Technical highlights

Invasive plant and animal research 2011–12

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Contents

Introduction

Our scientists undertake applied research to better manage Queensland's worst weeds and pest animals—to reduce their impacts on agriculture, the environment and the community.

The research program summarised in this document targets a wide range of pest species. Our team aims to develop effective control strategies and methods (e.g. biological control and herbicides), as well as improve knowledge of pest species' biology and complete impact assessments.

Invasive plant science

At the new Ecosciences Precinct at Dutton Park (Brisbane), we are investigating whether a number of species of herbivorous insects and mites, and pathogenic fungi, will provide long-lasting control of 10 of our worst weeds. This work is building on some remarkable past successes.

Finding suitable control agents is a long and detailed process. Initially, state and federal governments must approve a weed as a target for biological control (to ensure there are no negative impacts from widespread control, such as to the apiculture or nursery industries). Secondly, with approval granted, overseas field exploration is conducted in the weed's native range to identify potential agents that are damaging and host-specific. Thirdly, candidate agents are assessed in quarantine within Australia for their ability to damage, and complete their life cycle, on non-target native, ornamental and agricultural plants. Finally, approval for release is sought from the Australian Government if the agents are found to be suitably host-specific.

Two South American vines—Madeira vine and cat's claw creeper—form dense foliage mats that cover trees and shrubs in riparian areas of Queensland and New South Wales. Since 2011, a leaf-feeding beetle from South America has been mass-reared and released into Madeira vine infestations throughout the weed's range in eastern Australia. In south-eastern Queensland, beetles successfully overwintered at a majority of sites, causing notable damage. Further releases occurred over the 2012–13 summer.

For cat's claw creeper, a leaf-mining jewel beetle is being released into infestations in south-eastern Queensland. This will hopefully complement the activity of two established biocontrol agents. A new agent for lantana (a bud mite) was approved for field release over the 2012–13 summer. Host-specificity tests are also being conducted for a rust fungus of lantana, a gallfly for the biocontrol of Siam weed and a cochineal scale insect that damages the Mexican cactus, Hudson pear. Mass-rearing, release and evaluation of biocontrol agents occur from our Brisbane and Charters Towers research facilities.

Other host-specificity tests are also currently underway for:

- a rust fungus of bellyache bush (a major agricultural weed of northern Queensland)—surveys for other potential agents were conducted in South America in early 2013
- a number of insect species and two rust fungi to complement existing biocontrol agents for prickly acacia (another major weed of Queensland's rangelands)
- one damaging insect of mother-of-millions, which awaits approval for release.

Recent monitoring indicates widespread biological control of another production weed, parthenium weed, in central Queensland. This success has been achieved about 30 years after release of the leaf beetle *Zygogramma bicolorata*, the stem-galling moth *Epiblema strenuana* and the stem-boring weevil *Listronotus setosipennis*; and about 10 years after release of the summer rust *Puccinia xanthii* var. *parthenii-hysterophorae* and the root-feeding moth *Carmenta ithacae*. In northern Queensland, the sap-feeding planthopper *Stobaera concinna* has now been observed on parthenium at many sites, after being thought not to have established after release during 1983–86. Field-establishment of the root-feeding moth *C. ithacae* has also been confirmed in a release site in northern Queensland. These examples highlight the often lengthy time for both establishment and impact of biocontrol agents.

Other biocontrol activities extend to assisting countries in the South Pacific to manage weeds, with financial support from aid agencies such as AusAID and the Australian Centre for International Agricultural Research. The rationale is that this reduces the risk of weed invasion in Australia, identifies control measures applicable in Australia, and provides a better understanding of the ecology and management of serious weeds that are a threat to Queensland. A good example is the recent introduction of the gallfly to quarantine for assessment to control Siam weed in Australia following a successful biocontrol program in Papua New Guinea.

A considerable research effort is also placed on new and improved methods of other control options by chemical, fire and mechanical means. Research into grader grass control now strongly indicates the importance of minimising disturbance, such as fire to reduce its dominance in the pasture. In contrast, simulations supported by field data suggest that high fire frequency or increased burning intensity could achieve control of lantana in some situations. Herbicide options are often the only feasible method for weed management and these are being explored for grader grass and many other species, including calotrope, yellow bells, Chinee apple, bellyache bush, prickly acacia, Senegal tea, Siam weed, black willow, *Acacia glauca*, badhara bush, navua sedge, bog moss, stevia and alligator weed. Much of this work is being undertaken from our research stations in Charters Towers and South Johnstone. The limited range of herbicides to control aquatic weeds has been addressed through a series of workshops to provide guidelines for their use, better processes for research and permit issue, and identification of 12 new actives. A series of workshops were also used to identify weeds at risk of developing herbicide resistance in non-cropping situations and recorded considerable variation in understanding of this problem.

Weed ecology remains an important component of our research. This includes projects to quantify seed longevity, seedling survival and time to reproductive maturity, and factors affecting germination, growth and regeneration success. Habitat requirements of weeds (e.g. cabomba) and their effects on the environment (e.g. cat's claw creeper) are also assessed and have implications for weed management. For example, nitrogen requirements are higher for invasive species (such as cat's claw creeper) than native species and growth of cabomba is reduced in alkaline water. Altering environmental conditions (e.g. pH, soil chemistry) may thus reduce the competitive ability of these invasive species. Viability of seeds of many species is being assessed following burial under different environmental conditions and over time (months to many years). Such knowledge importantly informs the duration of eradication programs. An accelerated ageing test is being used on some species to estimate seed longevity more rapidly.

We are also developing methods for the detection of environmental DNA (deoxyribonucleic acid) of invasive species in aquatic systems, including *Mimosa pigra*, pond apple and red-eared slider turtles. If successful, this should improve their delimitation and early detection. Our research supports the national Siam Weed Eradication Program and Four Tropical Weeds Eradication Program in northern Queensland by providing key ecological information, control methods and evaluation. The research on eradication feasibility and evaluation has now been complemented by a similar assessment of containment programs, allowing optimal investment decisions to be made about national and state management programs.

Pest animal management

On two Queensland cattle and sheep properties, movements of maremma guardian dogs and neighbouring wild dogs have now been monitored with GPS (global positioning system) and satellite collars. Maremmas behaved markedly differently on the two properties, staying near the homestead and not near livestock on the cattle property, and staying appropriately near their sheep flock on the sheep property. It was only on the sheep property that collared wild dogs were not in dangerous proximity to livestock. These comparisons will allow improved guidelines for their management.

Baiting using 1080 poison has been a cost-effective method of pig control. However, evidence that populations of non-target species are not adversely affected is needed to support the continued registration of 1080 for this use. Non-target animals, such as some bird species, could theoretically be poisoned. A two-year comparison of populations of susceptible species (such as ravens on properties baited or left unbaited with 1080 meat baits) in southern Queensland indicated minimal or no impact. Our recent research on feral pigs in northern Queensland has concentrated on baiting practices and impacts in freshwater environments. During 2010–11, we collaborated with European researchers on new methods and tools. Protocols are also being developed for evaluating pig control operations.

Two long-term projects on rabbit control have now demonstrated the long-term value and optimal methods of rabbit control. At Bulloo Downs in western Queensland, ripping warrens in a drought refuge has cost-effectively maintained rabbits in low numbers and in a restricted area. In contrast, similar areas with no rabbit control are now experiencing large post-drought increases in rabbit numbers. In south-eastern Queensland, the rabbit fence has played an important role in control, but this needs to be complemented by ripping warrens to again remove source populations. Recent work provides some insights into the complex dynamics between exotic pest species and native species. In some situations, rabbits appear to be supporting fox populations, which then keep native prey (such as bandicoots) at low densities. A third project on rabbits has shown how genetic resistance to rabbit haemorrhagic disease virus (RHDV) can develop rapidly in laboratory populations of wild rabbits. Additional work has shown that field strains of RHDV can be more virulent than the original strain and these may be better options for future releases, particularly if they can overcome localised resistance.

Over the past two years, we have been collating and analysing counts of feral pigs and goats across Queensland since the mid 1980s conducted by the Queensland Government during annual aerial surveys to estimate kangaroo numbers for harvest management. These counts have indicated regional trends in abundance, involving heavy declines following drought that has a long legacy, and an overall increase in goat numbers over the last 30 years. Commercial harvesting has had little broadscale impact on feral pig populations over the last five years, but has probably reduced feral goat numbers by up to 50% in some areas.

Pest management chemistry

At Coopers Plains, our chemistry group produces 1080 solution for use in pig, dog and fox baits. The group also tests various poisons as possible causes of death for animal mortalities reported by the public. In addition, testing for residues in baits is carried out to quantify how long chemicals last in the environment.

The team further supports herbicide control of weeds in Queensland by obtaining minor use permits from the Australian Pesticides and Veterinary Medicines Authority, which are required for the weed species, herbicide, application method and situation or environment. This is not a trivial task, requiring collection (as described in the project summaries) and compilation of considerable data. Similar work was required to obtain a new permit for the use of strychnine in bait and on rags on traps to control wild dogs and foxes in Queensland.

Funding, collaboration and research priorities

In the 2011–12 financial year, Biosecurity Queensland's Invasive Plant and Animal Science received total funding of $6.2 million. Queensland Government base funds provided $3.6 million, contributions from the Land Protection Fund amounted to $1.7 million and funding under contracts with external partners totalled $0.9 million (see page 33). Notable funding bodies for the latter were the Australian Government, Meat and Livestock Australia, the Rural Industries Research and Development Corporation and Anglo American Metallurgical Coal Pty Ltd.

The Invasive Animals Cooperative Research Centre was successful in its extension bid (2012–2017), which covers programs for control of terrestrial pests (e.g. rabbits and wild dogs), freshwater pests (e.g. tilapia and carp), community engagement, and development and registration of new toxins and fertility control agents. Biosecurity Queensland is leading the Land Pests Program. Our Toowoomba office—in collaboration with south-eastern Queensland local governments and others along the eastern seaboard—will run a new project on managing peri-urban dogs. The Invasive Animals Cooperative Research Centre will continue to provide innovative collaborative research and training.

Our research program for 2011–12 was endorsed by the Research Review Committee—a group of senior scientific, operations and policy staff from Biosecurity Queensland. The committee critically reviews proposed project outcomes and allocated investments, and makes recommendations on strategic priorities, existing research gaps and projects due for scientific review. In 2012–13, we have sought input on research priorities from Queensland local governments, natural resource management bodies and other stakeholders through an online survey.

Further information

A more streamlined *Technical highlights* has been produced for 2011–12. This substantially reduces the cost of production and recognises that more detailed information is available in journal articles, scientific reports, management manuals, fact sheets and websites. We encourage you to visit the Invasive Plant and Animal Science web pages on the Biosecurity Queensland website (www.biosecurity.qld.gov.au) for further information. Journal articles and scientific reports can also be obtained by emailing project leaders (see pages 21–23). In addition, you can browse through our recent scientific publications in the fully searchable eResearch Archive at www.biosecurity.qld.gov.au (search 'eResearch').

Part 1 Invasive plant science

1. Understanding grader grass (*Themeda quadrivalvis*) ecology for improved management

Project dates

July 2006 – June 2015

Project team

Dr Wayne Vogler and Laura Roden

Project summary

The effect of fire frequency and timing on grader grass populations is the final component of a broader research program, with results from completed ecology and management studies presented previously.

The fire research incorporates burning at three times (late dry season, start of wet season and end of wet season) and three frequencies (annual, two-year and four-year intervals). For comparison, we also apply the herbicide paraquat (250 g L^{-1}) at 2 L ha^{-1} of product prior to seed set at annual intervals. Changes in pasture species and biomass composition are measured annually.

