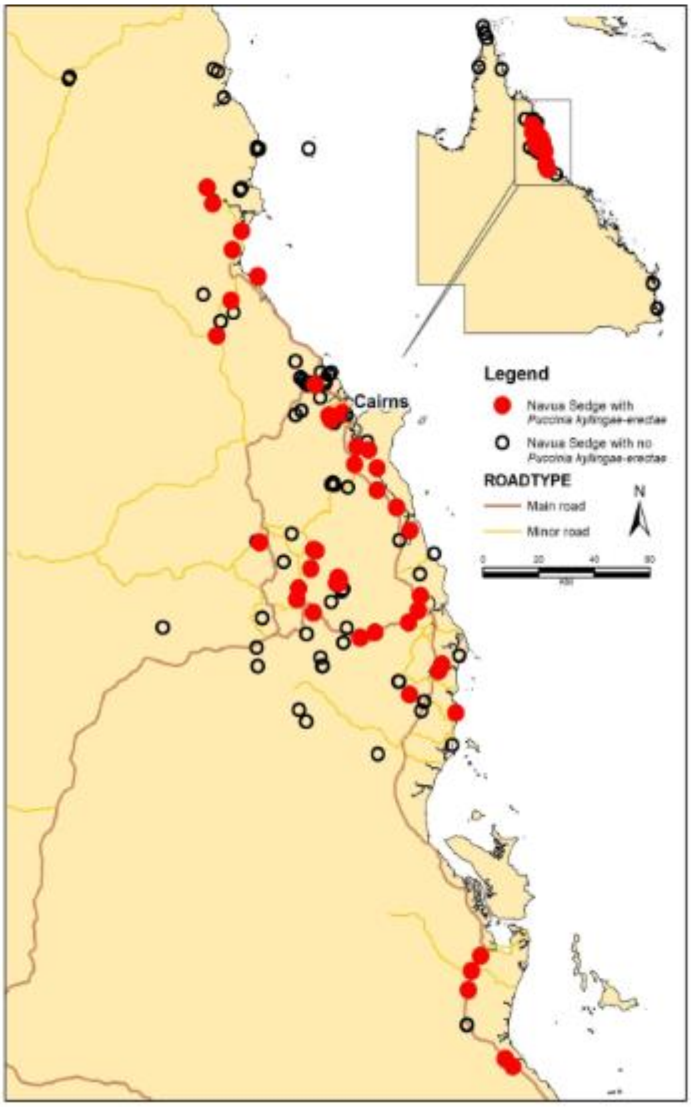
Navua sedge (*Cyperus aromaticus*) is an extremely aggressive perennial sedge affecting the beef and dairy industries in the Queensland wet tropics. The sedge is unpalatable, and can form dense stands, replacing palatable tropical pasture species. Current management options are mechanical and chemical, which are expensive and offer only short-term relief. Biocontrol is the most cost effective and long-term management option.

Surveys in equitorial Africa identified a new smut fungus (*Cintractia kyllingae*) attacking flower heads and seeds in Tanzania, Kenya and Nigeria, and a rust fungus (*Puccinia kyllingae-erectae*) attacking leaves and stems in Nigeria, Tanzania and Madagascar, as promising biological control agents. Research on the biology and host specificity of the flower smut pathogen from Tanzania and the rust pathogen from Madagascar are in progress in quarantine in CABI-UK.

A rust fungus infecting leaves and stems of Navua sedge was reported from a grazing property in Topaz, northern Queensland in August 2023. The rust is morphologically and genetically identical to *P. kyllingae-erectae* from Africa. The rust killed 80–95% of the above ground foliage (Figure 18), although Navua sedge resprouts from underground rhizomes.

The rust was found to be widespread in the Atherton Tablelands, and in the coastal lowlands, from Innisfail to Cape Tribulation (Figure 17). The rust was not found on pasture species or other native sedge species co-occurring with rust infected Navua sedge plants, indicating that it is likely to be host specific. Future studies will focus on determining the distribution, impact and host range of the rust pathogen in the field.

Figure 17 Puccinia kyllinga-erecta incidence (●) in the wet tropical regions of Queensland. The empty circles (○) represent sites where the rust has not yet been reported.



Evaluation of various herbicides for the management of Navua sedge in the glasshouse and field by the Federation University of Australia has been completed and data analysis is in progress. A student research project in collaboration with the Federation University of Australia on herbicide management of Navua sedge is in progress.

Figure 18 (A) Puccinia kyllingae-erectae rust infecting Navua sedge (B) causing above-ground tiller mortality.

Collaborators

- Prof Roger Shivas (University of Southern Queensland)
- Dr Marion Seier and Dr Daisuke Kurose (CABI-UK)
- Prof Florentine Singarayer, Dr Aakansha Chadha and Bhagya Ranasinghe Hathamune Gamage (Federation University, Ballarat)
- Dr Yu Pei Tan (Queensland Plant Pathology Herbarium)
- Melissa Setter and Stephen Setter (Biosecurity Queensland, South Johnston)
- Dr Shane Campbell (University of Queensland, Gatton)
- Dr Mutuku Musili and Frederick Munyao Mutie (East African Herbarium, Kenya)
- Dr John Elia Ntandu (National Herbarium of Tanzania)
- Emmanuel. C. Chukwuma (Forest Research Institute, Ibadan, Nigeria)
- Ocholi T Edogbanya (Kogi State University, Anyigba, Nigeria).
- Dr Isabel Larridon (Kew Gardens, UK)
- Dr Julia Kruse (Natural History Museum, Germany)
- Dr James Hereward (UQ, St Lucia)
- Dr Emilie Fillols (Sugar Research Australia, Gordonvale)
- Rajaonera Tahina Ernest (University of Antananarivo, Madagascar)
- Bernie English (Agri-Science Queensland, Mareeba)
- Rob Pagano (Beef grazier, Tarazali)
- John McKenna (Beef grazier, Malanda)
- Lawrence Di Bella and Richard Hobs, Herbert Cane Productivity Services Limited (Ingham)

- Lance Rodman (sugarcane farmer, Gordonvale)
- Sydes Travis (Far North Queensland Regional Organisation of Councils, Cairns)
- Malanda Beef Plan Group (Malanda)
- Tablelands Regional Council (Atherton)
- Cassowary Coast Regional Council (Innisfail)
- Hinchinbrook Shire Council (Ingham)
- Darryn Higgins (Cook Shire Council)
- Michael Zitha (Biosecurity Queensland, Thursday Island)

Key publications

Chadha, A., Florentine, S.K., **Dhileepan**, **K**., Dowling, K. & Turville, C. (2021). Germination biology of three populations of *Cyperus aromaticus*. *Weed Science* 69(1):69−81.

Chadha, A., Florentine, S.K., **Dhileepan**, **K**., Turville, C. & Dowling, K. (2022). Efficacy of halosulfuron-methyl in the management of Navua sedge (*Cyperus aromaticus*): differential responses of plants with and without established rhizomes. *Weed Technology* 36(3):397−402.

Chadha, A., **Osunkoya**, **O**.**O**., **Shi**, **B**., Florentine, S.K. & **Dhileepan**, **K**. (2022). Soil seed bank dynamics of pastures invaded by Navua sedge (*Cyperus aromaticus*) in tropical north Queensland. *Frontiers in Agronomy*, May 2022, doi:10.3389/fagro.2022.897417

Dhileepan, **K**., Musili, P.M., Ntandu, J.E., Chukwuma, E., Kurose, D., Seier, M.K., Ellison, C.A. & Shivas, R.G (2022). Fungal pathogens of Navua sedge (*Cyperus aromaticus*) in equatorial Africa as prospective weed biological control agents. *Biocontrol Science and Technology* 32(1):114−120.

Kruse, J., McTaggart, A., Dhileepan, K., Musili, P.M., Mutie, F.M., Ntandu, J.E., Edogbanya, O., Chukwuma, E.C. & Shivas, R.G. (2021). Broad and narrow host ranges in resolved species of *Cintractia limitata* s. lat. (Anthracoideaceae Ustilaginomycotina) on *Cyperus*. *Mycological Progress* 20(2):191−201.

Shi, **B**., **Osunkoya**, **O**.**O**., Chadha, A., Florentine, S.K. & **Dhileepan**, **K**. (2021). Biology, Ecology and Management of Invasive Navua sedge (*Cyperus aromaticus*) – A Global Review. *Plants* 10(9), 1851, doi.org/10.3390/plants10091851.

Tan, Y.P., Dhileepan, K., Ntandu, J.E., Kurose, D. & Shivas, R.G. (2021). *Curvularia tanzanica sp. nov*. *Fungal Planet description sheet: 1238* – 13 July 2021, *Persoonia* 46(2):438–439.

15. Biological control of prickly acacia (*Vachellia nilotica* ssp. *indica*)

Project dates

January 2007 - June 2025

Project team

Kunjithapatham Dhileepan and Boyang Shi

Project summary

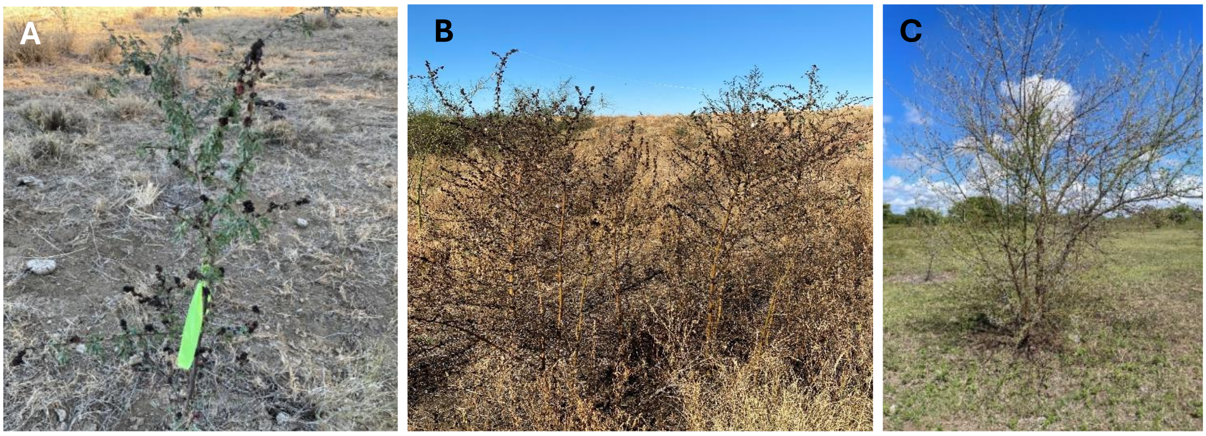
Prickly acacia (*Vachellia nilotica* subsp. *indica*) is a weed of national significance and a target for biological control, albeit with limited success to date. Native range surveys for prospective biological control agents were conducted in Ethiopia and Senegal based on plant phenotype and climate matching. Based on field host range, geographic range and damage potential, a gall thrips (*Acaciothrips ebneri*) inducing shoot-tip rosette galls, a gall mite (*Aceria* sp.) deforming leaflets, rachides, and shoot-tips in Ethiopia; and a gall fly (*Notomma mutilum*) inducing stem-galls in Senegal were prioritised for further studies.

Host specificity tests for gall thrips have been completed and the gall thrips was approved for field release in November 2022. Field releases commenced in January 2023 in partnership with NRM groups, local government agencies and grazing property owners. To date, field releases have been made in 32 sites covering coastal, central highlands and western inland regions in Queensland. Establishment of the gall thrips was evident in majority of the release sites. The gall thrips induced rosette galls in the actively growing shoot tips (Figure 19 A), resulting in shoot tip dieback (Figure 19 B) in prickly acacia seedlings (Figure 20 A), juvenile plants (Figure 20 B) and mature trees (Figure 20 C).

Host specificity testing for the gall mite has been delayed due to difficulties with gall mite importations from Ethiopia (unsafe to travel). Host specificity testing of the gall mite will recommence using gall mites sourced from Senegal.

Figure 19 Gall thrips inducing rosette galls in actively growing shoot tips (A) causing shoot-tip dieback (B) in prickly acacia.

Figure 20 Gall thrips causing shoot-tip dieback in pricky acacia seedling (A), juvenile plant (B) and mature tree (C) in release sites.



Collaborators

- Anthony King (Agricultural Research Council - Plant Protection Research Institute, Pretoria, South Africa)
- Nathalie Diagne (Senegalese Institute of Agricultural Research, Centre National de Researches Agronomique, Bambey, Senegal)
- Mindaye Teshome (Forestry Research Centre, Addis Ababa, Ethiopia)
- James Hereward (School of the Environment, University of Queensland, St Lucia)
- Charles Curry (Southern Gulf NRM, Mt Isa)
- Susan Walters (Central Highlands Regional Council, Springsure)
- Melissa Hays (Whitsundays Regional Council, Proserpine)
- Burdekin Regional Council
- Doug Allpass and Jana Sykorova (Desert Channels Group)
- David Lawrence (Rockhampton Regional Council, Rockhampton)
- Andries van Jaarsveld (Isaac Regional Council, Moranbah)
- Geoffrey Swan (Biosecurity Queensland, Emerald)
- Dache Geiger (Winton Shire Council)
- Richmond Shire Council
- McKinlay Shire Council
- Flinders Shire Council

Key publications

Dhileepan, K. (2009). 2. *Acacia nilotica* ssp. *indica*. pp. 17-37. In: *Weed Biological Control with Arthropods in the Tropics: Towards Sustainability* (eds. Muniappan, R., Reddy, D.V.P. & Raman, A.), Cambridge University Press, UK.

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16. Biological control and ecology of chinee apple (*Ziziphus mauritiana*)

Project dates

July 2021- June 2025

Project team

Olusegun Osunkoya, Kunjithapatham Dhileepan, Boyang Shi and Christine Perrett

Project summary

Ziziphus mauritiana (Rhamnaceae) (Indian ber/chinee apple) is a major pasture and environmental weed in northern Australia. Its impenetrable thickets hinder stock and affect pasture production. Current management options (mechanical and chemical) are expensive. Though present in Queensland since 1880, only limited data are available on its distribution and population ecology, economic loss and prospects for biological control. This project's aims are:

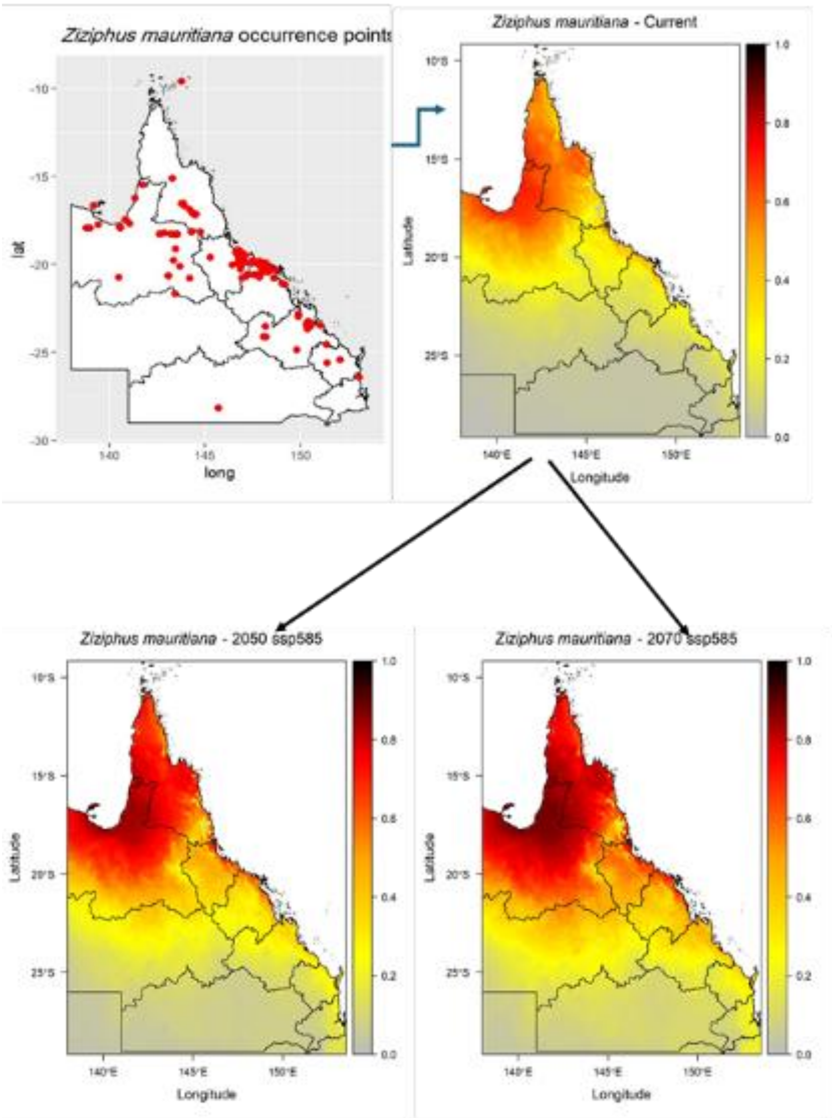
- Assess the economic impact of *Z. mauritiana* on primary producers
- Assess the ecological impact of *Z. mauritiana* on soil processes (seed bank, soil biota and chemistry)
- Identify climatically suitable areas in the native range to source biological control agents
- Develop a MAXENT model for *Z. mauritiana* to identify potential distribution, and response of the weed to anthropogenic disturbance and climate change

Results to date include:

- The weed had a lag phase of ~ 64 years, followed by several decadal invasion waves since introduction
- Control cost to grazing farmers of the weed averaged $65,000 per annum per grazier (~$30.29 per hectare), with machinery usage and maintenance having the lion share.
- Taking climate change into consideration for future projections the data indicate the range of *Z. mauritiana* will continue to expand considerably from 14% to 22.2% and 25.5% of the Queensland by 2050 and 2070, respectively (see figure below). The top end (far north and northwest QLD regions) and fringes of the eastern coastlands of Queensland were the preferred habitat for the weed.
- Infestation by chinee apple in central Queensland has led to major changes in soil chemistry, especially nitrogen, phosphorus and potassium and heavy metals (e.g., zinc, aluminium and sulphur).

- Native range surveys for phytophagous insects and plant pathogens associated with *Z. mauritiana* in Pakistan are in progress.
- In Australia, a specialist leaf-infecting pathogen, *Pseudocercospora jujube* is widespread and seasonal, but with limited impact on the weed. There were no other specialist natural enemies found on *Z. mauritiana* in Australia.

Figure 21 Spatial distribution and density of chinee apple in Queensland based on MAXENT niche-based software: upper illustrations are current and potential extent of the distribution, while the lower ones are distribution in response to time (i.e., climate change by 2050 and 2070, respectively).



Collaborators

- Wayne Vogler, Kelli Pukallus, Bradley Gray and Moya Calvert (Biosecurity Queensland)
- Scott Hardy (Whitsunday Regional Council)
- NQ Dry Tropics NRM
- Roger Shivas (University of Southern Queensland)
- Shane Campbell (University of Queensland, Gatton)

- Kumaran Nagalingam (CSIRO, Brisbane)
- Jürgen Kellermann (State Herbarium of South Australia)
- ICAR - National Bureau of Agricultural Insect Resources, Bangalore, India
- ICAR - Central Institute for Arid Horticulture, Bikaner, India
- University of Punjab, Lahore, Pakistan.
- Bangladesh Agricultural University, Mymensingh, Bangladesh
- Mengjun Liu (Hebei Agricultural University, Baoding, China)
- Saichun Tang (Guangxi Institute of Botany, Chinese Academy of Sciences, Guilin, China)
- Farzin Shaba (Qatar University, Doha)

Key publications

Bebawi. F.F., Campbell, S.D., Mayer, R.J. (2016). Seed bank persistence and germination of Chinee apple (*Ziziphus mauritiana* Lam.). *Rangeland Journal*, 38, 17–25.

Dhileepan, **K**. (2017). Biological control of *Ziziphus mauritiana* (Rhamnaceae): feasibility, prospective agents and research gaps. *Annals of Applied Biology* 170(3): 287-300.

Grice A.C. (2002). The Biology of Australian Weeds. 39. *Ziziphus mauritiana* Lam. *Plant Protection Quarterly*,17,2–11.

O'Brien, C.J., Campbell, S., Young, A., **Vogler, W**., Galea, V.J. (2023). Chinee Apple (*Ziziphus mauritiana*): A Comprehensive Review of Its Weediness, Ecological Impacts and Management Approaches. *Plants*, 12, 3213. https://doi.org/ 10.3390/plants12183213.

17. Impact and management of Navua sedge

Project dates

July 2020-June 2024

Project team

Olusegun Osunkoya, Christine Perrett, Boyang Shi and Kunjithapatham Dhileepan

Project summary

Navua sedge (*Cyperus aromaticus*) is an aggressive monocot weed affecting the beef, dairy, and sugarcane industries in the Queensland Wet Tropics. The weed is spreading through both seeds and underground rhizomes along roadsides and railway lines. There is an infestation in the Redland Bay area of southeast Queensland. Navua sedge is unpalatable and can form dense stands by replacing palatable tropical pasture species. Current management approaches are mechanical and chemical, but these are expensive and offer only short-term relief. Prospective biological control agents are being considered in a separate project. We continue to explore multiple methods (i.e. integrated weed management, including automated weed identification and mapping via drones) to improve control of the weed under different grazing conditions, herbicide application and plant competition. Our aims are to determine:

- Density thresholds of the weed with no effect on pasture productivity
- Benchmark data for estimation of efficacy of control treatments (cultural, chemical or, when available, biological, including mycoherbicides)
- Soil quality (soil seed bank, soil chemistry and biology [nematodes, bacteria and fungi]) of areas invaded by Navua sedge
- Economic impact of the weed in terms of loss of productivity and control cost

Results to date include

- Stakeholder consultation (mainly graziers and sugarcane/potato farmers) suggests that the Navua sedge incursion in northern Queensland is relatively recent (mean time 15-20 yrs) and at low levels of infestation (median level 22.5% of a property), but control cost increases with increasing level of infestation. Current control cost per property is $89 per hectare, with labour (compared to chemical and machinery cost) being the main driver of total control cost, especially in the grazing industry.
- Farmers are using a range of strategies to manage the weed, including a willingness to impose strict biosecurity measures (e.g. minimal slashing) and integrated weed management tactics while waiting for promising biocontrol agents to minimize the spread and impact of the weed
- The plant chemistry of Navua sedge differs to that of co-occurring pasture plants (signal, Rhodes, setaria and Guinea grasses), irrespective of land use (e.g., grazing vs cropping) and habitat type (riparian vs non-riparian or coastal vs upland areas). In particular, plant fibre and lignin contents are higher, while cellulose content in Navua sedge is lower compared to co-occurring pastures.
- Navua sedge will establish in various types of soils ranging from heavy clay to predominantly sandy soils, and viable seeds are concentrated in 0-5 cm depth of the soil (22,883 ± 1,828 seeds m^{-2}). Impact on soil chemistry appears minimal as very little significant difference was detected between infested and nearby control (non-infested) soils.
- Drone (UAV) imagery was captured on an infested property with various herbicide trials and treatments on the Atherton Tablelands in far north Queensland. Data continue to be processed using artificial intelligence (AI) protocols to aid in the automation of identification of the Navua sedge and its growth stages and mapping at the farm-scale level.

Figure 22 An abandoned block of a flooded sugarcane farm overrun by Navua sedge infestation in Cairns, Far North QLD.

Collaborators

- Malanda Beef Plan Group
- Joe Ralph (Beef producer Malanda)
- Marcus Bulstrode (Department of Agriculture and Fisheries, South Johnstone)
- Travis Sydes (Far North Queensland Regional Organisation of Councils)
- Lawrence Di Bella (Herbert Cane Productivity Services Ltd, Ingham)
- Dr Shane Campbell (University of Queensland, Gatton)
- Prof. Singerayer Florentine (Federation University, Ballarat, Victoria)
- Dr Nahina Islam (Central Queensland University, Rockhampton)
- Tablelands Regional Council
- Hinchinbrook Shire Council
- Mareeba Shire Council
- Cassowary Coast Regional Council

Key publications

Chadha, A., **Osunkoya**, **O**.**O**., **Shi**, **B**., Florentine, S.K. & **Dhileepan**, **K**. (2022). Soil Seed bank dynamics of pastures invaded by Navua Sedge (*Cyperus aromaticus*) in tropical north Queensland. *Frontier in Agronomy*. 4: 897417. doi: 10.3389/fagro.2022.897417.

Chadha, A., Florentine, S.K., **Dhileepan**, **K**., Dowling, K. & Turville, C. (2021) Germination biology of three populations of Navua sedge (*Cyperus aromaticus*). *Weed Science*. 69: 69–81. doi: 10.1017/wsc.2020.82.

Osunkoya, **O.O**., **Shi**, **B**., & **Dhileepan**, **K**. (2024). Stakeholder perspective of the economic cost of managing the invasive Navua sedge (*Cyperus aromaticus*) in tropical Queensland, Australia. *Invasive Plant Science and Management* (In review).

Shi, B., Osunkoya, O. O., Chadha, A., Florentine, S. K. & **Dhileepan, K.** (2021). Biology, Ecology and Management of the Invasive Navua Sedge (*Cyperus Aromaticus*)—A Global Review. *Plants* 10: 1–16. doi: 10.3390/ plants1009185.

18. Risk assessment for new and emerging invasive pest plant and animal species

Project dates

July 2021- June 2024

Project team

Olusegun Osunkoya, Christine Perrett, Moya Calvert and Brad Grey

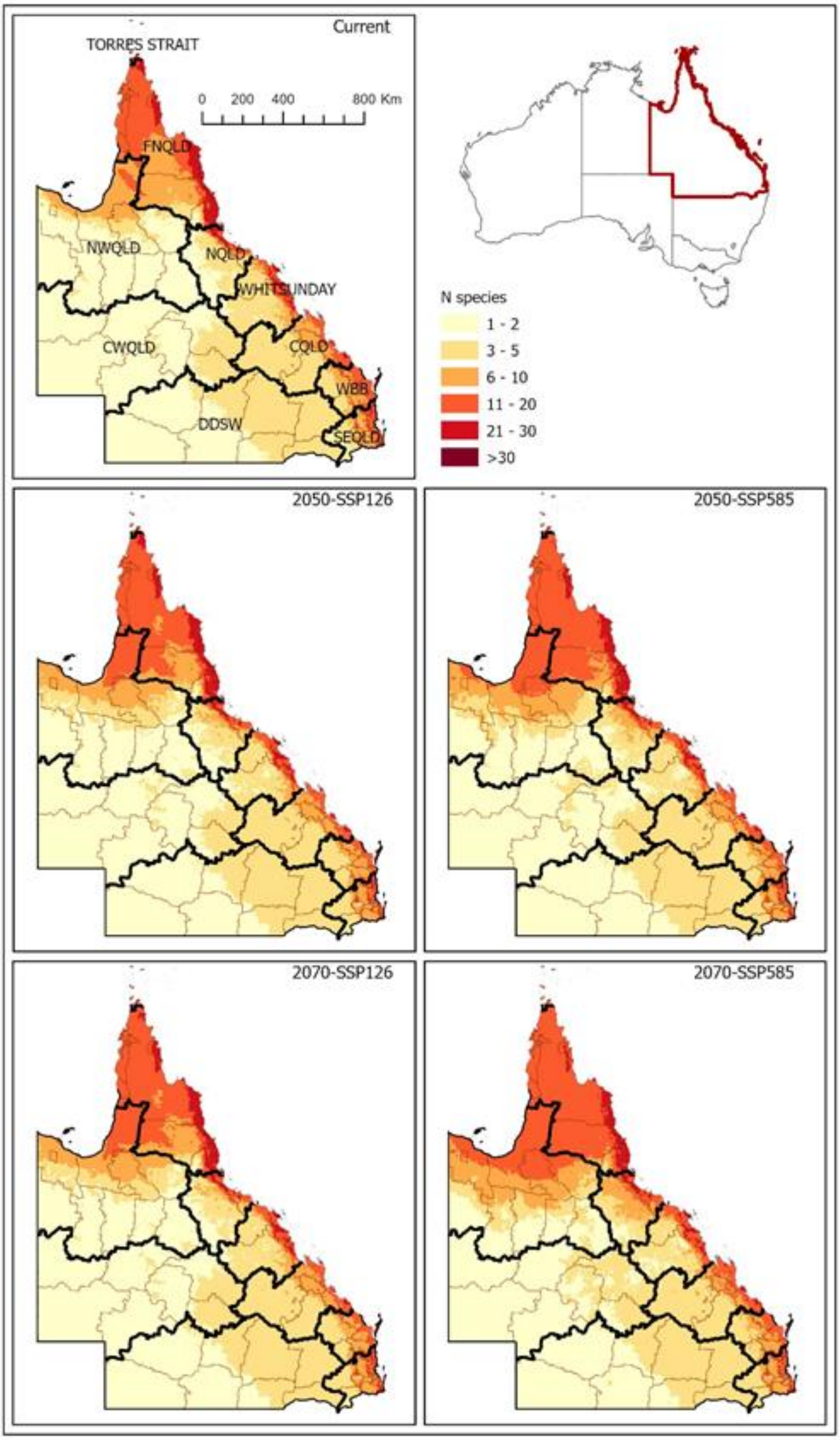
Project Summary

Biosecurity Queensland maintains a list of ~300 emerging weeds of Qld that are potential threats to agriculture and nature conservation (see https://www.qld.gov.au/environment/plants-animals/plants/herbarium/weeds/weed-species). Many of these emerging pest species appear to be in early stages of invasion in the State, but with potential to become widespread and troublesome in the future. However, their potential for spread and impact have not been systematically assessed, including their responses to climate change.

Project progress:

- We have modelled the current and future distribution for a number of these emerging (horizon) weed species of differing growth forms using MAXENT software.
- Range shifts were predicted for many species in response to climate change. Overall, range increase will occur more often than range contraction, and more so in trees compared to all other plant growth forms. Range stability was least in succulent weeds. Under climate change, the majority of the invasion hotspot areas were projected to remain geographically stable in Queensland (see Figure 23).
- Northern Queensland (especially the Gulf of Carpentaria and Cape York Peninsula areas), and the coastal communities along the eastern seaboard are hotspots for emerging weed species to establish and expand or contract in response to climate change.
- Based on observed and potential ranges, as well as species response to climate change, we have also prioritised species for management.

Figure 23 Predicted invasion hotspots using species richness (species count per 5 x 5 km pixel) of 54 emerging weeds across Queensland landscape. Habitat suitability was based on current (potential) situation (top panel) and in response to time and hence two climate change (SSP 126 and SSP 585) scenarios (2050-middle panel; 2070-bottom panel). Local government boundaries are indicated in thin lines and the ten Regional Organisations of Council (ROC) groupings are in thick lines.



Collaborators

- Josh Dyke (Local Government Association of Queensland)
- Queensland Herbarium
- Queensland local government pest officers
- NRM groups
- Jens Froese and Sam Nicol (CSIRO Brisbane)
- Biosecurity officers
- Jamie Camac (Centre for Biosecurity Risk Analysis Group, University of Melbourne, Victoria)
- Farzin Shabani (Qatar University, Qatar)

Key publications

Csurhes, **S**. (2021). *Risk assessment and prioritisation of 229 emerging weed threats detected in Queensland*. Unpublished technical report. Biosecurity Queensland. 54 pages.

Osunkoya, O.**O**., **Perrett**, **C**., **Calvert**, **M**., & **Csurhes**, **S**. (2022). Horizon scan for incoming weeds into Queensland, Australia. *Proceedings, 22nd conference of the Australasian Weeds Society*, Adelaide, South Australia, 9: 67-70.

Osunkoya O.**O**., Lock, C.B, **Dhileepan**, **K**. & Buru, J.C. (2021). Lag times and invasion dynamics of established and emerging weeds: insights from herbarium records of Queensland, Australia. *Biological Invasions*, 23 (11), 3383- 3408.

19. Real-time, drone-based weed identification for improved pasture management

Project dates

July 2022-June 2028

Project team

Olusegun Osunkoya, Kunjithapatham Dhileepan and Boyang Shi

Project summary

Conventional weed control is costly and time consuming. One challenge for control is weed identification in the field. This project trials real time weed identification using artificial intelligence on captured aerial images. Through our collaboration with Central Queensland University, we have secured a CSIRO funded grant for a PhD (3 years) scholarship. Our aims are:

a) Autonomous identification of weeds in a natural landscape using artificial intelligence.

b) Production of a map of weed locations at the landscape-scale (e.g., farm) which has commercial benefits to farmers, local government councils, and agricultural researchers.
c) Pass a file of these weed locations to a drone to carry out either spot spraying of herbicide or delivery of biological control agents.