Annual and biennial fires, along with the herbicide treatment, were implemented during 2011–12. Annual fires continued to result in more than 80% of the total biomass being grader grass. In contrast, less than 2% grader grass biomass was recorded in control (no fire or herbicide) and herbicide treatments. In the biennial and four-year fire treatments, grader grass increased to more than 70% of total biomass in the year following treatment, but then declined steadily in non-fire years to less than 30%. The results continue to indicate that dominance of grader grass is maintained by frequent ecosystem disturbance such as fire, thus disturbance should be minimised.

Collaborators

Department of National Parks, Recreation, Sport and Racing (Queensland)

Key publications

Keir, AF & Vogler, WD 2006, 'A review of current knowledge of the weedy species *Themeda quadrivalvis* (grader grass)', *Tropical Grasslands,* 40(4): 193–201.

Vogler, WD 2009, *Grader grass management guide*, Burdekin Dry Tropics Natural Resource Management, Northern Gulf Resource Management Group, Southern Gulf Catchments, 8 pp.

2. *Tecoma stans* herbicide trial

Project dates

April 2010 – August 2012

Project team

Dr Wayne Vogler, John McKenzie, Laura Roden and Dannielle Brazier

Project summary

Tecoma stans, a declared Class 3 weed, has naturalised at many locations throughout Queensland, including rehabilitation areas of a central Queensland mine. *Tecoma stans* is of particular concern here as it compromises the ability of native species to establish, impacting on the rehabilitation objectives of the operation.

In the past, the mining company has tried both herbicides and controlled burning to eradicate *T. stans* infestations, with limited success. Therefore, it has funded a research project to develop a management plan to control this weed on the mine site.

A herbicide rate screening trial was completed, identifying glyphosate (Roundup® 360) and metsulfuron-methyl (Brush-off®) as effective herbicides when applied using a splatter gun. Basal bark herbicide application using fluroxypyr (Starane™ Advanced) or triclopyr/picloram (Access™) also caused high mortality. Cut stump treatments using several herbicides were not effective, resulting in frequent suckering from the plant base and adjacent surface roots.

Ecological studies have shown that the seed bank is exhausted within six months. Plants as small as 0.3 m tall can reproduce, although this is not common. Most plants must reach almost 1 m in height prior to producing seeds.

3. Ecology of Captain Cook tree (*Cascabela thevetia*) in northern Queensland

Project dates

July 2007 – June 2012

Project team

Dr Faiz Bebawi and Chris Crowley

Project summary

Captain Cook tree is a Class 3 declared weed that has established large infestations at several locations in northern Queensland. We have been undertaking research to better understand its ecology and the implications for timing and effectiveness of control strategies. This has included seed germination, seedling survival, time to reproductive maturity, and growth and development studies. We have also investigated sap-flow velocity and water-use efficiency of trees under natural conditions to determine when control options are likely to be most effective.

All experiments have now been completed, apart from sap-flow and water-use efficiency measurements, which will be finalised in coming months. Previous editions of *Technical highlights* have reported the results of completed research components. In 2011–12, seedling survival research was finalised. The results show that young plants are hardy, with survival rates generally higher than those reported for other woody weeds growing in similar environments, and 81% of young plants exposed to full sunlight remained alive after 4.3 years compared with 51% for plants growing under full shade.

Collaborators

John Ramsey (landholder), Bob Mayer (Queensland Department of Agriculture, Fisheries and Forestry, Townsville)

4. Weed seed dynamics

Project dates

August 2007 – June 2020

Project team

Dr Faiz Bebawi and Chris Crowley

Project summary

Currently, there are many declared weeds for which we know very little about seed ecology, including seed longevity. This information is important in control programs, as it allows land managers to plan activities based on the length of time that will be required to deplete seed banks in the absence of replenishment. In this project, seed longevity of 12 priority weed species—including mesquite, prickly acacia, Chinee apple, parthenium, orange-flowering and pink-flowering lantana, gamba grass, calotrope, leucaena, yellow bells, yellow-flowering and peach-flowering Captain Cook tree, neem and stevia—are investigated under two different soil types (black clay and river loam), two grass cover conditions (grassed and non-grassed) and four burial depths (0 cm, 2.5 cm, 10 cm and 20 cm).

Preliminary results suggest that Chinee apple, yellow oleander, yellow bells, neem and calotrope have relatively short-lived seeds, with no viable seeds recorded after burial for 24 months. Gamba grass has also demonstrated a rapid loss of viable seed from the seed bank following burial, with less than 4% remaining after 12 months. Mesquite appears to have moderate seed persistence, with less than 0.5% viability after 36 months. Prickly acacia, leucaena, lantana and parthenium are demonstrating long-term persistence.

Collaborators

Bob Mayer (Queensland Department of Agriculture, Fisheries and Forestry, Townsville)

5. Controlling calotrope (*Calotropis procera*) in northern Australia

Project dates

June 2010 – June 2014

Project team

Dr Shane Campbell, Chris O'Donnell, Laura Roden, Kelli Pukallus and Dr Wayne Vogler

Project summary

This project is part of a larger collaborative research program (funded by Meat and Livestock Australia) aimed at improving understanding of the distribution and rate of spread, reproductive biology, invasiveness and control of calotrope. Biosecurity Queensland is focusing on improving control options, while Charles Darwin University and the Northern Territory Department of Land Resource Management investigate the other aspects. Control research implemented to date includes:

- testing of cut stump, frill, basal bark and soil herbicide applications to provide practical options for control of isolated plants
- screening and rate testing of foliar herbicides to provide more effective options
- evaluation of aerial application of tebuthiuron for broadscale control in appropriate areas (in conjunction with Dow AgroSciences)
- testing the susceptibility of calotrope to mechanical control through cutting experiments and evaluation of demonstration sites.

While calotrope appears difficult to kill using herbicides, preliminary results indicate that there is at least one effective herbicide for each of the application techniques being investigated. Calotrope also appears susceptible to being cut off below ground with 100%, 0% and 0% regrowth recorded for plants cut at 0 cm, 10 cm and 20 cm depths, respectively. However, demonstrations of mechanical techniques indicate that large-scale seedling recruitment can occur afterwards.

Collaborators

Charles Darwin University, Department of Land Resource Management (Northern Territory)

Key publications

Grace, BS 2006, 'The biology of Australian weeds 45. *Calotropis procera* (Aiton) W.T. Aiton', *Plant Protection Quarterly,* 21(4): 152–160.

Vitelli, J, Madigan, B, Wilkinson, P & van Haaren, P 2008, 'Calotrope (*Calotropis procera*) control', *The Rangeland Journal,* 30(3): 339–48.

6. Herbicide application research

Project dates

June 2008 – June 2013

Project team

John McKenzie and Dannielle Brazier

Project summary

The objective of this project is to improve herbicide control options for priority weeds in central, western and northern parts of the state. Recently, we have been investigating the use of low-volume, high-concentration applications of several chemicals on bellyache bush. The purpose is to provide control options for this weed in inaccessible locations. We have also been testing several herbicides (including a new product) on calotrope, Chinee apple and prickly acacia using the stem injection technique. This is to increase the range of options, particularly for sensitive areas where water-based herbicide applications are generally preferred to those employing diesel as the carrier. The use of misters as a potential control option for prickly acacia regrowth is also being investigated.

The bellyache bush research is now completed, with metsulfuron-methyl proving highly effective as low-volume, high-concentration applications. A minor use permit application has been submitted to the Australian Pesticides and Veterinary Medicines Authority, seeking approval for this technique to be used in Queensland. The stem injection research is progressing well, with at least one effective herbicide showing promise for each of the targeted weeds. The misting research is still in its early stages.

Collaborators

Desert Channels Queensland

Key publications

Brazier, D, McKenzie, J, Owen, A, Campbell, S, Vitelli, J, Reid, A & Mayer, R 2010, 'Evaluating herbicides for the control of the invasive weed florestina (*Florestina tripteris* DC. Prod.)', in SM Zydenbos (ed), *Proceedings of the 17th Australasian weeds conference*, The New Zealand Plant Protection Society (Inc.) & the Council of Australasian Weed Societies Inc., Christchurch, New Zealand, pp. 421–3.

McKenzie, J, Brazier, D, Vitelli, J, Owen, A & Mayer, R 2010, 'Stem injection: a control technique often overlooked for exotic woody weeds', in SM Zydenbos (ed), *Proceedings of the 17th Australasian weeds conference*, The New Zealand Plant Protection Society (Inc.) & the Council of Australasian Weed Societies Inc., Christchurch, New Zealand, pp. 459–61.

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

Project dates

July 2007 – June 2013

Project team

Dr K Dhileepan and Mariano Treviño

Project summary

Research conducted at the Centre for Agricultural Bioscience International (CABI) Europe–UK on the rust pathogen *Phakopsora jatrophicola* concentrated on the comprehensive host-specificity assessment of the rust strain ex Trinidad (W 2512/IMI 397973). Host-range testing is now near completion, with 33 out of 39 test plant species fully assessed. Visible symptoms caused by the selected strain of *P. jatrophicola* on non-target species range from none (i.e. *Actephila lindleyi, Petalostigma pubescens*), to yellowing and/or leaf spotting from tissue death (i.e. *Cleistanthus dallachyanus*, *Codiaeum variegatum*), to restricted sporulation (*Aleurites moluccana, Beyeria viscosa*).

Samples of any non-target species showing visible symptoms thought to be related to the rust pathogen have been taken for more in-depth microscopic evaluation. Full details of the host-range testing will be documented for each test species in the final project report. The remaining six non-target species were difficult to source, but were established under quarantine conditions at CABI Europe–UK and were tested during the last quarter of 2012.

Studies to determine the life cycle of *P. jatrophicola* have continued by attempting to induce germination of resting stages and produce spores for infection studies through different stimuli, such as fluctuating incubation temperatures and exposure to hydrogen peroxide.

Collaborators

Marion Seier (CABI Europe–UK, United Kingdom), Tanya Scharaschkin (Queensland University of Technology)

Key publications

Bebawi, FF, Vitelli, JS, Campbell, SD, Vogler, WD, Lockett, CJ, Grace, BS, Lukitsch, B & Heard, TA 2007, 'The biology of Australian weeds 47. *Jatropha gossypiifolia* L.', *Plant Protection Quarterly,* 22(2): 42–58.

Heard, TA, Chan, RR, Senaratne, KADW, Palmer, WA, Lockett, CJ & Lukitsch, B 2009, '*Agonosoma trilineatum* (Heteroptera: Scutelleridae): a biological control agent of the weed bellyache bush, *Jatropha gossypiifolia* (Euphorbiaceae)', *Biological Control,* 48(2): 196–203.

8. Biological control of prickly acacia (*Acacia nilotica* ssp. *indica*)

Project dates

January 2007 – June 2014

Project team

Dr K Dhileepan, Catherine Lockett, Di Taylor and David Perovic

Project summary

A scale insect (*Anomalococcus indicus*), a leaf-webber (*Phycita* sp. 'A') and a leaf weevil (*Dereodus denticollis*) were imported into the Brisbane quarantine facility in January 2011. Colonies of the leaf-webber and the scale insect have been established in the quarantine and so far no-choice host-specificity tests have been completed for 28 test plant species. Larvae of the leaf-webber fed and developed through to maturity on 13 native species. Due to the high potential non-target risk, this agent will not be pursued further. For the scale insect, mature gravid females have developed only on three non-target test plant species so far (*A. complanata*, *A. falcata* and *A. farnesiana*).

Significantly fewer mature females developed on these non-target plants than on *A. nilotica*, suggesting they are not preferred host species. Further assessment on the suitability of the non-target plants for sustaining populations of the scale are in progress, using no-choice demographic studies. A gall rust (*Ravenelia acacia-arabicae*) and a leaf rust (*Ravenelia evansii*) were sent to the Centre for Agricultural Bioscience International (CABI) Europe–UK for preliminary host-specificity testing.

Collaborators

Roger Shivas (Biosecurity Queensland, Brisbane), Marion Seier (CABI Europe–UK, United Kingdom), Institute of Forest Genetics and Tree Breeding (India)

Key publications

Dhileepan, K 2009, '*Acacia nilotica* ssp. *indica* (L.) Willd. ex Del. (Mimosaceae)', in R Muniappan, GVP Reddy & A Raman (eds), *Biological control of tropical weeds using arthropods*, Cambridge University Press, Cambridge, pp. 17–37.