Project progress:

- We have captured aerial images using drones with red-blue-green and multispectral (higher resolution) cameras at various sites for three major weeds of Queensland - parthenium (in the Whitsunday area), Navua sedge (in Far North Queensland) and chinee apple (in Central Queensland).
- Classification of growth stages and identification of parthenium from field images have been relatively poor, but have been successful with images collected in a controlled environment using a series of parthenium and naturally co-occurring, non-parthenium (monocot) plants. We are working on extending this success back to field-collected images.

Collaborators

- Peter Trotter (Aspect Imaging, Sunshine Coast, Queensland)
- Naina Islam and Nanjappa Aswath (Institute for Future Farming Systems, Centre for Intelligent Systems, Central Queensland University, Rockhampton Qld)
- Felipe Gonzalez (Centre for Robotic Engineering- Queensland University of Technology)
- Marcus Bulstrode (Sustainable Farming Systems Agri-Science Queensland, Department of Agriculture & Fisheries, South Johnstone, Queensland)
- Local government pest officers

Key publications

Costello B., **Osunkoya**, **O.O.**, Sandino, J., Marinic, W., Trotter, P., **Shi**, B., Gonzalez, F., **Dhileepan**, **K.**, (2022). Detection of Parthenium Weed (*Parthenium hysterophorus* L.) and Its Growth Stages Using Artificial Intelligence. *Agriculture*, 12, 1838. https://doi.org/10.3390/agriculture12111838

Hu, K., Coleman, G., Zeng, S., Wang, Z., Walsh, M. (2020). Graph weeds net: A graph-based deep learning method for weed recognition. *Computer & Electronics in Agriculture*, 174, 105520. https://doi.org/10.1016/j.compag.2020.105520

Islam, N., Rashid, M.M., Pasandideh, F., Ray, B.; Moore. S., Kadel, R. (2021). A Review of Applications and Communication Technologies for Internet of Things (IoT) and Unmanned Aerial Vehicle (UAV) based Sustainable Smart Farming. *Sustainability*, 13, 1821. https://doi.org/10.3390/su13041821

Lambert, J.P.T., Hicks, H.L., Childs, D.Z., Freckleton, R.P. (2018). Evaluating the potential of Unmanned Aerial Systems for mapping weeds at field scales: a case study with *Alopecurus myosuroides*. *Weed Research* 58 35–45.

20. Weed biological control agent rear and release

Project dates

Ongoing

Project team

Kelli Pukallus and Mary Butler

Project summary

This project aims to mass-rear, release and monitor biological control agents in northern Queensland for the control and management of invasive weed species. Recent agents include *Cecidochares connexa* (stem-galling fly) for *Chromolaena odorata* (Siam weed), *Acaciothrips ebneri* (gall thrips) for *Vachellia nilotica* (prickly acacia) and *Zygogramma bicolorata* (leaf-feeding beetle) for *Parthenium hysterophorus* (Parthenium).

The project conducts monitoring of establishment, spread and impact of current and past biological control agents and assists with the collection and redistribution of agents on invasive weed species for landholders and local governments.

Figure 24 Clockwise from top left: 1.Acaciothrips ebneri gall damage on prickly acacia flowers at a release site in North Queensland. 2. Acaciothrips ebneri adults (black) and nymphs (red) on gall damage they have caused on a prickly acacia plant. 3. A science support officer releasing Cecidochares connexa flies onto Siam weed in North Queensland. 4. Released female Cecidochares connexa flies, getting straight to work and laying eggs in Siam weed growing tips.

C. connexa mass-rearing project concluded in June 2024 after 4.5 years. Over 66,400 adult flies & 3,600 galled stems were released into nine QLD LGA's. Field assessments show significant impact on flowering and plant growth at some sites and limited at others. Populations are persisting and continuing to spread to new locations and Siam weed infestations. QDAF assisted NT Government with their colony and galled stems were provided from TWRC colony for overseas colony establishment and releases. 60 insect and 19 fungus species have been identified and catalogued to date, in association with Siam weed within Queensland.

A. ebneri project recently commenced with nearly 3,000 galled stems from TWRC colony and field collections, released into prickly acacia infestations across six QLD LGA's. Establishment is noted at most sites with the thrips spreading to nearby trees of all sizes, reducing flowering and seeding.

Collaborators

- Charters Towers Regional Council
- Townsville City Council
- Hinchinbrook Shire Council
- Douglas Shire Council
- Cassowary Coast Regional Council
- Queensland Department of Environment and Science
- NQ Dry Tropics
- Bush Heritage Australia
- Tablelands Regional Council
- Queensland Department Resources
- Queensland Department of Transport and Main Roads
- Northern Territory Government, Department of Environment and Natural Resources
- Defence Australia
- Ergon Energy
- Queensland Corrective Services, Townsville
- Burdekin Shire Council
- Central Highlands Regional Council
- Isaac Regional Council
- Cairns Regional Council
- NQ Plantations
- Mareeba Shire Council
- Plant Biosecurity Laboratories – Biosecurity Queensland
- Sun Metals Refinery and Solar Farm
- Glencore Copper Refineries
- Barcaldine Shire Council
- Longreach Shire Council

Key publications

Pukallus, K., Kronk, A. & Franklin, M. (2022). First release and establishment of the biological control agent *Cecidochares connexa* for the management of *Chromolaena odorata* (L.) R.M. King & H. Rob (chromolaena) in Australia. In: Proceedings of the 22nd Australasian Weeds Conference. C. Brodie, J. Emms, L. Feuerherdt et al., eds. Weed Management Society of South Australia Inc., Adelaide, South Australia. pp. 238-241.

21. Biological control compendium

Project dates

July 2022 – July 2025

Project team

Kelli Pukallus

Project summary

A biological control agent compendium will be compiled for agents released within Queensland for the management of invasive weeds. The compendium will include agent biology information, identification and history. It will also include agent locations utilising data shared on open digital platforms to enable field collections and redistribution of agents by landholders and local government staff and release procedures.

There have been 122 entries made into the digital platform iNaturalist, comprising 19 biological control agents and three weed species, with more to follow based on field surveys. These data transfer into Atlas of Living Australia, an additional open catalogue resource of biodiversity data. This will assist with the identification, location and noted impact of biological control agents within Australia.

Fact sheet templates of new and previous biological control agents have been developed, to be incorporated into the Compendium and are available for printing.

22. Biological control of parkinsonia (*Parkinsonia aculeata*) with *Eueupithecia vollonoides (*UU2)

Project dates

February 2020 – June 2024

Project team

Kelli Pukallus and Mary Butler

Project Summary

Parkinsonia aculeata is a woody invasive weed species found throughout northern Australia. Previous biological control projects involved the mass-rearing of *Eueupithecia cisplatensis*

(UU). On completion of the four-year project, over 248,000 *E. vollonoides* (UU2) pupae were released into 89 sites across Queensland, Northern Territory and Western Australia.

The project assisted with studies on monitoring and pheromone trapping of *Eueupithecia species* within several locations across northern Queensland and provided pupae for research within Australia and New Zealand. TWRC reared UU2 and field collected UU larvae were provided for research. This project was conducted with funding from MLA and CSIRO.

Collaborators

- CSIRO, Brisbane
- Meat and Livestock Australia
- University of Queensland
- Mount Isa City Council
- Central Highlands Regional Council
- Flinders Shire Council
- Richmond Shire Council
- Cloncurry Shire Council
- Isaac Regional Council
- Barcaldine Regional Council
- Charters Towers Regional Council
- Longreach Shire Council
- Livingstone Shire Council
- Mount Isa Water Board
- Northern Territory Department of Environment, Parks and Water Security
- Malak Malak Lands Trust
- Western Australian Department of Primary Industries and Regional Development
- Kimberley Rangelands Biosecurity Association
- Biosecurity Officers
- Fitzroy Basin Association
- McKinlay Shire Council
- Townsville City Council

Key publications

Murray,C., Walter, G. and Rafter, M. (2022). Pheromone trapping for monitoring the establishment and spread of *Eueupithecia cisplatensis* and *E. vollonoides*, biological control agents for *Parkinsonia aculeata*. In: *Proceedings of the 22nd Australasian Weeds Conference*. C. Brodie, J. Emms, L. Feuerherdt et al., eds. Weed Management Society of South Australia Inc., Adelaide, South Australia, p237.

Rafter, M., McKay, F., Parisi, M., Sosa, A., Heard, T., White, A., Fichera, G., Brookes, D., Nagalingam, K., Kaye, L., Sathyamurthy, R. (2022). Biology, host specificity and DNA barcoding of cryptic *Eueupithecia species* (Lepidoptera: Geometridae), and implications for biological control of *Parkinsonia aculeata* (Fabaceae) in Australia. *Austral Entomology*, 61(1):8.

Rafter, M. A., **Pukallus, K.**, Wenting, S., Walter, G. H. & White, A. (2022). Parkinsonia biological control: Establishment, spread and impact of UU1 and UU2 across northern Australia. In: Proceedings of the 22nd Australasian Weeds Conference. Eds. Brodie, C., Emms, J., Feuerherdt, L., Ivory, S., Melland, R., Potter, S., Weed Management Society of South Australia Inc., Adelaide, South Australia, p236.

23. Sicklepod ecology and control

Project dates

January 2016 – June 2027

Project team

Melissa Setter and Stephen Setter

Project summary

Sicklepod (*Senna obtusifolia*) is a serious weed of many parts of northern Queensland from Cape York to Mackay, and in many situations, including pastures, crops, road and power corridors and creek banks. It degrades riparian zones and pasture systems reducing biodiversity and beef production.

The project aims to improve management tools for sicklepod by investigating: seed production and longevity, pre-emergent herbicide efficacy, and low-volume/high-concentration herbicide application techniques.

Pre-emergent herbicide efficacy research in the Dry Tropics has been completed, and efficacious herbicides and rates identified. This is being presented initially at the Australian Weeds Conference in 2024. Pre-emergent herbicide efficacy research in the Wet Tropics has now commenced. Seed longevity continues to be monitored. To date there is still some seed surviving after eight years buried in soil in the Wet Tropics.

Figure 25 Establishing pre-emergent herbicide trial plots in sicklepod near Yalboroo (north of Mackay).

Figure 26 Brush-cutting between sicklepod plots at Mossman.

Collaborators

- Biosecurity officers
- Biosecurity Queensland research officers and centres officers
- Local governments in northern Queensland (e.g. Cook Shire Council, Douglas Shire Council, Cassowary Coast Regional Council, Hinchinbrook Shire Council, Mackay Regional Council)
- Queensland Parks and Wildlife Service
- Landholders

Key publications

Setter, **M.J.**, **Setter**, **S.D.**, Higgins, D. & **Vogler**, **W**. (2019). Controlling weed recruitment in isolated areas of Cape York Peninsula, Proceedings of the 1st Queensland Pest Animal and Weed Symposium, Ed. T. Sydes, (Weed Society of Queensland Pty. Ltd.), Gold Coast, May 2019. (Oral Presentation)

24. Aquatic weeds of northern Australia—ecology and control

Project dates

January 2015 – June 2026

Project team

Melissa Setter and Stephen Setter

Project summary

Aquatic weeds are an increasing problem, especially with the increase in commercial trade of aquatic plants, particularly via the internet. Several escaped aquarium plants are markedly problematic in the Wet Tropics but have potential distributions across large parts of northern Australia. These include Hygrophila (*Hygrophila costata*), Bogmoss (*Myacca fluviatilis*), Amazonian frogbit (*Limnobium laevigatum*) and Aleman grass (*Echinochloa polystachya*).

This project addresses specific ecological questions to improve management of current infestations and predict/restrict further infestations. Control options will also be investigated for selected species. Specifically, currently planned research includes:

- Seed and vegetative reproduction in regional populations of hygrophila.
- Herbicide control of bogmoss.
- Seed viability and longevity in regional populations of Amazonian frogbit.
- Seed presence, viability and longevity in regional populations of Aleman grass.

Bogmoss herbicide control research has been completed and presented at the 2023 Queensland Weed Symposium along with research into herbicide control of Aleman grass. No viable hygrophila seed was found and the value of continuing this research is being evaluated. No fruiting bodies of Amazon frogbit were found in North Queensland and arrangements are being made to use fruits from southern Queensland for future research. This will entail seed longevity studies in fresh, salt and brackish water to assist with understanding dispersal mechanisms.

Collaborators

- Biosecurity officers
- Far North Queensland Regional Organisation of Councils
- Terrain NRM
- Cairns Regional Council
- Cassowary Coast Regional Council
- Hinchinbrook Shire Council

Key publications

Setter, **M**., **Setter**, **S**., **Vogler**, **W**. & **Warren**, **C**. (2023). Effect of Foliar Herbicides and Nemo® Wetter on Aleman grass (*Echinochloa polystachya*) in north Queensland, Australia. In: Proceedings of the Queensland Pest Animal and Weeds (PAWS) Symposium, Dalby, Queensland. pp 104-109 (Speed presentation and poster).

Setter, **S**., **Setter**, **M**. & **Vogler**, **W**. (2023). Effect of Foliar Herbicides on Emergent Bogmoss (*Mayaca fluviatilis* Aubl.) in north Queensland, Australia. In: Proceedings of the Queensland Pest Animal and Weeds (PAWS) Symposium, Dalby, Queensland. pp 228-234 (Poster Presentation).

Setter, **S**., **Setter**, **M**. & **Vogler**, **W**. (2022). Survival of tropical weed species propagules after immersion in fresh, brackish and salt water. In: Proceedings of the 22nd Australasian Weeds Conference. C. Brodie, J. Emms, L. Feuerherdt et al., eds. Weed Management Society of South Australia Inc., Adelaide, South Australia. pp. 287-290. (Poster Presentation).

25. *Harrisia martinii* biological control and integrated management

Project dates

July 2020 – June 2024

Project team

Tamara Taylor, Lauren Kelk and Katrina Hodgson-Kratky

Project summary

Harrisia continues to spread in density and geographic extent across Queensland and into New South Wales, affecting grazing livestock health, the movement of native species, native vegetation in National Parks, and public amenity in parks and natural areas. Although the current biological control agent, the Harrisia mealybug (*Hypogeococcus pungens*), has shown greater effectiveness with impact on Harrisia health this year—potentially due to increased rainfall and humidity—additional measures are needed to further control Harrisia infestations.

Our research this year included finalising several studies: the impact of sheep grazing on Harrisia density in Goondiwindi and the short and long-term effects of using fire as a control method, motion-detecting camera analyses of vertebrate animals interacting with Harrisia cactus, and an assessment of seed viability after consumption by potential dispersers. Additionally, we quantified the presence of another biological control agent, *Tucumania tapiacola* (stem-feeding moth), which complements the effect of the Harrisia mealybug. Results from these studies, along with a summary of herbicide options and landowner interviews, will be compiled into a new Harrisia cactus integrated management manual, expected to be released by the end of 2024.

Figure 27 (L) Damage to a Harrisia martinii stem caused from feeding by Dasiops bourquini fly larvae in Argentina. (R) Attempting to get the emerged adult D. bourquini flies to mate and lay eggs on a Harrisia plant in the UNNE laboratory in Argentina.

Meanwhile, our collaborators in the native range of *Harrisia martinii*, at UNNE (Universidad Nacional del Nordeste) in Corrientes, Argentina, are progressing with alternative biological control agents. The planned importation of the biocontrol agent *Nealcidion cereicola* (a stem-feeding Cerambycid beetle) has been delayed until late 2024 due to travel restrictions that prevented fieldwork in 2023. Collection sites have now been identified, and a field trip to collect the beetles is scheduled for November 2024. In March 2024, UNNE successfully collected the stem-feeding fly *Dasiops bourquini* in Formosa, obtaining two stems with live fly larvae that produced 50 adult flies. As predicted, there were issues with mating, and the flies did not reproduce in the cage provided in the laboratory. UNNE is constructing new rearing cages and hope for better results with future collections.

During their investigations, UNNE researchers worked at night due to daytime temperatures reaching up to 50°C, which rendered insects difficult to find. Night collections revealed a range of potentially damaging insects that could serve as biological control agents for Australia. The researchers are currently identifying these species to evaluate their host specificity to Harrisia cactus and determine if they are suitable for import into quarantine in Australia for further testing.