Dhileepan, K, Lockett, CJ, Robinson, M & Pukallus, K 2009, 'Prioritising potential guilds of specialist herbivores as biological control agents for prickly acacia through simulated herbivory', *Annals of Applied Biology,* 154(1): 97–105.

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

Project dates

September 2002 – June 2014

Project team

Dr K Dhileepan and Mariano Treviño

Project summary

The cat's claw creeper leaf-mining jewel beetle (*Hylaeogena jureceki*), a native of tropical South America, was approved for field release in Australia in May 2012. This insect feeds and develops on both the 'long-pod' and 'short-pod' forms of this weed, but shows a marked preference for long-pod form when feeding and egg laying in the quarantine.

A trip to South America was undertaken to conduct surveys for potential biological control agents for cat's claw creeper over a three-week period (March–April 2012). A total of 84 sites were surveyed across 4500 km, covering southern Brazil, southern Paraguay and northern Argentina. In addition to the seven known species of specialist insects (*Charidotis auroguttata*, *Carvalhotingis visenda*, *C. hollandi*, *Neocrassana undata*, *Hylaeogena jureceki*, *Hypocosmia pyrochroma* and *Apteromechus notatus*), an unidentified leaf-miner, a seed-feeding cecidomyiid and a stem-galling rust fungus were also catalogued during the survey.

Collaborators

Stefan Neser and Anthony King (Agricultural Research Council—Plant Protection Research Institute, South Africa), Dr Tanya Scharaschkin (Faculty of Science and Technology, Queensland University of Technology)

Key publications

Dhileepan, K 2012, '*Macfadyena unguis-cati* (L.) AH Gentry—cat's claw creeper', in M Julien, RE McFadyen & J Cullen (eds), *Biological control of weeds in Australia: 1960 to 2010*, CSIRO Publishing, Melbourne, pp. 351–9.

Dhileepan, K, Treviño, M, Bayliss, D, Saunders, M, Shortus, M, McCarthy, J, Snow, EL et al. 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.

10. Biological control of Hudson pear (*Cylindropuntia rosea*)

Project dates

October 2009 – June 2012

Project team

Dr Bill Palmer and Peter Jones

Project summary

DNA analyses of the *Cylindropuntia* spp. naturalised in Australia and plant material from South Africa, Mexico and Spain were not definitive. More detailed genetic work is required to resolve the taxonomy of the genus and assist identification of suitable agents.

Biotypes of a cochineal scale insect (*Dactylopius tomentosus*) from Mexico, South Africa and South Australia were cultured. Host-range testing of the Australian biotype has shown that it is compatible with Australian populations of *C. rosea*, Spanish and Mexican populations of *C. rosea*, and Australian populations of C. *fulgida* var. *mamillata* and *C. imbricata*.

Host-range testing of the Mexican biotype has indicated that this biotype will not attack any of the Australian or Spanish populations of *C. rosea*, giving a clear indication that there are taxonomic issues with the species *C. rosea*.

Host-range testing of the South African biotype, which is an outstanding biocontrol agent for *C. fulgida*, so far indicates good activity against *C. rosea* collected from Mexico and Cracow (Queensland). Good activity has also been observed on Australian populations of *C. imbricata, C. fulgida* var. *mamillata* and *C. kleiniae*. Of the three biotypes under testing, this biotype appears the most vigorous.

Further surveying of *D. tomentosus* was undertaken in Mexico by Dr Carla Chavez in December 2011.

Collaborators

Royce Holtkamp (Department of Primary Industries, New South Wales), Catherine Mathenge (University of Western Sydney), Carla Chavez Moreno (University of Michoacan, Mexico), Mayra Pérez and Sandi Cuen (Aridamerica AC, Mexico), Helmuth Zimmermann (Helmuth Zimmermann & Associates, South Africa)

Key publications

Holtkamp, RH 2012, '*Cylindropuntia imbricata* (Haw.) FM Knuth—rope pear *Cylindropuntia rosea* (DC.) Backeb.—Hudson pear', in M Julien, R McFadyen & JM Cullen (eds), *Biological control of weeds in Australia*. CSIRO Publishing, Melbourne, pp. 198–202.

Mathenge, CW, Holford, P, Hoffmann, JH, Zimmermann, HG, Spooner-Hart, R & Beattie, GAC 2010, 'Determination of biotypes of *Dactylopius tomentosus* (Hemiptera: Dactylopiidae) and insights into the taxonomic relationships of their hosts, *Cylindropuntia* spp.', *Bulletin of Entomological Research,* 100(3): 347–58.

11. Biological control of mother-of-millions (*Bryophyllum* spp.)

Project dates

January 2000 – July 2012

Project team

Dr Bill Palmer and Wilmot Senaratne

Project summary

We maintained cultures of *Osphilia tenuipes* and *Alcidodes sedi* in quarantine at the Ecosciences Precinct throughout the year. These insects remain promising biocontrol agents if they can be approved for release. Unfortunately, neither is completely host-specific to the weed. Host testing indicates that *Osphilia* will also attack the ornamental kalanchoe, which is sold as a 'pot of colour' in nurseries. *Alcidodes* is less host-specific than *Osphilia*. Risk to the ornamental plant industry can be minimised by property hygiene, insecticides and other practices.

Nevertheless, this potential conflict of interest means that approval for release of these agents would only occur after they are declared under the *Biocontrol Act 1987* in Queensland. The Act provides protection against litigation and prevents legal injunction to stop releases of the agent. This is being pursued for *Osphilia*, but is unlikely to be finalised until at least 2015.

Collaborators

Bob Parker (Biosecurity Queensland, Brisbane), Michelle Rafter (The University of Queensland)

Key publications

Palmer, WA & Rafter, MA 2012, '*Bryophyllum delagoense* (Ecklon & Zeher) Schinz—mother-of-millions', in M Julien, R McFadyen & J Cullen (eds), *Biological control of weeds in Australia*, CSIRO Publishing, Melbourne, pp. 99–107.

McLaren, DA, Palmer, WA & Morfe, TA 2006, 'Costs associated with declaring organisms through the *Biological Control Act* when conflicts of interest threaten weed biological control projects', in C Preston, JH Watts & ND Crossman (eds), *Proceedings of the 15th Australian weeds conference*, Weed Management Society of South Australia, Adelaide, pp. 549–52.

12. Biological control of Madeira vine (*Anredera cordifolia*)

Project dates

June 2007 – June 2013

Project team

Dr Bill Palmer and Liz Snow

Project summary

Approval to release the leaf-feeding beetle *Plectonycha correntina* was given by both Australian Government regulatory authorities (Department of Agriculture, Fisheries and Forestry and Department of Sustainability, Environment, Water, Population and Communities) in early 2011 and the insect was released from quarantine in April 2011.

Mass-rearing of the insect commenced immediately within the glasshouses at the Ecosciences Precinct. It was reared successfully in these facilities and sufficient beetles were produced to begin field releases. Adult beetles were given to the New South Wales Department of Primary Industries to establish a mass-rearing program at the Grafton Primary Industries Institute for releases in that state.

By July 2012, some 33 500 beetles had been released throughout most areas of infestation in Queensland and New South Wales, with a large number being released in the western suburbs of Brisbane. Releases were usually of 50–1000 adults placed at a single point.

Approximately 30% of release sites showed evidence of establishment by July 2012. Batch size did not appear to affect establishment success. The insect did not appear to disperse large distances from the release site.

Dr Neser and Dr Dhileepan visited South America in the hope of finding populations of *Phenrica sp. or other potential biocontrol agents, but no insect species were forthcoming.*

Collaborators

Dr Stefan Neser and Liamé van der Westhuizen (Agricultural Research Council—Plant Protection Research Institute, South Africa), Department of Primary Industries (New South Wales)

Key publications

Palmer, WA & Senaratne, KAD 2012, '*Anredera cordifolia* (Ten.) Steenis—Madeira vine', in M Julien, R McFadyen and JM Cullen (eds), *Biological control of weeds in Australia*, CSIRO Publishing, Melbourne, pp. 60–4.

Cagnotti, C, McKay, F & Gandolfo, D 2007, 'Biology and host specificity of *Plectonycha correntina* Lacordaire (Chrysomelidae), a candidate for the biological control of *Anredera cordifolia* (Tenore) Steenis (Basellaceae)', *African Entomology,* 15(2): 300–9.

13. Biological control of lantana (*Lantana camara*)

Project dates

July 1996 – June 2014

Project team

Michael Day, Natasha Riding and Kelli Pukallus

Project summary

The herringbone leaf-mining fly (*Ophiomyia camarae*) continues to be mass-reared at the Tropical Weeds Research Centre in Charters Towers and field-released at climatically suitable sites north of Rockhampton. The fly is widely found from Rockhampton to Cooktown and is causing seasonal defoliation. Populations in south-eastern Queensland appeared to have died out.

The sap-sucking bug *Aconophora compressa* and the pathogen *Prospodium tuberculatum* have been found around Mackay for the first time. *Aconophora* is now found from the New South Wales border to Gladstone, around Mackay and Mount Fox, and is widespread on the Atherton Tableland. *Prospodium* is found from the New South Wales border to Bundaberg, around Mackay and Paluma, and is widespread on the Atherton Tableland. The budmite *Aceria lantanae* has been approved for release in 2012–13. A colony was established outside quarantine and field releases commenced in spring 2012.

A report on the host-specificity testing of the pathogen *Puccinia lantanae* was received from Centre for Agricultural Bioscience International (CABI) Europe–UK. Further testing is recommended prior to submission of an application to Australian Government regulatory authorities for its release.

Collaborators

Agricultural Research Council—Plant Protection Research Institute (South Africa), CABI Europe–UK (United Kingdom), Centre for Origin Research (United States), CSIRO Plant Industry, CSIRO Ecosystem Sciences, Department of National Parks, Recreation, Sport and Racing (Queensland), Office of Environment and Heritage (New South Wales), Department of Primary Industries (New South Wales), The University of Queensland, local governments in Queensland and New South Wales

Key publications

Day, M 2012, '*Lantana camara* L.—lantana', in M Julien, R McFadyen & J Cullen (eds), *Biological control of weeds in Australia*, CSIRO Publishing, Melbourne, pp. 334–46.

Day, MD & Zalucki, MP 2009, '*Lantana camara* Linn. (Verbenaceae)', in R Muniappan, GVP Reddy & A Raman (eds), *Biological control of tropical weeds using arthropods*, Cambridge University Press, Cambridge, pp. 211–46.

14. Biological control of mikania vine (*Mikania micrantha*) in Papua New Guinea and Fiji

Project dates

July 2006 – June 2012

Project leader

Michael Day

Project summary

The rust fungus *Puccinia spegazzinii* has been widely released in Papua New Guinea and has established in 12 of the 15 provinces in which *Mikania micrantha* occurs. Recent releases in two provinces still need to be checked. Establishment success was 87% at release sites over 100 m above sea level, while success was only 38% at release sites at a lower elevation. The rust spread up to 40 km from some sites within 12 months.

In Fiji, the rust was released on four islands and established on Viti Levu and Vanua Levu only. The rust has caused the cover of *M. micrantha* to decrease by 50% at several monitoring sites in both countries.

Collaborators

Australian Centre for International Agricultural Research, Secretariat of the Pacific Community, Ministry of Primary Industries (Fiji), National Agricultural Research Institute (Papua New Guinea), Cocoa and Coconut Research Institute (Papua New Guinea), Papua New Guinea Oil Palm Research Association, Centre for Agricultural Bioscience International Europe–UK (United Kingdom), Roch Desmier de Chenon (Consultant, Indonesia)

Key publications

Day, M 2012, '*Mikania micrantha* Kunth—mile-a-minute', in M Julien, R McFadyen & J Cullen (eds), *Biological control of weeds in Australia*, CSIRO Publishing, Melbourne, pp. 368–72.

Day, MD, Kawi, A, Kurika, K, Dewhurst, CF, Waisale, S, Saul Maora, J, Fidelis, J, Bokosou, J, Moxon, J, Orapa, W & Senaratne, KAD 2012, '*Mikania micrantha* Kunth (Asteraceae) (mile-a-minute): its distribution and physical and socio economic impacts in Papua New Guinea', *Pacific Science,* 66: 213–23.

15. Improving weed management in Vanuatu

Project dates

October 2011 – September 2014

Project leader

Michael Day

Project summary

An AusAID-funded project to increase the capacity of weed management in Vanuatu commenced in October 2011. Department of Livestock and Quarantine Services (DLSQ) staff travelled to Papua New Guinea in November to work with National Agricultural Research Institute (NARI) staff to gain experience handling the mikania rust *Puccinia spegazzinii* prior to its introduction into Vanuatu. DLSQ staff travelled to Brisbane in December to discuss and prepare project plans with the Australian project leader.

A workshop was held in Port Vila in March to discuss agreed project activities with regional staff and how best to implement them. During the workshop, a field trip was undertaken around Efate to inspect various weed infestations and discuss options for control. The mikania rust was hand-carried into Vanuatu by NARI staff, who also assisted in establishing a culture in the quarantine facility. Rearing is now in its third generation and field releases have commenced.

Brochures covering the main weeds were printed by the Secretariat of the Pacific Community and have been distributed around the major islands of Vanuatu. Import permits have been received for *Neochetina bruchi*, a biocontrol agent for water hyacinth. Applications for import permits for parthenium and cat's claw creeper agents are being prepared.

Collaborators

Department of Livestock and Quarantine Services (Vanuatu), Secretariat of the Pacific Community, National Agricultural Research Institute (Papua New Guinea)

16. Biological control of *Chromolaena odorata*

Project dates

July 2011 – June 2014

Project team

Michael Day and Natasha Riding

Project summary

Chromolaena odorata (chromolaena or Siam weed) was first detected in Australia in 1994, near Bingil Bay, northern Queensland. It is a Class 1 weed in Queensland and has been the target of a national cost-share eradication program. However, a national decision was made in 2011–12 that eradication was no longer considered technically feasible. To assist in managing this weed beyond the eradication program, biological control options should be investigated, since this control tactic has the potential to reduce the weed's impact and slow its spread.

The gallfly *Cecidochares connexa* was first introduced into Indonesia in 1995, and subsequently into Micronesia, Papua New Guinea and Timor Leste. In January 2012, it was imported from Papua New Guinea into quarantine at the Ecosciences Precinct and host-specificity testing commenced against plant species in the tribe Eupatorieae. Sixteen species have been tested at least four times, with galls developing on *Chromolaena odorata* and the weed *Praxelis clematidea* only. Adults emerged from both species, but far fewer emerged on *P. clematide*a than on *C. odorata*. Single species no-choice trials and paired-choice trials are still to be conducted. Testing is expected to be completed by late 2013.

Collaborators

National Agricultural Research Institute (Papua New Guinea)

Key publications

Day, M & McFadyen, R 2012, '*Chromolaena odorata* (L.) King and Robinson—chromolaena', in M Julien, R McFadyen & J Cullen (eds), *Biological control of weeds in Australia*, CSIRO Publishing, Melbourne, pp. 162–9.

Day, MD & Bofeng, I 2007, 'Biocontrol of *Chromolaena odorata* in Papua New Guinea', in P-Y Lai, GVP Reddy & R Muniappan (eds), *Proceedings of the seventh international workshop on biological control and management of* Chromolaena odorata *and* Mikania micrantha, National Pingtung University of Science and Technology, Taiwan, pp. 53–67.

17. Weed eradication and containment—feasibility and program evaluation

Project dates

July 2003 – June 2013

Project team

Dr Dane Panetta, Simon Brooks and Dr Shane Campbell

Project summary

Methods for evaluating weed containment programs have been developed. Evaluation is relatively straightforward if containment is either absolute or near absolute, and may be based on total containment area and direct measures of containment failure (e.g. levels of dispersal, establishment and reproduction beyond, but close to, containment lines). Where containment is only partial, other measures of containment effectiveness will be required—such as changes in the rates of detection of new infestations following the imposition of interventions designed to reduce dispersal, the degree of compliance with such interventions, and the effectiveness of tactics intended to reduce seed production or other demographic drivers of weed spread.

The units for reporting eradication progress in the Four Tropical Weeds Eradication Program database have been converted from a buffered infestation area to fixed management areas of 1 ha (100 m × 100 m) to enable more consistent and accurate reporting. This transition has been accompanied by more intensive recording of plant presence and absence, enabling individual cells within large infestations to progress to the monitoring stage. This is useful for showing current eradication progress within single infestations. However, a finer scale of recording increases the discovery rate of local management areas in the short term.

Collaborators

Oscar Cacho (University of New England), Biosecurity Queensland (South Johnstone), local government staff

Key publications

Panetta, FD 2012, 'Evaluating the performance of weed containment programmes', *Diversity and Distributions*, 18(10): 1024–32.

Panetta, FD, Cacho, O, Hester, S, Sims-Chilton, N & Brooks, S 2011, 'Estimating and influencing the duration of weed eradication programmes', *Journal of Applied Ecology*, 48(4): 980–8.

18. Ecology and control of national weed eradication targets

Project dates

July 2008 – June 2013

Project team

Simon Brooks, Dr Shane Campbell, Dr Wayne Vogler, Kirsty Gough, Stephen Setter and Judy Clark

Project summary

The project concentrates on the key biological parameters influencing the field operations targeting tropical weeds for eradication, such as seed bank persistence, age to maturity, control measures and dispersal potential.

New trials established this year include:

- seed longevity (or persistence) for *Mikania micrantha* using buried seed packets at South Johnstone
- seed persistence for *Limnocharis flava* under varying periods of immersion
- buoyancy of seeds of high-priority tropical weeds (to aid dispersal modelling)
- effect of viability on terminal velocity on propagules (seeds) of asteraceous weeds
- seed longevity, potential depletive measures and seedling population dynamics of Koster's curse (*Clidemia hirta*) in the field.

Buried-packet trials investigating longevity of melastome (e.g. Koster's curse and *Miconia calvescens*) seeds (in the wet tropics) and Siam weed seeds (in the dry tropics) continued this year, as did observations on growth to maturity of invasive melastomes. Immersion, salinity, depletive chemicals and wash-down additive treatments were also investigated on seeds from a range of species targeted for eradication.

The following Siam weed trials were completed, with data being prepared for publication:

- refined rates of low-volume herbicide application via 'splatter gun'
- effects of repeat burning on Siam weed seed banks
- growth rates and time to maturity of Siam weed in pot trials.

Collaborators

Biosecurity Queensland (South Johnstone and Townsville), CSIRO Ecosystem Sciences (Atherton), Department of National Parks, Recreation, Sport and Racing (Queensland)

Key publications

Breaden RC, Brooks SJ & Murphy HT 2012, 'The biology of Australian weeds 59. *Clidemia hirta* (L.) D. Don.', *Plant Protection Quarterly*, 27(1): 3–18.

19. Class 1 weed control packages

Project dates

July 2008 – June 2013

Project team

Joseph Vitelli, Barbara Madigan and Annerose Chamberlain

Project summary

This project aims to develop reliable and effective control options that can be integrated into eradication programs for Queensland Class 1 weeds (currently 53 Class 1 species are naturalised). Research includes investigating control options and collecting basic ecological data (e.g. time to reproductive maturity and soil seed bank persistence).

Control studies

A herbicide trial using picloram granules and picloram gel on alligator weed was initiated at Miriam Vale in August 2011. The treated area contained no regrowth eight months later. A dose response trial is planned to optimise the application rate.

An additional trial was initiated in April 2012 at the Ecosciences Precinct to determine the most effective herbicides (dichlobenil, glyphosate, imazapyr, metsulfuron, picloram, sulfometuron and picloram + metsulfuron) and number of applications (1, 2, 3, 4 and 5) to control alligator weed. A critical impediment to effective control of this species has been continued regrowth from root fragments. The trial will determine root fragment viability following treatment by herbicides.

Other studies include chemical control of Senegal tea and black willow, and both mechanical and chemical control of badhara bush.

Ecological studies

Accelerated seed ageing trials are continuing for Senegal tea, Siam weed, *Acacia glauca* and badhara bush.

Collaborators

Jane Oakey and Brad Pease (Biosecurity Queensland, Brisbane), Biosecurity Queensland field staff, Brisbane City Council, Capricorn Pest Management Group, Logan City Council, Seqwater, Brett Cawthray (Gladstone Regional Council), Scott Day (Central Highlands Regional Council)

20. Expanding the aquatic herbicide list—a proactive approach

Project dates

22 March 2011 – 21 May 2012

Project team

Joseph Vitelli and David Holdom

Project summary

Our ability to manage aquatic weeds is hindered by a lack of available tools. This project aimed to improve the chemical options available to managers entrusted with managing aquatic ecosystems by gaining input from key individuals in state and federal agencies involved in aquatic weed management. The project outcomes were:

1. a set of nationally consistent guidelines on the use of agricultural chemicals in aquatic systems
2. an improved and standardised process for undertaking small-scale aquatic weed research, leading to a streamlined process for the issuing of aquatic minor use permits
3. the identification of 12 actives with new formulations and chemistry that are safer for operational staff, pose reduced risk to aquatic organisms and improve the control of many floating, submerged and semi-terrestrial aquatic weeds.

The ongoing national stakeholders group (established as part of the project) will continue to ensure a consistent approach to chemical use in aquatic systems and will be facilitated through the National Aquatic Weed Management Group. This stakeholder group will be a conduit to deliver up-to-date information pertaining to aquatic herbicides to the appropriate agencies in each state and territory. In addition, the Australian Pesticides and Veterinary Medicines Authority (APVMA) will be able to use the report findings to assist with future aquatic herbicide registrations.

Collaborators

Karl Adamson (APVMA, Canberra), Phillip Sinclair and Zahid Saeed (Department of Sustainability, Environment, Water, Population and Communities, Canberra), Tony Dugdale (Victorian Department of Primary Industries, Knoxfield), John Moore (Western Australian Department of Agriculture and Food, Albany), Andrew Petroeschevsky and David Officer (New South Wales Department of Primary Industries, Grafton), Tony Cook (New South Wales Department of Primary Industries, Calala), Steve Wingrave, (Northern Territory Department of Land Resource Management, Palmerston), Stephen Johnson (New South Wales Department of Primary Industries, Orange), Nimal Chandrasena (ALS Laboratory Group, Sydney)

21. Identifying herbicide resistance patterns in non-cropping systems

Project dates

March 2011 – May 2012

Project team

Joseph Vitelli, David Holdom, David Thornby, Barbara Madigan and Jens Froese

Project summary

Herbicide resistance in cropping weeds is well documented, with populations of many crop weeds now identified as being resistant to a wide range of herbicides. Herbicide resistance in non-agricultural situations, however, is often not reported and little is known about the risks of herbicide resistance in these land uses.

The intensive use of glyphosate for weed control has resulted in glyphosate-resistant weeds evolving in many situations, including railways, rights-of-way, roadsides and irrigation channels. Widespread resistance to glyphosate in these areas will have significant impacts on weed management, including potential spread to other land uses. An electronic survey and eight workshops were used to identify weeds targeted and weed management practices in non-agricultural areas across three catchments in Queensland. Glyphosate was the most widely used herbicide, followed by metsulfuron-methyl.

A weed risk assessment based on information obtained identified 16% of the 122 weed species assessed as having a high risk of developing glyphosate resistance. Water authorities were identified as the sector most at risk. The surveys also identified considerable variation in the knowledge of herbicide resistance and management risks. Other constraints to the use of weed management practices included budget constraints, environmental factors, training and understanding of alternatives.