Figure 28 Combination of damage from sheep feeding, Harrisia mealybug and Tucumania moth.

Collaborators

- John Conroy, Megan Leech and Ted Vinson (Biosecurity Queensland, Operations Team)
- Kelli Pukallis (Biosecurity Queensland, Tropical Weed Research Centre)
- Angela Ezeh (University of Queensland)
- NSW Department of Primary Industries

- Debi Bancroft (Northern Slopes Landcare Association)
- Goondiwindi Regional Council
- Robert (Doughy) Deans, Goondiwindi
- CONICET – CECOAL – Universidad Nacional del Nordeste (UNNE), Argentina

Key publications

Ezeh, A.E. (2024). *Herbivore-plant interactions: implications for the biological control of Harrisia martinii (Cactaceae) by Hypogeococcus species (Hemiptera: Pseudococcidae) in Australia*. PhD Thesis, University of Queensland.

Ezeh, A.E., Hereward, J.P., **Day**, **M.D**., **Taylor**, **T**. & Furlong, M.J. (2023). Confirming the identity of the Hypogeococcus species (Hemiptera: Pseudococcidae) associated with *Harrisia martinii* (Labour.) Britton (Cactaceae) in Australia: implications for biological control. *Austral Entomology*, 62(2), 235-245.

Taylor, **T**.**K**., **Kelk**, **L**., **Conroy**, **J**. (2023). Integrated management of Harrisia cactus – Can livestock help? *Conference Proceedings: 2nd Pest Animal and Weed Symposium*, p. 76-85. Available at: https://icebergevents.eventsair.com/paws2023/proceedings

26. Biological control of pasture weeds in Vanuatu and Queensland

Project dates

October 2018 – June 2024

Project team

Tamara Taylor and Lauren Kelk

Project summary

Biosecurity Queensland have been collaborating with Manaaki Whenua Landcare Research (MWLR) New Zealand over the last six years on a project that aims to find biological control solutions for pasture weeds in Vanuatu. The weeds selected for research also occur in Queensland. The project is funded by the New Zealand Ministry of Foreign Affairs and Trade as part of an aid program that provides Pacific Island countries with assistance to support their grazing industries. This collaboration has resulted in valuable progress toward finding biological control agents that can be used in Australia.

Over the last six years we have been working on finding biological control agents for sicklepod (*Senna obtusifolia* and *S. tora*). We provided samples of sicklepod from various populations in Queensland to MWLR, which were included in a large genetic study of sicklepod across the world. The results indicate that *Senna obtusifolia* in Queensland are closely related to those in Vanuatu and Malaysia. Malaysia is not considered to be in the native range of the species and therefore not likely to have co-evolved natural enemies that will be helpful in controlling sicklepod in Australia or Vanuatu. Field studies conducted by the Malaysian Agricultural Research and Development Institute confirmed that nothing useful could be found in Malaysia. The native range of sicklepod is thought to be Central and South America. Genetic analysis determined that the most closely related populations in the native range, compared with both Queensland and Vanuatu populations, were from the Caribbean (samples from the Dominican Republic), Central America (samples from Costa Rica & Nicaragua) and South America (samples from Brazil). Therefore, natural enemies of sicklepod from these regions are most likely going to have an impact on sicklepod in both Vanuatu and Queensland.

A staff member from QDAF travelled to the Dominican Republic in December 2023 to collect the larvae of the stem-feeding moth, *Anabasis ochrodesma*. High levels of damage to all plants observed in the Dominican Republic included mortality of leaves from larval feeding and leaf tying, as well as larval feeding within the stems which killed stem tips. This damage resulted in sicklepod plant growth restricted to 30-45cm in height, compared with sicklepod plant heights of over 1.5m often observed in Australia. The importation of the moth larvae and subsequent establishment of a colony in quarantine was very successful. The first non-target plant species tested was *Senna gaudichaudii*, as this species occurs in both Queensland and Vanuatu. Unfortunately, the moth was able to feed and reproduce on this first host test species, indicating that *A. ochrodesma* is not host specific and can't be used as a biological control agent for sicklepod in Australia. The moth colony has been terminated in quarantine and arrangements are now underway to find an alternative agent.

Figure 29 Feeding and leafy tying impact on sicklepod by Anabasis ochrodesma (moth larvae) in the Dominican Republic.

Figure 30 Anabasis ochrodesma feeding damage on sicklepod in QDAF quarantine glasshouse.

Collaborators

- Manaaki Whenua Landcare Research, New Zealand
- Ministry of Foreign Affairs and Trade, New Zealand
- Biosecurity Vanuatu
- Department of Environment, Vanuatu
- Michael Day (Entomologist and Biological Control Consultant, QDAF Honorary)
- Malaysian Agricultural Research and Development Institute
- Kelvin Guerrera (Environmental Consultant Biologist & Entomologist, Dominican Republic)

Key publications

Cock, M.J.W. & Evans, H.C. (1984). Possibilities for biological control of *Cassia tora* and *C. obtusifolia*. *Tropical Pest Management*, 30: 339-350.

Palmer, W.A. & Pullen, K.R. (2001). The phytophagous arthropods associated with *Senna obtusifolia* (Caesalpiniaceae) in Mexico and Honduras and their prospects for utilization for biological control. *Biological Control* 20: 76–83.

Palmer, W.A., Heard, T.A., Sheppard, A.W. (2010). A review of Australian classical biological control of weeds programs and research activities over the past 12 years. *Biological Control*, 52 (3): 271-287.

27. Giant rat's tail grass classic biological control

Project dates

July 2022 – June 2024

Project team

Tamara Taylor, David Comben and Lauren Kelk

Project summary

Sporobolus natalensis and *S. pyramidalis* grasses (GRT) are classified as restricted invasive plants under the Biosecurity Act 2014. Originating from Africa, giant rat's tail grass is a tall, upright grass forming large tussocks. Like other weedy Sporobolus species, it aggressively competes with native flora and valuable fodder species, reducing pasture productivity and degrading natural habitats. Traditional control methods have proven challenging, prompting land managers to seek alternative solutions, including biological control.

Efforts to find effective insect biological control agents for GRT have been ongoing since initial surveys in South Africa in 2001/2002. Two species of wasp (*Tetramesa* sp. A & B) were identified as promising natural enemies with larvae that feed within the grass stems, impacting stem growth and flowering. Subsequent field studies in South Africa from 2016 to 2022 confirmed these wasps were only found on the target GRT species. In addition, laboratory testing found that *Tetramesa* A & B were only able to complete development on GRT and not on any of 24 other grass species from South Africa. Following these findings, arrangements were made to import the wasps into QDAF quarantine in Brisbane for further testing on native Australian and economically important grasses. The first two importations of GRT stems in 2023 did not yield sufficient adult wasps to produce laboratory colonies. In November 2023, a QDAF staff member supervised a successful third collection and importation from South Africa, resulting in adequate numbers of live wasps that initially reproduced in the laboratory.

However, the rearing of *Tetramesa* wasps from GRT in laboratory conditions has proven exceedingly difficult. Despite extensive efforts by qualified entomologists in South Africa, sustained breeding success has never been achieved. Our own attempts included using various methods and environmental adjustments, but after three generations, the laboratory colony eventually dwindled and perished. We were able to use some of our last female wasps that could not be used for the colony to test whether they would lay eggs that could develop to adulthood on one Australian grass species. Although these females were unmated, females of this species can lay unfertilised eggs through a process called parthenogenesis. For *Tetramesa* sp. (GRT), all of the progeny produced via parthenogenesis are male. The females did lay eggs which developed to adulthood on our single native grass plant, producing one male wasp. This does not bode well for the potential of *Tetramesa* sp. (GRT) to be suitable for release in Australia, but more testing would need to be done to confirm this result. Discussions are ongoing to determine the future direction of classic biological control research for GRT using *Tetramesa* sp., given these challenges.

Figure 31 GRT stem with Tetramesa wasp.

Figure 32 A QDAF researcher collecting GRT from a roadside in South Africa.

Figure 33 QDAF staff and the team from Rhodes University South Africa assisting with the collection and packaging of GRT stems for export to Australia.

Collaborators

- Rhodes University, South Africa
- AgriFutures Australia

- Meat and Livestock Australia
- Australian Department of Agriculture, Fisheries and Forestry

Key publications

Sutton, G.F. (2021). Prioritising biological control agents for release against *Sporobolus pyramidalis* and *Sporobolus natalensis* (Poaceae) in Australia. Doctoral dissertation, Rhodes University.

Sutton, G.F., **Day**, **M.D**., Canavan, K. & Paterson, I.D. (2023). Anthropogenic disturbance affects specialist, but not generalist, endophagous insects associated with two African grasses: implications for biological control. *Biocontrol Science and Technology*, 33(11): 1051-1064.

van Steenderen, C.J., Sutton, G.F., Yell, L.D., Canavan, K., McConnachie, A.J., **Day**, **M.D**. & Paterson, I.D. (2023). Phylogenetic analyses reveal multiple new stem-boring Tetramesa taxa (Hymenoptera: Eurytomidae): implications for the biological control of invasive African grasses. *BioControl*, 68(6), 697-708.

28. Chemical registration – providing tools for weed control

Project dates

July 2012 – June 2025

Project team

Joe Vitelli, Katrina Hodgson-Kratky and David Holdom

Project summary

Biosecurity Queensland holds permits for the use of pesticides to control invasive plants. The need for permits has increased as pesticide registrants focus primarily on more profitable crop protection rather than environmental protection, resulting in reduced availability for controlling invasive species outside of crops.

Ten weed permits were issued to Biosecurity Queensland in 2023–24 by the Australian Pesticides and Veterinary Medicines Authority (APVMA). These permits provide herbicide control options for weeds such as witchweed, thunbergia, calotrope, cacti, gamba grass, rat’s tail grasses, African fountain grass, perennial mission grass, Siam weed and kudzu.

Control recommendations are provided in pest fact sheets (https://www.daf.qld.gov.au/business-priorities/biosecurity/invasive-plants-animals/fact-sheets) that are regularly updated.

Collaborators

- Local governments
- Seqwater
- Sumitomo Chemical
- Nufarm Australia

- Macspred
- Corteva
- Department of Environment and Science, Ecosciences Precinct
- Sonia Jordan, Steve Csurhes, Craig Hunter, Michael Graham, Lyn Willsher, Tobias Bickel and Michelle Smith (Biosecurity Queensland)
- Marie Bigot (CSIRO)

Figure 34 Spraying Amazon frogbit with a flumioxazin herbicide at the Wappa Dam to generate efficacy data for the renewal of permit PER91744.

Key publications

APVMA (2022) PER11463: Permit to allow minor use of picloram, triclopyr, aminopyralid, imazapyr, glyphosate, 2,4-D, fluroxypyr and many other herbicides for control of environmental weeds in non-crop areas. Issued 14 April 2022.

APVMA (2022) PER91744: Permit to allow minor use of a flumioxazin and glyphosate with Bonus or Nemo surfactants for control of Amazon frogbit in non-potable and offline potable waterways associated with Wappa Dam. Issued 29 September 2022.

APVMA (2023) PER14357: Permit to allow minor use of imazapyr, dicamba, triclopyr, glyphosate and other herbicides for control of *Striga* species. Issued 23 August 2023.

APVMA (2023) PER87689: Permit to allow minor use of glyphosate for control of various weeds on assets and embankments of water storage facilities. Issued 24 October 2023.

APVMA (2023) PER89485: Permit to allow minor use of Imazapyr, metsulfuron-methyl, hexazinone and tebuthiuron for control of calotrope in various situations. Issued 14 September 2023.

APVMA (2023) PER90719: Permit to allow minor use of amitrole, ammonium thiocyanate, MSMA, triclopyr, aminopyralid and picloram for control of introduced cacti in various situations. Issued 4 December 2023.

APVMA (2023) PER10557: Permit to allow minor use of imazapyr for control of thunbergia in specified non-crop situations. Issued 15 December 2023.

APVMA (2024) PER94351: Permit to allow minor use of flupropanate for control of various grasses in pastures and various non-crop situations. Issued 3 May 2024.

APVMA (2024) PER11833: Permit to allow minor use of picloram, triclopyr, aminopyralid, metsulfuron-methyl, glyphosate and fluroxypyr for control of Siam weed in agricultural non-crop areas, commercial and industrial areas, forests, pastures and rights-of-way. Issued 6 June 2024.

APVMA (2024) PER14849: Permit to allow minor use of imazapyr, picloram, triclopyr, aminopyralid, metsulfuron-methyl, glyphosate, clopyralid and fluroxypyr for control of kudzu in non-agricultural areas, native vegetation and pastures. Issued 7 June 2024.

APVMA (2024) PER92465: Permit to allow minor use of picloram, triclopyr, metsulfuron-methyl and imazapyr for control of cacti in various situations. Issued 14 June 2024.

APVMA (2024) PER92475: Permit to allow minor use of picloram, triclopyr, aminopyralid, metsulfuron-methyl and glyphosate for control of cacti in various situations. Issued 14 June 2024.

29. Treatments and strategies for red witchweed eradication

Project dates

July 2014 – June 2025

Project team

Joseph Vitelli, Katrina Hodgson-Kratky, Bahar Farahani and Melissa Brien

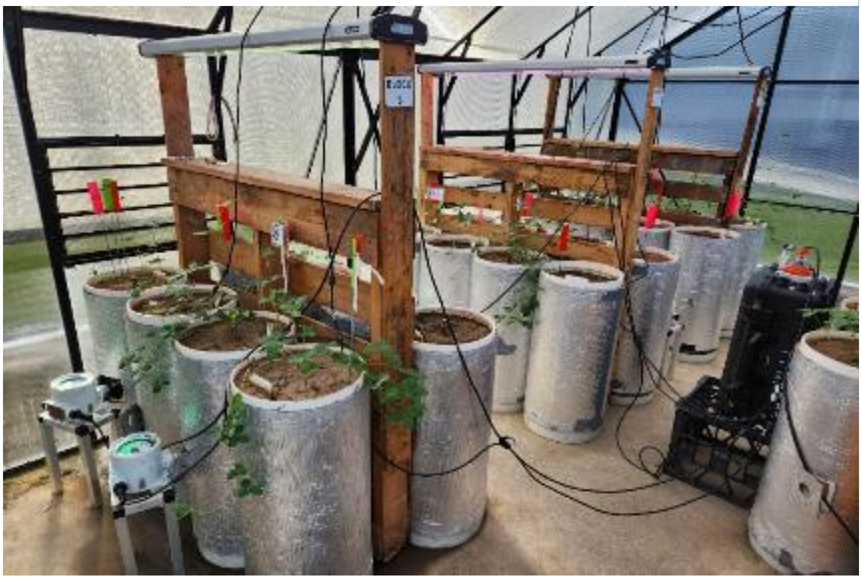
Project summary

Red witchweed (RWW) is a national eradication target that was first discovered in Australia in 2013 on a sugarcane-growing property west of Mackay in 2013. As a parasite of several grass and legume crops, it has the potential to cause significant losses for the agricultural industry if allowed to spread. Over the last ten years, the eradication program has been treating infested properties to reduce the soil seed bank and prevent further seed production. The aims of this project are to optimise the seed bank depletion treatments and monitor the seed bank at the infested sites to assess the program's progress towards eradication.

Monitoring the RWW soil seed bank proved difficult because the seeds are very small and difficult to identify in soil samples. Instead, monitoring occurred on RWW seeds that were buried in plastic sachets inside perforated canisters across the active eradication management zone. Seeds were exhumed each year and tested for viability. Less than 1% of seeds exhumed in early 2024 were viable, suggesting that the treatments have been effective at reducing the soil seed bank. These results have provided evidence to support the release of land from quarantine, with about 50% of paddocks released so far.

A pot trial was also conducted over 4 years at the Ecosciences Precinct to optimise seed bank depletion treatments used in the eradication program. Treatments included soil fumigation with ethylene and dazomet and the use of a false host crop to stimulate suicidal germination. A combination of all three treatments has so far provided the highest reduction in seed viability. The trial has concluded, although seed processing and viability testing is ongoing.

Figure 35 Pot trial at the Ecosciences Precinct optimising soil seed bank depletion treatments to eradicate red witchweed.