Collaborators

Christopher Preston (The University of Adelaide), Andrew Storrie (Agronomo, Albany, Western Australia), John Cameron (Independent Consultants Australia Network, Hornsby, New South Wales)

22. Ecology and management of *Mimosa pigra*

Project dates

July 2008 – June 2013

Project team

Joseph Vitelli and Barbara Madigan

Project summary

Research on the biology and control of *Mimosa pigra* supports the effort to eradicate the species at Peter Faust Dam near Proserpine. This includes advising on the timing of site revisits to ensure plants are detected and controlled prior to setting seed, and predicting how long the eradication effort needs to continue. Soil cores were not extracted during 2011–12, as the core area was under water after heavy rains filled the dam in early 2010. However, prior to inundation it was estimated that the seed bank would be exhausted by 2017.

Collaborators

Jane Oakey and Brad Pease (Biosecurity Queensland, Brisbane), Kay Bailey, Christopher Collins, Bert Lukitsch, Ian Cowie, Ben Stuckey, Em Pedler and Ben Matthias (Department of Land Resource Management, Northern Territory), Tim Heard and Gio Fichera (CSIRO Ecosystem Sciences), Chris Hawkins and Tracey Vinnicombe (Department of Agriculture and Food, Western Australia), Syd Laker (Adjumarllarl Rangers), Willy Rioli, Vivian, Kim, D Tipakalippa, Colin and Nicholas Hunter (Tiwi Land Council, Pirlingimpi Community)

Key publications

Vitelli, JS, Oakey, J, Madigan, BA, Driver, L, Chamberlain, AA & Heard, TA 2011, 'Preliminary study in the use of molecular tools to help determine the origins of *Mimosa pigra* infestations in Queensland, Western Australia and the Northern Territory', in J Hodgon (ed), *Proceedings of the 11th Queensland weed symposium*, The Weed Society of Queensland Inc., Mackay, 31 July – 3 August 2011, Weed management: Back to basic, pp. 65–8.

Vitelli, JS, Madigan, BA & Worsley, KJ 2006, '*Mimosa pigra* in Queensland', in C Preston, JH Watts & ND Crossman (eds), *Proceedings of the 15th Australian weeds conference*, Weed Management Society of South Australia, Adelaide, pp. 251–4.

23. Ecology and control of wet tropics weeds

Project dates

January 1999 – June 2013

Project team

Stephen Setter, Dr Wayne Vogler, Laura Roden, Barbara Madigan and Darren Evans

Project summary

Navua sedge (*Cyperus aromaticus*)

We conducted a foliar herbicide rate screening trial at Gordonvale and Malanda, following a foliar herbicide screening trial near Millaa Millaa in 2010–11. Sempra™ (halosulfuron 750 g/kg), in conjunction with the wetter Bonza™, has proven to be the most effective herbicide. Withholding period issues will need to be resolved prior to seeking registration for use on grazing land. Further pot and field trials will be implemented to provide refined management options.

A trial to determine the persistence of navua sedge seed in the soil was implemented 10 years ago. Initial seed viability was 77%. Viability of seed retrieved this year was 5%, 7% and 34% after being buried at 0 cm, 2 cm and 10 cm respectively.

Bogmoss (*Myaca fluviatilis*)

Currently no adequate control options exist for this aquatic weed. Triclopyr, endothal, imazapyr, metsulfuron, flumioxazin, carfentrazone and diquat were applied at three rates to submerged bog moss growing in 2 L jars. The most effective herbicides/rates will be tested in a time-exposure trial and in a large-container trial, using emergent bog moss.

Stevia (*Stevia ovata*)

Management studies have been initiated, including determining germination requirements (temperature and light), soil seed bank longevity, age to reproduction and herbicide screening trials.

Collaborators

Cairns Regional Council, Cassowary Coast Regional Council, Far North Queensland Regional Organisation of Councils, Tablelands Regional Council, landholders at Millaa Millaa, Malanda and Gordonvale

24. Population viability analysis models for better management of lantana (*Lantana camara*)

Project dates

July 2008 – June 2012

Project team

Dr Olusegun Osunkoya, Christine Perrett and Cameron Clark

Project summary

We followed the productivity and fate of more than 2000 lantana plants for three years at sites with four land uses in the Nanango region, 200 km north-west of Brisbane—a hoop pine plantation, a cattle farm and two eucalyptus forests, one with occasional grazing and one with a periodic burning regime.

Density and rainfall affected the weed's reproductive capacity and growth, but not its survival. Average fruit production ranged from 1049 to 7409 fruit per plant each year. Plant growth (67.7%) contributed more to observed population growth rate (› 200% per year) than fecundity (20.6%) or survival (10.8%). Across size groups, the contribution was in the following order—juvenile (20–27%), seed (18–28%), seedling (18–22%), small adult (4–15%), medium adult (1–7%) and large adult (‹ 2%).

From a control perspective, it is difficult to determine a single weak point that might be exploited to reduce growth of lantana populations below a sustaining rate. The triennial fire regime applied did not result in local control of lantana. However, simulations showed that, except for the farm population, periodic burning could work within 4–10 years for control of the weed, but fire frequency should increase to once in 2 years. For the farm, site-specific control may be achieved by 15 years if the biennial fire frequency is tempered with increased burning intensity.

Collaborators

S Raghu (CSIRO Ecosystem Sciences), Joe Scalan (Biosecurity Queensland, Toowoomba)

Key publications

Osunkoya, OO, Perrett, C, Fernando, C, Clark, C & Raghu, S 2012, 'Stand dynamics and spatial patterns of the invasive *Lantana camara* L. (Verbenaceae)', *Plant Ecology,* 213: 883–97.

25. Impacts of environmental weeds on soil processes

Project dates

January 2010 – June 2012

Project team

Dr Olusegun Osunkoya, Christine Perrett and Cameron Clark

Project summary

Information on changes in soil chemistry mediated by lantana has been provided in previous reports. This summary is on the invasive cat's claw creeper vine *Dolichandra unguis-cati* (Bignoniaceae). Soils from infested versus uninfested areas and leaves of cat's claw creeper and three co-occurring vine species (one exotic—*Passiflora suberosa*, and two native—*Parsonsia straminea* and *Smilax australis*) were collected at six sites (riparian and non-riparian) in south-eastern Queensland.

The invasion effect of cat's claw creeper on soil chemistry was more pronounced in non-riparian than in riparian habitat. Significantly higher values were obtained in cat's claw creeper-infested soils for ~50% of traits. Leaf ion concentrations differed significantly between exotic and native vines. Observed higher leaf nutrient load (especially nitrogen, phosphorus and potassium) in invasive plants aligns with species' preference for disturbed habitats with higher nutrient input. The higher load of trace elements (aluminium, boron, cadmium and iron) in leaves suggests that cycling of heavy metal ions (many of which are potentially toxic at excess level) could be accelerated in soils of cat's claw creeper-invaded landscapes. Our findings suggest that cat's claw creeper may improve soil fertility and influence nutrient cycling, perhaps through legacy effects of its own litter input.

Collaborators

Tanya Scharaschkin (Queensland University of Technology), Alan Andersen (CSIRO Ecosystem Sciences)

Key publications

Osunkoya, OO & Perrett, C 2011, '*Lantana camara* L. (Verbenaceae) invasion effects on soil physicochemical properties', *Biology and Fertility of Soils,* 47(3): 349–55.

Osunkoya, OO, Polo, C & Andersen, AN 2011, 'Invasion impacts on biodiversity: responses of ant communities to infestation by cat's claw creeper, *Macfadyena unguis-cati* (Bignoniaceae) in subtropical Australia', *Biological Invasions,* 13(10): 2289–302.

Osunkoya, OO & Perrett, C 2011, '*Lantana camara* L. (Verbenaceae) invasion effects on soil physico-chemical properties', *Biology and Fertility of Soils,* 47: 349–55.

26. Cabomba (*Cabomba caroliniana*) ecology

Project dates

October 2010 – July 2012

Project team

Dr Tobias Bickel and Cameron Clark

Project summary

Cabomba poses a significant ecological and economic threat to Australian fresh waters as it reduces biodiversity through displacement of native aquatic plants and seriously interferes with human use of freshwater resources. Currently there is little knowledge about the habitat requirements and dispersal abilities of this weed, severely hampering efforts to prevent further spread.

Cabomba has very specific habitat requirements. The pH of the water is a strongly limiting factor, with cabomba preferring slightly acidic to neutral water (pH6–7). Cabomba seems to satisfy most of its nutrient requirements from the substrate. Nutrient concentrations in solution are of less importance, indicating that cabomba will be able to establish well even in nutrient-poor (oligotrophic) systems as long as there are sufficient nutrients available in the substrate.

Cabomba was able to regenerate even from single node stem fragments. About 50% of the tested fragments developed healthy new shoots. Regeneration success was not dependent on nutrient availability. However, establishment (rooting in substrate) was strongly dependent on fragment size. Single node fragments mostly failed to establish, while fragments with four nodes or more (~10 cm in length) had a high likelihood of establishment.

Collaborators

Brisbane City Council, CSIRO, Seqwater, National Aquatic Weed Management Group, Noosa and District Landcare, Department of Primary Industries (Victoria)

27. Livestock guardian dog and wild dog (*Canis lupus familiaris* and *C. l. dingo*) interaction study

Project dates

May 2009 – December 2011

Project team

Dr Lee Allen, James Speed and Mark Goullet

Project summary

As in 2010–11, we placed GPS collars on maremma guardian dogs and satellite collars (GPS/Argos) on wild dogs to monitor daily movement patterns, and determine the overlap in home ranges and the potential for guardian dog and wild dog interactions. With little difference observed between individuals, maremmas at Stratford Station were found rarely to venture more than 3 km from the homestead, with three individuals occasionally moving as far as 5 km.

Most of Stratford's paddocks containing calves and weaners (that the property owners thought to be protected by maremmas) were rarely visited. Collared wild dogs ranged widely throughout Stratford and neighbouring properties. However, there was barely any overlap between maremma and wild dog locations at Stratford. This is in contrast to the situation during 2010–11 studies on Dunluce Station, where maremmas remained close to sheep in paddocks, which was apparently sufficient to prevent attacks on sheep by wild dogs.

No DNA evidence was found indicating that maremmas had interbred with wild dogs (and vice versa) during the two-year study, even though considerable opportunity for interbreeding existed.

Collaborators

Ninian Stewart-Moore and Robyn and Terry Brennan (landholders)

Key publications

Allen, L 2012, *Livestock guardian dog/wild dog interaction study*, final report to Australian Bureau of Agriculture and Resource Economics, Department of Agriculture, Fisheries and Forestry, Toowoomba.

Allen, L & Byrne, D 2011, 'How do guardian dogs "work"?', in G Saunders & C Lane (eds), *Proceedings of the 15th Australasian vertebrate pest conference*, Invasive Animals Cooperative Research Centre, Sydney, p. 158.

28. Non-target impacts of 1080 meat baits for feral pigs (*Sus scrofa*)

Project dates

June 2010 – June 2012

Project team

Dr Matt Gentle, James Speed, Dr Tony Pople, Amanda Millar and Michael Brennan

Project summary

Meat baits containing 1080 are widely used to control feral pigs but may provide a poisoning risk to non-target species, particularly carrion-consuming birds and goannas. This project completed a series of population-level counts of susceptible bird species pre- and post-aerial baiting in Culgoa National Park, and three nearby unbaited properties in May and November 2011 and May 2012. This work supports the continued use of 1080 in baits for control of feral pigs.

Bird species monitored were those susceptible to 1080 and known to investigate meat baits, including the Australian magpie, brown falcon, Australian kestrel, wedge-tailed eagle, pied and grey butcherbird, and three raven/crow species. Count data was collected and analysed using distance-sampling techniques. Comparison of pre- and post-baiting densities indicate no consistent, significant declines in the bird species abundance on the baited site (Culgoa National Park) relative to the unbaited control sites.

In November 2011 and May 2012, a sample of 40 baits was monitored via remote cameras and radio transmitters to determine the species visiting and consuming bait. While some baits were moved (particularly by goannas, ravens/crows and birds of prey), few were sampled and none were entirely consumed by non-target species.

The results suggest minimal, if any, impact on susceptible bird species from 1080 meat baits used for feral pig control.

Collaborators

Department of National Parks, Recreation, Sport and Racing (Queensland), The University of Queensland

Key publications

Gentle, M 2010, 'What gets killed by meat baits for feral pigs?', in *Proceedings of the 3rd Queensland pest animal symposium*, Gladstone, Queensland.

29. Feral pig (*Sus scrofa*) best practice research in northern Queensland

Project dates

July 2009 – June 2013

Project team

Dr Jim Mitchell, Brian Ross and Kyle Risdale

Project summary

Feral pigs continue to cause environmental and economic impacts in northern Queensland. Previous research within this project has focused on improving control options (particularly baiting) and quantifying the impacts of feral pigs.

During 2011–12, interaction with overseas research organisations involved in management of the European wild boar occurred to determine if any different technologies could be identified to aid management of feral pigs in Australia. Project leader Jim Mitchell received a 2011 Churchill Fellowship that allowed him to visit several leading European research facilities.

Key findings have been provided to stakeholders in Queensland through presentations at several forums. In particular, European countries use thermal imagery for improved surveillance and monitoring, have developed target-specific bait feeders that could be used for feral pigs, and have advanced models that could be modified to predict the effect of large-scale control programs on the dynamics of feral pig populations.

Feral pig expertise and monitoring has also been provided for a large federal government–funded project being coordinated by Terrestrial Ecosystem Services Pty Ltd. It is aimed at developing monitoring protocols for organisations to demonstrate the effectiveness of large-scale pest animal control programs undertaken to protect key habitats.

30. Long-term effects of ripping warrens in the drought refuge in south-western Queensland

Project dates

January 2004 – June 2012

Project team

Dr David Berman, Michael Brennan and Peter Elsworth

Project summary

Control of rabbits on large, arid zone properties has often been considered ‘too big a problem’ to warrant effort. At Bulloo Downs in south-western Queensland (a property of some 1.1 million hectares), rabbit numbers were estimated to exceed 600 000 in the mid 1990s. Following a demonstration ripping trial in 2000–01, a large-scale ripping program destroying 55 000 warrens was undertaken over 2001–04. Ripping was limited to the drought refuge (areas within 1 km of permanent water). Monitoring conducted at Bulloo Downs in 2011 showed that rabbit numbers remained very low (‹ 4 rabbits per kilometre of spotlight count at Bulloo Downs) in spite of three successive years of high rainfall.

This is in contrast to Coongie Lakes, where no rabbit control was conducted and numbers continued to increase. Rabbit densities almost reached 100 rabbits per kilometre at Coongie Lakes, and had spread over 15 km from the drought refuge. The results indicate that ripping of drought refuge areas in the arid zone can provide effective, long-term control of rabbits over extensive areas.

Collaborators

South West Natural Resource Management Ltd

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.

31. Adaptive management of rabbits (*Oryctolagus cuniculus*) in south-eastern Queensland

Project dates

January 2000 – December 2012

Project team

Dr David Berman and Michael Brennan

Project summary

This trial was initiated to investigate the benefits of rabbit control. At Cottonvale on the Granite Belt in southern Queensland, a site was selected where rabbit density was high outside the Darling Downs Moreton Board rabbit proof fence ('dirty' side) and low immediately over the fence ('clean' side). Monitoring was undertaken pre- and post-rabbit control to determine the effect of changing rabbit abundance on the abundance of native and introduced mammals.

Photos taken with movement-sensing cameras indicated there was a high number of foxes and rabbits on the 'dirty' side of the fence. Bandicoots were present on the 'clean' side but not on the 'dirty' side. Rabbit control by ripping warrens and burning log piles reduced rabbit numbers on the 'dirty' side, and there was a corresponding reduction in fox numbers.

Up to a year after rabbit control there were no bandicoots photographed on either side of the fence, perhaps because of predation by foxes that were forced to switch from rabbits as prey. Three years after ripping, rabbits were not detected on the 'clean' side and were much reduced on the 'dirty' side. Foxes were not detected on either side and bandicoots returned to pre-rabbit control numbers on the 'clean' side. These results suggest benefits to native animals due to rabbit control and a corresponding reduction in foxes.

Collaborators

Susan Fuller (Queensland University of Technology), Mark Ridge (Darling Downs Moreton Rabbit Board), Shane Cartwright (Queensland Murray–Darling Committee), Harley West (Granite Borders Landcare)

Key publications

Brennan, M & Berman, D 2008, 'The value of having no rabbits in South East Queensland', in G Saunders & C Lane (eds), *Proceedings of the 14th Australasian wertebrate pest conference*, The Vertebrate Pests Committee & the Invasive Animals Cooperative Research Centre, Canberra, p. 102.

32. Resistance to rabbit haemorrhagic disease virus in Australian rabbits (*Oryctolagus cuniculus*)

Project dates

July 2007 – December 2012

Project team

Peter Elsworth, Dr David Berman and Andrew Granzotto

Project summary

Rabbit haemorrhagic disease virus (RHDV) has been a successful biological control tool in the control of rabbits throughout Australia. Challenge testing of rabbits collected from numerous populations throughout Australia demonstrated that rabbits are becoming resistant to RHDV. The levels of resistance differed between sites and were correlated with rainfall, with regions of intermediate annual rainfall (300–450 mm) showing greatest resistance.

Breeding trials have shown that wild rabbits bred solely from survivors of direct challenge with RHDV inherit resistance and cannot become infected with low doses of virus. This can progress quickly, with an entire group being resistant within two generations.

Further challenge testing using field isolates of RHDV collected from Turretfield in South Australia and tested against rabbits bred from Turretfield wild rabbits, showed that those isolates performed better than the initial release strain. Additionally, the most recent field isolates produced greater virus titre in the liver, greater mortality and reduced survival time compared to older isolates. This indicates that the field isolates at this site are maintaining, and may even be increasing in, virulence.

The best field isolates will be tested against resistant rabbits from a different population to assess whether it can overcome localised resistance.

Collaborators

Brian Cooke (Invasive Animals Cooperative Research Centre), Greg Mutze, Ron Sinclair and John Kovalivski (Biosecurity South Australia), Tanja Strive (CSIRO)

Key publications

Cooke, BD, Elsworth, PG, Berman, DM, McPhee, SR, Kovalivski, J, Mutze, GJ, Sinclair, RG & Capucci, L 2007, *Rabbit haemorrhagic disease: wild rabbits show resistance to infection with Czech strain 351 RHDV initially released in Australia*, report submitted to Australian Wool Innovation & Meat and Livestock Australia, Invasive Animals Cooperative Research Centre, Canberra.

Story, G, Berman, D, Palmer, R & Scanlan, J 2004, 'The impact of rabbit haemorrhagic disease on wild rabbit (*Oryctolagus cuniculus*) populations in Queensland', *Wildlife Research*, 31(2): 183–93.

33. Distribution, abundance and harvesting of feral goats in the Australian rangelands (1984–2011)

Project dates

May 2011 – February 2012

Project team

Dr Tony Pople and Jens Froese

Project summary

Densities of feral goats in the rangelands of Australia have been estimated over the past three decades by aerial surveys for kangaroo management. These surveys describe a feral goat population in Australia that has grown from 1.4 million in 1997 to 4.1 million in 2008. In 2010, there were an estimated 3.3 million feral goats in the rangelands of Australia, with 70% in New South Wales. In Queensland, there has been an increase in feral goat numbers since 1984 to a population of 491 000 in 2010, increasing almost fivefold in the mulga lands. However, numbers in Queensland have been declining since 2006.

A caveat on these population estimates is that observers on aerial surveys cannot readily distinguish truly feral goats from domestic or managed goats. However, Australian Bureau of Statistics data suggest that the numbers of domestic goats relative to feral numbers are low (but the data needs validation).

The numbers of goats processed at abattoirs has increased from 0.6 million in 1988 to 1.6 million in 2010. A further 8% on average are exported live annually. Assuming 90% of these goats are feral, these figures suggest a commercial harvest rate that has fluctuated between 20% and 50% of the estimated wild population.

Collaborators

Australian Collaborative Rangelands Information System, Department of Environment and Heritage Protection (Queensland), Department of Environment and Conservation (Western Australian), Department of Primary Industries (New South Wales), Department of Environment (New South Wales)

Key publications

Pople, T & Froese, J 2012, *Distribution, abundance and harvesting of feral goats in the Australian rangelands 1984–2011*, final report to the ACRIS Management Committee, Alice Springs, ‹http://www.environment.gov.au/land/rangelands/acris/index.html›.

34. Pest management chemistry

Project dates

Ongoing

Project team

Lesley Ruddle, Alyson Herbert, Emily Strong and Vincent Were

Project summary

This project provides chemistry services to science, policy and operational activities within Biosecurity Queensland's Invasive Plants and Animals Program.

The project provides chemical advice and support to pest management in Queensland and undertakes toxicological and ecotoxicological investigations into the use of vertebrate pesticides. The laboratory, as a unit of Chemical Science, utilises laboratory and formulation facilities at the Health and Food Sciences Precinct at Coopers Plains.

Ecotoxicology

Sodium fluoroacetate (1080) residues in baits (n=370) were completed for the Fox Eradication Branch, Tasmanian Department of Primary Industries, Parks, Water and Environment for input into a Tasmanian model describing the degradation of 1080 baits in the environment.

Forensic toxicology

During 2011–12, our laboratory performed investigations relating to possible animal poisonings by sodium fluoroacetate (n=80), strychnine (n=30), anticoagulant (n=23), zinc phosphide (n=10) and metaldehyde (a molluscicide) (n=4). Most investigations related to domestic dogs and cats, but a number involved wildlife (macropods).

Formulation chemistry

During the year, our formulation facility produced 3270 L of 36 g/L 1080 pig bait solution in accordance with upcoming registration of the formulation with the Australian Pesticides and Veterinary Medicines Authority.

Testing of post-preparation sodium fluoroacetate solutions and meat baits continued throughout the year. Additional testing of 24 sodium fluoroacetate formulations was undertaken for industry.

Collaborators

Biosecurity Queensland

35. Chemical registration—providing tools for invasive pest control

Project dates

July 2015 – June 2015

Project team

David Holdom and Joe Vitelli

Project summary

Biosecurity Queensland holds permits for use of pesticides to control invasive plants and animals. 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.

Applications to obtain registrations or permits for pesticide use follow a set of guidelines laid down by the Australian Pesticides and Veterinary Medicines Authority (APVMA). More information is required for new (unregistered) pesticides than for registered products. The volume of information required also varies depending on the sensitivity of the situation (e.g. aquatic environments) and the extent to which the proposed new use varies from existing registered or permitted uses.

While Biosecurity Queensland has primary responsibility for some pesticides, such as sodium fluoroacetate (1080), the project focuses on obtaining off-label permits for registered, rather than new, chemicals. Consequently, investigations are normally restricted to likely crop and environmental residues, environmental impact, efficacy and safety relating to the use of the pesticide in a new situation or for a new pest. Project staff work with other scientists to ensure data is available to address these issues and that any studies conducted for regulatory purposes meet APVMA requirements and guidelines.

Permits issued by APVMA to Biosecurity Queensland during 2011–12 include strychnine for wild dogs and foxes, and herbicides for candy leaf, *Mimosa pigra*, fireweed, Senegal tea plant and *Hymenachne* spp. In addition, Queensland was added as a jurisdiction to permits held by the New South Wales Government for tussocky grasses, mimosa bush and tropical soda apple.