Collaborators

- Local governments
- Michelle Smith, Matt Birch and Tom Bowditch (Biosecurity Queensland)
- University of Queensland

Key publications

Epée, M., Paul,T. (2018). Comparative analysis on the management of the parasitic weed *Striga* in the USA, Australia and Kenya. Available at SSRN: https://ssrn.com/abstract=3231805 or http://dx.doi.org/10.2139/ssrn.3231805

Eplee, R.E. (1992). Witchweed (*Striga asiatica*): An overview of management strategies in the USA. *Crop Protection, 11*, 3-7. doi: https://doi.org/10.1016/0261-2194(92)90071-C

Williams, A.M., Riding, N. & **Vitelli**, **J**.**S**. (2022). Monitoring *Striga asiatica* (Orobanchaceae) seedbank for eradication success, Paper presented at the 22nd Australasian Weeds Conference, Adelaide, South Australia. http://era.daf.qld.gov.au/id/eprint/10923/

30. Improved control strategies and methods for leucaena

Project dates

July 2023 – December 2026

Project team

Joseph Vitelli, Katrina Hodgson-Kratky, Bahar Farahani, Melissa Brien and Clare Warren

Project summary

Leucaena is a forage crop that has become a major environmental weed in tropical and sub-tropical Australia. The management of leucaena is problematic, with limited cost-effective control options for dense infestations and a long-lived seed bank that results in heavy regrowth following above-ground control. This collaborative project led by the University of Queensland (UQ) will evaluate a range of control techniques and strategies for different life stages of leucaena and in different environments.

UQ PhD students, Caian Oliveira and Alexander Leslie, have ongoing trials in Gatton evaluating the effects of pre and post-emergent herbicides on seedlings and mature trees. A pot trial will also commence at the Ecosciences Precinct in mid-2024 to evaluate the efficacy of a soil fumigant, dazomet, for reducing the leucaena soil seed bank.

Trials to refine herbicide rates, determine optimal herbicide application timing and compare economic feasibility of application methods are also being planned. Additionally, the effectiveness of fire for controlling leucaena and competitiveness of improved pasture grasses against leucaena will be assessed in future trials.

Figure 36 Leucaena pre-emergent herbicide trial at the University of Queensland in Gatton conducted by a PhD student.

Figure 37 Leucaena post-emergent herbicide trial at the University of Queensland in Gatton conducted by a PhD student. Untreated trees (right) and trees 2 months after various herbicide treatments (left).

Collaborators

- Caian Oliveira, Alexander Leslie and Shane Campbell (The University of Queensland, School of Agriculture & Food Sciences)
- Eric Dyke and Glenn Proctor (Bundaberg Regional Council)

Key publications

Campbell, S., **Vogler, W.**, **Brazier**, **D**., **Vitelli, J.** & **Brooks, S.** (2019). Weed leucaena and its significance, implications and control. *Tropical Grasslands—Forages Tropicales*, *7*(4), 280-289. doi:https://era.daf.qld.gov.au/id/eprint/7107/

31. Management of giant rat's tail grass using wick wipers

Project dates

February 2017 – June 2024

Project team

Joseph Vitelli, Katrina Hodgson-Kratky, Bahar Farahani and Melissa Brien

Project summary

Giant rat's tail grass (GRT) and the other introduced weedy *Sporobolus* grasses are unpalatable, perennial, tussock-forming grasses of serious concern to the grazing industry across eastern Australia. Herbicide application with wick wipers is a useful method for controlling GRT in pastures and is being increasingly used by landholders.

This project aims to optimise wick wiper application and the integration of this method with other management approaches.

A trial is ongoing at a grazing property in Mapleton combining wick wiper application of a flupropanate and glyphosate herbicide mixture with fertiliser application. Previous research has suggested that fertilising may enhance GRT forage quality to encourage GRT utilisation, although in this trial, no significant differences have been observed with the addition of fertiliser. Wick wiping, however, was successful in reducing the GRT population and increasing the population of Setaria and other pasture species in the current trial.

Figure 38 Trial in Mapleton to assess the effect of wick wiper application of flupropanate and glyphosate herbicide combined with fertiliser application to manage GRT.

Collaborators

- Drew Rapley, Tom Cowan and Shane Campbell (University of Queensland)
- Peter Thompson (property manager, Elgin, Conondale)

Key publications

Campbell, S.D., Oudyn, F., Campbell, R., Crossing, M., Connolly, A., Harper, K., **Vogler**, **W**., Martin, S. & **Vitelli, J.S.** (2022). *Herbicide and fertilizer application trials to improve production in Giant rat's tail grass (GRT) infested pastures*, Paper presented at the 21st Australasian Weeds Conference, Sydney, New South Wales. https://era.daf.qld.gov.au/id/eprint/9132/

Rapley, D. (2020). *The biology of* Ustilago sporoboli-indici *and its potential role in integrated management of weedy Sporobolus grasses in Australia*, Honours thesis, University of Queensland.

32. Native and introduced pathogens of giant rat's tail grass

Project dates

February 2019 – June 2027

Project team

Joseph Vitelli, Katrina Hodgson-Kratky, Bahar Farahani and Melissa Brien

Project summary

Giant rat's tail grass (GRT) and the other introduced weedy *Sporobolus* grasses are unpalatable weeds of rangelands that cause significant losses for the pastoral industry each year. Fungal biological control (biocontrol) agents are under development for integration with current practices to improve GRT management.

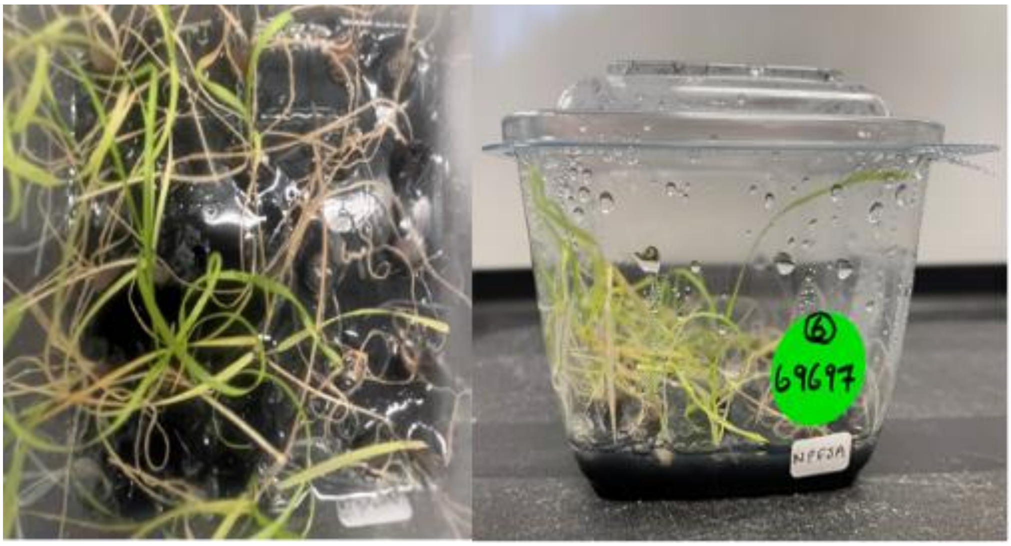
The aims of this project are to assess the suitability of endemic and naturalised fungal pathogens to control GRT.

Eight endemic fungal pathogens that were collected from diseased *Sporobolus* tissues during Australian field surveys have been prioritised as candidates for mycoherbicide development. These isolates caused significant damage to GRT seedlings in the lab and testing will continue in the glasshouse to determine their impact on weedy *Sporobolus* and non-target species.

The naturalised GRT leaf smut (*Ustilago sporoboli-indici*) pathogen is another promising control agent for GRT because it causes sterility and appears to be host-specific in the field. Field surveys are ongoing to confirm that it does not significantly impact non-target native and introduced pasture species. If host-specificity is confirmed, the effect of environmental conditions on leaf smut infection in GRT will be tested in the lab to establish guidelines on optimising its spread as a biocontrol agent.

Figure 39 Sporobolus spp. recently infected with GRT leaf smut in a growth facility at the Ecosciences Precinct.

Figure 40 Above (left) and front (right) views of weedy Sporobolus seedlings infected with a candidate fungal biocontrol agent in a sterile environment.



Collaborators

- Australian Department of Agriculture, Fisheries and Forestry
- AgriFutures Australia
- New South Wales Environmental Trust
- NSW Biocontrol Taskforce

- Bundaberg Regional Council (including Eric Dyke and James Anderson)
- Gympie Regional Council
- HQ Plantations Pty Ltd
- AgForce Queensland
- Eloise Martin, Nontaporn Kukuntod, Drew Rapley, Brooke Johnstone and Shane Campbell (The University of Queensland, School of Agriculture & Food Sciences)
- Tracey Steinrucken (CSIRO)
- Roger Shivas (University of Southern Queensland)
- Kaylene Bransgrove and Yu Pei Tan (DAF Plant Biosecurity and Product Integrity)
- David Officer (NSW Department of Primary Industries)
- Melodina Fabillo (Queensland Herbarium)

Key publications

Steinrucken, T.V., **Vitelli**, **J**.**S**., **Holdom**, **D**.**G**. & Tan, Y.P. (2022). The diversity of microfungi associated with grasses in the Sporobolus indicus complex in Queensland, Australia. *Front Fungal Biol*. doi: 10.3389/ffunb.2022.956837.

Steinrucken, T.V. & **Vitelli**, **J**.**S**. (2023). Biocontrol of weedy *Sporobolus* grasses in Australia using fungal pathogens. *BioControl*, *68*(4), 341-361. doi: https://doi.org/10.1007/s10526-023-10195-5

33. Management of sticky florestina

Project dates

July 2022 – June 2025

Project team

Wayne Vogler and Clare Warren

Project summary

Sticky florestina (*Florestina tripteris*) is an annual plant from semi-arid North America that was introduced to central-western Queensland anecdotally in the 1960s and reported as a pest in the late 1980s. Much of central, western and southern Queensland is highly suitable for florestina and improved management options are needed to reduce future potential negative impacts to production and the environment. The project assesses herbicide and integrated management options for sticky florestina in central west Queensland, including along roadsides, pasture and environmental areas. The project also examines aspects of the biology of florestina.

A seed buoyancy study has been completed. Under highly agitated water conditions it can take up to three days for all seed to sink indicating the potential for long distance dispersal in flowing water.

The viable seed bank in dense florestina infestations has been estimated at 27,000 per m^2. After one year of seed burial 70% of seed remained viable indicating that the seed bank may be relatively persistent. Seed is relatively susceptible to dry heat with all seed killed by heating at 125 ^oC for 15 seconds indicating that prescribed burning of pastures could significantly reduce the surface seed bank and assist with long term management.

Figure 41 Typical roadside florestina infestation in central western Queensland (L) Flowers and mature seed of florestina (R).

Collaborators

- Longreach Regional Council
- Central West Regional Pest Management Group
- Remote Area Planning and Development Board (RAPAD)

Key publications

McKenzie, J., **Brazier**, **D**., Campbell, S., **Vitelli**, **J**., Anderson, A & Mayer, R. (2014). Foliar herbicide control of sticky florestina (*Florestina tripteris* DC.), *The Rangeland Journal*, 36: 259-265.

Soto-Trejo, F., Schilling, E.E., Oyama, K, Lira, R. & Davila, P. (2016). A taxonomic revision of the genus *Florestina* (Asteraceae, Bahieae), *Phytotaxa*, 268 (2): 91-109.

34. Strategic invasive grass control to reduce risk of further invasion in northern Queensland

Project dates

July 2022 – June 2025

Project team

Wayne Vogler, Clare Warren, Melissa Setter and Stephen Setter

Project summary

Gamba grass, grader grass and giant rat's tail grass are serious invasive weeds in northern Australia causing large scale environmental damage and economic loss. In northern and eastern areas of Queensland, these high priority grasses are spreading from small early invasion infestations. The particular hotspots being targeted are Cape York, Atherton Tablelands, Yeppoon, Mackay, Whitsunday and Burdekin regions.

The project is engaging a range of land managers via linking with local governments to identify and control or eradicate strategic outlier infestations of these grass species on both private and publicly owned land.

Strategic infestations have been identified within the boundaries of the six local government collaborators. On ground activities have been defined for each grass species relevant to their situation and are continuing in all local government areas.

Control and monitoring activities have been conducted throughout 2023-24 at each identified infestation.

Figure 42 Cook Shire Council Gamba grass. Before treatment April 2023 (L), After treatment November 2023 (R).

Figure 43 Burdekin Shire Council grader grass. Before treatment March 2023 (L), After treatment February 2023 (R).

Collaborators

- Burdekin Shire Council, Cook Shire Council, Livingstone Shire Council, Mackay Regional Council, Tablelands Regional Council and Whitsunday Regional Council.

Part 2: Pest animal management

35. Refining management of feral deer in Queensland

Project dates

July 2020 – June 2024

Project team

Matt Amos, Michael Brennan, Tony Pople and Cameron Wilson

Project summary

Feral deer populations continue to increase and spread in Queensland, posing increasing risks to communities, agriculture and the environment. Information on best practice control methods and monitoring remains limited, and efficacy of control tools are not well known.

This project is assessing, documenting and disseminating information on the cost-effectiveness and feasibility of control and monitoring methods at five study sites in Queensland: Brisbane, North Pine Dam, Sunshine Coast, Yeppoon and Wild Duck Island. The first four sites require on-going control, but the last site provided an opportunity for eradication.

We have been monitoring a rusa deer population on Wild Duck Island with a camera grid in support of a Queensland Parks and Wildlife Service (QPWS) attempt to eradicate them on this environmentally important island. A 44 hexagonal camera grid monitoring array tracked the decline in estimated deer abundance down to the last deer in 2022. Following its removal, the camera grid provided proof of freedom in 2023/24. A total of 168 rusa deer were culled by QPWS between 2018 and 2024 and the probability of eradication was calculated at 99.4%.

Figure 44 The last rusa deer culled on Wild Duck Island showing unique hair whorls above eyes.

Collaborators

- Dave Forsyth, Sebastien Comte and Andrew Bengsen (NSW DPI)
- Steve Burke, Dan Williams and Jon Mills (Queensland Parks and Wildlife Service, Department of Environment and Science)
- Mark Kimber (Sunshine Coast Regional Council)
- Jess Doman and Perry Ward (Seqwater)
- Bill Manners, Dan Franks and Robyn Jones (Brisbane City Council)
- Darren Sheil (Moreton Bay Regional Council)
- Leise Childs, Dave Mitchell and John Wyland (Livingstone Shire Council)

Key publications

Amos, **M**., **Brennan**, **M**., **Pople**, **A**., Cathcart, T., Kimber, M., Wojtala, J., Doman, J., Manners, B., Franks, D., Jones, R., Childs, L., Mitchell, D., & Wyland, J. (2021). Broadscale monitoring of feral deer population trends and control effort in Queensland peri-urban environs, *18th Australasian Vertebrate Pest Conference*, Virtual, 25-27 May.

Amos, **M**., **Pople**, **T**., **Brennan**, **M**., Sheil, D., Kimber, M., Cathcart, A. (2023). Home ranges of rusa deer (*Cervus timorensis*) in a subtropical peri-urban environment in South East Queensland, *Australian Mammalogy* 45(1): 116-120. https://doi.org/10.1071/AM21052

Forsyth, D., Comte, S., Bengsen, A., Hampton, J. & **Pople**, **T**. (2023). Glovebox Guide to Managing Feral Deer, a PestSmart publication, Centre for Invasive Species Solutions, Canberra. https://pestsmart.org.au/wp-content/uploads/sites/3/2023/10/CISS-Glovebox-Guide-Feral-Deer-final.pdf

36. Monitoring and control methods for new vertebrate pests

Project dates

July 2023 – June 2025

Project team

Peter Elsworth

Project summary

New incursions of vertebrate pest species are a constant threat with the movements of goods and the increase in the illegal pet trade. Being able to quickly detect and find species in the wild will help to prevent the establishment of wild populations.

The project aims to review the biology and ecology of species with a high risk of incursion and establishment. Using this information, strategies to maximise detection and capture of these species in the wild will be developed, with critical knowledge gaps identified to guide research priorities.

High risk species have been prioritised, including, American corn snake, African pygmy hedgehog, Boa constrictor, squirrels, and iguanas. Detection and capture strategies have been identified for American corn snake and African pygmy hedgehog with the remaining species to be reviewed in the 2024/25 financial year.