Collaborators

Biosecurity Queensland field staff, APVMA screening officers

External funding

Research and development contracts

Project/research area	Funding body	Funds ($)
Weed biocontrol in the Solomons and Vanuatu	AusAID	26 000
Controlling calotrope in northern Australia	Meat and Livestock Australia	120 000
Biological control of prickly acacia	Rural Industries Research and Development Corporation	112 000
	Meat and Livestock Australia	45 000
Biological control of Hudson pear	Department of Industry and Investment (New South Wales)	73 000
Biological control of Mikania vine in Papua New Guinea and Fiji	Australian Centre for International Agricultural Research	39 000
Water weed herbicide research	Rural Industries Research and Development Corporation	117 000
Cabomba ecology and dispersal in Australia	Rural Industries Research and Development Corporation	81 000
Identifying herbicide resistance in non-cropping systems	University of Adelaide	53 000
Fox bait assessment	Department of Primary Industries, Parks, Water and Environment (Tasmania)	39 000
Interactions between livestock guardian dogs and wild dogs	Department of Agriculture, Forestry and Fisheries (federal)	10 000
Improving feral pig management	Queensland Murray–Darling Committee	11 000
Feral pig best practice research	Terrestrial Ecosystem Services	49 000
Distribution and abundance of feral goats	Australian Collaborative Rangelands Information System through Ninti One Ltd	40 000
Monitoring abundance and disease status of Queensland rabbits	Department of Industry and Investment (New South Wales)	8 000
Herbicide control of yellow bells (*Tecoma stans*)	Anglo American Metallurgical Coal Pty Ltd	102 000
Herbicide control options for priority weeds	DuPont	20 000
Total		**945 000**

Land Protection Fund

Project/research area	Funds ($)
Weed seed dynamics	53 000
Herbicide application research	69 000
Biological control of bellyache bush	26 000
Biological control of prickly acacia	142 000
Biological control of mother-of-millions	70 000
Biological control of cat's claw creeper	142 000
Biological control of Madeira vine	194 000
Biological control of lantana	112 000
Rearing and release of weed biological control agents	100 000
Ecology and control of wet tropics weeds	74 000
Environmental weed ecology research	51 000
Water weed ecology and management research	109 000
Feral pig best practice research in northern Queensland	32 000
Feral deer best practice research	96 000
Rabbit best practice research	311 000
Pest management chemistry and chemical registration	145 000
Total	**1 673 000**

Research staff

Ecosciences Precinct

GPO Box 267
Brisbane Qld 4001

Tel: (07) 3255 4518
Fax: (07) 3846 6371

Email: donna.buckley@daff.qld.gov.au
Email format for other staff: firstname.lastname@daff.qld.gov.au

Dr Tony Pople	Acting Principal Scientist
Dr Dane Panetta	Principal Scientist, Professional Leader
Dr Bill Palmer	Principal Entomologist Adjunct Associate Professor, School of Biological Sciences, The University of Queensland
Dr Kunjithapatham Dhileepan	Principal Entomologist
Joseph Vitelli	Principal Weed Scientist
Michael Day	Senior Entomologist
Dr Olusegun Osunkoya	Senior Scientist Adjunct Senior Lecturer, Environmental Futures Centre, Griffith University
Dr Tobias Bickel	Aquatic Weed Scientist
Cathy Lockett	Entomologist
David Holdom	Scientist
Di Taylor	Scientist
Annerose Chamberlain	Experimentalist
Peter Jones	Experimentalist
Christine Perrett	Experimentalist
Natasha Riding	Experimentalist
Wilmot Senaratne	Experimentalist
Liz Snow	Experimentalist
Mariano Treviño	Experimentalist
Jens Froese	Project Officer
Donna Buckley	Administration Officer
Rose Broe	Image Archivist
Patrick Rogers	Senior Operations Supervisor
Mark Mitchell	Groundsperson
Cameron Clark	Experimentalist (casual)

Health and Food Sciences Precinct

PO Box 156
Archerfield Qld 4108

Tel: (07) 3276 6112
Fax: (07) 3216 6565

Email: lesley.ruddle@daff.qld.gov.au
Email format for other staff: firstname.lastname@daff.qld.gov.au

Lesley Ruddle	Senior Scientist
Alyson Herbert	Experimentalist
Emily Strong	Scientific Assistant (casual)

Robert Wicks Pest Animal Research Centre

Toowoomba

PO Box 102
Toowoomba Qld 4350

Tel: (07) 4688 1083
Fax: (07) 4688 1448

Email: jennifer.harvey@daff.qld.gov.au
Email format for other staff: firstname.lastname@daff.qld.gov.au

Dr Matt Gentle	Acting Professional Leader
Dr Lee Allen	Senior Zoologist
Dr David Berman	Senior Zoologist
Dr Matt Gentle	Senior Zoologist
Peter Elsworth	Experimentalist
Michael Brennan	Experimentalist
James Speed	Experimentalist
Mark Goullett	Temporary Experimentalist
Jennifer Harvey	Project Officer

Inglewood

PO Box 178
Inglewood, Qld 4387

Tel: (07) 4652 1599
Fax: (07) 4652 1295

Email: maria.granzotto@daff.qld.gov.au
Email format for other staff: firstname.lastname@daff.qld.gov.au

Glen Rettke	Equipment and Services Officer
Jack Koina	Maintenance Officer/Acting Equipment & Services Officer
Andrew Granzotto	Scientific Assistant
Maria Granzotto	Administration Officer/Cleaner

Tropical Weeds Research Centre

Charters Towers

PO Box 187
Charters Towers Qld 4820

Tel: (07) 4761 5700
Fax: (07) 4761 5757

Email: debra.haynes@daff.qld.gov.au
Email format for other staff: firstname.lastname@daff.qld.gov.au

Dr Shane Campbell	Professional Leader
Dr Jim Mitchell	Senior Zoologist
Dr Wayne Vogler	Senior Weed Scientist
Dr Faiz Bebawi	Senior Weed Scientist
Simon Brooks	Weed Scientist
Dr Chris O'Donnell	Weed Scientist
John McKenzie	Rangeland Weeds Officer
Dannielle Brazier	Experimentalist
Barbara Madigan	Experimentalist (Agronomy)
Kelli Pukallus	Experimentalist
Laura Roden	Experimentalist
Debra Haynes	Centre Administration Officer
Sharon Rossow	Administration Officer
Rodney Stevenson	Operations Supervisor
Carl Andersen	Maintenance Officer
Chris Crowley	Scientific Assistant
Kirsty Gough	Scientific Assistant
Samuel Hughes	Scientific Assistant
Kyle Risdale	Scientific Assistant
Judy Clark	Scientific Assistant

South Johnstone (Centre for Wet Tropics Agriculture)

PO Box 20
South Johnstone Qld 4859

Tel: (07) 4064 1130
Fax: (07) 4064 2249

Email: donna.vanhaaren@daff.qld.gov.au
Email format for other staff: firstname.lastname@daff.qld.gov.au

Melissa Setter	Weed Scientist
Stephen Setter	Experimentalist
Richard Boyne	Experimentalist

Publications and presentations

Journal articles

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Papers

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Vitelli, JS, Oakey, J, Madigan, BA, Driver, L, Chamberlain, AA & Heard, TA 2011, 'Preliminary study in the use of molecular tools to help determine the origins of *Mimosa pigra* infestations in Queensland, Western Australia and the Northern Territory', in J Hodgon (ed.), *Proceedings of the 11th Queensland weed symposium*, The Weed Society of Queensland Inc., Mackay, 31 July – 3 August 2011, Weed management: Back to basic, pp. 65–8.

Presentations

Balu, A, Dhileepan, K, Krishnakumar, N, Murugesan, S, Senthilkumar, P, Senthilkumar, M & Mahalakshimi, R 2011, 'Diversity of lepidopteran insect herbivores and pollinators on *Acacia nilotica* in Tamil Nadu, India', presented to the Indian Forest Conference, New Delhi, India, 22–25 November.

Day, MD, Kawi, AP, Fidelis, J, Tunabuna, A, Orapa, W, Swamy, B, Ratutini, J, Saul-Maora, J & Dewhurst, CF 2011, 'Biology, field release and monitoring of the rust *Puccinia spegazzinii* de Toni (*Pucciniales: Pucciniaceae*), a biocontrol agent of *Mikania micrantha* Kunth (Asteraceae) in Papua New Guinea and Fiji', presented to the International Symposium for Biological Control of Weeds, Kona, Hawaii, 11–16 September.

Gentle, M 2012, 'Feral pig harvesting statistics', presented to the Queensland Pest Animal Symposium, Caloundra, 28 July – 2 August.

Gentle, M & Allen, L 2012, 'Impact and management of peri-urban wild dogs', presented to the Queensland Pest Animal Symposium, Caloundra, 28 July – 2 August.

Posters

Bickel, TO & Clark, C 2011, 'Impacts of floating aquatic weeds', presented at the 23rd Asian Pacific Weed Science Society Conference, Cairns, September 2011.

Boyne RL, Osunkoya OO & Scharaschkin T 2011, 'Leaf anatomy of invasive and non-invasive climbers: does it correspond with ecological performance?', presented at the XVIII International Botanical Congress, Melbourne, July 2011.

O'Donnell, C, Campbell, S & Roden, L 2011, 'Control of *Calotropis procera* (calotrope, rubber bush) in northern Australia', presented at the Northern Australia Beef Research Conference, Darwin, 3–5 August.

Pukallus, K 2011, 'The little fly that could … status of *Ophiomyia camarae*, a biological control agent for *Lantana camara*', presented at the 11th Queensland Weed Symposium, Mackay, 31 July – 2 August.

Setter, SD & Patane, KA 2011, 'Dispersal of pond apple (*Annona glabra*) by rodents, agile wallabies and flying foxes', presented at the 23rd Asian Pacific Weed Science Conference, Cairns, 26–29 September.

Setter, SD, Patane, KA, Logan, P & Sydes, D 2011, 'Pond apple (*Annona glabra*)—investigating selective mechanical control options', presented at the 23rd Asian Pacific Weed Science Conference, Cairns, 26–29 September.

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Setter, SD, Patane, KA, Madigan, BA & Setter, MJ 2011, 'Bogmoss (*Myaca fluviatilis Aubl.*)—investigating control options for this new threat to our waterways', presented at the Far North Queensland Pest Advisory Forum, Cairns, 25 August.

Media

Allen, L 2011, 'Guardian dog webinar', *Crows Nest Advertiser* & *Highfields Herald*, 6 December.

Allen, L 2011, 'Weeds and pests seminars', *Daily News*, 8 November, *Barcoo Independent*, 11 November, *Pittsworth Sentinel*, 9 & 16 November, *Queensland Country Life*, 10 & 17 November, *Stanthorpe Border Post*, 8 & 15 November, *Warwick Daily News*, 15 & 22 November & 6 December, *Rural Weekly*, 11 November, *Clifton Courier*, 23 November, *Murilla Advertiser*, 1 December, *Chinchilla News*, 1 December, *Rural Weekly*, 9 December.

Allen, L 2011, 'Weeds and pests seminars', radio, ABC Southern Queensland (Toowoomba), 06:30 AM News and Zinc 666 (Mt Isa), 9 December.

McKenzie, JR 2011, 'Rubber vine burning: landholders urged to apply for a fire permit to control rubber vine', radio, Zinc FM, 5 December.

McKenzie, JR 2011, 'Time to move on rubber vine', *North Queensland Register*, 12 November.

McKenzie, JR 2012, 'Nip bellyache bush in the bud', *Queensland Country Life*, 5 January.

Vitelli, J 2011, 'Importance given to herbicide resistance', *Fraser Coast Chronicle*, 27 October.

Vitelli, J 2011, 'Prevent weeds from resisting herbicides—free workshops', media release, Department of Agriculture, Fisheries and Forestry, Brisbane, 29 September.

Vitelli, J 2011, 'Prevent weeds from resisting herbicides—free workshops', *MySunshineCoast*, 30 September, ‹http://www.mysunshinecoast.com.au/articles/article-display/prevent-weeds-from-resisting-herbicides-free-workshops,23174›.