Figure 45 American corn snakes and African pygmy hedgehogs would compete with and prey on native animals and spread diseases of livestock and humans if they became established in Queensland.

Collaborators

- Steve Csurhes, Duncan Swan and Matt Ryan (Biosecurity Queensland)

Key publications

ABARES. (2021). The National Priority List of Exotic Environmental Pests, Weeds and Diseases: Information Paper (Version 2.0), ABARES report to client prepared for the Chief Environmental Biosecurity Officer, Department of Agriculture, Water and the Environment, ACT. CC BY 4.0.

Bomford, M. (2008). Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand, Invasive Animals Cooperative Research Centre, Canberra.

37. Evaluating breeding success of wild rabbits in various harbour types

Project dates

July 2021 – June 2024

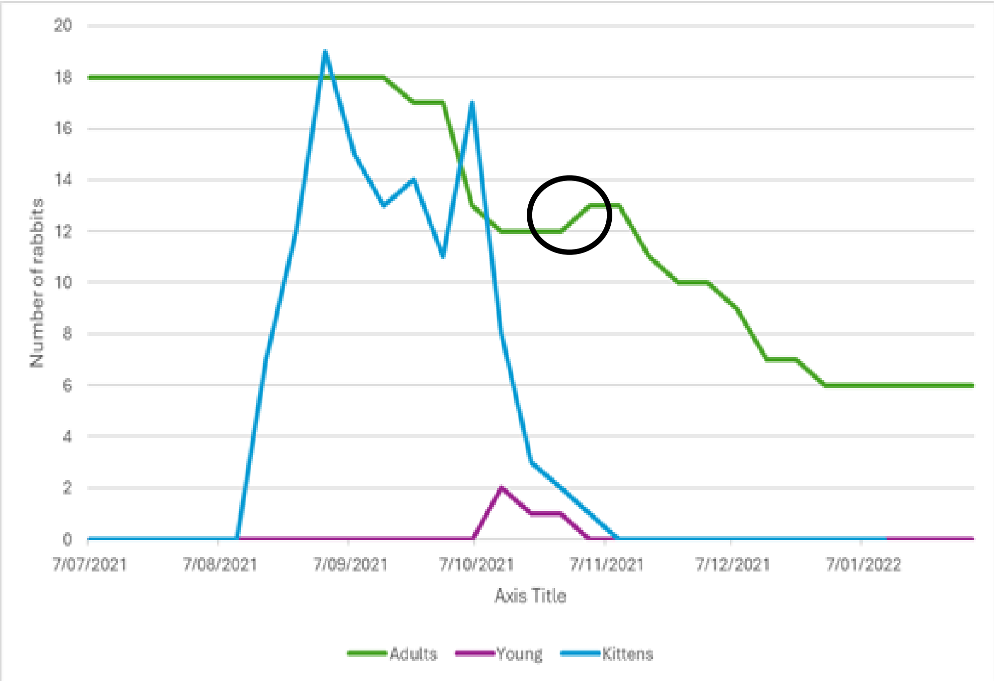
Project team

Peter Elsworth

Project summary

Harbour removal can be a very effective management tool for the control of rabbits. Removing breeding harbour prevents rabbit populations recovering after biocontrol virus outbreaks and harbour destruction reduces numbers. The project evaluated breeding success of rabbits, i.e., the number of kittens born that survive to adulthood, at three sites in the Southern Downs region where extensive harbour removal programs had reduced rabbit numbers and removed the best breeding locations. Remote cameras were deployed on remaining areas of possible breeding to capture images of all the rabbits using those locations. This allowed the population to be monitored through the breeding season to determine kitten emergence from burrows and survivorship of all rabbits.

Figure 46 Rabbit population at a site in Southern Downs Regional Council area showing numbers of kittens, young and adult rabbits through the 2021/22 breeding season. The circled area shows where one kitten survived to adulthood. Overall, the population declined by 66% despite 36 kittens being born.



Breeding success was very low in the remaining breeding harbour with only one kitten surviving to adult in each of two of the three sites evaluated. Overall, rabbit populations at the three sites declined by 75%, 66%, and 4.5% (95% following additional fumigation control) despite an average of 35 kittens born at each site.

Removal of key breeding harbour meant that remaining rabbits in lower quality breeding harbour had very low breeding success resulting in population decline. Population impacts could have been caused by predation (with kittens being preyed on caught on camera), weather conditions such as heavy rainfall, and biological control virus activity.

Figure 47 (Left) A rabbit escapes predation because it has a burrow for cover. (Right) No escape where burrows have been ripped (light grey soil pile).

Collaborators

- Darling Downs and Moreton Rabbit Board
- Southern Downs Regional Council
- Toowoomba Regional Council

Key publications

Berman, D., **Brennan**, **M**. & **Elsworth**, **P**. (2011). How can warren destruction by ripping control European wild rabbits (*Oryctolagus cuniculus*) on large properties in the Australian arid zone? *Wildlife Research*, 38: 77-88.

Cox, T.E., Ramsey, D.S.L., Sawyers, E., Campbell, S., Matthews, J. & **Elsworth**, **P**. (2019). The impact of RHDV-K5 on rabbit populations in Australia: an evaluation of citizen science surveys to monitor rabbit abundance. *Scientific Reports*, 9(1), 1–11.

Elsworth, **P**. (2023). Property-level rabbit control using harbour destruction restricts breeding success, Pest Animal and Weed symposium, Australia, Dalby, 28-31 August.

38. Testing management strategies for feral pigs

Project dates

June 2021 – June 2024

Project team

Matthew Gentle, Lana Harriott, Aiden Sydenham, Cameron Wilson, Peter Elsworth, James Speed, Catherine Kelly and Tony Pople

Project summary

Effective feral pig control is hampered through the inadequate coordination of efforts in time and space. Moreover, there is a need to optimise control and monitoring practices as supported by science-based information. This project aimed to improve the capacity for effective management of feral pigs in northern Australia through refining and testing optimised management and monitoring practices on demonstration sites in southern (Westmar) and northern (Collinsville) Queensland.

Conventional aerial (helicopter) surveys using standardised techniques were successful at Westmar (southern Queensland). However, a concurrent helicopter survey using a thermal camera offered increased detection of pig groups. A reduction in the survey height and speed and placement of transects in riverine habitats were required to improve the detection of feral pigs during helicopter surveys at Collinsville (northern Queensland).

Figure 48 Feral pigs, including one fitted with ear-tag (left) as recorded by a monitoring camera (right) at Westmar, southern Queensland.

At Westmar, a total of 5017 pigs were removed by helicopter shooting over the almost 2 year period (June 2022 – April 2024). Monitoring through aerial (helicopter) surveys and camera trapping indicated a dramatic ~82% and ~96% reduction (respectively) in the pig population from pre-control levels. At Collinsville, a total of 1079 pigs (2022, n= 607; 2023 n =472) were removed by helicopter shooting during the same period.

The reduced detection of feral pig groups limited aerial shooting harvest rates at low pig densities at Westmar. At Collinsville, the heavy vegetation canopy cover limited visibility of feral pigs. Techniques to improve detection, such as thermal assisted aerial shooting, may assist in these situations but requires further testing.

Figure 49 Observer surveying for feral pigs from a helicopter (left) with the assistance of distance marker poles (right) at Westmar, southern Queensland.

Collaborators

- Southern Queensland Landscapes
- NSW Department of Primary Industries
- Western Downs Regional Council
- Whitsunday Regional Council
- Centre for Invasive Species Solutions
- African Swine Fever Prevention and Preparedness Project
- Australian Government's Established Pest Animals and Weeds Management Pipeline Program

Key publications

Gentle, **M**., **Harriott**, **L**., **Kelly**, **C**., **Sydenham**, **A**., Marshall, D. (2024). Enhancing feral pig management in northern Australia – validation through demonstration of optimised management, Final Report, Federation Funding Agreement, Enhancing National Pest Animal and Weed Management, 42 p.

39. Feral pig movements, contact rates, disease prevalence and management in Southern Queensland

Project dates

June 2023 – June 2026

Project team

Matthew Gentle, Lana Harriott, Cameron Wilson, James Speed, Aiden Sydenham and Tony Pople

Project summary

Feral pigs are reservoirs of infectious diseases of economic or public health significance, including many exotic to Australia. This project collects data on feral pig movements and disease prevalence to inform pig management strategies and disease modelling. This has been assisted through collation of GPS tracking data from collared feral pigs undertaken as part of the project "African Swine Fever Prevention and Preparedness (2021-24)" funded by the Queensland Government.

Japanese Encephalitis Virus (JEV) antibodies were detected in ~50% of sampled pigs. However, negative results from tonsil swabs indicate these pigs were not actively shedding the virus (April 2024), which is not unexpected due to JEV's short duration of viremia. These and other prevalence results from *Brucella suis* (Brucellosis), *Leptospira spp*. (Leptospirosis), *Coxiella burnetii* (Q-fever), along with the feral pig movement data, will be shared with the University of Queensland and NSW Department of Primary Industries to examine feral pig contact rates and networks to inform disease preparedness and management.

Efficient feral pig management also requires an understanding of movement behaviours, home range and habitat use. As a case study, the home and core activity ranges of feral pigs were used to identify optimal strategies for bait placement. Comparisons between simulated feral pig 1080 meat baiting strategies (i.e. different spacings, systematic vs targeted placement, aerial and ground baiting) at two study sites in Queensland found that systematically spaced aerial transects at 4 km intervals were the most efficient means of intersecting feral pig ranges. These findings help to direct the optimal distribution of baits to improve the likelihood of encounter by feral pigs (and thus the efficiency of feral pig control programs).

Collaborators at Southern Queensland Landscapes NRM captured and fitted 24 feral pigs with GPS tracking collars at Westmar in southern Queensland. The movements of these GPS-tracked animals were compared before/after aerial shooting, and to other pigs not exposed to aerial shooting. The results show that feral pigs did not disperse or shift their home range, utilise different habitats, or congregate in response to aerial shooting. These are important findings to inform feral pig control strategies, particularly for managing disease outbreaks.

Figure 50 Project staff and collaborators sampling feral pigs from control program at Westmar, southern Queensland to examine disease prevalence.

Figure 51 GPS-collared feral pig recorded by monitoring camera, Westmar, southern Queensland.

Collaborators

- Catherine Kelly (Biosecurity Queensland)
- Darren Marshall and Aiden Sydenham (Southern Queensland Landscapes)
- Tatiana Proboste and Ricardo Soares Magalhaes (University of Queensland)
- Andrew Bengsen (NSW Department of Primary Industries)

Key publications

Gentle, **M.**, **Wilson**, **C.** & **Cuskelly**, **J.** (2022). Feral pig management in Australia: Implications for disease control, *Australian Veterinary Journal*, 100(10): 492-495. doi.org/https://doi.org/10.1111/avj.13198

Wilson, **C.**, **Gentle**, **M.**, Marshall, D. (2023). Feral pig activity and landscape feature revisitation across four sites in eastern Australia. *Australian Mammalogy, 45(3):* 305-316, doi: https://doi.org/10.1071/AM22034

Wilson, **C.**, **Gentle**, **M.** & Marshall, D. (2024). Enhancing strategic deployment of baiting transects for invasive species control – a case study for feral pig baiting in north-eastern Australia. *Wildlife Research*, 51: doi:10.1071/WR23115.

40. Pest animal control – toxin permit support

Project dates

July 2022 – June 2024

Project team

Matthew Gentle and Peter Elsworth

Project summary

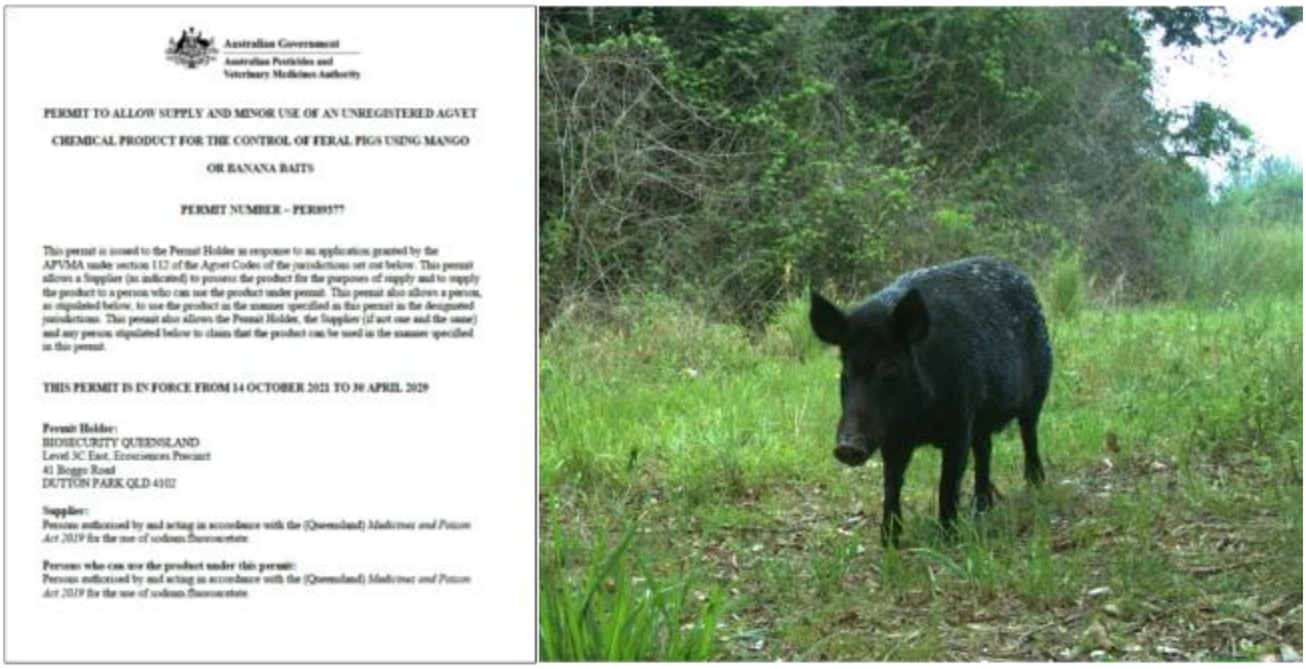
Toxins and baiting applications for vertebrate pest management require continued assessments for potential suitability, supply or alternatives under minor-use permit or national registration through the Australian Pesticide and Veterinary Medicines Authority (APVMA). This project provides technical and knowledge resources from pest animal researchers to consult with stakeholders and regulators to collate, review, and evaluate data to ensure the optimal and safe use of (suitable) vertebrate toxins in Queensland.

It is important to review existing permits to ensure safe and effective use of toxins, particularly as improved baits/toxins become available. Following review, the continued use of strychnine on wild dog and fox traps in Queensland were not supported given the recent commercial-availability of PAPPutty (active para-aminopropiophenone), an effective and humane alternative.

Minor use permit applications to support limited, restricted use of 1080 on fruit substrates and meat baits for feral pigs were submitted to the APVMA; the former has been approved and is in force until April 2029, and the latter remains under assessment (June 2024). Feedback was also provided to support progression of the (national) registration of Eradicat, a bait product to target feral cats.

An application to enable the aerial distribution of wild dog baits up to a maximum of 40 baits/ linear km were submitted to the APVMA to update the permit conditions following recent legislative changes. This permit aims for continued support of best-practice, efficacious wild dog control in rugged areas within the Southern Downs Regional Council region, matching the technique successfully used in adjacent areas of eastern New South Wales.

Figure 52 Cover of issued permit for PER89377 (left) to support the use of mango or banana baits to control feral pigs (right).



Australian Government
Australian Pesticides and Veterinary Medicines Authority

PERMIT TO ALLOW SUPPLY AND MINOR USE OF AN UNREGISTERED AGVET CHEMICAL PRODUCT FOR THE CONTROL OF FERAL PIGS USING MANGO OR BANANA BAITS

PERMIT NUMBER – PER89377

This permit is issued to the Permit Holder in response to an application granted by the APVMA under section 112 of the Agvet Codes of the jurisdictions set out below. This permit allows a Supplier (as indicated) to possess the product for the purposes of supply and to supply the product to a person who can use the product under permit. This permit also allows a person, as stipulated below, to use the product in the manner specified in this permit in the designated jurisdictions. This permit also allows the Permit Holder, the Supplier (if not one and the same) and any person stipulated below to claim that the product can be used in the manner specified in this permit.