Forums and workshops

Allen, L 2011, 'How do guardian dogs work?', presented at the Wild Dog Control Workshops, Nindigully & Boolba, 17–18 August.

Allen, L 2011, 'How do guardian dogs work?', presented at the Pest Plant and Animal Forum, Goombungee, Dalby, Warwick, Clifton, Bell, Millmerran, Pittsworth, Chinchilla & Condamine, 14–18 November.

Bickel, TO 2011, National Aquatic Weed Management Group meeting, Sydney, June.

Bickel, TO 2011, War on Weeds Aquatic Weeds Forum, presented to community groups and stakeholders, Noosa, June.

Brooks, SJ 2011, 'Database analysis and research trials', presented to the Tropical Weed Eradication Management Committee, Cairns, 24 November.

Brooks, SJ 2011, 'Siam weed database analysis', presented to the external review panel of the Siam Weed Eradication Program, South Johnstone, 23 August.

Brooks, SJ 2012, 'Research update', presented to the Tropical Weed Eradication Management Committee, South Johnstone, 4 May.

Campbell, SD 2011, 'Recent Siam weed research', presented to the external review panel of Siam Weed Eradication Program, South Johnstone, 23 August.

Campbell, SD 2011, 'Tropical Weed Research Centre research update', presented at Dalrymple Landcare Meeting, Charters Towers, 3 December.

Campbell, SD 2012, 'Calotrope and other related research', presented at the Asbestos Grass Information Day, Southern Gulf Catchments, Burke and Wills Roadhouse, 27 June.

Campbell, SD 2012, 'Ecology and management of bellyache bush', presented at the National Bellyache Bush Workshop, Townsville, 26–27 March.

Elsworth, PG 2012, Far North Queensland Pest Advisory Forum, Ingham, 24 May.

Holdom, D 2011, 'Herbicide groups with resistant weed populations', presented to weed managers from non-cropping systems: Cairns, Townsville, Mackay, Rockhampton, Brisbane, Maroochy, Main Beach & Gympie, 11–20 October.

Holdom, D 2011, 'Weed seed bank dynamics', presented to weed managers from non-cropping systems: Brisbane, Maroochy, Main Beach & Gympie, 17–20 October.

Holdom, D 2011, 'What to do if you suspect you have resistant weed populations', presented to weed managers from non-cropping systems: Cairns, Townsville, Mackay, Rockhampton, Brisbane, Maroochy, Main Beach & Gympie, 11–20 October.

Madigan, B 2011, 'Weed seed bank dynamics', presented to weed managers from non-cropping systems: Cairns, Townsville, Mackay & Rockhampton, 11–14 October.

McKenzie, JR 2012, 'Parkinsonia management', presented to the Fitzroy River Coastal Catchment, Rockhampton, 28 March.

McKenzie, JR 2012, Grazing Land Management–Weed Module, Charters Towers, 15 June.

McKenzie, JR 2012, Grazing Land Management—Weed Module, Greenvale, 17 August.

McKenzie, JR 2012, 'Work undertaken at TWRC', presented at the Dry Tropics Pest Advisory Forum, Tropical Weeds Research Centre, 18 April.

Mitchell, J 2011, 'Key findings from Churchill Fellowship tour of Europe to learn about European wild boar management', presented at the Dalrymple Landcare Meeting, Charters Towers, 17 February.

Mitchell, J 2012, 'Effect of feral pigs on freshwater ecosystems', presented at the Cape York Peninsula Pest Management Advisory Group meeting, Cairns, 19 April.

Mitchell, J 2012, 'Feral pig research', presented to the NQ Dry Tropics Natural Resource Management Board during visit to the Tropical Weeds Research Centre, Charters Towers, 17 May.

Mitchell, J 2012, 'Feral pig research update', presented at the Gulf Pest Taskforce meeting, Normanton, 6 June.

Mitchell, J 2012, 'Key findings from Churchill Fellowship tour of Europe to learn about European wild boar management', presented at the Robert Wicks Pest Animal Research Centre seminar, Toowoomba, 28 February.

Mitchell, J 2012, 'Key findings from Churchill Fellowship tour of Europe to learn about European wild boar management', presented at the Far North Queensland Pest Advisory Forum, Ingham, 24 May.

O'Donnell, C 2011, 'Overview of calotrope research trials', presented to the Gulf Catchments Pest Taskforce, Burketown, 2 November.

Palmer, WA 2011, 'Recent developments in weed biocontrol in Brisbane', presented to the New South Wales Environmental and Aquatic Weeds Biological Control Taskforce, Grafton Primary Industries Institute, Junction Hill, 30 November.

Palmer, WA 2012, 'Recent developments in weed biocontrol in South-East Queensland', presented at the South East Queensland Pest Advisory Forum, Gympie, 3 July.

Pukallus, K 2011,' Overview of biological control processes', presented to North Queensland Teachers, Tropical Weeds Research Centre, Charters Towers, 1 July.

Setter, SD 2012, 'Wet tropics research update', presented at the Northern Biosecurity Officers meeting, Cairns, 21 February.

Thornby, D 2011, 'Impact of herbicide resistant weed', presented to weed managers from non-cropping systems: Cairns, Townsville, Mackay, Rockhampton, Brisbane, Maroochy, Main Beach & Gympie, 11–20 October.

Thornby, D 2011, 'Managing herbicide resistant populations', presented to weed managers from non-cropping systems: Cairns, Townsville, Mackay, Rockhampton, Brisbane, Maroochy, Main Beach & Gympie, 11–20 October.

Thornby, D 2011, 'What is herbicide resistance?', presented to weed managers from non-cropping systems: Cairns, Townsville, Mackay, Rockhampton, Brisbane, Maroochy, Main Beach & Gympie, 11–20 October.

Vitelli, J 2011, 'Expanding the Aquatic Herbicide List Project', presented to national aquatic weed managers from state, territory and federal departments, Sydney Domestic Airport, September.

Vitelli, J 2011, 'Herbicide resistant project overview', presented to weed managers from non-cropping systems: Cairns, Townsville, Mackay, Rockhampton, Brisbane, Maroochy, Main Beach & Gympie, 11–20 October.

Vitelli, J 2011, 'Interactive herbicide resistance survey questionnaire', presented to weed managers from non-cropping systems: Cairns, Townsville, Mackay, Rockhampton, Brisbane, Maroochy, Main Beach & Gympie, 11–20 October.

Vitelli, J 2012, '*Mimosa pigra* research update', presented to the *Mimosa pigra* stakeholders group, Proserpine, 29 March.

Vivian-Smith, G 2012, 'Chromolaena impacts in Timor Leste and PNG', presented to the Tropical Weeds Management Group, Townsville, 4 May.

Vogler, W 2011, 'Navua sedge herbicide update', presented at the Far North Queensland Pest Advisory Forum, Cairns, August.

Vogler, W 2012, Asbestos Grass Information Day. Southern Gulf Catchments, Burke and Wills Roadhouse, June.

Lectures and seminars

Allen, L 2011, 'How do guardian dogs work?', webinar, Toowoomba, 12 December.

Day, M 2011, 'AusAID weed biocontrol projects', presented to the Kenyan Scientists Delegation, Brisbane, 22 November.

Day, M 2011, 'Biocontrol of lantana', presented to Conservation Volunteers Australia, Brisbane, 6 July.

Day, M 2011, 'Biocontrol of *Mikania micrantha* in Papua New Guinea and Fiji', Wuhan Botanical Gardens, Wuhan, China, 29 August.

Day, M 2011, 'The use of *Puccina spegazzinii* for the biocontrol of *Mikania micrantha* in Papua New Guinea', Guangdong Provincial Key Laboratory of Biocontrol of Forest Pests and Diseases, Guangzhou, China, 31 August.

Day, M 2012, 'Biocontrol of weeds', Department of Livestock and Quarantine Services, Port Vila, Vanuatu, 27 March.

Day, M 2012, 'Biological control of weeds in Papua New Guinea', National Agricultural Research Institute, Lae, Papua New Guinea, 24 January.

Dhileepan, K 2011, 'Biological control of prickly acacia and bellyache bush', presented at the Arid Zone West – Biosecurity Officers meeting, Ecosciences Precinct, 25 October.

Dhileepan, K 2012, 'Biological control of bellyache bush and prickly acacia: research updates', presented at the NBIC meeting, Meat and Livestock Australia, Brisbane, 29 June.

Dhileepan, K 2012, 'Biological control of bellyache bush: native range surveys in South America', presented at the NBIC meeting, Meat and Livestock Australia, Brisbane, 29 June.

Holdom, D 2011, 'Regulation of pesticides', presented to national aquatic weed managers from state, territory and federal departments, Sydney, 23 September.

Mitchell, J 2011, 'Feral pigs', presented to University of Queensland students, Tropical Weeds Research Centre, Charters Towers, 15 July.

Osunkoya, OO 2011, 'Studying population dynamics of *Lantana camara* for better management', presented at Environmental Future, Griffith University Seminar series, Nathan, Brisbane, November.

Palmer, WA 2012, 'Weed biocontrol—where to now?', presented to the Entomological Society of Queensland, Ecosciences Precinct, Brisbane, 14 May.

Pukallus, K 2011, 'Plant and insect biology and identification, preservation and botanical drawing', presented to the School of Distance Education (yrs 5–8), mini-school, Bivouac Junction, Burdekin River, SIS program, 27 October.

Pukallus, K 2011, 'The world of insects: introduction to insects', presented to the School of Distance Education (yrs 5–7), mini-school, Charters Towers, SIS program, 25 October.

Pukallus, K 2012, 'Insects on display', Millchester Primary School Library display, Charters Towers, SIS program, term 1 & 2.

Pukallus, K 2012, 'Weeds and the environment', presented to the Millchester Primary School (yr 1), Charters Towers, SIS program, 26 March.

Vitelli, J 2011, 'A national aquatic weed trial permit', presented to the national aquatic weed managers from state, territory and federal departments, Sydney, 23 September.

Vitelli, J 2011, 'Class 1 weed research', presented to visiting scientists from Kenya under the AusAid Kenya Program, Ecosciences Precinct, Brisbane, 22 November.

Vitelli, J 2011, 'Class 1 weed research and aquatic herbicides', presented to the arid zone west biosecurity officers, Ecosciences Precinct, Brisbane, 25 October.

Vitelli, J 2011, 'Current and potential aquatic herbicides', presented to the national aquatic weed managers from state, territory and federal departments, Sydney, 23 September.

Vitelli, J 2011, 'Issues of aquatic weed management in Queensland', presented to the national aquatic weed managers from state, territory and federal departments, Sydney, 23 September.

Vitelli, J 2011, 'Stakeholders network group', presented to national aquatic weed managers from state, territory and federal departments, Sydney, 23 September.

Vitelli, J 2012, 'Registration of products for aquatic weed management', presented to Nufarm representatives, Ecosciences Precinct, Brisbane, 28 February.

Vogler ,W 2011, 'Weed ecology and control', presented to University of Queensland students, Tropical Weeds Research Centre, Charters Towers, 15 July.

Field days

Allen, L 2011, How do guardian dogs work?, Westec, Barcaldine, 14 September.

Brooks, SJ 2011, Wet tropics field trip, Asian-Pacific Weed Science Society Conference delegates, Innisfail, 28 September.

Gentle, M 2012, Feral pig research and control—predator control field days, Agforce & Australian Wool Innovation, Millmerran & the Gums, 18–19 January.

Palmer, WA 2012, Biological control—where to now?, Mary River Catchment Landcare Group, Magnolia Farm, Tinana, 26 May.

Setter, SD 2011, Wet tropics field trip, Asian-Pacific Weed Science Society Conference delegates, Innisfail, 28 September.

Vogler, W 2011, 23rd Asia Pacific Weed Science Society Conference field tour, Asian-Pacific Weed Science Society, Cairns, September.