THIS PERMIT IS IN FORCE FROM 14 OCTOBER 2021 TO 30 APRIL 2029

Permit Holder:
BIOSECURITY QUEENSLAND
Level 3C East, Ecosciences Precinct
41 Boggo Road
DUTTON PARK QLD 4102

Supplier:
Persons authorised by and acting in accordance with the (Queensland) *Medicines and Poisons Act 2019* for the use of sodium fluoroacetate

Persons who can use the product under this permit:
Persons authorised by and acting in accordance with the (Queensland) *Medicines and Poisons Act 2019* for the use of sodium fluoroacetate

Collaborators

- Southern Downs Regional Council
- Queensland Parks and Wildlife Service
- NSW Department of Primary Industries
- Centre for Invasive Species Solutions

Key publications

APVMA (2024) PER89377: Permit to allow supply and minor use of a registered AGVET chemical product for the control of feral pigs using mango or banana baits. Issued 12 April 2024.

41. Improving detection and response to red-eared slider turtles

Project dates

July 2020 – June 2025

Project team

Lana Harriott, Catherine Kelly and Aiden Sydenham

Project summary

Red-eared slider turtles (REST) are the most commonly traded reptile in the world and have significant environmental impacts where they establish outside of their native range, including competition with native turtle species and consumption of native flora and fauna. Internationally, they are one of the world's worst invasive alien species. The need for surveillance to detect new REST incursions and monitor populations had resulted in the development of basking platforms and, in some cases, basking traps – utilising the behaviour of turtles to bask in the sun as an opportunity to monitor and control. The design of basking platforms is continually improving however it has become evident that juvenile turtles are not using these platforms that regularly detect adult REST. As a result, current monitoring efforts may not detect the presence of juvenile REST, limiting the collection of information on breeding ecology to inform management priorities and effort.

After designing and implementing a pilot trial of a juvenile-specific platform in 2022-23, and confirming its ability to detect juvenile REST, further trials aimed to compare the effectiveness of the juvenile and adult platforms. These are necessary to inform the best method for platform deployment and determine if, and how significantly different, the turtle detections are between platforms. Platforms were deployed in pairs at three locations in NSW with known or suspected REST presence. We trialled fitting solar panels to reduce the need for servicing cameras and hence reduce the disturbance to wildlife, particularly turtles. However, the solar panels did not function as expected and cameras did not function for extended periods. Excessive rainfall and camera damage further limited the trial findings. Adult turtles at a pond in Trumper Park (eastern Sydney) were regularly observed by the public using both the platform types, suggesting that adults at times may also like to bask aquatically in shallow water.

Research will continue to compare adult and juvenile platforms, and test an alternative acoustic method of monitoring by using hydrophones to detect REST vocalisations.

Figure 53 Left: From left to right: Biosecurity Queensland staff with staff from Canterbury-Bankstown Council, Sydney Feral and CSIRO at a field site for REST research. Right: A juvenile Rest platform (left) and adult REST platform (right) deployed as a pair, at Trumper park, Woollahra, NSW.

Collaborators

- Andrew O'Brien (Sydney Feral and Commercial Pest Control Pty Ltd)
- Simon Linke (CSIRO)
- Stacy Harris, Matt Ryan and Duncan Swan (Biosecurity Queensland)
- Dianne Gleeson and Jack Rojhan (University of Canberra)
- Lisa Wellman and Tarnya Cox (NSW Department of Primary Industries)

- Eddie Ferry (Fairfield City Council, NSW)
- Robyn Young (Canterbury-Bankstown Council, NSW)
- Rachel Anderson and Paul Fraser (Woollahra Municipal Council, NSW)

Key publications

García-Díaz, P., Ramsey, D.S., Woolnough, A.P., Franch, M., Llorente, G.A., Montori, A., Buenetxea, X., Larrinaga, A.R., Lasceve, M., Álvarez, A. & Traverso, J.M. (2017). Challenges in confirming eradication success of invasive red-eared sliders, *Biological Invasions*, 19(9): 2739-2750.

Harriott, **L**., **Amos**, **M**., **Brennan**, **M**., **Elsworth**, **P**., **Gentle**, **M**., Kennedy, M, **Pople**, **T**., Scanlan, J., **Speed**, **J**. & **Osunkoya**, **O.O**. (2022). State-wide prioritisation of vertebrate pest animals in Queensland, Australia, *Ecological Management and Restoration*, 23(23): 209-218.

42. Development of surveillance tools for the Asian black-spined toad (*Duttaphyrnus melanostictus*)

Project dates

July 2020 – June 2025

Project team

Lana Harriott and Catherine Kelly

Project summary

As the most common vertebrate stowaway species detected at Australian borders, the Asian black-spined toad (ABST, *Duttaphyrnus melanostictus*) is a significant biosecurity concern. Several populations of ABST have established outside of its native range in Asia, where they cause significant economic and environmental impacts. Much of northern and eastern Australia has habitat that is highly suitable for ABST and hence their invasion and establishment is a serious concern.

To manage the risk of an ABST population establishing in Queensland there is the need for a targeted, robust surveillance and response network. This project aimed to test a range of new and developing tools that could be applied in this network. We have conducted experiments to test, optimise, and determine the effectiveness of management tools for ABST. This has generated a large amount of data that requires analysis and reporting. This will benefit Queensland through access to field-tested tools to respond to an ABST incursion.

Traps used for cane toad management require modifications (reduced mesh size) to restrain the smaller sized ABST. However, ABST generally exhibited trap-shy behaviour despite being attracted to the lures (ABST calls and light). Alternative trapping methods for ABST are likely required for successful management.

Radio- tracking of ABST at a newly invaded site in Madagascar has shown their daily activity is relatively sedentary and shelter sites during the day are frequently re-used. This project will further analyse these data to provide Queensland with tools and techniques for appropriate surveillance methods for ABST.

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Figure 54 Left: Setting up an enclosed arena in Madagascar for field ABST trapping tests. Right: An ABST escaping from an unmodified Toadinator™ trap designed for cane toads.

Collaborators

- Lin Schwarzkopf (James Cook University)
- Ben Muller (Madagascar Fauna and Flora Group)
- Mirzura Kusrini (IPB University, Indonesia)
- Dianne Gleeson (University of Canberra)
- Peter Caley (CSIRO)
- Susan Campbell (Western Australian Department of Primary Industries and Regional Development)
- David Ramsey (Arthur Rylah Institute, Victoria)
- Phil Cassey (University of Adelaide)

Key publications

Kelly, **C.L.**, Schwarzkopf, L., Christy, T.M. & Kennedy, M.S. (2023). The toad less travelled: comparing life histories, ecological niches, and potential habitat of Asian black-spined toads and cane toads. *Wildlife Research*, 51: WR22111.

Licata, F., Ficetola, G.F., Falaschi, M., Muller, B.J., Andreone, F., Harison, R.H., Freeman, K., Monteiro, A.T., Rosa, S. & Crottini, A. (2023). Spatial ecology of the invasive Asian common toad in Madagascar and its implications for invasion dynamics, *Scientific Reports*, 13: 3526.

43. Wild dog management and predation on cattle and wild herbivores in the Queensland dry tropics

Project dates

July 2020 – June 2024

Project team

Lana Harriott, Peter Elsworth, James Speed, Catherine Kelly and Aiden Sydenham

Project summary

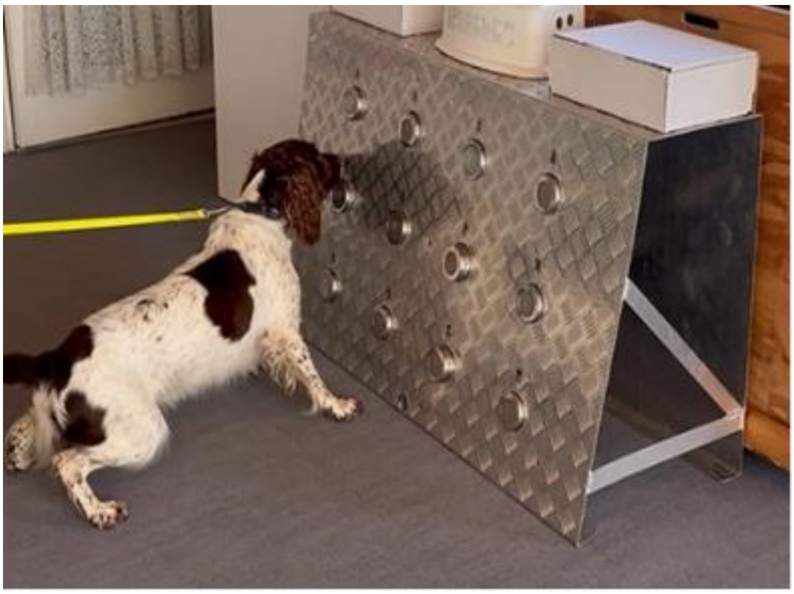
Wild dogs (*Canis familiaris*) are a management priority for many Queensland local governments and rank the highest priority invasive animal species across Queensland regional organisation of council groups. Effective management requires evidence-based understanding of their impacts and behavioural responses to control tools.

This project aimed to evaluate wild dog management tools and assesses the application of new technology for wild dog research purposes. This would be achieved through: an assessment of GPS video collars and their ability to contribute data on wild dog movements, predation, and interactions with control tools, the ongoing monitoring of cluster fences at two sites, Morven and Tambo, and finally, by determining whether dogs can detect 1080 or PAPP in meat baits and CPE capsules.

Ongoing delays from adverse weather and trapping restricted the ability to test the GPS video collars, but further testing is planned in a new project. Monitoring at Morven and Tambo continues to provide data on the presence and abundance of fauna species inside and outside of cluster fences. This monitoring will continue to be conducted by the University of Southern Queensland.

This project demonstrated that a trained scent detector dog could accurately detect 1080 in its stock solution (1080 + blue dye) and confirmed that it can differentiate between stock solution and the non-toxic solution of only blue dye. However, once the 1080 was in a fresh meat or a dried meat bait it could not be detected, nor could the dog detect 1080 in a CPE capsule. However, 88% of the time, the dog correctly identified a commercial DOGGONE bait. The ability to detect PAPP will be tested in the 2024/25 financial year.

Figure 55 Detector dog, Bullet, indicating on a DOGGONE 1080 bait.



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Collaborators

- Phillip Hayward (Biosecurity Queensland)
- Megan Brady (The Turner Family Foundation)
- Benjamin Allen and Geoff Castle (University of Southern Queensland)
- Tracey Kreplins (Department of Primary Industries and Regional Development, WA)
- Craig Murray (Detection Dog School)
- Malcolm Kennedy (Department of Environment and Science, Queensland)

Key publications

Castle, **G**. (2022). The effects of cluster fencing on native and introduced fauna. PhD Thesis, The University of Southern Queensland: doi.org/10.26192/yy20w.

Castle, **G**., Smith, D., Allen, L.R., Carter, J., **Elsworth**, **P**. & Allen, B.L. (2022). Top-predator removal does not cause trophic cascades in Australian rangeland ecosystems, *Food Webs*, 31: e00229.

44. Ecology and management of chital deer in north Queensland

Project dates

July 2014 – June 2025

Project team

Tony Pople, Mike Brennan, Matt Amos and Cameron Wilson

Project summary

The project assesses the ecology, impacts and capacity for increase and spread of chital deer (*Axis axis*) in north Queensland to develop long-term management strategies. Limiting factors are likely to be a combination of wild dog predation and food supply. Basic ecological data (diet, reproduction, population dynamics, movements) have been collected. Current work assesses habitat use, diet, and fawn and adult survival. The project has been built on what became productive collaborations, including two completed PhDs and a third in progress.

Figure 56 Remote camera and satellite collar technology working in tandem to provide information on movement, reproduction and survival of adult chital and fawn.

Satellite telemetry (50 collared females) and ~55 remote cameras will describe movement patterns, habitat use of deer and, most importantly, survival rates of adults and fawns. A genetic component explores possible movement corridors across the region to try and explain their slow rate of spread and patchy distribution. These patterns of movement cannot otherwise easily be determined. Metabarcoding is providing a more detailed description of chital deer diet than the initial assessment using macroscopy. Machine learning will be used to identify individuals by their spot patterns on camera images. This will enable a more comprehensive analysis of survival using mark-resight analysis than from telemetry alone.

The final stages of the project will involve analysis of these long-term data to better describe and explain the labile population dynamics and clumped dispersion that has been described to date.

Collaborators

- Australian Research Council Linkage grant to James Cook University
- Keith Staines and Glen Harry (Sporting Shooters Association of Australia)
- Kurt Watter (University of Queensland)
- Dave Forsyth, Andrew Bengsen and Sebastien Comte (NSW DPI)
- Carlo Pacioni and Luke Woodford (Arthur Rylah Institute, Victoria)
- Jordan Hampton (Ecotone Wildlife Veterinary Services)
- Tom De Ridder (Q Biotics Group)
- Landholders in the Charters Towers region
- Ashley Blokland (Charters Towers Regional Council, now Biosecurity Queensland)

- Heather Jonsson (Dalrymple Landcare Committee)
- Thijs Krugers and Rachel Payne (NQ Dry Tropics)
- Catherine Kelly, Matt Quin, Jodie Nordine, Mohit Deolankar, Ben Hirsch, Lin Schwarzkopf, Jan Strugnell and Iain Gordon (James Cook University)
- Centre for Invasive Species Solutions

Key publications

Forsyth, D. M., **Pople**, **A**., Woodford, L., **Brennan**, **M**., **Amos**, **M**., Moloney, P. D., Fanson, B. & Story, G. (2019). Landscape-scale effects of homesteads, water, and dingoes on invading chital deer in Australia's dry tropics. *Journal of Mammalogy*. doi: 10.1093/jmammal/gyz139.

Kelly, **C.L**., Schwarzkopf, L., Gordon, I.J., **Pople**, **A**., Kelly, D.L. & Hirsch, B.T. (2022). Dancing to a different tune: Changing reproductive seasonality in an introduced chital deer population. *Oecologia* 200, 285-294. https://doi.org/10.1007/s00442-022-05232-6

Kelly, **C.L**., Gordon, I.J., Schwarzkopf, L., Pintor, A., **Pople**, **A**., Hirsch, B.T. (2023) Invasive wild deer exhibit environmental niche shifts in Australia: Where to from here? *Ecology and Evolution* 13, e10251. https://doi.org/10.1002/ece3.10251

Pople, **A**., **Amos**, **M**. & **Brennan**, **M**. (2023). Population dynamics of chital deer (*Axis axis*) in northern Queensland: Effects of drought and culling. *Wildlife Research* 50: 728-745. https://doi.org/10.1071/WR22130

Watter, K., Baxter, G.S., **Pople**, **T**. & Murray, P.J. (2019). Effects of wet season mineral nutrition on chital deer distribution in northern Queensland. *Wildlife Research* 46, 499-508.

45. Coordinated management of feral deer in Queensland

Project dates

May 2022 – June 2025

Project team

Tony Pople, Mike Brennan, Matt Amos and Cameron Wilson

Project summary

Populations of the four deer species in Queensland are increasing and spreading. With funding from the Australian and Queensland Governments, control of six priority deer populations is being evaluated. Workshops on deer management were run during 2022-23.

The project aims to evaluate the effectiveness of ground and aerial control of deer in a range of environments. Local or regional control strategies will be developed.

Two large chital deer populations have been surveyed prior to aerial and ground culling. Two additional populations will be surveyed then culled in winter 2024. These populations are regionally concentrated and so culling offers a long-lasting reduction in density.

We have estimated the size of a red deer population on the northern edge of the species' southern distribution near Kingaroy. Culling is planned for winter 2024. In the granite belt, a large fallow deer population has been monitored with remote cameras, prior to culling in late 2024 or early 2025.

Figure 57 Left: Project staff ready to conduct aerial surveys for feral red deer near Kingaroy. Right: Fallow deer captured on remote camera as part of population monitoring in the granite belt.

Collaborators

- Annelise Wiebkin (National Deer Management Coordinator)
- NQ Dry Tropics
- Burnett Mary Regional Group
- Queensland Parks and Wildlife Service
- NSW Department of Primary Industries
- Sunshine Coast Regional Council, Brisbane City Council, Whitsunday Shire Council, Burdekin Shire Council.
- Biosecurity Officers
- Queensland landholders

Key publications

Bengsen, A.J., Forsyth, D.M., **Pople**, **A.R**., **Brennan**, **M**., **Amos**, **M**., Leeson, M., Cox T.E., Gray, B., Orgill, O., Hampton, J.O., Crittle, T. & Haebich, K. (2022). Effectiveness and costs of helicopter-based shooting of deer. *Wildlife Research*, doi:10.1071/WR21156.

Forsyth, D., **Pople**, **T**., Page, B., Moriarty, A., Ramsey, D., Parkes, J., Wiebkin, A. & Lane, C. (eds) (2017), 2016 National Wild Deer Management Workshop Proceedings, Adelaide, 17-18 November 2016, Invasive Animals Cooperative Research Centre, Canberra, Australia.

National Feral Deer Action Plan. (https://feraldeerplan.org.au/).

Queensland Feral Deer Management Strategy 2022-27. (https://www.daf.qld.gov.au/__data/assets/pdf_file/0008/1644218/Feral-Deer-Management-Strategy.pdf).

External Funding

Research and Development Contracts

Project/research area	Funding body	Funds spent ($)
Integrated management of cabomba	CSIRO	45,954
Weed management in the Pacific	Landcare Research New Zealand	175,950
Biocontrol of pasture weeds, Vanuatu	Landcare Research New Zealand	62,047
Biocontrol of parkinsonia	CSIRO	9,615
Biocontrol of cat’s claw creeper	Seqwater	20,000
Biocontrol of invasive cacti	Australian Government	150,526
Aquatic weed management tools	Australian Government	4,595
Navua sedge management	Australian Government	1,674
Strategic invasive grass control	Australian Government	90,000
Coordinated management of feral deer	Australian Government	92,884
Four tropical weeds eradication	National cost share	79,426
Weed biocontrol prioritisation	Centre for Invasive Species Solutions	3,146
Feral pig management	Australian Government	109,798
Total		**845,615**

Land Protection Fund

Project/research area	Funds spent ($)
Pesticide permits	41,288
Biocontrol of prickly acacia	164,325
Biocontrol of bellyache bush	159,275
Biocontrol of cat's claw creeper	91,132
Biocontrol of parthenium	29,743
Biocontrol of opuntioid cactus	46,913
Biocontrol of Harrisia cactus	85,590
Biocontrol of Navua sedge	91,938
Biocontrol of African tulip tree	62,727
Biocontrol of clidemia	83,242
Biocontrol of giant rat's tail grass	112,508
Biocontrol of chinee apple	76,983
Biocontrol of lantana	40,381
Rearing and release of biocontrol agents	183,158
Biocontrol agent compendium	32,420
Weed biocontrol prioritisation	11,025
Quarantine management	153,615
Water weed ecology and management	143,250
Aquatic weed in sensitive environments	69,618
Weed seed dynamics	75,052
Giant rat's tail grass wick wiper	28,422
Navua sedge ecology and management	78,271
Drone-based weed identification	46,140
Weed risk assessment	62,886
Red-eared slider eradication	44,884
Asian black-spined toad surveillance	15,061
Evaluating rabbit breeding success	31,772
Ecology and management of chital deer	113,115
Coordinated management of feral deer	28,769
Refining management of feral deer	119,801
Wild dog management	134,560
Monitoring and control of new vertebrate pests	42,437
Feral pig management	76,494
Pest animal toxin support	31,922
Total	**2,608,717**

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Publications and presentations

Journal articles

Amos, **M**., **Brennan**, **M**., Burke, S., & Doman, J. (2023, 28-31 August 2023). Testing indices of deer abundance using camera traps 2nd Pest Animal and Weed Symposium, Dalby, Australia.

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Dhileepan, **K**., King, A.M., **Taylor**, **D**.**B**.**J**., Pollard, K.M., Seier, M.K. (2024). Biological control of cat's claw creeper (*Dolichandra unguis-cati*) in Australia and South Africa – current status and future prospects. *Annals of Applied Biology* 184: in press.

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Steinrucken, T. V., **Vitelli**, **J**. **S**., **Holdom**, **D**. **G**., & Tan, Y. P. (2022). The diversity of microfungi associated with grasses in the *Sporobolus indicus* complex in Queensland, Australia [Original Research]. *Frontiers in Fungal Biology*, 3. https://doi.org/https://doi.org/10.3389/ffunb.2022.956837

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Elsworth, P. (2023). Property-level rabbit control using harbour destruction restricts breeding success, Pest Animal and Weed symposium, Australia, Dalby, 28-31 August. https://icebergevents.eventsair.com/paws2023/proceedings

Everitt, R., **Harriott**, **L**., **Gentle**, **M**., & Cathcart, A. (2023)*. Managing wild dogs at Hunchy: Pest, partnership, and people power.* Presented at the Pest Animal and Weed Symposium, Dalby, Queensland, 28-31 August. https://icebergevents.eventsair.com/paws2023/proceedings

Farahani, **B**. **S**., **Bickel**, **T**., **& Vitelli**, **J**. **S**. (2023, 28-31 August 2023). Accelerating giant rat's tail grass (GRT) soil seed bank depletion through chemigation. 2nd Pest Animal and Weed Symposium, Dalby, Australia.

Gentle, **M**. **N**., **Harriott**, **L**., **Kelly**, **C**. **L**., **Wilson**, **C**., Sydenham, A., Fuller, B., Gaschk, C., & Marshall, D. (2023, 20-21 June 2023). Enhancing the effectiveness of feral pig control and monitoring in Queensland agricultural lands. National Feral Pig Conference, Cairns, Australia.

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Nguyen, N., **Bickel**, **T**.**O**., **Perrett**, **C**., **Gill**, **L**., Bigot, M. & Atkins, S. (2023). Regeneration of macrophytes from a lake propagule bank after removal of the invasive *Cabomba caroliniana* using herbicide and manual control, *16th International Symposium on Aquatic Plants*, Belgium, Antwerp, November 2023.

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Books and book chapters

Day, **M.D**., Witt, A.B.R. & Winston, R.L. (2024). The use of arthropods for ecologically-based weed management in agriculture. in *Ecologically-based weed management: Concepts, challenges and limitations*, Korres, NE, Travlos, IS & Gitsopoulos, TK, eds, John Wiley & Sons, pp. 119-138.

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Posters

Lu-Irving, P., Encinas-Viso, F., **Callander**, **J**., **Day**, **M**., Le Roux, J. (2023). Population genomics of invasive lantana: implications for improved biocontrol, XXIII International Congress of Genetics, Melbourne, 16-21 July.

Forums and workshops

Amos, **M**. (2023). *Oh Deer! What can the matter be?* Toowoomba Field Naturalist Club, Toowoomba, 3 November.

Amos, **M**. (2023). *TRC Pest Management Team Meeting – DAF Deer Research*, Toowoomba Regional Council, Toowoomba, 15 November.

Amos, **M**., **Brennan**, **M**. (2024). *Wild Duck Island Deer Eradication*, QPWS Pest Forum, North Stradbroke Island, 12 March.

Bickel, T.O. (2024) Invasive Plants and Animals State-wide Oversight Group / *Aquatic Weed Ecology and Management*, various stakeholders, Virtual, March 2024.

Bickel, T.O. (2024) *Natural Resource Management Forum/ Water Weed Research Update*, various stakeholders, Beaudesert, May 2024.

Bickel, T.O. (2024) *State Land Pest Management Committee/ Aquatic Weed Ecology and Management*, various stakeholders, virtual, May 2024.

Brennan, **M.** (2023). *Feral deer research update*, South-East Queensland Pest Advisory Forum, Esk, 8 November.

Brooks, **S**. & **Brazier**, **D**. (2023). *Encapsulated herbicide research update*. Dry Tropics Regional Pest Management Group. Townsville, 21st November.

Brooks, **S**. (2024). *African tulip tree research*. Hinchinbrook Natural Resource Management forum. Ingham, 14th March.

Brooks, **S**. (2024). *Encapsulated herbicide and neem seed research update*. LGAQ forum. Georgetown, 14th May.

Brooks, **S**. (2024). Limnocharis flava *- recent discoveries*. Dry Tropics Regional Pest Management Group, Bowen, 16th May.

Day, M.D. (2023). Forest Biosecurity Regional Training Workshop, Tanoa Plaza Hotel, Suva, Fiji, 5-9 September.

Dhileepan, **K**. (2023). Two new biocontrol agents for prickly acacia and bellyache bush. Rural Lands Committee Meeting, Winton, Qld, 2 August 2023.

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Gentle, **M**. & **Amos**, **M**. (2023). Bowen river syndicate feral pig and deer workshop. Collinsville, 7 September.

Gentle, M. (2024). Research update – Feral pigs, Local Government Association of Queensland Natural Resource Management Forum, Cunnamulla, 28 May.

Gentle, M., **Sydenham, A.** & **Harriott, L**. (2024). Westmar feral pig workshop for landowners, Westmar, 18 April.

Harriott, L. (2024). *Science beyond the lab: A glimpse into the world of invasive animal research*, National Youth Science Forum, Dutton Park, 15 January.

Harriott, **L.** (2024). *Tackling the turtles: The development of surveillance and control tools for red-eared slider turtles*, 1 million turtles: A vision for community driven turtle conservation workshop, Wodonga, 23-24 March.

Harriott, **L**. & **Sydenham**, **A**. (2024). *Tackling the turtles: The development of surveillance and control tools of red-eared slider turtles*, Wide bay - Burnett invasive species advisory committee, Virtual, 12 June.

Hodgson-Kratky, **K**. (2024). Local Government Association of Queensland Natural Resource Management Forum, *Red witchweed eradication and weedy* Sporobolus *management.* Local government, St Lawrence, Queensland, 19 June.

Osunkoya, **O**.**O**. (2023) *Risk Assessment of emerging weeds of Queensland: A horizon approach.* Presentation to The Burdekin dry tropics management group, Bowen, Central Queensland, Sept 2023

Osunkoya, **O**.**O**. (2023). *Risk Assessment of emerging weeds of Queensland: A horizon approach*. Presentation to The Gulf Catchments Pest Task Force Karumba, NW Queensland, October 2023.

Osunkoya, **O**.**O**. (2024). *Risk Assessment of emerging weeds of Queensland: A horizon approach*. Presentation to The Darling Down Southwest Queensland regional Council, St George, Darling Downs, April 2024.

Pukallus, **K**., **Brooks**, **S**., **Warren**, **C**. & **Brazier**, **D**. (2023). Weed control overview to Cert III Distance Education students. TWRC, Charters Towers. 19 July.

Pukallus, **K**., **Brooks**, **S**., **Warren**, **C**. & **Brazier**, **D**. (2023). Weed control overview to Cert III Distance Education students. TWRC, Charters Towers. 23 August.

Pukallus, K. & **Butler**, **M**. (2023). Charters Towers Distance Education Under 8's Day. Charters Towers. 20 October.

Pukallus, K. & **Butler**, **M**. (2024). Charters Towers Distance Education Year 3 students. TWRC, Charters Towers. 22 February.

Pukallus, K. **& Butler**, **M**. (2024). Pentland State School Under 8's Day. Pentland. 16 May.

Pukallus, K. & **Butler**, **M**. (2024). Charters Towers Distance Education Year 6 students. TWRC. 19 June.

Pukallus, **K**. (2023) Regional Pest Management Group Meeting. QDAF biological control update and facility tour. TWRC, Charters Towers. 17 August.

Shi, **B**. & **Dhileepan**, **K**. (2023). Parthenium biological control research. South East Queensland Pest Advisory Forum, Esk, Qld, 8 November 2023.

Taylor, **D**. (2024). An update on the biological control of bellyache bush. Stakeholder meeting, Katherine, NT, 13 June 2024.

Taylor, **D**. (2024). An update on the biological control of prickly acacia. Stakeholder meeting, Katherine NT, 13 June 2024.

Taylor, **T**. (2023). *Harrisia cactus integrated management*. Cactus Master Class for local government weeds officers and NRM groups, Longreach, November 2023.

Taylor, **T**. (2023). *Harrisia cactus research update from Queensland*. Harrisia Task Force meeting, Northern Slopes Landcare Assoc. and New South Wales Government, Local Land Services, November 2023.

Taylor, **T**. (2024). *Harrisia cactus – the impact of livestock on density and fruiting*. Mitchell Landcare, Mitchell (Mungalalla), Queensland, April 2024.

Taylor, **T**. (2024). *Harrisia cactus integrated management*. Southern Rural Lands Officers Group, St George, Queensland, April 2024.

Vogler, **W**. (2023). *Weeds and Fire*, Queensland Fire and Emergency Services Land Management Forum, Charters Towers, 19 July.

Vogler, **W**. (2023). *GRT Alternative Control Methods*, State Land Pest Management Committee, Brisbane, 13 September.

Vogler, **W**. (2023). *Prickly Acacia*, NSW State Prickle Bush Taskforce Meeting, Online, 12 October.

Vogler, **W**. (2023). *Invasive Aquatic Grasses*, GBR Network, Online, 10 November.

Vogler, **W**. (2023). *Management Actions for Herbaceous Weeds on Roadsides*, TMR Environmental Forum, Brisbane, 16 November.

Vogler, **W**. (2023). *Cacti Ecology and Control Research*, Cactus Masterclass, Longreach, 21 November.

Vogler, **W**. (2023). *Sticky Florestina Project Update*, Shire Rural Lands Officer Group, Longreach, 22 November.

Vogler, **W**. (2024). *Florestina*, LGAQ Natural Resource Management Forum, Blackall, 28 May.

Vogler, **W**. (2024). *Challenges with Understanding Evolving Fuel States in Northern Australia*, North Australia Fire Managers Forum, Townsville, 4 June.

Lectures and seminars

Bickel, **T**.**O**. (2024). *Integrated Crop Health and Management/Aquatic Plant Ecology and Management*, University of Queensland, Gatton, March 2024.

Day, **M.D**. (2023). Introduction to the biological control of weeds, SAEMEO BIOTROP, Bogor, Indonesia, on-line, 27 October.

Day, **M.D**. (2023). Minimizing the risk in weed biocontrol – host specificity testing of natural enemies, SAEMEO BIOTROP, Bogor, Indonesia, on-line, 27 October.

Day, **M.D**. (2023). Status and options for weed biological control in Indonesia & the Philippines, SAEMEO BIOTROP, Bogor, Indonesia, on-line, 27 October.

Day, **M.D**. (2024). Biological control of *Mikania micrantha* using the rust *Puccinia spegazzinii*, Christmas Island, 27 June.

Day, **M.D**. (2024). Challenges and opportunities in weed biological control, Asian-Pacific Forest Invasive Species Network, on-line, 27 May.

Elsworth, P. (2023). *Biological control*, Australia Awards Indonesia: Effective biosecurity for humans and animals, Brisbane, 12 September.

Elsworth, P. (2024). *Biological Control of Vertbrate Pests* – AGRC3042, School of Veterinary Science, The University of Queensland, Gatton, 12 March.

Elsworth, P. (2024). *Vertbrate Pest Impacts on Crops* – Integrated Crop Health and Management, School of Agriculture and Food Sciences, The University of Queensland, Gatton, 13 May.

Elsworth, P. (2024). *Vertbrate Pest Impacts on plants and the Environment* – Plant and Environmental Health, School of Agriculture and Food Sciences, The University of Queensland, Gatton, 12 April.

Gentle, M. (2024). Invasive vertebrate Pests – AGRC3042, School of Veterinary Science, The University of Queensland, Gatton, 12 March.

Harriott, L. (2023). *Wild dog ecology, control, and implications for rabies management*, Australia Awards Indonesia: Effective biosecurity for humans and animals, Brisbane, 12 September.

Hodgson-Kratky, **K**. (2024) *Accelerating red witchweed soil seedbank decline*, University of Queensland students, Dutton Park, Queensland, 29 April.

Osunkoya, **O**.**O**. (2024). *Risk assessments of Queensland emerging weeds*. Seminar series Biosecurity Queensland IPA, Brisbane, March 2024.

Osunkoya, **O**.**O**. (2024). *Studying population dynamics of invasive alien species for better management*. Seminar presentation to higher degree (M.Sc.) students, School of Agriculture, Queensland University, Brisbane, May 2024.

Vogler, **W**. (2023). *Giants Rats Tail Grass*, Sunshine Coast Regional Council Webinar, Online, 7 December.

Field days

Pukallus, K. (2024) CTRC Careers Expo. PCYC, Charters Towers. 30 May.